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Rapid magma ascent recorded in trachytes and lamprophyres of Saray volcano, NW Iran

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Saray volcano (SV) is a small stratovolcano of Miocene age located in the northwest of Iran. The youngest volcanic activity is characterized by the extrusion of an ultrapotassic trachytic lava dome in the center of Saray volcano and a sequence of lavas and block-and-ash flow deposits. Several small domes and plugs within the crater of SV exhibit the youngest stage. They consist of hybrid magmatic rocks marking the transition to lamprophyric dykes that crosscut the trachytic pyroclastic deposits.

Mineralogical and geochemical investigations point to two different melts, with a similar subduction related source: (1) The different trachytic rock types contain mainly sanidine, diopsidic clinopyroxene and phlogopite. The remarkably large sanidine macro- to megacrysts (up to 6 cm) are rich in Ba (up to 6.6 wt% BaO). They exhibit complex zoning pattern including oscillatory zoning mainly caused by variation in the Ba content. Their isolated occurrence within the groundmass proves their formation, most likely in the magma chamber. (2) The lamprophyrs and hybrid magmatic rocks are characterized by phlogopite megacrysts (up to 2 cm), clinopyroxene and apatite phenocrysts embedded in a groundmass of sanidine and glass. In addition, the hybrid lava contains carbonatitic melt. These rocks are rich in dense inclusions of glimmerites, pyroxenites and olivine-rich xenoliths.

Remarkable is the occurrence of two chemically different primary phlogopite populations: Phl-I represents (OH)-phlogopites formed co-genetically with sanidine and diopside in the trachytic magma. In contrast, the hydroxide free phlogopite phl-II is F-rich, and characterized by high Fe, Ba and Ti concentrations. The occurrence of phl-II in glimmerite xenoliths as well as in lamprophyres and associated carbonatitic melts suggests its formation in the upper mantle. Microchemical investigations point to a short period of crystal transfer between the two melts: trachytes show an increase of F in the rims of phl-I, whereas the adjecent phl-II shows strong signs of corrosion leading to a release of F. In contrast, phl-I xenocrysts in lamprophyres show strong signs of resorption followed by a Ba-, Ti- and Fe-rich rim corresponding to phl-II. Rare sanidine xenocrysts in hybrid magmas are also strongly resorbed.

Linking petrological and microchemical data with field observations enables us to decipher the different stages of the youngest activity of Saray volcano. Remelting of sanidine accompanied by the formation of Ba-rich rims marks heating of the trachytic melt by the hotter lamprophyric melt. CO_2-rich conditions are indicated by carbonatitic melts in lamprophyr, and the replacement of diopside by dolomite and quartz in early erupted trachytes and hybrid magmas. The preservation of dense xenoliths within the lamprophyric magma and the different features of phl-I and phl-II point to a rapid rise of the carbonate bearing, CO_2-rich lamprophyric magma that triggered the trachytic eruption period. The significant microtextures observed in the different trachytic eruption products suggest a short reaction time of the different melt prior to eruption.