PUB. 200

SAILING DIRECTIONS (PLANNING GUIDE & ENROUTE)

★

ANTARCTICA

★

Prepared and published by the
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FIFTH EDITION

Pub. 200, Sailing Directions (Planning Guide and Enroute) Antarctica, Fifth Edition, 2005, is issued as Part I and Part II, with both Planning Guide and Enroute information combined in one volume.

This publication has been corrected to 9 July 2005, including Notice to Mariners No. 28 of 2005.

Explanatory Remarks

Sailing Directions are published by the National Geospatial-Intelligence Agency (NGA) under the authority of Department of Defense Directive 5105.40, dated 12 December 1988, and pursuant to the authority contained in U. S. Code Title 10, Sections 2791 and 2792 and Title 44, Section 1336. Sailing Directions, covering the harbors, coasts, and waters of the world, provide information that cannot be shown graphically on nautical charts and is not readily available elsewhere.

Part I.—Generally, Sailing Directions (Planning Guides) are compiled in separate volumes. They are intended to assist duplication by consolidating useful information about all countries adjacent to a particular ocean basin within one volume. This information is provided in Part I for the region extending between 60˚S and the coast of Antarctica. The region is governed by the Antarctic Treaty and U.S. Public Law 95-541 (Antarctic Conservation Act of 1978). Mariners are advised to consult these rules and regulations before proceeding into the area.

Part II.—The chartlet on Page VII illustrates the limits of Sailing Directions (Enroute) for the Antarctic area. Sailing Directions (Enroutes) include detailed coastal and port approach information which supplements the latest revised print of the largest scale chart for sale by the National Geospatial-Intelligence Agency. This information in provided within Part II which is divided into geographic areas called "Sectors."

Bearings.—Bearings are true, and are expressed in degrees from 000˚ (north) to 360˚, measured clockwise. General bearings are expressed by the initial letters of the points of the compass (e.g. N, NNE, NE, etc.). Adjective and adverb endings have been discarded. Wherever precise bearings are intended, degrees are used.

Corrective Information.—Corrective information and other comments about this publication can be forwarded to NGA, as follows:

1. Mailing address—
   Maritime Division
   ST D 44
   National Geospatial-Intelligence Agency
   4600 Sangamore Road
   Bethesda MD 20816-5003
2. E-mail address—
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New editions of Sailing Directions are corrected through the date of publication shown above. Important information to amend material in the publication is available as a Publication Digital Update (PDU) from the NGA Maritime Division website.

NGA Maritime Division Website (PDUs)
http://164.214.12.145/sdr

Courses.—Courses are true, and are expressed in the same manner as bearings. The directives "steer" and "make good" a course mean, without exception, to proceed from a point of origin along a track having the identical meridional angle as the designated course. Vessels following the directives must allow for every influence tending to cause deviation from such track, and navigate so that the designated course is continuously being made good.

Currents.—Current directions are the true directions toward which currents set.

Distances.—Distances are expressed in nautical miles of 1 minute of latitude. Distances of less than 1 mile are expressed in meters, or tenths of miles.

Geographic Names.—Geographic names are generally those used by the nation having sovereignty. Names in parentheses following another name are alternate names that may appear on some charts. In general, alternate names are quoted only in the principal description of the place. Diacritical marks, such as accents, cedillas, and circumflexes, which are related to specific letters in certain foreign languages, are not used in the interest of typographical simplicity.

Geographic names or their spellings do not necessarily reflect recognition of the political status of an area by the United States Government.

Heights.—Heights are referred to the plane of reference used for that purpose on the charts and are expressed in meters.

Internet Links.—This publication provides Internet links to web sites concerned with maritime navigational safety, including but not limited to, Federal government sites, foreign Hydrographic Offices, and foreign public/private port facilities. NGA makes no claims, promises, or guarantees concerning the accuracy, completeness, or adequacy of the contents of these web sites and expressly disclaims any liability for errors and omissions in the contents of these web sites.

Lights and Fog Signals.—Lights and fog signals are not described, and light sectors are not usually defined. The Light Lists should be consulted for complete information.

Radio Navigational Aids.—Radio navigational aids and radio weather services are not described in detail. Publication No. 117 Radio Navigational Aids and NOAA Publication, Selected Worldwide Marine Weather Broadcasts, should be consulted.

Sales.—For sale by the Superintendent of Documents, U.S. Government Printing Office, Mail Stop: SSOP, Washington, DC 20402-0001. Phone: toll free (866) 512-1800, DC area (202) 512-1800.

GPO Bookstore Website
http://bookstore.gpo.gov

Scientific Research Stations.—There are no ports or harbors in the Antarctic region with extensive berthing facilities. In addition, positive identification of channels, landmarks, or visual navigational aids is difficult. A few year-round and seasonal base stations exist where scientific research is conducted by a nation or by the combined efforts of several nations. Depending on the weather conditions, these stations may or may not be approachable by support vessels without the assistance of icebeakers during austral summers. Vessels visiting these stations must receive advance approval.

Soundings.—Soundings are referred to the datum of the charts and are expressed in meters.

Special Warnings.—Special Warnings may be in force for the geographic area covered by this publication. Special Warnings are printed in the weekly Notice to Mariners upon promulgation and are reprinted annually in Notice to Mariners No. 1. A listing of Special Warnings currently in force is printed in each weekly Notice to Mariners, Section III, Broadcast Warnings, along with the notice number of promulgation. Special Warnings are also available on the Maritime Division website.

NGA Maritime Division Website (Special Warnings)
http://164.214.12.145warn/warn_j_query.html

Time Zone.—The Time Zone description(s), as well as information concerning the use of Daylight Savings Time, are included. The World Time Zone Chart is available on the Internet at the website given below.

World Time Zone Chart
http://www.odci.gov/cia/publications/factbook/reference_maps/pdf/time_zones.pdf

Winds.—Wind directions are the true directions from which winds blow.

Reference List

The principal sources examined in the preparation of this publication were:

British Hydrographic Department Sailing Directions.

Argentine Naval Hydrographic Sailing Directions.

U.S. National Science Foundation journals, reports, and documents.

Reports from United States Naval and merchant vessels and various shipping companies.

Other U.S. Government publications, reports, and documents.

Charts, light lists, tide and current tables, and other documents in possession of the Agency.

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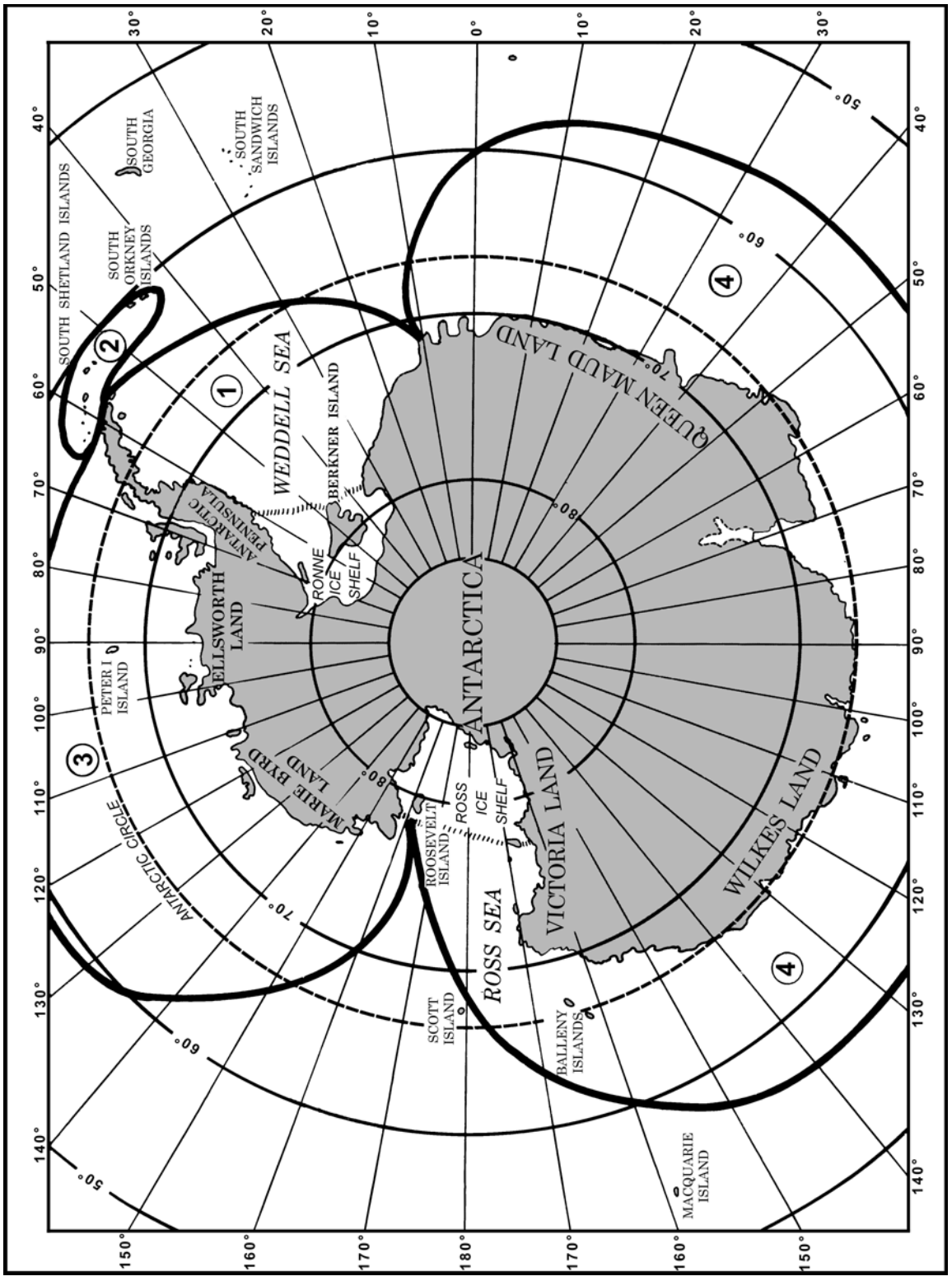
ANTARCTIC CIRCLE
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150°

Feet to Meters

Feet	0	1	2	3	4	5	6	7	8	9
0	0.00	0.30	0.61	0.91	1.22	1.52	1.83	2.13	2.44	2.74
10	3.05	3.35	3.66	3.96	4.27	4.57	4.88	5.18	5.49	5.79
20	6.10	6.40	6.71	7.01	7.32	7.62	7.92	8.23	8.53	8.84
30	9.14	9.45	9.75	10.06	10.36	10.67	10.97	11.28	11.58	11.89
40	12.19	12.50	12.80	13.11	13.41	13.72	14.02	14.33	14.63	14.93
50	15.24	15.54	15.85	16.15	16.46	16.76	17.07	17.37	17.68	17.98
60	18.29	18.59	18.90	19.20	19.51	19.81	20.12	20.42	20.73	21.03
70	21.34	21.64	21.95	22.25	22.55	22.86	23.16	23.47	23.77	24.08
80	24.38	24.69	24.99	25.30	25.60	25.91	26.21	26.52	26.82	27.13
90	27.43	27.74	28.04	28.35	28.65	28.96	29.26	29.57	29.87	30.17

Fathoms to Meters

Fathoms	0	1	2	3	4	5	6	7	8	9
0	0.00	1.83	3.66	5.49	7.32	9.14	10.97	12.80	14.63	16.46
10	18.29	20.12	21.95	23.77	25.60	27.43	29.26	31.09	32.92	34.75
20	36.58	38.40	40.23	42.06	43.89	45.72	47.55	49.38	51.21	53.03
30	54.86	56.69	58.52	60.35	62.18	64.01	65.84	67.67	69.49	71.32
40	73.15	74.98	76.81	78.64	80.47	82.30	84.12	85.95	87.78	89.61
50	91.44	93.27	95.10	96.93	98.75	100.58	102.41	104.24	106.07	107.90
60	109.73	111.56	113.39	115.21	117.04	118.87	120.70	122.53	124.36	126.19
70	128.02	129.85	131.67	133.50	135.33	137.16	138.99	140.82	142.65	144.47
80	146.30	148.13	149.96	151.79	153.62	155.45	157.28	159.11	160.93	162.76
90	164.59	166.42	168.25	170.08	171.91	173.74	175.56	177.39	179.22	181.05

Meters to Feet

Meters	0	1	2	3	4	5	6	7	8	9
0	0.00	3.28	6.56	9.84	13.12	16.40	19.68	22.97	26.25	29.53
10	32.81	36.09	39.37	42.65	45.93	49.21	52.49	55.77	59.06	62.34
20	65.62	68.90	72.18	75.46	78.74	82.02	85.30	88.58	91.86	95.14
30	98.42	101.71	104.99	108.27	111.55	114.83	118.11	121.39	124.67	127.95
40	131.23	134.51	137.80	141.08	144.36	147.64	150.92	154.20	157.48	160.76
50	164.04	167.32	170.60	173.88	177.16	180.45	183.73	187.01	190.29	193.57
60	196.85	200.13	203.41	206.69	209.97	213.25	216.54	219.82	223.10	226.38
70	229.66	232.94	236.22	239.50	242.78	246.06	249.34	252.62	255.90	259.19
80	262.47	265.75	269.03	272.31	275.59	278.87	282.15	285.43	288.71	291.99
90	295.28	298.56	301.84	305.12	308.40	311.68	314.96	318.24	321.52	324.80

Meters to Fathoms

Meters	0	1	2	3	4	5	6	7	8	9
0	0.00	0.55	1.09	1.64	2.19	2.73	3.28	3.83	4.37	4.92
10	5.47	6.01	6.56	7.11	7.66	8.20	8.75	9.30	9.84	10.39
20	10.94	11.48	12.03	12.58	13.12	13.67	14.22	14.76	15.31	15.86
30	16.40	16.95	17.50	18.04	18.59	19.14	19.68	20.23	20.78	21.33
40	21.87	22.42	22.97	23.51	24.06	24.61	25.15	25.70	26.25	26.79
50	27.34	27.89	28.43	28.98	29.53	30.07	30.62	31.17	31.71	32.26
60	32.81	33.36	33.90	34.45	35.00	35.54	36.09	36.64	37.18	37.73
70	38.28	38.82	39.37	39.92	40.46	41.01	41.56	42.10	42.65	43.20
80	43.74	44.29	44.84	45.38	45.93	46.48	47.03	47.57	48.12	48.67
90	49.21	49.76	50.31	50.85	51.40	51.95	52.49	53.04	53.59	54.13

The following abbreviations may be used in the text:

Units

˚C	degree(s) Centigrade	km	kilometer(s)
cm	centimeter(s)	m	meter(s)
cu.m.	cubic meter(s)	mb	millibars
dwt	deadweight tons	MHz	megahertz
FEU	forty-foot equivalent units	mm	millimeter(s)
grt	gross registered tons	nrt	net registered tons
kHz	kilohertz	TEU	twenty-foot equivalent units

Directions

N	north	S	south
NNE	northnortheast	SSW	southsouthwest
NE	northeast	SW	southwest
ENE	eastnortheast	WSW	westsouthwest
E	east	W	west
ESE	eastsoutheast	WNW	westnorthwest
SE	southeast	NW	northwest
SSE	southsoutheast	NNW	northnorthwest

Vessel types

LASH	Lighter Aboard Ship	ro-ro	Roll-on Roll-off
LNG	Liquified Natural Gas	ULCC	Ultra Large Crude Carrier
LPG	Liquified Petroleum Gas	VLCC	Very Large Crude Carrier
OBO	Ore/Bulk/Oil		

Time

ETA	estimated time of arrival	GMT	Greenwich Mean Time
ETD	estimated time of departure	UTC	Coordinated Universal Time

Water level

MSL	mean sea level	LWS	low water springs
HW	high water	MHWN	mean high water neaps
LW	low water	MHWS	mean high water springs
MHW	mean high water	MLWN	mean low water neaps
MLW	mean low water	MLWS	mean low water springs
HWN	high water neaps	HAT	highest astronomical tide
HWS	high water springs	LAT	lowest astronomical tide
LWN	low water neaps		

Communications

D/F	direction finder	MF	medium frequency
R/T	radiotelephone	HF	high frequency
GMDSS	Global Maritime Distress and Safety System	VHF	very high frequency
LF	low frequency	UHF	ultra high frequency

Navigation

LANBY	Large Automatic Navigation Buoy	SPM	Single Point Mooring
NAVSAT	Navigation Satellite	TSS	Traffic Separation Scheme
ODAS	Ocean Data Acquisition System	VTC	Vessel Traffic Center
SBM	Single Buoy Mooring	VTS	Vessel Traffic Service

Miscellaneous

COLREGS	Collision Regulations		
IALA	International Association of Lighthouse Authorities	No./Nos.	Number/Numbers
		PA	Position approximate
IHO	International Hydrographic Office	PD	Position doubtful
IMO	International Maritime Organization	Pub.	Publication
loa	length overall	St./Ste.	Saint/Sainte

Warning on the Use of Floating Aids to Navigation in General to Fix a Navigation Position

The aids to navigation depicted on charts comprise a system consisting of fixed and floating aids with varying degrees of reliability. Therefore, prudent mariners will not rely solely on any single aid to navigation, particularly a floating aid. An aid to navigation also refers to any device or structure external to a craft, designed to assist in determination of position. This includes celestial, terrestial, and electronic means, such as the Global Positioning System (GPS) and Differential GPS (DGPS). Here, too, the prudent mariner will not rely solely on any single aid to navigation.

The buoy symbol is used to indicate the approximate position of the buoy body and the sinker, which secures the buoy to the seabed. The approximate position is used because of practical limitations in positioning and maintaining buoys and their sinkers in precise geographical locations. These limitations include, but are not limited to, inherent imprecisions in position fixing methods, prevailing atmospheric and sea conditions, the slope of and the material making up the seabed, the fact that buoys are moored to sinkers by varying lengths of chain, and the fact that buoy and/or sinker positions are not under continuous surveillance but are normally checked only during periodic maintenance visits which often occur more than a year apart. The position of the buoy body can be expected to shift inside and outside the charting symbol due to the forces of nature. The mariner is also cautioned that buoys are liable to be carried away, shifted, capsized, sunk, etc. Lighted buoys may be extinguished or sound signals may not function as the result of ice or other natural causes, collisions, or other accidents. Many of these factors also apply to articulated lights. For the foregoing reasons, a prudent mariner must not rely completely upon the position or operation of floating aids to navigation, but will also utilize bearings from fixed objects and aids to navigation on shore. Further, a vessel attempting to pass close aboard always risks collision with a yawing buoy or with the obstruction the buoy marks.

Use of Foreign Charts

In the interest of safe navigation, caution should be exercised in the use of foreign charts not maintained through U.S. Notice to Mariners.

Foreign produced charts are occasionally mentioned in NIMA Sailing Directions when such charts may be of a better scale than U.S. produced charts. Mariners are advised that if or when such foreign charts are used for navigation it is their responsibility to maintain those charts from the Notice to Mariners of the foreign country producing the charts.

The mariner is warned that the buoyage systems, shapes, colors, and light rhythms used by other countries often have a different significance than the U.S. system.

Mariners are further warned about plotting positions, especially satellite-derived positions such as from GPS, onto foreign charts where the datum is unknown or the conversion from WGS-84 is unknown.

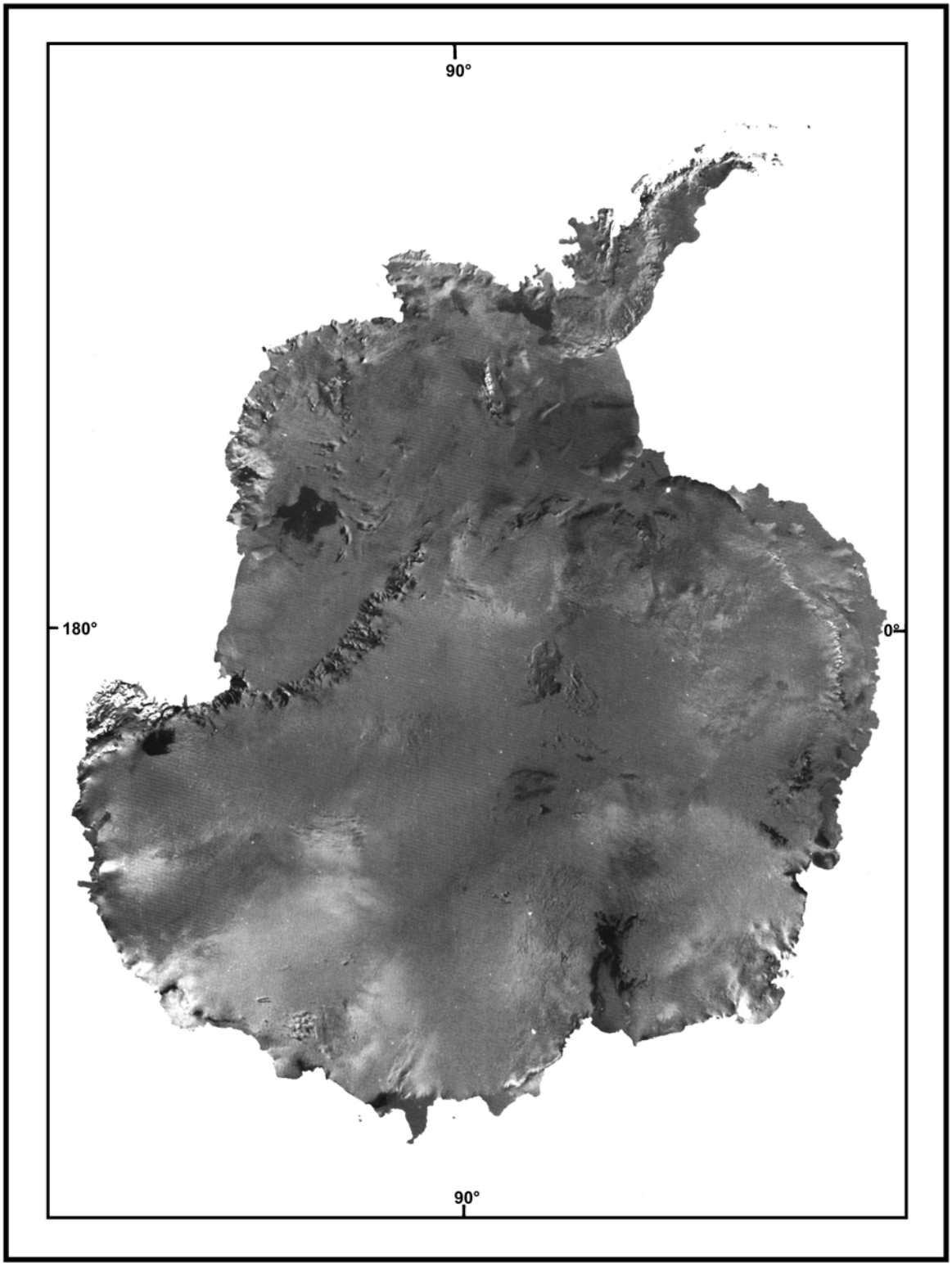
Chart Notes Regarding Different Datums

Particular caution should be exercised during a passage when transferring the navigational plot to an adjacent chart upon a different geodetic datum or when transferring positions from one chart to another chart of the same area, which is based upon a different datum. The transfer of positions should be done by bearings and distances from common features. Notes on charts should be read with care, as they give important information not graphically presented. Notes in connection with the chart title include the horizontal geodetic datum which serves as a reference for the values of the latitude and longitude of any point or object on the chart. The latitudes and longitudes of the same points or objects on a second chart of the same area, which is based upon a different datum, will differ from those of the first chart. The difference may be navigationally significant. Additionally, datum changes between chart editions could significantly affect the positions of navigational aids found in the List of Lights and other NIMA publications.

Positions obtained from satellite navigation systems, such as from GPS, are normally referred to the World Geodetic System 1984 (WGS-84) Datum. The differences between GPS satellite-derived positions and positions on some foreign charts cannot be determined: mariners are warned that these differences MAY BE SIGNIFICANT TO NAVIGATION and are therefore advised to use alternative sources of positional information, particularly when closing the shore or navigating in the vicinity of dangers.

PART I

SATELLITE IMAGE MAP OF ANTARCTICA



Prepared by the United States Geological Survey in cooperation with the National Oceanic and Atmospheric Administration and the National Remote Sensing Center, England with support from the National Science Foundation.

THE ANTARCTIC

General

The Antarctic is defined by the Antarctic Treaty as the area lying S of 60˚S. Antarctica is defined as the Antarctic continent and the off-lying islands within its general proximity. The area covered by this publication extends N from the shores of Antarctica to 60˚S, or approximately to the limits of the drift ice.

Pub. 200, Sailing Directions (Planning Guide and Enroute) Antarctica, unlike the series of publications which cover the world in separate Enroute and Planning Guide formats, is a combination of both volumes and contains in one publication information normally found in both of the above. This combination of volumes was initiated due to the rather unique aspect of the Antarctic continent.

Part I, Sailing Directions (Planning Guide) Antarctica includes information concerning physical geography, meteorology, exploration, treaties and legal agreements, regulations, history, and navigation.

Part II, Sailing Directions (Enroute) Antarctica is comprised of four sectors and includes basic coastal and navigational information.

Polar Regions.—Various criteria have been used to define the polar regions and many have been based upon meteorological considerations, mean temperatures, the length of the frost-free growing season, the amount of ice, or the tree line.

Astronomically, the limits of the Arctic Circle and the Antarctic Circle may be considered to lie at approximately 66˚30'N and S, respectively, or at the point where the sun becomes circumpolar (90˚ minus the maximum declination of the sun).

Below the S polar region, the transitional subpolar region is often defined as the winter limits of the drift ice (about 60˚S). However, this subpolar region is sometimes considered as extending another 10˚ of latitude and well into the stormy seas surrounding Antarctica.

Geographic Names.—The lack of international agreement on the use of geographic names is a world problem. However, the problem of geographic names in Antarctica differs from that of any other land mass of comparable size because this area has unresolved questions of sovereignty.

As a result of the Antarctic Treaty, there is now a degree of agreement to handle this problem. Although some duplication and substitution of names occurs, most participating countries have now established nomenclature committees responsible for names in this region.

All proposed new names, together with the supporting arguments for their recognition, are considered by national committees. Subsequently, these names are brought forth for international agreement and are ultimately proclaimed by the initiating country. Some geographic features have not achieved international agreement on nomenclature, and different names may be found on charts produced by different countries.

In the United States, a gazetteer, Geographic Names of the Antarctic-1995, has been published with approval by the United States Board on Geographic Names and the Secretary of the Interior. This gazetteer contains names for features in Antarctica and the area extending N to the Antarctic Convergence.

For the names of submarine features, reference should be made to Undersea Features-1990, which is also published by the U.S. Board on Geographic Names. These names have been approved for use by U.S. Government agencies.

Climatology

The following information concerning weather along the shipping routes was prepared by the National Environmental Satellite Data and Information Service, National Oceanic and Atmospheric Administration (NOAA).

Antarctic Climate.—The Antarctic is one of the coldest regions in the world with a recorded minimum temperature of -86.9˚C. The continental influence of Antarctica is enhanced by its size and altitude. Along with minimum sunlight and maximum radiational cooling, the continental influence produces extremely cold winters. These severe conditions are tempered on the coast and at sea by a vast expanse of relatively warm ocean surrounding the continent.

Most of the ice-free ocean area is located in a belt of strong, persistent W winds. The boundaries between the polar continental and polar maritime air masses (Antarctic front) and between the polar maritime and tropical maritime air masses (polar front) represent areas of frequent and intense storm activity throughout the year. Most of these storms form to the N of 70˚S and circle the continent from W to E. Lows forming along the polar front tend to move SE toward the continent. Some penetrate the interior, while others end up in the Ross Sea and the Weddell Sea, where they dissipate. Some tend to stagnate in the Bellingshausen Sea where the resultant NE winds provide a milder climate than on the E side of the Antarctic Peninsula.

The storms of this region resemble those of the N hemisphere except that the winds blow clockwise toward the center. The contrast in air mass temperatures and the uncomplicated land and sea distribution makes fronts and weather changes more distinct than in the N latitudes. This is especially true of cold fronts. In addition, the storm movement is more constant, more rapid, and less erratic than in the N. The average speed of these systems ranges from about 20 knots in summer to more than 30 knots in winter. The regularity of movement enables vessels proceeding E to remain in an area of good or bad weather if its speed matches the speed of these troughs and ridges (good weather). Vessels proceeding W usually encounter a series of disturbances. These storms have a tendency to occur every 3 to 5 days. The first indications of their approach is often a cirrus or altocumulus cloud deck observed some 100 to 200 miles away on the W horizon. Several hours later, the barometer begins to fall and mist gradually fills the air reducing visibility to a few miles. About 8 hours after the first cirrus, a stratus deck forms, becoming overcast within a few hours. The passage of the low is indicated by rising pressure and winds from a W quadrant.

In addition to the intense low pressure systems and their associated fronts, frequent cold frontal troughs occur which extend for hundreds of miles to the N and NW. The sudden and often violent changes occurring during the E passage of these troughs can create problems for vessels.

Summer (October-March).—Since nearly 85 per cent of the sea ice melts during the summer, navigation is much less restricted, particularly from December through March. However, the weather remains hazardous. During September and October when the ice cover reaches its N position and the temperature difference between the air masses is the greatest, storms are most frequent and intense. To the S of 60˚S, two to six storms per month are common. By the middle of summer this frequency is usually cut in half. The effects of these storms are greatest along the N portions of the routes.

Through the Drake Passage, where extratropical storm activity is frequent in early summer, gales are encountered up to 20 per cent of the time. The frequency slackens to 15 per cent and less by the middle of summer as storm activity decreases. The worst conditions are found on the W side of the passage where SW through NW winds blow at an average of about 20 knots throughout the season. These winds are responsible for wave heights of 3m or more, which are reported 20 to 35 per cent of the time even in the middle of summer. They are reported more than 50 per cent of the time during the rough October period. Under mostly cloudy skies visibility remains good except in precipitation, which occurs about 30 to 40 per cent of the time. Snow and frontal fogs can decrease visibility to less than 0.5 mile, but this is uncommon. Snow is most likely early in the season and to the S. Temperatures hover around freezing in these waters while near Cape Horn they range from about 4.4˚ to 8.9˚C; the warmest readings occur in January and February.

The routes that approach Antarctica from the Atlantic Ocean usually encounter the roughest conditions. Winds from SW through NW are responsible for the gales that blow 10 to 20 per cent of the time even in the middle of summer. Gale frequencies, in general, decrease with increasing latitude. Gales are most likely to occur to the N of 55˚S from around South Georgia Island and E into the W part of the Indian Ocean area. Near 60˚S, NE gales become common by the middle of summer.

Fog is most likely during the middle of summer when visibility decreases to less than 5 miles about 40 to 60 per cent of the time and less than 0.5 mile about 10 to 20 per cent of the time.

Precipitation as well as fog restricts visibility. Precipitation is most likely along the N portions of the routes where it is encountered about 30 to 40 per cent of the time. It falls as snow on about one-half of the precipitation observations. Snow is most likely to occur to the S of 60˚S where temperatures average about -2.2˚ to 0˚C.

Routes from the Indian Ocean usually face less hostile conditions than those in the Atlantic region. To the S of the Cape of Good Hope, gales blow 20 to 30 per cent of the time, as storm activity remains frequent, but to the E of 60˚E in the middle of summer, the frequency drops to 5 per cent or less. Winds from SW through NW are common everywhere near 60˚S. To the S, winds from E are frequent, but strong winds are not. Fog and precipitation decrease the visibility in summer to less than 5 miles about 40 per cent of the time. Along the 60th parallel, isolated areas exist where the visibility falls to below 0.5 mile up to 20 per cent of the time. Precipitation is encountered about 30 to 40 per cent of the time. Snow accounts for 15 to 20 per cent of the precipitation observations. This is reflected in the temperatures which drop below freezing at about 60˚S.

Winds from SW through NW also prevail when entering the adjacent waters from the Pacific where extratropical activity is at a minimum in summer. Gales are encountered about 5 to 10 per cent of the time. To the S of 60˚S, winds are lighter and more variable. The visibility decreases to less than 5 miles about 20 to 40 per cent of the time. Temperatures close N of the region, which range from 7.8˚ to 11.1˚C on the average, decrease to an average of 1.7˚C to the S of 60˚S. This is reflected in the snowfall frequency which accounts for about one-half of all observations at these higher latitudes. Precipitation is generally encountered about 30 to 40 per cent of the time.

Along circumpolar routes near 60˚S there is some climatic variation in conditions. While W winds predominate, these routes are close to the transition area and velocities are generally slower than those farther N. Winds from E are also present on occasion. Gales are encountered only about 5 per cent of the time. The frequency of the visibility being less than 5 miles ranges from 20 per cent on the Pacific Ocean side to 40 per cent elsewhere. The visibility decreases to less than 0.5 mile about 5 to 10 per cent of the time with some isolated 20 per cent occurrences existing to the N of Queen Maud Land during the middle of summer. Temperatures range from 5˚ to 7˚C on the Pacific side and from -2˚ to 0.5˚C on the Atlantic side. This accounts for the variation in snow frequency which ranges from one-half of all precipitation to the S of the Atlantic as compared to less than 10 per cent to the S of the Pacific. In general, precipitation occurs 30 to 40 per cent of the time along these routes.

Winter (April-September).—Most winter navigation is restricted to the seas around and N of 60˚S because of ice. Along the routes that circle the continent at about 55˚S, winds blow mainly out of the SW through NW. They are strongest early and late in the season when gales are encountered 20 to 30 per cent of the time in the Drake Passage and in the waters to the S of the Atlantic. Elsewhere along these routes, gales can be expected 10 to 20 per cent of the time. During the middle of winter, gales are less frequent, but may still be expected about 20 per cent of the time in the Drake Passage.

The visibility is usually good, except during precipitation. It is best along the portions of the routes to the S of the Pacific Ocean and the Indian Ocean and worst to the S of the Atlantic Ocean and Drake Passage, off the Cape of Good Hope. In general, the visibility decreases to less than 5 miles about 20 to 40 per cent of the time. Sometimes fog or snow may reduce the visibility to less than 0.5 mile. This is most likely to the S of the Atlantic Ocean where the frequency is about 10 per cent.

On the average, temperatures are coldest and least variable in the middle of winter when they are near freezing everywhere along these routes except in the Pacific area where the average is a few degrees warmer. Early and late in the season, temperatures remain around freezing, or even a little below, to the S of the Atlantic. However, they are more likely to be a few degrees warmer elsewhere. This temperature spread is indicative of the snowfall distribution as well. In general, precipitation occurs about 40 to 50 per cent of the time along these routes with little seasonal variation. However, in the Drake Passage, the precipitation occurs as snow about one-quarter of the time. To the S of the Atlantic during the middle of winter and late season, snow occurs on about 30 per cent of all precipitation observations. To the S of the Indian Ocean and the Pacific Ocean, this frequency decreases to about 10 per cent.

The Antarctic Peninsula.—The rugged peninsula and the nearby islands project out into the adjacent waters, interrupting the general E flow around the continent and extending into the W winds of the lower latitudes. The climate benefits from the relatively warm waters that flow into the area for a good portion of the year. Its maritime nature is most apparent in summer when diurnal temperature variations are small, rain is prevalent, and winds are weakest. Weather producers include extratropical storms, from the oceans to the N, and cold continental outbreaks, from the S. Both are modified somewhat by local topography.

Storms, high pressure systems, and local topography produce variable, and often strong, winds throughout the region. Wind speeds are usually highest from June through October when averages range from 10 to 20 knots, depending upon exposure. Gales are most likely during this period. From November through May, wind speed averages range from 5 to 15 knots while gales blow on about 1 to 8 days per month. January and February are usually the quietest months.

Coastal and island locations are subject to foehn winds, which develop on the lee side of the mountains. Their descent causes a sharp increase in wind speed along with a drop in humidity and a rise in temperature. For example, the wind increased from calm to WSW at 44 knots at Hope Bay during an

observation in July. The humidity dropped from 86 to 20 per cent and the temperature increased from -10˚ to 6.1˚C.

In the Bellingshausen Sea, dissipating storms generate a preponderance of NE winds over its E shores. However, a strongly curved arc of mountains protects this area from the gales that blow along the flank of the Graham Land range. Hence, the leeward side of the Antarctic Peninsula has a noticeably high percentage of calms and light winds. For example, calms are reported at Port Lockroy on about 20 per cent of the observations from February through August.

Along the Argentine Islands, winds are variable and gales are infrequent. In Marguerite Bay during the summer, winds from NW through N have been observed to blow for weeks at a time. These winds produce a densely packed area of drift ice off the W coast of Adelaide Island, which clogs the S part of the bay. At times, winds from the N and NE reach gale force in this bay.

In Crystal Sound, the predominant winds blow from the SW, but the effects of the central plateau and coastal topography cause strong E gales close to the coast in some areas. Lows often bring N gales, which cause a rise in temperature and heavy snow. Darbel Bay is affected by winds blowing down the glaciers, particularly in the SE corner. Lallemand Fjord forms a natural funnel to strong winds blowing off the plateau, which turn to the N when moving up the fjord. The S part of Hanusse Bay is influenced by winds funneling through The Gullet.

Among the South Shetland Islands and the South Orkney Islands, winds are variable and often strong. Winds from E and W are both frequent as lows pass to the N and S of these islands. The stations at Admiralty Bay and Deception Island are sheltered from the worst effects of the high winds. At Deception Island, gales blow on an average of 35 days annually as compared to 60 days at Scotia Bay on Laurie Island. In the South Orkney Islands, winds are frequently from the NW and W. Winds from the SE and SW are also common. The stations on the South Shetland Islands have reported a slight preponderance of NE winds, but only SE and S winds are infrequent. Throughout the islands, winds are usually strongest from about July through October with average speeds ranging from 12 to 18 knots.

The visibility is often exceptional in this region, which is free of pollution and dust particles. Fog is reported less than 5 per cent of the time while the visibility is more likely to be reduced by rain, mist, drizzle, snow, blowing snow, and sea spray. On rare occasions, radiation fog forms in protected areas. This is usually composed of supercooled water droplets, but observations of ice fog have been reported at Marguerite Bay with temperatures below -31.7˚C. Occasionally steam fog or sea smoke, usually 15 to 30m thick, will form when very cold air off the continent blows out over warmer water.

Snowstorms and blowing snow can obscure the coast and adjacent waters. A 20-knot wind blowing over a recent dry snowfall can raise snow a few meters while a 40-knot gale can raise it as high as 15m and reduce the visibility to less than 100m.

In the South Shetland Islands, blowing snow is the major restriction to visibility. At Deception Island, poor visibility is reported on an average of 84 days annually as compared to Scotia Bay, in the South Orkney Islands, where 41 days are reported. The visibility is worst in winter throughout these islands.

The annual average number of days with fog or reduced visibility ranges from less than 20 in the Argentine Islands to more than 100 at Hope Bay. Winter is the worst period when 5 to 10 fog days per month occur on the average. December, January, and February are generally the months with the best visibility.

Most precipitation in this region falls as snow or other frozen forms. Rain frequency generally increases with decreasing latitude. Frequent precipitation does not necessarily coincide with large amounts, as much of it falls as light, dry, powdery snow. Blowing and drifting snow make measurements difficult while the topography and ice shelves complicate precipitation patterns. Another form of precipitation observed on the Antarctic Peninsula is rime or hoarfrost from supercooled fogs. Rime deposits on the windward sides of obstructions may build up to a thicknesses of a few meters.

Precipitation is usually generated by the frequent extratropical storms and their associated fronts. Many of these systems, moving E from W of Cape Horn, are channeled through the Drake Passage and deflected S across the Antarctic Peninsula and into the Weddell Sea.

Precipitation is frequent throughout the year along the Antarctic Peninsula and over the islands. In the Bellingshausen Sea, it is observed on about 15 to 25 days per month on the average. September through October and March through April seem to be the peak periods along the coasts. Snow is usually most frequent, but rain reaches a peak during the latter period. From December through April, rain occurs on up to 12 days per month over the off-lying islands. At Signy Island during March, rain falls on an average of 12 days while snow occurs on 16.

Gray overcast conditions blanket the area for days at a time. Dense masses of frontal clouds can cover large areas of the open sea, restricting daylight and reducing visibility. Near Deception Island, cloudy conditions prevail on an average of 240 days annually while clear days are only observed about 4 times per year at some island locations. Near the coast, the onset of offshore winds sometimes improves conditions. The least cloudy conditions generally occur from May through September. In coastal waters on both sides of the peninsula, clear skies are estimated to occur about 10 per cent of the time. Summer is usually the cloudiest period in many locations, but local variations occur. For example, on Stonington Island, in Marguerite Bay, the least cloudy months of December and January coincide with the period of least frequent precipitation. In the South Orkney Islands, the cloudiest period is from October through April.

While an extreme of -89.6˚C was recorded in the interior at Vostok (78˚27'S., 106˚52'E.), temperatures along the coast are much warmer. On the peninsula, extremes range from -26.1˚ to 45.5˚C. Extreme maximums range from 7˚C near the base of the peninsula to 15.5˚C in the South Shetland Islands. The extent of the cold continental air reaches a minimum in February when the warmer maritime air advances beyond the latitude of the South Orkney Islands.

In general, temperatures are warmer on the W side of the peninsula than on the Weddell Sea side. The distribution of ice and water may also account for temperature differences bet-

ween nearby locations. For example, Port Lockroy is usually 1.7˚ to 3.3˚C warmer than the Argentine Islands, which are only about 40 miles distant. Diurnal temperature changes are smallest in summer (2.8˚ to 5.6˚C) due to the small change in the angle of elevation of the sun between day and night. However, day to day differences are large. Changes of 11.1˚ to 16.7˚C can occur in a few hours by a change in the air mass. In Graham Land, high temperatures are often associated with foehn winds. At Hope Bay, maritime air crossing the mountains may reach a temperature of 10˚C, even in winter.

Maximum temperatures climb above freezing consistently from November through March. January and February are usually the warmest months when average maximums are about 2˚C and minimums range from -2.2˚ to -1.1˚C. Latitudinal influences are small in summer in this region. The coldest temp-eratures usually occur in July when maximums average -7.8˚ to -5.3˚C and minimums range from -17.8˚ to -9.4˚C.

The average relative humidity across this region ranges from 78 to 85 per cent with a small daily change. The annual range is also small, but lowest values usually occur on summer afternoons. Although humidities are high, the relatively low temperatures mean that absolute moisture is small. When a foehn wind blows, humidities can drop below 30 per cent, particularly on the islands. Highest readings occur when relatively warm air from the N flows across the colder water. Areas of fog may occur when the saturation point is reached. The highest recorded readings in this region occur in the islands. At Scotia Bay, in the South Orkney Islands, the average relative humidity ranges from 86 per cent in January to 92 per cent during June and August.

East Antarctica.—The circumpolar trough that flanks this region throughout the year reflects the large number of storms that affect the area. Winds are mostly from the E quadrant while gales are frequently generated by the storms and interior winds. Precipitation, under mostly cloudy skies, is usually snow as temperatures do not often climb above freezing.

The prevailing winds blow from NE to SE throughout the year, although S winds are also somewhat common. In general, winds are strongest in winter, blowing from the prevailing directions at averages of 20 to 35 knots at many locations. At Sanae in May, NE winds average a speed of 39 knots. In summer, the averages decrease to 10 to 25 knots. Gales blow on about 100 days annually and are most likely from March through September. In many locations, katabatic or drainage winds boost the averages. Novolazarevskaya, Roi Baudouin, Mawson, and Mirnyy are particularly susceptible along this coast. The winds usually extend out only into the near coastal waters and are local. For example, at Gauss, winds are lighter and gales much less frequent than at nearby Mirnyy Station. Mawson is exposed to SE winds which blow, at an average of 20 to 25 knots, for 60 to 85 per cent of the time all year-round, and 80 to 85 per cent from February through May and again from August through September.

Maximum wind gusts throughout the year range from 80 to 120 knots and usually blow from the SE or ESE. By contrast, the second most common wind conditions are calms which occur 5 to 15 per cent of the time at Mawson. Sanae also has a relatively high percentage of calms. Strong wind gusts are common throughout the region and many locations have recorded speeds of 100 knots or more. While they can occur in any season, strong gusts are most likely from April through October. Snow prevails and is recorded on 150 to 200 days annually along these coasts. Precipitation amounts are often not reported because of the difficulty in obtaining accurate measurements. At the few stations where records are available, the averages range from 150 to 630m annually. At Novolazarevskaya, the peak period for snow is from July through October. Mirnyy Station records about 600mm of precipitation each year with 50 to 100mm of snow per month from May through September.

The coast is usually less cloudy than the open sea. Sheltered locations on the lee side of high ground often have frequent periods of broken clouds. May through September is usually the least cloudy period. Showa, one of the few locations measuring clear days, records 69 days annually when skies are clear. This reaches a peak during the period from May through September when 6 to 8 clear days per month occur on the average. Summer is usually the cloudiest time.

Good visibility prevails and exceptional visibility is common. Coastal stations are usually not affected by sea fog or radiation fog and most report true fog less than 2 per cent of the time. At Sanae, fog or poor visibility has been reported on 25 days annually. Snow, rain, and drizzle are common restrictions and can cause the visibility to decrease below fog limits. Strong winds can reduce visibility with sea spray on the water and blowing snow along the coast. This blowing snow can obscure both the coastline and adjacent waters.

In general, fog is most likely in summer when relatively warm air is cooled by the water or ice. In coastal waters, the visibility can decrease to less than 0.5 mile on up to 10 days per month. In winter, the visibility is more wind and precipitation related. At Halley Bay, blowing snow has been recorded on average on 188 days annually and on 16 to 19 days per month from March through November.

Along this coast there is a temperature swing of about -1.1˚C from winter to summer. Maximums in the middle of summer average 0˚ to 1.7˚C with the minimums being 4.4˚ to 8.3˚C colder. Extreme maximum temperatures may reach up to 5˚C. Temperatures generally decrease rapidly as the sun moves to the N. By April, the maximum temperatures average less than -6.7˚C. July, August, and September are the coldest months. Average maximums range from -16.1˚ to -13.9˚C at lower elevations to -25˚C at Halley Bay (30m above Mean Sea Level) in August. Minimums usually decrease to -17.8˚C. Extreme minimums range from -34.4˚ to -51.1˚C.

The average relative humidity along this coast ranges from 55 to 85 per cent. The determining factors seem to be exposure to winds off the water and temperature. Foehn winds can drop the humidity to less than 30 per cent. The highest humidity often occurs in winter, when temperatures are lowest, although the moisture content of the air may be very small.

West Antarctica.—Storms in this area are frequent and often move past Cape Adare into the Ross Sea. The area extending from the Adelie Coast to George V Land is known as the windiest region in the world and the “home of the blizzards.” Stormy conditions are almost continuous for 9 months of the year and frequently reach hurricane force. Cyclogenesis is pronounced W of the Ross Sea where frequent outbreaks of cold continental air steepen the horizontal temperature gradients. The resulting differences between cold dry contin-ental

air and relatively warm moist maritime air are also pronounced in the Ross Sea with its sharply indented coastline. These differences, and therefore cyclonic activity, are most pronounced during September and October.

In this region, particularly around the Ross Sea, the frequency of extratropical cyclones and continental air mass outbreaks increases the frequencies of winds from W to S. At Little America, winds are mostly from the E, except from July through September when S and SW winds are more common. At Cape Hallett, S winds are frequent all year-round while SW winds are common from April through August. Winds from SE and S make up most of the observations at Cape Denison while E winds prevail at Oasis.

The extreme wind speeds experienced along these coasts are the result of extratropical cyclones and local katabatic winds off the interior highlands and ice plateaus. However, these winds seldom extend more than 3 miles to seaward.

In Commonwealth Bay, violent SE gales are common. Along the coast between the Adelie Coast and George V Land, strong land winds can develop at night even in the relatively quiet summer season. At Cape Denison, the annual average wind speed is 38 knots and this is probably the windiest region in the world. The average wind speed for July is 47 knots with gales blowing on 29 days on the average. For the year, gales occur on an average of 284 days and blizzards are almost continuous for 9 months.

Other locations are less windy and some are well sheltered from strong winds. At Cape Hallett, when strong winds aren't blowing from the S, there is a good chance that conditions are calm. Extreme winds at most locations approach or exceed 100 knots. At Wilkes, a maximum gust of 120 knots was reported blowing from the ESE during October.

Reduced visibility is often associated with storms. In the frontal zone, precipitation may be accompanied by fog while blowing snow is often a problem in coastal waters. In this region the winds are the rule rather than the exception. At Dumont d'Urville, near Cape Denison, 132 days annually are reported with blowing snow and 346 days with wind speeds of 28 knots or more. This station records 30 days per year with fog as compared to 50 days at McMurdo. The fog is most likely to occur from April through October. At Little America, the visibility decreases to less than 0.5 mile on 40 days per year.

Most of the precipitation in this region falls as snow. Although a large number of snow days are recorded each year, in many places, amounts are not large since many snows are light. At Oasis, 200mm of precipitation was recorded as compared to 300mm at Wilkes, where snow falls on an average of 104 days annually. At Cape Hallett, snow, measuring about 200mm, falls on an average of 181 days annually, with the maximum occurring during February and March. Mist is observed sometimes during the summer months.

Cloud amounts are often difficult to assess due to persistent blowing snow. Cumulus clouds are uncommon, but cirrus is widespread and forms at lower levels than in temperate regions. While extratropical storms and their associated fronts bring an abundance of cloudiness to this region, the downslope flow from the interior often dissipates clouds and this is reflected in cloud cover minimums over the Ross Ice Shelf and on the Wilkes Land coast. Cloudiness reaches a seasonal minimum in winter when the long nights and expansion of the ice field further intensify the polar anticyclones. At Little America, clear skies have been reported on as many as 17 days in July. Minimum cloud coverage usually occurs from May through September and a maximum occurs in summer.

Along these coasts, the average maximum temperatures range from above freezing in summer to -12.2˚C and less in winter. Minimums are usually 2.8˚ to 5.6˚C cooler in summer and 5.6˚ to 11.1˚C cooler in winter. As a result of foehn winds descending from the interior, extreme high temperatures have reached from 4.4˚ to 10˚C. These are most likely to occur in January although they have occurred in November and December at some locations. The coldest temperatures are recorded from July through September and range from -34.4˚ to -51.1˚C.

Diurnal temperature variations are similar to those in temperate latitudes except in winter. When the sun is continuously below the horizon (May, June, and July), the temperatures remain above the daily average from 0900 to 1900, but they fall below during the remaining hours.

During December and January, the average maximum temperatures range from -1.1˚C at McMurdo to 4.4˚C at Oasis. The minimums average below freezing everywhere. By March, temperatures everywhere usually remain below freezing even during the day. The coldest temperatures occur from June through August when average maximums range from -12.2˚ to -23.3˚C and average minimums range from -17.8˚ to -34.4˚C. The warmest region is along the S coast of Wilkes Land while the coldest is along the Ross Sea shore.

Because of the pronounced continental influence and the extensive ice fields, the relative humidity is low along these coasts and ranges from 45 to 85 per cent on average. The higher readings are often due to the low temperatures and not any large moisture content. The highest readings occur at Cape Denison from March through May when averages range from 80 to 87 per cent. This is due to a combination of minimum ice cover and falling temperatures. At Oasis, with its frequent land winds and relatively warm temperatures, the usual humidity in summer is about 45 per cent.

Geophysical Features

Physical Geography.—Antarctica is a geographically isolated land mass centered approximately at the South Pole and surrounded by water. South America, the nearest continent to Antarctica, lies about 380 miles away. The land area of Antarctica is approximately 5.4 million square miles, or slightly larger than the size of the continental United States and Mexico. The continental shelves of Antarctica, although relatively narrow, have an area of about 1.5 million square miles.

The weather conditions of Antarctica are extremely cold and harsh, and about 98 per cent of this continent is permanently covered with an ice sheet that averages 2,000m in thickness. Only areas along the coast, the Transantarctic Mountains, and the Ellsworth Mountains have extensive snow and ice-free areas.

East Antarctica (Greater Antarctica), the area lying between approximately 30˚ W and 165˚ E, is characterized by a vast dome-shaped cover of ice that is generally over 3,000m thick and locally exceeds 4,000m in thickness. Beneath the ice sheet in East Antarctica, the bedrock surface is made up of large

lowland plains bounded by several large interior and coastal mountainous regions. The Transantarctic Mountains separate East Antarctica from West Antarctica, and extend from the Oates Coast to Coats Land. They range in elevation from 2,000 to 4,530m.

West Antarctica (Lesser Antarctica) includes Marie Byrd Land, Ellsworth Land, and the Antarctic Peninsula. This area would be a mountainous island archipelago if the ice cover were removed. The mountains of the Antarctic Peninsula are considered to be a continuation of the South American Andes to which they are linked by a sub-marine arc, the Scotia Ridge, that curves out to enclose the Scotia Sea. The South Orkney Islands, the South Sandwich Islands, and South Georgia are but above-water peaks of this undersea chain.

Vinson Massif, the highest peak, attains a height of 5,140m and rises in the Ellsworth Mountains.

Two great indentations in the continent, the Ross Sea and the Weddell Sea, reduce Antarctica to its narrowest width of about 1,200 miles.

East Antarctica (Greater Antarctica) is twice as large as West Antarctica (Lesser Antarctica) and geologically much older, having been inactive since Precambrian time. This area is what geologists call a "shield," a term used to describe a very old and stable part of the earth's crust. It is similar to the continental shields of Africa, Australia, and Canada. In East Antarctica, the shield forms a high plateau which on average is one of the world's highest continents. If the ice were removed from this area, much of the underlying land would remain above sea level.

The base of East Antarctica is composed of high-grade metamorphic and intrusive igneous rocks such as basalts. Flat-lying sedimentary and volcanic rocks, such as sand and siltstones, overlie the base. These strata are exposed extensively in the Transantarctic Mountains but rarely in other sections of this area.

West Antarctica (Lesser Antarctica) is geologically very different. This area is composed of a series of mountain ranges whose rocks are much younger, but its geologic structure is less well known. The base is believed to be of Paleozoic age and mostly composed of igneous intrusives and metamorphic rocks. Strongly folded and metamorphosed sedimentary and volcanic sequences of Paleozoic and Mesozoic age mantle this base level.

The relatively few lakes that are located in Antarctica have few associated streams. These lakes rarely receive sediments and are rarely thermally stratified in the summer. Most of the lakes are highly saline and have low species diversity. They may or may not be permanently covered by ice.

Ice-free oases, or "dry valleys," occur in some portions of East Antarctica. They are the result of evaporation and sublimation of water and ice, and the restricted flow of glaciers into the valleys. The soils, ponds, or lakes within the valleys are usually saline because there is no external drainage. The best known dry valleys are those located in the S part of Victoria Land and the Bunger Oasis region.

Permafrost.—Knowledge of the permafrost conditions in Antarctica is limited. Dry permafrost, a condition in which the soil or rock contains no ice or contains very little ice, prevails over most of the continent, but ice-rich permafrost has been identified at some locations. When dry permafrost materials thaw, there is little or no reduction in volume and consequently no expansion upon refreezing. However, the melting of ice-rich permafrost produces large volumes of water. This almost spontaneous liquefaction can cause the mass movement of sediment and water even on slight inclines. The base of the permafrost in the McMurdo-Dry Valley area is irregular, ranging from 440 to 550m in depth at McMurdo Station to 970m near Lake Vanda. This irregularity is explained by steep geothermal gradients, the high salinity of groundwater, and possible solar heating beneath the lake ice. Ice-rich permafrost is more prevalent in the Antarctic Peninsula, especially in depressions and on slopes facing S.

Volcanism.—Evidence of volcanic activity (past and present) has been found along the Transantarctic Mountains between McMurdo Sound and Cape Adare, and in the Queen Maud Range. It has also been found in Marie Byrd Land, the Antarctic Peninsula, and the South Shetland Islands.

The largest volcano, Mount Erebus, rises on Ross Island and attains a height of 3,743m. The crater of this volcano consists of a pool of molten lava.

Fumarole activity (a hole or vent from which vapors rise) has been reported at Mount Erebus; at Mount Terror, on Ross Island; at Mount Morning, which rises 140 km SW of Mount Erebus; on Deception Island, in the South Shetland Islands; and on Thule Island, in the South Sandwich Islands.

Seismic studies were conducted in the McMurdo Sound and Mount Erebus areas and the data collected showed that one small earthquake occurred every 2 days. Other tectonically active areas are the Antarctic Peninsula, with its surrounding islands, and the Scotia Arc region. Prominent tectonic features include active volcanoes in the South Sandwich Islands and the South Shetland Islands.

Extensive seismic studies are needed to determine the stability of the entire continent. However, it can be reasonably assumed that East Antarctica is a more stable area in comparison to West Antarctica.

Terrestrial Biota.—The terrestrial ecosystems of the Antarctic are simple and lack diversity because they exist under extreme conditions for life support. In addition, in many cases, they represent the early stages of colonization following deglaciation. Even so, interrelationships between organisms are poorly understood. Due to energy pathways or food webs being simple, the ecosystems are vulnerable to disruption and are slow in recovering from disturbances.

The ecosystems of Antarctica comprise mainly non-vascular plants and small invertebrates. The vegetation on the continent consists mostly of scattered patches of crptogams such as mosses, lichens, algae, and fungi. The invertebrates include bacteria, protozoa, and certain arthropods such as springtails and mites.

The maritime areas of the continent have less snow, higher temperatures, and more precipitation. Therefore, these areas have additional developed vegetation such as ferns, fruiticose, crustose lichens, and some flowering plants. Invertebrates and other low life forms are more abundant and small wingless insects, annelids, spiders, and molds exist.

Ice Sheet.—The enormous ice sheet that covers Antarctica accounts for about 65 to 70 per cent of the world's freshwater. The average thickness of this ice sheet is approximately 2,000m, but it attains a thickness of over 4,500m in places.

From the high elevations in the interior, the ice slowly flows outward to the edge of the continent. At the coast, the flows combine to form ice shelves in many places. These ice shelves comprise more than 10 per cent of the area of Antarctica. The largest are the Ross Ice Shelf (700,000km^2), the Filchner Ice Shelf, the Ronne Ice Shelf, and the Amery Ice Shelf. An ice shelf may range in thickness from 200 to 600m and may be either floating or grounded.

Icebergs.—Eventually, as the ice shelves grow, icebergs calve off the leading edges and move N into the adjacent waters. These icebergs can be of enormous size, some measuring larger than 60km by 100km horizontally. They can also rise up to 100m above sea level and extend up to 400m below sea level, causing deep scouring of the continental shelf.

In 1987, it was reported that a massive iceberg (Designated B9) was calved from the Ross Ice Shelf. This berg was the largest piece of floating ice on record, being approximately 208km long, 53km wide, and 250m thick. (Three times the size of Long Island, NY.)

The icebergs move in a N direction in response to the ocean currents and can generally be found as far N as 45˚S in the Pacific Ocean and 35˚S in the Atlantic Ocean and the Indian Ocean.

The ice cap of Antarctica represents a potential resource to those areas of the world deficient in freshwater resources. The annual yield of icebergs that break off the ice cap is approximately 1,000km^3. If 10 per cent of this annual iceberg production could be transported economically, the water demands of an urban population of 500 million could be satisfied.

Sea Ice.—Whereas icebergs calve off the front of ice shelves, sea ice (drift ice) forms from the freezing of seawater and covers enormous areas around Antarctica, with significant physical and biological implications. The area of the sea ice varies several fold between the summer and the winter. In March, sea ice covers approximately 3 ,000,000km^2; in August or September, it covers approximately 20,000,000km^2, hence, in effect, doubling the ice area of Antarctica. In winter, this ice cover completely encloses Antarctica and can extend as far N as 55˚S. Individual ice floes extend 10 to 100m across and can be about 3m thick, but most of the drift ice is "first-year ice," which averages 1.5m in thickness. As the summer progresses, the ice moves N and melts. Consequently, open water can be found in coastal areas while a zone of drift ice occurs farther offshore. Sea ice moves in response to the winds and can travel up to 65km in a day.

The widely varying extent of the ice is believed to have an important influence on worldwide climatic conditions. However, the relationship is complex and only partially understood. Two factors that play a role are the thermal insulating properties of ice and its high albedo. Sea ice acts as a thermal insulator that restricts the exchange of heat between the atmosphere and the ocean. Because of its high albedo relative to water, it affects the amount of radiant energy that is absorbed regionally. These properties along with the wide seasonal fluctuations in the extent of the sea ice cover will affect the heat transfer in Antarctica and, hence, the global climate.

The sea ice provides habitat for many seals and penguins. While these animals feed on organisms in the ocean, the sea ice offers a refuge from predators. Therefore, these animals are frequently found at the edge of the sea ice near open water.

History of Exploration

History.—The concept of a southern continent intrigued even the ancient Greeks, who believed that such a continent was needed to balance the land masses of the North Hemisphere. In 1772-1775, Captain James Cook circumnavigated Antarctica, but saw no continent. However, the 1800s brought many adventurers to this region.

The first person to sight the continent, as reported by the Americans, was Nathaniel Palmer in November, 1820; Captain Edward Bransfield, as reported by the English, in January, 1820; and Captain Fabian Von Bellingshausen, as reported by the Russians, 1820-1821. Between the years of 1838 and 1843, three expeditions, led by d'Urville, Wilkes, and Ross, were made to Antarctica in order to find the S magnetic pole. Although the goal of these expeditions was not realized, other significant scientific contributions were made. A number of "firsts" in the history of the continent include achievements by Bull, Gerlache, Borchgrevink, Bruce, Mawson, and Amundsen. Subsequently, scientific research programs began in the early 1900s and have continued to the present.

Early geologic exploration of Antarctica began in the late 19th century with the collection of rock fragments from the sea bottom. Extensive programs were carried out by teams of scientists who accompanied voyages to Antarctica from the 1890s to the 1920s. Progress was made in mapping and in understanding Antarctica's geology, glaciology, and geography. After World War I, advances in transportation and communications allowed even greater exploration.

The International Geophysical Year (IGY) conducted in 1957-58 was the beginning of Antarctica's role as an international science laboratory. Base stations were maintained by twelve countries during this period. New data was obtained on meteorology, upper atmosphere physics, geomagnetism, seismology, glaciology, and geography.

EXPLORATION AND RESEARCH HISTORY OF THE ANTARCTIC CONTINENT

Expedition	Expedition	Remarks
James Cook	1772-1775	Circumnavigated Antarctica but did not sight the continent.
Fabian von Bellingshausen	1820	Circumnavigated Antarctica but did not sight the continent.
Nathaniel Palmer	1820-1831	Discovered the Antarctic Peninsula in 1820.
Edward Bransfield	1820	Discovered the Antarctic Peninsula (According to British reports).
James Weddell	1822-1824	Discovered the Weddell Sea in 1823.

EXPLORATION AND RESEARCH HISTORY OF THE ANTARCTIC CONTINENT

Expedition	Expedition	Remarks
James Clark Ross	1839-1843	Discovered the Ross Sea and the Ross Ice Shelf.
Charles Wilkes	1838-1842	Discovered Wilkes Land.
Dumont d'Urville	1837-1840	Discovered the Adelie Coast
Adrien de Gerlache	1897-1899	First to winter aboard ship in the area.
C. E. Borchgrevink	1898-1900	First to winter on the continent.
William S. Bruce	1902-1904	First to set up a permanent station in the region.
Douglas Mawson, T. David, and A. Mackay	1911-1914	First to reach the South Magnetic Pole.
Roald Amundsen	December 14, 1911	First to reach the geographic South Pole.
Robert Scott	1901-1913	Various expeditions. Reached the geographic South Pole on January 17, 1912, but perished in blizzard with four others on return journey.
Ernest Shackleton	1907-1922	Various expeditions.
United Kingdom	1923-1939	First continuing scientific research program.
Hubert Wilkins	1928	First flight across the Antarctic Peninsula.
Richard E. Byrd	1928-1941	Various expeditions. First to fly over the geographic South Pole in 1929.
Lincoln Ellsworth	1933-1939	Demonstrated feasibility of aircraft landings and takeoffs.
United States	1946-1947	Operation Highjump. The largest expedition in Antarctica.
United States	1947-1948	Operation Windmill.
International effort— • Argentina • Australia • Belgium • Chile • France • Japan • New Zealand • Norway • Russia • South Africa • United Kingdom • United States	1957-1958	International Geophysical Year (IGY). First major international scientific effort.

The record of investigations begins in the 1830s with observations made by James Eights and the Charles Wilkes expedition. Robert Cushman Murphy made important contributions concerning subantarctic birds and terrestrial flora and fauna in the early 1900s.

Between 1920 and 1955, four expedition teams from the United States developed a sizable data base on Antarctic terrestrial features, including that of the interior. The Second Byrd Antarctic Expedition (1935-37) explored the inland mountains and nunataks, and made extensive discoveries. The United States Service Expedition of 1939-1941 investigated the natural resources of Antarctica; studied botany, zoology, and oceanography; and made physiological observations of expeditionary personnel. Two United States Navy projects, Operation Highjump (1946-1947) and Operation Windmill (1947-1948), made extensive observations on the Antarctic.

In the late 1950s, the United States established a permanent expedition, the United States Antarctic Research Program (USARP).

In 1968, the first drill hole to penetrate rock through the ice, which was 2,164m thick, was made at Byrd Station (elevation 1,530m).

ANTARCTIC RESEARCH STATIONS

Country	Station	Location	Comments
Argentina	Orcadas (LOK)	Laurie Island.	Permanently manned.

ANTARCTIC RESEARCH STATIONS

Country	Station	Location	Comments
Argentina	Esperanza (LTS)	Trinity Peninsula	Permanently manned.
	Vice Comodoro Marambio (LUU)	Seymour Island	Permanently manned. Landing strips.
	General Belgrano II (LTS4)	Coats Land	Permanently manned.
	General San Martin (LTS2)	Debenham Island	Permanently manned.
	Jubany (J25)	King George Island	Permanently manned.
	Almirante Brown (LOY)	Danco Coast	Summer occupation only.
	Primavera (LTR88)	Danco Coast	Summer occupation only.
	Teniente Camara	South Shetland Islands	Temporary occupations.
	Decepcion	Deception Island	Temporary occupations.
	Melchior	Palmer Archipelago	Temporary occupations.
	General Belgrano (LTA)	Filchner Ice Shelf	Temporary occupations.
	Teniente Matienzo (LUM)	East Coast-Graham Land	Temporary occupations. Landing strips.
	Alferez de Navio Sobral	Filchner Ice Shelf	Temporary occupations.
	Petrel	Joinville Island Group	Temporary occupations. Landing strips.
Australia	Macquarie	Macquarie Island	Permanently manned.
	Mawson	MacRobertson Land	Permanently manned. Landing strips.
	Davis	Ingrid Christensen Coast	Permanently manned. Winter landings on sea ice.
	Casey	Budd Coast. Wilkes Land	Permanently manned. Landing strips.
	Heard Island	Atlas Cove	Summer only occupation.
	Law Base	Larsemann Hills	Summer only occupation.
	Law Dome	110 km from Casey	Summer only occupation.
Brazil	Commandante Ferraz (ZXOECF)	Keller Peninsula	Permanently manned.
Bulgaria	Ochridski	Livingston Island.	Periodically manned.
Chile	Capitan Prat (CCZ)	South Shetland Islands	Permanently manned.
	General Bernardo O'Higgins (CATU2)	Trinity Peninsula	Permanently manned. Landing strips.
	Julio Escudero	South Shetland Islands	Permanently manned. Landing strips.
	Eduardo Frei Montalva	King George Island	Permannetly manned. Landing strips.
	Teniente Luis Carvajal	Adelaide Island	Summer occupation only. Landing strips.
	Presidente Gonzalez Vidiez	Danco Coast	Summer occupation only.
	Yelcho	Palmer Archipelago	Summer occupation only.
	Ripamonti	King George Island	Summer occupation only.
	Risopatron	Robert Island	Summer occupation only.
China	Great Wall	South Shetland Islands	Permanently manned.
	Zhongshan	69˚22'S, 76˚23'E	Permanently manned.
Ecuador	Vicente	Antarctic peninsula	Occassionally manned.
Finland	Aboa	Dronning Maud Land	Summer occupation only.

ANTARCTIC RESEARCH STATIONS

Country	Station	Location	Comments
France	Alfred Faure		Permanently manned.
	Port aux Francais	Iles Kerguelen	Permanently manned.
	Dumont d'Urville	Terre Adelie	Permanently manned. Landing strips.
	Martin-de-Vivies		Permanently manned.
	Dome C (Concordia)	Antarctic plateau	Summer use only.
Germany	Dallmann	King George Island	Summer station only.
	Georg von Neumayer (DLA21) (DB9020)	Eckstrom Ice Shelf	Permanently manned. Landing strips.
	Kohnen	Dronning Maud Land	Summer use only. Landing strips.
India	Maitri	70˚45'S, 11˚44'E	Permanently manned. Helipad.
Italy	Baia Terra Nova	Victoria Land	Summer use only. Landing strips.
	Dome C (Concordia)	Antarctic plateau	Summer use only.
Japan	Syowa (JGX)	East Ongul Island	Permanently manned. Landing strips.
	Miznho	East Antarctica	Summer occupation only.
	Asuka (JGY)	Queen Maud Land	Summer occupation only.
	Dome Fuji	Valkyrjedomen peak	Summer occupation only.
Korea	King Sejong (6NA20)	King George Island	Permanently manned.
New Zealand	Scott (ZLQ)	McMurdo Sound	Permanently manned. Landing strips.
Norway	Troll	Dronning Maud Land	Summer occupation.
	Tor	Dronning Maud Land	Summer occupation.
Peru	Macchu Picchu		Summer occupation only.
Poland	Henryk Arctowski (3ZL301)	King George Island	Permanent occupation. Scientific base.
Russia	Bellingshausen (UGE2)	King George Island.	Permanently manned.
	Molodezhnaya (RUZU)	Enderby Land	Permanently manned. Landing strips. Airfield. Main Russian research base.
	Mirny (UBA) (UFE)	Queen Mary Land	Permanently manned.
	Vostok (RKIS)	East Antarctica	Permanently manned. Landing strips.
	Novolazarevskaya	Dronning Maud Land	Permanently manned.
	Progress	Princess Elizabeth Land	Permanently manned.
	Druzhnaya 4 (ULO1)	Ingrid Christensen Coast	Summer occupation only.
	Soyuz (RUNI)	McRobertson Land	Summer occupation only.
South Africa	Marion Island	Prince Edward Islands	Permanently manned.
	Sanae IV (ZRP)	Queen Maud Land	Permanently manned.
	Gough Island	Tristan de Cunha group	Permanently manned.
	E-base	Queen Maud Land	Summer occupation only.
Spain	Juan Carlos I (3ZL34)	Livingston Island	Summer occupation only.
	Gabriel de Castilla	Deception Island	Summer occupation only.
Sweden	Wasa (SLUI)	Dronning Maud Land	Summer use only.
Ukraine	Vernadsky	Galindez Island	Permanently manned.
United Kingdom	King Edward Point (ZBH)	South Georgia	Permanently manned.

ANTARCTIC RESEARCH STATIONS

Country	Station	Location	Comments
United Kingdom	Bird Island	W end of South Georgia	Permanently manned.
	Signy (ZHF33)	South Orkney Islands	Summer use only.
	Adelaide Island (Rothera) (ZHF45)	West Coast-Graham Land	Permanently manned. Landing strips.
	Halley (VSD)	Coats Land	Permannently manned. Landing strips.
United States	Palmer (NGH)	Anvers Island	Permanently manned. Heliport.
	McMurdo (NGD)	Ross Sea	Permanently manned. Airfield. Largest station in Antarctica.
	Amundsen-Scott (NPX)	South Pole	Permanently manned. Landing strips.
Uruguay	Artigas (C2C)	South Shetland Islands	Permanently manned. Landing strips.

Note.—In addition to the above research bases and stations, numerous small refuges, most with provisions and fuel, are situated on the continent and off-lying islands. Vessels should contact McMurdo Station for the latest information concerning the locations and conditions of these refuges.

Currently, work is being done in all aspects of Antarctic research with funding, management, and guidance provided by the National Science Foundation (NSF).

Additional information concerning stations and bases is available from the Council of Managers of National Antarctic Programs (COMNAP), at their website, as follows:

COMNAP Home Page

http://www.comnap.aq

Significant international interest in the continent developed during the International Geophysical Year (IGY) 1957-1958. This marked the beginning of major scientific activities that have continued to the present. Although earlier expeditions conducted some scientific activities, the efforts of international working agreements reached during the IGY period were recognized as unique by all nations involved. Twelve nations established over sixty research stations in Antarctica during the IGY period. This became the basis for the Scientific Committee on Antarctic Research (SCAR) and the formulation of the Antarctic Treaty. The nations included Argentina, Australia, Belgium, Chile, France, Japan, New Zealand, Norway, South Africa, Russia, the United Kingdom, and the United States.

In 1958, the SCAR, as a committee of the International Council of Scientific Unions, was tasked to continue the scientific and logistic cooperation which began during the IGY period. The SCAR seeks to identify scientific problems of Antarctica, their scope and significance. The member nations work independently or jointly to bring available logistics support and scientific personnel to seek solutions to these problems, maintaining multinational efforts as the common objective.

Following the IGY period, with the claims issue made by seven nations to portions of Antarctica unsettled since 1945, the United States called a conference in 1959. The Washington Conference convened on October 1 and was attended by those 12 nations which had conducted substantial activities in Antarctica including the following seven claimant states (The United Kingdom, France, Australia, New Zealand, Norway, Argentina, and Chile). The final act of the Washington Conference on the Antarctic was the Antarctic Treaty, signed at Washington on December 1, 1959. Subsequently, this treaty was ratified by all the signatories by June 23, 1961, with the continued spirit of cooperation achieved during the IGY period. By April 1991, thirty nine nations were signatories.

An agreement reached in Madrid in April of 1991, signed by all 39 parties, imposes a ban on all mineral exploitation in Antarctica for 50 years. The agreement demilitarizes the continent, establishes the right to scientific research for all countries, and creates a procedure for monitoring the environment.

Sovereignty.—Seven of the original 12 signatories to the 1959 Antarctic Treaty have claimed sovereignty over parts of Antarctica. These countries are Argentina, Australia, Chile, France, New Zealand, Norway, and the United Kingdom. Some areas of Antarctica are claimed by more than one of these countries, while other areas remain unclaimed. The remainder of the original signatories (Belgium, Japan, South Africa, Russia, and the United States) have neither made claims nor recognized claims made by other countries. In the Antarctic Treaty, the disagreement over the issue of territorial sovereignty is dealt with in a manner that allows the parties to cooperate in the conduct of the specific activities addressed by the treaty.

Historical Impact.—To date, the major impacts on the terrestrial environment from the present occupation of Antarctica are localized and are mostly associated with support facilities such as fuel-handling and storage; waste disposal; and construction, operation, and maintenance of stations and field camps. Those environmental features that have been affected include rocks, soils, lakes, ponds, terrestrial biota, and glacial snow and ice. The degree to which they have been affected, in some cases, is unknown, but is generally only local in extent.

During 1980 and again in 1991, the National Science Foundation performed comprehensive environmental impact assessments of U.S. activities in Antarctica. The assessments concluded that continuation of these activities would have no significant continental impacts on Antarctica.

Only a few localized impacts of any significance could be identified. Most of these impacts are significant only in instances where research being carried out requires an undisturbed environment for its success.

The protection of the Antarctic environment is of prime concern to personnel working in Antarctica, and this concern is reflected in directives issued under the Antarctic Treaty.

Current scientific activities and tourism in Antarctica have little impact on the marine environment. Those impacts that have been noted are only local in extent. A small number of birds and seals are lost to scientific collecting. Activities near rookeries, such as helicopter overflights and foot expeditions, are restricted.

Impact on the marine environment has been limited in the past except for the harvesting of mammals. The disposal of garbage, sanitary waste, and solid waste in coastal waters degrades water quality on a local scale. Vessel traffic and the handling of petroleum products have resulted in small oil spills or oil discharges which may harm local animal populations. During 1989, a vessel ran aground to the SW of Palmer Station, spilling 170,000 gallons of fuel into the sea.

Commercial harvesting of whales and seals has had significant impacts in the past. Twentieth century whaling greatly reduced the populations of baleen whales. The International Whaling Commission now regulates whaling. The fin, blue, humpback, and southern right whales are protected from harvesting, and harvest quotas have been set for other species. The reduction of the number of whales in this century from approximately 975,000 to approximately 338,000 means that less krill are consumed by whales. Whereas baleen whales used to consume an estimated 180 million tons of krill, they now only consume an estimated 33 million tons, increasing the availability of krill for other predators. Subsequently, the population of crabeater seals increased and the populations of other predators may also have increased. Hence, whaling may have altered the populations of many species besides the whales themselves.

Fur seals and elephant seals were captured for their fur and blubber, respectively, during the eighteenth and nineteenth centuries, and the number of fur seals was severely reduced. Both of these seals are now protected by the Convention for Conservation of Antarctic Seals.

In the early 20th century, a whaling station was established in King Edward Cove, on South Georgia Island, to support whaling operations. The activities in this harbor grossly polluted the water with organic effluents and fuel oil, impacting the local marine communities. However, contamination has stopped and evidence indicates that the benthic fauna has recovered.

The Antarctic environment has been contaminated at extremely low levels with organochlorides as a result of human activities outside of Antarctica. The entire impact of these contaminants is not known. However, DDT and other chlorinated hydrocarbons have been found in Antarctic birds. In addition, DDT, PCBs, and other organochlorides have also been found in krill, although at concentrations that do not pose a human health hazard.

Marine traffic is considerable in the Drake Passage, which is used by vessels too large to pass through the Panama Canal. Commercial shipping, which includes oil tankers, pass through this area, usually to the N of the Antarctic Convergence. Recently, several cruise vessels have transited Antarctic waters.

Bases.—McMurdo Station is the main United States base and also the largest multipurpose research and logistics center in Antarctica. The population of bases on the continent may reach 2,000 people during the summer and 800 people during the winter. The U.S. bases rely heavily on aircraft, rather than on ships, for transport of personnel and priority cargo. However, when fuel or bulk cargo is transported (some 90 per cent of the total), it is shipped to McMurdo. Icebreakers are used to open an approach channel, enabling cargo vessels and tankers to off-load directly at this station. McMurdo has one of the few airfields on the continent that are suitable for use, at times, by wheeled aircraft.

Ice

Formation and Growth of Sea Ice in Polar Regions.—An understanding of the formation, growth, and decay of sea ice is desirable for comprehension of many of the problems in ice seamanship. The climatic factors bearing on the formation of ice naturally vary from place to place and from season to season. However, a knowledge of the basic physics involved should be of great assistance and enable mariners to recognize certain salient features of ice and take advantage of its properties.

Freezing.—In temperate and tropical latitudes, the ocean acts as a storehouse of radiant heat from the sun, the visible and infra-red wave lengths being largely absorbed in the surface layers. The heat that is stored by this action is then given off to the air at night and at other periods when the air is colder than the sea surface. However, in higher latitudes, insufficient heat is stored in the short daylight periods to compensate for the losses at night and the temperature of the surface water is lowered. As the altitude of the sun becomes lower, less radiation is received and more is reflected from the sea surface due to the low angle of incidence of the rays. Finally, the water reaches freezing point and further loss of heat results in the formation of ice.

Conditions then become even less favorable for the retention of radiant heat from the sun; since, ice reflects much more of the visible radiation than does water. The cooling of the air that is in contact with the ice becomes accelerated and even more ice is formed as this cold air spreads.

Salinity.—Fresh water freezes at 0˚C, but sea water remains liquid until a lower temperature is reached due to the presence of salt. The greater the amount of salt (salinity), the lower the freezing point. Ordinary sea water, with a salinity of 35 parts per thousand, does not begin to freeze until it has been cooled to -1.88˚C.

Salinity may also affect the rate of freezing through its influence on the density of the water. Fresh water contracts on cooling and sinks below the surface until a temperature of 4˚C is reached. On further cooling, fresh water expands and its density decreases. If the cooling takes place at the surface with no other process of mixing at work, the coldest water will stay in a layer at that position. It is then necessary for only the layer at the surface to be cooled to the freezing point for ice to form.

The temperature of maximum density decreases faster than the freezing point with increasing salinity. These two temperatures coincide at a salinity of 24.7 parts per thousand. This means that with a salinity of 24.7 parts per thousand or greater, density currents operate until the freezing point is reached and theoretically the entire body must be cooled to this temperature before ice can form on the surface.

However, in nature, rapid cooling of still water often occurs under conditions where heat is removed from the surface layers faster than it can be supplied from the deeper layers through convection currents. In such a case, ice will form on the surface of the water before the deeper layers have approached the freezing point.

A practical outcome of the foregoing is that if a body of water originally of uniform density is losing heat at the surface, ice will be formed most readily in fresh water, less readily in sea water of low salinity, and least readily in sea water of high salinity. The greater heat removal required to freeze sea water is due not only to its relatively low freezing point, but also to the increased tendency of the cooled surface water to sink as the temperature of maximum density decreases.

Ice Propagation.—Ice forms first in shallow water, near the coast or over shoals and banks; in bays, inlets, and straits in which there is no current; and in regions with reduced salinity, such as those near the mouths of rivers. It then spreads from these areas.

The first sign of freezing is an oily or opaque appearance of the water. This is due to the formation of needle-like spicules and thin plates of ice, about 1 centimeter wide, which are known as frazil crystals. These crystals of fresh ice, which are free of salt, increase in number until the sea is covered by a thick and soupy slush, known as grease ice.

Snow, falling into water, aids the freezing process by cooling and by providing nuclei for the ice crystals. In such conditions, the slush forms into new ice. Except in sheltered waters, an even sheet of ice seldom forms immediately. The slush, as it thickens, breaks up into separate masses and frequently into the characteristic pancake form, the rounded shape and raised rim of which are due to the fragments colliding with each other. The formation of slush dampens down the sea and swell, and if the low temperature continues, the pancakes of ice adhere to each other, forming a continuous sheet or floe.

An accumulation of spongy ice lumps, known as shuga, is the next normal stage of formation from grease ice. On further freezing and depending upon the salinity and wind exposure, shuga develops into nilas, an elastic crust of high salinity and up to 10 centimeters thick, or into ice rind, a brittle and shiny crust of low salinity up to 5 centimeters thick. When the ice reaches a thickness of from 10 to 30 centimeters, it is collectively referred to as young ice which is the transition stage between nilas and first-year ice. First-year ice is usually between 30 centimeters and 2 meters thick. Ice up to 3m or more in thickness that has survived at least one summer melt is known as old ice. Multi-year ice is the term now used to describe old ice which has survived more than two summers melts. Old ice has a bluish-green tone on its surface in contrast to the greenish-white tone of first-year ice. Multi-year ice usually develops an intense blue tone with age.

Melting.—The melting of ice takes place mostly at the expense of the heat of the surrounding water. This heat may have been absorbed from solar radiation in the vicinity or provided by currents originating in warmer latitudes. Melting also results from direct absorption of radiation by the ice and from contact with warm air. Ice will condense dew from warm, moist air on its surface, and each increment of moisture so condensed will melt several times its weight of ice in the ratio of the latent heat of evaporation to the heat of fusion.

Another factor tending to accelerate the rate of ice melting from solar radiation, once it has commenced, is the increased stability of the surface layers of the sea brought about by the freshening effect of the melt water. Mixing between the surface and deeper layers, already diminished by the wave-damping action of floating ice, is further decreased by the formation of a surface stratum of relatively low density. The normal transfer to greater depths of heat received as infra-red radiation in the top layers is retarded, and the melting of the ice is thereby speeded up.

The phenomenon of "dead water" is sometimes encountered by vessels in areas where a layer of nearly fresh water that has derived from melting ice extends to about keel depth. Under such conditions, the propulsive power of a vessel may be largely dissipated in generating internal waves in the boundary between the fresher water and the more saline water. Consequently, the vessel slows down, begins to steer sluggishly, and appears to be "stuck" in the water. Fortunately, this state of affairs occurs only when the speed of the vessel is below the speed of propagation of such waves, which is not more than 2 or 3 knots. Therefore, "dead water" will usually affect only sailing vessels, in light winds, small craft, or tugs with very heavy tows.

In regions where the spring melting of ice is brought about chiefly by atmospheric transfer of heat from lower latitudes and where local fogs restrict the solar radiation reaching the ice and sea surface, the fresh surface layers of sea water may become greatly chilled and the rate of melting reduced.

In places where the vertical exchange of water caused by wind, sea, currents, and tides occurs, melting of the ice is expedited by heat being brought to the upper layers.

Disintegration.—In spring, as the duration of daylight begins to increase and the mean air temperature at the sea surface rises, the snow cover of the sea ice and the top layers of the ice itself begin to thaw. Under conditions of low humidity, most loss on the upper surface of the ice will take place through evaporation imperceptible to the ordinary observer. When the relative humidity is high, pools of dew and melt water will form on the surface. This fresh water, running down through cracks and holes in the ice, will freeze again on contact with the cold sea water; hence, sealing the openings. In addition, cracks extending only part way through the ice will be widened by the expansion of the water freezing in them. On further rising of the air temperature and melting of the surface, these cracks open up again and fresh water in a layer, as much as 1m thick, flows under the ice.

Sea ice less than 1 year old melts more readily than older ice because of its higher salt content. Fast ice usually melts first near the shore, forming the so-called "offshore water." As melting progresses, the ice farther out from the shore becomes honeycombed with cracks due to tides, air temperature changes, temperature gradients in the ice, and ice pressure. Under the influence of wind and current, this ice now com-

mences to disintegrate and an increased number of channels and polynyas (open areas) are produced. With the first strong wind, the ice breaks into smaller pieces and finally all the fast ice disintegrates into drift ice.

Decay of the ice is expedited by mechanical attrition from the swell. The physical erosion of the floes produces scaling, resulting in the formation of a quantity of small blocks and brash. The scaling process enables the sea to reach more extensive areas of ice where the cycle continues.

The final stages of melting vary with the type of ice. Ice of one winter's growth melts readily in low latitudes, if brine is still present. The internal melting due to variations in the salt content produces a honeycombed appearance with a much greater surface area. Since the rate of heat absorption through conduction is proportional to the area exposed, the ice so formed quickly disappears. Fresher and firmer hummocky ice is longer lived. The old floes are heavily undercut at the water line, but honeycombing is rare, due to the absence of salt. Underwater rams are produced by the melting back of the uppermost meters of ice. The years-old hummocks, having a homogeneous structure of nearly salt-free ice and a minimum of exposed surface in proportion to their bulk, survive the longest in warmer waters.

Break-up on rivers usually occurs three or four weeks after the mean air temperature has risen above 0˚C. Ice on lakes breaks up two or three weeks later, and sea ice may break up about this same time.

Comparison of Arctic and Antarctic Ice.—The warmth of the Arctic summer has no parallel in the Antarctic and, mainly because of this thermal difference, the ice sheets of the N polar region are unlike those of the S. The edge of the Antarctic cap, overflowing its land support, is free to spread over the sea until it fractures and large strips become detached. Hence, such large strips that form tabular or box-shaped bergs are generally a characteristic of only the S polar region.

In Greenland, by contrast, the edge of the inland ice ends on land and usually icebergs that are irregular in shape are formed. Hence, the pinnacled and picturesque berg is generally a characteristic of only the N polar region.

The Antarctic sea ice surrounds the continent while the Arctic sea ice forms a central mass surrounded by land. The ice moves around and outward from Antarctica and it is unusual for sea ice to be more than 1 or 2 years old. The drifts in both the Weddell Sea and the Ross Sea carry the ice out into the open oceans in a period of just over 1 year.

However, in the Arctic, floes of great age are frequent. Ice formed off the Siberian coast may take from 3 to 5 years to drift across the polar basin and down the E side of Greenland. Subsequently, ice of this age becomes pressed and hummocked to a degree unknown in lower latitudes. During the Arctic summer, melting on the surface is considerable and pools of fresh water are formed on the floes. In the Antarctic, surface pools on floes in the ice such as these are almost unknown.

The outstanding difference between Arctic and Antarctic ice, which becomes soon apparent to the navigator, is the softer texture of the latter.

While Arctic sea ice appears to be formed primarily through surface freezing of sea water, Antarctic sea ice apparently includes substantial amounts of infiltrated snow ice and underwater ice. Infiltrated snow ice is formed by the flooding and refreezing of extensive fields of snow lying on existing floes. Underwater ice results from the growth and consolidation of a cloud of ice crystals in the cold water column beneath existing ice.

Classification.—Ice met at sea consists for the most part either of icebergs, originating from glacier and continental ice sheets, or of sea ice, formed by the freezing of the top layers of the sea itself. Sea ice proper accounts for probably 95 per cent of the area of ice encountered, but bergs are important because of the manner in which they drift far from their place of origin and constitute a grave menace to navigation. A certain amount of ice may also originate in rivers or estuaries as freshwater ice, but it is already in a state of decay by the time it reaches the open sea and its importance is no more than local.

Icebergs.—Icebergs are large masses of floating (or stranded) ice derived from the fronts of glaciers, from glacier ice tongues, or from the shelf ice of the Antarctic. They are products of the land and not of the sea. Their structure and, to some extent, their appearance depend upon the source from which they are derived.

Antarctic ice islands, commonly called tabular icebergs, are significantly larger and more numerous than their Arctic counterparts. Some, with observed horizontal dimensions of more than 200km by 50km, have calved away from the Ross, Ronne, and other ice shelves. These huge tabular floes, which may tower as high as 200m above the sea surface, have been observed grounded at depths of about 500m. However, Antarctic icebergs rarely find their way into the main shipping lanes. They move in a N direction in response to the ocean currents and can generally be found as far N as 45˚S in the Pacific Ocean and 35˚S in the Atlantic Ocean and the Indian Ocean.

Bergs are usually an opaque, flat, and white color with soft iridescent hues of blue or green. Many bergs show veins of soil or rock debris and others may have yellowish or brownish stains, probably due to diatom (minute algae) films. Under certain conditions of illumination, an iceberg may appear dark in color in contrast with the sky or with other bergs under direct sunlight. This phenomenon has often led mariners to report islands where none exist.

The ratio of the mass of the submerged portion of a berg to its total mass is equal to the ratio of the specific gravity of the berg to that of the water in which it is floating. On account of the origin of glacial ice in compacted snow, berg ice contains up to perhaps 10 per cent of trapped air and is somewhat less dense than ordinary ice. Measurements of the specific gravity of icebergs have given values close to 0.9, while the cold sea water in which they float has a specific gravity of about 1.027. Consequently, about seven-eights of the mass of a berg is submerged.

It is often erroneously assumed that an iceberg floats with a draft seven times its height above the water, but these ratios hold good for only mass and not for linear dimensions. Actual reported measurements of bergs indicate that the draft is seldom more than five times the exposed height for the blockiest bergs, and may be as low as one or two times the exposed height for the pinnacled and irregular types.

On a clear day, an iceberg can be seen at a great distance due to its brilliant luster. However, an iceberg may not be perceptible until dangerously close during foggy weather. When the fog is dense and the sun is shining, the first appearance of an

iceberg is in the form of a luminous, white object. If the sun is not shining, the first appearance is in the form of a dark, somber mass with a narrow streak of black at the water line. The diffusion of light in the fog will produce a blink around the berg that augments the apparent size of the ice mass.

Icebergs may, at any time, calve off large sections of sheet ice or glaciers, relieving stresses set up by temperature changes or responding to vibrations from sound or wave action. After falling into the water, they may travel up to the surface again with great force and often at a considerable distance away. Icebergs are often so balanced that this calving causes a shift in their center of gravity with consequent capsizing and readjustment of their mass to a new state of equilibrium. Therefore, vessels and boats should keep well clear of icebergs that give any evidence of disintegrating or overturning. In addition, icebergs may also possess underwater spurs and ledges which extend considerable distances from the visible portions.

In good weather, icebergs can be of great assistance to navigation in floating ice as they may mark shoals, break up a consolidated mass of ice, and provide reference points. Having a relatively small sail area in proportion to their bulk, icebergs are not affected by wind to the same extent as drift ice. With the wind blowing drift ice past a berg, an optical illusion often occurs and the berg seems to be moving to windward and cutting a channel through the ice. Illusion or not, such a lee may be a desirable place for a vessel to lie in order to avoid heavy ice. Under such circumstances, vessels have reported laying out an ice anchor to a berg, but a careful watch must be kept for growlers which have calved off. Vessels are frequently alarmed by the presence of icebergs in an anchorage area. However, it is usually safe unless the bergs are of mammoth size or disintegrating.

When navigating in fog, the presence of a large number of growlers, bunched together, may be a good indication of an iceberg to windward. In calm weather, growlers may sometimes be found distributed in a curved line, with the iceberg located on the concave side of the curve.

Sea Ice.—Sea ice can be divided into fast ice and drift ice, according to mobility.

Fast ice forms in sheltered bays, gulfs, and fjords, as well as among floating lumps of old ice. Developing along the shore and spreading into the sea, fast ice joins the new ice formed around islands, grounded floebergs, and floating masses of old ice. Although subjected to repeated fracturing with the fall in temperature of the air, it then spreads farther and farther into the sea, increasing in thickness and offering more and more resistance to breaking up. Finally in the first months of the winter, the fast ice extends up to its maximum distance offshore, beyond which the region of drift ice is found. The width of a belt of the fast ice depends upon the configuration of the shore, since the more rugged the coastline and the greater the number of islands in its vicinity, the greater is the width of the fast ice. Hummocks stranded in shoal water also assist fast ice to develop. Fast ice can extend a few meters or several miles from the shore. Generally, fast ice that projects more than 2m above sea level is known as an ice shelf.

Along open coasts, the fast ice is liable at all times to break up and drift away. However, this break-up may not occur in regions where the configuration of the land is such as to shelter the ice from the prevailing winds. In addition, stranded bergs sometimes act as anchors for fast ice and prevent it from breaking out and drifting into the open sea.

Drift ice is the term widely used to include any area of sea ice, other than fast ice, no matter what form it takes. When drift ice is highly concentrated, over seven-tenths of the surface, it is then described as pack ice. Flat pieces of sea ice that are 20m or more wide are called floes. An ice-covered area over 10km wide that is formed by floes freezing together is called an ice field.

The age of floes may often be judged by the presence of colored bands at their edges. During the summer, minute algae, known as diatoms, adhere to the underside of pieces of floating ice, which may be slowly growing through the freezing of fresh water derived from melting of their upper side. In the winter, the ice grows more rapidly and diatoms are absent due to the lack of sunlight. Consequently, the intervals between two winter freezings are marked by yellow strata of frozen diatoms and may indicate the age of the floe.

A piece of sea ice that rises less than 1m above the sea level; covers an area of about $20m^2$, and often appears transparent, green, or almost black in color is known as a growler.

A large piece of sea ice that rises between 1 and 5m above the sea level and covers an area of about 100 to $300m^2$ is known as a bergy bit.

A massive piece of sea ice that is composed of a hummock or several hummocks, rises up to 5m above sea level, and is separated from any ice surroundings is known as a floeburg.

Pack Ice.—Pack ice may be composed of high concentrations of drift ice, detached fragments of fast ice, and, to a lesser extent, disintegrated particles of land ice.

Pack ice is classified according to the thickness of its arrangement and may be described as compact pack, consolidated pack, close pack, and open pack. The ice masses themselves are described according to size and may be ice fields, floes, or pancakes. Depending on their surface, they may be described as level or hummocked.

The belts of pack ice usually lie perpendicular to the prevailing wind. Projections, called tongues, are sometimes formed by the wind or currents and extend considerable distances from the ice edge. Bays or bights may also be formed by the wind or current in a belt of pack ice. The degree of openness and the physical character of the ice forming the belt greatly determine the resistance offered against such actions. When the wind produces this effect, the indentation is usually small. However, indentations formed in the pack ice by the influence of a current sometimes are of huge dimensions.

Often consolidated pack ice, the heaviest form, will drift away from the shore or will separate, forming cracks, fractures, and leads through the ice area. When the separation is wide enough to permit the passage of a ship, it is called a lead. A lead between pack ice and the shore is known as a shore lead and one between pack ice and fast ice is known as a flaw lead. A lead ending in an impenetrable barrier is known as a blind lead.

Navigation in shore leads and flaw leads is dangerous because the pack ice can close against the fast ice or the shore. Before leads refreeze, lateral motion generally occurs between the floes. Hence, unless the pressure is extreme, numerous large patches of open water remain. These nonlinear shaped

open patches, which are called polynyas, may contain small fragments of ice. In summer, the leads do not generally refreeze.

Pressure Ice.—The deformation of ice results in greater thickness and is caused by the movement and interaction of floes. This process is usually caused by winds, tides, and currents. It transforms a relatively flat sheet of ice into pressure ice which has a rough surface.

Pressure set up in the floes produces bending, tenting, and rafting. Bending, the first stage, is an upward or downward motion and occurs in thin and very plastic ice. In heavier floes, which are less resilient, tenting occurs. Here, the ice bends up until a crack is formed perpendicular to the direction of pressure. This results in the formation of a flat-sided arch with a cavity beneath that resembles a tent-like structure. Rafting, the most frequent movement, is the overriding of one floe on top of another.

When pieces of ice pile up haphazardly over one another and form a wall or line of broken ice, the process is known as ridging and the wall is referred to as a ridge. When this action results in the pressure ice having a surface consisting of numerous mounds, the process is known as hummocking. The surface is referred to as hummocked ice and each mound is referred to as a hummock. When weathered, hummocked ice has the appearance of smooth hillocks.

The ridges in pressure ice may be as high as 15m where grounded against a coast, but in deep water and away from the land they are usually no more than 10m high.

Massive detachments of ice resulting from hummocking are called floebergs. These should not be confused with icebergs, or growlers, which are of glacial origin.

Movement.—Any wind will tend to regroup ice that is more or less scattered over a considerable area. As the wind rises, the separate floes form lines at right angles to the wind direction. These lines break up when the wind changes and, after a time, realign themselves at right angles to the new wind direction. When the wind blows out from the coast, a channel of open water usually forms between the shore and the ice or any such existing channel increases in width. When the wind blows toward the coast, the fast ice tends to move closer to shore and reduce the width of any existing channel. If the wind is strong enough, hummocks may be produced along a line lying approximately at right angles to the wind direction.

The rate at which the different floes travel is not so much dependent upon the size and depth of the floe as upon the nature of its surface. Since pack ice is made up of a conglomeration of young ice, old floes, and icebergs, it varies radically in resistance to wind and current. Surface irregularities, such as hummocks and pressure ridges, act as sail areas. Hence, the rate of movement of a floe depends to a certain extent on the amount of hummocking in proportion to the area and weight of the floe. As a result of previous pressure, hummocked floes in turn become the cause of still further pressure. When two floes are moving at different rates, either the distance between them is increased and an open lane is produced or the distance between them is decreased and they are brought into physical contact. In gaining momentum, larger floes will accelerate more slowly. However, once underway, they will retain their motion long after smaller floes have stopped. Therefore, in the early stages, the large and heavy floes will be charged and overtaken by smaller floes. In the later stages, the smaller floes will be disrupted by the larger ones and their surface appearance will be changed. This process will then create new and further differences in the speed of their movement.

The swinging or turning of floes is due to the tendency of each cake of ice to trim itself to the wind when the cover is sufficiently open to permit this freedom of movement. In close pack ice, this tendency may be produced by pressure from another floe. Since floes continually hinder each other and the wind may not be constant in direction, even greater forces may result. Hence, the wind can also produce a rotating motion in the floe. This shearing or rotating effect results in excessive pressure at the projecting corners of floes and usually forms a hummock of loose ice blocks. The process of rotating is referred to as screwing and this action is extremely dangerous to vessels.

During its motion, ice opens up and closes like an accordion. There are always a certain number of lanes or leads present, otherwise the ice could not move. In summer, these lanes usually remain open, except in very high latitudes. However, in winter they are soon frozen over with young ice. In addition, the swell tends to break up the ice. Consequently, as a result of all these actions, the ice is alternately being broken up, even throughout the winter, and subjected to pressure.

Signs of Ice.—There are two reliable signs of drift ice, ice blink and abrupt smoothing. Ice blink, the reflection of ice on the lower clouds, is the indication that has been most used by experienced polar navigators. It is rarely, if ever, produced by bergs, but is nearly always distinct over consolidated and extensive pack ice. On clear days with a mostly blue sky, ice blink is reported to appear as a luminous yellow haze on the horizon in the direction of the ice. On days with an overcast sky or low clouds, it is reported to appear as a whitish glare on the clouds, the yellow color being absent. Under certain conditions, ice blink has appeared as brilliant, scintillating strips on the horizon.

Abrupt smoothing of the sea and the gradual decrease of the normal sea swell is a sign that drift ice lies to windward.

Other likely signs of ice include fog and the presence of birds.

In late spring and summer, a thick band of fog often lies over the edge of the drift ice. In fog, white patches indicate the presence of ice at a short distance.

In the Antarctic, the presence of the Antarctic Petrel or the Snow Petrel indicates the proximity of ice. The former bird is normally seen only within about 400 miles of the ice edge and the latter considerably closer.

The lowering of the sea surface temperature is reported to give little or no indication of the proximity of ice. However, if the surface temperature falls to 1˚C and the vessel is not in one of the main cold currents, the ice edge may be considered to lie between 100 and 150 miles distant. If the temperature falls to -0.5˚C, the nearest ice should generally be considered to lie not more than 50 miles distant.

Signs of Open Water.—Dark patches or steaks on the underside of low clouds, sometimes almost black in comparison with the clouds in general, usually indicate the presence of open water below them. This phenomena is known as water sky.

Like ice blink, water sky depends upon the greater absorption of sunlight by water than by ice or snow and the subsequent diffusion of the reflected light in the lower atmosphere.

Dark spots in fog give a similar indication, but are only visible at a short distance. A dark bank on the underside of a cloud at a high altitude indicates the existence of small patches of open water below which may connect with a larger distant area of open water.

The sound of a surge in the ice indicates the presence of large expanses of open water in the immediate vicinity.

When approaching ice, a darkness appearing on the low horizon indicates that there is probably open water beyond the ice, in some cases up to 40 miles or more beyond the visible horizon.

With a cloudless sky, no iceblink is possible although a yellow or white haze or glare on the horizon may indicate the presence of ice. However, abnormal refraction may occur. This effect raises the horizon and enables the observer to see the ice or patches of open water at greater distances than would normally be possible. The ice or area of open water, or a mixture of the two, may be seen as an erect or inverted image, or both images may be seen at once, one above the other. In the latter case, the erect image is the higher of the two. Allowance must also be made for the fact that refraction causes the apparent dimensions of ice to increase. Hence, sometimes bergy bits appear to be icebergs. Areas of open water often appear dark relative to the ice.

Drift.—While the general direction of the drift of icebergs over a long period of time is known, it may not be possible to predict the drift of an individual berg at a given place and time because bergs lying close together have been observed to move in opposite directions. Bergs usually move under the influence of the prevailing current at the depth to which they are submerged. Such currents may often be in opposition to the existing wind and current at the surface.

Drift ice moves with the wind and tide, usually to the left of the true wind in the S hemisphere and to the right in the N hemisphere. The speed of drift may not depend entirely upon the strength of the wind, since it is influenced greatly by the presence or absence of open water in the direction of the drift, even though the open water may be somewhat distant.

Neglecting the resistance of the ice, Ekman's theory of wind drift calls for the ice to drift 45˚ from the wind direction. Observations show that the actual drift is about 30˚ from the wind direction on the average, or very nearly parallel to the isobars on a weather map. In winter, when the ice is more closely packed and offers more resistance, its drift deviates less from the wind direction than in summer, and tidal influences become more important. Therefore, the speed of drift ice (pack ice) can be fairly closely determined from the wind speed.

Note.—The National Ice Center (NIC) operates MetFax which is a dial-up service. In order to receive MetFax, ships must have a facsimile (fax) machine with polling function capability. The products available include sea ice analysis and forecasts for the Antarctic.

To receive weather data charts from MetFax and access the autopolling system, receivers should dial (301) 763-3190 or 3191. When connected, receivers should follow the menu and select the data required. To access the system, a Personal Identification Number (PIN) is required which allows the NIC to identify users and requests in order to maximize services. PIN access is provided at no cost. For a PIN or further information concerning MetFax, send requests to the NIC at the following address:

National Ice Center
Federal Building No. 4
4251 Suitland Road
Washington D.C. 20395
Facsimile: (301) 457-5305

The National Climatic Data Center (NCDC) provides weekly Antarctic sea ice analysis charts on a mail subscription basis. For further information contact NCDC at the following address:

National Climatic Data Center (NCDC)
151 Patton Ave
Asheville NC 28801-5001
Telephone: (828) 271-4800
Facsimile: (828) 271-4876

For further information concerning ice, see Pub. No. 9, The American Practical Navigator (Bowditch-2002 Edition); or contact the National Science Foundation (NSF) at the following address:

National Science Foundation (NSF)
Office of Polar Programs (OPP)
4201 Wilson Boulevard
Arlington VA 22230
Telephone: (703) 292-8030
Faxcsimile: (703) 292-9081

Ice Terms

The following glossary provides definitions in general use for the many kinds of ice encountered at sea. The terms are based on the nomenclature established by the World Meteorological Organization (WMO).

