TIMING RELATIONSHIP BETWEEN RADIAL AND CONCENTRIC OFFSET DYKES AT SUDBURY, ONTARIO: A CASE STUDY OF THE FOY AND HESS OFFSET DYKES.

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Introduction: The Sudbury impact structure is host to the largest Ni-Cu-PGE deposits in North America [1]. Among these are the so-called Offset Dyke (OD) deposits, such as Copper Cliff Mine which hosts ~15% of the known Sudbury ore [2]. Despite their economic value, there is still much controversy regarding their origin. Using the Foy and Hess ODs as a case study, we employ a combination of field mapping, microscopy, and geochemical analysis to attempt to answer some of these pressing questions. The results of this research will lead to new exploration strategies for locating new ore deposits in the Sudbury footwall.

Background: Offset Dykes are igneous intrusions genetically linked to the Sudbury impact event. The primary rock type is granodiorite; although, historically the lithology of ODs is referred to as quartz diorite. They range from ~1 m to ~400 m thick, and ~100 m to ~50 km in length. They commonly exhibit two phases: an inclusion-rich phase commonly associated with ore deposits, and an inclusion-free phase [3].

Foy Offset Dyke. Foy is the longest of the radial dykes, hosted by the north range Archean granitoids, greenstones, and gneisses. The southern segment extends northwest for 16 km, it is then offset to the east, where it extends north for ~20 km. The dyke ranges from 50 m to 400 m thick. Where it connects to the embayment the primary composition is inclusion-rich pyroxene-granodiorite, containing granite, diabase, and gneiss clasts. Further north there are both inclusion-free and inclusion-rich phases [4]. The primary mineralogy of the ODs is epidote + biotite + chlorite + amphibole + albite + quartz + calcite [5]. The age of the dyke has been determined as 1.852 $^{+4}/_{-3}$ Ga [6].

Hess offset dyke. The Hess is the longest concentric dyke, extending ~50 km in the north range, varying from 10 m to 100 m thick. The lithology varies between two phases of grano-diorite: sulphide-poor inclusion-free phase enclosing a sulphide-rich and inclusion-rich phase[7]. The inclusion-rich phase includes clasts of granite, gneiss, norite, anorthosite, and heterolithic breccia resembling footwall breccia [7].

Results: *Field work.* Field mapping and sampling was completed at the intersection of the Foy and Hess ODs. An area of approximitely 1 km^2 was mapped at a 1:50 scale to determine the distribution of clasts >30 cm in diameter. No contact between the Hess and Foy was apparent in the field despite excellent exposure. Inclusions were found in two distinct locations: granitoid inclusions from the batholith host rock were found up to 5 m away from the OD - host rock contact, and within the inclusion-rich phase, which is found in the core of the Hess and Foy dykes. Inclusions of granitoid, diabase, gneiss, and the inclusion-poor phase were found. The contact between the two phases was sharp, but gradational. A 'transition zone' marked the gradual change from inclusion-free to inclusion-rich phases, ranging from ~1cm to 100 cm thick.

Petrography. Petrographic analysis of this transition zone shows that the minerals have a strong preferred orientation – even if the phases themselves lack foliation – and a high concentration of biotite and chlorite. The inclusion-free phase is typically coarser grained, with higher quartz-albite content. The inclusion-rich phase typically finer grained and contains more biotite. Sulfides in the latter phase are more common, coarser and euhedral.

Geochemistry. Major oxides were determined from the matrix of the OD samples from both phases of the Hess and the Foy. Results were typical of ODs [8], and showed little variation between Foy and Hess or between the inclusion-free and inclusion-rich phases.

Discussion: The lack of a distinct contact between the Hess and Foy dykes suggests that the concentric and radial dykes were emplaced at the same time. The presence of the inclusion-free phase inside the inclusion-rich phase suggests that the inclusion-free phase was emplaced first. The presence of large granitoid inclusions near the OD-country rock suggests rapid, violent emplacement. Further work on the Hess and Foy ODs is necessary to ascertain the timing relationship between the different phases and the radial and concentric dykes.

References: [1] Farrow, C. E. G. & Lightfoor, P. C. (2002) *CIM, 54,* 273-297. [2] Scott, R. G. & Benn, K. (2002) *Economic Geology, 97,* 1447-1458. [3] Murphy, A. J., & Spray, J. G. (2002) *Economic Geology,* 97, 1399. [4] Tuchscherer, M. G. & Spray, G. (2002) *Economic Geology, 97,* 1377-1397. [5] Fleet, M. E., Barnett, R. L., and Morris, W. A. (1987) *Canadian Mineralogist, 25,* 499-514. [6] Ostermann, M., Scharer, U., & Deutsch, A. (1996) *Lunar and Planetary Institute Contribution, 922*, 38-39. [7] Wood, C. R. (1998) *M Sc. Thesis UBC.* [8] Lightfoot, P. C. et al. (1997) *Economic Geology, 92,* 647-673.