INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS

No 26. May 1967

SCAR

SCIENTIFIC COMMITTEE ON ANTARCTIC RESEARCH

BULLETIN

ARGENTINA AUSTRALIA BELGIUM

CHILE FRANCE JAPAN NEW ZEALAND

NORWAY SOUTH AFRICA UNITED KINGDOM

UNION OF SOVIET SOCIALIST REPUBLICS

UNITED STATES OF AMERICA

PUBLISHED BY

SCOTT POLAR RESEARCH INSTITUTE, CAMBRIDGE ENGLAND

INSTITUTO ANTARTICO ARGENTINO, BUENOS AIRES, ARGENTINA

Reprinted from *Polar Record*, Vol 13, No 86, 1967, p 549–583.

The Polar Record, Vol 13, *No* 86, 1967, *p* 703–37
Printed in Great Britain

SCAR BULLETIN

No. 26, May 1967

REPORT ON GEODETIC AND CARTOGRAPHIC ACTIVITIES, 1960–65

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CONTENTS

Introduction

The survey and mapping achievements of the SCAR nations during the IGY period (1955–56 to 1959–60) are summarized in the chapter on Cartography of the Antarctic volume of the *Annals of the IGY*, (in press).

The review of activities presented in this paper covers the five years which have elapsed since the end of the IGY period, including the 1964–65 summer field season. The report has been compiled from contributions received from members of the SCAR Working Group on Geodesy and Cartography, National Reports to SCAR, and miscellaneous sources of information.

A list of relevant Recommendations made at the Fourth, Fifth and Eighth Meetings of SCAR is given at the end of this report.

Index maps show the air photography, ground control and major oversnow traverses achieved by each nation, and the sheet lines of, or notes referring to, maps and charts published as first or revised editions. General maps and charts of the whole continent are not shown, but reference to these is made in the text.

The 1960–65 period has seen marked increases in map production, air photography coverage, and in the networks of survey control points. All known exposed rock features have been photographed from aircraft, although not all such photography is of mapping quality. The increased use of electronic distance measurement equipment has been a major factor in the establishment of the now large number of mapping control points; similarly, radio-altimeter heighting from aircraft has been proved to be a rapid and acceptably accurate technique for determining elevations of the ice sheet, particularly in the inland regions.

In the fields of hydrography and oceanography a wealth of data has been amassed during re-supply voyages and by ships engaged on special missions. Detailed hydrographic surveys have been carried out at most coastal bases and along other stretches of the coast.

* Secretary, SCAR Working Group on Geodesy and Cartography. In view of the political situation under the Antarctic Treaty, no consistent editorial policy for place-names is possible in the *SCAR Bulletin*. Ed.

Many new gravity stations were occupied during the period under review, and an increased number of ties were made to the world network. The continental gravity network was greatly strengthened by the linkage of regional nets.

Magnetic surveys made by the many traverse parties have been very useful for correcting magnetic charts, and for research on secular variation which is exceptionally large and complicated in Antarctica.

National activities

ARGENTINA

Geodetic and topographical surveys (Index Map No 1)

As part of a glaciological project a traverse from "Ellsworth" station to the vicinity of Moltke Nunataks (lat 77° 58′ S, long 35° 30′ W) in March 1961 repeated the triangulation accomplished in December 1957 between "General Belgrano" station and Salta refuge (lat 78° 01′ S, 35° 48′ W).

During the 1961–62 season a number of astronomical fixes were made along a glaciological traverse between "Ellsworth" and "General Belgrano" stations. Topographical observations were made throughout a journey from "Esperanza" station (Hope Bay) to "General San Martín" station in Marguerite Bay. This traverse route was along the sea ice to "Teniente Matienzo", thence to the southern end of Bowman Coast and over the peninsula to Marguerite Bay, a journey of some 850 km (528 miles).

From October 1962 to January 1963 a triangulation, comprising sixteen stations, was carried out between "General Belgrano" and "Ellsworth" stations. This work was a continuation of the 1957 triangulation from Moltke Nunataks to "General Belgrano". Local topographic surveys were made in the vicinity of "Orcadas", "Esperanza", "Teniente Matienzo" and "General Belgrano" stations.

Between 27 July and 17 September 1963 topographic survey work was done along a traverse of 585 km (364 miles) in the region south-westward of "Esperanza" station. During 1963 local survey work was continued at "Orcadas", "Esperanza", "General Belgrano", "Decepción" and "Teniente Matienzo" stations.

During the 1963–64 summer season a surveyor and a glaciologist worked on the Filchner Ice Shelf, and in the area around Moltke Nunataks and Bertrab Nunatak (lat 77° 55′ S, long 34° 30′ W). An expedition ship made a radar survey of the Filchner Ice Front.

The 1964–65 programme included topographic surveys at "General Belgrano", "Decepción" and "Esperanza" stations, and at Moltke Nunataks, Bertrab Nunatak, Robertson Island (lat 65° 10′ S, long 59° 40′ W), Paradise Harbour (lat 64° 51′ S, long 62° 54′ W) and Cape Longing (lat 64° 33′ S, long 58° 50′ W).

Hydrography and oceanography

Ships of the Grupo Naval Antártico (included in which are the surveying ship *Chiriguano* and oceanographic ships *Cápitan Cánepa* and *Comandante General*

Zapiola) have carried out extensive hydrographic and oceanographic programmes each summer season.

In the 1959–60 period tide gauge readings were taken at "Almirante Brown", "Melchior" and "Esperanza" stations.

During 1960, bathymetry formed part of the oceanographic activities in the northern part of Drake Passage, between positions lat 54° 49′ S, long 68° 13′ W and lat 59° 40′ S, long 73° 50′ W. The surveying ship *Chiriguano* worked in the Archipiélago Melchior area during the 1960–61 summer, and further tide gauge readings were obtained at "Melchior" and "Esperanza". The latter work was continued at "Esperanza" during 1961 and the 1961–62 summer.

In March 1962, the oceanographic ship *Capitán Cánepa* made surface and deep current measurements in Drake Passage using the "Swallow" current meter. A second ship, the icebreaker *General San Martín*, obtained bathymetric and other oceanographic data in the eastern and north-east parts of the Weddell Sea, in the area between Hope Bay and Robertson Island, and at Scotia Bay (South Orkney Islands). Ships going to and from Antarctica took sea temperature readings to delineate the Antarctic Convergence.

From December 1962 to January 1963 the oceanographic ship *Comandante General Zapiola* worked in Drake Passage. Servicio de Hidrografía Naval collaborated with the Texas Agricultural and Mechanical College (Department of Oceanography and Meteorology) on a programme which included the study of deep currents and geophysical observations, and bathymetry.

In March 1963 the *Comandante General Zapiola* operated in Drake Passage and Bellingshausen Sea. Servicio de Hidrografía Naval and the Lamont Geological Observatory, University of Columbia, New York, co-operated in oceanographic activities among which were bathymetry and geomagnetism.

During the latter half of 1963, oceanographic operations in Drake Passage were continued by *Comandante General Zapiola* and *Capitán Cánepa*. In 1963–64 summer season "General San Martín" worked in the Weddell Sea and Drake Passage.

An automatic tide guage was used to record heights of the tide at "Esperanza" station during 1963 and the 1963–64 summer.

The transport vessel *Bahía Aguirre* carried out a programme of hydrography in Mar de la Flota (Bransfield Strait) and in Gerlache Strait. The *General San Martín* obtained oceanographic data in these areas, and in Bismarck Strait, Marguerite Bay and the waters around Peter I Øy.

Geomagnetism

Geomagnetic readings have been taken by the ships engaged in oceanography, and at the scientific stations "Orcadas", "Ellsworth", "Decepción", "Esperanza", "Melchior", "Teniente Camara" and "Almirante Brown".

Map and chart production (Index Map No 1)

New editions of hydrographic charts Nos 110 (Península Antártica) and 129 (Archipiélago de Palmer y Estrechos de Bismarck y de Gerlache) were published in 1963 and 1964 respectively.

Two large-scale first editions were published in 1964:

H-771 Canales Peltier y Neumayer
H-772 Archipiélago Biscoe: Fondeadero Rosalena (Islas Avellaneda)

A 1:10000000 scale topographic map of Argentina, published in 1961, shows the Antarctic regions lying to the south of South America, between the Ross Sea and Prinsesse Astrid Kyst.

AUSTRALIA

Geodetic and topographical surveys (Index Map No 2)

During March and April 1960 the surveyor based at Mawson carried out a barometric heighting traverse along the route of a dog sledge journey of 242 km (150 miles) from Cape Batterbee (lat 65° 51′ S, long 53° 48′ E) to Edward VIII Gulf via the Napier Mountains, and obtained three astro-fixes for mapping control. Later in 1960, four astro-fixes were taken in western Enderby Land, and one in the southern Prince Charles Mountains.

Operating from Mawson, the Dakota aircraft equipped with a Wild RC9 camera (vertical) and Fairchild K17 cameras (oblique), obtained vertical and trimetrogon photography over Framnes Mountains, the coastal regions east and west of Mawson, Munro Kerr Mountains and Larsemann Hills (south coast of Prydz Bay), parts of the Prince Charles Mountains, and Grove Nunataks (lat 72° 53′ S, long 74° 53′ E). Radar-altimeter heighting was carried out in the course of a round flight of some 1530 km (950 miles) over the ice sheet south-west of Mawson, along a flight from Mawson to Prydz Bay, and from Davis station to Grove Mountains.

During the 1960–61 summer season *Magga Dan* carried a Beaver aircraft which flew trimetrogon photography (K17 cameras) over Banzare Coast between Cape Southard and Cape Goodenough. Astro-fixes were taken at the Henry Islands (lat 66° 49′ S, long 120° 37′ E) and in Davies Bay (lat 69° 20′ S, long 158° 38′ E). The second expedition ship, M.V. *Thala Dan*, obtained astro-fixes on the west coast of Enderby Land and at the eastern end of Kronprins Olav Kyst.

There was no field survey activity between March 1961 and December 1961.

For the 1961–62 summer operations *Thala Dan* carried a Beaver aircraft and two small helicopters. Trimetrogon photography and radar-altimeter heighting flights were made over coastal regions between Vincennes Bay and the western boundary of Terre Adélie, along the coast of George V Land between Mertz Glacier and Cape Freshfield, and over the coastal mountains of Oates Land and northern Victoria Land between longs 155° E and 169 °E. Astro-fixes were taken at six coastal features to provide ground control for the air photography. During the relief of Mawson Station, tellurometers were used to extend the existing triangulation of the coast and islands to Mount Henderson and north Masson Range in the Framnes Mountains.

In 1962, the heights of the Framnes Mountains triangulation stations were determined by spirit levelling. The surveyor led a survey/glaciological traverse from Mawson to the Amery Ice Shelf; barometric heighting was carried out along the route, and mapping control was established by astro-fixes at Mount Rivett

(lat 67° 51′ S, long 66° 15′ E), Church Mountain (lat 68° 02′ S, long 66° 05′ E) and Anniversary Nunataks (lat 68° 03′ S, long 63° 00′ E). Barometric heights were recorded along the ANARE seismic traverse of 1430 km (888 miles) from Wilkes to "Vostok", and along shorter traverses radiating south, south-east and east from Wilkes.

The 1962–63 summer programme of air photography and radar-altimeter heighting covered stretches of Knox, Budd, Sabrina, Banzare and Wilkes Coasts. Astro-fixes were taken at Cape Goodenough (lat 66° 15′ S, long 126° 10′ E) and at Penguin Point (lat 67° 38′ S, long 146° 14′ E). During the change-over period at Wilkes, surveyors carried out a trilateration over the northern Windmill Islands, and a tellurometer traverse for 32 km (20 miles) eastward from Wilkes. In the same period *Nella Dan* delineated the Amery Ice Front by a radar plot controlled by astro-fixes.

In the spring of 1963, barometric heighting was carried out along an over-snow traverse from Davis to the Polar Record Glacier.

In 1964, local triangulation was carried out in the southern part of Newcomb Bay to provide control for hydrographic work. A large-scale survey was made at the site chosen for a new station to replace Wilkes station. Astro-fixes were taken at the satellite station "S2", 80 km (50 miles) east-south-east of Wilkes; on the highest part of the large ice dome in lat 66° 45′ S, long 112° 40′ E; and at Cape Poinsett. Barometric heights were recorded along some 1585 km (985 miles) of traverses east and south-east of Wilkes. In the Mawson area, four stations in the Framnes Mountains were beaconed as preparation for tellurometer traverses to the west and south.

During January and February 1965, a tellurometer traverse was run for some 550 km (344 miles) from Mawson to Mount Mueller (lat 66° 55′ S, long 55° 33′ E) via Framnes Mountains, Baillieu Peak, Hansen Mountains, Leckie Range and Rayner Peak. Prominent features along the route were fixed by theodolite angles and/or terrestrial photography. Survey parties were transported by a ship-borne Beaver aircraft and two Bell 47-G2 helicopters. Tellurometers MRA3 Mark III and Wild T3 theodolites were used for the survey. In the same period, the aircraft flew trimetrogon photography over the northern Prince Charles Mountains, the coast and islands between Mawson and Edward VIII Gulf, and over the Schwartz Range, Rayner Peak and Leckie Range mountain groups.

Hydrography

Local hydrographic surveys were made at Davis and Mawson during the change-over period at each station January–February 1961. The surveys covered the anchorages and seaward approaches.

The western approaches to Wilkes, and Newcomb Bay, were surveyed in January 1962.

In February 1965, a large-scale survey was made of the near approaches to the site of the Wilkes replacement station, on the south coast of Newcomb Bay.

Several thousand nautical miles of ocean soundings have been recorded by the expedition ships each summer season, in coastal waters between longs 44° E and 166° E and in the waters around Heard Island and Macquarie Island.

Gravity

A United States scientist with the 1960–61 ANARE summer expedition took readings at Mirny, Mawson, Davis, Heard Island, Archipel de Kerguelen and at four coastal stations in Enderby Land. Gulf-Wisconsin pendulum apparatus was used at Mirny and Mawson, a La Coste-Romberg gravimeter at the other stations. A Mawson-Mirny-Melbourne tie was established.

The 1962 expedition at Wilkes, using Worden gravimeters, took readings: (*a*) at 470 stations along the seismic traverse Wilkes–Vostok, (*b*) at 84 stations along a traverse of 190 km (118 miles) south-eastward from Wilkes, and (*c*) at 26 stations in a gravity survey of the Windmill Islands. A 1962–63 summer expedition established the gravity tie Wilkes–Lewis Island–Chick Island–Macquarie Island–Melbourne.

In 1963, observations were made at approximately 5 km (3 miles) intervals along traverses of 480 km (298 miles) and 160 km (100 miles) east-south-east and east from Wilkes, respectively.

Further work was done in the Wilkes area during 1964, along 483 km (300 miles) of traverses over the large ice dome in lat 66° 45′ S, long 11° 40′ E.

Geomagnetism

Regular geomagnetic readings have been taken at Mawson, Wilkes and Macquarie Island throughout the period 1960–65.

The 1960–61 summer expeditions made field observations at Davis, Heard Island, Chick Island, Enderby Land coast (3 stations) and Oates Land coast (2 stations).

The 1961–62 summer expeditions re-occupied magnetic stations at Davis, Lewis Island, Chick Island and Commonwealth Bay. Four new stations were established on the coast of Oates Land.

Observations for H, D and Z were made at intervals of 48 km (30 miles) along the 1962 Wilkes-"Vostok" traverse.

The 1962–63 summer expedition re-occupied Davis and Heard Island magnetic stations and established a new station on the Amery Ice Shelf.

A 1963 traverse of 480 km (298 miles) east-south-east from Wilkes took observations of H, D and Z at 80 km (50 miles) intervals.

Map and chart production (Index Map No 3)

From 1960 to 1965 the Division of National Mapping published six maps in the 1:250000 scale series. The sheets cover much of the mountain regions in Enderby Land, and the Mawson area. In addition to these, twenty 1:250000 sheets were compiled at 1:100000 scale. These compilations cover the coastal regions between longs 42° E and 69° E, part of the northern Prince Charles Mountains, and Grove Mountains.

Two non-series maps were published:

1963 Framnes Mountains (1:100000)
1964 Heard Island (1:50000)

Throughout the period under review, 19 compilation sheets at 1:1000000,

and 46 sheets at 1:500000, were revised whenever new air photography, ground control and other survey data became available.

The Hydrographic Service, Royal Australian Navy, published large-scale charts for Mawson, Davis and Wilkes anchorages and approaches, and an ocean navigation chart at 1:8500000 with limits lats 31° S to 72° S, longs 43° E to 173° E.

A second edition of the *Gazetteer of Australian Antarctic Territory* was published in 1965.

BELGIUM

Geodetic and topographical surveys (Index Map No 4)

From October 1959 to May 1960 a sledging party from "Base Roi Baudouin" surveyed approximately 8000 sq km (3090 sq miles) of western Sör-Rondane. This work was continued during the period September 1960 to January 1961. When operations were completed, 39 triangulation stations had been established between the western nunataks of Sör-Rondane and Byrdbreen (lat 72° S, long 26° E). Two astro-fixes were taken on Princesse Ragnhild Kyst, and one on Mount Rossell (Belgicafjella).

The survey parties carried out trigonometric and barometric heighting in the Sör-Rondane area and along their routes from "Base Roi Baudouin". Heights were reduced to mean sea level at Breidvika.

In the summer of 1959–60 an air photography programme ("Operation Iris 60") was carried out by a de Haviland Otter aircraft equipped with a Wild RC5a vertical camera (19 cm × 13 cm format). and two Williamson oblique cameras (13 cm × 13 cm format). Flights were made along 750 km (466 miles) of coast between longs 12° E and 34° E, east-west over Sör-Rondane, and over Belgicafjella (Monts Belgica). The vertical coverage amounted to 6700 sq km (2587 sq miles). In October 1960, a photographic flight was made over Dronning Fabiolafjella (Yamato Mountains).

"Base Roi Baudouin" was closed from February 1961 until the 1963–64 summer when a joint Belgian–Dutch expedition resumed operations in Dronning Maud Land. No survey work was done during their first year.

The second Belgian-Dutch expedition (1964–65) obtained air photography of eastern Sör-Rondane and commenced ground survey operations in that region. A triangulation project was started on the ice shelf near "Base Roi Baudouin", as part of a long-term programme to study relative deformation of the ice shelf.

Hydrography and oceanography

The 1959–60 summer expedition on board *Erika Dan* carried out a full programme of oceanography including ocean soundings between Cape Town and Breidvika, ocean current observations, and a hydrographic survey of Breidvika. An automatic tide guage was operated at Breidvika.

Similar work was done by the 1960–61 party in *Erika Dan*. General oceanographic and bathymetric observations were made over an area of 200 sq km (77 sq miles) in the vicinity of Breidvika and during the voyage to and from Cape Town.

Gravity

The sledge parties which operated (1959–61) south of "Base Roi Baudouin" and in western Sör-Rondane took readings at 30 stations, 17 of which were on rock. During November 1960 aircraft made some 80 flights over Sör-Rondane in the course of a gravimetric triangulation survey.

Geomagnetism

Regular readings have been taken at "Base Roi Baudouin" during its occupation.

Map production (Index Map No. 4)

L'Institut Géographique Militaire published four maps:

1960 Côte de la Princesse Astrid, Partie Est (1:250000)
1960 Côte de la Princesse Ragnhild, Partie Ouest (1:250000)
1960 Côte de la Princesse Ragnhild, Partie Est (1:250000)
1963 Monts Belgica (1:25000)

CHILE

Hydrography and oceanography

Throughout the period 1960–65 Chilean Antarctic expeditions have accomplished a considerable amount of work in the fields of hydrographic surveying (which has included geodesy and topography) and oceanographic research.

