Magma mixing recorded by chronologically constrained melt inclusions

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Understanding the reliability of melt inclusions (MI) has become more important as the use of this technique has increased in recent decades. Generally, the chemical compositions of MI in a single sample or even in the same crystal host span a wide range. Here, we studied a single olivine phenocryst from the Solchiaro eruption on Procida Island (Southern Italy) to understand the reliability of MI to record magma mixing processes. The selected olivine hosts multiple MI and chromite inclusions and shows reverse zoning from $Fo_{\sim 83}$ to $Fo_{\sim 87}$. We recognized three groups of MI based on petrography and P X-ray mapping that we refer to as early MI (EMI), intermediate MI (IMI), and late MI (LMI). We analyzed the MI for their major element compositions plus S and Cl. These three groups of MI are discriminated by their major element compositions. EMI represent the first stage of olivine formation, whereas IMI formed as a result of fractional crystallization and progressive growth. LMI formed as the magma was mixing and represent the last stage of crystallization of the olivine before eruption. The LMI represent a melt inclusion assemblage (MIA) *sensu strictu*. LMI were all trapped at the same time and at the same chemical and physical conditions because they were trapped along a single olivine growth band as revelaed by P X-ray maps. These MI contain only glass at room temperature. The LMI show correlations between some major element compositions of LMI increase or decrease with inclusion size up to ~20 μm and plateaud as MI are ≥22 μm. This correlation suggests that larger LMI (≥22 μm) are reliable carriers of the pre-eruptive melt composition. This study shows that MI accurately record mixing processes during the differentiation of the magma before eruption.