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Découvrir la revue

and V. A. Markin then outline how the great later nineteenth century works in Quaternary geology by Piotr Alekseevich Kropotkin are little known in the west, at least relative to his writings in anarchist philosophy. A. Gaigalas reviews Quaternary research in the Baltic countries, including discussion on social and political context, and thoughtfully structures the article into periods ranging from nineteenth century to post-1990 progress. A. Gaigalas, M. Graniczny, J. Satknas, and H. Urban review the work of Czesław Pachucki, considered a pioneer of modern glaciomorphology in Lithuania and Poland. O. Kondratienė and M. Stančikaitė then present a paper on studies of the Quaternary formations in Lithuania by Valerija Čepulytė (1904–1987) – the first woman in Lithuania to take a doctoral degree in geographical science. In the final paper on the European theme, F. R. Van Veen discusses early ideas about erratic boulders and glacial phenomena in the Netherlands.

Reviews of themes that relate to east Asia and Australia are the next set of conference papers in the volume, beginning with a paper on one hundred years of investigation on the planation surfaces in China by K. Zhang, followed by a paper on the Palaeo-Tokyo Bay concept by M. Yajima. Papers on Australia follow, beginning with a review of work on Australian Cenozoic history by D. Branagan, and followed by discussion on the study of desert dunes in Australia by C. R. Twidale, and a paper by D. R. Oldroyd on early ideas on the development of the river systems of the Sydney region of eastern Australia. Finally, W. Mayer discusses early geological investigations of the Pleistocene Tamala Limestone in Western Australia.

R. H. Grapes then presents a paper on New Zealand geomorphologist Sir Charles Cotton (1885–1970). Finally, M. S. Brook presents a review of the work of George Leslie Adkin (1888–1964) on glaciation and earth movements in the Tararua Range, North Island, New Zealand.

Biochemical Controls on Paleoceanographic Environmental Proxies

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This publication comprises eleven papers presented at the 2005 meeting of the Geological Society of London, in a session entitled 'Biogeochemical Controls on Palaeoceanic Proxies'. According to the opening paragraph of the book, the primary goal of the organizers was to have an interdisciplinary evaluation of the pros and cons of those proxies now widely used for paleoceanographic modelling and paleoclimatic reconstructions. A secondary goal was to provide a forum to describe techniques, largely untried but based on new, exciting research.

As a neophyte on the subject of proxies, my first question was, "What is the context in which the authors are using this term"? Fortunately, the editors William Austin and Rachael James had forestalled me. According to their definition in the Introduction, proxies are "… biogenic components which have a close relationship to environmental parameters and may be identified as so-called 'proxy-variables'..., providing measurable descriptions of key climatic and environmental variables". However, the definition of proxy in your standard dictionary is somewhat different than its use in the above sense.

The publication includes contributions that provide timely and necessary reviews, as well as those that represent original research. There are five general or review papers if we include the Introduction. Four papers highlight benthic foraminifera. Three of the others focus on planktonic foraminifera, one on corals, and one on an intertidal acorn barnacle.

How does one review this interesting but somewhat eclectic series of papers? I decided that the most logical approach is to focus on subject matter. That was obviously what motivated the editors in their selection of the first three papers, which review the various proxies and analytical techniques. Following the brief but insightful introduction, James and Austin give a fascinating oversight of important biological and geochemical proxies and how they are of immeasurable value in paleoclimatic modelling and in interpreting paleoceanographic conditions. These authors point out that biologically produced carbonates are the biosphere's largest carbon reservoir, with calcareous organisms affecting the oceans' CO_2 and pH content and, hence, atmospheric CO_2.

In the sections on the fossil groups, James and Austin cover foraminifera, coccolithophores, diatoms, corals and molluscs. These authors include the foraminifera in the Kingdom Protoctista, although recent classifications assign them to the Rhizaria. Oxygen isotope analyses of foraminifera are invaluable for indicating sea-surface temperatures, paleoclimates and salinity. An increasingly versatile proxy determined from foraminifera tests is the Mg/Ca ratio, which is an important paleothermometer. Other promising proxies are: the Sr/Ca ratio in coccoliths, which correlates with rates of organic carbon fixation and calcification; δ^{30}Si and δ^{15}N values in diatoms, which denote nutrient utilization; and Sr/Ca and U/Ca ratios in corals, which relate to sea-surface temperatures.

James and Austin note that serious obstacles to using geochemical proxy records in modelling are contaminants, preservation of the fossils, and recrystallization. Equally critical caveats are that the present may not be a true reflection of the past, so that established calibrations are variable, and that the proxy relationships for extinct species cannot be calibrated. Subsequent papers elaborate on some of the above concerns.

The paper on biomineralization by R.P.J. Williams evaluates inorganic and organic formation of calcite, a mineral that is always contaminated with magnesium if precipitated from sea water. Calcium carbonate may form within, around or upon an organic matrix, which is usually part of the eukaryotic cell. But whether calcite or aragonite is precipitated is determined by biological selectivity. Coccoliths are formed almost exclusively of calcium carbonate, as most magnesium is expelled by metabolic processes within the cells, whereas foraminiferal shells contain a much higher concentration of magnesium.

