



Oil and Gas geomanifestations in the Mura-Zala Basin, the western Pannonian Basin System

The most prospective geological area for oil and gas in Slovenia is the Neogene Mura-Zala Basin (Fig.1 – left) situated in SW part of the Pannonian Basin System. Within the Mura-Zala Basin, Middle to Upper Miocene strata in the Lendava - Petišovci area (Fig.1 – right) have a considerable potential for oil and gas reserves and resources. Oil and gas were discovered in this area in 1942 – since then known as the Petišovci Field - as a continuation of the already known Lovaszi Field at the time in the neighbouring Hungary. However, as “oil” springs in the wider area, they were known already in the 18th century.

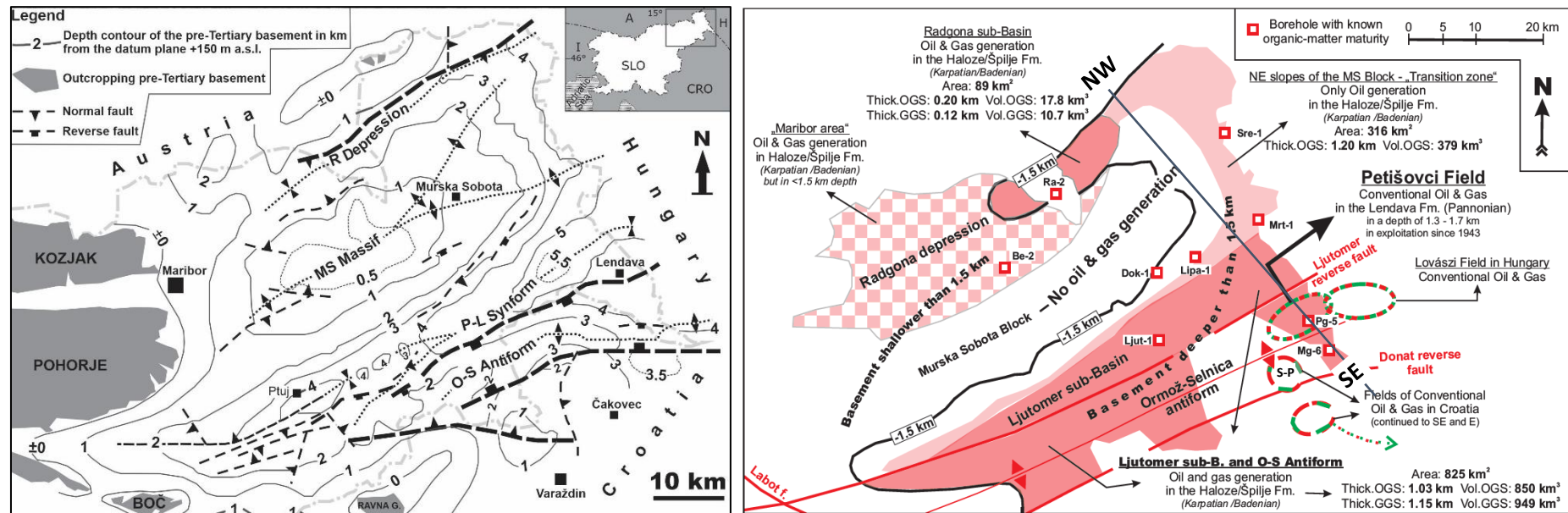


Fig. 1. Left: Structural map of the Mura-Zala Basin by depth contours of the pre-Tertiary basement (simplified after Djurasek, 1988, and Gosar, 1994/95). Right: In 2016, EU Unconventional Oil and Gas Assessment Project has been carried out by Geological Surveys of Europe. Areas and volumes of potential oil and gas generation strata (OGS and GGS) were defined (Markič et al. 2016) based on TOC, OM maturity, HI, and kerogen type data as studied and interpreted by Hasenhüttl et al. (2001), and Sachsenhofer et al. (2001).



