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Geobarometric data of the magma plumbing system of Fogo volcano, Cape Verde Archipelago

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Fogo is one of the most active oceanic volcanoes in the world with at least 14 historic eruptions recorded since 1500 AD. The island's morphology is characterized by the scar of the giant Monte Amarelo flank collapse dated at 123-63 ka [1]. Subsequent eruptions have partly filled the depression and built up the present Pico do Fogo edifice (2829 m asl). In order to find out whether the island evolution was accompanied by changes in the depth of magma fractionation, we have conducted a thermobarometric study of prehistoric and historic basanitic to phonotephritic volcanic rocks with a main focus on the most recent eruptions of 1951 and 1995. Clinopyroxene-melt equilibrium data of 26 samples from 10 eruptions indicate that final clinopyroxene fractionation before eruption occurred at 420-870 MPa, equivalent to 15-30 km depth, in the uppermost lithospheric mantle just below the Moho (12-14 km, [2]). We found no petrological evidence for prolonged magma storage within the crust or the volcanic edifice itself. For the 1951 and 1995 eruptions, microthermometry of CO2-dominated fluid inclusions in olivine and clinopyroxene phenocrysts and xenoliths yields pressures of 200-290 MPa, significantly shallower than the respective clinopyroxene-melt data (460 to 680 MPa). The shallower pressures are interpreted to reflect short-time (hours to days) stagnation of the ascending magmas within the lower crust at 8-11 km depth.
Our data indicate a weak tendency to shallower fractionation depths during the evolution of Fogo's plumbing system. The oldest sample studied yields the highest pressures (810-870 MPa) of the data set. Two samples of late pre-collapse age yield pressures of 450-630 MPa. This apparent tendency to shallower fractionation levels seems to be interrupted by the Monte Amarelo flank collapse event, with pressure estimates for subsequent eruptions ranging from 670-730 MPa to 460-680 MPa for the oldest and youngest post-collapse eruption, respectively. Similar long-term trends towards shallower levels of magma storage systems have been described e.g. for Hawaii and La Palma (Canary Islands); they may reflect changing thermomechanical properties of the lithosphere and changing local stress fields as a result of intrusions and volcanic load. Our data also suggest that the giant Monte Amarelo collapse had a profound effect on Fogo's magma plumbing system down to upper mantle depths, which is in accordance with conclusions drawn for other oceanic island volcanoes such as El Hierro and Tenerife (Canary Islands) and Tahiti-Nui (French Polynesia).

[1] Foeken J, Day S, Stuart F (2009) Cosmogenic ^{3}He exposure dating of the Quaternary basalts from Fogo, Cape Verdes: Implications for rift zone and magmatic reorganisation. Quaternary Geochronology 4:37-49

[2] Pim J, Peirce C, Watts A, Grevemeyer I, Krabbenhoeft A (2008) Crustal structure and origin of the Cape Verde Rise. Earth Planet Sci Lett 272:422-428