Magmatic metal fluxes in convergent and collided margins

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Oceanic plate subduction causes water and other crustal materials to be recycled into the mantle via hydrated oceanic crust and wet sediments. This water (and other fluid-soluble components) is released into the overlying mantle wedge where it acts to lower the solidus of peridotite, causing partial melting and the formation of hydrous arc basalts. Fractionation of these basalts near the upper plate Moho and interaction with crustal rocks and partial melts, generates magmas of intermediate, hydrous, calc-alkaline composition.

Arc magmas are also uniquely oxidized (typically ΔFMQ+2) and S-rich (dissolved mainly as SO_2), reflecting seafloor oxidation of the subducting oceanic plate. Despite these high f_{O2} conditions, high f_{S2} may also result in the stabilization of small amounts of sulfide in the asthenospheric mantle source region and in fractional crystallization products (amphibole-rich cumulates) at the base of the crust. These trace sulfides will preferentially partition highly siderophile elements (HSE) such as Au and PGE from the flux of magma over the life of the arc, and will become progressively enriched in these elements. Throughgoing magmas may lose some of their complement of HSE, but concentrations of more abundant and less strongly siderophile/chalcophile elements such as Cu and Mo will be largely unaffected. Thus, these magmas are potential sources of porphyry Cu-Mo-(Au) deposits and related high sulfidation epithermal Au deposits.

In contrast, the residual subduction-modified mantle wedge and lower crust represent enriched reservoirs of HSE, locked up in trace sulfide phases. The asthenospheric reservoir is unlikely to persist long after subduction ceases (due to mantle convection), but the lithospheric reservoir has greater permanence.

During or after arc or continent collision, a variety of tectonic processes, such as crustal thickening, lithospheric mantle delamination, and post-collisional rifting, can cause a second stage of melting in amphibolitic former-arc crustal roots, giving rise to magmas that are similar (but typically somewhat more alkaline) to arc magmas. Such conditions (now under lower f_{S2} because of the absence of a flux of new S from active subduction) may cause re-dissolution of HSE-rich trace sulfides, and consequent enrichment of the melts in these metals. Collisonal and post-collisional magmas are thus associated with Au-rich porphyry and alkalic-type epithermal Au deposits.

Evolution of the Siberian Platform; Constraints from diamondiferous xenoliths of Nyurbinskaya

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This study provides evidence of subducted crust underlying the Siberian Platform, and supports models of lithosphere formation by subduction-zone stacking. Garnets in a large suite of highly diamondiferous mantle xenoliths (121) entrained by the Nyurbinskaya kimberlite have a unique distribution of oxygen isotope compositions, where >82 % of the xenoliths contain garnets with $\delta^{18}O$-values above the mantle range [1]. This xenolith suite presents an opportunity to constrain the nature of diamond-bearing mantle protoliths, and provides a snap-shot of the Siberian mantle lithosphere.

Geochemical characteristics of these garnet grains fall into 3 distinct groups: 1) Harzburgitic garnets with high Mg#, low-REE abundances, sinusoidal REE-patterns, and $\delta^{18}O$-values within the mantle range; 2) Type-1 eclogitic garnets that are LREE-depleted, with modest positive and negative Eu-anomalies, and $\delta^{18}O$-values commonly above the mantle range; and 3) Type-2 eclogitic garnets with lower HREE-concentrations and higher Mg# than Type-1 eclogitic garnets, display convex-upward REE profiles with a peak at Sm, and ~70% have mantle-like oxygen isotope compositions.

Trace-element compositions of these garnets, in addition to those resulting from kimberlite-interaction, record metasomatic processes operative in the lithosphere beneath Yakutia. Type-1 eclogitic garnets are derived from crustal precursers altered at low-temperature. In contrast, harzburgitic garnets are derived from highly-depleted mantle materials that have interacted with a carbonatitic-melt, and similar processes may account for Type-2 eclogitc garnets. These results indicate that a significant portion of Nyurbinskaya mantle xenoliths are of crustal origin, with some modified by infiltrating metasomatic melts/fluids. Similar geochemical characteristics are observed in xenolith populations across Yakutia and are common features of diamond-inclusions. These observations suggest subducted lithosphere is present in all terranes of the Siberian Platform, and indicate that ubiquitous small-volume metasomatism may be linked to diamond growth in this region.

[1] Spetsius *et al.*, (2008) *Eur. J. of Min.* **20**; 375-385