

Temperature-dependent reaction kinetics in volcanic hydrothermal systems: analogue reaction experiments

*Jamie Ian Farquharson¹, Takumi Imura², Kyoko S Kataoka¹

1. Niigata University, 2. Yamagata University

Adataro volcano in Fukushima Prefecture is home to multiple complex hydrothermal processes, broadly divided across four alteration zones. Operative reactive processes include pyrite alteration, the formation of clays, silica redistribution, and precipitation of sulfates and other minerals. Intriguingly, evidence for low-temperature hydrothermal alteration is found in direct contact with zones of extreme high-temperature alteration, highlighting that the reaction conditions (pressure-temperature-composition: PTX) are highly spatially and temporally variable. Through a series of reactive experiments at different temperatures (20–80 °C), we characterise the evolution of rock physical properties as a function of alteration in the laboratory. Specifically, we quantify changes in mass, porosity, and permeability of nominally pristine andesite samples as they are progressively altered by exposure to sulfuric acid from between 24 and 2880 hours. In addition, we quantify the change in rock colour (i.e. bleaching) observable as plagioclase is subject to pseudomorphic replacement by amorphous silica and lighter-coloured clay minerals are formed. This approach could prove useful for characterising alteration in the field, where precise analytical techniques may be impractical. In concert with extensive geochemical characterisation, field surveying, and reactive modelling, these experiments form part of a larger effort to understand the nature of the hydrothermal system at Adatarayama.

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