Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.35754

Mineral-Driven Biomethanation: A Geomicrobial Approach for Carbon Sequestration and Energy Generation

YIFAN LIU, MUHAMMAD JAVED AND BOZHONG MU
East China University of Science and Technology

For climate change mitigation, large-scale carbon capture and storage is essential, involving megaton quantities of CO_2 injected into deep geological formations. Over time, this CO_2 engages with subsurface fluids, minerals, and native microbes, influencing its fate via microbial transformation, physical entrapment, and enduring mineral capture. These integrated biogeochemical activities turn geological formations into dynamic bioreactors, where minerals modulate redox states, facilitate electron transfer, supply micronutrients, and act as pH regulators and carbon sources. Our previous work developed meta-omic approaches to analyze reservoir microbes involved in hydrocarbon breakdown and methane production. We examined various electron donors for microbial CO_2 reduction, such as zero-valent metals, iron minerals, and bioelectrochemical setups, detailing conversion routes, rates, and effects of CO_2 injection. Expanding on this, we investigated orange hydrogen-driven biomethanation for combined energy generation and carbon control. Through water-olivine-CO_2 reactions producing orange hydrogen, we observed about 12% greater conversion efficiency compared to using external green hydrogen under similar conditions. Metagenomics revealed *Methanothermobacter* as the primary hydrogen-utilizing methanogen. Additional tests and modeling validated the precipitation of carbonate minerals, like siderite and magnesite, as stable abiotic carbon stores. This geomicrobial method highlights the dual benefit of mineral-facilitated biomethanation: enabling sustainable energy production and long-term carbon sequestration, contributing to a cleaner, greener future.