The 1960–61 expeditions carried out detailed surveys of Ensenada Rojas (Greenwich Island) and Puerto Leith (Danco Coast). Reconnaissance surveys were made at Orne Harbour, Punta Leniz and Skontorp Cove on Danco Coast; South Bay (Palmer Archipelago), and at Puerto Svend Foyn in Gerlache Strait. Bathymetry was carried out at Hugo Island (lat 64° 57′ S, long 65° 45′ W); Bransfield Strait; Marguerite Bay; Palmer Archipelago; South Shetland Islands; Argentine Islands; Gerlache Strait; Danco Coast, and along the route from Brialmont Cove (Danco Coast) to Liège Island (Palmer Archipelago). Ocean soundings were recorded along some 6940 km (3750 nautical miles) of steaming in Drake Passage, and in Bellingshausen Sea. This work was part of combined oceanographical activities by Chile and the United States of America (Operation "*Yelcho–Vema*").

In 1961–62, surveys were carried out at South Bay (Palmer Archipelago), Français Cove (Graham Coast) and Caleta Suarez, and reconnaissance survey work was done in Bismarck Strait. Bathymetry was carried out at Adelaide Island; Bahía Chile (Greenwich Island); Caleta Balleneros (Deception Island); Isla Bulnes (Bransfield Strait); Anvers Island; Neumayer Channel and Dallmann Bay (Palmer Archipelago); Paradise Harbour (Danco Coast) and adjacent channels; south coast of Isla Lautaro (Gerlache Strait); south-east coast of Wiencke Island; English Strait; Bismarck Strait; along the route from Andvord Bay to Errera Channel (Danco Coast), and from Paradise Harbour to Pendulum Cove (Deception Island). Rectification surveys were made in Bismarck Strait, Peltier Channel (Palmer Archipelago), Pendulum Cove and at Hugo Island. Tidal stream and current observations were made at Caleta Gloria

(Danco Coast), Pendulum Cove, South Bay, Puerto Soberanía (Greenwich Island) and at Covadonga Harbour in Bransfield Strait. Tide guage readings over 5 days were obtained at Français Cove. Tellurometers were used to amend the positions of Montravel Rock (Bransfield Strait) and Punta Prat (Robert Island). Again, during this summer season, the Chilean oceanographic ship *Yelcho* and the Columbia University vessel *Vema* carried out a combined oceanographical programme. Appromixately 4500 km (2425 nautical miles) of ocean soundings were taken in Drake Passage and in the waters westward of the South Shetland Islands and Palmer Archipelago.

During the 1962–63 season a further 4075 km (2200 nautical miles) of sounding lines were run in Drake Passage, and a hydrographic survey of Nelson Strait (South Shetland Islands) was completed. Other soundings were taken in Bransfield Strait; Caleta Nailon (Mitchell Cove in Robert Island); northward of Robert Island; in Lapeyrère, Fournier and Borgen Bays (Anvers Island); Grandidier Channel; between Matha Strait and Pendleton Strait (Biscoe Islands); and between Bismarck Strait and Marguerite Bay. Tide gauge readings were taken at South Bay (22 days); Rada Covadonga (23 days); and Harmony Cove, Nelson Island (15 days). A local triangulation was carried out at Covadonga Harbour.

From November 1963 to April 1964 the oceanographic ship *Yelcho* conducted oceanographic operation "Marchile III" in Drake Passage. Twenty-two lines of soundings were run (on north–south courses) between longs 53° W and 74° 30′ W, and south to lat 67° S, as a contribution to the General Bathymetric Chart of the Oceans (GEBCO). At Pendulum Cove, Deception Island, a hydrographic survey was completed, and tide guage readings were taken over a period of 29 days. Other hydrographic work was done at Caleta Nailon (Robert Island). Helicopter photography was flown over Nelson Strait to check the existence and/or position of the shoals charted in the northern entrance.

In the 1964–65 season bathymetry was included in the oceanographic operation "Marchile IV" in Drake Passage. The hydrographic programme for this season comprised surveys of Nelson Strait and Caleta Nailon, and further work in Pendulum Cove.

Gravity

Gravimetric surveys have been made at Deception Island, and over extensive areas of Tierra O'Higgins and the South Shetland Islands.

At sea, gravity readings were taken in the course of oceanographic work in Drake Passage during the 1960–61 and 1961–62 seasons.

Geomagnetism

A geomagnetic observatory was established at "Base Gabriel González Videla" in 1961. Continuous records of the components D, H and Z were kept until 1963 when the observatory was dismantled.

The 1960–61 oceanographic activities in Drake Passage included geomagnetic readings along 3400 km (1830 nautical miles) of traverse. This work was continued in 1961–62 when readings were taken along traverses totalling 4075 km (2200 nautical miles).

Chart production (Index Map No 7)

L'Instituto Hidrográfico de la Armada published two new hydrographic charts during the period:

No 1502 Canal Grandidier (1:200000)
No 1503 Estrecho Pendleton–Estrecho Matha (1:200000)

Also published were new editions of six hydrographic charts, a small-scale map of Sector Antártico Chileno, and three small-scale special maps showing magnetic variation and curves of horizontal and vertical magnetic force.

FRANCE

Geodetic and topographical surveys (Index Map No 4)

During the relief of Dumont d'Urville station, 1960–61, a survey group worked on Ile de Gouverneur, Iles des Pétrels and Pointe Géologie. Their work was done mainly for the establishment of a new station on the northern part of Ile des Pétrels, and for the construction of new landing facilities.

In 1961–62, surveyors attached to the station construction group made a survey of the area south-east of Ile des Pétrels. The survey of the coastline between Port-Martin and Rocher Janet (lat 66° 33′ S, long 139° 10′ E) was revised. Between Rocher Janet and Rocher Mathieu (lat 66° 20′ S, long 136° 49′ E) the survey was made by radar. A geodetic triangulation was completed in the region of Cap Bienvenue, and an astro-fix was obtained at Rocher Mathieu.

At Archipel de Kerguelen a survey was carried out, using tellurometers and Wild T3 theodolites. Thirteen stations, including one astronomical station, were established. Fourteen lines of from 3 to 50 km (2 to 31 miles) were measured, over a total distance of 450 km (280 miles). Alouette II helicopters were used to photograph Port-aux-Française and environs.

A survey of Ile de la Possession (Iles Crozet) was made by a party from L'Institut Géographique National, 1961–62, at 1:100000 scale. Local surveys of Port Alfred and environs were made at scales of 1:10000 and 1:5000. Tellurometers were used to measure a base-line of about 6 km (4 miles). Reconnaissance photography was flown by an Alouette II helicopter.

In the 1962–63 season field work at Archipel de Kerguelen included first-order geodesy, a reconnaissance survey of Presqu'île Ronarc'h and a radar survey of the south and east coasts. At Iles Crozet a radar survey was carried out along stretches of the coasts of Ile de l'Est, Iles aux Cochons and Iles des Apôtres.

By the end of the 1963–64 season approximately two-thirds of the air photography coverage of Archipel de Kerguelen had been completed. As in previous seasons, the photography was taken by SOM cameras (13 cm × 18 cm format, $f = 150$ cm) mounted in an Alouette II helicopter.

During the 1964–65 season at Archipel de Kerguelen eight Laplace stations were established in the Port Christmas region and a plane-table survey was made in the north-west of the area. Alouette II helicopters were used to obtain photographic coverage of Presqu'îles Loranchet and Joffre, and of Iles Foch and

Howe. A topographic survey, including air photography, was carried out at Port-aux-Français.

Hydrography

During the 1960–61 season in Terre Adélie a programme of hydrography was carried out: (*a*) in the region west of Pointe Géologie, (*b*) north-west of Ile de Gouverneur and (*c*) off the coast of Iles des Pétrels. Automatic tide gauge readings were taken at Pointe Géologie throughout January 1961.

In 1961–62 soundings were taken in the waters around l'Archipel de Pointe Géologie, Iles Dumoulin, Iles Fram, and to the north-eastward of Glacier de l'Astrolabe. Further tidal observations were made by means of an automatic tide gauge.

Gravity

In 1962–63 a Worden gravimeter was used to establish a network of 114 stations in Archipel de Kerguelen, mainly in the Peninsule Amiral Courbet Glacier Cook and Mont Ross regions. At Iles Crozet, eight stations were established on Ile de la Possession and one station on Ile aux Cochon. Both nets were linked to the world network.

Geomagnetism

Continuous geomagnetic measurements have been recorded at Dumont d'Urville and Port-aux-Français observatories during the entire period.

Field measurements were made at 38 points along a traverse of 150 km (93 miles) from Dumont d'Urville during October–December 1962.

Map and chart production (Index Map No 4)

The following maps were published by l'Institut Géographique National:

1962 Archipel de Kerguelen: Presqu'île de la Société de Géographie (1:100000); Glacier Cook (1:100000) Mont Ross (1:100000); Presqu'île Rallier du Baty (1:100000).
1963 Archipel de Kerguelen: Environs de Port-aux-Français (1:10000).
1964 Iles de Kerguelen: Carte de Reconnaissance de la Presqu'île Ronarc'h (1:10000).
1962 Iles des Crozet: Ile de la Possession (1:50000).
1962 Ile de la Possession: Région de Port Alfred (1:10000).
1962 Ile de la Possession: Mouillage de Port Alfred (1:5000)
1964 Iles Crozet; Ile de la Possession, Carte de Reconnaissance (1:50000).

In the period 1961–64 the Service Hydrographique de la Marine published the following charts:

No 5748 (3rd edition)	Iles de Kerguelen (1:250000).
No 6087 (3rd edition)	Iles de Kerguelen: Baie de Morbihan (Partie est) (1:30000).
No 5523 (4th edition)	Iles Crozet (1:516400).
No 6497 (1st edition)	Iles Crozet (1:75000).
No 5769 (2nd edition)	Ile St Paul (1:20000) Ile Amsterdam (1:70000). Iles Heard et MacDonald (1:372300)
No 6285 (2nd edition)	Terre Adélie: Du glacier du Français au glacier de l'Astrolabe (1:100879).

JAPAN

Geodetic and topographical surveys (Index Map No 8)

During November and December 1960, the Fourth Japanese Antarctic Research Expedition (JARE) made a reconnaissance survey of Dronning Fabiolafjella (Yamato Mountains) situated about 300 km (186 miles) south-west of "Syowa" station. This survey was a continuation of work commenced by the 1959 expedition. Nine triangulation stations and one astronomical station were established on rock features.

In the 1960–61 summer, the JARE ship M.V. *Soya* established two astronomical stations on Kronprins Olav Kyst, in longs 42° 13′ E and 44° 29′ E, to provide control for air photography. Later in 1961 field survey parties from "Syowa" operated in two regions: the coast between "Syowa" and Prins Harald Kyst, and along a traverse of some 890 km (553 miles) from the base to the terminal point in lat 74° 56′ S, long 38° 26′ E. Barometric heighting was carried out along the latter traverse and further mapping work was done in Dronning Fabiolafjella.

During January 1962, a Cessna-185 aircraft, equipped with a Zeiss aero-topograph RMKII camera, photographed the coast between longs 37° E and 45° E. An astronomical station was established on the east coast of Lützow-Holmbukta.

"Syowa" station was closed in February 1962. The scientific programme was resumed in 1966.

Hydrography and oceanography

Soya recorded ocean soundings and oceanographic data during her 1960–61 and 1961–62 voyages to and from Antarctica, and in the coastal waters of Enderby Land and eastern Dronning Maud Land. Similar work was carried out by *Umitaka-Maru* in the 1961–62 summer. In the oceanic waters south of lat 60° S, *Umitaka-Maru* worked between longs 25° E and 80° E.

A tidal analysis has been made from tide gauge readings recorded at "Syowa" in February–March 1961.

Gravity

The gravity value at "Syowa" was first determined by the 1958–59 expedition, and was confirmed by the 1959–60 expedition. Both expeditions used a Worden gravimeter which had a stable and relatively small drift. A gravity tie with Cape Town was established.

Measurements were made at 109 points along the 1961 traverse of 890 km (553 miles) southwards from "Syowa".

The GSI pendulum apparatus was used to establish a new gravity station at "Syowa" during the 1961–62 season. The gravity value obtained was referred to the value at Tokyo via Cape Town. In the same season gravity surveys were made in West Ongul Island.

Detailed reports on JARE gravity determinations are given in the *Bulletin of the Geographical Survey Institute*, November 1960, and *Antarctic Record* No 17, January 1963.

Geomagnetism

Continuous readings of geomagnetic components were taken at "Syowa" during the period February 1959 to December 1961. Field surveys have been made in the Ongul Islands, Dronning Fabiolafjella and at outcrops near Shirasebreen. Rock samples for palaeomagnetic research were collected in these localities.

Using a proton magnetometer, *Soya* carried out seaborne geomagnetic surveys during her 1960–61 and 1961–62 voyages.

Map and chart production (Index map No 9)

During the period under review the Geographical Survey Institute published three four-colour topographic maps:

1963 Lützow-Holm Bay (1:250000)
1963 Prince Olav Coast (1:250000).
1964 West Ongul Island (1:5000).

The 1:250000 scale sheets were compiled at 1:40000 by stero-plotting, using JARE air photography and ground control. The large-scale map of West Ongul Island was compiled by the steroplanigraph and aerotriangulation method.

Japanese Antarctic Research Expeditions produced two monochrome maps:

1961 Reconnaissance map of Mitzuho Plateau (1:1000000)
1961 Geomorphic map of Yamato Mountains (1:100000).

One first edition and five revised editions of hydrographic charts were published by the Japanese Hydrographic Office:

S13 (1st edition)	Lützow-Holm Bay to Amundsen Bay (1:800000).
S 1 (5th edition)	Cape of Good Hope to Prince Harald Coast (1:4800000).
S 2 (4th edition)	Southern Sea of Cape of Good Hope (1:2500000).
S 3 (4th edition)	Northern Sea of Prince Harald Coast (1:2500000).
S10 (3rd edition)	Lützow-Holm Bay and approaches (1:200000).
S11 (3rd edition)	Approaches to Lützow-Holm Bay (1:600000)

A list of place-names approved by the Promotive Headquarters of Japanese Antarctic Research Expeditions was published in *Antarctic Record*, No 20, 1964, p 90–93.

NEW ZEALAND

Geodetic and topographical surveys (Index Map No 8)

The 1960–61 New Zealand Geological and Survey Antarctic Expedition (NZGSAE) worked in two regions. The Northern Party estabished 15 astronomical stations and 6 minor survey stations, and measured two base-lines, in the area from Byrd Glacier (lat 80° 30′ S, long 156° E) to Beaumont Bay (lat 81° 25′ S, long 160° 30′ E), between long 157° E and Ross Ice Shelf. The Southern Party operated from Beaumont Bay to Nimrod Glacier (lat 82° 25′ S, long 161° E), between long 160° E and Ross Ice Shelf. Fourteen astronomical stations and seven minor survey stations were established, and four base-lines were measured.

This work completed the survey of an area of about 15540 sq km (6000 sq miles) which had been commenced in previous seasons.

In the 1961–62 season NZGSAE again had two survey teams in the field. The Northern Party surveyed an area of approximately 28490 sq km (11000 sq miles) between Nimrod Glacier and the upper Beardmore Glacier. Astro-fixes were taken at six points, 13 minor stations were established and two base-lines were measured. About 41440 sq km (16000 sq miles) of territory between the Beardmore Glacier and Axel Heiberg Glacier (lat 85° 25′ S, long 162° 30′ W) was surveyed by the Southern Party. Eleven astro-fixes were taken, 21 minor stations were established and two base-lines were measured.

The activities of the 1962-63 NZGSAE field parties were centred round Terra Nova Bay. Working southward from Rennick Glacier, the Northern Party surveyed an area of about 26900 sq km (10000 sq miles). Ground control comprised five astronomical stations, three base-lines and twelve minor survey stations. One United States Geological Survey (USGS) station was occupied and five USGS stations were intersected. The Southern Party established survey control over some 38850 sq km (15000 sq miles) between Terra Nova Bay and Mawson Glacier (lat 76° 12′ S, long 162° 30′ E). Two base-lines were measured, four astronomical stations and nine minor stations were established, three USGS stations were occupied and two USGS stations were intersected.

Topographic surveying was among the projects undertaken by the Federated Mountain Clubs of New Zealand–Tararua Tramping Club Antarctic Expedition, 1962–63. An eight-man team worked in two groups—on the western side of Tucker Glacier, between lats 71° 50′ and 72° 30′ S, longs 164° 30′ and 167° E. The two parties measured three base-lines and established twenty-three control points over an area of about 9065 sq km (3500 sq miles). Five USGS stations were intersected by both parties.

In the 1963–64 season the NZGSAE Northern Party operated in northern Victoria Land and Oates Land, in the region between Tucker Glacier and Matusevich Glacier, lats 69° 30′ S to 72° 30′ S, longs 157° E to 168° E. Nine base-lines were measured and 48 new survey stations, including four astronomical stations, were established. One USGS station was occupied, and four were intersected. This work provided control for mapping an area of about 103600 sq kms (40000 sq miles). The Southern Party worked between Axel Heiberg Glacier and Shackleton Glacier, lats 84° 30′ S to 85° 20′ S, longs 163° 30′ W to 175° 30′ W. This survey team took two astro-fixes, established 15 minor control stations, occupied four USGS stations and intersected four USGS minor stations. Two base-lines were measured. An area of 6480 sq km (2500 sq miles) was mapped by this party.

The 1963–64 season's work completed the main reconnaissance survey of the Ross Dependency.

In 1964–65 the NZGSAE Northern Party carried out a triangulation in the Allan Nunatak region (lat 76° 45′ S, long 159° 45′ E). This work provided adequate photo control for large scale mapping of the area. The Southern Party operated in the mountains at the head of Nimrod Glacier.

New Zealand provided the surveyors for the joint New Zealand–United

States Ross Sea Islands Survey 1964–65. This expedition, comprising 22 scientists, was borne in USS *Glacier* and carried out topographic surveys in widely separated areas, including Franklin Island, Coulman Island, Possession Islands and Balleny Islands.

Since the 1961–62 season the accuracy of surveys has been greatly improved by the introduction of astronomical determinations by paired observations on daylight stars or on celestial bodies in the four quadrants. The final laydown of positions is now always adjusted to fit the 1961–62 and 1962–63 US Geological Survey tellurometer traverse determinations which are based on an initial datum in the McMurdo station area.

Hydrography and oceanography

From January to December 1960 continuous tidal readings were obtained at Scott Base by means of a pressure type tide gauge, and studies of currents in McMurdo Sound were undertaken during the 1960–61 season. In February 1961 the New Zealand Antarctic ship HMNZS *Endeavour* took soundings in McMurdo Sound.

Bathymetry was included in oceanographic programmes carried out by the *Endeavour* during two 1962–63 summer voyages between New Zealand and Hut Point, McMurdo Sound. In November and December 1962, tide and current studies were made at Cape Crozier, Ross Island.

During the period October 1963–March 1964, *Endeavour* recorded ocean soundings between New Zealand and the Ross Sea, and in January 1964 ran bathymetric profiles in the area of the submarine ridge which extends from the Balleny Islands to Macquarie Island.

During the 1964–65 season *Endeavour* took soundings along her routes to and from McMurdo Sound, and in the course of an oceanographic cruise in the sub-Antarctic region bounded by the Snares, Auckland Islands, Campbell Island, Antipodes Island and Bounty Islands.

