Trachyte petrogenesis

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Trachytes are typically interpreted in terms of extreme fractional crystallization from basaltic magmas. Data from Mauritius suggest otherwise. Here, intrusive, nepheline-bearing trachytes are associated with Older Series basalts (9.0-4.7 Ma), as confirmed by a U-Pb zircon age of 6.8 Ma. Major elements cluster at ~63 wt% SiO_2 and Na_2O+K_2O ~12 wt%, forming a prominent Daly Gap when plotted with the basalts. Incompatible trace elements are enriched in all trachytes, except for Ba, Sr and Eu, which show prominent negative anomalies. REE patterns have variable abundances, prominent negative Eu anomalies and shapes that differ markedly from the basalts. Initial ε_{Nd} values cluster at 4.03 ± 0.15 (n = 13), near the lower end of the range for basalts (ε_{Nd} = 3.70 – 5.75), but initial Sr is highly variable (I_{Sr} = 0.70408 – 0.71034) compared to the relatively constant I_{Sr} of 0.70411 ± 19 for the basalts. Fractional crystallization models, using PELE, starting with a primitive Mauritian basalt parent (P = 1 kbar, fO_2 = QFM-3) fail, because when plagioclase joins olivine in the crystallizing assemblage, successive liquids become depleted in Al_2O_3, do not produce nepheline, and do not approach trachytic compositions. Plutonic xenoliths from Mauritius do not fill the Daly Gap as in some other occurrences (e.g. Hawaii, Pantelleria, Azores, Kerguelen). Fractional crystallization is not the operative process in Mauritius. Likewise, liquid immiscibility is excluded because the compositions do not fall at the ends of known miscibility gaps. What remains as plausible is some type of partial melting process, although the source cannot be Precambrian continental crust, as suggested to exist under Mauritius (Torsvik *et al.*, 2013, Nature Geosci. 6, 223) because such material should not yield nepheline-bearing melts, and would not account for the Sr-Nd isotopic compositions. Partial melting of extant gabbroic bodies, either from the oceanic crust or from Réunion plume-related magmas should yield quartz-saturated melts different from the critically undersaturated Mauritian trachytes. A remaining possibility is that the trachytes represent direct, small-degree partial melts of fertile, perhaps metasomatized mantle. This is supported by the presence of trachytic glasses in many mantle xenoliths, and experimental results show that low-degree trachytic melts can be produced from mantle peridotites even under anhydrous conditions (e.g. Falloon *et al.*, 1997, EPSL 152, 149). If some feldspar is left behind as a residual phase, this would account for the negative Ba, Sr and Eu anomalies observed in Mauritian trachytes. These considerations may also apply to other trachyte occurrences worldwide.