Cannibalization of previous Na-rich clinopyroxenes by ascending basic magmas of the Garrotxa Volcanic Field (NE, Spain)

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The Garrotxa Volcanic Field (GVF) is a Quaternary monogenetic volcanic field belonging to the NE Spain volcanic province, recording a Neogene alkaline intraplate magmatic activity consequence of the rift-type extensional tectonics that has affected the eastern margin of Iberia since late Oligocene. The GVF is mainly characterized by alkaline basaltic rocks (basalts and basanites) both potassic and sodic in affinity. In general, mineral assemblage includes olivine and clinopyroxene phenocrysts and microphenocrysts, and a groundmass formed mainly by variable amounts of plagioclase and Fe-Ti oxides. Clinopyroxenes (cpxs) are not petrographically homogeneous and two types are distinguished: (I) Non to normal zoned phenocrysts with beige centres often surrounded by thin brown rims and (II) reversely zoned phenocrysts with green rounded cores wrapped by a beige mantle and an outer brown rim. The green cores (diopsides with Na_2O up to 1% and Al_2O_3 up to 7%) in Type II cpxs show petrographic and chemical evidences in agreement with a xenocrystic nature (e.g. sharp optical and chemical contrast between cores and mantles, rounded shape, high Fe/Mg ratios, or coexistence of type I and type II phenocrysts in a single sample). In this sense, their chemical compositions are in accordance with cpxs crystallized from a more evolved liquid than the primitive ascending basanitic magmas in which they are included. These xenocrysts seem to be petrographically and chemically related to cpxs from clinopyroxenite and gabbroic cumulates which can be found in some of the GVF samples. Therefore, we hypothesize that green cpxs were entrapped or cannibalized by the basic rising magmas. Preliminar cpx-melt calculations indicate that mantles of type II cpxs crystallized at maximum of ca. 30 km depth and consequently, cannibalization occurred at higher depths. This is consistent with the presence of green cpx-bearing mafic and ultramafic cumulates at or near the crust mantle-boundary.

Linking mantle melting and eruption rates at Stromboli volcano: A U-series perspective

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Over the last several hundred years, the steady-state activity of Stromboli volcano has been characterised by persistent mild explosive eruptions, ejecting black scoria bombs. Periodically, lava flows and paroxysms, ejecting also light-coloured pumices, interrupt the 'normal' activity. A degassed and highly porphyritic basaltic-shoshonitic magma (HP-magma), is erupted by the normal activity and lava flows, whereas a slightly more mafic and volatile-rich magma with low phenocryst content (LP-magma) is erupted as pumices only by the paroxysms. Whilst the former is considered as deriving from a shallow level reservoir, the latter has a deeper origin and might resemble the primitive melts generated from the mantle source.

We present new U-series disequilibria measurements on a suite of HP and LP magmas from the present-day activity of Stromboli volcano. Small but significant differences are observed in ($^{238}U/^{232}Th$), ($^{230}Th/^{238}U$) and ($^{226}Ra/^{230}Th$) between HP and LP magmas, testifying and further constraining the complex processes occuring in the shallow level magma chamber (e.g. crystal fractionation, mixing, recycling of material from previous activity).

On the contrary, the variation of ($^{230}Th/^{232}Th$) seems to be little affected by the shallow level processes and can be used to constrain the melting regimes beneath the volcano. This is particularly true for the LP magmas that should reflect the composition of the primitive magma. Indeed, the LP data show an impressive time-related constant variation of ($^{230}Th/^{232}Th$) during the last 15 years that is interpreted as an increase in the melting rate of the mantle source. More importantly this variation can be directly related with the increase in eruption rate that is suggested by both observation (increase of major explosive events and lava flows) and estimates based on the volcano morphology and erupted volumes. This suggests that U-series, and ($^{230}Th/^{232}Th$) in particular, can represent an important tool to estimate the rate of magma production and then possibly forecast the eruption rates in basaltic volcanoes such as Stromboli.

The variation in ($^{230}Th/^{232}Th$) is also discussed with the aim of estimating the turnover times of both the HP and LP systems.

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