Petrology of the Trill Offset Dike, Sudbury, Canada

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The differentiated impact melt sheet of the 1.85 Ga Sudbury Igneous Complex (SIC) hosts world-class Ni-, Cu-, and PGE-bearing sulfide mineralization. Significant and in particular PGE-rich mineralization is associated with quartz-dioritic dikes (offset dikes), which formed radially and concentrically to the SIC. These offset dikes are part of the Sudbury impact melt system. The origin and differentiation of the dike rocks as well as mode and timing of their emplacement are still under discussion .

The Trill offset dike is located on the western margin of the SIC and was discovered by Wallbridge Mining Company Ltd in 2005. The dike has been traced over a distance of 1.8 km along strike. Its thickness varies between 3 to 20 m and may change into anastomosing sets of various dikelets. The dike rocks comprise at least three texturally distinct varieties: (1) a macroscopically glassy appearing variety, which partly shows spherulitic devitrification textures (QDg), (2) a fine-grained, homogenous quartz-dioritic rock (QD), typical for most offset dikes at Sudbury, and (3) a fine-grained quartz dioritic rock which is rich in xenoliths and sulphides (IQD = inclusion-rich quartz diorite). Like other offset dikes, the mineralized IQD is mostly located at the dike centre with sharp to transitional contacts to the QD. The QD phase is 0.5 to 7 m and the IQD phase 1.50 to 4 m wide. The QDg occurs mainly as dike offshoots of up to 0.7 m thickness and with sharp margins to the host rock. Towards the contact with the granitic host rock, the QD displays either a sharp contact or a ondulous transition zone that suggests mixing of the QD melt with host rock material.

In order to test the hypotheses of dike emplacement and mineralization, the Trill Offset dike was mapped and geochemical data of the dike, its mineralization and host rock were acquired. The chemical composition of the QDg is very homogeneous and similar to the average composition of the quartz-dioritic dikes from the North Range of the SIC. The QD is more heterogeneous in composition and varies along a mixing line between QDg and host rock composition. This mixing trend is in accordance with the textural indication of mixing between QD melt and host rock material. QD samples free of host rock contamination are almost identical in composition to the QDg.

The contact relationship in the field between the QDg and QD are not in accordance with the QDg being simply a chilled margin of the QD. They most likely represent two intrusive stages that occurred at different physical conditions (e.g. temperature gradient between melt and host rock). The final emplacement stage is represented by the mineralized inclusion-rich quartz diorite.

References:

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