Aged ridge.—A ridge which has undergone considerable weathering. These ridges are best described as undulations.

Anchor ice.—Submerged ice attached or anchored to the bottom, irrespective of its formation.

Area of weakness.—A satellite-observed area in which either the ice concentration or the ice thickness is significantly less than that in the surrounding areas. Because the condition is satellite observed, a precise quantitative analysis is not always possible, but navigation conditions are significantly easier than in surrounding areas.

Bare ice.—Ice without snow cover.

Belt.—A large feature of ice arrangement; longer than it is wide; from 1 km to more than 100 km in width.

Bergy bit.—A large piece of floating ice generally showing between 1 and 5m above sea-level and normally about 100 to 300m^2 in area.

Bergy water.—An area of freely navigable water in which ice of land origin is present in concentrations of less than one-tenth. There may be sea ice present, although the total concentration of all ice should not exceed one-tenth.

Beset.—Situation of a vessel surrounded by ice and unable to move.

Big floe.—See Floe.

Bight.—Extensive crescent-shaped indentation in the ice edge formed by either wind or current.

Brash ice.—Accumulations of floating ice made up of fragments not more than 2m wide.

Bummock.—From the point of view of the submariner, a downward projection from the underside of the ice canopy, the counterpart of a hummock.

Calving.—The breaking away of a mass of ice from an ice wall, ice front, glacier, or iceberg.

Close pack ice.—Pack ice in which the concentration is seven-tenths to eight-tenths, composed of floes mostly in contact.

Compacted ice edge.—A ridge which has undergone considerable Close, clear-cut ice edge compacted by wind or current, usually on the windward side of an area of pack ice.

Compacting.—Pieces of floating ice are said to be compacting when they are subjected to a converging motion, which increases ice concentration and/or produces stresses that may result in ice deformation.

Compact pack ice. —Pack ice in which the concentration is ten-tenths and no water is visible.

Concentration. —The ratio expressed in tenths describing the amount of the sea surface covered by floating ice as a fraction of the whole area being considered. Total concentration includes all stages of development that are present. Partial concentration may refer to the amount of a particular stage or of a particular form of ice and represents only a part of the total.

Concentration boundary.—A line approximating to the transition between two areas of pack ice with distinctly different concentrations.

Consolidated pack ice.—Pack ice in which the concentration is ten-tenths and the floes are frozen together.

Consolidated ridge.—A ridge in which the base has frozen together.

Crack.—Any fracture of fast ice, consolidated ice, or a single floe which has been followed by a separation ranging from a few centimeters to 1m.

Dark nilas.—Nilas which is under 5cm in thickness and is very dark in color.

Deformed ice.—A general term for ice which has been squeezed together and in places forced upwards (and downwards). Subdivisions are rafted ice, ridged ice, and hummocked ice.

Difficult area.—A general qualitative expression to indicate, in a relative manner, that the severity of ice conditions prevailing in an area is such that navigation in it is difficult.

Diffused ice edge.—Poorly defined ice edge limiting an area of dispersed ice; usually on the leeward side of ice.

Diverging.—Ice fields or floes in an area are subjected to diverging or dispersive motion; hence, reducing ice concentration and/or relieving stresses in the ice.

Dried ice.—Sea ice from the surface of which melt water has disappeared after the formation of cracks and thaw holes. During the period of drying, the surface whitens.

Drift ice.—Term used in a wide sense to include any area of sea ice other than fast ice no matter what form it takes or how it is dispersed. When concentrations are high, i.e. seven-tenths or more, drift ice may be replaced by the term pack ice.

Easy area.—A general qualitative expression to indicate, in a relative manner, that ice conditions prevailing in an area are such that navigation is not difficult.

Fast ice.—Sea ice which forms and remains fast along the coast, where it is attached to the shore, to an ice wall, to an ice front, between shoals or grounded icebergs. Vertical fluctuations may be observed during changes of sea level. Fast ice may be formed in situ (in its original place) from sea water or by the freezing of drift ice of any stage to the shore. It may extend a few meters or several hundred kilometers from the coast. Fast ice may be more than 1 year old and may then be prefixed with the appropriate age category (second-year or multi-year). If it is thicker than about 2m above sea-level, it is called an ice shelf.

Fast ice boundary.—The ice boundary at any given time between fast ice and drift ice.

Fast ice edge.—The demarcation at any given time between fast ice and open water.

Finger rafted ice.—Type of rafted ice in which floes thrust "fingers" alternately over and under the other.

Finger rafting.—Type of rafting whereby interlocking thrusts are formed, each floe thrusting "fingers" alternately over and under the other. Common in nilas and gray ice.

Firn.—Old snow which has recrystallized into a dense material. Unlike snow, the particles are to some extent joined together. However, unlike ice, the air spaces in it still connect with each other.

First-year ice.—Sea ice of not more than one winter's growth developing from young ice. It has a thickness of from 30cm to 2m and may be subdivided into thin first-year ice/white ice, medium first-year ice, or thick first-year ice.

Flaw.—A narrow separation zone between pack ice and fast ice, where the pieces of ice are in a chaotic state; it forms when pack ice shears under the effect of a strong wind or current along the fast ice boundary.

Flaw lead.—A passageway between (pack) drift ice and fast ice which is navigable by surface vessels.

Flaw polynya.—A polynya between pack ice and fast ice.

Floating ice.—Any form of ice found floating in water. The principal kinds of floating ice are lake ice, river ice, and sea ice, which form by the freezing of water at the surface, and glacier ice (ice of land origin), which is formed on land or in an ice shelf. The concept includes ice that is stranded or grounded.

Floe.—Any relatively flat piece of sea ice 20m or more wide. Floes are subdivided according to horizontal extent, as follows:

1. Giant—over 10 km wide
2. Vast—2 to 10 km wide
3. Big—500 to 2,000m wide
4. Medium—100 to 500m wide
5. Small—20 to 100m wide

Floeberg.—A massive piece of sea ice composed of a hummock, or a group of hummocks, frozen together and separated from any ice surroundings. It may protrude up to 5m above sea level.

Flooded ice.—Sea ice which has been flooded by melt-water or river water and is heavily loaded by water and wet snow.

Fracture.—Any break or rupture through very close ice, compact ice, consolidated ice, fast ice, or a single floe resulting from deformation processes. Fractures may contain brash ice and/or be covered with nilas and/or young ice. Their length may vary from a few meters to many kilometers.

Fracture zone.—An area which has a great number of fractures.

Fracturing.—Pressure process whereby ice is permanently deformed and rupture occurs. Most commonly used to describe breaking across very close ice, compact ice, or consolidated ice.

Frazil ice.—Fine spicules or plates of ice suspended in water.

Friendly ice.—From the point of view of the submariner, an ice canopy containing many large skylights or other features which permit a submarine to surface. There must be more than ten such features per 30 nautical miles (56 km) along the submarine's track.

Frost smoke.—Fog-like clouds due to the contact of cold air with relatively warm water, which can appear over openings in the ice, or to leeward of the ice edge, and which may persist while ice is forming.

Giant floe.—See Floe.

Glacier.—A mass of snow and ice continuously moving from higher to lower ground or, if afloat, continuously spreading. The principal forms of glacier are inland ice sheets, ice shelves, ice streams, ice caps, ice piedmonts, cirque glaciers, and various types of mountain (valley) glaciers.

Glacier berg.—An irregularly-shaped iceberg.

Glacier ice.—Ice in, or originating from, a glacier, whether on land or floating in the sea as icebergs, bergy bits, or growlers.

Glacier tongue.—Projecting seaward extension of a glacier, usually afloat. In the Antarctic, glacier tongues may extend for over many tens of kilometers.

Grease ice.—A later stage of freezing than frazil ice when the crystals have coagulated to form a soupy layer on the surface. Grease ice reflects little light, giving the sea a matte appearance.

Grey (gray) ice.—Young ice 10 to 15cm thick. Less elastic than nilas and breaks on swell. Usually rafts under pressure.

Grey (gray)-white ice.—Young ice 15 to 30cm thick. Under pressure more likely to ridge than to raft.

Grounded hummock.—Hummocked grounded ice formation. There are single grounded hummocks and lines (or chains) of grounded hummocks.

Grounded ice.—Floating ice which is aground in shoal water (See Stranded ice).

Growler.—Smaller piece of ice than a bergy bit or floeberg, often transparent but appearing green or almost black in color, extending less than 1m above the sea surface and normally occupying an area of about $20m^2$.

Hostile ice.—From the point of view of the submariner, an ice canopy containing no large skylights or other features which permit a submarine to surface.

Hummock.—A hillock of broken ice which has been forced upwards by pressure. May be fresh or weathered. The submerged volume of broken ice under the hummock, forced downwards by pressure, is termed a bummock.

Hummocked ice.—Sea ice piled haphazardly one piece over another to form an uneven surface. When weathered, it has the appearance of smooth hillocks.

Hummocking.—The pressure process by which sea ice is forced into hummocks. When the floes rotate in the process it is termed screwing.

Iceberg.—A massive piece of ice of greatly varying shape, protruding more than 5m above sea level, which has broken away from a glacier. May be afloat or aground. Icebergs may be described as tabular, dome-shaped, sloping, pinnacled, weathered, or glacier bergs.

Iceberg tongue.—A major accumulation of icebergs projecting from the coast, held in place by grounding and joined together by fast ice.

Ice blink.—A whitish glare on low clouds above an accumulation of distant ice.

Ice bound.—A harbor, inlet, etc. is said to be ice bound when navigation by ships is prevented on account of ice, except possibly with the assistance of an icebreaker.

Ice boundary.—The demarcation at any given time between fast ice and drift ice or between areas of drift ice of different concentrations (See Ice edge).

Ice breccia.—Ice of different stages of development frozen together.

Ice cake.—Any relatively flat piece of sea ice less than 20m wide.

Ice canopy.—Drift ice from the point of view of the submariner.

Ice cover.—The ratio of an area of ice of any concentration to the total area of sea surface within some large geographic locale; this locale may be global, hemispheric, or prescribed by a specific oceanographic entity such as Baffin Bay or the Barents Sea.

Ice edge.—The demarcation at any given time between the open sea and sea ice of any kind, whether fast or drifting. It may be termed compacted or diffuse (See Ice boundary).

Ice field.—Area of floating ice consisting of any size of floes, which is greater than 10km wide (See ice patch).

Ice foot.—A narrow fringe of ice attached to the coast, unmoved by tides and remaining after the fast ice has moved away.

Ice-free.—No sea ice present. There may be some ice of land origin present (See Open water).

Ice front.—The vertical cliff forming the seaward face of an ice shelf or other floating glacier varying in height from 2 to 50m or more above sea level (See Ice wall).

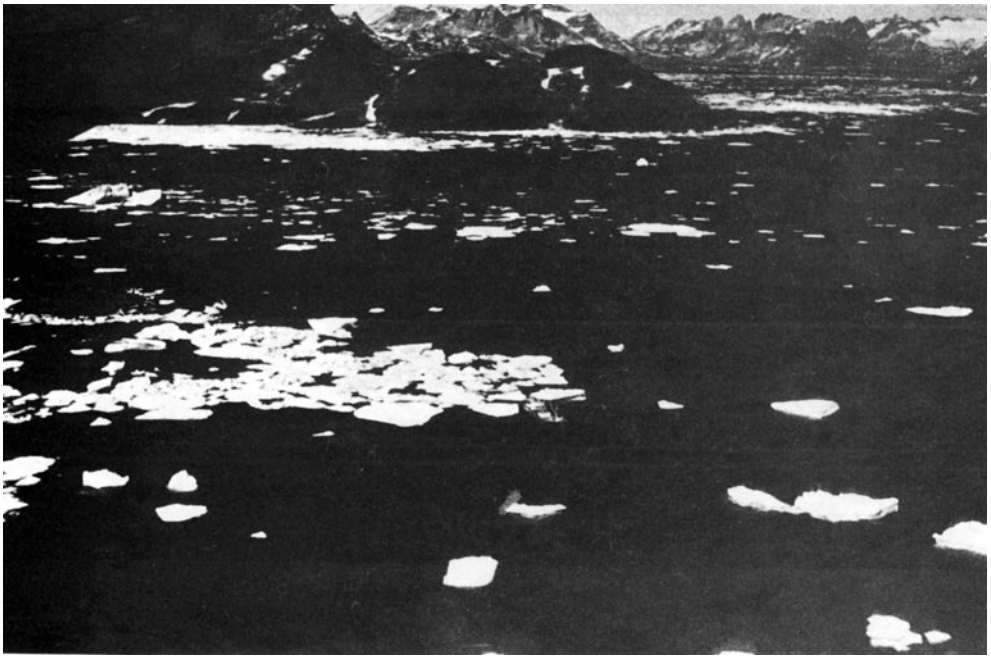
Ice island.—A large piece of floating ice protruding about 5m above the sea level which has broken away from an Antarctic ice shelf, having a thickness of from 30 to 50m, and an area of from a few thousand square meters to $500km^2$ or more. Usually characterized by a regularly undulating surface which gives it a ribbed appearance from the air.

Ice jam.—An accumulation of broken river ice or sea ice caught in a narrow channel.

Ice keel.—From the point of view of the submariner, a downward-projecting ridge on the underside of the ice canopy; the counterpart of a ridge. Ice keels may extend as much as 50m below the sea level.

Ice limit.—Climatological term referring to the extreme minimum or maximum extent of the ice edge in any given month or period based on observations over a number of years. Term should be preceded by minimum and maximum (See Mean ice edge).

Ice massif.—A variable accumulation of close or very close drift ice (pack ice) covering hundreds of square kilometers which is found in the same regions every summer.



H.H. Valeur—Denmark

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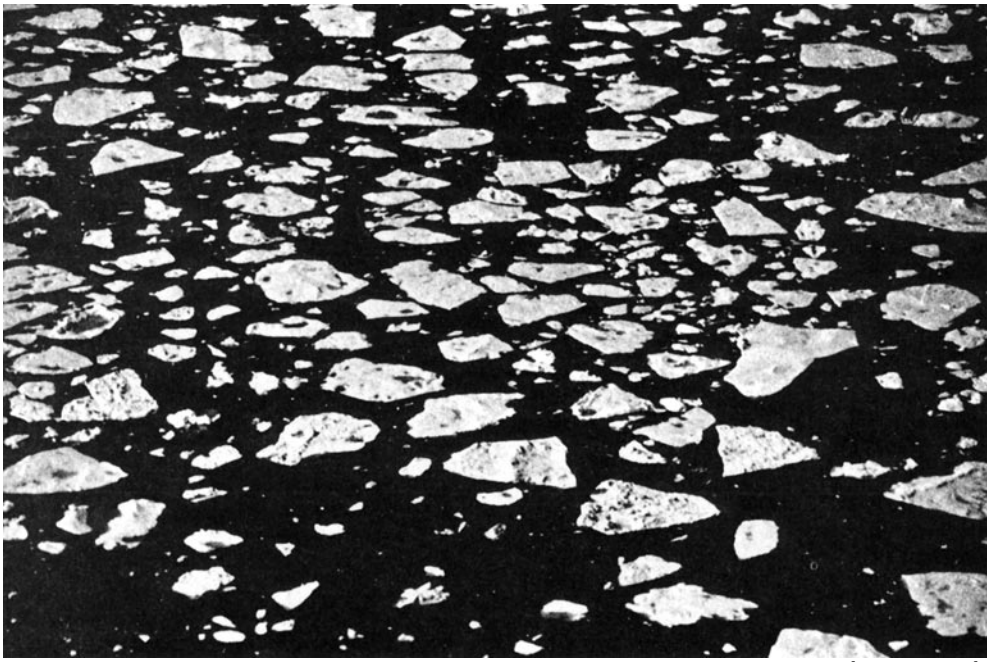
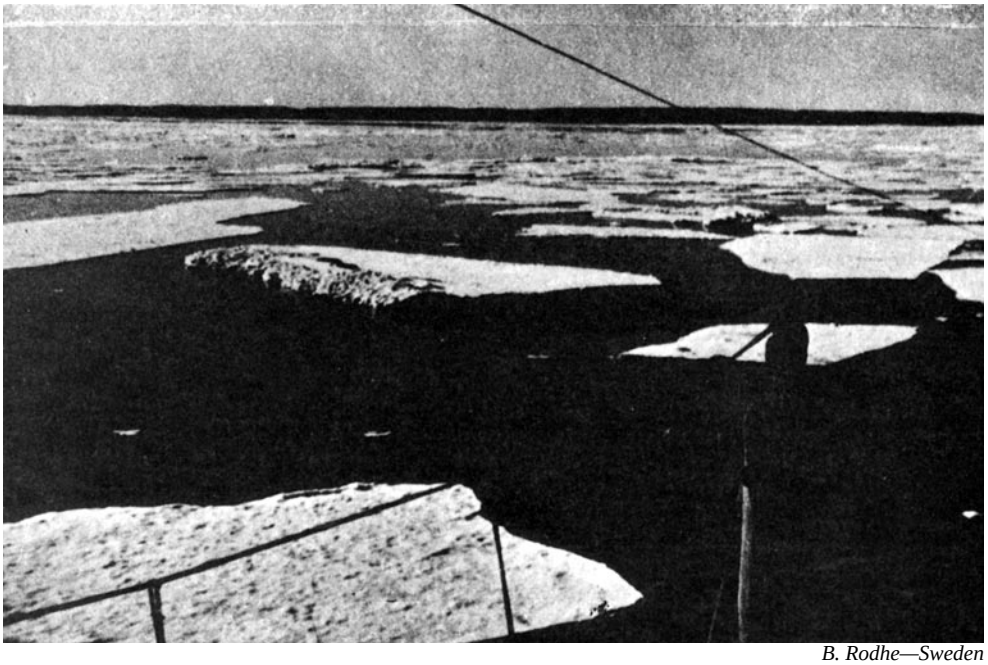
VERY OPEN PACK ICE

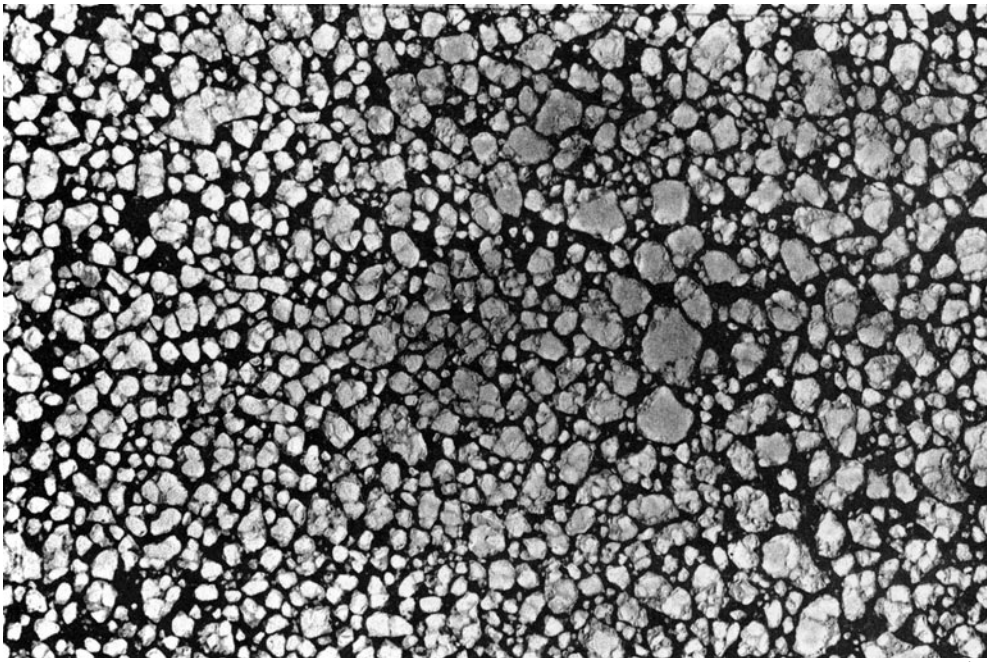


H.H. Valeur—Denmark



B. Rodhe—Sweden

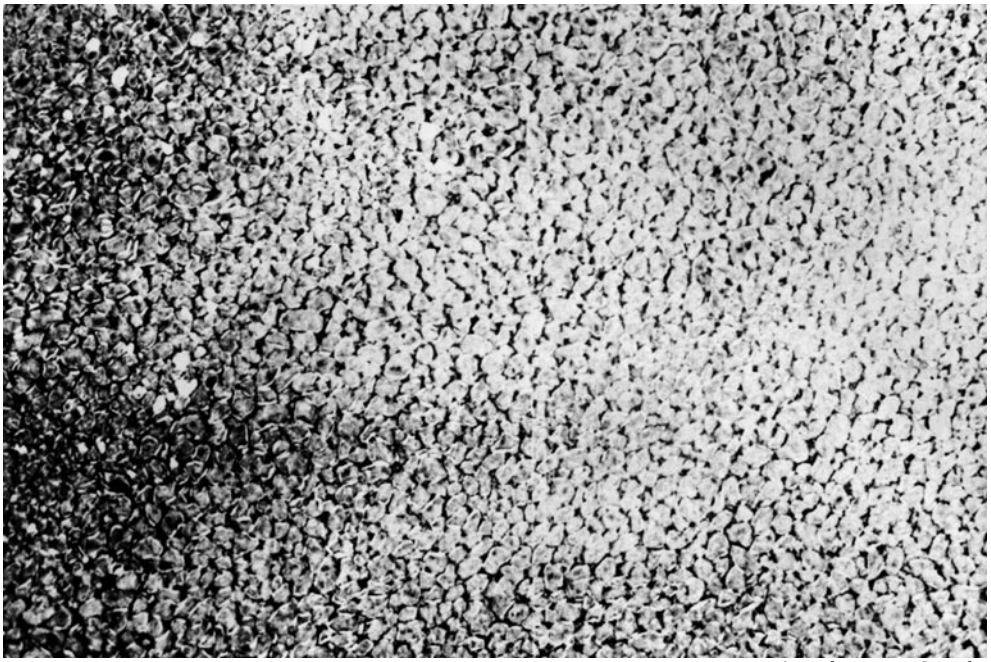
OPEN PACK ICE



Russia

R. Van Humbeck—Canada

CLOSE PACK ICE



Armed Forces—Canada

Hamburg—Germany

VERY CLOSE PACK ICE

Armed Forces—Canada

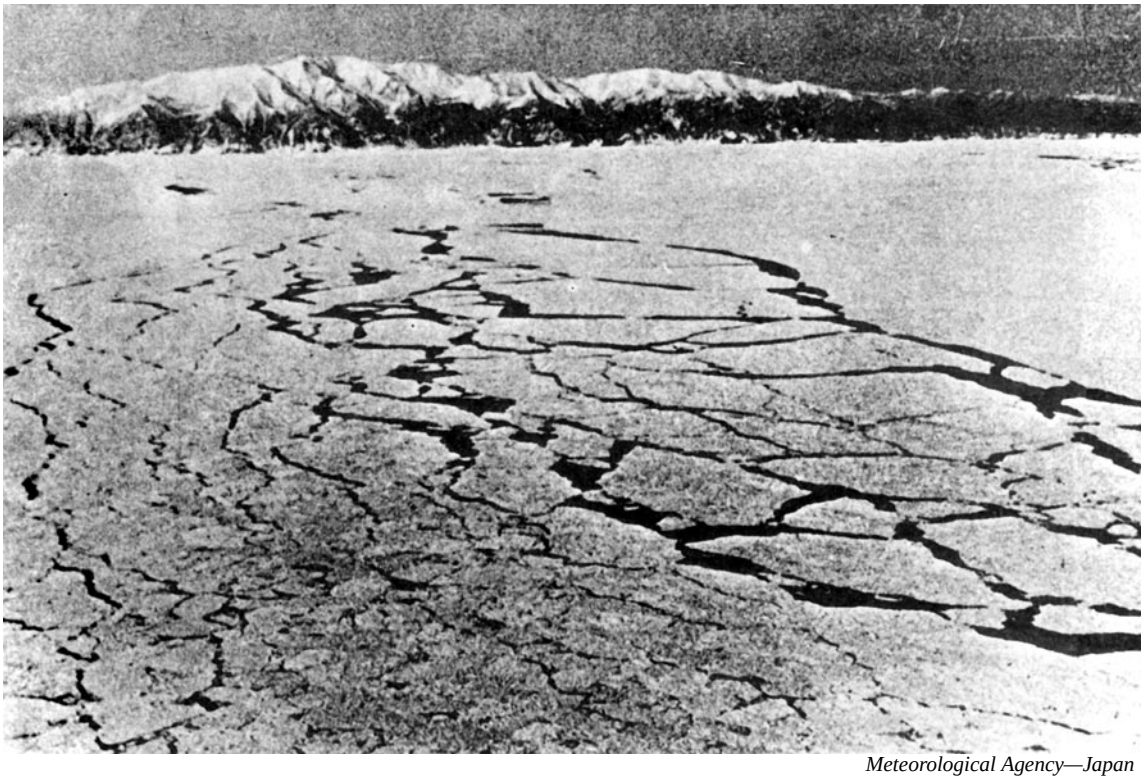
Meteorological Agency—Japan

COMPACT PACK ICE

Armed Forces—Canada

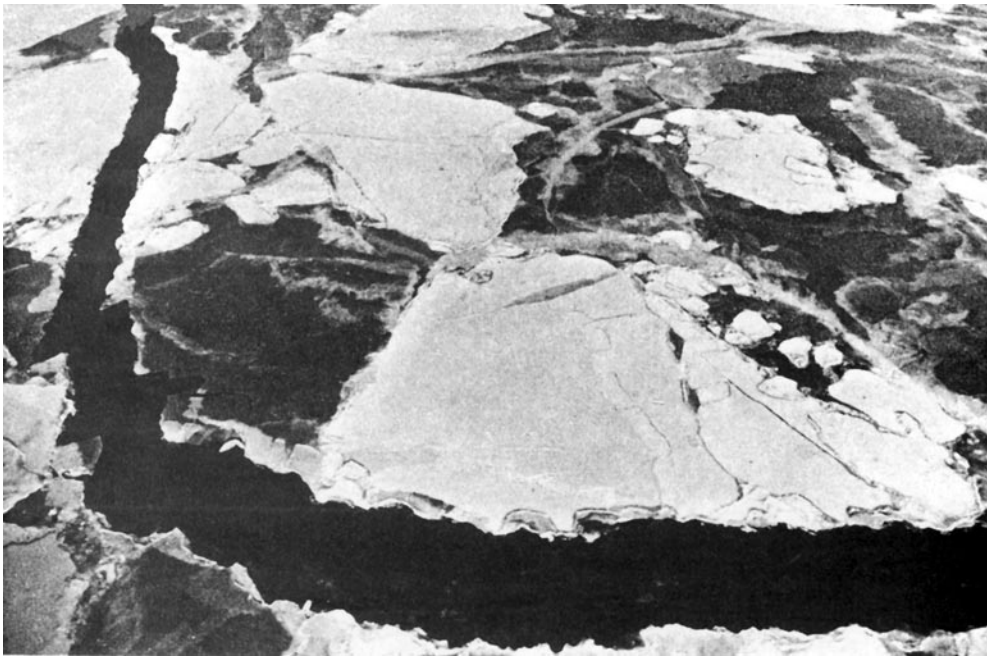
J.F. Hurley—United Kingdom

CONSOLIDATED PACK ICE



Meteorological Agency—Japan

FRACTURE ZONE



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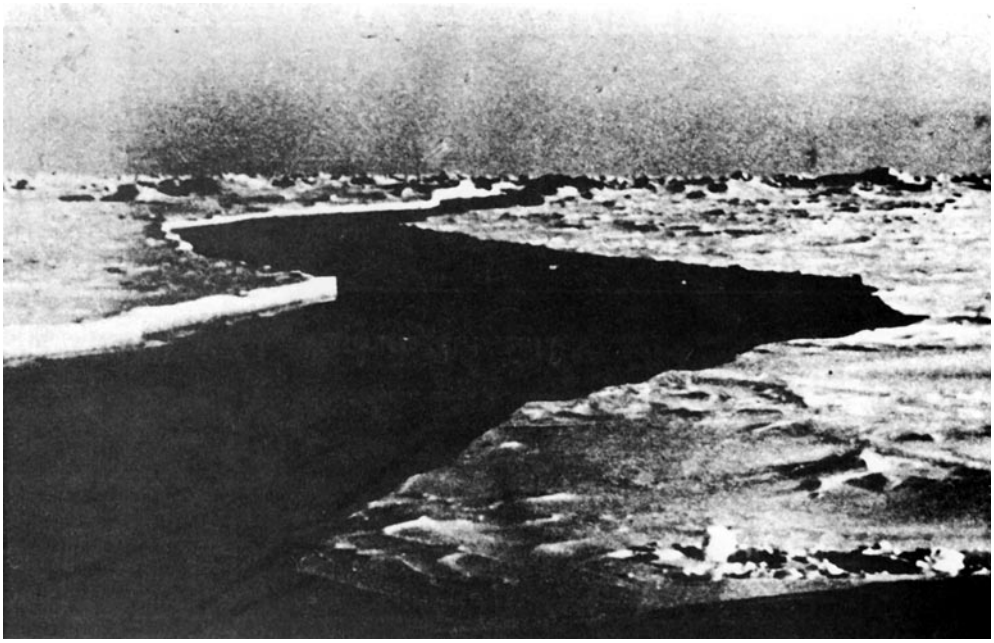
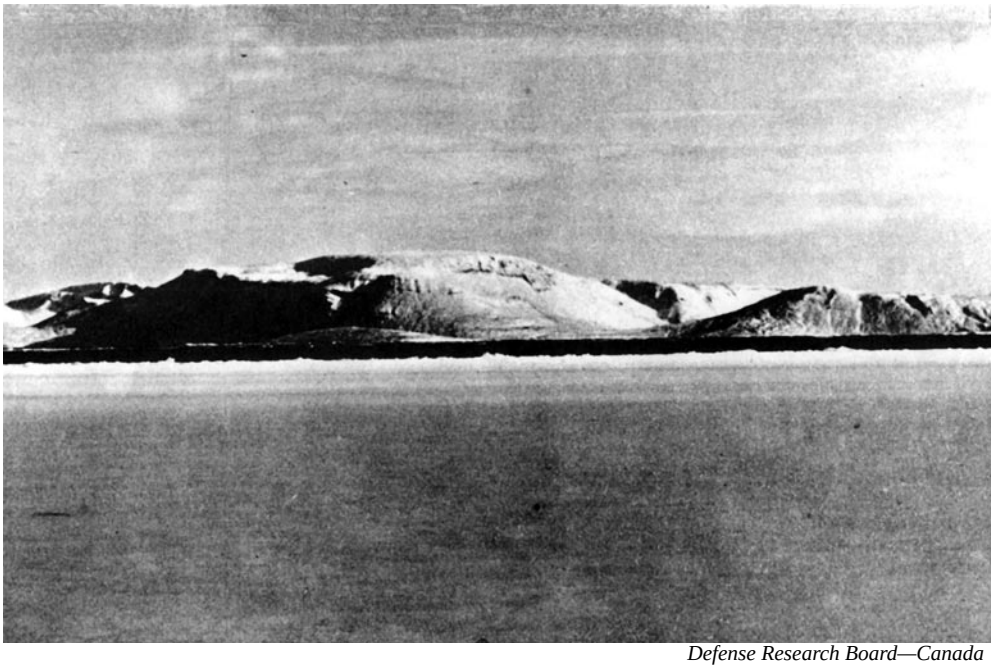


N.M. Shakirov—Russia

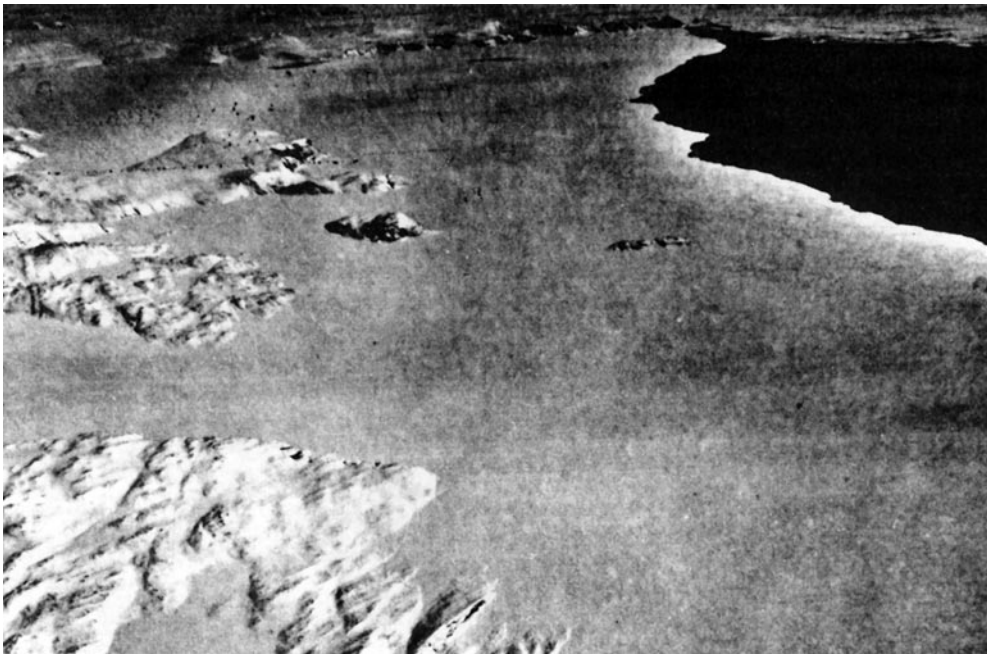
LEAD

Trans-Antarctic Expedition—United Kingdom



Defense Research Board—Canada

SHORE LEAD

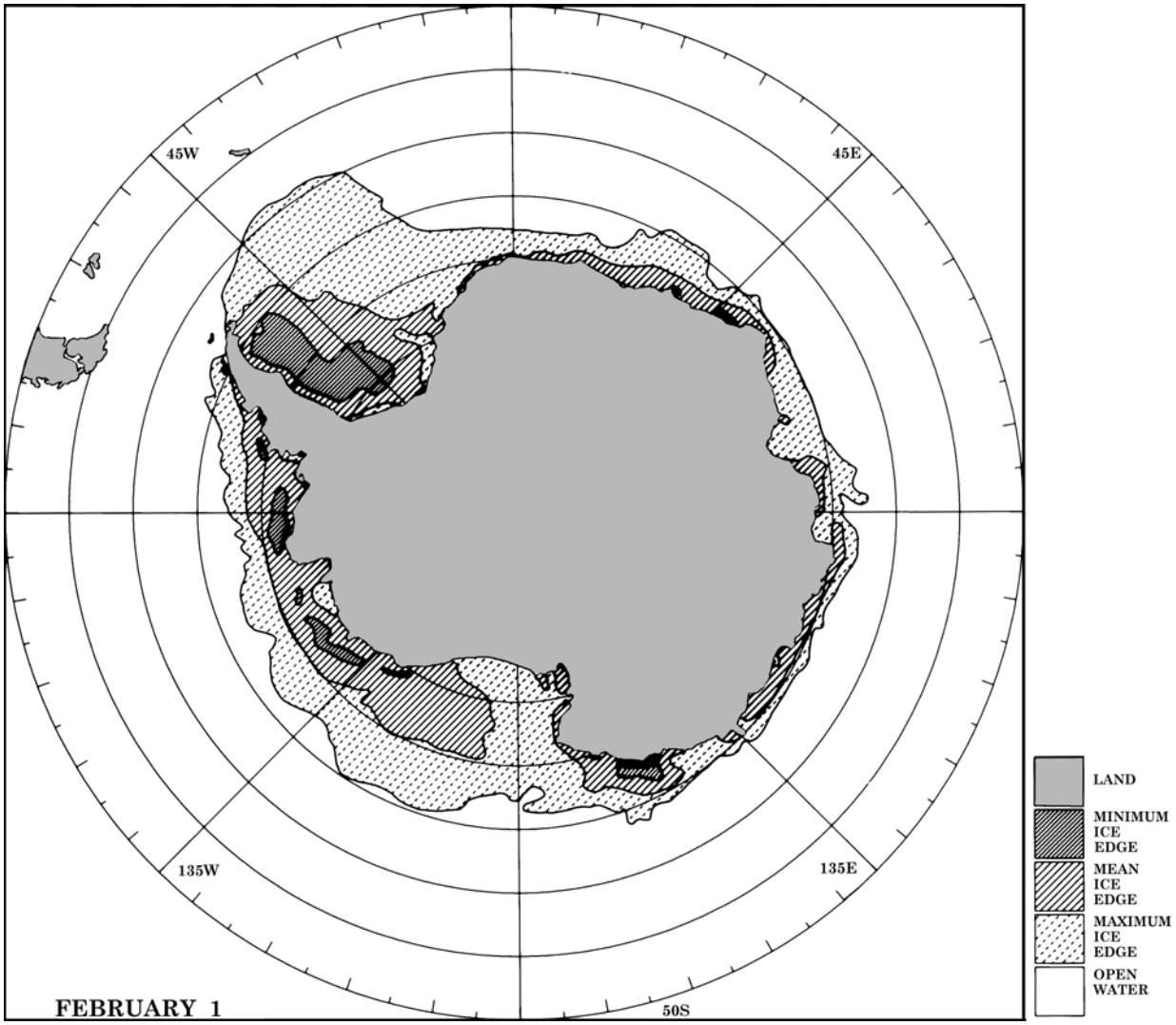


Armed Forces—Canada

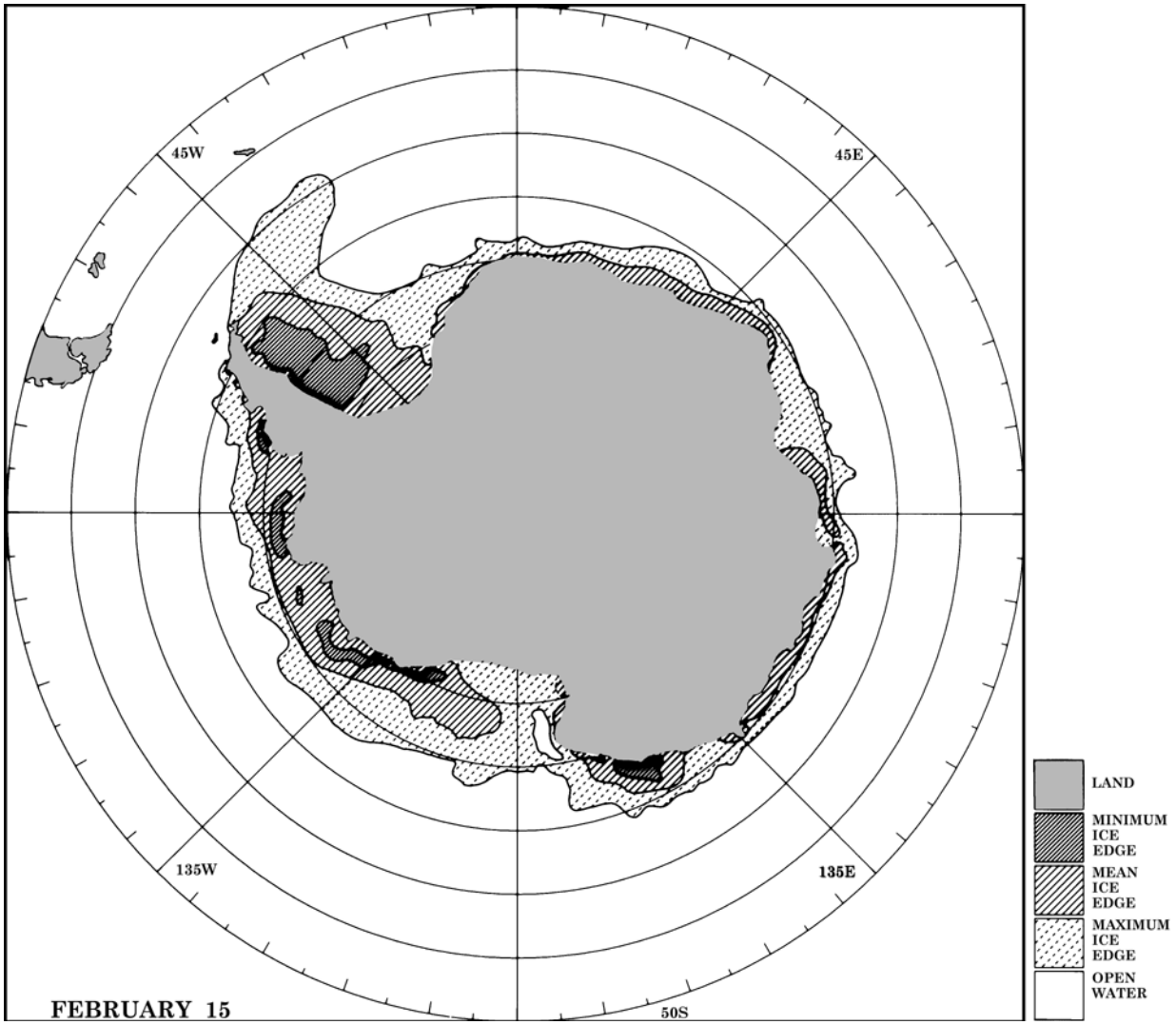
V.A. Voevodin—Russia

FLAW LEAD

MAXIMUM — MEAN — MINIMUM ICE EDGES



MAXIMUM — MEAN — MINIMUM ICE EDGES



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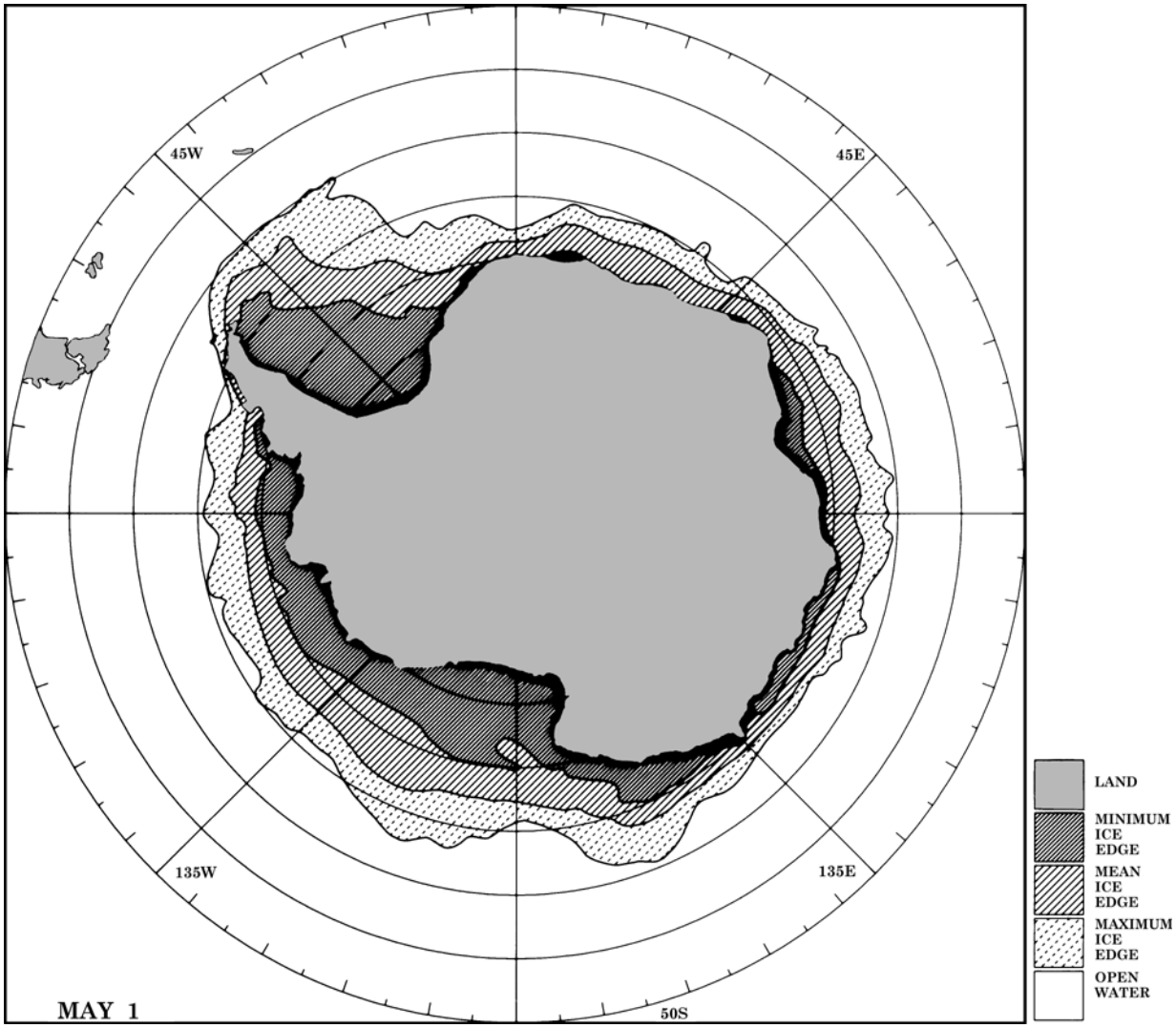

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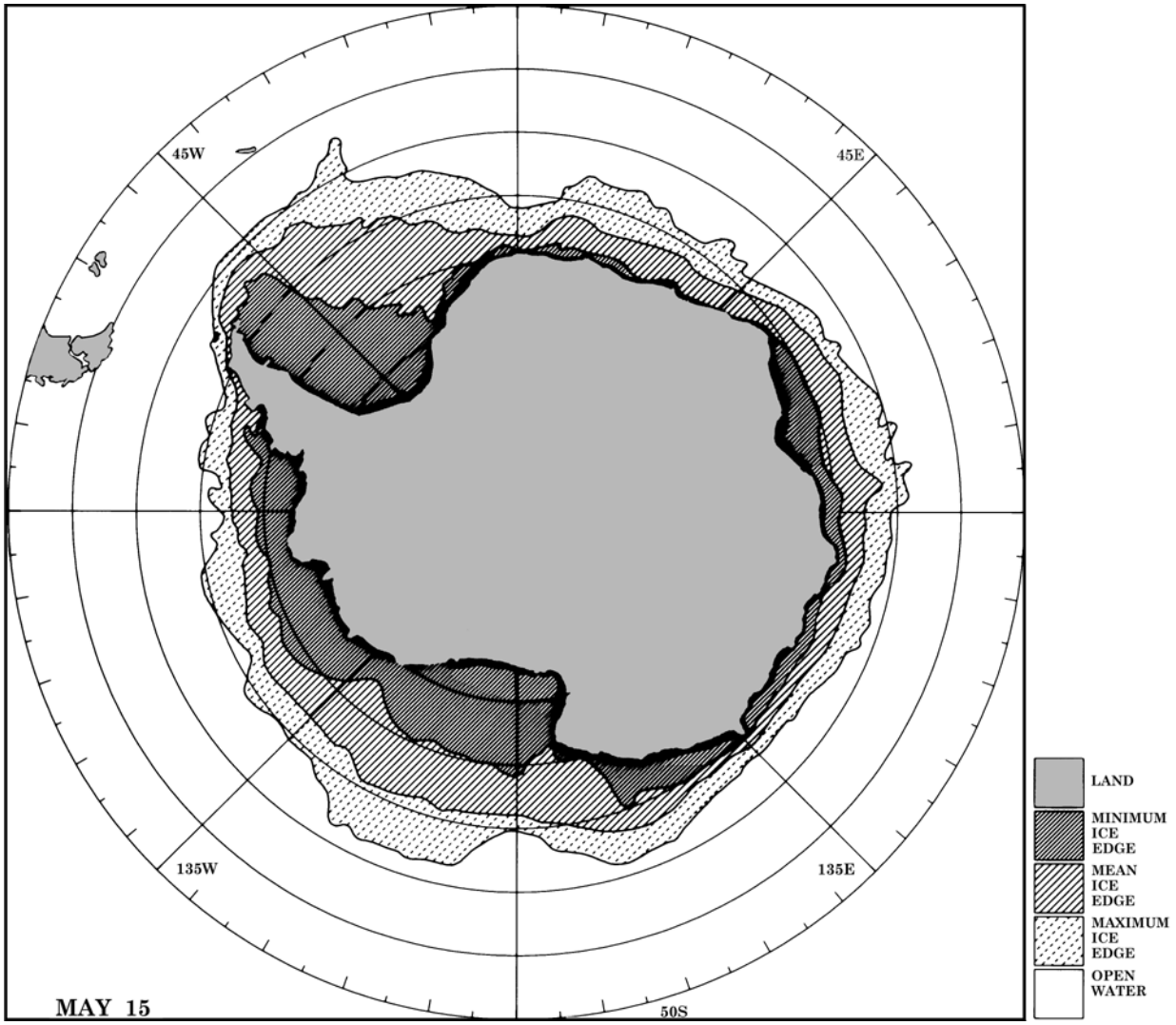

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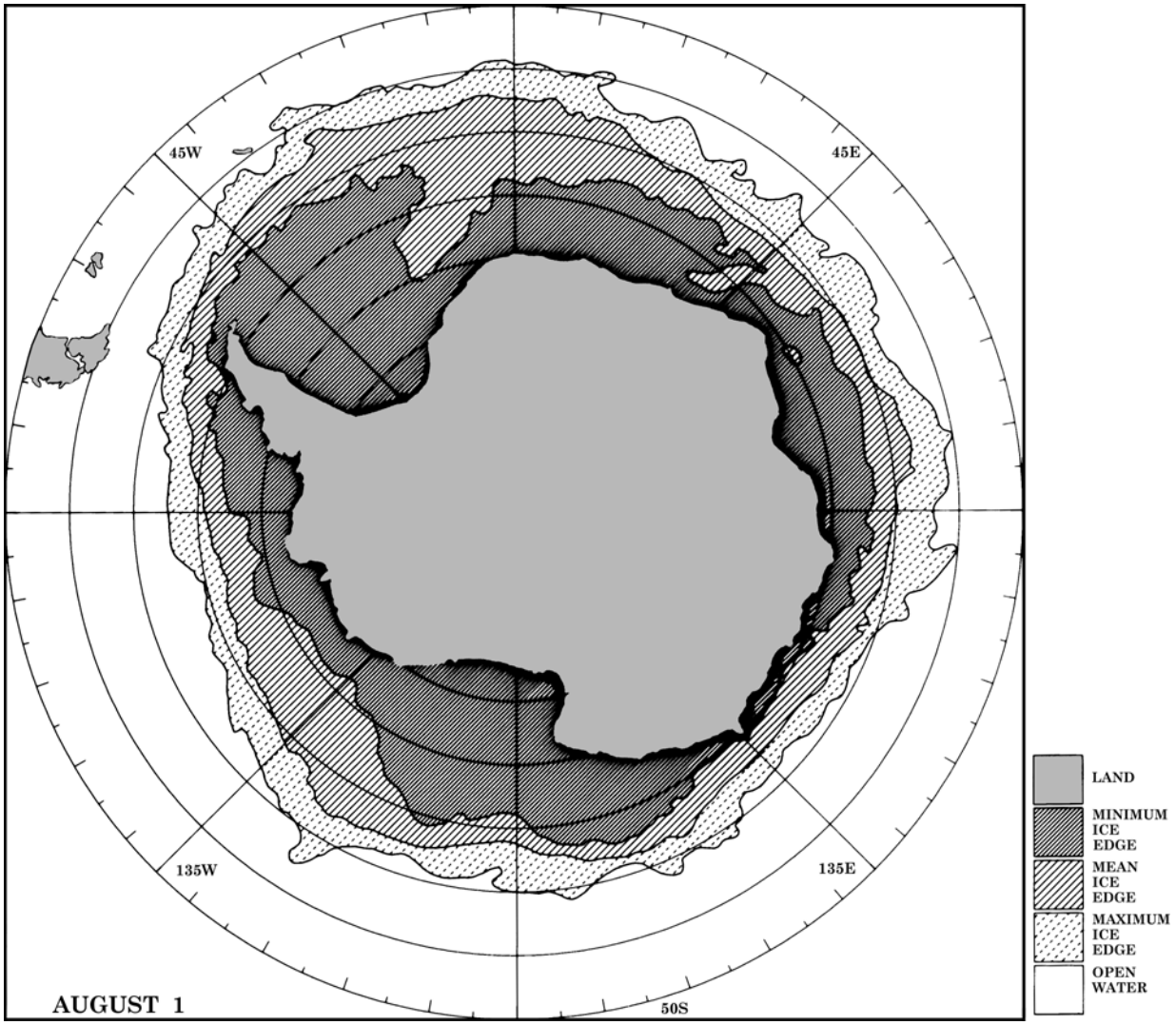

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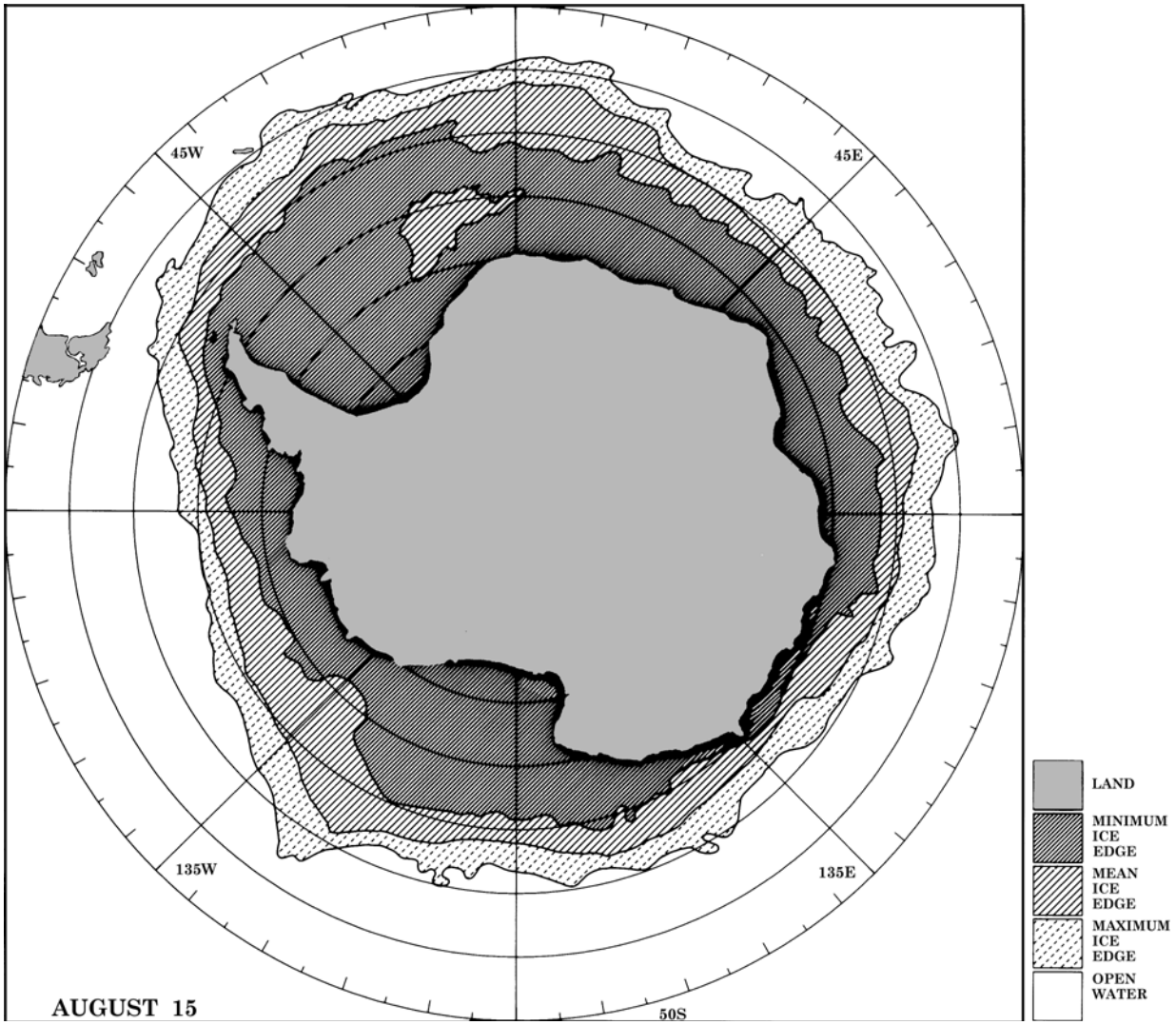

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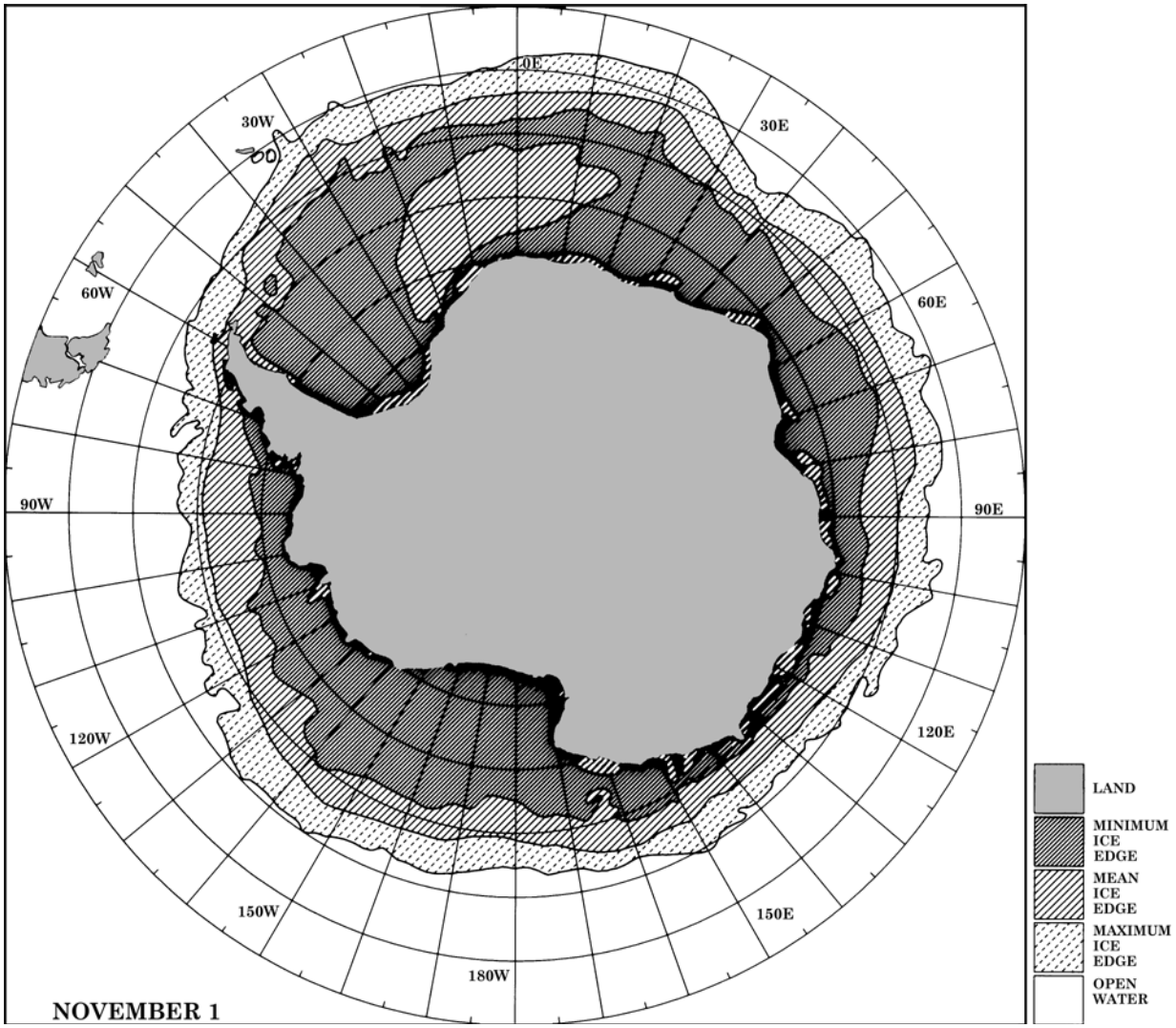

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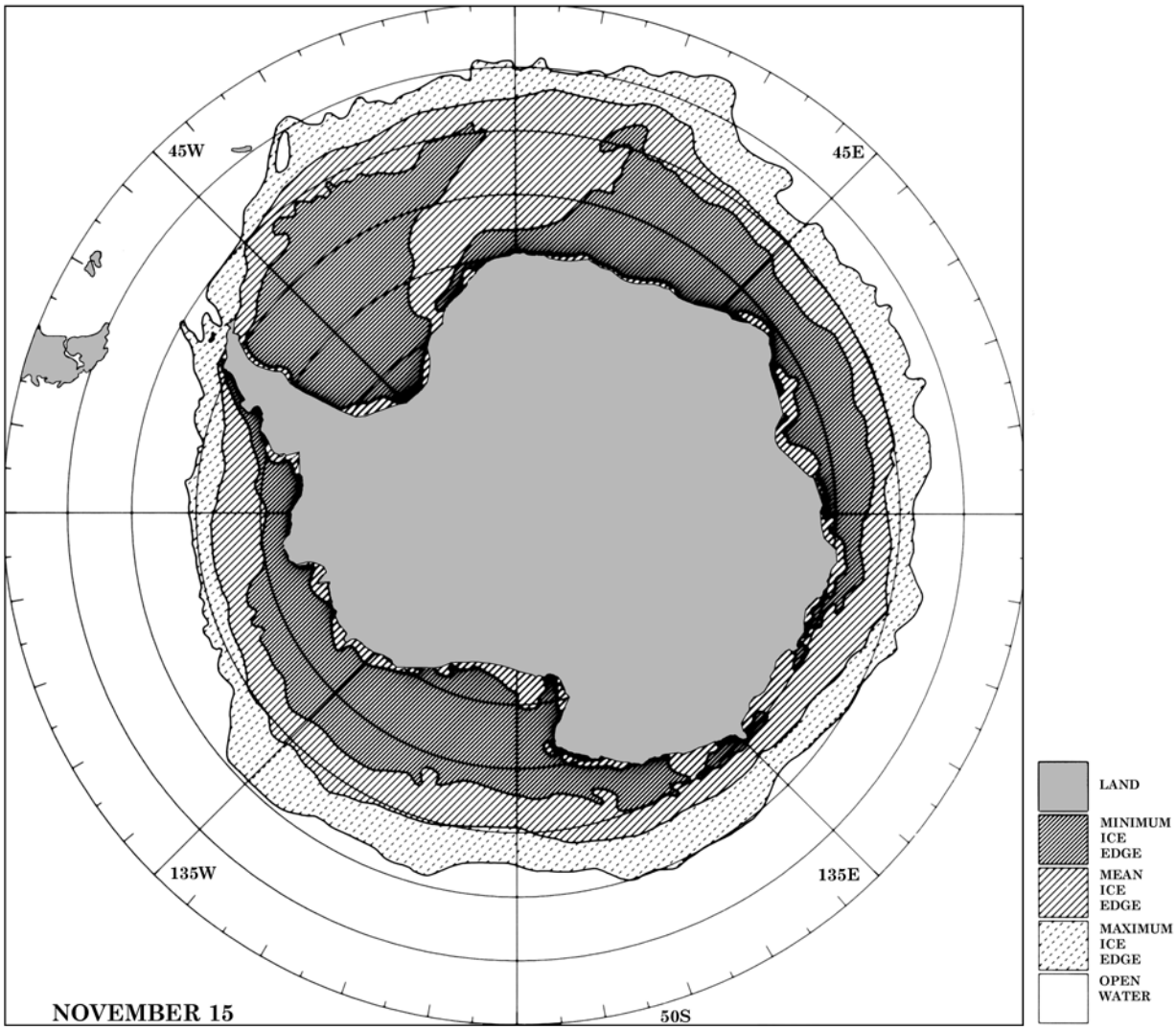


Ice of land origin.—Ice formed on land or in an ice shelf, found floating in water. The concept includes ice that is stranded or grounded.

Ice patch.—An area of pack ice less than 10km wide.

Ice port.—An embayment (indentation) in an ice front, often of a temporary nature, where ships can moor alongside and unload directly onto the ice shelf.

Ice rind.—A brittle shiny crust of ice formed on a quiet surface by direct freezing or formation of grease ice, usually in water of low salinity. Thickness to about 5cm. Easily broken by wind or swell, commonly breaking in rectangular pieces.

Ice shelf.—A floating ice sheet of considerable thickness showing 2 to 50m or more above sea level, attached to the coast. Usually of great horizontal extent and with a level or gently undulating surface. Nourished by annual snow accumulation and often also by the seaward extension of land glaciers. Limited areas may be aground. The seaward edge is termed an ice front.

Ice stream.—Part of an inland ice sheet in which the ice flows more rapidly and not necessarily in the same direction as the surrounding ice. The margins are sometimes clearly marked by a change in the direction of the surface slope, but may be indistinct.

Ice under pressure.—Ice in which deformation processes are actively occurring and therefore a potential impediment or danger to shipping.

Ice wall.—An ice cliff forming the seaward margin of a glacier which is not afloat. An ice wall is aground, the rock basement being at or below sea level (See Ice front).

Jammed brash barrier.—A strip or narrow belt of new, young, or brash ice (usually 100 to 5,000m wide), formed at the edge of either drift or fast ice or at the shore. It is heavily compacted mostly due to wind action and may extend from 2 to 20m below the surface but does not normally have appreciable topography. Jammed brash barriers may disperse with changing winds but can also consolidate to form a strip of unusually thick ice as compared to the surrounding drift ice.

Lake ice.—Ice formed on a lake, regardless of observed location.

Large fracture.—Fracture more than 500m wide.

Large ice field.—An ice field over 20km wide.

Lead. Any fracture or passage-way through sea ice which is navigable by surface vessels.

Level ice.—Sea ice which is unaffected by deformation.

Light nilas.—Nilas which is more than 5 centimeters in thickness and rather lighter in color than a dark nilas.

Mean ice edge.—Average position of the ice edge in any given month or period based on observations over a number of years. Other terms which may be used are mean maximum ice edge and mean minimum ice edge (See Ice limit).

Medium first-year ice.—First-year ice 70 to 120cm thick.

Medium floe.—See Floe.

Medium fracture.—Fracture 200 to 500m wide.

Medium ice field.—An ice field 15 to 20km wide.

Multi-year ice.—Old ice up to 3m or more thick which has survived at least two summers' melt. Hummocks even smoother than in second-year ice, and the ice is almost salt-free. Color, where bare, is usually blue. Melt pattern consists of large interconnecting irregular puddles and a well-developed drainage system.

New ice.—A general term for recently formed ice which includes frazil ice, grease ice, slush, and shuga. These types of ice are composed of ice crystals which are only weakly frozen together (if at all) and have a definite form only while they are afloat.

New ridge.—Ridge newly formed with sharp peaks and slope of sides usually 40˚. Fragments are visible from the air at low altitude.

Nilas.—A thin elastic crust of ice, easily bending on waves and swell under pressure, thrusting in a pattern of interlocking "fingers" (finger rafting). Has a matte surface and is up to 10 centimeters in thickness. May be subdivided into dark nilas and light nilas.

Nip.—Ice is said to nip when it forcibly presses against a ship. A ship so caught, though undamaged, is said to have been nipped.

Old ice.—Sea ice which has survived at least one summer's melt, thickness up to 3m or more. Most topographic features are smoother than on first-year ice. May be subdivided into second-year ice and multi-year ice.

Open ice.—Floating ice in which the concentration is four-tenths to six-tenths with many leads and polynyas, and the floes are generally not in contact with one another.

Open water.—A large area of freely navigable water in which sea ice is present in concentrations less than one-tenth. When there is no sea ice present, the area should be termed ice free.

Pack ice.—Concentration of seven-tenths or more of drift ice (See Drift ice). (The term was formally used for all ranges of concentration.)

Pancake ice.—Predominantly circular pieces of ice from 30cm to 3m in diameter. Up to about 10m in thickness with raised rims due to the pieces striking up against one another. It may be formed on a slight swell from grease ice, shuga, or slush or as a result of the breaking of ice rind, nilas, or under severe conditions of swell or waves, of gray ice. It also sometimes forms at some depth, at an interface between water bodies of different physical characteristics, from where it floats to the surface. Its appearance may rapidly cover wide areas of water.

Polynya.—Any non-linear shaped opening enclosed in ice. Polynyas may contain brash ice and/or be covered with new ice, nilas, or young ice. Submariners refer to these as skylights. Sometimes the polynya is limited on one side by the coast and is called a shore polynya or by fast ice and is called a flaw polynya. If it recurs in the same position every year, it is called a recurring polynya.

Puddle.—An accumulation of melt-water on ice, mainly due to the melting of snow, but in the more advanced stages also to the melting of the ice. Initial stage consists of patches of melted snow.

Rafted ice.—Type of deformed ice formed by one piece of ice overriding another (See Finger rafting).

Rafting.—Pressure processes whereby one piece of ice overrides another. Most common in the new and young ice (See Finger rafting).

Ram.—An underwater ice projection extending from an ice wall, ice front, iceberg, or floe. Its formation is usually due to a more intensive melting and erosion of the unsubmerged part.

Recurring polynya.—A polynya which recurs in the same position every year.

Ridge.—A line or wall of broken ice forced up by pressure. May be fresh or weathered. The submerged volume of broken ice under a ridge, forced downwards by pressure, is termed an ice keel.

Ridged ice.—Ice piled haphazardly one piece over another in the form of ridges or walls. Usually found in first-year ice (See Ridging).

Ridged ice zone.—An area in which much ridged ice with similar characteristics has formed.

Ridging.—The pressure process by which sea ice is forced into ridges.

River ice.—Ice formed on a river, regardless of observed location.

Rotten ice.—Sea ice which has become honeycombed and which is in an advanced state of disintegration.

Sastrugi.—Sharp, irregular ridges formed on a snow surface by wind erosion and deposition. On mobile floating ice, the ridges are parallel to the direction of the prevailing wind at the time they were formed.

Sea ice.—Any form of ice found at sea which has originated from the freezing sea water.

Second-year ice.—Old ice which has survived only one summer's melt. Thickness up to 2.5m and sometimes more. Because it is thicker than first-year ice, it stands higher out of the water. In contrast to multi-year ice, summer melting produces a regular pattern of numerous small puddles. Bare patches and puddles are usually greenish-blue.

Shearing.—An area of ice is subject to shear when the ice motion varies significantly in the direction normal to the motion, subjecting the ice to rotational forces. These forces may result in phenomena similar to flaw.

Shear ridge.—An ice ridge formation which develops when one ice feature is grinding past another. This type of ridge is more linear than those caused by pressure alone.

Shear ridge field.—Many shear ridges side by side.

Shore lead.—A lead between drift ice and the shore, or between drift ice and an ice front.

Shore melt.—Open water between the shore and the fast ice, formed by melting and/or due to river discharge.

Shore polynya.—A polynya between drift ice and the coast, or between drift ice and an ice front.

Shore ice ride-up.—A process by which ice is pushed ashore as a slab.

Shuga.—An accumulation of spongy white ice lumps, a few centimeters wide; they are formed from grease ice or slush and sometimes from anchor ice rising to the surface.

Skylight.—From the point of view of the submariner, thin places in the ice canopy, usually less than 1m thick and appearing from below as relatively light, translucent patches in dark surroundings. The undersurface of a skylight is normally flat. Skylights are called large if big enough for a submarine to attempt to surface through them (120m), or small if not.

Slush.—Snow that is saturated and mixed with water on land or ice surfaces, or as a viscous floating mass in water after a heavy snowfall.

Small floe.—See Floe.

Small fracture.—Fracture 50 to 200m wide.

Small ice cake.—An ice cake less than 2m wide.

Small ice field.—An ice field 10 to 15km wide.

Snow-covered ice.—Ice covered with snow.

Snowdrift.—An accumulation of wind-blown snow deposited in the lee of obstructions or heaped by wind eddies. A crescent-shaped snowdrift, with ends pointing downwind, is known as snow barchan.

Standing floe.—A separate floe standing vertically or inclined and enclosed by rather smooth ice.

Stranded ice.—Ice which has been floating and has been deposited on the shore by retreating high water.

Strip.—Long and narrow area of pack ice, about 1km or less wide. Usually composed of small fragments detached from the main mass of ice which have run together under the influence of wind, swell, or current.

Tabular berg.—A flat-topped iceberg. Most tabular bergs form by calving from an ice shelf and show horizontal banding (See Ice island).

Thaw holes.—Vertical holes in sea ice formed when surface puddles melt through to the underlying water.

Thin first-year ice/white ice.—First-year ice 30 to 70cm thick. May sometimes be subdivided into first stage (30 to 50cm thick) and second stage, (50 to 70cm thick).

Tide crack.—Crack at the line of junction between an immovable ice foot or ice wall and fast ice, the latter subject to rise and fall of the tide.

Tongue.—A projection of the ice edge up to several kilometers in length, caused by wind or current.

Vast floe.—See Floe.

Very close pack ice.—Pack ice in which the concentration is nine-tenths to less than ten-tenths.

Very open pack ice.—Pack ice in which the concentration is one-tenth to three-tenths and water preponderates over ice.

Very small fracture.—Fracture 1 to 50m wide.

Very weathered ridge.—Ridge with peaks very rounded, slope of sides usually 20˚ to 30˚.

Water sky.—Dark streaks on the underside of low clouds, indicating the presence of water features in the vicinity of sea ice.

Weathered ridge.—Ridge with peaks slightly rounded and slope of sides usually 30˚ to 40˚. Individual fragments are not discernible.

Weathering.—Processes of ablation and accumulation which gradually eliminate irregularities in an ice surface.

White ice.—(See Thin first-year ice/white ice).

Young coastal ice.—The initial stage of fast ice formation consisting of nilas or young ice. Its width varies from a few meters up to 200m from the shoreline.

Young ice.—Ice in the transition stage between nilas and first-year ice, 10 to 30cm thick. May be subdivided into gray ice and gray-white ice.

Magnetic Field

(The following information was prepared by the U.S. Naval Oceanographic Office.)

Antarctic Magnetic Field.—The dip poles, commonly referred to as the magnetic poles, are the points on the earth's surface at which the horizontal component (H) of the total

magnetic field decreases to a minimum (approaches zero) and where the magnetic field is most nearly all vertical. At such a point, a dip needle will stand straight up and down.

The magnetic poles should not be confused with the geomagnetic poles. Although the term geomagnetic pole does not have a rigorous definition and usage varies among different textbooks, the most common definition is a theoretical point at which the axis of a central dipole field intersects the earth's surface. However, the earth's magnetic field is not a pure dipole as it contains approximately 5 per cent quadrupole and external magnetic field components. Therefore, the two principal magnetic dipoles (North and South) do not correspond with the geomagnetic poles.

There is a misconception that the needle of a magnetic compass points to the magnetic pole. Actually, the direction indicated by such a needle is the local horizontal direction of the earth's magnetic lines of force. These lines eventually converge at the magnetic poles but wander considerably. A compass cannot be used in regions near the magnetic pole to find direction as it will remain in any direction in which it happens to be placed. In reality, a rather large area, in which a compass cannot be used, surrounds the magnetic pole because of the low magnitude of H. Where H is approximately 6,000 nanoteslas (nT) or less, the compass is frequently erratic. The magnetic compass is not reliable for underway navigation where H is 3,000 nT or less. An illustration of horizontal magnetic intensity contours shows the areas bounded by the 3000 and 6,000 nT contours. In comparison with the North Magnetic Pole, the region surrounding the South Magnetic Pole, where the compass is unreliable, is much smaller.

Magnetic Poles.—The computed location of the North Magnetic Pole on January 1, 2005 was 83˚12.6'N, 118˚19.2'W; the computed location of the South Magnetic Pole on the same date was 64˚31.8'S, 137˚51.6'E. These locations were computed using the 2005 Epoch World Magnetic Model, WMM-2005, which was used in the compilation of charts published by U.S. National Geospatial-Intelligence Agency (NGA) beginning in January, 2005.

WMM-2005 is a product of NGA. The U.S. National Geophysical Data Center (NGDC) and the United Kingdom's British Geological Survey (BGS) produced WMM-2005, with funding provided by NGA and United Kingdom's Defence Geographic Imagery and Intelligence Agency (DGIA). It is the official model for both the U.S. and U.K. defense establishments, the North Atlantic Treaty Organization (NATO), and the World Hydrographic Office (WHO) navigation and attitude/heading referencing system.

World Magnetic Model (WMM) Home Page

http://www.ngdc.noaa.gov/seg/WMM

Magnetic Variation.—Magnetic variation information printed on topographic maps and navigation charts is derived from a model, which must be redefined at least every five years. The principal reason is that the earth's magnetic field changes appreciably in that period of time, and it has not been possible to predict the secular change with confidence more than a few years into the future.

Variation, also known as magnetic declination, is measured in angular units and named East or West to indicate the side of True North on which the N part of the magnetic meridian lies. East variation is positive and West variation is negative. The DoD publishes grid variation charts which illustrate the angle between the grid and magnetic meridians at any place.

Anomalies.—Significant magnetic anomalies may exist due to local magnetization in the earth's crust. These geologically produced magnetic fields cannot be modeled on a world-wide basis. Individual detailed geomagnetic surveys are required. Local conductivity anomalies will affect the way external magnetic fields generate currents in the crust, which in turn generate induced magnetic fields. These induction fields will also be local in character. Observations of erratic compass behavior should be reported with details of the particular circumstances at the time. Any disturbances to the geomagnetic field can also interfere with magnetic navigation. The flow of the solar wind (which contains electrons and protons) past the earth creates magnetic disturbances at the earth's surface. Some of these disturbances are known to be highly localized while others occur over wide areas. Auroras are the visible result of a significant magnetic storm.

There are four different periodicities of magnetic disturbances. Although magnetic storms can occur at any time, they are most numerous during the period of maximum activity in the 11-year sunspot cycle. There is a weak semi-annual periodicity where the level of disturbance is at a maximum in October and April. More prominently, magnetic storms tend to have a 27-day repetition period due to the synodic rotation period of the sun, that is, the apparent rotation period as seen from the earth. Magnetic storms typically last 2 to 3 days. The substorms which accompany them only last from 1 to 3 hours and tend to occur more frequently and more strongly at local midnight.

During a particularly intense magnetic storm, such as occurred in March 1989, electrical currents are generated in the magnetosphere and the ionosphere. The magnetic fields of these currents also induce fluctuating voltages in the earth and cause additional current. The total current can significantly alter the geomagnetic field observed at the earth's surface and change its direction as much as several degrees and its magnitude as much as 10 per cent.

Navigation.—Navigation by magnetic compass in polar regions is much less reliable than in equatorial and midlatitudes. Low directive force on the compass card, the enhanced effects of magnetic storms near the magnetic poles, the relatively sparse knowledge of local anomalies in regions outside commercial traffic areas, and the slow drift of the actual magnetic pole positions all contribute. As a minimum, the most current magnetic information and charts should be carried. Any chart older than the current model should be replaced.

Charts of the geomagnetic field are available from the Department of Defense (DoD). Magnetic variation charts are published every 5 years. Charts of the total intensity, vertical intensity, horizontal intensity, and inclination (magnetic dip) are published every 10 years.

Meteorology

The meteorological conditions encountered on the Antarctic continent and adjacent seas are the world's most adverse. The frequent passage of intense cyclonic offshore storms (60˚ to 70˚S), the strong outflow of relatively cold air from the continent (katabatic winds), extremely low temperatures, and precipitation in excess of evaporation are the major features that contribute to the rigorous climatic conditions. Not only are the average conditions harsh, but the weather can be extremely variable. This high degree of variability and the relatively sparse number of weather stations makes meteorological forecasting somewhat unreliable.

In coastal areas, the mean temperatures range from about 0˚C in summer to -30˚C or lower in winter. The Antarctic Peninsula, particularly its NW coast and the islands of the Scotia Arc, have a milder winter, with mean temperatures of approximately 10˚C. The mean temperatures on the continental plateau are much colder, ranging from -40˚C in summer to -70˚C or lower in winter. These extremely low temperatures result from the loss of heat by radiation from the snow covered ground. The temperature is actually much higher at a height of only a few meters above the ground.

Coastal areas can be stormy. Storm conditions are associated with cyclonic centers or depressions which are frequently generated around Antarctica between 60˚S and 70˚S. The S extent of these storms can penetrate the coastal areas, causing windy conditions and heavy snowfalls.

Katabatic winds or gravity winds occur when cold, dense air flows down the slopes from the high continental interior. These winds can be extremely strong. With the passage of cyclonic storms, conditions are enhanced for katabatic outflow from the continent, particularly along the E coast of the Antarctic Peninsula and along most of the coast of East Antarctica. These katabatic winds often last for the entire period, one to several days, between cyclonic storm passages. They are more frequent in winter and may continuously exhibit wind speeds in excess of 70 knots for several hours. During the summer, the frequency of windstorms (both katabatic and cyclonic) is sig-nificantly reduced, but by no means nonexistent.

The primary role of the polar regions in relation to global climate is that they provide a major heat sink to counterbalance the heat source of the tropics. Atmospheric motions are initiated and maintained by patterns of heating and cooling. Changes in these thermal patterns, if persistent, can change atmospheric circulation patterns which, in turn, feed back to alter the thermal patterns.

Thermal patterns are influenced by the composition of the atmosphere and by radiative and reflective properties of the earth's surface. Constituents of the atmosphere, both natural and anthropogenic, which can significantly affect radiative properties of the air and hence the climate, include carbon monoxide, water vapor, and ozone. Chlorofluoromethane, nitrous oxide, methane, and carbon tetrachloride also affect the radiative properties, but to a less certain degree.

Radiative properties of the earth's surface also have a strong influence on the patterns of heating and cooling and, thereby, atmospheric motions. Seasonal fluctuations in the extent of the ice around Antarctica strongly influence the heat exchange between the air and sea surface. This interaction affects air temperature and the degree to which Antarctica acts as a global heat sink. For example, the strength, frequency, and track of cyclonic storms near 65˚S varies seasonally in response to the seasonal fluctuations of the drift ice boundaries. In the summer when the ice has receded, the intensity and frequency of cyclonic storms is reduced and they tend to pass to the S of their mean winter tracks.

The reflective properties or albedo of the surface of Antarctica strongly influence the heat budget of the polar region and hence the climate. Snow and ice can reflect up to 98 per cent of incoming solar radiation but they average about 80 per cent, while moderately rough ocean water will reflect only 10 to 15 per cent. This characteristic of the Antarctic ice cap provides a powerful positive feedback mechanism, affecting climate. For example, a decrease in the average Antarctic temperature will lead to an increase in sea ice cover, which, in turn, increases the albedo of the S pole and leads to further cooling. While the importance of Antarctica in influencing the global climate is clear, the interactions and feedback mechanisms of the atmosphere-hydrosphere-cryosphere system are far too complex and polar observations far too meager to provide a complete understanding of its role.

Weather-Related Phenomena

Superstructure Icing.—In certain weather conditions, ice accumulating on hulls and superstructures can be a serious danger to vessels. Ice accumulation may occur because of fog with freezing conditions; freezing rain or drizzle; and sea spray or salt water breaking over vessels when the air temperature is below freezing (about -1.9˚C).

The most dangerous form of icing is caused by sea spray, sometimes known as "glaze ice," which has high density and great powers of adhesion.

In evaluating the potential for superstructure icing, two categories were subjectively selected. Moderate ice accumulation seems to occur when the air temperature is less than or equal to -2˚C and the wind is stronger than or equal to 13 knots. If the air temperature decreases to -9˚C or below and the wind reaches 30 knots or more, ice accumulation takes place at an accelerated rate. This category is termed severe. For example, on a small fishing vessel of 300 to 500 tons displacement, ice accumulation in the severe category would exceed about 4 tons per hour.

Radio and radar failures due to ice accumulating on aerials and insulators may be experienced soon after superstructure icing begins. The ice tends to form high up on vessels and a large amount of accumulation may result in a loss of freeboard and stability.

The probability of forecasting gales with freezing air temperatures is made difficult by the sparseness of meteorological and oceanographic information in the Antarctic region. For this reason, superstructure icing represents a serious hazard to navigation anywhere S of the Antarctic Circle.

Immersion Hypothermia.—Immersion hypothermia is the loss of heat when a body is immersed in water. With few exceptions, humans die if their normal rectal temperature of approximately 37.6˚C drops below 25.9˚C. Cardiac arrest is the most common direct cause of death. Except in tropical

waters warmer than 20˚ to 25˚C, the main threat to life during prolonged immersion is cold or cold and drowning combined.

Cold lowers the body temperature, which in turn slows the heart beat and lowers the rate of metabolism. This increases the amount of carbon dioxide in the blood and results in an impaired mental capacity which is a major factor in death by hypothermia. Numerous reports from wrecks and accidents in cold water indicate that people can become confused and even delirious, further decreasing their chances of survival.

The length of time that a human can survive in water depends on the water surface temperature and, to a lesser extent, on a person's behavior. The table following shows the approximate human survival time in the sea. Body type can cause deviations, since thin people become hypothermic more rapidly than fat people. Extremely fat people may survive almost indefinitely in water near 0˚C if they are warmly clothed.

The cooling rate can be slowed by the person's behavior and insulated gear. Studies have shown that if the critical heat loss areas can be protected, survival times will increase. The Heat Escape Lessening Posture (HELP) was developed for those persons in the water alone and The Huddle for small groups of people, but both methods require life preservers.

HELP involves holding the upper arm firmly against the sides of the chest, keeping the thighs together, and raising the knees to protect the groin area. In The Huddle, people face each other and keep their bodies as close together as possible. These positions improve survival time in water with a temperature of 8.9˚C to 4 hours, or approximately double that of a swimmer and one and one-half times that of a person in the passive position.

Table of Survival Time versus Water Temperature

Water temperature	Exhaustion or unconsciousness	Expected time of survival
0˚C	15 minutes	15 to 45 minutes
0˚ to 5˚C	15 to 30 minutes	30 to 90 minutes
5˚ to 10˚C	30 to 60 minutes	1 to 3 hours
10˚ to 15˚C	1 to 2 hours	1 to 6 hours
15˚ to 20˚C	2 to 7 hours	2 to 40 hours
20˚ to 25˚C	3 to 12 hours	3 hours to indefinite
25˚C	Indefinite	Indefinite

Near-drowning victims in cold water (temperature less than 21.1˚C) show much longer periods of revivability than usual. The keys to a successful revival are immediate cardiopulmonary resuscitation (CPR) and administration of pure oxygen. The whole revival process may take hours and require medical help.

Windchill—Frostbite.—A body begins to lose heat when it is warmer than the surroundings. The rate of loss depends on the barriers to heat loss such as clothing and insulation in addition to the speed of air movement and the air temperature. Heat loss increases dramatically in moving air that is colder than skin temperature (33˚C). In the Antarctic, windchill results from the intense cold and strong winds. This combination affects not only comfort, but the morale and safety of personnel.

The equivalent windchill temperature relates a particular wind and temperature combination to whatever temperature would produce the same heat loss at about 3 knots, the normal speed of a person walking. At extremely cold temperatures, wind and temperature effect may account for only two-thirds of the heat loss from the body. For example, at a temperature of -40˚C, about one-third of the heat loss from the body occurs through the lungs in the process of breathing. Conversely, heat loss is not as great in bright sunlight.

When the skin temperature drops below 10˚C, a marked constriction of the blood vessels occurs, leading to vascular stagnation, oxygen want, and some cellular damage. The first indication that something is wrong is a painful tingling. Swelling of varying extent follows, provided freezing has not occurred. Excruciating pain may then be felt if the skin temperature is lowered rapidly, but freezing of localized portions of the skin may be painless when the rate of change is slow.

Cold allergy is a term applied to the welts which may occur. Chilblains usually affect the fingers and toes and are manifested as reddened, warm, and itching swollen patches. Trench foot and immersion foot present essentially the same picture. Both result from exposure to cold and a lack of circulation. Wetness can add to the problem as water and wind soften the tissues and accelerate heat loss. The feet swell, discolor, and frequently blister. Secondary infection is common and gangrene may result.

Injuries from the cold may, to a large extent, be prevented by maintaining natural warmth through the use of proper footgear and adequate, dry clothing. Personnel should avoid being in cramped positions or wearing constricting clothing. They should also carry out active exercises of the hands, legs, and feet.

Frostbite usually begins when the skin temperature falls within the range of -10˚ to -15.5˚C. Ice crystals form in the tissues and small blood vessels. Once started, freezing proceeds rapidly and may penetrate deeply. The rate of heat loss determines the rate of freezing, which is accelerated by wind, wetness, extreme cold, and poor blood circulation. Parts of the body most susceptible to freezing are those with surfaces large in relation to their volume, such as toes, fingers, ears, nose, chin, and cheeks.

Navigational Information

Pilotage.—Pilotage is not available at any place within the area covered by this publication. However, vessels approaching a manned base or harbor are advised to seek information concerning navigational conditions by radio.

Navigational Aids.—Lights, ranges, buoys, and beacons etc., are virtually non-existent in the Antarctic region. Such aids are subject to damage and failure by ice or storm, or may disappear altogether and remain unreported for long periods of time.

Polar Charts.—Even in high latitudes, mariners have exhibited an understandable partiality for Mercator charts, on which a rhumb line appears as a straight line, and these have been used virtually everywhere ships have sailed. However, as the latitude increases, the superiority of the Mercator projec-

tion decreases, primarily because the value of the rhumb line becomes progressively less. At latitudes greater than 60˚, the decrease in utility begins to be noticeable, and beyond 70˚, it becomes troublesome. In the clear polar atmosphere, visual bearings are observed at great distances, sometimes 50 miles or more. The use of a rhumb line to represent such a bearing and distance at high latitudes introduces excessive errors. Another problem with the use of Mercator charts at high latitudes is the increasing rate of change of scale over a single chart. This aspect results in the shape of the land mass being distorted and subsequent errors in measuring distances.

At some latitudes, the disadvantages of the Mercator projection outweigh its advantages. The latitude at which this occurs depends upon the physical features of the area, the configuration and orientation of land and water areas, the nature of the operation, and mostly, upon the previous experience and personal preference of the mariner. Because of differences of opinion in this matter, a transitional zone exists in which several projections may be useful. Under all circumstances, a wise navigator should be prepared to use any of them, because coverage of the operating area may not be adequate on the preferred projection.

Charts of polar areas are generally inferior to those of other regions because of lack of detail, inaccuracy, and poor coverage.

Relatively few soundings are available in polar areas and many of the coastal features are only shown on the chart by their general outlines. Large areas are perennially covered by ice which presents a changing appearance as the amount, position, and the character of the ice changes. Heavy covers of ice and snow also prevent the accurate determination of the surface features beneath.

Polar charts, of which relatively few are available, may be inaccurate because they are based upon limited information and reports from those who have been in the areas. These reports are usually less reliable than in other areas as icebergs are sometimes mistaken for islands, especially those having morainic deposits; and ice-covered islands are occasionally mistaken for grounded icebergs. In addition, shorelines are not easy to detect and inlets and sounds may be completely obscured by ice and snow.

The three chart projections most commonly used near the poles are the transverse Mercator, the modified Lambert conformal, and the polar stereographic. When a gyro is used as a directional reference, the track of the craft is approximately a great circle. A desirable chart is one on which a great circle is represented as a straight line with a constant scale and with angles correctly represented. These requirements are not met entirely by any single projection, but they are approximated by both the modified Lambert conformal and the polar stereographic.

Polar Navigation.—Navigation in polar regions does not differ materially from that in lower latitudes. However, unique conditions, such as high latitude and meteorological factors, require the use of special techniques. Much of the thinking of the marine navigator is in the terms of the “rectangular” world of the Mercator projection, on which the meridians are equally spaced with vertical lines perpendicular to the horizontal parallels of latitude. On such a projection, direction is measured relative to the meridians a straight line on a chart represents a rhumb line.

In polar regions, conditions are somewhat different as the meridians rapidly converge at the poles, which are centers of a series of concentric circles constituting the parallels of latitude. The rapid convergence of the meridians renders the usual convention of direction inadequate for some purposes and even visual bearings cannot be adequately represented as rhumb lines. At the pole, all directions are toward the opposite pole and lines of position, in the usual sense, are replaced by longitude.

Stars circle the sky without noticeable change in altitude and planets rise and set once each sidereal period (12 years for Jupiter, 30 years for Saturn). At the S pole, the sun rises about September 23; slowly spirals to a maximum altitude of approximately 23˚27' about December 21; slowly spirals downward to the horizon about March 21; and then disappears for another 6 months.

It requires about 32 hours for the sun to cross the horizon, during which time it circles the sky one and one-third times. The twilight periods, following sunset and preceding sunrise, last for several weeks. The moon rises and sets about once each month and only celestial bodies with S declination are visible at the pole.

The long polar night is not wholly dark as the full moon at this time rises relatively high in the sky. In addition, light from the aurora australis is often quite bright, occasionally exceeding that of the full moon. Even the planets and stars contribute an appreciable amount of light in this area where the snow cover provides an excellent reflecting surface.

All time zones, like all meridians, meet at the pole. Local time does not have its usual significance, because the hours of the day bear no relation to periods of light and darkness or to the altitude of celestial bodies.

Operations in polar regions are attended by hazards and problems not encountered elsewhere. Lack of knowledge, sometimes accompanied by fear of the unknown, has prevented navigation in these areas from being conducted with the same confidence with which it is pursued in more familiar areas. As experience in high latitudes has increased, much of the mystery surrounding these areas has been dispelled and operations there have become more predictable.

Before entering polar regions, navigators should acquaint themselves with the experience of those who have preceded them into these areas. This information can be found in accounts of explorers, reports of previous voyages in high latitudes, and articles in professional journals concerning operations in polar regions. The search for knowledge should not be confined to just navigation and such subjects as survival, geography, ice, climate, and weather should be studied.

Planning, important in any operation, is vital to the success of polar navigation. Vessels should be provided with all the needed charts, publications, and special navigational material. All available data and information from previous operations in the area should be available. Key personnel should be adequately instructed in polar navigation prior to departure or while enroute to the region. Forecasts on anticipated ice and weather conditions should be obtained before departure and on approach to the continent.

Radar.—In polar regions, where fog and long periods of continuous daylight or darkness reduce the effectiveness of both celestial navigation and visual piloting, radar is particularly valuable. Its value is further enhanced by the fact that polar seas are generally smooth, resulting in relatively little oscillation of the shipborne antenna. In addition, when ice is not present, relatively little sea return is encountered from the calm sea.

However, certain limitations exist with the use of radar in polar regions. Similarity of detail along the polar shore is even more apparent by radar than by visual observation. Lack of accurate detail on charts adds to the difficulty of coastal identification. Identification is even more of a problem when the shoreline is beyond the radar horizon and accurate contours are not shown on the chart. When an extensive mass of ice extends out from shore, accurate location of the shoreline is also extremely difficult.

Experience is required to interpret accurately the radar returns in polar regions where ice may cover both land and sea. A number of icebergs lying near the coast may be located too close together to be resolved, giving an altered appearance to a shoreline, or they may be mistaken for off-lying islands. The shadow of an iceberg or pressure ridge and the lack of return from an open lead in the ice may easily be confused. Smooth ice may look like open water.

As with visual bearings, radar bearings require correction for convergence unless the objects observed are quite close to the vessel.

As the state of the sea increases, so does the minimum size of berg that can be detected. On very rough seas, bergs as high as 15m cannot always be detected in the sea return. Only in exceptionally smooth seas can radar be depended upon to pick up growlers.

Meteorological conditions in certain areas affect radar propagation in a manner that may, under certain conditions, reduce the range in fog when radar is most needed.

Caution is essential during periods when vessels are navigating in consolidated ice during low visibility. Generally, large icebergs can be distinguished from adjacent drift ice returns at ranges of 3,500m or more, but they may be obscured at lesser ranges. Therefore, in no case should the radar be accepted as 100 per cent accurate, resulting in the relaxation of normal safety precautions.

Radio Direction Finder.—The Radio Direction Finder (RDF) is useful when the few transmitting stations in the polar region are within range. One of the principal uses of RDF in polar regions is to assist in locating other vessels, for rendezvous or other purposes. This is particularly true in an area of many icebergs, where radar may not distinguish between ships and bergs.

Magnetic Compass.—The magnetic compass depends for its directive force upon the horizontal intensity of the magnetic field of the earth. As the magnetic poles are approached, this force becomes progressively weaker until at some point the magnetic compass becomes useless as a direction-measuring device. In a marginal area, the magnetic compass must be kept under almost constant scrutiny as it may become somewhat erratic in dependability and its error may change rapidly. Compass observation logs are always useful to keep as a reference. Magnetic storms may also cause additional mag-netic compass errors.

The magnetic poles themselves are somewhat elusive, because they participate in the normal diurnal, annual, and secular changes in the earth's field, as well as more erratic changes caused by magnetic storms.

Measurements indicate that the magnetic poles move within an elongated area of perhaps 100 miles in a generally N/S direction, and somewhat less in an E/W direction. Normally, they are at the S end of the area of movement at local noon and at the N end 12 hours later. However, during severe magnetic storms, this motion is upset and becomes highly erratic. Due to the motions of the poles, they are sometimes regarded as areas rather than points. Some evidence exists to support the belief that several secondary poles exist, although such alleged poles may be anomalies, possibly of intermittent or temporary existence. Various severe anomalies have been found to occur in the polar areas and others may exist.

The continual motion of the poles may account, at least in part, for the large diurnal changes in the variation encountered in high latitudes. Changes as large as 10° have been reported.

Measurements of the earth's magnetic field in polar regions are neither numerous nor frequent. The isogonic lines in these areas are close together, resulting in rapid changes within short distances in some directions. As a result, charted variation in polar regions is not at the same order of accuracy as elsewhere.

The decrease in horizontal intensity encountered near the magnetic poles, as well as magnetic storms, also affects the deviation of vessels. Any deviating magnetic influence remaining after adjustment, which is seldom perfect, exerts a greater influence as the directive force of horizontal intensity decreases. It is not uncommon for residual deviation determined in moderate latitudes to increase 10 or 20 fold in marginal areas. Interactions between correctors and compass magnets exert a deviating influence that may increase to a troublesome degree in high latitudes.

The heeling magnet, correcting for both permanent and induced magnetism, is accurately situated only for one magnetic latitude. Near the magnetic pole, its position might be changed, but this may induce sufficient magnetism in the Flinders Bar to more than offset the change in deviation due to the change in the position. In addition, the relatively strong vertical intensity may render the Flinders Bar a stronger influence than the horizontal field of the earth. When this occurs, the magnetic compass reading remains nearly the same on all headings.

Another effect of the decrease in the directive force of the compass is a greater influence of frictional error. This, combined with an increase in the period of the compass, results in greatly increased sluggishness in its return to the correct reading after being disturbed. For this reason, the magnetic compass may be frequently inaccurate for quite a long period after an impact by the vessel against ice.

Magnetic storms can also affect the magnetism of vessels as well as that of the earth. Changes in deviation of as much as 45° have been reported during severe magnetic storms, although it is possible that such large changes may be a combination of deviation and variation changes.

The area in which the magnetic compass reduces its value cannot be determined in specific terms. However, a magnetic

compass in an exposed position generally performs better than one in an enclosed position. However, there is a danger of the compass liquid freezing when it is subjected to extremely low temperatures. Sufficient heat to prevent the liquid from freezing can normally be obtained from the compass light, which should not be turned off during severe weather.

Despite the various limitations, the magnetic compass is a valuable instrument in much of the polar regions, where the gyrocompass is also of reduced reliability. Careful compass adjustment, frequent checks, and review of the records of previous behavior are advised.

Gyro Compass.—The gyro compass is generally reliable up to about 70˚. At higher latitudes, the disturbing effect of imperfections in the compass or the adjustment is magnified. The latitude adjustment becomes critical and the speed error increases as the speed of the vessel approaches the rotational speed of the earth. In addition, the ballistic deflection error increases and the compass becomes slow to respond to correcting forces. Subsequently, frequent changes of course and speed, which are often necessary when proceeding through ice, introduce errors that are slow to settle out. When the gyro compass is deflected by the impact of the vessel against the ice, it does not return or stabilize quickly to the correct heading.

These errors increase and become more erratic as the vessel proceeds to higher latitudes. Extreme errors as large as 27˚ have been reported at latitudes greater than 82˚. The gyro compass probably becomes useless at about latitude 85˚. At latitude 70˚, the gyro error should be determined frequently and the gyro compass should be compared frequently with the magnetic compass. Instructions for use at high latitudes are sometimes provided by the manufacturer of the gyro compass.

Bearings.—Natural landmarks are plentiful in some areas, but their usefulness is restricted by the difficulty in identifying them, or locating them on the chart. Along many of the coasts in the Antarctic, the various points and inlets bear a marked resemblance to each other. In addition, the appearance of the coast is often very different when many of its features are masked by a heavy covering of snow or ice.

Bearings of landmarks are useful, but they have limitations. When bearings of more than two objects are taken, they may fail to intersect at a point because the objects may not be charted in their correct relation to each other. Even a two-point fix may be considerably in error since the objects used may be charted in correct relationship to one another, but in the wrong position geographically. However, in restricted waters, it is usually more important to know the position of the vessel relative to the nearby land and shoals than to know the accurate latitude and longitude. The bearings and distances of uncharted, locally known objects then become valuable.

When a position is established relative to nearby landmarks, it is good practice to use this to help establish the identity and location of some prominent feature a considerable distance ahead. Through this practice, unidentifiable or uncharted features can be used to establish future positions.

In high latitudes, it is not unusual to make use of bearings of objects which are located a considerable distance from the vessel. Because of the rapid convergence of the meridians in these areas, such bearings are not accurately represented by straight lines on a Mercator chart. Therefore, if this projection is used, the bearings should be corrected in the same manner as radio bearings because both can be considered to be great circles. Neither visual nor radio bearings require a correction when plotting on a Lambert conformal or a polar stereographic chart.

Soundings.—Soundings are so important in polar regions that echo sounders are customarily operated continuously while underway. A good practice is to have two such instruments, preferably those of the recording type with a wide flexibility in range. Enough soundings have been obtained to produce an accurate portrayal of the bottom configuration in only a few parts of the polar regions. Hence, caution should be maintained at all times in order to avoid unobserved shoaling.

The polar regions have relatively few shoals, but a number of pinnacles and ledges may rise abruptly from the bottom in some areas. Such dangers constitute a threat to vessels because they exist in areas generally not surrounded by any apparent shoaling. Therefore, in unknown areas, vessels are advised to send one or more small craft ahead with portable sounding gear. It should be noted that echo sounders will not give a reading when ice is under the vessels or when the water beneath the ship is disturbed by turbulence by ice floes being shoved around. A vessel proceeding in uncharted coastal waters may minimize the risk of grounding by having a boat equipped with a portable echo sounder scout ahead.

