THE ORIGIN AND TIMING OF MULTIPHASE CEMENTATION IN CARBONATES: IMPACT OF EUROPEAN SCALE GEODYNAMIC EVENTS ON THE MIDDLE JURASSIC LIMESTONES DIAGENESIS (PARIS BASIN, FRANCE)

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The Middle Jurassic carbonates of the eastern part of the Paris Basin are capped by Callovian–Oxfordian clay formations. These have been investigated at the instigation of the French government as potential sites for the permanent storage of nuclear waste. The shallow marine carbonates display surprisingly low values of porosity and permeability (Φ <15 ‰ and K<0.5 mD). The main objective of this study is to determine the causes and timing of the cementation that altered the petrophysical properties of these carbonates thereby destroying their potential as oil reservoirs; a fate that did not befall their equivalents in deeper, central parts of the Paris Basin. Using conventional petrographic tools and diagenetic investigation techniques together with geochemical analyses (stable O and C isotopes, Sr isotopes, major elements), we identify six calcitic spar phases, two dolomite phases, and several phases of fracturing and stylolitization ordered in paragenetic sequence. Cement quantification shows the predominance of two blocky calcite cement phases (75% of total cementation). O and Sr isotopes from these calcite cements suggest that the parent fluids resulted either from a mixing of trapped Jurassic seawater and meteoric water, or from buffered meteoric waters. In the geological history of the Paris Basin, evidence of the earliest meteoric water inputs is from the Early Cretaceous, when the Middle Jurassic carbonates cropped out along the London–Brabant Massif. Lateral meteoric recharge may have occurred as a result of two separate uplift events (Late Cimmerian Unconformity and Late Aptian Unconformity) and the related exposures of carbonates to the north of the study area. This palaeohydrological circulation brought about a significant reduction of porosity (from 40% to 10%) through calcite cement precipitation. The Early Cretaceous events are of great importance in the diagenetic evolution of the sedimentary basins bordering the London–Brabant Massif across all of northwestern Europe.

A subsequent dolomite and calcite cementation phase accounts for about 5% of the total cement volumes. This late cementation may have been caused by hydrothermal fluids ascending along active fractures during the Late Oligocene extension phase.