Thermal Conductivity Measurements vs. Estimates: Why it Matters

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Abstract

The geothermal and the oil and gas industries both rely on thermal conductivity data. These data are used in geothermal reservoir temperature, production temperature, and reservoir lifespan models, which are vital to the success of geothermal ventures. This information is also used to calculate oil reservoir thermal histories and plan some secondary oil recovery methods. Estimated thermal conductivity values for each rock type are commonly used in the absence of site-specific measurements; however, using estimates can cause problems. Projects can and do fail due to a lack of accurate thermal conductivity data. Shallow formation thermal conductivities and temperature measurements are used to calculate local and regional heat flow for geothermal applications. Heat flow is then used along with deep formation thermal conductivities to calculate temperature at depth. Models have been created to simulate ten years of production from a geothermal reservoir using commonly reported thermal conductivity values as a baseline. The same models have been run using the maximum and the minimum measured thermal conductivity values for various rock types, yielding results indicating that power production could be as much as 8% higher or 15% lower than the baseline case. Limestone is an example of a sedimentary rock type with a large range of thermal conductivities. The thermal conductivity of limestone in many publications and online resources is usually stated as a range, from about 2.5 to 3.0 $Wm^{-1}K^{-1}$; however, our measurements using a divided bar and more than 160 limestone core samples from the Williston Basin yielded results ranging from a low of 1.0 to a high of 5.7 $Wm^{-1}K^{-1}$; a variation of more than a factor of five.