The cataclysmic Campanian Ignimbrite eruption (Campi Flegrei, Southern Italy): Volatile melt-fining processes and the effects of physico-chemical heterogeneities

R. MORETTI[1,2], I. ARIENZO[2], F. BRUN[3], L. CIVETTA[4,2], M. D'ANTONIO[5,2], C. LE LOSQ[6], L. MANCINI[2], D.R. NEUVILLE[6], G. ORSI[2],

[1]Dip. Ing. Civile, Seconda Univ. Napoli, Italy (*presenting author)
[2]Istituto Nazionale di Geofisica e Vulcanologia, Napoli, Italy.
[3]Dip. Scienze Fisiche, Univ.Napoli "Federico II", Italy.
[4]Dip. Scienze della Terra, Univ.Napoli "Federico II", Italy.
[5]Géochimie&Cosmochimie, IPGP, Paris, France
[6]Sincrotrone Trieste S.C.p.A., Basovizza (TS), Italy.

The late Pleistocene trachytic Campanian Ignimbrite (CI; 300 km^3 DRE) covers the Campanian Plain near Naples, and is found behind ridges more than 1,000 m high at 80 km from source, the Campi Flegrei caldera (CFc). Very dilute pyroclastic density currents suggest a magma reservoir highly enriched in volatiles. Volatile concentration, H_2O particularly, exceeds significantly that of other explosive CFc eruptions. To understand such an enrichment and come out with a significant budget of discharged volatiles, particularly H_2O, we analyzed products from the different eruptive phases. Together with FTIR analyses on melt inclusions (MIs), we also characterized pumice glasses for their water content by adopting Raman spectroscopy. CI pumices display high values of porosity (> 60%, but typically > 70%), usually determined by density measurements on bulk samples. However, microscale analyses (2D and 3D) of natural pumices show a significant variability of porosity and permeability within samples. Such a variability may encompass up to 50% of porosity and contrasts with the typical values inherited by pumices at magma fragmentation. This variability is too often overlooked in the pertinent literature and ascribed to local effects within the large-scale dynamics occurring at the moment of the volcanic explosion and leading to generation of Plinian columns. Therefore, we also characterized, at the same micrometric scale of Raman investigations, pumice structure by means of conventional X-ray μCT tomography at the Elettra synchrotron facility in Trieste (Italy). Data substantiate a model in which water accumulation in the CI magma chamber is made possible by a melt fining process, similar to chromatographic separation, that occurs over a time scale comparable to that of magma residence time. This process produced extensive gas fluxing within the magma chamber, leading to an overpressurized CO_2-dominated gas cap (about 150 km^3), uniformly distributed at the top of the magma chamber. The main features of the magmatic "chromatographic" column can be retrieved by our joint Raman and synchrotron X-Ray μCT approach, that allowed investigating the effects of water exsolution and the structural changes in the polymeric network of the pre-fragmentation melt (quenched in the pumice glass).

Geochemical signature of an injection complex in the deep middle crust

SAMUEL MORFIN[1*], EDWARD SAWYER[1] AND DANIEL BANDYAYERA[2]

[1]Université du Québec À Chicoutimi, Sciences Appliquées
[2]Bureau de l'Exploration géologique du Québec
samuel.morfin@uqac.ca (* presenting author)
ewsawyer@uqac.ca
Daniel.Bandyayera@mrnf.gouv.qc.ca

Introduction

Upward transfer of anatectic magma from its lower crustal source is the mechanism of crustal differentiation [1][2]. Recently, it has become evident that a large proportion of anatectic magma does not reach the brittle/ductile transition depth. Field studies show that in the granulitic crust, anatectic magma is mostly transported in a pervasive network of narrow veins. Consequently, the upward migration of magma is arrested at, or close to, the level of the granite solidus and much leucogranite is accumulated at the granulite/amphibolite transition in the form of an injection complex [3]. This changes our perspective on the overall process of chemical differentiation of the crust

Method

Since the formation of an injection complex is mostly controlled by the depth of the solidus, which changes over the time span of a regional metamorphic event, it is expected that at a single crustal depth leucogranites should show a wide degree of chemical evolution.

Results

Both major and trace elements indicate that the Opinaca Injection Complex (Québec) contains a continuum of leucogranite compositions ranging from cumulate to highly fractionated (Fig. 1).

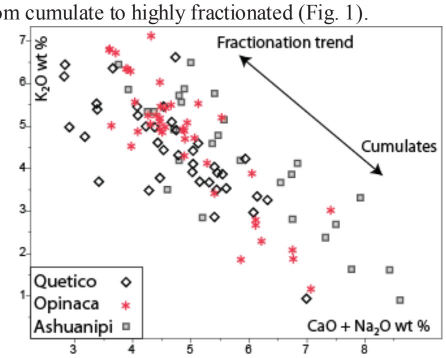

Figure 1: Na_2O+CaO vs K_2O plot showing that (1) the variety of fractionation degree in the Opinaca is similar to deeper crustal levels (Ashuanipi Subprovince) with (2) a greater proportion of evolved compositions although less evolved than higher crustal levels leucogranites (Quetico Subprovince).

Conclusion

Development of injection complex in the deep middle crust result in the accumulation of large volumes of leucogranites of various degrees of evolution close to the granite solidus depth. Evolved granites are thus not only concentrated in the upper crust, many remain in the deep middle crust. Crustal differentiation is thus not as efficient as presently thought both in terms of volume and chemical distribution. Consequences of these changes should be considered into future crustal scale models (e.g. presence of water, heat distribution).

[1] Sawyer et al. (2011) Elements **7**, 229-234. [2] Brown et al. (2011) Elements **7**, 261-266. [3] Morfin et al. (submitted) Lithos.