

BOOK REVIEWS

DNAG celebrates Arctic geology

Grantz, A., Johnson, L. and Sweeney, J. F. (editors) 1990. *The Arctic Ocean Region*. Geological Society of America, Boulder, Colorado, U.S.A. 644 pp., 11 plates + 3 microfiche cards. ISBN 0 8137 5211 6. Price \$85.00.

In comparison with most other areas of the world, geological knowledge of the Arctic region is in its infancy. The principal reason for this, of course, is the practical difficulty of working in an inhospitable environment, but politics have played their part, not least because the Arctic Ocean has been for many years a no-man's land between the superpowers. With changing attitudes in the Soviet Union, however, the opportunities continue to grow for collaborative Arctic research. In fact, many of the fundamental problems still to be resolved require international co-operation. Aside from purely academic research, joint commercial ventures are also being explored. For example, half the Arctic Ocean is bounded by the extensive and poorly known shelf seas of the Soviet Arctic. Major gas discoveries in the Barents Sea and Kara Sea have already been reported by the Soviet authorities, but further exploration and exploitation would clearly benefit from collaboration with western oil companies.

Against this background, *The Arctic Ocean Region, Volume L*, of the *Decade of North American Geology* series is a welcome addition to the bookshelf. The aim of the book, as stated in the foreword, is to be a "comprehensive summary of the geology and solid earth geophysics of the Arctic region". With a few caveats, this aim is achieved successfully.

The book contains 32 chapters arranged into 10 subject areas. Chapters 1 and 2 provide an introduction, and a history of research and exploration. The remainder of the book is divided into sections as follows: *ice cover* (two chapters); *bathymetry and physiography* (one chapter); *geophysical data* (five chapters including seismicity, gravity, magnetic anomalies, geothermal observations and seismics); *the North American plate boundary* (one chapter); *continental margins* (six chapters beginning with East Greenland and working across Arctic Canada and Alaska to eastern Siberia); *ridges, borderlands and basins* (five chapters); *Arctic Basin sediments, fossils, paleoclimate and history* (two chapters); *Late Neogene and Quaternary geology* (two chapters); *mineral resources* (three chapters); and *the origin of the Arctic Basin* (two chapters). A summary and comprehensive index finish the book. Three microfiche cards contain an extremely useful bibliography, particularly the Soviet references.

A separate slipcase contains 11 high-quality plates (mainly maps) covering: bathymetry; seismicity and heat flow; gravity; magnetic anomalies; sedimentary thickness; seismic reflection profiles (the East Greenland shelf, Arctic Basin, and the Canadian and Alaskan margins of the Canada Basin); the East Greenland continental margin; and Phanerozoic tectonic features of the Arctic Ocean region.

The book has been edited to a high standard and typographical errors are few and far between. I was greatly amused by the unfortunate (intentional?) juxtaposition of the running head and illustration on p. 4. The text is well illustrated, and the use of red to enhance some of the black and white line diagrams both improves the clarity and increases the quantity of data that can be presented. The plates are a great bonus to purchasers of this book—they contain a multitude of data and have obviously been compiled with great care. If there was enough wall space available in my office, these plates would certainly be occupying it.

All geologists working in Arctic regions will want to own a copy of this book; however, they should be aware of the following points before buying it.

(1) As part of the *Decade of North American Geology* series, there is inevitable bias towards the North American part of the Arctic. The Barents Shelf and the western part of the Soviet Arctic are therefore only mentioned in passing, which seems a shame as their incorporation would have made the volume a complete reference work for Arctic regions.

(2) The book was compiled before recent Soviet collaboration with

the west, so that this is a predominantly western view of Arctic geology. However, despite the western bias of the authorship, a clear effort has been made to incorporate Soviet literature.

(3) The volume has taken some time to prepare (a perpetual frustration for editors of large, multi-author compilation volumes) and most of the contributions date from the mid-1980s. On the negative side this means that more recent data are already available for some topics (nearly one-third of the contributions have notes added in proof); on the positive side it means that more time has been available to produce a book of high quality and rigorous editorial standard. Overall, the delayed publication does not matter too much for a review volume of this type, as long as the delay is recognized.

Despite these caveats, *The Arctic Ocean Region* is an impressive volume and is worthy of its place in a series celebrating the centenary of the Geological Society of America. Not only does this book elegantly summarize what is known about the Arctic region, it also looks forward to the challenges that lie ahead; it will provide a benchmark against which progress in the coming years can be measured. At \$85.00 the book represents excellent value, especially considering the high-quality plates and the microfiche bibliography. As Arctic research gathers momentum, I am sure we will not have to wait for the bicentenary of the GSA before a second edition is required.

