Juvenile glass fragments in phreatic explosion debris from Turrialba Volcano, Costa Rica

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After several years of increasing fumarolic activity, Turrialba volcano experienced small phreatic explosions on January 5-6, 2010, leaving a 55x20 m crater with an incandescent floor. Ash and lapilli from the explosions consists mostly of crystal-rich and altered material originally erupted in 1864-1866 and earlier. Nevertheless, careful examination of the tephra revealed that ~1% of the medium to coarse ash-sized particles consists of fresh glass. The freshness of the glass and its unusual chemical traits suggest that this glass is juvenile. EMP analysis of the glass fragments showed them to be calcalkaline andesites, whose major element compositions were largely consistent with derevation by low-P crystal fractionation of basaltic parental magmas. Na$_2$O, however, is depleted in most glass fragments (1.1-2.8 wt. %) compared to Turrialba's basaltic lavas (2.8-3.8). Incompatible trace element compositions determined by LA-ICPMS are broadly similar to those of the 1864-1866 basalts. REE element patterns are strongly light enriched and most fragments have the elevated Ba/Ce and La/Nb ratios (8-16 and 1.8-2.2 respectively, which is commonplace for calcalkaline lavas. However, one fragment had Ba/Ce and La/Nb ratios (5 and 1.1) more typical of an ocean island basalt, but was otherwise similar in composition to the other fragments.

The concentrations of S in all fragments were near the EMP detection limit, and Cl in most samples were also unusually low for a Turrialba basalt. The concentrations of F, however, were highly variable, ranging from 0.03 to 0.6 wt. %. High F was associated lower concentrations of Na, REE and HFS elements. We speculate the F was enriched by interaction with high-T fumarolic gasses which also leached highly-charged cations and Na.

Important findings are: (1) phreatic explosion debris can contain juvenile glass fragments that provide compositional information about the magma triggering the unrest; (2) magmas intruding into Turrialba's upper edifice at present are basalts or basaltic andesites with varying La/Nb; and (3) gas streaming can affect compositions of apparently fresh glass, particularly Na concentrations.

Glass composition impact on water reactivity at the glass surface

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Understanding the interactions of water with glass surface is of great interest to improve glass alteration models. In this study, the impacts of soda-lime borosilicate glass composition [1] and particularly the effect of network formers such Si and Zr, and of charge compensators such Ca and Na, on water penetration and water structure at the first time of alteration were investigated. Two surface characterizations were used: X-ray reflectometry to determine the thickness and density of the modified glass zone and attenuated total reflection infrared spectroscopy to precise the predominant alteration mechanisms (water diffusion through glass network or hydrolisis) resolving the O-H streching band into four components corresponding to different types of water in glass (hydroxilic group, free, newtwork and ion bounded water). The results of glass alteration at pH=3 and 30°C have shown that hydrolisis was the predominant mechanism after few seconds for glass having a low ZrO$_2$/SiO$_2$ ratio. This phenomenon can be explained by the high amount of NBO content. For the other glasses, the diffusion was the limiting reaction characterized by a modified zone having a density close to the hydrated glass and a high amount of free water. The calculated water diffusion coefficients hilighted a decrease of the water diffusion with an increase of Ca content in glass probably due to the compaction of the network by incorporation of divalent cations [2].

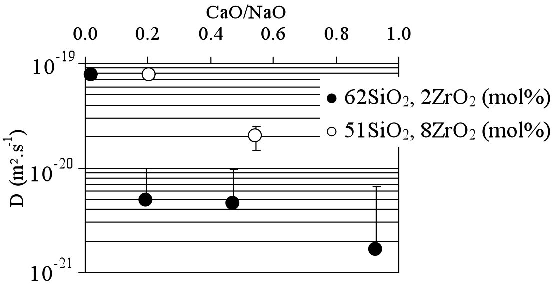

Figure 1: Diffusion coefficients of water through the glasses at pH=3 and 30°C calculated from the first Fick law.

[1] Angéli *et al.* (2010*) J. Am. Ceram. Soc.* **93**, 2693–2704.
[2] Indris *et al.* (2005) *Phys. Rev. B* **71**, 064205.