Mica compositions record carbonatite - silicate wall-rock interaction

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Carbonatites contain variable amounts of silicate minerals with mica being the most common one. However, mica abundance in carbonatites should be low because of the low SiO_2 and Al_2O_3 solubility in carbonatitic melts. Enhanced mica formation in carbonatites may therefore record introduction of silica by carbonatite magma – wall-rock interaction. To investigate this further, we studied coarse-grained calciocarbonatite veins of the southern Palabora carbonatite (RSA), as the large carbonatite - silicate wall-rock interface along carbonatite veins preserves such interaction effects particularly well. At the contact between these veins and the host silicate rocks (clinopyroxenite and fenite = metasomatized basement granite/gneiss), a systematic compositional variation in mica correlates with mica abundance reflecting the intensity of contamination. Carbonatitic micas typically prefer to incorporate Mg over $^{[VI]}Fe^{2+}$. Accordingly, enhanced mica formation related to contamination by Mg-poor rocks (fenites) causes a prefered Mg consumption from the magma. This results in a local decrease of the Mg/Fe ratio in the magma. The resulting limited availability of Mg finally induces an increased incorporation of $^{[VI]}Fe^{2+}$ into mica. Since fenite is Fe-poor, its contribution to Fe introduction can be neglected. A direct contamination effect can be observed for Al which is highly abundant in fenite: the stronger the contamination, the higher is the incorporation of Al in mica. On the other hand, contamination by Al-poor host rocks (clinopyroxenites) that supply Si and Mg but insufficient Al promote an enhanced $^{[IV]}Fe^{3+}$ incorporation into mica and hence the formation of tetraferriphlogopite. This study shows that a small-scale local variation of the mica composition records the intensity and rock type with which carbonatitic magma reacts. We conclude that contamination-controlled compositional changes in mica must be considered when using mica composition as a geochemical monitor of carbonatite evolution.