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ANTARCTIC GEOLOGY

Proceedings of the First International Symposium on Antarctic Geology, held in Cape Town, 16–21 *September* 1963.
Edited by R. J. Adie, Amsterdam, North-Holland Publishing Company, 1964

BY T. SORGENFREI*

Geological work has been in progress in the Antarctic for more than sixty years. Up to World War II, the efforts were of an occasional nature but during later years work has been carried out in a more systematic manner by a number of national research expeditions. A new stage in the geological exploration of Antarctica was initiated when the Scientific Committee on Antarctic Research appointed its Working Group on Geology to advise on the various aspects of co-operation in Antarctic geological research. In the Symposium under review, the Working Group has demonstrated the results so far achieved.

Antarctic geology is, in general, a well organized compilation of the most significant recent results of geological mapping and studies in the Antarctic and Sub-Antarctic regions. The Symposium covered practically all fields of geology which may be pursued in these regions, as is illustrated by the following list of sections in which the papers were grouped (the figures in brackets indicate the number of papers in each section): I, Sub-Antarctic islands (3); II, Geomorphology (7); III, Glacial geology (4); IV, General geology (14); V, Stratigraphy (7); VI, Mineralogy (2); VII, Igneous and metamorphic petrology (13); VIII, Geophysics (3); IX, Geochemistry (1); X, Geochronology (7); XI, Palaeontology (5); XII, Structural geology and Tectonics (5); XIII, Submarine geology (3); and XIV, The relationship of Antarctica to the southern continents (2).

Some of the new discoveries are surprising, as for instance that of the saline lakes of the Vestfold Hills in Princess Elizabeth Land and in the Wright Valley in South Victoria Land. The salinities of these lakes are higher than that of the ocean, and the evidence is that the increase of salinity is due to evaporation. The desert conditions of polar and sub-tropical regions thus display more fundamental similarities than might generally be expected! The paper by van Autenboer on the Sør Rondane region includes interesting details of the effects of the very extreme Antarctic desert climate. The nature of the honeycomb-weathering, excellently described and illustrated, is not yet completely understood, while the interpretation of the encountered gypsum crusts and aggregates as recent evaporites seems to be well founded.

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Many other interesting geological and little-known features are reported.

A typical soil structure of Antarctica is "patterned ground". Trail has described patterned moraine from the Prince Charles Mountains in Mac.Robertson Land, and Black and Berg studied patterned ground in Victoria Land. Patterned soil is only found in areas of unconsolidated sediments and is due to the formation of ice and sand wedges. The growth rate of the patterned ground has been estimated by the two authors who conclude that none of the examples studied by them required more than about 10000 years to form.

Students familiar with the glacial morphological features and post-glacial history of the northern hemisphere may interpret the raised beaches described from Graham Land by Adie as the effect of isostasy. Observations of higher levels of former glaciation and snow cover may be supporting evidence in this connexion. According to Oliver, moraines were thus found up to about 1000 m above the present ice surface on the slopes of Mount Kyffin at Beardmore Glacier. The glacially striated bedrock stituated with a minimum relief of 300 m above the present glacial surface in the Ellsworth Mountains as reported by Craddock and others is another example.

The papers on volcanic activity also deserve comment.

Several extinct volcanoes have been surveyed in the Sub-Antarctic islands and Antarctica. Bellair's paper deals with the comparatively unexplored Iles Crozet of the Prince Edward–Crozet Ridge. These islands bear no traces of recent glaciation and are entirely volcanic. It is supposed that the volcanoes have been active fairly recently, and there is evidence of magmatic differentiation in so far as the most recent flows are andesitic while the more ancient flows are richer in ferromagnesian components.

The islands of l'Archipel Kerguelen are built up of basaltic and more acid rock types. From these islands Bellair and Nougier have described an interesting granodioritic to dioritic–kersantitic pluton. Fumaroles evidence recent volcanism.

From Heard Island, Stephenson reported pillow lavas. The volcanic, presumably fumarolic, activity and thermal energy of Deception Island were studied by Casertano.

The majority of the papers are concerned with the regional geology of Antarctica in its various aspects. In view of the difficulties of local stratigraphic nomenclature, Grindley and Warren should be commended for their excellent outline and correlation of the stratigraphic units of the western Ross Sea region.

