

These involved studies of phytoplankton primary production and fish, under research directors Dr Phan van Nghan and Yoshimine Ykeda, both of USP. Marine biological programmes were integrated with the Second International Biological Experiment (SIBEX) and Biological Investigations of Marine Antarctic Systems and Stocks (BIOMASS).

Other biological studies included the biochemistry and physiology of the King George Island flora and fauna, and chemical and taxonomic research on lichens near the Polish base Arctowski. Two geological teams from USP and University of the Vale do Rio dos Sinos were transported by *Barao de Tefé* to Elephant Island and Fildes Peninsula (King George Island) for programmes involving geological mapping and studies of metamorphics and deformation. Geophysical research was undertaken by the Brazilian Institute of Space Research, involving VLF radio wave propagation and radiation measurements in the lower atmosphere. Ornithological and iceberg records were maintained by both ships.

The Brazilian National Council of Scientific and Technological Development, represented on the International Council of Scientific Unions, has provided twenty scholarships for Brazilian scientists to study current Antarctic research in other countries.

Reviews

RESOURCES POLICY FOR ANTARCTICA

ANTARCTIC RESOURCES POLICY: SCIENTIFIC, LEGAL AND POLITICAL ISSUES. Orrego Vicuna, F. (editor). 1983. Cambridge, Cambridge University Press. 335p, illustrated, hard cover. ISBN 0 521 259525. £32.50.

In October 1982, under the auspices of the Chilean Air Force, the Tinker Foundation and the Chilean Foreign Ministry, the Institute of International Studies of the University of Chile organized a conference on Antarctic Resources Policy, distinguished by being the first international conference held on the Antarctic continent. Invited scientists, academicians and diplomats who gathered together in low risk environment to discuss issues of mutual concern regarding Antarctic resources. The papers in this volume form the official record of that conference.

Following an introductory chapter, 22 papers deal with five themes; the state of Antarctic knowledge and experience (5 papers), policy for conservation of Antarctica's living resources (4 papers), policy for exploration and exploitation of Antarctica's mineral resources (6 papers), Antarctica and the law of the sea (3 papers), and policy for Antarctic cooperation (4 papers). The authors represent ten Antarctic Treaty Consultative Nations plus Canada. Regrettably, a list of conference participants is not included.

The papers vary in quality, as is often the case with a conference volume of this type. For example, Fuch's paper dealing with Antarctic history fails to mention Admiral Richard E. Byrd and does not deal in any meaningful way with the explosion of knowledge that has occurred since the International Geophysical Year. It provides, however, a brief and useful summary of the bases for territorial claims in Antarctica. In contrast are paper by Knox and Gjelsvik. Knox's summary of the living resources of the Southern Ocean is quite detailed and a useful reference. Gjelsvik provides comparison summary with

detailed maps and cross sections of the state of knowledge of Antarctica's potential mineral resources.

Holdgate's paper deserves special attention. It focuses on the dominant role of the Antarctic environment in determining and constraining human activity, i.e. the impact of the environment on potential activity in the Antarctic. Holdgate notes significant differences between Antarctic environment and ecosystems and those we are more familiar with, and examines problems of impact assessment, pointing out pitfalls that hazard simplistic approaches. He finally suggests ten considerations that must be part of any development and management scheme. This article is well worth reading by all who have an interest in impact assessment. While it focuses on applications to the Antarctic, the arguments presented are universal.

Heap summarizes in a brief paper the philosophy of cooperation that has been part of the treaty since its conception. He points out that the treaty was not the result of great altruistic ideals to preserve a continent for science. The 12 nations came together from perceived necessity to negotiate a treaty which grew out of 'fear'; no one gained from it, but all stood to lose if it was not negotiated. Nations assumed responsibility and obligation with no rights conferred in return, and only moral sanctions to enforce observance of the obligations. Heap suggests that future developments should include the extension of the obligation system to deal with future problems. All that is asked of those countries who would join the system, according to Heap, is that they accept the same obligation as the existing consultative parties.

Powell's paper summarizes briefly and usefully the issues that need to be resolved if the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) is to be successful. Of particular interest are the problems facing the Scientific Committee as they attempt to cope with the ecosystem approach to resource management. Data are limited, early decisions on single species may be required, and the models used to derive 'maximum sustainable yield' as a management tool have limitations. The concept of the use of indicator species could provide a sound scientific base for providing advice to the Commission, though agreement on this point may be difficult; in summary Powell lists seven management procedures that might well be a part of the final Rules of Procedure.

Relationships between BIOMASS, CCAMLR, and the SCAR Group of Specialists on Southern Ocean Ecosystems and their Living Resources are described by Nagata. Interactions between these groups and other governmental or non-governmental international organizations pose intriguing questions in relation to CCAMLR and more general Antarctic issues; Nagata suggests the need for more interaction between the sciences, especially biology and physics, as attempts to derive a model for Antarctic ecosystems are evaluated.