Foraminifera are possibly the most versatile fossil group as paleoceanographic and paleoclimatic proxies, whether one is utilizing planktonic or benthic species. Papers by Zeebe et al., Pearson and Burgess, and Schmidt et al. discuss the former group, but from very different perspectives.. Zeebe et al. examine the biology and geochemistry of foraminifera from a modeller's vantage point: they note that seawater carbonate chemistry significantly affects $\delta^{13}C$ and $\delta^{18}O$ in planktonic foraminifera and that the stable boron ratios in the shells of these organisms help to reconstruct the pH values for ancient sea water. One significant aspect, which must be considered in any reconstructions based on proxies, is that foraminifera dramatically alter their chemical and isotopic micro-environment.

Pearson and Burgess evaluate preservation and diagenesis in high-latitude, Eocene planktonic foraminifera from both hemispheres. Specimens recovered from deep-sea oozes and chalks underwent dissolution, overgrowth and recrystallization during diagenesis. A series of beautiful scanning electron microscope images vividly emphasize some of the differences in specimens of the same species but from different locations.

Schmidt et al. review how size differences and rate of growth affect trace element compositions in planktonic foraminifera. Some species show an increase in Sr/Ca ratios with increasing size; this would have a significant bearing if the ratios were being used to distinguish glacial and interglacial settings. Another concern, noted by the authors, is that the analyses on tests of the same size do not guarantee that they all represent the same life-cycle stage of a species.

The four papers dealing with benthic foraminifera are by Gooday et al., Mackensen, McCorkle et al., and Cage and Austin. Gooday et al. review the morphology-based and trophic biodiversity of modern deep-sea benthic forams, which include many delicate taxa that are rarely preserved. One such group is the komokiaceans. The thrust of the paper is that palaeoproductivity, as determined from benthic foraminifera, is a useful parameter for oceanic settings, but must be treated with caution because of the high loss of soft-shelled taxa. Soft-shelled species play an important role in carbon cycling at abyssal depths.

On the basis of field observations, Mackensen discusses the $\delta^{13}C$ signal in living benthic foraminifera. The data provide insights into $^{13}C/^{12}C$ ratios, which can then be used to interpret fossil signals. Two important conclusions are that fossil infaunal species having lower $\delta^{13}C$ values generally reflect enhanced organic carbon fluxes to the seafloor, and that ages based on $\delta^{13}C$ may be too old.

One of the most stimulating papers, by McCorkle et al., represents original research on foraminiferal proxies. These authors determined the carbon and oxygen stable isotope composition of two species of benthic foraminifera over a period of two years. They used twelve culture chambers, which were continuously flushed with sea water kept at a constant temperature and composition. Differences between the chemistry of specimens' tests and that of the water confirmed the view that much is still to be learned about shell chemistry. When one considers that the authors studied only two of thousands of known species of benthic foraminifera, acquisition of such knowledge will not be easy.

Seasonal changes in water temperature in shelf seas have a significant impact on the geochemistry of benthic foraminifera. Cage and Austin demonstrate some fluctuations in $\delta^{18}O$ resulting from such changes and how they may be difficult to separate from other controls such as seawater carbonate chemistry.

The two remaining papers represent a refreshing change of direction. Cuif et al., in a study of fine-scale growth patterns in the coral *Goniastrea*, show that the growth layers of the coral fibres are composed of nanograins of aragonite. Diagenetic changes at the nanometre scale can be seen in corals from the Norian, indicating that one must exercise caution when interpreting isotopic data in the fossils. There are some beautiful SEM images of *Goniastrea* and the Triassic coral *Retiophyllia*, which enhance the quality of the paper. However, the technical editing has been casual.

As a fitting finale to the book, Craven et al. report on variations in carbon and oxygen isotopes in the skeletal carbonate of the barnacle *Semibalanus balanoides*. This barnacle lives within the intertidal zone, and so shows differences in isotopic composition depending on how long it is submerged. The authors found that the main factor affecting the carbon-isotope ratio of the shell is the difference in the CO_2/O_2 ratio between air and sea water.

Throughout the volume, the quality of the papers is generally high. Most are well written and several are improved by use of colour illustrations. This is especially important since most of the figures are graphic plots and without colour would struggle to catch the eye. An example of effective use of colour is Figure 4 in Zeebe et al., which has far more appeal than most of the other graphics in the book. While on the subject of graphics, I would have liked to see all generic names given in full rather than simply the first letter. This causes difficulties for the non-specialist and is a false saving of space.

One essential addition for the non-specialist would be a glossary, especially one that included abbreviations and acronyms. I have rarely encountered so many and had so much difficulty finding the meaning and/or a definition.

My overall impression of the volume is that the editors gave its organization considerable thought. The subject is topical, with proxies becoming critical in helping to unravel paleoceanographic and paleoclimatic conditions. This is a publication well worth reading and, if you are a specialist, you should buy a personal copy.

Otherwise, I recommend encouraging your library to purchase the volume, so that you will gain many new insights into the fascinating topic of proxies in biominerals and some of the pitfalls to be avoided when applying them.