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Carbonatite metasomatism of the lithospheric mantle as a source for the high CO_2 degassing at Etna volcano

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Etna volcano (Italy) is located in a complex geodynamic setting, being next to a subduction zone and on the boundary between oceanic and continental lithosphere. Magmas range from tholeiites to alkali basalts, with geochemical features mostly resembling intraplate volcanism. An influence of the subduction has been proposed to explain trace element patterns and the exceptionally large amount of degassed volatiles (H_2O and CO_2). In order to further constrain lithospheric and asthenospheric sources, we performed high precision HFSE measurements in magmas from Etna and other active volcanoes of the central Mediterranean.

The most striking feature of magmas from Etna is their exceptionally high Nb/Ta, up to 26 in the early tholeiitic products of the volcano. Although not as extreme as in Etna, lavas from Vulture volcano also display Nb/Ta significantly higher than what is typically observed in intraplate volcanoes worldwide [1]. The anomalous Nb/Ta cannot be explained by the influence of the nearby Ionian subduction as this ratio does not correlate with any other proxy typical of subduction (e.g. Ba/Th) and maximum values were found in the early tholeiitic products of the volcano that are devoid of subduction flavors. Instead, we identify the source of the high Nb/Ta in domains of the subcontinental lithospheric mantle (SCLM) affected by carbonatitic metasomatism, similar to what observed in the nearby Hyblean province. Carbonatite-like metasomatism of the SCLM can not only explain the high Nb/Ta but also other features such as the low Zr/Nb, Rb/Th and K/Nb of Etnean magmas.

Since the SCLM was enriched in carbon by carbonatite-like metasomatism, we propose that such a reservoir is responsible for the anomalously high CO_2 emission of Etna. The mantle corner flow, triggered by the roll back of the Ionian subduction provides a possible mechanism to supply C-rich SCLM fragments to the sources of Etna lavas. A similar process on the opposite side of the Ionian subduction could explain the HFSE signature of Vulture, which is surprisingly similar to that of Etna.

[1] Pfänder *et al* (2012) CGA 77, 232-251.