The regime for conserving Antarctica's living resources was the culmination of actions under the Antarctic Treaty. Couratier notes the progression from early recommendations under the treaty to the Agreed Measures, the Convention for the Conservation of Antarctic Seals, and finally CCAMLR. The geographic area of application, participation in the Convention, and whether this is a conservation or a fishing convention are discussed, with some interesting insights revealed.

Zeggars, who has long participated actively in Antarctic treaty negotiations, provides most useful observations on issues that had to be resolved before CCAMLR could be agreed upon. We meet for the first time 'internal' and 'external' accommodations—subjects of critical importance that are discussed in more detail in the paper by Brennan. Zeggars notes that CCAMLR may be the model for a mineral resources regime only if that regime takes the form of a convention outside the Antarctic Treaty itself. Finally he stresses the dynamism that led to the successful resolution of difficult and complex issues and the

adoption of CCAMLR, and pleads for continuation of that effort to resolve procedural issues that are bogging down the convention's function.

In the minerals resources section Gonzalez-Ferrar deals with the impact of geologic data on the mineral resources regime debate. Reviewing published data on possible hydrocarbon deposits in Antarctica, he raises several interesting questions. Who has really benefitted from the 'moratorium' on resource development? Is it really scientific interest that is motivating countries that have recently and publicly expressed an interest in Antarctica? The paper closes with clear statement of the need for a regime for mineral resources in Antarctica. Bergsager brings a wealth of experience from close association with Norwegian North Sea oil development and management, providing an excellent review of possible sites for hydrocarbon exploration and exploitation in Antarctica, the management issues that must be resolved, and the question of the availability of technology for Antarctic operation. He does not attempt a definitive statement, but highlights events and issues for those unfamiliar with offshore development.

Guillaume's brief paper deals with three questions, concerning whether or not there is oil on the continent, available technology, and the legal framework for possible commercial activities. Beeby attempts to summarize in a few pages the points of agreement, the understandings, and the unresolved legal political issues being considered by those who are negotiating a regime for Antarctic mineral resources. His contribution is especially appropriate as Beeby has been a key figure in negotiations so far. His paper raises more questions than it answers, but provides an overview of the breadth of issues in the current debate.

I found Vicuna's discussion of options for a regime on Antarctic mineral resources most interesting. He notes that there have been a number of suggestions as to the best way to manage the resources of the Antarctic, ranging from a pure 'common heritage' approach to the application of Law of the Sea or High Sea principles. Given the range of possibilities, Vicuna suggests that the regime will probably be defined under the Antarctic Treaty system simply because that system has been successful to date, and the bulk of the knowledge and experience is in the hands of the Consultative Parties. The 'thorniest' problems that will emerge during the negotiations, according to Vicuna, will be the powers to be exercised and their allocation. These issues then become the theme of the discussion of the various options considered, and the author closes with a note of warning that just as the process of internal accommodation will require sacrifices and compromises, so will an effective and lasting external accommodation.

Brennan discusses the main 'international political realities' that bear on the question of a regime for Antarctic minerals. As one who was for a long time involved in Antarctic treaty affairs, as well as the Law of the Sea negotiations, Brennan carefully weaves throughout his paper words of caution and advice to all parties, paying special attention to the matter of internal and external accommodation. His thoughtful paper leads us right up to the present, including the possibility of United Nations action regarding Antarctica (as happened one year after the Teniente Marsh meeting). Brennan closes with two lists of conclusions, the first dealing with the Treaty itself, the second with the possible mineral regime for Antarctica.

The section on Antarctica and law of the sea consists of three papers, dealing with legal and political aspects of the law of the sea that relate to the Antarctic Treaty, the various Conventions, and future regimes that may evolve either under the Treaty or as separate Conventions. Van der Essen provides a useful historical review of the treatment of the law of the sea issue in Article VI of the Treaty, noting the ambiguity in the article that apparently resulted from changes made in drafting. A detailed review of the law of the sea issues as dealt with in the development of the Convention on Seals at CCAMLR is

presented, with a closing argument that during the evolution of the Antarctic Treaty System the jurisdiction exercised under the Treaty System has expanded from its original definition. Vicuna considers in detail the relationship between the Antarctic Treaty and the institution of the law of the sea with special reference to work of the Conference on the Law of the Sea. His juridical approach to questions of maritime jurisdiction, the continental shelf areas, and the sea-bed regime is useful, and the closing paragraphs dealing with the maintenance of the essence of the Antarctic Treaty System in the face of external pressures raise a warning flag for all to consider. Continental shelf areas of Antarctica are considered by Infante from a legal point of view; the author discusses the principles of the law of the sea and their application to the Antarctic Treaty System. Of critical importance will be the definition of the continental shelf and the resolution of the jurisdiction issues as they relate to a regime for Antarctic minerals.

