

Development of short-lived, ferruginous conditions in the Western Interior Province of Wyoming under a highly oxygenated Carboniferous atmosphere

ALEX KOVALICK¹, ANDY W HEARD², MARIA PROKOPENKO³, ROBERT GAINES³, SUNE GRØNLUND NIELSEN², KOSUKE T GOTO⁴ AND ANDREY BEKKER¹

¹University of California, Riverside

²Woods Hole Oceanographic Institution

³Pomona College

⁴Geological Survey of Japan, AIST

Presenting Author: fkova001@ucr.edu

Important biogeochemical signals of ferruginous (anoxic and iron-rich) conditions in the ancient oceans are recorded by Precambrian Iron Formations (IFs) and Phanerozoic Oolitic Ironstones (OIs). OIs have similar mineralogy, sedimentary textures, and depositional environments to Precambrian Granular IFs but were deposited under vastly different atmosphere-ocean redox regimes. While ferruginous conditions were relatively common and extensive in the Precambrian oceans, they were far less so after the rise of atmospheric oxygen to nearly modern levels in the early Phanerozoic. To investigate the nature of iron cycling in ferruginous conditions under an oxygenated atmosphere, we collected OIs from the Late Mississippian to Early Pennsylvanian (ca. 325 Ma) Horseshoe Shale Member of the Amsden Formation, which was deposited under atmospheric oxygen concentrations around 25%, exceeding that of the modern atmosphere. The Horseshoe Shale Member developed in a protected lagoonal setting along the western slope of the Transcontinental Arch some 20 Ma after the Antler Orogeny. The Amsden Formation OIs in this study were collected in outcrops of the Wyoming Range, stratigraphically within mottled red and olive-tan shales and grey to maroon marls. Iron ooids display both primary and diagenetic textures within oolitic lamina of alternating hematite and chamosite mineralogy. Using LA-ICP-MS to measure Rare Earth Element contents and microdrilled powders to obtain iron isotope values for each of these minerals separately, we reconstruct the biogeochemical conditions that enabled polymineralic iron-oooid precipitation. Large, non-overlapping ranges in Fe isotope values for hematite (0.21 to 0.41‰) and chamosite (-0.37 to -0.24‰) are consistent with distinct formation pathways rather than whole-scale mineral replacement, reinforcing primary origins for each. Negative Ce anomalies in hematite, both positive and negative Ce anomalies in chamosite, and large positive MREE anomalies in hematite are consistent with Mn- and Fe-oxyhydroxide cycling across a redoxcline in the water column or in sediments. Strong positive Eu anomalies (up to 2.8) in hematite points to high-temperature, hydrothermal fluid influence in the basin. These results shed light on several outstanding questions for OI genesis and carry some implications relevant to the active debate over the primary