

## Oil outcrops in the Croatian part of Pannonian Basin System as a field trip research object of Petroleum Geology course

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This work comprises data about oil outcrops in the Croatian part of the Pannonian Basin System (CPBS) based on field trip research of a Petroleum Geology course. Field trips are held to conclude, in which geological circumstances can be seen outcrops of reservoir rocks and oil on surface. The Pannonian Basin System is a back-arc-basin system, where in the past the Central Paratethys was located, and after it, brackish and fresh-water environments formed (Velić *et al.*, 2012). Basins, depressions and subdepressions were formed along dextral and sinistral strike-slip faults. CPBS belongs to its southwestern part and it is divided into the Drava, Sava, Mura, and Slavonija-Srijem depressions. The general depositional environment is very similar in all parts of the basin. It is divided into three megacycles, mainly infilled with Neogene-Quaternary rocks.

From NW to SE, there are three main sites, where oil outcrops are found (Fig. 1.). Peklenica, located in the Medimurje region, belongs to the Mura depression. Oil outcrops (visible irisation) can be seen in the Peklenica Stream and around an old mining shaft. Outcrops correlate with the Selnica-Peklenica anticline (Velić, 2007).



Fig. 1.: Topographic map showing the locations of the outcrops.

To the southeast, there is another location in the Sava depression, called Mikleuška (Fig. 1.), named after a village 2 km away. In Mikleuška, traces of oil tar and bitumen from bituminous schists were found but it was not enough for profitable exploitation. The next significant place on that territory is a 72 m deep well „Martin“, which intersects granitic rocks saturated with oil. At the bottom of the shaft, nine horizontal halls are found, which are following fractures in the granitic host rocks. Oil was situated in the fractures of granitic rocks and in the upper sedimentary rocks. It is brown to black coloured, hardly flammable and burns with fuliginous flame. Approximately a few hundred litres of oil were put in barrels and uplifted to the surface daily (Žgaljić, 1984), with a total of 100 t annually from 1854/1855 until 1943 (Gretić & Bobić, 2002). Clays on the top stops oil to lift up to the surface, so the only natural outcrops are those ones, where oil seeps out from sides of the stream. Surrounding area consists of Paleozoic and Mesozoic magmatic and metamorphic with Neogene sedimentary rocks. From lithological

point of view, the surrounding rocks are Miocene sandstones and marls and Pliocene beds. The outcrops are not on the surface because they are covered with Quaternary sediments.

The southernmost location is the village of Paklenica (Fig. 1.), located 100 km SE from Zagreb. It also belongs to Sava depression. Oil is noticed in the Paklenica Stream, mostly in the upper part. Oil outcrops are also found in the bottom of Sisvete Peak (321 m) and in the valley of the Voćarica Stream. CH<sub>4</sub> and H<sub>2</sub>S gases are also present. There are a few shallow shafts along the anticline Kozarica. Going through the valley of the Paklenica Stream, crossing over the structure called structural nose, there are outcrops starting from Pleistocene sediments represented by gravel and sand. Pleistocene sediments are followed with Pliocene beds (clay and sand), with an occasional appearance of lignite. In upper Miocene beds (Pontian) coal has been found and excavated along a 50-m-long pit. Lower Pontian beds are the host rocks for some hydrocarbons. Pannonian beds consist of white marls, while Sarmatian is represented by laminated marls that are mostly bituminous. Those marls are the source rocks. The structural nose in its middle part has *Lithothamnium* limestone and Badenian sandstone. In the upper part, bituminous marl is found. The top of the structure is eroded. Thus, without an adequate seal, oil outcrops are found on the surface.

We have come to the conclusion, that oil outcrops in Peklenica and Mikleuška are similar. The sides of the streams are eroded, so the horizontally flowing oil is going out from the source rocks and seeps slowly, but continuously into the streams. Other recent occurrences are in the old mining shafts, where oil is mixed with water now. However, the situation in Paklenica is different. There is an uplifted structural nose, which is uncovered, so oil appears on the surface from abandoned wells.

The names of those villages Paklenica, Peklenica are significant, and may have the same origin from old Croatian words „*pekel*, *pakal*“ which means oil tar. Today these outcrops are just of historical significance, interesting, because oil is still on surface. On the other hand their present day economic value is negligible.

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