Large-scale intraplate deformation caused the cementation of Jurassic carbonates in the eastern Paris Basin

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In the eastern Paris Basin, the Oxfordian (Upper Jurassic) and Bathonian to Bajocian (Middle Jurassic) carbonate platforms have been intensively cemented, despite rather low burial (< 1000 m). These limestone units are separated from each other by a 150 m thick succession of Callovian - Oxfordian clay-rich rocks. These claystones are currently under investigation by the French national radioactive waste management agency (Andra).

Most of the initial porosity in the Middle and Upper Jurassic limestones is now sealed by successive stages of calcite precipitation, which have been thoroughly characterized both petrographically and geochemically over the last fifteen years (Buschaert et al., 2004; Vincent et al., 2007; Brigaud et al., 2009; André et al., 2010; Carpentier et al., 2014). However, despite these research efforts, the timing and temperature of the fluids involved in the cementation of these carbonate rocks were still uncertain.

Here, we present and discuss newly acquired δ₁⁴⁷Ca temperatures and U-Pb ages of calcite cements filling the intergranular pore space, as well as vugs and microfractures.

The Middle Jurassic limestones were largely cemented during the Late Jurassic / Early Cretaceous period, as shown by our new LA-ICP-MS U-Pb ages that agree with the previous Isotope Dilution-TIMS U-Pb age of 147.8 ± 3.8 Ma from Pisapia et al. (2017). This event is believed to be associated to the Bay of Biscay rifting. Our data also reveal a second and more discrete crystallization event during the Late Eocene / Oligocene period, related to the European Cenozoic Rift System (ECRIS). In both cases, calcite was precipitated from fluids in thermal disequilibrium with the host rocks.

By contrast, the Upper Jurassic limestones were largely affected by the successive deformation events that occurred during the Late Mesozoic / Cenozoic period. New LA-ICP-MS U-Pb ages acquired in ca. 200 µm-thick fractures reveal that calcite crystallized during three successive periods corresponding to the Pyrenean compression, the ECRIS extension and, finally, during the Alpine compression. These compression phases generated late stylolitization and subsequent dissolution/recrystallization in the Upper Jurassic limestones, while such tectonic features are rare in the Middle Jurassic.

Therefore, as opposed to the more conventional « burial-induced » model, our study highlights the
role of stress propagation in the cementation of carbonate rocks hundreds of kilometers away from the rifting or collisional areas.

References: