

**SEARCH AND CHARACTERIZATION FOR THE SOURCE ROCKS OF  
OIL-GAS FIELD VELEBIT (SE PANNONIAN BASIN, SERBIA)  
BASED ON BIOMARKER DISTRIBUTION IN CRUDE OILS**

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Twenty five crude oils from the Velebit oil-gas field (SE Pannonian Basin, Serbia) were investigated in order to define depositional environment, lithology, thermal maturity and depths of corresponding source rocks, and in that way to help in revelation of their localities that are still unknown. Saturated biomarkers (*n*-alkanes, isoprenoids, steranes and triterpanes) were analysed by gas chromatography (GC), gas chromatography-mass spectrometry (GC-MS) and gas chromatography-mass spectrometry-mass spectrometry (GC-MS-MS). All samples were of moderate (I) degree of biodegradation, characterized by the absence of *n*-alkanes and undisturbed distributions of branched and cyclic/polycyclic alkanes. Based on the distribution and abundance of biomarker compounds, typical source and maturity parameters were calculated. Principal Component Analysis (PCA; program SPSS 11.0 for Windows) was used as an additional tool in interpretation of biomarker ratios. PCA showed that thermal maturity was the most significant parameter controlling composition and distribution of biomarkers in the Velebit oils (40% of variance explained) and that, in addition, variation in source rock facies had considerable effect on the biomarkers composition of the investigated oils (21% of variance explained).

Source parameters, *i.e.*, the distribution of regular C<sub>27</sub>-C<sub>29</sub> 14 $\alpha$ (H)17 $\alpha$ (H)20(R)-steranes (approximately 31%:35%:34%), and oleanane, and gammacerane, indexes (22.52-28.30 and 5.41-7.06 respectively) indicated miscellaneous lacustrine-terrestrial-marine origin of investigated oils, probably related to fluvio-deltaic depositional environment. Due to extremely mild temperature (approximately 69 °C) and pressure conditions (68.42 to 75.45 bar) in Velebit reservoir rocks and short lateral distances of bitumen migration in this part of the Pannonian Basin (Dolton, 2006), biomarkers in these oils were considered as reliable parameters in the assessment of corresponding source rocks characteristics. Numerous biomarker ratios, Pristane/Phytane (0.63-0.97) and rearranged sterane and terpane biomarker ratios (*i.e.* Ts/Tm > 1.40;  $\Sigma$ C<sub>27</sub>diasteranes/ $\Sigma$ C<sub>27</sub>steranes > 0.50; C<sub>30</sub>-diahopane/C<sub>29</sub>Ts > 0.35) indicated predominantly reductive depositional environment and siliclastic nature of source

rocks. Some indices corroborated presumption on deltaic depositional environment. Specific age-diagnostic ratios: oleanane indices,  $C_{30}$ -moretane/ $C_{30}$ -hopane ratios ( $\leq 0.07$ ) and  $C_{29}\alpha\alpha 20(S)$ -sterane/ $C_{29}\alpha\alpha 20(S+R)$ -steranes ratios ( $> 0.5$ ), showed that source rocks of investigated oils were of Mesozoic (most probably late Cretaceous) age, which made them different from most oils in Pannonian Basin, which are Tertiary in age. Values of the most often used maturity parameters ( $C_{30}$ -moretane/ $C_{30}$ -hopane,  $C_{31}22(S)$ -hopane/ $(C_{31}22(S)+22(R))$ -hopanes),  $C_{29}\alpha\alpha 20(S)$ -sterane/ $C_{29}\alpha\alpha 20(S+R)$ -steranes,  $C_{29}\beta\beta 20(R)$ -sterane/ $(C_{29}\beta\beta 20(R)+C_{29}\alpha\alpha 20(R))$ -steranes) (0.05-0.07, 0.58-0.60, 0.52-0.57, 0.57-0.63, respectively), pointed to high maturity level of investigated oils. Vitrinite reflectance equivalent (% Rc) values of the oil samples were calculated using equation connecting % Ro of the kerogen and 20S/20R  $C_{29}$  sterane ratio of the extract from the same sample (Gürgey, 2003). Resulting values of % Rc are in the 0.89 – 1.01 range, indicating that source rocks of Velebit oils are at the end of the peak of the main stage of oil generation (Peters *et al.*, 2005) which is in good accordance with all other biomarker maturity parameters. Assuming that in the investigated part of the Pannonian Basin, oil was generated at maturation levels corresponding to present-day burial depths (Dolton, 2006), using the calculated values of % Rc, annual mean surface temperature of 11°C, the average geothermal gradient of 48 °C/km in the region and the diagram that relates depth, vitrinite reflectance and regional geothermal gradient (Suggate, 1998), we estimated the source rocks depth interval of 2810 m to 2930 m and temperatures interval of hydrocarbons generation of 145.9 °C to 151.6 °C. On the other hand, using basin-independent equation  $T = (\ln(Ro)+1,68)/0,0124$  (Barker and Pawlewicz 1994) and the calculated % Rc values, temperature interval of oil generation was calculated to be in the 125 °C to 136 °C range. Considering the fact that this part of the Pannonian Basin is characterized by short-distance lateral but extensive vertical migration of hydrocarbons, with oil and gas accumulations found in immature sediments above mature sources (Dolton, 2006), it can be presumed that source rocks of Velebit oils are at the present-day depths of approximately 3000 m, within or in close proximity to the Velebit oil field.

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