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Petrogenesis of carbonatites

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In this talk I review current ideas about the petrogenesis of carbonatite systems. Carbonatites are mostly plutonic igneous rocks which consist mainly of carbonate minerals (calcite, dolomite and ankerite) and minor but economically significant phosphates, oxides, and silicates. They were emplaced into the crust in continental intraplate settings such as cratonic interiors and margins, as well as rift zones, but very rarely on oceanic islands.

Plutonic carbonatites on the Earth were never parental or any other liquid compositions. They are cumulate rocks, that formed when phases that crystallized from a carbonate-rich melt physically separated and accumulated. Their parental melts formed either by

1. direct partial melting of carbonate-bearing mantle producing alkali-bearing dolomitic melts, or by
2. silicate-carbonate liquid immiscibility in the deep crust after fractional crystallization of carbonate-bearing, silica-undersaturated magmas such as nephelinites, melilitites, or phonolites, forming alkali calcio-carbonatite liquids.

The evolved carbonate melts, complementary to the cumulate component, may be represented on the modern Earth by the only currently active carbonatite volcano, Oldoinyo Lengai, in Tanzania (Mitchell et al. 2012). This remarkable and unique volcano has erupted natro-carbonatite (rich in Na, K and Ca carbonate components) in recent times. It has generally been considered an anomaly, as its erupted melt compositions contrast completely with all known plutonic carbonatites. This confusion has been compounded by a long-held view based on early experimental studies (Cooper 1975), that no liquid line of descent exists in Na_2CO_3-K_2CO_3-$CaCO_3$ systems by which parental alkali-calcio carbonatites could evolve to natro-carbonatites similar to those erupted at Oldoinyo Lengai. However, more recent experimental studies (Weidendorfer et al. 2017) have challenged this view with the result that Oldoinyo Lengai may not be anomalous at all and may represent the complementary evolved liquid to plutonic cumulate carbonatites. This component may generally not be preserved in the ancient geological record due to its instability in surficial environments or alkali loss during fenetization.

Cooper, A., et al. (1975). American Journal of Science **275**: 534-560.

Mitchell, R. H. and J. B. Dawson (2012). Lithos **152**: 40-46.

Weidendorfer, D., et al. (2017). Geology **45**: 507-510.