Insights into the Formation of Southeastern Mediterranean Seep Carbonates

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Authigenic seep carbonates, which are found globally at continental margins, can serve to characterise the seepage of hydrocarbon-enriched fluids into the oceans. This study aims to identify past seepage activity and gas migration pathways on the south-eastern margin of the Mediterranean, based on the analysis of authigenic seep carbonates collected during the 2016 EUROFLEETS 2 SEMSEEP expedition aboard the RV AEGEO. Seep carbonates with three different morphologies (chimneys, crusts and pavements), are studied using standard sediment petrography (fluorescence, CL and standard optical microscopy), as well as X-ray diffraction, Raman spectroscopy and stable isotope analyses. Recurrent cement and replacement phases identified contain different amounts of aragonite, low-magnesium calcite (LMC), high-magnesium calcite (HMC) and dolomite. Carbonate chimneys consist of micrite (δ¹³CVPDB of -10 to +5 ‰) with dispersed barite and dolomite crystals and fan-shaped aragonite (δ¹³CVPDB of -52 to -30 ‰). Locally, aragonite fans are replaced by LMC spherulites and blocky HMC. Botryoidal LMC cements are forming in small cavities. Carbonate crusts consist mainly of micrite rich in fossils and detrital grains with LMC breccias, HMC nodules (δ¹³CVPDB of -35 to -20 ‰) and cements and fan-shaped aragonite cement. These are partly replaced by LMC microsparite and show several growth stages. Carbonate pavements consist mainly of micritic dolomite and HMC. LMC microsparite can be identified as well. Fan-shaped aragonites are locally present as pore-lining cement. Fe-oxides are coating the low- and high-Mg calcitic and dolomitic cements. Raman spectroscopic analyses confirm the presence of aragonite, dolomite and specific organic compounds associated to different crystals.

Sediment petrography, XRD and stable isotope analysis reveal several phases of methane seepage through time. Distinct mineralogies (dolomite and aragonite) within the seep carbonate morphologies, result from different formation mechanisms (anaerobic oxidation of methane during aragonite formation and predominately sulphate reduction during dolomite formation). Raman spectroscopy highlights the presence of organic compounds within specific carbonate...
phases, which might play an important role in the carbonate formation.