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Cold-seep carbonates from the Gulf of Cadiz and their inferred relation to gas hydrates

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The upper and middle slope of the continental margin of the Gulf of Cadiz is characterized by the extensive occurrence of mud volcanoes, diapiric ridges, pockmarks and methane seepage sites, most of them controlled by faults. The shallow sediments on the most active structures have high methane contents and gas hydrates were identified on some of them, indicating that these sites are preferential pathways for the escape of hydrocarbon-rich deep fluids (mainly methane).

Methane-derived authigenic carbonates, with characteristic depleted C isotopic signatures, are found associated with the mud volcanoes, diapiric ridges or along faults, mainly along the upper and mid-continental slope, where the Mediterranean Outflow water is in direct contact with the seafloor. Two distinct groups of methane-derived authigenic carbonates can be defined: one consisting of dolomite crusts, nodules and chimneys, and the other of aragonite pavements, slabs, crusts and buildups. The widespread abundance of methane-derived authigenic carbonates is interpreted as evidence of several episodes of extensive methane seepage. In this work is discussed the relation of the methane-derived authigenic carbonates with gas hydrates.

Considering the present day seabottom water temperature (ranging from 8 to 12°C) and assuming extreme limits for seabottom temperature variation, considering the oxygen isotopic composition of the Gulf of Cadiz bottom waters, both for the North Atlantic Deep Water and the Mediterranean Outflow water, and assuming that the oxygen isotopic ratio variations are the typical between glacial and interglacial stages (within the range from +0.5 to +1.5 permil SMOW) the isotopic composition of the original fluids from which the authigenic carbonates were precipitated were estimated according to the different mineral temperature of precipitation equations. Considering the minimum and maximum temperature limits, admitted to be possible to occur at these sites, not all the measured carbonate isotopic values are compatible with precipitation from normal seawater isotopic composition.

Aragonite pavements are estimated to be formed from normal seawater oxygen isotopic compositions and from a 18O-enriched pore waters indicating a contribution from dissociated gas hydrates. The aragonite pavement samples indicate a formation in environments near or at the sediment seawater interface, while the dolomite chimneys indicate a formation in more confined within the sediment column. The dolomite chimneys indicate formation conditions similar to normal seawater; formation conditions resulting from the destabilization of gas hydrates; or formation conditions during the precipitation from pore waters during gas hydrates formation.

The 87Sr/86Sr ratios of the analyses of authigenic carbonates do not indicate a clear and major addition of Sr from deep seated fluids, but they preferably reflect the contemporaneous seawater Sr composition. The dolomite chimney sample indicate signal that supports a contribution from a deeper seated fluids and/or an older seawater origin.