Origin and significance of melilitites in the Oslo Rift using Mg isotopes

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Nepheline-normative basalts are rare, but many aspects of their source and petrogenesis are important for understanding the origin of such highly fractionated magmas. Melting experiments have been used to argue that the partial melting of pyroxenites, peridotites, or eclogites alone is insufficient in producing SiO_2-undersaturated alkali lavas whose major element compositions are of nepheline-normative magmas [e.g., 1]. In particular, carbonates have been suggested to be essential in the formation of such rocks [2]. Carbonate-bearing lithologies demonstrate δ^{26}Mg compositions that are typically lighter (e.g., –1.92‰; [3]) than the average peridotitic mantle (–0.25‰ ± 0.07) [e.g., 4].

A recent study characterizing HIMU-intraplate lavas in New Zealand [5] attributed the δ^{26}Mg fractionation to a mixing of melts derived from recycled carbonated garnet eclogites and peridotites. The Skien area of the Oslo rift has similarly produced nephelinite-normative lavas with extreme REE fractionation and HIMU signatures [6]. We analysed melilitite basalt samples for Mg isotopes, major elements, and REE to investigate the origin of these compositions. We find that on average the δ^{26}Mg signatures of the samples do not deviate from the average peridotite mantle. Gd/Yb ratios range from 8.0-9.1, exhibiting strong HREE depletion and garnet signature. The combination of low (<0.5) FC3MS (FeO/CaO – 3MgO/SiO_2) values and generally low (<60) FeO/MnO ratios indicate garnet peridotite as a source and the δ^{26}Mg composition suggests the absence of involvement of recycled carbonated lithology. The difficulty of generating such magmas with carbonate-free peridotite in experiments may suggest the role of indigenous mantle carbonate.

[1] Kogiso *et al*., (2003) *EPSL* **216**, 603-317 [2] Dasgupta et al., (2007) *J. Petrol* **48**, 2093-2124 [3] Wang et al., (2014) *Nat. Commun.* [4] Teng *et al.,* (2010) *GCA* **74**, 4150-4166 [5] Wang *et al.,* (2016) *GCA* **185**, 78-87 [6] Anthony et al., (1989) *GCA* **54**, 1067-1076