Crystal-rich basaltic andesites of the current Arenal eruption in light of experiments with crystal-poor basalt

F. PARAT[1,2]*, M.J. STRECK[3], F. HOLTZ[4] AND R. ALMEEV[4]

[1]Géosciences Montpellier, Univ. Montpellier, France (*correspondence: Fleurice.Parat@gm.univ-montp2.fr)
[2]Mineralogie-Geochemie, Univ. Freiburg, Germany
[3]Department of Geology, Portland State Univ., Portland, OR 97207, USA (streckm@pdx.edu)
[4]Institute of Mineralogy, Univ Hannover, Germany (f.holtz@mineralogie.uni-hannover.de)

Arenal volcano is nearly unique with its 43 year long continuous activity erupting remarkably monotonous basaltic andesites but mineral zoning records indicate complex open-system processes including the episodic injections of basalt. The condition of the mafic input as well as the evolution to the currently erupting basaltic andesite were addressed by an experimental study on a phenocryst-poor (~3%) Arenal-type basalt (50.5 wt% SiO_2) from a nearby scoria cone containing olivine (ol, Fo_{92}), plagioclase (pl, An_{86}), clinopyroxene (cpx, mg#=82) and magnetite (mag, X_{ulvo}=0.13).

Our experiments (200 MPa, 900-1050°C, oxidizing and fluid-saturated conditions with various water activities, XH_2O_{fluid}=0.3 to 1) produced at 1050°C and water-saturated conditions (H_2O_{melt}=5 wt%), only magnetite, whereas mag+cpx+ol crystallized at low water activity. Plagioclase and cpx crystallized at water-saturated conditions with olivine at 1000°C and with amphibole at 950-900°C, whereas they crystallized with opx at low water activity (for T=1000-900°C). The mineral assemblage as well as the mineral compositions of the natural basalt were reproduced at 1000°C with basaltic andesitic melt (55 wt% SiO_2) with 5 wt% H_2O.

Our results can be used to substantiate previously envisioned crystallization environments beneath Arenal. Basaltic magma inputs are water-rich at relatively high pressure and high temperature. Evolution to more evolved magmas would have happened under fluid-saturated conditions but variably water activities. A decrease of water activity (degassing?) induces the change of the mineral assemblage pl+ol+cpx to pl+cpx+opx observed in basalt (e.g. ET3-1) to andesitic tephras (e.g. Ar7/68). On the other hand, the lack of opx and the presence of amphibole also in basaltic andesitic tephra units of earlier eruptive phases (e.g. ET3-2) indicate water-saturated conditions at temperature lower than 950°C. Continuous degassing may contribute to persistent small-scale explosive activity - so characteristic for the current eruption-, likely prevailed during crystallization of the water-rich magmas at Arenal. Mixing of magma batches (with subtle but distinct compositional and mineralogical differences) plus the occasional process of concentrating mineral contents by melt expulsion will do the rest to make crystal-rich basaltic andesites of the current eruption.

Iron reduction by a *Clostridia* consortium

MADHAVI PARIKH, CHU-CHING LIN, TAMAR BARKAY AND NATHAN YEE*

School of Environmental and Biological Sciences, Rutgers University, New Brunswick, NJ, USA (*correspondence: nyee@envsci.rutgers.edu)

Background

One of the major pathways of inorganic contaminant (e.g. Cr, Hg, Pu and U) transformation in Earth's critical zone is through redox reactions with Fe (II). Reactive Fe (II)-bearing minerals are known to form during microbial respiration of ferrihydrite. However, the common crystalline iron oxide phases in the critical zone are notoriously recalcitrant towards microbial reduction. Here we report the cultivation of a microbial consortium, enriched from subsurface sediments, that rapidly reduces crystalline goethite (α-FeOOH) and hematite (Fe_3O_2), and produces highly reactive Fe (II)-bearing particles.

Materials and Methods

A sediment core collected from the United States Department of Energy Field Research Center (FRC) in Oak Ridge Tennessee was used as inoculum for anaerobic enrichment cultures. The media were initially amended with acetate and citrate as the electron donors, and active cultures were eventually tranferred to media containing fumarate as the carbon source. After a purified consortium was obtained, the genomic DNA was extracted and DGGE analysis was performed to determine the microbial community composition. Iron reduction experiments were conducted to evaluate the ability of this consortium to reduce goethite and hematite when provided with alternate electron donors. Periodically, samples were collected and the mineral transformation products were analyzed using powder X-ray diffraction (XRD).

Results and Discussion

Enrichment cultures Oak Ridge FRC resulted in the cultivation of a microbial consortium that exhibited robust iron reducing activity. This consortium consisted of two strictly anaerobic spore-forming microorganisms. 16S rRNA gene sequences indicated that both organisms belong to the class *Clostridia* in the *Firmicutes* phylum. When given peptone, the consortium was able to reduce goethite and hematite at rates an order of magnitude faster than any pure culture reported to date. The biogenic ferrous iron produced by this consortium was largely retained in the solid phase. The Fe (II) precipitates exhibited distinct coloration and were highly reactive towards oxygen. Notably, these secondary ferrous iron phases were not detectable by XRD, suggesting that the Fe (II)-bearing solids were amorphous.