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The Cadomian encompasses Armorican, Monian and Avalonian

D'Lemos, R. S., Strachan, R. A. and Topley, C. G. (editors) 1990. *The Cadomian Orogeny*. Geological Society of London Special Publication No. 51. Geological Society of London, Bath, U.K. 433 pp. Price £58.

Special publications of the Geological Society of London appear to be designed to associate advances in fieldwork with geochemical and geophysical investigations. The volume under review is concerned with late Proterozoic tectonics of the Armorican massif of France (18 papers) and related areas (eight papers) in England, southeastern Ireland, parts of Wales, southwestern Iberia and especially Canada. Contributors to the Armorican massif include both British and French authors, although this fact introduces an editorial inconsistency in so far as the French authors where needed usually use accents whereas the British are not too mindful of this feature of French orthography. In places this inconsistency occurs in single lists of references, as for example Balé on p. 179 is accented in one reference but not in another. Otherwise the volume is well-edited and contains few typographic or grammatical errors.

In the discussion of their findings most authors employ stratigraphic, structural, geochronometric and geochemical data. Geophysical data with the exception of a single article on palaeomagnetism are conspicuous by their absence. As a whole this compendium has an aspect of a program report. Thus, for instance current controversies about stratigraphic units, such as the Brioverian, are reflected in papers that leave this unit undivided or elect to recognize its separation into lower and upper sub-units. In this and other respects the introductory statement by the editors and the article by Jean Cogné are especially useful and should be read prior to delving into the rest of the book.

The advances in investigations of late Precambrian geology are underscored by frequent, although not always entirely discriminate, use of isotopic age dates. For instance the paper by C. Guerrot and J. J. Peucat dealing with U-Pb geochronology of the Cadomian orogeny is the only paper that has a systematic evaluation of analytical procedures. One of the by-products of extensive isotopic dating has been

the continuation of Cadomian orogenic events into Cambrian times, and of the post-orogenic plutonism into the Ordovician. Thus some of the post-orogenic intrusives are as young as 480 Ma and are cut by even later, mafic dykes. These findings imply that the tendency of grouping Cadomian and Avalonian events should be reappraised. Another point arising from these radiometric dates is that the at present accepted isotopic and stratigraphic time-scales should be re-examined.

Geologically, the book lays much emphasis on igneous intrusions, although how these are related to the plate tectonic evolution of the Armorican massif is still debated. Some authors in the book propose that the Armorican continental crust originated by progressive Cadomian cratonization, while others (the editors in the Preface) maintain that subduction-related tectono-magmatic activity in the region was analogous to the present-day Andean belt and did not involve continent-continent collision. Considering that in numerous papers in the volume various authors indicate Cadomian back-arcs and arcs, it is clear that the Andean analogy is as yet premature.

The addition of sundry articles dealing with Canadian and European, essentially Avalonian, terranes is useful, but limited by somewhat unsystematic choice. Thus there are four papers on Canadian topics, but only one on the well-investigated Midlands block of England, and while southwestern Iberia has been discussed there is nothing on northwestern Iberia. This indicates that the book is, as already mentioned, a progress report—useful, locally informative, well illustrated and generally well-written, but suffering from the lack of regional balance. All the specialists in late Proterozoic geology and aspects of structure should have it on their shelves; I cannot, however, recommend it too strongly to a general reader who would not find even a comprehensive detailed map of the areas examined.

Nicholas Rast

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Structural puzzles in the Columbia province

Reidel, S. P. and Hooper, P. R. (editors) 1990. *Volcanism and Tectonism in the Columbia River Flood-basalt Province*. Geological Society of America Special Paper 239. Geological Society of America, Boulder, Colorado, U.S.A. Price \$52.50.

Continental flood-basalt provinces pique the interest of a wide range of geoscientists, lately including those trying to explain major extinctions. The Columbia River province in the Pacific Northwest of the U.S. has been intensely investigated during the past two decades for other reasons: it was being evaluated as both a site for potential nuclear power plants, and as a repository for high-level nuclear wastes. This well-produced and extensively illustrated volume presents some of the results of this research, much of which is buried in technical reports published by various contractors and government agencies. About 75% of the papers deal with the stratigraphy, established largely on the basis of chemical composition, petrologic variation and magnetic reversals, of the up to 4 km-thick sequence of Miocene basalt. The remainder address the structures, structural history and tectonic setting of the province.

