CHARACTERIZING EARLY EUKARYOTIC HABITATS IN LACUSTRINE AND MARGINAL-MARINE ENVIRONMENTS.

E. E. Stüeken[1] and T. W. Lyons[2], [1]University of Washington, Department of Earth & Space Sciences, 4000 NE 15th Avenue, Seattle WA 98195-1310, evast@uw.edu, [2]University of California - Riverside, Department of Earth Science, 2258 Geology Building, Riverside CA 92521.

Introduction: The origin of eukaryotes in the Precambrian was an important step towards the evolution of complex life on Earth; however, the environmental settings in which the earliest eukaryotic cells thrived are not well characterized. Eukaryotic cells require oxygen for at least two reasons: first, because aerobic respiration yields copious metabolic energy, and second, important nutrients are more stable under oxic conditions. Shallow marine environments that became oxygenated long before the deep ocean may therefore have been preferable habitats for eukaryotic life, as supported by trends in microfossil assemblages. By extension, it has been argued that non-marine environments, including lakes and rivers, may have been populated relatively early, but their redox states and nutrient inventories are not well known.

Here we present new geochemical data from the Stoer Group (1.2 Ga) and the Torridon Group (1.0 Ga) in northern Scotland, two putatively non-marine settings that have yielded eukaryotic microfossils in previous studies [1]. Both units contain packages of grey and red shales or sandstones and frequently display exposure surfaces, suggesting that water depth probably never exceeded a few meters. Unlike the Stoer Group, the Torridon Group displays frequent silt-mud couplets and a relatively high degree of grain sorting and roundness, consistent with fluvial or possibly tidal influence and a connection to the ocean. Iron speciation indicates that the Torridon Group, where microfossils are relatively abundant and diverse, was likely deposited under oxic conditions, whereas the Stoer Group, with far fewer microfossils, was intermittently stratified with euxinia at depth. Bulk elemental concentrations combined with organic carbon, sulfur [2], and nitrogen isotopes suggest that nutrient supply did not differ markedly between surface waters at the two sites. Although we cannot rule out taphonomic bias in the microfossil data, we tentatively conclude that (a) at least in these two settings redox rather than nutrients exerted the primary control on eukaryotic dominance and (b) dynamic environments such as rivers or tidally influenced shallow seas were perhaps ideal habitats for early eukaryotic organisms, because even shallow lakes such as in the Stoer Group may have developed anoxia more quickly during periodic stagnation under the O_2-poor Mesproterozoic atmosphere [3]. Our study thus supports the notion that oxygenation of surface environments may have been a prerequisite for the evolution of complexity on Earth and perhaps elsewhere.

References: [1] Strother P. K. et al. (2011) *Nature*, *473*, 505-509 [2] Parnell J. et al. (2010) *Nature 468*, 290-293 [3] Planavsky N. J. (2014) *Science, 346*, 635-638.