Paleoceanography of Paleozoic Midcontinental Seaways: Introduction

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Paleoceanography has emerged recently as a discrete subdiscipline within the earth sciences. This, to a large extent, is a direct consequence of the Deep Sea Drilling Project (DSDP) and the revolution in the earth sciences resulting from the development of the concept of plate tectonics. Logically, the first, and most significant, strides in the field have been made by applying modern oceanographic concepts and approaches to the study of Cenozoic and Cretaceous deep-sea sediments. These studies have demonstrated that the sedimentary record of the deep-sea floor preserves large amounts of information that can be used to infer physical and biological oceanographic conditions which, when coupled with plate tectonic reconstructions, document local, regional, and global changes in the oceans through time. Perhaps even more important, paleoceanographic investigations have demonstrated the need for multidisciplinary approaches to the solution of problems in the earth sciences and have contributed substantially to the reduction of communication barriers between such diverse fields as geophysics, geochemistry, sedimentology, paleontology, and astronomy.

Whereas the rapid, dramatic advances to paleoceanography were made technically possible by the DSDP program, they were made conceptually possible by having the modern oceans available as a well-known model for comparison. Inevitably, these same approaches would later be applied to the study of the more ancient record of marine sediments, preserved on continents, representing the remains of Mesozoic and older oceans. Although there was no distinct beginning to this approach, I would suggest that the publication of Thomas J. M. Schopf's textbook, Paleoceanography (Harvard University Press, 1980), marks a major turning point in the study of pre-Cretaceous paleoceanography that probably defines this transition as well as can any single work. The strength of the work lies in its broadly multidisciplinary data base. Schopf argued, in a detailed and well-documented way, that evidence necessary to interpret the geological history of the world's oceans must be drawn from every possible source and that data thus collected must be carefully assembled to produce internally consistent and scientifically accurate syntheses.

It was my respect for this work, coupled with a sense that multidisciplinary studies have been much more commonly applied to the study of
oceanography than to paleoceanography, that prompted the symposium entitled, "Paleoceanography of Paleozoic Midcontinental Seaways," held at the North-Central Section meeting of the Geological Society of America, at Kent State University, April 24-25, 1986. This was a logical site because many of the modern, active students of midcontinental Paleozoic problems reside within this region. Since many of these workers are paleontologists and biostratigraphers, the Paleontological Society was the logical sponsor.

The symposium was designed to deal with a broad spectrum of problems related to the paleoceanography of midcontinental Paleozoic settings, the epeiric seaways. Each contributor has attempted to synthesize a wide range of data. One of the central themes to emerge was that accuracy of paleobathymetric determinations is critical. The vertical and lateral extent of epeiric seaways had a profound effect upon gradients in temperature and water chemistry, patterns of circulation, and faunal distribution. Slight variations in estimates of water depth can result in major differences in interpretation of paleoceanographic conditions. Therefore studies on paleoceanography of epeiric seas reflect a preoccupation with paleobathymetry.

Papers dealt with rocks of ages from Ordovician to Permian and ranged over many topics from a discussion of the effects of sea level changes on the planetary albedo, by Gildner and Cisne, to the description of lag deposits interpreted to have formed by submarine erosion along the pycnocline, by Baird and Brett. Models describing epeiric circulation patterns, presented by Witzke, will be useful to future workers concerned with shallow water circulation. Whereas Witzke's work was centered upon physical oceanographic processes, other workers stressed paleobiological approaches. Anstey, Rabbio, and Tuckey used ordination analysis to examine the relationship between bryozoan faunal composition and paleobathymetry. Markes Johnson, co-convenor of the symposium, summarized the history of development of paleoceanography of midcontinental areas and also utilized evidence from faunal composition to make paleodepth estimates for Early Silurian platform seas.

Although all the papers presented have firm data bases, the work of Droste and Shaver, detailing the paleoceanographic setting of the Late Silurian basins and arches region, and that of Busch and West, using transgressive-regressive (T-R) units inferred from Permo-Carboniferous rocks in Kansas, illustrate well the detail of interpretations that can be drawn from the existing robust data sets.

Paleozoic epeiric seas were very different from modern oceans in several essential ways. They tended to be rather shallow and, because of their being more or less landlocked, only distantly connected to the open ocean. This difference cannot be viewed as simply a matter of degrees. Rather, it may be that tidal and wind driven water mass circulation and mixing, storm effects, and biological productivity were fundamentally different from most present-day shallow water regions. Thus substantial errors in interpretation could result from direct analogy with open ocean settings. For this reason the approaches taken to their study must be tailored to reflect those differences. The great epicontinental seas of the Paleozoic had, at various times, tenuous connections with the open ocean. These connections were often very limited. Thus chemical and salinity gradients were probably markedly different than those that exist over the modern continental shelves.

These differences offer challenges and, potentially, offer the possibility for the development of new generalizations as a framework to be tested against new observations. The data base is enormous! Paleozoic rocks in the midcontinent of North America have been studied, from many different perspectives, for well over a century. Certainly, the marriage of our detailed understanding of the dynamics of ocean systems, coupled with the broad array of studies on these rocks, should provide novel solutions to long-standing questions and problems. Hopefully, this will be the first of several symposia on the paleoceanography of midcontinental Paleozoic seas.

SYMPOSIUM PROGRAM

James P. Kennett: Opening remarks
Markes E. Johnson: North American Paleozoic oceanography: Toward a modern synthesis
Gary G. Lash: Sedimentologic and geochemical evidence for Early
Ordovician fluctuations in bottom-current intensity, northwestern Iapetus Ocean
Raymond F. Gildner and John L. Cisne: Albedo changes from later Ordovician sea level changes
Robert L. Anstey, S. Frank Rabbio, and Michael E. Tuckey: Bryozoan faunal gradients and paleobathymetry in a Late Ordovician epeiric sea
Gregory A. Schumacher and David L. Meyer: Tempestites and variable crinoid preservation: Examples from the Upper Ordovician of Ohio and Indiana
Markes E. Johnson: Bathymetry of North American Early Silurian platform seas
Paula E. Allen and Ronald D. Stieglitz: Cyclic deposition of peritidal and shallow subtidal carbonates on the northwest margin of the Michigan Basin: A reference section for regional synthesis of mid-Silurian (Niagaran) depositional events
John B. Droste, and R. H. Shaver: Paleoceanography of the Late Silurian seaway in the midwestern basins and arches region
G. C. Baird and C. E. Brett: Submarine erosion on a Paleozoic anaerobic basin slope; fate of two Devonian limestone beds in the Genesee Formation of New York state
Brian J. Witzke: Circulation models for epeiric seas: Inferences from Paleozoic facies of the midcontinent
Thomas W. Kammer and Thomas W. Bjerstedt: Evidence for equatorial upwelling during the early Mississippian in southern West Virginia
William I. Ausich: Crinoids and the eastern interior basin: Paleobiogeography within a late Osage (Mississippian) cratonic basin
Richard M. Busch and Ronald R. West: Heirarchical T-R unit stratigraphy as a framework for Permo-Carboniferous paleoceanographic studies
Ronald R. West and Richard M. Busch: Paleoceanography as revealed by sixth-order T-R units and the understanding of chaetetid reefs in Middle Carboniferous strata of Kansas

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(Received May 27, 1986; revised November 26, 1986; accepted November 26, 1986.)