Oxygen Isotope Measurements of Albite-Quartz-Zeolite Mineral Assemblages, Hokonui Hills, Southland, New Zealand

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Abstract: The oxygen isotopes of albite, quartz, and zeolites from the Hokonui Hills, New Zealand, constrain crystallization temperatures and the type of pore fluids present during diagenesis. A section of altered vitric tuffs in this region contains an extremely sharp reaction boundary between a heulandite-chlorite assemblage containing fresh detrital plagioclase and a laumontite-albite-quartz assemblage. A laumontite vein follows the local joint pattern and forms the reaction boundary, suggesting that laumontitization occurred as a result of fracturing and increased fluid flow during uplift. The albite ($\delta^{18}O$ = + 15.0)-quartz ($\delta^{18}O$ = + 19.9 to + 20.5) geothermometer constrains the temperature of alteration between 145 ° and 170 ° C with a pore water $\delta^{18}O$ of + 1.8 to + 3.5. The tuff was buried to an estimated maximum temperature of about 225 ° C, indicating that alteration occurred after maximum burial.

Framework oxygen was extracted from zeolites by reaction with ClF_3 after the zeolites were thermally dehydrated in a vacuum. Laumontite was dehydrated at 300 ° C, and stilbite at 150 ° C. The precision of the method is typically about ± 0.45‰. Fractionation curves for dehydrated zeolites are based on a general expression from the literature for feldspars, which depends only on the Si/Al ratio of the mineral. Measured $\delta^{18}O$ values for laumontite in the groundmass of the altered tuff were + 14.4‰. The laumontite-quartz pair constrains the temperature to between 139 ° and 162 ° C, in excellent agreement with the albite-quartz pair, and supporting the petrographic observation of co-crystallizing albite-laumontite.

Oxygen isotope values for fracture-filling laumontite in the vitric tuff, as well as those for groundmass and vein laumontite from other parts of the stratigraphic section, cluster around + 14.5, suggesting that laumontite probably crystallized under similar conditions throughout much of the section. Oxygen isotope values for stilbite veins from various parts of the section indicate that this mineral crystallized at lower temperatures than the laumontite, for a given fluid isotopic composition, in agreement with the observed cross-cutting of laumontite by stilbite.

Key Words: Albite • Diagenesis • Formation temperature • Heulandite • Laumontite • Oxygen isotopes • Quartz • Stilbite • Zeolites

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