Gravity

The 1960–61 NZGSAE Northern Party used a Worden gravity meter to make observations at twelve points in the Barne Inlet–Cape Parr (lat 81° 17′ S, long 160° 35′ E) region. In the same season a Victoria University of Wellington Expedition carried out gravimetric traverses in the Koettlitz Glacier region.

During the 1961–62 season eighteen stations, mostly on rock, were occupied in the mountains between Beardmore Glacier and Nimrod Glacier. In the McMurdo Sound region stations were occupied on Black Island, Minna Bluff saddle and Cape Crozier.

The 1962–63 NZGSAE Northern Party carried out a gravity traverse from Cape Royds, on the west coast of Ross Island, to David Glacier in southern Victoria Land. Readings were taken at twenty-two stations on rock, sea ice and land ice.

In 1963-64, the NZGSAE Northern Party made gravity measurements at thirty stations on rock, glacial ice and inland ice along their traverse through northern Victoria Land and Oates Land.

In March 1964 a combined New Zealand–United States reconnaissance party, transported by *Glacier*, took readings on Sabrina and Borradaile Islands (Balleny Islands). A Worden Gravity meter, with ties at Scott Base and Wellington, was used for the observations.

Geomagnetism

Continuous standard magnetic observations were made at Scott Base throughout the period, and at "Hallett" station until March 1964 when the main science building and auroral tower was destroyed by fire.

Proton magnetometer marine traverses were made each summer season by the ships which operated between New Zealand and McMurdo Sound.

During the 1961–62 season, two New Zealand scientists travelled in USS *Burton Island* to make a magnetic survey in coastal waters from McMurdo Sound to Commonwealth Bay, George V Land, where they took observations on shore and fixed the position of the South Magnetic Pole. At this site similar observations had been made by earlier Australian and French expeditions.

Proton magnetometer measurements were made by *Endeavour* during 1962–63 re-supply voyages between New Zealand and Antarctica.

The combined New Zealand–United States Balleny Islands Reconnaissance Expedition, 1964, made magnetic measurements at Sabrina and Borradaile Islands.

Map production (Index Map No 9)

In the period 1960–64 the Department of Lands and Survey published eighteen provisional sheets, and three full colour sheets, at 1:250000 (Series NZMS 166). These maps were compiled from US Navy trimetrogon photography and surveys by New Zealand expeditions. They cover the coastal regions between Mawson Glacier and Axel Heiberg Glacier.

Large-scale maps have been published for Cape Crozier (1:50000). Beaufort Island (1:25000) and Cape Bird (1:25000).

In 1963 a third edition of the small-scale general map "Antarctic Regions" was published.

Supplements to the *Provisional Gazetteer of the Ross Dependency* were published in 1960–63.

NORWAY

Norwegian field activities in Antarctica ceased in January 1960 when "Norway Station" was transferred to the South African National Antarctic Expedition.

Map and chart production (Index Map No 10)

During the period 1961–64 Norsk Polarinstitutt published twelve sheets, at 1:250000 scale, which cover much of the mountain ranges of Fimbulheimen and eastern Maudheimvidda. The maps were compiled from 1951–52 and 1958–59 air photography controlled by triangulation and other field work by the Norwegian–British–Swedish Antarctic Expedition (NBSAE), 1949–52, and the Norwegian Antarctic Expedition, 1956–60.

In 1963 two special maps were produced as supplements to the *Norwegian–British–Swedish Antarctic Expedition, 1949–52, Scientific Results*, Vol VI, Part 3:

Maudheimvidda Aust (1:500000).
Kronprinsesse Märtha Kyst: Maudheimvidda (1:1000000).

The routes of NBSAE field parties and air photography flight lines are shown on these maps.

The latest revised editions of the twelve hydrographic charts of the Southern Ocean were published in 1962 (sheets 1–10) and 1964 (sheets 11–12). These charts are not official publications; they are compiled by H. E. Hansen for Den Norske Hvalfangerforenin [Whalers' Insurance Association], Sandefjord.

SOUTH AFRICA

Geodetic and topographical surveys

A surveyor accompanied South African National Antarctic Expeditions (SANARE) for the first time in December 1960. During the second half of the 1960–61 season, and the first half of the 1961–62 season, he fixed the position of the base ("Norway station") by astronomical observations, established azimuths for the geophysical and meteorological programmes, measured a base-line at the station, accompaned the geologist on a geological/geophysical expedition to the mountains and established a small local triangulation on nunataks in the vicinity of the inner margin of the ice shelf. An attempt was made to measure the ice movement in this "hinge" area, relative to the triangulated points.

Little work was done in the second half of the 1961–62 season, since all the members of the relief expedition were engaged on building the new base "Sanae". The surveyor who accompanied this expedition carried out astronomical programmes at "Sanae" in order to establish its geographical position. An azimuth line was determined for geomagnetic observations, and rhombic and radio theodolite aerials were laid out.

During the first half of the 1962–63 season a base-line of 2 km (1¼ miles) in length was measured in the vicinity of "Sanae". This base-line was extended into a network of eighteen stations by triangulation and trilateration for which a Wild T2 theodolite and three MRA2 tellurometers were used respectively. Very significant changes, due to ice movement, were observed in the network upon remeasurement after an interval of only six weeks.

Since a surveyor did not accompany the relief expedition in the following two years, no activity in this field took place in the second half of the 1962–63 season and the whole of the 1963–64 season.

A surveyor accompanied the relief expedition which sailed from South Africa at the end of December 1964, with the intention of remeasuring the network established in 1962–63, and undertaking other ice-flow measurements in addition to the usual astronomical and azimuth determinations.

Barometric heighting was carried out along geophysical traverses from the base to inland mountains.

Hydrography

In January 1964 the South African expedition ship *RSA* took coastal soundings during a radar survey of the ice front between longs 1° 15′ W and 5° W.

Gravity

A 1961–62 field party carried out a gravity survey from "Norway" station to the mountains of Ahlmannryggen, some 160 km (100 miles) southwards, using a Worden gravimeter.

In the period October–December 1962, 51 stations were established at 3 km (1·9 miles) intervals along traverses in the "Sanae" area, and 97 stations at 3 km intervals were established along a traverse from "Sanae" to Ahlmannryggen. A Worden Master model gravimeter was used for this and subsequent work.

During 1963, observations were made at 101 stations, at 3 km intervals, along two geophysical traverses from "Sanae" to the Ahlmannryggen region, and at 11 stations on "Blaskimen Ice Rise", which lies to the south and south-west of "Sanae".

In 1964 observations were made at 15 stations on the ice shelf (Fimbulisen) east of "Sanae". The traverse interval between stations was 3 km.

In the early part of 1965 determinations were made in the coastal region north and north-east of "Sanae".

Geomagnetism

A La Cour normal-run magnetograph was used for routine standard observations at "Norway station" from January 1960 to February 1962 when the magnetic station was closed down in order to transfer the equipment to the new base at "Sanae". Magnetic recording at "Sanae" commenced in June 1962.

In 1960 field surveys (terrestrial observations only) for measurement of H and Z were made at eight points between "Norway station" and the Fimbulisen ice front, and at three points south of the station to a maximum distance of 60 km (37 miles). A number of orientated rock samples were collected from surface rocks in the nunatak area about 100 km (62 miles) south of "Norway station".

In 1961, an Askania magnetometer was used for magnetic observations in the course of reconnaissance geological mapping of the region between lats 71° 20′ S and 72° 20′ S, longs 0° 30′ W and 2° 05′ W. Rock samples were collected for palaeomagnetic research.,

A proton magnetometer was used to measure total magnetic field force (F) along three 1962 traverses; nine stations were observed at 3 km intervals between "Sanae" and Polarsirkelbukta 16 km (10 miles) north-west of the base, 97 stations were observed at 3 km intervals along the route from Sanae to "Depot 72" some 190 km (118 miles) south-south-west, and 150 stations were observed at intervals of 23 m (75 feet) in the Ahlmannryggen area. Vertical magnetic field force (Z) was measured by BMZ magnetometer at 27 stations along a triangular traverse of about 70 km (43 miles) in the "Sanae"–"Norway station"–"Blaskimen Ice Rise" region. Rock samples for palaeomagnetic studies were collected.

In 1963 field observations (Z) were made at 44 stations along traverses to the mountains.

The limited field programme during 1964 included repeat observations of H and Z at three stations within 40 km (25 miles) of "Sanae". Geomagnetic observations were made by *RSA* on relief voyages to "Sanae" and to Marion Island and Gough Island.

Map production (Index Map No 4)

In 1961 the Trigonometrical Survey Office produced a 1:250000 scale sketch map of the areas visited by the first South African Expedition, 1960. It was compiled from magnetic compass and cyclometer surveys, and information from Norwegian sources. Revised editions, showing traverse routes, geophysical and glaciological observation points, ice and rock features, place-names and supply depots, were produced in 1963 and 1964.

UNITED KINGDOM

Geodetic and topographical surveys (Index Map No 5)

Throughout the period 1960–65, surveyors of the British Antarctic Survey (known as Falkland Islands Dependencies Survey prior to 1 January 1962) continued to work in the Antarctic Peninsula, the South Shetland Islands, the South Orkney Islands, the South Sandwich Islands and Tottanfjella in Dronning Maud Land. Survey parties operated from six stations: Hope Bay (Trinity Peninsula), Argentine Islands (Graham Coast), Adelaide, Stonington Island (Marguerite Bay), Fossil Bluff (George VI Sound) and Halley Bay.

All survey stations established on rock as part of a triangulation scheme or tellurometer traverse were permanently marked. Position was established by astro-fixes in each area of survey, and as the work proceeds it will be possible to produce co-ordinates in sympathy throughout the whole area of systematic survey.

In the 1959–60 season part of South Georgia was photographed from the air by HMS *Protector*'s helicopters.

In 1960 and 1961, topographical survey was carried out from three bases. In the northern part of Antarctic Peninsula a tellurometer traverse was run round the Joinville Island group, linking these islands to the triangulation of Trinity Peninsula; this was also extended southward through Prince Gustav Channel and down the east coast of the peninsula to Seal Nunataks (lat 65° 03′ S, long 68° 18′ W). Sledge wheel and compass surveys of Drygalski, Green and Crane Glaciers were completed, leaving unsurveyed on the east coast only a few small areas between lats 65° S and 75° S. A local triangulation scheme was established in the Argentine Islands to provide control for large-scale mapping. From Stonington Island (lat 68° 11′ S, long 67° 00′ W) a sledge wheel and compass traverse was carried out over extensive unsurveyed areas between lats 68° 30′ S and 69° 30′ S and on Pourquoi Pas Island and the nearby mainland, and previous surveys were augmented by plane-tabling.

The 1961–62 season saw the reconnaissance for the survey of northern Adelaide Island and of the southern part of George VI Sound. The 1961–62 triangulation of south and south-eastern Adelaide Island, and of the off-lying islands,

linked this area to previously established control in Laubeuf Fjord (lat 67° 30′ S, long 67° 50′ W). By the end of this season, previous years' work had been completed and an area of 3110 sq km (1200 sq miles) lying mainly to the south and east of the station, had been surveyed by sledge wheel and compass traverses from Stonington Island. Observations for the Joinville Island survey were completed, and six additional tellurometer lines were measured on Robert, Greenwich, King George and Nelson Islands in the South Shetland Islands.

In 1962–63, a looped tellurometer traverse of 515 km (320 miles) was completed in George VI Sound, south of Fossil Bluff. In eastern Adelaide Island a figure-of-eight tellurometer traverse was measured; this was linked eastwards to earlier triangulation in Laubeuf Fjord and Hanusse Bay (lat 66° 57′ S, long 67° 29′ W) and extended southwards to include the Faure and Amiot Islands in Marguerite Bay.

A reconnaissance of the northern part of George VI Sound was made in 1963–64. Cairns were built on the stations in preparation for the completion of the tellurometer traverse in George VI Sound. On the east coast of Graham Land additional detail was filled in by sledge wheel and compass traverses from lat 68° S to Churchill Peninsula (lat 66° 32′ S, long 62° 46′ W), and in the areas of Starbuck Glacier (lat 65° 38′ S, long 62° 20′ W). In western Dronning Maud Land a topographic survey of Tottenfjella, the westernmost range of Heimefrontfjella, was extended eastwards to cover the central part of the mountains. Royal Naval survey parties completed; (*a*) a triangulation connexion across Bismarck Strait, linking two earlier separate triangulation schemes; (*b*) a tellurometer traverse from Southern Thule to Visokoi Island (South Sandwich Islands); (*c*) local triangulation in Southern Thule and Candlemas Island groups, and (*d*) air photography of the South Sandwich Islands.

In 1964–65 a tellurometer traverse was run on the plateau of central Palmer Land, from approximately lat 71° 15′ S, long 66° 40′ W, eastwards to Mount Andrew Jackson (lat 71° 22′ S, long 63° 22′ W). Additional work was carried out on Adelaide Island, in western Dronning Maud Land and in the South Orkney Islands. A private party undertook a large-scale survey of Royal Bay, South Georgia.

Hydrography and oceanography

In 1960–61 a full hydrographic survey was carried out at the western end of South Georgia, including Stewart Strait, Bird Sound, Elsehul, Undine Harbour, Right Whale Bay and their approaches. Very numerous lines of soundings were run around the island. From November 1960 to February 1961 RRS *Shackleton* made surveys on ocean passages in the South Atlantic Ocean, off the west coast of Antarctic Peninsula and east of Joinville Island.

In the 1961–62 summer *Shackleton* continued hydrographic work in the South Atlantic Ocean and off the west coast of Antarctic Peninsula.

In the 1962–63 season Adelaide anchorage and the south-western approaches to Adelaide Island were surveyed in detail.

In the South Shetland Islands a full survey of Discovery Bay (Greenwich Island) was carried out by a Royal Naval hydrographic survey party during the

1963–64 summer, and work was begun in the northern approaches to Argentine Islands and in Bismarck Strait. In March 1964 RRS *John Biscoe* and a Royal Naval hydrographic survey party worked in the Argentine Islands area. Also during the 1963–64 summer, the absolute and relative positions of most of the islands in the South Sandwich group were fixed by parties from the royal Navy and the British Antarctic Survey from *Protector*.

Numerous lines of soundings were run by *Protector* and *Shackleton*.

In the 1964–65 season hydrographic surveys of the southern approaches to Signy Island (South Orkney Islands) and the approaches to Berge Bay (Signy Island) were carried out. In Graham Land, hydrographic surveys of the Argentine Islands and the approaches to French Passage and Bismarck Strait were completed.

In addition to the above work, very numerous lines of soundings were run, local surveys made, and dangers investigated by *Protector*, *Shackleton* and *John Biscoe* in many parts of British Antarctic Territory and in the approaches to South Georgia.

Continuous tide gauge readings were taken at the station in the Argentine Islands throughout the period under review. At Halley Bay coastal currents were measured at intermittent periods.

Gravity

During a 1959–60 geophysical survey by *Shackleton* gravity measurements were carried out in the Scotia Sea, Bransfield Strait and adjacent areas. A Worden gravimeter was used to obtain data at many points in the South Shetland Islands, north-west Graham Land and off-lying islands, and at Port Stanley (Falkland Islands). The survey has been linked to the international gravity network by connecting it to a base station at Buenos Aires via Port Stanley and Montevideo. In subsequent years repeat readings were taken, wherever possible, to improve the accuracy of the work. A number of stations has also been occupied in the South Orkney Islands, South Sandwich Islands and in South Georgia.

In 1963–64, a reconnaissance traverse was made from Stonington Island across the Graham Land plateau to the east coast, then northwards to Foyn Coast. In addition to this, local detailed work was carried out in north-eastern Trinity Peninsula and in the Marguerite Bay area.

In the 1964–65 season the east coast gravity traverse was extended northward; to Hope Bay, and local surveys were made in the region of Joerg Peninsula.

Sea seismic shooting

Since 1962 several seismic refraction lines have been surveyed between the South Orkney Islands and South Georgia, as part of the geophysical investigations of the Scotia Ridge. In 1962–63 refraction profiles were obtained across, and in, Bransfield Strait; four of these were 80 km (50 miles) long and made use of a portable, land-based recording station. A sonobuoy system has been developed, making it possible for seismic work to be carried out at sea using only one ship. This system was successfully used in Bransfield Strait in the 1964–65

season. Interpretation of the data has now been completed. Over 1610 km (1000 miles) of seismic refraction lines have been shot.

Geomagnetism

During the period under review regular geomagnetic readings of elements, D H and Z have been taken at the Argentine Islands and Halley Bay stations. In addition, reconnaissance and detailed survey has been carried out in north-east Trinity Peninsula extending southwards along Nordenskjöld Coast, with stations spaced at 1 km (0·6 mile) intervals in the areas of detailed survey. Similar work has been done from Stonington Island along Foyn Coast and Oscar II Coast.

Seaborne geomagnetic surveys were made by *Shackleton* in the following periods, using a proton magnetometer:

January–February 1960: 1610 km (1000 miles) of traverse for total field measurement, and reconnaissance surveys off the South Shetland Islands and in Bransfield Strait.

November 1960–March 1961: 11265 km (7000 miles) of traverses across the Scotia Ridge, for total field measurement. Detailed work in Bransfield Strait, South Sandwich Islands and over Meteor Deep.

November 1961–April 1962: total field measurement over 16 000 km (10000 miles) of traverses across the Scotia Ridge. Detailed work in Bransfield Strait and north-east of the South Shetland Islands.

November 1962–April 1963: total field measurement over long traverses within the Scotia Ridge with 16 km (10 miles) spaced grids in selected areas.

November 1963–April 1964: further investigation of the Scotia Ridge; detail in Bransfield Strait, near Elephant Island and Clarence Island, and other selected areas.

November 1964–April 1965: Traverses along selected lines in Drake Passage.

To date, about 48300 km (30000 miles) of geomagnetic traverse have been made.

Map production (Index Map No 6)

Topographical maps published by the Directorate of Overseas Surveys, 1960–65, include a small-scale map of Antarctica (1:15000000), one of the Falkland Islands, Falkland Island Dependencies and British Antarctic Territory (1:9000000) and one of British Antarctic Territory (north of lat 75° S) with South Georgia and South Sandwich Islands (1:3000000).

In the 1:500000 scale series DOS 710, sheets 14 and 17 have been published and sheet 13 is in preparation.

Of the 33 sheets at 1:200000 published during the period, six are compiled from sledge wheel and compass traverses in the central Antarctic Peninsula and two are based on the east coast traverses. The 13 provisional sheets of Alexander Island were compiled mainly from Ronne Antarctic Research Expedition, 1947–48, photography, with very little control. The remaining 12 sheets in this series are the result of the work of the Trans-Antarctic Expedition, 1955–58. A map of this expedition's route was published at 1:2000000.

The hill-shaded series of maps at 1:25000 now cover Horseshoe Island,

Deception Island and Hope Bay. In addition to these, the South Orkney Islands (West sheet) at 1:100000 and two sheets at 1:10000 (Anvers Island: Arthur Harbour, and Argentine Islands with Anagram Islands) have been published, together with Anvers Island (South coast) East and West sheets at 1:25000.

The Hydrographic Department published seven new hydrographic charts:

No 1774	Plans in the South Shetland Islands (various scales).
No 3213	Plans in Graham Land (various scales)
No 3560	Gerlache Strait—Cape Wollaston to Cape Murray (1:200000).
No 3572	Bismarck Strait, with Lemaire Channel, French Passage and Penola Strait (1:100000).
No 3573	Grandidier Channel (1:200000).
No 3577	Adelaide Island, south-west approaches (1:75000) with plan of Adelaide anchorage (1:25000).
No 3592	South Georgia: Stewart Strait (1:25000) with approaches to Stewart Strait (1:100000) and Bird Sound (1:12500).

