EGW 2019
7th European Geothermal Workshop
Karlsruhe, 9-10 October 2019

Contribution ID: **158** Type: **Poster**

Effects of elevated confining pressure and temperature conditions on deeply buried sandstone reservoirs

Wednesday, October 9, 2019 5:40 PM (20 minutes)

Connected open pores forming the matrix porosity are important fluid pathways in siliciclastic geothermal and hydrocarbon reservoirs at 2-5 km depth. Therefore, grain rearrangement by mechanical compaction, authigenic mineral formation during early and late diagenesis, as well as chemical compaction have a profound impact on permeability (Taylor et al., 2010; Busch et al., 2017). Petrophysical measurements in combination with petrographic information was employed to characterize potential analogs to reservoirs in Rotliegend fluvio-eolian sandstone units.

Petrophysical measurements were conducted on plug samples with a diameter and length of 3.0 cm. Helium porosity was measured with a micromeritics® AccuPyc II 1340 gas pycnometer. Klinkenberg-corrected permeability under steady-state conditions was measured at 1.2 MPa confining pressure at room temperature (22° C) using dry, oil-free lab air as a permeant. Also, Klinkenberg-corrected permeability under steady-state conditions was measured at confining pressures of 2, 5, 10, 30 and 50 MPa at room temperature (22° C) during loading and unloading cycles. Permeability pressure sensitivity coefficients after David et al. (1994) were determined from the measured permeability hysteresis curves. Selected samples were also measured at reservoir temperatures of 140° C in order to evaluate the effect of elevated temperatures on the permeability in reservoirs compared to ambient measurements. Detailed mineralogical composition, the grade of compaction (Lundegard et al., 1992), and the impact of authigenic minerals on pore space reduction were derived from thin sections with point-counting adjusted to the maximum grain size.

Helium porosities range from 3.8-25.7 %, while ambient permeabilities range from 8.882*10-18 m^2 - 2.899*10-13 m^2. Dependent on the initial permeability under ambient conditions (1.2 MPa confining pressure, 22 °C), permeabilities are reduced from below one order of magnitude up to four orders of magnitude. Permeabilities for less compacted and less cemented samples are reduced by below one order of magnitude, permeabilities for highly cemented but not highly compacted samples are reduced by one-two orders of magnitude, and permeabilities for highly compacted sandstones are reduced by up to three orders of magnitude. Consequently, the permeability pressure sensitivity coefficient γ ranges from 0.5 –22.2 10-2 MPa-1. The temperature effect shows inconclusive results in regards to its effect on permeability. Results highlight the significant heterogeneity in production relevant properties like permeability and porosity, although the bulk mineralogical composition is very similar. Thus, detailed characterizations are necessary to evaluate different permeabilities in seemingly heterogeneous sandstones. This allows to better predict unexpected reductions of fluid flow rates and zones requiring stimulation in geothermal and hydrocarbon reservoirs.

References

Busch, B., Hilgers, C., Gronen, L., Adelmann, D., 2017. Cementation and structural diagenesis of fluvio-aeolian Rotliegend sandstones, northern England. Journal of the Geological Society 174, 855-868.

David, C., Wong, T.-F., Zhu, W., Zhang, J., 1994. Laboratory measurement of compaction-induced permeability change in porous rocks: Implications for the generation and maintenance of pore pressure excess in the crust. Pure and Applied Geophysics 143, 425-456.

Lundegard, P.D., 1992. Sandstone porosity loss; a" big picture" view of the importance of compaction. Journal of Sedimentary Petrology 62, 250-260.

Taylor, T.R., Giles, M.R., Hathon, L.A., Diggs, T.N., Braunsdorf, N.R., Birbiglia, G.V., Kittridge, M.G., MacAulay, C.I., Espejo, I.S., 2010. Sandstone diagenesis and reservoir quality prediction: Models, myths, and reality. AAPG Bulletin 94, 1093-1132.

Authors: Mr MONSEES, Alexander C. (Department of Structural Geology and Tectonics, Institute of Applied Geosciences, Karlsruhe Institute of Technology); Dr BUSCH, Benjamin (Department of Structural Geology and Tectonics, Institute of Applied Geosciences, Karlsruhe Institute of Technology (KIT), Adenauerring 20a, 76131 Karlsruhe, Germany); Dr SCHÖNER, Nadine (Winterhall Dea Deutschland AG); Prof. HILGERS, Christoph (Department of Structural Geology and Tectonics, Institute of Applied Geosciences, Karlsruhe Institute of Technology)

Presenter: Mr MONSEES, Alexander C. (Department of Structural Geology and Tectonics, Institute of Applied Geosciences, Karlsruhe Institute of Technology)

Session Classification: Poster Session