Isotope dating of illite authigenesis: constraining time of hydrocarbon emplacement, burial diagenesis and diagenetic/thermal overprinting

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Diagenetic illite may form in a variety of ways, including 1) direct precipitation from pore fluids, 2) conversion of and growth on smectitic precursors (e.g. grain coatings), and 3) reaction of detrital and early diagenetic phases (e.g. K-feldspar + kaolinite). In some cases, illite formation appears also to be related to hydrocarbon migration and/or trapping [1]. In these cases, dating of authigenic illite may help determine the time of hydrocarbon migration or trapping. In others, illitization may be a product of thermal events [2] whose timing can be constrained by dating the separated illite. In cases where illite is formed over a long time/temperature interval by the reaction of other phases to illite [3], age dating provides an average time illite of formation with a timespan of ten's of millions of years or more depending on the burial history.

The classical model of illite formation being stopped by hydrocarbon charging as documented within the Rotliegend [1] is compared to the Unayzah sandstones where illite formed by a reaction of detrital K-feldspar and early diagenetic kaolinite due to burial with no evidence that hydrocarbon emplacement, fluid migration, or thermal events related to illite precipitation [3]. A different illitization scenario is provided by illite authigenesis within the well-compacted Cambro-Ordovician oil-bearing sandstones of the Hassi Messaoud field. Here, diagenetic illite is difficult to differentiate from tectono-thermal micas of similar size and crystallinity. Illite age dating indicates that hydrocarbons migrated into the Ordovician reservoirs during Middle Jurassic time at a present-day depth of ~ 4000 m.

These studies highlight some of the approaches and applications of illite age dating to constrain the timing of hydrocarbon entrapment and to better understanding diagenetic processes involving illitization.

[1] Zwingmann et al. (1999), GCA, 63, 2805–2823.
[2] Clauer et al. (in review), AAPG bulletin
[3] Franks and Zwingmann (2010), AAPG bulletin 94, 1133-1159.