Are all mantle plumes equal in Nickel and PGE potential?

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Continental flood basalts (CFBs), derived from mantle plumes (rising from the convecting mantle and possibly as deep as the core-mantle boundary), are one of the major hosts for world-class Ni-Cu-PGE ore deposits. Each plume may have a complex history and heterogeneous composition. Therefore, some plumes may be predisposed to be favourable for large-scale Ni-PGE mineralisation.

Geochemical data from 10 large igneous provinces (LIPs) have been collected from the literature to explore favourable chemical signatures for Ni-PGE mineralisation. The provinces include Deccan (65 Ma), Kerguelen (110-95 Ma), Ontong Java (121 Ma), Parana (132 Ma), Ferrar (184 Ma), Karoo (184 Ma), Emeishan (250 Ma), Siberia (250 Ma), Midcontinent (1.10 Ga) and Bushveld (2.06 Ga). Among the LIPs, Bushveld, Siberia, Midcontinent, Emeishan and Karoo are "fertile", hosting magmatic ore deposits of various type, size and grade. They most commonly intruded through, or on the edges of, ancient cratonic blocks. In contrast, the "barren" LIPs erupted through both continental and oceanic crustal terrains of various ages.

Radiogenic isotopic signatures indicates that the depleted mantle reservoir for almost all LIP magmas is the deep-seated mantle plumes (FOZO), and not the more widespread depleted asthenospheric mantle (MORB) source: this confirms generally accepted models. However, several important chemical characteristics of LIPs, "fertile" and "barren" in terms of their Ni-PGE potential, have been identified in this study.

Lavas generated from fertile plumes in general contain a relatively high proportion of primitive high-MgO melts that are low in Al_2O_3 and Na_2O, but in general highly enriched in almost all strongly incompatible elements such as K, P, Ba, Sr, Pb, Th, Nb, and LREE. The fertile LIP lavas have relatively high Os contents ($\geq$ 0.03 to 5 ppb) and low Re/Os ($<$ 10). They display trends of Sr-Nd-Pb isotopic variations between FOZO and EM1, and have elevated K/Ti, Ba/Th and Ba/Nb ratios. These characteristic elemental and isotopic signatures suggest that interaction between plume-related magmas and ancient cratonic SCLM plays an important role in producing Ni-PGE fertility in LIP magmas; significant contributions of nickel and PGE may be derived from pre-existing Ni- and PGE-rich sulfide phases in the SCLM.

In contrast, barren LIPs contain fewer high-MgO lavas. The barren LIP lavas in general have low Os contents (mostly $\leq$ 0.02 ppb) with high Re/Os (10 - $\geq$ 200). They show isotopic variations between FOZO and EM2 and have high Rb/Ba ratios. These signatures may indicate the involvement of deep recycled material in the mantle plume sources for barren LIPs, but low degrees of interaction with old lithospheric-type roots.