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Fluid flow systems and hydraulic trapping of hydrocarbons – Hajdúszoboszló and Ebes gas fields, Hungary

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Groundwater flow mobilises, transports and accumulates hydrocarbons, thus the evaluation of recent fluid flow systems contributes to the mapping of hydraulically favourable places for hydrocarbon trapping and preservation. The aim of our research was (i) to understand the recent fluid flow systems and regional pressure field in the broader area of Hajdúszoboszló and Ebes, Hungary, (ii) to find potential areas for hydraulic trapping in the study area and (iii) to explore the hydraulic connection between Hajdúszoboszló and Ebes gas fields and their surroundings.
First the hydrostratigraphic build-up was determined based on borehole sequences, seismic horizons and sections. Then mapping of the fluid-potential field was carried out based on measured hydraulic (pressure and hydraulic head) data by pressure vs. elevation profiles, tomographic fluid-potential maps, and hydraulic cross sections. This evaluation was complemented by water chemical and temperature data analyses by TDS (total dissolved solids content) and temperature vs. elevation profiles, tomographic isoconcentration and isotherm maps, as well as cross sections.
Based on the results of the data processing two distinct flow systems were identified and characterized, namely the nearly hydrostatic, gravitational, and the overpressured flow system, which are well known in the Pannonian Basin. The boundary of these two systems is located in different elevations depending on different geological build-up, but for the whole study area it is located around (-1500)m asl. Beneath the Nyírség (recharge area), gravitational downward flow is superimposed to the deeper upward flow and thus a potential minimum zone evolves. This zone can function as a hydraulic trap, so this can be the upper limit of vertical hydrocarbon migration. As the aim of this research, the connection between the flow systems and the areas of Hajdúszoboszló and Ebes gas fields were analysed in detail. The favorable hydraulic conditions of entrapment and accumulation right here are provided by coincidences of different factors. Namely, in the area of the Hajdúszoboszló gas field upward gravity-driven flow dominates from the elevated Pre-Neogene basement, which may focus flows of the underpinning overpressured system from the South, up to the land surface. This upward flow zone could force the dominantly horizontal SW-directed gravitational flows to turn upward, whilst pressure and temperature drop, as well as salinity increase and these together decrease the solubility of hydrocarbons in groundwater. Furthermore the differences related to the topography of the Pre-Neogene basement between the Hajdúszoboszló–Ebes High and the Derecske Trough were described, as they determine the pressure and heat dissipation and secondary migration pathways as well.
These conclusions demonstrate the significance of hydraulic studies in the understanding of secondary hydrocarbon migration and accumulation. Combining these methods with the otherwise used industrial practice as a hand-in-hand experience, they can help to reach better scores in hydrocarbon exploration.

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