Mineralogical characterization and crystallization kinetics of fibrous and acicular volcanic orthopyroxenes from Mt. Etna, Sicily, Italy

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The present study reports mineralogical characterization of unusual acicular and fibrous orthopyroxenes occurred in the autoclastic volcanic products from Santa Maria di Licodia, belonging to "Mt. Calvario Formation", Etna Volcano. The orthopyroxene is associated to Na-feldspar, augitic clinopyroxene, apatite and Fe-Ti oxides and shows variable morphology from prismatic to fibrous, with composition enstatite to ferroan-enstatite. Prismatic and acicular morphologies highlight a composition with high Fe contents (FeO 18-20 wt%) and moderate Ca enrichments (~1 wt %), whereas the fibers present enrichment in Mg contents (FeO < 11%). Fibrous orthopyroxene has been investigated by Trasmission Electron Microscopy (TEM), revealing fibers less than 1 μm in diameter, with perfectly euhedral habit, high crystallinity and crystal order. Selected Area Electron Diffraction (SAED) patterns show sharp and intense reflections, with limited streaking effects, probably corresponding to polytypic disorder and twinning. Corresponding HRTEM images confirm the occurrence of rare packing defects and twinning, giving rise to lamellar nanostructures in both parallel and orthogonal orientations with respect to c fiber axis. A remarking feature is represented by the systematic occurrence of a very thin amorphous film that envelops the entire fiber. Focused-beam EDS microanalyses highlighted reverse zoning, with Fe-enriched cores and Mg-enriched rims.

Orthopyroxenes with fibrous morphology are rare [1, 2] and there is no evidence in literature about their presence in volcanic environment. The occurrence of the fibrous orthopyroxene in the volcanic area studied [3] allowed to undertake this detailed mineralogical investigation. The data obtained provide some preliminary constrains on crystallization kinetics pointing to conditions of high temperature crystallization and very fast cooling.

[1] Abu El-Rus et al. (2006) - Lithos, **89**, 29-46. [2] Bryant et al. (2007) - Geochem. Geophys. Geosyst., **8**, 24 pp. [3] Gianfagna et al. (2012) EMC2012 - **1**, 533.

Magmatic evolution at Yellowstone: The role of isotopically juvenile magma inferred from zircon age, trace-element and Hf isotope data

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Yellowstone caldera (USA) is a prime example of a long-lived, large-volume silicic magma system that has produced numerous eruptions of rhyolite and basalt during Quaternary time, including caldera-forming eruptions at ca. 2.1 Ma, ca. 1.3 Ma and ca. 0.640 Ma [1]. The most recent post-caldera eruptive episode at Yellowstone produced the Central Plateau Member (CPM) of the Plateau Rhyolite, which erupted between ca. 170-70 ka. Previous research (e.g., [2]) has documented that the Nd isotopic compositions of the CPM rhyolites lie between that of the local crust and Yellowstone basalts, leading to the hypothesis that both local crust and isotopically juvenile material are required to explain the genesis of the CPM rhyolites. Additionally, it is clear from oxygen isotopic studies that the low $\delta^{18}O$ values of the CPM rhyolites (~4 to 4.5‰) require some contributions from remelted, hydrothermally altered crustal rocks [3, 4]. Here we use zircon age, trace-element and Hf isotopic compositions to explore the role of isotopically juvenile magma in the generation of the CPM rhyolites.

New Hf isotope data from CPM zircons demonstrate the presence of zircons with juvenile Hf isotope compositions (-4 to 0 ε_{Hf}) relative to their host CPM glasses (-5.7 to -6.2 ε_{Hf}), which requires that isotopically juvenile silicic magmas contributed mass to the CPM magma reservoir. Local crustal sources and older Yellowstone rhyolites have ε_{Hf} values lower than the CPM rhyolites (<-6.5 ε_{Hf}) and therefore cannot represent the sources responsible for contributing the high-ε_{Hf} zircons observed in the CPM rhyolites. Instead, new Hf isotope data show that the Yellowstone basalts (-0.1 to 5.5 ε_{Hf}) are the only source identified to date with an appropriate isotopic composition to account for the Hf isotopic heterogeneity observed in CPM zircons. Thus, these data suggest that 1) the high ε_{Hf} CPM zircons crystallized from isotopically juvenile silicic magma that is a hybrid of silicic liquids derived from Yellowstone basalts and local crust and 2) this isotopically juvenile hybrid magma is then added to the CPM reservoir periodically thorough time. In turn, these data provide direct evidence supporting the concept that both crustal-derived and mantle-derived (i.e., juvenile) components are required to generate Yellowstone rhyolites.

[1] Lanphere *et al*. (2002), *Geol Soc Am Bull*, **114**, 559-568. [2] Hildreth *et al*. (1991), *J. Pet*., **32**, 63-138. [3] Bindeman *et al*. (2008), *J. Pet*., **49**, 163-193. [4] Watts *et al*. (2012), *Contrib. Mineral. Petrol*., **164**, 45-67.

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