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Magma mixing in ijolite from the Ditrau Alkaline Massif, Romania: Textural relations and compositional variations of mafic minerals

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Small discrete rounded mafic aggregates, here named ijolites, occur in tinguaite dykes in the Ditrău Alkaline Massif, Eastern Carpathians, Romania. The massif comprises a series of ultramafic to mafic rocks, felsic silica-saturated and oversaturated syenites and granites, as well as undersaturated alkaline rocks which formed during an extensional event of the Alpine evolution associated with a rifted continental margin. In this study we focus on mineral textures and chemistry of mafic constituents in ijolite aggregates and the potential for magma mixing of mafic and felsic alkaline melts.

The dark grey ijolite aggregates of porphyritic texture have a sharp margin with the surrounding tinguaite dykes and vary in diameter from 1 to 9 centimetres. Clinopyroxene phenocrysts are settled in a fine-grained groundmass composed of small clinopyroxene and biotite grains, interstitial cancrinite and K-feldspar with accessory titanite, apatite and magnetite. Huge aggregates of totally recrystallized biotite pseudomorphs after unknown phases also occur up to 1 cm in size.

Euhedral to anhedral clinopyroxene phenocrysts show oscillatory or patchy zoning and often contain euhedral titanite and F-apatite grains. Their rims are resorbed reflecting partial dissolution and overgrowth by a later clinopyroxene generation in all cases. They are classified in terms of quadrilateral and sodic components, and are mainly of diopsidic to augitic composition. They have variable diopside and aegirine contents of Di10-94Aeg2-63, while the hedenbergite content varies within Hd0.5-40. The highest Di-contents belong to chromian diopsides (up to 0.68 wt.% $Cr2O_3$), whereas pyroxenes with the highest Aeg-contents reach relatively high Zr-contents as well (up to 0.67 wt.% ZrO_2). All the pyroxenes exhibit high Al-contents (up to 8.90 wt.% $Al2O_3$). Ti/Al ratios of the phenocrysts fall between 0.125 and 0.250 indicating a relatively high crystallization pressure. Groundmass aegirine-augite and the aegirine-augite rims overgrowing phenocrysts have Ti/Al ratios above 0.25 which probably indicates a low crystallization pressure.

Biotites have moderate Al- and low Ti-contents. Pseudomorphs of biotite after the unkown phases are more magnesium-rich (with mg# values ranging from 0.60 to 0.65) than groundmass phases and breakdown products of clinopyroxene (mg# between 0.44 and 0.58). Relatively high Mn-contents are characteristic (0.88–1.11 wt.% MnO) in all biotites. A strongly negative correlation between Mg and Mn on the octahedral site indicates an exchange of these elements. On the hydroxyl site F-contents range between 1.2 and 1.9 wt.% in biotite pseudomorphs while the other mica phases ranging between 0.2 and 1.4 wt.% F. F-contents show negative correlations with Mn, Fe, Al and K.

Diopsides in ijolite have the same composition as clinopyroxenes in camptonites (Di93) of the massif which suggest the same initial basanitic magma source for these rocks. The sodic fractionation trend from Di94 towards Aeg63 in the ijolite clinopyroxenes approaches the aegirine composition in nepheline syenites (Aeg90) of the massif. The latter Na-enrichment of the resorbed ijolite clinopyroxenes, the F-rich biotite pseudomorphs and the abundant cancrinite could be a testimony of mixing between basanitic and nepheline syenitic magma.