Sixteen other charts were published as new editions or large corrections.

Numerous unpublished maps for the location of place-names were issued by the Research Department of the Foreign Office. These are not shown on the index map.

A gazetteer of the British Antarctic Territory, South Georgia and South Sandwich Islands was produced in 1962, and the first supplement was issued in 1964.

UNITED STATES OF AMERICA

Geodetic and topographical surveys (Index Map No 13)

During the 1959-60 field season, air photography was completed for about 168000 sq km (45000 sq miles). This mapping photography covered sections of the McMurdo Sound region, Sentinel and Horlick Mountains, and Executive Committee Range.

In the same season, topographical survey work was carried out by traverse parties operating in Victoria Land and Byrd Land. A feature of the Victoria Land operations was the preliminary mapping of the formerly unknown Arctic Institute Range and Rennick Glacier. During the Byrd Land traverse more than 100 nunataks were discovered and surveyed. The latter operations extended from the vicinity of Martin Peninsula westwards through the Executive Committee Range to the Edsel Ford Ranges.

In February 1960, USS *Glacier* and USS *Burton Island* carried out topographical and scientific surveys of the coastal areas between longs 94° W and 102° W.

During the 1960–61 season about 317100 sq km (118800 sq miles) of mapping photography was obtained over the mountains west of Ross Ice Shelf from lat 78° S to, and including, Beardmore Glacier and portions of Queen Maud Range. North of lat 75° S, about 40 per cent of the north Victoria Land mountainous area was photographed. Land-based control operations were carried out in the eastern Horlick Mountains, along the western edge of the Ross Ice

Shelf, in the mountains south-east of Thurston Island and in southern Victoria Land. *Glacier* and *Staten Island* extended the coastal work commenced by the 1959–60 expedition to the Thurston Island–Eights Coast region, and established the insularity of "Thurston Peninsula".

During the 1961 to 1962 season, a detailed control survey was accomplished in the vicinity of McMurdo for a large-scale map of the base. Two helicopter-supported tellurometer traverses ("Topo North" and "Topo South") extended over a distance of 2527 km (1570 miles) from Cape Hallett to Beardmore Glacier and furnished control for mapping an area of about 259000 sq km (100000 sq miles). Air photography for mapping was obtained in the mountains west and south of the Ross Sea and Ross Ice Shelf, and over the Whitmore Mountains. Reconnaissance photographic flights were made over the Pensacola Mountains and the Heritage Range of the Ellsworth Mountains. During January and February 1962 *Glacier* established the positions and elevations of points along the Byrd Land coast from Cape Colbeck to the vicinity of Cape Dart.

During the 1962–63 summer, United States Geological Survey engineers carried out two helicopter-supported Electrotape traverses over a distance of 2588 km (1608 miles). "Topo East" extended eastward from the Beardmore Glacier terminal point of "Topo South" (1961–62) to the Ohio Range of the Horlick Mountains. "Topo West" extended the 1961–62 "Topo North" traverse westward from Cape Hallett through northern Victoria Land to the Wilson Hills and Mount Murchison (67° 19′ S, 144° 15′ E). This work provided control for about 207200 sq km (80000 sq miles) of mapping. Additional control was established by engineers attached to geological parties working in the Ellsworth Mountains and the mountains southward of the Pensacola Mountains. The air photography programme for this season included mapping photography of the mountains west and south of the Ross Ice Shelf, and in northern Victoria Land. Reconnaissance photographic flights were made over the Ellsworth Mountains and along the coast of Byrd Land between Cape Colbeck and Edsel Ford Ranges.

During the 1963–64 season, additional mapping control was obtained in the Ellsworth Mountains, and in the Pensacola Mountains where the Neptune Range was completely controlled for topographical mapping. Engineers established a precise ice-strain net north-east from "Byrd" for about 97 km (60 miles) towards the ice divide. At Cape Hallett, a large-scale plane-table survey was carried out for a topographical map of the penguin rookery and skua nesting areas. At "Byrd" experiments were conducted on a new system for daylight stellar observations. Air photography for mapping was obtained in the Queen Maud Range, northern Victoria Land and Balleny Islands. Special purpose photography was flown over Shackleton Glacier, Mount Weaver, Cape Crozier penguin rookery, Byrd–Mulock Glaciers area, McMurdo Sound (for ice movement studies), Dumont d'Urville station, Bay of Whales, Okuma Bay area, Minna Bluff and the Victoria Land dry valley areas.

During the 1964–65 season, 193 km (120 mile) helicopter-supported Electrotape traverses were run around Ross Island and in northern Victoria Land near Terra Nova Bay. A 386 km (240 mile) traverse using similar techniques was run

from "Hallett" to Rennick Glacier. Glacial strain nets were established at mile-posts 60 and 120 along "Army–Navy Drive", and astronomical observations were taken at these points as well as at "Byrd". The detailed McMurdo survey accomplished during the 1961–62 season was expanded for further large-scale mapping of the base. The precise ice-strain net begun near "Byrd" was completed so that the network extends from "Byrd" for 170 km (106 miles) to the ice divide between the Fichner and Ross Ice Shelves. In February of 1965 a tracking station was put into operation at McMurdo to gather satellite doppler data of geodetic quality. Limited control activities and an astronomic observing programme were carried on at "Palmer" station. Air photography was taken taken of 476360 sq km (183925 sq miles), including parts of Byrd Land, Pensacola Mountains, Heritage Range, northern Victoria Land and Queen Maud Range.

Hygrography and oceanography

During each summer season, ships of the United States Navy "Task Force 43" have gathered a considerable amount of data in Antarctic waters, mainly in the South Pacific sector.

During the 1959–60 season *Burton Island* and *Glacier* recorded 25820 nautical miles of ocean and coastal soundings, including off-shore soundings at Peter I Øy.

During 1960–61 season "*Staten Island*", "*Glacier*" and "*Edisto*" recorded a total of 44680 nautical miles of soundings over widely separated routes in the South Pacific and South Atlantic sectors and in the New Zealand–Ross Sea region. In this and the previous season hydrographic work was carried out in the Thurston Island region.

During the 1961–62 season, *Burton Island* obtained ocean and coastal soundings on the re-supply voyage from New Zealand to McMurdo Sound, and along the route McMurdo Sound–Commonwealth Bay–Wellington. *Eastwind* recorded soundings on re-supply voyages between New Zealand and McMurdo Sound, and *Glacier* charted about 800 nautical miles of coastline between Cape Colbeck and Cape Dart.

In the early months of 1961 and 1962, the Columbia University research vessel *Vema* co-operated with the Chilean oceanographic vessel *Yelcho* on systematic programmes in Drake Passage. Their work included bathymetry and current measurements, using Swallow buoys.

1962 saw the first cruise of the US Antarctic Research Programme vessel *Eltanin*. Comprehensive oceanographic studies were made in Drake Passage and adjacent waters during three cruises.

In the 1962–63 summer season seven ships of "Task Force 43" were engaged on sounding the water between New Zealand and McMurdo Sound.

During 1963 *Eltanin* operated in Antarctic waters between longs 22° W and 83° W, south to lat 67° S. In the course of six cruises from South American ports, the ship steamed 40000 nautical miles and completed about 200 ocean stations.

During 1964, approximately 40000 nautical miles were covered by the

Eltanin in cruises covering the areas of the Pacific Ocean, Drake Passage, Scotia Sea, and South Atlantic Ocean. A continuous record of soundings was obtained. Physical and chemical oceanographic data were gathered at pre-planned stations.

Five ships of the 1963–64 Naval Support Force, Antarctica, continued the work of recording soundings on passage. An oceanographic programme was carried out by *Atka* in the eastern part of the Ross Sea between lats 74° and 78° S, and between longs 157° and 176° W.

From January to March 1965, *Glacier* carried out an extensive programme of bathymetry and other oceanographical observations while transporting the joint United States–New Zealand Ross Sea Islands survey team of scientists. Operational areas included Beaufort, Franklin and Coulman Islands, Moubray Bay-Cape Adare, Balleny Islands and Macquarie Island. Controlled bottom profiles were recorded over a distance of 3754 nautical miles, special attention being paid to delineating the Macquarie Ridge.

During the six cruises of *Eltanian* in 1965, the ship operated between the ports of Valparaíso, Chile, and Wellington, gathering bathymetric and oceanographic data in mostly uncharted waters.

Gravity

The 1959–60 Victoria Land traverse party took some 400 observations along the 2468 km (1534 miles) route. Similar work was carried out along the traverse from "Byrd" to Martin Peninsula and Edsel Ford Ranges, the measurements being made at intervals of 5 km (3 miles). A high range Worden gravity meter was carried during airborne magnetic flights between McMurdo and "Hallett" and between "Byrd" and "Amundsen–Scott" stations, in order to make ties between stations and to strengthen the continental gravity network. In McMurdo Sound, measurements were made at 5 km (3 miles) intervals along a traverse from the base to Inaccessible Island. The US Navy Bellingshausen Sea Expedition obtained gravity data during its work in the Thurston Island area during this and subsequent seasons.

During the 1960–61 season, measurements were taken along three major traverses: "McMurdo" to the South Pole, "Byrd" to Eights Coast, and "Byrd" to the South Pole. In addition, gravity ties were made between Christchurch and McMurdo, "Hallett" and McMurdo, and between "Byrd" and McMurdo.

The inter-station gravity programme was continued during the 1961–62 season, utilizing supply flights to inland stations. Several ties were made between McMurdo and "Amundsen–Scott", and between McMurdo and the new and old "Byrd" stations. Gravity values were established at the "Sky-Hi" summer station (lat 75° 14′ S, long 77° 10′ W), 25 gravity stations were occupied in the McMurdo Sound area and 142 observations were taken on Roosevelt Island. In addition, measurements were made along a traverse of 1693 km (1052 miles) in Ellsworth Land.

During the 1962–63 season, gravity values were determined at 202 stations along traverse routes between the South Pole and the vicinity of Queen Maud Range and the Horlick Mountains, and about 40 stations were occupied between "Byrd" and the Whitmore Mountains. Work was continued in the McMurdo

Sound region; values were measured at 17 stations in Taylor Glacier Dry Valley and at 40 stations along the Victoria Land coast.

During the 1963–64 season, 520 observations were made by a traverse party which covered 2690 km (1670 miles) in the region between "Byrd", Whitmore Mountains, the southern ends of the Ellsworth and Pensacola Mountains and Filchner Ice Shelf.

Gravity measurements were made along the 1964–65 summer traverse from the South Pole station to the "Pole of Inaccessibility" (lat 82° 06′ S, long 54° 58′ E).

Geomagnetism

During the period under review routine standard observatory observations were made at "Byrd" and "Amundsen–Scott" stations. Observations at "Eights" station were started in 1963.

Magnetic readings were taken at intervals of about 5 km (3 miles) along the 1959–60 Byrd Land and Victoria Land oversnow traverses. Airborne magnetic profiles were flown between McMurdo and "Hallett", and between "Byrd" and "Amundsen–Scott". A magnetometer was towed on reconnaissance flights to the north, east and south of "Byrd", and a detailed survey of Ross Island was made, with flight lines 8 km (5 miles) apart.

During the 1960–61 season, magnetic observations were made by the three major oversnow traverse parties described in the section on gravity above. An air-lifted field party operated in the Walgreen Coast region where readings were taken on the ground and in flight between stations.

Magnetic observations were included in the scientific programme carried out along the 1961–62 Ellsworth Land traverse of about 1700 km (1055 miles).

During the 1962–63 season, 25 geomagnetic stations for D, I, H, Z and F, and 1600 stations for total intensity, were occupied along two triangular traverses from "Amundsen-Scott" to the Queen Maud Range–Horlick Mountains region. The research vessel *Eltanin* towed a proton magnetometer throughout operations in Drake Passage and Scotia Sea during 1962.

Measurements of the elements D, H, Z, I and F were made along the 1963–64 traverse route "Byrd"–Heritage Range–Filchner Ice Shelf–Whitmore Mountains–"Byrd". Total intensity was measured at 2060 stations approximately 1 km apart. Observations for total magnetic field formed part of the scientific work accomplished by *Eltanin* in Drake Passage, Scotia Sea, northern Weddell Sea and the coastal waters of north-western Graham Land.

Glacier towed a proton magnetometer for 3500 nautical miles during the 1964–65 operations in the Ross Sea and the Balleny Islands–Macquarie Island–New Zealand areas.

A magnetician was a member of the 1964–65 South Pole–"Pole of Inaccessibility" traverse party.

On cruises 16–21 during 1965, the proton magnetometer was towed by *Eltanin* to obtain magnetic field observations over the 38000 nautical miles covered in her trans-Pacific crossings, and south of New Zealand in the area of Macquarie Ridge.

Map and chart production (Index Map No 14)

In 1962 the American Geographical Society published new editions of its 1:3000000 and 1:5000000 scale maps of Antarctica. In 1965 a new edition of the 1:5000000 scale map was published.

In 1963 the National Geographical Society published a general map, with historic notes, at 1:9820800. A wall map edition is available at 1:6145920.

In 1961, the US Navy Photographic Interpretation Center produced a plastic relief model of Antarctica at a scale of 1:11250000 (vertical exaggeration 30:1), depicting topographical and ocean bottom relief.

Two maps of the Antarctic showing sub-glacial and ocean bottom features were published in 1961 at 1:10000000 by the US Geological Survey. One publication is a two-piece plastic relief model with a vertical exaggeration of 25:1. The lower part of the model shows the sea bed and sub-glacial topography; the upper, removable section is semi-transparent and shows the sea level surface of the continental ice mass. Ice-free areas are shown on both layers.

In 1961, the US Geological Survey produced three sheets in the 1:500000 series. They cover coastal areas between longs 112° 30′ E and 127° 30′ E. Nineteen sheets at 1:250000 were published by this mapping organization during the period 1962–65; three cover the Executive Committee Range, three cover the Sentinel Range of the Ellsworth Mountains, seven cover the Horlick and Thiel Mountains, five cover part of the southern Victoria Land mountains and one sheet covers Ross Island. A 1:500000 scale sketch map of northern Victoria Land was produced in 1963.

Between September 1960 and September 1964, the US Naval Oceanographic Office published 13 new charts and 32 new editions in their Antarctic hydrographic chart coverage. They range in scale from 1:3580 to 1:11250000. The Organization also published seven Air Navigation Charts at 1:2188800 and seven Antarctic Strip Charts at various scales.

New and revised editions of aeronautical charts at various scales were produced by the US Air Force Aeronautical Chart and Information Center. They comprise six Global Navigation and Planning Charts at 1:5000000; 26 World Aeronautical Charts at 1:1000000, and one Aerospace Planning Chart at 1:9000000.

USSR

Geodetic and topographical surveys (Index Map No 11)

The 1959–60 summer season saw the beginning of preliminary work for the complex exploration and mapping of the Dronning Maud Land mountains.

During the 1960–61 season, 62000 sq km (23950 sq miles) of the mountains and coastal regions were photographed from LI-2 aircraft equipped with AFA-TE (f = 55 mm) cameras and synchronized recordings of statoscope and radio-altimeter readings. The main survey was made at a scale of approximately 1:50000. Additional surveys were made at "Schirmachervatna" (lat 70° 45′ S, long 11° 30′ E) and the "Novolazarevskaya" station area, at 1:15000 and 1:5000 respectively. Horizontal ground control for the air photography was provided

by a main network of 29 astronomical stations, and 109 secondary stations established at aircraft landing places when geological parties were in the field. Altitudes of the principal points of the vertical photographs (obtained from the radio-altimeter and statoscope readings) were used for height control.

Air photography coverage of the mountain regions in Enderby Land north of lat 68° 30′ S, between longs 44° E and 52° E, was obtained in February and March 1962, using the cameras and procedure adopted for the Dronning Maud Land operations. The site selected for the new scientific station "Molodezhnaya" (lat 67° 40′ S, long 45° 51′ E) was photographed at 1:200 to 1:10000 scale. For ground control of the photography, 11 astronomical determinations were made. These points were photographed at a larger scale and identified on the 1:50000 scale air photography.

In the period 1962–64 the co-ordinates and altitudes of a number of geodetic points were determined (by triangulation and levelling) in the "Molodezhnaya" area for horizontal and vertical control of the air photography. A tachymetric survey of "Molodezhnaya" station was made, for a topographical plan at 1:2000 scale.

Previous air photography of the Mirny–West Ice Shelf coastal area was repeated in 1960 to provide material for a study of ice coastline changes. The coverage included Drygalski Island and the large stranded iceberg (lat 64° 40′ S, long 98° 53′ E) on which the Soviet field station "Pobeda" is situated.

In 1961, the study of sub-glacial relief was recommended. A 1961–62 summer traverse party from Mirny carried out geodetic levelling over a distance of some 1500 km (930 miles) round the triangle "Komsomol'skaya" (lat 74° 06′ S, long 97° 30′ E)—"Sovetskaya" (lat 78° 23′ S, long 87° 32′ E)—"Vostok"—"Komsomol'skaya". Elevations of the ice sheet were determined at 278 points of which the co-ordinates were established by astronomical and geodetic methods. Simultaneous reciprocal vertical angles were used for determination of heights. In addition, parallel barometric levelling was carried out along this traverse to provide data for a study of the accuracy of the latter method.

The study of sub-glacial relief was continued during the period December 1963 to January 1964, when a team of sixteen scientists completed a traverse of about 3300 km (2050 miles) from "Vostok" to the "Pole of Inaccessibility" (lat 82° 06′ E, long 54° 58′ E), thence to "Molodezhnaya" by way of lat 78° S, long 20° E. Along the first leg of the traverse altitudes were determined, at about 10 km (6 miles) intervals, by trigonometrical levelling. The co-ordinates of these points were established by astronomical observations and electronic distance measuring equipment, Owing to bad weather the party was obliged to use less accurate methods along the route from the "Pole of Inaccessibility" to "Molodezhnaya"; astro-fixes were taken at intervals of about 200 km (124 miles) and the positions of intermediate points were fixed by compass courses and speedometer readings. Altitudes along this section of the traverse were ascertained by barometric levelling based on the known elevations of "Vostok" and "Molodezhnaya". Height errors along the "Vostok"–"Pole of Inaccessibility" leg were estimated to be ±5 m, and ±50 m along the subsequent legs.

From February to April 1964 a joint Soviet–French field party used tellurometers to carry out geodetic and glaciological projects along a traverse of 2300 km (1430 miles) from "Vostok" to Mirny by way of "Komsomol'skaya" and "Pionerskaya" (lat 69° 44′ S, long 95° 30′ E).

During the 1964–66 summer season German members of the Soviet Antarctic Expedition determined the elevations of fixed points along a traverse of 100 km (62 miles) inland from Mirny. The main purpose of this traverse was to obtain data for a study of the ice sheet movement.

Hydrography and oceanography

During the period November 1959 to April 1960 the Soviet expedition ship *Ob'* recorded ocean soundings and oceanographic data along 8300 nautical miles of steaming in Antarctic waters during the voyage Cape Town–"Lazarev"–"Syowa"–Mawson–Mirny–Ross Island–Amundsen Sea–Bellinghaussen Sea–Drake Passage. A hydrographic survey was carried out at Peter I Øy. Tide and current observations were made in "Leningradbukta" (lat 70° S, long 12° 30′ E).

During the 1960–61 and 1961–62 season, *Ob'* carried out programmes of oceanography, including bathymetry, in coastal waters between Mirny and "Leningradbukta". Similar work was done in the 1962–63 season (also a hydrographic survey of the approaches to "Molodezhnaya") and again in 1963–64.

