Unravelling Earth's oxygenation history: The extraordinary legacy of Robert A. Berner

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From his pioneering studies of sediment diagenesis during the 1960s, Bob Berner developed a keen sense for the controlling factors on carbon cycling in marine sediments and the mineral products that result from coupled microbial processes, such as pyrite formed via sulfate reduction. Bob liked to think of himself as a geologist, despite defining many if not most of the initial pathways that led to highly integrated fields such as biogeochemistry, geobiology, and astrobiology. From that geological vantage point, Bob was tuned into the microbially facilitated minerals that can preserve deep into the rock record. And by calibrating those minerals against the observable factors that favor and limit the styles and rates of microbial C cycling and their products in modern settings—such as sulfate and oxygen availability, the quantity and quality of organic matter, and iron geochemistry—Bob gave us a C-S-Fe framework for inferring such fundamental conditions as ancient freshwater versus marine and oxic versus anoxic deposition. Bob also gave us many of the earliest and most robust numerical simulations of sediment diagenesis, and he expanded those views to become the leader in modeling oxygen and carbon dioxide contents in the Phanerozoic atmosphere, building from his deep friendship and respect for Bob Garrels. These efforts, collectively, have guided our examination of the evolving Earth surface system.

This talk will develop the historical milestones of Bob's contributions to paleoenvironmental reconstructions. Included will be the steps taken in partnership with Rob Raiswell and Don Canfield and from that platform an exploration of the mechanistic state-of-the-art for iron paleoredox tracers and their relationships to new, refined, and anticipated trace metal proxies. These metals, both their concentrations and isotope relationships, are key to reconstructing local and global marine redox, the patterns and controls on nutrient availability in the oceans, atmospheric compositions, and the co-evolution of life. Undoubtedly, most of the analytical, numerical, and experimental toolbox available today for investigating Earth's ancient climates, oceans, and life bears Bob Berner's profound influence. And his game-changing extrapolation of the modern world to understand the past began with simple but elegant analysis of pore waters in marine muds more than fifty years ago.