The Trans-Antarctic Mountains are the geological backbone of Antarctica. They have accordingly been visited and surveyed by a large number of students who reported formations ranging from the Precambrian to the Pleistocene from this mountain range. The sequence includes metasedimentary folded rocks and intrusives from the following systems: Precambrian, Cambrian, Ordovician–Silurian, Devonian, and Carboniferous. In addition, the thick sequence known as the Beacon Group includes continental sediments of Devonian, Carboniferous, Permian, Triassic, and Jurassic age, and dolerites and basalts are associated with these sediments.

To complete the stratigraphic record mention should be made of the new

formation of Cretaceous age discovered at Cape Legoupil in Graham Land, and the Tertiary tuffaceous flagstones from the South Shetland Islands.

Thickness of the stratigraphic sequence, or part of it, have occasionally been given. The group of undated formations, possibly of early to middle Palaeozoic age, of the Ellsworth Mountains has been estimated to be about 12200 m thick. In the region of the Nimrod–Beardmore–Axel Heiberg glaciers the sequence ranging from the Precambrian to the Triassic totals about 16000 m. It is accordingly very likely that the thickness of the sequence of the most well developed portions of the basin may approach 20000 m. The papers on the geological dating of the many non-fossiliferous, or almost barren, formations are of notable interest.

The discovery of Archaeocyatha in the slate-graywacke formation of the Ross System of Robertson Bay was a real advance in providing evidence for the correctness of the dating of the Ross System to the Lower Palaeozoic as pointed out by Oliver.

The Beacon Group, which locally may be more than 2000 m thick, was also repeatedly discussed during the Symposium. This group is an assemblage of continental sediments including sandstones, siltstones, shales and arkoses, genetically comparable with the Karroo and Gondwana systems. However, the discussions showed that it was premature to amend the stratigraphy and the correlation of the Beacon Group with formations of other regions.

In other respects the plant fossils of the Beacon Group, ranging from the Devonian to early Jurassic, are the stratigraphic keys to Antarctic geology. Dr Plumstead commented on these important organic remains, and compiled data on the fossil sites in her paper.

Another subject which aroused general interest were the tillites. The bulk of the tillites of the Ross Dependency (Nimrod, Beardmore, and Axel Heiberg glaciers) and other areas are referred to the Devonian-Carboniferous period by Grindley and others. However, from Plunket Point, also in the Ross Dependency, Oliver reports tillites which are tentatively correlated with the Jurassic or Cretaceous Mawson Tillite in Victoria Land. We are thus confronted with at least two tillite horizons in Antarctica.

Incidentally, the discussion showed that the definition of tillite caused some dispute—a demonstration of the need for current critical observations even of well-known concepts.

Igneous and Metamorphic petrology are mainly referred to section VII but much information is also included in the papers of the sections dealing with general geology, stratigraphy etc.

As would be expected, many metamorphic grades have developed in Antarctica, but the variety of metamorphism reveals some general trends. The Precambrian has thus been subjected to a higher grade of metamorphism during an early orogeny than the subsequent younger sequences. Rocks of granulite facies and, particularly, amphibolite facies are the rule in the Precambrian of the Trans-Antarctic Mountains and the East Antarctic Precambrian shield.

In some regions, the Precambrian as well as the sequence of rocks ranging from late Precambrian to Ordovician have been subjected to metamorphism, probably

in middle or late Palaeozoic time. This happened, for example, in the western Ross Sea region where the Ross Supergroup of early Palaeozoic rocks commonly belong to the greenschist facies. However, occasionally these rocks also grade into the almandine-amphibolite facies.

Granitic intrusions are encountered in several regions. In the Thiel Mountains, Ford reports the occurrence of large intrusive bodies of approximately Palaeozoic age. The gabbro-granite suite of Graham Land, on the other hand, is of early Tertiary age, as reported by Adie.

One of the most remarkable igneous rock features of Antarctica is the succession of thick Quartz-Diabase intrusive sheets of South Victoria Land. The individual sills are between 100 and 450 m thick and extend over areas of thousands of square miles. It is assumed that they were formed from highly fluid magma. The fact that it has been impossible to locate feeders to the diabase masses makes them no less interesting. The rock composition is tholeiitic within the silica range of 52 to 56 per cent, and the sheets have differentiated by liquid fractionation into rocks with basaltic, diabasic and gabbroic texture.

