Carbonate associated sulfate as a chemostratigraphic tool

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For hydrocarbon exploration, stratigraphic correlation of lithological units over distance and across structural complications is essential. For carbonate-rich lithologies, the carbon and oxygen isotope composition of carbonate is readily available as a chemostratigraphic tool. With regards to the potential complication of diagenetic overprints, the sulfur and oxygen isotope composition of sulfate that is trapped in the carbonate minerals may represent a more robust alternative. The advantage of the isotope composition of carbonate associated sulfate (CAS) over the isotope composition of carbonates lies in the fact that while diagenetic processes can alter the carbon and oxygen isotope composition of the carbonates, they are expected to only lower the CAS content by removing sulfate during recrystallization, but not to change the isotope composition of CAS that remains in the carbonate rock.

Indeed, the isotope composition of CAS has been shown to be a useful tool for the reconstruction of changes in the global sulfur cycle over time and has also been applied to reconstruct environmental conditions during the formation of authigenic carbonates. These applications rely on a careful selection of samples, typically samples that are unlikely to contain sulfur compounds other than CAS, thus limiting the potential for contamination during the extraction of CAS. When working in hydrocarbon systems, the luxury of being able to pick ideal samples is not given and the question becomes if isotopes of CAS can still provide valuable information and serve as a stratigraphic tool.

To assess the applicability of CAS as a tool in carbonate-rich formations that are relevant for major hydrocarbon plays, we analyzed samples from the Mississippian limestone from southwest Missouri that were deposited in a carbonate ramp environment and Leonardian-aged stacked calcitic and dolomitic carbonates from the Brokeoff Mountains from southern New Mexico that were deposited in a carbonate platform setting in the Permian Basin.

Our findings demonstrate that many analytical challenges must be overcome before the isotope signature of CAS can be considered a reliable chemostratigraphic tool, but also show that this approach can yield valuable information even for samples that cannot be considered as ‘ideal’.