CONVERSION ANGLE TABLE FOR VISUAL BEARINGS IN POLAR WATERS

Difference of Longitude

Mid Latitude	0˚	0.5˚	1˚	1.5˚	2˚	2.5˚	3˚	3.5˚	4˚	4.5˚	Mid Latitude
61	0.0	0.2	0.4	0.7	0.9	1.1	1.3	1.5	1.7	2.0	61
62	0.0	0.2	0.4	0.7	0.9	1.1	1.3	1.5	1.8	2.0	62
63	0.0	0.2	0.4	0.7	0.9	1.1	1.3	1.6	1.8	2.0	63
64	0.0	0.2	0.4	0.7	0.9	1.1	1.3	1.6	1.8	2.0	64
65	0.0	0.2	0.5	0.7	0.9	1.1	1.4	1.6	1.8	2.0	65
66	0.0	0.2	0.5	0.7	0.9	1.1	1.4	1.6	1.8	2.1	66
67	0.0	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.8	2.1	67

CONVERSION ANGLE TABLE FOR VISUAL BEARINGS IN POLAR WATERS

Difference of Longitude

Mid Latitude	0°	0.5°	1°	1.5°	2°	2.5°	3°	3.5°	4°	4.5°	Mid Latitude
68	0.0	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	68
69	0.0	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	69
70	0.0	0.2	0.5	0.7	0.9	1.2	1.4	1.6	1.9	2.1	70
71	0.0	0.2	0.5	0.7	0.9	1.2	1.4	1.7	1.9	2.1	71
72	0.0	0.2	0.5	0.7	1.0	1.2	1.4	1.7	1.9	2.1	72
73	0.0	0.2	0.5	0.7	1.0	1.2	1.4	1.7	1.9	2.2	73
74	0.0	0.2	0.5	0.7	1.0	1.2	1.4	1.7	1.9	2.2	74
75	0.0	0.2	0.5	0.7	1.0	1.2	1.4	1.7	1.9	2.2	75
76	0.0	0.2	0.5	0.7	1.0	1.2	1.5	1.7	1.9	2.2	76
77	0.0	0.2	0.5	0.7	1.0	1.2	1.5	1.7	1.9	2.2	77
78	0.0	0.2	0.5	0.7	1.0	1.2	1.5	1.7	2.0	2.2	78
79	0.0	0.2	0.5	0.7	1.0	1.2	1.5	1.7	2.0	2.2	79
80	0.0	0.2	0.5	0.7	1.0	1.2	1.5	1.7	2.0	2.2	80
81	0.0	0.2	0.5	0.7	1.0	1.2	1.5	1.7	2.0	2.2	81
82	0.0	0.2	0.5	0.7	1.0	1.2	1.5	1.7	2.0	2.2	82
83	0.0	0.2	0.5	0.7	1.0	1.2	1.5	1.7	2.0	2.2	83
84	0.0	0.2	0.5	0.7	1.0	1.2	1.5	1.7	2.0	2.2	84
85	0.0	0.2	0.5	0.7	1.0	1.2	1.5	1.7	2.0	2.2	85

The table should be entered with the middle latitude and the difference in longitude (between the object and the vessel). The angles listed in the table (corrections) represent the difference between the great circle bearing and the rhumb line direction (Mercator). The sign of the correction to be applied is, as follows:

Latitude of Vessel	Object/Landmark (direction from vessel)	Correction Sign
South	East	-
South	West	+
North	East	+
North	West	-

In very deep water, 2,000m or more, the echo return from the bottom is sometimes masked by the sound of ice coming in contact with the hull of the vessel. This is generally not a problem when the bottom is close enough to be menacing. Ice generally prevents the effective use of a hand lead unless the vessel is stopped.

When vessels become beset by ice, they may lose steerage way and drift with the ice. Such vessels may be in danger of grounding as the ice moves over a shoal area. Therefore, it is important that soundings be continued to be taken even when a vessel is beset. If necessary, a hole should be made in the adjacent ice and a hand lead used. A vessel with limited means for freeing itself may prudently save such means for use only when there is danger of grounding.

Useful information concerning the depth of water in the vicinity of a vessel can sometimes be obtained by watching the ice. A stream of ice moving faster than surrounding ice or a stretch of open water located in loose drift ice often marks a channel leading through shoal water. A patch of stationary ice located in the midst of moving ice often may mark a shoal.

Some knowledge of earth formations may also prove helpful. The slope of the land is often an indication of the underwater gradient. Shoal water is often found off low islands and spits, etc., but seldom near a steep shore. Where glaciation has occurred, moraine deposits are likely to have formed an off-shore bar. Submerged rocks and pinnacles are more likely to be encountered off a rugged shore than near a low, sandy beach.

Icebergs.—Radar can easily pick up large icebergs in ample time to avoid collision. However, small bergs or growlers, which are capable of inflicting serious damage to vessels, may go undetected even with moderate conditions of wind and sea. Only in exceptionally smooth seas can radar be depended upon to pick up growlers. Therefore, it is unsafe for any vessel, because of radar, to assume immunity to ice hazards.

Air temperatures are not a reliable guide to the presence of icebergs, nor can sea temperatures be depended upon to give warning of their approach. It is true that a small increase in water surface temperature can usually be detected within about 1 mile of an iceberg. This increase is due to the freshening of the surface layer of the sea by the melting ice. However, variations of surface temperature of the same order of magnitude are frequently encountered in the total absence of icebergs.

In fog, the use of the steam whistle or foghorn for detecting small bergs or growlers by echo is of little value. The sound waves will only be reflected by a high, vertical wall of ice and they are not always discernible. Hence, the absence of an echo does not mean that no bergs are close.

Care should be exercised when approaching icebergs and soundings should be taken continuously as submerged projections caused by overcutting may extend a considerable distance to seaward.

Vessels hove-to in drift ice during heavy weather are advised to place their bow against a floe and use their engines to hold themselves up into the wind. If vessels are allowed to drift in such circumstances, serious damage may be sustained from grinding and surging floes. Often in the mass of ice, old ice is integrated by a film of young ice. Under such conditions, it is prudent to remain amongst the young ice since its soft texture will buffer the vessel against encroachment by old ice.

When approaching snow-covered land from ice-free waters, a yellowish landblink is usually observed before the land is seen above the horizon. Many of the coasts of Antarctica are fronted by a belt of ice which extends between 20 and 60 miles offshore. Hence, a strip of ice-free water lies adjacent to the shore. When transiting in this strip of water, vessels should maintain observations of any movement of the belt of drift ice. With onshore winds, the belt of drift ice may be driven in quickly and such vessels placed in danger of being set on to the land.

An accumulation of icebergs offshore invariably marks a shoal. An area of water lying offshore from which a line of icebergs extends is almost certain to be foul. Islands with nearly continuous lines of icebergs extending between them and the shore are usually connected to the coast by shallow water or by a submerged shoal ridge. However, if the icebergs are concentrated around the islands, leaving wide spaces free of ice, such spaces are probably clear of shoals. A coast that is fringed by glaciers or studded with inshore bergs, but is free of ice to seaward, is usually considered to be safe up to about 1 mile from the shore.

Bays in which icebergs are found generally have a channel leading into them. Channels, the sides of which are bordered with bergs, may invariably be considered safe if their centers are clear of ice. Open water will usually be found during the summer adjacent to coasts where offshore winds prevail.

Duration Of Sunlight.—Rising, setting, and twilight data are tabulated in the Nautical Almanac to latitude 72˚N and 60˚S. Within these limits, the times of these phenomena can be determined. Graphs are used in the higher latitudes instead of tables because they give a clearer picture of conditions, which may change radically with relatively little change in position or date. Under these conditions, interpolation is simpler by graph than by table. In those parts of the graph which are difficult to read, the times of the phenomena's occurrence are themselves uncertain, being altered considerably by relatively small changes in refraction or height of eye. The graphs for high latitudes may be found in the Air Almanac which is published each year by the U.S. Naval Observatory.

The graph displaying the semiduration of sunlight may be used for latitudes higher than 60˚ and shows the number of hours from sunrise to meridian passage or from meridian passage to sunset. There is continuous daylight in the area marked "sun above horizon." The figures near the top of the graph indicate, for several convenient dates, the LMT of meridian passage. With the aid of the intermediate dots, the LMT for any given day may be obtained to the nearest minute. Using the latitude and the LMT of meridian passage, the semiduration can be extracted. The time of sunrise may be found by subtracting the semiduration from the time of meridian passage. The time of sunset can be found by adding the semiduration to the time of meridian passage. Similar graphs for twilight and semiduration of moonlight in high latitudes are also displayed.

ODAS.—The term Ocean Data Acquisition System (ODAS) covers a wide range of devices for collecting weather and oceanographic data. However, the devices of most concern to vessels consist of buoy systems which support instruments. These buoy systems may be expected to become more numerous each year and may be found in polar waters.

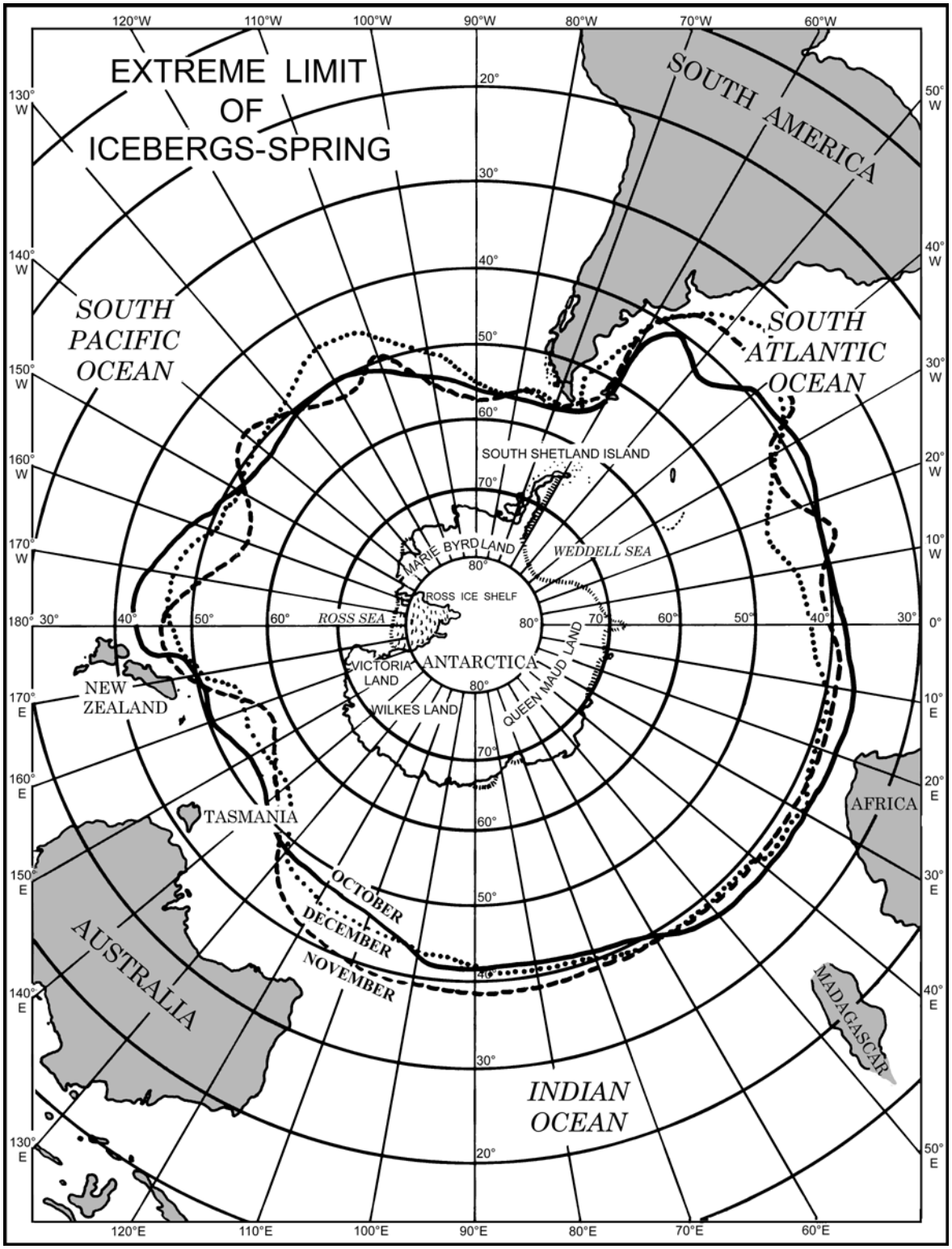
The buoy systems vary considerably in size and are either moored or free-floating. As far as possible, positions of the former will always be widely promulgated, and, if considered to be of a permanent enough nature, will be charted. In both types, the instruments may be either in the float or attached at any depth beneath it.

The buoys are colored yellow and marked ODAS with an identification number. The moored buoys usually display a yellow light, showing a group of 5 flashes every 20 seconds.

ODAS may be encountered in unexpected areas and often in deep water where navigational buoys would not be found. It should be noted that valuable instruments are often suspended beneath these systems or attached to the mooring lines. In some cases, the moorings have been cut loose beneath the buoy by unauthorized salvors, with the consequent loss of the most valuable part of the system.

The moored buoys may be up to 7.5m in diameter and 2 to 3m in height. The free-floating buoys are usually much smaller, 2m wide, and do not display a light.

Caution.—Vessels should use extreme care when navigating in the regions covered by this publication as very few of the bays, inlets, and harbors have been carefully surveyed. Information contained herein was compiled from numerous sources, much of which appears to be contradictory. Charts of the region lack details and should be utilized only as a guide.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SOUTH ATLANTIC OCEAN
SOUTH SHETLAND ISLAND
MARIE BYRD LAND
WEDDELL SEA
ROSS ICE SHELF
ROSS SEA
ANTARCTICA
VICTORIA LAND
QUEEN MAUD LAND
WILKES LAND
NEW ZEALAND
TASMANIA
AUSTRALIA
AFRICA
MADAGASCAR
INDIAN OCEAN
OCTOBER
DECEMBER
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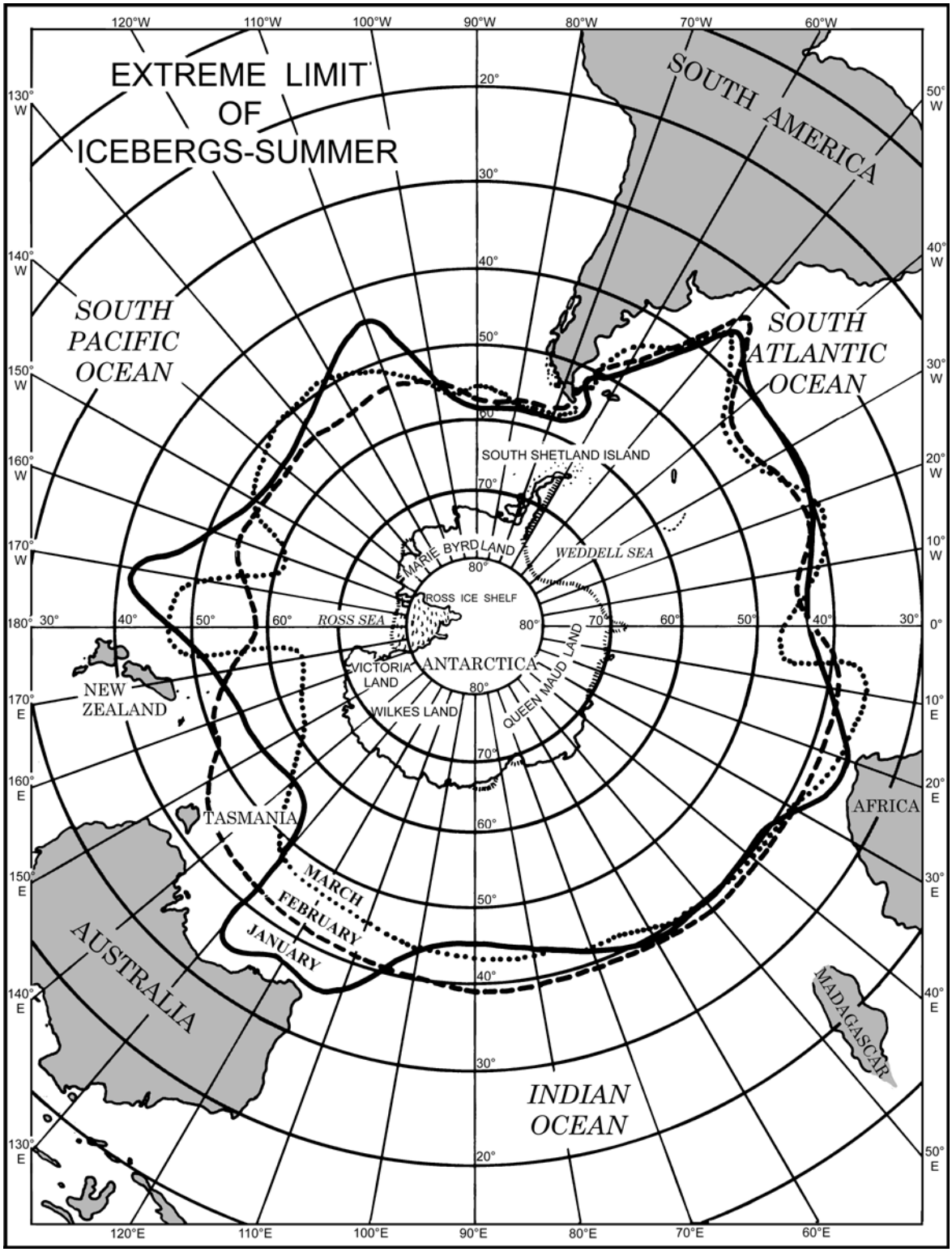
120°E 110°E 100°E 90°E 80°E 70°E 60°E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WEDDELL SEA
ROSS ICE SHELF
ROSS SEA
ANTARCTICA
VICTORIA LAND
WILKES LAND
QUEEN MAUD LAND
NEW ZEALAND
TASMANIA
AUSTRALIA
AFRICA
MADAGASCAR
INDIAN OCEAN
MARCH
FEBRUARY
JANUARY
120°W
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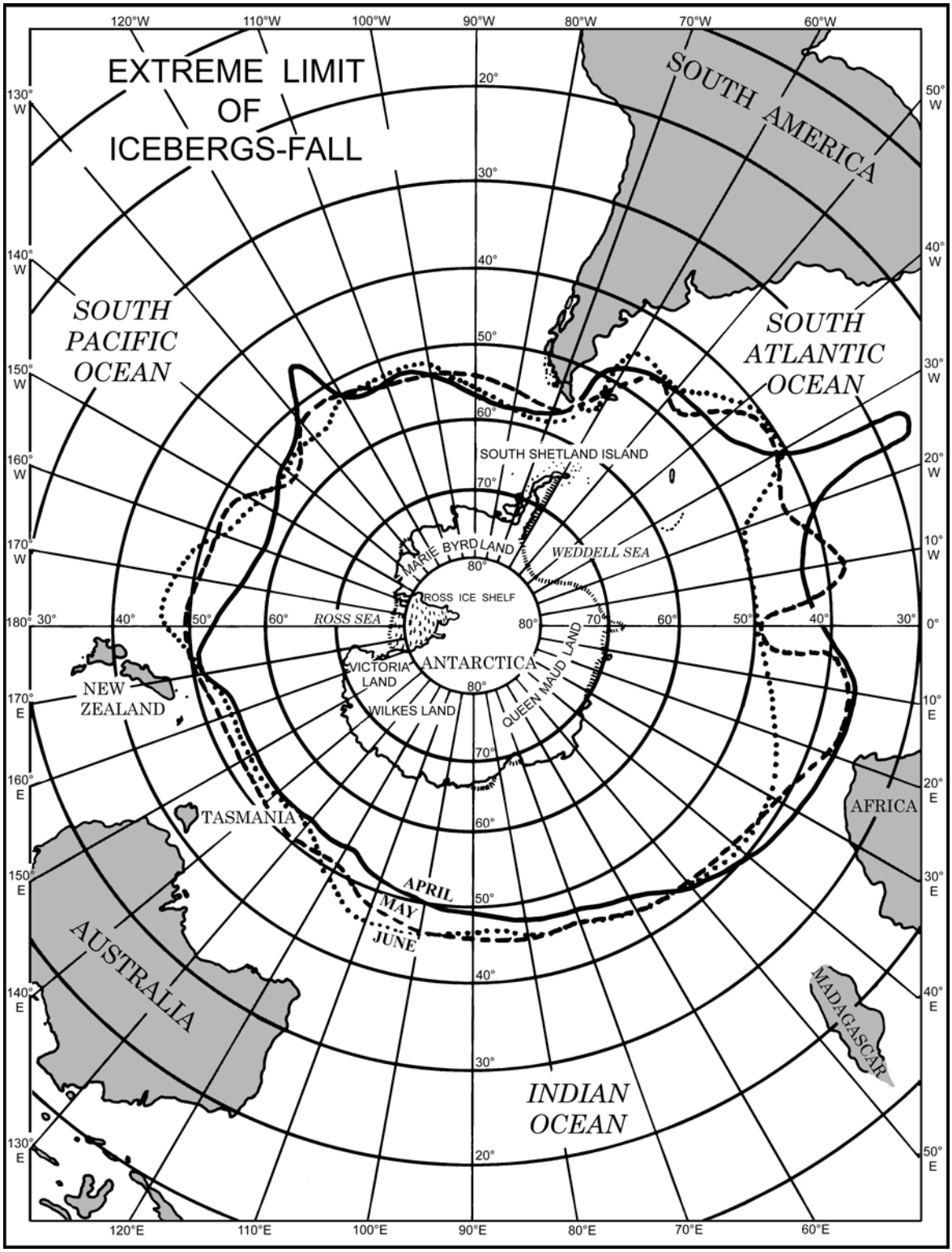
EXTREME LIMIT OF ICEBERGS-FALL
SOUTH AMERICA
SOUTH PACIFIC OCEAN
SOUTH ATLANTIC OCEAN
SOUTH SHETLAND ISLAND
MARIE BYRD LAND
WEDDELL SEA
ROSS ICE SHELF
ROSS SEA
ANTARCTICA
VICTORIA LAND
WILKES LAND
QUEEN MAUD LAND
NEW ZEALAND
TASMANIA
AUSTRALIA
AFRICA
MADAGASCAR
INDIAN OCEAN
APRIL
MAY
JUNE
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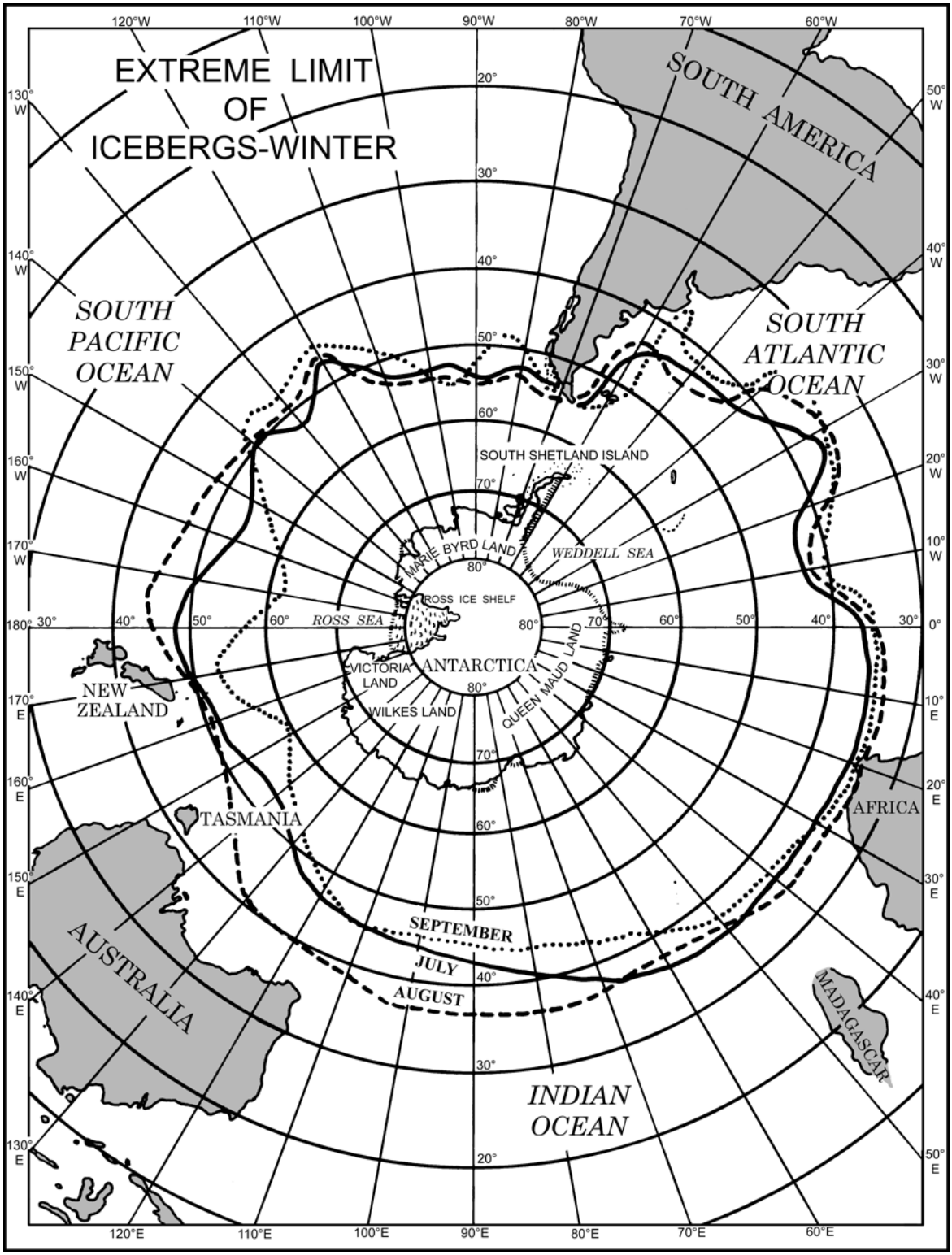
EXTREME LIMIT OF ICEBERGS-WINTER
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WEDDELL SEA
ROSS ICE SHELF
ROSS SEA
ANTARCTICA
VICTORIA LAND
WILKES LAND
QUEEN MAUD LAND
NEW ZEALAND
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AUSTRALIA
AFRICA
MADAGASCAR
INDIAN OCEAN
SEPTEMBER
JULY
AUGUST
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Reliance should not be placed upon sketchy reports by observers as the unusual phenomena and atmospheric conditions in the S pole region often lead the inexperienced observer to optical errors. Navigation in this area becomes further complicated with sea ice, sudden and violent changes in the weather, dangerous shoals, compass instability, and the absence of navigation aids.

The most serious danger is that caused by the pressure of ice on a vessel, which may result in the crushing of the hull or damage to underwater hull fittings. The risk is greatest when a vessel is navigating in pack ice. Apart from this hazard, vessels beset in ice, and hence drifting with it, may be forced into waters that are dangerous for navigation.

Distances.—The following navigable surface distances (nautical miles) between points combine the use of great circles and rhumb lines:

From:	Anvers Island—Antarctic Peninsula (64˚00'S., 64˚00'W.)	
To:	Boston, United States	7,235
	Buenos Aires, Argentina	1,856
	Cape Town, South Africa	3,811
	Fremantle, Australia	6,839
	Montevideo, Uruguay	1,762
	Panama	4,489
	Port Stanley, Falkland Islands	885
	Rio de Janeiro, Brazil	2,604
	Ushuaia, Argentina	606
	Valparaiso, Chile	1,987

From:	Cape Adare—Ross Sea (71˚00'S., 172˚00'E.)	
To:	Auckland, New Zealand	2,287
	Dunedin, New Zealand	1,532
	Fremantle, Australia	3,504
	Hobart, Tasmania	1,843
	McMurdo Sound, Antarctica	380
	Melbourne, Australia	2,208
	Pearl Harbor, Oahu	5,662
	Sydney, Australia	2,338
	Wellington, New Zealand	1,800

Note.—Due to changing ice conditions in the Antarctic region, the above distances may differ from those actually steamed.

Electronic Navigation and Communication

In general, radio wave propagation in high latitudes follows the same principles that apply elsewhere. However, certain anomalies occur, and although these are but imperfectly understood and experience to date has not always been consistent, there is much that has been ascertained. An understanding of these conditions is important if maximum effective use is to be made of electronics in high latitudes.

Communication between the scientific stations in Antarctica and the rest of the world, including vessels at sea, is vital. However, radio communications in high latitudes presents special problems. The permanent stations on the various parts of Antarctica are widely separated within an area of four million square miles. Hence, these stations are isolated by great distances and by ice caps. Most radio communications depend on the high frequency band, using the ionosphere as a reflector. A network of high frequency radio systems connects other parts of the world to Antarctica, including summer bases, field parties, ships, and aircraft. Generally, this high frequency network of communications is effective over great distances, but the system may become ineffective at times due to atmospheric disturbances, high ionospheric absorption flutter, drift static, and local man-made interference.

Disturbances.—The ionosphere is irregular and unstable in the auroral zone and the intensity of absorption is high nearly all of the time, especially during the daylight hours.

Man-made interference is caused by locally produced noise such as generators, transmitters, mobiles, switchgear, power lines, scientific equipment, etc. Because the Antarctic atmosphere is not restrictive to noise interference, a receiver unit becomes unusually sensitive to locally produced noise. In addition, the noise from other electrical equipment is accentuated by low ground conductivity.

Drift static and/or precipitation static are caused by electrically charged particles and are a common phenomena in this region. Static discharges are a serious problem frequented by severe blizzards, particularly when the drifts are dry and powdery, driven over a long distance by a gradient wind, and steep fronted. This phenomena usually builds up an electrical charge of several thousand volts before it discharges and can strongly distort high frequency radio systems. It is reported that measures to reduce smaller forms of static shocks have been successful to some degree by filterization and special grounding.

Flutter, which is a rapid succession of reflected pulses resulting from ionospheric storms, is common in polar regions. Its effect is particularly noticeable on voice circuits and in severe cases, radio teletype reception is impacted. Since flutter is usually associated with fading signal strength, high powered transmitters are sometimes suggested, but they should not exceed signal to noise ratios required for good reception.

It is important that the signal to noise ratio at the receiver should be at as high a level as is necessary to give intelligible communication. However, it is equally important that the power used to transmit the signal should not be greater than necessary. Hence, it should not be so great as to cause radio frequency interference with scientific programs and other radio reception, nor is it desirable for logistics reasons to use more power than is necessary.

The specification of signal to noise ratio for the mode of signal to be employed presents no problems. Nor is there any problem in measuring the noise level on which to base this specification. As previously stated, the ionosphere in the

auroral zone is unstable. Therefore, the theory of measuring noise level in this case becomes highly speculative.

Disturbances on the sun may cause interference with radio communication. At the time of an intense solar flare or eruption, a flash of ultraviolet light and a stream of charged particles are emitted from the sun. The flash of ultraviolet light takes only 8 minutes to reach the earth, where it produces great ionization (electrification) at abnormally low layers of the upper atmosphere. Short radio waves, which travel round the earth by being reflected from a higher layer of the upper atmosphere, cannot penetrate this barrier of ionization and a radio "fadeout" is experienced. However, long radio waves may be reflected more strongly from the base of the lower layer of ionization. Since these short wave radio fadeouts and long wave enhancements are caused by the effects of ultraviolet light from the sun, they are confined to the sunlit side of the earth and are almost simultaneous with the flare, lasting on the average for about 20 minutes.

The stream of charged particles, traveling much more slowly than light, arrives at the earth, if it is suitably directed, in about one to three days. The stream visibly signals its arrival at the earth by producing a bright and active aurora. It also causes great ionization in the upper atmosphere, which is much more prolonged than that caused by the ultraviolet light. There is again deterioration in short wave radio communications, which may be a complete "blackout" in higher latitudes. At this time, currents of up to a million amperes may circulate in the upper atmosphere. The resulting magnetic field may extend to the surface of the earth and may deflect a compass needle noticeably from its normal position. The effects of these magnetic and ionospheric storms, which may persist with varying intensity for several days, are usually greatest in higher latitudes. Radio "blackouts" and simultaneous deflections of magnetic compasses are not uncommon in and near the auroral zones. When a great aurora is seen in abnormally low latitudes, it is invariably accompanied by a magnetic and ionospheric storm. Unlike the fadeouts which occur only on the sunlit side of the earth, the interference with radio communications that accompanies an aurora and a magnetic storm may occur by day or at night. All these effects occur most frequently and in most intense forms at the time of sunspot maximum.

Polar Cap Disturbance (PCD) is an ionospheric disturbance which is in no way dependent on the ice cap in the polar region. It is the result of the focusing effect the earth's magnetic field has on particles released from the sun during a solar proton event. The effect concentrates high energy particles in the region of the magnetic pole with the result that normal very low frequency propagation is disrupted. The effect on radio waves is known as Polar Cap Absorption (PCA).

Historically PCDs produced large or total absorption of high frequency radio waves crossing the polar region. A transmission path that is entirely outside the polar region is unaffected by PCDs. The PCDs, often called PCA Events (PCAs), may persist for a week or more, but commonly the duration lasts only a few days. The frequency of this phenomenon increases during those years of peak solar activity.

Sudden Ionospheric Disturbance (SID) is a sudden increase in the ionization density in the lower part of the ionosphere. It is caused by very sudden and large increases in X-ray flux which is emitted from the sun, usually during a solar flare. These disturbances (SIDs) also occur during flares called X-ray flares that produce large X-ray flux, but which have no components in the visible light spectrum. The effect, which is restricted to sunlit propagation paths, causes a phase advance and is known as a Sudden Phase Anomaly (SPA). The SID effects are related to solar zenith angle and consequently occur mostly in lower latitude regions. Usually, a phase advance over a period of 5 to 10 minutes occurs which is followed by a recovery over a period of 30 to 60 minutes.

International Maritime Satellite Organization (INMARSAT).—Around the world satellite communication systems have now become synonymous with reliable and quality transfer of information. The International Maritime Satellite Organization (INMARSAT) is an international consortium comprising over 75 partners who provide maritime safety management and maritime communications services.

The INMARSAT system consists of a number of satellites, which maintain geosynchronous orbits, and provides quality communications coverage between about 77˚N and about 77˚S, including locations with less than a 5˚ angle of elevation.

INMARSAT-A, the original system, provides telephone, telex, and fax services. However, this system is being replaced by INMARSAT-B, which, by the use of digital technology, is providing the services with improved quality and higher data transmission rates. INMARSAT-C provides a store and forward data messaging capability, but no voice communication.

To qualify for access into the system, the National Science Foundation (NSF) applied through COMSAT, the United States representative to INMARSAT. Because McMurdo Station, the main United States base in Antarctica, qualifies as a search and rescue coordination center for that region, the application was approved and the base now operates within the network as a ship/earth station. Since 1983, a permanent communication link between McMurdo Station and the United States has been provided via INMARSAT.

Global Maritime Distress and Safety System (GMDSS).—The Global Maritime Distress and Safety System (GMDSS) provides a great advancement in safety over the previous usage of short range and high seas radio transmissions. This system, fully implemented since 1 February 1999, consists of satellite as well as advanced terrestrial communications operations.

The GMDSS has been adopted by the International Convention for the Safety of Life at Sea (SOLAS) 1974. It applies to cargo vessels of 300 grt and over and all vessels carrying more than 12 passengers on international voyages. Unlike previous regulations, the GMDSS requires vessels to carry specified equipment according to the area in which they are operating. Such vessels navigating in polar regions must carry VHF, MF, and HF equipment and a satellite Emergency Position Indicating Radiobeacon (EPIRB).

It should be noted that after 1999, compliant vessels are no longer required to maintain a voice listening watch on VHF channel 16 or 2182kHz and considerable difficulty may be experienced in establishing communications between a GMDSS and a non-GMDSS equipped vessel.

SafetyNET.—NAVTEX is an international automated direct printing service for providing coastal navigational information, distress warnings, and meteorological warnings, including ice

reports. It is an element of GMDSS and has replaced the broadcasts of safety information over MF morse frequencies.

The SafetyNET broadcast system provides the same information as NAVTEX to vessels on the high seas and is delivered by the INMARSAT-C system.

Global Positioning System (GPS).—The NAVSTAR Global Positioning System (GPS) is a satellite-based system, operated by the U.S. Air Force, which provides very accurate positioning, time, and velocity information to multiple users. It is an all-weather system with world wide and continuous usage which will replace OMEGA and other such hyperbolic radio navigation systems. The space component of GPS consists of 24 satellites, of which a minimum of six are observable from any place on earth. GPS receivers convert data from the satellites to produce three-dimensional positions (latitude, longitude, and altitude). They compute information for fixes in terms of the World Geodetic System (1984) reference ellipsoid; hence, a datum shift correction may be required before a position can be plotted on a chart.

GPS provides two services for navigation positioning, as follows:

1. Standard Positioning Service (SPS)—The standard level of positioning and timing accuracy. It is available without restrictions to any user on a continuous worldwide basis. As of midnight (EDT) 1 March 2000, Selective Availability was set to zero; users should experience a GPS horizontal accuract of 10 to 20m or better.
2. Precise Positioning Service (PPS)—An encoded level intended for use by the Department of Defense.

Note.—For further information concerning the International Maritime Satellite Organization (INMARSAT), the Global Maritime Distress and Safety System (GMDSS), the SafetyNET system, and the Global Positioning System (GPS), see Pub. No. 9, The American Practical Navigator (Bowditch-2002 Edition); Pub. 117, Radio Navigation Aids; and Annual Notice to Mariners No. 1.

Oceanography

The Antarctic continent is surrounded by waters forming a confluence of the S portions of the Pacific Ocean, the Atlantic Ocean, and the Indian Ocean. Adjacent to the continent lie the Weddell Sea, the Bellingshausen Sea, the Amundsen Sea, and the Ross Sea. The water surrounding Antarctica is unique among the world's oceans because the configuration of land and water in the southern hemisphere permits a circumpolar oceanic flow comprising about 10 per cent of the world's sea water. The only major physical boundary that constricts the zonal flow is Drake Passage which lies in the Scotia Sea region between the southernmost part of the South American continent and the Antarctic Peninsula. Great depths within this passage permit an unhindered flow of water. However, this area can become exceptionally stormy because there is no barrier to reduce the persistent and strong W winds.

Antarctica provides the S boundary of the adjacent waters whereas the N boundary is defined by the cold water lying S of the Antarctic Convergence or Polar Front Zone.

The continental shelves surrounding Antarctica are relatively narrow and deep. Although they have an average width of 30km, they comprise an area of approximately 4,000,000km^2 and reach depths of 500 to 900m at the shelf edge. This is two to four times greater than the world average shelf depth, and may be caused by isostatic subsidence in response to the weight of the ice cap. At the edge of the shelf, the gradient steepens to define the continental slope. The water depth increases rapidly to approximately 3,000m over a distance of less than 100km. Seaward of the continental slope, the continental rise and deep ocean bottom lie at depths greater than 3,000 and 4,500m, respectively. These areas are underlain by thick sediments.

The Antarctic Convergence.—The Antarctic Convergence occurs where the cold Antarctic water merges with warmer tropical waters and downwells or dives underneath the warmer surface of the South Atlantic Ocean, the Pacific Ocean, and the Indian Ocean. This phenomenon occurs in a remarkably discernible climatic and oceanic boundary which extends to the 50th parallel. In many locations this line is easily and precisely distinguished by a quick alteration in surface temperature; hence, producing a physical boundary between the waters lying adjacent to Antarctica and those of the sub-polar region or Polar Front Zone.

The Antarctic Convergence may form the extreme N limit of drift ice, but such ice is rarely found so far to the N. The waters to the S of the Antarctic Convergence are ice laden and abound with sub-polar aquatic life, forming a feeding ground for pelagic birds and the world's largest population of seals and whales.

The Antarctic Divergence.—In the zone of Antarctic upper water, between the continent and the Antarctic Convergence, there is an area of divergence of surface waters and consequent upwelling, which coincides with the boundary between the E and W wind belts. The position of this Antarctic Divergence and the occurrence and strength of divergent motion are both variable and depend on the prevailing meteorological conditions. Influenced by the wind and the rotation of the earth, the ocean surface water on each side of the Divergence moves in a direction to the left of the wind direction. The Divergence lies N of the drift ice and between 5˚ and 10˚ of latitude S of the Antarctic Convergence.

Tides—Currents.—The Antarctic Circumpolar Current, known as the West Wind Drift, is the world's greatest current. Strong W winds between about 40˚S and 60˚S (Roaring Forties) drive this current in an E direction at approximately 0.5 meter per second. This current completely encircles Antarctica and is so deep that it can reach the ocean bottom. Closer to Antarctica, E or SE winds prevail that cause a W current which is known as the East Wind Drift. The flow of this current is complicated by the irregular coastline and gyres (eddies) can form in bays such as the the Weddell Sea, the Ross Sea, and Bellingshausen Sea.

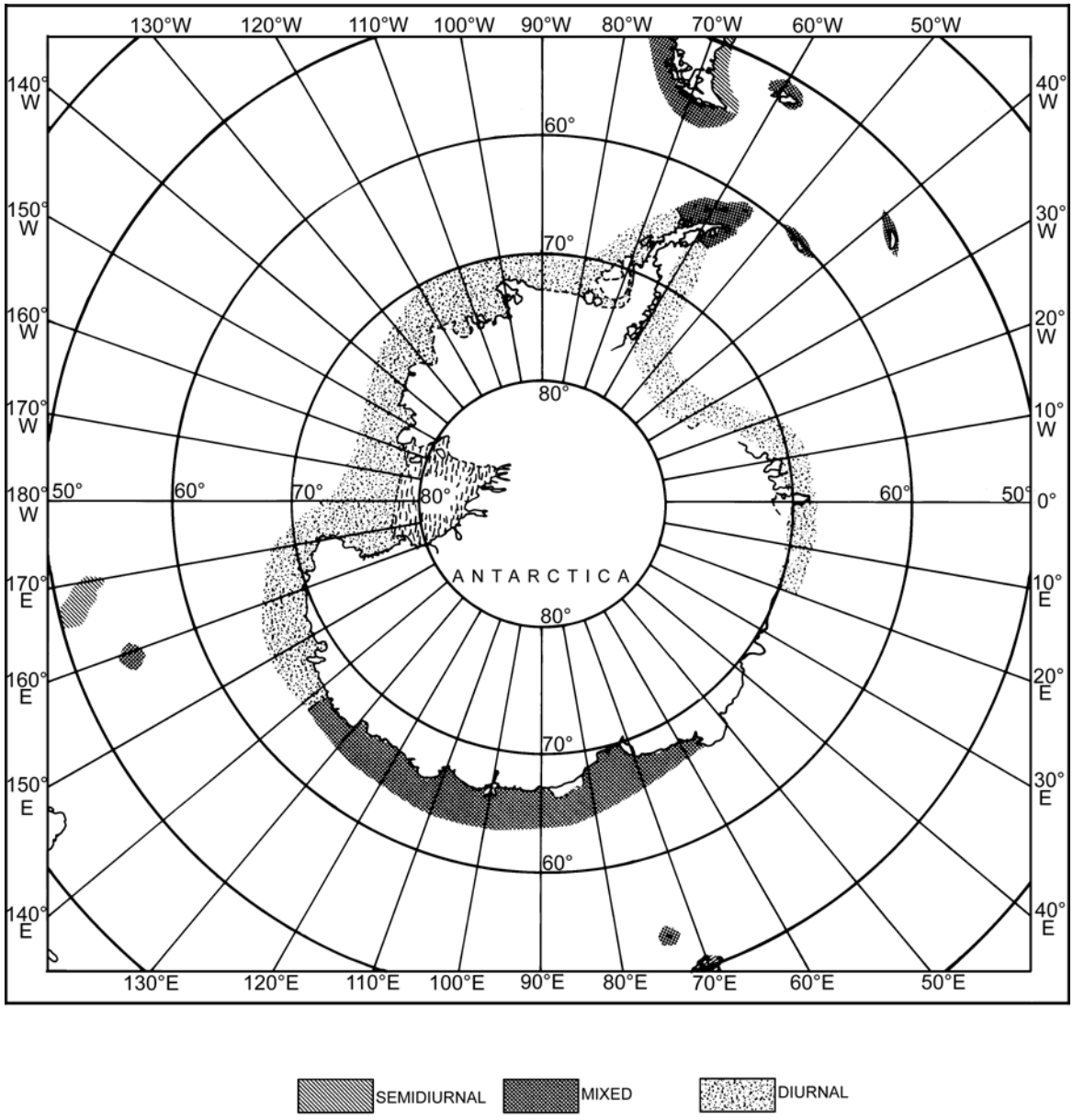
Relatively warm, saline, and nutrient-rich water, which has flowed at depth to high latitudes from lower latitudes, upwells to the surface in a zone. This zone of general upwelling, known as the Antarctic Divergence, separates the Circumpolar Current from the East Wind Drift. This divergence, located 150 to 200 miles from the coast, is not entirely continuous, but disappears to the E of Drake Passage.

More than half of the bottom waters of the world's oceans are formed around Antarctica. Cold winter temperatures and ice formation produce dense seawater which sinks to the ocean

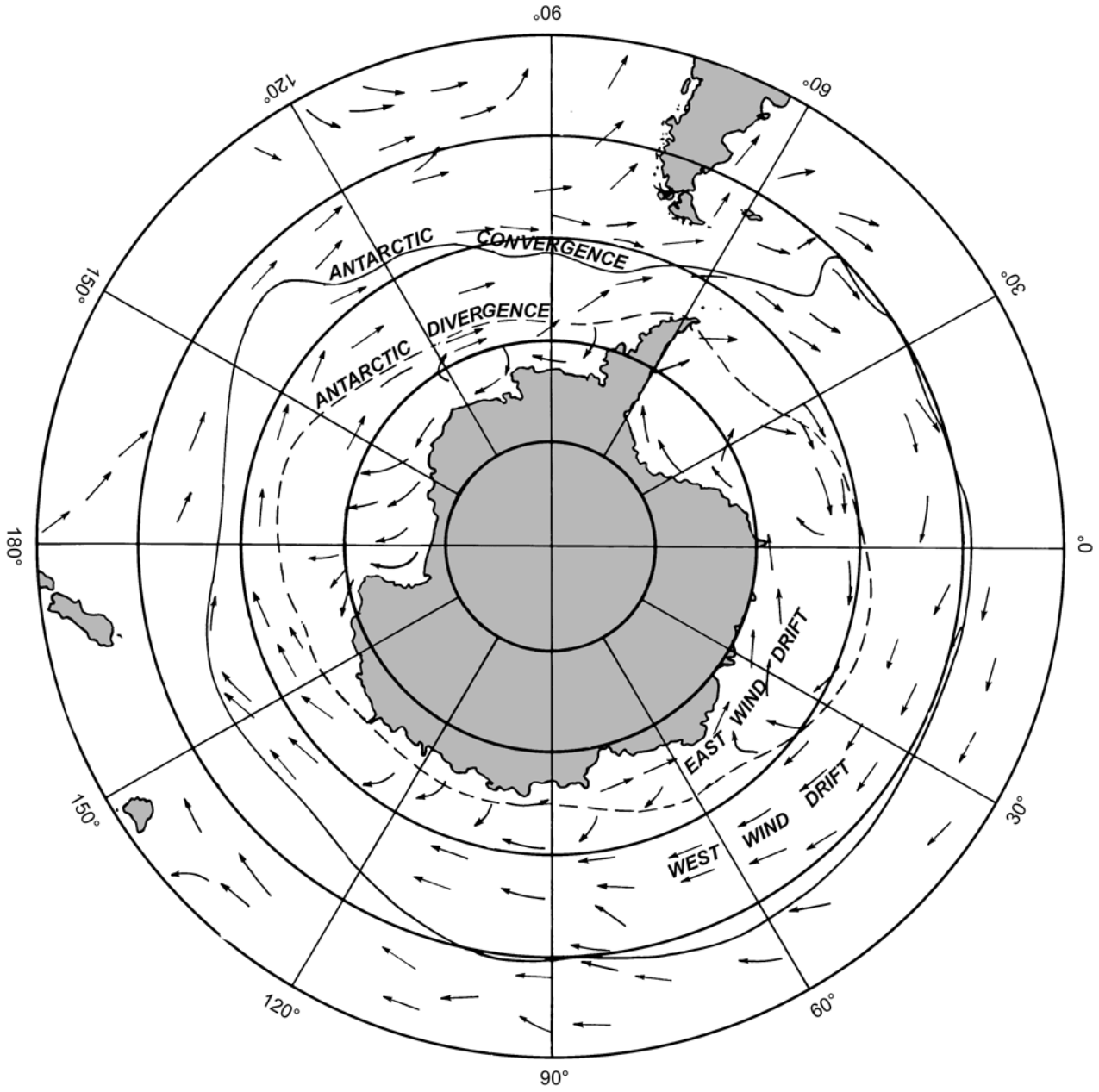
bottom, where it spreads to the N. The continual production of this Antarctic Bottom Water plays an important role in renewing the bottom waters of the oceans; without this renewal, the respiration of animals in the deep ocean would deplete the oxygen content of the bottom waters. In the Weddell Sea, which is believed to be the major source, bottom water formation appears to occur year-round, particularly on the S and W continental shelf. Estimates of bottom water formation in the Weddell Sea vary from 2 to 5 million cubic meters per second.

Tides are long-period forced waves whose speed is determined by the balance between the attraction of the sun and moon and the frictional effects of the ocean bottom. Tidal movement around Antarctica is unique in the world's ocean basins in that there are no significant land masses to impede the E/W (counterclockwise) sweep of the tides around the continent. The tidal movement is therefore principally a progressive wave, and the tide is predominantly diurnal. Diurnal tides are characterized by one high water and one low water each tidal day (a lunar day of 24 hours and 50 minutes).

Wind-generated waves are greatest around 50˚S to 60˚S because of predominant W winds and the long fetch. The tip of the Antarctic Peninsula extends into this region and rough seas can be encountered along its ice-free coastline. Higher latitudes and ice cover account for smoother seas along the rest of the Antarctic coast.



TYPES OF TIDES



GENERAL SURFACE CIRCULATION

Surface Temperature.—The Antarctic Convergence is a boundary surface which separates the heavier, colder Antarctic water to the S from the lighter but more saline water to the N. The mean position of this circumpolar boundary is fairly constant, lying at about 50˚S in the Atlantic sector and between 50˚S and 60˚S in the Pacific sector. Its position is marked by steep horizontal temperature and salinity gradients at the surface. Across the convergence, the temperature ranges in the summer from 3.9˚ to 6.7˚C and in the winter from 1.1˚ to 2.8˚C. Surface waters immediately S of the convergence have an average temperature of about 1.1˚ to 2.2˚C in the winter and 2.8˚ to 5˚C in the summer, while further S near the continent temperatures vary only from about -1.7˚ to -0.5˚C.

Salinity in the region to the N of the Antarctic Convergence changes only little throughout the year. However, to the S of the convergence, the melting of ice during spring and summer results in a highly variable distribution of surface salinity. Partially-melted fields of drift ice produce extensive local areas of relatively low salinity.

Tsunamis.—Earthquakes, volcanic eruptions, and submarine landslides frequently produce an unusual wave called a seismic sea wave or a tsunami. Tsunamis have long wave

lengths and travel across the open ocean at high speeds. As they approach the shore, the wave length decreases and the wave height increases, so that they can be a formidable agent of destruction. In the open ocean, the wave height is only 0.3 to 0.6m and may pass unnoticed. However, near the shore, the wave may build rapidly to heights of more than 15m.

Approximately 6 tsunamis occur in the Pacific Basin per year and only one of these is likely to cause local damage. There is little chance that a tsunami will form that is large enough to affect the entire Pacific Basin, including the Antarctic. Such a tsunami may occur only once every 7 to 10 years, but even then stations in the Antarctic would probably not experience any damage.

Marine Biota.—The food web of the Antarctic is short, allowing unusually large populations of top carnivores to develop. The key element is krill which are the dominant zooplankton. Krill serve as an important link between the primary production and the marine mammals and birds. Krill, which grow to several centimeters in length, are large marine herbivores (shrimp-like crustaceans) and are found in swarms, several to hundreds of meters wide. They serve as the prime food source for seals, squid, penguins, whales, and several other animals.

Squid are the predominant cephalopod in the adjacent seas to the continent. They live in open waters and may be concentrated near the Antarctic Convergence.

Fish stocks include Antarctic cod, icefish, whiting, toothfish, and silverfish. However, these stocks are believed to be less abundant and fewer in number of species relative to other oceans.

Crabeater seals are the most abundant of the continent and leopard seals are the largest of such species. Weddell seals are the most well known because of their proximity to the existing land bases. Ross seals are the rarest of the Antarctic breeds.

Southern fur seals and elephant seals are found N and S of the Antarctic Convergence. To the S of the convergence, these seals only inhabit the islands N of and along the Antarctic Peninsula.

Several species of penguins inhabit the continent, including adelie, which are the most abundant; emperor; chinstrap; macaroni, which breed mostly near the subantarctic islands; and gentoo.

Several spieces of whale migrate to the adjacent seas during the austral summer and have a circumpolar distribution. Baleen whales, which feed intensively on krill and other zooplankton, include fin, blue, sei, humpback, and minke. Southern right whales are occasionally found off the continent, but generally inhabit more temperate waters. Sperm whales and killer whales (related to dolphins) are found in the adjoining waters throughout the entire year.

Bioluminescence.—Bioluminescence is the emission of light by biological organisms. In the ocean environment, organisms may be stimulated to glow around the hulls and in the wake of vessels, submerged vessels, small boats, and divers. This phenomenon is generally infrequent in the Antarctic region, but luminescence can occur in all waters at any time. Some strong luminescence activity has been reported in ice as it is broken by icebreakers. It has also been reported along the Antarctic Convergence, in the Scotia Sea, and around the South Sandwich Islands, South Georgia Island, the South Orkney Islands, and the South Shetland Islands.

Krill have been reported to give off a luminescence in the form of a greenish light. When vessels pass through extensive areas (swarms) of krill, flashes from the individual crustaceans have been observed within 100m of the hull against the background color of the water.

Optical Phenomena

Optical phenomena are common in the region to the S of 50˚S and their frequency reaches a maximum in Antarctica. These phenomena, whose appearance range from intricate geometric patterns to colorful electrical displays, are associated with the refraction, reflection, or diffraction of light, and electromagnetic activity.

There is almost no dust or solid particles in the Antarctic air and the prevailing winds blowing off the continent have small moisture content. Consequently, the visibility is usually very good and often exceptional, a fact which, if not appreciated, may lead the observer into serious error when judging distances. An object which may be thought to be but 5 miles distant could well be 30 miles away, and mountains have been sighted at 300 miles.

Mirages—Abnormal Refraction.—An unusual lapse rate of temperature (and therefore density as well) with height immediately above the sea (or land) surface produces a distortion in the appearance of objects near the horizon; such a phenomenon is known as mirage.

When the surface is relatively cold (and the wind very light) so that the density of the air decreases rapidly for a short distance above the surface, light rays from objects near the horizon are bent down, the same way in fact as are usually the rays of the sun when entering the earth's atmosphere at a low altitude. These objects then appear to have been lifted above their true positions and hence, seem much closer to an ob-server. Objects below the horizon may actually become visible and this effect is known as looming. If the images are also stretched vertically, this refraction phenomenon is known as towering.

A further occasional effect produced when the air is appreciably warmer than the sea, is a superior mirage in which an inverted image is seen over the real object. Sometimes an erect image is seen immediately above and touching the inverted one. The object and its images in this instance are usually well defined in contrast with the shimmering object and image of the inferior mirage. Superior mirage is most often experienced in high latitudes and wherever the sea surface temperature is abnormally low. The impression of a greatly expanded ice field can be created, particularly when great numbers of otherwise invisible bergs are lifted into view as the stretched upper image of a superior mirage.

An inferior mirage, the effect of which is to decrease the distance at which objects are visible in a horizontal direction, is due to a rapid increase of density with height close to the surface. This may occur when air of comparatively low temperature blows over a warmer sea, or over a tarred road or desert when a hot sun is beating down on it. In such cases, the light rays are bent up and away from the surface. This occurs because light rays travel faster through the warm, less dense air at the surface than through the more dense air above. Coastlines,

vessels, and islands may appear at times to be floating in the air above a shimmering horizon. Sometimes the hulls of vessels are either invisible or appear with an inverted image underneath. Inferior mirage is comparatively uncommon at sea and is more likely to be observed near a coast. This effect may cause an observer to overestimate the distance to the shore or nearby objects.

A case known as stooping causes the visual image of a distant object to be foreshortened in the vertical and is the opposite of towering. This flattening may be so slight that it is not noticeable, yet it will seriously affect the determination of distances.

Generally, mirage effects are mostly observed when the sun is low in altitude.

On clear days shortly after sunset or before sunrise, green light is sometimes refracted from the sun's spectrum. When refractive conditions are suitable, red, orange, and yellow waves of sunlight are not refracted sufficiently to reach the eye, but green waves are. The visual result is a green flash in the surrounding sky. In well-developed cases, if the atmosphere is both abnormally refractive and clear, a fully developed blue coloration or blue flash can be seen.

Fata Morguna is a complex mirage that is characterized by multiple distortions of images, generally in the vertical, so that such objects as houses are distorted and magnified into fantastic, tall castles. An unusual density stratification is required to produce this mirage, namely the joint occurrence, in vertically adjacent layers, of density gradients that would give an inferior mirage and a superior mirage.

Parhelia, mock suns, and Parselenae, mock moons, are quite common. These images appear as refraction of the sun or moon, respectively, and take forms such as symmetrically arranged rings or arcs, usually of many colors. Prismatic sunrise and sunset both appear as a high arch, with the colors of the spectrum extending from the top of the arch to the horizon, in the sky opposite the sun.

Solar Haloes and Lunar Haloes are produced by refraction and reflection through and from ice crystals. They appear as rings, mock images, contra images, and other shapes.

Solar and Lunar Coronas consist of a series of rainbow-colored rings around the sun or moon. They resemble halos, but have a reverse sequence of the spectrum colors, red being the color of the outer ring. This reversal sequence is due to the diffraction. They are observed through high cloudiness and their radius varies inversely with that of the cloud particles.

The multicolored rainbow and whitish fogbow are due to refraction through water droplets, the colors varying with the size of the drops. The smaller the drops the lighter the colors and the nearer the violet end of the spectrum. Hence, the white rainbows sometimes seen over the Ross Ice Shelf.

Diffractional phenomena are often similar to those caused by refraction except for a reversal in the spectrum colors, red being away from the source of light. Several widely observed phenomena in the Antarctic are due to diffraction. These include the broken bow or glory, which consists of colored rings around shadows projected against fog banks or clouds.

Iridescent clouds are brighter than other forms of phenomena and usually appear as a deep, blue, central tract with banded margins of vivid purple, orange, green, and other colors.

Earth shadows, or aerial shadows, are believed to be produced by mountain peaks and take the form of dark blue bands projected into the sky as straight or curved shadows.

Other reflection phenomena observed in the Antarctic include iceblink, landblink, water sky, and land sky. Iceblink is a white or yellowish-white glare cast on the underside of clouds by considerable amounts of sea ice while landblink is its land ice counterpart. Water sky and land sky are observed as dark reflections of open water or land on the underside of an overcast. The pattern formed is known as a sky map. The sharply contrasting water sky and iceblink may sometimes be observed side by side from a great distance, strikingly outlining adjacent surface water and ice.

Whiteout is a condition in which daylight is diffused by multiple reflection between a snow surface and an overcast sky. Contrasts vanish and the observer is unable to distinguish the horizon or any snow surface feature. In addition, depth perception is greatly reduced. As falling snow, drift, fog, and mist are not involved, a dark object can be seen at any distance. This condition is a special hazard to low-flying aircraft.

Auroral Forms.—Aurorae are among the most beautiful of all natural phenomena. Their cause, which has attracted study since the 17th century, is still not fully understood by scientists.

The generally accepted thesis at the present time is that streams of electrically charged particles, possibly electrons and protons, are shot from the flaming surface of the sun with a velocity of a little less than that of light. These particles are believed to be pulled toward the N and S magnetic poles of the earth, striking the alternated outer atmosphere which may extend up to 800 miles above the earth's surface. There, the streams collide with atoms and molecules of the atmosphere, stripping off outer electrons and causing light-producing states. There are indications that the greatest auroral activity is associated with sunspots and magnetic disturbances, but this has not been proven. Aurorae are not visible when the sky is overcast, during daylight, or when brilliant moonlight obscures the effects.

The light of the aurora is emitted by the atmospheric gases when they are bombarded by a stream of electrically charged particles originating in the sun. As this stream of particles approaches the earth, it is directed towards the two magnetic poles by the earth's magnetic field and so it normally enters the upper atmosphere in high latitudes in each hemisphere. Therefore, the aurora occurs most frequently in two zones girdling the earth about 20° to 25° from the N and S magnetic poles. The aurora of the N hemisphere is called Aurora Borealis and that of the S hemisphere Aurora Australis.

The emission of the light that is seen as aurora, takes place at heights above 60 miles. Consequently, the aurora may be seen at distances of up to 600 miles from the place where it is overhead.

Auroral rays are always aligned along the direction of the lines of force of the earth's magnetic field so that when they cover a large part of the overhead sky, they appear to radiate from a point to form a crown or corona. The point from which they radiate lies in the direction in which the S pole of a freely suspended magnetic needle (a dip needle) points. The luminance of the normal aurora is below the threshold of color perception of the eye, so the forms appear gray-white in color. However, a brilliant display may be strongly colored, greens

and reds being predominant. When the aurora is brilliant, with colors, and the rays have rapid movement, the phenomenon produces a very magnificent display, beyond description.

Much of the S auroral zone lies within the continent of Antarctica. This zone extends N into the adjacent oceans, passing near Macquarie Island, and reaching its lowest latitude, 53˚S, at approximately 140˚E. Hence, the Aurora Australis is seen more frequently over the SE parts of the Indian Ocean and in Australian waters than at the same latitudes in the South Atlantic Ocean. It is believed to be centered over Wilkes Land and is usually associated with the moonless Antarctic night.

While the overhead aurora is mainly confined to the two auroral zones, where it may be seen at some time on every clear and dark night, there are times when it moves towards the Equator from each zone. On rare occasions, it has even been visible in the tropics. Departures of aurora far from its usual geographical position occur at times of great solar activity, when large sunspots appear on the sun's disk. The aurora that is seen widely over the earth usually follows about a day after a great flare or eruption has occurred in the central part of the sun's disk and is known as the Great Aurora. It is at this time that observers in lower latitudes may see the aurora, not as the familiar unspectacular glow on the horizon, but in the many striking forms that it may assume when it is situated nearly overhead.

Solar Activity.—Being closely associated with solar activity, the intensity and frequency of auroral displays are greatest at the time of the maximum of the 11-year sunspot cycle and least at the time of sunspot minimum. Especially at the time of sunspot minimum, the aurora shows a tendency to recur at intervals of 27 days, which is the period of rotation of the sun as observed from the earth. This suggests that a particular local area of the sun is the source of a continuous stream of particles, which is sprayed out, rather like water from the rotating nozzle of a hose. This stream sweeps across the earth at intervals of 27 days. Marked disturbances in the earth's magnetic field, which are called magnetic storms when they are of exceptional severity, are associated with the aurora.

Saint Elmo's fire is less frequent than the aurora, but may occur anywhere. It is more likely in summer than in winter and is best observed at night or under stormy conditions because of its faintness. Saint Elmo's fire occurs when static electricity collects in sufficiently large charges around the tips of pointed objects. These charges ionize the air in the vicinity and leak off in faintly luminescent discharges. Eerie flickers of blue light are observed on the masts of vessels and on airplane wings, often in the vicinity of storms. Sometimes, these discharges are described as weird greenish glows or as thousands of tiny air-like electrical sparks flickering along the sharp edges of the surfaces.

Regulations

Legal Information and Regulations

Antarctic Treaty.—Below is a summary of the Antarctic Treaty which was signed by 12 nations at Washington D.C. on December 1, 1959 and ratified in 1961.

In the treaty, the seven territorial claimant nations agreed for a period of 30 years to set aside their claims. However, the treaty is non-expiring and signatory nations must adhere to the agreements and conventions unless they give a 12-month advance notice that they intend to withdraw.

Argentina, Australia, Chile, France, New Zealand, Norway, and the United Kingdom claim land and maritime sectors; some of the claims are overlapping. Argentina, Australia,and Chile claim Exclusive Economic Zone rights or similar extending 200 miles seaward from their continental claims, but these claims are not recognized. The United States and many other states do not recognize these territorial claims and have made no claims themselves, although Russia and the United States reserve the right to do so. No claims have been made in the sector from 90˚W to 150˚W. Several states with territorial claims in Antarctica have expressed their intention to submit data to the United Nations Commission on the Limits of the Continental Shelf to extend their continental shelf claims to adjoining undersea ridges.

Article I states that Antarctica shall only be used for peaceful purposes and no military action or testing of weapons can be carried out.

Article II gives scientists the freedom of investigation.

Article III states that all scientific information, observations, and results shall be accessible.

Article IV states that the treaty shall not renunciate any previously made territorial claims. It also says that no new claims or enlargement of existing claims are allowed.

Article V prohibits nuclear explosions, nuclear waste, and radio active waste.

Article VI states that the treaty applies to the area located to the S of 60˚S. It also says that the treaty should not affect the rights of any nations under international law regarding the high seas within this area.

Articles VII and VIII give any of the contracting nations the right to observe, inspect, and examine any other nation's work in order to ensure compliance with the treaty. In addition, nations shall give advance notice of their expeditions and voyages to the Antarctic.

Article IX states that regular meetings shall be held and nations may make recommendations concerning the Antarctic. However, these recommendations must be unanimously agreed.

Article X prohibits any activity that is not allowed by the treaty.

Article XI states that any disputes between the signatory nations will be peacefully resolved.

Article XII states that the treaty will be in effect for a minimum of thirty years, but can be amended or modified.

Articles XIII and XIV state that the treaty shall be subject to ratification, shall be deposited in the United States archives, and shall be written in English, French, Russian, and Spanish.

The following two items that are included in the treaty are of particular operational importance to mariners:

1. Article VII.3 gives any of the contracting nations the right to inspect any other nation's work in order to ensure compliance with the treaty. This includes the inspection of all ships discharging, or loading, cargoes or personnel.
2. Article VII.5 requires each contracting party to inform the other contracting parties of expeditions to Antarctica by its ships or "organized in or proceeding from its territory."

Planned U.S. government expeditions are reported through the Department of State by the National Science Foundation, which funds and manages the United States Antarctic Research Program.

Nongovernmental U.S. vessels or nongovernmental expeditions, organized in or proceeding from the U.S.A., should report their plans directly to the Office of Ocean Affairs, Room 5801, Department of State, Washington, D.C. 20520.

Subsequent agreements since 1959 include the following:

1. The Agreed Measures for the Conservation of Antarctic Fauna and Flora were recommended at the Third Antarctic Treaty Consultative Meeting held at Brussels in 1964 and were subsequently ratified by the treaty nations.

In the analyses of comparison between Antarctic fauna and flora with other parts of the world, the relationship to their environment has sustained little hindrance by man, except in the case of whales. In addition, it was established that Antarctica offers outstanding research opportunities, due to its present state of untempered ecology. In parallel, it was also established that the Antarctic fauna, seals and penguins in particular, are peculiarly vulnerable and susceptible to extermination, willfully or by accidental introduction of disease.

The Antarctic Conservation Act of 1978 (Public Law 95-541), enacted by the 95th Congress, is the United States basis for the ratification of The Agreed Measures.

Regulations pursuant to U.S. Public Law 95-541 (the Antarctic Conservation Act of 1978) establish Specially Protected Areas (SPA), into which entry is restricted, and make it unlawful, unless authorized by permit, to carry out the following:

a. kill, handle, or import Antarctic animals or birds.

b. introduce species into Antarctica not already native to the continent.

c. discharge pollutants.

An Annex to The Antarctic Conservation Act of 1978 concerns pollution control. The Director of the National Science Foundation has determined that those provisions of the act regarding pollution control shall be implemented by an administrative directive in lieu of formal regulations. This directive (United States Antarctic Program Directive No. 84-1) directs that U.S. Antarctic Program participants will comply with the Code of Conduct for Antarctic Expeditions and Station Activities.

2. The Convention on the Conservation of Antarctic Marine Living Resources 1980 (CCAMLR).

U.S. Public Law 98-623 (Title 3: Antarctic Marine Living Resources Convention) provides the legislative authority necessary to implement the convention. This law makes it unlawful to harvest marine species in Antarctica and in violation of the convention. The law also directs the Secretary of Commerce to promulgate regulations pursuant to the convention.

The area to which the new convention applies extends farther N than the area to which the Antarctic Treaty applies. The treaty covers the area to the S of 60˚S, whereas the convention extends N to the Antarctic Convergence, defined in the convention as being as far N as 45˚S. Antarctic marine living resources are defined as all species of living organisms found S of the Antarctic Convergence.

By designating all populations, not just harvested ones, as resources, the convention recognizes the interdependence of all components of an ecosystem. This broad concept of resources is a significant advance for conservation in international agreements concerning renewable marine resources.

3. Guidelines for visitors to the Antarctic were discussed in 1979 at the 10th Antarctic Treaty consultative meeting. Subsequently, the treaty nations adopted a recommendation (X-8) which is primarily intended to inform tourists and nongovernment expeditions of suitable actions and behavior. The recommendations included subjects such as disturbing wildlife, retaining litter, use of sporting guns, introduction of plants or animals, collecting eggs or fossils, taking care of historic monuments, and entering restricted areas.

4. In 1988, the signatory nations tried to pass a Mineral Resources Agreement, commonly referred to as CRAMRA, which banned mineral and oil exploration. However, this agreement was never ratified.

Subsequently, in 1991 at Madrid, representatives of the treaty nations signed a Protocol on Environmental Protection to the Antarctic Treaty (Madrid Protocol 1991) that significantly modified environmental standards in Antarctica and superseded CRAMRA.

The protocol applies to the area, as defined in the treaty, as that located to the S of 60˚S. It prohibits any activity relating to mineral resources, other than scientific research; it requires an environmental impact assessment of any proposed activity; and it obliges member nations to devise rules and procedures relating to liability for damages.

The protocol has four annexes which describe the procedures for environmental impact assessment, the elaborate measures for conservation of fauna and flora, the procedures for waste disposal and management, and the rules concerning disposal of waste at sea and the prevention of marine pollution.

Law of the Sea.—In 1982, the Law of the Sea was established which conflicted with the rules and regulations of the Antarctic Treaty.

In regard to the Law of the Sea and the Madrid Protocol, it should be noted that Article VI of the Antarctic Treaty states "nothing in the present Treaty shall prejudice or in any way affect the rights, or the exercise of the rights, of any State under international law with regard to the high seas within that area." Hence, open access to the territorial waters of the high seas around Antarctica has been allowed.

Specially Protected Areas.—The regulations pursuant to the Antarctic Conservation Act of 1978 (U.S. Public Law 95-541) established several Specially Protected Areas (SPA), into which entry is restricted. Collecting of native plants and driving of vehicles in these areas are prohibited.

Permits authorizing entry into SPAs may be issued only if there is a compelling scientific purpose for entry and only if the actions allowed under the permit will not jeopardize the natural ecological system of the area.

Specially Protected Areas are listed in the accompanying table.

For additional information and applications concerning permits, contact the National Science Foundation (NSF), Office of Polar Programs (OPP), 4201 Wilson Boulevard, Arlington, VA 22230.

Sites of Special Scientific Interest.—At the Eighth Antarctic Treaty Consultative Meeting, in 1975, the representatives of the nations recognized the need to protect scientific investigations which might suffer from willful or accidental interference. Subsequently, in order to avoid any interference and to protect sites, which could not be designated as Specially Protected Areas (SPA), certain locations have been identified as Sites of Special Scientific Interest. Different rules apply to each site, but in general, they should only be entered by persons engaged in scientific research. In addition, vehicles should not be used in the sites and helicopters and low-flying aircraft should avoid them.

The Sites of Special Scientific Interest likely to affect marinersare listed in the accompanying table.

SPECIALLY PROTECTED AREAS

Special Area No.	Location
1	Taylor Rookery, MacRobertson Land (67˚26'S., 60˚50'E.)
2	Rookery Islands, Holme Bay (67˚37'S., 62˚33'E.).
3	Ardery Island (66˚22'S., 110˚28'E) and Odbert Island (66˚22'S, 110˚33'E.), Budd Coast
4	Sabrina Island, Balleny Islands (66˚54'S., 163˚20'E.)
5	Beaufort Island, Ross Sea (76˚58'S., 167˚03'E.)
7	Cape Hallett, Victoria Land (72˚18'S., 170˚19'E.)
8	Dion Islands, Marguerite Bay (67˚52'S., 68˚43'W.)
9	Green Island, Berthelot Islands (65˚19'S., 64˚10'W.)
13	Moe Island, South Orkney Islands (60˚45'S., 45˚41'W.)
14	Lynch Island, South Orkney Islands (60˚40'S., 45˚38'W.)
15	Powell Island, South Orkney Islands (60˚45'S., 45˚02'W.)
16	Coppermine Peninsula, Robert Island (63˚23'S., 59˚24'W.)
17	Litchfield Island, Palmer Archipelago (64˚46'S., 64˚06'W.)
18	Coronation Island, South Orkney Islands (60˚33'S., 45˚36'W.)
19	Lagotellerie Island, Marguerite Bay (67˚53'S., 67˚24'W.)
20	New College Valley, Caughley Beach,Cape Bird, Ross Island (77˚14'S., 166˚23'E.)
21	Avian Island, Marguerite Bay (67˚46'S., 68˚54'W.)
22	Mount Melbourne, Victoria Land (74˚21'S., 164˚42'E.)
23	Dufek Massif, Davis Valley Pond and Forlidas Pond (82˚27'S., 51˚21'W.)
24	Terre Adelie (66˚40'S., 140˚02'W.)
25	Cape Evans, Ross Island (77˚38'S., 166˚25'E.)
26	Lewis Bay, Mount Erebus, Ross Island (77˚25'S., 167˚28'E.)
27	Cape Royds, Ross Island (77˚33'S., 166˚10'E.)
28	Hut Point, Ross Island (77˚51'S., 166˚38'E.)
29	Cape Adare, Victoria Land (71˚19'S., 170˚09'E.)

SITES OF SPECIAL SCIENTIFIC INTEREST

Site No.	Location
1	Cape Royds, Ross Island (77˚33'S., 166˚08'E.)
2	Hut Point Peninsula, Ross Island (77˚49'S., 166˚39'E.)
3	Barwick Valley, Victoria Land (77˚18'S.,161˚00'E.)
4	Cape Crozier, Ross Island (77˚30'S., 169˚25'E.)

SITES OF SPECIAL SCIENTIFIC INTEREST	
Site No.	**Location**
5	Fildes Peninsula, King George Island, South Shetland Islands (62˚12'S., 58˚56'W.)
6	Byers Peninsula, Livingston Island, South Shetland Islands (62˚38'S., 61˚05'W.)
7	Haswell Island, Queen Mary Land (66˚31'S., 93˚00'E.)
8	Admiralty Bay, King George Island, South Shetland Islands (62˚12'S., 58˚27'W.)
9	Rothera Point, Adelaide Island (67˚35'S., 68˚08'W.)
10	Caughley Beach, Cape Bird, Ross Island (77˚15'S., 166˚23'E.)
11	Mount Erebus, Ross Island (77˚31'S., 167˚07'E)
12	Canada Glacier, Victoria Land (77˚37'S.,163˚03'E.)
13	Potter Peninsula, King George Island South Shetland Islands (62˚15'S., 58˚41'W.)
14	Harmony Point, Nelson Island, South Shetland Islands (62˚18'S., 59˚14'W.)
15	Cierva Point, Danco Coast (64˚10'S., 60˚57'W.)
16	Bailey Peninsula, Budd Coast, Wilkes Land (66˚17'S., 110˚32'E.)
17	Clark Peninsula, Budd Coast, Wilkes Land (66˚15'S., 110˚36'E.)
18	White Island, McMurdo Sound (78˚10'S., 167˚25'E.)
19	Asgard Range, Victoria Land (77˚35'S., 161˚05'E.)
20	Biscoe Point, Anvers Island, Palmer Archipelago (64˚49'S., 63˚48'W.)
21	Port Foster, Deception Island, South Shetland Islands (62˚55'S., 60˚39'W.)
22	Prins Harald Kyst, Lutzow-Holmbukta (69˚15'S., 39˚45'E.)
23	Svarthamaren, Dronning Maud Land (71˚54'S., 5˚10'E.)
24	Mount Melborne, Victoria Land (74˚21'S., 164˚41'E.)
25	Marine Plain, Vestfold Hills (68˚36'S., 78˚07'E.)
26	Greenwich Island, Discovery Bay, South Shetland Islands (62˚29'S., 59˚41'W.)
27	Port Foster, Deception Island, South Shetland Islands (62˚58'S., 60˚38'W.)
28	South Bay, Doumer Island, Palmer Archipelago (64˚52'S., 63˚36'W.)
29	Alexander Island, Graham Land (70˚50'S., 68˚30'W.)
31	Mount Flora, Hope Bay, Trinity Peninsula,(63˚25'S., 57˚01'W.)
32	Cape Shirreff, Livingston Island, South Shetland Islands (62˚28'S., 60˚47'W.)
33	Ardley Island, Maxwell Bay, King George Island (62˚08'S., 59˚08'W.)
34	Lions Rump, King George Island, South Shetland Islands (62˚08'S., 58˚08'W.)
35	Low Island, Western Bransfield Strait (63˚20'S. to 63˚35'S. and 61˚45'W. to 62˚30'W.)
36	East Dallman Bay, Brabant Island (64˚00'S. to 64˚20'S. and 62˚50'W. to intertidal zone)
37	Botany Bay, Cape Geology, Victoria Land (77˚00'S., 162˚32'E.)

Operations Support.—Antarctic research is a remote expeditionary activity requiring a support system capable of providing virtually all necessities for living and working in Antarctica. Such necessities include special cold weather clothing, food and housing, transportation, utilities, communications, tools, equipment, research instruments and laboratories, and all supplies, particularly fuel, essential for life support.

The National Science Foundation (NSF) funds and manages the entire United States Antarctic Program, obtaining operations support, under contracts, from private sector firms and, on a reimbursable basis, from the Department of Defense (DoD) and the Department of Transportation (DoT).

Major logistic elements currently provided include the operation and maintenance of McMurdo Station and an advance staging facility in Christchurch, New Zealand; aviation support on the Antarctic continent; intercontinental air and sealift support between the U.S.A. and Antarctica; and communications support. The DoT, through the U.S. Coast Guard, provides

icebreaker services to support surface resupply and research activities.

Note.—For information concerning operations and logistics in the Antarctic; the Antarctic Treaty, including any modifications or amendments; U.S. laws and regulations pursuant to the Antarctic Treaty; Specially Protected Areas; Sites of Special Scientific Interest; historic monuments; and research bases, questions and correspondence should be directed to:

The National Science Foundation (NSF)
Office of Polar Programs (OPP)
4201 Wilson Boulevard
Arlington, VA (22230)
Telephone: (703) 306-1031
Facsimile: (703) 306-0139

Pollution.—The International Convention for the Prevention of Pollution from Ships, as modified by the Protocol of 1978 (MARPOL 73/78) is implemented into United States law by The Act to Prevent Pollution from Ships (33 U.S.C. 1901). The International Convention includes five annexes. Annexes I, II, and V are mandatory and the remainder optional.

Annex I contains regulations concerning the prevention of pollution by oil.

Annex II contains regulations concerning the control of pollution by noxious liquid substances carried in bulk.

Annex III contains regulations concerning the prevention of pollution by harmful substances carried in packaged forms, containers, or tanks.

Annex IV contains regulations concerning sewage from ships.

Annex V contains regulations concerning the disposal of garbage from ships and the management of ballast.

Special Areas and Particularly Sensitive Sea Areas are designated in the Annexes. In these areas more stringent restrictions are applied to avoid the effects of harmful substances. A Particularly Sensitive Sea Area may lie within a Special Area.

The Antarctic Area, which is the sea area S of 60˚S, has been designated in the Annexes as a Special Area (1992).

For further information, see Annual Notice to Mariners No. 1, MARPOL 73/78, and The Act to Prevent Pollution from Ships (33 U.S.C. 1901).

In accordance with Regulation 13G of Annex I of the MARPOL Convention, single-hull tankers should be phased out or converted to a double-hull configuration according to a schedule based on their year of delivery. These requirements are designed to reduce the risk of oil spills from tankers involved in low-energy collisions or groundings.

The types of vessels affected by these regulations and their phase-out schedule is, as follows:

1. **Category 1—**Commonly known as Pre-MARPOL Tankers, consists of the following types of vessels:
   a. Tankers of 20,000 dwt and over carrying crude oil, fuel oil, heavy diesel oil, or lubricating oil as cargo.
   b. Tankers of 30,000 dwt and over carrying other oils, which do not comply with the requirements for protectively-located segregated ballast tanks.

   The phase out schedule for Category 1 vessels is, as follows:
   a. Vessels delivered on or before 5 April 1982—not allowed to trade after 5 April 2005.
   b. Vessels delivered after 5 April 1982—not allowed to trade after the anniversary date, in 2005, of their delivery date.
2. **Category 2—**Commonly known as MARPOL Tankers, consists of the following types of vessels:
   a. Tankers of 20,000 dwt and over carrying crude oil, fuel oil, heavy diesel oil, or lubricating oil as cargo, which comply with the MARPOL requirements for protectively-located segregated ballast tanks.
   b. Tankers of 30,000 dwt and over carrying other oils, which comply with the MARPOL requirements for protectively-located segregated ballast tanks.

   The phase out schedule for Category 2 vessels is, as follows:
   a. 5 April 2005 for vessels delivered on 5 April 1977 or earlier.
   b. Anniversary date in 2005 for vessels delivered after 5 April 1977 but before 1 January 1978
   c. Anniversary date in 2006 for vessels delivered in 1978 and 1979.
   d. Anniversary date in 2007 for vessels delivered in 1980 and 1981.
   e. Anniversary date in 2008 for vessels delivered in 1982.
   f. Anniversary date in 2009 for vessels delivered in 1983.
   g. Anniversary date in 2010 for vessels delivered in 1984 or later.
3. **Category 3—**Consists of tankers 5,000 dwt and over but less than the tonnage specified for Category 1 and Category 2 vessels.

   The phase out schedule for Category 3 vessels is, as follows:
   a. 5 April 2005 for vessels delivered on 5 April 1977 or earlier.
   b. Anniversary date in 2005 for vessels delivered after 5 April 1977 but before 1 January 1978
   c. Anniversary date in 2006 for vessels delivered in 1978 and 1979.
   d. Anniversary date in 2007 for vessels delivered in 1980 and 1981.
   e. Anniversary date in 2008 for vessels delivered in 1982.
   f. Anniversary date in 2009 for vessels delivered in 1983.
   g. Anniversary date in 2010 for vessels delivered in 1984 or later.

Single-hull tankers of 5,000 dwt and over are prohibited from carrying heavy grade oil (HGO) after 5 April 2005. Single-hull tankers of 600 dwt and over but less than 5,000 dwt are prohibited from carrying HGO after the anniversary of their delivery date in 2008.

Search and Rescue

Masters of vessels operating within the Australian Search and Rescue Region (SRR) are advised that an Australian Government protocol for ships assisting people in distress at sea is now in place (2002). This protocol sets out important principles that must be recognized to ensure a smooth post-

rescue effort while minimizing the disruption to the intended voyage of the rescuing vessel. It provides guidance to ships' masters on the processes to be followed in relation to landing people who have been rescued at sea. Copies of the protocol can be obtained from the web site listed below.

Protocol for Commercial Shipping Rescuing Persons at Sea in or Adjacent to the Australian Search and Rescue Region

http://www.dotrs.gov.au/transinfra/sea_rescue_protocol.htm

Automated Mutual-assistance Vessel Rescue (AMVER)

The Automated Mutual-assistance Vessel Rescue (AMVER) System is operated by the U.S. Coast Guard to promote safety of life and property at sea. It is a maritime mutual assistance organization which provides important aid to the development and coordination of search and rescue (SAR) efforts in many offshore areas of the world.

Merchant vessels of all nations making offshore voyages are encouraged to send movement reports and periodic position reports to the AMVER center in New York via selected radio stations or via INMARSAT.

Information from these reports is entered into a computer which generates and maintains dead reckoning positions for such vessels. Characteristics of vessels that are valuable for determining SAR capability are also entered from available sources. Appropriate data concerning the predicted location and SAR characteristics of each vessel is then made available upon request to recognized SAR agencies of any nation, or persons in distress, for use during an emergency. Such information is kept strictly confidential and only disclosed for reasons connected with maritime safety.

Generally, participation in AMVER is voluntary. However, requirements exist for certain U.S. flag or U.S. interest vessels.

The U.S. Maritime Administration (MARAD) regulations state that United States flag merchant vessels of 1,000 grt or more, operating in foreign commerce, and foreign flag vessels of 1,000 grt or more, for which an Interim War Risk Insurance Binder has been issued under the provisions of Title XII, Merchant Marine Act (1936), must report to the AMVER center.

Title 47 of the Code of Federal Regulations (CFR CH. 1, Sec. 80.905) states that United States vessels, which transport more than six passengers for hire, operated more than 200 nautical miles from the nearest land must participate in AMVER while engaged on a voyage where the vessels is navigated in the open sea for more than 24 hours.

Participating vessels must send a Sailing Plan Report, a Position Report, a Deviation Report, and an Arrival Report.

Departure Reports have been eliminated in favor of the more common practice of filing a combined Sailing/Departure Report. However, Departure Reports will continue to be accepted indefinitely.

A world-wide radio station network of coastal facilities supports AMVER. To ensure that no charge is applied, all AMVER reports should be passed through the specified stations.

In cases of emergency, all distress messages must be sent to the nearest radio communications station, not the AMVER center.

Note.—For further details of the system, see Pub. 117, Radio Navigational Aids; and the AMVER Bulletin, which is available from U.S. Coast Guard District Offices, Marine Inspection Offices, and Captain of the Port Offices.

Detailed instructions in English and several other languages are contained in the AMVER Users Manual which may be obtained free of charge from the following address:

AMVER Maritime Relations Office
U.S. Coast Guard
Battery Park Building
New York, NY (10004)
USA

Australian Ship Reporting System (AUSREP)

The Australian Ship Reporting System (AUSREP) is compulsory for Australian-registered commercial vessels and for foreign vessels on voyages between Australian ports. All other vessels are encouraged to participate when within the AUSREP area.

The objective of the AUSREP system is to contribute to the safety of life at sea by:

1. Limiting the time between the loss of a vessel and the initiation of SAR action, in cases where no distress signal is sent out.
2. Limiting the search area for a SAR action.
3. Providing up-to-date information on all shipping resources available in the area, in the event of SAR action.

The AUSREP area, and Australian SAR region, covers the coast of Australia, as well as the coast of Antarctica between 75˚E and 163˚E, and extends N to approximately 6˚S at its W limit and to 12˚S at its E limit. The limits are best seen in the accompanying graphic.

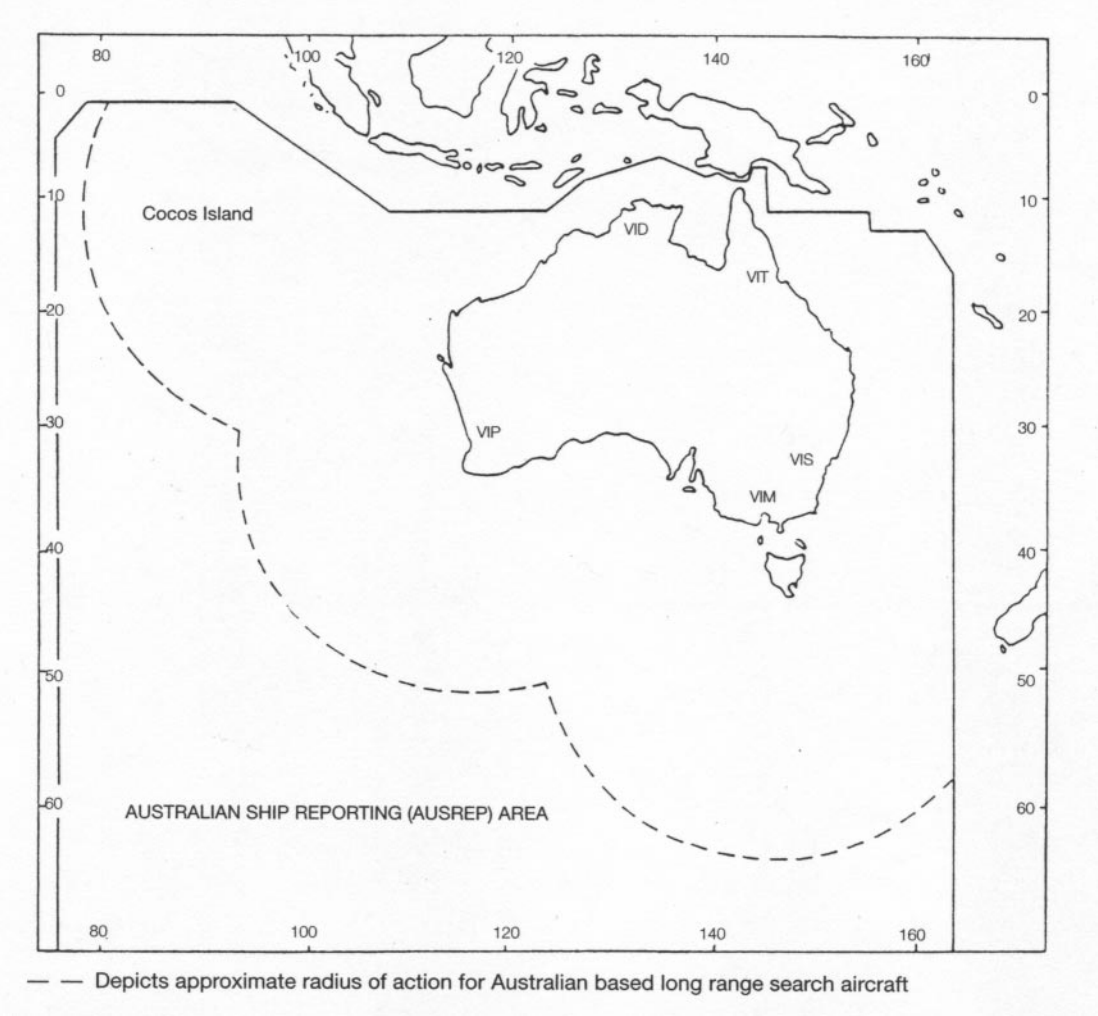
The system is operated by the Australian Maritime Safety Authority (AMSA) through AusSAR, specifically the Rescue Coordination Center Australia (RCC Australia).

Telephone:	AusSAR AUSREP +61(0)2 6230 6880 AusSAR Maritime +61(0)2 6230 6811
Facsimile:	+61(0)2 6230 6868
Address:	P.O. Box 2181 Canberra ACT 2601 Australia
Internet:	http://www.amsa.gov.au/amsa/sar.htm

The AUSREP/REEFREP Interface, a two-way automatic data exchange interface, has been implemented between the REEFREP Ship Reporting System and the existing AUSREP system. This will avoid the need for dual reporting by vessels when participating in the AUSREP and REEFREP systems and will enhance the information available in each system. Further information about REEFREP can be found in Pub. 127, Sailing Directions (Enroute) East Coast of Australia and New Zealand.

On departure from an Australian port or on entering the AUSREP area, the following procedures are applicable:

1. Masters are to send a Sailing Plan (SP) to RCC Australia.



2. A computerized plot is maintained of the vessel's estimated position.

3. Position updates can be done by either of the following methods:

a. Masters may agree to their vessels being queried via INMARSAT-C which, when requested, will auto-matically send a PR. This is the prefered method of sub-mitting a PR.

b. Position Reports (PR) are sent to RCC Australia each day between 2200 UTC and 0800 UTC at the time that has been nominated by the vessel's master so that a report is received at least every 24 hours. Dates and times shall be in Coordinated Universal Time (UTC).

4. On arrival at the destination or on final departure from the AUSREP area, a Final Report (FR) should be sent to RCC Australia.

5. Should a vessel at any time be in a position more than 2 hours steaming from the position that would be predicted from the last SP or PR, a Deviation Report (DR) should be sent to the MRCC.

6. All dates and times used in AUSREP reports are to be in Coordinated Universal Time (UTC).

Sailing Plan (SP).—The SP is sent up to 24 hours prior to joining the AUSREP system, with the following exceptions:

1. At ports within the REEFREP area, the SP must be sent prior to departure.

2. At other Australian ports, the SP may be sent up to 2 hours after departure.

3. When entering the system from sea at an ocean boundary, the SP may be sent 24 hours prior to entering the area or up to 2 hours after crossing the boundary.

The SP contains information necessary to initiate a plot and give an outline of the intended passage. If a vessel does not sail within 2 hours of the time stated in the SP, then that SP must be canceled and a new one sent.

The AUSREP report format for an SP is given in the accompanying table.

Position Report (PR).—The PR is sent at the Date/Time of Next Report as listed in Field N of the Sailing Plan. These reports must be sent between 2200 UTC and 0800 UTC at the nominated daily reporting time until and including the day of arrival in, or departure from, the AUSREP area. The interval between PRs should not exceed 24 hours.

Masters are reminded that facsimile and e-mail submissions are not acceptable for AUSREP PRs. RCC Australia cannot keep a SAR watch for vessels that do not use GMDSS communications (INMARSAT or HF DSC) at sea. Where masters have nominated polling as the method of reporting, AUSREP PRs are sent automatically and regularly when the terminal is polled by RCC Australia.

The information contained in the PR will be used by RCC Australia to update the plot. The PR must reflect the position and course of the vessel at the designated reporting time. However, the speed should be the anticipated speed until the next report time.

The PR is normally automatically processed by RCC Australia, but may not be seen by an operator. If the PR contains important additional safety information that requires the immediate attention of the operator, the word "ALERT" should be placed in Format Field X of the PR. The word "ALERT" should be used only to identify important safety information for immediate action.

The ETA at port of destination or AUSREP area boundary should always be confirmed in the last PR of a passage. It may also be amended in any PR whenever the Master is aware of a revised ETA.

The AUSREP report format for a PR is given in the accompanying table.

Deviation Report (DR).—A DR must be sent to RCC Australia if a vessel, at any time, is in a position more than 2 hours steaming from that which would be predicted from the last SP or PR. A DR can also be sent when any other voyage details are altered.

Failure to send an appropriate DR may have a negative effect on SAR operations. If the vessel is in distress and has not sent out a distress message, the AUSREP procedures may result in RCC Australia initiating an air search to locate the vessel. The search aircraft will start looking in the area related to the vessel's route and speed as indicated in the SP and subsequent PRs. If the vessel has not submitted a DR when there is a change in route and speed, the search aircraft may be unable to find any survivors. It is in the vessel's best interest to keep RCC Australia up-to-date on all voyage details.

The AUSREP report format for a DR is given in the accompanying table.

Final Report (FR).—An FR is sent, as follows:

1. For vessels enroute overseas and departing the AUSREP area, the FR should be send at the AUSREP boundary.
2. For vessels ending a voyage at an Australian port within the REEFREP SRS area, the FR must be sent at the last REEFREP reporting point
3. For vessels ending a voyage at any other Australian port, the FR can be sent within 2 hour's steaming of the port or pilot station. Under no circumstances should the FR be sent more than 2 hours prior to arrival.

As an alternative, the FR may be telephoned to RCC Australia immediately after berthing, but not more than 2 hours after arrival. If it is known that the vessel is to anchor or berth where telephone facilities are not available, the FR should be sent via the appropriate coast radio station or INMARSAT-C.

The AUSREP report format for an FR is given in the accompanying table.

Sending an AUSREP report.—AUSREP reports can be sent, as follows:

1. In an Australian port.—All reports should be made from the vessel directly to RCC Australia, in order to avoid delays that may be associated with using intermediate agencies. Collect telephone calls, facsimile messages, or INMARSAT-C may be used to send an SP or an FR.
2. Via INMARSAT.—Reports must be addressed RCC Australia and sent via the Pacific Ocean Region (POR) or Indian Ocean Region (IOR) satellites to Xantic Land Earth Station (LES) Perth. These procedures apply only to AUSREP messages. Calls are free of charge when submitted within the AUSREP area.

INMARSAT-C fitted vessels will not be charged for messages sent via INMARSAT-C if these procedures are followed: Select Special Access Code (SAC) 43 through Xantic LES Perth only; Pacific Ocean (222) or Indian Ocean (322).

INMARSAT-A, B, or M fitted Ship Earth Stations will be charged for messages sent via INMARSAT-A, B, or M to RCC Australia.

While participating in AUSREP, vessels should ensure that their INMARSAT equipment remains active in the LOGIN mode at all times.

The preferred method of submitting an AUSREP report is via INMARSAT-C using the previously-described polling option as opposed to sending the reports manually.

3. Via the AMSA HF DSC Network.
4. Via REEFCENTRE.—Vessels transiting through the REEFREP area should send a PR via REEFCENTRE on the appropriate VHF channel, except, as follows:
   a. Send the SP directly to RCC Australia prior to departure.
   b. Send the PR directly to RCC Australia if the VHF channel is unavailable.

Polling.—The AMSA has introduced the use of INMARSAT-C polling as an option to replace the submission of PRs; polling is the preferred method of sending a PR to RCC Australia. Vessels can request RCC Australia to poll the vessel using INMARSAT-C by inserting the word "POLL" in Format Field N of the SP instead of nominating a Date/Time of Next Report. Polling involves RCC Australia sending a signal to the vessel's INMARSAT-C terminal to prompt an automatic position report, which includes the vessel's position, course, and speed. INMARSAT-C polling eliminates the need for a manual submission of the PR. Sailing Plans, Deviation Reports, and Final Reports must still be submitted as normal.

Non-reporting to AUSREP (NOREP).—In the case of a foreign vessel departing on an overseas voyage from an Australian port, if the Master does not intend to send AUSREP Position Reports, this fact must be indicated in the SP by the inclusion of the word NOREP in place of the nominated daily reporting time in Field N; amplifying remarks may be included in Field X. Under this option, RCC Australia will not undertake SAR action unless specific information is received which indicates an air search is warranted. However, a NOREP vessel must still comply with the mandatory REEFREP reporting requirements when the vessel enters the REEFREP area.

Overdue AUSREP Reports.—AUSREP is a positive reporting system. If a PR or an FR is not received by RCC

Australia within 2 hours of the expected time, action is taken to determine the vessel's location and confirm the safety of the crew. It should be noted that in some parts of the AUSREP area, the ability to conduct an air search may be restricted by aircraft range limitations.

To avoid unnecessary search action it is most important that vessels report at the nominated reporting time each day and send their FR when leaving the AUSREP area. If a vessel is unable to pass a PR or an FR, all attempts must be made to pass a message to this effect through another vessel, a harbor, or other shore authority either by VHF, signaling lantern, or emergency transmitter.

The action taken by RCC Australia if a report is not received as expected will depend on the prevailing circumstances, but will generally include the following:

1. Internal checks to establish if the vessel's report has been received by RCC Australia.
2. For INMARSAT-equipped vessels, an attempt to contact the vessel directly.
3. Attempts to contact the vessel via HF DSC to the vessel's MMSI number.
4. Extensive communication checks with Australian and overseas CRS, owners, agents, and other ships are carried out to trace the last sighting or contact with the vessel.

By the time 21 hours have elapsed, search planning will be in progress and details included in NAVAREA X and facsimile weather broadcasts. By the time the report is 24 hours overdue, positive SAR action will have been initiated to locate the vessel. It should be noted that resources available for an air search decrease with the distance from an Australian base and that the times may differ if the vessel is participating in INMARSAT-C polling.

Reports to AMVER.—While participating in AUSREP, masters may also wish their reports to be forwarded for inclusion in the AMVER system operated by the U.S. Coast Guard. This should be indicated by including the word "AMVER" in Format Field Y in each message.

For vessels participating in INMARSAT-C polling, if Format Field Y in an SP indicates that the reports are to be passed to AMVER, the AUSREP system will automatically forward PRs to AMVER.

An AMVER report will only be forwarded if a vessel is in the AUSREP area and is currently participating in the AUSREP system.

Reports to other reporting systems.—Reports from ships to other reporting systems (JASREP, etc.) are not forwarded by RCC Australia. Ship are requested to pass these reports direct.

AUSREP Reporting Format

Field	Meaning	Type of Report			
		SP	PR	DR	FR
A	Vessel name, call sign, and IMO number.	X	X	X	X
B	Date/time of position.		X	X	
C	Position (latitude and longitude).		X	X	
E	Course. If in REEFREP area, the name of the next reporting point, including any alternative route, if applicable, may be substituted.	R	X	A	
F	Speed (vessel's anticipated average speed, in knots and tenths of knots, until next report). If in REEFREP area, the ETA at the next reporting point may be substituted.	X/R	X	A	
G	Name of last non-Australian port of call.	A			
H	Date/time and point of entry into AUSREP area (point is either the Australian port of departure or the latitude/longitude of crossing the AUSREP area boundary).	X			
I	Next foreign (non-Australian) destination and ETA.	A		A	
J	1. Coastal pilotage (Yes/No). 2. Last name of pilot. 3. License number of pilot.	R		A	
K	Date/time and point of exit from the AUSREP area (the point is either the latitude/longitude of crossing the area boundary or the Australian port at which the vessel is to arrive).	X		A	X
L	1. Name of final reporting point for REEFREP SRS area, or 2. AUSREP route information (vessel's intended track—state rhumb line or coastal, great circle, or composite with limiting latitude). If both are provided, put the REEFREP information first and sepa-rate from the AUSREP information with a slash (/).	X/R		A	

AUSREP Reporting Format					
Field	Meaning	Type of Report			
		SP	PR	DR	FR
M	Coast radio maritime communication stations monitored (coast radio stations monitored, INMARSAT A and C numbers, and the MMSI/DSC number. if equipped).	X		A	
N	Date and time (UTC) of next report. (See **Note 1** below.)	X	X	X	
O	Draft, fore and aft, in meters and tenths of meters.	R			
P	1. Normal name of cargo. 2. Is cargo classified as hazardous (Yes/No)?	R		A	
Q	Defects or other limitations such as damage, failure, or breakdown affecting the safety of the vessel.	A		A	
R	Pollution (or reports of any seen).	A		A	
U	Vessel type, length (in meters), and gross tonnage.	R			
V	Medical personnel carried.	X			
X	Remarks. If choosing INMARSAT-C polling, include the make and type of INMARSAT-C terminal here.	A	A	A	X
Y	Request to relay a report to AMVER. (See **Note 2** below.)	A	A	A	A

Key:

1. X—Required field.
2. R—Vessels transiting the REEFREP Ship Reporting System should also include these fields.
3. A—Include if appropriate.

Notes:

1. See text under **Non-reporting to AUSREP (NOREP)** for vessels electing not to participate in the AUSREP system. When polling is selected as the method of position reporting, the word "POLL" should be included in this section.
2. Place the word "AMVER" in Format Field Y; do not separate the letters in the word "AMVER" by spaces, as this may disrupt the computer processing. Masters should note that an AMVER report will only be forwarded if a vessel is in the AUSREP area and is currently participating in the AUSREP system.

New Zealand

A voluntary ship reporting system has been established for all vessels operating in the New Zealand Search and Rescue Region (NZSRR) S of 60˚S for the purpose of assisting Rescue Coordination Center New Zealand (RCCNZ) in coordinating SAR operations in that area (60˚S to the S edge of the Ross Sea bounded by 163˚E to 131˚W).

All vessels are requested to notify Taupo Maritime Radio upon entry to and departure from the area. Vessels are also encouraged to make daily position reports. The information will be used for search and rescue purposes only. Contact can be made, as follows:

1. INMARSAT-C 582-451-200-067
2. Telephone 64-4-914-8333
3. Facsimile 64-4-914-8334
4. E-mail maritime@bclnz.com

Seas

Marginal Seas

(The following information was prepared by the U.S. Naval Oceanographic Office.)

The marginal seas are divided geographically, as follows:

1. The Ross Sea Sector (160˚E to 120˚W).
2. The Amundsen-Bellingshausen Sea Sector (120˚ to 60˚W).
3. The Weddell Sea Sector (70˚W to 0˚).
4. The Continental Coast Sector (0˚ to 160˚E).

The Ross Sea Sector.—Drift ice concentration along the Ross Ice Shelf to the E of Ross Island begins to diminish in late October and reduces to open water (less than one-tenth ice concentration) by late November. An open-water flaw polynya, centered at 75˚S, 165˚E, forms by late November. The ice-free area off the shelf expands to the N and eventually meets the retreating outer edge of the ice during the second half of January. Drift ice in the S portion of the Ross Sea drifts NW against Victoria Land where it persists throughout the austral summer. Thick ice floes are also advected into the central and easternmost portions of the Ross Sea by prevailing W winds and currents. Sea ice coverage becomes minimal in the middle of February.

Reinforced vessels can normally reach the NE end of Ross Island by the end of December, and all shipping by the third week of January. The route becomes closed to nonreinforced

vessels in the first week of March and closed to all vessels in the middle of March. The Ross Sea becomes covered with very close or compact ice in April.

In McMurdo Sound, the maximum extent of fast ice in the approaches to McMurdo Station, on the Hut Point Peninsula, is normally 30 miles and occurs in the middle of October. However, fast ice continues to thicken until the first part of December when the average winter's maximum thicknesses are 0.9 to 1.2m at the fast ice edge, 1.2 to 1.8m at several nautical miles inside the edge, 1.8 to 2.1m off Hut Point, and 2.7 to 3m along the Ross Ice Shelf. The thickest section of fast ice ever recorded in the sound was 6.4m thick.

A channel leading through the fast ice to Hut Point is kept open by icebreakers from the middle of December to early January, depending upon the severity of the winter. Vessels will normally need icebreaker assistance for a period following the channel completion. The channel is usually open to all vessels in late January although, it was open one year as early as 10 December.