The final section of the book deals with Antarctic cooperation. Guyer's paper on the role of Antarctica in international relations usefully reviews the way the outside world has viewed Antarctica as an object of international relations. His evaluation of the Antarctic Treaty as a pragmatic and flexible document that has evolved into the Antarctic Treaty System is a useful reminder that the framework of the Treaty, combined with willingness of the consultative parties to reach consensus, has resulted in responses to problems as they have arisen. Guyer underscores the idea that Antarctica has not been an issue in international relations because the Treaty has worked, and notes that the basic philosophy has been one of persistence and permanence, a philosophy that must continue to prevail. Scully provides another view on the evolution of the Antarctic Treaty into what is now described as the Antarctic Treaty System. His thoughtful paper, along with those by Guyer, Zeggner, and Brennan, could well be made required reading for those who would understand how the Antarctic Treaty System works. The evolutionary process is emphasized, along with the pragmatism and flexibility that have been essential elements of the evolution. The lack of institutions in the Treaty itself, i.e. no Secretariat, the use of ad hoc specialists to deal with specific issues, and the elaboration of the consultative process are somewhat unique. The early identification of issues and the progression from recommendations under the treaty to special Conventions to deal with issues is a procedure that has worked well. Scully reminds us that the Antarctic Treaty does not end in 1991, but rather it may be reviewed at and following that date if any of the Consultative parties so desire. The prediction is made that no major amendments or modifications of the Treaty will occur at that time. It is suggested, however, that once a mineral resources regime is negotiated there will be a need to ensure cooperation between the various components of the Antarctic Treaty System, without changing their decentralized nature. Increased efforts for cooperative research will be essential to the operation of the resource regimes, and continuing consideration of the integration of the Antarctic Treaty System into the international system must be considered. In closing, Scully outlines briefly his views on the essential components of a minerals regime for Antarctica.

Canadian experience in Arctic resource development is reviewed by Roots. This paper complements Bergsager's; the two might well have been placed together. Roots points out that although the first encouraging signs of oil in quantity in the Canadian Arctic appeared 30 years ago, no oil had been produced at the time the Teniente Marsh meeting was held. He reviews the geography and geology of areas where oil is known, comments on the technology required to meet the special environmental conditions in polar regions, and discusses technological limitations. He notes that in areas of extreme physical conditions lacking an existing infrastructure there is a close relationship between policy and economics on the one hand, and the state of technology and science on the other.

In conclusion he lists eight points learned from Arctic experience, that emphasize the close ties between technologies and political decisions relating to their application.

The final paper considers jurisdictional problems as they relate to Antarctic mineral resources. Sollie contrasts the Svalbard Treaty of 1920 with the Antarctic Treaty as a means of identifying some potential jurisdictional issues. A number of interesting points are raised and questions asked about how problems have been and will be dealt with under the Antarctic Treaty System. Sollie continues to be somewhat cautious in his response to the possible development of a minerals regime in Antarctica.

The importance and the timing of this volume cannot be overemphasized. It appears on the market at a time when external interest in the Antarctic is increasing. The most common criticism of the Antarctic Treaty consultative process is that it is closed. This book is the first easily accessible collection of papers that opens to public view the thoughts and opinions of those who have been helped to shape the Antarctic Treaty System. The book is expensive, but for any who want to learn about the development of the Treaty, it is well worth the investment. This volume should be on the bookshelf of all participants in treaty meetings, and required reading for those who would enter that arena. Had the editor chosen to present the papers in a somewhat more logical order the usefulness of the volume would have been greater. Nevertheless, I recommend it to all, and for those who wish to maximise their return on investment, I heartily encourage them to read it several times.

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ANTARCTIC GLACIOLOGY AND GEOPHYSICS

ANTARCTICA: GLACIOLOGICAL AND GEOPHYSICAL FOLIO. Drewry, David J. (editor). 1983. Cambridge, Scott Polar Research Institute. iv + 9 folios (5 to be added), maps, hard cover. ISBN 0.901021.04.0. £59.00.

The publication of this work appears very timely, as it compiles most of the measured and derived physical data currently available on Antarctica, comprehensively updating previous compilations of about 20 years ago. The progress this folio reports is mainly due to results obtained by a decade of research involving the recently-developed glaciological technique of airborne radio echo sounding. This has so far allowed the study of about half of Antarctica. Thus a considerable body of new data complements information obtained both by classical techniques, for example seismic studies, and such other recent developments as balloon altimetry and Landsat satellite imagery.

The basic data are summarized in a series of maps featuring surface and bedrock topography, ice sheet thickness, residual magnetic field and internal layering of the ice sheet. A further section deals with derived physical information, for example ice sheet driving stresses, isostatically adjusted bedrock, and depth to magnetic basement. All the maps are well printed in attractive colours, representing clearly the main features with illustrative inserts and diagrams. The scale of the maps (1:10 000 000 and 1:6 000 000) is adequate for both general and local reading of the data. It must be pointed out, however, that the density of information is not homogeneous for all Antarctica; as a consequence some of the maps do not cover the whole continent. Explanatory texts are generally very