In 1964–65 *Ob'* obtained further hydrographic and oceanographic data while on passage between long 6° E and Mirny. Areas investigated included Prydz Bay (where the Amery Ice Front was delineated), Amundsen Bay, Lena (Casey) Bay, "Alasheyev Bay" and "Leningradbukta".

Gravity

From October 1960 to February 1961 a Worden gravimeter was used for observations along a traverse of some 1600 km (955 miles) from Mirny to "Vostok" by way of lat 71° 59′ S, long 87° 00′ E and "Komsomol'skaya". Other readings were taken during 1960, at "Lazarev Ice Shelf" (224 stations), West Ice Shelf (92 stations), Shackleton Ice Shelf (5 stations) and "Pobeda" (20 stations).

During the 1961–62 summer season observations were made at intervals of 10–15 km (6–9 miles) along the traverse "Komsomol'skaya"–"Sovetskaya"–"Vostok"–"Komsomol'skaya".

During the period January to March 1963, gravity observations were made at 74 stations in the coastal regions of Enderby Land, between longs 44° E and 51° E. Gravity readings formed part of the scientific work carried out by *Ob'* during her 1962–63 voyages.

Gravimetric observations were made along the 1963–64 traverses "Vostok"–"Pole of Inaccessibility"–"Molodezhnaya" and Mirny–"Vostok".

Geomagnetism

Throughout the period under review standard continuous measurements of D, H and Z elements have been made at the Mirny observatory. Field magnetic variations and other measurements were recorded at "Lazarev" (1960), "Vostok" (1960–61, 1963–65), "Novolazarevskaya" (1961–65) and at "Molodezhnaya" (1964–65).

A field gravity survey was carried out along the 1960–61 traverse Mirny—lat 71° 59′ S, long 87° 00′ E—"Komsomol'skaya"—"Vostok". Instruments used were Z magnetometer and surveying compass.

Absolute determinations of D, H and Z were made by the 1961–62 traverse party along the route "Komsomol'skaya"–"Sovetskaya"–"Vostok"–"Komsomol'skaya", at intervals of 30–40 km (19–20 miles).

During the 1963–64 season geomagnetic work was carried out along the traverse from "Vostok" to "Molodezhnaya". Observations of the vertical component (Z) and total field strength were made every 20 km (12 miles), with more detailed observations every 50–60 km (31–37 miles).

Map and chart production (Index Map No 12)

Two general maps of Antarctica were produced during the period:

1961 Rel'yef Antarktiki [Antarctic relief] (1:12000000)
1962 Karta Antarktidy [Map of Antarctica] (1:3000000) in nine sheets.

In 1964 a 1:200000 scale series was published; 39 sheets cover the coastal regions from Davis to Wilkes.

An additional three sheets in the 1:1000000 scale series were compiled in 1964 for publication in 1965. They cover the coastal areas between long 36° E and 72° E.

During the period 1961-62 the Gidrograficheskaya Sluzhba VMF [Naval Hydrographic Service] published a series of five 1:2500000 scale general charts for the coasts and seas from long 6° E west to long 160° E; seven charts at 1:500000 scale for the coastal waters between Cape Poinsett and "Ob Bay", and two charts at 1:500000 for the west coast of Graham Land and off-lying islands.

In addition to the foregoing publications, 42 topographic and geographic maps were prepared for the Antarctic atlas.

International activities

SCAR Working Group on Geodesy and Cartography
Recommendations approved by SCAR.

Fourth Meeting of SCAR, Cambridge, 1960

(*a*) That all member nations use in their topographical maps the conventional signs recommended by the Working Group on Cartography, and requests the Secretary of that working group to distribute these conventional signs in published form to members of SCAR and to other interested agencies.

(*b*) That

(i) those member nations which have not already done so, immediately exchange their gazetteers of place-names, as recommended by SCAR at its Third Meeting;

(ii) in future, members of SCAR distribute, on a similar basis, amendments to their gazetteers giving early details of any new place-names decided upon;
(iii) that any member nations finding that they are in conflict with respect to place-names endeavour to resolve their differences bi-laterally.

(*c*) That SCAR, having considered the statement submitted jointly by the United States Advisory Committee on Antarctic Names and the United Kingdom Antarctic Place-Names Committee on the subject of under-ice features, recommends that features lying under an ice cover should be named according to the already adopted geographical terminology prefixed with the term "sub-glacial", the abbreviations of this prefix on maps being "Sg".

(*d*) That member nations prepare and maintain air photography flight index diagrams, preferably on 1:1000000 scale base maps, showing appropriate information with respect to:

(i) location, date and identification of air photography,
(ii) scale of photography and camera characteristics,
(iii) whether photography consists of verticals and/or obliques,
(iv) evaluation of quality,
(v) that the originating countries forward each year to every other member nation, and to the Secretaries General of IUGG and IGU, one up-to-date copy of their photo-indexes.

(*e*) That nations intending to concentrate their future mapping efforts at scales not less than 1:3000000 in any particular area, as shown in the index prepared by the USSR, should inform SCAR accordingly at its regular meetings, and that wherever possible nations should co-operate to cover whole sheets.

(*f*) That SCAR, wishing to encourage the production of scientific atlases of Antarctica, recommends that member nations assist wherever practicable, and that where such assistance is given, it be duly acknowledged in the publication.

Fifth Meeting of SCAR, Wellington, 1961

V. Gd–1. That member nations should carry out research similar to the work done in the United States in connexion with the development of special photogrammetric techniques for identification of disturbances of snow and ice surface, particularly in the so-called "featureless" area of Antarctica, in order that these forms may be adequately portrayed on 1:1000000 scale maps. Also, that SCAR seek the advice of the International Society for Photogrammetry in this matter.

V. Gd–2. That all Antarctic maps carry a reliability diagram and "history" panel, and that future editions of the map catalogue include a brief description of the base material used in map compilation.

V. Gd–3. That any member requiring an increased distribution of map material, over that recommended by SCAR at its Third Meeting, inform the Secretary of the working group in order that the Secretary may endeavour to make arrangements for this distribution.

V. Gd–4. That member nations planning to produce atlases of scientific information of Antarctica should use, to the extent feasible, uniform or similar base sheets, striving by means of international co-operation to attain uniformity

in scale, orientation, projection, and other details of map design; while at the same time complying with any applicable recommendations of map specifications adopted by SCAR.

V. Gd–5. That all one-sheet maps of Antarctica be prepared with the Greenwich zero-longitude meridian pointing vertically towards the top of the map sheet.

V. Gd–6. That members undertake geodetic surveys in local areas for the purpose of establishing, on ice-free rock outcrops, a framework of permanent marks that can subsequently be used as a basis for accurate ice movement surveys.

V. Gd–7. That the possibility of using artificial satellite observations for determination of absolute geodetic position be investigated by members, and the advice of both COSPAR and IUGG be sought in this matter.

V. Gd–8. That the Secretary of the Working Group distribute to members details of the types of "ice markers" (*a*) proposed by the United States, and (*b*) successfully used by Expéditions Polaires Françaises in Greenland over a period of at least ten years.

V. Gd–9. That the Secretary of the working group distribute to members reports on practical experience in the use of electronic distance measurement equipment in polar conditions including (*a*) reports received from individual members. (*b*) special reports to be supplied by manufacturers, (*c*) reports to be sought from Canada.

V. Gd–10. That the UNO Cartographic Office be informed of the map symbols adopted by SCAR and be asked to ensure that the symbols used on the 1:1000000 scale International Map of the World conform to these in respect of Antarctic areas.

Sixth Meeting of SCAR, Boulder, 1962

There was no meeting of the Working Group on Geodesy and Cartography during the Sixth Meeting of SCAR.

Seventh Meeting of SCAR, Cape Town, 1963

The working group did not meet on this occasion, but informal discussions were held at the Commonwealth Survey Officers Conference at Cambridge (England) in July 1963 and at the Thirteenth General Assembly of IUGG at Berkeley (USA) in August, 1963. Australian, British, New Zealand and South African members attended the Cambridge meeting; Australian, British, Chilean, French, Japanese, New Zealand and United States members attended the meeting at Berkeley. As the meetings were informal no recommendations were submitted to SCAR for approval.

Eighth Meeting of SCAR, Paris, 1964

VIII. Gd–1. That the possibilities of long-distance ties and geodetic satellite surveys continue to be investigated by members particularly:

(*a*) That USA bear in mind the possibility of international co-operation in the Antarctic using SECOR or any other appropriate system.

(*b*) That France investigate and report on the feasibility of applying its satellite photographic system to a geodetic survey connexion between Antarctica and Australia, New Zealand and other continents and islands.

VIII. Gd–2. That for the convenience of member countries which do not normally use the metric system, future topographic maps should show a scale of kilometres, statute miles and nautical miles together with an altimetric conversion scale of metres and feet.

VIII. Gd–3. That for the purpose of co-ordination in map scales produced by different countries, the following scales should be used for Antarctic maps:

(*a*) general maps: 1:3000000; 1:5000000; 1:10000000; 1:20000000 and 1:40000000;

(*b*) topographical maps: 1:1000000; 1:500000; 1:250000 or 1:200000; 1:100000; 1:50000 and 1:25000.

VIII. Gd–4. That the following minor variations in the SCAR Standard Symbols be used on topographical maps of Antarctica:

(*a*) in respect of items 16, 17, 26 and 27: use the descriptive words "definite", "approximate" and "conjectural" and symbolization as if for a "zero" contour;

(*b*) in respect of item 60: replace the word "station" by the words "spot heights";

(*c*) in respect of items 16, 20, 21, 22, 23 and 25: include a footnote "desirable to show date, if limits defined";

(*d*) in respect of items 25 (*a*), 28 (*a*), 39 (*a*) and 45 (*a*): alter descriptive note to read "for use on medium and small scale maps";

(*e*) in respect of the Explanatory Notes: include a paragraph stating that where a non-standard symbol appears on a map it should be specifically included in the map legend.

VIII. Gd–5. That the Secretary of the working group prepare, at the appropriate times, five-yearly reports of activities similar to the charter on cartography that has been prepared for the Antarctic Volume of the *Annals of the IGY*.

VIII. Gd–6. That SCAR member countries continue mapping programmes in the Antarctic with the primary objectives of:

(*a*) completing a general small scale map of the continent as soon as practicable;

(*b*) providing the mapping support required by other scientific disciplines and required for navigation and logistic purposes.

(*c*) information on cartographical activities provided in the annual National Reports to SCAR should be in sufficient detail and be distributed in time for effective use.

Action arising from the SCAR Recommendations

Interchange of cartographic material. All members have distributed copies of their published maps, charts and gazetteers (where applicable).

Mapping specifications. The SCAR recommendations relating to projections, scales, sheet lines, standard symbols, marginal information etc., have been adopted by most nations.

Scientific atlases of Antarctica. USSR has compiled a comprehensive atlas in two volumes. The first volume, which contains 75 pages of text and more than 40 maps, was published in late 1965. The second volume, to be published in 1967, will be a textual supplement to the first volume.

The American Geographical Society has started production of an Antarctic Map Folio Series which will comprise some 20 folios, each devoted to one subject or scientific discipline. Folio No 1 (Aeronomical maps for the Antarctic), Folio No 2 (Physical characteristics of the Antarctic ice sheet), and Folio No 3 (Antarctic maps and surveys 1900–1964) were published during 1965.

Standard symbols for topographical maps. The symbols approved by SCAR during the Fourth (1960) and Fifth (1961) Meetings were distributed, in booklet form, to all members of the working group and other interested organisations, At the United Nations Technical Conference on the International Map of the World on the Millionth Scale, Bonn, 1962, the SCAR symbols were adopted, and now are in the Specifications of IMW.

Catalogue of Antarctic maps and charts. A catalogue of topographical maps and aeronautical and hydrographic charts of the Antarctic was distributed by the working group Secretary in November 1961. A second edition was published in May 1964. The catalogue is kept up-to-date by periodical lists of amendments and additions.

Geodetic surveys for accurate measurement of ice movement. Members of the working group were furnished with a diagram showing the geodetic position determinations desired by the Working Group on Glaciology.

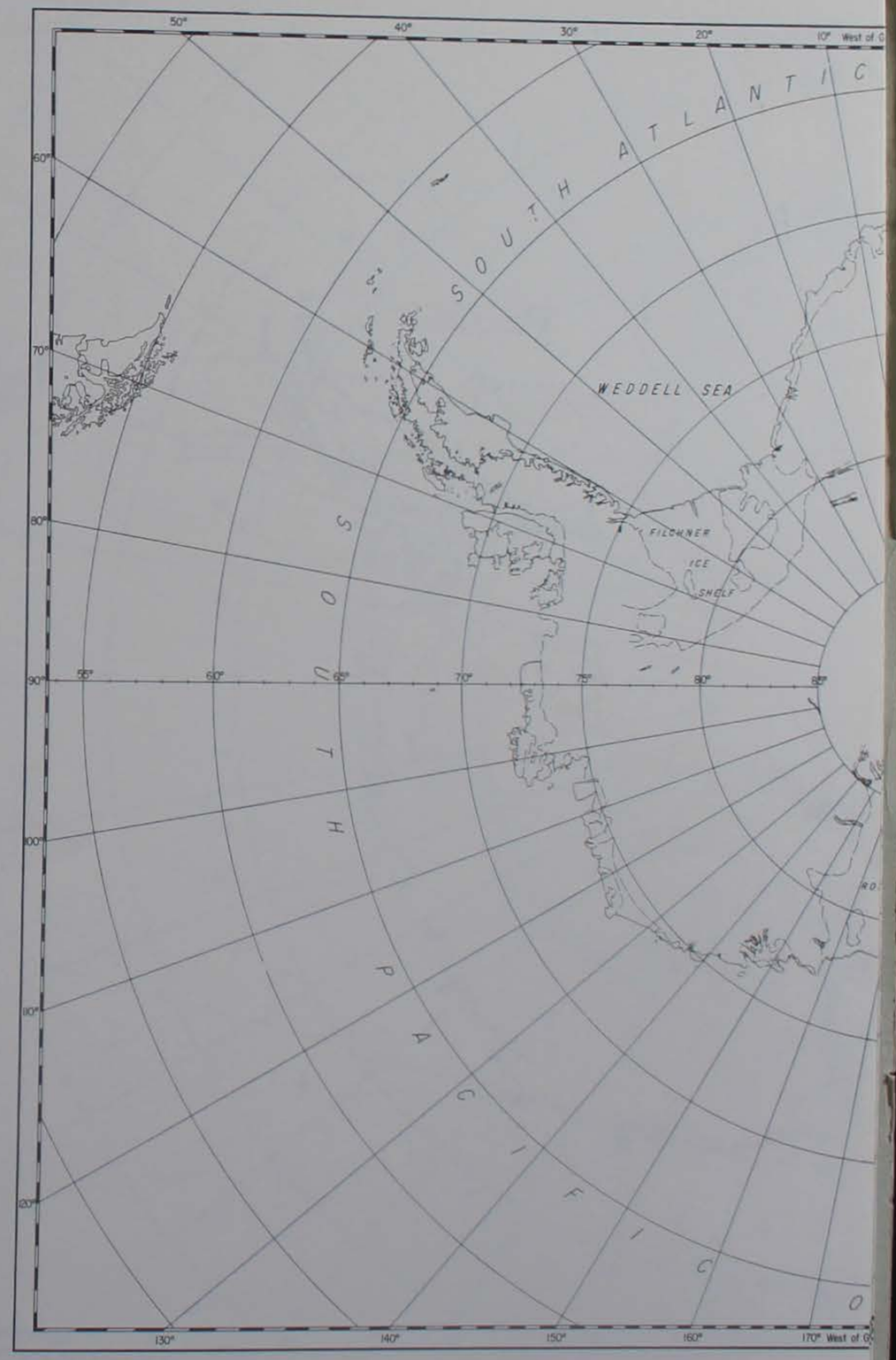
Use of artificial satellites for determination of geodetic position. The terms of this recommendation were conveyed to the Secretary of the ICSU Committee on Space Research (COSPAR) and the Secretary of the International Association of Geodesy (IAG). The subject was discussed at the IAG/COSPAR Symposium on the Use of Artificial Satellites for Geodesy, held in Washington, April 1962. The United States member of the Working Group on Geodesy and Cartography was represented at this Symposium. He prepared a synopsis of the proceedings which was sent to all members of the working group.

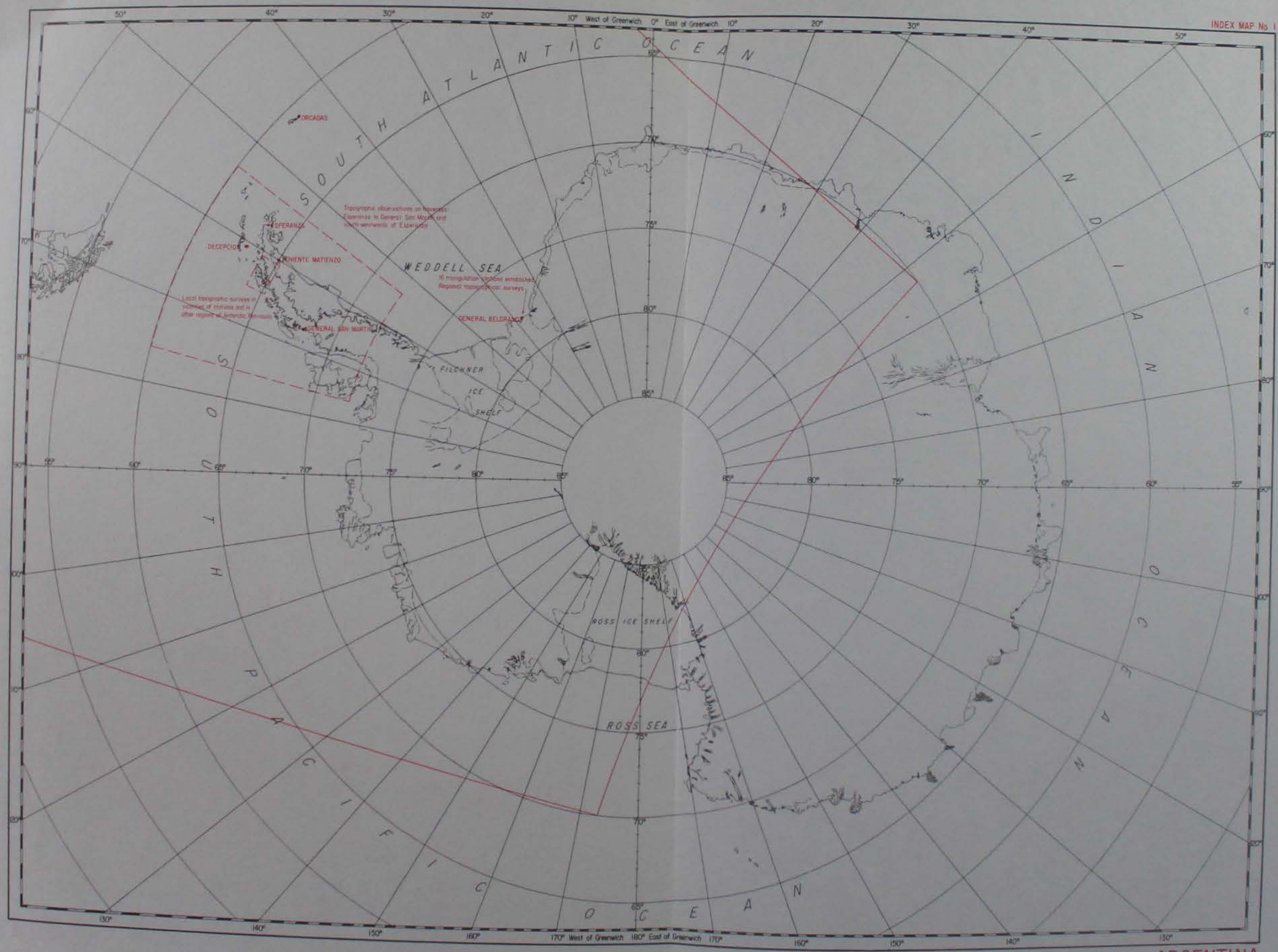
Relevant points made by COSPAR, in response to SCAR's request, are summarised in *SCAR Bulletin* No 13, p 194–95.

