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Evidence for post-depositional diffusional loss of hydrogen in quartz phenocryst fragments within ignimbrites

Tamás Biró[1], István János Kovács[2,*], Dávid Karátson[1], Roland Stalder[3], Edit Király[2], György Falus[2], Tamás Fancsik[2], and Judit K. Sándorné[4]

[1]Eötvös University, Institute of Geography and Earth Sciences, Department of Physical Geography, Pázmány Péter sétány 1/C, H-1117, Budapest, Hungary
[2]Geological and Geophysical Institute of Hungary, Geochemical and Laboratory Department, Stefánia út 14, H-1143, Budapest, Hungary
[3]University of Innsbruck, Institute of Mineralogy and Petrography, Innrain 52f, 6020, Innsbruck, Austria
[4]Hungarian Institute for Forensic Sciences, Mosonyi u. 9, H-1087, Budapest, Hungary

Abstract

Ignimbrite-hosted quartz phenocryst fragments contain much lower hydroxyl defect concentration than quartz in igneous rocks. Pre-eruptive and post-depositional loss of hydrogen were hypothesized as the main processes for lowering the initial magmatic concentrations of hydroxyl defects. The aim of this study was to examine the hydroxyl defect concentration of quartz phenocryst fragments from various vertical positions above the base of pyroclastic density current (PDC) deposits. It aims to record the vertical variations of hydroxyl defect concentrations to have an insight into potential post-depositional hydrogen loss of PDC deposits. Ignimbrite-hosted quartz phenocryst fragments were examined from two different ignimbrites in the Bükk Foreland Volcanic Area (North Hungary). Unpolarized micro-FTIR measurements on 23–35 unoriented crystal fragments from each sample were performed representing four different vertical positions of each site. Present results imply that hydroxyl defect concentrations show a pronounced decrease upward from the base of the deposits. The initial ~12 ppm hydroxyl defect concentration decreases to <3 ppm within <10 m from the base. Ignimbrites with contrasting degree of welding are characterized by different hydroxyl defect concentrations of quartz phenocryst fragments at the same height above the base. Thus, post-depositional dehydration is supposed to be the main factor causing the observed vertical decreasing trend. The modeling of post-depositional dehydration by considering typical ignimbrite emplacement temperatures (300–700 °C) and thicknesses (20–50 m) revealed that neither different cooling rates or different crystal diameters could cause the observed decrease in hydroxyl defect concentrations in ignimbrites. Other factors, such as contrasting pre-depositional thermal history, presence of melt- and fluid inclusion, and crack density of crystals could also play an important role in affecting the final hydroxyl defect concentrations.

Keywords: Quartz, FTIR spectrometry, water, ignimbrites, diffusion