Imaging Fluid Flow in Geothermal Wells
Using Distributed Thermal Pertabation Sensing

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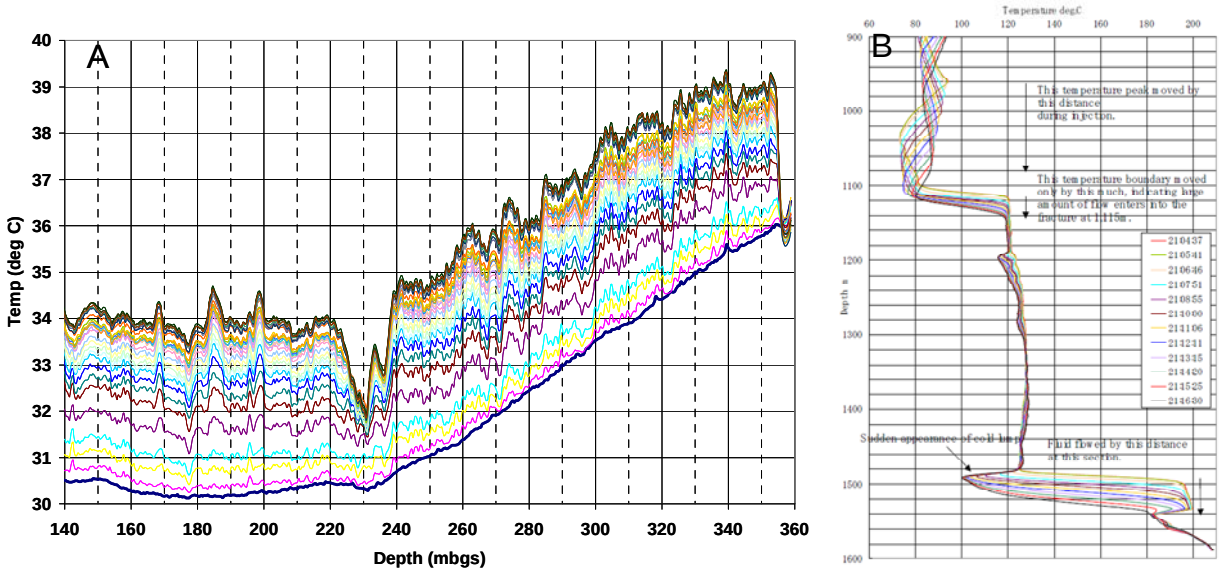
Berkeley Laboratory has developed a new flow imaging tool which we refer to as a Distributed Thermal Perturbation Sensor (DTPS), which consists of a fiber-optic DTS and a heat trace cable installed along the axis of a borehole. In addition to imaging flow locations within a borehole, careful analysis of data from static boreholes can be used to estimate basal heat flux and formation thermal conductivity (Freifeld et al., 2008, *Geophys. Res. Lett.* 35, L14309). To operate the DTPS, the sensor is lowered into the wellbore similar to a traditional wire line cable. A baseline temperature profile is subsequently recorded. Next, the heat trace cable is used to provide constant heating along the borehole and the thermal transient is recorded. DTS monitoring continues after heating concludes during the ensuing cool-down phase. Figure 1a shows data acquired from a wellbore in a fractured volcanic tuff formation and evidence for rapid fluid influx at 230 mbgs. Figure 1b shows thermal profiles (Ikeda, 2002, Twenty-Seventh Workshop on Geothermal Reservoir Engineering Stanford University, Stanford, California, January 28-30, SGP-TR-171) logged using a DTS in a geothermal borehole during a cool water injection. We are developing a high-temperature DTPS system for imaging fluid flow into and out of geothermal wells.



A. Data acquired from a fractured reservoir using a DTPS to image flow through a volcanic tuff. Flowing fractures at a depth of 230 mbgs and 236 mbgs appear as regions with smaller temperature increases. B. DTS data from Ikeda et al., 2002 showing the use of a water injection to perturb borehole temperature to characterize a geothermal wellbore.