New insight into the underlying structural controls of Ni-Cu-PGE mineralization in the Milnet Mine Zone, Parkin Offset Dyke, Sudbury impact structure*

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The Sudbury impact structure is widely recognized as a 1.85 Ga 200- to 250-km tectonically altered multi-ring impact basin located in central Ontario, Canada. There are now sixteen known offset dykes surrounding the Sudbury Igneous Complex (SIC). There are seven radial dykes, three concentric and two discontinuous dykes. The radial dykes are often linked to the SIC via an embayment structure(s) that typically contains abundant sulfides. The offset dykes are traditionally separated into quartz diorite and inclusion bearing quartz diorite phases that vary compositionally between quartz monzodiorite, granodiorite, and tonalite. The inclusion-bearing phase is associated with disseminated to massive Ni-Cu-PGE sulfide; however, there are also few mineralized examples of inclusion free quartz diorite. Previous research suggests the offset dykes are formed via the emplacement of a proto-SIC melt along an impact-induced or pre-existing fracture.

The Whistle-Parkin is a 12 km radial offset dyke located in the northeast corner of the impact structure. The Whistle segment of the dyke is connected to the SIC via a 0.5 km long and 250 m wide embayment. The Whistle extends for 1.5 km from the embayment where it is then apparently displaced ~2 km to the northwest. Beyond the apparent displaced fault zone is the Parkin portion of the dyke, which is known for another ~10 km to the northeast. Recent exploration activities have suggested the Whistle and Parkin actually represent two different dykes, rather than a faulted continuation. Regardless, the Parkin has an apparent displacement at ~6 km from the SIC at the Milnet Mine Zone, which contains abundant Ni-Cu-PGE mineralization. We hypothesize that the offset at the Milnet Mine Zone is an emplacement along an unconformity between two formations of the Huronian Supergroup, rather than an impact-induced or pre-existing fracture. The unconformity acts as a weakness, similar to that of a fracture, for the emplacement of the dyke to take advantage of. In addition, the emplacement along the unconformity acts as a structural trap for Ni-Cu-PGE mineralization, perhaps creating the two known ore bodies in the Milnet Mine Zone. The historical Milnet mine produced 157,130 tonnes grading 1.54% Ni, 1.49% Cu, 2.26 g/t Pt, and 2.98 g/t Pd. The Milnet 1500 zone was discovered in 2009, intersecting 14.24 m containing 8.00 g/t TPM, 2.57% Cu, and 0.78% Ni. More recent drilling intersected 8.0 m grading 4.32 g/t TPM, 4.11% Ni, and 0.60% Cu and in another hole 12.85 m containing 1.85 g/t TPM, 0.33% Ni, and 0.73 Cu. Understanding the underlying structural controls of the offset dykes and the associated Ni-Cu-PGE mineralization can aid in the development of future exploration techniques.