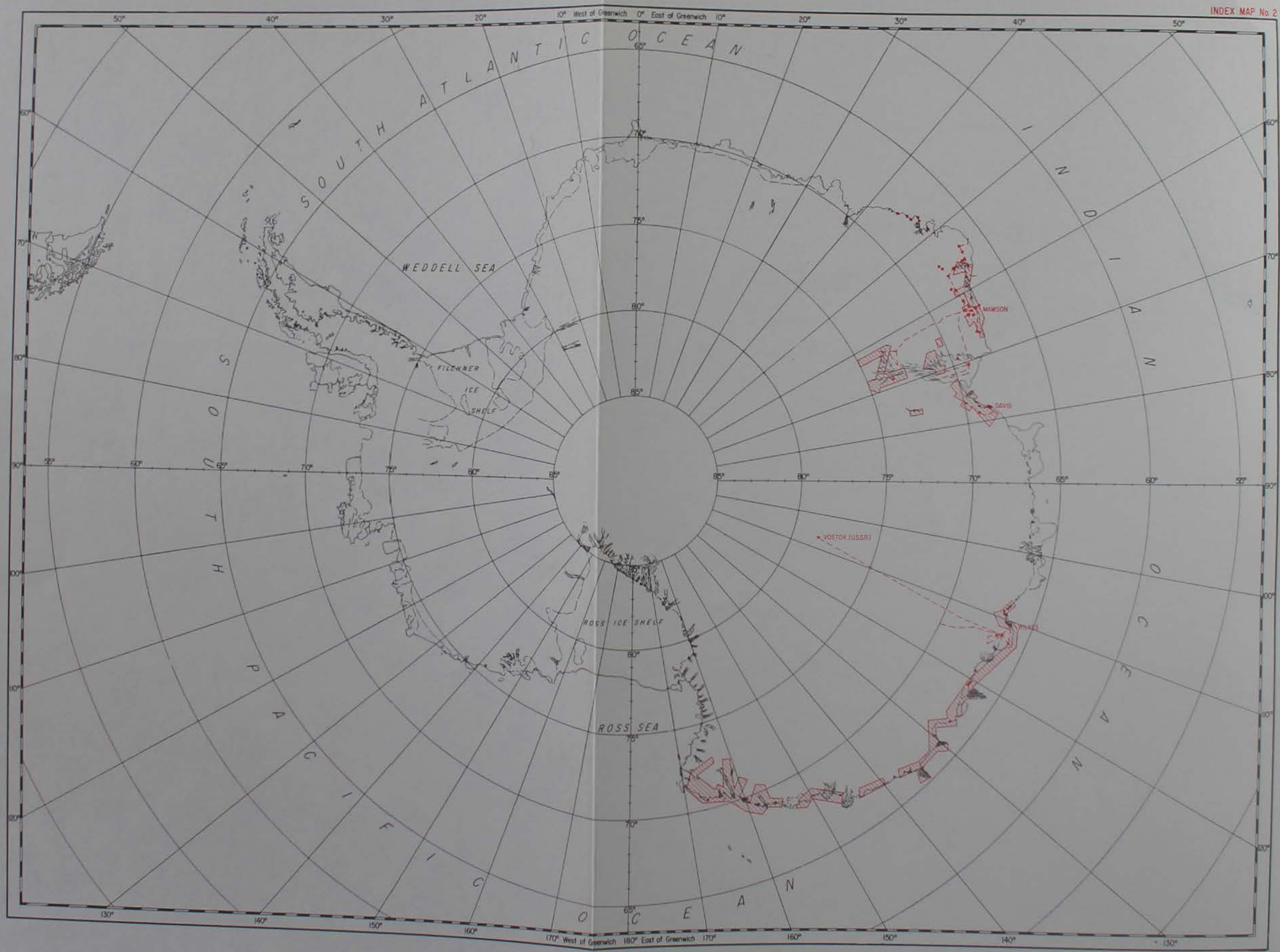
Bi-lateral agreement on place-names. A satisfactory measure of agreement has been reached by nations operating in areas of common interest.

Exchange of air photography flight index diagrams. These have been prepared and distributed by Australia, Belgium, Norway, the United Kingdom and the United States of America in the form recommended by SCAR.

Development of special photogrammetric techniques for identification of snow and ice surface disturbances. This recommendation has been referred to the international Society for Photogrammetry for advice.


50°
40°
30°
20°
10° West of G
60°
70°
80°
90°
100°
110°
120°
55°
60°
65°
70°
75°
80°
85°
130°
140°
150°
160°
170° West of G
SOUTH ATLANTIC
WEDDELL SEA
FILCHNER
ICE
SHELF
SOUTH PACIFIC
Ground Traverses


INDEX MAP No. 1
10° West of Greenwich 0° East of Greenwich 10°
170° West of Greenwich 180° East of Greenwich 170°
SOUTH ATLANTIC OCEAN
INDIAN OCEAN
SOUTHERN OCEAN
PACIFIC OCEAN
ORCADAS
ESPERANZA
DECEPCION
TENIENTE MATIENZO
GENERAL SAN MARTIN
GENERAL BELGRANO
WEDDELL SEA
FILCHNER ICE SHELF
ROSS ICE SHELF
ROSS SEA
Topographic observations on Navigation Experience in General San Martin and South-westwards of Esperanza
Local topographic surveys in vicinities of Instituto and in other regions of Antarctic Peninsula
16 triangulation stations established
Regional topographical surveys
Topographic Map 1:10,000,000
Hydrographic Charts (various scales)
ARGENTINA
SURVEY AND CARTOGRAPHIC ACTIVITIES



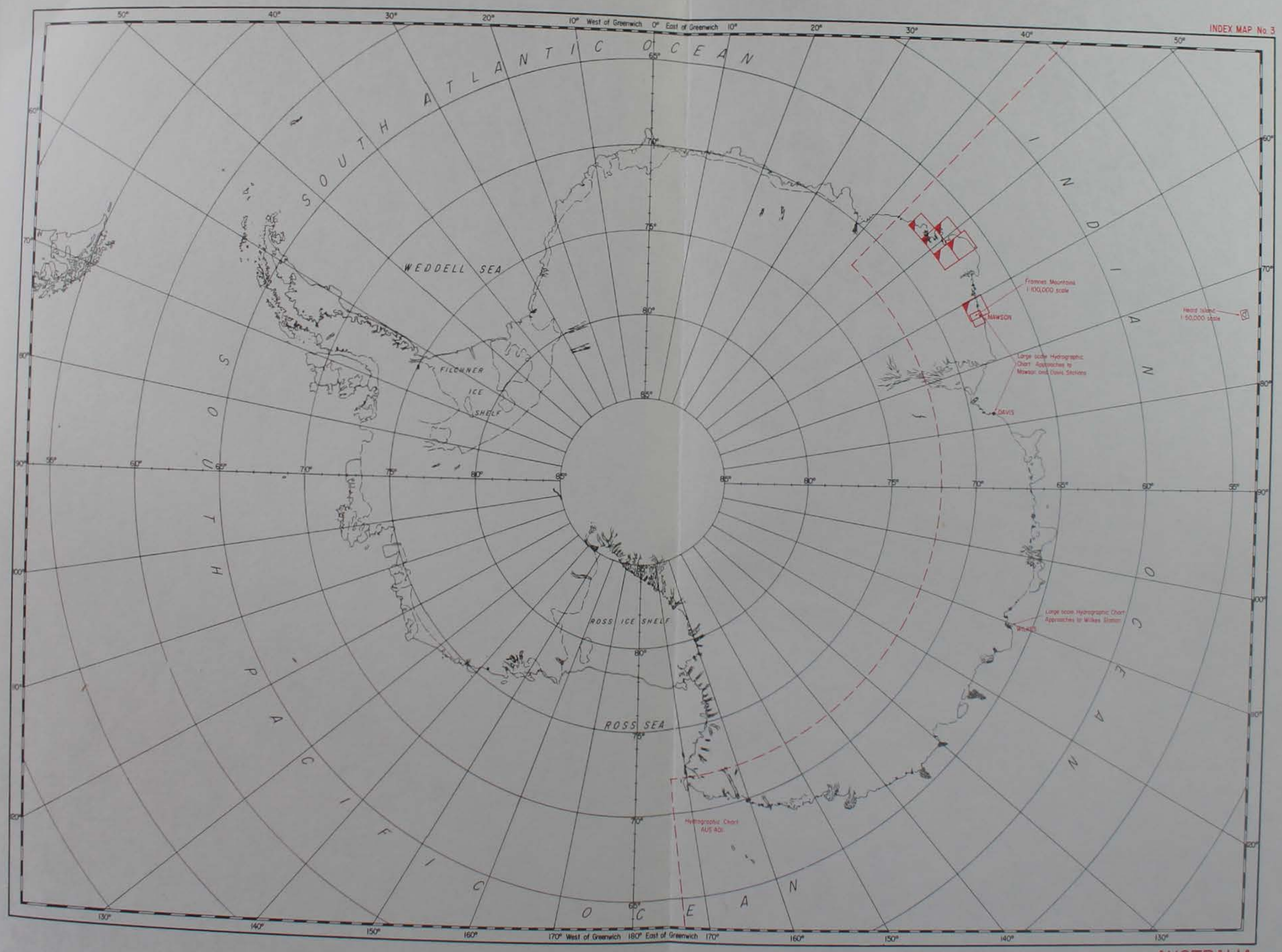
Ground Traverses

Ground Control Stations

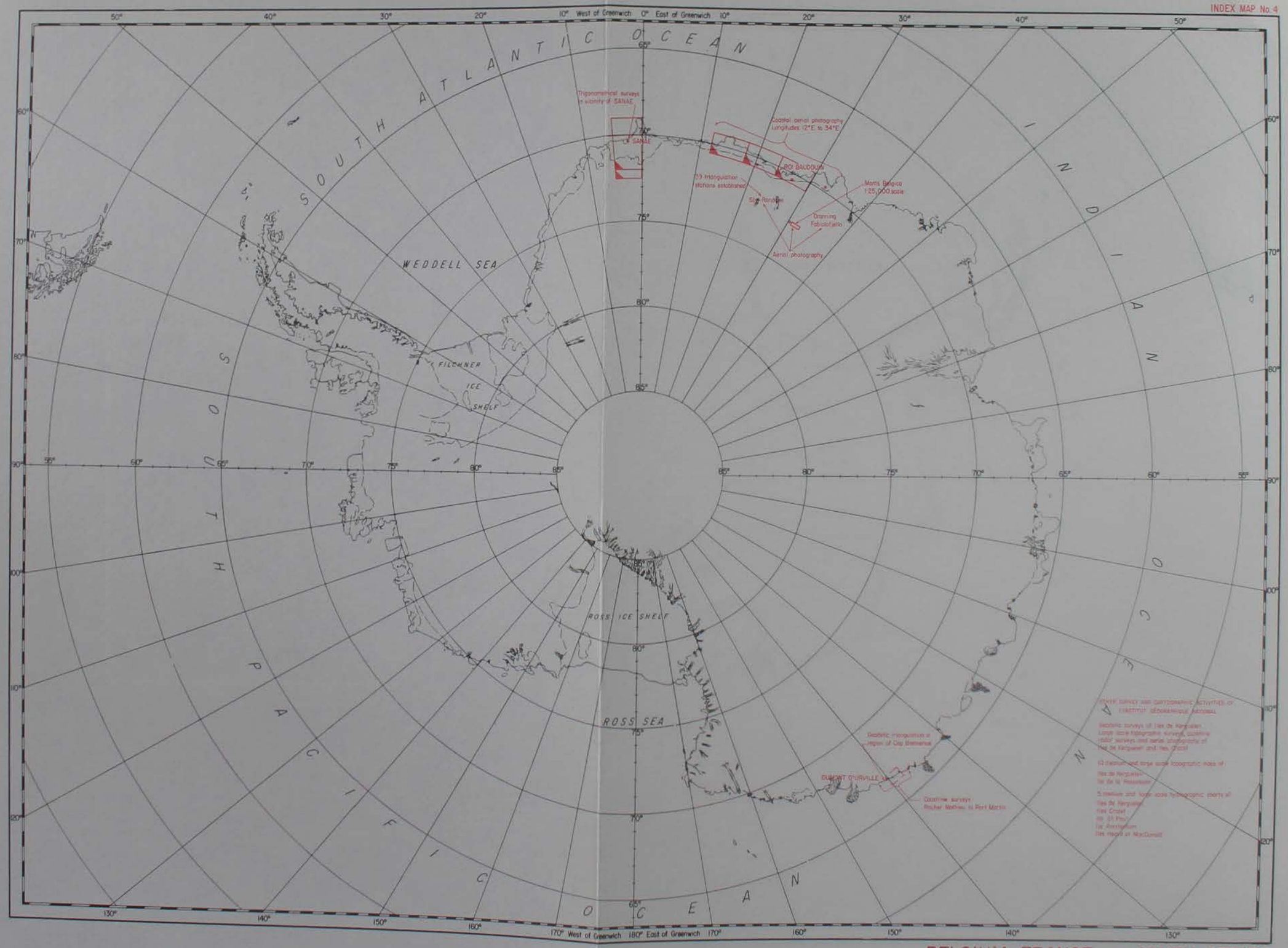
Aerial Photography (mapping and marginal quality)

AUSTRALIA

SURVEY ACTIVITIES



AUSTRALIA
CARTOGRAPHIC ACTIVITIES



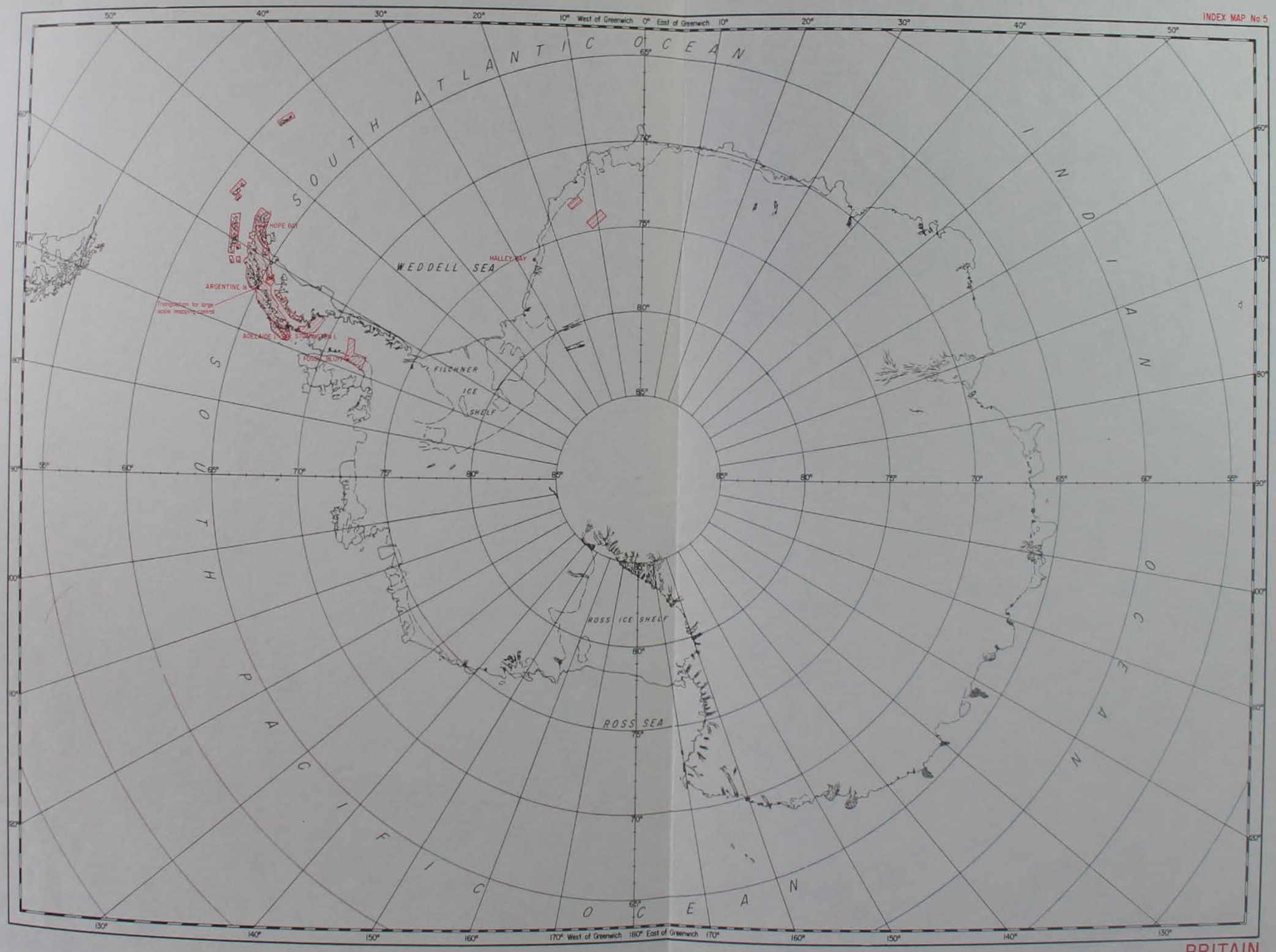
Ground Control Stations (Belgium and France) •

Topographic Maps (Belgium and S.Africa) 1:250,000

Hydrographic Chart (France)

