A new tectonic model for the southern Abitibi Belt: factors contributing to a VHMS-rich metallogenic province

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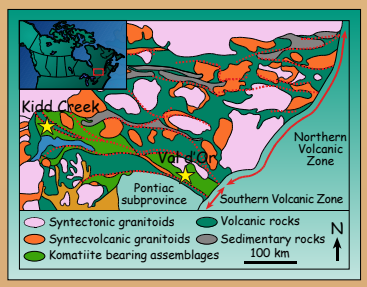


Regional geology

Volcanism in the Abitibi subprovince corresponds to a period of global crustal growth. Geochronological and geochemical data support the presence of an arc as early as 2750 Ma with volcanism terminating at ~2700 Ma. The subprovince has been subdivided into the Northern Volcanic Zone (NVZ) regarded as a coherent unit, and the Southern Volcanic Zone (SVZ) where there is evidence for autochthonous and allocthonous relationships between supracrustal packages.

Three major periods of volcanic activity have been recognised:

1) an early arc phase characterised by calc-alkaline volcanic sequences of the Hunter Mine and Deloro groups near the northern boundary of the SVZ (2725-2730 Ma)
2) a 2720 and 2707 Ma phase defined by contiguous packages of tholeiites from Kidd Creek though Munro Township to the Stoughton-Roquemaure assemblage in the west
3) a post-komatiite younger arc phase between ~2710 and 2698 Ma.

The Kidd Creek Volcanic complex

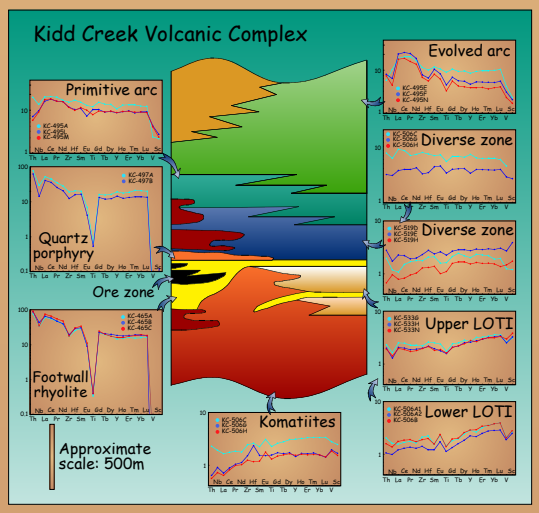
A detailed study of the 10 by 20 km KVC, host to the Kidd Creek VHMS deposit, has revealed abundant compositional diversity.

The lowest portion of the KVC comprises several hundred metres of spinifex-textured komatiites and komatiitic basalts. These komatiites are widely recognised to have been associated with anomalously thickened oceanic crust in a plume-related setting.

The komatiites are overlain by a previously unrecognised suite of low Ti tholeiites (LOTI). These occur adjacent to and intercalated with rhyolites and icelandites that comprise much of the footwall stratigraphy to the ore body.The strongly depleted trace element signature of the LOTI requires a highly depleted mantle source similar to that of boninites. Modern analogues of these rocks are typically found in areas of arc initiation.

This is consistent with much of the stratigraphy above the LOTI, which comprises a sequence of primitive arc tholeiites overlain by evolved arc basalts. The presence of the diverse zone mafic flows complicates this idealised model, as it includes basalts with both MORB-like and arc-like affinities.

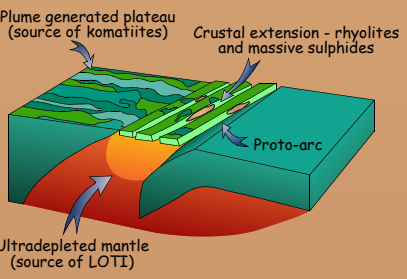
The Kidd Creek deposit occurs at a point where the stratigraphy changes from plume related rocks to arc related ones. Plume activity, although waning in the KVC did not cease with the onset of LOTI (arc initiation) volcanism. This provides strong evidence that interaction of the plume with the subduction zone resulted in plate reconfiguration and the development of a new arc.

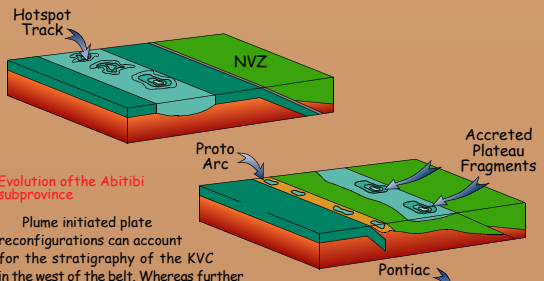


The rhyolites that comprise the footwall stratigraphy to the deposit are interpreted to be the result of melting of extended bouyant lithosphere on the plateau margin, contemporaneous with melting of ultra depleted mantle to form LOTI.

In the context of this model, the KVC rhyolites are the result of crustal extension and melting in buoyant lithosphere integral to the proto-arc setting. As such the Kidd Creek deposit did not result from a unique metallogenic process and formed in a subduction-related setting. The proximity of a mantle plume may have contributed to the high mantle heat flow in the area and the size of the deposit.

Proto-arc development at a plateau margin





Evolution of the Abitibi subprovince

Plume initiated plate reconfigurations can account for the stratigraphy of the KVC in the west of the belt. Whereas further to the east jamming of an existing subduction zone created the basement for the VHMS-hosting Val d'Or and Heva Formations.

Following the collision of the plume with the subduction zone, plateau tholeiite sequences such as the Blake River (BRG) and Kinojevis (KJ) groups were obducted onto the southern margin of the Abitibi belt.

Implications for exploration

The revised plume-arc interaction tectonic model for the Abitibi belt presented above provides a new conceptual framework for exploration for VHMS in Archean terranes. The model highlights a number of extensional terranes (proto-arc and back-arc) that are prospective for VHMS and can be recognised by distinctive geochemical criteria.

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