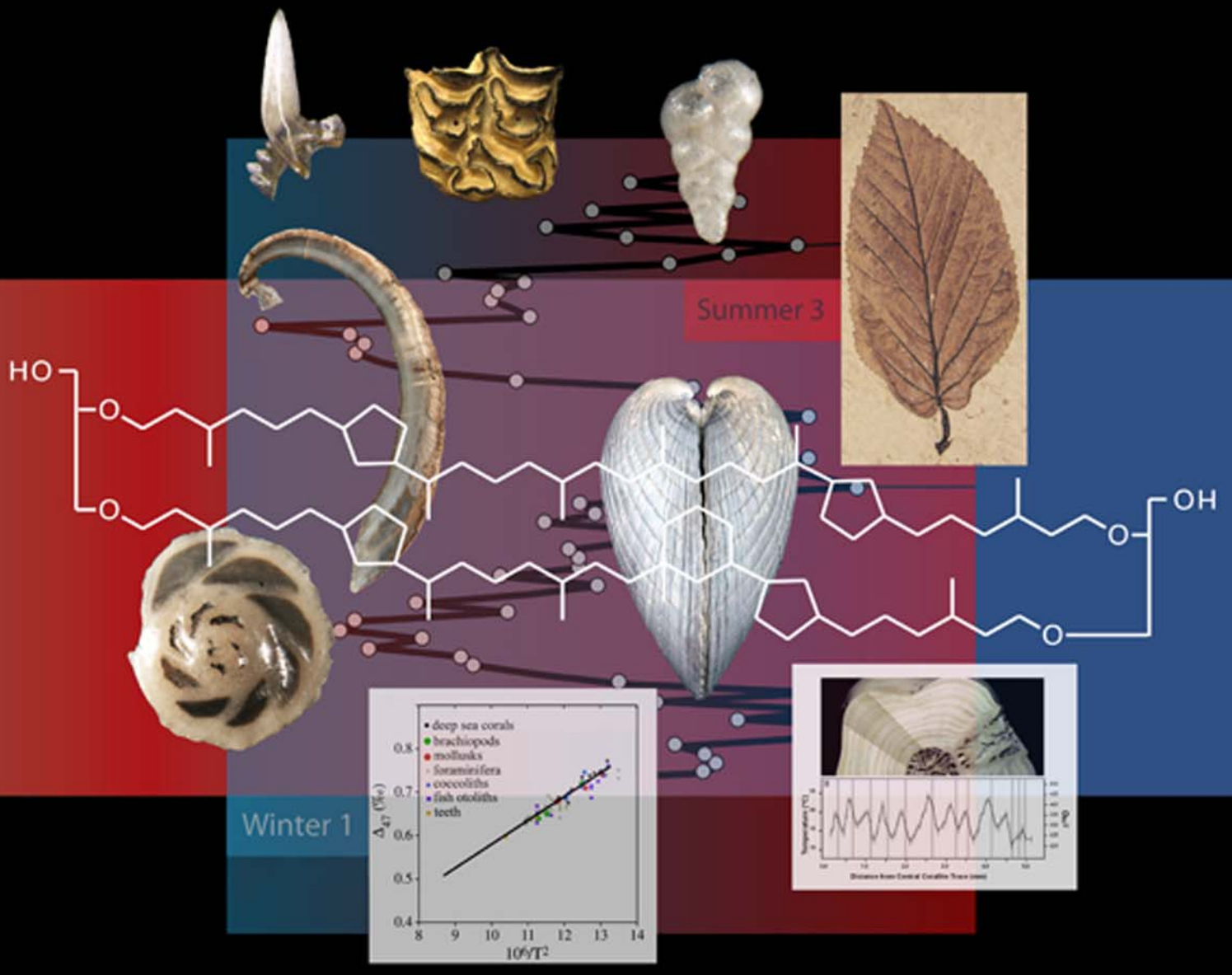
Reconstructing Earth's Deep-Time Climate



Linda Ivany and Brian Huber, Editors

The Paleontological Society Papers Volume 18

RECONSTRUCTING EARTH'S DEEP-TIME CLIMATE

The State of the Art in 2012

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Linda C. Ivany and Brian T. Huber
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COVER
Cover designed by Mary Parrish, Smithsonian Institution (SI).