BELGIUM, FRANCE AND SOUTH AFRICA

SURVEY AND CARTOGRAPHIC ACTIVITIES

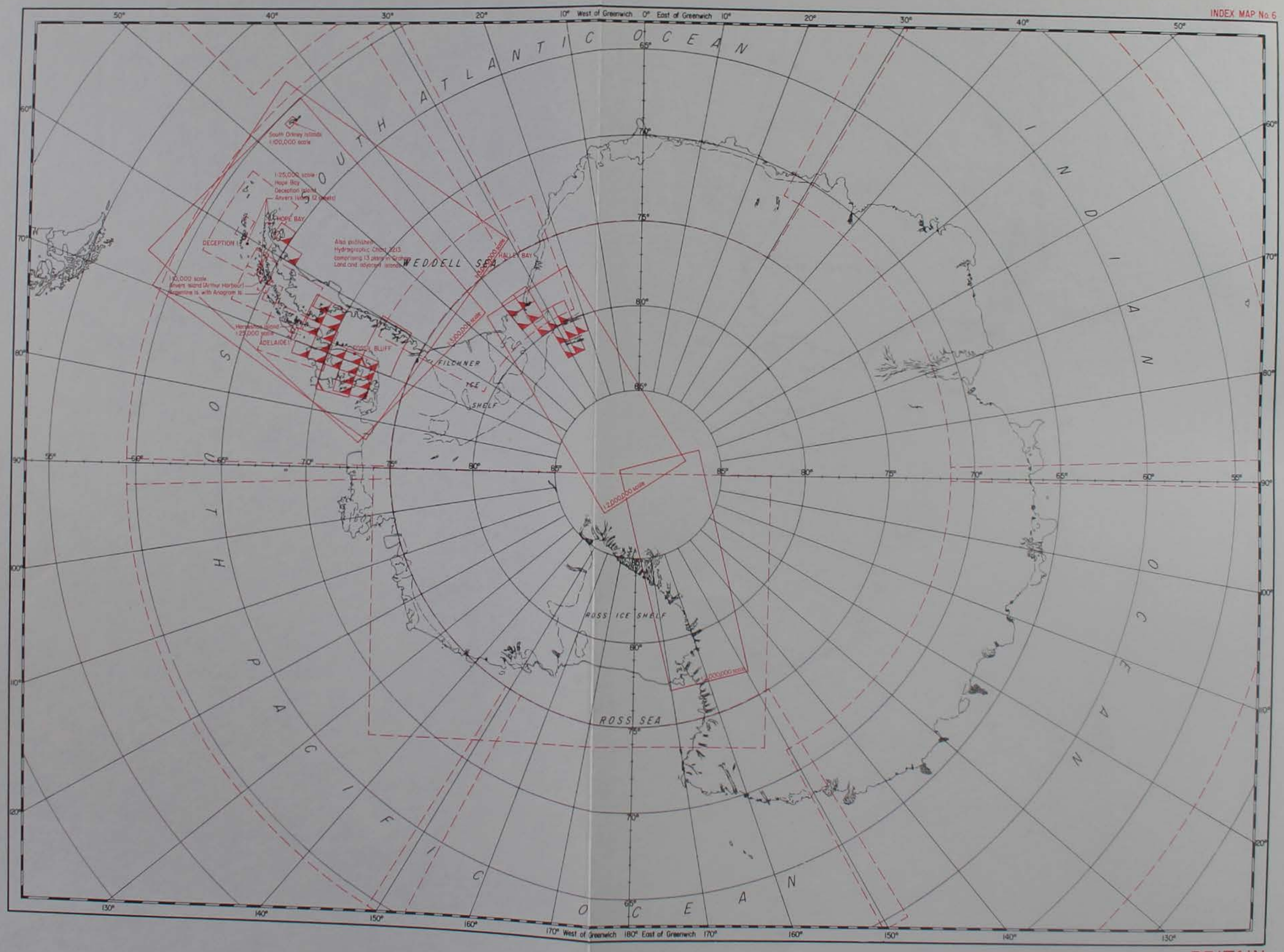


BRITAIN

SURVEY ACTIVITIES

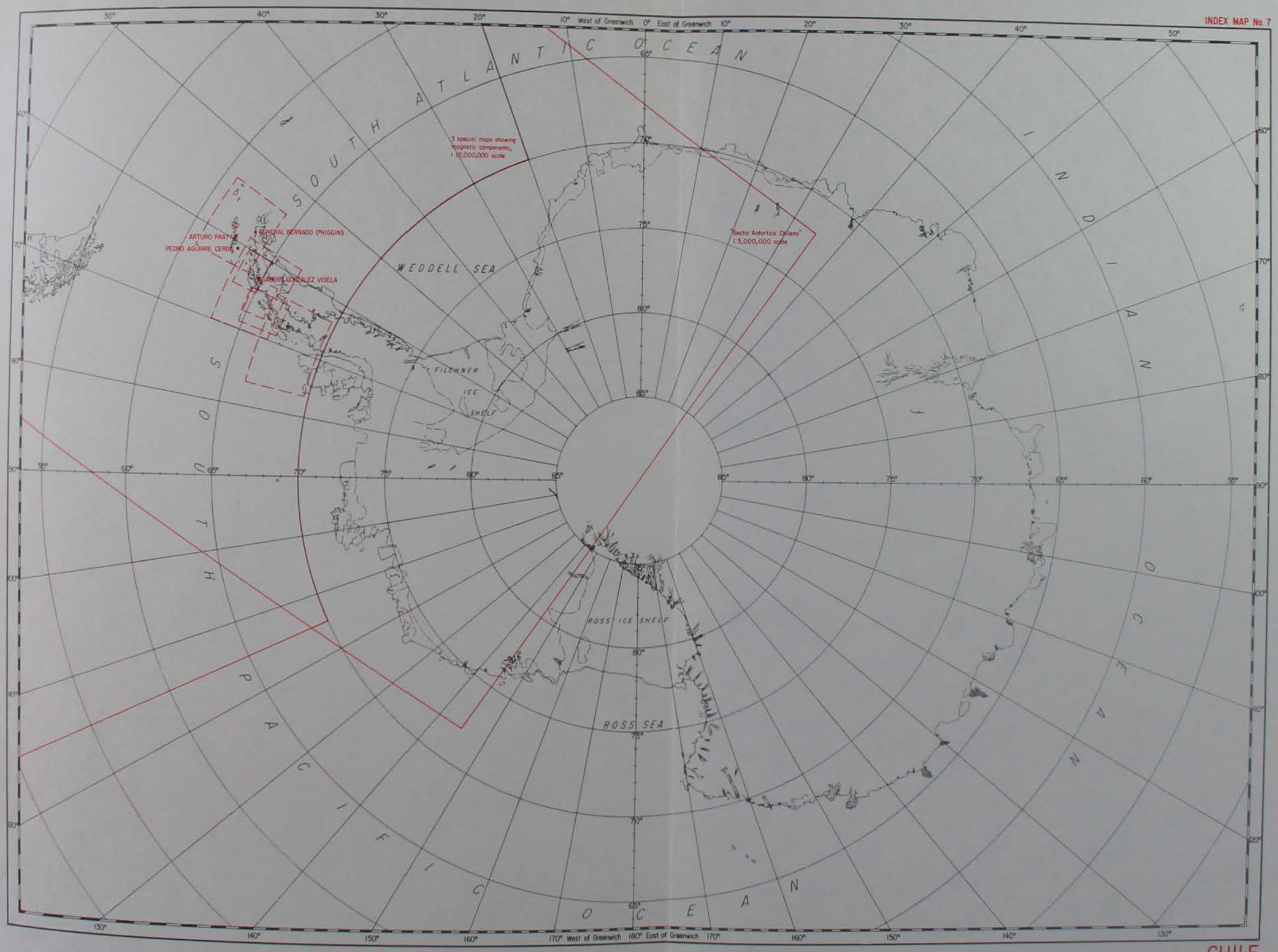
Areas of Topographic Surveys

Aerial Photography



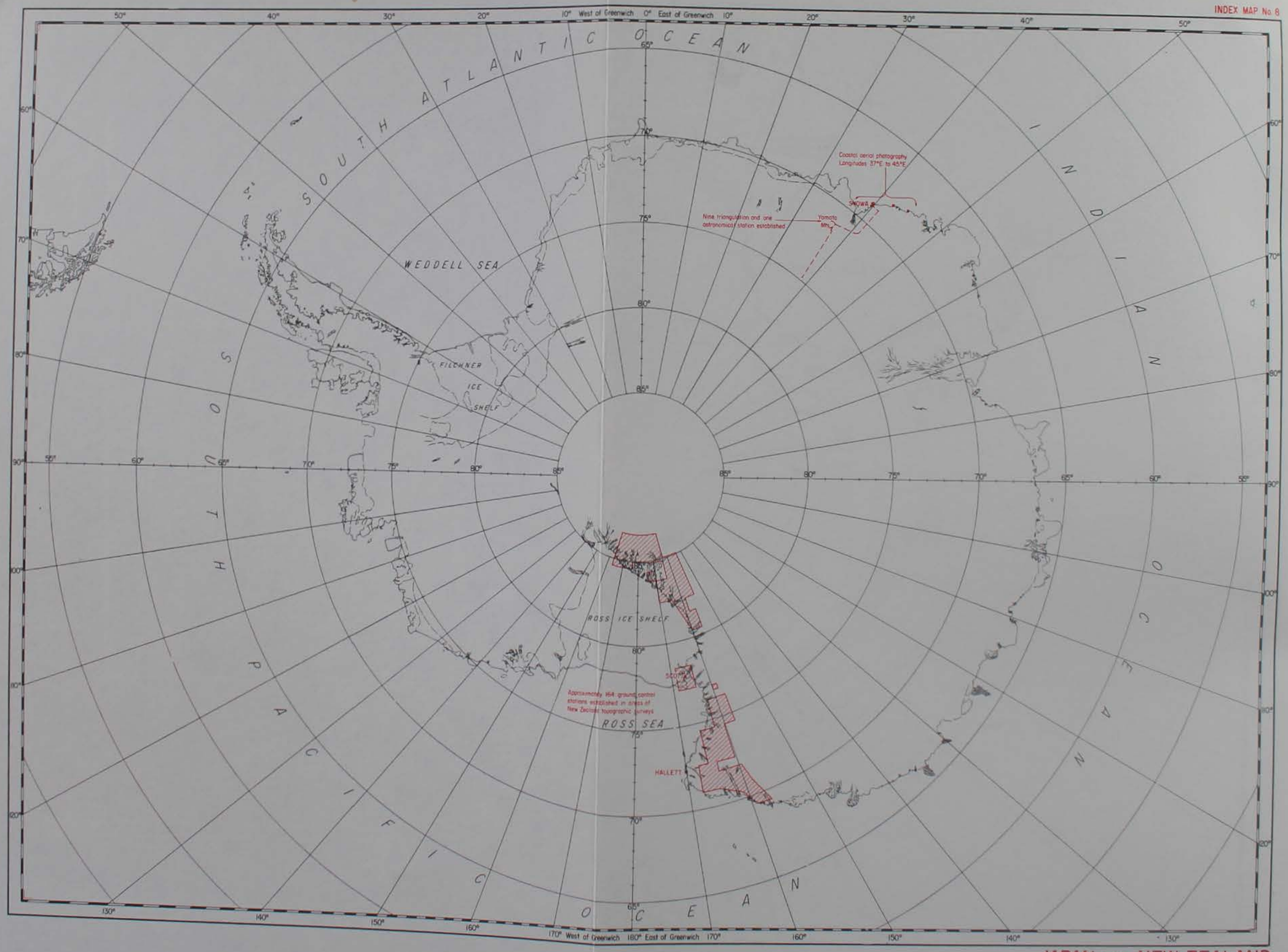
Topographic Maps 1:500,000 1:200,000 various scales Hydrographic Charts (various scales)

BRITAIN
CARTOGRAPHIC ACTIVITIES



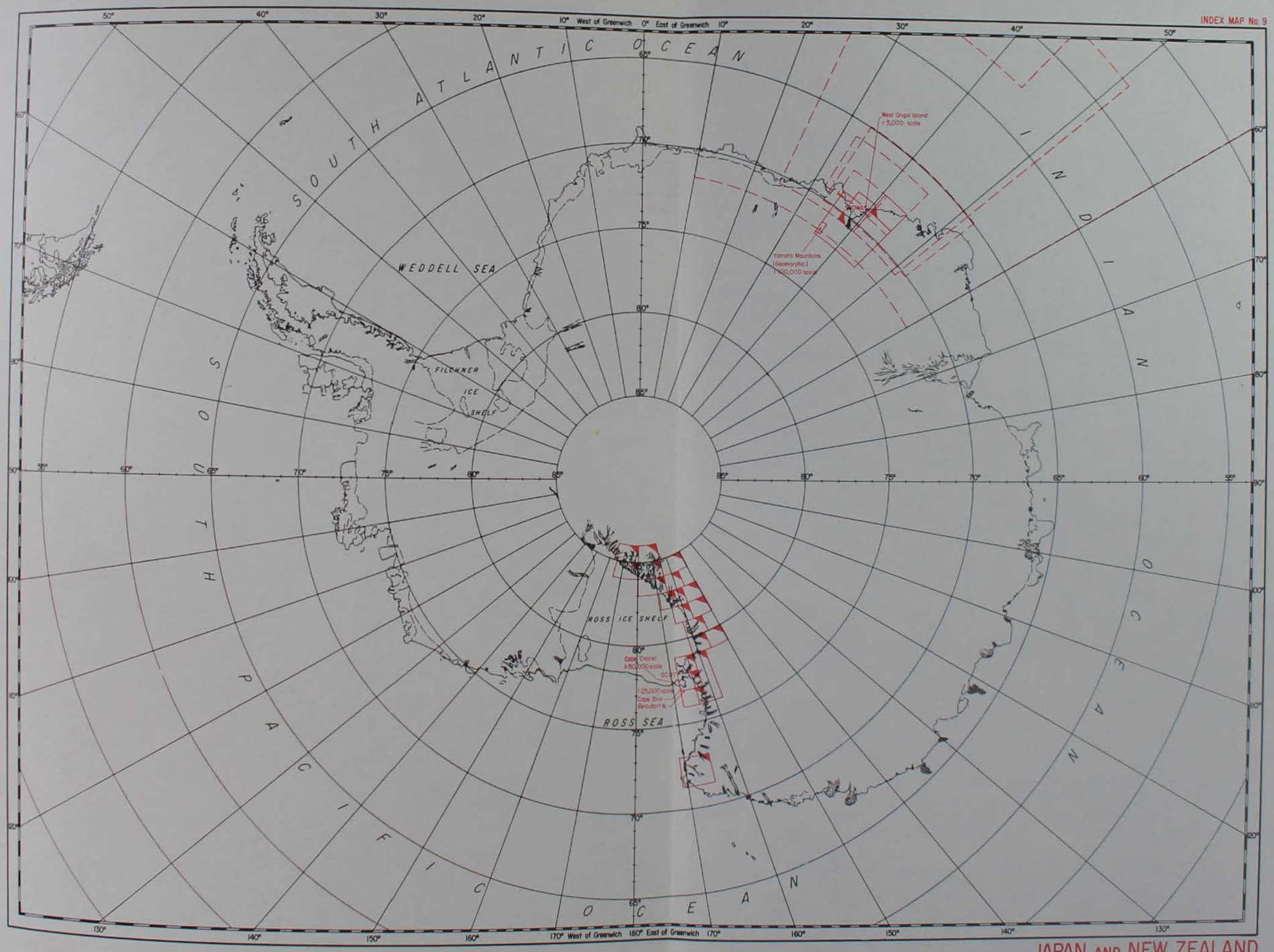
CHILE

CARTOGRAPHIC ACTIVITIES



JAPAN AND NEW ZEALAND

SURVEY ACTIVITIES

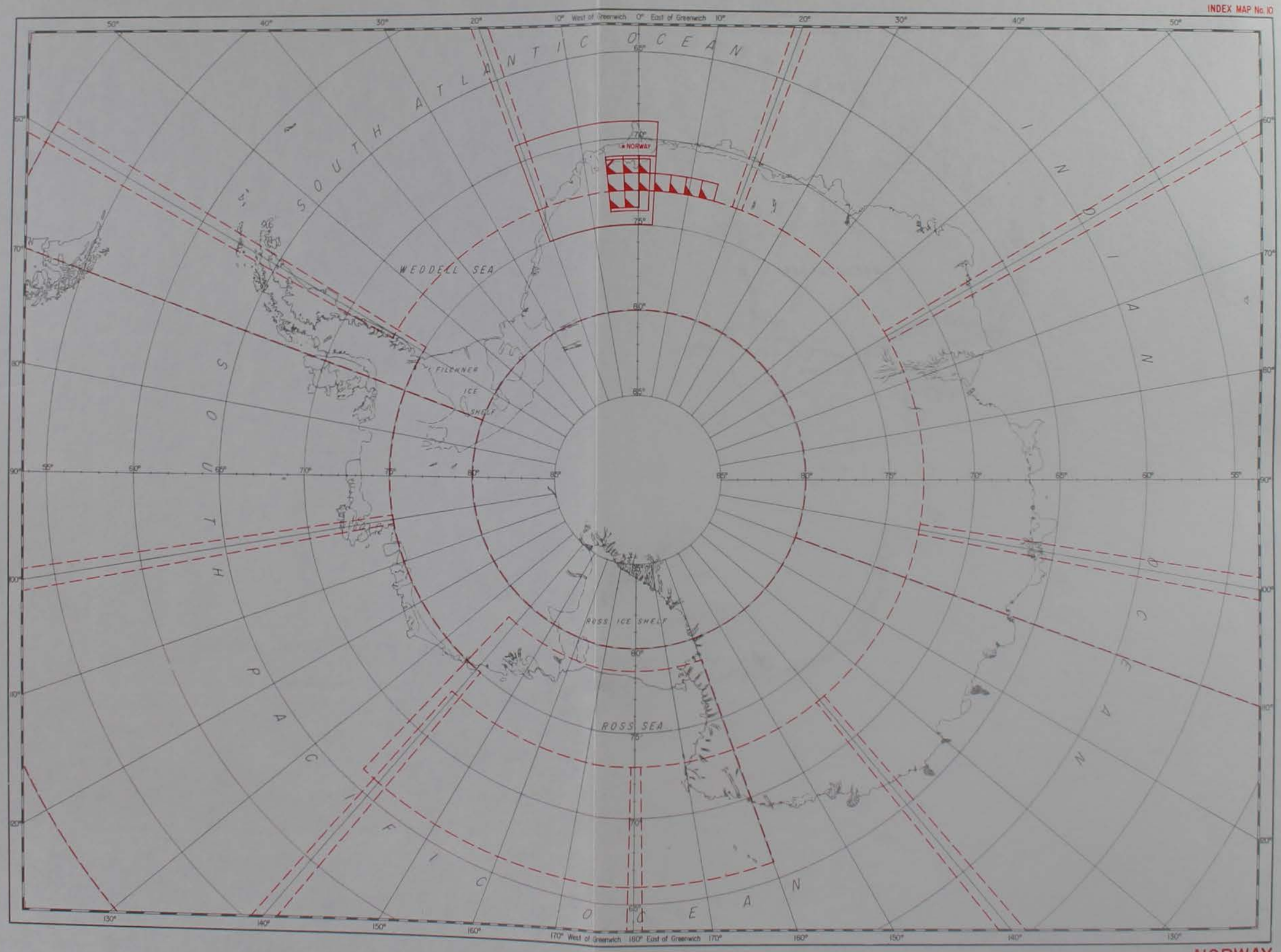


Topographic Maps 1:1,000,000 (Japan) 1:250,000 (Japan and NZ) Hydrographic Charts (Japan)

