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Subsurface dolomite formation during post-depositional flow of sulphate-bearing fluids from underlying salt giants: Early Pliocene example at DSDP Leg 42A, Site 374, Ionian Abyssal Plain

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Deciphering exact mechanisms for the formation of massive dolomite deposits has long been an enigma in sedimentary geology. The recognition that microbes can play a role in the dolomite precipitation process has added a new dimension to the study of the origin of dolomite formations in both shallow and deep-water environments. This scientific advance has evolved, particularly, through the investigation of dolomite-containing, organic-rich hemipelagic sediments cored on various continental margins during DSDP and ODP drilling campaigns, as well as intensive evaluations of modern hypersaline dolomite-precipitating environments with complementary culture experiments conducted in the laboratory. For example, the association of an active subsurface microbial community in contact with underlying brines of unknown origin leading to in situ dolomite precipitation has been observed in a Quaternary sequence of hemi-pelagic, organic carbon-rich sediments drilled on the Peru Margin, ODP Leg 201, Site 1229 (1). Specifically, it can be concluded that the long-term activity of subsurface microbes can be maintained by post-depositional flow of sulfate-bearing fluids from underlying large-scale evaporite deposits, or salt giants, promoting in situ dolomite precipitation.

Another example of dolomite precipitation directly associated with the underlying Messinian salt giant was found at DSDP Leg 42A, Site 374 in the Ionian Abyssal Plain. Deep-sea drilling recovered a lowermost Pliocene sequence of diagenetically altered sediment (Unit II) separating the overlying Pliocene open-marine deposits (Unit I) and the underlying end Messinian dolomitic mudstone with gypsum layers (Unit III). The lower portion of this altered interval contained in Core 11, Section 2 (378.0 - 381.5 mbsf) comprises a dolomicrite with an unusual crystal morphology (2). The original interstitial water geochemical profiles indicate that a saline brine is diffusing upwards from below and into the dolomicrite sequence. There appears to be on-going bacterial sulfate reduction in this boundary zone between the evaporitic and normal pelagic sediments with a significant decrease in sulfate concentrations, whereas the chloride profile remains constant. It was concluded that the earliest Pliocene marine sediments of Unit II had been dolomitized after burial as a consequence of ionic migration across a steep Mg-concentration gradient (3). However, with the addition of a microbial factor into the study of the dolomite precipitation process, an alternate interpretation is possible. We propose that, at the location of DSDP Leg 42A, Site 374, modern subsurface dolomite precipitation is ongoing and the site is a "natural laboratory" in which to investigate the microbial phenomenon in the context of a giant evaporite deposit. This actualistic example may provide a new model for the origin of massive dolomite deposits associated with other salt giants in the rock record.

(1) Meister, P., et al., 2007. Sedimentology, 54, 1007-1031.
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