Water distribution profile in a weathered rhyolitic glass as measured by IR microspectroscopy

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It is widely known that alteration of volcanic glass proceeds during weathering. The altered glass has a higher refractive index compared with the unaltered glass and therefore can be recognized at the rim of the glass under an optical microscope. Taniguchi (1980) measured the thicknesses of altered glass layer for 18 rhyolites from Kozushima Island and estimated the growth rate of the altered layer. This altered layer has been considered to be the hydrated glass. The present study aims to investigate the mechanism and rate of water transport inside the Kozushima rhyolitic glass during weathering by means of IR microspectroscopy.

A doubly polished thin section of Ohsawa rhyolite from Kozushima was prepared. This rhyolite underwent weathering for 26,000 years (Yokoyama et al., 2004). IR spectral line profile analysis with 10x60 um aperture was conducted with 1 um step for a length of 100 um on the section of glass having ˜15 um of altered layer from the glass surface to the interior.

The concentrations of total water (H2O molecule + OH species) and molecular H2O were determined from the peak heights at 3550 cm-1 and 1630 cm-1, respectively. The concentrations of H2O and OH did not decrease within the altered glass (depth 0-15 um) and the maximum total water content was 0.8 wt%. In deeper side of the altered glass, the H2O concentration decreased with depth and became constant at depth ˜90 um, while the OH concentration was roughly constant. These results indicate that the hydrated region where the H2O concentration decreases extends beyond the first altered glass layer. Since the OH concentration was constant in the hydrated region, this hydration can be preceded by H2O diffusion. Based on the concentration profile of molecular H2O, the diffusion coefficient of H2O was estimated to be ˜10E-10 um2/s. This value is significantly larger than the H2O diffusivity at 20 degree C (˜10E-13 um2/s) extrapolated from the reported H2O diffusivity data determined above 400 degree C, indicating very fast H2O diffusion during glass weathering. These results suggest the needs for reevaluating water diffusion and hydration mechanisms for glass weathering.