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Decoding recent mud-volcano activity in the westernmost Mediterranean: Evidence from sediment/porewater data and geochemical modeling

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Recent studies have demonstrated the occurrence of active mud volcanism in the West Alboran Basin. Though most of the mud volcanoes (MVs) discovered in this region are dormant, a few structures evidence active hydrocarbon venting, as Carmen MV. This study focuses on sedimentological and geochemical investigations on one piston core, GP05PC, recovered from the summit of Carmen MV during the Gasalb-Pelagia cruise (2011). Although the full core consists of mud breccia sediments, a dramatic change occurs between enhanced methane concentrations in its lowermost and dissolved SO42- in its uppermost sediments. At the boundary of 150 cm, methane is oxidized and sulphate reduced. In the lowermost interval, the depletion of major elements (i.e. Ca2+ and Mg2+), the enrichment of trace species (i.e. Li+ and B) and the radiogenic 87Sr all point to a deep fluid source. The δ18Opw and δDpw compositions of pore water (5.7‰ and -10‰ VSMOW, respectively) together with the mineralogical results (presence of randomly insterstrafied (R0) illite-smectite minerals (I/S) to more illitic (>50% I) and ordered ones (R1-R3)) indicate smectite to illite transformation at greater depth and support smectite dehydration as the main porewater freshening mechanism. Water formation temperatures calculated through the application of empirical geo-thermometers (K-Na, K-Mg and K-Ca) together with the presence from I/S mixed layers (R3) suggest that fluids were generated at temperatures ∼100-200ºC. This temperature indicates that, under a regional geothermal gradient, the fluid source originates from ∼ 8 km depth. From an adjacent borehole it is known that sedimentary units of Early to Middle Miocene age occur at that depth (Jurado and Comas et al., 1992). The δ13Cmethane and δDmethane composition of methane (-59‰ VPDB and -184‰ VSMOW, respectively) of the deepest sample also may be associated to a thermogenic origin.
The absence of hemipelagic sediment draping, the distinctive seawater-like pore water composition in the uppermost part of the mud breccia together with the abrupt transition to the interval with typical deep-source fluid composition, all point to a very recent mud and associated gas-expulsion. Such outburst leads to the downward intrusion of seawater coincident with the episode of gas-bubble expulsion. A numerical transport-reaction model has been applied to the distinctively kink-shaped pore water Cl, SO42–CH4, and other profiles in core GP05PC, to derive the very recent timing for this eruption event (López-Rodríguez et al., 2017).

References:
Jurado, M. J. and Comas, M. C. (1992). Well log interpretation and seismic character of the Cenozoic sequence in the Northern Alboran Sea, Geo-Marine Letters, 12, 129–136.

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