The Formation of the Ntaka Hill Ni-Cu Deposit: Plume Magmas Captured by an Island Arc

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The Ntaka Hill Ni-Cu deposit is located in south-east Tanzania ca. 250 km west of the port city of Mtwara, and contains 117,880 (measured and indicated) and 238,500 (inferred) tonnes of contained nickel hosted by the harzburgitic to pyroxenitic Ntaka mafic-ultramafic intrusion. This deposit is relatively unique in this area of Africa, with only the small deposits at Munali (Zambia), Mpemba (Malawi) and Rovuma (Mozambique) also known. As a result, this study set out to investigate the tectonic and magmatic setting of the Ntaka Hill deposit, in order to add context to this, and other, magmatic deposits in the Mozambique belt, but also to understand the spatial prospectivity of this area of Africa.

Here, we present new geochemical and geochronological data from the country rocks and the Ntaka intrusion itself that suggest this area of the Mozambique Belt constitutes an exotic nappe terrane that was part of the Neomozambique Ocean in the Neoproterozoic.

The lithological sequence in the region consists of a 770-720 Ma "basement" of intermediate-felsic paragneiss possibly after volcanogenic sediments (with minor Cu-Zn VMS-like sulfides) that show typical arc-like geochemical signatures. These are intruded by 700-650 Ma amphibolites (±garnet) after mafic-intermediate intrusives that also have arc-like geochemistry. This sequence is then intruded by the ca. 670-650 Ma Ntaka mafic-ultramafic intrusion, which has a much more mantle-like, non-arc origin, and hosts the Ni-Cu mineralization. The mafic-intermediate intrusives occur synchronous with, and outlast, the ultramafic magmatism, suggesting this event was transient in the context of the overall tectonic regime. The final magmatic event in the terrane is the intrusion of sill-like 640-620 Ma orogenic granites that are coeval with 640-600 Ma upper amphibolite-granulite facies metamorphism.

The broader geodynamic setting in the region consisted of the Congo-Tanzania-Bengweulu Block/Craton to the west and the Azania-Dhawar blocks/craton to the east (both of which contain Archean-Paleoproterozoic detritus) of the Neomozambique Ocean. Subsequently, based on the island-arc like geochemical characteristics of the 700-650 Ma mafic intrusive rocks and the lack of detrital zircons >1000 Ma, we suggest that the Ntaka region represents a Neoproterozoic intra-oceanic island arc which was accreted to either East Africa or Azania shortly before full continental collision (the East African Orogeny) at ca. 640-620 Ma. We hypothesize that the short-lived ultramafic magmatism at ca. 660 Ma represents a brief (ca. 10 Ma?) period during which the island arc intersected a mantle plume "hot spot," resulting in the emplacement of magmas with primary liquid compositions of ca. 15% MgO.

The high-flux emplacement of plume-related high MgO magmas into the overlying arc rocks and sediments led to the rapid formation of a juvenile magmatic plumbing system. Assimilation of the sulfidic felsic-intermediate (volcano)sedimentary material drove parts of the system to sulfide saturation. However, despite this favorable setting, magmatism appears to have abruptly ceased as suggested by the "immature" sill-complex architecture of the intrusion, poor segregation of high-low tenor sulfides, and U-Pb geochronology. This indicates that the transgression of the arc over the plume tail was a relatively short-lived event, and lasted in the order of <10 m.y.