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Rock thermal properties prediction based on acoustic wave velocity in geothermal reservoirs

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Energy transition and the current ambition of the geothermal industry requires the exploitation of currently used sedimentary aquifers in adjacent sites and the exploration of new reservoirs in distant locations or deeper underground layers. In new areas, physical, mechanical and thermal properties of rock are needed for correct reservoir characterization and implementing a geothermal project safely and economically. The problem is that most of the available data come from hydrocarbon wells that are not necessarily in a favourable place for geothermal activities. Geothermal projects do not normally generate rich datasets and the lack of appropriate methodologies to convert downhole logs to rock properties slows down the increase in the number of geothermal doublets. Hence, it is often impossible to predict rock properties with sufficient accuracy to evaluate geothermal project performance and reduce uncertainties in quantifying the risks of induced seismicity and drilling. In this study, we aim at predicting rock thermal properties including thermal conductivity, and thermal diffusivity based on wireline logs. Ultrasonic techniques are increasingly being used in various fields such as mining, geotechnical, civil and underground engineering. As they are non-destructive and easy to apply, they are employed both in situ and in the laboratory to characterize the dynamic properties of rocks.
Many studies have shown that the thermal conductivity of a porous rock depends mainly on the mineralogical composition, porosity of the rock, presence of fluids filling the pores, and ambient temperature and pressure. Porosity and thermal conductivity play an important role in the transport properties of fluid-rock interactions and the characterization of building materials. To inspect the relation between acoustics and rock thermal properties, rock samples from three wells in the North sea have been studied. Our results confirm the correlation between thermal conductivity and P-wave. In addition to P-wave, the travel time of S-wave through these sandstone samples has been recorded. The major difference between P and S waves is that due to their wave movement, P waves travel through any kind of material, whether it is a solid, liquid or gas. On the other hand, S waves only move through solids and are stopped by liquids and gases. For this reason, S waves are sometimes referred to as shear waves because they are unable to alter the volume of the material that they pass through. This also accounts why fewer S waves are recorded than P waves. The difference between P and S-waves could be representative of total void space within rock. The increase in Vp-Vs means the volume of non-solid part of the rock increases that is why shear wave cannot propagate through the samples as good as P wave.

Participation

In-Person

References

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