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Preface

Rodinia and the Mesoproterozoic earth–ocean system

We could hardly introduce this volume without mentioning the now infamous words of our respected colleague, Roger Buick, who, in a statement somewhere between a tongue-in-cheek caricature and an honest representation of available data, claimed that the Mesoproterozoic Era was 'the dullest time in Earth history' (Buick et al., 1995). If anything is certain, though, it is that the Mesoproterozoic was *not* dull. Rather, the Mesoproterozoic is emerging as a time of significant change in terms of global carbon cycling, biogeochemical cycling of redox sensitive elements, and evolutionary diversification in both prokaryotic and eukaryotic communities, including the appearance of the first unambiguous multicellular algae. Furthermore, many of these major biogeochemical transitions may have been concurrent with, and perhaps causally linked to, the global tectonic events that resulted in the assembly of the supercontinent Rodinia.

The contributions to this special issue are, to say the least, an eclectic mix of Mesoproterozoic geology. Rather than finding answers in this volume, we hope that the reader will find questions. We have, therefore, asked the authors, while remaining acutely aware of the constraints of their data, to broaden the expression of their ideas in order to foster new lines of inquiry. Toward this end, we have not discouraged the presentation of potentially conflicting hypotheses — it is at the points of conflict that breakthrough understanding will occur.

For those working in Precambrian geology, such an approach is familiar. After all, the concept of a Rodinian supercontinent emerged from fragmentary evidence, reconstructed in a new way. Recognized first by the Neoproterozoic rifted margins it left behind, the Mesoproterozoic assembly of Rodinia began to take shape when ancient mobile belts were rejoined in geologic models. The result was the SWEAT hypothesis (Moores, 1991), in which Moores proposed specific tests of his hypothesis, challenged future workers to continue the search for a supercontinent, and set the SWEAT hypothesis up as the 'straw man' for subsequent hypotheses. Such a simple, elegant model is a tough act to follow.

The contributions to this volume reflect the complexity of the questions regarding the Mesoproterozoic era, and perhaps the complexity of the answers. Large-scale tectonic interpretations, grounded in fieldwork and geochronology, provide not only the framework for addressing these questions, but also a wealth of testable hypotheses. Because each tectonic scenario carries specific implications for nearby basins, single-basin studies allow questions of plausibility to be addressed. In this volume, smaller scale studies each focus on aspects of Rodinia, and each draws local or regional conclusions that must be incorporated into the emerging global framework.

This special issue contains 10 papers, with 10 different perspectives on Rodinia. The astute reader will note that there is no consensus on what Rodinia looked like, precisely how it assem-

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bled, or even when these events occurred. Each paper presents a piece of the puzzle, and it falls to those of us working on these problems to find a solution appropriate to all the data. We have, therefore, simply organized the volume to begin with regional overviews and end with more localized investigations.

Karlstrom and coworkers present a somewhat controversial reconstruction of Rodinia, based on a wide variety of field-based evidence. By combining paleomagnetic data, detrital zircon geochronology, and outcrop patterns of sedimentary basins and deformation fronts within Laurentia, they attempt to 'fingerprint' piercing points surrounding Laurentia. They conclude that the southern margin of Laurentia represents an active margin through much of the pre-Rodinian Proterozoic and suggest that placement of Australia along the southwestern Laurentian margin best explains the distribution of geologic data. In contrast, Thorkelson et al. reevaluate age constraints and emplacement mechanisms of the Wernecke breccias in northwestern Canada and suggest that mineralogical and textural similarities of these breccias to the Olympic Dam breccias in Australia support a more northerly placement of Australia with respect to Laurentia. Obviously, Australia cannot be in both places in Rodinia. However, the juxtaposition of competing hypotheses may suggest tests to distinguish between them.

In the third paper, Ross et al. examines the detrital grains within sedimentary sections and tries to account for their derivation. Such an approach provides a potentially powerful means of testing regional scale tectonic hypotheses. Ross et al. suggest an intermediate position for Australia, as detritus from westerly sources is deposited in the Muskwa and related basins. In the fourth paper, Luepke and Lyons take a paleoceanographic approach, using sulfur isotopic composition to constrain the extent of restriction in the basin. They conclude that the lower Belt Supergroup was deposited in a marine setting with episodes of restriction driven by regional tectonic events along western Laurentia. By observing paleoceanographic change through stratigraphy, Luepke and Lyons propose specific linkages between deposition in western Laurentia and geochronologically constrained tectonic events, thereby providing a number of chronologic 'piercing points' with which to test possible reconstructions.

