ORGANIC GEOCHEMISTRY OF CRUDE OILS FROM THE ZRENJANIN OIL FIELD (SE PANNONIAN BASIN, SERBIA)

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Crude oil samples from the Zrenjanin oil field (Pannonian Basin, Serbia) were investigated in order to define the depositional environment, lithology, thermal maturity and geologic age of the corresponding source rocks. A comprehensive organic geochemical investigation of the oils from this oil field has not been carried out so far.

Zrenjanin oil field is located in the Banat Depression of the southeastern part of the Pannonian Basin (Serbia). The reservoir rocks in this oil field are found in two deposits: Deposit I – Zrenjanin, and Deposit II – Zrenjanin North. The reservoir rocks of the Deposit I are located in Paleogene, Badenian and Jurassic sediments. The reservoir rocks of the Deposit II are located in Sarmatian and Paleogene sediments. Both deposits are represented by breccias, conglomerate and clay. The oils were collected from the depths between 2072 and 2096 m (Deposit I) and between 2275 and 2368 m (Deposit II). The temperature and the pressure in the Deposit I were 126.8 ºC and 223.4 bar. The temperature and the pressure in the Deposit II were 136.1 ºC and 241.2 bar.

The saturated fractions of the oils were analyzed by gas chromatography/mass spectrometry (GC/MS) and gas chromatography/mass spectrometry/mass spectrometry (GC/MS/MS). The aromatic fractions were analyzed by GC/MS.

Total ion chromatograms (TICs) of the saturated fractions of all Zrenjanin oils are characterized by domination of *n*-alkanes in the *n*-C_{14} - *n*-C_{39} range, with CPI values between 0.93 and 0.97. High Pr/*n*-C_{17} (0.84 - 1.05) and Ph/*n*-C_{18} (1.19 - 1.45) ratios and low unresolved complex mixture (UCM) are characteristic of all samples pointing to biodegradation or low maturity level of these oils (Peters et al., 2005). Considering sharp predominance of *n*-alkanes in TICs of the saturated fractions and temperatures in deposits, the obtained results could be attributed to low maturity. Pristane/phytane (Pr/Ph) ratios are in the 0.66 - 0.76 range, indicating reducing redox conditions during deposition of precursor organic material (Didyk et al., 1978).

The precursor organic matter (OM) type of the oils was evaluated on the basis of abundance and distribution of regular sterane isomers C_{27}-C_{29}ααα(*R*), abundance of C_{30} steranes, tetracyclic polyprenoids (TPP; Holba et al., 2003), values of the sterane/hopane ratios, and presence of the pentacyclic triterpane oleanane. The distribution of C_{27}-C_{29} regular steranes in all samples was found to be uniform and indicated a mixed origin for the oils. Marine C_{30} steranes (4-desmethylsteranes) are present in low concentration, showing marine influenced depositional environment for the corresponding source rocks. Intermediate values of the TPP ratios suggested some input of fresh water OM. However, high values of the sterane/hopane ratio pointed to the significant contribution of the algal biomass to the precursor OM. Finally, presence of pentacyclic triterpane oleanane in all samples proved input from angiosperm land plants, confirming mixed origin of Zrenjanin oils.

Evaluation of the lithology and depositional environment of the source rocks of the Zrenjanin oils was based on the rearranged sterane and hopane biomarker ratios: $\sum C_{27}$diasteranes/$\sum C_{27}$steranes, Ts/(Ts+Tm), C_{30}diahopane/C_{30}hopane and C_{29}Ts/C_{29}hopane. All these ratios are used as indicators of thermal maturity, but also depend significantly on the lithological composition of the source rocks. These parameters for Zrenjanin oils have low values, confirming low maturity of these oils but they also indicate low content of clays in their source rocks.

The maturity assessment of the Zrenjanin oils was done using typical sterane isomerisation maturity parameters, methylphenanthrene index (MPI 1), and vitrinite reflectance equivalent (Peters et al., 2005; Radke, Welte, 1983). The values of these parameters confirmed low level of thermal maturity of the investigated oils corresponding to calculated vitrinite reflectance, Rc of 0.60-0.70 %. However, the mean values of the sterane isomerisation maturity parameters for Deposit I (C_{29} ββ/(ββ+αα) ≈ 0.33 and C_{29} S/(S+R) ≈ 0.38) and Deposit II (C_{29} ββ/(ββ+αα) ≈ 0.40 and C_{29} S/(S+R) ≈ 0.47) made a clear difference between the oils from these two deposits, and suggested two source rocks, different in maturity, for the Zrenjanin oils.

Geologic age of the source rocks of the Zrenjanin oils was evaluated using the age-specific biomarker ratios: oleanane index (OI; Moldowan et al., 1994) and nordiacholestane ratio (NDR; Holba et al., 1998). These results indicated Tertiary age for the studied oils. However, the mean values of OI for Deposit I (OI ≈ 29 %) and for Deposit II (OI ≈ 21 %) indicated a possible difference in geologic age and/or angiosperm input of the investigated oils, and confirmed the presumption of the existence of two source rocks for the Zrenjanin oils.

It can be concluded that the Zrenjanin oils originate from low mature, Tertiary aged source rocks, with OM most probably deposited under restricted saline lagoonal conditions or in a brackish environment. The obtained results suggest that Zrenjanin crude oils originate from different sources than other Banat oils. Two source rocks, different in maturity and possibly in age, are proposed for Zrenjanin and Zrenjanin North deposits.

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