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Unveiling Microbial Activity in Rock Pores: Tailored Sample Preparation and SEM-EDS Insights

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Studying the interactions among microbes within rock pores and their impact on mineral phases is essential for comprehending subsurface ecosystems and biogeochemical processes, particularly in the realm of subsurface energy operations. In this paper, we introduce an approach that merges customized sample preparation methods with traditional Scanning Electron Microscopy (SEM) featuring Energy-Dispersive X-ray Spectroscopy (EDS) to both visualize microbes in rock pores and analyze the alterations in mineral phases induced by microbial activity.

Customizing the sample preparation process is crucial to preserving the delicate microbial structures within rock pores. We have devised a protocol that incorporates gentle fixation, embedding, and broad-ion-beam (BIB) polishing to preserve the in-situ arrangement of microbes while facilitating optimal SEM-EDS analysis. This method minimizes sample artifacts, enhancing the accurate representation of microbial structures. Through careful selection of imaging parameters and leveraging SEM imaging, we successfully visualized microbes in their natural habitat, allowing us to observe patterns of microbial colonization, biofilm formation, and interactions with mineral surfaces.

The addition of EDS analysis complements SEM imaging by furnishing elemental composition data at micro- to nanoscale resolutions. Mapping mineral phases and identifying elemental changes induced by microbial activity provided valuable insights into biomineralization processes, dissolution, and precipitation events. Such information is crucial for understanding how microbial communities influence the mineralogical composition of rocks. Our findings highlight the diverse microbial communities residing in rock pores and their intricate impact on mineral phases. Distinct patterns of mineral alteration, including the formation of biominerals and the dissolution of specific phases, were observed. The integration of tailored sample preparation techniques with conventional SEM-EDS emerges as a straightforward yet potent tool for investigating microbial interactions in rock pores.

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