The Neoproterozoic Chuar Group: A unique window into the coevolution of life and environment in a restricted marine setting. C. W. Diamond[1] C. M. Dehler[2], K. E. Karlstrom[3], and T. W. Lyons[1], [1]University of California, Riverside, [2]Utah State University, [3]University of New Mexico.

The Tonian-Cryogenian (1000-635 Ma) was a time of dramatic change in Earth history. Coincident with the initial breakup of Rodinia, the first major diversification of eukaryotes began ~800 Ma, setting the stage for the first appearance of metazoans shortly after. As this critical evolutionary transition progressed, large-scale perturbations to biogeochemical cycling and climate are evident in dramatic excursions in the carbon isotope record, both positive and negative, and the onset of global glaciation at ~717 Ma. Recent advances in geochronology and correlation have contributed significantly to building a more holistic picture of this pivotal time in Earth history, though there are still many conflicting lines of evidence, and many questions about the cause and effect relationships driving this dynamic reorganization of Earth surface environments remain unanswered.

Here, we present new iron speciation and elemental data from the Chuar Group (~780-742 Ma) of the eastern Grand Canyon. The Chuar was first recognized as being richly fossiliferous more than a century ago by Charles Walcott. Over the past few decades, careful examination has identified the Chuar as a virtual "konservat-lagerstatten" of early eukaryotic microfossils. A diverse assemblage of beautifully preserved acritarchs is present throughout the 1600 m succession. In the upper Chuar (Kwagunt Formation), in phase with a large positive excursion in organic carbon isotopes, acritarch diversity falls and gives way to the first appearance of vase-shaped microfossils (VSMs). A similar trend in the carbon isotope data accompanying the appearance of VSMs has now been identified in many locations on multiple continents[1], suggesting that these successions were, at least intermittently, connected to the open ocean and thus had the potential to capture signals of changing ocean chemistry.

Focusing primarily on the organic-rich black shales of the upper 400 m of the Chuar, we have found an overall increase in total sulfur content coincident with a transition from lower TOC variegated shales to higher TOC black shales in the Awatubi Member. This transition is initially echoed by an increase in total iron content; however, this enrichment is transient. The overlying Walcott Member is characterized by Fe concentrations significantly lower than the crustal average, and the partitioning of that small Fe pool indicates that it was largely not reactive toward sulfide on diagenetic timescales. Instead, the heightened sulfur levels observed in the Walcott Member appears to largely reflect sulfidation of organic matter, consistent with the notion of limited supplies of reactive Fe.

Although the carbon isotope and fossil records indicate that the this basin shared some connection with the open ocean, sedimentological evidence for repeated subaerial exposure suggests a very shallow water depth for much, if not all, of the Chuar's deposition. The major element composition of the uppermost Chuar is consistent with a shallow, restricted setting, under a strong influence of local watershed effects. Aluminum concentrations are generally high, reaching a maximum of over 3-times crustal average. The majority of other major and minor elements, however, remain almost exclusively below average crustal values. Together, this indicates a very high degree of chemical weathering, which we interpret to reflect the recycling of locally uplifted Mesoproterozoic sedimentary rocks.

Most redox sensitive trace elements show only slight enrichments in the upper Chuar when normalized to an immobile crustal element like titanium. Molybdenum concentrations, however, average 2-3 times the crustal value and reach a maximum observed concentration of 32 ppm. Mo concentrations are typically appreciably elevated only in sediments underlying a water column bearing free hydrogen sulfide (euxinia). Despite the vanishingly small amounts of pyrite found in this study, we interpret the heightened Mo concentrations together with the observed sulfidation of organic matter to be reflecting euxinic deposition of the upper Awatubi and Walcott Members—under highly restricted marine conditions.

Vase shaped microfossils, interpreted to be early heterotrophic eukaryotes, appear for the first time well into this euxinic interval. This relationship could be a reflection of preservational bias or intermittent connectivity to the open ocean. However, their presence at that time in this basin is unequivocal. The coexistence of euxinic conditions and VSMs in a shallow basin potentially carries strong implications for our interpretation of the lifestyle, tolerance to low oxygen conditions, and overall habitats of eukaryotic organisms as their diversity expanded rapidly in the Early-Middle Neoproterozoic.

[1] Dehler, C. (2014) *Geology*, 42, 731-732.