Geophysical Research Abstracts
Vol. 20, EGU2018-7343, 2018
EGU General Assembly 2018


# First assessment for geothermal utilization of two regionally extensive Devonian carbonate aquifers in Alberta, Canada

Leandra Weydt (1), Claus-Dieter Heldmann (1), Hans G. Machel (2), Ingo Sass (1,3)

(1) Department of Geothermal Science and Technology, Technische Universität Darmstadt, Schnittspahnstraße 9, 64287 Darmstadt, Germany, (2) Earth and Atmospheric Sciences, University of Alberta, Edmonton, AB T6G 2E3, Canada, (3) Darmstadt Graduate School of Excellence Energy Science and Engineering, Jovanka-Bontschits-Straße 2, 64287 Darmstadt, Germany

The Canadian Province of Alberta has one of the highest per capita $CO_2$-equivalent emission of any jurisdiction in the world, predominantly due to industrial burning of coal for electricity generation and the mining operations in the oil sand deposits. To reduce $CO_2$-emission and to approach the targets of the Paris Accord from 2015, geothermal energy should become part of the energy mix in Alberta.
The Upper Devonian carbonate aquifer systems within the Alberta Basin are promising target formations for geothermal energy. To assess their geothermal potential, detailed knowledge of the thermo- and petrophysical rock properties is needed. To furnish a preliminary assessment of the potential for geothermal utilization an outcrop analogue study on two regionally extensive Devonian aquifers, the Southesk-Cairn Carbonate Complex and the Rimbey-Meadowbrook Reef Trend, were conducted. Samples taken from outcrops were used as analogue to equivalent formations in the reservoir and correlated with core samples of the reservoir. Analogue studies enable determination and correlation of facies related rock properties to identify sedimentary, diagenetic, and structural variations, which understanding allows for a more reliable reservoir property prediction.
Rock samples were taken from several outcrops of Upper Devonian carbonates in the Rocky Mountain Front Ranges. The samples were analysed for several thermo- and petrophysical properties, i.e. thermal conductivity, thermal diffusivity and heat capacity, as well as density, porosity and permeability. Thermal conductivity and permeability measurements were also performed on seven drill cores from the stratigraphically equivalent Leduc and three drill cores of the slightly younger Nisku Formation in the subsurface of the Alberta Basin. Additionally, thermal conductivity, thermal diffusivity and heat capacity were measured on about 45 plugs taken from four of the aforementioned core wells of the Leduc Formation. Furthermore, open-access petrophysical core data retrieved from the AccuMap database were used for correlation.
The results from both carbonate complexes indicate good reservoir conditions regarding geothermal utilization with an average reservoir porosity of about 8 %, average reservoir permeability between 10-12 and 10-14 $m^2$, and relatively high thermal conductivities ranging from 3 to 5 W m-1 K-1. The most promising target reservoirs for hydrothermal utilisation are the completely dolomitized reef sections. The measured rock properties of the Leduc Formation in the subsurface show no significant differences between the Rimbey-Meadowbrook reef trend and the Southesk-Cairn Carbonate Complex. Differences between the dolomitized reef sections of the examined Leduc and Nisku Formation are also minor to insignificant, whereas the deeper basinal facies of the Nisku Formation differs significantly.
In contrast, the outcrop analogue samples have lower porosity and permeability, likely caused by low-grade metamorphism and deformation during the Laramide Orogeny that formed the Rocky Mountains. As such, the outcrop analogues are, in this case study, no valid proxies for the buried reservoirs in the Alberta Basin.
Taken together, all available data suggests that dolomitization enhanced the geothermal properties, but depositional patterns and other diagenetic events, e.g. fracturing, also played an important role.