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Using low-temperature thermochronology and numerical models to quantify the history of hydrothermal activity in Beowawe, Nevada

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The history of hydrothermal systems and hot springs is difficult to quantify because hydrothermal mineral deposits are often difficult to date at sufficient resolution. Quantifying hydrothermal activity is important for gaining insights on how geological processes such as earth quakes and faulting mechanisms interact with fluid flow. Here we combine high-density apatite (U-Th)/He data with numerical models of heat flow to determine the history of an active hydrothermal system. We determined Apatite-Helium (AHe) ages of surface rock samples collected around a hydrothermally active normal fault in Beowawe (Nevada,USA). AHe ages in the vicinity of the hot springs along the fault showed significant thermal overprint. Samples located at a distance of ∼50m were unaffected by hydrothermal activity and showed AHe ages that were equal to the U-Pb age of the volcanic host rock of 15.2 M.y. The observed thermal overprint is caused by high temperatures (∼95 C) of the hydrothermal fluids along the Malpais fault that have heated the adjacent rocks over long timescales. The size of the thermally affected area depends on the duration of hydrothermal activity; the longer the system is active the larger the thermal aureole around the fault. We used a numerical model of advective and conductive heat flow to calibrate the duration of hydrothermal activity using the AHe data. Combining low-temperature thermochronology with a thermal model can therefore be used as a tool to quantify hydrothermal activity over geological time scales.