Fast ice begins to deteriorate in late December and to dislodge in late January. By the first week of March, all fast ice is usually gone except for a narrow strip attached to the shelf. Soon thereafter, new ice rapidly forms and the sound is frozen over by late March.

Sea ice in the Ross Sea area reaches its maximum extent during late September. The heaviest ice is encountered between 67˚30'S and 72˚30'S. Multi-year floes, 2.4 to 3.6m thick, drift into the N central area from the E. Sea ice in the W part of the Ross Sea is principally first-year ice, 0.6 to 1.2m thick. The movement of ice during the austral winter is in a N direction away from the ice shelf, and as a consequence, relatively thin ice, up to only 0.3m thick, prevails off the shelf front.

Numerous icebergs occur throughout the Ross Sea. The S half of the sea is covered by the Ross Ice Shelf, the front of which varies in height above sea level from 30 to 55m. Tabular icebergs are periodically calved off the shelf front. Most of these bergs are between 300 and 3,048m long with an estimated freeboard-to-draft ratio of 1:5. However, icebergs of 16 to 22 miles in length are occasionally formed. The largest berg observed in the Ross Sea was 100 miles long. The icebergs drift to the W off the Ross Ice Shelf and then to the N along Victoria Land. Icebergs may enter McMurdo Sound, but normally they do not drift farther than 77˚30'S.

The W flow of the East Wind Drift is strongly influenced by the deep indentation of the Ross Sea. One branch of this current passes outside the entrance of the Ross Sea, while another branch sets S along the sea's E boundary. The S branch continues W along the Ross Ice Shelf at a rate of 1 to 3 knots and is then deflected N along the coast of Victoria Land. This outflow from the Ross Sea rejoins a branch of the East Wind Drift near Cape Adare. The combined flow then passes between the Balleny Islands and the continent.

Satellite imagery was used to make observations of sea-ice drift motion near the Ross Sea along the Getz Ice Shelf, between Cape Colbeck and Mount Siple. The sea ice studied displayed a highly variable motion when observed over two-day time intervals with typical speeds ranging from nearly zero to 0.6 knot. In agreement with the circulation pattern, a general W flow was observed near shore.

In the S part of the Ross Sea, the ocean tide beneath the Ross Ice Shelf is dominated by diurnal, harmonic constituents, with small semidiurnal tidal constituents. Along the N margin of the ice shelf, near 78˚S, the tropic (diurnal spring) tide ranges from 0.9m to more than 2m near the Siple Coast. The amplitudes of the diurnal tide constituents are larger in the Ross Sea than in the adjacent S part of the Pacific Ocean, indicating a diurnal resonance related to the shape of the embayment and the depth of the sea.

The main inflow into McMurdo Sound is the Cape Bird Current which reaches Cape Bird as a W flow and turns into the sound with velocities of up to 3 knots. Direct current measurements (1967) made at a depth of 55m, between Cape Bird and Beaufort Island, indicate a W current with an average speed of 1 knot and a maximum speed of 2.7 knots. The Cape Bird Current continues along the W coast of Ross Island until it approaches Cape Royds where it joins a strong NW flow from under the Ross Ice Shelf, near Cape Armitage. However, direct current measurements made more than 1 mile from the coast near Cape Armitage indicate a flow towards the Ross Ice Shelf. The flow along the W side of McMurdo Sound, near the Dailey Islands, is towards the NW at an average speed of 0.2 knot. This flow is part of the outflow from the Cape Bird Current with some addition from the N flow near Cape Armitage. The surface flow in the center of McMurdo Sound is directed towards the Ross Ice Shelf. It is uniformly slow, usually having a mean speed of less than 0.1 knot.

Since a large portion of the Ross Sea is generally covered with ice, the sea surface temperatures in summer are almost at the freezing point, ranging from -1.7˚ to 0.3˚C.

Salinity in the Ross Sea area is strongly influenced by the amount of melting and freezing that occurs at the sea surface and beneath the ice shelves. The Ross Sea Shelf water, which forms primarily from freezing at the sea surface in the W part, has the highest salinity and density of any sea water in the Antarctic region. The horizontal surface salinity distribution is also influenced by the clockwise circulation pattern in the Ross Sea, the highest salinity values being concentrated in the W part.

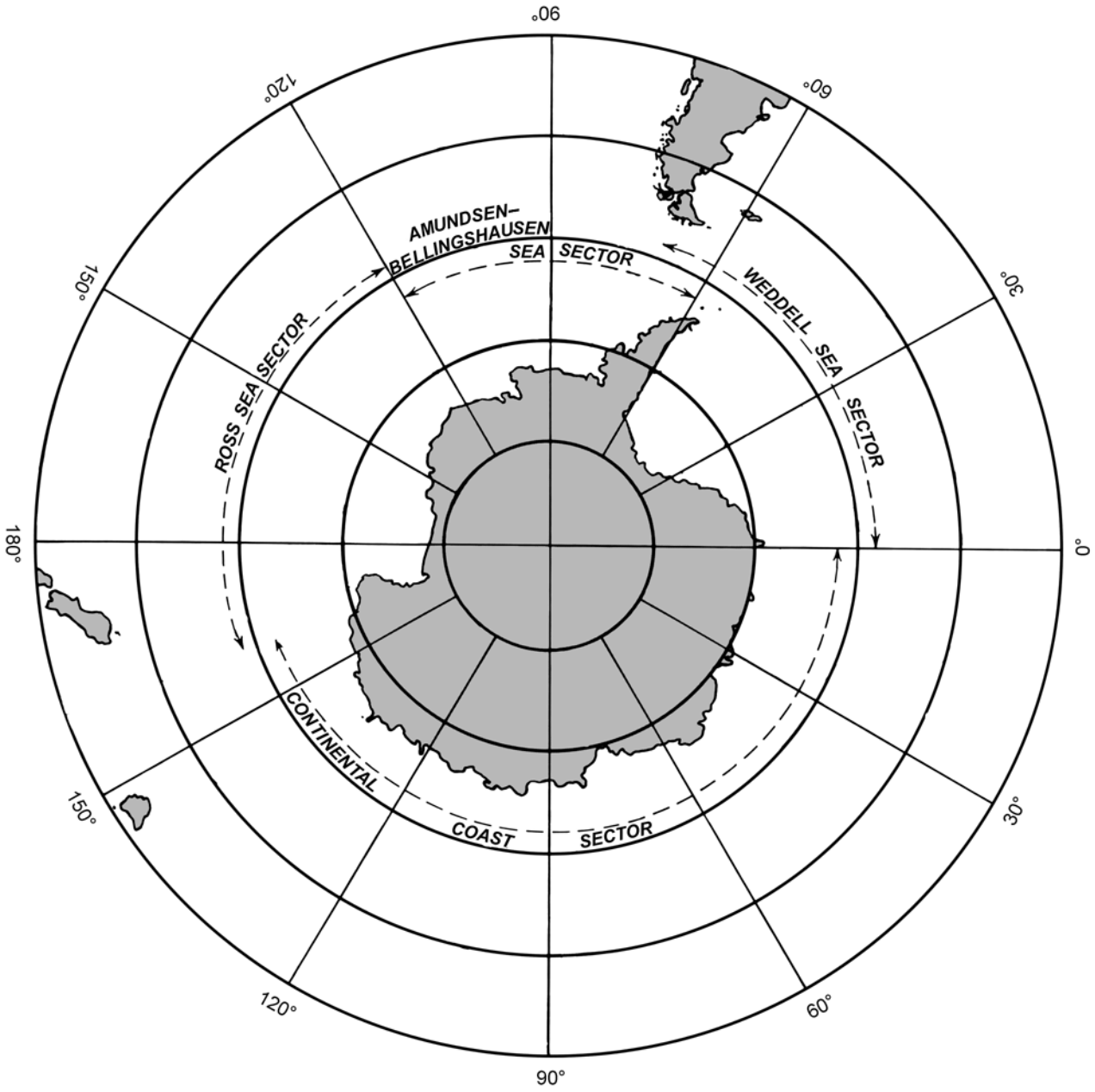
The density field is determined primarily by the salinity distribution, hence, only minor horizontal variations in density are present in the Ross Sea.

The Amundsen-Bellingshausen Sea Sector.—Ice conditions in the Amundsen Sea and the Bellingshausen Sea are highly variable from year to year and the N movement of the outer edge of the drift ice fluctuates. This outer edge normally reaches its lowest latitude in the Bellingshausen Sea and the Amundsen Sea during late August and the middle of September, respectively.

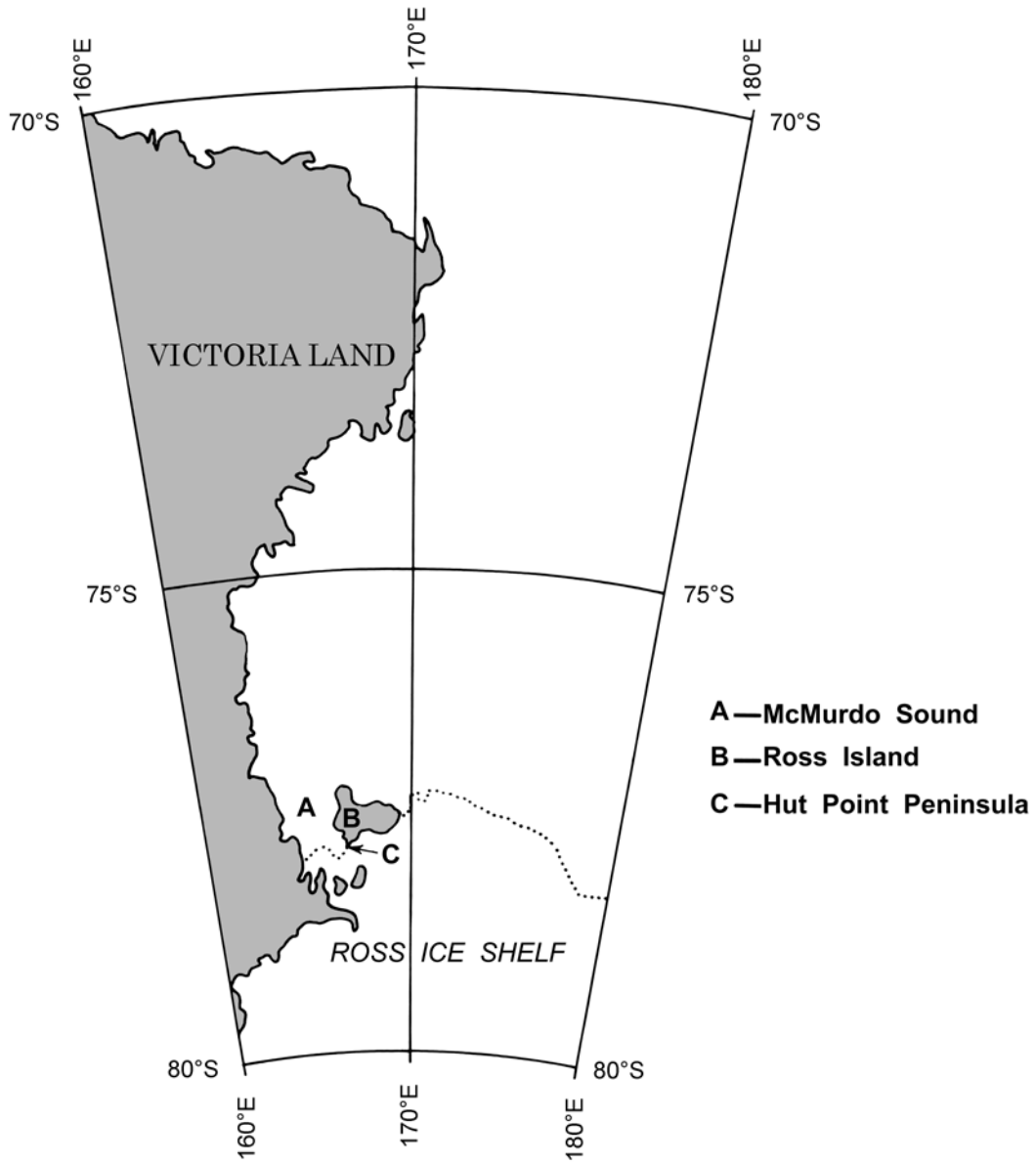
Usually by early November, polynyas develop to the SW of Alexander Island, to the W of Smyley Island, to the W of the King Peninsula, and to the N of Bear Peninsula. These polynyas expand N and can join with the open water in mild summers. Sea ice coverage in both of the seas is minimal during early March.

Palmer Station (64˚46'S., 64˚03'W.) is normally open to reinforced vessels from the middle of December to the middle of May and to all vessels from the middle of January to the middle of April. The opening and closing of the approach to Palmer Station varied greatly during the navigation seasons from

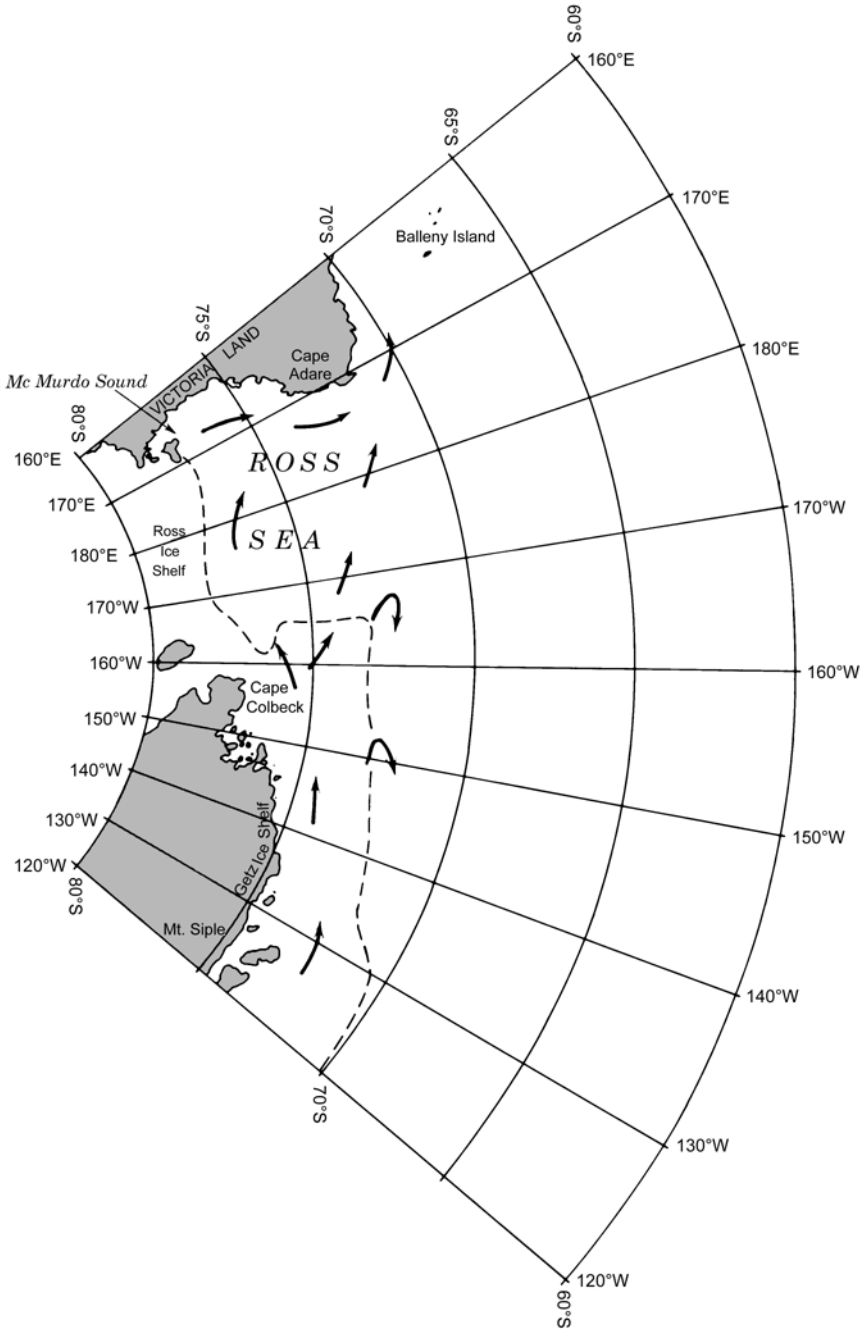
1974/75 through 1982/83. The approach opened to reinforced vessels as early as late October and as late as early February. It closed to reinforced vessels as early as the middle of April and as late as the end of June.



MARGINAL SEAS

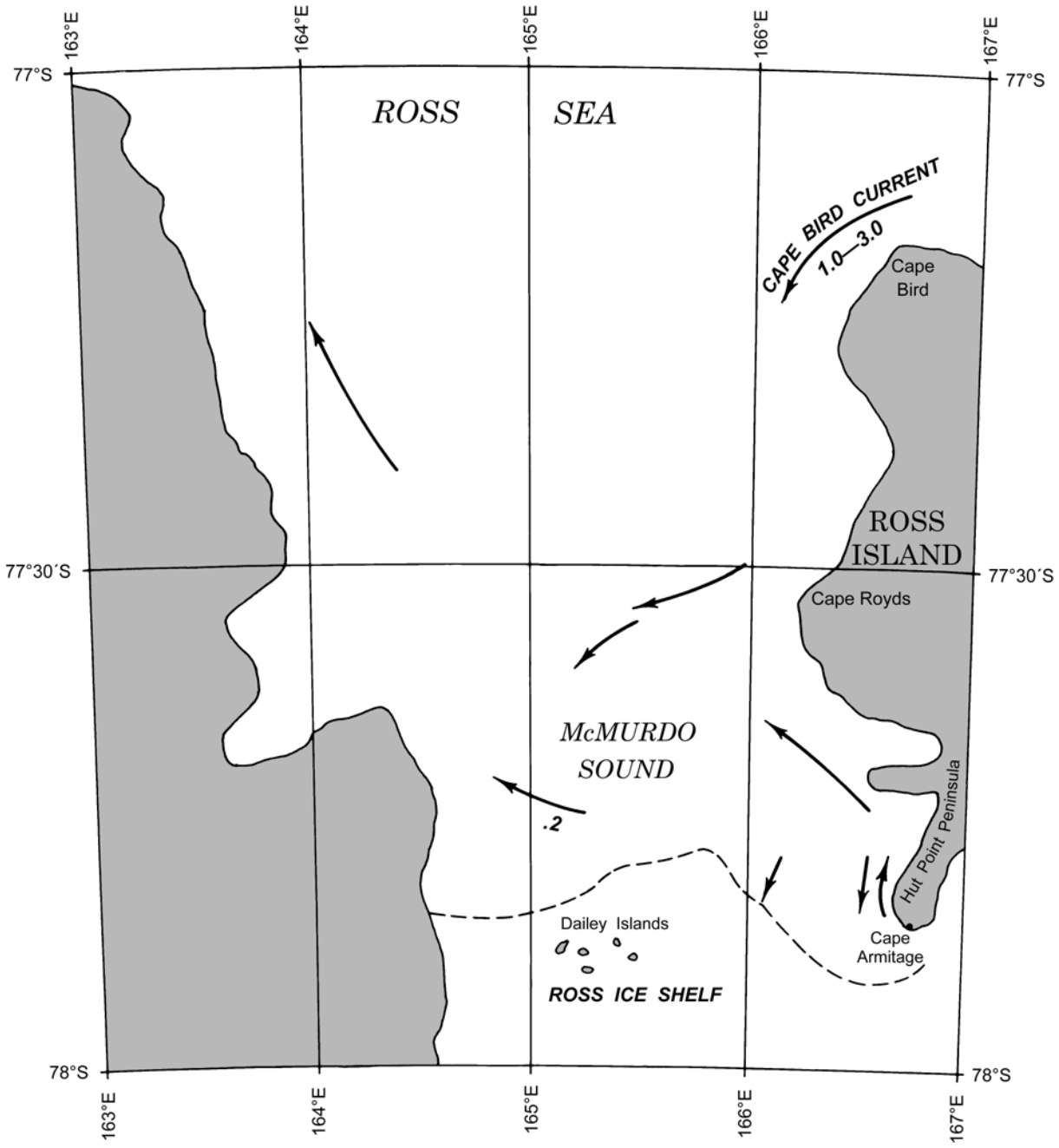


ROSS SEA LOCATOR CHART



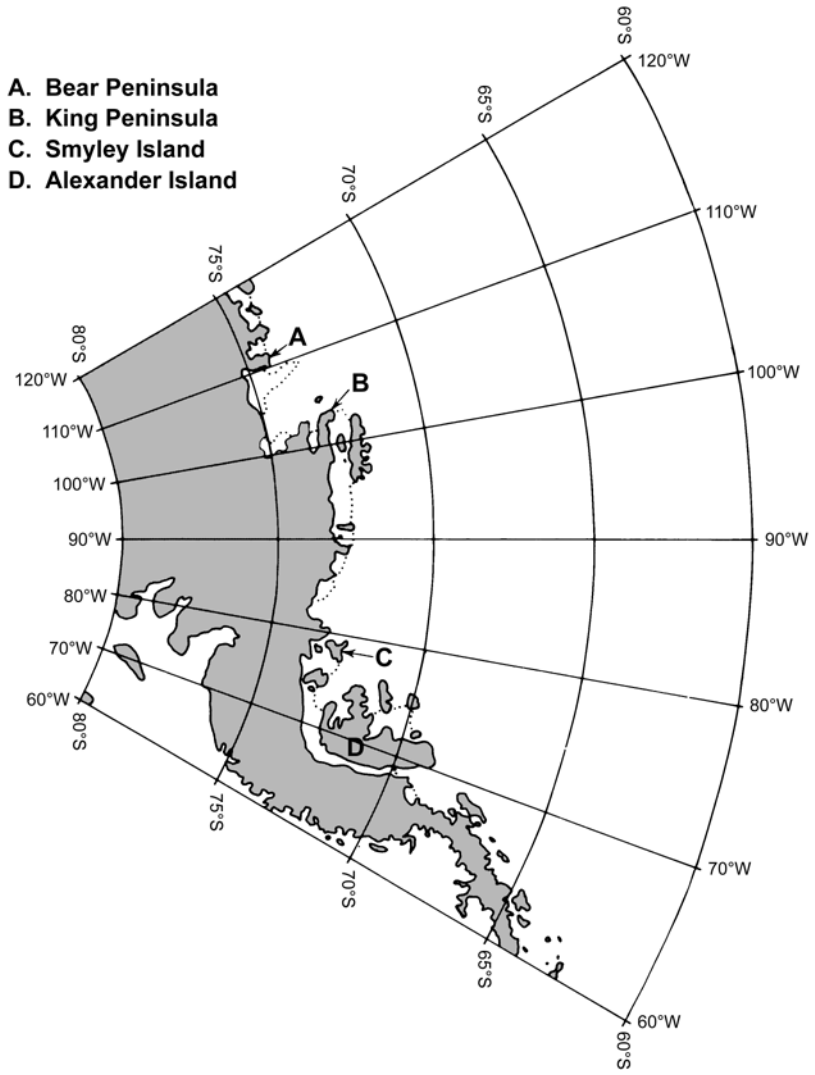
GENERAL SURFACE CIRCULATION
----Typical Mid-Summer 7/10 Ice Concentration Limit

ROSS SEA GENERAL SURFACE CIRCULATION

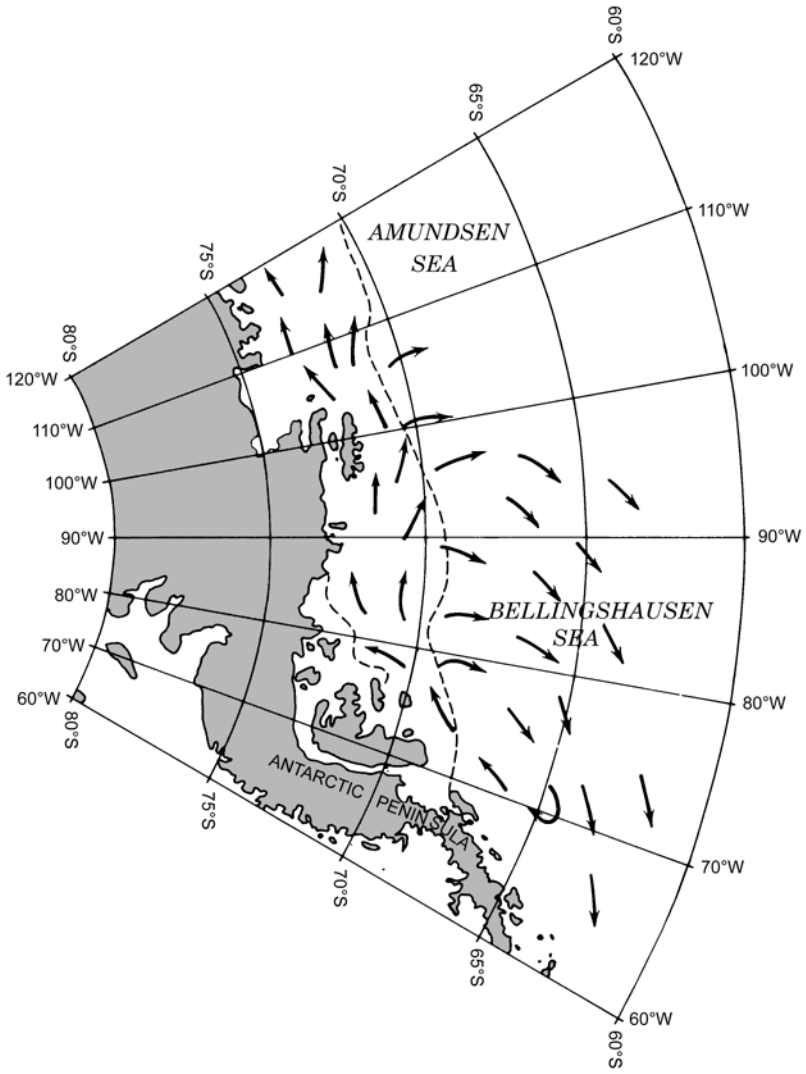


GENERAL SURFACE CIRCULATION
Speed in knots

McMURDO SOUND GENERAL SURFACE CIRCULATION

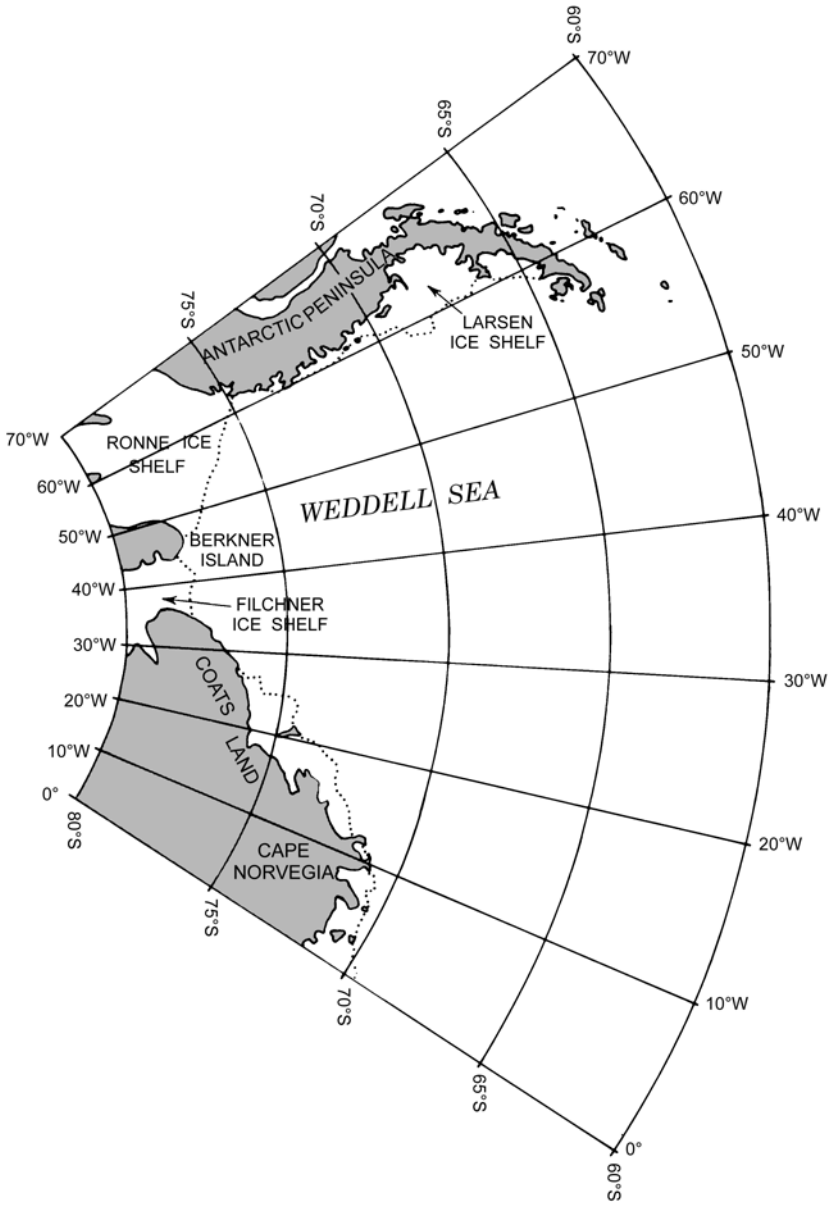


AMUNDSEN—BELLINGSHAUSEN SEA LOCATOR CHART

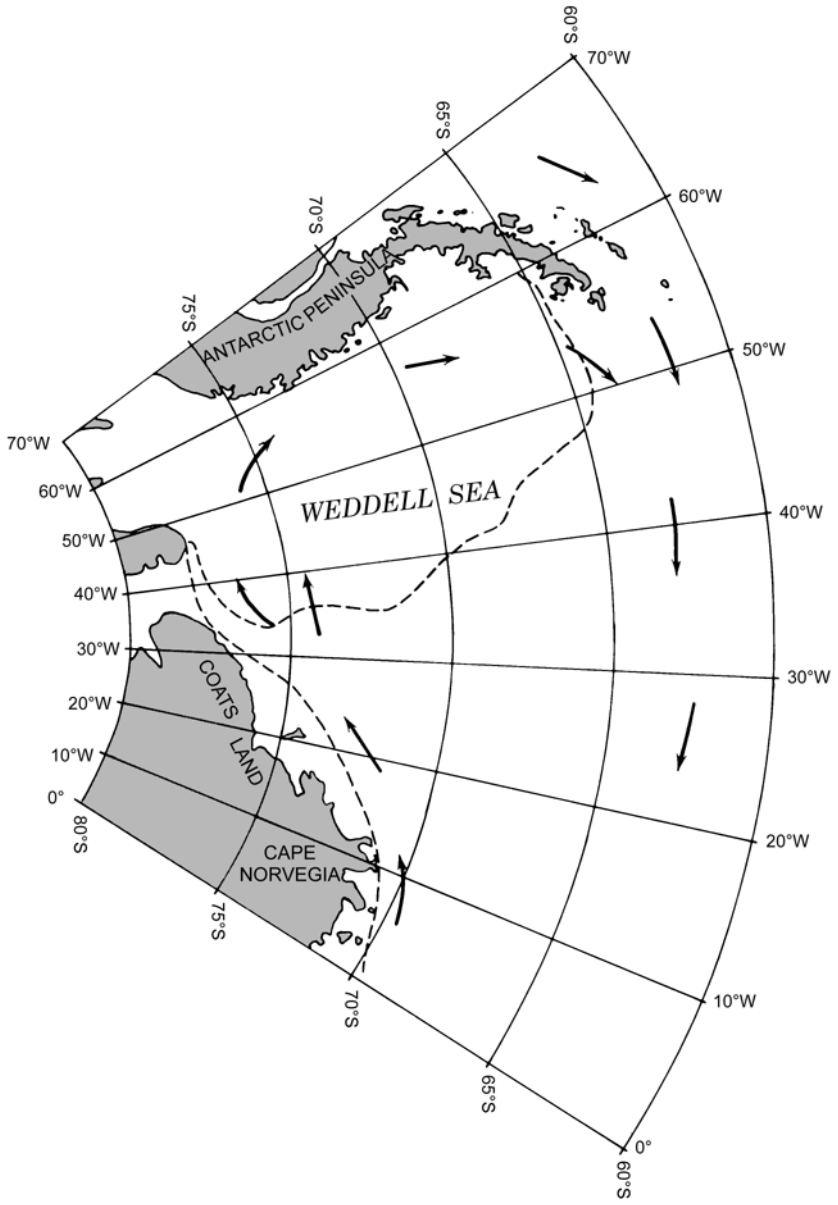


GENERAL SURFACE CIRCULATION
----Typical Mid-Summer 7/10 Ice Concentration Limit

AMUNDSEN—BELLINGSHAUSEN SEA GENERAL SURFACE CIRCULATION

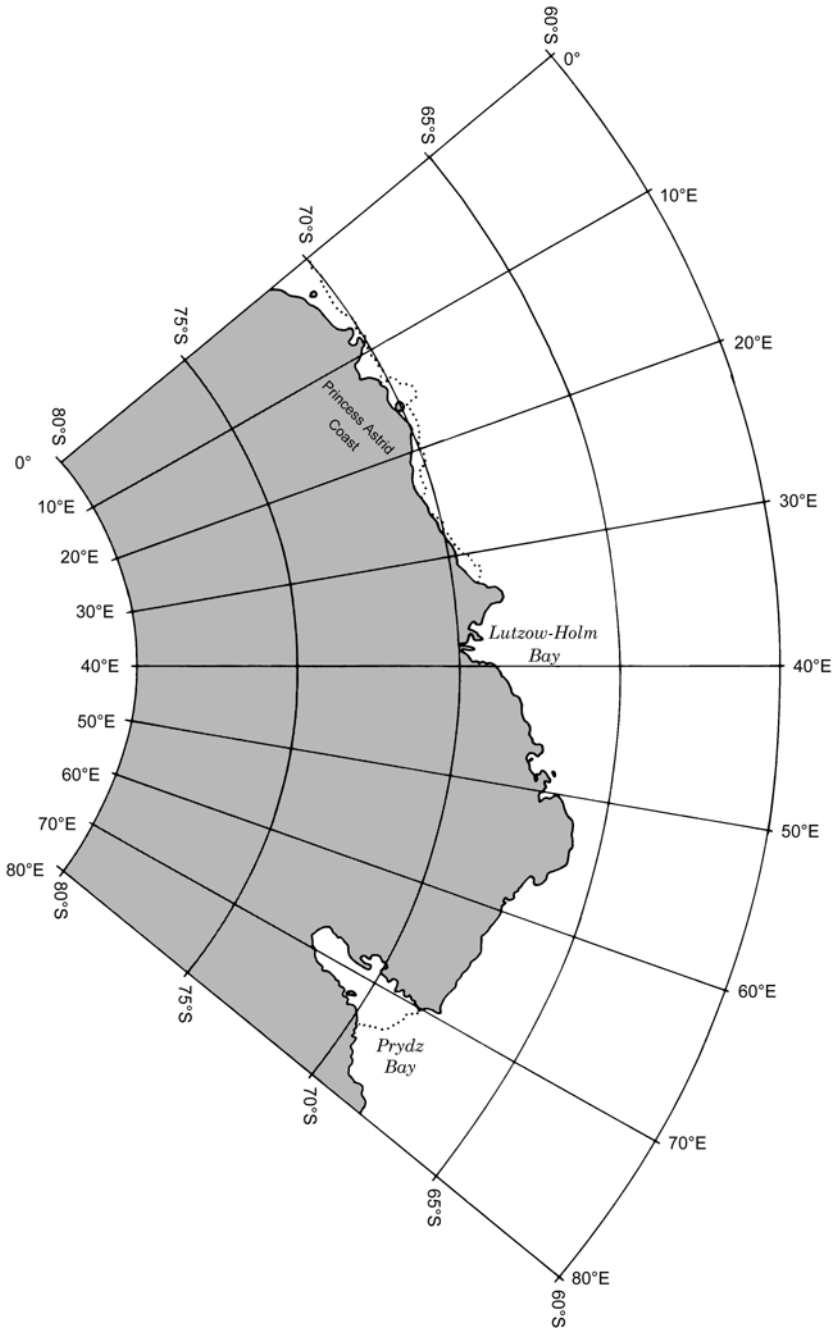


WEDDELL SEA LOCATOR CHART

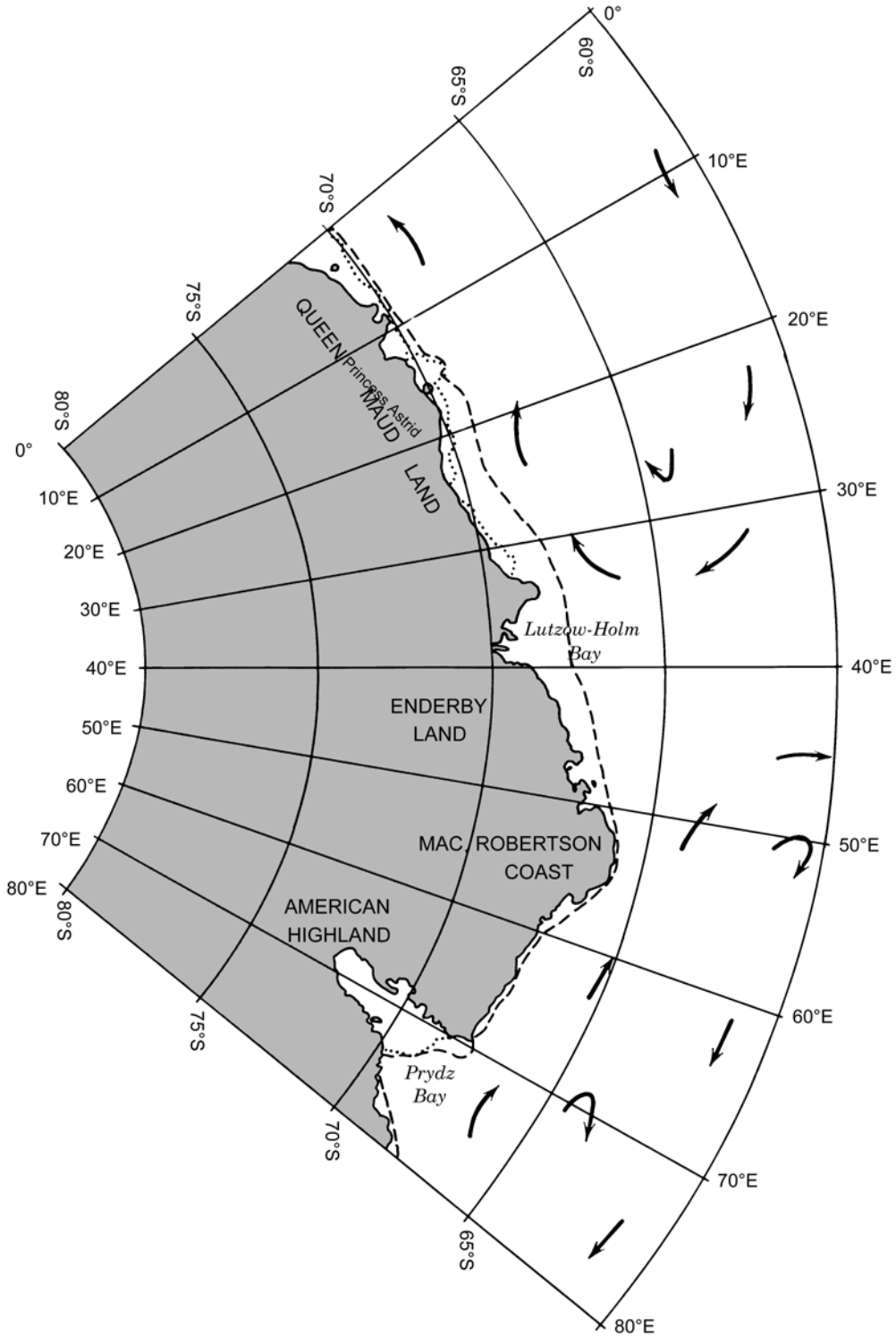


GENERAL SURFACE CIRCULATION
----Typical Mid-Summer 7/10 Ice Concentration Limit

WEDDELL SEA GENERAL SURFACE CIRCULATION

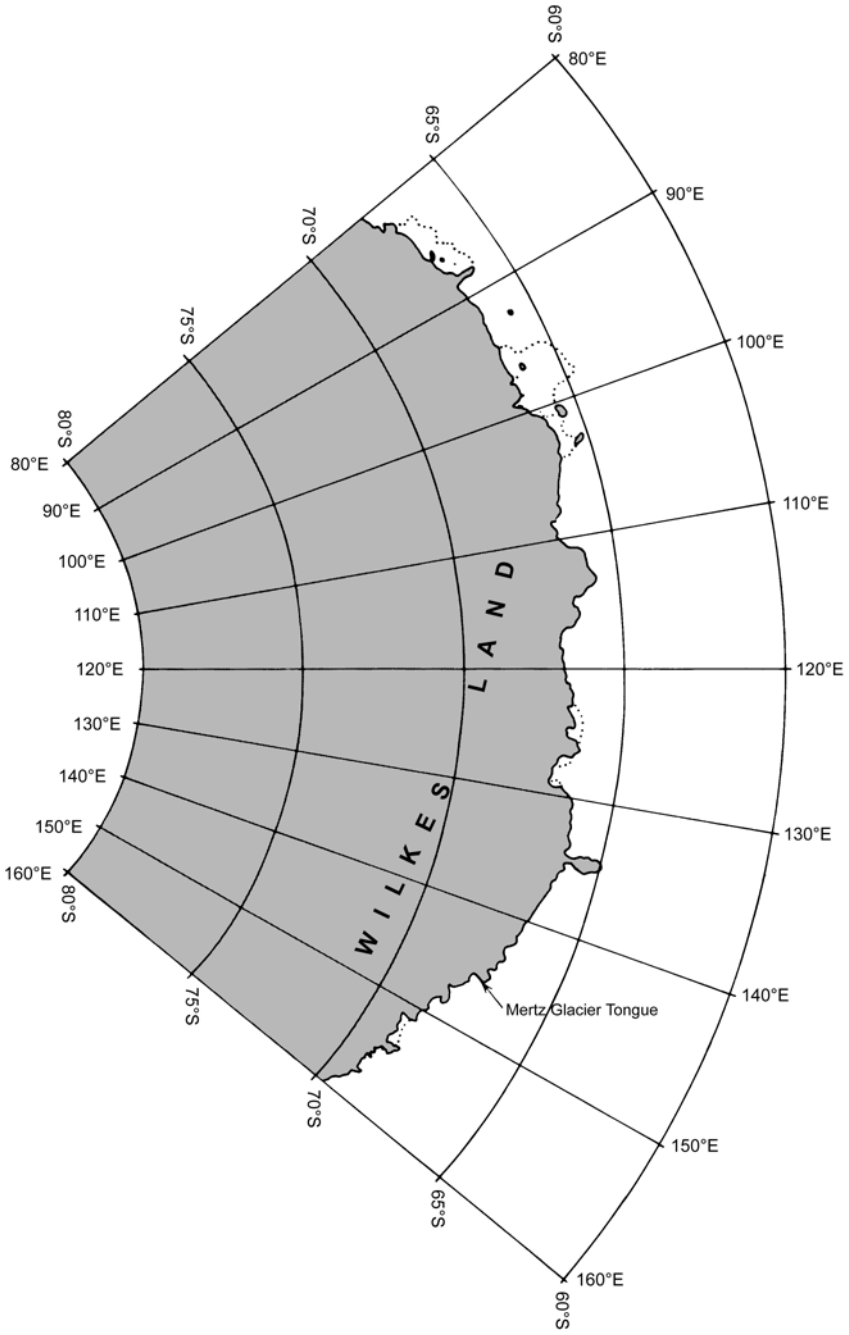


CONTINENTAL COAST SECTOR FROM 0˚ TO 80˚E
LOCATOR CHART

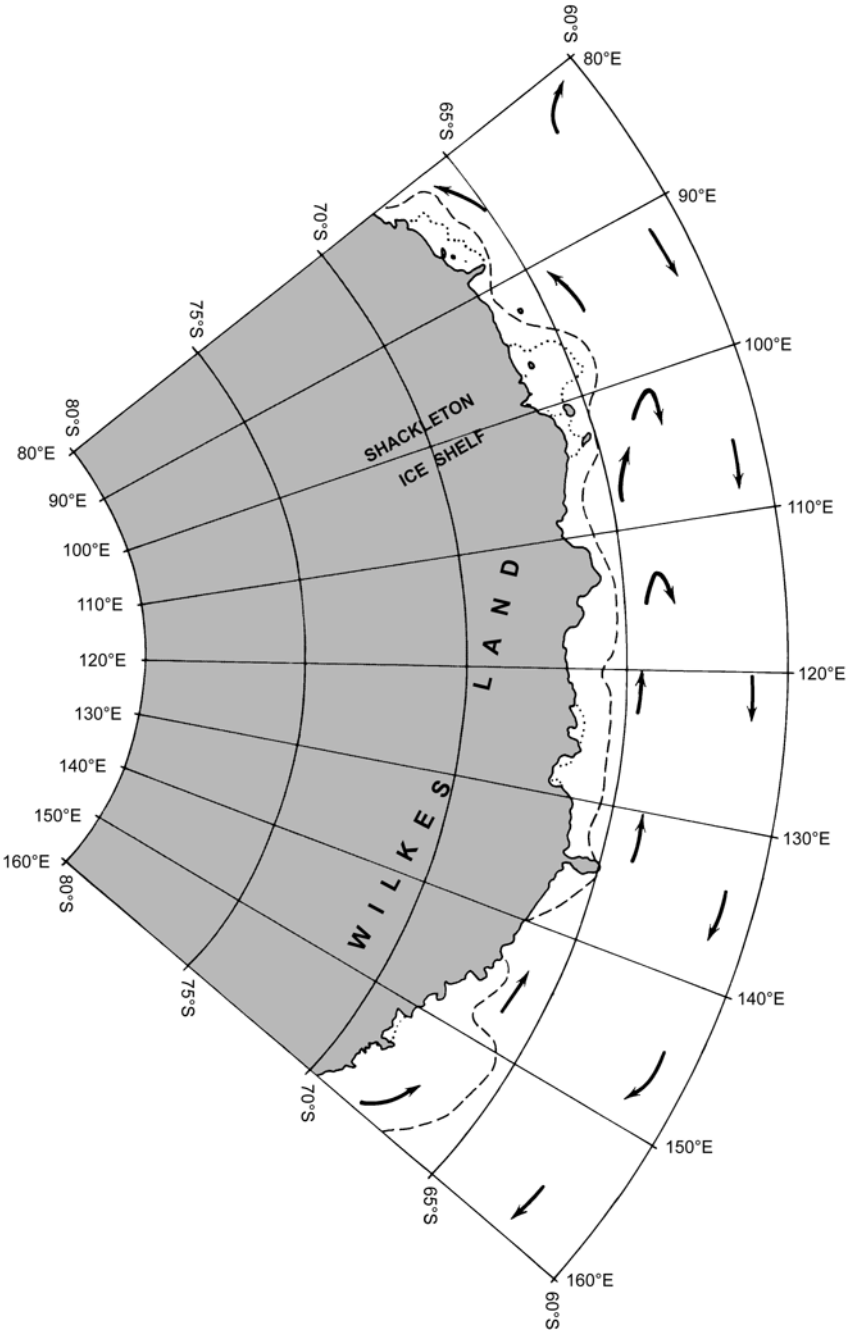


GENERAL SURFACE CIRCULATION
---Typical Mid-Summer 7/10 Ice Concentration Limit

CONTINENTAL COAST SECTOR FROM 0˚ TO 80˚E



CONTINENTAL COAST SECTOR FROM 80˚E TO 160˚E
LOCATOR CHART



GENERAL SURFACE CIRCULATION
----Typical Mid-Summer 7/10 Ice Concentration Limit

CONTINENTAL COAST SECTOR FROM 80˚E TO 160˚E
GENERAL SURFACE CIRCULATION

Rothera Station (67˚34'S., 68˚08'W.) is normally open to reinforced vessels from early February through the middle of April.

The current pattern within the Amundsen Sea and the Bellingshausen Sea is typical of the general adjacent seas circulation. The W current follows the coast with an outward cyclonic flow which eventually merges with the E current near the Antarctic Convergence.

The surface temperatures in the Amundsen Sea and the Bellingshausen Sea range from -1.7˚C, near the coast, to greater than 1.7˚C, near the Antarctic Convergence (62˚ to 64˚S). The surface shows an expected warming trend to the N of the Antarctic Convergence. The horizontal variations of surface salinities are small.

The Weddell Sea Sector.—The Weddell Sea contains throughout the year a large portion of the Antarctic ice cover. During the austral winter, the ice cover for all of Antarctica reaches its northernmost extent to the N of the Weddell Sea. During the austral summer, most of the W part of this sea is covered by heavy drift ice. Summer sea ice is normally discharged from the perennial ice regime in an ice tongue extending out to the NE.

The maximum ice cover is attained during the first week of September in the Weddell Sea region to the W of 40˚W. It is attained during the last week of September in that part to the E of 40˚W.

During the winter period of the mid-1970s, an extensive open-water polynya formed generally from 5˚W to 25˚W and from 63˚S to 70˚S. Scientists have hypothesized that this recurring polynya was the result of wind divergence and a large vertical ocean heat flux.

Flaw leads usually appear during the first half of November. During most summers, the Weddell Sea is clear of ice to the coast, between the Greenwich meridian and 20˚W. Sea ice becomes minimal in the last week of February.

Halley Station (75˚31'S., 26˚56'W.) is usually open to reinforced vessels from early January to the middle of March. During most years, this year-round station can be reached by all vessels from the middle of January through late February. Further S, Berkner Island can normally be reached by reinforced vessels from the middle of January to the middle of February. Only during relatively light ice years can all vessels reach Berkner Island and then only for a period lasting from late January through the middle of February.

Level and rafted ice up to 4.9 and 11.9m thick, respectively, have been encountered in the E part of the Weddell Sea during the navigation season. A special hazard exists in the lowermost W part of the Weddell Sea which is sometimes navigable. Ice floes, consisting of many decades old ice and fast ice, may be layered with snow, frozen slush, and solid ice up to a thickness of 24.4m.

Sea ice and glacier ice (icebergs) drift in a clockwise pattern about the Weddell gyre (eddy). Sea ice presents the greatest obstruction to navigation in the W part the sea where it compresses against the Antarctic Peninsula and is forced upward into pressure ridges. Glacier ice is mostly concentrated within a zone, 100 miles wide, extending along the continental coast, the W part of the sea, and the latitude of 60˚S.

The Weddell Sea acts as a collection area for numerous icebergs, some having mammoth dimensions. Giant tabular icebergs are formed when floating glacier tongues, which project tens of nautical miles into the sea, are broken off, possibly from the impact of another giant iceberg. An iceberg, 60 miles long and 40 miles wide, calved from the Amery Ice Shelf in late 1963 and is believed to have impacted the Trolltunga Ice Shelf. This shelf then broke off in September 1967 to form a berg, 57 miles long and 29 miles wide, which in turn impacted the Larsen Ice Front in March 1968 and supposedly caused the detachment of another berg, 50 miles long and 20 miles wide.

The oceanography of the Weddell Sea is strongly influenced by the presence of the Antarctic Peninsula and the ice shelves. The mountain barrier, 1,200 to 1,981m high, standing on the peninsula has a strong effect on the climate and on the wind driven water and ice circulation in the W part of the Weddell Sea. Barrier winds blowing along the W side of the sea, winds blowing from the E along the E side of the sea, and winds reacting to the presence of the Weddell Sea low-pressure atmospheric system, cause a cyclonic circulation of the surface waters. The result is a well-defined cyclonic gyre (eddy) within the Weddell Sea. Surface currents near the Scotia Ridge have been determined to set E at a rate of 0.2 knot. A weak flow, with a rate of less than 0.1 knot, has been determined to set W in the central portion of the gyre.

At the E entrance to the Weddell Sea, a narrow current, with a rate of generally less than 1 knot, flows approximately parallel to Coats Land. The core of this current has a characteristic width of about 60 miles and is strongest near the edge of the continental shelf. The current sweeps into the S boundary of the sea at 77˚S before turning N and flowing parallel to the coast of the Antarctic Peninsula. This current has a broad outflow from the NW corner of the sea that sets in a NE direction and passes close S of the Scotia Ridge where it merges with water from the Bellingshausen Sea.

Tides in the Weddell Sea are mainly diurnal, but mixed tides can be found at the N extremity of the Antarctic Peninsula.

The sea surface temperatures near the Ronne and Filchner Ice Shelves and along the E part of the Antarctic Peninsula are very near the freezing point in summer due to the coverage of ice. The temperatures increase toward the E as the E borders of the Weddell Sea tend to be free of ice.

Higher surface salinity values in the Weddell Sea are found near the ice shelves and along the E part of the Antarctic Peninsula. Only minor horizontal variations in density are present in the Weddell Sea.

The Continental Coast Sector.—The sea ice reaches its northernmost extent in late September in this area. Aided by very strong winds that blow seaward off the continental ice plateau, areas of open water develop in late October off the coast of Wilkes Land (80˚E to 150˚E). Polynyas also form to leeward (W side) of glacier tongues, giant grounded icebergs, and fields consisting of large grounded bergs or consolidated sea ice. A large polynya usually forms early in Prydz Bay. The N ice edge rapidly retreats to the S in November and December. Minimum sea ice coverage occurs during the third week of February.

The most accessible area of the Antarctic coastline lies between the Mertz Glacier Tongue and **Dumont d'Urville Station** (66˚40'S., 140˚01'E.). The navigation season for this station normally ranges from the middle of December to late

March for reinforced vessels and from early January to early March for all vessels.

Reinforced vessels may normally reach **Mirnyy Station** (66˚33'S., 93˚01'E.) from early January to the middle of March and all vessels from late January to early March. **Davis Station** (68˚35'S., 77˚58'E.) is normally open to reinforced vessels from late December to mid-March and to all vessels from mid-January to mid-February.

At **Mawson Station** (67˚36'S., 62˚52'E.), the navigation season occurs after the fast ice breakout. It lasts from the middle of January to late March for reinforced vessels and from late January to early March for all vessels.

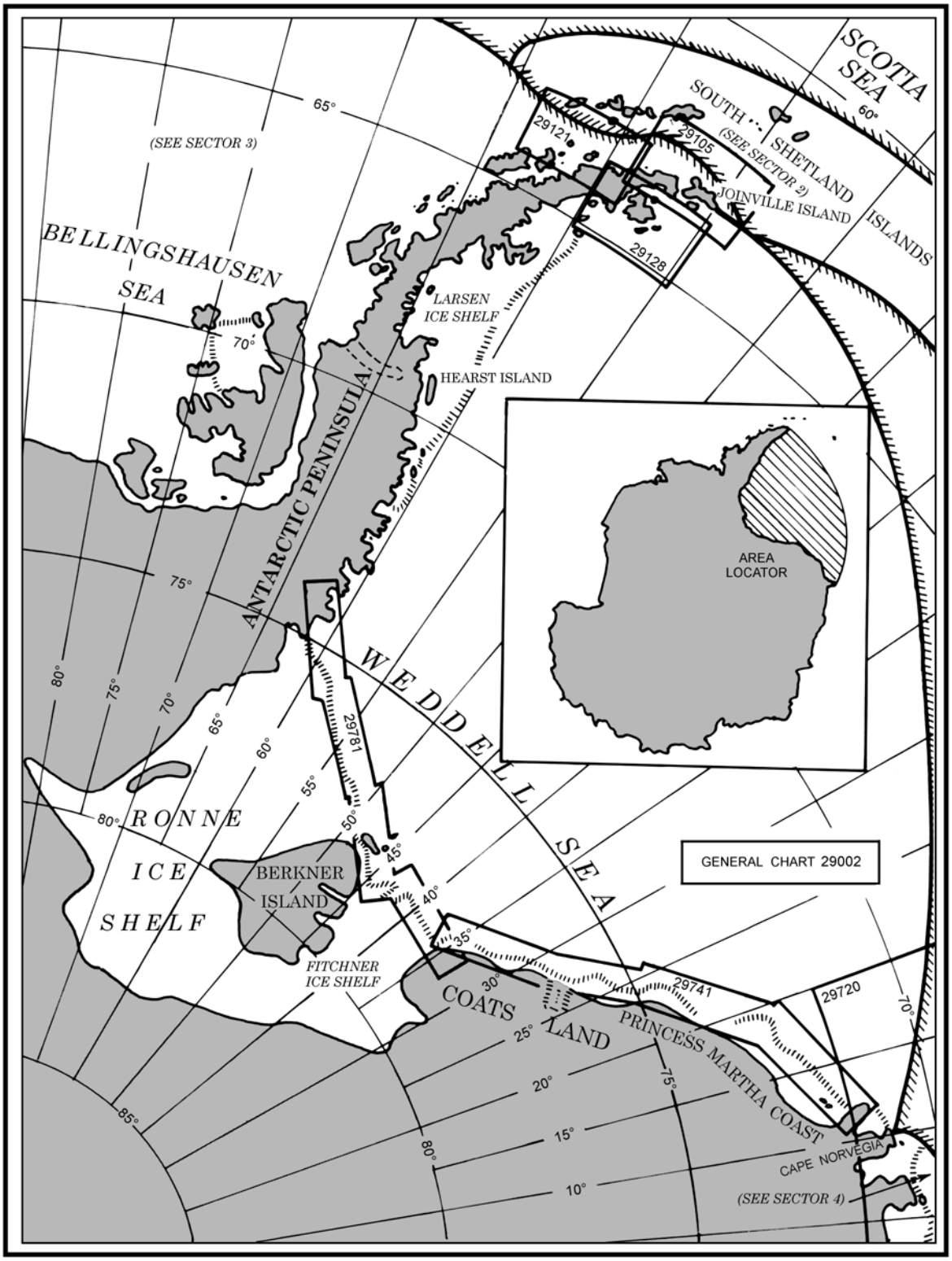
Permanent ice conditions exist in Lutzow-Holm Bay and along the coast from 150˚E to 140˚E. It is normal for fast ice to remain attached to ice shelves and ice tongues throughout the year. Fast ice attains a mean maximum thickness of 1.8m at Mawson Station and Mirnyy Station, and 2.1m along the Princess Astrid Coast (20˚E to 5˚E). In the vicinity of **Molodezhnaya Station** (67˚40'S., 45˚51'E.), a floe, of fast ice origin, was reported to be 4m thick. In comparison, a hum-mocked floe, of drift ice origin, was reported to have a depth in excess of 8m.

Glacier ice, such as an iceberg, occurs throughout the area, but is much more concentrated in the coastal region. Glacier ice generally drifts from E to W except between 90˚E and 80˚E where it drifts N and then E to the vicinity of 60˚S. This coastal area is known to calve giant icebergs, some up to 300m thick and 60 miles long.

The current system along the E continental coast is typified by a weaker W current near the coast and a stronger E current near the convergence zone. The main exception to this general current structure occurs between approximately 20˚E and 40˚E. This region represents the E portion of the Weddell Sea gyre (eddy) where the clockwise current flows toward the continent. It joins water from the West Wind Drift at the convergence zone and from the East Wind Drift near the coast. Other small projections jutting from the continent, such as Enderby Land and the Shackleton Ice Shelf, lead to the formation of much smaller clockwise gyres (eddies). These gyres (eddies) block the coastal current and usually join the two drift systems. A strong N flow is generally present near 80˚ E.

As with other regions which surround the Antarctic continent, sea temperatures are close to the freezing point near the icebound coast and increase toward the convergence zone' larger gradients occur leading to temperatures from 1.1˚ to 2.2˚C. Horizontal variations of salinity and density are small..

PART II



Additional chart coverage may be found in NGA/DLIS Catalog of Maps, Charts, and Related Products (Unlimited Distribution).

SECTOR **1** — CHART INFORMATION

SECTOR 1

THE WEDDELL SEA—CAPE NORVEGIA TO JOINVILLE ISLAND

Plan.—This sector describes the Weddell Sea, on the N coast of Antarctica. The descriptive sequence is E to W along the coast from Cape Norvegia to Joinville Island.

General Remarks

1.1 The **Weddell Sea** (72˚00'S., 45˚00'W.), which indents the coast of Antarctica between Cape Norvegia and the Antarctic Peninsula, is one of two great seas in Antarctica. Backed in many areas by mountains, ice shelves and glaciers line most of the coast. The shoreline is relatively smooth, except on the W side, where many small islands lie scattered along the coast.

The sea is covered with drift ice which extends outward or shrinks back with the seasons, varying by as much as 30 miles, daily.

The Continental Shelf extends seaward for about 45 miles from the ice shelf fronting the E side of Weddell Sea, and, at one point on the S side, it extends about 340 miles N from the Filchner Ice Shelf. On the W side, the Continental Shelf lies beneath the ice shelf, except at the N end of the Antarctic Peninsula, where it extends about 45 miles seaward.

Entrance to the Weddell Sea is best gained along a route running parallel to the 10˚W meridian. Once along the coast, the route leads in a SW direction and parallel to the ice front. In summer months, the belt of sea ice is relatively narrow in this area and there is not the influence of ice pressure produced by currents and topographic projections which exists in the W part of the sea. Departure from the Weddell Sea is best accomplished by reversing the route of entry.

Due to ice conditions, the W part of the Weddell Sea is impassable.

Meteorological conditions are variable in the Weddell Sea, often hindering vessel operations.

Winds—Weather.—The N limit of the drift ice, which varies from year to year, profoundly influences the climatic conditions of the Weddell Sea. Other contributing factors are the continent and its source of cold air, the warm seas from the N, and the extent of the sea ice. Temperatures are particularly affected by the drift ice density and winds.

In winter, temperatures drop rapidly and usually remain between 0˚ and -15˚C, occasionally dropping into the -30˚ to -40˚C range. The lowest temperatures in the winter normally occur in clear, calm weather.

Wind, weather, and temperature changes are more rapid and violent in the winter months.

During the summer, mean temperatures are at or about 0˚C for 1 to 4 months, at times rising to between 5˚ and 10˚C on the Antarctic Peninsula. The highest temperatures for the continent occur along the N fringes of the Antarctic Peninsula and the neighboring islands.

The average wind velocity is 16 knots, ranging in summer from calm to 30 knots. Winds are strongest during spring, particularly in September. Clouds and precipitation occur with N winds, and clear skies and a drop in temperature accompany S winds. In summer, if light winds are combined with a drop in temperature, rapid freezing will result. Also, in summer, surface water temperatures are generally below 0˚C, with isothermal and isohaline conditions existing to great depths. The layer of relatively warm water that exists in other areas is noticeably absent.

A semipermanent low over the Weddell Sea, combined with a semipermanent high centered over the continent, causes E winds along the coast.

A succession of depressions moving W to E and then N, with well-defined cyclonic ridges between them, characterizes the area's circulation patterns. Depressions enter the Weddell Sea along three main routes, as follows:

1. Between the NE tip of the Antarctic Peninsula and the South Orkney Islands.
2. Across the Antarctic Peninsula with their centers lying to the N of Marguerite Bay.
3. Across the Antarctic Peninsula with their centers lying S of Marguerite Bay.

If the edge of the drift ice lies farther S than usual in a particular winter, depression tracks may occur farther to the S.

Along the narrow, high-pressure wedge of the Antarctic Peninsula, the atmosphere is unstable; hence, abrupt changes and irregularities in all climatic elements are characteristic of the W part of the Weddell Sea.

Precipitation generally occurs as ice or snow. In summer, measurable amounts of rain are recorded at the Antarctic Peninsula. Blizzards occur infrequently in December and January, and more often in February and March.

Ice.—Ice conditions in the Weddell Sea are generally unfavorable. Drift ice is composed of fragments of level ice, hummocky floes, and icebergs. The N limit varies as much as 300 miles in different years. This limit exceeds that of other Antarctic areas and fluctuates as much as 30 miles daily.

About 85 per cent of the drift ice melts each year. The following year, the drift ice is predominantly first-year replacement ice with a thickness of only 1.5m. Constituents of the drift ice are influenced unequally by wind and current, resulting in differential movement that has a decisive effect on the composition and stability of the ice cover.

Prevailing E winds prompt a W current with a velocity of less than 1 knot. The current sets SW at the E entrance and flows parallel to the coast and along the Filchner Shelf before being deflected N. Farther out in the Weddell Sea, the current changes direction. The wind and current force the ice to the W, along the E coast of the Antarctic Peninsula. The ice jams along the coast, being subjected to great pressure from the current, and eventually works its way N.

Floes are more heavily compressed here than elsewhere along the Antarctic coasts, rendering the SW part of the Weddell Sea unapproachable in any season. In late summer, the NE and E central parts of the sea are most likely navigable, but ice conditions are extremely variable.

Katabatic winds, caused by surface cooling pushing outward from the land, carry drift ice away from the immediate vicinity of the ice shelves.

Icebergs, the products of numerous glaciers and ice fronts, may be encountered in all parts of the Weddell Sea. In 1969, two giant icebergs, one 25 miles wide and 55 miles long and the other 38 miles wide and 62 miles long, were reported in the Weddell Sea.

Tides—Currents.—The tides in the Weddell Sea, as in the rest of the Antarctic Ocean, are predominantly diurnal, characterized by one HW and one LW each tidal day. At the N extremity of the Antarctic Peninsula, mixed tides are present. The range of tide varies from 0.6m in the N limits of the sea to 3m in the W part of the sea.

The tidal currents tend to flood in a counterclockwise direction and ebb in the reverse.

A belt of clockwise eddies, known as the Antarctic Circumpolar Current or West Wind Drift, transports large volumes of water E and NE around Antarctica. Along the coast of the continent, E or SE winds prevail, resulting in a W current known as the East Wind Drift. Since these are associated with clockwise eddies they eventually turn N.

One clockwise eddy is a semipermanent feature of the Weddell Sea. Its rotation sets W and is then forced N, due mostly to the configuration of the W coast of the Weddell Sea, specifically the protuberance of the Antarctic Peninsula. The current sets W and is then directed between NE and E, joining with the Antarctic Circumpolar Current in the N part of the Weddell Sea. A small branch of the current leads NW through Joinville Strait, eventually becoming part of the current system of the Bellinghausen Sea.

Depths—Limitations.—Depths in the Weddell Sea are generally greater than 3,600m. The 500, 800, and 1,000m curves extend from the Antarctic Peninsula to Coats Land, between 72˚S and 73˚S. The 900m curve is irregular, extending S at one point to the E limit of the Filchner Ice Shelf, between 35˚W and 40˚W. To the E of this area, the bottom shoals grad-ually to Coats Land, where the continental shelf is compara-tively narrow and irregular, with the 500m curve lying close to the coast. On the W side of the Weddell Sea, soundings indi-cate the existence of a broad shelf. To the S of the 500m curve, a series of level terraces occur, with depths of 270 to 475m. The bottom is composed mostly of blue glacial mud approximating red clay.

Caution.—The charted areas of the Weddell Sea have not been completely surveyed and most of the data is of reconnaissance nature only.

When approaching the NW and W parts of the sea from high latitudes, ice may trap a vessel and subject its hull to regions of high pressure. Therefore, mariners must use extreme care when navigating in these waters.

Cape Norvegia to the Filchner Ice Shelf

1.2 The E coast of the Weddell Sea includes Queen Maud Land, which extends W from Cape Norvegia to the E end of the Filchner Ice Shelf, in Coats Land.

Cape Norvegia (71˚20'S., 12˚18'W.), on the E side of the Weddell Sea, is prominent; the land rises to a height 500m close SE of it. Stranded icebergs have been reported stretching to the SW of the cape in depths of up to 221m, but greater depths lie E of this area.

The cape is fronted by an ice shelf, about 50 miles wide, which is called Riiser-Larsen. An angle is formed at the cape and a large bight is contained SW of Seal Bay. Two small islands lie at this point and may best be seen on the chart.

The **Princess Martha Coast** (72˚00'S., 7˚30'W.), in Queen Maud Land, is fronted by a cliffed ice face, 21 to 36m high. The W part of the coast consists of the Riiser-Larsen Ice Shelf, an extensive ice mass. The shelf leads SW from Cape Norvegia to Lyddan Island. An inlet, extending 8 miles S, indents the shelf 20 miles SW of Seal Bay. Depths within the inlet are unknown and two islands lie at the head.

The **Kraul Mountains** (73˚20'S., 14˚10'W.), standing 60 miles from the coast, are surrounded by the Riiser-Larsen Ice Shelf. They form a chain of peaks and nunataks, rising to an elevation of 1,199m.

Lyddan Island (74˚25'S., 20˚45'W.), ice-covered, lies at the SW end of the Riiser-Larsen Ice Shelf, about 25 miles from Queen Maud Land. It is about 45 miles long and has three narrow arms.

Coats Land (77˚00'S., 27˚30'W.) encompasses the E coast of the Weddell Sea, between 20˚W and 36˚W, where it joins the E end of the Filchner Ice Shelf. Contained within Coats Land are the Caird Coast and the Luitpold Coast, presenting a near continuous ice cliff to the sea.

The **Stancomb-Wills Glacier** (75˚18'S., 19˚00'W.) leads NE from Coats Land, becoming the extensive Stancomb-Wills Glacier Tongue (75˚00'S., 22˚00'W.) to the SW of Lyddan Island.

The **Caird Coast** (76˚00'S., 24˚00'W.) leads SW to the W limit of Hayes Glacier. Within this coast are the Brunt Ice Shelf, the Dawson-Lambton Glacier, and the Hayes Glacier.

Brunt Ice Falls (75˚55'S., 25˚00'W.) extends 50 miles along the Caird Coast to where the steep, ice-covered shore descends to the **Brunt Ice Shelf** (75˚40'S., 25˚00'W.). This shelf borders the coast between the Stancomb-Wills Glacier Tongue and the NE end of the Dawson-Lambton Glacier.

1.3 **McDonald Ice Rumples** (75˚28'S., 26˚18'W.) is a severely disturbed glacial area lying on the N side of the Brunt Ice Shelf. It descends from ice-covered hills, 305 to 610m high, and terminates at the sea in perpendicular ice walls, 120 to 153m high. Crevasses and pressure ridges are present within the area. A small bay lies N of the glacier and is open to N winds. Within the bay, the glacial ice descends to about 1m above sea level. The seaward end of the glacial face extends about 17 miles SW. A sounding of 146m found in this bay indicates that the glacier is aground and is moving upward.

Halley Bay (75˚24'S., 26˚30'W.) indents the ice shelf to the W of McDonald Ice Rumples, 18 miles SW of Lyddan Island. A least depth could not be determined (1984) in the bay because, like much of the coast, it had not been accurately surveyed. Halley, a permanently-manned station of the British Antarctic Survey, is situated in the vicinity of the bay. This station is continually moving due to the motion of the ice.

Tottan Hills, standing more than 200 miles E of Halley Bay, were reported (1981) to be visible from the station.

The **Dawson-Lambton Glacier** (76˚08'S., 26˚45'W.) is a huge glacial out-flow lying about 30 miles SSW of Halley Bay.

It is heavily crevassed and broken, rises to elevations of 900 to 1,200m, and forms a 30-mile front with a floating tongue.

The **Hayes Glacier** (76˚16'S., 27˚54'W.), discovered in 1967 and charted as part of Dawson-Lambton Glacier, leads SW to the border of the Luitpold Coast.

The **Luitpold Coast** (77˚30'S., 32˚00'W.) is that part of Coats Land lying between the Hayes Glacier and the E end of the Filchner Ice Shelf. The coast attains a height of 610m and slopes gradually to an unbroken ice cliff, 9 to 30m high. About 25 miles SW of the Hayes Glacier and about 0.4 mile seaward of the ice front, an angle (76˚41'S., 30˚25'W.) of the ice wall exists in a depth of 114m. Many large icebergs, showing tidemarks, have been reported grounded in this area.

An inlet, 12 miles long, indents the ice shelf, 55 miles SW of the Dawson-Lambton Glacier. In 1984, depths within this inlet were unknown.

From this point, the ice shelf leads SW for 60 miles to **Vahsel Bay** (Duke Ernst Bay) (77˚49'S., 35˚07'W.). The E side of this bay is bounded by nunataks and glaciers.

The Schweitzer Glacier and the Lerchenfeld Glacier, which lead W, join with the Penck Glacier, which descends to the N. These glaciers then extend 8 miles NW as an ice tongue into Vahsel Bay. Two huts are reported to stand in an indentation on the N side of the Schweitzer Glacier.

1.4 General Belgrano II is a base station surmounting a small rock outcrop with an elevation of 50m. It is situated at the junction of the Schweitzer Glacier, the Lerchenfeld Glacier, and the Penck Glacier, and overlooks Vahsel Bay.

Littlewood Nunataks are a group of four lichen-covered rock outcrops, each about 45m wide and brick-red in color, which are located between the Schweitzer Glacier and the Lerchenfeld Glacier. Bertrab Nunatak is a bare rock, 530m high, standing SW of the Lerchenfeld Glacier.

The coast leads W for 5 miles from the ice tongue formed by the glaciers and then S for about 10 miles to the Wiedenmann Glacier. Moltke Nunataks, forming a chain standing in a N/S line, rise along this stretch of coast, 8 miles SW of the ice tongue.

A glacier, 15 miles long, lies S of Moltke Nunataks and extends to the E end of the Filchner Ice Shelf.

The coast in the vicinity Vahsel Bay is reported to be unstable and calving of ice occurs.

A glacier was reported (1955) to be in motion in the vicinity of Vahsel Bay. Deep fissures and deformations were noted in the ice shelf, which was 41m high. Many tabular icebergs were also reported in this area.

The Filchner Ice Shelf to the Bowman Peninsula (The Lassiter Coast)

1.5 The S coast of the Weddell Sea extends W from the E end of the Filchner Ice Shelf and encompasses Berkner Island and the Ronne Ice Shelf.

The **Filchner Ice Shelf** (79˚00'S., 40˚00'W.) extends about 130 miles in a general W and WSW direction, between Vahsel Bay and Berkner Island, and S for over 200 miles. It is fed by the Slessor Glacier, the Recovery Glacier, and the Support Force Glacier.

The Slessor Glacier and the Recovery Glacier lie on either side of the **Shackleton Range** (80˚30'S., 25˚00'W.). This mountain range, standing on the SE side of the Filchner Ice Shelf, rises to an elevation of 1,875m and extends in an E/W direction for about 100 miles.

The Slessor Glacier, about 75 miles long and 50 miles wide, flows W into the Filchner Ice Shelf, on the N side of the range. The Recovery Glacier, about 60 miles long and 40 miles wide at its mouth, flows W into the Filchner Ice Shelf, to the S of the range. The Support Force Glacier, a major glacier in the Pensacola Mountains, flows N into the ice shelf.

The **Pensacola Mountains** (83˚45'S., 55˚00'W.), rising on the S side of the ice shelf, is a range which extends about 280 miles in a NE/SW direction. This range is located in the E part of **Edith Ronne Land** (83˚00'S., 60˚00'W.), which forms the inland border of the Filchner and Ronne Ice Shelves.

The huts of the former Shackleton Station are reported to stand about 34 miles W of Vahsel Bay.

The General Belgrano Station, an Argentinean base now reported closed, is situated about 20 miles W of the former Shackleton Station. A beacon, 42m high, and a flagpole stand at the site. The beacon consists of an iron tripod with a slatted yellow and black topmark. A black wooden tripod, with a black square topmark, was reported (1962) to stand about 1 mile W of the station.

About 60 miles W of Vahsel Bay, the ice shelf projects N in a promontory that is 30 miles wide and 15 miles long. The NE side of this promontory is indented by a crevasse that extends about 18 miles S. The site of the former Ellsworth Station, marked by huts, is situated on the E side of the entrance to the crevasse. The W side of the promontory trends 27 miles S and SW to Gould Bay.

Gould Bay (78˚00'S., 45˚00'W.) lies at the junction of the Filchner Ice Shelf and Berkner Island. It is the S part of the Weddell Sea that is accessible to ships. The bay is about 20 miles wide and is reported to offer a suitable place to land a wintering party.

Berkner Island (79˚30'S., 47˚30'W.), lying at the W end of the Filchner Ice Shelf, is ice-covered, about 200 miles long, and about 85 miles wide. It rises to an elevation of 975m.

General Belgrano III (77˚54'S., 45˚59'W.), a base administered by Argentina, was reported to have been deactivated in 1983.

Hemmen Ice Rise (77˚57'S., 49˚46'W.), 11 miles long and 2 miles wide, extends from the NW extremity of Berkner Island in the Ronne Ice Shelf.

1.6 The **Ronne Ice Shelf** (78˚30'S., 61˚00'W.) is the larger of the two major ice shelves located at the head of the Weddell Sea. It extends NW from Berkner Island to the S end of the Antarctic Peninsula. The shelf is bordered to the W by Ellsworth Land and covers an estimated area of 329,914 square kilometers.

A penguin rookery lies about 34 miles NW of Gould Bay, N of Berkner Island. Close W of the rookery, an inlet indents the ice shelf and extends 2 miles S.

The Ronne Ice Shelf leads NW for about 60 miles, where it is fronted by numerous ice peaks, and then trends NW for 180 miles to the Bowman Peninsula.

The **Orville Coast** (75˚45'S., 65˚30'W.) is the land bordering the W side of the Ronne Ice Shelf between Cape Adams, at the S end of the Bowman Peninsula, and Cape Zumberge, to the S. The coast is entirely icebound within the ice shelf.

Cape Zumberge (76˚14'S., 69˚40'W.), a steep and rocky cape, is located on the W side of the Ronne Ice Shelf.

Information for this part of the Weddell Sea is limited as it is the least accessible by vessels due to the concentration of drift ice.

The Antarctic Peninsula

1.7 The **Antarctic Peninsula** (69˚30'S., 65˚00'W.) is the area at the NW end of the Ronne Ice Shelf where the coast turns sharply N. It is the major peninsula of the continent, extending from Prime Head, at its N extremity, to a line between Cape Adams and a point located on the mainland coast, S of the Eklund Islands.

The peninsula consists of a snow-covered plateau, 1,067m high, in its N part and gradually increases to an elevation of 3,658m in its S part. The plateau is broken occasionally by snow-covered peaks. The cliffs on the W side of the plateau are dissected by numerous glaciers and icefalls which descend to the coastal limits. Numerous bays and indentations form the W shore which, for the greater part, is covered by piedmont ice. Many islands, islets, and rocks lie seaward of the cliffs. The E coast is broken by valley glaciers that fill long fjords, the seaward approaches of which are inaccessible by vessels due to an extensive shelf ice formation fringing the greater portion of the E shore.

Palmer Land—West Coast

1.8 **Palmer Land** (71˚30'S., 65˚00'W.) is that part of the Antarctic Peninsula lying S of a line joining Cape Joremy and Cape Agassiz. It includes the Lassiter Coast, the Black Coast, and the Wilkins Coast between Cape Adams and Cape Agassiz.

The **Lassiter Coast** (73˚45'S., 62˚00'W.) is that part of the E coast of Palmer Land extending between Cape Adams and Cape Mackintosh. Glaciers are an integral part of the terrain in this vicinity, with many leading E into the Weddell Sea.

Bowman Peninsula (74˚47'S., 62˚22'W.), located at the S end of Palmer Land, is 25 miles long and 15 miles wide in its N and central portions. It leads in a N/S direction, is ice-covered, and narrows toward the S, where it terminates at Cape Adams.

Cape Adams marks the N entrance point of Gardner Inlet, at the N end of the Ronne Ice Shelf.

Mount Austin (74˚53'S., 63˚10'W.), a conspicuous rocky mass, stands at the head of Gardner Inlet and rises to an elevation of 955m.

Nantucket Inlet (74˚35'S., 61˚45'W.), ice-filled, is 6 miles wide and 13 miles long. It is bounded on the S side by the Bowman Peninsula and on the N side by the Smith Peninsula. This inlet is fed from the NW by the Johnston Glacier. Mount Owen, 1,105m high, stands at the head of this inlet. The S side of the entrance to the inlet is formed by the ice-free face of the coastal piedmont. Open water leads, bordering the fringing coastal ice, reportedly appear less frequently to the S of the inlet.

The **Smith Peninsula** (74˚25'S., 61˚15'W.), which is ice covered, is a dog-legged peninsula 10 miles wide and 25 miles long. Cape Fiske forms the easternmost extremity of this peninsula.

Keller Inlet, ice-filled, is 10 miles wide at its mouth. This inlet lies N of the Smith Peninsula and indents the coast for about 12 miles in a NE direction. Like many inlets along this peninsula, it is glacier-fed.

Mount Nash (74˚14'S., 62˚20'W.), 1,295m high, stands 13 miles WNW of Keller Inlet and 12 miles NNE of Mount Owen.

Wright Inlet, lying between Cape Little and Cape Wheeler, is engulfed with ice that is fed by the Swann Glacier and the Waverly Glacier.

Mount Tricorn (73˚58'S., 61˚45'W.), a distinctive massif, has a vertical rock face, 1,610m high, and stands at the head of Wright Inlet. It is generally snow-free, while the interior land in the vicinity is completely snow-covered.

Howkins Inlet (73˚40'S., 60˚54'W.) lies 18 miles N of Cape Wheeler. Arctowski Peak, standing 8 miles WSW of the head of this inlet, is isolated, snow-covered, and 1,410m high.

Howkins Inlet is entered between Lamb Point and Cape Brooks. It was reported (1973) that an ice front extended into the Weddell Sea at this point and completely encompassed all the inlets in this area. Lamb Point is low and ice-covered. Cape Brooks is fronted by steep, conspicuous walls which rise to a height of 465m.

1.9 **New Bedford Inlet** (73˚22'S., 61˚15'W.), located N of Howkins Inlet, is a large, pouch-shaped and ice-filled bay. It is 10 miles wide, 13 miles long, and extends between Cape Brooks and Cape Kidson. The N and S shores of this inlet present almost vertical and ice-free piedmont cliffs; the head is fed by glaciers. The rock walls of the glaciers are evenly cut and, to a large degree, are ice-free. The head of the inlet is marked by a distinctive and isolated massif. This massif is entirely snow-covered and rounded on its W side, but rocky and snow-free on its E slopes, where it terminates in a sharp, projecting cape. The ice in the inlet is undulating, with many rifts and crevasses.

Court Nunatak (73˚22'S., 61˚36'W.), which is 3 miles long and 685m high, stands close E of a glacier, on the W side of New Bedford Inlet. Mount Barkow rises at the E end of the ridge that separates the glaciers near the head and rises to an elevation of 1,390m.

Mount Grimminger (73˚18'S., 62˚18'W.), rising NE of Mount Barkow, is cone-shaped, mostly ice-covered, and 1,680m high.

The high, rocky coastal piedmont extends to the S of New Bedford Inlet and loses its cliff-like face, assuming the aspect of a continuous slope. Widely scattered peaks rise in the interior and areas of level country lie between them.

Cape Kidson, located on the N side of New Bedford Inlet, is an abrupt rock scarp, 300m high.

Mossman Inlet, narrow and ice-filled, recedes 10 miles N between Cape Kidson and Cape Deacon, on the S side of the Kemp Peninsula.

The **Kemp Peninsula** (73˚08'S., 60˚15'W.) is that part of the mainland extending E at the N limit of the Lassiter Coast. This irregular ice-covered peninsula extends 26 miles in a N/S

direction and is 5 to 12 miles wide. It projects E between the heads of Mason Inlet and Mossman Inlet and rises to an elevation of 305m. Cape Deacon, ice-covered, is located at the S end of the peninsula. The N end of the peninsula is low, ice-covered, and known as Cape Mackintosh.

On the N side of the Kemp Peninsula, E of Cape Mackintosh, Mason Inlet indents the coast and extends 15 miles in a SW direction. This inlet is ice-filled and fed by the Clowes Glacier which enters from the W. Cape Mackintosh marks the N limit of the Lassiter Coast and the S limit of the Black Coast.

The **Black Coast** (71˚45'S., 62˚00'W.) extends 130 miles N from Cape Mackintosh to Cape Boggs. Glaciers are common along the S part of this coast, with very few glaciers in the N part.

Violante Inlet (72˚35'S., 61˚05'W.), large and ice-filled, is 16 miles long and 12 to 15 miles wide. It is entered between Cape Fanning, on the N side, and Cape Herdman, on the S side. The Maury Glacier, 4 miles wide, and the Defant Glacier, 2 miles wide at its mouth, flow, respectively, ENE and ESE into the inlet.

On the S side of this inlet, close E of the Maury Glacier, Mount Reynolds rises to an elevation of 1,130m. It is snow-capped and marked by a large massif. The walls of the massif are composed of a series of aretes, having bare rock on the steep lower slopes and snow on the heights. They are surmounted by a network of connecting sharp peaks and ridges. Inland from this massif, numerous glaciers descend from the high interior and flow between the mountain masses of the coastal range.

Pullen Island (72˚35'S., 60˚57'W.) is snow-covered, 5 miles long, and rises to a height of 495m at its N end, about 5 miles E of the glacial wall in the inlet. This island is distinctive because of its precipitous, ice-free cliffs on the N side and its gentle slopes on the S side. The slopes terminate in a long, low terrace which extends S close to the piedmont shores of the inlet.

1.10 The **Merz Peninsula** (72˚15'S., 61˚05'W.), irregular and ice-covered, extends about 15 miles in an E/W direction and is 25 miles wide. It lies between Hilton Inlet and Violante Inlet, on the E coast of Palmer Land.

Cape Christmas is abrupt and rises to a height of 320m. Cape Fanning marks the entrance to Wust Inlet.

Wust Inlet (72˚20'S., 60˚50'W.) is 2 to 5 miles wide and ice-filled. Schott Inlet leads N and indents the Merz Peninsula about 17 miles N of Violante Inlet. Flagon Point marks the S side of the entrance into Schott Inlet and is surmounted by two peaks, 293 and 395m high.

At the E edge of the ice front, about 7 miles E of Flagon Point, Butler Island rises to an elevation of 183m. It is 6 miles wide, circular, and ice-covered.

At the NE end of the Merz Peninsula, a smaller peninsula leads N and forms a headland, 271m high. This headland is ice-covered, surmounted by small rock outcrops, and is known as Cape Darlington.

Hilton Inlet (71˚57'S., 61˚20'W.) is ice-filled, 12 miles wide, and 22 miles long. It leads between Cape Darlington and Cape Knowles. The Gruening Glacier, a broad glacier, descends in a SE direction between steep, rocky walls into the NW part of the inlet. The Kellogg Glacier, 9 miles long, leads SE and joins with the Gruening Glacier, close inland of the head of Hilton Inlet. Another unnamed glacier flows into the inlet from the S.

1.11 The **Condor Peninsula** (71˚46'S., 61˚30'W.) encompasses that part of the Black Coast between Hilton Inlet and Odom Inlet. Cape Knowles, located at the S end of the peninsula, rises to an elevation of 320m.

Cape MacDonald, a distinctive headland, forms the S side of the entrance to Odom Inlet and is composed of a vertical, bare rock wall. It reaches the maximum height of 430m at the N end, where it descends in a perpendicular cliff to the sea ice. A snow-free nunatak, with an identical outline, stands close S of this entrance point.

Cape Bryant (71˚12'S., 60˚55'W.) is located about 20 miles N of Cape MacDonald. The coast between is indented by Odom Inlet, Lamplugh Inlet, and Palmer Inlet.

Odom Inlet trends SW for about 10 miles. Many rocky peaks stand at the head of this inlet between which numerous glaciers descend to the sea. This inlet widens as it recedes from the entrance.

O'Sullivan Peak (71˚26'S., 62˚06'W.), 1,768m high, stands about 11 miles W of the N arm of Odom Inlet, near the S end of an ice-covered ridge.

1.12 **Mount Jackson** (71˚23'S., 63˚22'W.) dominates the upland in the S part of Palmer Land. This remarkable massif is a vast cirque open to the N. From the S and E, it presents a steeple summit, 4,191m high, which stands majestically above the high plateau. On the N side, it is flanked by another peak, about 1,000m lower in elevation. A range of mountains rises E of Mount Jackson and flanks the coast.

Cape Howard is located at the terminus of the Snyder Peninsula, between Odom Inlet and Lamplugh Inlet. The cape is marked by a high, flat-topped, and snow-covered promon-tory which has steep, snow-free cliffs on its S face and a distinctive, pyramidal-shaped rock at its lowest extremity.

Lamplugh Inlet indents the coast for 7 miles between Cape Howard, to the S, and Cape Healy, to the N. This inlet narrows, from a width of 5 miles at the entrance, to a width of about 1 mile, at the head. Several large, rocky masses, with steep slopes, stand above the piedmont at the head of the inlet.

The Foster Peninsula is high, ice-covered, and protrudes from the coast to the N of Lamplugh Inlet. It terminates in Cape Healy, at the S end, and Cape Musselman, at the N end.

Cape Healy is composed of a prominent, square-shaped rock with a stepped profile on its S face. Cape Musselman is located 4 miles N of Cape Healy, on the S side of the entrance to Palmer Inlet. Between Cape Healy and Cape Musselman, the coastal piedmont has extensive ice falls descending E to the sea ice which is about 15m above sea level.

Palmer Inlet, rectangular-shaped, indents the coast for about 8 miles and is ice-filled. Its shores are formed by almost vertical cliffs of the piedmont, with many bare and rocky walls.

Marshall Peak (71˚09'S., 61˚32'W.), standing 6 miles inland of Palmer Inlet, rises to an elevation of 1,205m. This peak is ice-covered, except for its rocky NE side.

Cape Bryant, located at the N side of Palmer Inlet, is a high snow-covered and dome-shaped cliff with a dimpled skyline.

The Black Coast leads 27 miles NW and N from Cape Bryant to Cape Sharbonneau.

1.13 Mount Hill (70˚56'S., 61˚42'W.), 945m high, stands 23 miles NW of Cape Bryant and is marked by a thin cap of bare rock at its summit.

Cape Sharbonneau rises 8 miles NE of Mount Hill, at the S entrance to Lehrke Inlet. This cape is formed by a rounded snow-covered headland.

Morency Island lies offshore, about 10 miles NW of Cape Bryant. This island is 213m high and rocky, with steep cliffs on its E side and gentle slopes on its W side.

Steele Island, 12 miles long and 10 miles wide, lies 8 miles NE of Cape Bryant. It is snow-covered and rises to an elevation of 488m. The deep slopes of the island are crevassed, but no rock outcrops are visible. Like Butler Island, Steele Island lies at the edge of the ice shelf, on the W side of the Weddell Sea.

Lehrke Inlet (70˚49'S., 61˚45'W.) is 8 miles wide and recedes SW for 17 miles. It is ice-filled and entered between Cape Sharbonneau, on the S side, and Cape Boggs, on the N. Many massive ridges and peaks stand close inland from the head of this inlet and steep ice falls descend to the coastal low lands. An islet, 12m high, lies off the mouth of the inlet.

The Eielson Peninsula, rugged and mainly snow-covered, borders the NW side of Lehrke Inlet. It is 20 miles long, about 10 miles wide, and terminates at Cape Boggs. This cape is composed of an ice-capped headland, with precipitous cliffs of igneous rock, and is 762m high. It forms the coastal abutment of the Eternity Range foothills.

Mount Thompson (70˚40'S., 62˚21'W.), standing at the SW end of the Eielson Peninsula, is 1,692m high. Dolleman Island, 396m high, lies 8 miles E of Cape Boggs. It is rounded and ice-covered.

Cape Boggs forms the N extremity of the Black Coast at its junction with the Wilkins Coast.

1.14 The **Wilkins Coast** (69˚40'S., 63˚00'W.) extends between Cape Boggs and Cape Agassiz, the N limit of Palmer Land.

The **Eternity Range** (69˚46'S., 64˚34'W.) stands inland of the Wilkins Coast and trends in a N/S direction for about 28 miles. Mount Faith, Mount Hope, and Mount Charity are the three most prominent features of this range.

Mount Hope (69˚46'S., 64˚34'W.), 2,859m high, is the central and highest peak of the Eternity Range. It is flanked by Mount Faith, 2,652m high, rising 9 miles N and Mount Charity, 2,682m high, rising 11 miles S.

Dyer Plateau (70˚30'S., 65˚00'W.), broad and ice-covered, lies W of the Eternity Range and rises to an elevation of 1,067m. The Eland Mountains, another range, stands at the S end of the Wilkins Coast, to the E of the Eielson Peninsula. They extend for about 20 miles in a NE/SW direction and rise to an elevation of 2,440m.

1.15 Smith Inlet (70˚25'S., 62˚00'W.) indents the coast and extends 15 miles W. The Clifford Glacier flows into the E end of this inlet. It is a broad glacier, about 40 miles long, and flows in an ESE direction through the gap lying between the Eland Mountains and Mount Tenniel, which is 1,625m high.

Cape Collier, a broad and ice-covered projection, marks the N side of the entrance to Smith Inlet. Numerous snow-covered nunataks and ridges, up to 762m high, stand on the slopes of the piedmont in this vicinity and rise steeply from the sea ice. At the entrance to Smith Inlet, depths of 36.6m off Cape Collier and 110m off Smith Inlet have been recorded.

The coast trends 17 miles N and NW from Cape Collier to James Nunatak, which is conical and rises to an elevation of 410m. Lewis Point, located 5 miles N of James Nunatak, is marked by rocky exposures on its N side and surmounted by an ice-covered dome, 510m high. This point is located at the S end of the mouth of the Anthony Glacier.

1.16 Ewing Island (69˚54'S., 61˚13'W.) lies 20 miles E of Lewis Point at the S end of the Larsen Ice Shelf. This island is ice-covered and dome-shaped. It is 8 miles in diameter and rises to an elevation of 305m.

The Anthony Glacier flows in an ESE direction to the coast, close NW of Lewis Point.

Stefansson Strait (69˚26'S., 62˚25'W.) is ice-filled, 35 miles long, and 3 to 10 miles wide. It leads between the Wilkins Coast and Hearst Island. The shelf ice in the straight varies. It was reported (1940) that shelf ice in the N part was 146m above sea level, while it was only 15m above sea level in the S part.

The highlands, to the E of the Eternity Range, descend in a maze of lower peaks and an ice-covered plateau which is bordered by hills, up to 1,524m high. A broad coastal piedmont extends to the E of these mountains and reaches the coast in steep ice cliffs, up to 610m high.

Cape Rymill, the NE point of the coastal piedmont, is located 14 miles above the S entrance to Stefansson Strait. It is faced by a steep metamorphic rock cliff, 457m high, which projects out from the ice cap.

Rhino Rock, black and steep, stands 6 miles SSW of Cape Rymill and rises to an elevation of 1,219m. It forms the E extremity of a rounded and rocky massif, 1,524m high. This massif extends inland for about 7 miles, with its W end buried beneath the continental ice. Rhino Rock is located 4 miles W of the cliffed edge of the piedmont and appears to be separated from its parent mass by a low column.

1.17 Hearst Island (69˚25'S., 62˚10'W.) lies on the E side of Stefansson Strait, 4 miles E of Cape Rymill. This island is 36 miles long, 7 miles wide, and has no visible rock outcrops. It is ice-covered, domed-shaped, and rises to an elevation of 366m. The W side of the island is steep and crevassed. The sea ice fronting the E side of the island is usually widely broken into pressure ridges and contains many icebergs.

The coast trends NNW for about 9 miles from Cape Rymill to **Cape Reichelderfer** (69˚22'S., 62˚43'W.), a rounded and ice-covered headland. A nearly vertical rock cliff, known as DeBusk Scarp, is located 4 miles W of the cape. It is 2 miles long and rises to an elevation of 300m.

The coast to the N of Cape Reichelderfer is indented by an inlet. The N side of the inlet, which is 5 miles long, is bordered by Finley Heights. The Bingham Glacier feeds into the inlet from the W. This glacier crosses Palmer Land, extending from the coast of the Weddell Sea to the coast of Marguerite Bay. It is about 8 miles wide at the E entrance and rises in steep ice falls from the ice shelf, which is 45m above sea level, to an elevation of 2,134m, near the meridian of 64˚30'W. Its N and S flanks are marked by high peaks, with numerous tributary glaciers entering from the bordering highlands.

Finley Heights, to the N of the Bingham Glacier, fronts the ice shelf and forms a stretch of rugged coast, about 7 miles long. It rises to a prominent, snow-covered, and rocky mass, 1,070m high.

1.18 Cape Hinks (69˚10'S., 63˚10'W.), located at the NE end of Finley Heights, is formed by a low, dark, and rocky cliff, 222m high.

The Lurabee Glacier, lying on the N side of Finley Heights, is about 5 miles wide. It extends in a SW direction for 10 miles where it joins the major transverse rift crossing Palmer Land.

Cape Keeler is located 20 miles N of Cape Hinks. The coast between is distinctive and is formed by a series of low fault troughs which are bordered by vertical rock walls and terminate in low, steep faces.

Scripps Heights surmount the peninsula extending between the Lurabee Glacier and the Casey Glacier. Its peaks are rugged and largely ice-covered. The heights terminate at Cape Walcott, an ice-covered headland, 625m high.

Casey Inlet, lying close N of Cape Walcott, is fed from the W by the Athene Glacier and the Casey Glacier. Athene Glacier is 10 miles long and merges with the terminus of the Casey Glacier, which is 6 miles long.

From Casey Inlet, the coast extends 7 miles and is formed by Miller Point, Cape Mayo, and Cape Keeler.

Miller Point, low and black, is formed by bare rock. It is 232m high and forms the termination of a rocky and ice-covered mass. Between this rocky mass and Cape Mayo, a small glacier trends NW for about 15 miles and merges with the highland ice which inundates the tableland.

Cape Mayo, a bare and rocky cliff, is the terminus of a flat, snow-covered tableland which is 435m high. A narrow glacier lies between the rocky walls of Cape Keeler and Cape Mayo. It trends NW for about 15 miles and merges with the snow-covered tableland.

Cape Keeler, 518m high, has a flat and tent-shaped summit which slopes gently to the E in slate cliffs. This cape forms the S side of the entrance to Revelle Inlet.

The coast to the N of Cape Keeler trends NW along the inlet and consists of a high, snow-covered tableland. It has steep cliffs through which bare rock is occasionally seen. Revelle Inlet lies between Cape Keeler and Cape Agassiz. It is broad, ice-filled, and 15 miles long.

Cape Agassiz, 130m high, is located at the terminus of the Wilkins Coast and Palmer Land. It is formed by a narrow, ice-drowned spur which extends between Revelle Inlet and Mobiloil Inlet.

1.19 The **Larsen Ice Shelf** (67˚30'S., 62˚30'W.), located in the NW part of the Weddell Sea, is 300 miles long. It extends N along the E coast of the Antarctic Peninsula from close S of Hearst Island to Cape Longing. The ice shelf encompasses the N extremity of Palmer Land and almost the entire length of Graham Land. At one point, this shelf is about 120 miles wide. A protrusion in the ice shelf occurs about 55 miles NE of Hearst Island. At this point, the ice extends E for about 23 miles from the general contour of the shelf.

Gipps Ice Rise (68˚46'S., 60˚56'W.) is 10 miles long, 9.5 miles wide, and stands 270m above the ice shelf. It is located on the Larsen Ice Shelf, 35 miles NE of Hearst Island, and is bounded by ice cliffs on all sides. Depths along the edge of the ice shelf range from 610m, at the N end of the protrusion described above, to a least depth of 60m, close E of Cape Longing.

Graham Land—West Coast

1.20 Graham Land (66˚00'S., 63˚30'W.) is that part of the Antarctic Peninsula lying N of a line between Cape Jeremy and Cape Agassiz. It includes the Bowman Coast, the Foyn Coast, the Oscar II Coast, the Nordenskjold Coast, and the Trinity Peninsula.

The **Bowman Coast** (68˚10'S., 65˚00'W.), the southernmost coast of Graham Land, extends 80 miles N from Cape Agassiz, at the extremity of the Hollick-Kenyon Peninsula, to Cape Northrup. Several inlets mark the shore of the Bowman Coast and are all engulfed by the Larsen Ice Shelf.

Mobiloil Inlet, which is ice-filled, leads SW between the Hollick-Kenyon Peninsula, to the SE, and Rock Pile Point, to the NW. The Hollick-Kenyon Peninsula is 40 miles long, ice-covered, and leads from the main mountain mass of the Antarctic Peninsula. It separates Casey Inlet from Mobiloil Inlet.

Glaciers radiate from a wide roadstead, located to the W of Mobiloil Inlet, into the interior of the Palmer Peninsula. One of these glaciers flows E to the head of the inlet. Along the Bowman Coast, these glaciers are separated by rocky, ice-covered peninsulas. The locus of these glaciers is known as the Traffic Circle. It is located S of Mount Ptolemy and is marked by a conspicuous beehive-shaped nunatak, known as Hub Nunatak.

On the N side of the inlet, a peninsula extends E for 10 miles. It is marked by Rock Pile Peaks, 1,109m high, which consist of many sharp peaks and ridges standing prominently above the ice sheet that envelopes its lower heights. The E extremity of the peninsula is formed by Rock Pile Point, an ice-covered and rocky cape, which has several bare rock faces and is 244m high.

Solberg Inlet lies between Rock Pile Peaks, to the S, and the Joerg Peninsula, to the N. It is 5 to 18 miles wide, ice-filled, and trends about 14 miles in a general W direction to the continental plateau escarpment. A remarkable cirque mountain stands at the head of the inlet and reaches an elevation of 1,372m. The terrain at the head is composed of a maze of jagged snow-covered peaks which extend in wild confusion to the summit of the continental plateau. Between these peaks, heavily crevassed ice falls fill the lower slopes. These glacier-filled valleys have steep gradients and trend in a jumbled pattern toward the continental plateau.

Trail Inlet, lying 15 miles N of Solberg Inlet, is entered between Three Slice Nunatak and Cape Freeman. This inlet recedes SW for 15 miles and is ice-filled.

A glacier, about 3 miles wide, lies close W of Solberg Inlet and trends SW in a remarkable series of terraced ice falls to the continental plateau, which is 1,676m high at this point. On the W side of the plateau, similar ice falls descend sharply and extend SW to the NE part of Neny Fjord, on the Fallieres Coast. The S wall of the glacier is formed by a group of rounded ridges, inundated by highland ice, which gradually descends to the coast and forms a peninsula. This peninsula,

known as the Joerg Peninsula, is about 15 miles long, 3 to 5 miles wide, and projects E toward the Weddell Sea. It is mostly bare on the N side where the rocky faces are too steep for snow to lodge upon them. The N side is indented by a number of small coves at the head of which are many gaps. Small glaciers, widely crevassed, descend from the heights through these gaps. The peninsula is submerged by highland ice which rests as a thin cap on the heights. The seaward termination of the peninsula is formed by a large, rocky mass which attains an elevation of 1,067m. Pylon Point, the E slopes of which are completely glacerized, projects seaward and forms a low, rolling ice cape. The shelf ice at the E side of this point rises 61m above sea level and is heavily crevassed.

1.21 **Three Slice Nunatak** (68˚02'S., 64˚57'W.), mostly snow-covered, stands 4 miles NE of Pylon Point. This feature, which is about 2 miles long and 1 mile wide, is very distinctive and serves as an excellent landmark. A serrated ridge, with three prominent slices, forms it's long axis.

The shelf ice lying E of this nunatak is badly crevassed and at a distance of 5 miles, attains a height of only 18m above sea level.

Seligman Inlet is broad and extends 6 miles inland. Choyce Point and Cape Freeman form the N and S entrance points, respectively, of this inlet. At the S side of the entrance, three narrow glaciers break through the vertical rock wall in divergent directions. Cape Freeman is formed by a low, ice-covered spur with a prominent, dome-shaped nunatak standing at its E end. Choyce Point, 910m high, is ice-capped and rocky.

Blackface Point, located 3.3 miles NW of Cape Freeman, is a precipitous headland with exposed black rock at its extremity.

The S side of Seligman Inlet is bounded by steep, rocky cliffs, over 910m high. The Lewis Glacier and the Ahamann Glacier, separated by Cape Church, flow between the rock walls into this inlet.

Tonkin Island, 518m high, lies about 11 miles NE of Cape Freeman. This island is narrow and ice-capped. Its S end is formed by a bare rock in the shape of a pyramid, about 1 mile long. Close N of the pyramid, a snow-covered ridge, 411m high, extends N for about 2.5 miles.

Francis Island lies 12 miles ENE of Choyce Point and has an irregular shape. This island is 7 miles long, 5 miles wide, and rises to an elevation of 707m. It is mainly ice-covered, but has several rock exposures and rocky peaks. Like Tonkin Island, it is encompassed within the ice shelf.

Tent Nunatak, a conspicuous and pyramidal rock, stands 6 miles N of Choyce Point and marks the S limit of Whirlwind Inlet. It is 0.5 mile in diameter and emerges from the ice shelf, 1 mile from the S entrance of the inlet.

Whirlwind Inlet is wide and consists of two bays. A prominent series of narrow glaciers and broken ice falls, known as the Whirlwind Glaciers, descends from the N, W, and SW through its vertical rock walls to the ice shelf.

