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Stable isotope investigation of the Geitafell (Iceland) hydrothermal system using spatially extensive sampling and microscale observations.

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The Geitafell central volcano formed between 6 and 5 million years ago within the rift zone in central Iceland. The temperature gradient around a central gabbroic intrusion drove meteoric water circulation in an ancient geothermal system that is now well exposed by erosion, enabling sampling that is not possible in active geothermal systems. The origin of Geitafell hydrothermal fluid is constrained to $\delta^{18}O_{water} = -8 \pm 1‰$ and $\delta D_{water} = -60 \pm 10‰$ based on previous measurement of hydrothermal epidote in which $\delta^{18}O$ values range from -1.8 ‰ to -5.5 ‰ and δD values range from -106‰ to -79‰. The well constrained fluid sources enable us to trace water-rock reaction quantitively from the samples collected over an extensive area around the contact and the host rocks beyond, ranges up to 4000 meters away. The new δD values of bulk altered basalts from different mineral alteration zones around the gabbro intrusion range from -106 ‰ to -97 ‰. In addition, we focus on quartz and epidote $\delta^{18}O$-$\Delta^{17}O$ measurements from Geitafell. From quartz measurements, we estimate $\delta^{18}O$ of equilibrium fluids ranging from -9‰ to -3‰, while epidote $\delta^{18}O$-$\Delta^{17}O$ values align directly with a meteoric water value of $-8 \pm 1‰$ and +0.03‰. Compared to epidote, quartz $\Delta^{17}O$ is more scattered, apparently because some of it forms at lower temperature than epidote that leads to larger O-isotope fractionation. Furthermore, we conducted cathodoluminescence (CL) imaging of quartz specimens extracted from both vein formations and vesicle-filling aggregates. The CL images show crystals are generally euhedral in shape and grow with c-axes pointing inward to the vein centers. Some crystals display turbid growth zoning, oscillatory growth zoning and truncation of concentric growth zoning. The CL-mottled crystals of quartz and overgrowth of chalcedony surrounding some grains of euhedral quartz is also observed. Combination of triple O-isotope data and microscale observations of quartz veins from a low-$\delta^{18}O$ hydrothermal system allows to place further constraints on the progress of water-rock exchange and fluid temperature around the intrusive contact.