Neon diffusion in Durango fluorapatite

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We report on neon diffusion in Durango fluorapatite, which was one of the first age standards used to quantify diffusivity of helium in apatite. Thermochronometric time-temperature models require knowledge of temperature-sensitive diffusivities, which can be calculated from laboratory step-heating experiments.

Unlike the helium in apatite system, the neon in apatite system exhibits complex behavior that appears sensitive to the high temperatures necessary to extract measurable neon on the timescale of hours in the laboratory. We show characteristic Arrhenius plots from high temperature experiments (up to 1100 °C) and discuss the patterns observed, including slowly but continuously dropping diffusivities during isothermal and retrograde heating experiments. We interpret these effects as evidence of crystallographic changes in apatite at high temperature, and show evidence for this assertion from previous studies of volatile loss in apatite.

In an effort to work around this problem and to interrogate the temperature range of interest for neon diffusion over geologic timescales, we present the results of diffusion experiments designed to circumvent these problems. We present a preliminary closure temperature in the range of 250-300°C for the neon in apatite system, and discuss potential techniques for further refining this diffusion model along with the geologic applications of the neon in apatite system and the (U-Th)/Ne thermochronometer in other uranium- and thorium-bearing mineral systems.