Cape Northrup forms the N end of the inlet and also marks the N limit of the Bowman Coast. This cape consists of a conspicuous rocky bluff, 1,160m high, which is mostly ice-free and has nearly vertical sides.

The **Foyn Coast** (66˚40'S., 64˚20'W.) trends 87 miles in a NE direction from Cape Northrup. It is marked by a continuous range of sharp snow-covered peaks with steep slopes and ridges.

Mamelon Island lies 11 miles ENE of Cape Northrup. It is mostly ice-covered, with a smooth and rounded summit.

Hodges Point, located 6 miles ENE of Cape Northrup, is rocky and terminates in an impressive black cliff. This point has twin summits, 940 and 960m high.

The Hess Glacier leads E to the ice shelf, 12 miles N of Cape Northrup. It is dominated on the S side by Mount Thorarinsson, a pyramidal peak, 860m high. This peak is one of the most distinctive features along the coast.

1.22 Mill Inlet, entered between Monnier Point and Cape Robinson, lies 13 miles N of the Hess Glacier. Karpf Point, located on the N side of this inlet, is formed by a turret-shaped bluff, 1,503m high, and is mainly ice-free. It marks the termination of the inland plateau escarpment. A small rock nunatak stands 1 mile SSE of this point.

Cape Chavanne, located at the head of the inlet, is a prominent and partly ice-free bluff. It's S extremity stands at the mouth of the Breitfuss Glacier and is formed by a conspicuous, elongated dome. The N side of the inlet is flanked by the Cole Peninsula, which is 15 miles long and 8 miles wide. This peninsula is ice-covered, except for several rocky spurs which radiate from Mount Hayes.

Mount Hayes, a plateau-type mountain, rises to a height of 1,140m and stands at the base of the peninsula. Cape Robinson, forming the seaward end of the peninsula, is a rounded and ice-covered promontory.

Between Cape Robinson and Cape Alexander, Cabinet Inlet, which is ice-filled and fed by glaciers, extends NW for about 36 miles. Spur Point, Balder Point, and Cape Casey are headlands projecting from the W side of the inlet.

Stanley Island, 520m high, lies 4 miles NE of Spur Point. Ice-free cliffs descend to the ice shelf from its summit which stands at the W end. The true Antarctic Circle crosses the S extremity of this island in 66˚33'S.

Cape Casey, located 9 miles N of the island, is formed by a prominent, partly ice-free promontory which rises 753m above the level of the ice shelf. An island, 792m high, lies about 3 miles NW of this cape.

Cape Alexander forms the S end of the Churchill Peninsula. This ice-covered peninsula extends about 30 miles in a SE direction.

1.23 The **Oscar II Coast** (65˚45'S., 62˚30'W.) extends 97 miles NE from Cape Alexander to Cape Fairweather and is indented by several inlets. The Jason Peninsula, a prominent projection, extends E from the coast.

The Hektoria Glacier, consisting of a series of long bays, forms the N portion of this coast. The bays are bordered by steep, rugged, and rocky peninsulas. The coast, to the S of the glacier, is formed by the steep slopes of several pyramid-shaped peaks and ridges which front the inland plateau. A few steep glaciers flow from the high interior between these peaks and ridges.

Adie Inlet extends SW for 25 miles at the S end of the Oscar II Coast. It leads between Astro Cliffs, located on the Churchill Peninsula, and Veier Head, located on the Jason Peninsula. Gulliver Nunatak, 575m high, stands on the N side of this inlet

and is long and narrow. It has rugged and mainly ice-free sides and rises steeply to a flattened, ice-free summit. Gemini Nunatak and Borchgrevink Nunatak stand 5 miles and 10 miles, respectively, NNE of Gulliver Nunatak.

Mount Fritsche (66˚00'S., 62˚42'W.), 987m high, stands NW of Borchgrevink Nunatak. This mountain is rugged, steep, and marks the N side of Richthofen Pass. The pass is 6 miles wide at its mouth and extends W for about 15 miles. It reduces the width of the peninsula, in the vicinity of Leroux Bay on the W coast, to about 25 miles. The pass is completely filled with glacier ice which flows E from the high plateau between the steep rock walls.

Philippe Rise stands E of this area and extends SE for about 10 miles. It consists of a low, snow-covered promontory, 7 miles wide, which rises to an elevation of 395m at the W end. Medea Dome, snow-covered and 350m high, stands at the E end of this promontory.

1.24 The Jason Peninsula extends 33 miles E from Philippe Rise and reaches to within 3 miles of the Weddell Sea. The E terminus of this peninsula is formed by Cape Framnes. The current in the vicinity of this cape has been reported to set NNE at a velocity of 1 knot.

Stratton Inlet, which is ice-filled, indents the S side of the peninsula, E of Veier Head. Standring Inlet, which is also ice-filled, indents the N side of the peninsula.

Chapman Point (65˚55'S., 61˚20'W.) and Tashtego Point, located 21 miles NW, form the entrance to Scar Inlet, which is 22 miles long and ice-filled.

Cape Disappointment forms the E end of the peninsula that separates Scar Inlet from Exasperation Inlet. This cape is fronted by snow-free cliffs and rises to an elevation of 225m.

Exasperation Inlet, which is ice-filled, is divided by Delusion Point and Caution Point into numerous bays which are fed by glaciers.

Foyn Point, located N of Exasperation Inlet, is surmounted by a peak, 525m high.

The Evans Glacier, lying N of Foyn Point, flows between Whiteside Hill and Shiver Point. It forms a bay, about 4 miles wide, which indents the coast and extends about 15 miles to join with the Hektoria Glacier. With Flanders Bay on the W side, the Evans Glacier reduces the width of the peninsula to about 12 miles at this locality.

Cape Fairweather, 705m high, is located at the N end of the Oscar II Coast and flanked by glaciers. This cape is ice-covered, except for several rocky exposures along its SE and E sides.

The **Nordenskjuold Coast** (64˚30'S., 60˚30'W.) is that portion of Graham Land lying between Cape Fairweather and Cape Longing, 61 miles NE. It consists of a high ice-covered tableland with steep slopes. This striking tableland is known as the Detroit Plateau.

A group of islands, lying S of the Nordenskjuold Coast, consists mainly of Robertson Island, Lindenberg Island, and the Seal Nunataks.

Robertson Island, the largest and E of the group, lies 32 miles ESE of Cape Fairweather and is about 10 miles long and 7 miles wide. It is dome-shaped and snow-covered with several high, pillar-shaped rock masses. The summit at the S end of the island is 396m high.

Christensen Nunatak, standing within the Seal Nunataks, rises to an elevation of 299m, about 1 mile N of Robertson Island.

Lindenberg Island, with a sugarloaf appearance, lies 11 miles N of Robertson Island. It is about 1 mile in diameter, 200m high, and dark. A number of low, snow-covered rocks extend up to about 1 mile NE of this island. The island is volcanic, although no evidence of volcanic activity has occurred since 1902.

1.25 The Seal Nunataks is a chain which consists of 14 main islets that extend 30 miles NW from Robertson Island.

Oceana Nunatak, about 1 mile long, lies close off the NW extremity of the island. It is formed by rugged and black lava mass. Castor Nunatak, 1 mile long, lies about 1 mile from the W side of the island and has a high summit on its SE side. Hertha Nunatak, a low and featureless rock, is about 1 mile long and lies 2 miles NW of Castor Nunatak. Arctowski Nunatak, 1 mile long, lies about 2 miles N of Hertha Nunatak and has a high summit at its E end. Gray Nunatak, 0.5 mile long, lies about 1 mile NW of Arctowski Nunatak and has a high summit at its E extremity. Donald Nunatak, lying close W of Gray Nunatak, is lower and has no distinctive features. Bruce Nunatak, lying 1 mile NW of Donald Nunatak, is formed by a dark and high-ridged rocky mass, 3 miles long.

Dallmann Nunatak and Bull Nunatak, both 0.5 mile long, lie 2 miles NW and 3 miles SW, respectively, of the W extremity of Bruce Nunatak. Unnamed rocks lie about 3.5 miles N and 1 mile S of Dallmann Nunatak. Pedersen Nunatak, the westernmost of the group, lies 8 miles NE of Cape Fairweather. All of these nunataks are snow-free and of volcanic origin.

From Cape Fairweather, the Nordenskjuold Coast leads NE for about 45 miles to Sobral Peninsula.

Sentinel Nunatak, standing 16 miles NNE of Cape Fairweather, is high, black, and pyramidal in shape. It marks the S side of the Dryglaski Glacier. This glacier is 18 miles long and flows SE from Herbert Plateau.

Tillberg Peak, 610m high, is ice-free and stands on a ridge that runs E from Foster Plateau toward Sentinel Nunatak. Ruth Ridge, black and rocky, runs in a N/S direction to the N of the Dryglaski Glacier. It is 1.5 miles long and terminates in a peak at its S end. This ridge forms the S end of the Detroit Plateau and marks the change in direction of the plateau escarpment along the E coast of Graham Land, turning W to form the N wall of the Dryglaski Glacier.

Cape Worsley is located E of Ruth Ridge and fronts the ice shelf. This cape is dome-shaped, 225m high, and has snow-free cliffs on its S and E sides.

The Sobral Peninsula trends NE for 20 miles and then extends S from the main coast for 11 miles, terminating at Cape Sobral. This cape is partly ice-free and appears from the air to be an island.

A deep fiord, walled by glaciers, indents the Sobral Peninsula and extends inland for 30 miles into the Antarctic Peninsula.

Larsen Inlet, 11 miles wide at its mouth, recedes for 14 miles and is filled with an ice shelf, broken and crevassed in many places. It is entered between Cape Sobral and Cape Longing, a rocky point. A deep fjord, leading E, indents the middle of this inlet.

Cape Longing forms the N end of the Nordenskjuold Coast and also the N limit of the Larsen Ice Shelf. A depth of 60m is reported to lie about 4.5 miles E of Cape Longing and is the shallowest depth charted along the Larsen Ice Shelf.

1.26 The **Trinity Peninsula** (63˚37'S., 58˚20'W.) is that portion of Graham Land lying N of a line between Cape Longing and **Cape Kater** (63˚46'S., 59˚54'W.).

Cape Dubouzet forms the NE extremity of the peninsula. Between this cape and Cape Roquemaurel, 50 miles SW, the land is comparatively low and covered with a continuous ice sheet, with occasional rock outcrops. Numerous rocky islets and submerged reefs lie offshore and extend up to 10 miles seaward. These waters have not been thoroughly surveyed and caution must be exercised when approaching the coast. The most prominent peaks in this vicinity are Mount Bransfield, 762m high; Mount Jacquinot, 474m high; and Mount D'Urville, 1,083m high.

Prince Gustav Channel (63˚50'S., 58˚15'W.) divides the mainland from the Ross Island group. It is about 80 miles long and varies in width from 9 miles, between Bald Head and Vega Island, to 14 miles, between Cape Longing and Nygren Point at the S entrance. Three uncharted islands of considerable size were reported to lie within this channel. The center of the channel can be navigated safely in deep water as far S as 64˚06'S, where passage is blocked by a permanent ice shelf. In January 1985, a vessel secured alongside this ice shelf. Vessels may pass on either side of Carlson Island in safety, but are advised to pass not less than 1 mile off Pitt Point due to the existence of uncharted shoals lying close inshore. It was reported that strong tidal currents, sometimes with rates in excess of 2 knots, set up and down the channel. The N flow was reported to be the most pronounced and in addition, strong eddies were observed in the vicinity of the W side of Carlson Island. Caution should also be taken in the vicinity of Cape Lachman as a drying spit extends about 180m N from the shore, a depth of 37m lies within 1 mile N of the cape and a bank, with a depth of less than 55m, extends 2 miles farther NE into the channel.

On the W side of the channel, Cape Longing forms the end of a large, pear-shaped peninsula. This peninsula is connected to the mainland by Longing Gap, a low valley, which is faced with snow-free cliffs, up to 180m high. On the E side of the peninsula, a small and rocky cliff rises to a summit, 340m high. The remainder of the E side as well as the N side are entirely covered by ice.

Tower Peak, standing 5 miles NW of Longing Gap, is 830m high and has a rocky exposure which stands out clearly from the evenly contoured ice field.

The Sjuogren Glacier, lying 19 mile NW of Cape Longing, is about 15 miles long. It flows SE from the Detroit Plateau and enters the channel in the form of a tongue. This glacial tongue is 5 to 7 miles wide and extends E to the vicinity of Persson Island. Mount Hornsby, a prominent and snow-capped mountain, backs the glacier.

Mount Wild, a sharply-defined rocky ridge with several peaks, has a summit, 926m high. A small nunatak stands on the glacial tongue, about 6 miles ENE of this ridge.

From Mount Wild, the coast leads N for about 13 miles to Mount Roberts. This peak is 955m high and has a dark, mostly ice-free summit with a flat, sloping top.

The Aitkenhead Glacier lies N of Mount Roberts and leads 10 miles E from the Detroit Plateau to Prince Gustav Channel, close N of Alectoria Island. This latter island is less than 1 mile long, 91m high, low, and nearly ice-free.

Mount Bradley has a pyramidal peak, 837m high. It stands N of the Aitkenhead Glacier, at the S end of a ridge which descends from the Detroit Plateau.

A least channel depth of 7.3m is reported to lie close W of Pitt Point.

Caution.—Extreme care must be taken when navigating in this area due to the incomplete nature of the surveys.

1.27 Pitt Point (63˚51'S., 58˚24'W.) consists of a promontory, 90m high, which is located 40 miles above the S entrance of the channel. The Victory Glacier, gently sloping, is 8 miles long and lies close N of the point. Azimuth Hill, standing 6 miles N of Pitt Point, is a low and rocky outcrop, 84m high.

Between Cape Longing and Azimuth Hill, the coast consists of an almost continuous line of ice cliffs backed by an escarpment of rock or ice that rises towards Detroit Plateau.

Russell East Glacier lies on the N side of Azimuth Hill. It is 6 miles long, 3 miles wide, and leads in an E direction. Mount Canicula is formed by two peaks, 825 and 890m high. It stands 3 miles E of Sirius Knoll, on the divide which separates the Russell East Glacier from theRussell West Glacier.

Long Island, 3 miles long, lies SE of Azimuth Hill. Its summit, 108m high, rises at the N end and is surmounted by a cairn. The Cugnot Ice Piedmont is 15 miles long and 3 to 6 miles wide. It leads NE from the Russell East Glacier to Eyric Bay and is bounded on the N side by theLouis Philippe Plateau.

1.28 The Louis Philippe Plateau, occupying the central part of the Trinity Peninsula, is 11 miles long, 5 miles wide, and rises to a height of 1,370m.

Church Point is located 11 miles NE of Azimuth Hill and S of Cugnot Ice Piedmont. It is surmounted by a dark, distinctive rocky peak, 340m high. Camp Hill, small and ice-free, stands 2 miles E of the point and is 120m high.

Red Island, lying 2.5 miles SSE of Church Point, is prominent, ice-free, and 1 mile in diameter. It is circular, flat-topped, and has reddish cliffs of volcanic rock which rise to an elevation of 496m. An isolated, rocky pillar, 494m high, stands NW of this island. It resembles a monument and is prominent from the NE and SW.

A depth of 66m is charted about 4 miles ESE of Red Island. A depth of 1.1m is reported to lie about 3.5 miles SE of Red Island. A depth of 16.8m was reported (1982) to lie about 1.8 miles SE of Red Island.

Crystal Hill fronts the coast 3.5 miles E of Camp Hill. It is ice-free, 150m high, and forms the summit of the headland lying between Camp Hill and Bald Head. McCalman Peak, standing 3 miles N of Criptal Hill, is 550m high and forms the summit of a ridge.

Bald Head is located 3.5 miles NE of Crystal Hill. This headland is bare, ice-free, and 152m high. Several islands lie off the coast between Crystal Hill and Bald Head, including

Egg Island, Tail Island, Eagle Island, Corry Island, and Vortex Island.

Egg Island, lying 1 mile SE of Crystal Hill, is 442m high. Tail Island, 171m high, lies 1 mile E of Egg Island. Both of these islands are shaped like mounds, surrounded by extensive scree slopes, and almost ice-free.

Eagle Island, the largest of the group, is square-shaped and about 4 miles in diameter. Its NE extremity rises to a flat-topped peak, with an ice-free summit, 560m high. The N side of the island is ice-free, except for a small glacier lying about midway. The S part of the island has an ice cap, 150 to 300m high. Scree cliffs and low rocks border the S side of this ice cap.

Corry Island, 2 miles long and 508m high, is separated from Eagle Island by a channel, 0.3 mile wide. It is rounded, ice-capped, and fringed by cliffs and steep scree slopes which are broken in places by ice falls. Vortex Island is the smallest of the group. It is 0.5 mile long and has a jagged, rocky peak, 244m high. A penguin colony is located on its NE side.

1.29 The E side of Prince Gustav Channel is formed by James Ross Island and Vega Island.

James Ross Island is 40 miles long and 1,629m high. This island, which is part of the James Ross Island group, is separated into two sections by a neck of land extending from the SW corner of Croft Bay to the NE corner of Rohss Bay. The SE portion of the island, which is the larger of the two parts, rises at the center in the form of Mount Haddington. The island rock underlying the ice cap is mainly volcanic and, where visible, appears as dark, wall-like cliffs. There is no dominating ice cap in the NW part, but mountainous masses, known as Massey Heights, rise to elevations of 360 to 940m. Although the defined entrance begins at Nygren Point, for our purposes the description will begin at Cape Foster.

Cape Foster is located at the S end of James Ross Island, 7 miles SE of Nygren Point. Trending NW for 2 miles from this cape, the coast is indented by Carlsson Bay. The Tait Glacier backs the head and a prominent, rocky headland projects from the N shore of the bay.

1.30 **Nygren Point** (64˚23'S., 58˚13'W.), located 3 miles WNW of Carlsson Bay, is rocky and marks the actual S entrance to Prince Gustav Bay. The coast trends 7 miles NNW from this point to Cape Broms. This stretch of the coast appears conspicuous because of the alternating ice falls flowing from the high interior and the bare, rocky cliffs.

A large bay, about 10 miles wide, lies between Cape Broms and Cape Obelisk and is known as Rohss Bay. The W coast of James Ross Island in this vicinity is broken by a series of semicircular valleys with almost perpendicular walls of red and black basalt. The inland ice cap slopes to the sea between projecting rock masses which present vertical faces.

About 7 miles NNW of Cape Broms, Persson Island, 1.5 miles long, rises to an elevation of 213m and marks the E end of Sjuogren Glacier Tongue. Some conspicuous and rocky cliffs, known as Tumbledown Cliffs, front the channel, 3 miles N of Cape Obelisk. Holluschickie Bay, lying 6 miles NNE of these cliffs, is entered between Kotick Point, on the S side, and Matkah Point, on the N.

Lagrelius Point, located 3 miles N of Matkah Point, is long and narrow. It is 48m high, flat-topped, and has vertical sides.

From Lagrelius Point, the coast extends NE for 13 miles to Cape Lachman, the N extremity of James Ross Island. It is indented by a series of bays with variegated, perpendicular cliffs.

Carlson Island, ice-free and less than 1 mile in diameter, lies about 1.5 miles N of Lagrelius Point. Cliffs and scree slopes lead steeply to its summit which is flat-topped and 299m high. The coast trends 4 miles NE from the island and recedes inland for 2 miles between Rink Point and Stoneley Point. Whisky Bay indents the coast, 4 miles NE of Stoneley Point.

Cape Lachman forms the N end of James Ross Island and the W entrance point of Herbert Sound. A small, square-shaped headland is located near the NE end of Prince Gustav Channel. It is 97m high and is separated from the mountains to the S by a low and flat-topped scree spur.

Prince Gustav Channel terminates in the vicinity of Vega Island, close E of the N end of James Ross Island. This channel has never been known to be ice-free. It is reported that three sections lying in this area have been found to be recently frozen over and apparently open during the summer. One section lies in the strait between a group of six islands, located N of Vega Island, and the mainland. Another section lies in the area to the NNW of Cape Lachman while the third section lies within Herbert Sound, between The Naze and Vega Island. The three sections lie where the channel is narrow and strong currents are likely.

Farther S, there is strong indication that the water has remained frozen for several summers.

The Antarctic Peninsula, to the NE of Prince Gustav Channel, is indented by Eyrie Bay and Duse Bay. Eagle Island, Tongue Rocks, a group of volcanic rocks, and Beak Island lie off the entrances to these bays.

1.31 Beak Island, lying 0.5 mile NE of Eagle Island, is arc-shaped and 4 miles long. This island is 359m high, rocky, and ice-free. Its SE part is separated from the W part by a ridge, 88m high, which rises to a bluff at the S extremity. It was reported that good anchorage, in a depth of 26m, can be taken within a bay on the N side of the island, about 0.2 mile offshore. A good landing was also reported to exist on a sloping beach of volcanic sand.

Eyrie Bay, lying 6 miles W of Beak Island, is entered close N of Jade Point. This bay is 2.5 miles wide at its mouth and recedes for 3 miles. Jade Point is rocky and slopes gently with its lower part covered in greenish-tinged ice.

Cain Nunatak and Abel Nunatak are located W of Eyrie Bay, at the S end of Broad Valley. This valley is glacier-filled and lies on the S side of the Laclavegre Plateau (Laclavere Plateau).

View Point, located E of Eyrie Bay, forms the W entrance point of Duse Bay and rises to an elevation of 150m. The shore in the vicinity of this point consists of steep, dark-colored mountain slopes.

Duse Bay, 7 miles wide, lies between the W side of the Tabarin Peninsula and View Point. This bay recedes about 3.5 miles N and is nearly rectangular in shape. Two islands lie within the bay, close to the S shore, and three other islands of ice-free appearance lie close to the seaward end of the S

entrance point. Theodolite Hill, 680m high, stands 5 miles W of the NW corner of the bay has a small, rocky outcrop on its summit.

The **Tabarin Peninsula** (63˚32'S., 57˚00'W.) is 5 to 12 miles wide and 12 miles long, between Duse Bay and Hope Bay. Along the W side of this peninsula, a series of rock buttresses, known as Seven Buttresses, front the coast and extend for 4 miles. These buttresses are 150m high and separated by narrow ice falls. Buttress Hill, standing 2 miles E of the northernmost buttress in the series, is 690m high, flat-topped, and has steep, rock cliffs on its W side.

Cape Burd, located 2 miles S of Seven Buttresses, is a low, rocky cliff forming the SW extremity of the Tabarin Peninsula.

From Cape Burd, the coast leads E for 4.5 miles to a bay which indents the coast and extends inland for 2 miles. Depths of 23.8 and 12.1m are reported (1980) to lie about 1.5 miles S and 1 mile S, respectively, of the entrance to this bay.

Cape Green, the SE extremity of the Tabarin Peninsula, is located 2.5 miles ESE of the bay. A depth of 40m was reported (1980) to lie about 3.3 miles S of this cape.

1.32 Herbert Sound (63˚53'S., 57˚40'W.), 16 miles long, leads S from Prince Gustav Channel, between James Ross Island and Vega Island, to Cape Lamb. The sound then leads E to its SE entrance, where it joins Erebus and Terror Gulf. In 1982, this sound was navigated for the first time. Passage was made in both directions with little ice being encountered. Depths of 150 to 400m were reported to lie in the center of the channel.

The N entrance lies between Cape Lachman and Keltie Head, which is rounded and has vertical cliffs rising to a small ice dome, 190m high.

Lachman Crags (Lachmans Crags), an escarpment, extends in a N/S direction and rises to an elevation of 620m. It stands on the W side of the sound, 3 miles SSW of Cape Lachman.

Croft Bay indents the coast, 8 miles S of Lachman Crags, on the SW side of the sound. Dreadnought Point forms the W entrance point of this bay and Stark Point forms the E entrance point. Dobson Dome, standing W of the bay, is a prominent mountain. It is snow-covered, dome-shaped, and 948m high.

From Croft Bay, the sound leads NE to the area lying N of The Naze. The sound narrows to a width of 2 miles in this area and is obstructed by numerous rocks and islets.

Between Cape Lachman and Cape Obelisk, 28 miles SSW, the coast is indented by a number of bays. These bays are separated by headlands which are fringed by rocky cliffs with extensive scree slopes. Brandy Bay lies 6 miles SW of Cape Lachman and provides safe anchorage with a good holding ground of thick, gray mud. It offers easy access to the hinterland and good protection, especially from N gales. Although ice collects in this bay, it rarely becomes packed during the summer months. It is reported that an orange hut stands on the SW side of the entrance to the bay and is clearly visible, except when covered with snow. Landing can be carried out by shallow inflatable craft.

The Naze, a peninsula, extends N from Terrapin Hill and forms the SE end of Herbert Sound. Terrapin Hill, 546m high, is rounded and reddish in color. Comb Ridge, forming the NE end of The Naze, rises to an elevation of 105m.

The E side of Herbert Sound is bordered by Vega Island. The strait leads S and then E for about 15 miles to where False Island Point forms the S extremity of a peninsula extending into the sound.

1.33 False Island Point is connected to the main part of Vega Island by a narrow, low, and gravel spit. From a distance, this point appears to be separated from the main island.

A line between Comb Ridge and False Island Point indicates the SE end of the sound and the entrance to Erebus and Terror Gulf. Humps Island (Humps Islet) lies 4 miles SSE of Combs Ridge. It is 0.5 mile long and has two summits rising near its W end, the tallest being 186m high.

Vega Island, the N of the Ross Island group, is about 16 miles long and 5 miles wide. It is high, precipitous, and has tower-like rocks. The lower falls of eruptive rock are plateau-like in form and brown in color.

Sandwich Bluff, located close W of the center of Vega Island, is a flat-topped mountain, 644m high, which is broken sharply at its W side by a steep, dark bluff. From the N, this bluff appears as a sandwich because of a horizontal snow-holding band of rocks on the cliffs.

Cape Well-Met, a dark and conspicuous headland, projects from the N coast, near the middle of the island. Devil Island, 207m high, lies close to the N shore in the vicinity of this cape. It has steep, stone sides and is ice-free.

Cape Gordon is located 6.5 miles SE of Devil Island. A rock, 1m high, lies about 6.5 miles E of this cape and is surrounded by a shoal area which may best be seen on the chart.

A rock lies about 0.5 mile offshore, 5 miles SW of Cape Gordon. Another rock lies 1.5 miles E of the cape, 4 miles NE of False Island Point.

The SE side of James Ross Island fronts Erebus and Terror Gulf and is marked by numerous glaciers. Trending S and SE from The Naze, the coast is fronted by steep cliffs which rise to a mostly ice-covered plateau.

1.34 Skep Point (64˚03'S., 57˚18'W.), high and ice-free, resem-bles a beehive from offshore. A shallow rock lies 2 miles ESE of this point.

Ula Point, ice-covered and low, lies 4.5 miles SE of Skep Point. Lonely Rock, lying 2.8 mile ESE of Ula Point, is 46m long, isolated, and prominent.

The area leading between the SE end of Herbert Sound and Erebus and Terror Gulf is not fully surveyed.

A depth of 15.8m was reported (1980) to lie about 1.3 miles E of Humps Island. Depths of 7.6m and 14m were reported to lie within 2.3 miles of each other, about 12 miles SE of Humps Island. It was reported (1982) that anchorage could be taken, in a depth of 15.8m, to the S of Comb Ridge. However, shallow depths were reported to lie about 2 miles SW of this anchorage area.

An unexamined depth of 32.9m is believed to exist about 23.5 miles ESE of Humps Island.

Between Ula Point and Cape Gage, 5 miles SSE, the Coley Glacier flows inland and extends 5 miles E to the gulf.

Cape Gage, located S of the glacier, is a rocky promontory which forms the E extremity of James Ross Island. This cape also forms the W side of the N entrance to Admiralty Sound.

1.35 Admiralty Sound (64˚20'S., 57˚10'W.) extends in a NE/SW direction and separates Seymour Island and Snow Hill Island from James Ross Island. It has a width of about 1 mile at the narrows. The W entrance to the sound is divided by Lockyer Island into two forks, each with a width of about 2 miles. The sound has not been surveyed, although a depth of 129m was reported to lie in its center, off Hamilton Point. No vessel has navigated the sound, which is sometimes ice-locked during the entire year. It is reported that strong tidal currents set through the sound.

The description of the sound is from N to S. It covers the W side as far as Cape Foster, located beyond the limits of the sound, and then proceeds to the islands.

The coast to the SW of Cape Gage trends for 5 miles to Ekelof Point, which is high, rocky, and forms the N entrance point of Markham Bay.

Between Ekelof Point and Hamilton Point, the S entrance point, three glaciers flow into the bay. The N glacier is about 1 mile wide and enters the bay between steep, rocky headlands. The central glacier, known as the Gourdon Glacier, is similar in size and form to the N glacier. It enters the bay between Saint Rita Point, a steep and rocky outcrop, on the N side and Rabot Point, high and rocky, on the S side. The Hobbs Glacier, the S glacier, is about 2 miles wide and has a lateral moraine on its higher slopes.

Hamilton Point consists of a headland, 5 miles long, the S end of which forms the N limit of the narrows of Admiralty Sound. A narrow, perpendicular ridge of rock, which is shaped like a tower, stands prominently on the high cliffs of Hamilton Point.

The coast between Hamilton Point and Cape Foster, 13 miles WSW, is occupied by the Swift Glacier, which terminates at the sea edge in steep ice cliffs. The Watchtower, a prominent and rocky feature, stands 4 miles W of the S end of Hamilton Point. It consists of a rocky mass which is steep-sided, flat-topped, isolated, and 396m high.

The coast then trends SW to Cape Foster and is fronted by three headlands. Jefford Point, the most prominent headland, consists of a rock cliff surmounted by ice.

Lockyer Island, lying at the SW end of Admiralty Sound, is 2.5 miles long and rises to an elevation of 460m. From the N, this island appears as a precipitous wall of dark tuffs capped by an ice dome, from which several small glaciers descend to the sea in sheer, vertical cliffs.

1.36 Snow Hill Island is located E of Lockyer Island and lies SE of James Ross Island, from which it is separated by Admiralty Sound. It is about 20 miles long and about 6 miles wide. The island is entirely snow-capped, except at the NE extremity which, for a distance of 3.5 miles, consists of a rugged projection with steep lofty cliffs of olivine-basalt. A low shore fronts the NW side of this snow-free projection. Anchorage may be taken about 90m off this low shore, in a depth of 11m, with a rocky bottom and good holding ground. The E side of the projection is perpendicular and offers no landing place.

The ice cap is extensive, hilly with deep depressions, and attains a maximum elevation of 300m. The inland ice terminates toward the sea in a vertical wall, which, on the E side, is from 1 to 6m high. On the E side, where the ice cap meets the bare and rocky walls of the N projection, a deep ravine exists and a running stream is found here in the summer months. The ice cliff, for a distance of 0.5 mile to the S of the ravine, is only 0.9m high and rests on the beach at LW. The ice cliff increases in height to 6m several miles to the S, but appears to be floating. Depths reported along the ice edge vary from 7 to 54m. The range of tide observed here was reported (1935) to be 1.5m. Vessels may moor to the low ice face, but calving may be a problem.

Anchorage may be taken about 0.5 mile from the E part of the ice cliff, at a point lying about 5 miles from the NE extremity of the island where the ice cap is about 3m above sea level. This anchorage is reported to have a depth of 13.7m, with a mud bottom. Anchorage can also be taken, in depth of 29m, gravel and rock, about 1 mile from the ice cliff.

The bottom is reported to be irregular to the S and E of Snow Hill Island, which indicates volcanic structure.

The interior ice dome lying opposite the NE extremity of the island rises to a large, wide shoulder which is about 150m above the sea level.

A beacon stands on the NE extremity of Snow Hill Island. It consists of a triangular framework tower, 5.2m high, with three horizontal panels painted yellow and orange.

The mean temperature at Snow Hill Island, during a period of 20 months, was reported to be -11.7˚C. The prevailing winds were SW and these were also the strongest and coldest. Winds from the SW prevail 38 per cent of the year and, during some months, 50 per cent of the time, with an average velocity of 32 mph. Winds from this quarter blowing during the winter months had an average velocity of 20 mph. The stronger the winds from this direction, the lower the temperature. The mean temperature when SW winds were blowing was reported to be more than 2˚ below normal.

Winds from the N and NNW are strong and, once started, are usually of long duration. These are foehn winds which bring warm weather, but they are not common. Winds from the NE are comparatively strong and cold. Calm periods usually raise the temperature above the normal, but bring a wide daily variation in temperature.

During the summer months, the temperature does not drop below -17.8˚C. The absolute minimum temperature of -41.7˚C was recorded in the month of August and the absolute maximum temperature of 9.4˚C was also recorded during August. Such irregularities are characteristic of this region due to the existence of the semipermanent low-pressure area in the Weddell Sea and to the unstable equilibrium of the high-pressure area over the plateau of the Antarctic Peninsula.

1.37 Picnic Passage, a strait, is about 0.5 mile wide and 1.5 miles long. It separates Snow Hill Island from Seymour Island to the NE. Strong currents and tide rips exist in this channel which shoals to depths of less than 2m in the center LW. The bottom deepens steeply on the NW side of the channel. Seymour Island is 8 miles long and 4 miles wide. It is entirely snow-free and has a remarkable appearance. The N portion of the island consists of a level, extensive plateau which reaches an elevation of 180m. Below this smooth plateau, terraces occur which contain valleys and small irregular knolls of hard rock. Cross Valley, which cuts through the island from E to W, has a bottom which is not much above sea level. This valley

opens at Penguin Point, on the E shore, and into Bertodano Bay lying close E of Bodman Point, on the W shore. A strip of deeply dissected land extends between Penguin Point and the NE extremity of the island. The SW portion of the island presents an appearance that is in marked contrast to the smooth surfaces of the N portion. The S half of the island has a peculiar ribbed appearance, being low and deeply dissected, with many low hills. Low, perpendicular, and rocky cliffs border the shore, but there are many landing places where the gorges slope gradually to the sea.

Penguin Point, located on the E side of Seymour Island, is the site of the Vice Comodoro Marambio base, an Argentinean station. Anchorage may be taken, in a depth of 22m, about 1 mile ENE of this point.

Several beacons are reported to stand 3 miles NNE of Penguin Point and at the NE end of the island.

Cape Wiman, low and rocky, forms the N extremity of the island. Bodman Point, a projection, is located on the W side of the island, 5 miles SW of this cape.

1.38 Cockburn Island, lying at the NE end of Admiralty Sound, is circular, 1 mile in diameter, and consists of a high plateau. This plateau has steep slopes and is surmounted on its NW side by a peak which is 451m high and pyramidal-shaped. The island is almost entirely ice-free. A bold ridge of rock, which resembles a tower, stands on the NE edge of the plateau. It is conspicuous and appears prominently in the profile of the island. A beach fronts the N extremity of the island. Colonies of penguins and cormorants are reported to inhabit the slopes of the island.

It was reported (1963) that anchorage in this area is not recommended because sustained offshore winds can blow the drift ice into the area and force the ship upon the lee shore. However, anchorage was taken (1963) on the W side of Seymour Island. A vessel obtained anchorage, in a depth of 54m, thick mud and gravel, about 4 miles SW of Bodman Point. It was reported (1963) that anchorage can also be taken, in a depth of 16m, thick mud and gravel, about 4 miles SSW of Bodman Point. These anchorages lying off the W side of the island were reported to appear well-protected from all directions except the N.

It was also reported (1963) that anchorage had been taken, in a depth of 10m, about 4 miles S of Cape Wiman. However, a tidal current, with an estimated rate of 2 knots, was reported to set NE/SW along the SE coast of the island.

According to a preliminary survey, shoals were reported to lie off Cape Wiman. It was also reported that the area between Cockburn Island and Bodman Point appeared to be extensively shoaled.

It is reported that access to the N coast of Seymour Island is doubtful without the use of an icebreaker. Ice conditions around the island are changeable and dependent on wind direction. There is considerable ice movement along the S coast of the island.

Currents generally set ESE and WSW in the vicinity of the island with velocities of up to 1 knot. However, currents of 3 to 4 knots have been observed near the SW extremity of Seymour Island where Picnic Passage separates the island from Snow Hill Island.

Directions.—It was reported that passage to Bertodano Bay, on the NW side of Seymour Island, was attempted by rounding Cape Wiman. The cape was passed 3 miles to the N and then an attempt was made to steer SW. Depths shoaled to less than 20m on this course that lead between Cockburn Island and Seymour Island. At this point, the vessel turned back on a NE course until the 180m curve was reached. A W course was then steered, passing Cockburn Island 4 miles to the N. With the left tangent of this island bearing 126˚ and the right tangent of Cape Gordon, on Vega Island, bearing 349˚, the vessels changed course to 177˚. A passage, with considerable depths, was then found by steering S, midway between James Ross Island and Cockburn Island. The bottom shoaled gradually from depths of over 365m lying between Cape Gage, on James Ross Island, and Cockburn Island to 15.8m at the anchorage area located 4 miles SSW of Bodman Point.

1.39 Erebus and Terror Gulf (63˚55'S., 56˚40'W.) lies on the SE side of the extremity of the Antarctic Peninsula. It is bordered on the NE side by Joinville Island and on the SW side by the James Ross Island Group. This gulf is noted for heavy ice conditions and variable currents. Many icebergs have been observed streaming into the gulf. A SW current, setting at 4 knots, has been observed at times in the gulf. In the vicinity of the Danger Islands, strong currents and whirlpools have been reported, which render steering difficult and dangerous. The gulf has not been thoroughly surveyed, but depths of 183 to 366m were reported to lie between the NW extremity of Joinville Island and the latitude of 65˚S.

An unexamined patch, with a depth of 32.9m, was reported to lie about 11.5 miles N of Ula Point in position 64˚01'S, 56˚30'W. In the N section of the gulf, a depth of 40.2m was reported (1982) to lie in position 63˚42'S, 55˚48'W.

1.40 Antarctic Sound (63˚20'S., 56˚45'W.), about 30 miles long and 7 to 12 miles wide, separates the NE end of the Antarctic Peninsula from the Joinville Island group. At the SE end of this sound, the passage narrows and is obstructed by Rosamel Island, Andersson Island, and Jonassen Island. There is a depth of 45.7m in the NW entrance to the sound and depths of over 549m in its central part. A depth of 36.6m lies in the SE entrance to the sound.

The sound is usually blocked by ice. On the few occasions when the sound has been reported to be ice-free, it was observed that heavy drift ice streamed through the narrow passage with the impetus of winds and current.

A vessel reported (1985) that the entire Antarctic Sound, to the N of Rosamel Island, was essentially ice-free and navigable during operations between 27 February and 12 March. However, there were some icebergs and drift ice during that period.

An Argentinean pilot reported that the Antarctic Sound is free of ice when there is a N wind and the N part of the passage is navigable. The S part of the sound is usually not navigable in winter because of ice accumulation.

In the winter of 1969-1970, an Argentinean Army Officer, stationed at a base in Hope Bay, reported that the sound was navigable on a year-round basis, with the N part of the passage being ice-free almost continuously and the S entrance being ice-free in N winds.

The N approach to the sound should be made from the NE, passing 9 miles off D'Urville Island in order to avoid the rocky shoal areas lying NW and W of it.

Zelee Rocks (62˚57'S., 57˚15'W.), lying about 17 miles NW of D'Urville Island, should be approached from the N with care. This group of rocks, both visible and submerged, should be given a berth of at least 1.5 miles.

1.41 Fridtjof Sound, lying at the SW side of the entrance to the Antarctic Sound, separates the Tabarin Peninsula from Andersson Island and Jonassen Island. It leads N for 6 miles, is 2 miles wide, and has a least charted depth of 51.2m lying near the N end. A small islet or nunatak lies on the W side of the sound, 5.5 miles NNE of Cape Green, and caution is advised when navigating in this area.

It was reported (1935) that when the S part of the Antarctic Sound is blocked by heavy ice, safe passage can be found within Fridtjof Sound for vessels with drafts up to 4.2m.

Gamma Hill, standing 5 miles N of Cape Green, rises to an elevation of 300m. Andersson Island lies on the E side of the sound and has a summit, 1,829m high.

Jonasson Island, separated from Andersson Island by Yalour Sound, is 2.5 miles in diameter and circular. Chaucheprat Point, the NW extremity of the island, is populated by a penguin colony at the foot of a scree slope. A cirque is located on the N side of the island which has the appearance of a large quarry.

Andersson Island and Jonasson Island are plateau-shaped, with ice caps falling in gentle slopes to the sea and ending as ice cliffs. Overfalls lie close off the NW extremity of Andersson Island.

Cape Scrymgeour, the E extremity of Andersson Island, is formed by a prominent promontory. It consists of an irregular mass of volcanic tuff rising perpendicularly out of the sea. This mass forms a lofty precipice and extends inland to the high plateau of the island.

Shoals were reported (1963) to lie N of the base of Cape Scrymgeour and close above the parallel of 63˚30'S.

Yalour Sound, leading between Andersson Island and Jonassen Island, is 1 mile wide and 4 miles long. Two small rocks lie within this strait and a depth of 7m is reported to lie in the NE entrance.

Rosamel Island, 416m high, lies 3.5 miles E of Cape Scrymgeour. This island rises in precipitous cliffs of volcanic rock to a summit that is flat and mainly ice-free.

From Fridtjof Sound, the coast of the NE end of the Antarctic Peninsula along the W side of the Antarctic Sound trends 3.5 miles NW to a bay. This bay recedes 0.8 mile and has a least depth of 29.3m in its entrance. Brown Bluff, 745m high, stands 1 mile SW of the head of the bay. This mountain is ice-capped, flat-topped, and has a prominent cliff, formed of reddish-brown volcanic rock, on its N face.

Trepassey Bay (63˚28'S., 56˚58'W.), less than 1 mile wide, lies 4 miles N of Brown Bluff; several mountains stand between them. Stone Point is located 3.5 miles N of this bay and marks the SE entrance to Hope Bay.

1.42 Hope Bay is entered between Stone Point and Sheppard Point, 1.7 miles NW, and extends 2.5 miles SW. A shelf extends 0.2 mile S from the NE part of the bay; its bottom slopes abruptly to depths of over 180m. Depths in the entrance gradually decrease to 24m, about 0.3 mile offshore. Numerous rocky and shoal areas lie close inshore.

Within the bay, depths of 110 to over 180m lie in the middle and depths of 18.2 to 40m lie in the SW part. The W part of the bay has only been partially surveyed and caution is advised in this area. A depth of 4.5m is reported to lie about 180m S of Sheppard Point.

The bay was reported (1963) to be open to shipping on an annual basis. It is estimated that a period of accessibility, from early December to late April, exists under ordinary conditions for ships which are not ice-strengthened.

Along the S side of Hope Bay, foul ground and shoals extend up to 0.3 mile offshore and ice cliffs, 150 to 300m high, back the coast.

Grunden Rock lies 160m offshore, 0.8 mile W of Stone Point. It is 12.5m high and about 90m long. Several other rocks, uncovered and awash, extend up to 0.2 mile N of Grunden Rock.

Grunden Rock Light (63˚24'S., 56˚58'W.) is shown from a metal framework tower and marks the NW part of the island. This light is reported to be unreliable.

An anchorage area, with a depth of 40m, lies 0.3 mile NW of Grunden Rock, off the entrance to Hut Cove. A lighted range, bearing 214˚, indicates the approach from seaward to the roadstead. Anchorage areas, with depths of 24 and 110m, are also reported to lie 0.2 mile NW and 0.2 mile W, respectively, of the above anchorage roadstead. Although vessels are protected from SW and WSW winds by anchoring close inshore, it is recommended that large vessels anchor outside the 90m curve.

Caution.—In early spring or late summer, care should be taken because the approaches to the anchorage areas may be blocked by bergy bits. This condition is also likely in areas where depths are less than 90m.

A rock, awash, is reported to lie close E of the W anchorage area as seen on chart..

1.43 **Hut Cove** (63˚24'S., 56˚59'W.), lying 1 mile W of Stone Point, is entered between Grunden Rock and Seal Point. Seal Point is located at the seaward end of a peninsula, which forms the W side of the cove, and is fronted by rocks. A landing place is located close SE of this point.

The depths within the cove decrease to 1.8m close to the shore. The cove has not been completely surveyed and appears to be generally foul. Jagged Rocks, a group of rocks, extends for about 200m in a NE/SW direction and lies centered about 180m off the W shore of the cove, 0.3 mile SE of Seal Point. Several rocks, awash, front the NE end of this group.

Esperanza, an Argentinean base, is situated on the peninsula, close S of Seal Point. It consists of a barracks and several huts, and is fronted by a small pier. A tower, situated near an observation spot, stands in the vicinity of the S end of the peninsula.

Eagle Cove (63˚24'S., 57˚00'W.), entered on the W side of Seal Point, has a least depth of 6.4m lying in its E side. Rocky cliffs line the coast in this vicinity and a former British base was situated at the top of the rocky area near the piedmont.

At the head of Hope Bay, the Depot Glacier, a large valley-glacier with a lateral moraine, terminates at the water's edge in

a high, vertical cliff. This glacier is fed by the highland ice sheet which extends for a considerable distance to the S.

1.44 Mount Flora, standing 0.7 mile SW of the head of Hope Bay, is 520m high and has a well-defined cirque facing NE.

Whitten Peak, standing 0.5 mile W of the head of Hope Bay, is 445m high and pyramidal shaped.

Mount Taylor, 998m high, and Twin Peaks, 752m high, stand W of Hope Bay and are both prominent.

On the W side, the Arena Glacier flows NE from Mount Taylor and enters the bay 2 miles SW of Sheppard Point.

Sheppard Point, the NW entrance point of the bay, is surmounted by Sheppard Nunatak, which is conical and 59m high. Anderson Nunatak, 183m high, stands 1 mile W of this point and rises above the coastal ice cliffs of the N shore.

The piedmont area in this vicinity is subject to sudden high winds. It was reported that down-slope winds from the SW have been recorded with velocities of up to 150 knots.

At Hope Bay, the MHWS is 2.7m and the MLW is -0.5m. It was reported (1963) that the tidal range is 3.7m. During a 23-hour period, the currents were observed to be weak and variable.

Cape Dubouzet, located 7 miles N of Hope Bay, forms the NE extremity of the Antarctic Peninsula. It also forms the NW entrance point of Antarctic Sound.

Mount Bransfield is a prominent, ice-covered cone from which two rocky spurs lead NE and ENE to the coast. A group of moraines lies between the two spurs and at the foot of a glacier which descends directly from the cone.

Koerner Rock, lying 3.5 miles SSW of Cape Dubouzet, is a small but conspicuous outcrop.

1.45 The Joinville Island group lies at the E extremity of Antarctic Sound. The largest islands are Dundee Island, Joinville Island, Bransfield Island, and D'Urville Island.

Dundee Island (63˚30'S., 55˚55'W.) is ice-covered and lies at the S end of the group. It is roughly circular, 14 miles long, and has a maximum width of 11 miles. The NE part of this island is low and smooth while a mountain of volcanic rock, covered by an ice cap, rises to an elevation of 590m in the S part. Cape Purvis forms the S extremity of the island and consists of a high bluff. Welchness, located at the W extremity of the island, consists of a low, gravel spit which projects 1 mile W from a line of morainic, ice-free hillocks. A light is reported to be shown from a structure, 9m high, standing in the vicinity of this spit.

A shoal patch, with a depth of 1.8m, was reported (1975) to lie about 3 miles SW of Welchness.

At the NW end of the island, a low and flat rocky beach fronts the ice face. The face is 12m high and forms the terminus of the ice cap which descends in a gentle slope from the higher interior. Several patches of exposed rock, brownish-green in color, can be observed where the snow mantle is thin.

Ski Beacon, 5.5m high, stands 1.3 miles NE of Welchness. This beacon was reported (1982) to be destroyed.

A radiobeacon is reported to be situated 1.5 miles E of Welchness, in the vicinity of Petrel, an Argentinean base, which consists of several huts. Petrel Cove lies close NE of the base. Anchorage can be taken, in a depth of 62m, about 0.7 mile NNW of the base. In the approach to this anchorage, the depths shoal rapidly from about 550 to 90m and then gradually level off. The maximum tidal range is 2.4m. It was reported (1963) that during a 27-hour period, a current in the anchorage area set SSW with an average velocity of 0.3 knot and a maximum velocity of 0.5 knot. Care should be taken as this anchorage affords little protection against NE gales due to the low elevations of Dundee Island and Joinville Island. The estimated access to this area is from the middle of December until the end of March.

The N side of the island, fronting Active Sound, consists mainly of ice cliffs but in some places there are beaches and exposed rock. From the W extremity of the island, a continuous ice cliff fronts the coast. Two rocks, known as Eden Rocks, lie off the E extremity of the island. Puget Rock, fronted by submerged rocks, lies close E of Eden Rocks, 2 miles E of the island.

1.46 **Paulet Island** (63˚35'S., 55˚47'W.), lying 3 miles SE of Dundee Island, is circular and 1 mile in diameter. This island is ice-free, with steep rocky and scree slopes rising to its summit, which is 353m high. It is composed of volcanic rock and has the appearance of a crater. A cone, fronted by a gravel beach, stands on the NE side of the island. It is backed by a lake which is nearly at sea-level and fills a cirque cutting into the island. A large penguin colony and a small cormorant colony are situated near this lake. A beacon, 2m high, stands on the island at an elevation of 100m.

Currents, with rates of 2 to 3 knots, have been recorded to the W of Paulet Island and S of Dundee Island.

Active Sound leads ENE from the Antarctic Sound and joins the Firth of Tay, which separates Joinville Island and Dundee Island. This sound has an average width of 2 miles and its shores are fronted by ice cliffs. A reef extends about halfway across the sound from the NW extremity of Dundee Island. A rock lies in the center of the sound at the E end where it joins Gibson Bay and the Firth of Tay. This sound was reported to be ice-locked.

The Firth of Tay, 12 miles long and 6 miles wide, leads in a NW/SE direction from the NE end of Active Sound. Active Reef extends for about 1 mile into the firth from the NE side of Dundee Island. A depth of 36m lies close N of Active Reef in position 63˚22'S, 55˚49'W.

1.47 **Joinville Island** (63˚15'S., 55˚45'W.) is the largest of the group, being 40 miles long and 12 miles wide. This island is completely ice-capped and rises to Mount Tholus, the summit, which is 1112m high. Smooth glacial slopes extend from Mount Tholus and are broken by a series of undulating hills. Mount Percy, 765m high, stands 6.5 miles E of Mount Tholus. The S coast of the island leads along Active Sound and the Firth of Tay.

D'Urville Monument (63˚25'S., 56˚18'W.), standing at the SW end of the island, rises abruptly and is 573m high. Suspiros Bay indents the coast of the island, 9.5 miles NW of the monument, and a rock, awash, lies within it. Nodule Nunatak stands inland from the bay and is prominent, isolated, and 440m high.

Gibson Bay, lying at the junction of Active Sound and Firth of Tay, indents the S side of Joinville Island and recedes for 1.5

miles. The interior slopes above this bay are irregular and crevassed. The shore of the bay is formed by ice cliffs, up to 18m high. Near the head of the bay, an island is reported to lie about 1 mile offshore.

The peninsula located to the E of Gibson Bay is surmounted by Mount Alexander, which consists of several summits and rises to an elevation of 595m. Haddon Bay, lying E of this peninsula, extends 2.5 miles N but has not been surveyed.

Tay Head (63˚21'S., 55˚34'W.) is located 6 miles E of Mount Alexander, at the end of a narrow peninsula, and is fronted by several small islets and rocks. Moody Point is located 13 miles E of Tay Head. The coast between is fringed by numerous rocks and small islands. Two rocks, known as Williwaw Rocks, lie about 1 mile SE of Moody Point. Scud Rock and Brash Island, both isolated, lie 4 miles S and 6 miles SE, respectively, of Moody Point. Brash ice is reported to be frequently found in the vicinity of Brash Island.

The **Danger Islands** (63˚26'S., 54˚41'W.) is a chain, consisting of seven islands, which trends in a NE/SW direction within 15 miles ESE of Moody Point.

Darwin Island (63˚26'S., 54˚46'W.), the largest in the chain, is 1 mile long and 172m high. Dixey Rock, the smallest island of the chain, is an isolated stack, 35m high. Other islands in the chain include Brash Island, Earle Island, and Beagle Island. A beacon, 2m high, is reported to stand on Heroina Island, the NE island of the chain. The area in the vicinity of these islands is difficult to access due to the large number of tabular icebergs found aground in the shallow waters.

The coast extending for 5 miles SW of Moody Point is formed by a single glacier which descends from the interior heights to a cliffed face, 30m high, at the water's edge.

Fitzroy Point is located 10 miles N of Moody Point. Depths of 29 to 102m lie within 1.8 miles of this stretch of the coast. Foul ground, with several rocks and islets, fronts Fitzroy Point and extends up to 2.5 miles SE and 1 mile offshore.

Fitzroy Point, which forms the NE extremity of Joinville Island, is low. Fliess Bay, lying close W of the point, and Ambush Bay, lying 5 miles further W, have not been surveyed. A dangerous rock is reported to lie 0.3 mile offshore between these two bays.

1.48 Etna Island, lying 5 miles NNW of Fitzroy Point, is 0.3 mile long and 0.3 mile wide. This island is 49m high and can be identified by its summit, which is cone-shaped and resembles a volcano. The N end of the island descends to the sea in a long slope while the S end abruptly drops from the summit to a low plateau. A horizontal band of stones, which is ice-free and appears black from a distance, aids in distinguishing this island. Several reefs, above-water, have been reported to extend up to 0.5 mile N and W from the island and it should be given a berth of at least 1 mile.

King Point forms the NW entrance point of Ambush Bay. Patella Island lies 2 miles NW of this point and is small, about 75m high, and prominent. A submerged rock is reported to lie about 0.5 mile SSE of the island.

Several islets and rocks lie off the coast between King Point and Rockpepper Bay and extend up to 1.5 miles offshore. Rockpepper Bay is entered close E of Boreal Point and recedes to the S. The E side of the bay is fronted by numerous small islets and rocks.

Papua Island, circular and about 0.3 mile in diameter, lies 3 miles WNW of Boreal Point. A large number of penguins have been sighted on this island.

The NW shore of Joinville Island fronts Larsen Channel.

Saxum Nunatak (63˚10'S., 56˚02'W.) is 457m high and isolated. When viewed from the S, this nunatak appears dome-shaped while from the N, it appears as a conspicuous, rocky wall.

A small islet lies at the NE end of Larsen Channel, N of Saxum Nunatak and 0.5 mile off the N shore of Joinville Island.

1.49 Madder Cliffs (63˚18'S., 56˚29'W.), formed of reddish rock, rise steeply from the sea and attain a height of 305m.

Suspiros Bay, lying close SW of Madder Cliffs, indents the coast of Joinville Island and recedes E for 1.5 miles. An island is reported to lie 0.2 mile off the S side of this bay. Another island, 0.4 mile long, is reported to lie 0.5 mile SW of the N entrance point. Anchorage may be obtained in the S part of the bay. It is reported that anchorage may also be taken between the two islands over a bottom of sand, mud, and stones.

It was reported (1963) that shoals were observed to lie to the W of Suspiros Bay, N of Cape Kinnes.

Balaena Valley, located E of Suspiros Bay, is ice-filled and gently slopes toward the bay.

Cape Kinnes, the W extremity of Joinville Island, is located 3.5 miles S of Suspiros Bay and fronts the Antarctic Sound.

Larsen Channel, 10 miles long and 1 to 2.5 miles wide, lies in a NE/SW direction and separates Joinville Island from D'Urville Island. This channel has never been reported to be ice-free and has a least reported depth of 88m. Rocks and islets extend up to 1.3 miles offshore along both sides of the E entrance. Two islets lie close off the N shore of Joinville Island, at the NE end of the channel. Overfalls were reported (1963) to exist about 0.5 mile NW of the W islet. A shoal, with a depth of 9.1m, lies about 2 miles off Joinville Island, 2 miles NW of Boreal Point.

1.50 D'Urville Island (63˚05'S., 56˚20'W.), the N of the Joinville Island group, is 17 miles long and 305m high. It has a smooth and unbroken ice cap which terminates at the coast in high cliffs. Several islets and rocks extend up to 7 miles seaward of this island.

Turnbull Point, the W extremity of the island, is exposed, rocky, and fronted by numerous rocks and islets. Hope Island, the largest of a group of islands, lies centered about 6 miles W of this point. This island is 31m high and a rock lies about 3 miles SSW of it. Care should be taken when navigating in this area.

The coast trends 12 miles SE from Turnbull Point to the S extremity of D'Urville Island. Burden Passage separates the SW side of the island from Bransfield Island. This channel is 2.5 miles wide and extends from the Antarctic Sound, at the NW end, to Larsen Channel, at the SE end. It is unsurveyed, but icebergs indicate the presence of considerable depths within this passage.

The coast of D'Urville Island forms the side of Larsen Channel and several rocks and islets extend up to 0.5 mile offshore. Medley Rocks, a group of reefs, front the NE end of the island and extend up to 2.5 miles offshore. Another group

of islets, rocks, and reefs lies 2 miles S of Medley Rocks and extends up to 1.5 miles E from the shore.

1.51 The **Wideopen Islands** (63˚00'S., 55˚49'W.), located 4.5 miles E of Medley Rocks, consists of two isolated rocks lying on the N side of the E approach to Larsen Channel.

Two other rocks and a shoal patch, with a depth of 18.5m, lie 2.5 miles E and 9 miles E, respectively, of the Wideopen Islands.

An islet, 11m high, lies 11.5 miles NE of the Wideopen Islands. A spit, with a depth of 20.1m, and a reef, covered to an unknown extent, lie 9.5 miles NNE and about 7 miles NNW, respectively, of the Wideopen Islands.

An islet, 0.3 mile long, lies 0.8 mile N of the coast of D'Urville Island, 5.5 miles W of Medley Rocks.

From the NE end of D'Urville Island, the coast trends W for 12 miles to Cape Juncal, the NW extremity of the island. Foul ground extends up to 1 mile W and 2 miles N of this cape. Southtrap Rock, located about 4 miles W of the cape, and Northtrap Rocks, located about 5.5 miles NW of the cape, lie near the approach to the Antarctic Sound and caution is advised when transiting in this area.

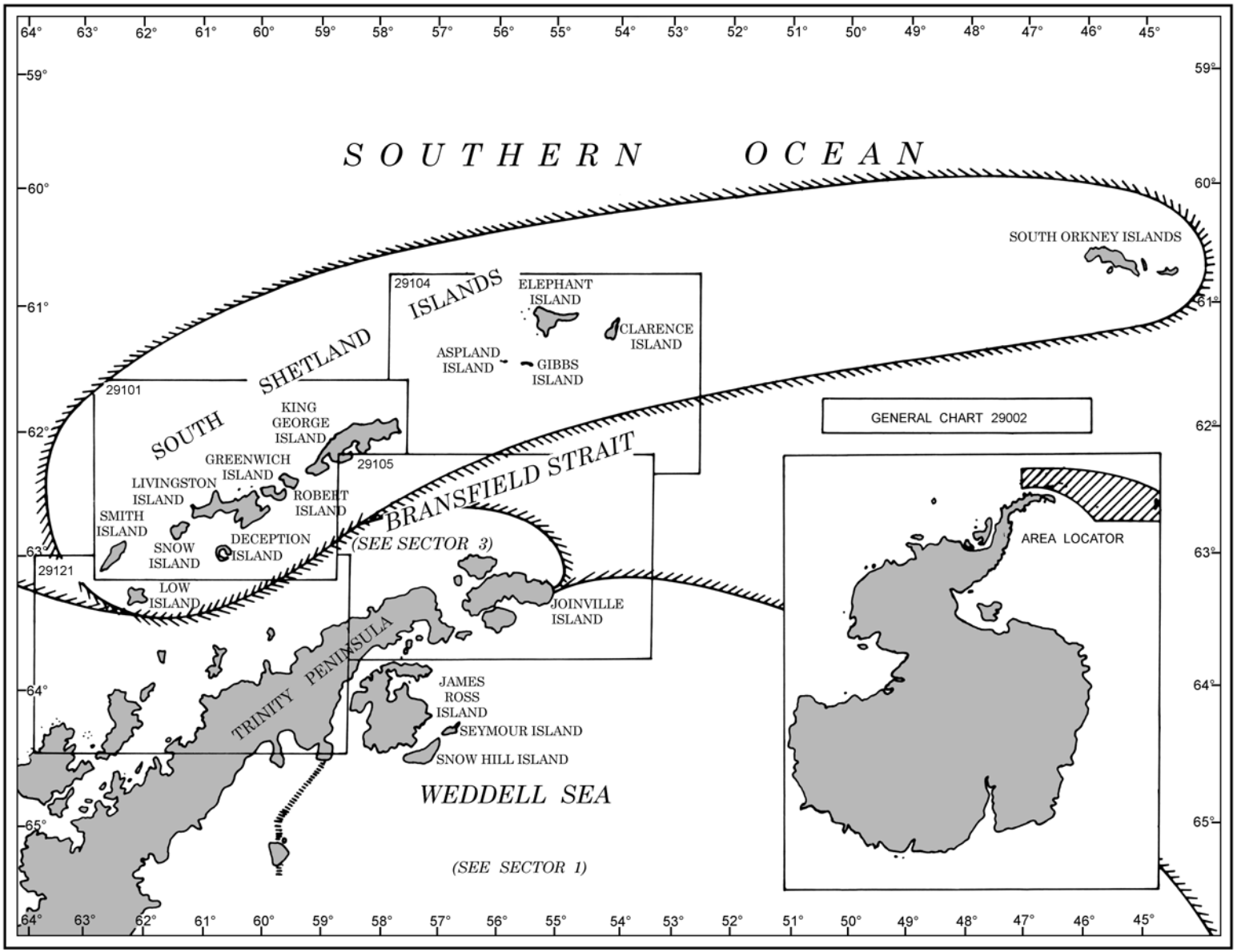
Montrol Rock lies 1 mile off the coast, 3 miles E of Cape Juncal. It is the largest of a group of above and below-water rocks which lie off the N coast of D'Urville Island. Harris Rock and a below-water rock lie 1.5 miles N and about 4 miles NNE, respectively, of Montrol Rock.

1.52 **Bransfield Island** (63˚11'S., 56˚36'W.), low and ice-covered, lies with its NE extremity located 3 miles SW of D'Urville Island. This island is 4.5 miles long, 3 miles wide, and is separated from D'Urville Island by Burden Passage. Between this island and Cape Dubouzet, on the mainland, the Antarctic Sound is about 9 miles wide.

The W and N coasts of the island are generally foul, with below-water rocks extending up to about 1 mile offshore in places. Knobble Head, a conspicuous rock exposure, forms the E extremity of the island. Several islets lie within 1.5 miles N of this point. Shoal patches, each with a depth of 20m, lie about 2 miles SE and 2 miles SSE, respectively, of this point. The northernmost of these patches is position approximate.

Archibald Point, exposed and rocky, is located at the SW side of the island. Shoals, with depths of 0.9 and 14.6m, lie 1.5 miles W and 3.5 miles SW, respectively, of this point.

A beach, on which a penguin colony is situated, fronts the NE side of the island.



Additional chart coverage may be found in NGA/DLIS Catalog of Maps, Charts, and Related Products (Unlimited Distribution).

SECTOR **2** — CHART INFORMATION

SECTOR 2

THE SOUTH ORKNEY ISLANDS AND THE SOUTH SHETLAND ISLANDS

Plan.—This sector describes the South Orkney Islands from E to W between Laurie Island and Coronation Island. It also describes the South Shetland Islands, SW from Clarence Island to Deception Island.

General Remarks

2.1 The **South Orkney Islands** (60˚35'S., 45˚30'W.), surrounded by ice, lie about 265 miles ENE of Joinville Island. The group consists of two principal islands, Laurie Island and Coronation Island, and a number of smaller islands which are all covered with snow and ice. The islands, as a rule, are enveloped in low mist and fog and stranded icebergs are usually encountered in all directions from them. Grounded bergs are generally encountered on the N side of the islands and indicate the nearness of land due to the narrow extent of the continental shelf on that side. Old bergs should be avoided due to disintegration. Grounded bergs should be given a wide berth since they may mask the shoals on which they have been stranded and may also be in the process of breaking up.

Many rocks are covered with ice and vessels may come upon them suddenly without warning, as depths of 36 to 55m have been reported to lie close alongside these sunken dangers. No kelp is found near these islands. Vessels should keep a lookout for areas of broken and discolored water, which should be avoided.

The **South Shetland Islands** (62˚00'S., 57˚00'W.), consisting of a group of more than 20 islands and islets, extend 270 miles in an ENE/WSW direction between the parallels of 61˚00'S and 63˚22'S, and the meridians of 53˚50'W and 62˚50'W.

The islands are largely volcanic; their N coasts are fronted by islets, rocks, and breakers while their S coasts are almost entirely clear of dangers.

The islands remain mostly ice-covered all year round. However, after midsummer, a few tracts that are free of snow carry lichens and mosses and, in some places, these may be supplanted by small patches of grass.

Winds—Weather.—The Weddell Sea Drift approaches the islands from the SW and brings cold water, drift ice, and bergs. The climate is cold, with a mean annual temperature of -4˚C, a mean summer temperature of 0˚C, and a mean winter temperature of -10˚C.

The prevailing winds are from the W quadrant. Winds from the S are cold and bring large masses of drift ice. The warmest winds blow from the NW and N, carrying fog and dense moisture.

Gales may reach storm force in the vicinity of the islands and are liable to persist for long periods. September is the worst month for high winds. Snow occurs about 20 days per month in all seasons, but the average cloud cover is more broken in winter than for the rest of the year.

Ice.—The concentration of the drift ice is dependent upon the winds, since a heavy swell causes the ice cover to break up and become more widely dispersed.

The islands lie within the probable mean limit of drift ice except during the summer months, from January to March. For the greater part of the remainder of the year, the South Orkney Islands are entirely surrounded by ice. Their S coasts, particularly the E parts, become icebound before the complete envelopment of the islands.

During winter, the South Shetland Islands are entirely icebound. The W and N parts of Bransfield Strait are usually clear of ice by November and remain open until March. In exceptional seasons, Deception Island may remain icebound.

Tides—Currents.—Currents may attain rates of up to 4 knots within the various straits leading between the islands and small bergs, moving under their influence, may seriously hamper navigation. In the vicinity of the South Orkney Islands, the predominant current is reported to set NE.

The currents set W along the N coasts of the South Shetland Islands and E along the S coasts. All the straits, except Nelson Strait, are fringed with rocks and due to the strong currents setting in and across them, are dangerous for low-powered vessels. The current that sets W along the N coast has been observed to flow even during gales from the opposite direction and rates of 5 to 6 knots have been recorded at times. A current with a rate of 4 knots was observed during the flood in the narrow channel leading between Spine Islet and Coronation Island. Currents with rates of about 3.5 knots were observed within Washington Strait and Lewthwaite Strait.

Tide rips are very common, particularly in the straits and channels leading between the various island, and are especially noticeable during calm weather. Tides along the N coasts of the South Shetland Islands are very irregular, there being at times HW for 24 hours. At other times, HW remains for about 3 or 4 hours and then the ebbs flows again. Generally, there is one flood and one ebb every 24 hours.

In most of the harbors, the tide rises 2.4 to 2.7m, but a spring tidal rise of 3.6m has been observed in Hero Bay. Winds have a marked effect upon the current, not only raising the tides beyond their normal levels but also affecting the period and velocity of the tidal currents. Near the entrance to Bransfield Strait, the tidal currents are strong and variable and a current setting NW with a rate of 1.5 to 2 knots has been experienced in the SW part of the strait. At the NE entrance, a current that sweeps around Joinville Island as it flows from the Weddell Sea may be encountered. This current usually divides, one branch flowing NE toward the South Orkney Islands and the other NW to where it joins the South Shetland Islands, producing eddies.

Caution.—The charting of the waters in the vicinity of the South Orkney Islands is inadequate, being based principally on running surveys.

Numerous bergs may be carried through the straits and narrow channels by the strong currents, often restricting navigation within these waters.

The South Orkney Islands

2.2 **Laurie Island** (60˚44'S., 44˚37'W.), located at the E end of the South Orkney Islands, is 12.5 miles long and lies in an E/W direction.

The E end of the island is formed by Cape Dundas, which is 229m high. The peninsula leading to this cape slopes gradually to a low plateau, rising again to a hill at the E extremity. It is joined to the mainland by a neck of land, 90m wide. Rocks and ledges front the SW side of this peninsula and seas break heavily over the rocks which lie up to about 1 mile E of it.

A shoal, with a depth of 9.1m, lies about 1.6 miles NNE of Cape Dundas. Hart Rock, 9m high, lies 3.2 miles NNE of the cape and Herdman Rocks lie about 3 miles NNE of it. Care should be taken when approaching this area.

Fitchie Bay, lying 2.5 miles SW of the Ferrier Peninsula, is 3 miles wide.

Graptolite Island (60˚44'S., 44˚28'W.) lies at the NE end of Fitchie Bay and a small islet is located 1.3 miles SW of it. A submerged wreck lies about 0.7 mile WSW of this island and a patch of discolored water is reported to lie 1 mile SSE of it.

A rock, with a depth of 2m, and a shoal, with a depth of 18m, lie about 1.5 miles SE and 1.7 miles ESE, respectively, of Cape Dundas. Another shoal, with a depth of 9.1m, lies in the SE approach to the bay, 1.5 miles SSW of Cape Dundas.

Aitken Cove, lying close SW of Fitchie Bay, is separated from Methuen Cove, to the SW, by Cape Whitson. Several conspicuous serrated ridges are located on the W side of Aitken Cove and a small glacier fronts the head. Cape Whitson is very exposed and is fronted by a continuous icecliff. Rocks, below-water and awash, lie within 1.5 miles SE of this cape. Murray Island, 18m high, lies 1.2 miles E of the cape.

Mill Cove, 0.6 mile wide, extends for about 0.6 mile in a N direction. Its E side, 244m high, is fringed by rocks which rise abruptly to a cliff. A terminal glacier, fronted by an icecliff, is located at the head. It fills a narrow column and extends N across the island to Brown's Bay. Valette Island, 0.3 mile long, lies in the entrance of the cove, close to the W shore. Depths of 37 to 55m lie in the center of the cove, but its N part is shoal in the middle.

Florence Rock, 24m high, lies 0.5 mile S of Valette Island and a small islet lies close NE it. Two rocks, the northernmost of which is 6m high, lie 0.5 mile ESE of Florence Rock. A shoal, with a depth of 9.1m, and another rock lie about 0.5 mile SSE and 0.3 mile NW, respectively, of Florence Rock.

Point Rae, the NE entrance point of Scotia Bay, is located 0.5 mile W of Valette Island.

Ailsa Craig, a precipitous island, is 169m high and lies 1 mile SSW of Florence Rock.

2.3 **Scotia Bay** (60˚46'S., 44˚40'W.) (World Port Index No. 63080), lying near the SE extremity of the Mossman Peninsula, is entered between Point Rae and Cape Murdoch. Depths of 53 to 119m lie about 1 mile NE of Cape Murdoch. Shoals, with depths of 29 and 31m, lie 0.9 mile NE and 1.1 miles NNE, respectively, of the cape.

It is reported that strong S winds cause many icebergs to lie in the approaches to Scotia Bay.

Five rocks lie offshore between Point Rae and Point Davis; however, the survey data for this area are extremely limited. It was reported that a least depth of 12.8m lies in the vicinity of these rocks.

Point Davis is located 1.2 miles WNW of Point Rae and cliffs extend inland to the coast at this point. Two below-water rocks, over which heavy seas break, lie about 0.3 mile S of this point. A rock, with a least depth of 1.8m, was reported to lie about 0.5 mile WNW of Point Davis.

Point Moreno, the E entrance point of a cove, is located 1.2 miles NW of Point Davis and fronted by a ledge that extends up to about 90m S. The cove, which is 0.3 mile long, has depths of 9 to 18m that decrease toward the shore. A shoal, with a depth of 1.8m, lies 0.2 mile NW of Point Moreno.

Anchorage in Scotia Bay is not recommended because the bay is exposed and it is too restricted within the cove. However, temporary anchorage may be taken, in depths of 14 to 18m, near the middle of the entrance to the cove. The masts of a radio station are reported to stand near the head of the cove.

Point Martin (60˚47'S., 44˚41'W.) is located 1.4 miles S of the cove, on the E coast of the Mossman Peninsula. Depths of less than 5.5m lie up to 0.4 mile offshore and the entire coast between the cove and Cape Murdock, 2.4 miles SE, is lined with cliffs. Two rocks, one marked by a beacon, lie about 1.3 miles NNW of Point Martin.

Two islets lie between Point Martin and Cape Murdock, 1 mile SE. Numerous below and above-water rocks lie within 0.5 mile of the cape.

Buchan Bay recedes for 0.5 mile between the two forks of the Mossman Peninsula and its shores are fronted by numerous rocks.

Cape Hartree, 155m high, is formed by a jagged saw-toothed promontory which is located 1.5 miles SW of the Mossman Peninsula.

Wilton Bay, 1.3 miles long, lies 2 miles NNW of the westernmost fork of the Mossman Peninsula. Cape Davidson, the S extremity of the Mackenzie Peninsula, forms the NW entrance point of this bay. A group of below and above-water rocks extends up to 0.3 mile S of this cape and the outermost is 11m high. Another rock, 12m high, lies about 0.3 mile W of the cape.

2.4 The **Mackenzie Peninsula** (60˚45'S., 44˚48'W.), steep and rocky, forms the W end of Laurie Island and is 366m high. Its W side, which has several indentations, leads NW from Cape Davidson to Route Point, the NW extremity.

Cape Roca is located 1.8 miles NW of Cape Davidson; an unnamed cape lies midway between them. A group of rocks front the coast, 0.2 mile N of Cape Davidson and several rocks lie up to 0.4 mile SSW of the unnamed cape. Another rock fronts the shore, close S of Cape Roca.

A group of prominent rocks lies N of the Mackenzie Peninsula. Nigg Rock, fringed by numerous small rocks, is the innermost of this group. It is 155m high and lies 0.5 mile off Route Point.

Eillium Island, 201m high, lies 0.5 mile NNW of Nigg Rock. An islet, 46m high, and a rock lie 0.2 mile NW and 0.5 mile E, respectively, of this island.

2.5 Jessie Bay is entered between Cape Robertson, located on the Mackenzie Peninsula, and Cape Mabel, located on the Price Peninsula. This bay is 4.5 miles long, 3.5 miles

wide, and Uruguay Cove lies at its head. Rocks, with depths of less than 1.8m, have been reported to lie in the middle of the bay, ENE of Route Point.

Uruguay Cove, about 0.5 mile wide and 0.5 mile long, is open to the sea on the N side and open to the SE across the low, narrow isthmus which separates it from Scotia Bay. A conspicuous and sugar-loaf shaped hill, 40m high, stands near the head of the bay and projects through the glacier which extends to the sea.

Mount Ramsay (60˚44'S., 44˚44'W.), 474m high, stands on the W side of Uruguay Cove and is one of the highest peaks on Laurie Island.

Mount Lola (60˚44'S., 44˚43'W.) is 171m high; another peak, 270m high, rises close E of it.

Uruguay Cove has general depths of 11 to 26m. Shoal patches, with depths of 6.4 and 11m, lie 0.5 mile NW and 0.4 mile NW, respectively, of Mount Lola. Another shoal patch, with a depth of 8.4m, is reported to lie about 0.3 mile SSW of Mount Lola.

Cape Mabel forms the N extremity of the Pirie Peninsula which is narrow and trends 3 miles N from the main island. This peninsula separates Jessie Bay from Brown's Bay. Cliffs extend along the coast in the vicinity of the cape. Islets lie 0.5 mile NW and 0.5 mile N of the cape.

2.6 **Mabel Island** (60˚44'S., 44˚42'W.), 180m long, lies 1.5 miles NW of Cape Mabel.

Brown's Bay, 1.5 miles wide, is entered between Thomson Point, located on the Pirie Peninsula, and Cape Geddes, located at the N end of the Ferguslie Peninsula. Several islets and a below-water rock lie off the E coast of the Pirie Peninsula and front this bay.

Cape Geddes, located at the N end of the Ferguslie Peninsula, is faced by a cliff, 152m high, and fronted by crushed rocks.

The depths within Brown's Bay have not been completely surveyed and are reported to vary between 18m, near to the shore, and 143m, in the E part of the center of the entrance. Rudmose Rocks, lying 0.8 mile N of Cape Geddes, are rounded, ice-worn, and may be seen above the surface of the water. Numerous other rocks lie close offshore between Rudmose Rocks and Cape Geddes.

Macdougal Bay, lying NE of the Ferguslie Peninsula, is not recommended for anchorage. The Watson Peninsula flanks the E side of this bay and Cape Valavielle, 43m high, forms its N extremity. Numerous rocks front the N coasts of the peninsula and lie up to 0.5 mile offshore. The outermost rock, 4.6m high, lies about 0.5 mile NW of Cape Valavielle.

Marr Bay and Mackintosh Cove, unsurveyed, lie E of the Watson Peninsula and are separated by a projection of land the N extremity of which is known as Fraser Point. Several exposed rocks front this point and a rock, 4.6m high, lies about 2 miles NE of it.

Cape Dundas is located 3.4 miles SE of Mackintosh Cove. The coast between is marked by several protruding points of land, each of which is fronted by numerous rocks and islets.

2.7 The **Weddell Islands** (60˚39'S., 44˚51'W.) and **Saddle Island** (60˚38'S., 44˚50'W.) lie 4.5 miles N and 5.7 miles N, respectively, of Route Point, on Laurie Island.

The Weddell Islands consist of two islands and a number of rocks. Two rocks, awash, and several below-water rocks lie close SW of the easaternmost island and seas break over this entire area. Scapa Rock, 20m high, lies 0.5 mile N of the westernmost island.

Saddle Island, 2 miles long, is nearly divided into two parts by a narrow channel filled with boulders. This island has twin summits, the tallest being 427m high and standing at the E end. A glacier lies on the S side of the island and forms a prominent landmark. Numerous rocks lie off the W side of the island and off the E extremity. A small, rocky cove indents the N side of the island is used for landing.

There are depths of 37 to over 360m in the waters lying between Laurie Island and the Weddell Islands. A least depth of 29m is reported to lie in the W end of the passage leading between the Weddell Islands and Saddle Island. Care should be taken when navigating within 1 mile S of the Weddell Islands.

Washington Strait, 3 miles wide, leads between Laurie Island on one side and Frederiksen Island and Powell Island on the other. A depth of 73m lies in the S part of the strait and lesser depths are reported to lie in the N part. The strait was observed to be free of dangers, except for shoal depths of 16.4 and 18.3m which were reported to lie 1.3 miles S and 2.3 miles SE, respectively, of the S end of Frederiksen Island. However, strong tidal currents and tide rips may be expected in this strait and grounded icebergs are frequently encountered here. Extreme care should be taken when navigating in this strait and its approaches as several islands lying in this vicinity are reported to have been incorrectly charted.

Several islands, the largest of which are Fredriksen Island and Powell Island, lie on the W side of the strait.

Fredriksen Island (60˚44'S., 44˚59'W.), 2.5 miles long and 0.5 mile wide, is rocky with steep slopes. It has no ice covering except for a few patches of permanent snow. The summit of this island rises at the N end and is 244m high. The N extremity of the island, which is known as Cape Barlas, is fronted by several above-water rocks. Numerous rocks and islets lie close off the E and W sides of the island, within about 1 mile of the cape.

A channel, with a least depth of 14.6m, lies close to the W side of Fredriksen Island and permits passage between this island and Powell Island, but considerable discolored water has been reported to exist on the W side of this strait.

2.8 **Powell Island** (60˚41'S., 45˚03'W.), lying close NW of Fredriksen Island, is 7 miles long and about 1.5 miles wide. The N extremity of this island is formed by Cape Faraday and its N part consists of glaciers. John Peaks, up to 415m high, rise near the S end of the island and are snow-covered.

Numerous rocks front the E shore of the island and a rock, with several below-water rocks lying within 0.2 mile N of it, lies about 0.8 mile ESE of Cape Faraday.

A group, consisting of seven rocks, and a below-water rock, which sometimes beaks, lie about 0.8 mile WSW and 1 mile SW, respectively, of Cape Faraday. A group of rocks fronts Cape Disappointment, the W extremity of the island, and lies up to 0.8 mile offshore. An islet lies almost midway between Capes Disappointment and Faraday.

Caution.—The S part of Powell Island, which includes John Peaks, Christoffersen Island, Michelson Island, Fredriksen

Island, and the adjacent islets all lie within a designated specially protected area. They are considered to support vegetation, birds, and mammals, representative of the South Orkney Islands.

2.9 Michelson Island lies near the S end of Powell Island and is connected to it by a narrow isthmus of boulders, intermittently submerged. This island is 0.6 mile long, 38m high, and several islets lie close off its NE end. A smaller and unnamed island, encompassed by foul ground, lies off the S end of Michelson Island. Grey Island, 0.2 mile long and 43m high, lies about 0.5 mile S of this unnamed island. Two small islets lie off the E end of Grey Island and foul ground extends up to 0.2 mile S of it.

Ellefsen Harbor (60˚45'S"45˚02'W.) (World Port Index No. 63070) is entered between Michelson Island and Christoffersen Island, 0.3 mile W. This harbor extends for 0.2 mile and has depths of 12.8 to 25.6m in the middle, decreasing toward the shore. Although small, the harbor has good holding ground and is sheltered. Across the entrance, a chain of above-water rocks extends for about 0.4 mile SSE from the S end of Christoffersen Island. The southernmost rock is 27m high and a rock, awash, lies close ESE of it.

The approaches to the harbor from the S and SE have not being fully surveyed and extreme care must be exercised. Entrance to the harbor may be made via a channel lying near the W side of Michelsen Island. This channel is about 180m wide and has depths of 11 to 24m. A dangerous rock lies in the entrance to the harbor, about 0.3 mile off the S extremity of Christoffersen Island.

Falkland Harbor, suitable only for small craft, is entered 0.4 mile NW of Ellefsen Harbor and is mostly foul.

Lewthwaite Strait separates Powell Island from Coronation Island to the W. This strait is 2.5 miles wide, but its navigable width is reduced to about 1 mile by rocks lying on each side and grounded icebergs are reported to be frequently found here. Extreme care should be taken when navigating in the approaches and within the strait, as many of the small islands in this vicinity have been reported to be incorrectly charted. A tidal current setting SW at a rate of 2 to 2.5 knots was experienced (1982) at a position about 8 miles NNE of the strait.

2.10 Several islands, the largest being Coronation Island, lie on the W side of Lewthwaite Strait. In addition, a group, known as the Robertson Islands, extends from the SE extremity of Coronation Island. This group includes Atriceps Island, Skilling Island, Steepholm Island, Matthews Island, and Coffer Island.

Atriceps Island (60˚47'S., 45˚09'W.), 1 mile long, is the southernmost of the group. South Cape forms the S extremity of this island. Vessels should navigate with extreme care in the areas lying to the S and SE of this cape as the salient points are frequently obscured by large icebergs and several shoal areas extend up to 3.6 miles S and 1.5 miles E from the island.

Skilling Island (60˚46'S., 45˚09'W.) is small and lies close NE of Atriceps Island. A rocky area lies between these islands and rocks extend up to 0.8 mile ESE from this island.

2.11 **Steepholm Island** (60˚46'S., 45˚09'W.), along with two smaller unnamed islands, lies close N of Skilling Island. An above-water rock and a rock, awash, lie about 0.7 mile E of these islands.

Matthews Island, the largest of the Robertson Islands, is horseshoe shaped and separated from Coronation Island, to the N, by The Divide, a narrow passage. Whale Bay is located at the W end of The Divide.

Coffer Island (60˚45'S., 45˚08'W.), lying close E of Matthews Island, is 105m high. Anchorage can be taken, in a depth of 27m, to the S of this island, but the berth is exposed to the E.

Coronation Island (60˚37'S., 45˚35'W.), the largest of the South Orkney Islands, extends for 25 miles in an E/W direction and is 3 to 8 miles wide. This island is mainly ice-covered and comprises many bays, glaciers, and peaks. The highest peak, Mount Nivea, rises to an elevation of 1,266m and stands on the E side of the central part of the island. The ridge of this peak descends to the sea in steep, rocky ridges that terminate in bold headlands, except on the N and NW coasts, where the ice cap descends in a gentle slope to the water's edge. Deacon Hill, a conspicuous and ice-covered peak, is 330m high. It forms the most prominent landmark when approaching from the N or S.

Orwell Bight (60˚43'S., 45˚23'W.), about 5 miles wide, indents the S coast of the island and is bounded on the W side by Signy Island. The coast in this vicinity is rocky and steep with icefalls and glaciers.

2.12 **Whale Bay** (60˚44'S., 45˚11'W.) leads to the W end of The Divide and as far as Saunders Point, 4.5 miles NW. The coast is fronted by many islands and rocks which extend up to about 0.5 mile offshore. This area, which was surveyed in 1965, is considered to be free of dangers to within 1.5 miles of the coast.

A depth of 37m lies in the entrance to Whale Bay; anchorage can be obtained, in a depth of 33m, within its NE corner, near The Divide.

Schist Point (60˚43'S., 45˚14'W.) is fronted by a small islet.

Amphibolite Point (60˚41'S., 45˚21'W.), located 4 miles NW of Schist Point, is conspicuous and pyramidal-shaped.

Olivine Point (60˚40'S., 45˚29'W.) is located 5 miles WNW of Saunders Point. The coast between is fronted by numerous islands and dangers which extend up to 0.5 mile offshore. A survey was made of this vicinity to within 2 miles of the shore and vessels approaching any closer should do so with care.

Reid Island (60˚41'S., 45˚30'W.) lies at the E side of the entrance leading into **Iceberg Bay** (60˚39'S., 45˚30'W.) at the head of which lies the **Sunshine Glacier** (60˚38'S., 45˚30'W.). This glacier is 3 miles long, 2 miles wide, and flows in a S direction. It is the largest glacier on the S coast of Coronation Island and terminates in icecliffs, up to 60m high.

Iceberg Bay is entered between Olivine Point and **Cape Hansen** (60˚40'S., 45˚35'W.). The bay has depths up to 183m lying in the center, but it shoals at the W end where there are several islets and rocks.

Shingle Cove (60˚39'S., 45˚34'W.), small and sheltered, lies in the NW corner of the bay. Landing on the beach at the SW side of this cove is reported to be usually easy. This cove is one of the few places in the vicinity from which access to the interior of Coronation Island can be made. A large cairn, 76m high, stands on the rocky spur which forms the SW side of the cove.

Marshall Bay (60˚39'S., 45˚38'W.) lies between Cape Hansen and **Cape Vik** (60˚40'S., 45˚40'W.). This bay is 2 miles

wide and has depths of 54 to 165m. A small rock lies 0.5 mile SW of Cape Vik.

Lynch Island (60˚39'S., 45˚36'W.), 33m high, lies on the E side of the bay and is designated as a Specially Protected Area.

The **Laws Glacier** (60˚38'S., 45˚38'W.), a confluent glacier-system, flows into Marshall Bay.

Anchorage can be taken, in a depth of 32m, about 1 mile W of Cape Vik.

2.13 Signy Island (60˚43'S., 45˚38'W.), 4 miles long and less than 3 miles wide, lies close S of the middle of Coronation Island, from which it is separated by **Normanna Strait** (60˚40'S., 45˚38'W.). This strait, 1 mile wide at its narrowest part, is deep and mostly clear.

North Point (60˚41'S., 45˚38'W.), the N extremity of Signy Island, is fronted by foul ground which extends up to 0.2 mile offshore. The island is fringed by numerous islets and above and below-water rocks; however, there are several good anchorages that are sheltered from the wind and have good holding ground.

Tioga Hill (60˚44'S., 45˚39'W.), 279m high, stands on the W side of the island and forms the summit. Robin Peak, 262m high, is the highest peak on the N side of the island. This hill is rocky with sheer cliffs on its E side. Jane Peak, 205m high, has a rocky turret and rises at the head of Borge Bay (60˚43'S., 45˚37'W.).

The **Oliphant Islands** (60˚45'S., 45˚36'W.) is a group consisting of several small islands, islets, and rocks, which lies close S of **Gourlay Point** (60˚44'S., 45˚36'W.).

Dove Channel (60˚45'S., 45˚36'W.) leads through this group in a general E/W direction and is obstructed by many reefs and shoals. A rock, awash, lies 0.3 mile NE of Gourlay Point and a shoal, with a depth of 9.4m, lies close ESE of it. Another shoal, with a depth of 5m, lies 0.6 mile SE of Gourlay Point.

Clowes Bay (60˚44'S., 45˚38'W.) is entered between the Oliphant Islands and **Confusion Island** (60˚44'S., 45˚38'W.), 1.3 miles W. Several islets and rocks front the N coast of this bay and lie up to about 0.2 mile offshore. The bay is divided by a chain of shoals which extend S from its head to an above-water rock lying 0.5 mile E of Confusion Island.

2.14 Moe Island (60˚45'S., 45˚42'W.) lies off the SW end of Signy Island from which it is separated by **Fyr Channel** (60˚44'S., 45˚41'W.). This channel has a depth of 9.1m, but rocks lie in both its SE and NW entrances. A shoal patch, with a depth of 4.3m, lies in the SE approach to the channel, 0.5 mile W of Confusion Island. Passage through the channel is recommended for boats only. Moe Island has been designated a Specially Protected Area.

Mariholm Island (60˚45'S., 45˚42'W.), 26m high, is the largest of a group of islands which lies about 0.5 mile S of Moe Island. Numerous obstructions front this island. A rock, with a depth of 3.6m and over which the sea often breaks, lies 0.3 mile E of Mariholm Island. Another rock, with a depth of 7m, lies 0.9 mile S of Confusion Island and a shoal patch, with a depth of 16.4m, lies 0.5 mile SE of it. A shoal, with a depth of 15.5m, lies about 1.5 miles SW of Mariholm island. Vessels navigating in this area are advised to pass to the S of all of these dangers.

Several irregular patches, in which the depths decrease rapidly from about 100m, lie S of Mariholm Island. The southernmost patch, with a least depth of 27m, lies about 3.5 miles SSW of Oliphant Island.

Porteous Point (60˚44'S., 45˚41'W.) and **Jebsen Point** (60˚43'S., 45˚41'W.) are separated by an unnamed bay which has several rocks fronting its E side. Anchorage can be obtained, in a depth of 35m, about 0.5 mile NNW of Porteous Point. Cummings Cove lies on the NE side of the point and has a beach at its head.

Port Jebsen, formed by a cove, lies close N of Jebsen Point. A stranded wreck lies at the head of this cove. Jebsen Rocks lie up to about 0.5 mile NW and N of the point.

2.15 The **Flensing Islands** (60˚42'S., 45˚41'W.), a group of four islands, lie about 1 mile N of Jebsen Rocks. The S island is 0.3m high, the central island is 3.3m high, and the other two islands are 1.2m high.

A below-water rock, foul ground, and an unexamined area front the coast between the Flensing Islands and North Point.

Spindrift Rocks (60˚42'S., 45˚40'W.), a group of rocks, lie close off the coast, 0.9 mile SW of North Point. The rocks are ice-free and a attain a height of about 15m.

Paal Harbor (60˚43'S., 45˚36'W.) lies between **Rethval Point** (60˚44'S., 45˚36'W.) and **Polynesia Point** (60˚43'S., 45˚36'W.). This inlet has depths of 18 to 31m in its entrance.

Borge Bay (60˚43'S., 45˚37'W.) lies between Berntsen Point, at the S side, and Balin Point, at the N side. Vessels are advised to approach this bay from the NE. A light is reported to be shown from a structure standing 0.1 mile S of Berntsen Point.

Outer Island lies 0.4 mile ESE of Berntsen Point and is surrounded by foul ground which extends up to about 0.2 mile offshore on the N side.

Bare Rock, 5.8m high, and Small Rock, 0.3m high, lie 0.2 mile NE and 0.3 mile N, respectively, of Berntsen Point. Numerous shoals, with depths of 6.4 to 11.3m, lie in the E approach to the N part of the bay. The outermost shoal, with a least depth of 8.8m, lies about 0.4 mile ENE of Balin Point.

2.16 Three Lakes Valley (60˚42'S., 45˚37'W.), which contains three freshwater lakes, lies between Mirounga Flats and Jane Peak. Mirounga Flats is a small and partially-enclosed tidal area that is located in the inner NW corner of the bay. Jane Peak is a conspicuous nunatak, 205m high, which rises on the W shore of the bay.

A disused pipeline, a beach on which landing can be made, and a stream from which freshwater can be obtained lie on the W side of the bay.

Factory Cove (60˚43'S., 45˚37'W.) is the site of Signy, a permanently-manned British Antarctic Survey Station. A radio station, with several masts, and a meteorological station stand on the E side of the cove. The station is fronted by a small pier and a slipway that are both accessible except at LW.

A stranded wreck is reported to lie on the beach at the cove. Anchorage may be obtained, in a depth of 26m, about 0.3 mile S of Balin Point and in a depth of 7.3m within the cove. It is reported that a vessel anchored, in a depth, of 36.6m about 0.3 mile N of Outer Island.

Powell Rock (60˚42'S., 45˚36'W.), with a least depth of 0.3m, lies about 0.4 mile NNE of Balin Point.

Stygian Cove (60˚42'S., 45˚37'W.) is small, shallow, and fronted by numerous reefs. The outermost reef lies 0.2 mile NE of **Berry Head** (60˚42'S., 45˚37'W.). This reef dries 0.3m and a shoal, with a depth of 7.3m, lies close E of it.

Caution.—When navigating in the vicinity of Borge Bay, care should be taken as many of the shoals have not been fully examined.

2.17 Gerd Island (60˚40'S., 45˚44'W.), 16m high, lies 1 mile W of **Stene Point** (60˚39'S., 45˚42'W.). A clear passage, about 0.8 mile wide, leads between this island and Coronation Island.

The entrance to **Norway Bight** (60˚37'S., 45˚49'W.) lies between **Mansfield Point** (60˚39'S., 45˚44'W.) and **Meier Point** (60˚38'S., 45˚54'W.). The shores of this bight are completely covered by glaciers.

The **Gosling Islands** (60˚39'S., 45˚55'W.), a scattered group of islands and rocks, lie close S and W of Meier Point. Anchorage can be taken, in depths of 18 to 36m, on the W side of Norway Bight and clear of the islands and rocks.

The **Monk Islands** (60˚40'S., 45˚55'W.), a group of very small islands and rocks, lie 2 miles S of Meier Point. The tallest island is 7.3m high and rocks extend up to 0.5 mile N and 0.5 mile S from it. Foul ground fronts the coast extending between Meier Point and **Cheal Point** (60˚38'S., 45˚59'W.).

The W coast of Coronation Island, between **Return Point** (60˚38'S., 46˚01'W.) and **Penguin Point** (60˚31'S., 45˚56'W.), is fronted by a series of rocky cliffs over which the highland ice spills in the form of icefalls and hanging glaciers.

Fulmar Bay (60˚37'S., 46˚01'W.), 1 mile wide, lies between Return Point and **Moreton Point** (60˚37'S., 46˚02'W.). An ice cliff, 49m high, rises within this bay and twin peaks, 635m high, stand close E of it.

Monroe Island (60˚36'S., 46˚03'W.), 299m high, is the largest and E of the **Larsen Islands** (60˚36'S., 46˚03'W.). The northernmost of this group of islands is 241m high.

Nicolas Rocks (60˚34'S., 46˚06'W.), a chain, extends seaward from the NW extremity of the Larsen Islands.

2.18 Sandefjord Bay (60˚37'S., 46˚03'W.) is large and has depths of 9 to 33m. The S entrance is about 1 mile wide, but the width of the navigable channel is reduced considerably by numerous rocks.

Sandefjord Peaks (60˚37'S., 45˚59'W.) consist of three mountains, the tallest being 636m high.

Sphinx Rock (60˚37'S., 46˚05'W.) lies close SW of Monroe Island.

The Twins (60˚37'S., 46˚04'W.), two rocks lying close together, are located 0.4 mile SE of Sphinx Rock. It is reported that tide rips occur to the W of these rocks.

Numerous above and below-water rocks lie in the NW part of the bay and may best be seen on the chart. **Mainsail Rock** (60˚37'S., 46˚03'W.), the most conspicuous, is 17.4m high.

Depths of 26 to 33m lie in the S entrance of the bay and decrease towards the head. The N entrance of the bay is narrowed by **Spine Island** (60˚36'S., 46˚02'W.), which lies between Monroe Island and Coronation Island. A channel, about 180m wide, leads through the N entrance and W of Spine Island where depths of 14.6 to 37m can be found. The channel leading to the E of the island is not recommended.

Anchorage can be obtained, in depths of 9 to 12m, in the N part of the bay and S of Mainsail Rock. It was reported (1950) that a vessel anchored 0.6 mile SSW of Mainsail Rock. However, anchoring within Sandefjord Bay was not recommended, except in calm weather, as the berths were subject to strong tidal currents. Anchorage can also be obtained, in depths of 26 to 33m, in the S entrance to the bay.

Tidal currents, with rates of 3 to 4 knots, have been experienced in the navigable channels and tide rips have been reported to be numerous. In addition, ice was reported to be very troublesome with small bergs and growlers continually drifting in and out.

Numerous islands and dangers lie W of Coronation Island.

Melson Rocks (60˚31'S., 46˚10'W.), which attain a height of 30m, lie 7 miles W of Penguin Point. A rock, on which the sea breaks, is reported to lie about 5.5 miles W of these rocks.

It has been reported that a rock dangerous to navigation lies in position 60˚29'S, 46˚16'E about 3.5 miles W of Melson Rocks.

Despair Rocks (60˚33'S., 46˚10'W.) lie 3 miles S of Melson Rocks. These rocks extend 0.5 mile SSE and the sea sometimes breaks over them.

Lay-brother Rock (60˚34'S., 46˚13'W.), awash, lies about 1.8 miles SW of Despair Rocks.

Sorlle Rocks (60˚37'S., 46˚15'W.) lie 3 miles S of Lay-brother Rock and attain a height of 20m.

Caution.—Vessels navigating in this area should not approach within 1 mile of the above dangers.

2.19 The **Inaccessible Islands** (60˚34'S., 46˚44'W.), a group of small and precipitous islands, lie 22 miles W of Penguin Point. The S island is 293m high, the middle island is 226m high, and the N island 160m high. The channels leading between the islands are mostly clear, but many off-lying rocks fringe the shores and landing is difficult.

Several small islets and rocks lie up to 0.8 mile offshore, 1 to 2 miles S of Penguin Point. Several other islets lie 1 mile further S.

The **Governor Islands** (60˚30'S., 45˚56'W.), a chain of islands and rocks, extend up to 1.5 miles N of Penguin Point. The largest island of this chain is 117m high; the outermost one is 17m high. Depths of 33 to 35m are reported to lie 1.8 miles N of Penguin Point. A shoal, with a depth of 25m, is reported to lie about 5 miles N of Penguin Point.

Tonsberg Cove (60˚32'S., 45˚55'W.) lies 1 mile SE of Penguin Point. From this cove, the coast extends ENE for 6 miles to **Conception Point** (60˚31'S., 45˚41'W.) and is fronted by many rocks.

Bridger Bay (60˚33'S., 45˚51'W.), semicircular and 2.5 miles wide, lies close W of **Tickell Head** (60˚32'S., 45˚48'W.).

Conception Point, the N extremity of Coronation Island, is located 4 miles NW of **Prong Point** (60˚32'S., 45˚34'W.). Foul ground, on which an islet lies, extends up to 0.8 mile N and 1.5 miles W of Conception Point. A patch, with a least depth of 27.4m, lies about 2 miles N of this point.

2.20 Ommanney Bay (60˚33'S., 45˚32'W.), 2 miles wide, lies between Prong Point and **Foul Point** (60˚32'S., 45˚29'W.)

and has depths of 37 to 44m. A rock lies in the SE portion of the bay, about 1 mile SW of Foul Point and 0.5 mile offshore. A glacier is located at the head of the bay.

The coast between Foul Point and **Cape Bennett** (60˚37'S., 45˚13'W.) is cliffy in places and is fronted by numerous islets and rocks which extend up to 1.5 miles offshore.

An islet, 107m high, and another islet, 29m high, lie close N and 1.5 miles E, respectively, of Foul Point. Many below-water rocks and foul ground lie between these islets.

The coast between Foul Point and **Palmer Bay** (60˚37'S., 45˚20'W.) is fronted by many rocks which extend up to 1.5 miles offshore. Depths of 46 to 66m lie to seaward of these rocks. Palmer Bay recedes for about 1 mile and is 2 miles wide. This bay has a cliffy coast and two rocks lie on its W side, close offshore. Anchorage is not recommended within the bay.

From the E entrance point of Palmer Bay, the coast trends E for 2.5 miles to Cape Bennett and is rugged. A group of islets extends 1 mile N from a point located 2 miles W of Cape Bennett.

The coast extends 6 miles S from **East Cape** (60˚38'S., 45˚11'W.) and is broken and irregular, with cliffy bays.

2.21 Raynor Point (60˚39'S., 45˚10'W.) is located 1 mile SE of East Cape. The coast between is formed by several rugged out-croppings with glacial slopes and foul ground extends up to about 0.5 mile offshore.

Gibbon Bay (60˚39'S., 45˚11'W.) lies 1.3 miles S of Rayner Point. A high cliff stands at its head and foul ground fringes its S and W sides.

The Turret (60˚40'S., 45˚09'W.), a prominent headland, forms the S entrance of point of the bay and is 462m high. Anchorage can be taken, in depths of 33 to 55m, within the bay. However, this bay is too open to afford any protection from winds and is frequently filled with drifting ice.

Spencer Harbor (60˚41'S., 45˚09'W.) lies 1.5 miles S of The Turret. This inlet has depths up to 90m lying close offshore and affords little protection.

Petter Bay (60˚43'S., 45˚10'W.) lies 0.5 mile S of Spencer Harbor and has depths of 19 to 66m. However, this bay is not recommended for anchorage, as it is too open to afford any protection except from the W. A group of islets, up to 35m high, lies within this bay, about 3 miles S of The Turret.

Matthews Island (60˚45'S., 45˚09'W.), 2 miles long, is separated from Coronation Island by The Divide, a narrow passage.

Anchorage can be taken, in a depth of 27m, close off the S side of **Coffer Island** (60˚45'S., 45˚08'W.), but this roadstead is not recommended.

The South Shetland Islands

2.22 Clarence Island (61˚12'S., 54˚05'W.), the E island of the South Shetland Islands, lies 215 miles W of the Inaccessible Islands.

Cape Bowles (61˚19'S., 54˚06'W.), the S extremity, is formed by a precipitous cliff. Mount Irving, 2300m high, rises 2 miles N of Cape Bowles.

Cape Lloyd (61˚07'S., 54˚01'W.), marked by a light, is the N extremity and slopes to the sea from the summit of a peak, 1,389m high. Tide rips have been reported to occur off this cape.

Sugarloaf Island (61˚11'S., 54˚00'W.) is the N of two islands which lie about 1 mile off the E side of the island.

Between **Humble Point** (61˚11'S., 54˚08'W.) and **Chinstrap Cove** (61˚14'S., 54˚11'W.), several islets lie within 2 miles of the W coast of the island.

Escarpada Point (61˚17'S., 54˚14'W.), the SW extremity of the island, is fronted by shoal patches on its SW side.

Cornwallis Island (61˚04'S., 54˚28'W.) lies 13 miles WNW of Clarence Island and is separated from it by **Prince Charles Strait** (61˚05'S., 54˚35'W.), which is clear and has depths of 18 to 42m.

Elephant Island (61˚10'S., 55˚14'W.), 24 miles long, lies in an E/W direction with Cape Valentine, the NE extremity, located 19 miles W of Cape Lloyd. The E part of this island is formed by an ice-covered plateau, 457m high, with steep slopes that end in rocky cliffs or glacier faces, up to 90m high. Cape Valentine, consists of a rocky cliff, 244m high, and is fronted by an islet. Point Wild, located on the N coast of Elephant Island, approximately 7 miles W of Cape Valentine, can be identified by a beacon and a monument. An underwater rock over which the depth is uncertain but which is considered dangerous to navigation has been reported (2002) to lie about 0.5 mile NNW of Point Wild in approximate position 61˚05' S, 54˚52' W.

2.23 Pinnacle Rock (61˚06'S., 54˚47'W.), 120m high and resembling a castle, lies 1 mile offshore, midway between Cape Valentine and **Cape Belsham** (61˚05'S., 54˚53'W.). A reef, on which the sea breaks, connects this prominent rock with the N coast.

