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A Carbonate Multi-Proxy Investigation of Oceanic Oxygenation across the Ediacaran–Cambrian boundary

WATSAWAN CHANCHAI[1], EMMY SMITH[2], LYLE L. NELSON[2], MARY LONSDALE[2], DALTON HARDISTY[3], JANET BURKE[3] AND KIMBERLY V. LAU[1]

[1]The Pennsylvania State University
[2]Johns Hopkins University
[3]Michigan State University

Presenting Author: wzc5325@psu.edu

The origin and timing of biotic diversification and environmental change across the Ediacaran–Cambrian boundary (ca. 541-537 Ma) are strongly debated, in part, due to the lack of geochronological constraints. The BAsal Cambrian carbon isotope Excursion (BACE), identified by a 4–7‰ decrease in carbon isotopes ($\delta^{13}C_{carb}$), is commonly used as a secondary marker for the Ediacaran–Cambrian (EC) boundary. Although the BACE has been interpreted as a global perturbation to the marine carbon cycle, its driving mechanisms and relationship to paleoredox conditions—both of which can impact biotic turnover—remain poorly understood. Here we present geochemical redox analyses, including cerium anomalies (Ce/Ce*) and iodine-to-calcium-magnesium ratios (I/(Ca+Mg)) of carbonate successions from three study sites (southwestern USA, northern Mexico, and northern South Africa) to investigate the pattern of marine oxygenation associated with the EC boundary. This multi-site approach will spatially constrain redox variability across different paleocontinents. Because each setting has distinct depositional and diagenetic histories, synchronous local redox changes would support interpretations of global environmental perturbations, while variability between the sites may indicate local redox fluctuations or diagenetic alteration. Primary and global redox signatures may support the use of the BACE as a robust marker for the EC boundary in carbonate successions. Our preliminary results indicate predominantly low or zero I/(Ca+Mg) ratios and Ce/Ce* values of ~0.9–1.1 prior to and during the BACE. These proxy values are consistent with local anoxia (i.e., I/(Ca+Mg) < 2.6 μmol/mol, Ce/Ce* > 1.0), with potential minor redox fluctuations following the BACE. Observed Eu anomalies (>1.5) in the southwestern USA section may indicate the presence of Eu-bearing minerals or possible hydrothermalism. We suggest the shallow marine waters during the early Cambrian were locally anoxic, with slight variations in redox conditions. Alternatively, discrepancies of Eu anomalies from different sites could imply variable diagenetic alterations. Ultimately, this study provides spatial and temporal redox constraints across the EC transition. Although the local proxies do not show a significant shift in local redox conditions with the BACE at these sites, small redox instability during this period could have reshaped marine ecosystems and encouraged biotic turnover across the EC.