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Estimation of the dissolution rates of andesitic glass, plagioclase and pyroxene in a flank aquifer of Poás Volcano, Costa Rica

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Abstract

The dissolution rates of andesitic glass, plagioclase and pyroxene have been calculated for andesitic lava and volcanoclastic material present in a flank aquifer receiving inputs of highly acidic brine from the summit hydrothermal system of Poás Volcano, Costa Rica. Bulk release rates for Na, Ca, Mg and Al along the flow path were calculated by use of solute compositions of acid-chloride-sulfate spring waters located in the Rio Agrio watershed on the NW flank of the volcano, tritium-based residence times and geometric estimates of the reactive surface areas of aquifer rocks. Petrographic data on the composition of interstitial glass and major-mineral phases were used in the mass-balance model NETPATH to calculate individual contributions of glass, plagioclase and pyroxene to the observed mass transfers of Na, K, Ca, Mg, Fe, Al and Si. By assuming that no secondary Al phases were precipitated along the flow path, and assuming a plagioclase composition close to An₃₈, we calculate that solution chemistry of the acid-chloride-sulfate waters of the Rio Agrio watershed is due to dissolution of approximately equal amounts of glass and plagioclase, with most of the Mg and Fe coming from pyroxene dissolution. Calculated rates are typically within one order of magnitude of experimentally-derived rates measured at similar pH and temperatures. In addition, the relative order of mineral reactivity was similar between field- and laboratory-based estimates: pyroxene > plag ≥ andesitic glass. The good agreement between the field- and laboratory-based estimates is attributed to the interaction of relatively fresh andesite and volcano-clastic material with low-pH fluids of the NW flank aquifer. The largest uncertainty in our calculation is estimation of reactive mineral surface area.

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