Incorporating Distributed Temperature Sensing into the USGS Geophysical Toolbox: Case Studies Combining Mile-Long Thermometers and X-Ray Vision (with Astigmatism)

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Abstract:

Hydrogeophysics is an emerging research area which is driven by the potential for geophysical methods to characterize aquifer properties and monitor hydrologic processes over large areas and with spatial and temporal resolution not possible or practical using conventional hydrologic approaches. Over the last several decades, the USGS geophysical 'toolbox' has evolved and expanded and now includes various surface, borehole, and crosshole methods based on measurements of electrical, electromagnetic, seismic, gravity, and nuclear magnetic resonance signals; these techniques have diverse applications to a wide range of hydrologic problems. In recent years, the USGS and the broader hydrologic community have embraced fiber-optic distributed temperature sensing (DTS) as a promising technology for studies of groundwater/surface-water exchange. DTS can measure temperature along cables which are kilometers long, with meter-scale spatial resolution, precision of 0.1^{0}C, and cycle times on the order of minutes. As with all geophysical methods, DTS is most powerful when treated as one component of a larger, integrated investigation. This presentation covers several studies in which DTS was used in combination with other geophysical methods (e.g., boat-towed resistivity profiling) to identify zones of enhanced groundwater/surface-water exchange. Field sites include the Columbia River adjacent to the Hanford 300 Area in Washington State and Waquoit Bay in Massachusetts. This presentation also reviews the USGS Office of Groundwater, Branch of Geophysics program to provide DTS training, support, and equipment loans to Water Science Centers.