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# Drilling the Mediterranean Messinian Evaporites to Answer Key Questions Related to Massive Microbial Dolomite Formation under Hypersaline Alkaline Conditions

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Deep-sea drilling in the Mediterranean during DSSP Leg 13 in 1970 revealed the basin-wide occurrence of a Messinian evaporite formation. This spectacular discovery was pursued further during a subsequent drilling program, DSDP Leg 42A, in 1975, which was designed, in part, to obtain continuous cores to study the evolution of the salinity crisis itself (Hsü, Montadert, et al., 1978). Specifically, drilling at a water depth of 4,088 m in the Ionian Sea, DSDP Site 374: Messina Abyssal Plain, penetrated about 80 m into the uppermost part of the Messinian upper evaporite formation. The sedimentary sequence comprises dolomitic mudstone overlying dolomitic mudstone/gypsum cycles, which in turn overlie anhydrite and halite. The non-fossiliferous dolomitic mudstone is generally rich in organic carbon, with TOC values ranging from 0.9% to 5.3%, of possible marine origin with a good source rock potential. Commonly laminated dolomitic mudstones contain preserved filamentous cyanobacterial remains suggesting that conditions were conducive for microbial mat growth. The Ca-dolomite, composed of fine-grained anhedral crystals in the size range of 2-4 $\mu$m, is probably a primary precipitate. The unusual interstitial brines of the dolomitic mudstone units have very high alkalinities with a low pH of 5 to 6. The Mg concentration (2250 mmoles/l) is extremely elevated, whereas the Ca concentration is nearly zero. Finally, the drilled evaporite sedimentary sequence was interpreted as being deposited in an alkaline lake/sea ("Lago Mare"), which covered the area during the latest Messinian.

Projecting forward 40 years since the DSDP Leg 42A drilling campaign, research into the factors controlling dolomite precipitation under Earth surface conditions has led to the development of new models involving the metabolism of microorganisms and associated biofilms to overcome the kinetic inhibitions associated with primary dolomite precipitation. Together with laboratory experiments, microbial dolomite precipitation has been studied extensively in rare modern environments, such as the arid coastal sabkhas of Abu Dhabi, UAE and the hypersaline coastal lagoons in Brazil. However, extrapolation of these studies of relatively limited aerial extent to interpret larger-scale, ancient dolomite formation of putative evaporitic origin remains elusive. Such ancient micritic dolomite formations with associated micro-porosity represent extremely valuable hydrocarbon reservoirs. Therefore, a comprehensive investigation of a relatively recent micritic dolomite deposit that has not experienced extensive burial depths and diagenesis is essential to extend our understanding of these important reservoir systems. Based on the limited data obtained during drilling at DSDP Site 374: Messina Abyssal Plain, the dolomitic mudstones of the uppermost Messinian evaporite complex represent an ideal candidate for such an extensive study in a "natural laboratory". Thus, to increase our understanding of the biogeochemical processes associated with ancient massive dolomite formation, we propose to document the scientific objectives to support a major new drilling campaign to study the sub-seafloor Messinian evaporite complex in the deep Mediterranean basins, using greatly enhanced drilling technology that is currently available within the new International Ocean Discovery Program (IODP).

Hsü, K., Montadert, L. et al., 1978. Initial Reports of the Deep Sea Drilling Project, Volume 42, Part 1: Washington (U.S. Government Printing Office).