JAPAN AND NEW ZEALAND

CARTOGRAPHIC ACTIVITIES

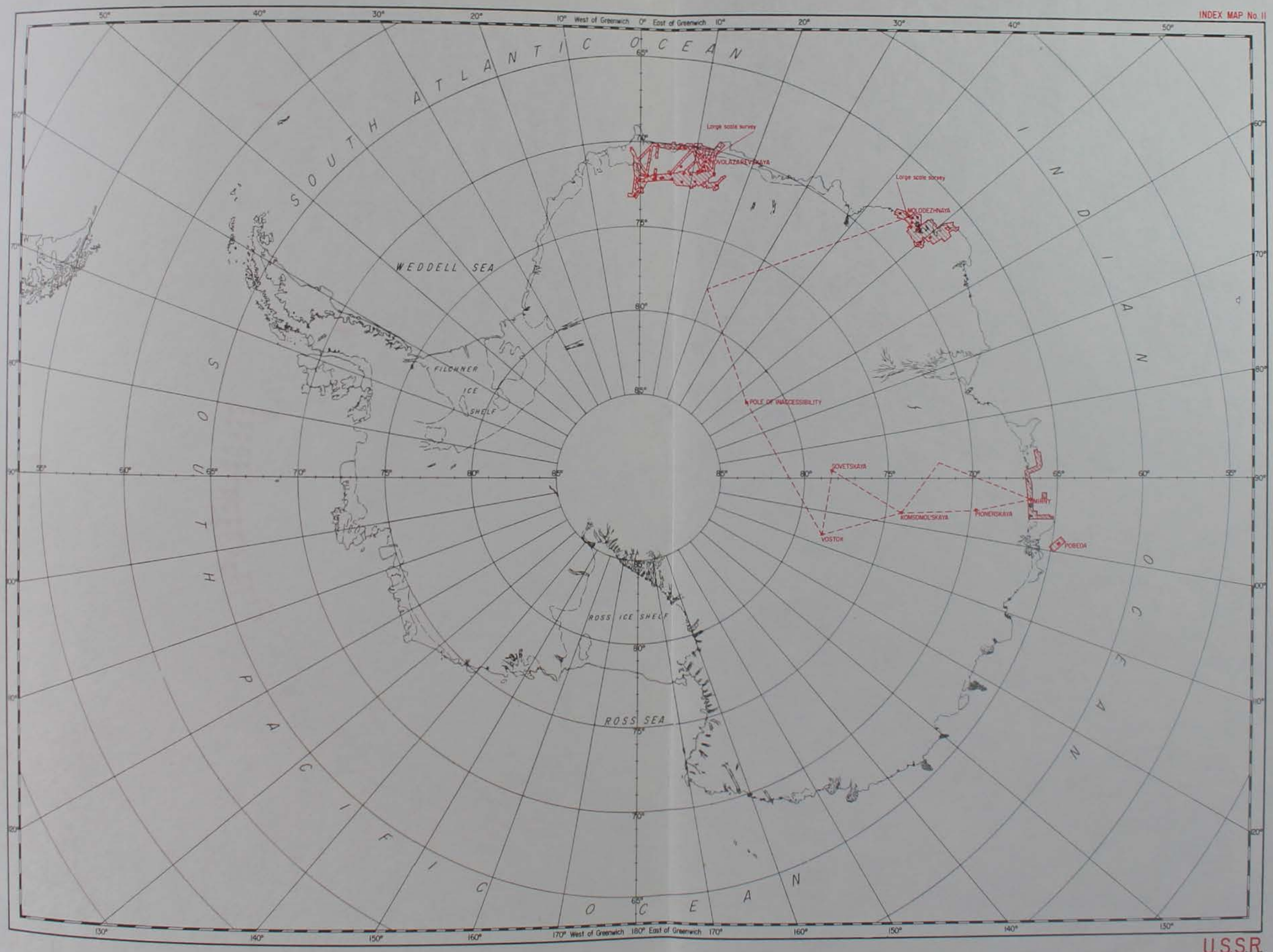
INDEX MAP No. 10



Topographic Maps 1:1,000,000 1:500,000 1:250,000 Hydrographic Charts (various scales)

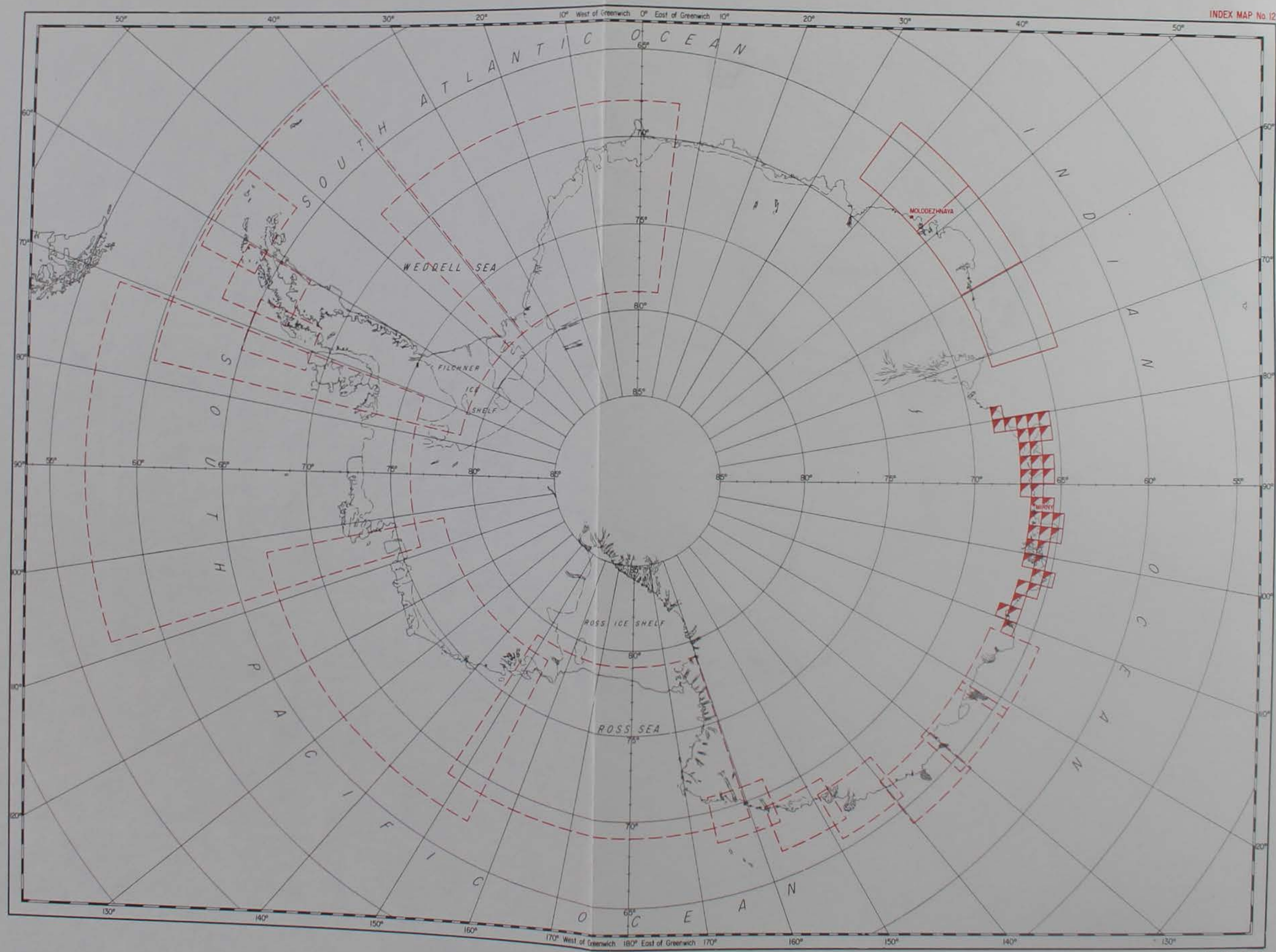
NORWAY

CARTOGRAPHIC ACTIVITIES



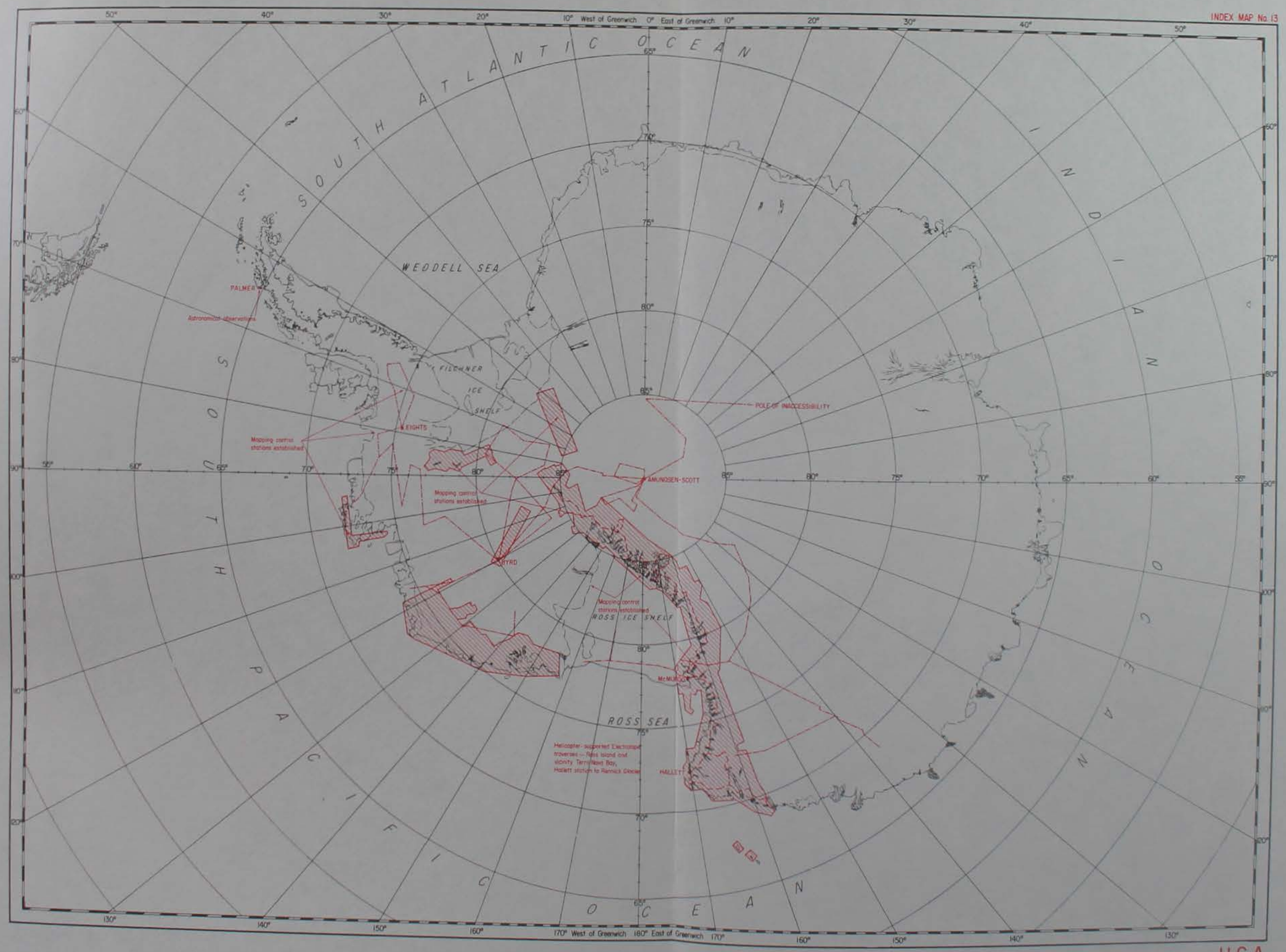
U.S.S.R.
SURVEY ACTIVITIES

Ground Traverses ---- Ground Control Stations • Aerial Photography



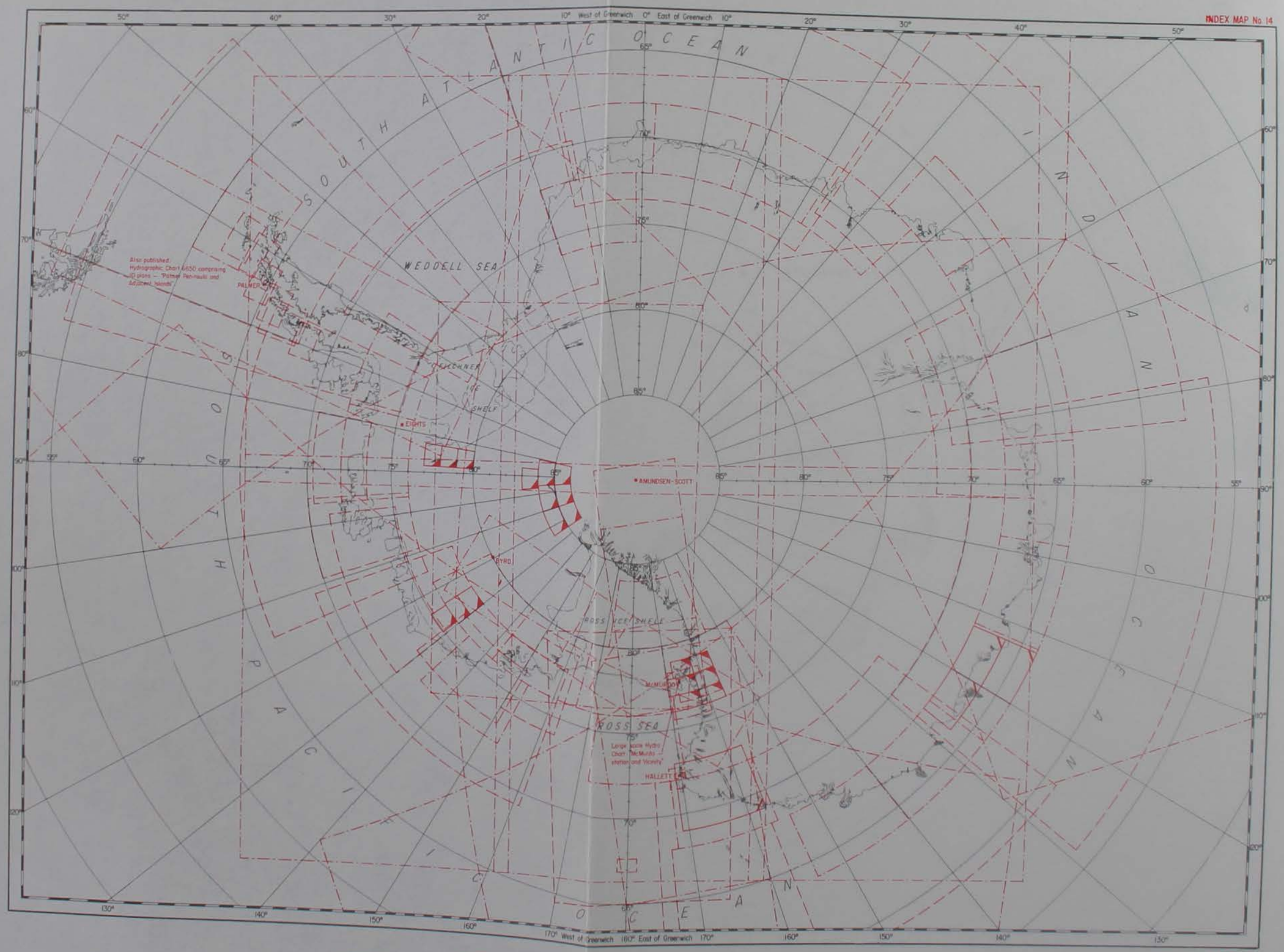
Topographic Maps 1:1,000,000 1:200,000 Hydrographic Charts (various scales)

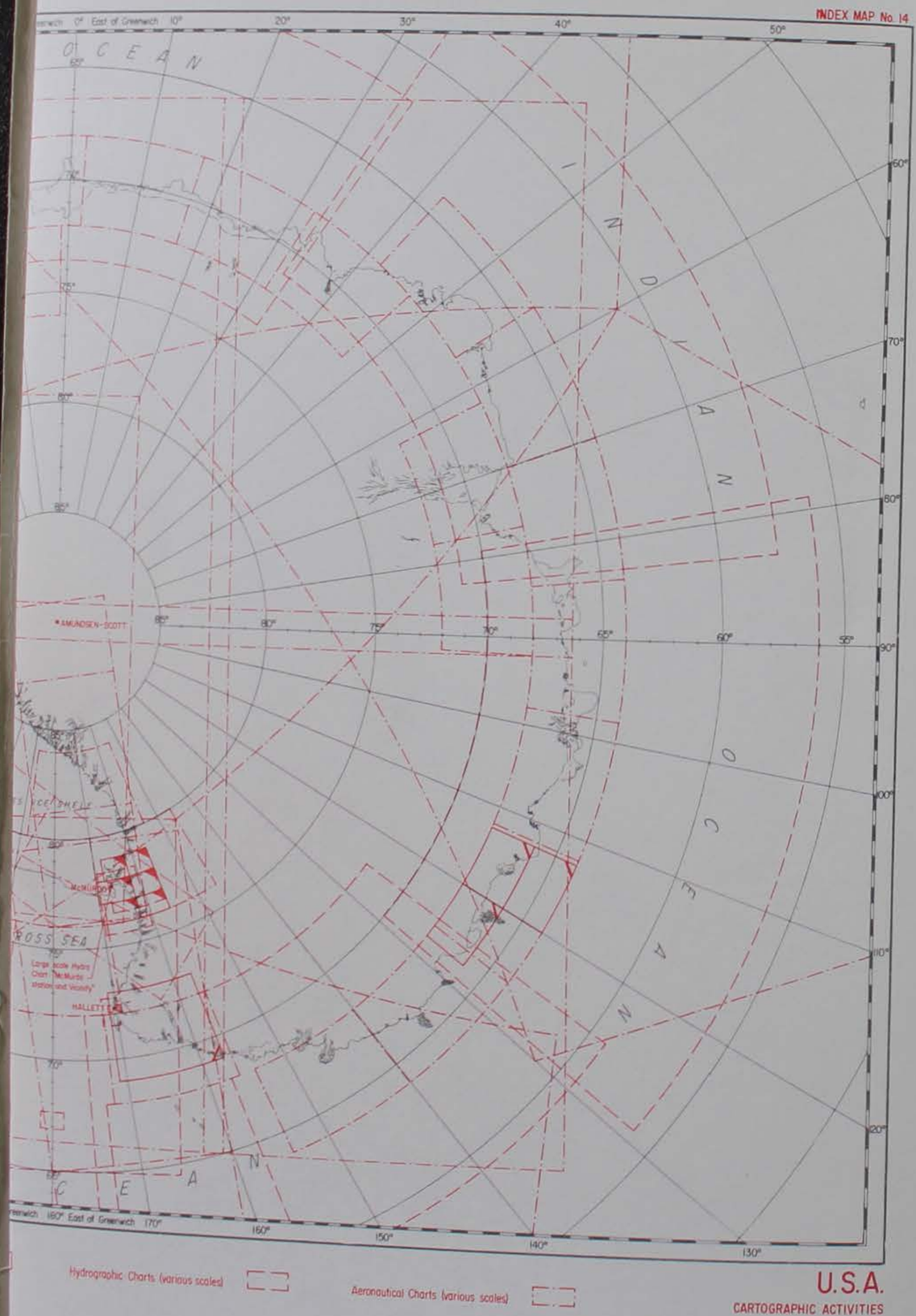
U.S.S.R.
CARTOGRAPHIC ACTIVITIES



U.S.A.
SURVEY ACTIVITIES

Ground Traverses Helicopter-supported ---- Over-snow ——— Aerial Photography (mapping and marginal quality)


INDEX MAP No. 14
SOUTH ATLANTIC OCEAN
INDIAN OCEAN
PACIFIC OCEAN
WEDDELL SEA
ROSS SEA
ROSS ICE SHELF
PALMER
EIGHTS
BYRD
AMUNDSEN-SCOTT
HALLETT
Also published Hydrographic Chart 6650 containing 10 plans – "Palmer Peninsula and Adjacent Islands"
Large scale Hydro Chart "McMurdo Station and Vicinity"
Topographic Maps 1:500,000
1:250,000
Hydrographic Charts (various scales)
Aeronautical Charts (various scales)
U.S.A.
CARTOGRAPHIC ACTIVITIES



NOTICE

The SCAR Bulletin is published in England in January, May and September each year as part of the *Polar Record*, the journal of the Scott Polar Research Institute.

Contributions are invited, and should consist of factual notes on the membership, equipment and activities of Antarctic parties; articles on matters of particular interest in connection with these activities are also welcome. Contributions should be sent to the Editor, Scott Polar Research Institute, Lensfield Road, Cambridge, England.

THE POLAR RECORD

This is the journal of the Scott Polar Research Institute. It is published in January, May and September each year and may be obtained direct from the Scott Polar Research Institute, Lensfield Road, Cambridge, England, or through any bookseller. The subscription is thirty-one shillings and sixpence a year, or ten shillings and sixpence a copy.

Printed in Great Britain at the University Printing House, Cambridge