

COUPLED PLAGIOCLASE EXCHANGE REACTIONS IN A NATURAL HYDROTHERMAL SYSTEM. P. B. Larson¹, ¹Department of Geology, Washington State University, P.O. Box 642812, Pullman, WA 99164-2812, USA <plarson@wsu.edu>

Stable isotope, electron microprobe, and, X-ray diffraction studies of plagioclase reaction products in the Rico hydrothermal system, Colorado, show that every ion in the plagioclase structure can exchange or move during alteration. However, the mineral structures are preserved during this ion exchange. Surficial dissolution-reprecipitation does not appear to provide a reasonable reaction mechanism. At Rico, a young (<5 Ma) hydrothermal system has pervasively altered rocks for up to 8 kilometers from the system's center. Reaction-rim textures in the distal parts of the system suggest that plagioclase reaction there was "trapped" in progress. Comparisons among these samples and those in which reaction is complete provide a plagioclase reaction model.

Studies have focused on minerals in a 65 Ma hornblende latite porphyry, which is widespread as dikes and sills in the Rico area, and which provided a homogeneous reactant to the hydrothermal fluid. Initial, magmatic, plagioclase phenocrysts in the latite had compositions in the range An(30-40). Primary crystals exhibit oscillatory zoning. Product plagioclase is nearly pure unzoned albite, An(<1). X-ray diffraction studies of Al-Si ordering (131 method) show that these ions are highly ordered in the product albite tetrahedral sites, but are poorly ordered in the magmatic plagioclase. Oxygen isotope ratios of the fresh plagioclase are near 9 per mil, but altered plagioclase ratios are as low as -4 per mil. Thus, all ions in the plagioclase can move during alteration: Na, Ca, and K are exchangeable and the An number of the plagioclase becomes altered; the Al and Si become ordered in the plagioclase tetrahedral sites; and the O isotope ratios change as the feldspar exchanges oxygen with the hydrothermal fluid.

Petrographic observations show that the plagioclase alteration proceeds along a front that moves inward from grain boundaries and fracture and cleavage surfaces. Albite twin planes cross undisturbed from unaltered grain cores to altered rims in partially

reacted phenocrysts. The crystal outlines do not change size or shape during alteration. These data suggest that the reaction occurs without altering the silicate frame structure of the feldspar. The frame structure is undisturbed as Ca, Na, and K are exchanged, as the Al and Si become ordered, and as the O is exchanged. The reaction rim most likely shields the reaction front from external fluids. This, and the persistence of the feldspar structure across the reaction front, suggest that dissolution-reprecipitation (D-R) is not a viable reaction mechanism. Diffusion through structural defects in the reaction rim probably transports ions to and removes ions from the reaction front. This reaction mechanism is probably common to many hydrothermal systems, and fluid-rock exchange models that invoke a D-R kinetic exchange mechanism are probably not valid for most plagioclase reactions.