The generally accepted tectonic model of Antarctica includes the Precambrian shield of East Antarctica, extending from about long 30° W to about long 150° E, and the fold belt of West Antarctica. The boundary between these two structural units is found immediately east of the Trans-Antarctic Mountains. Hamilton has modified this structural interpretation in his paper by suggesting that the progression of geosynclinal sedimentation and orogenic development occurred at progressively later time from the shield towards the Pacific. The events probably started in early Cambrian and continued through the Palaeozoic.

Other orogenic movements affected the Scotia Arc and Palmer Peninsula during Mesozoic and Cenozoic times respectively.

Voronov in his paper has tried to apply the tectonic terminology of Stille to the structural units of Antarctica, and in addition he discusses Neotectonic problems.

With this brief comment on the structural geology the review proper should be concluded, though *Antarctic geology* includes many other fascinating and important subjects which deserve mention. The reviewer feels, however, that a few comments on the technical and editorial features of the book should be offered.

First and foremost, words of praise on account of the good quality of many of the photographs and maps. In dealing with remote and generally inaccessible areas students of geology should never forget the paramount importance of good pictures of their subjects. In this connexion Oliver's paper on Plunket Point, the paper by Schmidt and others on the Patuxent Mountains, and Long's paper on the Horlick Mountains are particularly notable.

A book of this type and size can hardly be devoid of short-comings. Some of the deficiencies of *Antarctic geology* are due to the authors, and others are editorial. If, for instance, it is borne in mind that there are seventy six papers in the volume it is surprising how relatively unimaginative the authors have been regarding the titles of the papers. Most titles are of the type: "Geology of the A-mountains", "The petrography of igneous and metamorphic rocks of B-

Land" etc. This monotony makes it rather difficult to recognize characteristics of the individual papers and regions. The situation might have been remedied by good abstracts of the papers, but these, strangely enough, are missing.

One also notes the absence of a reference in the table of contents to the outline map of Antarctica to be found on p 747.

These are but small points, however, and do not detract from the merits of *Antarctic geology* for which the authors, the organizers of the Symposium, and the editor should be congratulated. *Antarctic geology* will become a geological treasury for all those interested in the geology of the white desert at the South Pole. Our gratitude to those who made it possible.

CATALOGUE OF DATA AT WORLD DATA CENTRES (WDC) OF THE IGY AND IGC

The Special Committee for the International Geophysical Year (CSAGI), established by the International Council of Scientific Unions (ICSU) to co-ordinate international planning for the IGY, placed particular emphasis on the importance of formulating a scheme for the collection and dissemination of data for the many synoptic observational programmes of the IGY. It was agreed that such data should be available to scientific institutions in all countries and that at least three World Data Centres (WDC) should be established, of which one should consist of a number of parts. As both the United States and the USSR offered to establish centres for all disciplines, it was decided to establish WDC-A in the United States, WDC-B in the USSR, and the third centre, WDC-C, comprising a number of discipline centres in various countries.

The exact nature of the operation of these centres is described in CSAGI Guide to IGY World Data Centres, *Annals of the International Geophysical Year*, Vol 7, Part 2, 1959. Each centre is responsible for (1) collecting a complete set of data in the field or discipline for which it is responsible, (2) safekeeping of the incoming data, (3) correct copying and reproduction of the data to maintain adequate standards of clarity and durability, (4) supplying copies to other WDC's and (5) preparing a catalogue of all data in its charge. They are also required to supply on request, and at a cost not exceeding that of copying and postage, copies of material collected as part of the international exchange and to make this material available to visiting scientific workers. Finally, they should collect reprints of publications on IGY-IGC subjects.

Catalogues of data in WDC's

Catalogues of data received by WDC's were issued for each six-month period from the beginning of the IGY. The first three in the series were published by the CSAGI Co-ordinator, and subsequent issues distributed by the WDC's. A final catalogue of IGY-IGC data was collected and edited by WDC-A. It was published in 1964 under the title of Catalogue of data in the World Data Centres, *Annals of the International Geophysical Year*, Vol 36.