Let me quickly sketch some of the features of the Columbia River province. Imagine a roughly circular area upwards of 150,000 km², underlain by as much as 175,000 km³ of basalt that was erupted in areally extensive flows, chiefly between 17 and 15 Ma. The northern third of the province approximates the proverbial featureless plain as far as structures are concerned and is commonly termed the Columbia Plateau. The southeast quadrant is cut by an impressive system of high-angle normal faults belonging to the late Cenozoic extensional Basin and Range province. But the most tantalizing structures constitute the Yakima fold belt in the western third of the area underlain by the Columbia River Basalt Group. Narrow anticlines, standing about 600 km above intervening broad, nearly flat synclines, have a mean spacing of about 20 km and radiate westward from the western edge of the undeformed Columbia Plateau. Some of these anticlinal ridges are 100 km long. Geometry and vergence typically change along the crest of an individual fold, which may be segmented and locally asymmetric or box-shaped. Reverse faults cut one or both flanks. Some workers have pointed out the similarity of these folds to 'wrinkle ridges' on lunar maria and other planetary surfaces.

Why would a general reader of this journal (excepting those for whom continental flood-basalts are a fetish) want to look through or read the six or so papers on the structure of the province? I can recommend them to those of you who are either unfamiliar with the Columbia province, or who like structural puzzles. In spite of the general agreement on matters of geometry and disposition, the origin of these folds is still debated. Why are they localized in the western third? What accounts for their apparently periodic spacing and variable geometry? Are they localized over structures in the basement or do we need more geophysical data to tell? Do they lie above a regional décollement, or are they genetically related to local, spaced faults? What is the role of regional lineaments or transecting structures? The papers in this book will arm you with enough information to begin your own analysis or speculation. Even better, let your students tackle the Yakima fold belt, if you would like to provide them with a neat structural problem in a well-controlled setting. Start by perusing the bedsheet-sized structure map of the province (in the pocket) which portrays faults and the hinges of folds. Then, read Hooper and Conrey, who provide a useful overview of the tectonic setting and large-scale strain. Reidel and others comprehensively review the geometry of the folds and the evidence that they were developing during eruption of the flood basalts. Price and Watkinson analyse the Umtanum fold and its associated thrusts, provide a glimpse of outcrop-scale cataclasis, and present balanced sections. Campbell confronts the sketchy evidence for the geology beneath the flood-basalts and how it might have influenced the structures within them. Watters presents an interesting mechanical model describing the basalts as an elastic multilayer in which early buckling at a dominant wavelength was followed by localized plastic yielding and reverse faulting.

I am not convinced that these papers and the map accompanying the volume definitively answer all of the questions I raised in the paragraph above, but they do provide an excellent overview and lots of food for thought. At the least, they offer a palatable and easily digestible introduction to a part of my local backyard that deserves close scrutiny by a wider group of structural geologists.

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Micrographs and metamorphism

Augustithis, S. S. 1990. *Atlas of Metamorphic-metasomatic Textures and Processes*. Elsevier, New York. Price \$177.25.

This is the second atlas of metamorphic textures produced by the author, and, in common with the first atlas (on transformed and deformed metamorphic rocks), the general purpose and content of this book is obscure. The book contains 85 pages of text followed by 370 black and white micrographs, accompanied by brief captions. The micrographs are generally of good quality, although they are arranged in the order that they are mentioned in the text, with no division into sections, which makes it impossible to use this book as an atlas. The reason for including many of the micrographs is unclear, and may seem very repetitive (for example, 15 micrographs showing myrmekitic intergrowths, and 19 showing symplectites seems excessive).

The text is divided into 17 chapters, and much space is devoted to historical review. To give one example, in the section which aims to give a "historic review of the trend of thinking that emphasizes temperature in metamorphism" the most recent reference mentioned is dated 1889! Throughout the book there is almost no reference to any of the key works published in the last few decades. Considerable space is devoted to disputing statements published at the beginning of the century (Termier, 1903, "dynamic metamorphism deforms but does not transform" is a favourite) which have long been overtaken by subsequent knowledge. The author goes to great length to argue for the idea of polymetamorphism (presenting numerous micrographs of 'crystalloblasts' in support), apparently holding the view that most metamorphic petrologists still believe that every mineral in a metamorphic rock crystallized simultaneously. A statement by Drescher-Kaden (1982) that "for every blastic growth a geotectonic event proceeded" is taken as the most recent significant comment on the role of stress in metamorphism. The author's own work is highly quoted, along with papers from various Theophrastus publications.