Sword Blades and Hair Driers: Geometries and Emplacement Mechanisms of Ore-Hosting Mafic-Ultramafic Intrusions

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Ore-hosting mafic-ultramafic intrusions come in a spectrum of shapes and sizes: channelized ribbon-shaped subvolcanic sills such as Noril'sk and Nkomati/Uitkomst; tube-like conduits such as Nebo-Babel and Limoiera; dike-sill transitions such as Eagle, Tamarack, Huangshandong, and Kalatongke, with morphologies resembling hair driers; and sword blade-shaped dikes with ultramafic cumulates at the bottom edge, as exemplified by Savannah (formerly Sally Malay) in Western Australia and the intrusions of the Expo-Ungava South Raglan trend in the Cape Smith belt, northern Quebec. Sulfide mineralization in the latter two types commonly takes the form of crosscutting, often breccia-textured bodies within the basal "keels."

Of these types, the least widely recognized as potential hosts to Ni-Cu-PGE sulfide mineralization are the blade-shaped dikes. These are well known in shallow volcanic environments, often associated with extension, e.g., in Iceland and Hawaii (REF?). They are thought to form when a vertically propagating dike reaches a level of neutral buoyancy and then starts to propagate laterally. Once the lateral extent exceeds the dike height, magma flow is dominantly horizontal. In the case of the Expo-Ungava deposits, mineralization is found at the bottom terminations of scimitar blade-shaped dikes; the Savannah deposit in Western Australia and the Eagle's Nest deposit in the Ontario Ring of Fire have very similar geometries. We propose that this geometry is more widespread than has previously been identified, and is not restricted to shallow intrusions.

We suggest that the relatively common Eagle-Kalatongke–type "hair drier" intrusion morphology may form when magma flowing through an established blade-shaped dike intersects more easily erodible country rocks and causes the dike to widen into a tube. If this interpretation is correct, the mineralization in the keels of such intrusions may be filling the basal termination of laterally propagating blades, rather than occupying the trace of upward injection of magma from a feeder dike into a funnel, as in the conventional interpretations of these deposits. The lenticular plan geometry of such deposits—Huangshandong being a prime example (REF?)—may be due to the intersection of the erosion surface with the lower portion of a horizontally disposed lenticular blade, as in the Tootoo and Mequillon deposits of the South Raglan trend (REF?). The Norilsk 2 intrusion may be another example, representing a continuum between blade-shaped dikes and tube-shaped chonoliths.

Emplacement and widening of initially blade shaped intrusions would be accompanied by periodic collapse of transient chilled margins and country-rock xenoliths into the basal edge of the propagating dike, and filling of this basal edge with accumulating crystals and sulfide liquid droplets. Subsequent downward percolation of coalesced sulfide liquid pools into the resulting partially consolidated pile of crystals and rock fragments could give rise to the distinctive sulfide ore breccias observed in many deposits, including Savannah and Aguablanca.