From Cape Belsham, which has a notched peak and is 244m high, the N coast extends 14 miles W and consists of rocky cliffs which fall steeply to the water's edge. The coast then extends 4.5 miles SW to **Cape Lindsey** (61˚06'S., 55˚29'W.), the W extremity of the island. Numerous rocks and islets front this stretch of coast and lie up to about 3 miles offshore.

Gibbous Rocks (61˚03'S., 54˚59'W.) lie 4 miles NW of Cape Belsham. **Borcegui Island** (61˚03'S., 55˚09'W.), 6m high, lies 1.5 miles offshore, 5 miles farther W.

2.24 Rodman Cove (61˚07'S., 55˚28'W.), located 3 miles NE of Cape Lindsey, has a narrow, sandy beach lying at the foot of its steep cliffs. Anchorage can be taken, in a depth of 18m, within this cove. The shores of Elephant Island offer little protection from the wind or sea and landings can only be made during calm weather.

Cape Yelcho (61˚03'S., 55˚22'W.) forms the NW extremity of the island. **Minstrel Point** (61˚04'S., 55˚25'W.), located 2 miles SW of the cape, lies at the foot of **Hammer Hill** (61˚04'S., 55˚21'W.).

Seal Islets (60˚58'S., 55˚24'W.), a group of small islands and rocks, lie about 8 miles N of Cape Lindsey. Anchorage may be taken, in a depth of 14m, off the S side of the islands, but this roadstead is not recommended as below-water ledges and rocks have been reported to exist in this area. Shoal patches, with depths of 6.4 and 18m, are reported to lie about 9 miles NW and 5 miles ENE, respectively, of Seal Islets.

Sealers Passage (61˚02'S., 55˚23'W.) lies between Cape Yelcho and Seal Islets. Shoal patches, each with a depth of 18.3m, lie in this passage, 2 miles NNW and 2 miles NNE of Cape Yelcho.

2.25 West Reef (61˚05'S., 55˚36'W.), surrounded by foul ground, consists of a chain of shallow rocks which extends up to about 6 miles W from Cape Lindsey. Vessels are advised not to navigate in this area except in very calm weather.

Stinker Point (61˚13'S., 55˚23'W.) is located 8 miles SSE of Cape Lindsey. Beaches, which lie close N and between 0.5 and 1 mile SE of this point, uncover at LW, but their approaches are encumbered by numerous rocks.

Cruiser Rocks (61˚13'S., 55˚28'W.), a group of rocks, extends up to 4 miles seaward between Cape Lindsey and **Cape Lookout** (61˚16'S., 55˚12'W.).

Table Bay (61˚09'S., 55˚24'W.) lies S of the peninsula of which Cape Lindsey, a headland, forms the seaward extremity. From this cape, the coast trends generally S then SE for 14 miles to Cape Lookout and consists mostly of rocky cliffs and hanging glaciers. Numerous islets and rocks front this stretch of coast and lie up to about 3 miles offshore.

Cape Lookout is formed by a steep bluff, 238m high. Anchorage may be taken, in a depth of 9m, within a small bay on the E side of this cape. The bay is fronted by a small spit which extends between two high rocks. A large glacier rises between two massive shoulders near the shoreward end of the spit.

Rowett Island (61˚17'S., 55˚13'W.), 1 mile long, lies 1 mile S of Cape Lookout. It has steep slopes and several jagged peaks.

Mount Pendragon (61˚15'S., 55˚14'W.), the summit of the island, is 975m high and rises 1.5 miles NW of the cape. Mount Elder, another prominent peak, stands 3 miles farther NNE.

The SE side of Elephant Island is mostly occupied by the **Endurance Glacier** (61˚10'S., 55˚08'W.), which extends between the slopes of Mount Elder and **Muckle Bluff** (61˚09'S., 54˚52'W.), located 12 miles NE of Cape Lookout.

Walker Point (61˚08'S., 54˚42'W.) is located 6 miles E of Muckle Bluff and fronted by foul ground. A below-water ridge extends between Elephant Island and Clarence Island, but has not been surveyed.

2.26 Gibbs Island (61˚28'S., 55˚34'W.) lies 16 miles SW of Elephant Island. This island has a thick snowcap and a pronounced dip near its middle. A small and crescent-shaped promontory stands close SE of the main part of the island. A prominent peak, 262m high, rises on this promontory.

The Spit (61˚29'S., 55˚30'W.), a short and narrow isthmus, is composed of boulders, up to 21m high, and connects the promontory to the main part of the island. Landing during calm weather may be made on a small beach on the S coast of the island.

Aspland Island (61˚28'S., 55˚55'W.), 3 miles long and 834m high, lies 5 miles W of Gibbs Island.

Eadie Island (61˚28'S., 55˚57'W.), less than 1 mile long and 443m high, lies close SW of Aspland Island and may be connected to it.

O'Brien Island (61˚30'S., 55˚58'W.) lies 1.5 miles SW of Eadie Island and has three sharp peaks. The middle peak forms the summit of the island and is 539m high.

Bridgeman Island (62˚04'S., 56˚44'W.), 233m high, lies 38 miles SW of O'Brien Island. This island is volcanic and appears as a truncated pyramid. Its summit is inclined to the S and covered with snow. The reddish-brown coasts of the island are nearly vertical on the N side and sloping on the S side. Cliffs face the shores of the island. Those on the N and W sides have a yellow appearance and rise almost sheer from the sea while those on the S and E sides are red and rise more gradually towards the summit. Dangers fronting the island are reported to all lie within 0.2 mile of the shores.

2.27 King George Island (62˚00'S., 58˚15'W.) lies with North Foreland, its NE extremity, located 28 miles WNW of Bridgeman Island. This island is fronted by numerous rocks and reefs. It is mostly covered with ice through which a few prominent nunataks rise.

Venus Bay (61˚55'S., 57˚54'W.) lies between North Foreland and **False Round Point** (61˚54'S., 58˚02'W.).

Esther Harbor (61˚55'S., 57˚59'W.), an inlet, lies at the W side of the head of the bay. Brimstone Peak, a steep and yellow bluff, forms the NE entrance point and Esther Nunatak forms the SW. A group of three small islets lies near the SW shore of the inlet and extends for about 1 mile in an E/W direction. These islets are 9m high and lie about 0.2 mile from the land ice which rests on a shelving, rock platform. Esther Harbor was formerly described as a good anchorage, but it has not been recently surveyed and is not presently recommended, even for small craft.

Foul ground, lying up to 1.8 miles offshore, fronts the coast between North Foreland and **Cove Rock** (61˚54'S., 57˚51'W.) and the SW side of Ridley Island. Foul ground, lying up to 1.3 miles offshore, also fronts the coast between False Round Point and Round Point.

Ridley Island (61˚51'S., 58˚03'W.), 254m high, is located 2 miles N of False Round Point; foul ground lies in between.

The coast trends 12.5 miles SW and W from False Round Point to **Round Point** (61˚56'S., 58˚28'W.). The waters lying off this stretch of the coast have not been fully surveyed.

2.28 Owen Island (61˚56'S., 58˚26'W.) and **Jagged Island** (61˚54'S., 58˚29'W.) lie about 1 mile E and 2.5 miles NNW, respectively, of Round Point. A rock, 12m high, lies 2 miles SW of Jagged Island.

Tartar Island (61˚56'S., 58˚29'W.) lies 0.5 mile NW of Round Point. A chain of rocks, lying between 2 and 8 miles offshore, extends along the E part of the N coast of King George Island. Numerous rocks and islets lie in this area and great care must be used navigating in the area.

Davey Point (61˚58'S., 58˚34'W.), conspicuous and rocky, is located 3 miles SW of Round Point.

Caution.—The N coasts of the islands in the South Shetland group are fringed by numerous rocks and reefs. Vessels should only approach these shores with extreme care. It is reported that the changes of depths in this area are sudden and give no warning of the dangers.

2.29 Stigant Point (62˚02'S., 58˚45'W.), 64m high and conspicuous, is located 10 miles W of Round Point. Foul ground lies off the coast in this vicinity and extends up to 2 miles offshore.

From this point, the coast extends for 15 miles SW to **Fildes Strait** (62˚14'S., 59˚00'W.), being heavily glaciated.

The **Flat Top Peninsula** (62˚13'S., 59˚02'W.), located 1 mile N of the SW extremity of King George Island, is fluted on its W side.

Numerous rocks and islets front the NW coast of the island. The **Atherton Islands** (62˚06'S., 58˚29'W.), two prominent islands, lie centered 8 miles SW of Stigant Point and attain heights of 40 and 44m.

Caraquet Rock (62˚07'S., 59˚02'W.) lies 4 miles WSW of **Bell Point** (62˚07'S., 58˚53'W.) and **Square End Island** (62˚10'S., 58˚59'W.) lies 3.3 miles NNE of the Flat Top Peninsula.

Sinbad Rock (62˚10'S., 59˚02'W.) lies 1.3 miles WNW of Square End Island; a below-water rock is reported to lie, position approximate, about 2.5 miles WNW of the Flat Top Peninsula.

Fildes Strait leads between the N extremity of **Nelson Island** (62˚18'S., 59˚03'W.) and the SW extremity of King George Island. The N entrance of this strait is foul and narrow and is navigable only by small boats. The tidal currents within the strait are reported to be so strong that passage is not recommended.

Several beaches, formed mostly of black sand and gravel, fringe the shores of the strait. Some scanty vegetation, consisting of thick-bladed tufts of coarse grass, grows on these beaches.

The NW side of the entrance to the strait is fronted by several dangers including **Upton Rock** (62˚12'S., 59˚08'W.), **Nancy Rock** (62˚13'S., 59˚06'W.), **Withem Island** (62˚14'S., 59˚09'W.), and **Weeks Stack** (62˚14'S., 59˚03'W.).

Nelson Island (62˚18'S., 59˚13'W.), 11 miles long and 7 miles wide, is completely ice-covered and has no conspicuous summit. A few bare-rock exposures lie near the coastal icecliffs. This island is completely fronted by many islets and rocks.

Duthoit Point (62˚19'S., 58˚50'W.), the E extremity of Nelson Island, forms the S entrance point of Fildes Strait.

Lone Rock (62˚21'S., 58˚50'W.), 3m high, lies 2 miles SW of **Pig Rock** (62˚19'S., 58˚48'W.), 65m high, at the S end of an area of rocks and foul ground which extends SE from Duthoit Point. A below-water rock is reported to lie, position approximate, about 2.3 miles ESE of Duthoit Point.

2.30 Edgell Bay (62˚16'S., 58˚59'W.), mostly unsurveyed, lies 4 miles N of Duthoit Point. **Spiro Hill** (62˚16'S., 59˚00'W.), 125m high and prominent, stands at the head of this bay. Anchorage can be taken, in a depth of 42m, about 0.8 mile SE of **Rip Point** (62˚15'S., 58˚59'W.), the NW entrance point of the bay.

Two Summit Island (62˚15'S., 58˚57'W.), 43m high and conspicuous, lies 1.3 miles NE of Rip Point and 0.3 mile S of **Halfthree Point** (62˚14'S., 58˚57'W.), the NE entrance point of Fildes Strait.

An isolated shoal patch, with a least depth of 11m, lies about 0.7 mile SW of the W extremity of this island. A narrow drying reef, about 0.3 mile long, lies 1.4 miles SSW of the W extremity of this island.

An unnamed point, located 1 mile SW of the W extremity of the island, projects into the W side of Edgell Bay; an area of shallow foul ground extends up to about 0.2 mile seaward from it. This foul area fronts the coast to the W of the point and extends up to about 0.3 mile offshore. Several rocks front this stretch of coast and lie up to 2.5 miles offshore.

Harmony Point (62˚19'S., 59˚15'W.) forms the W extremity of the island and the N entrance point of Harmony Cove. An extensive shoal area, with a least depth of 3m, lies about 4.5 miles WNW of this point. A shoal patch, with a depth of 10m, is reported to lie about 3.5 miles W of this point.

A racon is situated close E of this point.

Folger Rock (62˚16'S., 59˚15'W.), above-water, lies 2.5 miles N of Harmony Point.

Harmony Cove (62˚19'S., 59˚12'W.), lying on the W side of the island, is a small inlet. Its shores consist of low, rocky shelves which are backed by rocky mounds. Extensive penguin rookeries are situated in the vicinity of these mounds. This inlet provides no protection from the swell and is not recommended as an anchorage.

The Toe (62˚20'S., 59˚11'W.), marked by a beacon, forms the S entrance point to Harmony Cove.

Inca Point, a prominent headland, is located 1.3 miles E of Harmony Point. It is formed by a double rock and surmounted by a hut.

2.31 Ross Point (62˚21'S., 59˚08'W.) is located 4 miles SE of Harmony Point. The water lying to the E of a line joining these points has a light-green appearance, but this is believed to be due to the reflection from the glacier forming the coastline.

Shoals extend up to about 0.5 mile S of Harmony Point and foul ground extends up to about 0.5 mile offshore, for 1 mile E of the point. Numerous above and below-water rocks, some of which break heavily, lie on this area of foul ground. The S coast of Nelson Island between Ross Point and Duthoit Point, 8 miles ENE, is fringed with rocks.

Grace Rock (62˚22'S., 59˚01'W.), the southernmost of these rocks, lies 1 mile offshore, 3.5 miles ESE of Ross Point.

Maxwell Bay (62˚15'S., 58˚51'W.) lies between the SW end of King George Island and the NE side of Nelson Island. It is entered between **Stranger Point** (62˚16'S., 58˚37'W.) and Duthoit Point, the E extremity of Nelson Island.

Tu Rocks (62˚14'S., 58˚53'W.), a group consisting of three conspicuous islets, lies 2.3 miles SSW of **Nebles Point** (62˚12'S., 58˚52'W.). One of these islets is 4m high while the other two are 10m high. The S islet is marked by a beacon.

Ardley Island (62˚13'S., 58˚56'W.), 72m high, lies with Braillard Point, its NE extremity, located 0.8 mile WNW of Tu Rocks. The W end of this island is joined to the mainland by a drying spit. A light is shown from a structure, 6m high, standing on the N shore of this island.

Suffield Point (62˚12'S., 58˚55'W.), a conspicuous bluff, is located 1 mile N of Braillard Point.

Lapidary Point (62˚12'S., 58˚56'W.) is located 0.4 mile WSW of Suffield Point; Rocky Cove lies between them.

2.32 Jasper Point (62˚11'S., 58˚54'W.) is located 0.4 mile NE of Suffield Point; Norma Cove lies between them. This

point is faced by cliffs, which are composed of black and buff rocks with numerous veins of red and green jasper.

Ardley Cove lies 1 mile WSW of Suffield Point; a lighted beacon, 2m high, stands on the shore at its W end.

Teniente Marsh, a Chilean scientific station fronted by a small pier, and Bellingshausen, a Russian station, are situated at the head of this cove. An aeronautical radiobeacon is situated close N of the latter base.

Great Wall, a Chinese station, is situated close S of Ardley Cove and a quay, used by small craft, lies close to it. Artigas, a Uruguayan station, is situated in the vicinity of Jasper Point.

Anchorage, with good holding ground, can be taken, in a depth of 48m, mud, about 0.5 mile SW of Suffield Point. An airstrip is situated 1 mile N of Ardley Cove.

2.33 Collins Harbor (62˚11'S., 58˚51'W.), an inlet, can accommodate several large vessels. Anchorage can be taken, in depths of 22 to 29m, near the head. A survey indicated that the bottom near the middle of the entrance is irregular. When entering, vessels should favor the W side of the entrance in order to avoid a shoal, with a depth of 3m, lying 2.3 miles ENE of Suffield Point.

A spit, with depths of 9 to 18m, extends NNW from the E entrance point to the above shoal. A patch, with a depth of 13m, lies 2.3 miles ENE of Suffield Point.

Marion Cove (62˚13'S., 58˚48'W.) lies 2 miles SE of Collins Harbor. A shoal area, with depths of 2 to 6m, extends 0.3 mile NW from its S entrance point. A shoal patch, with depths of 7 to 9m, and an islet, 2m high, lie about 0.4 mile NNW and 0.5 mile ENE, respectively, of its S entrance point.

Noel Hill (62˚14'S., 58˚46'W.), a prominent slate knob, is 295m high and stands on the S side of this cove.

Foul ground and several below and above-water rocks lie on the N side of the cove, near its head. The cove is partly surrounded by icecliffs, but beaches front both sides of the entrance and a promontory stands on the S side of the entrance. Several hills, up to 95m high, rise behind the beach on the S side.

Foul ground fronts the N entrance point and a conspicuous square rock, 34m high, lies near the coast, 0.3 mile NNE of it. A group of rocks, one of which dries, lies 0.2 mile offshore, 1 mile E of the N entrance point. A shoal, with a depth of 6m, lies 0.2 mile farther ENE.

Anchorage by large vessels can be taken about 0.4 mile NE of the S entrance point; anchorage by small vessels can be taken near the head of the cove.

2.34 Potter Cove (62˚14'S., 58˚42'W.) lies 2 miles SE of Marion Cove, from which it is separated by a small peninsula.

Three Brothers Hill (62˚15'S., 58˚41'W.), 196m high, stands in the vicinity of this cove. It is very conspicuous and has been described as the neck of an extinct volcano.

Florence Nunatak (62˚13'S., 58˚37'W.), 342m high, rises 2.5 miles NE of Three Brothers Hill.

The cove is entered between an unnamed point, located 0.5 mile S of Three Brothers Hill, and **Winship Point** (62˚15'S., 58˚44'W.), 1.5 miles WNW.

A light is shown from a metal structure, 3m high, standing on the E side of the entrance to the cove, 0.3 mile NW of Three Brothers Hill. A beacon, 4m high, is situated 0.8 mile ENE of this light.

The coast trends 0.9 mile N from the E entrance point to a point located 0.2 mile NNW of Three Brothers Hill. It then extends 0.4 mile E to a stream on the E side of which stands a small, green pump house. The ruins of a jetty lie close E of the stream, but the beach in this vicinity slopes and is free from obstructions. This beach is reported to be the site of a colony of elephant seals. The low coast, with four huts standing along it, then continues ENE until it reaches an icecliff. This icecliff, which is 30 to 49m high, extends 0.6 mile N and then 1.5 miles WSW. Over time, the position of the face of the icecliff is reported to change.

From the SW end of the icecliff, a stony beach, backed by steep and snow-clad hills, extends 0.9 mile SSW to the W entrance point of the cove. A prominent outcrop stands midway along this beach and a lagoon forms in the shingle by the icecliff during the summer. A reef, which dries 2m in places, extends 0.2 mile from the shingle beach, opposite the N end of the lagoon. An area of foul ground, with numerous rocks, lies N of this reef. A rock, 8m high, lies 0.2 mile offshore, about 0.2 mile S of the lagoon.

Three above-water rocks, the tallest being 14m high, lie on a drying, rocky ledge which extends 0.2 mile S from the W entrance point of the cove. Two rocks, 22 and 23m high, lie 0.3 mile farther W and are prominent. Between the rocky ledge and these two rocks, a small beach fringes the shore and can be used as landing by boats, but care should be taken as many small reefs lie in the vicinity of the ledge.

It was reported that a vessel anchored, in a depth of 31m, black soft mud, near the head of the cove. This anchorage berth was reported to be sheltered, except from SE winds, and appeared to afford better holding ground than farther seaward. Vessels can also anchor about 0.3 mile NNW of the pump house with their sterns made fast to bollards on the shore. Such vessels should anchor with their sterns about 0.2 mile offshore. However, care must be taken as this places the stern of the vessel between two shoals, each with a depth of 6m.

Continual falls may be expected from the icecliff during the melt season and the cove often becomes filled with brash ice and blocks of stranded ice, making landings difficult. Potter Cove is recommended as a harbor of refuge, with good anchorage, during bad weather.

2.35 Admiralty Bay (62˚10'S., 58˚25'W.) (World Port Index No. 63090) lies between Demay Point and **Martins Head** (62˚11'S., 58˚14'W.), a prominent headland. The bay is irregular and contains three **Ezcurr Inlet** (62˚10'S., 58˚34'W.), **Mackeller Inlet** (62˚05'S., 58˚28'W.), and **Martel Inlet** (62˚05'S., 58˚22'W.). These inlets and the bay offer shelter from all winds and provide anchorage in moderate depths.

The entrance of the bay is clear and depths over 360m extend to the entrance to Martel Inlet.

Demay Point rises to The Tower, a prominent peak, the summit of which is formed by a square nunatak, 367m high. Telefon Point is located 1.8 miles SW of Demay Point and Telefon Rocks, up to 24m high, lie 1 mile E of it. Sentry Cove, a small inlet, indents the S side of Demay Point.

The shores along both sides of the bay are covered with glaciers. On the E side, the Vieville Glacier extends from **Vaureal Peak** (62˚11'S., 58˚18'W.) to **Point Hennequin** (62˚08'S., 58˚24'W.), 4.5 miles inside the bay. A sandy beach, on which a landing can be made, extends 0.8 mile N from this point. On the W side, glaciers slope from the heights to the water's edge between Demay Point and **Point Thomas** (62˚10'S., 58˚30'W.), is 4 miles inside the bay.

Sphinx Hill (62˚11'S., 58˚27'W.) stands close to the shore, midway between Demay Point and Point Thomas. This peak is conspicuous, isolated, black, and 296m high.

The coast is fronted by foul ground as far as 1.5 miles ESE of Point Thomas. **Napier Rock** (62˚10'S., 58˚26'W.), 5m high, lies 1.5 miles SE of Point Thomas. Shoals, with depths of 7 and 6m, lie 2.1 miles SE and 1.9 miles SE, respectively, of Demay Point.

A light is shown from a metal tower with a gallery, 8m high, standing in the vicinity of Point Thomas. A hut stands near this light.

Ezcurra Inlet is entered between Point Thomas and **Denais Stack** (62˚08'S., 58˚30'W.), a conspicuous rocky stack, lying 1.5 miles N. **Dufayel Island** (62˚10'S., 58˚34'W.) occupies the center of this inlet. The W end of this island is fringed by a shoal which has depths of 6 to 8m and extends up to 0.2 mile offshore. The outer edge of this shoal is steep-to and slopes abruptly to a depth of 37m. Vessels usually enter the inlet by passing to the N of the island and leave by passing to the S.

2.36 **Cardozo Cove** (62˚10'S., 58˚37'W.) and **Goulden Cove** (62˚11'S., 58˚38'W.) indent the SW end of the inlet. These coves both have glaciers at their heads and are separated by Rhyolite Head, a prominent headland. **Herve Cove** (62˚11'S., 58˚33'W.) and **Monsimet Cove** (62˚11'S., 58˚34'W.), two small indentations, lie on the S side of the inlet, S of Dufayel Island.

Anchorage is available, in a depth of 18m, to the SW of the island. The holding ground is good, but the shelter is poor as squalls can blow from all directions. Care must also be taken to avoid a shoal, with a depth of 6m, lying 0.2 mile W of the island.

The **Lange Glacier** (62˚07'S., 58˚30'W.) reaches the W side of Admiralty Bay between Denais Stack and **Crepin Point** (62˚06'S., 58˚29'W.), 2.5 miles N.

Admiralen Peak (62˚06'S., 58˚30'W.), 305m high and prominent, rises 1 mile SW of Crepin Point.

Wegger Peak (62˚06'S., 58˚31'W.), 304m high and prominent, stands 0.8 mile N of Admiralen Peak.

Cockscomb Hill (62˚05'S., 58˚30'W.), 141m high and conspicuous, rises 1 mile N of Crepin Point.

Mackeller Inlet is entered between Crepin Point and **Plaza Point** (62˚06'S., 58˚26'W.), 1.8 miles E. A shoal, with a depth of 2m, lies 0.5 mile WNW of Plaza Point. Depths of over 35m extend as far as the head of this inlet, but shoals, with a least depth of 4m, extend W from the **Keller Peninsula** (62˚05'S., 58˚26'W.) to the W side of the inlet.

2.37 Martel Inlet is separated from Mackeller Inlet by the Keller Peninsula, which is surmounted by several peaks up to 305m high. The inlet is divided by an extensive shoal area, with depths of less than 11m, which extends 0.8 mile SSE from the middle of its NW side. A below-water rock lies on this shoal area, 1.3 miles NW of Plaza Point. The shores of this inlet are fringed by numerous rocks.

Visca Anchorage (62˚05'S., 58˚24'W.) lies at the W side of the head of Martel Inlet and is divided by a small peninsula. This latter peninsula is 48m high and its summit is surmounted by a cairn.

Stenhouse Bluff (62˚04'S., 58˚24'W.), a headland, forms the SE end of the peninsula. O'Connors Rocks, up to 0.9m high, lie about 0.2 mile off the SW part of the peninsula, 0.2 mile W of the headland. A shoal area, with depths of 5 to 11m, extends up to about 0.3 mile S from the headland. A rock, with a depth of 4m, lies about 0.2 mile ESE the headland.

Sea Leopard Patch (62˚05'S., 58˚24'W.), with a least depth of 18m, lies 0.4 mile SSW of Stenhouse Bluff.

Above-water rocks extend up to about 0.2 mile S from Plaza Point. A shoal, with a depth of 7m, lies about 0.2 mile ESE of Plaza Point. A shoal, with a depth of 5m, extends about 0.2 mile into the inlet, 0.7 mile NE of Plaza Point.

A meteorological station, which was abandoned in 1961, is situated on the W side of Martel Inlet and an anemometer tower, 21m high, stands close N of it. A grave, marked by a cairn surmounted by a wooden cross, is situated 0.2 mile NW of this tower.

Convenient anchorage can be taken, in a depth of 31m, mud, about 0.3 mile ENE of the tower. The holding ground is good, but this roadstead is subject to violent squalls and strong winds. Sheltered anchorage is obtainable on the SE side of Martel Inlet within **Lussich Cove** (62˚06'S., 58˚21'W.). The berth has depths of 8 to 29m over a bottom of glacial mud.

Ternyck Needle (62˚05'S., 58˚16'W.), a prominent black nunatak, projects through the glacier on the NE side of the inlet, 4.8 miles ENE of Plaza Point.

Caution.—A local magnetic anomaly, up to 3˚, has been reported to exist within Martel Inlet, close E of Plaza Point.

2.38 **Lions Rump** (62˚08'S., 58˚07'W.) is located 5 miles NE of Martins Head. The coast between consists of a conspicuous and rocky cliff, up to 277m high, which is composed of dark gray columns of basalt.

Legra Bay (62˚10'S., 58˚12'W.) lies between **Loe Head** (62˚09'S., 58˚08'W.) and Martin Head. The beaches in this vicinity are steeply shelving and composed mainly of coarse shingle. Low Head is located 1.5 miles S of Lions Rump; the coast between is fringed by foul ground which extends up to 0.5 mile offshore. Shallow rocks, positions approximate, are reported to lie about 0.8 mile and 1 mile SE of Low Head.

King George Bay (62˚06'S., 58˚05'W.) is entered between Turret Point and Lions Rump, 5.5 miles SW. Its shores consist of low and level ice faces, fronted by shingle beaches. This bay is deep, but a number of islets and rocks obstruct its W side. These include **Twin Pinnacles** (62˚08'S., 58˚06'W.), **Growler Rock** (62˚07'S., 58˚08'W.), **Martello Tower** (62˚06'S., 58˚08'W.), and **Stump Rock** (62˚05'S., 58˚08'W.).

Vessels have taken temporary anchorage, in a depth of 37m, about 1 mile W of **Deacon Peak** (62˚06'S., 57˚54'W.); in a depth of 42m about 0.4 mile NE of Twin Pinnacles; and in a depth of 62m about 0.4 mile E of Growler Rock.

Vessels have also anchored, free from ice, in a depth of 37m, about 1 mile W of Penguin Island. Winds blowing from the W

at 25 to 30 knots were experienced in this anchorage, but the shelter proved satisfactory. This anchorage was also considered to be good during E winds.

2.39 **Penguin Island** (62˚06'S., 57˚54'W.), which is prominent, marks the E entrance to King George Bay. Deacon Peak, a volcanic cone, forms the summit of this island and is 171m high. The N part of the island consists of a plateau, 15m high, in which lies an extinct crater.

Penguin Island is separated from **Mersey Spit** (62˚05'S., 57˚55'W.) by a narrow strait which is obstructed with below-water rocks. The shores of the island are formed by large boulders and landing is difficult in all but calm weather. Depths of less than 6m extend up to 0.4 mile W of the island and depths of less than 18m extend up to 1 mile SW of Turret Point. A shoal, with a depth of 14.6m, lies about 4 miles E of the island. Anchorage can be obtained, in depths of 15 to 36m, black gravel and sand, to the W and SW of Penguin Island. Irregular depths were reported to lie 4 miles ENE of the E extremity of the island and rapid shoaling was reported to occur about 1 mile ENE of the island. It is recommended that great care be used when approaching the E side of the island and vessels should not anchor here. Anchorage can also be taken, in a depth of 42m, on the W side of the bay, about 0.5 mile N of Twin Pinnacles.

Mersey Spit lies 1 mile SW of **Three Sisters Point** (62˚04'S., 57˚53'W.) and is located on the E side of a small promontory. Turret Point, the E entrance point of the bay, forms the W extremity of this promontory.

Sherratt Bay (62˚02'S., 57˚50'W.) lies between Penguin Island and Cape Melville. **Penola Island** (62˚02'S., 57˚51'W.) is small and lies within this bay.

Cape Melville (62˚02'S., 57˚37'W.), 183m high, forms the E extremity of King George Island. This cape consists of a narrow, level, and rocky tongue which is backed by cliffs.

Melville Peak (62˚01'S., 57˚41'W.), 549m high, rises about 3 miles W of the seaward extremity of the cape.

Between Cape Melville and North Foreland, 7 miles N, the coast consists of sheer, crumbling cliffs with numerous rock falls and landslides of great size. This stretch of coast is fringed by rocks, reefs, and foul ground, which extend up to about 0.8 mile offshore, and should be given a wide berth.

Rocks, on which the sea breaks continuously, lie 0.8 mile S and 1.5 miles NE of Cape Melville. Rocks and foul ground extend up to 1.5 miles offshore between the cape and North Foreland.

Vessels are advised to pass at least 3 miles off Cape Melville.

2.40 **Foreland Island** (61˚57'S., 57˚39'W.), 24m high, lies 3.5 miles SSE of North Foreland and **Middle Island** (61˚58'S., 57˚38'W.) lies 1.5 miles farther S.

Simpson Rocks (61˚58'S., 57˚23'W.), up to 9m high, lie 7 miles NE of Cape Melville and should be given a wide berth. A navigable channel leads between Simpson Rocks and **Hauken Rock** (62˚01'S., 57˚33'W.), the outer group of rocks lying NE of Cape Melville.

Nelson Strait (62˚20'S., 59˚18'W.) leads between Nelson Island and **Robert Island** (62˚24'S., 59˚30'W.). It is deep and clear, particularly on the E side. However, this passage is not recommended, except in clear weather, due to strong tidal currents, tide rips, and a difficulty in identifying local features.

Parry Patch (62˚17'S., 59˚22'W.), with a least depth of 6m, lies in the W approaches, about 3.5 miles WNW of Harmony Point. Several shoals lie close NW, W, and SW of this shoal patch. After passing **Table Island** (62˚21'S., 59˚49'W.), Nelson Strait forms the shortest route leading to Potter Cove or Admiralty Bay, especially in November and December. The strait and its E end are clear of dangers, while some shoal patches lie at the W end. These include **Mellona Rocks** (62˚18'S., 59˚30'W.), **Liberty Rocks** (62˚19'S., 59˚27'W.), and **Salient Rock** (62˚22'S., 59˚20'W.). These rocks lie on the SW side of the strait and are among the outermost dangers. Foul ground fronts the NE shore of Robert Island and extends between 1.5 and 2.5 miles offshore. A shoal patch, with a least depth of 10m, lies about 3.5 miles W of Harmony Point.

2.41 Robert Island, 11 miles long, lies in a NW/SE direction and is 6 miles wide at its E end. This island is completely ice-covered and has no prominent peaks or other features. Only the SW and NW extremities of the island appear free of the enveloping snow and ice. The N coast of the island is fringed by foul ground.

From **Robert Point** (62˚28'S., 59˚23'W.), the SE extremity of the island, the E coast extends N for 5 miles and then WNW for 6 miles to **Newell Point** (62˚20'S., 59˚32'W.). This stretch of the shore is fronted by numerous rocks. A beacon is reported to stand on Robert Point.

From Newell Point, the coast extends W for 2.5 miles to a promontory. A shoal, with a depth of 6.4m, lies about 4 miles NNE of Newell Point. Foul ground extends up to about 4 miles seaward from the N side of Robert Island.

Clothier Harbor (62˚22'S., 59˚40'W.), an inlet, lies close W of the promontory and is completely surrounded by a maze of islets and rocks, many of which are below-water. Hence, extreme care must be exercised when approaching this area.

A rock, with a least depth of 1.5m, lies near the middle of the harbor and restricts the area available for anchoring. However, the roadstead can accommodate about nine small vessels. This anchorage has depths of 7 to 9m over a blue-clay bottom. Generally, one tide occurs every 24 hours with a rise of about 2.9m, but at times the tides are irregular.

Heywood Island (62˚20'S., 59˚41'W.) lies about 2 miles NW of Clothier Harbor.

2.42 **Fort William** (62˚23'S., 59˚43'W.), a conspicuous cape, forms the W extremity of the island. It is 90m high and comparatively free of ice and snow. A light is shown, between 15 November and 15 May annually, from a structure, 9m high, standing on this cape.

The **Coppermine Peninsula** (62˚22'S., 59˚43'W.) is flat-topped; its SE part is irregular and sloping. Fort William forms the extremity of the NW part of this peninsula. The entire area in the vicinity of the Coppermine Peninsula has been designated a Specially Protected Area.

Tide rips have been reported to extend up to about 0.2 mile W, S, and SE of Fort William. Two rocks, awash, with an above-water rock between them, lie about 0.5 mile SSE of the cape.

2.43 Coppermine Cove (62˚23'S., 59˚42'W.) lies on the W coast of Robert Island, close SE of Fort William.

The Triplets (62˚24'S., 59˚41'W.), a three-pointed peak, stands 1.8 miles SE of Fort William and surmounts the SE entrance point of the cove.

A bay indents the SW side of Robert Island and is entered about 1 mile SE of The Triplets. Numerous above and below-water rocks fringe the SW entrance point of this bay and extend up to 0.2 mile offshore. Anchorage can be taken, in a depth of 40m, on the W side of this wide bay, about 0.9 mile E of The Triplets. However, depths of less than 10m lie up to 0.3 mile from the coast, close NE of this anchorage. There are no known dangers on the E side of this bay.

Edwards Point (62˚29'S., 59˚30'W.), located 3.3 miles WSW of Robert Point, forms the S extremity of the island and also the N entrance point on the SE side of English Strait. A light is shown, between 15 November and 15 December annually, from a structure, 21m high, standing on the point.

English Strait (62˚27'S., 59˚38'W.) leads between Robert Island and **Greenwich Island** (62˚31'S., 59˚47'W.). It is deep and clear throughout, but the tidal currents are strong and variable and a dangerous NE set has been experienced. The NW entrance is encumbered with many islets and rocks. The outermost of these dangers is a rock, awash, which has been reported to lie about 17.5 miles NW of Fort William. The sea breaks heavily on this rock and its position is reported to be doubtful.

In the narrowest part of the strait, between **Passage Rock** (62˚23'S., 59˚45'W.) and Fort William, overfalls, which are dangerous to boats, occur. In addition, eddies have been reported to exist at times close to Fort William.

Table Island lies 2.5 miles NW of Fort William and is the most prominent object in the approaches to the strait. This island, 181m high, is perfectly level and its sides resemble a wall. A prominent cleft is located in the upper part of the NE end of the island. A rock, with a least depth of 8m, lies about 0.5 mile NE of Table Island.

2.44 The Watchkeeper (62˚18'S., 59˚49'W.), a low rock, lies 2.3 miles N of Table Island and has below-water rocks, which break, located about 0.5 mile W and 0.3 mile N of it. Another rock, awash, was reported to lie about 1 mile N of The Watchkeeper.

Asses Ears (62˚19'S., 59˚45'W.), a group of islets, lies 1.8 miles NE of Table Island. The northwesternmost islet of this group presents the appearance which suggests the name.

Monica Rock (62˚20'S., 59˚44'W.), 2m high, stands at the S end of a shoal, with a least depth of 4m, which lies 1.5 miles SSE of Asses Ears. Other shoal patches are reported to lie within 0.3 mile of this rock.

Turmoil Rock (62˚21'S., 59˚47'W.), awash, lies 0.8 mile SE of Table Island.

Chaos Reef (62˚22'S., 59˚46'W.) extends between Turmoil Rock and **Passage Rock** (62˚23'S., 59˚45'W.). A rock, 1m high, lies on the reef. Passage Rock is 18m high and lies 0.3 mile W of Fort William. Several dangers lie between Turmoil Rock and Passage Rock and foul ground extends up to 0.5 mile farther SSE.

Cheshire Rock (62˚22'S., 59˚45'W.), 1m high, lies 0.2 mile SSE of Passage Rock.

Bowler Rocks (62˚21'S., 59˚50'W.) lie 0.5 mile SE of Table Island, with **Holmes Rock** (62˚23'S., 59˚50'W.) and **Stoker Island** (62˚24'S., 59˚51'W.) lying 1.5 and 2.5 miles, respectively, farther SSW. The area in the vicinity of these rocks has not been examined.

Morris Rock (62˚23'S., 59˚48'W.), 53m high, lies 1.4 miles S of Table Island and is the northernmost of a scattered group of islands, rocks, and foul ground known as the Aitcho Islands.

The **Aitcho Islands** (62˚24'S., 59˚47'W.) lie on the SW side of English Strait and extend 3.5 miles SE between Morris Rock and **Cecilia Island** (62˚25'S., 59˚43'W.), which is 60m high. This group also includes **Jorge Island** (62˚23'S., 59˚46'W.), **Emeline Island** (62˚24'S., 59˚48'W.), and **Sierra Island** (62˚24'S., 59˚48'W.).

Dee Island (62˚26'S., 59˚47'W.), lying 1 mile off the N coast of Greenwich Island and 3 miles SW of Fort William, has a prominent double summit. Burro Peaks, 191m high, is prominent and rises near the S side of the island.

2.45 Greenwich Island (62˚28'S., 59˚48'W.), lying SW of Robert Island, consists of two parts which are joined by a narrow isthmus. This island is entirely ice-capped and rocky bluffs along the coasts form capes which project beyond the glaciers. The N coast of the island is fronted by foul ground and should not be approached within 5 miles.

Mount Plymouth, 518m high, stands near the center of the N part of the island. Two black and conspicuous peaks stand on the W side of the N part of the island. **Greaves Peak** (62˚28'S., 59˚59'W.), the westernmost, is 236m high and has sharp, double-pointed peak. **Crutch Peak** (62˚28'S., 59˚56'W.), 277m high, has a rocky peak and stands 1.5 miles E of Greaves Peak.

The N coast of the island between **Canto Point** (62˚27'S., 59˚44'W.) and **Duff Point** (62˚27'S., 60˚02'W.), the W extremity, is fronted by foul ground and several small islands which lie up to 5 miles offshore. These small islands include **Ongley Island** (62˚26'S., 59˚54'W.) and **Romeo Island** (62˚23'S., 59˚55'W.).

2.46 Discovery Bay (62˚29'S., 59˚43'W.) is entered on the W side of English Strait, between Canto Point and **Ash Point** (62˚29'S., 59˚39'W.), 2.3 miles SE. This bay recedes for 2.5 miles and is mostly fringed by icecliffs that are backed by featureless snow slopes, up to 300m high.

Ash Point consists of a low, rounded, and ash-covered promontory. It is steep-to with no off-lying dangers. A beacon, 6m high, stands on the point.

Poisson Hill (62˚29'S., 59˚39'W.), a rocky outcrop, is located 0.4 mile SSE of Ash Point. It is 80m high and marked by a beacon.

Lopez Nunatak (62˚29'S., 59˚39'W.), steep-sided and 254m high, stands 1 mile SSE of Ash Point.

Good anchorage may be obtained, in a depth of 40m, mud with good holding ground, about 0.6 mile NNW of **Fuente Rock** (62˚30'S., 59˚41'W.). Good anchorage can also be taken about 0.3 mile WSW of **Gonzalez Island** (62˚29'S., 59˚40'W.).

It is reported that tanker vessels anchor within the bay lying between the **Guesalaga Peninsula** (62˚29'S., 59˚40'W.) and Ash Point, where there is a jetty, 21m long, and several stern mooring posts.

2.47 Capitan Prat, a Chilean base, is situated at the head of **Iquique Cove** (62˚29'S., 59˚40'W.). Three radio masts, the tallest of which is 26m high, stand close to the base.

The Guesalaga Peninsula forms the NW side of this cove. It is low, shingle-covered, and surmounted by a prominent wooden cross and a small chapel. The cove, which lies NE of Gonzalez Island, forms a sheltered harbor for boats. Numerous rocks and reefs lie within the cove, in the entrance, and in the approaches. Local knowledge is advised. Boats without local knowledge should proceed with great care and should keep as close as possible to the N side of Gonzalez Island in order to avoid most of the dangers.

2.48 **Ferrer Point** (62˚30'S., 59˚42'W.), ice-free, is 47m high and fringed by many islets and rocks which extend up to 0.4 mile N of it. Fuente Rock, 9m high, lies about 0.4 mile N of the point and is marked by a beacon.

Canto Point, 61m high, has four conspicuous, rocky outcrops at its extremity. This point is fringed, on its E side, by numerous off-lying rocks and shoals. These dangers include **Bonert Rock** (62˚27'S., 59˚43'W.), which is 6m high, and **Ibar Rocks** (62˚27'S., 59˚43'W.), the outermost, which are 1m high and lie 0.7 mile ESE of the point. A shoal, with a depth of 8m, is reported to lie about 0.3 mile E of Ibar Rocks.

From Canto Point, the W shore of the bay trends S for 1 mile and then icecliffs extend SSW for 2.5 miles. This stretch of coast is fringed by foul ground which extends up to 0.5 mile offshore.

Tenorio Rock (62˚28'S., 59˚44'W.), 1m high, lies about 1.5 miles SSW of Canto Point.

Anchorage can be taken, in a depth of 31m, mud, about 1.3 miles SSW of Ash Point. Anchorage was also reported to have been taken, in a depth of 48m, thick mud, off the base with the E tangent of the NE extremity of Greenwich Island bearing 342˚ and the W tangent of the peninsula, which is located 2.5 miles SSW of Ash Point, bearing 191˚.

2.49 **Yankee Harbor** (62˚32'S., 59˚47'W.), an inlet, lies on the W coast of Greenwich Island and is formed by volcanic debris.

Glacier Bluff (62˚32'S., 59˚48'W.) forms the N entrance point of Yankee Harbor; **Spit Point** (62˚32'S., 59˚48'W.), marked by a beacon, forms the S entrance point. Foul ground and several shallow shoals are reported to lie up to about 0.3 mile S of Glacier Bluff. Foul ground is also reported to fringe the NE side of Spit Point. A rock, the position of which is doubtful, is reported to lie about 1 mile S of Spit Point.

A lofty escarpment of volcanic rocks stands close SE of the harbor and a glacier extends to the harbor shore. The harbor can accommodate several vessels, but it provides very little protection from heavy offshore gusts, particularly during E winds.

Anchorage can be taken, in depths of 29 to 33m, brown ash, about 0.2 mile E of Spit Point or, in a depth of 37m, about 0.5 mile E of the point. Anchorage can also be taken, in a depth of 46m, about 0.4 mile E of Spit Point. Although the anchor sinks deeply into the bottom, the holding ground is reported to be unreliable.

Hospital Point (62˚32'S., 59˚47'W.) is located 0.5 mile E of Glacier Bluff and a patch, with a depth of 15m, lies about 0.2 mile S of it. A rocky spit, with depths of less than 15m, extends about 0.2 mile S from the point. Rocks, awash, and depths of less than 6m lie up to 0.2 mile from the SE side of the harbor, near its S end. The harbor is otherwise clear of dangers to within 0.2 mile of the shore.

Anchorage has also been taken, in a depth of 59m, mud bottom, SE of **Triangle Point** (62˚32'S., 59˚51'W.). This anchorage was taken with Spit Point bearing 073.5˚ and Triangle Point bearing 311˚.

The rocky spit and shoals lying across the entrance protect the inner part of the harbor from rough seas and high winds. Anchorage can also be taken, in a depth of 31m, to the E of Triangle Point and about 1 mile W of Spit Point.

2.50 **Sartorius Point** (62˚34'S., 59˚39'W.), the S extremity of the island, is located 2.5 miles SW of Fort Point.

Ephraim Bluff (62˚34'S., 59˚43'W.), located 2 miles W of the point, forms the N entrance point of the SE entrance to McFarlane Strait. Reefs extend up to 0.5 mile S from this bluff.

Santa Cruz Point (62˚31'S., 59˚33'W.), the NE extremity of Greenwich Island and the S entrance point at the SE end of English Strait, is located 3.5 miles SE of Ash Point.

Fort Point (62˚33'S., 59˚35'W.), conspicuous, is located 3 miles S of Santa Cruz Point.

Hardy Cove (62˚32'S., 59˚35'W.) lies between Santa Cruz Point and Fort Point.

McFarlane Strait (62˚32'S., 59˚55'W.), lying between Greenwich Island and Livingston Island, is wide and clear at its S entrance, but narrow and foul at its N entrance. Except for small vessels with local knowledge, passage through this strait is not recommended. The tidal currents are strong, sometimes attaining rates of 5 or 6 knots, and there are numerous tide-rips and eddies.

The outermost danger in the NW approaches to the strait is a small, above-water rock which lies about 7.5 miles NW of Duff Point, the E entrance point at N end. Other dangers, consisting of below-water rocks, lie between 4.5 miles SW and 3 miles SSW of the above-water rock.

Pyramid Island (62˚26'S., 60˚06'W.), 206m high, lies about 2 miles NNE of **Williams Point** (62˚28'S., 60˚09'W.). It is conspicuous and has vertical sides. An unexamined shoal, with a reported least depth of 14.6m, lies about 2 miles NW of this island.

The **Zed Islands** (62˚26'S., 60˚10'W.) lie 1.5 miles NW of Williams Point. The W and tallest of these islands is 290m high.

Eliza Rocks (62˚26'S., 60˚14'W.), up to 8m high, lie about 1 mile WSW of Zed Islands.

2.51 The **Meade Islands** (62˚27'S., 60˚05'W.) lie close S of Pyramid Island, in the middle of the N entrance of the strait.

Cone Rock (62˚27'S., 60˚07'W.), 6m high, and **Channel Rock** (62˚28'S., 60˚05'W.), above-water, lie about 1 mile NNW and 0.8 mile S, respectively, of the Meade Islands. A beacon, 5.5m high, stands on Channel Rock.

Foul ground extends up to 1 mile E of Williams Point and constricts the passage, to the W of the Meade Islands, to a navigable width of only about 0.3 mile.

Cave Island (62˚27'S., 60˚04'W.) lies close within the entrance of the strait, near the E end of the Meade Islands.

Entering the strait from the SE and after passing Fort Point, vessels can easily identify Ephraim Bluff. This high bluff has one or two prominent outcroppings of dark rock on its S side. Below-water rocks lie off this bluff and extend up to about 0.5 mile offshore. Below-water rocks also front Triangle Point, the outer N entrance point of Yankee Harbor.

Livingston Island (62˚36'S., 60˚30'W.), 39 miles long, extends in an E/W direction and is 2 to 19 miles wide. The E part of this island is very mountainous and ice-capped, except on the steep slopes which form the coast. Between these slopes, ice cliffs descend to the water's edge. Several prominent and rugged peaks, partly ice-free, extend across the island with broad ice-filled depressions between them. The coast of the island consists of exposed rock ridges and glacier fronts. The W part of the island is very low and flat while, in sharp contrast, the E part has a wild mountainous topography.

Mount Bowles (62˚37'S., 60˚12'W.), the most prominent summit, stands 10 miles W of Renier Point.

Mount Friesland (62˚40'S., 60˚12'W.), 1,770m high, is prominent and stands in the interior of the E part of the island.

Bays indent all sides of the island, except the SE coast, which consists of one continuous ice face.

Renier Point (62˚37'S., 59˚48'W.), the E extremity of the island, forms the SE entrance point of McFarlane Strait. This point is massive, ice-free in summer, and gives the appearance of a bent needle from a distance.

Rugged Rocks (62˚37'S., 59˚48'W.), up to 1.5m high, extend about 1 mile NW from Renier Point. A reef, awash, lies 0.3 mile NW of these rocks. A rock, existence doubtful, lies close to the shore, 0.5 mile SW of the point.

Caution.—A dangerous wreck was reported (1997) to lie about 0.8 mile NNW of the outermost charted rock of Rugged Rocks. A dangerous rock was reported to lie 0.8 mile N of Renier Point.

2.52 The N side of the entrance to **Moon Bay** (62˚35'S., 60˚00'W.) is formed by **Edinburgh Hill** (62˚33'S., 60˚01'W.), a conspicuous and volcanic knob. This knob consists of a pillar, 95m high, which rises out of the sea and is connected to the shore by a narrow spit of loose rocks. Several below-water rocks lie close to the shore, near this knob.

Half Moon Island (62˚36'S., 59˚55'W.), 101m high, lies in the SE part of this bay. Anchorage may be taken, in depths of 13 to 27m, within a cove lying on the E side of this island. However, the holding ground is not considered to be very good and several rocks lie close off the entrance points of the cove. Teniente Camara, an Argentinean base, stands on the island, but was reported to be inactive. A beacon surmounts a small peak, 40m high, which stands near the SE extremity of the island.

Moon Bay is deep and affords protection from all winds except those from the E quadrant. Numerous rocks, awash, lie up to 0.4 mile off the S shore of the bay as far as about 3 miles W of Renier Point.

Inott Point (62˚32'S., 60˚00'W.) is located 5.8 miles SSE of **Williams Point** (62˚28'S., 60˚09'W.) and is backed by **Sharp Peak** (62˚32'S., 60˚04'W.), 425m high. Samuel Peak, another prominent hill, rises 2.5 miles WSW of Sharp Peak.

Dragon Cove (62˚28'S., 60˚08'W.), a small inlet, lies on the W side of McFarlane Strait, 1 mile SSE of Williams Point. Lister Cove, another small inlet, lies 2 miles farther SE.

The N coast is fronted by many dangers and vessels should give it a wide berth.

2.53 Hero Bay (62˚31'S., 60˚27'W.) lies between Williams Point and Black Point, a rocky headland, 15 miles W. Numerous islets and rocks lie within this bay to the S and SW of Desolation Island.

Siddons Point (62˚33'S., 60˚26'W.), a conspicuous promontory, is located in the middle of the S shore of this bay.

Desolation Island (62˚28'S., 60˚22'W.) lies in the E part of Hero Bay, about 5 miles W of Williams Point. From a distance, this island presents an unusual appearance of stratification which is caused by chasms in the black rock being filled with snow.

Cape Danger (62˚27'S., 60˚23'W.), the N extremity of Desolation Island, is located 5 miles W of Williams Point and is 60m high. A group of below-water rocks lies 0.4 mile N of this cape. These rocks are very dangerous in calm weather, especially since the tidal currents in this vicinity set strongly in both directions.

2.54 Craggy Island (62˚28'S., 60˚19'W.) forms the NE side of **Blythe Bay** (62˚28'S., 60˚20'W.). A below-water rock, existence doubtful, is reported to lie about 0.6 mile E of this island.

Cora Cove (62˚28'S., 60˚21'W.), a boat harbor, lies on the NW side of Blythe Bay. A small pond and a well, from which good water has been obtained, are situated in the vicinity of this cove.

A group of small islands and rocks, including **Wood Island** (62˚29'S., 60˚19'W.) and **Indian Rocks** (62˚29'S., 60˚17'W.), extends S and E from the S extremity of Craggy Island.

Anchorage may be taken, in a depth of 18m, within Blythe Bay, but the holding ground is uncertain. Vessels should not anchor in depths of less than 15m as the bottom in shallower depths is foul. Great care should be taken when selecting a berth as although the bottom feels soft, it may consist of only rocks covered with seaweed.

Gales from the NW are infrequent along this coast, but they are violent and vessels should seek shelter within Blythe Bay.

The **Dunbar Islands** (62˚29'S., 60˚12'W.), a group of small islands, lie between 1.5 miles and 2.5 miles SW of Williams Point. A chain of above-water rocks, lying 1 mile N of Siddons Point, extends NW into the bay and terminates in a rock, awash, which is located 5 miles E of **Black Point** (62˚29'S., 60˚43'W.).

Chapman Rocks (62˚30'S., 60˚29'W.) and **Lynx Rocks** (62˚32'S., 60˚32'W.) lie 3.5 miles NNW and 3.3 miles W, respectively, of Siddons Point. A bay lies between Black Point and Cape Shirreff, 3.5 miles NW; **Fortin Rock** (62˚29'S., 60˚44'W.), which is conspicuous, lies in its center.

2.55 Half Moon Beach (62˚29'S., 60˚47'W.) lies on the E side of Cape Shirreff. A dangerous ledge of rocks has been reported to lie about 0.5 mile E of this cape.

A below-water rock, which breaks heavily, is reported to lie about 3 miles E of Cape Shirreff and an underwater obstruction is reported to lie about 1.2 miles N of Black Point.

Shirreff Cove (62˚28'S., 60˚48'W.), which is sheltered, lies on the W side of Cape Shirreff.

San Telmo Island (62˚28'S., 60˚49'W.) lies on the W side of the entrance to the cove and provides protection. The best anchorages lie close NE of this island and 0.2 mile SE of it. These berths have depths of 33 to 40m over a good bottom of blue clay.

Winds from the NW blow directly into Shirreff Cove and, if of any strength, cause the sea to break heavily across the entrance. It is reported that a swell usually sets into the cove, causing vessels to roll considerably.

Barclay Bay (62˚33'S., 60˚58'W.) lies on the N coast between Cape Shirreff and **Start Point** (62˚35'S., 61˚13'W.), 14 miles SW. This bay recedes for about 4 miles and is reported to be filled with numerous below-water rocks. Dangers are reported to front the E and S coasts extending up to 2 miles offshore. Anchorage within this bay is not recommended.

Campastri, a group of two rocks, lies about 5 miles SW of Cape Shirreff and two other rocks are reported to lie about 2.5 miles S of this group.

2.56 Window Island (62˚34'S., 61˚07'W.) lies 2.5 miles NE of Start Point. A small islet and a rock are reported to lie close S and about 0.3 mile W, respectively, of this island. An unnamed island, existence doubtful, is reported to lie about 2 miles N of Start Point.

A group of stranded ice floes has been reported to extend up to 3 miles NNE of Start Point and may indicate that shoals are located in this area. Areas of foul ground lie NW of Start Point and extend up to 0.8 mile offshore. These areas also extend ENE as far as Window Island and SW to Barclay Bay.

The **Byers Peninsula** (62˚38'S., 61˚05'W.) is located W of a line joining **Cutler Stack** (62˚36'S., 60˚59'W.) and **Stackpole Rocks** (62˚41'S., 60˚58'W.), which lie 2.5 miles WNW of **Elephant Point** (62˚41'S., 60˚52'W.).

Vietor Rock (62˚41'S., 61˚06'W.) lies close offshore, 2.5 miles E of **Devils Point** (62˚40'S., 61˚11'W.).

Long Rock (62˚42'S., 61˚11'W.), a detached above-water rock, lies 1 mile SSW of Devils Point and **Conical Rock** (62˚43'S., 61˚11'W.) lies 1.3 miles S of it.

Anchorage may be obtained on the S side of the Byers Peninsula, 4.5 miles ESE of Devils Point.

New Plymouth (Puerto Echeverria)(62˚37'S., 61˚12'W.) consists of a bay which is entered between Start Point and **Rugged Island** (62˚38'S., 61˚15'W.), 2 miles SSW. This bay may be identified by **Eddystone Rocks** (62˚36'S., 61˚23'W.), which are prominent and lie 4.5 miles W of Start Point.

The Pointers (62˚36'S., 61˚19'W.), a group of below-water rocks, lies 2 miles E of Eddystone Rocks and 2 miles N of **Cape Sheffield** (62˚37'S., 61˚19'W.), the NW extremity of Rugged Island.

The head of the bay is obstructed by **Astor Island** (62˚39'S., 61˚11'W.) and areas of foul ground. This bay is not recommended as a harbor as it is exposed to NW winds, which send in a heavy sea, and the bottom consists mostly of rock and is very foul.

2.57 Morton Strait (62˚42'S., 61˚14'W.) has a navigable channel less than 1 mile wide. This channel has a least depth of 12.8m, but local knowledge is essential for safe passage. Numerous tide-rips and whirlpools have been reported to occur at the S entrance of this strait. In addition, strong tidal currents set through the strait and navigation is hazardous.

Hell Gates (62˚40'S., 61˚11'W.), a chain of above and below-water rocks and islets, extends across the strait between Livingston Island and Snow Island. Passage through this chain of dangers should be attempted only with local knowledge.

Svip Rocks (62˚35'S., 61˚38'W.) is a group of below-water rocks, existence doubtful, which is reported to lie in the NW approach to the strait, about 7.5 miles W of Cape Sheffield, the NW extremity of Rugged Island.

Snow Island (62˚47'S., 61˚23'W.) lies 4 miles SW of Livingston Island, from which it is separated by the strait. This island is entirely ice-capped and presents no distinctive rock outcrops. Numerous islets, rocks, and reefs surround the island and vessels should approach it with great care. Foul ground extends up to 4 miles seaward from the W side of this island.

Tooth Rock (62˚52'S., 61˚24'W.), jagged and 85m high, lies 1.3 miles S of **Cape Conway** (62˚51'S., 61˚24'W.).

Knight Rocks (62˚50'S., 61˚35'W.), located 1 mile apart, lie 2.3 miles WSW of **Monroe Point** (62˚49'S., 61˚30'W.), which is located 4 miles NW of Cape Conway.

Castle Rock (62˚48'S., 61˚34'W.), the largest and most conspicuous rock lying off the W side of the island, is 177m high; Keep Rock lies close SW of it.

From Devils Point, the S coast extends in a series of small bays to **Barnard Point** (62˚46'S., 60˚21'W.). This point is located 24 miles ESE of Devils Point and forms the S extremity of Livingston Island. That part of this stretch of coast extending between Devils Point and **South Bay** (62˚40'S., 60˚28'W.) is low and conspicuous due to the black rocks which form several bold headlands. The shore is fringed by a number of rocks which lie up to about 1 mile seaward. A shoal, with a depth of 13.7m, lies about 2 miles SW of Barnard Point.

2.58 Bond Point (62˚41'S., 60˚48'W.) is located between **Hetty Rock** (62˚40'S., 60˚44'W.) and **Elephant Point** (62˚41'S., 60˚52'W.), 1.8 miles WNW. Three shallow rocks lie about 1.8 miles S of Bond Point; an islet, position approximate, is reported to lie about 3 miles ESE of Elephant Point.

Walker Bay (62˚38'S., 60˚42'W.), which has not been examined, lies between **Hannah Point** (62˚39'S., 60˚37'W.) and Hetty Rock, 3.5 miles W.

South Bay (62˚40'S., 60˚23'W.), 2.5 miles wide, extends NE between high, rocky slopes. An islet lies 0.5 mile off Hannah Point, the NW entrance point of this bay. Several rocks and an area of foul ground also front this point. A bank, with a least depth of 27m, lies about 2.3 miles SE of Hannah Point.

The bay is open to S and SW winds which often bring in quantities of drift ice. High icecliffs prevent landing in the bay, but temporary anchorage may be taken.

An unnamed point, fronted by two small islets, projects into the bay from the N shore, 4 miles E of the NW entrance point. A prominent rock pillar stands on the E shore, 2.3 miles E of the point. Anchorage can be taken, in a depth of 31m, speckled gray mud, about 0.3 mile W of this pillar. A small islet lies

close to the shore, about 0.3 mile NE of this pillar. Two other small islets lie close together, about 0.5 mile SSE of the pillar.

2.59 Johnsons Dock (62˚40'S., 60˚22'W.), a small cove, lies at the NE end of South Bay and directly under **Mount Bowles** (62˚37'S., 60˚12'W.). The entrance to the cove is not easy to identify, but its E entrance point is formed by a prominent perpendicular cliff. The cove provides safe anchorage for six or seven vessels, moored in a nest, and has depths of 16 to 24m. Local knowledge is advised.

False Bay (62˚43'S., 60˚22'W.) is entered between Barnard Point and **Miers Bluff** (62˚43'S., 60˚27'W.), the S extremity of the **Hurd Peninsula** (62˚41'S., 60˚23'W.). The Huntress Glacier lies at the head of this bay. A conspicuous rock stands on the E side of the Hurd Peninsula, 2 miles NE of Miers Bluff. Anchorage can be taken on each side of the bay, 0.3 mile E or 1.5 miles E of this conspicuous rock.

Barnard Point is fronted by numerous rocks, which extend up to about 1 mile W and S, and several small islets lie close off Miers Bluff. An area of foul ground extends up to 0.3 mile SW of Miers Bluff.

From Barnard Point, the coast trends NE for 17 miles to Renier Point and consists of a continuous ice face.

Needle Peak (62˚44'S., 60˚11'W.), 372m high, stands on the coast, about 5 miles NE of Barnard Point. Its summit is sharp, pointed, and black. A small cove lies close NE of this peak, but it has not been surveyed.

Caution.—During thick weather, vessels should use care not to confuse False Bay with South Bay, which is entered close NW of the Hurd Peninsula.

2.60 Deception Island (62˚57'S., 60˚38'W.) lies 10 miles SW of Barnard Point. It is volcanic in origin and forms one of the most remarkable crater islands in the world.

Mount Pond (62˚57'S., 60˚33'W.), 550m high, rises on the E side of the island and **Mount Kirkwood** (63˚00'S., 62˚39'W.), 467m high, rises near the middle of the S side.

The E coast of the island is fringed, for 4 miles, by an ice face. A smaller ice face fringes part of the S coast and is fronted by an area of foul ground which extends up to 0.5 mile seaward. A few rocky islets lie close to the shores on all sides of the island. Several sandy beaches fringe the shores, particularly on the N side and at each end of the ice face on the E side. In other parts, the shore is steep-to and formed by cliffs. The W and SW coasts of the island are reported to be fronted by shallow depths. A shoal, with a least depth of 9.1m, lies off the W coast of the island, close NW of **Collins Point** (63˚00'S., 60˚35'W.), and another shoal, with a depth of 4.6m, lies close off the N side of the island.

2.61 Port Foster (62˚57'S., 60˚38'W.) (World Port Index No. 63095), a crater-like basin, is entered through **Neptunes Bellows** (63˚00'S., 60˚34'W.), a narrow passage, which lies on the SE side of the island.

Entrance Point is located on the S side of this passage and Fildes Point, the N entrance point, consists of a prominent, sheer cliff, 91m high. Vessels may anchor outside this entrance, in depths of 22 to 54m.

Ravn Rock, with a depth of 2.4m, lies in the center of the entrance to the passage. The channel leading between this rock and Entrance Point is narrow and obstructed by foul ground. The channel leading between the rock and Fildes Point is deep but only about 200m wide. A prominent stranded wreck was reported to lie close N of Entrance Point.

Within Neptunes Bellows, the depths rapidly increase to more than 90m. The tidal currents attain rates of up to 1.3 knots at springs and turn at about the times of HW and LW, by the shore.

Petes Pillar (63˚00'S., 60˚33'W.), a precipitous steep-to rock, is 48m high and lies close offshore, 0.4 mile E of Fildes Point. It is separated from the vertical cliff that forms the N shore of the passage by a narrow neck of drying rocks.

Secure anchorage, during W gales, can be obtained, in a depth of 25m, cinders and stones, about 1.5 miles E of Collins Point. Secure anchorage, during E gales, can be obtained, in a depth of 45m, cinders, in the lee of the island and about 2.3 miles NW of New Rock.

New Rock (63˚01'S., 60˚44'W.), 105m high, is prominent and lies about 1 mile SW of the island.

2.62 Neptunes Window (62˚59'S., 60˚33'W.), a narrow gap, lies between two rock pillars at the top of a cliff in a small cove. This cove lies on the NW side of a bay which is located between Petes Pillar and **South East Point** (62˚59'S., 60˚31'W.).

Stanley Patch (62˚59'S., 60˚38'W.), a rocky shoal, has a least depth of 27m and lies 1.8 miles NW of Collins Point.

Whalers Bay (62˚59'S., 60˚34'W.) is entered between Fildes Point and Penfold Point, 0.5 mile NW. Anchorage can be obtained, in depths of 64 to 91m, loose cinders, within the bay, but the holding ground is not good.

Pendulum Cove (62˚56'S., 60˚36'W.), lying on the NE side of Port Foster, provides shelter. Vessels can anchor, in depths of 20 to 29m, muddy ashes, about 100m offshore, but this berth is exposed to W and NW winds and the holding ground is poor.

A wreck is reported to lie close to the S shore of this cove.

Grumete Light is shown from a structure standing 2.2 miles WNW of Collins Point. When approaching Neptunes Bellows, the hill, on which this structure stands, appears in the shape of a flat pyramid, showing up clearly against the snowy slopes behind it.

Wensleydale Beacon (62˚57'S., 60˚42'W.), surmounting a hill, is situated on the W side of Port Foster, 4 miles NW of Collins Point. A lighted beacon stands 1.3 miles SSW of this beacon.

2.63 Sail Rock (63˚02'S., 60˚57'W.), 28m high, lies about 6.5 miles WSW of New Rock. It is pyramid-shaped and resembles a ship under sail when viewed from a distance. However, it appears more like a house with a gable roof from closer inshore. This rock is 305m long, 152m wide, and has steep, perpendicular sides. A shoal, with a depth of 17.3m, lies about 0.4 mile SW of this rock.

Lavebrua Island (63˚02'S., 60˚35'W.), 97m high, lies 1.5 miles E of South Point.

Boyd Strait (62˚50'S., 62˚00'W.) leads between Snow Island and Smith Island. It is wide, free of dangers, and deep.

Smith Island (63˚00'S., 62˚30'W.), 18 miles long and 4 miles wide, lies 42 miles W of Deception Island. This island is conspicuous due to its tall peaks and striking appearance.

Mount Foster (63˚00'S., 62˚33'W.), 2,103m high, has a triple peak and is snow-covered.

Mount Pisgah (62˚57'S., 62˚29'W.), 1,859m high, stands 4 miles NE of Mount Foster and is also snow-covered.

Mount Christi (62˚55'S., 62˚24'W.), 1,250m high, stands 3 miles NE of Mount Pisgah.

The coasts of the island are rugged and are faced by sheer, black cliffs while the high lands behind them are completely snow-covered. The W coast between **Gregory Point** (62˚55'S., 62˚33'W.) and **Cape James** (63˚06'S., 62˚45'W.), the S extremity, is formed by prominent, vertical cliffs, 610 to 914m high.

2.64 Van Rocks (63˚06'S., 62˚50'W.), consisting of two small groups of conspicuous pointed rocks, lies 2 miles W of Cape James.

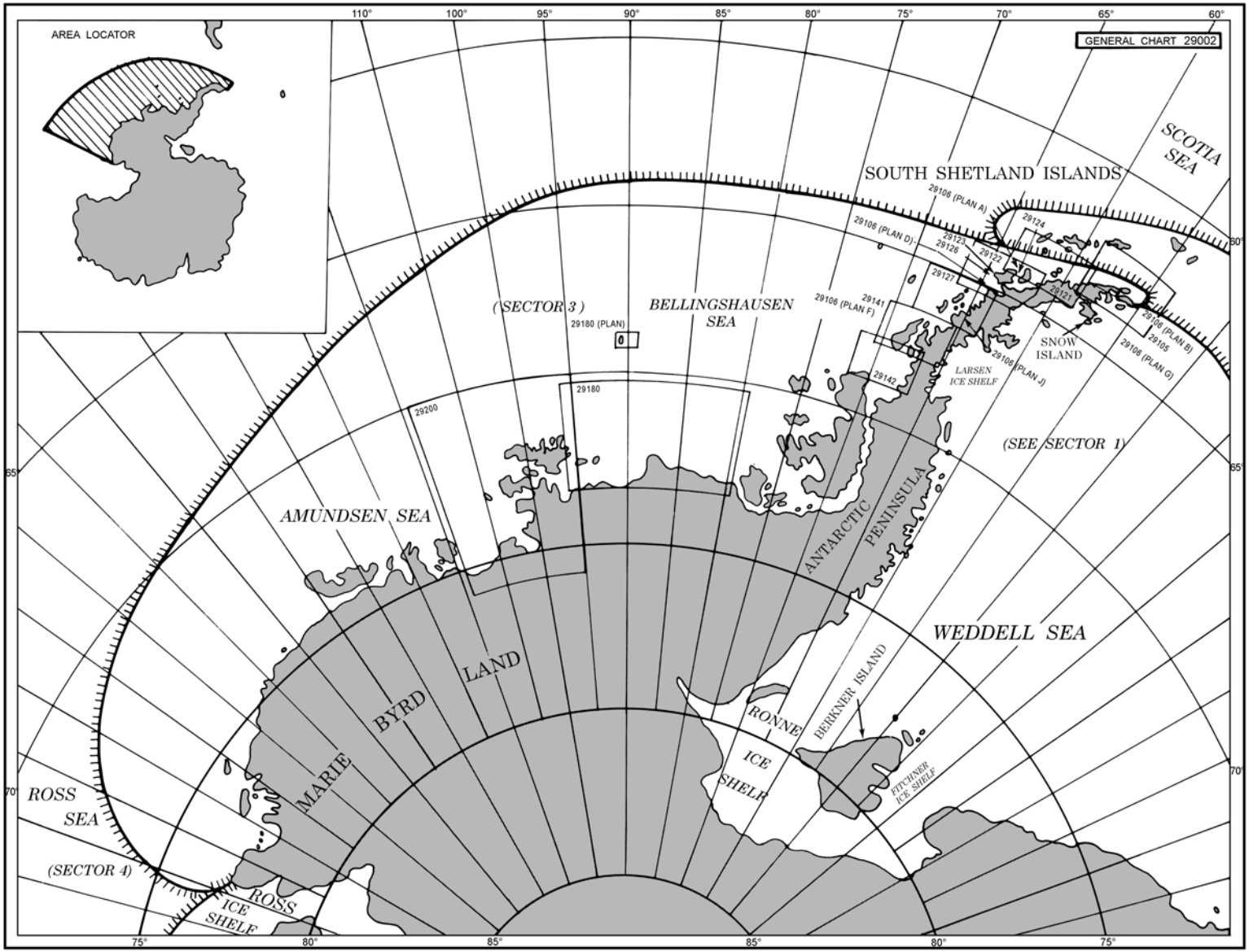
Cape Smith (62˚52'S., 62˚19'W.), the N extremity of the island, is fringed by foul ground and the entire N coast is fronted by breakers which extend up to 2 miles offshore.

A patch, with a least depth of 42m, lies 31 miles WSW of Cape Smith and another patch, with a least depth of 36m, lies about 2 miles, position doubtful, N of it.

2.65 Low Island (63˚17'S., 62˚09'W.) lies with **Cape Wallace** (63˚13'S., 62˚15'W.), its NW extremity, located 14 miles SE of Smith Island. This island has a low elevation and is almost entirely covered with snow, only a few rocks being visible. The entire N and W coasts of the island are fronted by foul ground between **Cape Hooker** (63˚18'S., 61˚59'W.), the NE extremity, and **Cape Garry** (63˚21'S., 62˚16'W.), the SW extremity. Several rocks front the N and W sides of the island and lie up to 2.5 miles offshore.

The E side of the island has not been fully examined, but a patch, with a depth of 16.4m, is reported to lie about 5 miles SSW of Cape Hooker.

Another patch, with a depth of 36.6m, is reported to lie about 33 miles WSW of Cape Garry.



Additional chart coverage may be found in NGA/DLIS Catalog of Maps, Charts, and Related Products (Unlimited Distribution).

SECTOR **3** — CHART INFORMATION

SECTOR 3

THE BELLINGSHAUSEN SEA AND THE AMUNDSEN SEA—JOINVILLE ISLAND TO CAPE COLBECK

Plan.—This sector describes the coast of Antarctica from Joinville Island to Cape Colbeck, including the Bellingshausen Sea and the Amundsen Sea. The descriptive sequence is W to E.

General Remarks

3.1 Bransfield Strait (63˚00'S., 59˚00'W.) separates South Shetland Island from the **Trinity Peninsula** (63˚37'S., 58˚20'W.). This strait is about 60 miles wide at its NE end and narrows to a width of 24 miles between Low Island and Hoseason Island, at its SW end.

The Antarctic Peninsula is nearly 800 miles long and separates the Weddell Sea from the Bellingshausen Sea.

The E side of James Ross Island is generally inaccessible due to drift ice. The W side is accessible for a period in summer, but there are few places where it is possible to land on the mainland.

Winds—Weather.—As the circumpolar trough lies across the central part of the Antarctic Peninsula, there is a significant climatic change from N to S. Winds from the SW prevail at Hope Bay, while SE winds are dominant at Marguerite Bay. At the Argentine Islands, the winds are more variable, with about the same frequency blowing from the N and S. Hope Bay experiences frequent SW gales, while SE gales are common at Marguerite Bay. Gales are less frequent at the Argentine Islands.

Tides—Currents.—The predominant direction of the current in most parts of Bransfield Strait is towards the NE; however, the current sets towards the SW on the S side of the strait. The currents, particularly those setting towards the NW, sometimes attain rates of 3 knots.

Joinville Island to Cape Kater

3.2 Joinville Island (63˚15'S., 55˚45'W.), the largest of the Joinville Island group, is fully described in paragraph 1.47.

Cape Dubouzet (63˚16'S., 57˚01'W.) is located 12 miles SW of the W extremity of Joinville Island. From this cape, the coast extends WNW for about 7 miles to **Prime Head** (63˚13'S., 57˚17'W.), the N extremity of the **Trinity Peninsula** (63˚37'S., 58˚20'W.), and then WSW for 17 miles to **Cape Legoupil** (63˚19'S., 57˚55'W.). It is irregular due to seasonal changes in the ice cliffs, which extend to the sea from the high inland slopes.

Gourdin Island (63˚12'S., 57˚18'W.) lies 1 mile N of Prime Head. Column Rock, a prominent pinnacle rising almost sheerly from sea level, lies 1.7 miles N of this island. Lafarge Rocks, a group of rocky islets, lies 6.5 miles W of Gourdin Island and Nomad Rock lies about 4 miles W of them.

Casy Island (63˚14'S., 57˚30'W.) lies 1 mile offshore, 5.5 miles SW of Gourdin Island. A depth of 152m, over a bottom of mud and small stones, was reported to lie between this island and the coast.

The **Duroch Islands** (63˚18'S., 57˚54'W.) lie within an area of foul ground which extends up to 2.5 miles seaward of Cape Legoupil. A beacon, equipped with a racon, is situated on an island about 1.4 miles WSW of the cape.

A beacon, 4m high, stands on an islet, 0.8 mile NW of Cape Legoupil. It has been reported destroyed (1997).

It was reported that good anchorage could be taken about 0.4 mile N of the beacon.

At Cape Legoupil, the ice cliffs are 3 to 9m high and are backed by a few crevasses. General Bernardo O'Higgins, a Chilean base station, is situated in the vicinity of this cape.

An anchorage berth, which can be used in calm weather, lies within **Covadonga Harbor** (63˚19'S., 57˚55'W.), close off the station and 0.3 mile ESE of the beacon. However, the bottom consists of rock and the holding ground is bad. In addition, large icebergs, which separate from the glaciers to the E, are set by strong currents through the islets and provide a hazard to vessels in this roadstead.

It has been reported (1997) that vessels should anchor in daylight hours only, in depths of less than 40m, and monitor the icebergs in the vicinity.

In good weather, anchorage can be taken, in a depth of 37m, mud and sand, in the middle of a cove lying on the SE side of the W extremity of Cape Legoupil.

3.3 Montravel Rock (63˚09'S., 58˚02'W.) lies about 11 miles NNW of Cape Legoupil and is marked by a beacon with racon, 4m high.

The area lying to the S and W of the beacon should be navigated with care as there are many dangers. Shoal patches, each with a depth of 11m and over which the sea breaks, lie about 5 miles NE and 3.5 miles WSW of the beacon. A shoal, with a least depth of 22m, lies about 5 miles ENE of the beacon; breakers have been reported to occur about 1 mile W of it. Rocks, 1.5 and 1.8m high, lie 3.5 miles SW and 4.5 miles SE, respectively, of Montravel Rock.

The dangers in this area are separated from Peralta Rocks, which lie 5.5 miles SW of Montravel Rock, by a clear and deep channel.

The **Cockerell Peninsula** (63˚24'S., 58˚08'W.) is located 7 miles SW of Cape Legoupil and consists of a rounded headland which is joined to the mainland by a narrow isthmus. Huon Bay, which recedes for about 2.5 miles, lies between this peninsula and the cape.

The **Tupinier Islands** (63˚22'S., 58˚16'W.), a group of nine small islands surrounded by foul ground, extend up to 4 miles NW of the Cockerell Peninsula.

Cape Roquemaurel (63˚33'S., 58˚56'W.) is located 24 miles WSW of the peninsula; a shoal, with a depth of 31m, is reported to lie about 8 miles NW of it.

Astrolabe Island (63˚17'S., 58˚40'W.), 564m high, lies with its S extremity located 16 miles WNW of the Cockerell Peninsula. A bay indents the N side of this island, but it has not been surveyed.

A group of three islets, with the westernmost islet located 3.5 miles ESE of the E extremity of the island, is surrounded by foul ground. A shoal, with a depth of 18m, is reported to lie about 1.5 miles W of the W islet. A rock, awash, lies about 8 miles SW of the W end of Astrolabe Island.

Jacquinot Rocks lie at the N edge of an area of foul ground, about 2 miles WNW of Astrolabe Island. A below-water rock, existence doubtful, is reported to lie about 10 miles WSW of the island. A shoal, with a depth of 5.5m, is reported to lie about 10 miles NW of the island.

Hombron Rocks lie about 3 miles offshore, 8 miles NE of Cape Roquemaurel, and are fronted by several reefs. Molina Rocks lie about 5.5 miles ESE of Astrolabe Island; a shoal patch, with a depth of 18m, lies close NW of them.

3.4 **Young Point** (63˚36'S., 58˚55'W.) is located 3.5 miles S of Cape Roquemaurel. Bone Bay, which is 3 miles wide at its entrance, indents the coast close S of this point. Blake Island, which is narrow and about 1 mile long, lies in the center of the approach to this bay and is fringed by foul ground on its W side. Whaleback Rocks lie about 1.5 miles W of this island. From the head of this bay, the Trinity Peninsula extends 18 miles to Prince Gustav Channel.

Cape Kjellman (63˚44'S., 59˚24'W.) is located 12 miles SW of the S entrance point of Bone Bay and is fringed by below-water rocks. The stretch of coast extending 6 miles ENE of this cape is fronted by numerous islets and dangers. Several hills, 305 to 1,158m high, stand along the Trinity Peninsula in this vicinity.

Cape Kater (63˚46'S., 59˚54'W.) is located 13 miles WSW of Cape Kjellman; Charcot Bay indents the coast between them. Almond Point projects from the head of this bay at the E side of the White Cloud Glacier. Webster Peaks, a group of four rocky hills, rises 5 miles WSW of this glacier and attains a height of 1,065m.

Two glaciers flow into the bay. The McNeile Glacier flows N to the SE side of Almond Point while the Andrew Glacier flows ENE to the W shore about 5 miles S of Cape Kater.

Anchorage, sheltered from W winds, may be taken, in a depth of 32m, shingle, about 0.5 mile off the W side of the bay.

The aspect of this entire part of the coast is a high ice-covered plateau in the interior with glaciers flowing toward the coast and forming a continuous ice platform, out of which only a few rocky points project.

Cape Kater to Cape Willems

3.5 **Lanchester Bay** (63˚55'S., 60˚06'W.) is entered between Wennersgaard Point, located 5 miles SSW of Cape Kater, and Havilland Point, 7 miles WNW. Chanute Peak stands on the E side of this bay; the Temple Glacier covers the E side of Wright Ice Piedmont which extends to **Cape Andreas** (64˚00'S., 60˚43'W.), 20 miles W.

Cape Page is located 2 miles W of Havilland Point. Short Island lies close offshore, 3.5 miles further SW.

The **Palmer Archipelago** (64˚15'S., 62˚50'W.), consisting of a number of islands, lies off the **Davis Coast** (64˚00'S., 60˚00'W.). The principal islands are Tower Island, Trinity Island, Hoseason Island, Liege Island, Brabant Island, Anvers Island, and Wiencte Island. These islands are separated from the mainland by a continuous channel which, from N to S, bears the names **Orleans Strait** (63˚50'S., 60˚20'W.), **Gerlache Strait** (64˚30'S., 62˚20'W.), and **Bismarck Strait** (64˚51'S., 64˚00'W.).

Depths of up to 366m are reported to lie 7 miles N of the extremities of the islands. Gerlache Strait is clear in the vicinity of Brabant Island and has depths of 212 to 914m. Shoaling occurs in the vicinity of Anvers Island and the depths decrease to less than 180m in some places within the strait.

Tower Island (63˚33'S., 59˚51'W.), 305m high, lies 10.5 miles N of Cape Kater.

Condyle Point (63˚35'S., 59˚48'W.) is located 1.5 miles E of the S extremity of this island; Cape Dumoutier is located 2.3 miles farther NE. Foul ground fringes the E, S, and W sides of this island and extends up to 1.5 miles offshore. A foul ground area also fronts the N side of the island. It is about 2.5 miles wide and extends up to 5 miles seaward.

Dumoulin Rocks (63˚26'S., 59˚47'W.) lie close N of Cape Leguillou. Kendall Rocks, consisting of several pillar-shaped islets, lie 5 miles NNE of Tower Island and have been reported to attain a height of 133m.

Ohlin Island, 170m high and 1.5 miles long, lies 5 miles WNW of Tower Island. Two islets and a below-water rock lie centered about 1 mile W of this island. Three islets and a below-water rock lie between 2 and 3 miles WSW of the island.

Caution.—The area lying ESE of Tower Island has not been completely surveyed and vessels should exercise great care when navigating in this vicinity.

3.6 **Gilbert Strait** (63˚38'S., 60˚16'W.) separates the dangers lying W of Tower Island from **Cape Neumayer** (63˚42'S., 60˚34'W.). An air survey (1957) of the strait and the area lying between Tower Island and Cape Kater revealed the existence of many uncharted dangers. However, a survey (1984) reported that a passage, 3 miles wide and clear, leads through the strait.

A research vessel reported (1977) that a clear passage led through Gilbert Strait along the meridian of 60˚28'W, but passed through unsurveyed areas.

Trinity Island (63˚45'S., 60˚44'W.), 15 miles long and 7.5 miles wide, lies 20 miles W of Cape Kater. Tower Hill, its summit, is 1,125m high and formed by a distinctive sharp cone. Huemul Island, 186m high, lies close off the rugged NW extremity of Trinity Island.

Three small islets, surrounded by foul ground, are reported to lie about 3.5 miles NE of Cape Wollaston, the NE extremity of Trinity Island. A dangerous area, about 1.5 miles in diameter, is reported, existence doubtful, to be centered about 3 miles ENE of this cape.

Several dangers are reported to lie up to 5 miles seaward of the W coast of Trinity Island. The SW part of the island is formed by an ice-covered tableland, the S extremity of which is known as Stottsburg Point. Spert Island, 160m high, lies close W of the W extremity of the island and several above and

below-water rocks lie up to about 1.8 miles N and NW of its N end.

Farewell Rock (63˚52'S., 61˚01'W.), a rocky reef, lies close off the SW end of Spert Island; a beacon, formerly lighted, stands near its E end. A rock, awash, lies 2.5 miles WNW of this reef. Banks, with least depths of 31 and 44m, lie 6 miles SW and 9 miles WSW, respectively, of the beacon.

Caution.—Vessels are advised not to approach within 5 miles of the N shore of Trinity Island as the area has not been completely surveyed and foul ground is reported to exist.

3.7 Mikkelsen Harbor (63˚54'S., 60˚47'W.) indents the S coast of Trinity Island, E of Stottsburg Point. This inlet has general depths of 46 to 164m. Anchorage can be taken, in a depth of 82m, fine clay, on a bank lying about 0.5 mile from the glacier at the head. Anchorage may also be taken, in a depth of 18m, about 0.2 mile SE of D'Hainaut Island, which lies in the center of the harbor. The harbor provides shelter from winds from E, through N, to WSW, but a rough sea sets in during S and SW winds. Drift ice and bergs set in from the SW and frequent calving of the glacier often renders this anchorage undesirable.

Klo Rock, with a least depth of 1.5m and on which the sea breaks, lies in the middle of the harbor. In addition, several other rocks obstruct the approaches to the harbor. Two beacons, each 30m high, stand on an islet, 9m high, which lies near the middle of the harbor, on the W side.

Orleans Strait leads between Trinity Island and the **Danco Coast** (64˚42'S., 62˚00'W.). This passage is about 4 miles wide, but is restricted to a navigable width of 2 miles. Vessels should pass to the S of the rocks lying off the SE side of Trinity Island but may pass either side of a rock located near the middle of the channel. A shoal, with a depth of 5.5m, was reported to lie about 2.5 miles SE of Awl Point, the SE extremity of Trinity Island.

Chionis Island (63˚53'S., 60˚38'W.), 127m high, lies about 1.2 miles SE of Trinity Island. A dangerous rock, existence doubtful, is reported to lie about 4.5 miles SE of this island.

A clear and navigable channel, 1.3 miles wide, leads through Orleans Strait. It passes S of Chionis Island and connects Gilbert Strait with Gerlache Strait.

Austin Rocks (63˚26'S., 61˚04'W.) lie centered about 13 miles NW of Trinity Island. This group attains a height of 42m and extends about 3 miles in a NE/SW direction.

Hoseason Island (63˚44'S., 61˚44'W.), 529m high, lies 19 miles W of Trinity Island and is marked by two snow-covered summits. Cape Barrow, the NE extremity of the island, is faced by a steep cliff and backed by gentle slopes which rise toward the N summit of the island. This cape is fronted by several rocks which extend up to 1 mile seaward. A below-water rock, existence doubtful, is reported to lie about 1.3 miles NNW of the cape. Cetacea Rocks and an islet, 66m high, lie centered 2.5 miles SE of the cape.

From Cape Barrow, the coast of the island extends 7 miles to Angot Point, its S extremity. Numerous small islets and rocks, both above and below-water, front the shores of this island.

Cape Possession, 259m high, is the W extremity of Chanticleer Island, which lies close off the W extremity of Hoseason Island. Numerous above and below-water rocks partially surround this island.

3.8 Intercurrence Island (63˚55'S., 61˚24'W.) is the northernmost and largest of the **Christiania Islands** (63˚57'S., 61˚27'W.). Babel Rock, 58m high, is one of two rocks which lie close N of this island and is surrounded by foul ground. The W and S shores of the island are fronted by foul ground which extends up to 2.5 miles seaward.

Small Island, 336m high and 1 mile in diameter, lies within the foul ground area close off the S shore. This island is reported to have a sphinx-like appearance when viewed from some directions. Several above-water rocks and a rock, awash, lie up to 1.5 miles SE of the island.

Two rocks, which break and are fringed by foul ground, are reported to lie about 5 miles E of Small Island. Chance Rock, a below-water rock, is reported to lie, position approximate, about 6 miles E of Small Island.

Diamonen Island, 171m high, is located 5 miles ESE of Small Island and a rock, 1.2m high, lies 0.8 mile NNW of it.

A shoal, with a depth of 11m, and a dangerous rock are reported to lie about 8 miles ESE and 1.5 miles W, respectively, of Small Island. A foul ground area, about 2.5 miles long, lies 7.5 miles NE of Intercurrence Island and extends in a N/S direction.

The Danco Coast is that portion of the Antarctic Peninsula forming the shore between Cape Kater and **Cape Renard** (65˚01'S., 63˚47'W.), 130 miles SW.

From Cape Kater, the Danco Coast trends 21 miles SW and W to **Cape Andreas** (64˚00'S., 60˚43'W.).

Cape Sterneck (64˚04'S., 61˚02'W.) is located 23 miles SW of Cape Andreas and the coast between is regular and unbroken. The shore is fringed by numerous small rocks, especially close N and S of this cape.

Cape Sterneck is formed by a bold and dark-colored cliff, 460m high. It is the NW extremity of a promontory and forms the SW limit of the Davis Coast. Monument Rocks, up to 55m high, lie 3 miles NNE of the cape and numerous small islets and rocks lie between them.

The Danco Coast appears as a continuous ice slope, broken only by several protruding rock masses. The plateau, rising farther inland, attains heights of 1,220 to 1,830m.

3.9 Hughes Bay (64˚13'S., 61˚20'W.), 22 miles long, irregularly indents the coast and recedes for about 8 miles. The shores of this bay are completely ice-covered except for several rocky headlands. The ice extends inland to the base of some irregular mountains which have steep, snow-free slopes.

Cierva Cove lies 6 miles SSE of Cape Sterneck and a hut surmounts its S entrance point. An islet lies 1 mile NW of the S entrance point. A beacon, 38m high, stands on an islet lying 2 miles N of the S entrance point.

Brialmont Cove lies 4 miles SSW of Cierva Cove and is entered between Charles Point and Spring Point. Alcock Island lies on an area of foul ground which fronts the W side of Charles Point.

Good anchorage can be taken, in depths of 25 to 30m, about 0.3 mile NNE of Spring Point, but strong winds often blow from the SSE. Primavera, an Argentinean base station, is situated in the vicinity of Brialmont Cove.

Midas Island, Moss Island, and Apendice Island, together with a number of shoals, lie up to 4 miles W of this stretch of coast and can be best seen on the chart.

Sprightly Island (64˚17'S., 61˚04'W.) lies 0.5 mile NW of Spring Point and Roget Rocks, surrounded by foul ground, lie 3.8 miles SW of it.

Tournachon Peak, 859m high, rises 1.5 miles SSW of Spring Point and is prominent.

Salvesen Cove (64˚24'S., 61˚20'W.) lies about 9 miles SSW of Spring Point and indents the coast for 2 miles. Ice rises in a series of terraces to the E of this cove. The S shore of the cove rises to a high, rugged ridge, with several rocky outcrops and ice-capped peaks, which extends inland to the plateau. Between Spring Point and this cove, the coastal ice cliff is fringed by numerous small, rocky islets. The S shore of the cove is formed by large glacier cliffs which extend NW for 7 miles to Cape Murray.

3.10 Cape Murray (64˚21'S., 61˚38'W.) is formed, in reality, by an island. This island has a number of extensive rocky exposures which are conspicuous and extend vertically down to the shore. Several islands, the largest being about 2 miles long, lie close off this cape and may best be seen on the chart.

Graham Passage, about 0.5 mile wide and 4 miles long, separates the Murray Island from the mainland. Cape Murray Bay, a small and sheltered harbor, is formed between Cape Murray and a small island lying close N. Anchorage may be taken, in a depth of 36m, within the E part of this harbor. However, deeper water lies in the W part and a depth of 110m with no bottom has been reported.

The **Reclus Peninsula** (64˚33'S., 61˚47'W.), high and rocky, forms the W side of Charlotte Bay. The Gaston Islands, 58 and 80m high, lie 1 mile WNW and 1 mile NNW, respectively, of this peninsula. A beacon, 6m high, surmounts the higher island. Several shoals lie close SE of these two islands.

3.11 Cape Anna (64˚35'S., 62˚26'W.), marked by a beacon, is located 18 miles SW of the peninsula and **Wilhelmina Bay** (64˚38'S., 62˚10'W.), a large indentation, lies between them. The head of this bay is fronted by several rocky masses, with numerous valley glaciers, and an extensive ice cliff. Several large islands lie in the E part of the bay and Plata Passage, a navigable channel, leads between them and the high ice-covered mainland.

Nansen Island, 6 miles long and the largest within the bay, lies 5 miles SW of the Reclus Peninsula; two small islands lie close off its N extremity.

Brooklyn Island lies 1 mile offshore, about 1 mile SE of Nansen Island. It is 3 miles long, high, and ice-covered. Wyck Island, 1 mile long, lies 1 mile S of the W extremity of this island.

Foyn Harbor (64˚33'S., 62˚01'W.) lies within Wilhelmina Bay. It is located on the E side of Nansen Island and is bordered by several small islands and rocks which lie on the E side of the entrance. Anchorage can be taken, in depths of 27 to 36m, rocky bottom with poor holding ground, in this harbor. However, this anchorage is not recommended due to the calving of the high glacier face and violent SE winds which have often been experienced in the bay.

Caution.—The tidal range in the vicinity of Nansen Island is about 1.3m. However, the tides are reported to be of a peculiar nature and very irregular.

3.12 Pelseneer Island (64˚39'S., 62˚13'W.), 2 miles long, lies in the center of the bay and about 2 miles from the head. This island has three summits, formed by needle-like peaks, from which icy slopes extend to the water's edge and terminate in vertical ice cliffs. A small island lies about 4 miles WSW of this island and is located in the center of the entrance of a wide cove.

Delaite Island, 2 miles long, lies 2 miles W of Nansen Island. A small islet and a below-water rock lie close off the S extremity of this island.

Emma Island, with several sharp peaks, lies 3 miles E of Cape Anna. A rock is reported to lie about 1 mile N of this island.

Louise Island, small and ice-capped, lies 1.5 miles ESE of Cape Anna.

Brabant Island (64˚15'S., 62˚20'W.) lies on the NW side of Gerlache Strait. It extends 33 miles in a N/S direction and is about 16 miles wide. The Solvay Mountains rise along the E side of the island. A rocky, ice-covered spur projects S from these mountains and ends in Mount Buckle, a conspicuous summit, 1,032m high. From Mount Buckle, the SE part of the island is formed by glacier slopes. Lagrange Peak, 452m high, stands 8 miles NE of Mount Buckle and backs a flat-topped, rocky headland.

Buls Bay indents the center of the E shore of the island and recedes for about 3 miles. The large Hippocrates Glacier, lies at the head of this bay and is fronted by several rocks. The rounded and prominent summits of the Solvay Mountains stand above the bay and attain heights of up to 1,590m at Cook Summit. D'Ursel Point, small and ice-free, forms the S entrance point of the bay. Although this bay has not been thoroughly surveyed, it was reported that anchorage could be taken close behind an island lying in the entrance. Strong winds, which sweep off the glacier at the head, have been experienced within this bay.

A large island lies close to the shore, about 3 miles NE of Buls Bay.

Lecointe Island (64˚16'S., 62˚03'W.), the largest of a group of three islands, lies 6 miles NE of Buls Bay. A light is reported to be shown on the N extremity of Guesalaga Island, the easternmost island of this group.

From Buls Bay, the coast trends generally NNE to Spallanzani Point, the NE extremity of Brabant Island, and is indented by several small bays and coves. Harry Island, steep and snow-capped, lies close to the coast in the vicinity of Spallanzani Point and has perpendicular cliffs on its W side. A small channel, with several arms, lies on the W side of this island and is not recommended for use. Bernard Rocks lie in the middle of this channel, between Harry Island and Spallanzani Point.

3.13 Two Hummock Island (64˚08'S., 61˚42'W.), lying 8 miles SW of Small Island, presents a convex appearance with a smooth snow mantle. Two pyramidal-shaped rocky nunataks project through the snow and their summits form a range which extends in the direction of the length of the island. The shore of the island is formed by ice cliffs, fronted by narrow strips of bare rock at the water's edge. Wauters Point, the N extremity of the island, is formed by a conspicuous and snow-covered cape.

Auguste Island, 1 mile long, lies 3.5 miles NE of Two Hummock Island. It is flat-topped, with steep slopes, and is

mostly free of snow. Landing may be made on the rocky shore of the NW part of this island.

Cobalescou Island lies 0.8 mile ESE of the SE extremity of Two Hummock Island. It is free of snow and has two flat summits, surmounted by broken rocks, each 26m high.

The Christiania Islands lie 5.5 miles NW of Two Hummock Island and are separated from it by Croker Passage. This passage deep, virtually clear of dangers, and joins Gerlache Strait, at its S end, being reported to be the safest and best approach to the latter channel. There is a 3m shoal reported to lie 4 miles SW of Two Hummock Island.

Liege Island (64˚02'S., 61˚55'W.) lies 4 miles NW of Two Hummock Island. The Brugmann Mountains, forming the highest land, rise in a steep range along the E side of this island. Neyt Point, a prominent projection marked by a beacon, is located on the E shore of the island, 1 mile SE of the N extremity, and marks the end of this range of irregular peaks. Mount Allo, 304m high, stands near this point. It is formed by a conspicuous sharp cone and is completely covered by snow. Anchorage can be taken about 1 mile SW of Neyt Point.

Moureaux Point, the N extremity, forms the seaward end of a narrow peninsula which is joined to the island by a rather high and narrow isthmus. Three islets lie about 1 mile offshore, close W of the point, and foul ground is located in this vicinity. A shoal patch, with a depth of 3.7m, is reported to lie, position approximate, about 2.5 miles NE of Moureaux Point.

Yoke Island, 72m high, lies 3 miles WSW of Moureaux Point and is surrounded by foul ground.

3.14 Chauveau Point (64˚05'S., 62˚02'W.), the SW extremity of the island, is bordered by numerous islets, rocks, and reefs. The channel leading between Liege Island and Brabant Island is obstructed by many islets and rocks. Davis Islet, the largest of these, almost entirely blocks the channel and forms two narrow passages. The N passage is about 0.3 mile wide and may be transited by small vessels. Such vessels should stay close to Liege Island in order to avoid the dangers fringing Davis Island. Several shoals front the S shore of this island and lie up to 0.5 mile seaward.

The N coast of Brabant Island trends generally NW for 7 miles then N for 5 miles to Duclaux Point, which forms the W entrance point of **Bouquet Bay** (64˚03'S., 62˚10'W.). This large bay is reported to be foul.

Cape Cockburn, the E extremity of the Pasteur Peninsula, is formed by a high, rocky cliff. This cliff extends 5 miles to Cape Roux, the W extremity. Depths of less than 9m are reported to lie up to 1.5 miles off this stretch of coast and two rocks, awash, lie on a foul ground area, which breaks, about 4.5 miles NW of Cape Roux.

From Cape Roux, the W shore of the peninsula trends SW for 4 miles to Point Metchnikoff, the N entrance point of **Guyou Bay** (64˚05'S., 62˚35'W.). This bay recedes SE for about 3 miles and the land at its head is much lower than that in the N part of the peninsula. Claude Point, a prominent vertical rock, forms the S entrance point of the bay. This bay is encumbered with numerous awash, above, and below-water rocks. Foul ground fronts Claude Point and extends up to 1.3 miles offshore.

Astrolable Needle (64˚08'S., 62˚36'W.), 1 mile S of Claude Point, is a pointed monolith, 104m high, visible from a great distance.

From Claude Point, the coastal range rises as a snow-covered ridge and extends S for 8 miles to Mount Parry. This peak is 2,522m high and dominates this part of the coast.

Duperre Bay (64˚27'S., 62˚41'W.), 3 miles long and 1 mile wide, contains a large glacier which descends from the heights of the interior mountains.

The W shore of the Pasteur Peninsula terminates in Lenaie Point. The W coast of Brabant Island is fronted by rocks and has not been thoroughly surveyed. Vessels navigating in this vicinity should exercise extreme care.

From Lenaie Point, the coast extends SE for 5 miles to Strath Point, the S extremity, above which stands Victoria Peak. This conspicuous summit is cone-shaped and 485m high.

From Cape Anna, the coast extends SW for 3 miles and is indented by **Orne Harbor** (64˚37'S., 62˚32'W.), a bay. This bay affords shelter from winds and swells. Anchorage can be obtained within this bay, but there is no protection from drift ice.

From Orne Harbor, the coast extends SW for 2 miles to where a conspicuous, black nunatak rises near the shore. It then trends 7 miles S and 3 miles W to **Beneden Head** (64˚46'S., 62˚42'W.). Steep glacial slopes extend into the interior, with occasional rocky outcrops, from this headland.

3.15 Errera Channel (64˚42'S., 62˚36'W.) separates Ronge Island from the mainland. Ronge Island lies with Georges Point, its N extremity, located 8 miles SW of Cape Anna.

Cuverville Island and Danco Island lie within this channel, 1.5 miles SE of Georges Point and 2.8 miles E of the S extremity of Ronge Island, respectively. Danco Island is fronted by rocks, which extend up to 0.2 mile offshore, and an above-water shingle patch lies 0.3 mile E of it.

Anchorage can be taken, in a depth of 26m, off the E part of the N end of Danco Island. However, vessels using this anchorage have reported some difficulty with icebergs being swept through the channel by the tidal current which attains a rate of 3 knots.

Mount Tennant, a conspicuous peak, is 688m high and rises in the N part of Ronge Island.

The Orne Islands and several above-water rocks lie on an area of foul ground which extends up to 1.3 miles N of Georges Point. Ferrer Rocks lie 1 mile W of Ketley Point, the W extremity of Ronge Island, and a shoal, with a least depth of 3.7m, is located close S of them. Useful Island, marked by a beacon, lies 2.8 miles W of Ketley Point and rocks extend up to about 1 mile ENE of it.

Andvord Bay (64˚50'S., 62˚39'W.) lies between Beneden Head and Duthiers Point, which is marked by a beacon, and extends 11 miles in a general SE direction. The S end of this bay is divided into two small inlets which trend E and S for about 2.5 miles. Depths within the main part of the bay are deep with the exception of a small indentation along the E shore, 5.5 miles SE of Beneden Head. Anchorage may be taken, as convenient, in depths of up to 73m. The shore at the head of the bay is formed by the cliffed face of a broken glacier which descends from the NE shoulder of Mount Theodore.

3.16 Neko Harbor (64˚50'S., 62˚33'W.), a small bay, indents the E shore of Andvord Bay. Two small coves lie on the S side of this bay at the base of steep slopes which ascend to the summit of Forbes Point. The harbor provides anchorage and has general depths of 55 to 90m. Shoals, with depths of less than 5.5m, fringe the shores.

A below-water rock, fringed by foul ground, lies close to the E shore of Andvord Bay, 3 miles NW of this harbor. Several coves indent the E shore of the bay to the S of Neko Harbor. A rock, awash, position doubtful, lies close off the N entrance point of the S of these coves.

The Coughtrey Peninsula, which terminates to the N in Duthiers Point, separates Andvord Harbor from Paradise Harbor. Mount Hoegh, Dallmeyer Peak, and Mount Inverleith, 1,820m high, stand on this peninsula and slope S toward the plateau.

Waterboat Point (64˚49'S., 62˚51'W.) is located 1.5 miles SW of Duthiers Point. Small vessels may anchor SW of this point.

Presidente Gonzalez Videla, a Chilean base, is situated in the vicinity of Waterboat Point. It was reported (1973) to be closed.

A below-water rock, existence doubtful, is reported to lie between Useful Island and the NW end of **Lemaire Island** (64˚49'S., 62˚57'W.), 6 miles SSW. A beacon stands on Molina Point, the NE extremity of Lemaire Island. Aguirre Passage, which is deep, separates this island from Waterboat Point.

Paradise Harbor (64˚51'S., 62˚54'W.), a wide bay, indents the coast to the SW of Andvord Bay. It lies S of Lemaire Island and E of Bryde Island. Anchorage may be taken, in a depth of 82m, clay with poor holding ground, in the harbor. The head of the harbor terminates in Skontorp Cove.

Ice constantly moves through the passage leading between the mainland and Lemaire Island. It often changes direction with the two daily tides, which attain rates of up to 3 knots, and vessels anchored here should be on constant alert. However, the tidal currents prevent the ice in the bay from freezing, even in winter months.

A light is shown from a pyramidal-shaped tower, 4m high, standing on O'Neill Point, the N extremity of Lautaro Island. This island is 58m high and lies at the W entrance to Bryde Channel, 1.5 miles W of Lemaire Island. It was reported that this light is often unreliable and is obscured S by high land.

Leith Cove and Skontorp Cove indent the E side of Paradise Harbor. A beacon stands on Garzon Point, the S entrance point of Skontorp Cove. The Coughtrey Peninsula projects from the N entrance point of this cove and a beacon stands at its N end. Anchorage can be taken, in a depth of 40m, rock, with good holding ground, within Skontorp Cove, 0.6 mile NE of Garzon Point.

Oscar Cove is entered between Garzon Point and Stoney Point, 1.5 miles W. A beacon, 7m high, stands on the latter point. Mascies Cove lies on the N side of Ferguson Channel, 1.5 miles W of Oscar Cove.

Almirante Brown, an Argentinean base, is situated in the vicinity of the Coughtrey Peninsula.

