Seismic Mapping of Massive Dolomite Deposit Associated with Demise of MSC Salt Giant in Ionian Basin

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The origin of massive dolomite deposits has been an enduring and challenging problem for carbonate sedimentologists since the initial recognition of dolomite as a discrete carbonate mineral \(\text{CaMg(CO}_3\text{)}_2\). The dolomite problem or enigma involves the fact that the mineral is very abundant in the geologic record, but it is rarely found forming in modern environments. However, when modern dolomite is observed, it is generally, but not exclusively, found forming in hypersaline environments and in minor amounts. Although the geologic record indicates that many ancient massive dolomite deposits formed in association with evaporites, modern examples of extensive amounts of dolomite being deposited under hypersaline conditions have not, or only rarely, been reported.

One example of a massive hypersaline dolomite deposit of relatively recent origin may be the dolomite units associated with the end phase, at approximately 5.33 Ma, of the Messinian Salinity Crisis (MSC) in the Ionian Basin, Central Mediterranean (Hsü, Montadert, et al., 1978, Initial Reports of DSDP, Vol. 42, Part 1). Drill core and interstitial waters obtained at DSDP Leg 42A, Site 374 in the Ionian abyssal plain revealed the presence of approximately 25 m of latest Miocene dolomitic mudstone (Lithologic Unit IIa) capped by 8.5 m of earliest Pliocene dolomite (Lithologic Unit II). Significantly, the pore-water geochemical data indicate that the dolomitization of the overlying earliest Pliocene nanofossil ooze may be an ongoing process. Deeper drilling below the two dolomite units (Lithologic Unit II and IIa) to the bottom of Site 374 recovered a further 29.5 m of gypsum/dolomitic mudstone cycles (Lithologic Unit IIIb) followed by 21 m of anhydrite and salts (Lithologic Unit IIIc). Hence, the latest Miocene/earliest Pliocene dolomite sequence recovered at DSDP Site 374 is directly associated with the Messinian Salt Giant and potentially represents a massive dolomite deposit of an undetermined horizontal extent.

In order to measure the lateral dimensions of the combined dolomite/evaporite lithologic units in the central Ionian Sea, the University of Hamburg, using the facilities of the RV Meteor, conducted a multi-channel reflection seismic survey centered at DSDP Leg 42A, Site 374. A powerful 6 kJoule sparker created the seismic signals, while a digital 144-channel streamer with an active length of 600 m recorded the data. The lowermost Pliocene reveals high lateral continuity and low reflection amplitudes, which is typical for the entire Pan-Mediterranean realm. The uppermost Messinian
unit is characterized by a package of strong and positive reflection amplitudes (High Amplitude Reflection Package, HARP). The lateral continuity of the corresponding reflections is very low and the upper boundary is quite irregular. It is unlikely that the reflection configuration results from depositional processes, but it rather suggests diagenetic processes. We correlate the HARP with the dolomite- and gypsum-bearing sediments cored at DSDP Site 374 (Lithologic Unit Illa, Illb, Illc), which is also consistent with the calculated depth. Based on preliminary estimates derived from the seismic survey, the areal extent of the dolomite deposit beneath the Ionian abyssal plain corresponds to a few 10,000 Km², potentially representing a massive hypersaline dolomite deposit.