

Evidence of an Early Cretaceous hydrothermal event in the Middle Jurassic Limestones of the Paris Basin

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In sedimentary basins, the precise temperature in shallow buried rocks ($< 60^{\circ}\text{C}$) are poorly recorded by classic geothermometers or low temperature thermochronometers. In the last ten years, thermal history and fluid flow periods in the shallow buried Paris Basin have been considerably improved. Different diagenetic studies, coupling petrographic observations and isotopic analyses ($\text{d}_{18}\text{O}_{\text{carb}}$) allowed to characterize a main episode of carbonate cementation during the Early Cretaceous, leading to the filling of intergranular space within the Middle Jurassic limestones. On the other hand, the scenarios of fluid flows within a reliable geological history are difficult to reconstruct because of the difficulty in finding calcites with two-phase aqueous fluid inclusions or apatite to obtain (U-Th)/He or fission track ages. These scenarios strongly depend on the interpretation of $\text{d}_{18}\text{O}_{\text{carb}}$ data that rely on strong working hypotheses on either the temperature or the oxygen isotopic composition of the mineralizing fluid ($\text{d}_{18}\text{O}_{\text{fluid}}$). Consequently, geological interpretations on the same calcite cements, filling inter-granular pore space or fissural porosity, can be diametrically opposed depending on the assumptions made. This demonstrates that temperature constitutes an important lock of diagenetical studies. The aim of this work is to independently reconstruct the (1) temperature and (2) $\text{d}_{18}\text{O}_{\text{fluid}}$ from calcite crystals of the Paris Basin. In order to answer this question, a diagenetic study was carried out using (1) classical methods (paragenetic association, stable isotopes) and (2) the recently developed D47 geothermometer.

The D47 temperatures of the 2 main blocky calcites indicate temperatures of 60°C and 85°C . The thermal history of the eastern Paris Basin, compiled from organic matter, clay minerals and apatite fission track data indicates that the D47 temperatures in calcite are about 20°C to 45°C higher than the temperature recorded in sediments during the Early Cretaceous. After ruling out the hypothesis of D47 resetting, we suggest that D47 temperatures recorded in these carbonate cements reflect a short hydrothermal event, probably too short to be recorded by organic matter or clay minerals. The $\text{d}_{18}\text{O}_{\text{fluid}}$ vary from $+2.5\text{‰}$ to $+8\text{‰}$ (vs SMOW), implying deep ascendant hydrothermal brine circulations. The high $\text{d}_{18}\text{O}_{\text{fluid}}$ at the origin of calcite might result from (1) fluids interacting at high temperature with minerals of a crystalline basement or (2) a mixture between hydrothermal fluids and fluids having dissolved a large amount of carbonates.

Mots-Clés: Delta47, Paris Basin, Carbonate

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