Bruce Island (64˚54'S., 63˚08'W.), 320m high, lies in the W entrance of Ferguson Channel and is separated from a peninsula by a deep channel. Mount Banck, a prominent peak, stands on this peninsula. Boutan Rocks, up to 5m high, lie about 1.3 miles SW of this island.

3.17 Wiencke Island (64˚50'S., 63˚25'W.) lies SE of Anvers Island and is separated from it by Neumayer Channel. Throughout the length of this island, three mountain ranges slope in a SE direction down to Gerlache Strait. Nemo Peak, 955m, and Nipple Peak form the NE range. Wall Range rises in the center of the island. The Fief Mountains stand at the SW end of this range and include Savoia Peak, the summit of the island, which is 1,435m high. A striking, serrated range of mountains rises NW of the central range and is separated from it by a wide valley. This range has Noble Peak standing at its NE end and Jabet Peak standing at its SW end.

Vazquez Island (64˚55'S., 63˚25'W.), 103m high, lies close SE of Principal Point, the SE extremity of Wiencke Island. A rock, 0.3m high, lies about 0.5 mile SW of this island; a rock, awash, is located 1 mile W of it.

Fridtjof Island (64˚53'S., 63˚22'W.), 136m high, lies, along with two small islets, about 1 mile off the E coast of Wiencke Island. Bob Island, 145m high, lies 3 miles SSW of this island.

Capstan Rocks, up to 10m high, lie about 0.5 mile S of Bob Island. A framework beacon, equipped with a radar reflector, stands near the E extremity of these rocks.

Breakwater Island, 33m high, lies close offshore, 5 miles S of Cape Astrup, the N extremity of Wiencke Island.

Cape Astrup is formed by a bold, round, and black-colored headland which is surmounted by an even sheet of ice. This sheet flows into the water on both sides of the cape. A rock, with a depth of less than 1.8m, lies about 0.3 mile N of the cape.

Neumayer Channel, which separates Anvers Island from Wiencke Island and Doumer Island, is entered, at its NE end, between Felicie Point, the S extremity of Lion Island, and Cape Astrup.

3.18 Demoy Point (64˚49'S., 63˚32'W.), located 3.5 miles SW of Noble Peak, is the W extremity of a peninsula which forms the N side of Port Lockroy. Casabianca Island, 46m high, lies 0.2 mile offshore, 0.5 mile NE of the point. A beacon stands near the E side of this island and another beacon stands near the N extremity of the peninsula. Anchorage may be taken, in depths of 22 to 36m, about 0.2 mile NE of Casabianca Island or, in a depth of 54m, about 0.3 mile E of the same island.

Dorian Bay lies on the N side of the isthmus, at the root of the peninsula which forms the N side of Port Lockroy. This bay is difficult to enter and may only be used by vessels with drafts of less than 4m. There are depths of 5 to 5.8m within the bay, over a bottom of soft mud. A reef, which nearly covers at HW, extends almost entirely across the entrance to the bay from its W entrance point. A narrow channel, with a depth of 2.7m, leads between the E end of the reef and the E entrance point of the bay. A hut is reported to stand on the S shore of the bay. Another hut, with a marker, is reported to stand near the SW end of the bay. An airstrip situated in the vicinity of Demoy Point is occasionally used. Anchorage can be taken, in a depth of 73m, about 0.2 mile E of the beacon standing on Casabianca Island.

3.19 Port Lockroy (64˚50'S., 63˚27'W.) (World Port Index No. 63100), lying on the W side of Wiencke Island and NE of Doumer Island, is one of the best harbors in this region. It

affords good shelter, with moderate depths, in good holding ground. This harbor is entered between Flag Point, on the N side, and Lecuyer Point, 0.5 mile SSE, and extends E for about 0.8 mile. The W half of the S side of the harbor is encumbered by two islands and two islets. The passages leading between these obstructions are reported to be foul. Goudier Island, with Bills Island located close NE, lies close off a small peninsula on the SW side of the harbor. Two islets, both bare, lie about 0.4 mile W of Bills Island. A channel, 0.2 mile wide, passes N of these islets and into the inner part of the harbor, which can only be used by small craft. Alice Creek, in the inner part, has a reef extending E at least halfway across its entrance.

The ocean swell does not penetrate into the harbor and rocks protect it from drifting icebergs. However, loose ice may be experienced due to calving of the glacier face which skirts the harbor shore. Vessels may approach the harbor through either Neumayer Channel or Peltier Channel, which are usually ice-free due to the currents. The N shore is formed by steep ice slopes which descend from the serrated hills. These slopes have vertical faces at the water's edge, 140 to 185m high. The E shores are marked by Smith Point and Besnard Point.

Goudier Island is fronted by a wharf, 4.5m long, which has a least depth of 0.9m alongside; however, it is reported to be in poor condition. A cairn and a mast stand on this island and a beacon stands on Bills Island.

The outer part of the harbor provides anchorage, but the bottom is rocky and the holding ground is not good during E winds. When entering the harbor, vessels should pass to the N of the islands and then proceed along the ice edge of the N shore. Good anchorage may be taken, in a depth of 16.5m, mud, about 0.3 mile NE of Bills Island. Anchorage may also be taken, in a depth of 18m, mud, about 0.2 mile N of Besnard Point which is located at the E side of the harbor.

Port Lockroy is usually ice-locked until the middle of December, but it affords an excellent harbor during the months of January, February, and March. However, winds from the S may block the entrances with loose drift ice.

Doumer Island lies in the S entrance of Neumayer Channel and is separated from Wiencke Island by Peltier Channel. This island is dominated by a snow-covered pyramid, 508m high, which rises steeply from the head of South Bay.

South Bay is entered between Py Point, the S extremity of Doumer Island and Cape Kemp, 1.2 miles NW. An emergency box of provisions is situated in the vicinity of Py Point. A spit, with several rocks awash, extends up to 0.3 mile from the head of this bay. Anchorage can be obtained, in a depth of 35m, about 0.7 mile NNE or 0.5 mile NW of Py Point. A shoal patch, with a depth of 7.3m, lies about 0.6 mile ENE of the point.

Homeward Point, located 1.5 miles NNE of Cape Kemp, is the W entrance point of Security Bay. Gauthier Point, marked by a beacon, forms the NE entrance point of this bay and is the NW extremity of the island. A shoal patch, with a depth of 8.8m, lies about 1 mile NE of this point.

3.20 Cape Lancaster (64˚51'S., 63˚44'W.), the S extremity of Andvers Island, forms the S extremity of an ice-covered promontory which rises gradually to Mount Ancla. A chain of reefs extends up to 1.5 miles S from this cape.

Exposure Rock, 3m high and over which the sea breaks heavily in rough weather, lies about 0.6 mile S of the cape. A chain of rocks, which runs parallel to the coast about 0.2 mile offshore, extends from close E of the cape to about 0.6 mile E of it.

Strong eddies and overfalls have been reported to occur up to about 1.2 miles seaward of this cape, especially during NE winds.

Borgen Bay (64˚45'S., 63˚31'W.) indents the coast and recedes for about 2 miles. The William Glacier lies at the head of this bay. From the bay, the coast trends E for 2 miles and then NE for 8 miles to Lion Sound. This stretch of the coast is bordered by sheer cliffs, many of which are so steep that snow cannot cling to them, and backed by several sharp summits. Billie Peak, 725m high, is the most prominent of these summits. Copper Peak, 1,125m high, rises 2 miles N of it and is green-colored.

Mount Francais, 2,821m high, is the tallest summit rising on Anvers Island and stands above and inland from this portion of the coast.

Lion Island (64˚41'S., 63˚08'W.), 411m high, stands 1.5 miles SSW of Iceberg Point. The entrances leading into Lion Sound are clear, but a reef extends about 1 mile SW from Felicie Point, the S extremity of this island. Two small islets lie close off the shore of Anvers Island, W of Felicie Point. A rock, with a depth of less than 1.8m, lies about 0.8 mile ENE of Hippolyte Point, the N extremity of the island. Dobrowolski Island lies close to the shore, 3 miles SW of Ryswyck Point.

Caution.—When navigating in the vicinity of Cape Lancaster, vessels should exercise extreme care as reefs, which do not break, have been reported to lie up to about 1 mile from the shore.

3.21 Ryswyck Point (64˚34'S., 62˚50'W.) forms the NE extremity of Anvers Island; Clifford Peak, 1,160m high, rises 4 miles W of it. Fournier Island lies 0.3 mile E of this point.

A group of islets and rocks, named The Waifs, lies in the middle of the S entrance to Schollaert Channel. Breakers have been observed to occur off the westernmost rocks of this group; foul ground lies between them and Fournier Island.

Chiriguano Light is shown from a framework tower standing on the southernmost islet of The Waifs.

A navigable channel leads between Ryswyck Point and Fournier Island and has a least depth, in the middle, of 20m. Vessels are advised to approach this channel from the N, steering a course of 168˚, and from the S, steering a course of 000˚. The channel leading E of The Waifs is deep, but vessels using it should keep at least 1 mile off the coast of Brabant Island. The fairway leading through Schollaert Channel is deep and clear of dangers, except for a rock, with a depth of less than 1.8m, which lies 0.2 mile NE of False Island.

Dallmann Bay separates Brabant Island and Anvers Island and forms the W entrance to Schollaert Channel. Several groups of low, snow-capped islands, which are surrounded by rocks, lie within this bay.

3.22 The **Melchior Islands** (64˚19'S., 62˚57'W.) lie in the center of Dallmann Bay between Mount Parry and The Hump. These islands consist of two groups, the West Melchior Islands

and the East Melchior Islands, which are separated by The Sound.

The East Melchior Islands consist principally of two islands, Eta Island and Omega Island, which are separated by a narrow strait. Omega Island is 183m high and is the largest of the entire group.

Andersen Harbor (64˚20'S., 63˚00'W.)(World Port Index No. 63120), an indentation in the SW side of Eta Island, lies at the W end of this strait. The SW shore of this harbor is formed by the N extremity of Omega Island. The harbor is entered between Tripod Island, on the N side, and Pabellon Island, on the S side. A beacon is situated on Pabellon Island. The harbor extends E for about 0.5 mile and has depths of 9 to 54m. It provides anchorage in depths of 20 to 51m.

The strait leading between Eta Island and Omega Island varies in width from 90 to 180m. It is 0.5 mile long and has shallow depths. A strong tidal current sets in and out of this strait.

A number of rocks lie S of the East Melchior Islands and extend up to 0.4 mile seaward. During a recent survey, a below-water rock, fronted by foul ground, was reported to lie about 2.5 miles E of the NE extremity of Omega Island.

A foul ground area extends up to 1.3 miles N of the East Melchior Islands. Peace Island, the Tau Islands, and several small islets lie on this area.

A beacon, 4m high, stands on an islet lying 0.4 mile NW of the W side of Omega Island. Another beacon stands on an islet lying 0.5 mile S of Omega Island.

The West Melchior Islands consist of the large Lambda Island, lying on the N side, and the smaller Gamma Island, lying about 1 mile S. A chain of small islands and islets extends in a NE/SW direction and lies centered between these two islands. Delta Island is the northeasternmost of this chain, followed close SW by Alpha Island, Beta Island, and Kappa Island. Epsilon Island lies close NW of Alpha Island and the Theta Islands lie close NW of Kappa Island. Two harbors are formed by this chain; Inner Harbor lies S of Lambda Island, while Melchior Harbor lies N of Gamma Island.

Islets and rocks, both above and below-water, all surrounded by foul ground, lie 3 miles ENE, 2.5 miles NE, and 3 miles NNE of the E extremity of Lambda Island and are best seen on the chart.

Inner Harbor recedes for about 0.2 mile and has depths of 31 to 71m. It may be entered from The Sound. Foul ground extends up to about 140m N into the harbor from the N shore of Alpha Island and up to about 100m N from the NW shore of Delta Island. Moorings are available near the NE extremity of Alpha Island.

3.23 Melchior Harbor (64˚19'S., 63˚00'W.) (World Port Index No. 63110), a sheltered haven, is 0.5 mile long. It is enclosed, except on the E side, by Delta Island and may be entered from The Sound. Harpun Rocks, with a least depth of 4m, lie in the NE entrance to the harbor, close SE of the S extremity of Delta Island. Anchorage may be taken in the center of the harbor, in depths of 31 to 77m, clay, sand, or stones, with good holding ground. However, vessels may be inconvenienced by icebergs and drift ice.

A foul ground area extends up to 0.5 mile N from Lambda Island, the N of the W group. The Rho Islands, several in number, lie within this area.

The W entrances to Inner Harbor and Melchior Harbor have not been surveyed and strong tidal currents, which often bring large quantities of drift ice, are reported to set through them. Moorings are available on the N shore of Gamma Island, about 0.2 mile SW of Gallows Point, its NE extremity. A hut and a beacon are situated near Gallows Point. Anchorage can be taken with the summit of the island that lies between Gamma Island and Kappa Island bearing 239˚ and the beacon on Gallows Point bearing 125˚. Anchorage may also be taken about 0.2 mile N of this latter beacon.

The Sound runs in a N/S direction between the East Melchior Islands and the West Melchior Islands. When approaching this channel from the N, vessels should head for the center until clear of a group of rocks which breaks and lies about 0.2 mile off the E shore of Lambda Island. Vessels should then head for Gallows Point, the S entrance point of Melchior Harbor, until they are past Delta Island, when the haven will be open to full view. Harpun Rocks lie about 0.2 mile S of Bills Point, the S extremity of Delta Island.

3.24 Gand Island (64˚24'S., 62˚51'W.), flat and ice-covered, is 3 miles long and 1.5 miles wide. It lies about 3 miles SSE of the Melchior Islands. Several rocks and reefs lie within 0.5 mile of the S shore of the island and a small island, known as Manoury Island, lies 1.3 miles S of it. Gand Island forms the N entrance point of Schollaert Channel and lies on its E side.

From Hackapike Bay, the coast extends N for 0.8 mile to Andrews Point which forms the S entrance point of Discovery Sound. Three rocks lie close N of Andrews Point.

Guepratte Island is covered with snow and lies on the W side of Schollaert Channel, 1.8 miles W of Andrews Point. Numerous small islands front the E shore of this island. Several rocks and areas of foul ground extend up to 1 mile seaward of the E side of this island.

Discovery Sound leads S of Guepratte Island and connects Fournier Bay with Schollaert Sound. Phils Island lies close to the S extremity of Guepratte Island and rocks extend up to 0.2 mile W of it. A least depth of 18.3m was reported to lie in the channel 0.2 mile SE of East Point, the E extremity of Phils Island.

3.25 Inverleith Harbor (64˚32'S., 63˚00'W.), an inlet, recedes S for 2 miles and provides anchorage in a depth of 102m. A glacier is located at the head of this harbor and a large amount of drift ice often flows into it. Several small rocks lie along the N shore of the Briggs Peninsula, at the E side of Fournier Bay. This bay is 8 miles long and 3 miles wide; a glacier fronts the head. A below-water rock lies near the middle of the entrance to this bay, 1.5 miles WNW of the Briggs Peninsula. The W shore of the bay extends 10 miles N to an unnamed point of land, which has foul ground extending up to 1.5 miles N of it.

The Thompson Peninsula projects from the NE side of Anvers Island, on the W side of Dallmann Bay, and forms the NW side of Fournier Bay. A number of islets lie close off its seaward extremity. Patagonia Bay lies between the Thompson Peninsula and the Gourdon Peninsula, 2 miles NW. The latter

peninsula forms the SE shore of Lapeyrere Bay. Pyramid Rock, 40m high, lies close off the NE extremity of the Gourdon Peninsula and The Hump rises on the N side of Lapeyrere Bay.

D'Abnour Bay is small and lies close W of **Cape Bayle** (64˚17'S., 63˚10'W.), the NE extremity of Anvers Island. From Cape Bayle, the N shore extends W for 10 miles to Cape Gronland, the NW extremity of the island. D'Abnour Bay is obstructed by many rocks and shoals.

The N shore of the island is fringed by numerous rocks and small snowy islands, with the most prominent being the **Lajarte Islands** (64˚14'S., 63˚24'W.), which extend up to 2.5 miles N from the coast. Breakers and foul ground are reported to extend up to about 5 miles N of these islands.

The W coast of Anvers Island is frequently obscured by fog and low clouds. Many rocks and snow-covered islands lie off the coast and up to 4 miles offshore. Approach to this stretch of coast is hazardous, except during periods of good visibility.

From Cape Gronland, the W coast of the island extends SW for 31 miles to Cape Monaco. The Paul Islands, a group of five islands, lie about 4 miles W of Cape Gronland.

Perrier Bay indents the W coast, 8 miles SW of Cape Gronland. The N entrance point of this bay is formed by Quinton Point and the S entrance point is formed by Giard Point. Hamburg Bay lies SW of Perrier Bay and is separated from it by a peninsula, 4.5 miles wide. Bonnier Point forms the W extremity of this peninsula. A chain of rocks, 2 miles long, extends NE from the S side of Hamburg Bay to beyond Perrier Bay. Gerlache Island lies 7 miles SW of Hamburg Bay. An extensive patch of below-water rocks, which break heavily even in calm weather, lies 2 miles N of this island.

Cape Monaco is located 8 miles SSW of Gerlache Island. The shore between is fronted by the Rosenthal Islands, which extend up to 1.5 miles seaward. The N of this group of islands is conspicuous. Numerous dangerous rocks, surrounded by breakers, lie in an area, with a diameter of 0.8 mile, centered about 4 miles NNW of Gerlache Island.

3.26 Cape Monaco (64˚42'S., 64˚15'W.), the W extremity of Anvers Island, is fringed with numerous small islands and rocks which extend up to 10 miles SW. Large icebergs are frequently grounded in the vicinity of these obstructions.

The Gossler Islands lie close off the cape. Buff Island, the outermost of this group, is formed by a steep rock, 33m high, with a sheer N side. It is very prominent and radar conspicuous.

Lenie Passage, which is deep and has a least width of 0.8 mile, leads between the Joubin Islands and the Gossler Islands. Numerous dangers lie close to the shores on each side of this passage.

At the E end, the dangers on the S side include Beaumont Skerries, which lie 3.5 miles S of Cape Monaco, and Scend Rock. The sea breaks heavily over Scend Rock and a rock, awash, lies 0.3 mile S of it. The dangers on the N side of the passage include shoal patches, with depths of 14 and 16m, and Rumbler Rock, which lies 4 miles SE of Cape Monaco.

At the W end of the passage, a shoal patch, with a depth of 8.5m, lies 5 miles W of Cape Monaco. This passage should be used in good weather as the water is smooth and the detour round the Joubin Islands can be avoided.

A conspicuous rock, upon which the sea breaks heavily, lies about 2.5 miles SE of Cape Monaco. A shoal, with a depth of 16.2m, lies about 2 miles S of the cape and a shoal, with a depth of 4.9m, lies about 3 miles W of the Gossler Islands.

Bonaparte Point is located 7 miles SE of Cape Monaco. The coast between is fronted by many small islands which lie up to 3 miles offshore. Two oil tanks are reported to stand on a small peninsula which is located 0.5 mile NE of Bonaparte Point. A small pier is situated on the S side of this peninsula. This pier can accommodate vessels of up to 5.4m draft, but lacks mooring facilities for large vessels.

Shortcut Island lies 0.8 mile ESE of Bonaparte Point. This island is separated from Anvers Island by a deep and narrow channel which provides a direct route between Arthur Bay and Biscoe Bay. A shoal, with a depth of 14.6m, lies about 1.3 miles SW of Halfway Island. Breakers were reported to occur about 1.5 miles NNW of Halfway Island. Vessels have anchored, in a depth of 36m, about 0.3 mile offshore, 7 miles SE of Cape Monaco.

3.27 Arthur Harbor (64˚46'S., 64˚04'W.), an inlet, lies between Bonaparte Point and Norsel Point, 1.2 miles NNW. It is fronted by six large islands and numerous islets and rocks. Torgersen Island lies 0.2 mile NW of Bonaparte Point. A beacon stands on this island, but it was reported (1992) to be destroyed. Elephant Rocks partly uncover and lie close N of this island.

Palmer Station (64˚46'S., 64˚04'W.), a United States base, stands on a small area of bare rock on Anvers Island, adjacent to Arthur Harbor. This base consists of a main laboratory building, a second major building, and several smaller structures. It has a helicopter landing pad, a dock, and two large fuel tanks.

The base is operated by the U.S. National Science Foundation in order to support scientific research, with an emphasis on marine biology. This base was designated (1991), along with its surroundings within 2 miles, as a Long Term Ecological Research Site. Any disturbance of the islands, waters, or wildlife at this site would be detrimental to the research. Vessels that have obtained prior approval to approach the site should contact the base 24 hours to 72 hours in advance for permission to anchor.

In January 1989, the Bahia Paraiso, an Argentinean vessel, struck a rock when leaving Arthur Harbor and proceeding W between DeLaca Island and Litchfield Island. The vessel drifted to a location lying immediately E of DeLaca Island, where it sank in shallow water, about 1.1 miles SW of the base. The hulk was reported (1992) to be lying on the bottom with a small portion visible at LW. It was also reported (1992) that there were plans to remove the fuel from the tanks of this vessel. The hulk is expected to remain indefinitely.

Litchfield Island, the largest island fronting Arthur Harbor, lies 0.2 mile W of Torgersen Island. Many dangerous ledges and pinnacle rocks extend SW from the S extremity of Litchfield Island. A dangerous rock lies 0.3 mile SSW of the S extremity and a shoal, with a depth of 3.3m, lies close E of it.

Humble Island and Breaker Island lie 0.4 mile and 0.8 mile, respectively, NW of Torgersen Island. Shallow depths front the W side of Torgersen Island and lie up to 0.1 mile offshore.

Arthur Harbor is easily entered; anchorage may be obtained, in a depth of 18m, clay, about 0.5 mile NNE of Bonaparte Point. It would be difficult for more than one vessel to anchor at the same time within the harbor due to its small size and many obstructions. The approach to the harbor, which lies between Hermit Island and the Outcast Islands, is not recommended.

A vessel, with a draft of 8.2m, has safely used the following described route. Starting from a position with Buff Island bearing 000˚ distant 3 miles, the vessel steered a course of 090˚ for 9.6 miles and then a course of 003˚ for 6.1 miles. When the left tangent of Halfway Island was bearing 003˚ distant 2.5 miles, the vessel then steered a course of 090˚ and passed midway between Janus Island and Spume Island until the right tangent of the former island was bearing 000˚. The vessel then steered a course of 038˚ toward the anchorage.

Caution.—A primary difficulty encountered in the approach to the harbor was reported to be the inability to correctly identify Halfway Island. Difficulty was also encountered in identifying Spume Island.

3.28 Biscoe Bay (64˚48'S., 63˚50'W.) is entered between an unnamed point, located 4 miles ESE of Bonaparte Point, and Biscoe Point, 3.5 miles ESE. The latter point is formed by a jagged and rocky peninsula on which a penguin rookery is situated. Access Point is located 0.8 mile SE of Biscoe Point. Shortcut Island lies 0.8 mile ESE of Bonaparte Point and is separated from Anvers Island by a deep, narrow channel which provides a direct route between Arthur Bay and Biscoe Bay. Several indentations, which might provide sheltered anchorage, lie on each side of the peninsula.

The **Wauwermans Islands** (64˚55'S., 63˚53'W.) lie 4 miles SW of Cape Lancaster. This group consists of numerous islands which extend in an E/W direction for about 9 miles. The islands are 9 to 91m high and are covered with snow. Water is available from streams on some of these islands during the summer months.

Wednesday Island, the E of the group, is almost circular, with a diameter of about 1.5 miles. The NE extremity of this island lies 3 miles WSW of Cape Errera. Brown Island lies 2 miles S of Wednesday Island and is small, brown, and almost free of snow. A reef, marked by breakers, extends up to about 1.5 miles S and SSW from this island. A dangerous rock, awash, lies about 1 mile S of the island.

Hazard Rock, isolated, small, and marked by a beacon, is 0.9m high and lies 2 miles SE of Brown Island. This rock forms an extreme danger in low visibility as it may easily be mistaken for floating ice and is not radar conspicuous. A dangerous rock lies about 0.5 mile N of Hazard Rock.

A light is shown from a structure standing on Tangent Island, the NW island of the group, which lies 6 miles WNW of Wednesday Island. Menier Island lies 4 miles S of Cape Errera and the Puzzle Islands lie 2 miles W of it. Numerous dangers lie in a chain that extends up to 1.5 miles NW of Menier Island and includes several islands, reefs, and shoals.

3.29 Butler Passage (64˚58'S., 63˚44'W.) leads between the E side of the Wauwermans Islands and the W side of the Puzzle Islands. The N entrance of this passage is formed by the junction of Bismarck Strait, Neumayer Channel, and Peltier Channel. The passage leads SW to the N entrance of Lemarie Channel, about 2.5 miles W of Cape Renard.

Bismarck Strait, at its W end, leads from seaward and separates the SW side of Anvers Island from the Wauwermans Islands, about 5 miles S. The strait has a width of about 3 miles between Exposure Rock, lying S of Cape Lancaster, and the northeasternmost of the Wauwermans Islands. It is mostly deep, but care is necessary when navigating in this vicinity as isolated shoals rise steeply on each side of the fairway channel. Bismarck Strait leads NE to Neumayer Channel and Gerlache Strait, and SSW through Butler Passage and Lemarie Channel.

Cape Willems to Darbel Bay

3.30 Flandres Bay (65˚02'S., 63˚20'W.), a large indentation, lies at the S end of the Danco Coast between **Cape Willems** (64˚57'S., 63˚16'W.), its NE entrance point, and Cape Renard, its SW entrance point. Between these capes, the bay has a width of about 11 miles, but it narrows toward the head which lies 15 miles SE. Numerous rocks and reefs front the shores of this bay.

The Moureaux Islands lie 3 miles from the head and 3 miles E of Rahir Point, a rocky promontory, which forms the W entrance point of the inner part of the bay. These islands are low, snow-covered, and connected by moraines, which at times appear above the sea.

The Guyou Islands and a shoal, with a depth of 10.9m, lie about 4 miles and 5.3 miles, respectively, WNW of Rahir Point. Swan Rock, 2.4m high, lies in the NE entrance of the bay, about 1.8 miles SSW of Cape Willems.

The head of the bay is narrowed to a width of about 4 miles in the vicinity of Rahir Point, which projects N from the S shore. Beyond this point, the inner part of the bay contains several small inlets. Briand Fjord, the N fjord, is 2 miles long and 1 mile wide. Etienne Fjord indents the coast in the SW part of the inner bay. It is 4 miles long and has an entrance about 1.5 miles wide. Thomson Cove indents the E side of Rahir Point. It is about 1 mile long and 1.5 miles wide.

The W side of a peninsula trends S for 2 miles and forms the E shore of Lauzanne Cove. From the W entrance point of this inlet, the S shore of Flandres Bay extends W for 1.5 miles to Sonia Point, a distinctive rocky projection. From this point, the coast extends NW to an unnamed point which forms the E entrance point of Hidden Bay. This stretch of shore is indented by four small bays. An extensive foul ground area extends up to 1.5 miles seaward of the entrance to this bay and many small islets lie on it. The shore then extends SSW for 4 miles to the head of Hidden Bay and then trends N for about 3 miles to Cape Renard.

Cape Renard (65˚01'S., 63˚47'W.) is a conspicuous headland, 740m high. This cape is marked by two steep needles, the slopes of which are too precipitous for snow to cover them. A light is shown from the E side of the cape.

The **Dannebrog Islands** (65˚03'S., 64˚08'W.) consist of a chain of islands and rocks lying S of the Bismarck Strait. This chain extends WSW for 20 miles from a position located about 5 miles W of Cape Renard. The Dannebrog Islands group also includes several large islands lying E of the above chain which are separated by Lemaire Channel. The area in the vicinity of the Dannebrog Islands has not been completely surveyed.

However, Nimrod Passage, which separates these islands from the Wauwermans Islands, is mostly deep and has a width of at least 0.8 mile, except for a shoal, with a depth of 14.6m, lying in the middle of its E end. Numerous dangers, which may best seen on the chart, lie between 22 and 31 miles W of Cape Renard.

3.31 Booth Island, the largest of the Dannebrog Islands, lies with Turquet Point, its N extremity, located 5 miles WSW of Cape Renard. This island is high, rugged, and consists of two rocky masses joined by a low, narrow peninsula of ice and snow. Gourdon Peak (Wandel Peak), 979m high, rises in the S part of the island. Two spurs extend N from this peak and fall steeply to the sea, enclosing a beautiful glacier between them. The W of these spurs forms a peninsula on the N side of which lies, Port Charcot, a small bay. Jeanne Hill, 193m high, and Louise Peak, 625m high, stand on this peninsula. A large penguin rookery is reported to be situated on the slopes of Jeanne Hill.

Francais Cove, a small creek, lies at the head of Port Charcot between Vanssay Point and Cholet Island.

Splitwind Island (65˚02'S., 63˚56'W.), with a group of rocks lying NE and SE of it, is located 0.5 mile NE of Turquet Point.

Port Charcot (65˚04'S., 64˚00'W.) indents the N side of Booth Island. This bay has depths over 25m lying W of Vanssay Point, but the bottom is rocky and the holding ground is very poor. This harbor offers protection from all winds except NE gales which raise a rough sea.

Hovgaard Island lies close SW of Booth Island and extends for 3 miles in a NE/SW direction. The shores of this island consist mostly of steep, vertical cliffs. A small peninsula forms the S extremity of the island, off which a number of rocks lie. A rock, which breaks, is reported to lie midway between Hovgaard Island and Petermann Island.

Pleneau Island, 54m high, lies close off the NE extremity of Hovgaard Island. A shoal area, with rocks that break, is reported to lie within 0.2 mile E of the E end of this island. A penguin rookery is situated on the NE end of the island.

Anchorage was obtained, in a depth of 49m, rock, within the channel leading between Pleneau Island and Booth Island. Anchorage was also taken with Gourdon Peak bearing 070˚, distant 1 mile. The islands lying around this anchorage afford good protection from all seas except those from the W.

The Vedel Islands lie 2 miles W of Hovgaard Island. This group consists of numerous islands and rocks, but has not been surveyed. A chain of rocks extends NE for 2 mile from this group and another group of rocks lies between 1 and 2 miles S of it.

A beacon, 6m high, is reported to stand on one of the Stray Islands, a small group, which lie S of the Vedel Islands and W of Petermann Island. Numerous dangers lie W, NW, and N of the Vedel Islands and extend up to about 5 miles seaward.

3.32 **Petermann Island** (65˚10'S., 64˚10'W.) lies 1 mile SSW of Hovgaard Island. Clayton Hill, a rocky mass, is 102m high and rises in the N part of this island. A beacon surmounts this hill and another beacon stands on the S end of the island. Port Circumcision, a small inlet, indents the E side of the island and has depths of 5 to 8.2m. A large cairn stands on Megalestris Hill, a rocky hillock, which is 35m high and rises in the S part of the island.

The E part of the N shore of the island is fronted by foul ground, while the W shore is mostly clear. Several islands lie S of Petermann Island. The largest of these are Charlat Island, Thiebault Island, and Boudet Island. A beacon stands on the SE end of Boudet Island and below-water rocks lie between this island and Herald Reef, 0.8 mile WSW.

Petermann Island may be approached through French Passage, Penola Strait, or Lemaire Channel. However, vessels should approach Port Circumcision from the SE. Anchorage can be taken to the S of Boudet Island, in a depth of 33m, rock, with the right tangent of Herald Reef bearing 277˚ and the beacon on Petermann Island bearing 004˚. This anchorage is protected to the E by the Graham Coast and somewhat to the W by the numerous small islands and reefs.

3.33 From Cape Renard, the coast extends SW for 13 miles and forms the E shore of Lemaire Channel. This stretch of coast is formed by steep cliffs, up to 610m high, which rise vertically from the water. Deloncle Bay, lying 6 miles SW of Cape Renard, forms an indentation in a glacier which rises steeply to the E. Loubat Point and Glandaz Point form, respectively, the N and S entrance points of this bay. Girard Bay lies 3 miles SW of Glandaz Point. Mount Cloos, snow-covered and dome-shaped, rises on the N shore of Deloncle Bay. A sharp, cone-shaped hill, 981m high, rises close W of this peak and has steep, bare, and rocky slopes.

The S shore of Girard Bay is formed by the high cliffs of Mount Scott, a rocky mass, which is in the form of a horseshoe. Duseberg Buttress rises opposite Petermann Island and is conspicuous. It consists of a rocky cone, 500m high. From this cone, the coast extends S and forms the E shore of Penola Strait. A beacon stands on Redondo Point, which is located 2.3 miles S of Duseberg Buttress.

Waddington Bay (65˚16'S., 64˚05'W.) is entered between Rasmussen Island and Cape Tuxen. Cape Tuxen is indented by several coves and surmounted by the steep slopes of Mount Demaria. This peak is 638m high, free of snow, and conspicuous. It stands perpendicular and resembles a crouching cat.

The Yalour Islands, a group of islands and rocks, lie in the middle of Penola Strait with a navigable channel passing on either side. The channel leading E of the group has not been surveyed and dangers may lie within it. The W side of the group is fringed by foul ground.

A rock, 2m high, lies about 2 miles W of Cape Tuxen and Barros Rocks lie 0.4 mile S of it.

French Passage leads between the Dannebrog Islands, to the N, and the Roca Islands and the Argentine Islands, to the S. This passage is believed to be clear of dangers; however, numerous pinnacle rocks and reefs lie in this vicinity and great care should be taken.

An above-water rock, with a below-water rock lying close NW of it, is located near the approach to French Passage, about 4 miles NE of the largest of the Gruls Islands. Two small islets, fringed by foul ground, are reported to lie, existence doubtful, about 4.5 miles W of the largest of the Gruls Islands.

3.34 The **Argentine Islands** (65˚15'S., 64˚16'W.) are the first group in an extensive chain of islands which extends in a

WNW direction for about 12 miles. This group lies 3 miles from Cape Tuxen and consists of an archipelago of islands, the largest having a diameter of about 0.7 mile, which are fringed by many rocks and reefs. None of these islands rise to a height of more than 65m. The islands in the group are separated by several narrow channels, through which swift currents run with many eddies.

The Argentine Islands can be divided roughly into seven groups. The five principal islands of the N group are Irizaro Island, Uruguayo Island, the two Corner Islands, and Grotto Island. Anchorage was obtained, in a depth of 31m, rock, off Irizar Island.

A group of islands lies SSW of the N group and is separated from it by Meek Channel. Galindez Island is the NE of this group; Skua Island is the SW. Winter Island almost fills the entire bight lying between the W side of the former island and the N side of the latter island. A disused hut is situated on the SE extremity of Winter Island. A beacon is reported to stand on the W end of Winter Island.

Galindez (Faraday), a British base, is situated on the peninsula that forms the NW end of Galindez Island. Marina Point is the NW extremity of this peninsula.

Meek Channel, with a least depth of 7.9m, leads between Corner Island and the NE side of Galindez Island. Corner Rock, with a least depth of 2.1m, lies in the E entrance and restricts the use of this channel to vessels of less than 60m in length. A reef, with a least depth of 2.1m, lies close off the NW part of Galindez Island. Thumb Rock lies at the SE end of the reef; Indicator Island lies on its SW part; and two islands, known as The Buttons, lie on its N part. A narrow channel, with a least depth of 8.5m, leads between the reef and the NW part of Galindez Island. A deep channel, reported to be clear of dangers, leads between the reef and the N side of Winter Island. These two channels lead to Skua Creek which separates Galindez Island from Winter Island.

3.35 Skua Creek (65˚15'S., 64˚16'W.) has a least depth of 4.6m in its N part and 0.9m in its S part. However, its S entrance is shallow and obstructed by numerous rocks. Cornice Channel separates Galindez Island from Skua Island. The N end of this passage is narrow and has a depth of 1.2m. The channel leading between Winter Island and Skua Island, which is known as Skua Creek, has depths that decrease from 20m at the NW entrance to 2.4m at the SE end. The SE end of this channel is also obstructed by foul ground. The NW entrance is narrowed by a bank extending from its NE side on which a rock, with a depth of 2m, lies.

A number of islands and above-water rocks lie up to 0.2 mile seaward of the W side of Skua Island. In addition, several shoals have been observed from the air to extend up to about 0.2 mile S from the S side of this island.

The NW part of the Argentine Islands contains three groups of islands. The N of these groups is the Forge Islands, the central group is the Three Little Pigs, and the S group is the Shelter Islands. Several above and below-water rocks lie in the channel leading between the Horseshoe Islands and Grotto Island.

The SW group of the Argentine Islands consists of two principal islands; Black Island is the SE island and Leopard Island is the NW island. Numerous above and below-water rocks front all the islands in this group. Black Island Channel, which leads between Skua Island and Black Island, is 180m wide, deep, and clear of dangers in the fairway. However, Runciman Rock, which is marked by breakers, lies in the middle of the S approach to this channel, about 0.2 mile E of Black Island. Shoals extend up to about 0.2 mile SE and S from Finger Point, the SW extremity of the island. A shoal, with a depth of 2.1m, lies about 0.3 mile E of Runciman Rock.

An area, which is about 0.5 mile long and 0.2 mile wide, lies with Winter Island and Skua Island, on its SE side, and the Three Little Pigs and the Shelter Islands, on its NW side. This area has depths of 14 to 34m. The channel, which leads to this area from Black Island Channel, passes between Skua Island and Shelter Island. It is deep and clear of dangers in the fairway.

The W group of the Argentine Islands consists of The Barchans, four principal islands. These islands are snow-capped and fronted by a number of islets and rocks. A beacon stands on the NW extremity of the NW island. Several isolated rocks and reefs lie up to 3 miles S of this group.

Anchorage can be obtained, in a depth of 23m, about 0.2 mile S of the central of the Three Little Pigs. Anchorage can also be obtained, in a depth of 31m, within the NW part of Meek Channel, E of Channel Rock. Both of these anchorages are protected from the swell, but drift ice may be troublesome. Small vessels may find good shelter within Stella Creek. The best approach to Stella Creek is via Black Island Channel, which passes between Skua Island and Shelter Island. Vessels proceeding to Stella Creek from the E by way of Meek Channel should keep close to the S side of the W of the Corner Islands in order to avoid Corner Rock.

3.36 Barros Rocks (65˚17'S., 64˚12'W.), a group of small islets, lie in a crescent-shaped chain about 3 miles W of Cape Tuxen. A rock, 1.8m high, lies, position approximate, lies about 0.5 mile N of this chain.

The Berthelot Islands lie centered about 4 miles S of Cape Tuxen. This group consists of three small and barren islands, the largest being 166m high. Numerous rocks lie between this group and the mainland. A rock, which breaks, is reported to lie about 2.5 miles W of the largest of the Berthelot Islands. Gaunt Rock lies 2.8 miles NNW of this rock and a shoal, with a depth of 11m, is reported to be located close NE of it. Shoals, with depths of 13.7 and 14m, lie 0.5 mile NW and 3 miles W, respectively, of this rock.

A foul ground area, which is about 0.8 mile in diameter, lies 8.5 miles W of Cape Tuxen.

Darboux Island, 270m high, lies 3 miles W of Cape Perez. It has precipitous sides and a conical, snow-clad summit. A small group of islands lies about 1 mile N of this island. Somerville Island lies 2.5 miles NW of Darboux Island. This island is located within an area of islets and rocks, about 2 miles in diameter. Gedges Rock and Grim Rock lie 10 miles W and 10 miles WSW, respectively, of the Berthelot Islands. A group of islands and rocks lies centered 6 miles SW of Grim Rock.

A shoal, with a least depth of 2.4m, lies 0.5 mile NW of Gedges Rock.

The Betbeder Islands, a group consisting of three main islands and three rocks, lie centered 22 miles W of Cape Tuxen.

A reef, almost awash and breaking, is reported to lie about 1 mile S of the W island of the Betbeder Islands. Another reef extends about 0.3 mile N from the largest island of the group.

Sooty Rock and Lumus Rock lie 3 miles and 7.8 miles, respectively, WNW of Betbeder Island. A shoal patch, with a depth of 9.7m, lies about 2.5 miles NNE of the Betbeder Islands. Sooty Rock is 18m high and breaks heavily.

A group of rocks lies between 4 and 6 miles N of the Betbeder Islands. A survey reported that two isolated shoals, with depths of 23.8 and 27.4m and surrounded by foul ground, lie about 4.3 miles NE of the W of the Betbeder Islands. A danger to navigation, existence doubtful, was also reported to lie about 1.8 miles NW of the W island of this group.

A below-water rock is reported to lie, position approximate, about 0.5 mile S of Sooty Rock. An isolated shoal, with a depth of 11m, lies about 6 miles NNW of the E extremity of Sooty Rock.

Caution.—Vessels navigating in this area are advised to exercise great care due to the numerous dangers and obstructions.

3.37 Beascochea Bay (65˚30'S., 64˚00'W.), 14 miles long, varies in width between 1 and 6 miles. Cape Perez, the N entrance point of this bay, is prominent due to its high, perpendicular cliffs. These cliffs are formed of pink granite and are surmounted by two summits, 310 and 500m high, in front of which a sharp, conical peak rises.

Deniau Island (65˚27'S., 64˚19'W.), with several islets lying close NE of it, is located in the entrance to Beascochea Bay. This island along with the Lippmann Islands, Lahille Island, Tot Island, and the Edwards Islands all lie within 6 miles of the NW end of the Takaki Promontory.

Leroux Bay is wide and extends for about 7 miles SE. It is bordered on the NE side by the ice-covered peninsula which forms Nunez Point. The entrance to the bay is reduced in width by the location of Lahille Island. The E entrance is 2 miles wide and lies between Lahille Island and Nunez Point. The W entrance is 3 miles wide and lies between Lahille Island and a group of three islands which are located 1 mile E of Chavez Island.

Chavez Island is separated from the mainland by a narrow channel, in which strong currents have been observed. This island rises in ice-covered slopes to two rocky pinnacles. The S pinnacle forms the summit of the island and is 671m high. The W side of the island is very precipitous.

Link Stack lies close off the N extremity of Chavez Island. The Triad Islands, a group of three, and Verge Rocks lie 2 miles E and 2 miles N, respectively, of this stack. An islet is also reported to lie 0.5 mile NE of the stack. Trickster Rocks, the Sanctuary Islands, and the Riddle Islands lie close off the NW and SW extremities of the island.

Bigo Bay (65˚43'S., 64˚30'W.) is entered between the NW extremity of Chavez Island and Cape Garcia, 7 miles SW. Mount Bigo, 1,981m high, rises at the head of this bay. Lizard Island lies parallel to the N side of the bay and is separated from it by a narrow channel. It is low and covered with ice except at the summit.

From **Cape Garcia** (65˚44'S., 64˚40'W.), the coast extends S for 5 miles and then SSE for 9 miles, where it forms the NE shore of Barilari Bay. This bay is 6 miles wide and its shores are formed by ice cliffs which face the seaward edges of broad, glacial slopes. At the head of the bay, three glaciers descend from the interior between high rocky masses.

3.38 Sphinx Island (65˚54'S., 64˚53'W.), 2 miles long and 0.5 mile wide, lies near the S entrance to Barilari Bay. This island is inaccessible and presents a bare rock summit with vertical ice faces on all its sides. Several islets and rocks lie close off the N and SE extremities of the island. The location of Sphinx Island reduces the width of the entrance to Barilari Bay.

A bay, which is obstructed by an island, lies between Loqui Point and Rossa Point, 6.5 miles WSW. Landing can be effected in the vicinity of the latter point. The Llanquihue Islands, which form the E side of Harrison Passage, extend 7 miles N from this island. Tuorda Peak, 871m high, rises 2 miles SE of Rossa Point, with the Hoek Glacier located E of it.

The **Biscoe Islands** (66˚00'S., 66˚30'W.) form a chain which extends parallel to the W coast of the Antarctic Peninsula. This chain lies between 15 and 20 miles from the mainland and is separated from it by Pendleton Strait and a maze of smaller islands and islets. The islands in the chain extend for 85 miles between the Martins Islands and Matha Strait. They are separated into two groups by Pendleton Strait. These islands are entirely covered by glaciers, presenting domes of ice that often are very extended and, in some cases, bare rock is observed only at the base of the ice cliffs near the water's edge.

The Biscoe Islands have not been accurately surveyed and no landing places, shelters, or harbors are known to exist within them.

Rabot Island lies close S of Renaud Island and is separated from the latter by Rodman Passage, about 1.5 miles wide. Extension Reef extends up to 8 miles SW from Rabot Island and many small islands lie on it. Numerous icebergs are also usually reported to be aground on this reef. A beacon is reported to stand on one of the islands lying near the SW end of the reef, 5.5 miles SSW of Monflier Point, the SW extremity of Rabot Island. Another beacon stands near Monflier Point and a hut is reported to be situated close to a small cove, 0.8 mile ENE of it.

Renaud Island is the largest of the Biscoe Islands. The entire W coast of this island is fronted by a foul ground area which extends up to 5 miles offshore. This area is dotted with innumerable islets and rocks, which break, and numerous below-water rocks and reefs. A chain of islets, surrounded by foul ground and about 1 mile long, lies 7.5 miles off the W coast of Renaud Island, abreast the middle of the island. A foul ground area extends 6 miles SSW from the S extremity of Renaud Island. Two islets, surrounded by foul ground, lie 11.5 miles W of the S extremity of the island. A shoal area, the existence of which is probable, is reported to lie about 26 miles W of the S extremity.

3.39 The **Pitt Islands** (65˚26'S., 65˚30'W.), a group of islands, are located near the N end of the Biscoe Islands. Two isolated islands lie close N of the main group, about midway between Snodgrass Island and Lumus Rock.

The Pitt Islands include Trundle Island, the NE of the group; Jinks Island; Snubbin Island, the W of the group; Nupkins Island; Sawyer Island; Pickwick Island, the largest of the group; Winkle Island; Tupman Island; Fizkin Island; and

Slumkey Island. Johannessen Harbor is bordered by Snodgrass Island, Weller Island, and Jingle Island. It is entered through Wardle Entrance. Buzfuz Rock lies 1 mile W of Snubbin Island.

Smiggers Island, Lacuna Island, and Trivial Island lie at the SE side of the Pitt Islands, with Huddle Rocks, the Symington Islands, Lorn Rocks, Cornet Island, Milnes Island, and Woolpack Island located farther E and SE.

A large number of islands and rocks, which may best be seen on the chart, lie within an unsurveyed area located E of Renaud Island. These include Karelin Island, Martin Island, the Vize Islands, Nusser Island, Wittmann Island, Laktionov Island, Schule Island, Budel Island, Bates Island, Hummock Island, Round Island, Hennessy Island, Zukriegel Island, Curtis Island, Dodman Island, and the Trump Islands. Jagged Island lies close E of Dodman Island, with Beer Island located close S of it.

Duchaylard Island (65˚43'S., 65˚07'W.), 555m high, has a prominent conical peak and lies at the SW end of Grandidier Channel, 5 miles SSW of Woolpack Island. Landing may be made at the SE end of this island.

3.40 Vieugue Island, 305m high, has a conical peak and lies 1 mile NW of Duchaylard Island. Hook Island and Holmes Island lie 1 mile NE and close SSW, respectively, of this island. Guile Island, Cat Island, and Runnelstone Rock lie 1.3, 3.3, and 5.8 miles, respectively, SW of the island.

Larrouy Island is 744 high; its S extremity lies 5 miles NNE of Ferin Head. Landing may be made on Tadpole Island, which lies 2.5 miles SW of Larrouy Island.

From the ice cliff at the SW entrance point of Barilari Bay, the coast extends SW for 6 miles and then W for 6 miles to **Ferin Head** (65˚59'S., 65˚20'W.). This headland is marked on its N face by a horizontal ridge, behind which rises a snowy cone, and forms the NE entrance point of Holtedahl Bay. The Fish Islands, a group of six, lie in the NE part of the entrance to the bay and extend 4 miles SW from Ferin Head. A depth of 36m was reported to lie about 4 miles WSW of Ferin Head.

From Ferin Head, the coast extends S for 3 miles to Sharp Peak. Prospect Point is located 1.3 miles S of Ferin Head and a hut is reported to stand on its NE side. Flounder Island, the largest of the Fish Islands, lies 1.5 miles SSW of Prospect Point.

Black Head (66˚06'S., 65˚37'W.) forms the N extremity of a peninsula which rises to Waldeck-Rousseau Peak, 3 miles S. This peak is conspicuous and bears some resemblance to the monolith at Cape Perez, but is not as sharp. Cape Evensen, located 7 miles SW of Black Head, is a bold headland, with cliffs of ice and rock, which forms the W extremity of the peninsula. A shoal, with a depth of 11m, was reported (1958) to lie about 1 mile NW of Cape Evensen. Marie Island lies close NW of this cape.

3.41 The **Saffery Islands** (66˚04'S., 65˚49'W.), a group with Turnabout Island at its SE end and Turtle Island at its NW end, lie between 2 and 8.5 miles WNW of Black Head. The Trump Islands lie between 4 and 5 miles WNW of Turtle Island, 5 miles WSW of Dodman Island. Breakers have been observed to front the W side of the Trump Islands and a below-water rock has been reported, from the air, to lie about 2.8 miles NNE of them. Another below-water rock is reported to lie about 0.8 mile W of these islands.

Auvert Bay (66˚14'S., 65˚45'W.), of undetermined extent, lies between Cape Evensen and Cape Bellue. A group of islands and rocks lies within 1 mile SSE of Cape Evensen. Risk Rock, above-water, and Pesky Rocks, also above-water, lie 1.8 miles WSW and 4.5 miles W, respectively, of this cape.

Malus Island, 30m high, lies 4 miles S of Cape Evensen and two low rocks lie 1 mile NE of it. A rocky islet lies 1 mile WSW of Cape Bellue and several rocks front the rocky cliffs on the NE side of this cape.

Crystal Sound separates the Biscoe Islands from the mainland. It is about 55 miles long, 20 miles wide, and contains numerous islands which are not easily distinguished from the drift ice. This sound has numerous shoals, which rise from very deep water, and navigation within it is exceedingly haz-ardous.

3.42 **Lavoisier Island** (66˚12'S., 66˚44'W.) is the northernmost of the S group of the Biscoe Islands. Foul ground extends up to 2.5 miles seaward from Cape Leblond, its N extremity. The W shore of the island, which has not been fully examined, is fronted by foul ground extending up to about 2.5 miles seaward. The E shore of the island has not been examined.

Dubois Island and Krogh Island lie close SW of the SW extremity of Lavoisier Island. Molnar Rocks lie about 4.5 miles off the W coast, abreast the middle of the island; a dangerous rock lies 1.3 miles NNW of them.

Watkins Island lies 3 miles S of Lavoisier Island. A group of islands extends S from this island, the southernmost being Decazes Island. Foul ground extends up to 3 miles W from this group.

Belding Island lies close W of the S extremity of Watkins Island. The NW shore of this island is fringed by foul ground. Several islets and areas of foul ground extend up to about 3.5 miles SW of the SW extremity of this island. An isolated and dangerous rock lies about 5.8 miles SW of the SW extremity of the island.

The NW shore of Watkins Island is fronted by numerous islets and rocks which extend up to 1.3 miles seaward. A rock, awash, and a below-water rock lie about 2 miles NW and 2.5 miles W, respectively, of the NW end of Watkins Island. An isolated, small island, existence doubtful, is reported to lie about 7 miles WSW of the NW extremity of Watkins Island.

Numerous small islands and rocks lie E of the Biscoe Islands.

Matha Strait (66˚34'S., 67˚30'W.), a channel, leads between the rocks, which lie SW of Belding Island and the Barcroft Islands, and the Sillard Islands, which lie off Cape Muscart, the NE extremity of Adelaide Island.

Darbel Bay to Square Bay

3.43 **Darbel Bay** (66˚37'S., 66˚32'W.) is entered between Cape Bellue and Cape Rey, 25 miles SW.

Rambler Harbor (66˚28'S., 66˚27'W.), a sheltered anchorage area, lies on the N side of Rambler Island. Reefs extend NE from this island to the first group of islands, the outermost of which is known as Atom Rock. Rambler Island is mostly surrounded by ice cliffs.

Vessels approaching this harbor from the S should keep outside the off-lying islands and enter from the N. A rock, awash, lies close off an isolated outcrop which projects midway along the W side of Sunday Island. This rock outcrop is only noticeable from the E and, being only 6m high, is difficult to identify when there is drift ice.

Two small, snow-covered rocks lie close off the ice cliffs of Rambler Island and opposite the SE extremity of Sunday Island. A low rock and an island lie 2.5 miles NNW of the Bragg Islands.

The **Loubet Coast** (67˚00'S., 66˚00'W.) forms the continuation of the W coast of the Antarctic Peninsula and extends from Cape Bellue to the head of **Bourgeois Fjord** (67˚40'S., 67˚05'W.), in Marquenite Bay.

Cape Rey (66˚36'S., 66˚27'W.), faced by dark and perpendicular cliffs, forms the seaward promontory of a rocky mass which extends S. This cape is bordered at its base by a dome-shaped ice sheet. The cape also forms the NE entrance point of Lallemand Fjord.

A small group of islands and rocks lies 2 miles NNE of the cape. A below-water rock is reported to lie, position approximate, about 0.5 mile W of the cape.

Caution.—Navigation within Darbel Bay is dangerous. When entering the bay between the Ouston Islands and the Darbel Islands, the largest of which lies 6 miles SSW of Cape Bellue, care should be taken to avoid the off-lying rocks which extend up to 0.5 mile N of the N end of the latter group. The entire area surrounding these groups of islands is foul.

3.44 The **Pauling Islands** (66˚32'S., 66˚58'W.), forming an isolated group, lie 12.6 miles NNW of Cape Rey. This group consists of a snow-domed island and several smaller ice-capped islands. Numerous rocks front the W and S sides of these islands. The main island is 100m high and surrounded by ice cliffs except at its NE extremity, where a rock outcrop projects to form a landing place. An island, existence doubtful, was reported to lie about 5 miles SW of this group.

Matsuyama Rocks, a group of islets and rocks, lie 4 miles SW of Cape Rey and front the shore where a rocky promontory protrudes from the ice cliffs. Holdfast Point and a small bay lie 8 miles S of this rocky promontory. Mist Rocks and an isolated rock lie about 1 mile W and 2 miles NW, respectively, of this promontory. A below-water rock is reported to lie, existence doubtful, about 4 miles NNW of this promontory.

Lallemand Fjord extends 40 miles S from Cape Rey and is entered between Holdfast Point and Roux Island, 11 miles SW. A small group of rocks lies close off **Orford Cliff** (66˚55'S., 66˚30'W.) which is located 7 miles S of Holdfast Point.

The E shore of the fjord is formed by a rocky mass, of which Cape Rey is the N extremity. Near the head of the fjord, this rocky mass is broken by a glacier which flows W from the high interior.

The S shore of the fjord is formed by two wide glaciers which flow down from a height of 1,220m. These glaciers are separated by a snow-covered, rocky plateau mass which is about 1,500m high. The W entrance point of the fjord is formed by a rocky peninsula which is surmounted by two prominent peaks.

Roux Island (66˚54'S., 66˚57'W.), 293m high, lies NE of the W entrance point from which it is separated by a channel, 0.3 mile wide. This island has vertical slopes on its N side.

3.45 Andresen Island lies on the E side of the entrance to Lallemand Fjord, 4 miles from the ice cliffs which form the E shore. Landing can be made on the NW extremity of this island where a rocky ridge extends to the coast.

Detaille Island, 36m high, lies 2 miles WNW of Andresen Island. Numerous above and below-water rocks and foul ground extend up to 0.8 mile from all sides of this island. A hut is reported to stand on the N side and a beacon surmounts the summit of the island.

Shmidt Point (66˚55'S., 67˚02'W.) is the N extremity of the Arrowsmith Peninsula, which extends 41 miles SSW to Cape Saenz. Hanusse Bay is entered between this point and Cape Mascart, the NE extremity of Adelaide Island, 20 miles NW. At the S end of this bay, Hansen Island lies close to The Gullet, a narrow passage which separates Adelaide Island from the mainland.

The Gullet lies between the Arrowsmith Peninsula and Adelaide Island and connects Hanusse Bay to Laubeuf Fjord. This passage is 0.2 mile wide and strong currents have been observed within it. On the N side, the passage opens into channels which lead on either side of Hansen Island. On the S side, the passage opens into channels which lead on either side of Day Island. Due to this topography, strong local winds may be encountered.

Day Island lies 2 miles N of Wyatt Island; two small islands lie 3 miles W of its SW extremity. Other small islands lie close off Adelaide Island and 1 mile NW of the N extremity of Day Island.

Wyatt Island lies 2.5 miles offshore, 6 miles NE of Webb Island. A razorback ridge of exposed rock projects through the blanket of snow and ice covering this island.

Pinero Island, prominent when viewed from the SW, lies 4 miles W of **Cape Saenz** (67˚33'S., 67˚39'W.); another small island lies 0.4 mile NE of it. Several jagged peaks, up to 380m high, rise at the S end of this island. The N end of the island is comparatively flat, 224m high, and is marked by a cairn with a flagstaff. A dangerous rock is reported to lie about 1 mile NNW of the N extremity of Pinero Island.

Covey Rocks lie about midway between Cape Saenz and Pinero Island.

3.46 **Pourquoi Pas Island** (67˚41'S., 67˚28'W.) lies 3 miles S of Cape Saenz. Lainez Point, a steep and rocky promontory, is 914m high and forms the W extremity of the island. The S slopes of this point form the N shore of Dalgliesh Bay. The S shore of the bay consists of steep cliffs. These cliffs front a rugged massif, 1,644m high, which forms the S part of the island. At the head of the bay, the slopes of a glacier descend from the high interior of the island. The E coast of the island is inundated by ice, with only a few bare rocks showing. The S part of this coast is faced by steep slopes, up to 1,128m high.

Nemo Cove, 1 mile wide and 1 mile long, indents the E coast of the island and Mount Arronax, 1,585m high, rises close N of it. The N coast of the island is indented by a large bay, 4 miles

wide. This bay recedes for 3 miles and its shores consist of low, glacial slopes with occasional rocky hills and shingle beaches.

Quilp Rock, consisting of two above-water rocks, lies about 3.5 miles NNE of Lainez Point. A small island is reported to lie about 7.5 miles W of Lainez Point.

Bigourdan Fjord, about 10 miles long and 3 miles wide, lies N of Pourquoi Pas Island. The W entrance of this fjord is formed by Cape Saenz. A reef obstructs the S half of this entrance and extends 1 mile N from Pourquoi Pas Island. The N shore of the fjord consists of a glacier-filled valley, which extends N to Lallemand Fjord, and several high, rocky massifs. Blaiklock Island, 1,341m high, lies at the E end of the fjord and is separated from Pourquoi Pas Island by a channel about 1 mile wide.

The Narrows lies between Pourquoi Pas Island and Blaiklock Island. This channel is about 0.5 mile wide and connects Bigourdan Fjord to Bourgeois Fjord. Strong currents usually set in this channel. A small island, fringed by rocks, lies in the NE entrance to this narrow channel.

It was reported (1979) that Jones Channel N of Blaiklock Island was blocked by an ice shelf and was not navigable.

Bourgeois Fjord is entered between the S extremity of Pourquois Pas Island and the S extremity of Lagotellerie Island. It extends 30 miles in a NNE direction to Blind Bay. Blind Bay forms the SW limit of the Loubet Coast and the NE limit of the Fallieres Coast. The Barnes Glacier and the Perutz Glacier lie at the head of this bay.

Ridge Island lies in the center of Bourgeois Fjord. This island is about 7 miles long and is marked by a razorback ridge of dark rocks, 668m high, which forms the long axis of the island. This ridge descends to a col in the N part of the island and, farther N, rises to a rounded hill, 305m high, which is very steep on its N side. A bay, with a broad and gently-sloping beach, lies S of this rounded hill and below the col. The S end of the island is 1 mile wide and is fronted by an ice cliff. A raised shingle beach fringes the SW end of the island and is covered with debris which has fallen from the steep slopes above it.

The entrance to Dogs Leg Fjord lies on the E side of Bourgeois Fjord, E of Ridge Island. This fjord extends for 7 miles in an E direction. Two islands lie in the entrance of the fjord, which is about 2 miles wide. A small rock was reported (1971) to lie about 2.5 miles WSW of these two islands.

3.47 Adelaide Island (67˚15'S., 68˚30'W.) is 73 miles long and extends in a NE/SW direction. This island has an average width of over 18 miles and lies seaward of the Loubet Coast. It is separated from the mainland by Hanusse Bay, in the S part of Matha Strait; by Loubet Strait; and by Laubeuf Fjord, in the N part of Marguerite Bay.

A range of mountains extends the entire length of the island and presents a number of steep slopes on its E side. On the W side of this range, a long terrace of snow and ice spreads from the base of the mountains to the sea. This terrace terminates in perpendicular cliffs, 30 to 45m high.

Jenny Island, 1.8 miles long and 0.9 mile wide, lies 4 miles ENE of Cape Alexandra. From some directions, this island has been reported to be difficult to distinguish. The S side of the island consists of cliffs, up to 244m high, with a small glacier at their base. The E side of the island is perpendicular and fringed by shingle beaches. These beaches are covered with debris that falls from the heights above. The N side of the island has gentle slopes. A conspicuous horizontal, stone terrace is located at the SW end of the island, at the foot of the highest peak. This terrace is 400 to 480m long, 50 to 100m wide, and rises to a height of 8m above the sea.

Temporary anchorage has been taken off the NE extremity of Adelaide Island. Anchorage, sheltered from strong NE winds, has also been taken, in a depth of 42m, about 1 mile S of the rocks fronting the SW side of Jenny Island.

3.48 Ryder Bay (67˚34'S., 68˚20'W.) is entered between an unnamed point on the SE coast of Adelaide Island, located 4 miles N of Jenny Island, and Rothera Point, 9 miles NE. Four glaciers flow into this bay.

Killingbeck Island, 28m high, lies 0.9 mile E of Rothera Point. This island consists mainly of snow-free, rocky outcrops and can be easily distinguished by its rounded hump from the S. However, this hump is sometimes hidden by icebergs which may be grounded on a reef extending up to about 0.8 mile S of the island.

Rothera Point, a rocky headland, is 38m high and usually free of snow during the summer. North Cove lies on the NE side and South Cove lies on the SW side of this headland. These two coves, which have gently sloping shingle beaches, may be used for boat landings, depending on the prevailing weather and ice conditions. The windward cove tends to fill with icebergs and brash ice; however, most icebergs are able to float freely in and out of these coves due to their great depths. A jetty, suitable for small boats, is reported to be situated within South Cove and has a depth of 0.8m alongside. A rocky ledge, with a least depth of 1.2m, fronts the E side of this cove.

A gray shingle beach, 300m wide, extends W between the headland and an ice field. Adelaide Island (Rothera), a British base station, is situated in the vicinity of this beach. An airstrip is situated 2.5 miles NW of Rothera Point. It stands on the NE side of Reptile Ridge which backs the NE shore of Ryder Bay.

An extensive shoal, with a least depth of 2.3m, lies centered 0.8 mile NW of Killingbeck Island. Several drying and below-water rocks also extend up to 0.4 mile N of this island. A rock, which dries 4.3m, lies close off the S extremity of Rothera Point and a number of other dangers are located between it and the island.

An area extending S and W of the island is encumbered with numerous dangers and is hazardous for boats. However, a clear channel, with a depth of 42m, leads between the island and this area. Local knowledge is advised. The approach to Ryder Bay is obstructed by the Leonie Islands.

3.49 Leonie Island (67˚36'S., 68˚21'W.), the largest and westernmost of a group of islands, is 1.5 miles long, conical, and 494m high. This island is reported to be often difficult to distinguish against the background of Adelaide Island. A below-water rock lies about 0.5 mile N of this island and several rocks, awash, lie 0.3 mile E and 0.5 mile S of the E extremity of the island. The area surrounding this island is otherwise unsurveyed.

Lagoon Island lies 2 miles E of Leonie Island. A shallow boat harbor, which is entered from the S, indents the shore of

this island. Foul ground is reported to extend from the entrance points of this harbor.

Limpet Island lies 1.5 miles SE of Leonie Island and is 25m high. Several small islands and below-water rocks lie within 0.3 mile N and W of this island. A rock, existence doubtful, was reported (1980) to lie about 0.8 mile SE of this island. Additional dangers were also reported to lie close SW of this rock.

Anchorage Island, the E of the group, lies 0.8 mile SE of Lagoon Island. This island is 1.5 miles long and 57m high in its N part; a small island lies close SE of it. Two small boat harbors indent the E side of Anchorage Island. The S harbor has depths of 3 to 7m, but was reported (1976) to be heavily blocked with ice. The approach to the N harbor was reported (1977) to be blocked by several grounded bergs. A number of below-water rocks front the S side and extend up to 0.4 mile S of the island. A channel, with a least depth of 7.7m, leads between Lagoon Island and Anchorage Island.

The Mikkelsen Islands, consisting of a group of nine islands, lie 2 miles SE of Anchorage Island. The southernmost island of this group is 17m high.

Anchorage Island and the Mikkelsen Islands consist mainly of snow-free rock and can be quite easily identified against the snow-covered background by vessels approaching from the S. Occasionally, the islands are obscured by large icebergs that drift in the deep water in this vicinity. From the SE, the two groups of islands merge together and identification is difficult.

The passage leading between Anchorage Island and the Mikkelsen Islands is deep, but a small islet, 2m high, lies 0.5 mile N of the N island in the Mikkelsen Islands. This islet is often obscured by bergs. Ives Bank, with a least depth of 11m, lies about 1 mile S of the W island of the Mikkelsen Islands. The passage should be navigated with great care.

An area, 18 miles long and 3 miles wide, lying in the approach to Rothera Point was examined in 1976. This area extends for 1.5 miles on each side of a line, 18 miles long, drawn on a bearing of 030˚ from a position located 3.5 miles E of the Guebrant Islands. A least depth of 95m within this area was reported to lie about 3 miles E of Killingbeck Island.

Deep-water routes lead between Jenny Island and Adelaide Island and then to the E of the Mikkelsen Islands or between Anchorage Island and the Mikkelsen Islands. However, the use of these routes may depend on the ice conditions.

Anchorage.—No safe anchorage exists in the vicinity of Rothera Point, Anchorage Island, or the Mikkelsen Islands. Temporary anchorage may be taken, by small vessels with local knowledge, in a depth of 35m, within the bay close N of Rothera Point and about 350m NW of the N extremity of the headland. However, this anchorage is very dangerous with the prevailing NE winds, especially at night, due to the risk of large icebergs drifting close inshore.

3.50 Weertman Island (66˚58'S., 67˚45'W.), the largest of the Bennett Islands, has a prominent pyramidal-shaped peak, 596m high. This island is the southernmost of a group of five which lies SW of Laird Island. A landing place is located at the NE extremity of Weertman Island, below a prominent cliff. A shoal patch, with a depth of 12.8m, lies about 2 miles NNE of the E end of this island.

Laird Island, 11 miles long, lies in the middle of Hanusse Bay. This island has a central range of mountains which rises to Mount Bridgman, 879m high. The coast of the island consists of an unbroken line of ice cliffs except at Tutton Point, its SW extremity. Several extensive rock exposures are located close N of this latter point. Numerous reefs and shoals lie up to 4.5 miles seaward of the N extremity of the island.

Buchanan Passage leads between Adelaide Island and Laird Island. Isacke Passage leads between Laird Island and the Arrowsmith Peninsula.

The **Sillard Islands** (66˚37'S., 67˚34'W.), a group of two, are ice-covered and lie 2.5 miles NE of Cape Masca, the NE extremity of Adelaide Island. These islands are surrounded by foul ground. A small reef and two rocks, awash, lie close off the N side of these islands, on S side of Matha Strait.

From the NW extremity of Adelaide Island, the W coast extends in an unbroken line of ice cliffs to Cenobite Rocks. The shore is steep-to and mostly clear of dangers.

At the beginning of January, a tongue of drift ice forms on the S side of the entrance to Matha Strait and usually extends from a position located 5 miles N of Cape Masca up to about 16 miles W of the cape. To the W of this ice tongue, a passage leads nearly 10 miles NNW. Later on, this passage forms a coastal channel, 5 to 10 miles wide, but gradually decreases in width until it closes entirely in the vicinity of Cape Adriasola. The ice tongue is formed mainly by wind action.

A number of large icebergs often lie grounded about 2 miles N of Cenobite Rocks and indicate the N limit of the shallow water.

The Amoit Islands, consisting of two groups, lie between 10 and 12 miles W of Cape Adriasola and are fronted by several reefs and rocks. The Ward Islands, two in number, are located in the S group and rise to heights of 6.7 and 7.6m. Cumbers Reef and a small island, 5.2m high, are located in the N group. These dangers may best be seen on the chart.

A shoal patch, with a depth of 33m and which breaks in a heavy swell, lies 2 miles N of Cumbers Reef. Grounded icebergs are reported to often indicate the shoal areas lying in the vicinity of the Amoit Islands, the Ward Islands, and Cumbers Reef.

3.51 Cenobite Rocks (67˚35'S., 69˚18'W.), a group of three, lie about 2.5 miles W of Adelaide Island. The largest of these rocks is 5.2m high. To the S of these rocks, the coast of Adelaide Island extends 4.5 miles SSE to Cape Adriasola and is fringed by numerous small islands and below-water rocks.

Cape Adriasola consists of a promontory fronted by an ice cliff. At many points on this ice cliff, rocky outcrops can be seen protruding a few meters above sea level. A small group of rocks, up to 2.4m high and usually obscured by ice, lies 0.8 mile W of this cape.

The Chatos Islands, a group of three, lie about 1 mile SSW of the cape. The group is fronted by numerous rocks and its largest island is 12m high. Cono Island, conspicuous and conical, is 58m high and lies 1 mile S of this group.

Johnston Passage separates the Amoit Islands from Cenobite Rocks. Grounded icebergs are reported to often indicate the shoal areas lying in the vicinity of the Amoit Islands, the Ward Islands, and Cumbers Reef.

Fullastern Rock, with a least depth of 1.8m, lies 6.5 miles WNW of Cape Adriasola, in the middle of Johnston Passage. It is steep-to and has been reported not to break. This rock is not always marked by grounded icebergs and should be given a wide berth.

3.52 From Cape Adriasola, the ice cliff trends 8.5 miles SE to Adelaide, a disused British base. The remains of the base, consisting of several boarded-up huts and three metal masts, stand on an ice-free rocky point, 24m high.

Numerous low islets, rocks, and reefs fringe this stretch of coast. The islets are sometimes ice-capped and frequently difficult to distinguish.

The coast extending for 3 miles SE of Cape Adriasola is fronted by foul ground lying up to 1 mile offshore.

Nueva Rock, which is steep-to and frequently breaks, lies 3.5 miles S of **Cono Island** (67˚41'S., 69˚10'W.). League Rock, 6m high, and the Esplin Islands, up to 6m high, lie 3 miles SE and 4 miles E, respectively, of Nueva Rock. Cox Reef, which dries, lies 2 miles ESE of Nueva Rock. A shoal patch, with a depth of 6.4m, lies 0.9 mile N of this reef. This shoal lies near the N end of a bank, with depths of 13 to 37m, which extends N from the reef.

Box Reef, a chain of drying rocks, lies between League Rock and the Esplin Islands and may best be seen on the chart. Hibbert Rock, awash, lies 0.9 mile SE of League Rock and foul ground extends up to 2 miles E of it.

Patience Rocks, up to 1.2m high, lie 0.7 mile NNW of the former base. From these rocks, foul ground extends 1 mile SW to within 0.2 mile of the foul ground extending E from League Rocks. Glover Rocks lie close SE of the former base and extend up to 0.4 mile from the shore. Launch Rock, with a depth of 1.5m, lies 0.5 mile SSW of the former base.

Avian Island (67˚46'S., 68˚54'W.) lies close off the coast, 0.2 mile SSE of the SW end of Adelaide Island. This island is rocky, ice-free, and 48m high at its S end. A lattice tower, 12m high, is reported to stand on the S end of this island. Several reefs fringe the W side of the island and extend up to about 0.5 mile S. Two huts are reported to stand on this island. A beacon with racon stands on the S coast of the island.

The Henkes Islands, separated by Crosse Passage from Skeen Rocks, lie centered 2.5 miles SSW of the former base. Crouch Island, the southernmost and largest of the group, lies 3 miles SSW of Adelaide Island. Its summit, which is 11m high, is surmounted by a tripod beacon. Preston Island lies close to Crouch Island. These islands are steep-to on their S sides and numerous shoals and areas of foul ground lie in their vicinity. Worth Reef and Dean Rocks extend up to 1 mile N and 1.5 miles E, respectively, from Preston Island. Biggs Island, 3.7m high, lies 1.3 miles S of Avian Island.

Anchorage can be obtained, in a depth of 27m, about 0.7 mile SSW of the former base. The shoal patches in the vicinity provide some protection from large icebergs which continually drift into this anchorage from the W. The anchorage may be approached from the E by passing through Crosse Passage, close N of Biggs Island, and then altering course to 320˚. By keeping the latter island astern, bearing 140˚, this course leads midway between Skeen Rocks and Worth Reef. The anchorage should be used only in case of necessity and is not recommended due to the frequency of icebergs drifting in the area.

From the SW end of Adelaide Island, the coast extends 7 miles E to Cape Alexandra which is faced by steep, rocky cliffs. It consists mostly of ice cliffs, up to 30m high, with occasional rock outcrops at their base. A short patch of rocky cliffs, 482m high, is located 1.5 miles W of Cape Alexandra.

3.53 Jennings Reef extends 3 miles E from Avian Island and up to 1.5 miles from the coast to the Rocca Islands. This reef consists of an extensive chain of low islands, shoals, and rocks. The Rocca Islands rise to a height of 6m.

The Ginger Islands, up to 13m high, lie 0.3 mile offshore, 4.5 miles ENE of Avian Island. A shoal patch, with a least depth of 3.4m, and a detached shoal, with a depth of 20m, lie 0.8 mile ESE and 2.5 miles S, respectively, of the Ginger Islands.

Fitton Rock, 7m high, lies 0.4 mile SSE of Cape Alexandra; a below-water rock lies 0.5 mile W of it. Another below-water rock is reported to lie about 0.7 mile NE of Fitton Rock.

Vessels have obtained anchorage, in a depth of 35m, about 0.8 mile NE of the Rocca Islands. This roadstead was reported to be almost completely free of any dangers from drifting ice bergs or bergy bits.

Square Bay to Alexander Island, including Marguerite Bay

3.54 **Square Bay** (67˚51'S., 67˚00'W.) is 9 miles long and 9 miles wide. Broken Island and Center Island lie within this bay. Lagotellerie Island and Horseshoe Island front the bay and separate it from Bourgeois Fjord.

The E shore of the bay is mostly formed by almost vertical, rocky walls which, in places, are faced by ice falls or hanging glaciers. The S part of the E shore is filled by a large glacier which extends into an interior valley. Many raised beaches and glacial moraines front the steep and rocky cliffs within this bay. The S shore of the bay consists of precipitous, bare rock walls which rise to Mount Wilcox, 1,402m high. These walls are broken up by two small glaciers, each about 1 mile wide.

Camp Point (67˚58'S., 67˚19'W.), a prominent pyramid-shaped promontory, has steep sides and is 1,010m high.

Broken Island lies in the N part of the bay, about 2 miles from the N and E shores. Two small islets, fringed by foul ground, lie close off the SW side of this island. Centre Island lies in the S part of the bay, about 3 miles N of the S shore. The Line Islands extend 1 mile in an E/W direction and lie in the S entrance to the bay, midway between Horseshoe Island and Camp Point.

3.55 **Horseshoe Island** (67˚52'S., 67˚16'W.) lies with its SW extremity located 1.8 miles E of Lagotellerie Island. Mount Breaker, 879m high, is the southernmost and tallest of several peaks standing in the SE part of this island. Penitent Peak, 823m high; Ryan Peak, 809m high; Trifid Peak, 646m high; Spincloud Heights, with two peaks 646 and 626m high; and Russet Pikes, 538m high, rise in the NE part of the island. The slopes of the peaks are covered by loose boulders, with the steepest being devoid of snow. Several conspicuous glaciers lie between the peaks.

Several small islets and rocks fringe the S side of Horseshoe Island; Reluctant Island lies close off the E extremity. A num-

ber of small islands front the SW shore of Horseshoe Island and foul ground fringes the W extremity. A shoal, with a depth of 3.7m, is reported to lie about 4 miles W of the NW extremity of this island. Another shoal, with a depth of 12.8m, lies about 2 miles WSW of the NW extremity.

Lystad Bay indents the W side of the island and is flanked, on its N side, by Mount Searle, 536m high. The S side of this bay consists of steep, bare cliffs. Several fresh water lakes lie beyond the glacier which fronts the N shore of the bay. A large glacier terminates at the water's edge in an ice cliff, 9m high, at the head of the bay. Two small islets lie in the N part of the bay, close S of the N entrance point. At the head, several islets and shoals extend up to 1.5 miles seaward from the face of the ice cliff. Sally Cove lies 2 miles NE of Beacon Head and Homing Head is located 2.5 miles NE of it. A hut is reported to stand near the head of the cove.

A conspicuous gravel spit fronts the S shore of the bay, close inside the S entrance point. Shoals, with depths of 6.4 and 4.1m, lie 0.5 mile W and 0.5 mile WNW, respectively, of this spit.

Anchorage can be obtained, in depths of 38 to 55m, within Lystad Bay. However, the depths may be less than those charted and the bottom consists of sand, gravel, and rock.

Caution.—Depths of only about 19m have been reported (1991) to lie up to 4.5 miles SW of Camp Point.

A submerged rock dangerous to navigation lies about 6 miles SW of Horseshoe Island, as best seen on the chart.

3.56 Calmette Bay (68˚03'S., 67˚10'W.) is entered between Camp Point and Cape Calmette, 6 miles SSE. Bare slopes, up to 780m high, front the NE side of this bay. The McMorrin Glacier descends into the bay from Mount Wilcox and Mount Metcalfe. The Todd Glacier descends toward the bay from Boulding Ridge.

Cape Calmette is formed by the NW extremity of a narrow and rocky peninsula which is 460m high and rises from the sea in precipitous cliffs. A group of below-water rocks lies 2 miles WSW of this cape. A rock, awash, was reported (1975) to lie about 3.5 miles WSW of the cape; another rock was reported (1981) to lie, position approximate, about 2 miles farther W.

Millerand Island lies 4 miles S of Cape Calmette and about 1 mile W of the mainland ice cliffs. The E and S shores of this island consist of a large glacier which slopes from the steep, rocky masses to the water's edge. A cove lies at the NE end of the island and is bounded by low, rocky spurs. These spurs extend from the base of a promontory which is 579m high. This cove has not been surveyed, but it may provide an anchorage. The island is reported to be radar conspicuous and has been sighted at a distance of 40 miles in good weather.

A chain of small islands and rocks lies close off the SW extremity of Millerand Island and extends up to 2 miles SE. Several reefs and numerous small islands also extend up to 3 miles NW and 6 miles W of the island. Pod Rocks lie 5 miles W of the island and a reef, with a least depth of 12.5m, is reported to lie about 5 miles SW of them. A fairway, with a least depth of 13m, leads through Powell Channel between Millerand Island and the Debenham Islands.

Caution.—Vessels are advised to use great care when navigating in the vicinity of Millerand Island and Calmette Bay as numerous dangers lie in this area and strong currents have been observed. In addition, violent winds often blow off the high interior in this vicinity.

3.57 The Debenham Islands, a chain of islands and rocks, extend between Cape Calmette and Millerand Island. This chain also extends NE in an arc from a point, located 4 miles W of the highest peak of Millerand Island, and then SE to the narrow strait which separates the latter island from the ice cliffs of the mainland. The principal islands of the chain are Barbara Island, Barry Island, Brian Island, Audrey Island, Ann Island, and June Island. The narrow passages which lead between the N islands of the group are foul and navigable only by small craft and boats. The passage leading between Brian Island and Audrey Island is about 0.2 mile wide, but is encumbered with numerous shoals and other dangers. A shoal, with a depth of 4.6m, lies midway between these two islands. A navigable channel leads between this shoal and the foul ground extending N from Audrey Island. It is about 90m wide and has a least depth of 14.6m.

Three shoals, with depths of 10 to 15m, lie between about 0.6 and 0.9 mile SW of the summit of Barbara Island. Numerous other shoals and dangers front this chain and strong currents have been observed in its vicinity.

Anchorage may be taken, in a depth of 38m, midway between Audrey Island and the mainland. Due to the violent winds, which sweep off the interior, vessels are advised not to anchor in the narrow passages or in the vicinity of any below-water dangers.

General San Martin, an Argentinean base, is situated on Barry Island. Beacons are reported to stand on Brian Island and Audrey Island, the two westernmost islets of the chain. The beacon on the former island is reported to be 30m high and situated at the W side.

Neny Island lies in the entrance to Neny Bay, 3 miles SE of Millerand Island. Its summit, formed by a sharp peak, rises in the center of the island and is 675m high. Store Point, a small projection, forms the N extremity of this island. The shores of the island are steep and partly free of ice in the summer. A rock, with a depth of 2m, lies about 0.4 mile ENE of Store Point. Two shallow shoals lie about 0.6 mile E of Store Point.

Trepassey Island lies 1.2 miles E of Store Point and is fronted on its E side by numerous small islands and above-water rocks. Several islets and rocks, which may best be seen on the chart, lie S and E of this island.

Beaumont Island lies 0.6 mile ESE of Trepassey Island. Burton Rocks, which cover and uncover, lie 2.5 miles SW of Beaumont Island, 0.8 mile S of the middle of the S side of Neny Island.

Tides—Currents.—At Barry Island, in the Debenham Islands chain, the MHHWS near the solstices is reported to be 1.8m above chart datum; the MLLW is reported to be 0.8m The tides in this vicinity are usually diurnal.

3.58 Stonington Island (68˚11'S., 67˚01'W.) lies 0.6 mile NE of Neny Island. This island is 0.3 mile long and extends in a NW/SE direction. Landing may be made on a few small stony beaches fringing the E and SW shores of the island.

The huts of a disused British base stand close E of Flagpole Point, the W extremity of the island. A flagstaff, with several radio masts standing close SE of it, is situated near this point.

Structures of the U.S. Antarctic Service Expedition (1940) and the Ronne Antarctic Research Expedition (1948) stand close E of the disused British base and are designated as a Historic Site under the Antarctic Treaty. Visitors may enter the buildings and inspect artifacts, but should avoid disturbing the site and secure all doors upon departure.

Neny Bay (68˚12'S., 66˚58'W.) is entered between the NW extremity of the Roman Four Promontory, on which stands a beacon, and Boulder Point, 1.9 miles NNW. Anchorage can be taken, in a depth of 49m, rock with patches of sand and mud, about 0.3 mile WSW of a framework tower situated near Boulder Point. The tidal current at this anchorage usually sets in a SE direction at a rate of 0.5 knot. This current has never been observed to set in a NW direction.

Neny Fjord, which extends 9 miles E, is entered between the Roman Four Promontory and the NW extremity of Red Rock Ridge, 5.5 miles WSW. Postillion Rock fronts the S side of the Roman Four Promontory. Red Rock Ridge, a conspicuous and reddish-colored peninsula, forms the S side of the fjord. This peninsula is 690m high and has vertical cliffs, up to 250m high, facing its N side. A glacier fringes its S side. A number of islands, of which Gremlin Island is the northernmost, lie close off the NW extremity of the peninsula. Numerous rocks lie up to 1 mile seaward of the W side of the peninsula and an isolated rock, awash, lies 7 miles SW of Gremlin Island. Two shoal patches, with depths of 14 and 10.7m, lie 11.5 miles W and 10.5 miles WNW, respectively, of Gremlin Island.

The Refuge Islands, about five in number, lie about 0.3 mile SW of the ice cliffs fringing Red Rock Ridge. A hut is reported to stand on one of these islands. A rock, awash, lies about 5.5 miles W of these islands. A shoal, with a depth of 8.9m, and a very shallow rock are reported to lie about 9 miles WNW and 8 miles N, respectively, of the islands.

A shoal, with a depth of 20.1m, lies about 11.5 miles W of the W extremity of Red Rock Ridge and another shoal, with a depth of 14m, lies about 1 mile SE of it. A shoal, with a depth of 3.1m, is reported to lie about 1 mile SSE of the latter shoal.

Rocky cliffs extend continuously S for about 4 miles from close E of Red Rock Ridge to where a glacier, about 1 mile wide, slopes steeply to the sea. This glacier lies on the Bertrand Ice Piedmont and is bordered on its S side by the notched and almost vertical walls of Black Thumb, a rocky column, which is 1,190m high. Mikkelsen Bay lies between the Bertrand Ice Piedmont and Cape Berteaux, 20 miles SSW.

3.59 Cape Berteaux (68˚50'S., 67˚30'W.) is formed by the W part of a conspicuous promontory, 1,210m high. Several peaks rise on the E part of this promontory.

The **Terra Firma Islands** (68˚42'S., 67˚32'W.) lie 7 miles NW of this cape and comprise a group of several islands and skerries. The islands are very steep and rocky. The S island of the group is the largest and is 320m high. A hut is reported to stand on a small island lying close N of the largest island.

Flyspot Rocks, a group of 13 islets and rocks, lie 18 miles NW of the largest of the Terra Firma Islands. The islets are snow-capped, the tallest being 37m high. Compass Island, rocky and ice-capped, is 30m high and lies 11 miles ESE of Flyspot Rocks.

A rock, awash, is reported to lie, position approximate, about 10 miles WNW of Cape Berteaux. Several unnamed islets, the positions of which are doubtful, are reported to lie between 22 miles W and 23 miles WNW of Cape Berteaux.

Mushroom Island, 152m high, lies 10 miles WSW of Cape Berteaux and rock exposures mark its NE side. A small island and a shoal, with a depth of 29m, lie 13.5 miles WNW and 2 miles N, respectively, of Mushroom Island.

Keyhole Island and another small island lie close N of Cape Berteaux, on the S side of Mikkelsen Bay. A rock, awash, is reported to lie about 14 miles W of Keyhole Island.

A bight lies between Cape Berteaux and an unnamed point, 30 miles SW, and is filled by an extensive mass of ice which is known as the Wordie Ice Shelf. This mass of ice is fed by numerous glaciers which descend from the inland mountains. Its front is 6 to 18m high, except close SE of Cape Berteaux where it descends almost to sea level.

The promontory forming the SW side of this bight, close SW of Cape Berteaux, is fringed by a glacier. Mount Guernsey, a rocky and flat-topped mountain, is 1,230m high and rises 32 miles SW of Cape Berteaux. Three islands lie near the edge of the Wordie Ice Shelf, between 8 and 12 miles SSE of Mushroom Island.

The Puffball Islands, a group of eight, extend 10 miles in a SW direction from a position located 13 miles WSW of Mushroom Island. Seven of these islands form a chain. The additional island of the group lies E of this chain and about halfway between it and the Wordie Ice Shelf. These islands are reported to be often hidden among the tabular icebergs in this area. However, they can sometimes be identified by their convex and ice-capped tops beneath which, nearly always on their N sides, small rock exposures protrude.

The Bugge Islands, a group of three, lie close together close off the SW end of the Wordie Ice Shelf. The largest island of this group is 366m high. Several islets and rocks front the N, SE, and SSW sides of these islands.

Caution.—Local magnetic anomalies exist in the vicinity of Compass Island, Flyspot Rocks, and Cape Berteaux.

Alexander Island to Cape Herlacher, including the Bellingshausen Sea

3.60 Alexander Island (71˚00'S., 70˚00'W.) forms the S entrance point of Marquerite Bay and is separated from the mainland of the Antarctic Peninsula by George VI Sound. This island is shaped like the letter "J" and extends for about 235 miles in a N/S direction. The width of this island varies from about 50 miles in the N part to nearly 150 miles in the S part. The N and W shores of the island are formed by a coastal piedmont which is similar to that on the W side of Adelaide Island.

Terminal Island, small and isolated, is 152m high and lies close off the N extremity of Alexander Island. Toadstool Rocks, up to 2m high, are reported to lie about 26 miles ESE of Terminal Island.

Caution.—Numerous shoal patches and isolated islands are charted up to 60 miles WSW, 40 miles NW, and 2 miles E of Terminal Island. The area surrounding this island is imperfectly surveyed and great care should be exercised when navigating in this vicinity.

3.61 Mount Bayonne stands 12 miles SW of the N extremity of Alexander Island. This peak has a comparatively small

mass and is 1,400m high. Mount Paris, rising at the N end of the Roven Mountains, stands close S of Mount Bayonne and is separated from it by a snowy spur and four sharp, needle rocks of uniform height. Mount Paris, 2,896m high, is the N and tallest of three peaks which extend 8 miles SSE in the form of a narrow crest. A deep depression, 3 miles wide, separates this crest from the S part of the Roven Mountains. The peaks in this latter range of mountains have rounded summits, rise up to a height of 2,440m, and have steep N and W sides. The range extends to Mount Cupola which rises 28 miles SSE of Mount Bayonne. Mount Calais, a detached summit, is 2,347m high and stands 22 miles SE of Mount Bayonne.

3.62 Cape Brown (69˚16'S., 69˚45'W.), 823m high, forms the W entrance point of George VI Sound, at its N end. This cape is chaotic in appearance, with jagged spurs and ridges descending in steep slopes to the sea. Schoklsky Bay lies on the N side of the cape. This bay extends NW for about 9 miles to Mount Calais and recedes for 6 miles. The Hampton Glacier enters the head of this bay.

The Douglas Range forms the E escarpment of Alexander Island and the W shore of the N part of George VI Sound. This range extends 90 miles SSE from the vicinity of the Hampton Glacier.

Mount Nicholas, 1,463m high, stands 5.5 miles SSW of Cape Brown and forms the N limit of the Douglas Range. Mount Stephenson, 2,987m high, forms the summit of this range and rises 33 miles S of the cape.

Other prominent peaks in the Douglas Range include Mount Spivey, Mount Huckle, Mount Egbert, Mount Ethelwulf, and Mount Ethelred.

Mount Tyrrell (69˚58'S., 69˚30'W.), 1,310m, stands 4 miles WNW of Damocles Point, on the W side of George VI Sound. The Toynbee Glacier separates Mount Huckle from this peak.

Tombaugh Cliffs, ice-free, front the N side of the Pluto Glacier, on W side of George VI Sound.

Fossil Bluff (71˚20'S., 68˚17'W.), a projection, is located 15 miles S of Tombaugh Cliffs. A British scientific base is situated in the vicinity of this projection, but is reported to be only occupied during the summer.

Two Step Cliffs (72˚04'S., 68˚25'W.), located 34 miles S of Fossil Bluff, form the N side of a cove. Kirwan Inlet lies 12 miles SSW of Corner Cliffs, which forms the S side of this cove.

Le May, a range of mountains, extends S from the S end of Douglas Range to **Mimas Peak** (71˚56'S., 69˚36'W.).

3.63 George VI Sound (71˚00'S., 68˚00'W.) is a major fault depression which skirts the E and S shores of Alexander Island. The N entrance of this sound, which is 13 miles wide, is formed by Cape Jeremyon, on the E side, and Cape Brown. The edge of the ice shelf at the N end of the sound is 12m high. The edge at the SW end is 9m high.

Vessels entering the N part of the sound are advised to keep to the center or the W side, as strong currents set in this area and the E coast appears to be more gently shelving with the probability of uncharted rocks and shoals lying within this area.

Mount Bagshawe (71˚28'S., 67˚10'W.), 2,225m high, is the summit of the Batterbee Mountains. To the S of these mountains, the E shore of the sound is formed by the sweeping front of the Goodenough Glacier, which is 40 miles wide.

At the SE extremity of Alexander Island, the sound has a width of about 35 miles wide. From this point, the sound extends WSW for about 65 miles to the **Eklund Islands** (73˚16'S., 71˚45'W.). The W and largest of these islands is 5 miles long and has two summits, 250 and 395m high. A cairn was reported (1984) to stand on the lower summit.

From the Eklund Islands, the sound continues W for 120 miles. Two large islands and one small island encumber this part of the sound. Several nunataks stand on the W and largest of these three islands.

The English Coast is considered to extend 240 miles W from **Buttress Nunataks** (72˚22'S., 66˚47'W.) to the Rydberg Peninsula.

Cape Vostok (69˚08'S., 72˚11'W.), fronted by a small islet, is located 41 miles WSW of Terminal Island and steeply rises, 2.5 miles ENE, to Saint George Peak, which stands at the W end of Havre Mountain Range. A number of prominent spurs project through this range.

The Johansen Islands, a group of five, lie 15 miles W of the cape and are partly snow-free and low.

Strong currents have been observed to set E or W off the N side of this part of Alexander Island; this area has been observed to be free from ice in the winter months.

Lazarev Bay is entered between Cape Vostok and the N extremity of Rothschild Island, 13 miles SSW. Umber Island, Dint Island, and the Glinka Islands lie within this bay.

3.64 Rothschild Island (69˚25'S., 72˚30'W.) lies 6 miles W of the NW extremity of Alexander Island, from which it is separated by an unsurveyed channel. It is formed by a black, rugged mass which extends for 18 miles in a SE/NW direction. The island is about 11 miles wide in its N part, narrowing perceptibly toward its S end, and is bordered on all sides by a fringing piedmont. Two peaks, each over 600m high, rise in the N part and near the center of the island.

This island has been reported at times to be actually a peninsula which extends W from Alexander Island.

A bank, with a least depth of 27m, lies 46 miles W of this island and extends for about 12 miles in an E/W direction.

Wilkins Sound (Wilkins Ice Shelf) (70˚15'S., 73˚00'W.) extends 60 miles W from the SE extremity of Rothschild Island to Charcot Island. From this latter island, the ice front extends S to Latady Island and then SE to the NE entrance point of Mendelsohn Inlet.

Dorsey Island lies off the W side of Alexander Island, 27 miles SSE of Rothschild Island. Merger Island lies 14 miles ESE of Dorsey Island, at the entrance to Haydn Inlet.

Charcot Island (69˚45'S., 75˚15'W.) lies 40 miles WSW of Rothschild Island, from which it is separated by Wilkens Sound. This island is pear-shaped, with the narrow end, 12 miles wide, forming its SW extremity. The remainder of the island has a width of about 45 miles. The entire island is covered by a low ice cap, 274m high, from which the only rock exposures are a series of isolated mountain peaks bordering its N shore.

Cape Byrd (69˚38'S., 76˚07'W.), the W extremity of the island, is formed by a sharp ice cape. Mount Monique, with a long summit, is 610m high and stands close NE of the cape.

Marion Nunataks, somewhat lower, rise 20 miles E of this peak. Mount Martine, over 600m high, rises 7 miles SE of these nunataks and is the most striking feature of the island. This mountain is formed by a rugged massif, having dark-colored jagged peaks with steep slopes. Cape Mawson, the SE extremity of the island, is located 15 miles SE of Mount Martine and is low.

Cheesman, a small and black islet, was reported to lie about 2 miles seaward of the N shore of the island. The entire area in the vicinity of this islet has not been fully surveyed. A patch, with a depth of 73m, was reported (1973) to lie about 25 miles N of the islet.

3.65 Carroll Inlet (73˚18'S., 78˚30'W.) forms the E boundary of the Bryan Coast, which extends W, as an unbroken ice cliff, for about 120 miles to approximately 85˚W, the E boundary of the Eights Coast.

The hinterland of **Ellsworth Land** (75˚30'S., 80˚00'W.) consists of a plateau, about 2,000m high, which is known as the **Hollick-Kenyon Plateau** (78˚00'S., 105˚00'W.). The Sentinel Ranges rise between 77˚30'S and 79˚00'S, and between 92˚30'W and 86˚00'W. Mount Ulmer, 3,672m high, stands near the N end of these ranges.

Vinson Massif (78˚35'S., 82˚25'W.), 5,140m high, is the highest known summit in Antarctica.

The **Bellingshausen Sea** (71˚00'S., 85˚00'W.), the limits of which have not been precisely agreed upon, is defined as lying between Thurston Island, on the W side, and Alexander Island, on the E.

Though drift ice covers the greater part of this sea for most of the year, the E portion of the region becomes almost ice-free for a few weeks, in the average year, during February and March. In a severe season, even the E portion remains usually ice-covered throughout the summer. In a light year, the region lying E of 90˚W is often almost clear of drift by early March.

Due to the action of the prevailing SE winds, polynyas, sometimes covering thousands of square meters, occur from time to time along the coastal regions. As the ice fails to clear from the SW corner of the Bellingshausen Sea, much of the ice in this area is either second or multi-year ice.

The Fletcher Islands, two prominent islands, are located SE of Thurston Island. Dustin Island lies 20 miles SE of Cape Annawan, the E extremity of Thurston Island, at the N side of the ice shelf. This island, about 610m high, is the larger of the two and has several prominent ice-free rock cliffs. A small island is reported to lie, existence doubtful, about 10 miles N of this island. McNamara Island, about 240m high, lies 15 miles E of Dustin Island, at the N side of the ice front.

Seraph Bay is formed between the W side of Dustin Island and the Tierney Peninsula, 18 miles NW. Peale Inlet indents the W side of this peninsula and extends SE for about 15 miles. A glacier flows into the sea about 10 miles NW of the W entrance point of this inlet.

3.66 Peter I Island (68˚47'S., 90˚35'W.), under Norwegian sovereignty, lies 212 miles NE of Thurston Island and 308 miles W of Cape Byrd, the W extremity of Charcot Island. The island is entirely covered with snow and ice, no bare rock being visible, except where the slopes are precipitous. It was reported that the shape of the island varies from that currently charted and several rocks lie close off its N end.

Lars Christensen Peak, the lofty and rounded dome of an extinct crater, is 1,753m high and forms the summit of the island. The W part of the island consists of precipitous slopes while the E part is lower and consists of a piedmont platform. The N side of the island consists of large twin glaciers.

Cape Eva (68˚42'S., 90˚37'W.), the N extremity of the island, is fronted by rocks which are surrounded by foul ground. Several below-water rocks and shoals extend up to 1 mile N from the NW extremity of the island. Breakers may be observed up to some distance seaward of these dangers. Two rocks, 2 and 53m high, lie 1 mile SW of the NW extremity. They are dark, snow-free, and have vertical sides with flat tops.

The Larsen Glacier lies 2 miles S of the NW extremity and the shore between consists of ice cliffs. Norvegia Bay lies between the S side of this glacier and Cape Ingrid, 1 mile S. An above-water rock lies close off the NE side of this bay.

Cape Ingrid consists of a bare, barren, and rocky promontory which is 152m high and has vertical sides. A shoal fronts the W side of this cape and extends up to about 0.3 mile seaward. Two small glaciers are located on the S side of this promontory. A large cavern, known as Celil Cave, is located in the rock cliffs of the cape.

Sandefjord Cove lies on the S side of Cape Ingrid. This inlet affords anchorage, in a depth of 38m, sand and volcanic stones, close to the coast. Vessels entering this cove should proceed with care as the bottom is reported to be uneven. Framnes Head, located at the head of this inlet, consists of a steep, rugged platform of lava and basaltic rock. This platform is 75m long and 40m wide; a depot hut was constructed on it in 1929.

3.67 Thurston Island (72˚06'S., 99˚00'W.) extends for about 120 miles in an E/W direction between Cape Annawan, its E extremity, and Cape Flying Fish, its W extremity. The Walker Mountains rise on the N side of this island and attain heights of up to 1,036m. Peacock Sound lies close of S of the island is filled by an ice shelf, of which the Demas Ice Tongue is the W extremity. Shernan Island, about 180m high, lies in the middle of the sound.

Several bays and inlets indent the N coast of Thurston Island. Cape Davies, the NE extremity of the Hughes Peninsula, is located 45 miles ENE of Cape Flying Fish. Glacier Roads indents the middle of the N shore of the island and extends between Cape Davies and the W side of the Noville Peninsula, 15 miles E.

Porters Pinnacles (71˚33'S., 99˚09'W.), a reef, consists of four pinnacles and one large rock, 9m high, and lies in the approach to Glacier Roads. This reef is located about 4 miles from the NW side of the Noville Peninsula and 20 miles ENE of Cape Davies. Mount Palmer rises near the N extremity of the Noville Peninsula. Bergy bits and pieces of ice floes frequently rest on top of this reef.

3.68 Cape Flying Fish (72˚06'S., 102˚29'W.), the W extremity of Thurston Island, forms the E boundary of the Walgreen Coast. This coast extends S for about 170 miles to Pine Island Bay and then WNW for about 185 miles to Cape Herlacher, the N extremity of the Martin Peninsula. The W boundary of the coast is still undetermined.

Peacock Sound is the largest of four bays, all open to the W, which indent the coast between Cape Flying Fish and a point, located about 170 miles S, where the Walgreen Coast turns to the W. This sound is 40 miles wide, at its N entrance, and is reported to extend SE for about 110 miles and then S for about 50 miles, but its farthest SE extent is unknown.

Cape Waite, the S entrance point of Peacock Sound, forms the NW extremity of the King Peninsula. From this cape, the coast extends about 50 miles S to the NE extremity of the Canisteo Peninsula. The bay lying close N of this latter peninsula is much smaller than Peacock Sound and an ice shelf was reported (1946) to obstruct its inner half.

Burke Island (73˚08'S., 105˚06'W.) is reported to lie with its S end located about 30 miles W of the SE extremity of the King Peninsula.

The Canisteo Peninsula is reported to project W and be 18 miles wide. Two small groups of islands, known as the Lindsey Islands, lie close off the NW extremity of this peninsula. The Sterrett Islands and the Edwards Islands lie close W of the SW extremity of this peninsula.

The Brownson Islands, reported to be a group of four, lie about 6 miles SW of the SW extremity of the Canisteo Peninsula.

Cranton Bay, 30 miles wide, extends about 20 miles E and lies close S of the SW extremity of the Canisteo Peninsula. From the S entrance point of this bay, the coast recedes to form Pine Island Bay, the last of the four major indentations in the S part of the Walgreen Coast. This bay is 20 miles wide at its entrance and extends SE for an unknown distance.

The Hudson Mountains, two parallel ranges of detached peaks, extend E along the shore between the Canisteo Peninsula and Pine Island Bay. The mountains are snow-covered and attain heights of up to 1,220m.

From the head of Pine Island Bay, the Walgreen Coast extends W for about 160 miles to the Martin Peninsula. Cape Herlacher forms the N extremity of this latter peninsula.

The Bear Peninsula extends N from the mainland, 40 miles E of the Martin Peninsula. It is about 50 miles long, 25 miles wide, and 880m high. A bay, of unknown extent, lies E of the Bear Peninsula and is reported to be about 75 miles wide. This bay is filled by the Thwaites Glacier Tongue, an extension of the ice shelf. The Thwaites Iceberg Tongue, which was reported (1966) to be separated from the glacier tongue, protrudes N for a farther 50 miles in the W half of the bay. Another bay lies between the W side of the Bear Peninsula and the E side of the Martin Peninsula. It is obstructed by the Dotson Ice Shelf.

The Kohler Range, an extensive mountain range, stands 30 miles S of the base of the Martin Peninsula. The peaks in this range attain heights of up to 4,570m.

A snow-covered island, 5 miles long, is reported, existence doubtful, to lie about 103 miles NNE of the Bear Peninsula. A number of bare, rocky islands are reported, existence doubtful, to lie close off the coastal ice cliffs of the NE end of the Bear Peninsula.

Cape Herlacher to Cape Colbeck, including the Amundsen Sea

3.69 The Amundsen Sea lies between the W side of Thurston Island and Cape Dart, 400 miles W.

Cape Dart (73˚07'S., 126˚09'W.), lying at the E side of Wrigley Gulf, is located at the foot of Mount Siple, a massive and snow-covered mountain, 3,110m high. An ice front extends between this cape and Cape Herlacher, 228 miles E, and partly encloses two islands. The E and smaller island, known as Wright Island, is 244m high. The W island, of which Cape Dart forms the NE extremity, is about 100 miles long. Three small islets are reported to lie within 18 miles N and NE of Mount Siple.

The Executive Committe Range extends in a NE/SW direction between position 76˚30'S, 127˚00'W, and position 77˚20'S, 128˚55'W.

Grant Island (74˚30'S., 131˚30'W.), the extent of which is not fully determined, lies at the W side of Wrigley Gulf. Shepard Island, reported to be 5 miles long and 4 miles wide, lies 7 miles W of this island. Forrester Island, 171m high, lies 14 miles NNE of Shepard Island and is covered with a layer of ice and snow, about 100m thick.

The Getz Ice Shelf fronts the coast between the vicinity of Cape Dart and Grant Island. Dean Island is enclosed within this ice shelf, 48 miles E of Grant Island.

