U/Pb dating of carbonates: A novel approach for rapid identification of appropriate samples

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Diagenetic carbonates are frequently found in petroleum reservoirs and are associated with significant changes in petrophysical properties. It is therefore critical to constrain their timing of formation and establish absolute ages when possible. Most carbonates are hardly datable due to their overall low concentration of uranium. However at sub millimeter scale, uranium concentration can vary by orders of magnitude making specific zones more suitable for dating than the bulk sample, provided that these zones behaved as closed systems over time. The LA-ICP-MS technique provides a very useful tool for rapid identification of such suitable zones, prior to analyses by isotope dilution method.

We report here the first U/Pb and Th/Pb dating of a fracture-filling low-Mg calcite sampled from a Mesozoic carbonate petroleum reservoir. Prior to dating analyses, this sample was characterized by LA-ICP-MS using matrix-matched (relatively to an in house synthetic calcite standard) quantitative analyses and mapping of trace element distribution. Large variations of trace element concentrations were illustrated along cleavage planes of the crystals. Although the cause of the variable segregation of uranium, thorium and other traces elements along cleavage planes is unclear, this resulted in variable $^{238}U/^{204}Pb$ and $^{232}Th/^{204}Pb$ ratios allowing the selection of appropriate sub samples of this calcite for dating by ID-MC-ICP-MS. Very precise and consistent U/Pb and Th/Pb ages of 112.6±1.9 Ma and 110.9±1.6 Ma respectively were obtained on this sample, giving great confidence in the measured absolute age of this calcite fracture-fill and the associated event of fluid circulation. This lower Albian age is consistent with the occurence of volcanic intrusions that are believed to have affected the reservoir through hydrothermalism.