Anomalies

In the neighbouring Croatia, south of Petišovci, Selnica and Peklenica oil and gas fields (S-P in Fig. 1-right) were exploited since the mid-19th century to the end of the 1950-ies. Natural oil springs were known there already centuries ago. In Peklenica, nowadays there is a field museum (Fig. 2), with a well in which an “outcropping” oil with gas bubbles are visible (Fig.2 - right). Also known hydrocarbons-bearing Neogene strata close to Peklenica site are those at Vučkovec, Vukanovec and Zebanec, which were put in gas production after some decades again (!) recently.



Fig.2. Field museum in Peklenica near Mursko Središće (Croatia). Left is historical view with wooden three-rigs. Right is oil in an old “museum” well. (Visit of the Peklenica oil museum was guided by Tamara Marković from the Croatian Geological Institute (HGI) in October 2018). The word “Peklenica” sources from the word “pekel” which means “oily lubricant”. It was used as a wheel lubricant, for oily compresses e.g for horses, and caws.

Oil and gas-bearing reservoirs of the Petišovci Field (7 x 2 km wide) (Fig 1-right) are divided into two bed-sets – the shallow and the deep one (Fig. 3). Both consist of alternating 10-40 m thick impermeable marls and porous oil-and/or-gas-bearing sandstones of low porosity – below 15 %, decreasing with depth to ca. 7% only. The Petišovci hydrocarbons are therefore characterized as the tight gas and oil. The shallow »conventional« reservoirs occur in 4 main horizons in a depth interval from ca. 1200 to 1800 m. They were exploited in the 1950s (mostly oil) and 1960s (mostly gas). Nowadays, they are depleted – offering a possibility for e.g., storage of imported natural gas or for CO₂ sequestration.

