Nd and Pb isotope geochemistry for Neoarchean alkaline intrusions in the western Superior Province, Canada

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Small volume post-tectonic alkaline intrusions of Neoarchean age are abundant in the western Superior Province. This study concentrates on the Quetico alkaline province, which consists of 15 bodies intruded between 2680 and 2690 Ma and comprises both mafic and felsic intrusions. The rock types include clinopyroxenites, hornblendites, monzodiorites, syenites and silico-carbonatites. The country rocks are slightly older (2695 Ma) (Davis and Corfu, 1995, Precambrian 95 Program and abstracts, p. 34) metaturbidites, which are geochemically similar to the felsic intrusions with respect to most major and trace element concentrations. Compared to primitive mantle values the samples are enriched in LILE, in particular Ba and Sr, and variously depleted in HFSE relative to neighboring REE. They have strongly fractionated REE patterns with \((\text{La/Yb})_n\) ratios between 3 and 64. Nd isotope ratios of the alkaline intrusions display significant variation both within single intrusions and on a regional scale. \(\varepsilon\text{Nd} (2680)\) ranges from +4.7 to -0.5, suggesting that the intrusions do not represent partial melts from a homogenous depleted upper mantle, and indicate little involvement of significantly older crust. In contrast Pb isotope ratios of leached K-feldspar from the felsic plutons are indicative of some contamination with the surrounding metasediments: \(^{206}\text{Pb}/^{204}\text{Pb} = 13.619 - 15.273; ^{207}\text{Pb}/^{204}\text{Pb} = 14.624 - 14.984; ^{208}\text{Pb}/^{204}\text{Pb} = 33.303 - 33.938.\) There is positive correlation between \(^{206}\text{Pb}/^{204}\text{Pb}\) and \(^{207}\text{Pb}/^{204}\text{Pb}\) and a less well defined positive correlation between \(^{206}\text{Pb}/^{204}\text{Pb}\) and \(^{208}\text{Pb}/^{204}\text{Pb}.\) \(^{207}\text{Pb}/^{204}\text{Pb}\) further correlates negatively with La/Nb and positively with SiO\(_2\). Within the
Quetico alkaline province REE/HFSE ratios are consistent with a model involving partial melting of a metasomatized mantle wedge. The intrusions are post-tectonic, indicating that igneous activity was not contemporaneous with subduction, but occurred after subduction ceased. Most lithologies are carbonate bearing suggesting a prominent role of CO$_2$-rich fluids in the mantle wedge prior to melting, and the LILE and LREE budget of the Quetico alkaline province appears to be largely controlled by variable fluid flux into the subarc mantle.

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