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Thermophysical properties of potential geothermal reservoir rocks: an outcrop analogue study of the sedimentary series of the Buda Mts., Hungary

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The detailed knowledge of sedimentary features from microscopic to regional scales is regarded as crucial in reservoir characterization and prediction of deep geothermal systems. Generally, in the early stages of reservoir exploration, characterization of the reservoir is accomplished by evaluation of drilling data and seismic surveys. However, for reservoir prognosis, the main geothermal parameters such as permeability, thermal conductivity, and reservoir heat flow have to be quantified with respect to a 3D structural model. Outcrop analogue studies serve to predict such subsurface thermophysical properties, and based on detailed facies analysis, the geothermal exploration concept becomes more precise and descriptive.

Our data from the Meso- and Cenozoic sedimentary series of Budapest include carbonates and clastic sediments of Triassic, Eocene, and Oligo-Miocene age as well as Pleistocene travertine, exposed on the western side of the river Danube. Field and laboratory analyses reveal distinct horizons of different geothermal potential and thus, enable us to identify and interpret corresponding exploration target horizons in geothermal prone depths of the Pannonian Basin.

Upper Triassic limestones (Main Dolomite, Budaörs Dolomite, Mátyáshegy Limestone) show values of thermal conductivity in the range of 2,0 to 3,5 W/(m·K). Matrix permeabilities measured with a gas mini-permeameter span in the range of 10^{-12} to 10^{-14} m^2. Additionally, these limestones are highly fractured and show a different degree of karstification increasing the fluid migration. Thus, hydrothermal exploration of such limestone reservoirs in geothermal prone depths of about 5 km known from the Zala and Danube basins of W Hungary is seen very promising.

Miocene bioclastic limestones (e.g, Tinnye Limestone) reveal lower values of thermal conductivity in the range of 1,0 to 1,5 W/(m·K). On the other hand, they are characterized by much higher permeabilities (10^{-11} to 10^{-12} m^2). Depending on their occurrence in the deep subsurface, they might be considered as reservoir rocks. Marls and travertines show values of thermal conductivity in the range of 2,0 to 2,5 W/(m·K). Matrix permeabilities of marls are low (10^{-15} to 10^{-16} m^2), whereas travertines are characterized by the highest permeabilities up to 10^{-11} m^2. Both, marls and travertines are not considered as deep geothermal reservoir rocks: marls due to their low permeabilities, and travertines due to their occurrence mostly in surface outcrops.

Clastic sediments of Palaeo- and Neogene age are grouped into low permeable and low heat conducting clays (e.g., Kiscell Clay), and high permeable, high heat conducting sandstones (e.g., Hárshegy Sandstone). Thus, hydrothermal exploration of high permeable sandstone reservoirs in geothermal prone depths known from different basins in Hungary (e.g., Central Great Plain) is also seen very promising.

Based on these preliminary results, further outcrop analogue studies will serve as a powerful tool to predict such subsurface properties and thus, finally lead to a better understanding of deep geothermal reservoirs in the Pannonian Basin.