V21A-2079

VOLATILES IN THE MAGMA ASSOCIATED WITH THE SOLCHIARO ERUPTION IN THE PHLEGREAN VOLCANIC DISTRICT (ITALY)

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1. Introduction

The Phlegrean volcanic district (PVD) is one of the best known areas in the world for its volcanic hazard. In fact, more than 1.5 million people live either right or in the proximity of this area. The PVD comprises three volcanic fields: the Campi Flegrei caldera and the islands of Ischia and Procida (Fig. 1a-b). The area has been the site of volcanic activity for more than 60 ka, and contains many volcanic centers (cinder cones, tuff rings, calderas). Some of these eruptions have been extremely violent. A better understanding of the past volcanic activities in the PVD could open new windows to help in predicting the style of future eruptions. In this poster we present results of a study of volatiles in the magma associated with the Solchiaro eruption on the Island of Procida, Italy. The Solchiaro eruption is one of the few primitive products erupted in the PVD and can provide information on the source of all magmas associated with this volcanic system.

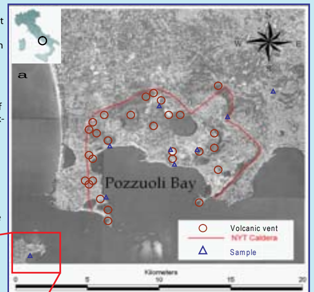


Fig. 1

two different dataset are presented here. For the first, phenocrysts were mounted in Indium in order to prevent H_2O/CO_2 contamination from epoxy at high vacuu of the SIMS. The MI and host phases were first analyzed with EMPA for major elements. SIMS volatiles analysis was performed at Woods Hole Oceanographic Institution (Woods Hole MA).
For the second set of analyses phenocrysts were mounted in indium and analyzed with SIMS at Virginia Tech.
Precision for volatiles by SIMS is 10% relative and for major element by EMPA is better than 10%.

2. Geological outline

The PVD is located near the margin of the Campanian Plain and is part of a more widespread Plio-Quaternary volcanic event that occurred in the circum-Tyrrhenian area. The Campanian Margin is located in the hinge zone between the eastern Tyrrhenian Sea and the southern Apennines. The PVD includes three volcanic fields that are thought to be part of the same magmatic system: the Campi Flegrei caldera and the nearby islands of Ischia and Procida (Fig. 1).
At Procida, volcanic activity began at least as early as 55 ka, and terminated with the Solchiaro eruption (between 19.6 ka and 14.1 ka. The most important feature of the volcanic products of Procida is their more primitive composition compered to those of Campi Flegrei (Fig. 2).
The vent of Solchiaro eruption is currently beneath the sea located and partially visible between Punta Solchiaro and Punta Pizzacco (Fig. 1b). The proximal facies is a lithified yellowish tuff. Going NE from the vent area deposits are composed of sub-parallel cm to dm-thick base surge layers. This facies gradually shifts northward into wave stratification facies. The sample collected for this study is from a layer of the sub-parallel facies.

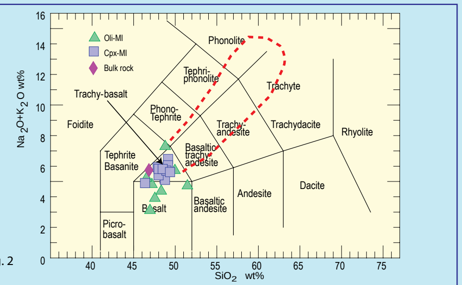
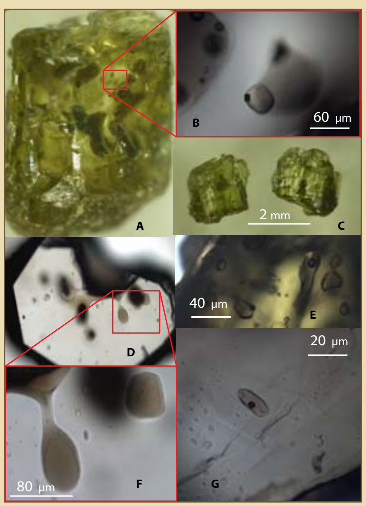


Fig. 2



3. Melt inclusion petrography

Melt inclusions (MI) are hosted in forsterite (Fo_{84-87}) and Mg-rich diopside.
MIs in forsterite are always glassy and some contain one or more bubbles and some contain no bubbles (Photo A, B, D and F). Size (1 to 200 μm) and colour (colorless to brownish) are both variable with larger inclusions being more brownish than smaller ones. Smaller inclusions are more often without a bubble. Unfortunately no melt inclusion assemblage (MIA) can be recognize in olivine hosted MIs. MI shape is variable ranging from perfectly elliptical through faceted (negative shape of olivine) to irregular (few cases). The host-inclusion edges are always smooth at microscopic scale. MIs in forstertite are often associated with chromite solid inclusions (Photo 1b), sometime within the MI and sometimes the MI appear to have nucleated on the chromite grains.
MIs in clinopyroxene (Photo C, E and G) are mostly glassy but sometimes are recrystallized and bubble rich (bubble 1-5 μm in diameter). Generally, clinopyroxene hosted MIs are smaller than those hosted in olivine (< 80 μm). Glassy clinopyroxene-MIs are sometimes wrinkled indicative of reheating of melt inclusions in nature. MIAs are not found in diopside.
Only glassy MI were analyzed, but sometimes they contained one or more bubbles. None of the MIs analyzed were reheated in the lab to avoid possible volatile loss as shown by previous analyses (here not discussed).

