

1. Research activity (max 1.000 words)

Research objectives:

General objective

Determination of the dynamics of crystallization of anhydrous and hydrous alkaline primitive magmas at deep crustal levels through the experimental calibration of clinopyroxene (Cpx) growth and dissolution kinetics.

Specific objectives

Experimental study of the system Cpx-melt in a natural alkaline basaltic composition from the Phlegrean Volcanic District (PVD) at deep crustal levels (crustal-mantle boundary; ~ 800 MPa).

In particular, I will work on:

1. the determination of growth and dissolution rates of Cpx through isobaric experiments at variable temperature, volatile content and time on a natural alkaline basaltic composition;
2. the determination of the Cpx-melt partition coefficients of trace elements at high pressure, variable time and H₂O conditions, through the analysis of trace elements distribution between Cpx and coexisting melt in longer and shorter, anhydrous and hydrous experiments.

Implications and applications

This project will allow to improve the understanding on the dynamics of the PVD feeding system, which is among the most dangerous volcanic systems in the world. The kinetics of Cpx crystallization and dissolution obtained from this experimental study at high pressure will be used to constrain the resident and ascent times of primitive magmas from deep levels to the surface. This information along with the localization of earthquake swarms is of paramount significance in order to limit the risk of both effusive and hydromagmatic eruptions that have characterized the recent eruptive history of the PVD. Although these are predicted to be low-magnitude eruptions, however,

they might have dramatic effects in such a densely inhabited area as Campi Flegrei is. Results obtained from this project will be also applied for the calibration of geothermobarometers, geospeedometers and also geohygrometers based on clinopyroxene composition.

Work plan and expected results

To achieve the specific objectives of my project as starting material will be used the most primitive basaltic composition of the PVD that occurs as lithic lava clasts in the deposit of the Solchiaro hydromagmatic center of Procida island (APR16; D'Antonio et al., 1999). High pressure (800 MPa) experiments will be performed by using the piston cylinder (PC) apparatus available at the HP-HT laboratory of the Earth Science Department (Sapienza University of Rome) and the 230 ton Paris-Edinburgh press (PEP) at 16-BM-B beamline of High Pressure Collaborative Access Team (HPCAT), at the Advanced Photon Source (Argonne National Lab, Chicago) during the first two years of my PhD. Crystallization and dissolution conditions will be simulated in laboratory through a series of equilibria and crystal-glass melting experiments conducted on the APR16 at anhydrous and hydrous (2-4 wt.% H₂O) conditions, temperatures between 1050°C and 1300°C and dwell time of 0.25, 3, 6 and 9 hours; these operative conditions have been chosen on the basis of previous preliminary experiments on APR16 (Bonechi et al., 2017). Experiments with the PC are quite straightforward as I am well trained since my bachelor and master degree works. These experiments will require time to prepare the cell assemblies, the starting materials and in particular the seeds because Cpx breaks easily along its cleavages. A set of crystallization and dissolution experiments will be performed by using in situ X-ray diffraction combined with high-resolution radiography at the PEP prior submission and peer-review of a beamtime proposal. By collecting X-ray diffraction patterns over time, along with radiography images, I will obtain: the cell parameters of the crystallized clinopyroxene, its volume and density at a given P and T that will be used to constrain the density of the residual melt, the glass-liquid transition temperature of PVD-like magma, its viscosity, the melt structure and nucleation/crystallization/dissolution rate of the liquidus phase (Cpx) as function of time. The most relevant aspect of these kind of experiments is the possibility to do in situ observation of the crystallization and dissolution processes, observing in real time the ongoing experiments and the exsolution of volatile at high pressure, thanks to a high resolution camera installed in the station. The textural and chemical variations of Cpx and coexisting glasses of the run-products will be respectively analyzed by SEM and EMPA, available at the Earth Science

Department (Sapienza University of Rome) and at CNR-IGAG (Rome). Moreover, SEM images will be used to estimate the Cpx growth/dissolution rate and to evaluate the Cpx-CSD of crystallization experiments. Starting from the second year of my doctorate, the CSD model will be developed during my stay at the Fribourg Universität (Germany) under the supervision of professor D. Dolejš; furthermore, in order to determine the partition coefficients between Cpx and melt, trace and rare elements will be analyzed by using the Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS). I will have the opportunity to use this analytical technique both at Mass Spectroscopy Laboratory at Charles University, Prague in collaboration with dr. A. Fabbri and at Bayerisches Geoinstitut, University of Bayreuth, Germany. Finally, in collaboration with dr. T. Ubide (University of Queensland) I will realize element mapping by using an optimization of LA-ICP-MS mapping as a tool for visualizing and quantifying internal structure of trace element concentration in igneous minerals.

2. Research products

a) Publications (ISI journals)

- Bonechi B., Perinelli C., Gaeta M., Tecchiato V., Granati S. F., (2017). *Experimental constraints on amphibole stability in primitive alkaline and calc-alkaline magmas*. Periodico di Mineralogia, 86, 231-245.

b) Abstracts

Bonechi B., Tecchiato V., Perinelli C. and Gaeta M. (2017) - *High-Mg basalts from Capo Marargiu (Sardinia, Italy): experimental constraints on amphibole stability in a primitive calc-alkaline magma*. Abstract in Congresso congiunto AIV-SGI-SIMP-SOGEi, Pisa, Italy.

Stagno V., **Bonechi B.**, Greaux S., Caruso M. and Scarlato P. (2017) - *The stability of an eclogitic clinopyroxene in the Earth's mantle: an experimental investigation*. Abstract in Congresso congiunto AIV-SGI-SIMP-SOGEi, Pisa, Italy.

Bonechi B. and Tecchiato V. (2016) - *High-Mg basalts at Capo Marargiu (Sardinia, Italy): experimental constraints on amphibole stability*. Abstract in Conferenza Rittmann Giovani Ricercatori, Bari, Italy.

N.B. I dottorandi del primo anno al punto 1 possono inserire il riassunto del progetto di ricerca (max 1.000 parole)