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Clay Mineral Assemblages as Proxies for Reconstructing Messinian Paleoenvironments in the Western Mediterranean

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Significant tectonic and climate changes at time of the Messinian Salinity Crisis (MSC) led to a complex sedimentation involving marked changes in sediment composition, particularly in clay mineral assemblages. One of the noticeable mineralogical changes across this time interval is the strong smectite increase in Messinian deposits in comparison to the underlying Tortonian and overlaying Pliocene sediments. As no break in the clay mineralogy is recognized in the open ocean (Chamley et al., 1978), such changes are also distinctive of the Mediterranean basins. Since the early discoveries of the giant Messinian evaporite formation (DSDP Legs 13 and 42A), a vast literature contributed, during the last decades, to the continuous debate and re-examination of the actual Messinian paleoenvironment.

Drilled records in the westernmost Mediterranean (Alboran Sea) have shown significant changes in the mineralogical assemblages associated to the Messinian events. This basin is depleted of significant salt deposits. Site 976 (ODP Leg 161) recovered a 670-m-thick, middle Miocene (Serravallian) to Pleistocene/Holocene sedimentary sequence, including a thin interval of Messinian sediment, lying directly upon the metamorphic basement. Analysis of clay mineral assemblages from the sedimentary cover of Hole 976B revealed an homogeneous clay association composed of illite, smectite, chlorite and kaolinite with no major changes in clay mineral abundances except for the sediment interval dated as Messinian, which is characterized by a sharp smectite increase (Martinez-Ruiz et al., 1999). Transmission Electron Microscope analyses of clay minerals revealed that smectite composition corresponds to Al-rich beidellites, which supports the existence of such smectites in peri-Mediterranean soils. Smectite formation was favored by the climate conditions at that time, comprising progressive aridification and the alternation of wet and dry climatic episodes. Diagenesis in these smectites is negligible, further evidencing a detrital origin. However, a closer look at clay mineral associations provides an alternate understanding of clay mineral origin, including the possibility of smectite authigenesis in a Mg-rich paleoenvironment. Furthermore, fibrous clays could have originated in such environments. Relationships between Mg-rich clays and carbonates in Messinian sediments should be a next step to explore further constraints on depositional conditions.

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