Locations of IGY World Data Centres

CSAGI No	Discipline	WDC-A (USA)	WDC-B (USSR)	WDC-C		Permanent services
				C-1	C-2	
II	Meteorology	Asheville, NC	Moscow, B-2	Geneva	—	—
III	Geomagnetism	Washington, DC	Moscow, B-2	Charlottenlund, Denmark	Kyoto, Japan	De Bilt, Holland; Gottingen, Germany; Tortosa, Spain
IVa	Aurora (instr.)	College, Alaska	Moscow, B-2	Stockholm	—	—
	(visual)	Ithaca, New York	Moscow, B-2	Edinburgh	—	—
IVb	Airglow	Boulder, Colorado	Moscow, B-2	Paris	Tokyo	—
V	Ionosphere	Boulder, Colorado	Moscow, B-2	Slough, England	Tokyo	—
VI	Solar activity	Boulder, Colorado	Moscow, B-2	Zurich; Arcetri-Firenze, Italy; Meudon, France; Pic-du-Midi, France; Freiburg, Germany; Sydney, Australia; Cambridge, England; NERA, Netherlands	—	—
			Simeis, Crimea			
VII	Cosmic rays	Minneapolis, Minnesota	Moscow, B-2	Stockholm	Tokyo	—
VIII	Longitude and latitude	Washington, DC	Moscow, B-1	—	—	Paris; Torino, Italy; Mizusawa, Japan
IX	Glaciology	New York	Moscow, B-1	Cambridge, England	—	—
X	Oceanography	Washington, DC	Moscow, B-1	—	—	Birkenhead, England
XI	Rockets and satellites	Washington, DC	Moscow, B-1	Slough, England	—	—
XII	Seismology	Washington, DC	Moscow, B-1	Strasbourg, France	—	—
XIII	Gravimetry	Washington, DC	Moscow, B-1	Uccle, Belgium	—	Paris
XIV	Nuclear radiation	Asheville, NC	Moscow, B-1	Stockholm	Tokyo	—

The catalogues of each discipline vary slightly in content but generally include the following information:

(*a*) Address of WDC, or Permanent Service, concerned.

(*b*) A brief explanation of the various projects studied, a description of the data collected and the forms in which it may be obtained from the WDC.

(*c*) A list of scientific stations and of projects conducted at each.

(*d*) A map showing the world-wide distribution of stations.

(*e*) A catalogue of data available at WDC.

(*f*) A list of publications, reports and papers containing summaries of data or results of special experiments conducted as part of the IGY-IGC programme.

EXCHANGE SCIENTISTS IN THE ANTARCTIC, 1963–4

[These names complete the list published in *SCAR Bulletin*, No 79, 1965, p 494]

Country of origin	Name	Subject	
Czechoslovakia	P. Haloupka	Cosmic ray physicist "Vostok"	
	M. Konecny	Magnetologist "Novolazarevskaya"	
France	A. Bauer	Glaciologist	Members of Soviet-French Glaciological Expedition
	J. M. Bulle	Electronic engineer	
	P. M. Camaret	Electronic engineer	
	P. Chaveyron	Electronic engineer	
	J. L. Le Goff-Charpentier	Geodesist	

INTERNATIONAL WHALING COMMISSION; SPECIAL MEETING, 1965

[By R. S. Wimpenny, Secretary, International Whaling Commission.]

At a special meeting held in London, from 3 to 6 May 1965, the International Whaling Commission agreed upon a catch limit for whales taken in the Antarctic by factory ships during the 1965–66 season. That they had failed to agree to a limit for the 1964–65 season was cause for much concern in many quarters in view of the serious state of the whale stocks. Although the Commission, set up under the International Whaling Convention 1946, had many achievements to its credit, including total protection for certain species and for immature and lactating whales, it had not been able over the years to set an overall catch-limit strict enough to prevent drastic depletion of the stocks. There were, naturally, difficulties for the member countries actively engaged in whaling in reconciling the long-term interests of conservation and the short-term interests of their whaling industries and consumers of whale products. Agreement by the Commission in 1963 of total protection for the hard-pressed Humpback Whale throughout the Southern Hemisphere, and for the Blue Whale in Antarctic waters except in one small area, was much welcomed, but increased the pressure on the Fin and Sei Whales.

The special meeting, called by the Chairman at the request of the majority of

member countries, considered a proposal, among others, that for the 1965–66 season the catch limit in terms of Blue Whale units (1 unit equals 1 Blue Whale or 2 Fin Whales or 6 Sei Whales) should be 4500 (in the 1963–64 season it had been 10000 units); furthermore, that the Commissioners should recommend to their governments further reductions for the 1966–67 and 1967–68 seasons so that the limit for 1967–68 would be less than the combined sustainable yields of the Fin and Sei Whale stocks as determined on the basis of scientific evidence. This proposal received the support of all thirteen Commissioners present.

