Using carbonate and methane clumped isotopes for sedimentary basins analysis

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Assesing the thermal and fluid-flow histories of sedimentary basins is required for understanding the origins of natural resources, including ores, geothermal fluids or hydrocarbons. Recent developements of clumped isotope geothermometries [1,2] promise to provide quantitative estimations of key parameters for basins analysis, such as the precipitation temperature of diagenetic phases (via Δ_{47} of carbonates [1]) and/or the generation temperature of natural gas (via $\Delta^{13}CH_3D$ and $\Delta^{12}CH_2D_2$ composition of methane [2]). Here, we focus on two case studies from different stratigraphic interval in the Paris basin, where both carbonate and methane clumped isotope compositions were used to address different issues related to petroleum systems analysis:

First, by coupling Δ_{47} data (n=45), U-Pb dating by LA-ICPMS (n=12), and fluid inclusions microthermometry (n=5) on Middle Jurassic carbonate reservoirs (1500-1800m deep), we precisely characterized temperature and timing of fluid-flows (water and oil) through reservoirs, as well as the origin of the paleo-fluids ($\delta^{18}O$, salinity) [3, 4].

The second case concerns a geochemical evaluation of the origin, maturity and compartimentalization of thermogenic methane in the deeper Rhetian sandstones (2500m depth), using conventinal gas molecular and isotopic compositions (bulk $\delta^{13}C$ and δD values on C1 to C5), as well as $\Delta^{13}CH_3D$ and $\Delta^{12}CH_2D_2$ measurements (n=5).

References
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