In the fifth paper, Geraldes et al. turns to the poorly known eastern portions of Rodinia with one of the first comprehensive tectonic and geochronometric studies of the Amazonian craton with respect to its position early in the assembly of Rodinia. These authors highlight some of the difficulties with reconstructing the position of Amazonia during the Mesoproterozoic.

In the second half of the volume, we return to Laurentia, with five papers focused on individual basins in northern Laurentia and Siberia. Although the northern margin of Laurentia has received much attention, the position of Siberia with respect to Laurentia is still poorly constrained, as are the relationships among the several Siberian and northern Laurentian sedimentary basins. In the absence of a well-defined ancient suture, consensus on the relative position of Siberia with respect to Laurentia has not emerged through classical methods. Rainbird et al. (1998) took a different approach, suggesting that the position of Siberia could be constrained by the presence and paleocurrent direction of Neoproterozoic detritus derived from the Grenville orogen in eastern Laurentia. In this volume, Khudoley et al. extend this approach to Mesoproterozoic rocks in eastern Siberia.

Within an emerging geochronologic framework, we can begin to examine the geochemical framework of sedimentary successions in some detail. Bartley et al. compile $\delta^{13}C$ and $^{87}Sr/^{86}Sr$ data from coeval successions of eastern and western Siberia, within the context of global tectonic events. Similarly, Kah et al. examine the sulfur isotopic record of sulfates and sulfides in an exceptionally well-preserved succession from northern Laurentia. Within the emerging framework of geochronology and tectonic change, such geochemical studies provide evidence for and tests of linkages among tectonic evolution, geochemical cycles, and biospheric evolution.

In the penultimate paper of this volume, Butterfield explores the potential paleobiological consequences of inferred biogeochemical changes. In the evolving ocean-atmosphere system of the Mesoproterozoic, the first demonstrably multicellular algae appear in the fossil record. These algae compete with the ancient microbial systems for space, thereby altering the fundamental nature of the sediments they inhabit.

Although the current evidence for changes in the Mesoproterozoic derives largely from geochemical, paleontological, and tectonic datasets, it has not gone unrecognized that the fundamental nature of carbonate rocks may also have undergone significant transformation during this interval. In the Proterozoic, as in the Phanerozoic, carbonate buildups provide a sensitive indicator of ocean geochemistry, sea level change, and continental margin geometry. In the final paper of this issue, Petrov and Semikhatov explore the sequence stratigraphic architecture of a Mesoproterozoic pinnacle reef from Siberia. This paper, though seemingly remote from the larger subject of Rodinia, reminds us of the importance of linkages between tectonics, geochemistry, and biota, at all scales.

It has been enlightening to watch the progress of these papers from initial submission to publication, and we would like to express our appreciation to all the authors for their efforts and their patience. We also are profoundly indebted to the many people who took the time to keep us honest by reading and reviewing manuscripts; Michael Arthur, Scott Carpenter, Drew Coleman, Ronadh Cox, Ian Fairchild, Charlie Gower, Charlie Jefferson, Jay Kaufman, David Kidder, Paul Link, Graham Logan, Darryl Long, Guy Narbonne, Mike Pope, Toby Rivers, Matthew Saltzman, Scott Samson, Graham Shields, Harald Strauss, Paul Strother, Dawn Sumner, Randy Van Schmus, Don Winston, and Shuhai Xiao. Our department chairs, Bill Dunne and Johnny Waters, deserve special recognition for helping us find the time and resources to organize this effort. Finally, we would like to extend personal thanks to our graduate and postgraduate mentors — John Grotzinger, Andrew Knoll, Paul Hoffman, Timothy Lyons, and Bill Schopf — who taught us that grand scientific ideas ultimately derive from detailed examination of the data.

This volume is dedicated to the memory of Christopher McArthur Powell, whose tireless efforts to unite scientists to the cause of Rodinia will be reflected in the scientific literature for years to come.

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