The effect of this proposal would be that by the end of the 1967–68 season the numbers of Fin and Sei Whales taken would be such that stocks would tend to increase thereafter towards a level from which the maximum sustainable yield could eventually be taken. There is, thus, for the first time, a plan for the effective conservation of whales in the Antarctic.

Japan, the Netherlands, Norway, the United Kingdom and the USSR are party to the 1962 Arrangements for the regulation of Antarctic pelagic whaling. They will meet in June to discuss proposals for the allocation of national quotas. They will also discuss the implementation of the international observer scheme.

STATIONS OPERATING IN THE ANTARCTIC, WINTER 1965

(Those marked with an asterisk are north of lat 60° S.)

Argentina

"Decepción", lat 62° 59′ S, long 60° 43′ W
"General Belgrano", lat 77° 58′ S, long 38° 48′ W
"Esperanza", lat 63° 24′ S, long 56° 59′ W
"Orcades", lat 60° 45′ S, long 44° 43′ W
"Teniente Matienzo", lat 64° 58′ S, long 60° 03′ W
"Almirante Brown", lat 64° 53′ S, long 62° 53′ W

Australia

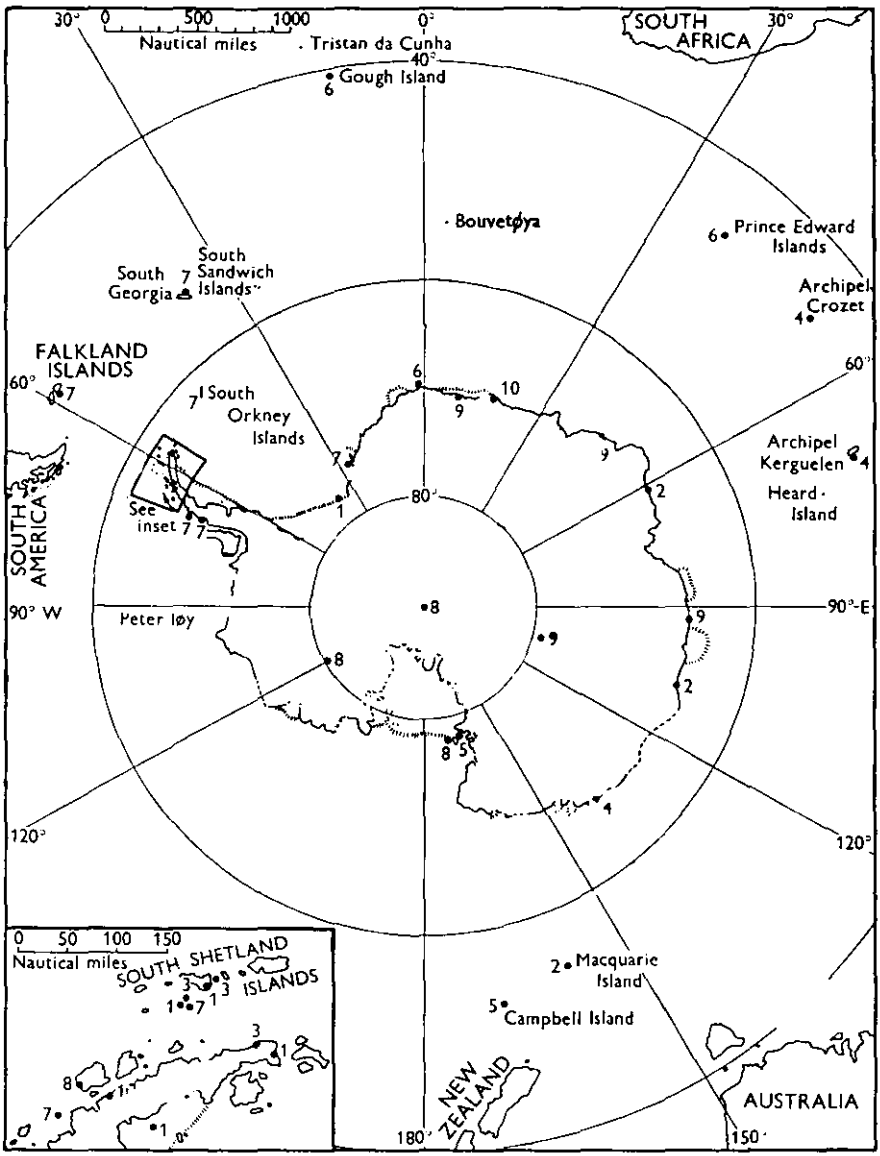
*Macquarie Island, lat 54° 30′ S, long 158° 57′ E
Mawson, lat 67° 36′ S, long 62° 52′ E
"Wilkes", lat 66° 15′ S, long 110° 32′ E

