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Hydrogeological analysis using heat as a tracer in a variety of geological settings

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Temperature measurements in the Earth's subsurface over the past decades have been proved to be capable of providing invaluable insights into the workings of almost any type of hydrogeological system thinkable. Compared to other tracers for groundwater flow, sub-surface temperature distributions are relatively to measure in boreholes or by the installation of shallow thermometers, for example, underneath river- or sea-beds. The advective component of heat flow provided by groundwater movement will result in deviations from purely conductive conditions governed by the geothermal heat flux, and annual average surface temperatures. When the advective component can be deduced from the measured temperature field, groundwater flow rates can be estimated. This talk will present a series of the most striking examples of the use of heat as a tracer for hydrogeological processes in a variety of geological settings. These range from thermal spring systems to seepage dynamics across the sea bed, and from flow along shallow faults to the implications of surface warming for the hydrogeology of high-latitude areas covered by permafrost. Going from a continental scale to the scale of meters, it will become clear how powerful of a tracer temperature can be. However, it will also be shown what the challenges and limitations are of the use of temperature as a tracer for the analysis of hydrogeological systems.