Small and large scale inhomogeneities in the magma chamber of the 18.6 ka Sarno plinian eruption of Mt. Somma-Vesuvius (Italy) based on melt inclusion studies in nodules

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The Sarno eruption is one of the oldest and largest eruptions of Mt. Somma- Vesuvius, but it has been little studied. Nodules (coarse-grain "plutonic" rocks) were collected from the phreato-magmatic phase of the Sarno eruption in C. Traianello quarry, located on the NE slope of Mt. Somma. These nodules are interpreted to be wallrock or previously crystallized material that was transported to the surface by the Sarno magma. Based on the mineral composition, most of the rocks can be classified as monzonite-monzogabbro, only one sample is more evolved with a syenitic composition. The nodules consist of An-rich plagioclase, K-feldspar, clinopyroxene (ferro-diopside), mica (phlogopite-biotite) ± olivine and amphibole. Unlike most of the nodules from the other eruptions, these samples do not have typical cumulative texture, but rather display a porphyrogranular texture. The phenocrysts are large (up to few mm) with variable compositional zoning, most commonly normal or reverse zoning, but irregularities and resorbtion surfaces are not observed. The phenocrysts are often partially to completely enclosed by later poikilitic feldspars. Sometimes irregular intergrowths of alkali feldspar and plagioclase and smaller mica, Fe-Ti oxides and/or clinopyroxene crystals can be observed. These features are interpreted as crystallized melt pockets. Based on their textures, the nodules may represent the *in situ* crystallizing melt on the walls of the magma chamber. The lack of the interstitial glass, which is common in nodules from similar environments, can be explained by the time difference between the plinian and the phreatomagmatic phase. The relatively long time difference might have provided sufficient time for the interstitial melt in Sarno samples to crystallize.

Minerals, especially clinopyroxenes, are abundant in crystallized silicate melt inclusions. They are usually 20-30 µm, but their size ranges between 5 and 60 µm. They have rounded to angular shape. Two types of melt inclusions can be distinguished. Type I consists of mica, Fe-Ti-oxide minerals and/or dark green spinel, clinopyroxene, feldspar and bubble. No volatiles (CO_2, H_2O) could be detected in the bubbles by Raman spectroscopy. Type II Inclusions are generally lighter in and they contain subhedral feldspar and/or glass and several dark phases which are possibly oxide minerals and/or tiny bubbles. The melt inclusions are randomly distributed in the crystals or they appear along a growth zone and are therefore interpreted to be primary. While the two types of inclusions are spatially associated and appear in the same zone, which would suggest a genetic relationship, the nature of any genetic relationship between the two types of MI is unclear.

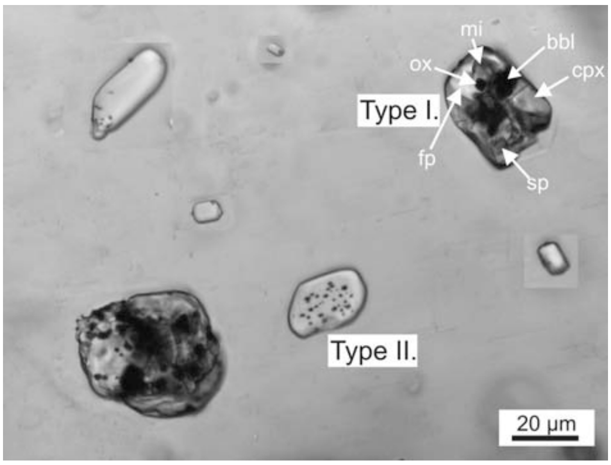

Fig. 1. Crystallized melt inclusions in clinopyroxene host. Cpx – clinopyroxene, sp – spinel, mi – mica, ox – Fe-Ti-oxide, fp – feldspar, bbl – bubble.

Heating experiments have been carried out to rehomogenize the inclusions for further analyzes. The two types of inclusions have similar homogenization temperature, ranging from 1205°C to 1250°C, based on their size. Larger MI homogenize at slightly higher temperatures compared to smaller MI. All crystals were quenched immediately after homogenization. In some cases a bubble reappeared during quenching, indicating that the homogenization probably was not complete, or the inclusion leaked during heating, or that the melt was close to volatile saturation and re-exsolved the dissolved volatiles during the quench. During reheating inclusions started melting at about 1050-1100°C. Mica starts melting just slightly above 1100°C, and it disappears about 1150°C. The bubbles become smaller during heating and they are the last phases to disappear, unless spinel is present, then that is the last phase to melt.

Crystallized melt inclusions in clinopyroxenes have been analyzed by LA-ICP-MS. Even though the two types of inclusions behave similarly during the heating experiment, they have significantly different compositions. Type I. (phono-tephrite – tephra-phonolite, similar to the products erupted during the plinian phase) are enriched in alkaline and incompatible elements compared to type II MI (basalt-basaltic andesite). Plotting the composition on MgO vs. SiO_2, Na_2O and CaO diagrams, a continuous trend can be observed indicating the evolved inclusions likely represent a melt that differentiated from the basaltic melt represented by type II inclusions. On the other hand, trace element contents of the inclusions define two distinctive groups that appear to be unconnected. This and the spatial distribution of the melt inclusions indicate that the melts are not differentiated from each other. Based on the calculated distribution coefficient between the host and the melts represented by the inclusions, only type I MI compositions are in or close to equilibrium with the host clinopyroxene. There is no indication that the composition of type II MI has been modified by entrapped solid phases, however it cannot be excluded. Type II inclusions may represent inhomogeneities within the crystallizing melt, but their high portion (about 20-30%) of the inclusions and their uniform composition makes it unlikely and suggest another origin. Further analyzes will be carried out to determine the volatile content and the major and trace element composition of the rehomogenized melt inclusions in order to explain the observed inhomogeneities and estimate a minimum crystallization depth.

Fluid inclusions in Sarno samples are usually single phase, secondary in origin, and not associated with melt inclusions, unlike in other nodule samples from Mt. Somma-Vesuvius. The observed differences in textures and melt and fluid inclusion populations in the samples from Sarno eruption compared to those from other eruptions of Mt. Somma - Vesuvius may indicate different pre-eruptive conditions and processes.