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0521021944 - Climate Modes of the Phanerozoic: The History of the Earth's Climate over the Past 600 Million Years

Lawrence A. Frakes, Jane E. Francis and Jozef I. Syktus

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# *Climate Modes of the Phanerozoic*

*The history of the Earth's climate  
over the past 600 million years*

LAWRENCE A. FRAKES

JANE E. FRANCIS

JOZEF I. SYKTUS

*Department of Geology and Geophysics  
University of Adelaide, South Australia*



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## *Preface*

This book covers the history of climate for the last 600 million years. Part of the book is a summary of palaeoclimate information for different slices of geologic time. We believe it is necessary to update and attempt to synthesize the great body of research on palaeoclimates generated over the last ten years or so. But there was a further purpose in the collection of these basic data and that was to establish a framework which we could use to compare and contrast similar climate states of the past, and from there to recognize some causes of climate change. We have divided climate history into Warm Modes and Cool Modes, in a way not unlike Fischer's (1982) 'Greenhouse' and 'Icehouse' states, but our Modes are of shorter duration and contain some controversial elements – we have questioned the theory that the Mesozoic climates were uniformly warm and ice free and instead propose a Cool Mode in the middle Mesozoic. We have also included a chapter on the climates throughout the Quaternary, something which is often missing or abbreviated in texts on geologic climates, not surprisingly considering the huge volume and the increased scale of detailed information available for such a relatively short time.

It is assumed that the reader will already be familiar with Earth history and have some understanding of the basic principles and techniques of palaeoclimatology, such as the measurement and interpretation of oxygen and carbon isotopes, and the significance and weaknesses of evidence from sedimentary rocks and fossils etc. Descriptions of palaeoclimatological methods and accounts of the historical development of ideas, both important aspects of palaeoclimatology, are abundantly available elsewhere and are here kept to a minimum for the purpose of economy; we apologize in advance for thus not including all such pertinent information.

It has become apparent in recent years that the carbon cycle is one of the major influences in climate change, both in the near future with the likely greenhouse warming, and during the Quaternary ice ages. Was the carbon cycle so dominant in the geologic past? This has been the question we have had in mind when compiling this palaeoclimate information. In the final chapter we bring together information about climate change from previous

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chapters and discuss the influence of the carbon cycle and the geological factors which may have influenced it. We do not suggest that we have found the answer to past climate change, but have highlighted some events and possible consequences that will hopefully inspire further analysis and exploration.

The climate system is now and was in the past affected by, and itself affects, a huge diversity of factors, including the carbon cycle, the nature of the oceans and their circulation patterns, distribution and types of vegetation, mantle composition and circulation, and extraterrestrial forces, to name only a few. Therefore, the sphere of literature that has to be examined to draw together clues about ancient climates is, not surprisingly, immense. To print every reference which has some use for palaeoclimate analysis and which we have consulted would take up a huge volume in itself. We have therefore tried to be more economical with our bibliography and have preferred to refer to many excellent review papers, or compiled volumes about palaeoclimates or relevant themes. We recommend that the source references in these papers be consulted for more thorough treatment of some aspects of climate systems or geological histories that we have been able to refer to only briefly.

One of the major problems that we have encountered when trying to compile and compare palaeoclimate information is the discrepancy between different time scales. Examine, for example, Fig. 7.3 in this book. We have illustrated the time scale used by Haq, Hardenbol and Vail (1987) for their sea-level curves alongside the DNAG (Decade of North American Geology) time scale (Palmer, 1983), matched by the absolute ages. There is a large discrepancy between the durations and positions of the Stages – the Cretaceous Berriasian of DNAG correlates with the Jurassic Kimmeridgian of Haq *et al.* Drawing parallels or correlations between different parameters will always be difficult and include some degree of uncertainty until more consistency between time scales is achieved.

We chose to use the time scale of DNAG (Palmer, 1983) since it was the most compatible with the majority of scales used in publications. If necessary we have mentioned in the figure captions how we matched information to the time scale (by matching absolute dates or Stage boundaries). To make full use of geological data for palaeoclimate work it is essential to state in each publication which time scale is being used when mentioning Stages/Ages – our task was made more difficult by the fact that many papers do not provide this information.

There are many people who have inspired, helped, discussed and argued with us during the preparation of this book. We express our gratitude to all of them. In particular, we would like to thank the reviewers: Judy Parrish, John Crowell and Thomas Crowley. The enigma of Cretaceous ice, which was the stimulus for the new climate modes, was discussed in the field in the



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deserts of central Australia with Neville Alley, Graham Kreig, Nick Lemon and Tan van Doan, and in Arctic Canada with Ashton Embry. Colleagues at the University of Adelaide provided a testing ground for our ideas, so our thanks are extended to Brian McGowran, Malcolm Wallace, Vic Gostin, George Williams, and to those involved in the practical preparation, including Sophia Tsemitsedis, Sherry Proferes, Rick Barrett and Fran Parker. Financial assistance was provided by the Australian Research Council and the University of Adelaide.

Lawrence Frakes

Jane Francis\*

Jozef Syktus.

- \* Present address: Department of Earth Sciences,  
University of Leeds,  
Leeds LS2 9JT, UK.