Clay mineral authigenesis – applications for hydrocarbon exploration and appraisal.

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Illite is a dioctahedral mica-like clay mineral commonly occurring in sedimentary rocks; within shales and sandstones. Isotopic and geochemical studies are important tools in understanding diagenetic and fluid flow histories, with implications for both exploration and reservoir management. Isotopic age data have the potential to yield information about the origin of hydrocarbons, the timing of fluid flow and related diagenetic events, the nature and distribution of potential formation damage and the timing of faulting and deformation. Authigenic illite in sandstones contains potassium and is therefore suitable for age determination using the potassium–argon (K/Ar) geochronometer. Diagenetic illite is of interest to the petroleum industry because it can provide a K-Ar date constraining a heating and/or fluid flow event within a sedimentary basin. Dating of K-bearing illite minerals using the K/Ar isotopic system offers the prospect of establishing the absolute timing of diagenetic events.

However, the radiogenic isotope systematics of sedimentary rocks is complex due to the intimate mixture of minerals of different origins such as: detrital phases, potentially from a variety of sources, as well as authigenic minerals. Consequently, it is often difficult to unambiguously interpret measured ages. Special sample preparation techniques involving freeze thaw disaggregation, to avoid over-crushing, and extensive size separation to reduce the amount of detrital phases can address these issues. Progressive size reduction down to submicron size fractions, (<0.1 μm or finer) increases the proportion of authigenic clay phases in the clay component, minimizes contamination and produces the most reliable isotopic ages for authigenic clay minerals. The validity and importance of the assumptions involved in K/Ar dating of authigenic illite, (e.g. contamination, closed system behaviour, excess Ar), must be carefully addressed and the sample material characterized using a wide range of tools comprising: XRD, SEM, particle granulometry and TEM.

Illite formation depends on several parameters including, temperature and pressure ranges and formation fluid chemistry. Variables which control the rate of illite growth are: temperature, pressure, concentration of reactants, (mainly K, Si), rate of supply of reactants, pore fluid velocity, rate of diffusion or active fluid flow, time and the presence of an aqueous pore fluid.

We will present applications of illite age dating in constraining the timing of clay mineral authigenesis within active hydrocarbon exploration case studies from the Cooper and Sydney basin in Australia, the Taranaki basin New Zealand and the Unazay sandstone reservoirs in Saudi Arabia.

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