

Middle and Upper Miocene source rock facies of Dilj Mt., Sava Depression, Pannonian Basin

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The main source rock facies in the Croatian part of the Pannonian Basin belong to the Middle Miocene and lower part of the Upper Miocene. These rocks are mainly identified in deep exploration wells, whereas outcrops are rare. Here we report on three stratigraphically different source rock intervals, which were recently discovered at Dilj Mt on the North-Eastern flank of Sava Depression. The oldest source rock interval is located within a continuous succession characterized by interlayering of marls and sandstones with dominant carbonate grains. The source rocks are dark grey, laminated marls with moderate Corg contents (1.7-3.6%) and HI values (470-510 mgHC/gCorg). The source rocks, up to 7 m thick, contain an abundant marine fauna and were dated into the lower NN5 zone (Early Badenian). Maceral composition and Rock-Eval analysis suggest a mixed Type II-III kerogen. In contrast to the above locality, two other outcrops represent re-sedimented source rocks. The source rock clasts are all of similar age, but the age of the debris breccia differs between the two sites. One locality is represented by a debris breccia interval, about 60 cm thick. Two different source rocks facies can be observed among the clasts, one of massive texture and black colour and one dark grey with thin laminae showing slumping. The massive facies contain 8.0 to 10.8% Corg with HI values from 547 to 578 mgHC/gCorg, while the laminated one contains less Corg values (~5.6%) but with higher HI (604 mgHC/gCorg). Geochemical properties and maceral analysis support the presence of oil-prone Type II kerogen. According to the palaeontological record, both the breccia and clasts are of Sarmatian age. The other outcrop with re-deposited source rocks is more than 2.5 m thick and contains significantly larger clasts compared to the first re-sedimented type outcrop (up to 1 m). The age of the source rock clasts is similar that of the previous debris outcrop. Interestingly, the laminated facies is not slumped like in the previous outcrop, but shows micro-faulting indicating a compressional event. The overlying sediments were biostratigraphically dated as Early Pannonian. Geochemical analysis has not yet been performed on samples from this location, but similar values as in samples from the first outcrop are expected based on similar facies and age. All analysed source rocks show very low thermal maturity (%Ro <0.25, Tmax <430 °C), indicating rather shallow burial and very limited uplift during the last compressional phase of the Pannonian Basin. The study results yield important information for the re-evaluation of the petroleum potential of the basin infill, considering the structural and stratigraphic setting of the source rock intervals within the basin. The same rocks in deeper settings might represent significant active source rock intervals that were inadequately considered in previous exploration.

Keywords: Source rocks, Badenian, Sarmatian, Lower Pannonian, Sava Depression, Pannonian Basin