

Biosignatures at Jezero Crater, Mars and Sahara Uranium Deposit, Utah, Show Similarities That Could Guide the Search for Mars Lifeforms

Scott Hill, Erich U. Petersen¹

¹University Of Utah, Salt Lake City, United States

Observations from the NASA Perseverance rover at Cheyava Falls (Jezero Crater) identify reduced mineral assemblages within oxidized Bright Angel Formation red beds, including scattered greigite nodules sometimes associated with vivianite reaction fronts. Adjacent to these red beds are reduced, bleached strata linked to choked estuarine deposits. These reduced minerals, occurring within an otherwise oxidized, low-temperature sedimentary environment, are interpreted as potential biosignatures of localized sulfate reduction zones, possibly mediated by sulfate-reducing microorganisms.

The Jurassic Sahara uranium deposit (Morrison Formation) provides a possible terrestrial analogue, preserving a comparable assemblage of greigite and mackinawite (both as framboids and scattered crystallites), pyrite, organic matter (humate), and coffinite. These minerals formed at a low temperature, mid-aquifer interface between reducing humic fluids on top and sulfate-rich brine on the bottom. At Sahara, sulfate-reducing bacteria and methanogenic archaea operated at this mid-aquifer, density stratified, two-fluid interface. Microbial sulfate reduction generated sulfide, while iron monosulfide seed crystallites formed within microbial cells and were dispersed into the aquifer, serving as nucleation sites for pyrite and greigite. Uranium, released from humic acid by archaeal methanogenesis, combined with reactive silica to produce the reduced mineral, coffinite. This process, termed semi-inorganic nucleation, reflects inorganic mineral growth initiated on biogenically produced seed crystallites and reactants.

Comparison with Cheyava Falls highlights several testable parallels, including greigite formation under mixed redox conditions, association with organic matter, and spatial linkage to redox interfaces. At Sahara, a life-mediated process produced framboidal sulfides, dispersed seed crystallites, radioactive humic matter, reduced uranium minerals, and subsequently oxidized uranium minerals with strong green fluorescence. Identification of analogous features in Martian samples—particularly at oxidized–reduced facies boundaries—would strengthen interpretations of microbial sulfate reduction and suggest that sulfur-based metabolisms may represent a broadly viable strategy for life in aqueous environments on different planets.