Applications in Geothermal Monitoring

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Reliability of resistivity-derived temperature: insights from laboratory measurements

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This contribution consists in studying the reliability of resistivity-derived temperature, for example from time-lapse electrical resistivity tomography (ERT) surveys. The idea of using temperature as a quantitative tracer is growing in the hydrogeophysical community, especially to simulate geo/hydrothermal systems. However, plenty of physico-chemical processes are influenced by temperature and most of them impact directly resistivity measurements. Therefore, one needs to take them into account to retrieve quantitative temperature estimates from resistivity measurements but, up to now, it is seldom the case. The experiment we conducted consisted in simulating an ERT monitoring of heat storage in a sandy aquifer. We show that using experimental relationships between fluid electrical conductivity and temperature alone does not allow reliable temperature estimates, simply because rock-water interactions are neglected. Worst, from a certain temperature (45°C here), the bulk resistivity starts to increase with temperature although this is not expected from the experimental law. Chemical analyses made on water samples collected during the experiment highlight the importance of accounting chemical reactions (e.g. calcite precipitation with increasing temperature) occurring when temperature changes as well as their kinetics. Finally, other parameters as surface conductivity cannot always be neglected when estimating temperature from resistivity measurements. This means that retrieving reliable temperatures from bulk resistivity measurements (e.g. time-lapse ERT) requires the knowledge of water mineralization as well as the rock / soil mineralogy in order to fully integrate physico-chemical reactions between groundwater and the host rock, for example with a joint inversion scheme.