MELT INCLUSION IN THE BACOLI AND THE MONTE SPINA ERUPTIONS, CAMPI FLEGREI (ITALY)

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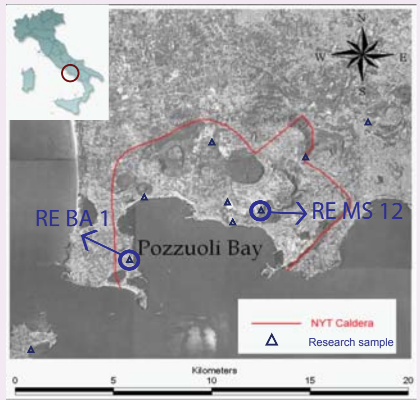
1. Introduction

Campi Flegrei is one of the largest and longest-lived active volcanic complexes on Earth. Its proximity to Naples and the towns surrounding Pozzuoli Bay (1.5 million inhabitants) necessitates an understanding of its potential volcanic hazard (fig. 1).

This study is part of a larger project to identify geochemical trends that may help to predict the style and nature of future eruptions in Campi Flegrei based on melt inclusion (MI). MIs are a useful tool to understand the evolution of magma systems and they represent the only way in determining the geochemistry of magma in those rocks have undergone pervasive secondary zeolitization process. Here we present results of two of the Campi Flegrei volcanic units, Bacoli volcano unit (10.6 ka; D'Antonio et al., 1999) and Agnano-Monte Spina Tephra unit (4.1 ka; De Vita et al. 1999).



2. Geological outline

The Phlegrean Volcanic District (PVD), comprising Campi Flegrei caldera and the Islands of Ischia and Procida, belongs to the Central Campanian Province which is part of the Plio-Quaternary volcanism in the circum-Tyrrhenian area (Peccerillo, 1999). The Campanian magmatism is connected to extensive tectonic phases which involved the Tyrrhenian margin of the Appennine Arc.

Since 12 ka 61 volcanic units are recognized and they are divided in 3 different cycles (Di Vito et al. 1999). The Bacoli volcano unit occurred during the 1st cycle and was a phreatomagmatic explosions. The volcanic products were erupted from a tuff ring located along the Neapolitan Yellow Tuff caldera (the Averno-Capo Miseno alignment; Di Girolamo et al., 1984). The sample studied from this unit is a zeolitized pyroclastic rock located in a prossimal aerea of the vent. The Agnano-Monte Spina Tephra unit occurred during the 3rd cycle and was represented by a series of eruptions with a large range of water-magma interaction. De Vita et al. (1999) identified 6 different member of that unit and the sample we studied is referred to the member B layer 2. The sample consists of pumice-lapilli collected from a lapilli lens included in a pyroclastic flow deposit.

3. Melt Inclusion petrography

Bacoli sample (RE BA 1). Phenocrysts represent about 20% of the volume of the total rock and consist, in order of abundance, of sanidine (Or80), Fe-rich diopside (Wo47, En36, Fs17- Wo48, En40, Fs12), plagioclase (An63-An79), biotite, titaniferous magnetite. Several different types of MIs were observed in all phases. Some MI contained only glass (picture 2), some contained glass and one or more bubbles (pictures 1 and 3). As described by Sorby (1858) MIs associated with apatite needles are common in both sanidine and clinopyroxene but not in plagioclase (picture 3). As spider builds his web around branches these MIs form meniscus in correspondence of apatite needles crossing or they connect two separated solid inclusion (picture 5).

MIs range in shape from pseudo pentagonal (2-3) passing from oval (1) and round to irregular. Glass can vary in color ranging from colorless to pinkish-brownish (picture 1-2-3), and most of them are randomly distributed into phenocrysts. MI size ranges from a few microns up to 150 μ.

Melt inclusion assemblage (MIA) are rarely found in plagioclase host (in correspondence with sieve texture zone, picture 6), even though they are present in other phase unfortunately with really small melt inclusion size (1-5 μ and probably less).

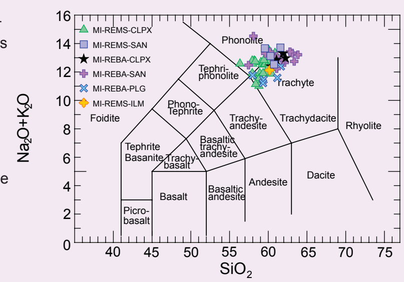
Agnano-Monte Spina sample (RE MS 12). Clinopyrixene (Wo44, En41, Fs15- Wo45, En38, Fs17), sanidine (Or79-80), biotite, titaniferous magnetite, forsterite, plagioclase are the phases present in that rock (in order of abundance) and they consist of about 35 % of the total rock volume. MIs were studied in Fe-rich diopside, sanidine, ilmenite and they mostly resemble the previous described MIs with few exceptions. MIs in sanidine are al most rectangular in shape, pinkish in coulor, and bubbles are always present sometimes accompanied with daughter crystals. Apatite is never found in feldspar, but on the other hand they can represent up to 20 % in volume of clinopyroxene host (picture5). Size of MIs in this sample are larger then those in the Bacoli sample (up to 250 μ). MIs in clinopyroxene

