

GEOCHEMICAL AND PETROLOGICAL CHARACTERIZATION OF PERMIAN BLACK SHALES AND OIL SHOWS FROM THE GREATER LODÈVE BASIN, SOUTHERN FRANCE

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The Lodève Basin represents a Permian half-graben system, located in Southern France, northwest of Montpellier. During its pre-rift phase, the Autunian Group was deposited, including 49 black shale layers with an average thickness of 20 to 30 cm. In this work, these black shale layers are characterized by a combination of classical organic geochemical methods in order to (i) determine the depositional environment and source rock quality, (ii) get an idea of the regional burial history and draw assumptions on possible petroleum systems. Furthermore, (iii) it was tried to correlate different oil shows from the Lodève Basin itself and its greater surrounding to either the Autunian black shales or the Toarcian Schistes Carton, which represents the second potential source rock in the greater area.

The Autunian Group spans around 700 m of pre-rift sediments and comprises three main formations: (1) The ca. 150 m thick Usclas formation., (2) the ca. 300 m thick Loiras formation., and the ca. 250 m thick Viala formation. containing the Mas D'Alary subformation. The frequency of black shale layers decrease from bottom (1) to top (3). The depositional environment of the Usclas formation is interpreted as a lacustrine setting with high terrestrial influence. This is indicated by organic matter composed of type I and III kerogen and Pr/Ph ratios between 1.7 and 4.2. In the Loiras formation, the setting evolved into a pure deep lacustrine environment with organic matter being exclusively composed of type I kerogen and a Pr/Ph ratio of 2.29. During the deposition of the Viala formation the setting changed to a more fluviate dominated system with black shales showing type I kerogen deposited only within the Mas D'Alary sub-formation. Furthermore, Pr/n-C17 and Ph/n-C18 ratios between 0.1 and 0.77 as well as by the presence of framboidal pyrite indicate oxygen-depleted to anoxic conditions for all investigated samples. All these interpretations are supported by microscopic investigations showing organic matter being mainly composed of liptinites and (in the Usclas formation) inertinites. Furthermore, quantitative maceral analysis reveals that around 3 % of organic content is present in form of dispersed, submicroscopic organic matter.

The most promising source rock potential is observed within the Usclas formation, with 33 included black shale layers showing average TOC contents of 2.94 wt.-% and S2 values of 10.19 mg HC/g rock. Next best potential is attributed to the Loiras formation with 13 black shale layers and average TOC values of 2.68 wt.-% and S2 of 11.00 mg HC/g rock. It is followed by the Mas D'Alary subformation including three black shale layers with a mean TOC content of 2.78 wt.-% and S2 of 13.39 mg HC/g rock. S1 values usually are not representative, since all samples are received from outcrops and already generated hydrocarbons were lost by weathering processes. The initial TOC content for all black shales is proposed to have been around 1.9 times higher before thermal maturation.

The thermal maturity of all Autunian black shales lie in the range of the early to peak oil-window indicated by a mean random vitrinite reflectance of 0.79 % and Tmax values of

approximately 439°C. This maturity is referred to a maximum burial depth of around 2,400 m, which was reached in the late syn-rift phase during the Late Permian.

Furthermore, six hydrocarbon samples were analyzed by gas-chromatography with respect to the composition of their aliphatic fraction. Two of them could be correlated to the Autunian black shales based on their distribution patterns of n-alkanes as well as their relative amount of pristine and phytane. No conclusive results were obtained by the other four samples derived from around the Lodève Basin, thus a correlation could not be fulfilled.