



Origin and diagenetic history of a Lower Jurassic petroleum source rock, Middle Atlas, Morocco

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The locality Aït Moussa (Boulemane province) exposes a seeping petroleum source rock of Pliensbachian to Earliest Toarcian age. The case is an example of hemipelagic, peri-Tethyan low latitude source rock generation with type II kerogen. The source rock interval is an alternation of radiolarian wackestones and silty marls. It is characterised by early diagenetic hydraulic fractures, spans over about 2.5 meters with a mean TOC of 4%; T_{max} =441 to 451°C; HI≈200 to 550 mg HC/g TOC. Early diagenetic, anoxic remineralisation of sedimentary organic matter induced hydraulic fracturing, calcite cementation, a negative shift of carbon and oxygen stable isotope values ($\Delta\delta^{13}\text{C}$ = -1.1; $\Delta\delta^{18}\text{O}$ = -2.0), and a relative enrichment of the middle weight rare earth elements (REE). Progressive burial resulted in three generations of Fe-calcite cemented veins, three generations of replacive dolomite and concluded by ankerite replacing dolomite. Compaction fluids induced a positive shift of $\delta^{13}\text{C}$ values ($\Delta\delta^{13}\text{C}$ = +0.4) and a flattening of the REE distribution pattern together with a general increase of the REE content, altogether likewise related to the dewatering of clay. Fe-bearing saddle dolomite represents the third generation of replacive dolomitisation (dol-3); it carries a highly positive Eu-anomaly (Eu/Eu*= 8.1) implying ascending hydrothermal fluids. Primary migration is recorded from dol-2 (Late Jurassic-Cretaceous) onward but was most effective after the formation of inclined stylolites that formed due to Eocene tectonic compression. Organic-geochemical analyses (GC, NMR of inclusions, non-expelled and expelled bitumen) indicate that thermal maturation advanced significantly after the onset of primary migration whereas differences in terms of Pr/*n*-C₁₇, Ph/*n*-C₁₈ and aromaticity corroborate the effects of differential expulsion. For source rock formation, a refinement of biostratigraphic data establishes a gross link to a Pliensbachian/Toarcian platform drowning interval that combines with a radiation episode of organic-walled phytoplankton that preceded the Toarcian oceanic anoxic event.