4. Results

1. Olivine-hosted MI and clinopyroxene-hosted MI differ in their water contents with the latter richer in H_2O (Fig. 5). Regarding other volatiles clpx-hosted MI are less variable than olivine-hosted MI (Fig. 3, 4, 5, 6).
2. All MI in olivine contain the same amount of water if instrumental precision is considered to be 10% (Fig. 5).
3. F, Cl, S, CO_2 contents are strongly variable in both olivine and clpx-MIs. Cl shows a wider range compared to F, S, CO_2 (Fig. 3, 4, 6).
4. Rough positive correlation is always found among Cl, F, S. Good positive correlation are shown both between Cl and F (Cl/F ~1.4) in clpx-MIs and Cl-S in olivine-MIs. (Fig. 3, 4).
5. CO_2 has negative correlation with F, S, Cl in olivine-MI with the exception of three MI. Clpx-MIs show good negative correlation between CO_2 and S.
6. K_2O has a positive correlation with Cl and F and roughly with water in clpx-MIs (Fig. 5).

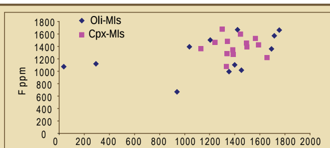


Fig. 3

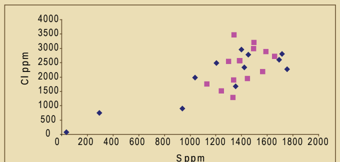


Fig. 4

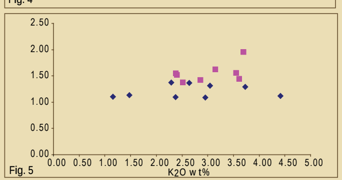


Fig. 5

5. Crystal sinking model vs. ascending deggasing path

Solubility relation for the system H_2O-CO_2-basalt at 1200 °C are shown in Fig. 7. Isobars in Fig. 7 were calculated using Volatilecalc software from Newman and Lowenstern (2002). A degassing path calculated with the software show a good fitting with sample data (expecially for olivine hosted MIs).
The observed volatile trend is consistent with crystallization of an upward migrating H_2O-CO_2 saturated magma.
However, if this had been the case there should be correlation between concentration of volatiles (depths of saturation) and Major element. In Fig. 6 K_2O and CO_2 do not show any trend. The former element is behhaving incompatible in this first stage of the crystallization and the latter is directly related with the saturation pressure.
Our interpretation is in agreement with the crystal sinking model proposed by Anderson et al. (2000) for the Bishop Tuff: phenocrysts may crystallize at various depth in the magma chamber and as they form they can sink and record different concentration in volatiles if the magma is volatile-saturated (Fig. 8a).
One of the analyzed olivine and one of the clinopyroxene presented inverse zonation and they could corroborate our hypothesis (Fig. 8c). Also, an olivine phenocryst showed CO_2 poor-MI in the core but a CO_2 rich-MI in the rim (Fig. 8.d)

Fig. 6

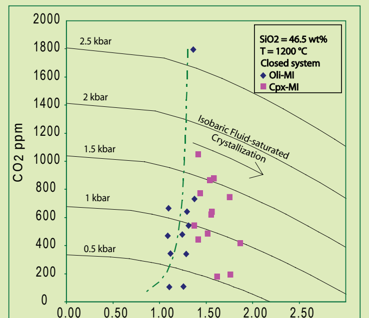
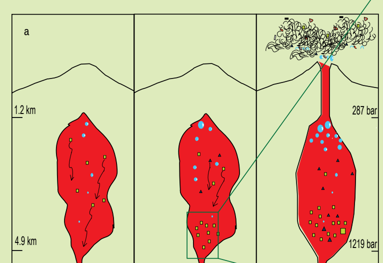


Fig. 7

6. Conclusion

As shown in other studies H_2O-CO_2 trends determined for Solchiaro have been interpreted as a degassing path of a volatile-saturated magma. However, MIs major element analysis of the Solchiaro eruption does not have correlation with their volatile concentrations (Fig. 6). MIs in cllinopyroxene show higher water contents suggesting a max of 30 % of crystallization under fluid saturated condition (arrow in Fig. 7) that can be reduced to 15 % if the 10 % error on H_2O-CO_2 are considered.
At the moment we cannot give an explanation of how F, Cl and S fit with this model. However, with the esclusion of three data points we can observe a negative correlation among F, S, Cl and CO_2. Particularly, Flourine show higher compatibility for CO_2-rich fluid. Another intrepretation would be that F is partitioned in the liquid phase as the magma is becaming richer in exsolved fluid.
The relatively primitive character of Solchiaro eruption gives us a better idea of the concentrations of volatiles close to the source of the PVD.



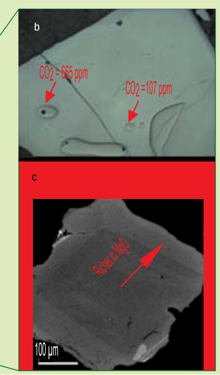


Fig. 8