Front cover images:
(top left to top right): Conodont element, photo by Kenneth G. MacLeod (Univ. Missouri); fossil horse tooth, photo provided by Bruce McFadden (Univ. Florida); benthic foraminiferan, image provided by Ines Wendler (Bremen Univ.); fossil leaf, photo by Dana Royer (Wesleyan Univ.).
(middle left to right): GDGT structure, see Tierney, this volume; cross-section of fossil bivalve shell, photo by Devin Buick, articulated fossil bivalve, image provided by Linda Ivany.
(bottom left to right): structure of planktic foraminiferan, photo by Brian Huber (SI); clumped isotope temperature calibration, see Affek this volume; fossil coral and data, see Ivany, this volume.
(background image) rudist isotope curve from Thomas Steuber (Univ. of Bochum), modified by Brian Huber (SI).

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PREFACE

The influence of climate change on biological and earth systems has always been of interest to geoscientists, but the subject has become ever more important in recent years as our planet experiences a climate shift of geological proportions. Increasingly, we are being called upon to provide insights about environmental and ecosystem responses to changes in climate of a magnitude that have not been recorded in the data-rich Holocene, or even Quaternary. Predictions that the Earth will, in the not-too-distant future, experience temperatures comparable to those of 'supergreenhouse' intervals, such as the early Eocene or Cretaceous, make studies of the deep-time sedimentary and fossil record more critical than ever.

Recent advances in paleoclimate research have produced a plethora of new and powerful climate proxies that could be integrated into organism-environment studies in deep time. This new generation of techniques offers the potential for truly quantitative estimates of paleotemperature, enabling us to address ever-more sophisticated questions about ancient environments and non-analog earth systems. Paleontologists and sedimentary geologists are eminently qualified to integrate faunal data with paleoclimatic data to provide new insights on the future based on what we can learn from the past.

The papers assembled in this volume review both new and long-applied methodologies for understanding climate in ancient marine and continental environments. We are very fortunate to have such an illustrious set of contributing authors—people at the forefront of the field and involved in proxy development and/or application in deep time. Our collective goal is to provide a solid, very current, and synthetic introduction to the basics of paleotemperature reconstruction. While we recognize that the word 'climate' means far more than just temperature, we have opted here to focus on that particular variable due to the time constraints of a one-day short course. Readers are referred to the excellent work on CO_2 proxies and paleoprecipitation, for example, that is now maturing in the literature.

We hope that this volume will provide background and perspective for earth scientists hoping to complement their work with published paleoclimate data or to produce new climate data as part of an integrated research program. Particular attention is given to the biological influences, assumptions, uncertainties and confounding problems associated with proxies that are used to reconstruct paleotemperatures of ancient terrestrial and marine environments.

Several people have made this volume possible, and we are indebted to them for their help and inspiration. We thank Lisa Park Boush for suggesting this short course topic and members of the Paleontological Society Council for supporting and encouraging it. Jack Hess, Howard Harper, and the Cushman Foundation Board of Directors graciously supported co-sponsorship by the Geological Society of America, the Society for Sedimentary Geology, and the Cushman Foundation, respectively. Tom Olszewski, Program Coordinator for the Paleontological Society, and Mark Wilson, Secretary, have been extraordinarily helpful (and patient) in making this short course happen. Sara Marcus worked tirelessly to copyedit the manuscripts and produce the final volume. Graphic artist Mary Parrish designed the cover art. Cover images and data are courtesy of our authors, Tom Steuber, Bruce MacFadden, Ines Wendler, and our own material. Melissa Cummiskey with the GSA helped with on-site arrangements for the short course. Anne Marie Quirke, Print Production Coordinator at Yale Printing and Publishing Services, ensured that the volume was printed and shipped in time for the short course. John and Mary Pojeta and the Paleontological Research Institution handled distribution of the volume. Lastly, we are indebted to the many reviewers who read and provided valuable feedback on these manuscripts, and who ultimately improved the quality of this volume.

—Linda C. Ivany (Syracuse University) and Brian T. Huber (Smithsonian Institution)