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Inferring aquitard hydraulic conductivity using transient temperature-depth profiles impacted by ground surface warming

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Aquitard hydraulic properties are notoriously difficult to assess, yet accurate aquitard hydraulic conductivity estimates are critical to quantify recharge and discharge to and from semi-confined aquifer systems via hydraulic head gradients. Such flux quantification is required to evaluate the risks of aquifer exploitation by groundwater abstraction and aquifer vulnerability to surface contamination. In this study, we consider a regionally important aquitard and compare existing hydraulic conductivity estimates obtained through traditional methods to those inferred from long-term hydraulic head monitoring and thermally-derived vertical groundwater fluxes (0.04--0.25 m/y). We estimate the fluxes using numerical modeling to analyse the propagation of decadal climate signals into temperature-depth profiles and fitting the simulated and observed inflection point depths (minimum temperature). Results reveal that climate-disturbed temperature-depth profiles paired with multi-level head data can yield accurate vertical fluxes and aquitard hydraulic conductivities. This approach for characterizing groundwater systems and quantifying flows to and from sedimentary aquifers is more efficient but yields results that are comparable to conventional methods.