Belgium/Netherlands

"Roi Baudouin", lat 70° 26′ S, long 24° 19′ E

Chile

"Capitán Arturo Prat", lat 62° 29′ S, long 59° 39′ W
"Presidente Pedro Aguirre Cerda", lat 62° 56′ S, long 60° 36′ W
"General Bernardo O'Higgins", lat 63° 19′ S, long 57° 55′ W



Occupied stations in the Antarctic, winter 1965. ●, Station

1, Argentina;
2, Australia;
3, Chile;
4, France;
5, New Zealand;
6, South Africa;
7, United Kingdom;
8, United States;
9, USSR;
10, Belgium/Netherlands.

France

*Ile de la Possession, Archipel Crozet, lat 46° 25′ S, long 51° 52′ E
*Ile Nouvelle-Amsterdam, lat 37° 50′ S, long 77° 34′ E
*Port aux Français, lat 49° 21′ S, long 70° 12′ E
"Dumont d'Urville", lat 66° 40′ S, long 140° 01′ E

New Zealand

"Scott base", lat 77° 50′ S, long 166° 44′ E

South Africa

*Marion Island, lat 46° 53′ S, long 37° 52′ E
*Gough Island, lat 40° 19′ S, long 9° 51′ W
"Sanae," lat 70° 20′ S, long 2° 25′ W

United Kingdom

Deception Island, lat 62° 59′ S, long 60° 34′ W
Stonington Island, lat 68° 11′ S, long 67° 00′ W
Argentine Islands, lat 65° 15′ S, long 64° 15′ W
Signy Island, lat 60° 43′ S, long 45° 36′ W
Adelaide, lat 67° 46′ S, long 68° 54′ W
Halley Bay, lat 75° 31′ S, long 26° 38′ W
*Grytviken, South Georgia, lat 54° 17′ S, long 36° 30′ W

USA

"Amundsen-Scott", South Geographical Pole
"New Byrd", lat 80° 01′ S, long 119° 32′ W
"McMurdo", lat 77° 51′ S, long 166° 40′ E
"Eights", lat 75° 15′ S, long 77° 06′ W
"Palmer Station", lat 64° 46′ S, long 64° 04′ W

USSR

Mirny, lat 66° 33′ S, long 93° 00′ E
"Novolazarevskaya", lat 70° 46′ S, long 11° 49′ E
"Molodezhnaya", lat 67° 40′ S, long 45° 51′ E
"Vostok", lat 78° 27′ S, long 106° 52′ E

PERMANENT WORKING GROUPS OF SCAR: CHANGES OF MEMBERSHIP*

(Amendments to *SCAR Bulletin* No 20, 1965, p 624–30)

Geology

South Africa: Dr O. R. van Eeden, Director, Geological Survey, PO Box 401, Pretoria

Geomagnetism

Chile: John Bannister P, Departmento de Geofísica, Sismología y Geodesia, Avenida Almirante Blanco Encalada 2008, Santiago

Glaciology

South Africa: D. C. Neethling, Geological Survey, PO Box 401, Pretoria

Logistics

Chile: Coronel (R) Alejandro Forch P, Instituto Antártico Chileno, Morandé 71-Piso 1, Correo 8, Santiago

Oceanography

South Africa: Captain J. K. Mallory, Officer-in-Charge, Naval Oceanographic Research Unit, c/o Maritime Headquarters, Youngsfield, PO Wynberg, Cape Province

* The Secretary of SCAR should be informed of changes of address of Working Group members: these changes will then be circulated to National Committees and to all members of the Working Group concerned.

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, Lensfied Road, Cambridge, England.

THE POLAR RECORD

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