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Experimental petrology constraints on the petrogenesis of chromitite layers (Rum Layered Intrusion, Scotland)

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Reactive liquid flow is a common process in layered intrusions and more generally in episodically refilled magma chambers. Interaction between newly injected melt and cumulates, or crystal mushes, perturbs the liquid line of descent of the melt and modifies mineral chemistry and texture. We present insights into the effects of assimilation of mafic cumulate rocks (gabbro, troctolite) by co-genetic picritic liquid using one-atmosphere, controlled-fO_2 phase experiments on picritic parental liquid to the shallow Rum layered intrusion, Scotland. For picrite-only experiments at fO_2=QFM, Cr-spinel (Cr/[Cr + Al + Fe3+] = 0.43; Fe2+/[Mg + Fe2+] = 0.32) saturates at 1320°C, olivine (Fo88) at ∼1290°C, plagioclase (An77) at 1200°C and clinopyroxene (Mg#: 0.81) at 1180°C. In picrite-gabbro interaction experiments, plagioclase (1230°C, An80) and clinopyroxene (1200°C) saturation temperature and mode are increased significantly. Cr-spinel in these experiments has a distinctive, low Fe2+/(Mg + Fe2+) ratio. In picrite-troctolite bulk melting experiments, plagioclase (An86) saturates at 1240°C and clinopyroxene at 1160°C. Al-spinel crystallizes at high temperature, and becomes more Cr-rich upon cooling, reaching the highest Cr/(Cr + Al + Fe3+) = 0.44 at 1185°C. In the hybrid reaction zone, the clinopyroxene and plagioclase stability is strongly decreased, while the spinel abundance is strongly increased. The experimental results show that plagioclase and clinopyroxene stability plays a major role in determining spinel composition and abundance. As Cr-spinel in lavas is frequently used as a petrogenetic indicator and thermobarometer, it is critical to consider melt modifications that occur during crystal-melt interactions. We compare our results to the Rum layered intrusion, where mafic crystal mush/cumulate was repeatedly percolated by reactive hot picrite melt (Leuthold et al., 2014). We propose a model for the formation of chromitite layers from picrite-troctolite and picrite-gabbro hybrid melts that is compatible with olivine, plagioclase and clinopyroxene chemistry. Chromitite deposits in layered intrusions are frequently associated to PGE deposits.

Leuthold J, Blundy JD, Holness MB, Sides R (2014) Successive episodes of reactive liquid flow through a layered intrusion (Unit 9, Rum Eastern Layered Intrusion, Scotland). Contrib Mineral Petrol 167:1021