The hydrodynamic entrapment model of the Tatárülés-Kunmadaras gas field

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In my work I examined the entrapment conditions of the Tatárülés-Kunmadaras gas field, which is related to a basement protrusion near Berekfürdő, East-Hungary. Hydrogeological interpretation has already been done for this area, for which I made oil hydrogeological investigations. The gas field was discovered and set production near Kunmadaras in the 1950s. My purpose was to explain the location of the field with oil hydrogeological investigations and on this basis, substantiate the effectiveness of the method.

In my work I used the "UVZ" method. This uses the basic principles and equations which were described by Hubbert (1953). The method wants to determine, in what amounts the hydrocarbons can accumulate and preserve in various geological and hydrogeological conditions. This procedure examines the hydrocarbon migration on hydrodynamic basis, emphasizing the role of water flow. The basic theory of the method is that the hydrocarbons move along with water, however their flow directions differ due to the density difference. The basic equation is:

$$U = V - Z,$$

in which Z is the elevation, V is the water potential with respect to oil or gas and U is the oil or gas potential. The method is basically graphic, the Z contours are the isolines of the reservoir top map. The V contours are the rescaled versions of the water equipotentials based on density differences. With the help of the V and Z contours, we can map the U potential surfaces. The three variables represent the combined effects of the lithological changes, the trap structure and the hydrogeological environment (Dahlberg, 1995). During the procedure we are looking for areas, where the potentials of the analysed fluids reduce to a minimum, because every hydrocarbon particle will migrate towards these zones. It is necessary for the minimum contours to be closed, so the fluid particles cannot release. In terms of hydrocarbon entrapment, the best occurrence is when a closing potential minimum overlaps with an anticlinal structure, but single minimum areas can hold large amounts of hydrocarbons, too.

To test the "UVZ" procedure, I have choosen the Tatárülés-Kunmadaras gas field, because there the structural and hydrogeological factors influence the entrapment of the hydrocarbons. The hydrocarbons stored in two main Pannonian reservoir layers. There are three principal fault zones in the area, which delineate the gas field from East and West (Czauner & Mádl-Szőnyi, 2011). Along these fault zones, the upwelling of water is very strong. The convergence of these fault zones marks the southern border of the field.

During my work I had only data from the upper reservoir strata. I made water equipotential maps, water potential maps with respect to gas, gas potential maps, hydraulic cross sections, water potential cross sections with respect to gas and gas potential cross sections. I made the calculations with three different gas density values, because I did not have an accurate value.

Based on my results, between the three fault zones in the examined reservoir, the direction of the water flow is west to east, which affects the gas entrapment. Consequently, the upwelling along the western fault is stronger, than along the eastern one. Based on the gas potential maps and cross sections, I showed that the gas entrapment is hydrodynamically possible in the area. The closed potential minimum zones are visible in every gas potential map and cross section. The most favourable area for the accumulation of gas is in the eastern side of the area, where a closed gas potential minimum overlaps with an anticlinal structure.

The sections also show the impact of hydrodynamic environment on the hydrocarbon accumulations (Fig. 1.). This manifest in, that at the case of the western, bigger anticlinal structure the minimum values of the gas potentials, so the most probable places of the accumulation of gas are not locate in the hinge zone of the structure, but these are in tilted position to southeast.

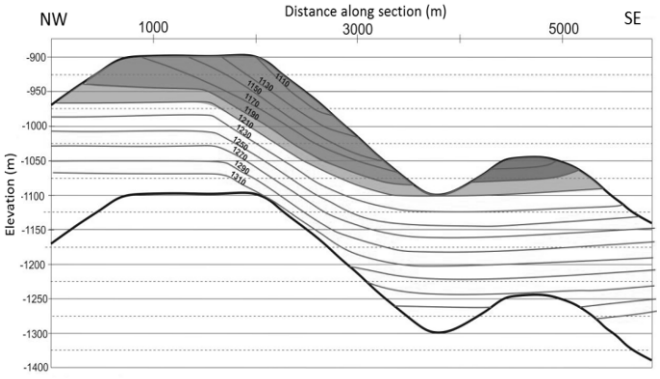

Fig.1.: The gas potential section made with density value 0.4 g/cm^3

It also proves that the gas field, what was discovered here in 1957, can be bigger. Some of the hydrocarbons could have washed towards east, southeast directions before the production. Based on this, the re-accumulation of hydrocarbons was possible in this directions.

Based on my results the Tatárülés-Kunmadaras gas field accumulated in a hydrodynamic trap. In this case, the "UVZ" method was suitable for the more accurate delineation of the trapping sites, so it can be an effective method in other fields, too.

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