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## Rediscovering the Panda Hill niobium-rich carbonatite in Tanzania

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The Panda Hill carbonatite complex is a Cretaceous calcite-rich carbonatite complex located approximately 15km south of the industrial town of Songwe, Mbeya District, Southern Tanzania. The carbonatite body itself occurs as a southern foot hill to the larger Panda Hill proper and has a surface expression of approximately 1.8km (north-south) by 1.4km (east-west). It is elevated to approximately 225m above the nearby rift-valley sediments. The Panda Hill carbonatite is the source-location for the barium-rich pyrochlore mineral pandaite [1].

Discovered in 1950, the Panda Hill carbonatite has been subject to multiple small-scale exploration programs in the 1950's 1960's and 1980's targeting niobium and phosphate. Medium-scale pilot processing (200,000t) for niobium also took place up to 1963 [2]. After 20,000m of drilling and extensive exploration from 2013 to 2015, Cradle Resources (in partnership with Tremont Investments Ltd) determined a JORC (2012) Mineral Resource of 178Mt at 0.5% Nb<sub>2</sub>O<sub>5</sub>. Additionally, an Exploration Target of between 200Mt to 400Mt at between 0.4% and 0.6% Nb<sub>2</sub>O<sub>5</sub> was estimated. Exploration and feasibility studies undertaken from 2013 to 2016 indicate the deposit is highly economic and plans are progressing to initiate mining; if successful the project will be the first niobium mine in Africa and the fourth niobium mine in the world.

The Panda Hill carbonatite complex is dominated by calcite carbonatite (sovite), particularly in the north of the deposit, with subordinate dolomite carbonatite and late-stage, narrow, cross cutting, ferro-carbonate dykes and rare narrow mafic dykes. To the south of the intrusive there is a complex interfingering relationship between the carbonatites and fenites derived from the Precambrian basement gneisses. Well-developed sub-vertical schlieren (flow banding) is present within the sovite and is defined by millimetre to centimetre bands of magnetite, pyrite, apatite, pyrochlore +/- mica (phlogopite). Recent mapping and structural analysis of the schlieren indicates the presence of three broad structural domains in the north which are interpreted to represent separate pulses of carbonatite intrusion. Flow parallel, coarse-grained magnetite-apatite-pyrochlore dominant bands (magnetite-carbonatite or pseudo-phoscorite [3]) up to 10m wide are also locally present throughout the sovite; the more extensive of these bands are interpreted to have been emplaced as basal members during carbonatite pulses. In 2014 a high-grade (~0.7% Nb<sub>2</sub>O<sub>5</sub>) core to the carbonatite was discovered under fenite cover, characterised by weakly to moderately weathered, magnetite rich carbonatite with relatively elevated silica (>5% SiO<sub>2</sub>) and iron (> 8% Fe<sub>2</sub>O<sub>3</sub>) due to leaching of calcite.

Niobium mineralisation primarily occurs in the carbonatites as euhedral pyrochlore crystals (0.1-2mm in diameter) within the schlieren banding. Isolated pyrochlore-dominant bands with crystals up to 10mm in diameter have also been identified in diamond core in the north of the deposit. The magnetite-carbonatite (pseudo-phoscorite) bands are of significant economic interest for niobium and average up to 4% Nb<sub>2</sub>O<sub>5</sub>. Pyrochlore alters to columbite in the regions of surficial weathering profile and in deeper, sub-vertical, karst-like weathering domains. Minor rare-earth mineralisation is present (predominantly

lighter REE's, typically < 0.5% total REE) throughout the carbonatite and can be locally enriched in the residual weathering profile.

*References:*

[1] Jager E and Niggli E (1958) Mineralogical Magazine 32:10-25

[2] Mgonde F (1994) Unpublished Master's Thesis: Carleton University, Ottawa, Canada

[2] Basu N and Mayila A (1986) Journal of African Earth Sciences 5:6 589-598

