Rheological properties of silicocarbonatite parental magmas: evidence from Root Zones

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Magnesiocarbonatite is produced by melting of a carbonated mantle above the solidus ledge, but larger fractions of melting produce a continuum of magma compositions with increasing silica concentration. Seven natural case studies have been identified where magmas with such transitional compositions have been rapidly emplaced with little apparent evolution, and where data exists to support investigation. The compositions are highly variable between localities, but nevertheless indicate that a $CO_2/(CO_2+H_2O)$ mol ratio of 0.75 can be used to model the rheological properties of magmas at the time of emplacement.

The subvolcanic intrusions of the Beara Peninsula in Ireland represent the most extensive continuum of rock compositions from dolomite silicocarbonatite to ultramafic alkaline lamprophyre to alkaline lamprophyre. The bulk rock compositions are modelled to have magma densities and viscosities that rapidly increase from the data that exists for pure calcium and sodium carbonatites (which contain much higher CO_2 concentration) to those typical of silicate magmas. However, the aqueous nature of fluid inclusions in carbonatites attests to the dehydration of magmas prior to emplacement. A $CO_2/(CO_2+H_2O)$ mol ratio of 0.60 is a volatile ratio that produces a modelled density that would be comparable to that of silicocarbonatite magmatic inclusions observed in carbonatite (Nesbitt and Kelly, 1977).

The implications of the results are that:

1. The rheological properties of parental magmas are extremely sensitive to volatile ratio and SiO_2, and rapidly diverge from existing data for end-member carbonate magmas;
2. Changes in magma rheology caused by devolatilisation will have considerable impact on the ascent of parental magmas if volatiles can escape;
3. Silicocarbonatite parental magma is, at least in some instances, a viable parental magma for carbonatite by crystallisation of silicate assemblages such as the phlogopite pyroxenites and phoscorites that are found in association with carbonatites.

Nesbitt, BE, and Kelly, WC, 1977. CMP 63, 271-294