Carbonate-associated sulfate provide the geological record of sulfate-driven anaerobic oxidation of methane

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Marine sediments at continental margins seep substantial amounts of methane. Microbial oxidation of the methane, the so-called sulfate-driven anaerobic methane oxidation (AOM), can support the growth of chemosynthetic communities and result in the build-up of authigenic carbonate close to the seafloor. However, it is difficult to trace back the activity of ancient sulfate-driven AOM owing to the lack of direct records. Here, we investigated oxygen and sulfur isotopes of CAS in authigenic carbonates from modern hydrocarbon seeps of the Gulf of Mexico, the Black Sea, and ancient seeps of the northern Italy (Miocene) and western Washington, USA (Eocene). Our data demonstrate that all deposits regardless of ages and locations have a relatively constant $\delta^{18}O_{CAS}$ versus $\delta^{34}S_{CAS}$ slope. Through a comparison with the literature, we suggest that the CAS in seep carbonates record the pore fluid sulfate's isotopic signals in fidelity. The $\delta^{18}O$ and $\delta^{34}S$ of CAS in seep-related carbonate appears to be a robust tool that can be used to track back the evolution of sulfate-driven AOM through the geological record.

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