Using clumped isotopes on hydrothermal carbonate sequences for assessing thermal water flow and fluid mixing

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Understanding the long-term temperature evolution of natural hydrothermal springs and artificial geothermal wells is helpful for assessing their economic potential. Natural fluid flow in hydrothermal systems is directly linked to fracture permeability that is depending on tectonic setting and tectonic activity. Timescales and impact of geologic changes in this context, however, are rarely known and fluid flow is furthermore be influenced by mineral formation within fractures (self-sealing effect) or in geothermal wells (scaling).

Studying three hydrothermal calcite sequences from Bad Nauheim, two from well pipes and one from an outflow area, shows clumped isotope temperatures between surface temperatures and minimum local reservoir temperatures. As an example, the temperature evolution in a 20th century well pipe shows within few years a permanent decrease from an initial maximum down to present-day temperatures. Inferred water $\delta^{18}O$ values indicate a strongly increasing fraction of meteoric water for the same time period, which is likely caused by mineralization in the hydrothermal flow path blocking and reducing this water fraction. This pilot study illustrates the potential to investigate flow fluid of geothermal system with hydrothermal calcites and may especially help to assess the temperature stability of natural hydrothermal outflows intended for geothermal heat use.