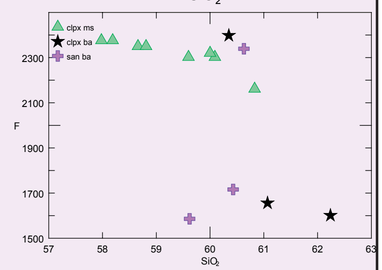
4. Geochemical data

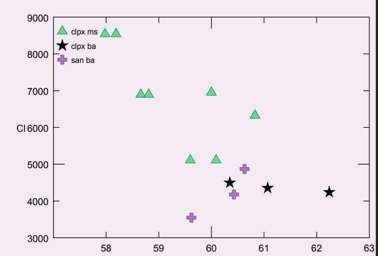
All types of MIs described in a previous chapter were geochemically investigated using Laser Ablation-inductively coupled plasma mass spectroscopy (LA-ICPMS) of Virginia Tech Geosciences Department. Data shows a strong overlapping regarding the two different eruptions in the edge between trachyte and phonolite (fig.3). In the same manner MIs hosted in different phases from the same eruption have similar composition indicating a syn-genetic formation. Bulk rock composition were not plotted since zeolite crystals were recognized in both samples (rare in RE MS 12 and abundant in RE BA 1; 0.5-4 mm in size) using Raman spectroscopy.

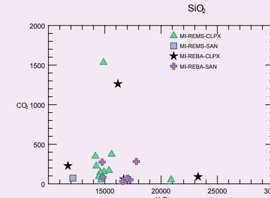
MIs Volatile analysis was carried out using secondary ion mass spectrometry (SIMS) of Woods Hole Oceanographic Institution. MIs show relatively high concentration in F and Cl ranging from 1586 to 2406 ppm and from 3546 to 8539 ppm respectively. Bacoli sample present lower values of these two volatiles then the Agnano-Monte Spina sample. Chlorine data seems to be affected by the content of SiO2 in MIs, while fluorine does not (fig. 4). H2O content ranges from 1.4 to 1.8 wt % for both eruptions with some exceptions (fig. 5). In RE MS 12 sample, one sanidine hosted MI has 1.22 wt % slightly lower than the other values probably because was the only MI to be heated (950 C°). Another MI of the same sample shows H2O of 2.1 wt %. Regarding RE BA sample, one clinopyroxene hosted MI shows a value of 2.3 wt%. CO2 contents are generally as low as 50 ppm that is comparable with C content of the host. In a few cases CO2 range from 140 to 370 ppm. In other two MIs CO2 content was higher than 0.1 wt %, but in both cases MIs were affected by fractures occurred during polishing with diamond powder. Lastly, sulfur slightly varies around 500 ppm. Generally speaking, incompatible trace elements are slightly less abundant in RE BA 1 sample than in RE MS 12 sample, but show similar trends in the spider diagrams (fig.6). Sr and Ba are the only two elements showing high variability among MIs in both samples. For instance, Sr can varies from 190 to 1,388 ppm in RE MS 12 sample, and Ba from 20 to 1,250 ppm in RE BA 1 sample (the highest values are recorded by clinopyroxene and plagioclase hosted MIs).

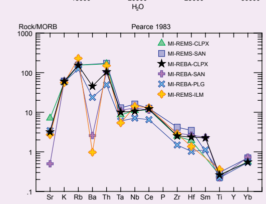
Regarding HFS contents, Nb-Ta-La-Ce are greatly higher in both samples respect to average value of upper crust, lower crust, MORB, OIB, AIB (fig.6). For example Ce show value up to 280 ppm and Nb up to 96 ppm.











5. Conclusive remark

1. The different types of melt inclusion show the same volatile-major-trace elements composition.
2. For both samples the same MI compositon in different host phases strongly suggest that the "boundary layer" does not represent an important problem in using MIs as a method.
3. The relative low contents of volatiles in MIs plus the absence of fluids inclusions in phenocrysts corroborate the idea that volatile exolution did not occur at this magma-evolution level.
4. The extremely high values of HFS in Agnano-Monte Spina sample suggest an intensive magma fractionation from a huge magma-reservoir.

6. Aknoldgement

I would like to thanks my sister since this poster had never being possible with out her existence.

7. References

To finish (excuse me bob)