A detached group of bare, rocky hills stands S of Grant Island. This group marks the W side of Wrigley Gulf and the E end of the Hobbs Coast. From this group, the Ames Range extends SE and consists of several large, isolated, and snow-covered masses which have flat tops and steep, precipitous sides. Large glaciers debouch NE between these masses. This high range extends SE to the E extension of the Hal Flood Range.

3.70 The **Hobbs Coast** (74˚50'S., 132˚00'W.) extends 120 miles SW from the W edge of the Getz Ice Shelf to the E side of Land Bay. The section of this shore lying between Land Bay and Hull Bay, 60 miles NE, is bordered by a coastal range. The peaks in this range are nearly bare and have steep, snow-free cliffs on their N faces. The S side of this range is drowned by the continental ice descending from the high interior plateau.

Hull Bay is completely filled by the Cordell Hull Glacier, which drains a vast basin. Mount Giles, over 900m high, forms the W entrance point and consists of a clump of glaciated mountain, snow-free only on the wind swept heights. Shoals are reported to probably lie along the portion of the coast in the vicinity of this bay. They cause grounding of the expanded ice tongue and render the bay inaccessible to vessels.

Cape Burks (74˚45'S., 136˚50'W.), a well-defined point, is located 15 miles NNE of the entrance to Hull Bay. This cape is marked by bare rock and a penguin rookery is situated in its vicinity.

Cruzen Island (74˚47'S., 140˚40'W.), lying 57 miles W of Cape Burke, is a rocky crag, over 300m high. It is composed of black, coal-like rock which is probably of volcanic origin. A vessel reported (1962) that this island was conspicuous among the many huge and grounded bergs in the area. A large ice field, not navigable in 1940 except by icebreakers, was reported to extend WSW and ESE of the island.

A small island was reported (1963) to lie about 15 miles SE of Cruzen Island.

Land Bay is about 10 miles wide. Mount McCoy, a high and flat-topped massif, stands near the head of this bay and has dark, snow-free, and vertical sides. The Land Glacier, heavily crevassed, descends into the bay on either side of this massif.

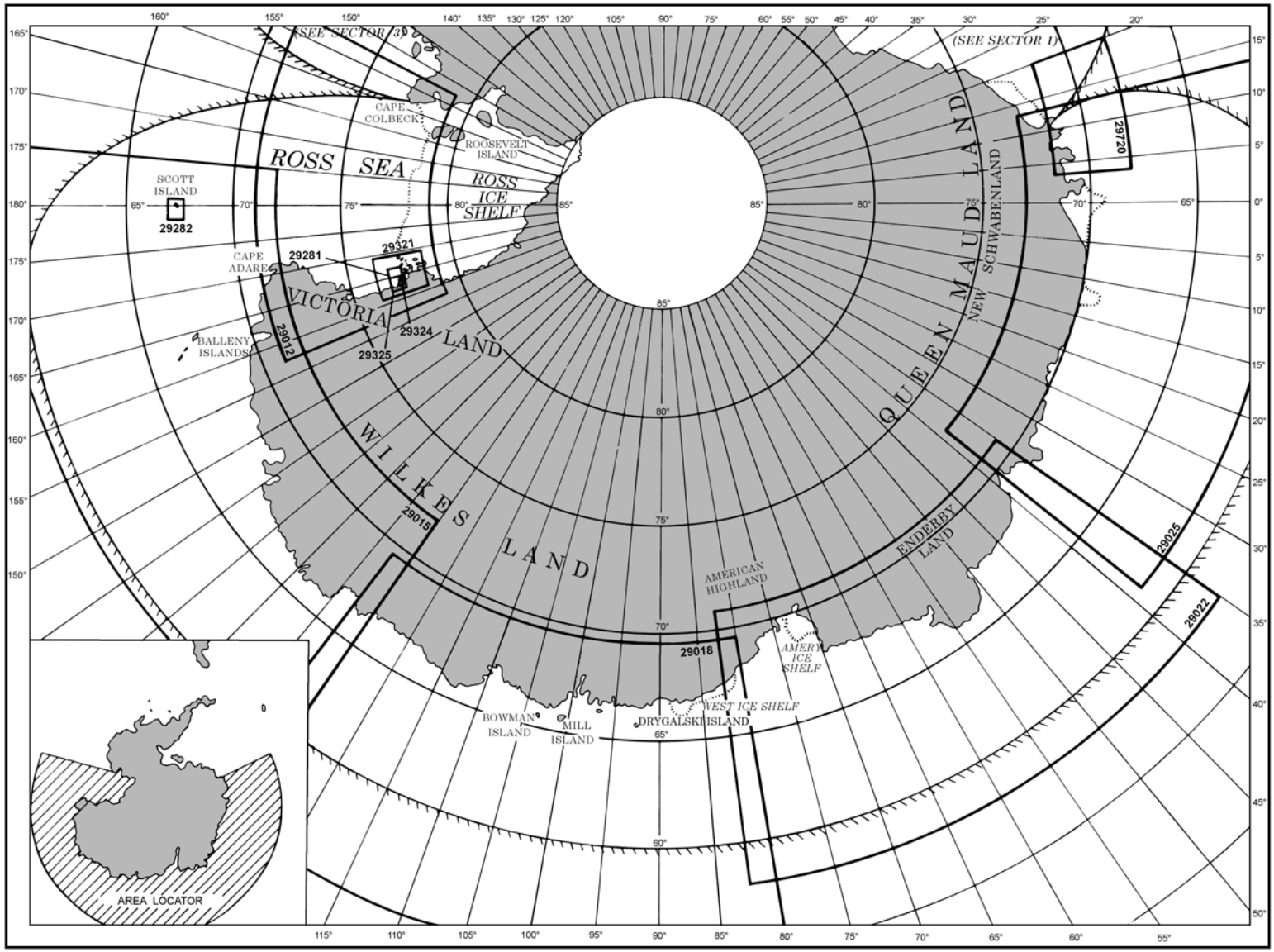
3.71 The **Ruppert Coast** (75˚45'S., 141˚00'W.) extends about 75 miles WSW from Land Bay to the N entrance point of Block Bay. It consists of an ice slope which has many snow-covered ridges. The Phillips Mountains, a coastal range of isolated peaks, stand behind the shore and attain a height of 1,200m.

Block Bay, 20 miles wide, lies between the W side of the Ruppert Coast and the Guest Peninsula. A glacier descends into the head of this bay. The Guest Peninsula is about 40 miles long, 25 miles wide, and extends in an E/W direction.

Sulzberger Bay, about 130 miles wide, lies between the W side of the Guest Peninsula and **Cape Colbeck** (77˚10'S., 158˚00'W.), the N extremity of the Edward VII Peninsula. The Alexandra Mountains form the coastal range which stands along the shores of the bay. This extensive bay is almost entirely filled by the Sulzberger Ice Shelf and four glaciers flow into its SE side. Although patches of water have been observed from aircraft, the bay has never been reported to be ice-free. A vessel reported (1962) that four low ice-covered islands lie within the bay, the N being located about 14 miles WSW of the Guest Peninsula.

Scott Nunataks, over 600m high, stand, with twin summits, on the W side of the bay, 53 miles ESE of Cape Colbeck. McKinley Peak, 760m high, rises 90 miles SE of Scott Nunataks, near the head of the bay. This mountain forms the SW end of the Ford Ranges, which extend along the S and E sides of the bay. These ranges consist of a series of mountain groups of variated structures and appearance. The Rockefeller Plateau, 760 to 1,220m high, stands about 270 miles SE of Cape Colbeck.

Marie Byrd Land is defined as that portion of Antarctica lying E of the Ross Ice Shelf and the Ross Sea and S of the Pacific Ocean. It extends E approximately to a line between the head of the Ross Ice Shelf and the Eights Coast. The Rockefeller Plateau is considered to be the Marie Byrd Land portion of the Antarctica Plateau.



Additional chart coverage may be found in NGA/DLIS Catalog of Maps, Charts, and Related Products (Unlimited Distribution).

SECTOR **4** — CHART INFORMATION

SECTOR 4

THE ANTARCTIC—CAPE COLBECK TO CAPE NORVEGIA

Plan.—This sector describes the coast of Antarctica between Cape Colbeck and Cape Norvegia, including the Ross Ice Shelf, McMurdo Sound, and the Ross Sea.

General Remarks

4.1 The Ross Sea is an extensive bight indenting the coast of Antarctica lying S of New Zealand. It is located between Victoria Land, on the W side, and the Edward VII Peninsula, on the E, and is bounded to the S by Ross Ice Front, the seaward edge of the Ross Ice Shelf. The depths in this sea are not great, generally ranging from 350 to 750m, but occasionally exceeding 900m. Pennell Bank, lying near the central area of the sea, has a least depth of 106m. McMurdo Sound, located in the SW corner of the sea, is 49 miles long and varies in width from 27 to 41 miles. The depths within the E part of this sound generally range from 650 to 890m, to the S of the Dellbridge Islands. Depths of about 550m extend S to the ice shelf. The W part of the sound has shallower depths, generally ranging from 200 to 450m.

Ice.—The Ross Sea is the most easily accessible area of this part of Antarctica. Every vessel that has attempted to enter this area at the correct season has been successful.

Tides—Currents.—The general W current setting near the continent is presumed to be divided by the Pennell Bank area. The S branch flows under the Ross Ice Shelf with a surface current setting W along the ice front at a rate of up to 3 knots. This current sets along the N coast of Ross Island and then toward the W shore of the Ross Sea, while an eddy sets round Cape Bird, the N extremity of Ross Island, and S as far as Cape Royds. In the vicinity of the latter cape, this current is joined by a strong N current which enters McMurdo Sound from beneath the Ross Ice Shelf. The combined current sets NW and N along the coast of Victoria Land and past Cape Adare. It then rejoins the main N branch current which sets NW between the continent and the Balleny Islands.

Cape Colbeck to Cape Adare

4.2 **Cape Colbeck** (77˚10'S., 158˚00'W.), the N extremity of the Edward VII Peninsula, is located about 45 miles N of Okuma Bay.

Okuma Bay (77˚50'S., 158˚20'W.), lying 53 miles E of Kainan Bay, is 3 miles wide and recedes about 4 miles into the ice shelf. A depth of 104m, with hard stone bottom, was reported to lie at the edge of the ice cliff on the E side of the bay and a depth of 238m, with hard stone bottom, was reported to lie near the ice cliff on the W side. Vast pressure ridges extend SE from the head of the bay where the shelf ice is comparatively low. It was reported (1955) that an icebreaker found this bay impossible to enter. The heavy ice within the bay was broken and hummocked by much pressure.

A current, with a rate of about 2 knots, sets into Okuma Bay from the N and brings with it large quantities of drift ice. This current then sets SW along the face of the ice shelf toward the Bay of Whales.

The Ross Ice Shelf extends about 400 miles between its seaward edge and the escarpment of the Queen Maud Mountains. It is 400 miles wide and lies between the coast of Victoria Land and the plateau of Maire Byrd Land. The W extremity of its edge is located at Cape Crozier, where immense pressure ridges are raised for several miles. The ice shelf was determined (1962) to be 67 to 98m thick. The E extremity of its edge lies E of Okuma Bay (158˚W.), where it merges with the plateau. The edge of the shelf is floating. An average depth of 567m has been determined to lie close off this edge between Cape Crozier and the Bay of Whales.

A survey in 1902 indicated that the edge of the shelf had receded 4 to 35 miles since the survey of 1841-42, with the greatest recession being between 164˚W and 169˚W and the least recession being to the W of 174˚E. The retreat of the barrier edge during the intervening 60 years has averaged 0.3 mile per year.

A survey in 1911 showed a slight advance over the greater portion of the edge, which indicated an advance rate during the intervening 9 years of 3.6m per day. A survey in 1935 showed a general advance of about 12 miles during the intervening 24 years, or slightly over 2.4m per day. The contour irregularities in the face of the edge and the height range of 4.6 to 46m were in very close agreement with the results obtained during 1911.

The N movement of the shelf surface has been measured at a point located about 10 miles E of Minna Bluff. It was determined that the shelf ice in this vicinity moved 556m in 13.5 months, or about 1.4m per day.

4.3 The Ross Ice Shelf is evidently afloat at its edge, except at the extremities, and is probably afloat for a considerable distance to the S.

It was reported that **Roosevelt Island** (79˚25'S., 162˚00'W.), ice-covered and 377m high, lies in the E part of the Ross Ice Shelf, with its N extremity located about 3 miles S of the head of the former Bay of Whales. This island extends about 90 miles S and has a width of about 40 miles. It was also reported that other snow-covered islands lie about 30 miles W and about 45 miles SE of Roosevelt Island.

The Bay of Whales was a natural harbor. However, an expedition reported (1955) that this bay no longer existed. Extensive calving of the Ross Ice Shelf has destroyed this feature, leaving a sheer wall of ice in its former position.

Kainan Bay (78˚10'S., 162˚30'W.) lies 37 miles NE of the NW end of Roosevelt Island. This bay was reported (1956) to be about 2.5 miles wide and to recede in a SW direction for about 2 miles. It was fringed by ice cliffs, 6 to 15m high. The bay is open to the NW and N and has depths of 549 to 640m over a bottom of brown silt.

It was reported (1955) that ice covered all of Kainan Bay except for an area, about 0.5 mile square, lying off the W entrance point. This ice was 2 to 3m thick and was covered with a

layer, 0.5m thick, of compacted snow. The prevailing winds in this vicinity are between E and SW, which tend to keep drift ice out of the bay. The bay can be approached by transiting the drift ice near 180˚. When open water is reached, vessels should then head E toward the bay.

The N coast of **Ross Island** (77˚30'S., 168˚00'E.) extends SE for about 25 miles between **Cape Bird** (77˚10'S., 166˚41'E.) and **Cape Tennyson** (77˚22'S., 168˚18'E.). This latter cape is formed by a dark, rocky outcrop projecting from the ice-covered slopes of **Mount Terra Nova** (77˚31'S., 167˚57'E.).

A bay lies close W of Cape Tennyson, where the slopes of **Mount Erebus** (77˚32'S., 167˚10'E.) recede S for about 7 miles. The coast extending to the E of Cape Tennyson consists of a precipitous cliff. **Williamson Rock** (77˚27'S., 169˚15'E.) lies close to the cliff, 13 miles ESE of the cape, and Cape Crozier, the E extremity of Ross Island, is located 5 miles SSE of it.

4.4 **Cape Crozier** (77˚31'S., 169˚24'E.), surmounted by a small cairn, consists of a black, basalt cliff, 61 to 122m high. **The Knoll** (77˚31'S., 169˚21'E.), a conspicuous cone, stands above the cape and is 369m high. This cone is backed by the black and bare slopes of **Mount Terror** (77˚31'S., 168˚32'E.).

The cliffs in the vicinity of the cape form a prominent series of basalt columns, about 30m long, which appear as narrow hexagonal rods that are curved and interlocked. The cliffs are interrupted, about 2 miles NW of the cape, by a low, pebble beach. Many stranded bergs have been observed near this beach and a depth of 22m is reported to lie about 0.3 mile offshore in this vicinity.

Beaufort Island (76˚56'S., 166˚56'E.), 686m high, lies 13 miles NNE of Cape Bird. This island is volcanic in origin and has an egg-shaped appearance. The E side of the island is steep, bare, and rocky while the W side consists of a long ice slope which terminates at the sea in cliffs, 2 to 15m high. The island appears to be surrounded by deep water, but the area has not been fully surveyed.

It was reported (1961) that a shoal area extended about 0.5 mile seaward from the SW extremity of the island. This shoal was reported to be marked by a color change and could be easily avoided.

Beaufort Island has been reported (1997) to lie 0.3 mile E of its charted position.

A strong current sets W through the passage leading between Beaufort Island and Cape Bird and, at times, attains a rate of 3 knots. The strength of this current, but not its direction, is affected by the tides. This passage is frequently blocked by drift ice which has traveled along the coast of Ross Island, but there is little danger of heavy pressure.

Cape Bird, the N extremity of Ross Island, is located 7 miles N of **Mount Bird** (77˚17'S., 166˚43'E.). This cape is formed by a rounded and lofty promontory, with many headlands of black lava.

Wohlschlag Bay (77˚22'S., 166˚25'E.) lies between Cape Bird and Cape Royds. The greater part of the shore of this bay, except within 2 miles of Cape Royds, is faced by inaccessible ice cliffs, 9 to 30m high.

4.5 **Cape Royds** (77˚33'S., 166˚09'E.), a dark mass of rock, is faced by steep cliffs. Rocky Point, located 2.5 miles N of the cape, is flanked, on the N side, by the unbroken glacier slopes of Mount Erebus and, on the S side, by **Horseshoe Bay** (77˚32'S., 166˚12'E.). This latter bay is 0.3 mile wide and provides shelter in emergencies. Between Horseshoe Bay and Cape Royds, the shore is fringed by a broad, sandy beach, above which stands a conspicuous peak, 67m high.

Backdoor Bay (77˚34'S., 166˚12'E.), about 0.8 mile wide, lies close E of Cape Royds. A dangerous rock, which uncovers, lies about 0.5 mile NW of Flagstaff Point, the W entrance point of this bay. The bay has depths of 18 to 33m, but the holding ground is poor and anchorage is not recommended. A hut is reported to stand on Flagstaff Point.

North Bay lies between Cape Barne, located 2 miles SE of Flagstaff Point and Cape Evans, 4 miles SE. Anchorage can be taken, in a depth of 35m, about 200m off the shore of the bay, although this is too close if the wind shifts from the prevailing SE. The bottom is quite steep and a depth of 100m lies about 0.3 mile from the shore. A depth of 27m was reported to lie about 0.6 mile from the shore and 0.4 mile from the face of the Barne Glacier, which fronts the head of the bay.

Cape Barne (77˚35'S., 166˚14'E.) consists of a steep and rocky bluff, 90m high, surmounted by a prominent volcanic pillar, 46m high. Mickle Island lies close offshore, about 0.8 mile N of this cape. Several sandy beaches fringe the shore between the cape and this island.

Cape Evans (77˚38'S., 166˚24'E.) consists of a low, triangular-shaped promontory. A shoal area extends 0.8 mile S from the cape. It was reported (1992) that a vessel touched bottom about 200m W of this area, indicating that shoals also extend SW from the cape.

McMurdo Sound (77˚30'S., 165˚00'E.) is entered between Dunlop Island and Cape Bird, the N extremity of Ross Island. This sound, which is reported to be deep throughout, extends S for about 50 miles to the ice edge. This region is perhaps the best known in Antarctica. Having been the site of four British expedition bases, it is now the location of the principal scientific base station of the United States. It is reported that there is no safe anchorage within McMurdo Sound.

4.6 The **Dellbridge Islands** (77˚40'S., 166˚25'E.), a group of four, lie S of Cape Evans. Inaccessible Island lies 1.3 miles SW of the cape and is 160m high at its E end. A submarine ridge, with depths of 101 to 152m, lies between this island and the cape. This ridge is an extension of the shoal fronting the cape and many icebergs have stranded in its vicinity. Tent Island lies 1 mile S of Inaccessible Island and is 137m high. A least depth of 58m was reported to lie 2.3 miles SW of this island. Big Razorback Island, 64m high, lies 1.3 miles E of Tent Island and Little Razorback Island, 36m high, lies 0.8 mile N of it.

From Cape Evans, the coast extends ESE for 4 miles to **Turks Head** (77˚40'S., 166˚46'E.), a precipitous, black headland, 158m high. It consists of ice cliffs, 12 to 30m high. The coast then extends S for 12 miles to Cape Armitage, the S extremity of Ross Island, and is mostly fronted by low ice cliffs.

Erebus Bay lies on the S side of the Erebus Glacier Tongue. Turtle Rock, 30m high, lies 1 mile offshore, about 2 miles S of the latter tongue. A shoal, with a least depth of 8.7m, lies about 0.5 mile offshore, 3 miles NNW of Cape Armitage. Vessels are

advised not to pass E of this shoal because the area is unsurveyed. A shoal, with a depth of 9.1m, is reported to lie about midway between this shoal and the shore.

Cape Armitage (77˚51'S., 166˚40'E.), the sloping termination of the Hut Point Peninsula, is backed, 0.5 mile NE, by Observation Hill which is 228m high. A memorial cross to Captain R.F. Scott, RN, and the southern party, who lost their lives on their return from the South Pole in March 1912, surmounts this hill.

Crater Hill, 301m high, stands 1.5 miles N of Cape Armitage and Castle Rock, 412m high, lies 3 miles NNE of it.

Hut Point, where Scott's party wintered in 1902-1904, is located 1 mile NW of Cape Armitage and fronted by shoals. Shoal patches, with depths of 8.8 and 4m, lie 2 miles N and 0.8 mile S, respectively, of this point.

Pram Point (77˚51'S., 166˚45'E.) is located on the edge of the Ross Ice Shelf, 1.3 miles NE of Cape Armitage.

Scott Base (77˚51'S., 166˚45'E.), the principal New Zealand base, stands on this point. It was originally established for the International Geophysical Year in 1957 and has been manned ever since. It was the base used by Sir Edmund Hillary for the Trans Antarctic Expedition and was the base to which Sir Vivian Fuch's party returned on 2 March 1958, after crossing the continent via the South Pole in 99 days.

The base consists of nine buildings, is permanently manned throughout the year, and is connected by road to McMurdo Station.

4.7 **McMurdo Station** (77˚51'S., 166˚40'E.) (World Port Index No. 63130), the principal United States base, stands on the low, volcanic hills at the S extremity of Ross Island. Part of the station fronts Winter Quarters Bay. This station is one of the seven original constructed by the United States for the International Geophysical Year (1955-56) and has been used continually since then. Over the years, the station has expanded to provide extensive facilities for both support activities and research. It now includes the 4,320-square meter Albert P. Crary Science and Engineering Center and numerous dormitories.

The base is the primary rescue coordination center for the continent and the operational hub for the U.S. Antarctic Program, which is managed by the National Science Foundation. Virtually all personnel, equipment, and supplies destined for continental bases and field camps, except Palmer Station on the Antarctic Peninsula, are routed through McMurdo. Bulk fuel and cargo are transported by ship to this station.

The station consists of approximately 110 buildings, with graded roads, a power plant, and other utility systems such as water and waste disposal. It has a communications system, surface vehicles, a heliport, a docking area, and a fuel depot. This latter depot consists of 20 storage tanks, with a total capacity of 30 million liters (8 million gallons). In addition, a diesel-fueled saltwater distillation plant produces fresh water for most needs.

An airfield (Williams Field) is situated in the vicinity of the station. It is reported that ski-equipped aircraft can land throughout the year and wheeled aircraft can land on an ice runway from October to early December. The field also includes facilities for refueling, repairing and servicing aircraft, and housing and feeding operating personnel.

A wharf, used by supply vessels, fronts the base in Winter Quarters Bay. It is 201m long, 140m wide, and constructed of ice. Vessels must obtain approval in advance to visit McMurdo and should contact the station 72 hours and 24 hours prior to arrival. (See Part I—Legal Information and Regulations.)

4.8 Mount Morning, 2,712m high, stands near the head of the sound at the W end of a peninsula which is located SE of the Koettlitz Glacier. **Mount Discovery** (78˚22'S., 165˚01'E.), 2,767m high, stands 20 miles ENE of this peak where the peninsula divides with the Brown Peninsula extending 15 miles N and Minna Bluff extending 25 miles ESE. Bratina Island lies close N of the Brown Peninsula.

Black Island (78˚07'S., 166˚05'E.), 1,110m high, lies with Cape Hodgson, its NW extremity, located 10 miles SE of Bratina Island. Cape Spirit forms the NE extremity of this island.

White Island, 16 miles long and 702m high, lies E of Black Island, from which it is separated by White Strait. Cape Spencer-Smith forms the N extremity of this island.

The ice front, which is generally 1.5 to 8m high, trends NE from a position located 20 miles S of Butter Point and then SE to a position 3 miles S of Cape Armitage. It then curves NE and NW and meets the S coast of Ross Island at Pram Point. This front, however, changes considerably from year to year.

The part of the E coast of Victoria Land that lies S of McMurdo Sound is quite unapproachable by sea.

From Cape Chocolate, the coast trends NNW for 17 miles to Butter Point and is backed by the Royal Society Range. Mount Lister, the summit of this range, is 3,891m high and rises 27 miles SW of Cape Chocolate. The Dailey Islands, a scattered group of five, lie NE of Cape Chocolate. The W of these small, volcanic islands is 183m high and lies 5 miles off the cape.

The Koettlitz Glacier descends into the sound SE of **Cape Chocolate** (77˚56'S., 164˚35'E.) and terminates in an ice cliff.

Butter Point, the S entrance point of New Harbor, is formed by an angle in the ice cliff, about 6m high. This angle marks the N extremity of the S of the piedmonts skirting the W shore of the Ross Sea. Vessels can moor on the N side of the ice cliff, using ice anchors placed about 200m inshore. The piedmont ice terminates in a low ice cliff which trends ESE for about 6 miles to The Strand Moraines. These moraines are separated from the piedmont glacier by a water-cut channel which undercuts the ice.

4.9 **New Harbor** (77˚36'S., 163˚51'E.), a bay, lies between Cape Bernacchi and Butter Point and recedes 6 miles SW. The Kukri Hills rise at the head of this bay; Mount Barnes, the summit, is 984m high.

The harbor has not been fully surveyed, but it is believed to be deep, although shoals may exist in the NW part. The current sets into this bay from the SE and may carry much drift ice. Winds from that direction usually form a heavy swell and there is little shelter within the bay. Strong W winds, descending via the glacier valley, may also be encountered.

From Cape Bernacchi, the coast trends NNW for 29 miles to Cape Roberts and is formed by a continuous piedmont. This piedmont varies in width from 3 to 12 miles and is fed by three outlet glaciers.

Cape Dunlop, a rocky headland, is located 11 miles SSE of Cape Roberts. It is formed of gneissic granite above which rests the piedmont ice.

Dunlop Island (77˚14'S., 163˚30'E.), 1.5 miles long and 18m high, lies E of Cape Dunlop from which it is separated by a strait, 0.3 mile wide.

Spike Cape, a bare and rocky point from which the piedmont ice has receded, is located 6 miles S of the island. Gneiss Point, long and rocky, is located 7 miles S of this cape. The Bay of Sails lies between these two rocky points. Another rocky outcrop, from which the piedmont ice has receded, is located at the head of this bay.

Mount Newall, 2,134m high, rises 12 miles W of Gneiss Point and forms the S side of the Wright Lower Glacier.

Marble Point (77˚26'S., 163˚50'E.) is located 2.5 miles S of Gneiss Point. Bernacchi Bay lies on the S side of this rocky spur. The bottom of the bay appears to regular and a depth of 75m lies in the middle, about 1.3 miles offshore. Between Gneiss Point and Cape Bernacchi, located at the S side of the bay, the shore, from which the face of the piedmont has receded, consists of a bare, rocky terrace, about 1 mile wide.

4.10 Granite Harbor (76˚33'S., 162˚44'E.) lies between Cape Archer, on the N side, and Cape Roberts, on the S. It is 12 miles wide and recedes W for about 10 miles. This harbor forms the seaward end of a deep valley filled by the Mackay Glacier, which descends in a gentle slope from the interior plateau. About 1 mile inside Cape Archer, ice falls descend between steep cliffs and reach the sea in the form of a small glacier tongue.

Point Retreat is located 5.5 miles SW of Cape Archer and is backed by Kar Plateau, a flat glacier-cut shelf of black dolerite. Dreikanter Head, located 1.5 miles NNW of Point Retreat, is a steep, dark promontory, 515m high. This promontory is mostly enveloped by glacier slopes. Lion Island, 230m high, lies 1.7 miles NNE of Dreikanter Head, at the edge of a glacier.

The Mckay Glacier is located at the SW side of the harbor; the Mckay Glacier Tongue projects seaward for about 2.5 miles, 3 miles SW of Point Retreat.

A bay, about 2 miles wide, lies on the S side of the tongue and Cuff Cape, a small and dark projection from which the glacier has receded, is located at its head. The shore to the S of this cape consists of steep ice falls which are almost free from silt and about 15m high. Flatiron, a flat and triangular-shaped shelf of granite from which the glacier ice has receded, is located about 1 mile S of Cuff Cape. Finger Point, the E end of this shelf, is sharp, precipitous, and gives the feature the appearance of a skyscraper.

The SW side of Flatiron forms the steep N shore of a small inlet, known as Devils Punchbowl, which is about 0.2 mile wide and 0.6 mile long. A small hanging glacier, known as the Dewdrop Glacier, fronts the head of this inlet. This glacier terminates in an ice face, 18m high, which lies close above the inlet and behind a dry, gravel beach fronting avalanche slopes. A long and narrow curving ridge of red granite forms the W and S shores of the inlet. This ridge is 305m high at its W end and descends gradually, reaching sea level at its E extremity. Devils Thumb, 250m high, is a conspicuous knob of granite standing about midway along the ridge.

Devils Punchbowl was reported (1958) to be obstructed and contain dangerous loose ice. No anchorage was available, as deep water extended up to the beach.

It was reported that a spit, with a depth of less than 37m, projects from the S side of the harbor, about 2 miles E of Devils Punchbowl.

The New Glacier lies S of Devils Thumb and is an extension of a level snow-covered plateau which forms the S side of the Mackay Glacier. The New Glacier is fed by the Minnehaha Ice Falls, which descend from a mottled cone standing W of Mount England.

Mount England (77˚02'S., 162˚27'E.), 1,205m high, is the most prominent massif rising on the S shore of Granite Harbor. Its slopes descend abruptly from the snow-covered summit to the New Glacier.

4.11 Cape Roberts (77˚02'S., 163˚12'E.), the S entrance point of Granite Harbor, is formed by a low, rocky, triangular-shaped spit which extends seaward for about 0.5 mile. Many grounded icebergs have been observed in the vicinity of this cape.

Discovery Bluff, 490m high, is located on the W side of Avalanche Bay, 7 miles WNW of Cape Roberts. This bluff consists of a conspicuous headland with steep slopes separated by gullies. Botany Bay lies between Discovery Bluff and Cape Geology, about 1 mile W. This latter cape is formed by a patch of gravel. A beach of granite boulders fronts the head of the bay.

From Cape Geology, the shore extends SW for about 1.5 miles to the face of th New Glacier, at the foot of Mount England. It is formed by steep, rocky cliffs, up to 229m high.

From Cape Archer, the coast extends NE for 13 miles to Cape Ross. Gregory Island, dark and 0.3 mile in diameter, lies close to the coast, 2 miles NE of Cape Archer. This island, which is 100m high, may be mistaken from seaward at times for the cape.

From Cape Archer, a piedmont extends inland for about 6 miles and is bordered by the hills rising along the N shore of Granite Harbor. At a point about 5 miles S of Cape Ross, this piedmont recedes about 0.3 mile from the shore and rests on a red granite platform.

From Cape Ross, the coastal piedmont extends NW for about 7 miles to Tripp Bay. Depot Island, small and 60m high, lies 0.8 mile offshore, about 2 miles NW of Cape Ross. The W side of this island has accessible slopes, but its other sides consist of perpendicular, granite cliffs rising from the water's edge.

Tripp Island, 110m high, lies in the center of Tripp Bay, 7 miles NW of Cape Ross. It is conspicuous, dark, and marks the entrance to two deep valleys which lie behind it. The N of these valleys is filled by the Fry Glacier, which is about 2 miles wide and has vertical smooth walls.

Cape Day is located 30 miles N of Cape Ross. Charcot Cove lies between this cape and Bruce Point, 7 miles NW. The Nordenskjold Ice Tongue occupies most of this cove, although inlets, which recede about 2 miles, lie between the tongue and each of the entrance points. This tongue is about 20 miles long, 5 miles wide, 30m high, and is believed to be afloat. Its surface is formed by hard, bare glacier ice, except on the N side and the seaward end, where drifting snow piles up. The surface is gen-

erally flat with gentle undulations. The N edge of the tongue terminates in a vertical ice cliff, 15m high, with overhanging snow cornices. The S edge is not uniform as the S winds produce marked erosion. This edge consists of steep slopes formed of serrated and scalloped green-glacier ice. There is no evidence of this ice tongue being actively fed. It is now believed that the tongue was once a part of a large piedmont and is now inactive and disintegrating.

The Harbord Glacier Tongue lies 14 miles N of the Nordenskjold Ice Tongue and the Cheetham Ice Tongue, the seaward extension of the Davis Glacier, is located 7 miles N of it. The Davis Glacier, 6 miles wide, trends W for about 15 miles and then curves SW. This glacier is heavily crevassed and a branch, which forms the Clarke Glacier, flows N behind Lamplugh Island from near its seaward termination. The Cheetham Ice Tongue is about 3 miles long, 2 miles wide, and 12m high. The structure of this tongue has not been fully determined, but it appears to be largely formed of snow. Its relationship with the Davis Glacier is based principally upon conjecture.

4.12 Prior Island (75˚41'S., 162˚54'E.) lies 5 miles S of Cape Irizar and about 1 mile off the SE end of Lamplugh Island. The granite cliffs of this island are about 90m high and covered with an ice cap, about 23m thick. Lamplugh Island, 4 miles wide and about 10 miles long, is 244m high and capped by glacial ice. Cape Irizar, the N extremity of the island, is formed by a bold, rocky headland. It is 180m high, consists of red granite, and has a glacial cap.

Franklin Island (76˚05'S., 168˚19'E.) lies 100 miles SSE of Cape Washington and about 80 miles E of Cape Day. This island is 6 miles long, 3 miles wide, and 310m high. It is covered with a thin ice cap. The N side of this island consists of precipitous cliffs, 150 to 180m high. Norway Rocks extend up to about 4 miles seaward of Bernacchi Head, the S extremity of the island. A stony beach, on which a large penguin rookery is situated, fronts the SW side of the island and is backed by cliffs, 122m high. A depth of 37m was reported to lie about 0.2 mile off this beach. It was reported that good anchorage could probably be found off the N side of this island during S winds.

4.13 Geikie Inlet (75˚30'S., 163˚00'E.), about 5 miles wide, lies between the cliffs on the S side of the Drygalski Ice Tongue and Cape Irizar, the N extremity of Lamplugh Island. Cape Reynolds, rocky and 100m high, forms the W shore of this inlet. The Clarke Glacier lies near Cape Reynolds. It is 1 mile wide, 8 miles long, and is bordered on the E side by Lamplugh Island.

The Drygalski Ice Tongue is fed by the Larsen Glacier and the David Glacier. This ice formation extends about 38 miles to its seaward extremity and varies in width. It is reported to have a maximum width of about 25 miles, along the shore. The David Glacier flows into the Drygalski Ice Tongue to the N of Geikie Inlet. This glacier is about 8 miles wide and is presumed to extend WNW as far as the interior plateau, about 25 miles inland.

Cape Philippi, a dark cliff with vertical sides, is the E extremity of the D'Urville Wall, a strongly glaciated cliff, about 1,000m high, which extends W and forms the N wall of the David Glacier. Above the cape, the summits of an extensive massif rise and separate the David Glacier from the Larsen Glacier. Mount Neumayer is the S of these summits and Mount Bellingshausen, 1,390m high, is the N. This latter peak has a steep and conspicuous cone.

4.14 Terra Nova Bay (74˚50'S., 164˚30'E.) lies between Cape Washington, 274m high, and the Drygalski Ice Tongue, 55 miles SSW, and recedes about 25 miles. The shores of the bay to the W of Cape Washington are formed by the ice cliffs, 15 to 48m high. These cliffs rise to the slopes of Mount Melbourne, 2,733m high, which rises 15 miles N. Occasionally, dark rocks project through the slopes of this peak and heavy ice falls are visible on its SW side. Mount Dickason, 2,033m high, stands about 37 miles NW of Cape Washington. Markham Island, 60m high, lies 8 miles NNW of the cape.

Gerlache Inlet lies 20 miles WSW of the same cape. Gondwana, a German scientific station, and Baia Terra Nova, an Italian scientific station, are situated in the vicinity of this inlet and are manned during summer.

Near Markham Island, the coast extends SW for 17 miles, the low shore rising to the slopes of a peninsula. Mount Abbott, 1,020m high, forms the summit of this peninsula and stands 25 miles WSW of Cape Washington. The S extremity of the peninsula consists of many low foothills. Evans Cove, 2.5 miles wide and free of dangers, lies close W of these foothills. The N shore of the cove is formed by a glacier with several conspicuous moraines.

Inexpressible Island, about 7 miles long and 3 miles wide, is 390m high and forms the W shore of the cove. A penguin rookery has been reported to exist at the S end of this island. Vegetation Island, narrow and about 1 mile long, lies 3 miles N of Inexpressible Island. Hells Gate Moraine is located between these two islands and extends SE to the shore of Evans Cove.

Terra Nova Bay is often ice-free when dense drift ice is found up to 20 miles offshore. This is due to the deflection of the current by the Drygalski Ice Tongue. The best approach to the bay is from the NE, but this route may be closed if strong SE winds have prevailed. Open water may be found near the N edge of the Drygalski Ice Tongue due to the current deflected by submarine eskers under the ice tongue.

Mount Nansen, a tabular-shaped massif, rises in terraces and terminates at its N end in precipitous walls. This massif, fronted by low and bare foothills, extends for about 8 miles N and forms the W side of Gerlache Inlet.

The Reeves Glacier fills a large indentation in the NW side of the bay, W of Gerlache Inlet. Hansen Nunatak, 965m high, stands near the center of this glacier, 18 miles W of Vegetation Island. Teall Nunatak stands about 5 miles seaward of Hansen Nunatak. Large moraines extend SE on the undulating and heavily crevassed surface of the glacier.

Mount Larsen, 1,562m high, forms the S wall of the Reeves Glacier and consists of sheer, faceted-granite cliffs on its N side. The Larsen Glacier, 3 miles wide, lies on the S side of Mount Larson and extends 25 miles from its seaward end to the interior plateau.

4.15 Cape Washington (74˚39'S., 165˚25'E.), a bold and truncated headland, is 274m high and forms the extremity of a spur of Mount Melbourne. This spur, which projects 7 miles SE and then 5 miles SSE, separates Wood Bay from Terra

Nova Bay. Vast quantities of drift ice, swept N by the tidal current or moved by the summer prevailing winds, are often trapped along the shores of the spur. A shoal, with a depth of 14.6m, was reported to lie within 0.5 mile of the cape.

Wood Bay lies between Cape Washington and Cape Johnson, 35 miles N. This bay provides shelter, but drift ice is often carried in by the tidal currents and SE winds. The ice within the bay may not break out until February. The S shore of the bay consists of ice cliffs.

Lady Newnes Bay (73˚40'S., 167˚30'E.) indents the coast between Coulman Island and Cape Johnson. This bay, about 80 miles wide, is completely filled by an extensive and undulating shelf ice. Most of the area lying seaward of this bay has not been surveyed.

Coulman Island (73˚28'S., 169˚45'E.), 18 miles long, lies 95 miles NE of Cape Washington. A peak, 1,998m high, stands at the S end of this island. Cape Anne, the S extremity of the island, consists of an abrupt cliff, 305m high, and is fringed along the shore by a thick ice foot. Cape Wadworth, the N extremity, consists of a vertical cliff, 793m high, with glacier cliffs on either side. Landings have been made on rocks lying under these cliffs.

Caution.—A local magnetic anomaly has been reported to exist in the vicinity of Coulman Island.

4.16 From Cape Phillips, located 17 miles N of the N end of Coulman Island, the coast extends N, with rocky cliffs and spurs, for 21 miles to Cape Daniell. Steep, high cliffs, which are broken occasionally by ice slopes, extend 14 miles SW from Cape Phillips to Cape Jones, a black bluff with vertical sides. Mount Brewster, 2,026m high, is dome-shaped and stands above Cape Jones. The ice slopes descend from the summit of this peak and completely cover this section of the coast.

Tucker Inlet lies between Cape Daniell and Cape Wheatstone, 8 miles NNE, and is usually blocked by drift ice. The head of this inlet consists of snow-covered hills which rise W to Mount Northampton. This latter peak is 2,467m high and stands 18 miles W of Cape Daniell.

The land extending between Cape Wheatstone and Cape Hallett, 17 miles N, is shaped into a peninsula by inlets receding at the N and S ends. Cape Wheatstone is a steep, rocky bluff which is capped by a dome of ice. Cape Hallett consists of steep cliffs which are backed by Quarterdeck Ridge, 1,660m high.

Edisto Inlet lies between Cape Hallett and the mainland. This inlet recedes S for about 8 miles and is 3 miles wide. There are depths of 293 to 558m within this inlet.

Moubray Bay lies between Cape Hallett and Cape Roget, 20 miles NNE. An isolated rock lies about 8.5 miles N of the latter cape.

4.17 The **Possession Islands** (71˚56'S., 171˚10'E.), a group of nine islands and islets, lie 5 miles offshore, 9 miles E of Cape Roget. These islands and islets vary in size from being 1.3 miles long to being mere pillars of rock. Possession Island, the N and largest island, is low and bare, except at its SW extremity. Archer Peak, 116m high and abrupt, forms the S extremity of this island. Foyn Island, the central island, is 247m high and has mostly vertical sides. Heftye Island, the southernmost island, is 64m high. Several of the islets in the group are formed by pillars which have vertical walls up to about 9m high. Landings have been made on these islands. The channel leading between the group and the mainland is 5 miles wide. This channel has been navigated by several vessels and is believed to be free of dangers, but it may be blocked by heavy drift ice at times. A tidal current has been experienced in the vicinity of this channel. The N current, with a rate of 3 knots, is reported to be considerably stronger than the S.

Cape McCormick, a conspicuous cliff, is located 11 miles NE of Cape Roget and is backed by steep glacial slopes which extend from the interior mountains. Mount Sabine, 3,719m high, and Mount Whewell rise close N of the cape. Mount Robinson stands behind Downshire Cliffs, 12 miles N of the cape, and has a conspicuous sharp peak.

From Downshire Cliffs, the coast extends 23 miles NNW to Cape Adare, the N extremity of the Adare Peninsula. This peninsula is 2,050m high; its E side descends in sheer cliffs to the sea. Several pillars of rock fringe the shore in this vicinity.

Cape Adare to Porpoise Bay

4.18 **Cape Adare** (71˚17'S., 170˚14'E.) is the E entrance point of Robertson Bay and also the NE extremity of Victoria Land. This cape consists of a vertical cliff of black basalt, 305m high. It is reported that a hut is situated near the N end of the cape. Two pillar rocks, known as The Sisters, lie close to the N extremity of the cape.

Several shoals have been reported to lie within an area located about 2.5 miles NW of the cape. However, deep water, over an uneven bottom, has been reported to lie about 3.5 miles NW of the cape. Shoals have been reported extending 3 to 4 miles W from Cape Adare.

Robertson Bay lies between Cape Adare and Cape Barrow, 19 miles W, and recedes for about 25 miles. This bay is dominated by the Admiralty Mountains, the slopes of which are so steep that, except in the valleys, no snow or ice is able to lodge, and bare rock is shown everywhere. This bay probably remains free of ice from January to April. New freezing usually begins in April, but strong offshore winds frequently drive the ice out of the bay during the winter months. Drift ice moves in and out of the bay under the influence of the tidal currents.

A current sets round Cape Adare and into Robertson Bay, bringing in masses of ice. This current sometimes attains a rate of 5 knots, but is much affected by the tide. An eddy current has been reported to occur within the inner part of the bay and then set out along its E side. Anchorage can be obtained anywhere off the E side of this bay, but usually in a depth of 27m close off the S side of a beach which lies 1 mile S of Cape Adare. However, this side of the bay is especially subject to SE blizzards. Anchorage can also be taken, in a depth of 20m, close off the E side of Colbeck Bay, a small inlet, lying near the head of Robertson Bay.

Caution.—Robertson Bay should be navigated with great care and vessels should give Cape Adare a wide berth.

4.19 **Atkinson Cliffs** (71˚17'S., 168˚55'E.), 680m high, are located 7.5 miles SE of Nelson Cliff, 540m high, from which they are separated by the Simpson Glacier Tongue, projecting about 2.5 miles seaward. Mount Cherry-Garrard, a conspic-

uous peak, stands on the Atkinson Cliffs; the Anderson Ice Falls lie close SE of them. The E side of these ice falls are bordered by a steep, rocky ridge which descends from the slopes of Mount Wright. Turret Island and Flat Island lie close SE of this ridge. Cape Barrow forms the NE end of the latter island and the W entrance point of Robertson Bay. The Shipley Glacier descends steeply and envelops the W sides of those two islands, ending at the water's edge in a vertical cliff, 27m high. Cape Wood forms the E extremity of Flat Island.

Cape Scott is located 22.5 miles NW of Nelson Cliff and 6 miles ESE of Cape Oakeley. Smith Inlet, 8 miles wide, appears to be a fjord and recedes for a considerable distance. Mount Dalmeny stands above the S shore of this inlet and Cape Oakeley, a dark and bold headland, forms its E entrance point. This section of the coast consists of dark, conspicuous cliffs fronting snow-covered hills. High mountains rise inland, the most prominent being Mount Pechell which stands 13 miles W of Cape Scott.

Yule Bay lies 20 miles NW of Smith Inlet and is entered between Cape Dayman and Cape Hooker, 9 miles NW. The latter cape forms the S end of a fork-shaped projection.

The Lyall Islands, a group of four, lie about 3 miles offshore, 6 miles SE of Cape Dayman. This portion of the coast is backed by high hills, the most prominent peak being Mount Elliot.

Cape North, located 27 miles WNW of Cape Hooker, consists of a vertical, snow-covered cliff, 61m high. The coast between this cape and Yule Bay consists of high ice cliffs.

4.20 The **Balleny Islands** (66˚55'S., 163˚20'E.), a group of five, lie with the SE island located about 190 miles NNW of Cape Hooker. The group forms a chain which extends in a NW/SE direction for about 100 miles. The islands are heavily glaciated and are volcanic in origin. Ice tongues project into the sea from their slopes.

The sea area lying between this group and the mainland is frequently impenetrable due to heavy drift ice. The current in the vicinity of the chain sets NW and field ice from the Ross Sea drifts toward the group and often becomes choked up between the islands and the mainland.

Young Island, the NW island, is long and narrow with a gentle, sloping plateau, 1,340m high. This island is 19 miles long, 4 miles wide, and is entirely covered with snow. Cape Ellsworth, the N extremity of this island, consists of a rocky bluff, 290m high, off which lie Seal Rocks, up to 15m high. Foul ground fronts these rocks and lies up to 2 miles seaward. A below-water rock lies about 3 miles NNW of this cape. Breakers, position approximate, were reported (1959) to exist in the vicinity of this rock.

The W side of the island is steep and crevassed, but the E side is low. The S extremity consists of a rocky wall, 186m high, capped by ice sheet. Cape Douglas, the E extremity, is located 4.5 miles NNE of the S extremity, and is fronted by two prominent and rocky bluffs, 162m high. A prominent cone is reported to stand 6.5 miles SSE of Cape Ellsworth.

Row Island lies 2.3 miles SSE of Cape Douglas. It is about 0.5 mile long and 183m high.

Borradaile Island, lying 3 miles SE of the S extremity of Young Island, is 2 miles long and 1 mile wide. This island is ice-capped, 381m high, and has sheer sides. Beale Pinnacle, 61m high, lies close to the E end of this island and is shaped like a boot. Rocks, which break, front the N and NW ends of this island and extend up to 2.5 miles seaward. The channel leading between Borradaile Island and Young Island has not been thoroughly surveyed.

Buckle Island lies 16 miles SE of Young Island. This island is 13 miles long, 4 miles wide, and extends in a NNW/SSE direction. It consists of a gentle sloping plateau, 1,238m high. In some places, rocky cliffs descend to the water's edge. In others, long ice cliffs forms the seaward edge of glacial slopes and descend between breaks in the rocky masses. Cape McNab, 354m high, forms the S extremity of this island. A glacier descends in the vicinity of the cape from the high interior and flows between rocky walls. Scott Cone, 31m high, rises 2 miles NNE of this cape. Eliza Cone, 67m high with an archway through it, rises 1 mile W of the cape.

Sabrina Island, about 0.7 mile long, lies 2 miles S of Cape McNab and is 90m high. A conspicuous pinnacle, known as The Monolith, stands at the S end of the island and is 79m high. A group of rocks, which breaks heavily, lies 2.5 miles SE of this pinnacle. Below-water rocks lie close N and NE of the island. A shoal is reported to lie in mid-channel between Sabrina Island and Buckle Island.

Sturge Island, the SE of the group, lies 45 miles SE of Buckle Island. It is 18 miles long and 8 miles wide. Steep, rocky cliffs and a broad ice tongue descend from the interior to form the coast. This island is completely ice-capped and Brown Peak, 1,167m high and prominent, stands in its S part. Cape Freeman, 672m high with a vertical rock wall, forms the N extremity of this island and Cape Smyth, with a long ice slope, forms the S extremity. Rocks, awash, lie within about 0.5 mile SE and SW of this latter cape. A shingled spit extends about 0.3 mile ESE from Cape Smyth and rises to a hill, 100m high. Four detached stacks lie close ESE of the seaward extremity of this spit. A shelf, with depths of 11 to 15m, extends up to about 0.5 mile S of the shingled spit. Temporary anchorage may be taken on this shelf about 0.2 mile from the spit.

4.21 **Scott Island** (67˚24'S., 179˚55'W.) lies 315 miles NE of Cape Adare. It is about 0.3 mile long, 1.5 miles wide, and extends in a N/S direction. When approaching the Ross Sea from New Zealand, many vessels prefer to proceed to Scott Island and then turn S. The N part of the island consists of precipitous cliffs, 41m high. The slopes above these cliffs rise to a rounded summit, 49m high, which stands in the center of the island. The slopes on the S side of this summit descend toward the S extremity of the island, where they end about 2m above the water. The island is completely ice-capped. Small coves lie at the NE and NW extremities of the island and are obstructed by many rocks over which the sea breaks.

Haggits Pillar, a column of rock, is 64m high and stands close off the W side of the island. A cavern, 15m high, passes through the N end of Scott Island. The S side of the island is fringed by foul ground. The remaining sides of the island have depths of at least 14m lying as close as 90m offshore.

Scott Island Bank extends up to 40 miles S of the island. An isolated depth of 60m is reported to lie about 28 miles SSW of the island.

4.22 Archer Point (69˚11'S., 157˚39'E.) is rocky and backed by the Wilson Hills, which extend WNW. A long and narrow glacier, with a forked end, lies close W of this point. It extends NNW from the Wilson Hills and projects about 15 miles seaward. Babushkin Island lies close E of this glacier and 5 miles NW of the point.The Terra Nova Islands lie 17 miles NNE of the point. They are small, low, and rocky.

Cape Kinsey is located 25 miles ESE of Archer Point and three small islands are reported to lie about 3.5 miles NW of it. The coast between is rugged and reaches the sea in steep, rocky points which are separated by glaciers and backed by the Wilson Hills. The most prominent headlands along this stretch are Williamson Head, located 4 miles E of Archer Point, and Drake Head, located 12 miles WNW of Cape Kinsey. Harald Bay indents the coast between Archer Point and Williamson Head. Davies Bay lies close W of Cape Kinsey and appears to recede for a considerable distance. A depth of 278m was reported to lie about 17 miles NE of Cape Kinsey. Many grounded icebergs have been observed along this stretch of coast and a strong NW tidal current sets in this vicinity.

Cape Cheetham (70˚18'S., 162˚42'E.) is located 82 miles SE of Cape Kinsey. The land between has not been fully surveyed. This cape appears to be an isolated pinnacle which forms the E extremity of Rennick Bay. The bay is about 18 miles wide; its W entrance point consists of high cliffs with outcroppings of rock. The Rennick Glacier flows into this bay.

From Cape Cheetham, the coast extends ESE for 18 miles to Cape Williams and is backed by the Bowers Mountains, which are rugged, snow-covered, and of moderate height. An island, known as Sputnik Island, is reported to lie about 15 miles SE of Cape Williams and a rock is located close off its SW end. Cape Cheetham is separated by a valley of col from Mount Bruce. This latter peak is 1,639m high and forms the summit of the Bowers Mountains.

Leningradskaya, a Russian station, is situated 18 miles SE of Cape Kinsey. It was reported to be unoccupied (1995).

The Lillie Glacier Tongue, 38m high, extends about 12 miles N from snow-covered, rounded hills between Cape Cheetham and Cape Williams. An islet, 909m high, is reported to lie close off the NW end of this glacier tongue and about 3 miles E of Cape Cheetham. A depth of 245m was reported to lie about 8 miles N of the tongue of the glacier. Many grounded icebergs and unbroken fast ice have been observed to fringe the shore in this vicinity. A strong NW current sets along this part of the coast.

4.23 Cape Freshfield (68˚20'S., 151˚00'E.) is located 150 miles WNW of Archer Point. The coast between is quite jagged and consists of numerous indentations. Lauritzen Bay lies about 15 miles W of Archer Point and is obstructed by an ice shelf. Depths of 117 to 362m have been reported to lie within this bay. The head of the bay is backed by Magga Peak, 244m high, which consists of a mass of sheer rock in flat-iron shape with a strip of fast ice, 1 mile wide, extending along the coast from its base. A cairn was reported (1962) to stand on the summit of this peak. Drury Nunatak and Reynolds Peak both stand about 14 miles SW of Magga Peak.

Cape Buromskiy, located 35 miles WNW of Archer Point, forms the W extremity of a small projection which extends NW from the coast. An island lies close W of this cape. The Mawson Peninsula, about 35 miles wide, is centered with its N extremity located about 40 miles E of Cape Freshfield.

The George V Coast is considered to lie between 155˚E and 142˚E. It was discovered and explored by the Australasian Antarctic expedition, under Sir D. Mawson (1911-14).

Virik Bank lies about 160 miles N of Cape Freshfield and has a least reported depth of 95m. A dangerous shoal has been reported to lie about 33 miles SW of this bank, but its existence and position are doubtful.

Deakin Bay (68˚23'S., 150˚10'E.) lies 18 miles W of Cape Freshfield. A depth of 585m over a bottom of slate, mud, and stone was reported to lie within this bay.

Cape Wild (68˚23'S., 149˚07'E.), the W entrance point of Deakin Bay, is located 28 miles W of Cape Freshfield. Cape Blake is located 8 miles NW of Cape Wild.

Horn Bluff, located 8 miles SW of Cape Blake, is formed by a prominent rock bastion projecting from beneath the ice cap. This bastion is fronted by coastal cliffs, 325m high, and its upper part consists of several great conspicuous columns, resembling organ pipes. The cliffs are broken only by shallow, narrow coves where the ice descends to the sea.

4.24 Cape Spencer is located 25 miles W of Cape Blake and about 5 miles E of Buckley Bay, which is filled by the high ice cliffs of the Ninnis Glacier. This large glacier descends steeply from the high interior through a broad valley and is heavily hummocked and crevassed. Dixson Island, 335m high, lies 33 miles NW of Cape Spencer, near the W limit of the Ninnis Glacier. This ice-covered island is about 11 miles long and 6 miles wide.

Cape Hurley (67˚36'S., 145˚18'E.) is located about 45 miles NW of Dixson Island and marks the point where the Mertz Glacier reaches the sea. This stretch of coast is unbroken by rock outcrops and, like the coast farther E, consists of an ice cliff behind which, 20 to 25 miles from the sea, rise ice-covered slopes, up to 920m high. Fisher Bay lies 4 miles W of Cape Hurley and is bounded on its W side by the E side of the Mertz Glacier Tongue.

The Mertz Glacier Tongue extends NE for about 30 miles from the coast and has a width throughout of about 20 miles. It terminates at the sea in ice cliffs, up to about 50m high. This tongue is believed to be afloat and a depth of 728m has been reported to lie close off its W edge. The surface of this tongue is heavily fissured.

4.25 Buchanan Bay, located 47 miles NW of Cape Spencer, lies on the W side of the Mertz Glacier Tongue. Mount Murchison, 567m high, stands 8 miles SW of this bay and is almost entirely covered in snow. Aurora Peak, 533m high, rises 4 miles SSW of Mount Murchison, from which it is separated by a gully. The W shore of the bay is formed by the continental ice slopes which rise to Mount Hunt. This latter peak is dome-shaped and 457m high. It forms the S end of a promontory which projects N and terminates in Cape de la Motte, the W entrance point of the bay. The Hodgeman Islands and the Close Islands lie close off the W and E sides, respect-ively, of this cape. The islands are all small and ice-capped.

Watt Bay, 6 miles wide, indents the coast close W of Mount Hunt. The shore descends to almost sea level at the head of this bay. Madigan Nunatak, a conspicuous and jagged ridge of gray

gneiss, rises 10 miles WSW of the head of the bay and is 731m high. The W part of the bay is obstructed by many rocks and small islands which lie up to 2 miles offshore.

4.26 Cape Gray (66˚51'S., 143˚22'E.), faced by ice cliffs, is located 12 miles NW of Watt Bay and is the N termination of an extensive ice plain which descends from the interior in a series of crevassed slopes.

The Way Archipelago consists of numerous small islands and rocks which front the coast and lie up to 2 miles offshore. Stillwell Island, the largest of this archipelago, lies close NE of the cape. This island is steep, rocky, about 0.3 mile in diameter. It is 37m high near the NW extremity.

Commonwealth Bay (67˚01'S., 142˚40'E.), 27 miles wide, lies W of Cape Gray and recedes for about 12 miles. The E side of this bay is obstructed by many islets which lie up to 2 miles offshore. The Hannam Islands lie about 2 miles offshore, 7 miles W Cape Gray. Whetter Nunatak, a conspicuous rocky outcrop, juts through the ice cliffs, 3.5 miles S of these islands. The Laseron Islands, a small group, lie on the SE side of the bay. The Mackellar Islands lie in the center of the bay and about 1.5 miles from the head. This group consists of about 30 rocks and small islands which extend over an area, about 2 miles long and 1 mile wide. The largest island in the group is about 0.5 mile long and is the site of a large penguin rookery. Several reefs and shoals lie in the vicinity of these islands and they should be approached with care.

4.27 Cape Denison (67˚00'S., 142˚40'E.), a rocky point, is located in the center of the S shore of Commonwealth Bay. This cape is formed by a glacial moraine of ice-polished gneiss. It is about 0.5 mile long, 1 mile wide, and has a mean elevation of 12m above sea level. Landing may be made within a cove lying close S of the cape. This cove is 0.2 mile wide, 0.5 mile long, and has an average depth of 4.6m.

About 0.5 mile inland, the morainic ice joins the inland ice sheet, which is 55m high. About 12 miles inland, the continental slopes rise to a height of 610m. Heavily crevassed ice slopes descend vertically to the sea in ice cliffs, 18 to 46m high, on each side of Cape Denison. A hut and a memorial cross are reported to stand near the cape.

Anchorage can be obtained about 1 mile W of Cape Denison, but the bottom is extremely uneven. This area appears to have depths of 37m or less over a bottom of mostly rock. The anchorage is protected from the strong prevailing winds, which blow offshore from between S and SE, and also from drifting icebergs and ice pressure.

At Cape Denison, the average wind speed is phenomenally high and it is probably the windiest region in the world. The annual average wind speed is reported to be 38 knots or gale force. Almost continuous blizzards blow for 9 months of the year in this vicinity and whirlwinds of snow occur during the rare periods of comparative calm.

It was reported (1985) that a sheltered haven for small boats lies close W of Cape Denison. A reef, which is partly above-water at LW, extends across the entrance. A rock, awash, was reported (1989) to lie about 1.6 miles W of the cape.

4.28 Point Alden (66˚48'S., 142˚02'E.) is the W entrance point of Commonwealth Bay. From this point, the coast extends W for 12 miles to Cape Decouverte. This latter cape is the NW extremity of the largest island in a group, known as the Cruzon Islands, which lie close off the coast and extend in a NW/SE direction for about 1.5 miles. The Sentinel Islands, another small group of rocky islands, lie about 3.5 miles E of Cape Decouverte and close off the ice cliffs.

From Cape Decouverte, the coast extends SW for 10 miles to the Zelee Glacier. This stretch of coast is fronted by many islands, some of which lie up to about 2.5 miles offshore.

Port Martin, a peninsula, is located 8 miles SW of Cape Decouverte and was the site of a former base. This base was destroyed in 1952, as a result of a storm of great violence and a fire.

Petrel Island (66˚40'S., 140˚00'E.) lies 30 miles WNW of Port Martin and is the site of Dumont d'Urville Base, a French station. A radiobeacon is situated at the island and is activated on request.

Two small islands, Recif Tottan and Recif Norsal lie 7.5 miles NNW and 6.5 miles NW of Dumont d'Urville Station. These islands have been reported (2004) to have a height of 1.9m.

4.29 The Zelee Glacier extends for about 7 miles NW and then about 2.5 miles W, meeting the coast again about 2 miles SE of Cape Jules. A few islands and shoals are reported to lie within 1.5 miles NE of the E side of this glacier. Two islands, located about 1 mile apart and fronted by shoals on their E sides, lie 4 miles NE of the N extremity of the glacier. Lacroix Nunatak, which reaches the coast about 1.5 miles NW of the glacier, is 88m high at its W end.

Cape Jules, 0.7 mile wide, is located 15.5 miles W of Cape Decouverte and projects about 0.8 mile from the coast. A small cove indents the middle of the N side of this cape. Tristan Island and Yseult Island lie close off the NW and NE extremities, respectively, of the cape.

From Cape Jules, the Adelie Coast extends W for about 10 miles to Cape Bienvenue. This latter cape is small, rocky, partially ice-covered, and 44m high. From Cape Bienvenue, the coast continues W for 10 miles to the Astrolabe Glacier Tongue. This tongue extends 4 miles NE from the ice cliffs and is about 3.3 miles wide. Piner Bay, an open bay, is formed between the NE extremity of the glacier tongue and Cape Bienvenue. Cape Geodesie, low and ice-covered, is located 2.8 miles NW of the W side of the Astrolabe Glacier Tongue. It has several prominent and rocky outcrops at the NE end.

The Geologie Archipelago extends W and N of the glacier tongues. This archipelago is roughly divisible into three island groups. The N group consists of the Dumoulin Islands, which are numerous and cover an area about 2 miles in extent. Icebergs are reported to ground along a line, which extends SSE for about 4 miles, from close E of these islands.

Islands are reported to lie about 6 miles NW and 8 miles N of Cape Geodesie. Breakers were reported (1958) to exist about 16 miles N of the cape.

From Cape Geodesie, the coast extends 31 miles WNW to Cape Pepin. About 8 miles NW of Cape Geodesie, the Liotard Glacier reaches the sea and forms a small tongue. Janet Rock, a small rock, lies 17.5 miles WNW of Cape Geodesie and close off the ice cliffs. The Francais Glacier lies about 7 miles W of Cape Pepin.

The Adelie Coast extends 20 miles WNW from Cape Pepin to Cape Robert and then 22 miles W to Cape Bickerton, the E entrance point of Victor Bay. Pourquoi Pas Point, an ice-covered cape, is located 20 miles NW of Cape Bickerton. This point forms the W entrance point of Victor Bay and also the W limit of the Adelie Coast.

Victor Bay extends about 7 miles to its head and is almost completely filled by the Commandant Charcot Glacier. Mathieu Rock lies close off the E side of the bay and X Rock lies 3 miles W of it. X Rock, 33m high, consists of a prom-inent, black mass which is streaked with quartz on its eroded flanks. Both of these rocks rise from islands that are embedded in the ice.

From Pourquoi Pas Point, the ice-covered cliffs of the Clarie Coast extend generally W for 140 miles to Cape Morse. The Pourquoi Pas Glacier Tongue lies near the E end of this coast.

The Dibble Glacier is located 30 miles W of Pourquoi Pas Point and close E of Davis Bay. The Dibble Glacier Tongue, about 18 miles wide, is reported to extend up to about 40 miles N from the coast.

Davis Bay, about 15 miles wide at its entrance, lies between the Dibble Glacier Tongue and Cape Cesney, its ice-covered W entrance point. Lewis Island, the site of an automatic weather station, is small and rocky. It lies close inside the E side of the entrance to Davis Bay.

About 9 miles WNW of Cape Cesney, a stubby peninsula terminates at Cape Keltie and forms the northernmost point of land on the Claire Coast. Freeman Point is located 23 miles W of Cape Keltie and forms the W entrance point of Perry Bay. This latter bay is about 12 miles wide at its entrance and recedes for about 4 miles. The Freeman Glacier fills the W side of this bay.

From Freeman Point, the coast extends 35 miles W to Cape Carr. This latter cape is prominent, ice-covered, and forms the seaward extremity of the W part of the Claire Coast. The Harrison Glacier and the May Glacier are located 13 miles ESE and 7 miles WSW, respectively, of Cape Carr.

The Banzare Coast extends between Cape Morse and Cape Southard. Porpoise Bay, Maury Bay, and Paulding Bay lie E to W, in that order, and completely indent this stretch of coast.

Porpoise Bay, 85 miles wide at its entrance, lies at the E end of the Banzare Coast. It recedes for about 46 miles and is entered between Cape Morse and Cape Goodenough. This latter cape, which forms the W entrance point, is ice-covered and the N extremity of the Norths Highland. The shores of the bay are interrupted by numerous glaciers. The W glacier terminates in Cape Spieden, a prominent tongue, which lies 16 miles SE of Cape Goodenough.

Porpoise Bay to Barrier Bay

4.30 Maury Bay (66˚33'S., 124˚42'E.) lies SW of Cape Goodenough and is entered between Stuart Point and Clark Point. This bay is believed to be generally filled by ice and is marked by prominent tongues which extend seaward from the Blair Glacier and the Hudson Glacier. The bay was reported (1963) to be fronted by the Voyeykov Ice Shelf, which extended up to about 30 miles offshore, as far E as Cape Goodenough.

Paulding Bay, centered 40 miles W of Maury Bay, is ice-filled. This bay indents the W end of the Banzare Coast between Clark Point and Cape Southard. It is about 50 miles wide at the entrance and recedes for 22 miles.

Henry Bay lies 35 miles SW of Cape Southard; the Henry Islands and Chick Island obstruct this cove. An automatic weather station is reported to be situated in the vicinity of this bay. The Dalton Iceberg Tongue extends up to about 60 miles N from the vicinity of Cape Southard.

Cape Mikhaylov is located 80 miles W of Cape Southard. Cape Waldron is located 85 miles WNW of Cape Mikhaylov; the Totten Glacier discharges on its E side.

The Budd Coast extends between Cape Waldron and the Hatch Islands, 140 miles W. Cape Poinsett, located 55 miles NW of Cape Waldron, is the N point of land along this coast. The Balaena Islands lie about 50 miles WSW of Cape Poinsett and close off the coast. The largest island of this group is 1 mile long and 46m high. It is composed of granite and has cliff-like slopes.

4.31 Cape Folger (66˚08'S., 110˚44'E.), located 17 miles SW of the Balaena Islands, is the E entrance point of Vincennes Bay. Shoals front this cape and extend up to about 20 miles WNW of it. Shoal depths of 12.8 and 16.4m are reported to lie about 14 miles NW and 8 miles NW, respectively, of the cape. Petersen Bank lies with its S end located about 24 miles NW of the cape.

Vincennes Bay is entered between Cape Folger and Cape Nutt, 67 miles SW. It indents the Budd Coast and the adjoining Knox Coast and recedes S for about 22 miles. The Adams Glacier and the Bond Glacier descend into the head of this bay. The Windmill Islands, forming a chain, lie close off the NE side of the bay. This chain extends S for 15 miles and its N end lies 6 miles SSW of Cape Folger. The Frazier Islands and the Donovan Islands, two groups located about 5 miles apart, lie between 5 and 7 miles off the E side of the bay. Nelly Island, the SE of the Frazier Islands, is 90 high. Chapel Island, the NE of the Donovan Islands, is 43m high.

Stonehocker Point is located on the E side of the bay, 9 miles SW of Cape Folger. The Swain Islands, a large cluster, lie centered 2.8 miles NE of this point, but have not been fully surveyed.

Newcomb Bay is entered between Stonehocker Point and Kirby Island, 0.8 mile S. It lies between the SW side of the Clark Peninsula and the Bailey Peninsula, 1 mile SW. A fairway leads to this bay from the W but it is encumbered by Fitzpatrick Rock, 1.2m high and ice-capped, which lies about 0.5 mile SW of the W extremity of the Clark Peninsula. Gibney Reef, which dries 1.5m, lies about 0.5 mile NW of the W extremity of the Clark Peninsula. Larsen Bank, with a least depth of 15.8m, lies about 0.5 mile ENE of Fitzpatrick Rock. The N part of this bay has depths of 18 to 82m and provides safe anchorage for large vessels over good holding ground.

Kilby Island is 13m high; a beacon stands on its summit. Another island, 30m high, lies 0.3 mile SSE of Kilby Island and is surmounted by a beacon. Molholm Island lies 0.6 mile ENE of Kilby Island and is also surmounted by a beacon.

Wilkes Station (66˚15'S., 110˚31'E.), in a state of disrepair and decay, is situated in a valley on the Clark Peninsula, 0.3 mile NE of Stonehocker Point. It was established by the U.S. in

1957 and remained active until 1969. During the summer, the station remains uncovered to a limit dependent on the season melt. Numerous radio masts can be seen in the vicinity of the former station.

Casey Station (66˚17'S., 110˚32'E.) is situated on the highest point of the Bailey Peninsula. This facility consists of numerous large modern buildings, which are painted with bright colors and are visible for 6 miles. A reinforced earthen wharf is situated in the vicinity of this station and is used for re-supply operations. A radiobeacon is situated at the station and will be activated on request.

The former station, which is now known as Old Casey Station or the Tunnel because of its tunnel-shaped construction, was closed in 1988.

Anchorage.—The bottom off the station is reported to consist of rock with poor holding ground. Vessels may anchor, in a depth of 44m, about 0.2 mile E of Kilby Island; in a depth of 29m, about 0.2 mile NNW of Molholm Island; or close E of Larsen Bank.

Caution.—It is reported that explosives are scattered across an area of 500 square meters lying close E of Wilkes Station. This area is marked by warning signs.

4.32 The Knox Coast extends W from the Hatch Islands to Cape Hordern. From Cape Nutt, this coast extends 146 miles NW to Cape Elliott.

The Underwood Glacier, located 2 miles W of Cape Nutt, pro-jects about 8 miles seaward. Merritt Island lies close to the shore, about 22 miles NW of this glacier.

Bowman Island, 305m high, lies 29 miles NE of Cape Elliott. It is low, dumbbell-shaped, and ice-domed. The center section of this island is about 2 miles wide. Two rocky islands, positions approximate, were reported (1948) to lie about 50 miles ENE of the N extremity of this island.

Mill Island (65˚37'S., 101˚00'E.), crescent-shaped and ice-capped, is 18 miles long and 4 miles wide near its middle.

Bowman Island and Mill Island are usually surrounded by drift ice and grounded icebergs.

The Shackleton Ice Shelf, an extensive ice sheet, fronts the coast and extends about 200 miles W from a point located 45 miles WNW of Merritt Island. It is fed by the glacial flows from the continent and extends N for about 120 miles. The seaward edge of this shelf is 18 to 31m high and is estimated to be about 180m thick. The observance of numerous grounded icebergs off its NW face suggests that the shelf may be aground at some points. Heavy drift ice is usually found along the N face of the shelf, being carried there by the W setting current.

Tressler Bank, with depths of 85 to 177m, extends 25 miles W and then 20 miles N from the NW end of the Shackleton Ice Shelf. The Davis Sea lies on the W side of the Shackleton Ice Shelf. The Queen Mary Coast extends E from Cape Filchner to Cape Hordern.

4.33 Junction Corner (66˚28'S., 94˚35'E.) marks the point where the W edge of the Shackleton Ice Shelf meets the mainland. The surface here is undulating with extensive pressure ridges and crevasses. The ice-covered slopes of the continent, up to 914m high, stand S of Junction Corner. They extend for about 30 miles but are devoid of any conspicuous landmarks.

From Junction Corner, the coast extends ESE for 38 miles to Cape Moyes, an ice-covered point. The Roscoe Glacier flows into the Shackleton Ice Shelf about midway between these two points. The Gillies Islands lie 5 miles N of Cape Moyes. They consist of two small, rocky outcroppings, 53m high.

Masson Island lies 23 miles N of Cape Moyes. This island is 19 miles long, 9 miles wide, and 465m high.

From Cape Moyes, the coast extends SE for 5 miles and then NE for 13 miles to **Cape Dovers** (66˚29'S., 97˚08'E.). Heavy ice falls descend from the interior slopes between these two capes. Henderson Island, ice-capped and 241m high, lies 5 miles N of Cape Dovers. The Bay of Winds, lying E of Cape Dovers, is 8 miles wide and recedes for about 12 miles. Alligator Island, lying in the center of this bay, is 0.5 mile long, narrow, and 150m high on its W side. Avalanche Rocks, lying on the SE shore of the bay, are a distinctive outcrop of rocks, 180m high. Delay Point, the E entrance point of the bay, consists of a sheer, rocky bluff, 183m high, which is surmounted by an ice cap, at least 60m thick. ice falls descend on either side of this point.

Hippo Island lies 2 miles N of Delay Point. This island consists mostly of dark-colored gneiss, interspersed with bands of red granite.

Cape Charcot, a sheer and rocky cliff, is located 7 miles E of Delay Point and forms the NE extremity of the Melba Peninsula. Cape Kennedy, located 4 miles S of Cape Charcot, forms the S extremity. The Reid Glacier, 8 miles wide, descends from the interior close SE of Cape Kennedy.

4.34 Cape Gerlache (66˚30'S., 99˚02'E.) is located 12 miles E of Cape Kennedy and forms the N extremity of the Davis Peninsula. This peninsula is 180m high, 4 miles wide, and forms the E limit of the Reid Glacier.

David Island lies at the entrance to the Reid Glacier. A channel, 3 miles wide, separates this island from Cape Charcot; another channel, 4 miles wide, leads between the island and the Davis Peninsula. David Island is 87m high and has several bare peaks and dark knolls. Watson Bluff, the NE extremity of the island, is formed by a projecting bluff of ice-worn gneiss, 274m high. The island is 12 miles long, 10 miles wide, and its summit consists of a bare ridge with steep, coarsely-weathered faces.

The Northcliffe Glacier, lying S of the Davis Peninsula, flows NNE and joins the Denman Glacier. This latter glacier projects 45 miles N from the general line of the coast.

Mount Barr Smith, 1,107m high, stands 40 miles S of David Island. Mount Strathcona, 976m high, stands 13 miles SSE of Mount Barr Smith. The coast to the W of David Island is fronted by the W part of the Shackleton Ice Shelf. Bigelow Rock lies off the W edge of the ice shelf, 23 miles NNE of Junction Corner. This small rock is reported to show about 3m of exposed rock above sea level.

4.35 Farr Bay (66˚35'S., 94˚23'E.) lies close W of Junction Corner. It is about 10 miles wide and recedes for about 5 miles into the ice-clad coast. From the W side of this bay, the land trends NW for 10 miles in a series of heavy, broken, and crevassed ice falls. The Helen Glacier lies 5 miles W of the bay

and is fronted by the Helen Glacier Tongue, which projects 10 miles seaward.

The **Haswell Islands** (66˚31'S., 93˚00'E.), a group of 12 small and rocky islands, lie off Mabus Point, the W entrance point of Wright Bay. The largest island is 0.7 mile long and 100m high.

Mirny Station (66˚33'S., 93˚01'E.), a Russian scientific station, is situated on the coast, close S of the Haswell Islands, and is permanently manned.

From Mabus Point, the coast extends SW for 8 miles and then NW for 15 miles to Cape Filchner. McDonald Bay lies on the E side of this latter cape. Adams Island lies 8 miles W of the Haswell Islands and 3 miles off the SW shore of the bay.

Drygalski Island (65˚45'S., 92˚30'E.) lies 45 miles NNW of the Haswell Islands. This island is 9 miles wide, 286m high, and has no rock visible. It is surmounted by a domed ice cap. A current setting NW has been observed in the vicinity of this island.

The Wilhelm II Coast extends from Cape Filchner to Cape Penck.

4.36 Cape Filchner (66˚30'S., 92˚12'E.), a sharp point on the ice-capped coast, is located 9 miles W of Adams Island. The mainland, 20 miles behind this cape, rises in a series of broken, crevassed ridges, up to 914m high.

From Cape Filchner, the very irregular coast extends W for 28 miles to Krause Point and then SW for 46 miles to the Posadowsky Glacier.

Gaussberg (66˚48'S., 89˚15'E.), an extinct volcano, is 350m high; its pyramidal summit descends sharply on the N side to the sea. Its N side consists of rocky terraces and bare slopes covered with loose rubble. On the S side of this volcano, the ice rises to a height of 122m. The slopes on the W and E sides are covered with vast ice falls. The Posadowsky Glacier, on the E side, descends about 450m in height over a distance of 6 miles.

Cape Penck is located 40 miles W of Gaussberg. A large bay, which recedes for 10 miles, lies between these two features; the Philippi Glacier is located at its head.

From Gaussberg, a large ice barrier, known as the West Ice Shelf, extends NW as far as 66˚S. The E edge of this shelf lies along 89˚E. This shelf fronts the coast up to about 81˚E and is reported to extend up to 100 miles seaward in places.

Barrier Bay (67˚47'S., 81˚15'E.) is formed between the SW edge of this shelf and the coast to the W.

Four Ladies Bank (67˚35'S., 77˚30'E.) has a least known depth of 124m and was discovered by Thorshavn (1937). Another bank, with a least depth of 97m, is reported to lie about 25 miles NNE of the shallowest part of Four Ladies Bank.

Princess Elizabeth Land

4.37 Princess Elizabeth Land was first sighted from the air by Sir Douglas Mawson in 1931 and later partially charted by Lars Christensen in 1934 and Klaus Mikkelsen in 1935. The E part of this land has not yet been fully explored, but recent reconnaissance by Russian and Australian expeditions has greatly improved knowledge of this area.

Princess Elizabeth Land extends from 73˚00'E to 87˚43'E, where it joins Wilhelm II Land. The part of the coast lying between 76˚E and 81˚E is named the Ingrid Christensen Coast; that part lying between 81˚00'E and 87˚43'E is named the King Leopold and Queen Astrid Coast.

Gillock Island (70˚14'S., 71˚32'E.), the extent of which is not known, lies within the Amery Ice Shelf some distance off Princess Elizabeth Land.

The King Leopold and Queen Astrid Coast was discovered from the air in January 1934 by Lieutenant Gunnestad during a flight from Thorshavn. No ice-free land was seen. The ice shelf changes imperceptibly into continental ice and the ice edge is liable to vary in position from year to year.

Banzare Bank (59˚20'S., 76˚50'E.) was reported to have a least known depth of 184m and appeared to lie near the W end of a large bank the E limit of which is yet to be determined. Depths of less than 550m were reported to lie about 160, 250, and 285 miles E of the Banzare Bank.

4.38 Prydz Bay (69˚00'S., 76˚00'E.) is contained between the Amery Ice Shelf, on the W side, and the Ingrid Christensen Coast, on the E.

The **Larsemann Hills** (69˚25'S., 76˚05'E.), consisting of 11 rocky peninsulas, occupy about 11 miles of ice-free coast extending between the Polar Record Glacier and the **Svenner Islands** (69˚02'S., 76˚45'E.), which lie 70 miles NE of Mount Caroline Mikkelsen.

Mount Caroline Mikkelsen (69˚45'S., 74˚07'E.) is 235m high. The Larsemann Hills rise to their tallest summit, 160m high, on the second peninsula from the E end.

A number of bases are situated in this area. Zhongshan, a Chinese station, stands in the this vicinity and Druzhnaya-4, a Russian station, is situated on the promontory between the Rogers Glacier and the Polar Record Glacier. Law Base, an Australian satellite station, is situated in this area. It is maintained from Davis Base and often activated during the summer months.

Ranvik Bay (69˚00'S., 77˚40'E.) is entered 15 miles NE of the Svenner Islands and is bounded on its N side by the **Rauer Islands** (68˚51'S., 77˚50'E.). These are a group of numerous and small rocky islands which lie SW of the **Sorsdal Glacier** (68˚42'S., 78˚10'E.). The glacier is about 10 miles wide and is broken with ice falls and crevasses. Calving of the glacier front occurs in the summer months. The glacier tongue extends up to about 8 miles seaward, N of the Rauer Islands.

4.39 The **Vestfold Hills** (68˚33'S., 78˚15'E.), a stretch of ice-free coast about 40 miles long, lies NE of the Sorsdal Glacier and stands 200 to 300m high. The ice cap, in which there are many ice-free saline lakes, can be seen rising behind this stretch of coast.

Davis Station (68˚35'S., 77˚58'E.), an Australian base, is permanently manned and includes a radio station which operates daily between 2330 and 1400 UT (GMT) and for longer periods on request. Numerous radio masts are situated in an area close N of the base buildings. A non-directional radiobeacon is situated at the base and will be activated on request.

A large number of islands lie up to 3 miles offshore, 25 miles NE of Davis Station. **Davis Anchorage** (68˚4'S., 77˚55'E.) lies in the S part of these islands and has been reported to be one of

the best in the Antarctic. It is used by research vessels and others engaged in re-supply operations. Vessels have remained at anchor here with winds of up to 50 knots. The bottom consists of patches of boulder-strewn medium sand lying between areas of rocky outcrops. The center of the anchorage, which has a depth of 22m, lies 0.4 mile S of Anchorage Island. Anchorage Patch, with a depth of only 12.1m, lies near the center. A wreck, with a depth of 19.8m, lies about 200m NE of this patch. The inshore limits of the anchorage are formed by O'Gorman Rocks, a rocky shoal area, which has a depth of only 1.3m. The W limits of the anchorage are formed by Newman Shoal, which dries 0.3m, lying 0.6 mile W of Torckler Rocks. A shoal, with a depth of 0.4m, lies about 200m S of Anchorage Island.

4.40 Thala Rock (68˚33'S., 77˚53'E.) is reported to lie, position approximate, about 0.3 mile W of the S extremity of Turner Island. This rock presents a danger to vessels approaching from the N.

Beacons, constructed of drums welded together, stand at the N end of Gardner Island, on the summit of Turner Island, and on the N end Torckler Rock. These drums are rusted and are hard to distinguish against the surrounding hillsides. Another beacon, cross-shaped, stands on the S summit of Anchorage Island. A small wharf, situated close S of the station buildings, can be used by small craft. It is constructed from boulders and earth fill. Amphibious vehicles can land over the beach lying adjacent to this wharf.

Caution.—Care should be taken when approaching Davis Station as many large icebergs may be encountered to the W of a line extending between Keuken Island and Barratt Island. The area lying to the E of this line may contain numerous small icebergs, bergy bits, and large quantities of brash ice. Local knowledge is required when approaching this base.

A local magnetic anomaly has been reported to exist in the vicinity of Davis Anchorage.

4.41 The **Svenner Islands** (69˚02'S., 76˚50'E.), a group of ten, lie 11 miles from the continental ice. An area of foul ground lies about 10 miles N of this group of small islands. The Sostrene Islands, consisting of two rounded islands, lie about 25 miles SW of the Svenner Islands and about 3 miles from the coast.

The main coast located opposite the Sostrene Islands trends SW for 45 miles to Mount Caroline Mikkelsen. From this peak, the coast extends N and forms Sandefjord Ice Bay, at the head of MacKenzie Bay. An island, known as Kista Rock, is the S in a chain of small islands which extends in a N/S direction within Sandefjord Bay. This island is reported to lie about 1 mile N of Mount Caroline Mikkelsen.

The Lars Christensen Coast is considered to be that part of the continent lying between the Murray Monolith and the head of the Amery Ice Shelf.

MacKenzie Bay, which indents the Lars Christensen Coast, is entered between the Amery Ice Shelf and Cape Darnley. On the W side of this bay, the ice slopes upward to a height of 274m high and is very crevassed. It then rises more sharply to the Prince Charles Mountains.

From its W edge located in MacKenzie Bay, the Amery Ice Shelf extends S for over 190 miles. The Seylla Glacier, the Charybdis Glacier, and the Nemesis Glacier, descending from the Prince Charles Mountains, join together and discharge on to this ice shelf, about 150 miles S of Cape Darnley.

4.42 Gillock Island (70˚26'S., 71˚32'E.), the extent of which is not fully known, lies within the ice shelf and some distance off Princess Elizabeth Land.

MacRobertson Land lies near 68˚S and extends from William Scoresby Bay to Cape Darnley. It consists of high, ice-covered land through which bare peaks rise at various intervals along or near the coast. The E part of this land is ice-covered and featureless, the shore presenting ice cliffs, 18 to 43m high. The W part is bordered by coastal cliffs and rocky headlands, and fronted by numerous islands and rocks. In the S part, many high peaks project above the ice slopes of the interior.

Cape Darnley (67˚43'S., 69˚30'E.), the extremity of the Bjerko Peninsula, consists of an ice cliff, 90m high, behind which slopes rise upward to a height of about 610m. Numerous icebergs have been observed stranded up to 50 miles NE of this cape. These grounded bergs often cause congestion of the drift ice in this vicinity. A depth of 141m over a rocky bottom was reported to lie close off the seaward extremity of the cape.

From Cape Darnley, the coast extends W for about 40 miles to Point Williams. This latter point consists of a bluff which forms the E entrance point of Shallow Bay.

Shallow Bay, a small recession in the ice cliffs, is about 10 miles wide. Dingsor Dome, a snow-covered mountain, stands 10 miles SSE of Cape Williams and is 792m high.

Murray Monolith, 244m high, stands 8 miles W of Cape Rouse and two rocks, awash, lie between them. Landing may be made at the foot of the W side of the monolith where the slope is not so steep. A dangerous rock is reported (1983) to lie about 5 miles NE of Cape Rouse.

4.43 Scullin Monolith (67˚47'S., 66˚42'E.) is crescent-shaped and 433m high. A reef extends N from the W extremity of the monolith, but vessels can approach it safely from the NNE.

The Gustav Bull Mountains stand 15 miles W of Scullin Monolith; several conspicuous peaks in this range rise about 5 to 7 miles S of the coast.

From Scullin Monolith, the coast extending W as far as Cape Daly is reported to be fronted by many uncharted rocks and below-water pinnacles. Shoals, with depths of less than 15m, have been reported to exist in this area. The depths vary rapidly in this vicinity and vessels are advised to exercise great care when approaching the coast.

From the Scullin Monolith, the coast extends gradually WNW for 49 miles to the Strahan Glacier. Cape Fletcher is located about midway along this stretch with Martin Reef, awash, lying within 10 miles of it. Many rocks and grounded icebergs have been observed in the vicinity of this cape. Foul ground has been reported to lie between 25 and 35 miles NNE of the cape.

The Strahan Glacier descends to the sea and calves numerous icebergs which, together with drifting bergs, usually congest Nilsen Bay, which lies close W. Many bergs ground within the bay. Stevens Rock, small and bare, lies 2 miles E of the Strahan Glacier and is 7m high. Storegg Bank lies about 30 miles N of the Strahan Glacier.

From the Strahan Glacier, the coast extends W, in a gradual convex arc, for 42 miles to Horseshoe Harbor. Cape Daly, an ice-covered promontory, is located about midway along this stretch. It is inconspicuous except when viewed from W and NW.

Several groups of snow-free islands lie within 15 miles NW of Cape Daly. These include the Thorgaut Islands, the Robinson Islands, and the Douglas Islands. The latter group, which rises to a height of 18m, is the outermost.

Holme Bay is entered between Gibbney Island and an unnamed point, 19 miles E. This bay is obstructed by a large number of scattered islands and rocks. A group of islands, known as the Rookery Islands, lies 2 miles offshore on the W side of the bay.

4.44 Mawson Station (67˚36'S., 62˚52'E.), an Australian scientific base, is situated at the head of Horseshoe Harbor and is permanently manned. This base consists of about 48 buildings and includes a power station, an aircraft hangar, a radio station, several garages for transport, a clinic, several laboratories, and living quarters.

Horseshoe Harbor may be approached through Holme Bay and Kista Strait, on the W side of which lie the Flat Islands and Moller Bank. Welch Rocks, Welch Island, and a group known as the Jocelyn Islands lie on the E side. The latter group consists of Verner Island, Petersen Island, Teyssier Island, and Lee Island. Anchorage may be obtained by small vessels, in a depth of 73m, within the harbor, which is about 0.2 mile wide. Entrance Island, 0.2 mile long, lies across the N side of the harbor and Entrance Shoal, with a depth of 7.9m, lies about 200m W of it. Local knowledge is essential for entering the harbor and approaching the station. Vessels are advised to contact the base by radio before attempting to enter.

Falla Bluff, a prominent headland, is located at the head of Utstikkar Bay. It is rocky, steep, and 366m high. Cape Simpson, a conspicuous and rocky bluff, is located at the N extremity of Ufs Island, 10 miles NW of this headland.

Byrd Head, a rocky and conspicuous outcrop, is located 2.5 miles WNW of Cape Simpson and is 366m high. Howard Bay lies between Byrd Head and Cape Simpson.

Cape Bruce, a bold and conspicuous bluff, is located 6 miles NW of Byrd Head. It is 184m high and forms the E entrance point of Oom Bay.

Oom Bay, about 2 miles wide, affords good shelter. However, several islands lie off the entrance and stranded icebergs have been observed in their vicinity. Landing may be made on shelving beaches fringing the lee sides of some of the islands.

Campbell Head, 182m high, is located 3 miles WNW of Cape Bruce. It consists of a bold, conspicuous promontory and forms the W entrance point of Oom Bay. Two small islands lie close off this promontory and a bay, which is filled by a glacier, lies on its W side.

The Kemp Coast extends between the head of Edward VII Bay and William Scoresby Bay. This coast consists of ice cliffs that are occasionally indented by bays. Except to the E of Cape Wilkins, mostly no bare rock is visible. Until recent years, heavy drift ice has rendered this coast inaccessible to vessels.

From Campbell Head, the ice-covered coast extends W for 20 miles to Trethewry Point, a rocky promontory projecting about 1 mile N from the coast. Rocky islands lie 0.5 mile E and close W of the seaward extremity of this point.

Numerous islands front the coast to the E of William Scoresby Bay. Dales Island, 50m high, lies 13 miles N of **Trethewry Point** (67˚24'S., 59˚47'E.). The Warnock Islands and Farrington Island lie 1 mile S and 4.5 miles SSW, respectively, of Dales Island. The Twins, two islands, lie 1.5 miles E of Farrington Island.

The William Scoresby Archipelago, which consists of numerous small and ice-free islands, extends for about 10 miles in a NE/SW direction between Farrington Island and the mainland coast to the S.

4.45 The **Sheehan Islands** (67˚22'S., 59˚46'E.), two in number, lie 1 mile N of Trethewry Point and at the E end of another group. These islands, which are separated by a narrow strait, are 0.5 mile long and have steep, rocky slopes with a rugged outline. Islay Island, 3 miles long and 1 mile wide, lies close W of the Sheehan Islands. Hum Island lies 0.8 mile SW of McDonald Point, the E extremity of Islay Island. Couling Island, 114m high, lies 0.5 mile N of Islay Island.

Macfie Sound separates the SW portion of William Scoresby Archipelago from Bertha Island. This sound extends in an E/W direction and is about 1 mile wide. A sounding of 183m, with no bottom, was observed in the E part of the entrance to this sound, midway between Sheehan Island and Trethewry Point.

William Scoresby Bay is entered between Green Point and Hope Point. Bertha Island, which is low at its E end and 122m high at its W end, is formed of fine-grained gneiss-like rock of a lightish-brown hue. The island also has many intrusions of a darker, igneous rock and a remarkable quantity of garnets. These rocks show the effects of severe wind erosion, being weathered into fantastic shapes.

The head of William Scoresby Bay is reported to consist of two coves, separated by a tongue of ice. No suitable anchorage has been found within this bay, but it affords excellent shelter in any weather and a landing may be made in several places. The shores of the bay are backed by hills, up to 213m high.

4.46 Cape Wilkins (67˚15'S., 59˚18'E.) is located 6 miles NW of Green Point and forms the NW extremity of Fold Island. The Tillett Islands lie 6 miles N of this cape.

Stefansson Bay lies close W of Cape Wilkins. This bay is about three times the size of William Scoresby Bay and is open to the N.

The Kemp Coast extends to the W of Stefansson Bay and consists of a series of dark, bold headlands, up to about 180m high. The continental ice flows to the sea between these headlands. The inland ice rises gently to an even skyline, which is broken only by Kemp Peak, 340m high, standing 16 miles SW of Cape Wilkins.

The Law Islands lie on the W side of the entrance to Stefansson Bay, 5 miles W of Cape Wilkins. Blackrock Head, a conspicuous and rocky outcrop, is located on the mainland behind these islands, 7 miles W of Cape Wilkins.

From Blackrock Head, the coast trends NW for 3 miles to a bold headland, 180m high.

4.47 West Stack (67˚03'S., 58˚03'E.), a rocky outcrop, is located 3 miles NW of East Stack. From this outcrop, the coast

projects SSW in the form of a rocky bluff. Edward VIII Bay, about 12 miles wide, is entered about 20 miles NW of West Stack. This bay lies between the Oygarden Group, on the S side, and the Austnes Peninsula, on the N. The Oygarden Group, a chain of rocky and irregular islands, extends for 17 miles in a E/W direction close off the mainland. Kvarsnes Foreland, a prominent and rocky headland, is located on the S shore of the bay and is 107m high.

Cape Boothby, rounded and prominent, is located 8 miles N of the entrance to Edward VII Bay. This cape is fronted by below-water rocks which extend up to 2 miles seaward.

Kloa Point, a prominent promontory, projects about 1 mile E from the coast. It was reported (1961) that a dangerous rock lies about 1.3 miles NNW of this point.

Rayner Peak stands 60 miles WSW of West Stack; low, ice-covered land extends N for some distance from it. Several peaks, up to 457m high, stand to the W of Cape Boothby.

From Cape Boothby, the coast extends NW for 13 miles to Cape Davis and consists of an unbroken ice cliff, 18 to 36m high.

Magnet Bay (66˚22'S., 56˚20'E.), about 8 miles wide, lies 9 miles WNW of Cape Davis. The Galten Islands lie close off the E entrance point of this bay. The shore of the bay does not recede deeply into the land. Several prominent and rocky outcrops project from the head of this bay. The peaks of the Nicholas Range rise 10 miles S of the bay. Cape Borley is located 48 miles NW of Cape Davis.

4.48 Enderby Land (67˚30'S., 53˚00'E.), extending between 45˚E and Edward VII Bay, was discovered by Biscoe in 1831. It is covered by an ice sheet, above which stand sev-eral conspicuous mountain ranges.

The continental shelf is clearly defined in this vicinity. It extends 15 to 25 miles seaward of Enderby Land and has depths of 149 to 200m. Lines of grounded icebergs have been observed at intervals in this vicinity and these greatly influence the movements of the coastal drift ice. Prevailing winds and swells often drive the ice near to the land.

In summer, gales from between NE and E are not uncommon in this area, but, at other times, they blow with great violence from between S and SE. In summer, a persistent swell is reported to set toward the land from between N and NW. During the summer, the current in this area is reported to set W at a rate of about 7 miles per day.

From Cape Borley, the ice cliffs extend W for 14 miles to Doyle Point. Conradi Peak, 1,040m high, stands 15 miles SW of Doyle Point. From this point, the coast extends WSW for 5 miles and then WNW for 14 miles to Cape Batterbee, a rocky outcrop fronting the face of the ice cap. Vicars Island lies 5 miles offshore, about 10 miles E of Cape Batterbee. Several small islands and one large island lie close N of this cape.

Proclamation Island (65˚51'S., 53˚41'E.) is very prominent and consists of darkish-colored rock. It has steep, rocky slopes and a rounded summit, 244m high.

The Aagaard Islands, a group of small islands, lie close W of Proclamation Island. These islands often serve to anchor the drift ice which is carried by the currents along the coast and held against the shore by the N swell.

The coast located behind the Aagaard Islands extends W for 30 miles to Cape Close. Simmers Peaks, four sharp and black peaks, stand about 7 miles S of this part of the coast and are 840m high.

From Cape Close, the coast extends SW for 35 miles to Cape Ann.

4.49 Cape Ann (66˚10'S., 51˚22'E.) is formed by a small projection in the ice cliff. Mount Biscoe, a prominent and black-colored peak, stands above this cape. This peak is 700m high, sharp, and has steep slopes.

From Cape Ann, the coast extends in a general SSW direction for 40 miles to near 50˚S where it trends S. This part of the coast is usually fringed by dense drift ice.

White Island, the limits of which have not been fully defined, lies N of the Sakellari Peninsula, from which it is separated by Styles Strait.

Casey Bay, about 25 miles wide, indents the coast SW of the Sakellari Peninsula. Pinn Island and a number of smaller islands lie at the head of this bay. Alasheyev Bight lies W of Casey Bay and is separated from it by a promontory, 25 miles wide.

Molodezhnaya Station (67˚40'S., 45˚51'E.) is the main Russian research base. It is permanently manned and includes a meteorological station and an airfield.

Spooner Bay, which lies in the SE corner of Alasheyev Bight, was entered by a vessel for the first time in 1961. It is reported that this bay is backed by a number of reddish-tinged, rocky hills. The E side of the bay consists of a vertical face of black rock with an organ-pipe formation, 100m high.

Queen Maud Land extends between Coats Land and Enderby Land. Very little exposed rock lies near the coast of this land and the shore is mostly formed by high cliffs of continental ice or shelf ice. Depths of 1,646m were reported to lie at the edge of the ice and indicated that the shelf was floating and that the edge of the land mass was located still some distance to the S.

The E coast of Lutzow-Holm Bay is formed by a vast ice sheet which slopes gently W to the sea and terminates in an ice cliff, 20m high. Numerous bare, rocky areas, some of which are quite extensive, protrude through this ice sheet. Many islands fringe this part of the coast, which extends S to 70˚S.

4.50 The **Flatvaer Islands** (69˚01'S., 39˚33'E.), a group which includes Ongul Island, lie 3 miles offshore, near the E entrance point of Lutzow-Holm Bay. The islands are hilly, 30 to 49m high, and are filled by small ponds, which are ice-free during the summer.

Syowa Station (69˚00'S., 39˚35'E.), a main Japanese base, is situated within a bay on the NE side of Ongul Island and is permanently manned.

From the head of Lutzow-Holm Bay, the W shore of the bay extends N for 30 miles to an unnamed point. Padda Island, 255m high, lies 5 miles N of this point.

The coast then extends in a general NW direction for about 110 miles to the N extremity of the Riiser-Larsen Peninsula.

The Prince Harald Coast was discovered by air in 1937 and is considered to extend between the N extremity of the Riiser-Larsen Peninsula, in 34˚E, and the mainland in the vicinity of the Flatvaer Islands, in 40˚E. A chain of reddish-colored, ice-free mountains is reported to stand along this coast.

The Riiser-Larsen Peninsula to Cape Norvegia

4.51 The Princess Ragnhild Coast, discovered by air in 1931, is considered to extend between 20˚30'E and 34˚00'E. This coast consists of a continuous ice cliff with high mountain ranges rising in the interior. The Riiser-Larsen Peninsula separates the Princess Ragnhild Coast from the Prince Harald Coast.

Gunnerus Bank lies off the Riiser-Larsen Peninsula. It extends about 120 miles seaward and has a least known depth of 421m. This bank drops abruptly off to depths of over 1,800m at its W side, but slopes gradually on its E side.

From the NE end of the Riiser-Larsen Peninsula, the coast extends W for 20 miles and forms the N shore of a broad peninsula. The ice-covered land in this vicinity is devoid of nunataks or bare outcrops. From this latter peninsula, the coast extends SW for about 250 miles in the form of high ice cliffs to 23˚'E. It then extends W to 20˚E.

Breid Bay (70˚15'S., 24˚15'E.), about 20 miles wide, indents the ice cliffs and recedes S for about 15 miles. This bay is reported to have a least depth of 187m. The former Roi Boudouin Station, which was closed in 1967, was situated on the S side of this bay.

The Sor Rondane Mountains, up to 3,460m high, stand about 75 miles S of Breid Bay. From the coast in the vicinity of the bay, the ice-covered land rises gradually to a height of about 700m high at the base of these mountains. The ice in this vicinity, including Godel Ice Port, was reported (1960) to extend to about 70˚05'S.

The Princess Astrid Coast, discovered by sea in 1931, is considered to extend between 5˚E and 20˚E.

4.52 **Novolazerevskaya Station** (70˚46'S., 11˚50'E.), a permanently-manned Russian scientific base, and **Georg Forster Station** (70˚46'S., 11˚50'E.), a permanently-manned German scientific base, are situated along this coast. A coastal radio station is situated at the former base.

From the latter station, the land mass extends 180 miles SW and rises fairly evenly to the Wohlthat Mountains, which are 4,300m high.

The Princess Martha Coast is considered to extend between 5˚E and 20˚W. It is fronted by a cliffed ice face, 21 to 36m high. The W part of this coast consists of low continental ice without any nunataks. The E part consists of slopes rising to the Maudheimvidda Mountains, which are over 3,000m high.

At position 70˚00'S, 00˚30'W, a tongue of ice projects N for about 65 miles and varies in width from about 55 miles at its base to about 25 miles at its seaward end. This tongue has been determined to be afloat with depths of over 2,000m lying near its edge. Many icebergs have been observed packed up against this ice tongue in a chaotic mass. These bergs are apparently carried by the coastal current.

4.53 **Byrd Ice Port** (69˚34'S., 00˚41'W.), an indentation, lies on the W side of a tongue of ice which projects N from the Fimbul Ice Shelf. This ice port was reported (1964) to be about 5 miles wide and to be fringed by ice cliffs, 6 to 18m high. Several islands were reported to lie within this tongue of ice.

From Byrd Ice Port, the ice tongue continues SW for about 20 miles to the mouth of an unnamed ice port. This latter ice port is about 13 miles wide and depths of 263 to 2,295m have been reported to lie within its entrance. The shelf then extends SSW for about 18 miles where it is interrupted by a stretch of the Princess Martha Coast, 17 miles long, which is not fronted by a shelf.

Sanae Station (70˚18'S., 02˚22'W.), a South African base, is situated near the NE extremity of a peninsula which separates the Jelburt Ice Shelf from the Fimbul Ice Shelf.

From the E entrance point of **Norsel Ice Port** (71˚01'S., 11˚00'W.), the shelf was reported (1964) to extend 140 miles ENE to the W end of a peninsula which forms the E side of the Jelbart Ice Shelf. An island lies close off the W side of the Jelbert Ice Shelf.

Atka Ice Port (70˚35'S., 07˚51'W.) is 15 miles wide at its entrance and was reported (1982) to extend for about 14 miles S into the shelf. It was reported (1955) that wave action had undercut the shelf in numerous places and several underwater ice rams projected up to 30m seaward. The shelf within the ice port is 4 to 12m high. A depth of 50m was reported to lie close to the ice front in the SW part of this ice port.

4.54 **Georg Von Neumayer Station** (70˚39'S., 08˚15'W.), a permanently-manned German scientific base, is situated close W of Atka Ice Port. Anchorage may be obtained, in a depth of 147m, off the W side of Atka Ice Port and also, in a depth of 73m, within its SW corner. Vessels, with icebreaker assistance, can usually reach Atka Ice Port by approaching it between 15˚W and 5˚W and then proceeding along the ice front.

Norsel Ice Port, an inlet on the shelf, lies 32 miles NE of Cape Norvegia and was reported (1961) to be 5 miles wide. It was the unloading point for Maudheim Bay during the Norwegian-Swedish-British Expedition of 1950, when the depth alongside was reported to be 393m.

Druzhnaya-3 (71˚06'S., 10˚49'W.), a Russian base, is manned during the summer.

Svea Station (74˚35'S., 11˚13'W.), a Swedish base, is situated about 200 miles S of Cape Norvegia and is manned during the summer.

Between the W limit of the Princess Martha Coast and Cape Norvegia, 215 miles NE, the coast is fronted by an ice shelf about 50 miles wide.

Cape Norvegia (71˚20'S., 12˚18'W.) forms an angle in the coast; on its W side lies a bight known as Seal Bay. Two small islands lie on the SW side of this bay. The cape is fronted by an ice shelf, about 50 miles wide.

How to use the Index—Gazetteer

Geographic names of navigational features are generally those used by the nation having sovereignty and are listed alphabetically. Diacritical marks, such as accents, cedillas, and circumflexes, which are related to specific letters in certain foreign languages, are not used in the interest of typographical simplicity.

Geographic names or their spellings do not necessarily reflect recognition of the political status of an area by the United States Government. Positions are approximate and are intended merely as locators to facilitate reference to the charts.

To use as a Gazetteer note the position and Sector number of the feature and refer to the Chart Information diagram for the Sector. Plot the approximate position of the feature on this diagram and note the approximate chart number.

To use as an Index of features described in the text note the paragraph number at the right. To locate this feature on the best scale chart use the Gazetteer procedure above.

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