The post-Minoan plumbing system behaviour at Santorini Volcanic field: implications for the current unrest phase

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Explosive volcanic eruptions are often triggered by replenishment of the magma chamber by new magma. In the case of the historical eruptions at Santorini extremely short residence time has been recently estimated for the intrusion of basaltic andesitic magma in the dacitic reservoir. Understanding the occurrence of replenishment and the dynamics of magma mixing is thus crucial to a correct evaluation of the risk of explosive volcanoes.

The post-caldera islets of Palea- and Nea-Kameni formed as result of nine eruptive events from A.D. 46-47 till 1950 in the center of the Santorini Minoan caldera. These nine eruptive events lead to the emplacement of dacitic lava flows and domes also characterised by the presence of basalts to andesites mafic magmatic enclaves.

Dacitic rocks have low porphyritic index that increases with time. Plagioclase is the prevalent mineral phase, followed by clinopyroxene, orthopyroxene and opaque minerals. Few resorbed xenocrysts of olivine with coronae of pyroxene are also present. Basalts to andesites mafic enclaves have variable texture spanning from cumulate to aphyric. Porphyritic enclaves with olivine in groundmass are also found. Mafic enclaves have ellipsoidal or cuspate shape, with some chilled margins clearly suggesting their molten state at time of incorporation in the host magmas. Host lavas show a general decrease of the evolution degree with time, at the same time enstatite contents of pyroxenes and anorthite contents of plagioclase decrease from mafic enclaves to host lavas. Sr isotopes systematically increase with time and thus toward the less evolved compositions of lavas and mafic enclaves. The latter, along with mineral separates, generally show slightly more enriched radiogenic compositions in respect with host lavas, with the exception of 46-47 A.D. eruptive events.

All data point to mixing/mingling between mafic and dacitic magmas and enclave crumbling processes. The increases in Sr isotope ratios with time and toward more mafic magmas suggest crustal contamination of mafic magmas. Our data suggest the existence of a shallow layered reservoir with dacitic magmas overlaying lower mafic magmas. Cumulitic processes, crystal fractionation eventually accompanied by variable degree of assimilation of crustal country rocks, also characterised the lower part of the plumbing system allowing further layering and evolutionary processes of the mafic magmas which, in turn, generate the complex and variable textures shown by mafic enclaves. Type, composition and distribution of mafic enclaves change in different eruptions suggesting that different part of the layered reservoir where frequently and variably sampled during time. This clearly points to periodic arrival of more mafic magmas during the post-Minoan activity of Santorini suggesting a still very active magma source in agreement with data available for the current unrest phase at Santorini Volcanic field.