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Multicomponent geothermometry applied to a medium-low enthalpy carbonate-evaporite geothermal reservoir

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In order to improve the knowledge of the thermal state of medium to low-enthalpy thermal systems hosted in carbonate-evaporite rocks, a mineral-solution equilibrium model was compared to other theoretical geothermoters. We use the GeoT code (Spycher et al., 2014) which calculates reservoir temperatures based on a statistical evaluation of mineral saturation indices.

The calculations were applied to study the medium and low enthalpy geothermal systems in the Tyrrhenian-Apennine area (central Italy). The study area is mainly characterized by Paleozoic metamorphic basement and a Mesozoic carbonate–evaporite sequence overlain by Oligocene–Mid Miocene flysch formations and Quaternary volcanic complexes associated with crustal extension in the Tyrrhenian area. A regional aquifer is hosted in the carbonate-evaporate formations, and smaller aquifers are hosted in the volcanic rocks.

For reservoir temperature calculations the chemical composition of 58 springs and wells with a temperature between 22° and 65°C was taken into account. The waters are classified as Ca-HCO_3 waters with low TDS, Ca-SO4 waters with high TDS and few HCO_3-NaK type waters.

The calculated reservoir temperatures of the medium-low enthalpy hydrothermal systems in Tyrrhenian-Apennine area range between 40 and 100°C. As expected, cation geothermometers provide unrealistic values of equilibrium temperature. Calculations based on the chalcedony geothermeter provide more realistic temperatures than the quartz geothermometers because silica solubility at temperatures <180°C is controlled by amorphous silica or chalcedony. GeoT simulation results show that all the considered mineral phases are either near saturation or oversaturated and the equilibrium temperatures range between 48° and 116°C. The statistical approach of "best clustering minerals", used in this model, solves the problems related to cation or single component geothermometers. For these cases, multicomponent geothermometry coupled with optimization provides a reliable approach to reconstruct fluid composition at depth and estimate reservoir temperatures.

Spycher, N. et al (2014), Integrated multicomponent solute geothermometry, Geothermics, 51, 113-123.