Documenting magmatic processes at Filicudi Island, Aeolian Arc, Italy: integrating plagioclase textural and in situ compositional data

Michelle Harris[1*], Wendy Bohrson[2]

[1]Central Washington University, Ellensburg, USA
harrism@geology.cwu.edu (* presenting author)
[2]Central Washington University, Ellensburg, USA
bohrson@geology.cwu.edu

Documenting the physiochemical processes that influence magma composition is critical for forecasting eruption style and managing volcanic hazards. Although studies have documented how compositional diversity develops in magmas on Earth, controversy exists regarding the roles that recharge, assimilation and fractional crystallization (RAFC) play in magma evolution. Studies of Filicudi Island, Italy, document a compositional range from calc-alkaline basalt (51 wt. % SiO_2) to high-K andesite (62 wt. % SiO_2) that cannot be simply related by FC, implying magma recharge and crustal contamination/assimilation played vital roles. Integration of plagioclase textural and in situ compositional data allows documentation of the quantitative roles and chronology of RAFC.

Filicudi Island is one of seven major islands of the Aeolian archipelago in the southern Tyrrhenian Sea, Italy. Stratigraphic studies define four main cycles of activity that range in age from 1.02 to 0.04 Ma (*1*). Cycles are characterized by a succession of plagioclase bearing magmas that show recurrent reversals to more MgO-rich magmas, a lack of systematic correlation between SiO_2 and MgO, and an overall SiO_2 increase with time, implying recharge, assimilation, and fractional crystallization took place. Images obtained from Nomarski Differential Interference Contrast and Back-Scattered Electron methods document five main texture types within seven samples that span the compositional range of Cycle Three, the most widely exposed cycle. Identified textural types include monotonous, complex oscillatory, sieved cores with oscillatory rims, oscillatory cores with sieved rims, and sieved cores and rims.

Detailed core-to-rim traverses of crystals of each textural type using Electron Microprobe analysis document mostly core-to-rim decreases in Anorthite content, although a few significant core-to-rim increases do occur. Similarly, incompatible trace elements generally show increases from core-to-rim with decreasing Anorthite content, or more complex trends, providing evidence that (A)FC processes played a dominant role. Conversely, core-to-rim increases in Anorthite content with associated Fe and Mg increases provide strong evidence that at least one recharge event occurred within the associated magma body. LA-MC-ICPMS analyses will be performed on selected crystals that encompass the range of Anorthite, trace element and textural types to document core-to-rim changes in $^{87}Sr/^{86}Sr$. Isotopic data will further characterize the RAFC history of these magmas as well as will complete a data set that can be quantitatively modeled to provide thermal and mass constraints on this phase of magmatic activity at Filicudi Island.

1. A. P. Santo, Volcanological and geochemical evolution of Filicudi (Aeolian Islands, south Tyrrhenian Sea, Italy). *Journal of Volcanology and Geothermal Research* **96**, 79 (2000).

Reactive transport modeling of CO_2 sequestration in mine tailings

ANNA L. HARRISON[1*], IAN M. POWER[1], SIOBHAN A. WILSON[2], GREGORY M. DIPPLE[1], K. ULRICH MAYER[1], AND SERGIO A. BEA[3]

[1]University of British Columbia, Vancouver, Canada, aharriso@eos.ubc.ca (* presenting author), ipower@eos.ubc.ca, gdipple@eos.ubc.ca, umayer@eso.ubc.ca
[2]Monash University, Clayton, Australia, sasha.wilson@monash.edu
[3]Lawrence Berkeley National Laboratory, Berkeley, United States of America, sabea@lbl.gov

Mineralization of atmospheric CO_2 within carbonate minerals occurs passively in ultramafic mine tailings via weathering of Mg-silicates and hydroxides [1]. If this process were accelerated, large mines may have the capacity to sequester millions of tonnes of CO_2 annually. Supplying elevated partial pressures of CO_2 (pCO_2) into tailings may accelerate CO_2 sequestration by increasing dissolved inorganic carbon and enhancing mineral dissolution. Passive carbon mineralization has been documented at the Mount Keith Nickel Mine (MKM) in Western Australia [2]. MKM produces tailings consisting primarily of Mg-silicate minerals. Brucite [$Mg(OH)_2$] is present at lower abundance [2], yet is more rapidly carbonated, thus was practical for experiments and modeling.

Gas streams with elevated pCO_2 have been used to enhance brucite carbonation rates in zero-dimensional batch experiments. In tailings, however, multi-dimensional flow means that interactions between transport and chemical reactions will play a role in governing carbonation rates. To investigate carbonation efficiency in tailings under elevated pCO_2 conditions, brucite columns were supplied with 10 vol.% CO_2. Quantitative mineralogical analyses of solids indicate the extent of carbonation declined with distance from the injected CO_2.

Two modeling studies have been undertaken using the reactive transport code, MIN3P [3], to calibrate the model and to elucidate the processes likely to govern the rate and extent of carbonation in tailings. Modeling of column experiments indicated a strong advective gradient in the gas phase was developed due to CO_2 injection, thereby enhancing vertical CO_2 transport. A second modeling study was undertaken in which passive carbonation in an active tailings storage facility at MKM was modeled and calibrated with field data to complement previous work simulating an inactive facility at this mine [4]. The active facility is periodically replenished with slurries of fresh tailings, resulting in lateral flow in addition to the evaporative driven vertical flow occurring in the inactive facility. This more complex flow regime may affect both reactive cation transport and the ingress of atmospheric CO_2, thereby altering the extent of carbonation.

These studies permitted the development of a comprehensive model that describes both passive and accelerated CO_2 sequestration in tailings. Our calibrated model will enable assessment of sequestration potential and help guide implementation of accelerated sequestration strategies at mine sites.

[1] Wilson et al (2009) *Econ. Geol.* **104**, 95-112. [2] Wilson (2009), PhD thesis, UBC. [3] Molins and Mayer (2007) *Water Resour. Res.* **43**, W05435. [4] Bea et al (*in press*) *Vadose Zone J.*