

Komatiite Magmas and Sulfide Nickel Deposits: A Comparison of Variably Endowed Archean Terranes

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Abstract

Komatiites are found in most Archean granite-greenstone terranes, but sulfide Ni mineralization associated with these rocks has a very biased distribution. The global endowment of sulfides Ni in Archean komatiites is overwhelmingly dominated by the Kalgoorlie terrane of the Eastern Goldfields Superterrane in the Yilgarn Craton. The question of whether the Kalgoorlie terrane komatiites possess any exceptional attributes which could explain this bias is addressed through an exhaustive compilation of geochemical data from this terrane and a number of others: the southeastern Youanmi terrane of the Yilgarn Craton; the eastern terranes of the Eastern Goldfields superterrane (Kurnalpi, Burtville and others); and the Abitibi greenstone belt of the Superior province.

High MgO komatiite magmas, with MgO in the 25 to 30% range, are found in all the terranes sampled, but the proportion of these compositions appears to be higher in the Kalgoorlie terrane, and the abundance of strongly adcumulate olivine cumulates is much higher. Crustal contamination is apparently more extensive and advanced in the Kalgoorlie terrane than in all the others, but there is no systematic difference in the lithophile trace element (LILE) characteristics and degree of source depletion evident in the most primitive magmas from all the terranes. Consideration of variable-valency transition metals V and Cr indicates there are no systematic variations in oxidation state between the terranes and komatiites uniformly evolved close to the quartz-fayalite-magnetite buffer. Platinum-group element (PGE) variations imply that komatiites in all the terranes were emplaced sulfide undersaturated and were derived from sources with remarkably similar PGE contents. There is no evidence that the Kalgoorlie terrane magmas were in any way exceptional.

The Forrestania and Lake Johnston Belts of the Youanmi terrane include the only known examples of Al-depleted komatiites hosting significant Ni sulfide resources, and they are also the only komatiites of this type that form adcumulate dunite bodies. The presence of adcumulate dunitites, formed by high magma fluxes in central conduits, is the common feature between these belts and the Kalgoorlie terrane. Coupled with evidence for higher degrees of contamination in the Kalgoorlie terrane, and the availability of accessible crustal S sources, it appears that magma flux, rather than primitive magma composition, is the critical factor, and that craton-scale deep lithospheric structure is the ultimate control on the rate of magma supply between mantle source and crustal emplacement site. The Kalgoorlie terrane komatiites were emplaced at

exceptionally high rates, giving rise to well-developed long-lived magma conduits, either lava tubes or subvolcanic channelized sills, which are interpreted to be the essential condition for forming large deposits.