

Source Rock Potential of the Organic Rich Turonian - Upper Campanian Carbonates of Northern Lebanon

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ABSTRACT

Upper Cretaceous chalks, marls, and shales are the most prolific petroleum source rocks in the eastern Mediterranean region. 209 core samples from the Turonian – Upper Campanian rock succession in north Lebanon were collected and analyzed for their organic matter (OM) content, quality, maturity, and depositional environment. This work provides a contribution to the relatively scarce geochemical information available for the eastern Mediterranean and discusses its implication on future petroleum exploration. Total organic carbon, total inorganic carbon, and total sulfur were measured on all samples. Rock-Eval pyrolysis, vitrinite reflectance, macerals analyses, X-ray fluorescence analyses, and organic geochemical analyses, by means of gas chromatography – flame ionization detection (GC-FID) and gas chromatography – mass spectrometry (GC-MS) on aliphatic hydrocarbons, were performed on a selection of representative samples.

The total organic carbon (TOC) measurements revealed a very good source rock potential for a 150 m interval within the Upper Santonian – Upper Campanian, with an average of 2% TOC. High HI values ranging from 400 to 900 mg/g TOC characterize these source rocks as type I kerogen and reflects a good preservation of the organic matter. A positive correlation between TOC and TS implies a system controlled by the availability of organic matter for sulfate reduction and deposition in a dysoxic marine environment (oxygen depleted). A negative correlation between TOC and CaCO₃ is due to the variable preservation of organic matter induced by fluctuation of oxygen content in sea water and/or variation in organic matter primary productivity related to fluctuation in upwelling intensity. Dominance of alginite macerals vis-à-vis terrestrial macerals, C₂₇₋₂₉ steranes composition, presence of the C₃₀ sterane, elevated C₃₁ 22R homohopane/C₃₀ hopane (>0.25), as well as terrigenous/aquatic ratio (TAR) of n-alkanes all point towards a marine depositional environment. Tmax values ranging from 410 to 430 match the other maturity parameters such as vitrinite reflectance (0.25–0.4%) as well as the steranes and hopanes isomerization ratios calculated from GC-MS analysis, and all point towards immature organic matter. However, the equivalent Upper Cretaceous in the offshore Levant basin has enough overburden to have reached maturity. But, the accurate extrapolation of the organic matter quality and quantity to the offshore is yet a challenge with the data at hand. Hence, a more detailed understanding of the depositional conditions is needed for this section as well as analogous Upper Cretaceous sections in the eastern Mediterranean region.