High-Resolution Approaches in Stratigraphic Paleontology

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P.J. Harries
Editor

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P.J. Harries
Department of Geology
University of South Florida
Tampa, USA

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Contributors

Thomas J. Algeo Department of Geology, University of Cincinnati, Cincinnati, Ohio 45221-0013

Richard K. Bambach Department of Geological Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA 24060

Carlton E. Brett Department of Geology, University of Cincinnati, Cincinnati, Ohio 45221-0013

Kenneth Carpenter Department of Earth and Space Sciences, Denver Museum of Natural History, 2001 Colorado Blvd., Denver, CO 80205

Roger A Cooper Institute of Geological and Nuclear Sciences Limited, Lower Hutt, New Zealand

Jeffrey G. Eaton Department of Geosciences, Weber State University, Ogden, Utah 84408-2507

Edward Fowler Agua Dulce, California, 91350

Peter J. Harries Dept. of Geology, Univ. of South Florida, 4202 E. Fowler Ave., SCA 528, Tampa, FL 33617-5201

James I. Kirkland Utah Geological Survey, P.O. Box 146100, Salt Lake City, Utah 84114-6100

Susan M. Klofak American Museum of Natural History, 79th Street and Central Park West, New York, NY 10024-5192 and Department of Biology, City College of the City University of New York, Convent Avenue and 138th Street, New York, NY 10031

Marilyn A. Kooser Department of Earth Sciences, University of California, Riverside, California 92521

Michał Kowalewski Department of Geological Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA 24060

Neil H. Landman American Museum of Natural History, 79th Street and Central Park West, New York, NY 10024-5192

Patrick I. McLaughlin Department of Geology, University of Cincinnati, Cincinnati, Ohio 45221-0013

Jared R. Morrow Department of Earth Sciences, University of Northern Colorado, Greeley, CO 80639

Peter M. Sadler Department of Earth Sciences, University of California, Riverside, Riverside, CA 92521

Charles A. Sandberg United States Geological Survey, Box 25046, MS 939, Federal Center, Denver, CO 80225-0046

Kathleen B. Sarg American Museum of Natural History, 79th Street and Central Park West, New York, NY 10024-5192

Charles E. Savrda Department of Geology and Geography, 210 Petrie Hall, Auburn University, Auburn, Alabama 36849-5305

Mark Webster Department of Earth Sciences, University of California, Riverside, California 92521

Margaret M. Yacobucci Bowling Green State University, Department of Geology, 190 Overman Hall, Bowling Green, OH 43403-0218

Preface

Since at least the Renaissance, as exemplified by Steno's contributions, there has been the recognition that Earth history can be interpreted from the analysis of the geologic record. The primary aim of most geologic studies has been and continues to be the reconstruction of that history, so that theoretically the dynamics of the Earth's systems and the interactions between those systems can be reconstructed along time slices. High-resolution stratigraphic analysis was developed, as the name implies, to glean data from the record at increased levels of temporal and spatial resolution to accomplish that aim. The application of the technique initially focused largely on lithologic and paleontologic indicators and their variability that can be employed to improve resolution and erect frameworks for various intervals in the geologic column.

During the past few decades, especially as paleontology has become a tool used to address an increasing range of geologic, evolutionary and environmental questions, high-resolution approaches have become an integral component of numerous studies. To a certain degree this represents an increased and more detailed analysis of the fossil record, but, to a greater degree, this reflects the need for both temporally and geographically refined paleontologic data to tackle the broad spectrum of questions currently being investigated. Paleontology has undergone a rapid maturation during the past 50 years and one of the important elements of this process has been the realization that to effectively delve into the details of evolutionary and paleoecologic questions, fine temporal resolution is a necessity. However, there are limits to the resolution that can be achieved due to such controls as the rate of rock accumulation, taphonomic overprinting, as well as a wide range of other factors that obscure the record. Furthermore, to a certain degree 'high resolution' is in the eye of the beholder. Because of the vagaries of preservation and due to the ever-changing environments that

were inhabited by organisms of the past, the resolution that can be achieved differs substantially between depositional settings, taxonomic group, and also can be, at least in part, related to the nature of the questions being asked.

The overarching aim of this volume is to look at state-of-the-art approaches currently being used and to show how integrating a variety of these approaches is a necessity to producing and analyzing robust datasets and to delve into some of the limitations inherent in the analysis of paleontologic data. The success of high-resolution paleontologic approaches has been largely triggered by the integration of numerous approaches that have been applied in concert to investigating the geologic record. These approaches come from a wide range of disciplines and integrate lithologic, paleontologic, geochemical, and geophysical data, among others, that have increased the stratigraphic refinement. Although elements of these various approaches are inherent in this book's contributions, the theme of the book is concentrated on paleobiologic approaches to spatial and temporal resolution as well as how refined high-resolution frameworks can be employed to investigate environmental, ecologic, and evolutionary changes and patterns.

This volume loosely covers a spectrum of topics following a progression from more theoretical to more applied contributions. In the theoretical arena, there are a number of critical constraints and concepts that are addressed. One of the over-arching questions in high-resolution paleontology revolves around the rock record itself and how much temporal precision can be teased from it. The contributions in this volume (see Chapters 1 and 4) offer to different perspectives and scales related to the issue and point to the limitations as well as the strengths of the fossil record. In addition, more rigorous application of quantitiative techniques has become an integral part of the geosciences, and their application to various paleontologic problems, including high-resolution problems, is no exception approaches (see Chapters 2, 3, as well as the accompanying CD and Chapter 13).

As all the chapters attest, there is more to high-resolution approaches than simply the ability to document the paleotnologic record at increasingly finer levels of resolution. Data critical to the analysis of a host of evolutionary, ecologic, environmental questions can be generated at sufficient temporal and geographic resolution so that detailed responses to environmental changes and variability can be analyzed. Although the general field is certainly not limited to these topics, this volume focuses on evolutionary and environmental issues (Chapters 5-8) that can only be effectively addressed once a high-resolution database exists. The final set of chapters (9-12) focus on different methodologies that can be employed to produce high-resolution frameworks.

The thirteen chapters that comprise this volume offer a broad perspective on both theoretical and practical issues related to high-resolution paleontologic studies. They not only point to approaches that have been successfully employed to investigate a range of paleobiologic issues, but also

suggest directions for further study and new techniques that can potentially continue to decrease the temporal intervals inherent in our understanding of 'high resolution'. So, break out your hammers, fire up your computers, there's work to be done!

Peter J. Harries
Tampa, Florida

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