American Mineralogist, Volume 84, pages 183–192, 1999

In situ conditions and interactions between microbes and minerals in fine-grained marine sediments: A TEM microfabric perspective

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ABSTRACT

Microbes, their exocellular secretions, and their impact on the mineralogy and microfabric of fine-grained continental margin sediments were investigated by transmission electron microscopy. Techniques were used that retained the in situ spatial relations of both bio-organic and mineralogical constituents. Photomicrographs were taken of characteristic mineral-microbe associations in the first meter of burial at conditions ranging from aerobic to anaerobic. Single-celled prokaryotes, prokaryotic colonies, and eukaryotic organisms were observed as were motile, sessile, and predatory species. Bacterial cells dominate the assemblage. The most commonly observed mineral-biological interaction was the surrounding, or close association, of isolated heterotrophic bacterial cells by clay minerals. Almost without exception, the external surfaces of the bacteria were covered with secreted exocellular slimes composed of cross-linked polysaccharide fibrils. These fibrils act to bind sediment grains into relatively robust microaggregates, roughly ≤ 25 μm in diameter. These exocellular polymers can significantly impact the interaction between microbes and minerals, as well as the chemical and physical transport of fluids and dissolved aqueous species through the sediment. Although pore water chemical profiles from the field sites studied have dissolved Fe and Mn, no close association was found between the microbes imaged and precipitated metal oxyhydroxides or other authigenic minerals, such as is commonly reported from laboratory cultures.