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Analyses of the thermal parameters of Calcalpine basement rocks of the Vienna Basin for a hydrothermal reservoir assessment

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The Calcalpine basement of the Vienna Basin offers aquifer structures for a hydrothermal utilisation. Investigations concerning the basement structures, and the thermal and hydrological properties respectively, form the basis for a reservoir assessment to estimate the hydrothermal potential. The structural and lithological features within the Calcalpine succession, as well as information about depth, lateral extension, thickness and homogeneity of reservoirs are obtained from hydrocarbon exploration and production in the area. The prediction of hydrothermal properties of aquifers, thermal properties of the adjacent permeable and impermeable zones of the Calcalpine basement, and the relation to their mineralogical and petrophysical parameters are the aims of the presented investigations.

Log analyses, petrophysical measurement of core samples, petrographical and microfacial analyses were conducted to analyse the hydrothermal diversification within the stratigraphic successions of the Lunz-Frankenfels- and the Goeller-Nappe, ranging from the Permo-Scythian to the Paleocene. In order to estimate the influence of pressure on thermal parameters, core samples from different depths covering the Calcalpine formations, were taken according to their availability. The analyses of thermal conductivity, thermal capacity, density and porosity were carried out by laboratory measurements under dry and high saline conditions. The influence of the quantitative and qualitative mineralogical composition on thermal properties was determined by comparing XRD-analyses with measured thermal properties.

Useable hydrothermal reservoir rocks are predominantly present in the Wetterstein Dolomite and Hauptdolomite, especially regarding the joint- and fracture-porosity. The variations of thermal conductivity result from the facial diversifications of the sedimentary and diagenetic environments, as well as the type and intensity of the dolomitisation processes. The different types of dolomites were distinguished by size and habitus of the crystals, the various phases of dolomitisation, the sedimentary and diagenetic structures, the occurrence of micro-fossils, the mineralogical composition, and the coexistence with other mineralisations. Apart from the influence of porosity, the variations concerning the thermal conductivity of the dolomites (with a measured range from 3.11 W/(K*m) to 5.21 W/(K*m)) resulted in the first place from the mineralogical composition and to a minor degree from other parameters, like grain size. A comparison of various analysed dolomites of the investigated Calcalpine nappes (Lunz-Frankenfels-Nappe and Goeller-Nappe) showed that the dolomites of the Lunz-Frankenfels-Nappe are on average more heterogeneous, have higher clay mineral contents and lower porosities.

An influence of the pressure on the thermal properties is evident in siliciclastic formations, whereas the dolomites do not show a depth-dependent variation of the thermal conductivity. The diversifications of the measured thermal conductivity of siliciclastic formations, for example from the Werfen-Formation to the Gießhübl-Formation range from 2.09 W/(K*m) to 5.16 W/(K*m). The log analyses (especially sonic-, density- and neutronlogs) were primarily carried out to obtain an estimation of lithology, compaction, porosity and pore content, and additionally to receive input data for a calculation of the thermal conductivity of the siliciclastics. By comparing the results based on log data with measurement data of core samples a calibration of the log analyses was assembled. In summary, results of the applied investigations represent a data base for thermo-dynamic calculations and finally for a hydrothermal reservoir simulation.