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Preliminary Paleosalinity and Paleoredox Reconstructions across Multiple Tonian-Aged Shale Successions

MICHELLE NORMAN[1], CHRISTINA WOLTZ[2], CAROL DEHLER[3], SUSANNAH PORTER[4], DIEGO P FERNANDEZ[1], CHRISTOPHER R ANDERSON[1], MARIANO N. REMÍREZ[5], KARL KARLSTROM[6] AND CHADLIN M. OSTRANDER[1]

[1]University of Utah
[2]Imperial College
[3]Utah State University
[4]University of California Santa Barbara
[5]George Mason University
[6]University of New Mexico Albuquerque

The late Tonian Period (ca. 750 Ma) is associated with an emergence of diverse, locally abundant early eukaryotes known as vase-shaped microfossils (VSMs). They are the earliest known shell-forming amoebozoans (testate amoebae) and are commonly preserved within organic-rich facies. Very rarely, VSMs preserve primary organic matter within their tests, which potentially suggests reducing, anoxic conditions were present for VSM preservation. Testate amoebae still exist on Earth's surface today, and are abundant in modern terrestrial settings such as wetlands and ponds. However, modern testate amoebae are almost entirely absent from marine environments. This leads us to investigate the depositional environments of Tonian testate amoebae, where salinity and redox conditions likely played important roles in their ecology and preservation.

To better understand the roles of paleosalinity and paleoredox in VSM preservation and ecology, we are conducting a detailed geochemical investigation within three VSM-bearing, late Tonian sedimentary successions: the Red Pine Shale (Uinta Mountain Group, Utah), the Chuar Group (Grand Canyon, Arizona), and the Visingso Group (Lake Vattern, Sweden). Our paleosalinity analyses are largely based on B/Ga, Ba/Sr, and S/TOC ratios. We are also testing the potential utility of stable thallium (Tl) isotopes as a paleosalinity proxy. To calibrate this potential paleosalinity proxy, data was collected from modern basins with varying salinities. Thallium isotopes additionally provide information about paleoredox, as do redox-sensitive trace metals such as V, U, and Mo, which we have also analyzed.

Our presentation will summarize geochemical data from the aforementioned late Tonian sections and also multiple modern sections. Data from modern environments show that most basins unaffected by anthropogenic activity plot along a salinity mixing line, based on their Tl isotope ratios and measured salinity. Preliminary Sr/Ba data from the late Tonian samples show a consistent trend along the brackish and freshwater fields, potentially indicative of fluctuating fluvial input into shallow marine settings. Ultimately, our aim is to have multiple Tonian and recent data suites and a new paleosalinity proxy that will formulate a framework for making faithful interpretations about paleosalinity and paleoredox conditions within environments hosting late Tonian eukaryotes.