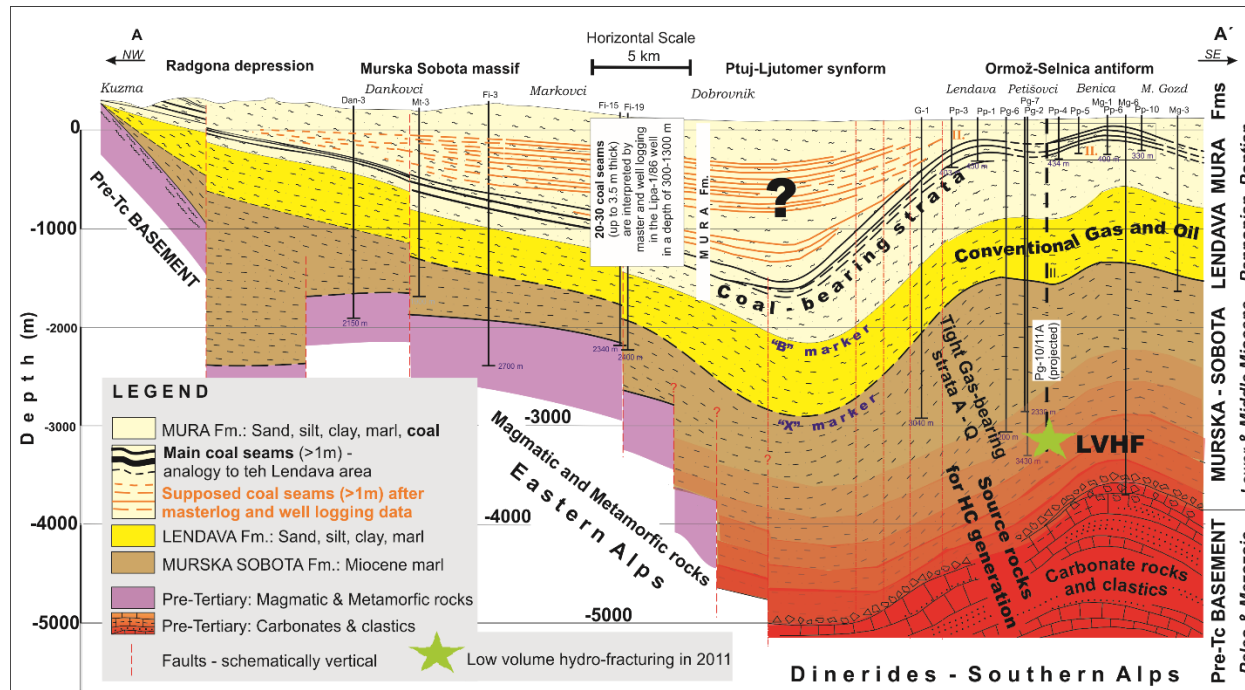


Fig. 3. NW-SE cross-section (see Fig 1- right) via NE Slovenia. Note on the SE part of the cross-section an antiform structure with coal measures and “conventional” oil and gas-bearing strata, exhausted in the 1950-ies – now suitable for CO₂ sequestration (CCS). In deeper strata, below ca 2.2 km, many layers with tight gas occur which were detected already in the 1960-ies, and hydraulically fractured (low volume hydrofracturing - LVHF) in two wells in 2012. Right – one of the two newest gas wells in Petišovci – in production since 2012. Question mark refers to coal strata registered in master logs in deep oil, gas, and geothermal wells in NE Slovenia, but not exactly proved by core drilling giving their true thickness (see more in Coal in the Mura Formation).



The deep reservoirs start at a depth of 2200 m and are developed as about 17 tight gas-bearing (“A-F-Q”) layers down to a depth of 3550 m (deepest wells), maybe even more. The deepest well was Mg-6/1985 (3858 m). It was the only one reaching the pre-Tertiary carbonate basement in the broader Petišovci area.

The whole set of the Petišovci reservoirs is a typical antiform structure (Kerčmar, 2018) formed by lifting between the Donat and Ljutomer reverse faults. It may be interpreted that hydrocarbons were generated in an originally synform setting (to reach the oil and gas generation windows), which was later lifted.

Lifting has lasted still in the Pontian (Uppermost Miocene) times as known from the coal measures antiform structure (Markič et al., 2011) in the uppermost Mura Formation (Fig. 3) The lifting with accompanying fissure system enabled migration of hydrocarbons upwards into porous sandstone reservoirs in which hydrocarbons were trapped by impermeable marl layers.

References

Djurasek, S. 1988: Rezultati suvremenih geofizičkih istraživanja u SR Sloveniji (1985-1987). (Results of geophysical exploration in Slovenia (1985-1987)). Nafta, 39, 311-326.

Gosar, A. 1994/95: Modelling of seismic reflection data for underground gas storage in the Pečarovci and Dankovci structure – Mura depression (in Slovene with Eng. abstract). Geologija, 37/38, 483-549. <http://www.geologija-revija.si/dokument.aspx?id=853>

Hasenhüttl, C., Kraljić, M., Sachsenhofer, R.F., Jelen, B. & Rieger, R. 2001: Source rocks and hydrocarbon generation in Slovenia (Mura Depression, Pannonian Basin). Marine and Petroleum Geology, 18: 115-132, doi:10.1016/S0264-8172(00)00046-5.

Kerčmar, J. 2018: Natural gas reservoirs of the oil-gas field Petišovci (in Slovene with Eng. abstract). Geologija, 61/2, 163-176. <http://www.geologija-revija.si/dokument.aspx?id=1339>

Markič, M., Turk, V., Kruk, B., Šolar, S.V. 2011: Coal in the Mura Formation (Pontian) between Lendava (Slovenia) and Mursko Središće (Croatia), and in the wider area of NE Slovenia) (in Slovene with Eng. Abstract). Geologija, 54/1, 97-120. <http://www.geologija-revija.si/dokument.aspx?id=1121>

Markič, M., Lapanje, A., Rajver, D., Rman, N., Šram, D., Kumelj, Š. 2016: Geological evaluation of potential unconventional oil and gas resources in Europe – Evaluation of the potential in Slovenia - H2020 call, B.2.9.: “Energy Policy support on unconventional gas and oil” from the European Commission, by JRC-



IET, service contract no. 11411 between The European Union and GEUS and subcontracting agreement between GEUS and GeoZS. Geological Survey of Slovenia, 37 p.

Sachsenhofer, R. F., Jelen, B., Hasenhüttl C., Dunkl, I. & Rainer, T. 2001: Thermal history of Tertiary basins in Slovenia (Alpine-Dinaride-Pannonian junction). Tectonophysics, 334/2: 77-99. ISSN 0040-1951.

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