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Using thermal springs to quantify deep fluid flow and its thermal footprint in the Alps

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While several studies have shown that meteoric water can penetrate large parts of the crust and can strongly alter subsurface temperatures, the extent and thermal effects of deep fluid flow in mountain belts are still largely unknown. Here we present a newly compiled database of thermal springs in the Alps, which we use to quantify the extent of deep fluid flow and its thermal effects. The database contains temperature and discharge data for 500 springs and hydrochemistry and isotope data for 150 of the springs. We discuss the distribution of springs and the relation with tectonic and seismic activity of the Alps. We present a new heat and fluid flow model code and use this code to inversely model the depth of fluid conduits and faults that feed the springs. In addition, the model is used to quantify the thermal footprint of hot springs and the effects of fluid flow on low-temperature thermochronometers. The modelled maximum flow depth and temperatures are compared with independent estimates based on the chemical composition of spring water. The results provide one of the first large scale images of deep fluid and its thermal effects at the scale of an orogen.