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Approaches to understanding life before the rise of atmospheric oxygen

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The Archean fossil record is notably poor. Despite major advances in deciphering the record of life in Proterozoic successions, attempts to push this understanding back into Archean time have produced frustratingly meager results. Our approach to developing a deeper understanding of the Archean biosphere has been by interrogating the biogeochemical cycles of Fe, S, and C, and reconstructing conspicuous patterns of electron transduction in ancient marine sedimentary basins. We've been working with recently collected diamond drill cores obtained by the Agouron Drilling Project through the Transvaal Supergroup from the Griqualand West structural basin in the Northern Cape Province, South Africa. This sedimentary framework is unique because it captures and provides a view of geobiological processes operating in a wide range of paleoenvironments. Three drill cores cover the development, progradation, and ultimate demise (by drowning) of the Campbellrand carbonate platform (ca. 2590Ma-2500Ma); one captures the platform top shallow marine and intertidal paleoenvironments, the other two run through slope and basinal sections (rich in banded iron formation) deposited adjacent to the platform margin increasing in water depth (to likely more than 1 km). With geobiological data and observations from these cores we can begin to reconstruct the flow of electrons in Late Archean Earth surface environments. In this talk I will present the results of two studies aimed at constraining the interplay between Fe, C, and S. Results from this approach to understanding Archean life may provide, in an integrated fashion, insight into a time before the rise of oxygen, where the fossil record and commensurate biological understanding remain penurious