U-Pb dating: diagenesis and fluid circulation in the Middle Orfoxdian limestones of the Ornans Plateau (Jura)

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Résumé

During the 60-80s, the Jura fold-and-thrust belt was extensively explored for its hydrocarbon potential. These drilling campaigns and seismic profiles significantly enhanced our understanding of the geological structure of this region. More recently, U-Pb dating on calcite has provided new chronological constraints on the activity of fault systems in the Jura area.
Our study focused on the spatial and temporal evolution of reservoir qualities and transport properties of Middle Oxfordian limestones of the Ornans Plateau. These limestones are exclusively microporous despite a large variability of original microfacies linked to various depositional environments (open sea to lagoon) and they show a spatial evolution of their petrophysical signature at the platform scale. We carry out in situ U-Pb dating using Laser ablation on carbonate cements to clarify the diagenetic history and the associated pore-fluid flows at the origin of these petrophysical evolutions. These U-Pb data provide the first chronological constraints on pore-fluid evolution through the tabular geological units of the Jura.

An initial CL investigation using a cold cathode equipment coupled to an optical microscope revealed three generations of calcite cements. Particular attention was given to the elemental spectra of each analytical spot to identify mixed signals from depth. A second CL study was carried out to discard spots located across two calcite generations. This combined approach highlights both pulsed crystallization events and more prolonged cementation phases. Clumped isotope analyses provide additional constraints on crystallization temperatures and fluid sources.

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The results reveal a complex diagenetic evolution: early cementation around 155 Ma, followed by three distinct cementing phases dated to (i) 145–115 Ma, (ii) 40–30 Ma and (iii) 21–17 Ma.
These findings provide new insights into the long-term diagenetic and fluid history of the Jura platform carbonates and have important implications for current fluid flow in regional aquifers. Furthermore, this work supports ongoing efforts to evaluate the potential for helium and hydrogen exploration in the Jura region by offering a better understanding of fluid migration pathways and reservoir evolution through time.

Mots-Clés: U Pb calcite, Clumped isotopes, Diagenese, Jura, Fluid circulation