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Geology of Greenland

K. D. Collerson

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provides, in almost excesssive detail, support for the industry's often-repeated view that no real shortage of non-fuel minerals prevails and that price and technology, aided by substitution and recycling, will ensure their continuing supply.

Ample mineral resources exist, but the long term view is clouded by doubt about their availability. The reader is left to reach his own appreciation of the radical differences between the problems of short and long term supply. The editors' contributions and choice of authors and topics imply reliance on a technological "fix"; serious questions are nevertheless raised about environmental constraints and the world economy's ability to pay: E Just's exceptionally gloomy article anticipates economic failure by the year 2000

Over the whole debate looms the problem of energy supply M. H Thomas concludes that coal and nuclear power are at present the only abundant sources, and that environmental and technological problems guarantee an irreversible trend to higher costs. He endorses Hubbert's 1973 assessment of the longer term future: "The real crisis confronting us is . . not an energy crisis but a cultural crisis"

The two most imaginative and stimulating chapters - by D B Brooks on mineral and environmental conservation and H E Cohen on extraction and processing technology - look the furthest ahead: taken together they sketch a new mineral economics Cohen also identifies some novel and attractive research targets

Elsevier's high technical quality is evident, and apart from several slips by M H Govett there appear to be remarkably few errors in a work heavy with statistics. There is some duplication and much unevenness' contributions range from primers (G. J S. Govett, F. M Vokes) to outlines for advanced studies (L S Collett, H. E Cohen) The scanty attention paid to the crucial influence of politics on exploration and mining investments is disappointing Moreover, although the U.N.'s role in exploration is copiously documented, the significance and future evolution of the immeasurably larger private sector programs and expenditures are only briefly discussed. For those who believe that industry remains the most effective tool for identifying and developing mineral resources, this is a serious defect. The Sino-Soviet countries receive less attention than their resources might merit.

The book may provide some references for university mineral economics courses, but few of its chapters will interest people in the industry, and although it assembles much otherwise unfamiliar and dispersed information it is too flawed to be recommended to bureaucratic policy makers, and also too technical for their political masters.

MS received February 28, 1977

Geology of Greenland

Arthur Escher and W. Stuart Watt
Gronlands Geologiske Undersogelse
Geological Survey of Greenland
Oster Voldgade 10, DK-1350
Copenhagen K,
Denmark, 1976, 603 p.
DKr 195 including postage.

Reviewed by K. D. Collerson
Department of Geology
Memorial University of Newfoundland
St John's, Newfoundland A1C 5S7

Greenland is a geologically unique region of the crust, with a wealth of rock-types and a chronological record spanning almost 4000 m.y. of Earth history Vestiges of this record, continuously exposed along an extensive deeply embayed coastline, offer almost limitless opportunities to observe geological relations between major crustal units Therefore, whether it is in the Archean, Proterozoic or Phanerozoic record, significant conclusions can be drawn concerning the processes which shaped the Earth's crust through geological time This impressive volume provides a concise and authoritative introduction to practically every aspect of the geology of Greenland. It is the result of more than 30 years field and laboratory research and is a fitting testament to the fact that the Greenland Geological Survey has mastered the logistical problems of working efficiently in an exposed and potentially hostile area.

The book comprises 21 chapters and was written by 29 authors with first hand experience in Greenland who are either staff members of the Geological Survey of Greenland, faculty members of universities in Denmark, Switzerland, Britain, Eire, and Canada, or employed by an exploration company with interests in Greenland. It is lavishly illustrated with 472 text figures, including some 258 plates and 126 maps, which occur either within the text or as fold-outs The individual chapters, range in length from 10 to 119 pages and describe specific areas or particular aspects of the geology of Greenland maintaining a consistently high standard of lucidity and scientific content. They are well documented and references are included at the end of each chapter. The book is well cross referenced and contains an extensive index.

For a number of years we have been witnessing an overall decline in the quality of presentation in scientific publications due principally to increasing publication costs. This has commonly resulted in a reduction of plate quality; in many case failing to show the features which they were intended to depict. Such is not the case with this book It serves as a good example for other larger and richer geological surveys, of the type of publication that is possible and desirable.

The book is influenced to a considerable degree by the geological architecture of Greenland. Perhaps in no area of the world, with the possible exception of coastal Labrador and Baffin Island, are Precambrian gneisses as well exposed as they are along the coast of Greenland Therefore, following a short resume of the geological framework and economic potential of Greenland by the editors, the succeeding five chapters emphasize the Precambrian shield of Greenland and the geology of the main structural provinces recognised therein

In view of the current interest in the structural and geochemical evolution of the Earths' early crust, discoveries in Greenland during the last decade are of considerable significance. The review by Bridgwater *et al.* of the Archean gneiss complex presents the reader with a concise description of the lithological units comprising it, starting with the earliest rocks (the pre-3600 m.y. Isua supracrustals and the Amitsoq

gneisses) and treating in considerable detail its chronological evolution. In the four chapters which follow, outlines are given of the structural provinces which were affected by events during the early Proterozoic, viz. the Nagssugtoqidian, Rinkian and Ketilidian Mobile Belts.

The next chapter by Emeleus and Upton presents an account of Gardar age (1330-1150 m.y.) activity in South Greenland, a period of ensialic sedimentation, volcanism and alkaline plutonism which was responsible for the production of some of the worlds most spectacular and yet enigmatic igneous rocks, i.e., the Ilimaussaq intrusion.

Credible structural models for the formation of orogenic belts, and in the last few years, plate tectonic explanations, have been severely hampered by the lack of stratigraphic, bio-stratigraphic and structural detail on a local scale. In the three chapters which follow, Precambrian to Tertiary relationships in the East Greenland Caledonian and North Greenland fold belts are presented with abundant regional and more specialised local stratigraphic detail. As a result these chapters document not only the Precambrian history of the region but also its tectonic and lithological evolution during the formation of the Palaeozoic Proto-Atlantic Ocean (Iapetus), its subsequent closure to form the Caledonides and eventual fragmentation in the Mesozoic to generate the present Atlantic Ocean. Pertinent to this latter event are discussions of the East and West Greenland Tertiary igneous provinces

The remaining chapters in the book which are by no means less important, include a discussion of the Quaternary geology of Greenland, a review of the metallogenic potential and organic fossil energy resources of Greenland, and an outline of fossil flora and palaeovertebrates. It concludes with an account of recently discovered kimberlites in Western Greenland.

The book is a scholarly and well edited work. It will certainly become one of the classics of regional geology and is a real bargain at approximately $35.00.

MS received May 5, 1977

Volcanism in Australia

Edited by R. W. Johnson
Elsevier Scientific Publishing Company, 405 p. 1976.
Price $23.25

Reviewed by P. M. Clifford
Department of Geology
McMaster University
Hamilton, Ontario L8S 4M1

This volume is an interesting assemblage of papers about volcanoes in Australasia. Most of us have scant idea about the range and continuity of activity there, and few of us have actually watched a volcano at work. This book enlightens us on both matters

The 28 constituent papers are arranged as a "tour" clockwise from Australia via Papua-New Guinea to New Zealand. Six papers have a geochemical bias. Three of these deal with island arc situations, one with activity on a continental plate. All areas show a wide compositional range for their volcanic rocks and none lead to a satisfying petrogenetic model. Four papers cover odds and ends - an early Cambrian flood basalt province in northern Australia, long flows in Queensland, a model for ore deposits associated with andesitic strato-volcanoes, and a discussion of volcanic emanations in the Solomon Islands which supports the idea of exhalative ore deposition.

The bulk of the book, however, is concerned with physical studies. Eight deal with observed eruption patterns, four more discuss activity of volcanoes recently deceased, and four have to do with geophysical means of keeping a wary eye on potentially dangerous volcanoes.

Given the many active volcanoes in Australasia, and their tendency to violence, this emphasis is not surprising. Precise levelling, infra-red scanning, magnetic and thermal surveys and seismic monitoring are all yielding interesting and eventually useful results. But assessment of hazard based upon eruptive history and style is still the most common approach, and it is this that may be served by the volcanic histories, with their descriptions of repose patterns, and the style and products of individual eruptions. These histories, too, are a valuable antidote to the disease of layer-cake thinking which can often afflict interpretations of ancient volcanic assemblages. These island-arc volcanoes are erratic in output, rarely providing an identifiable unit which is distributed all about the vent. When they come close to doing this (a pyroclastic eruption perhaps) but are not badly damaged by tectonic activity, there is the chance, as at Witori volcano on New Britain, to examine unaltered tephra and to see just how good correlation of units may be based upon such things as textural variations. Such studies link the currently alive to the long-since dead.

G. A. M. Taylor, in whose memory these papers are published, would, I suspect, have been pleased to see these accounts of the growth of work he began at Rabaul in 1950. For readers far removed from the area, the papers have interesting points to make, and are worth reading. But there is not really enough of general application to make it worth buying, except by the most avid volcanologists.

MS received May 18, 1977

Applications of Thermodynamics in Metamorphic Petrology

By Edgar Froese
Geological Survey Paper 75-43
Printing and Publishing Supply and Services Canada
Ottawa, Canada, K1A 0S9
73 pages, 1976
Price $3.00 in Canada,
$3.60 in other countries

Reviewed by H. J. Greenwood
Department of Geological Sciences
The University of British Columbia
Vancouver, B.C. V6T 1W5

This small and compact book fills neatly a serious gap that has developed between theoretical-experimental petrologists and more field-oriented chemical petrologists. Thermodynamic theory and calculation has been assuming an ever-increasing role in the