THE SUDBURY IGNEOUS COMPLEX (SIC) AS IMPACT MELT LAYER. GEOCHEMICAL EVIDENCE FOR IN-SITU DIFFERENTIATION.

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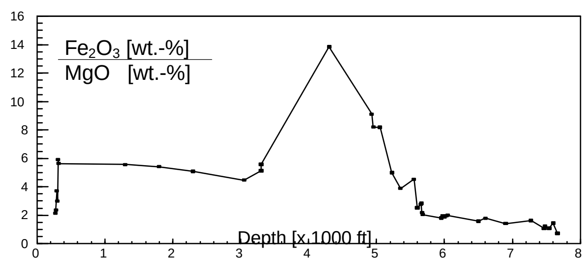
Summary. The 1.85 Ga Sudbury Igneous Complex (SIC) of the Sudbury multi-ring impact structure [1], together with the coeval clast-rich impact melt breccias, the Sublayer and Offset Dikes, are herein interpreted as the product of an in-situ differentiation of a homogeneous impact melt. The origin of the SIC by impact melting of crustal lithologies only, has already been demonstrated [*e.g.*, 1]; yet the genetic relationships between the SIC lithologies, *i.e.*, norite, quartz-gabbro, and granophyre remained controversial [see 2 for discussion]. New major, minor and trace element data, and Sr, Nd isotope characteristics for the continuously sampled drillcore 70011 (INCO Ltd., North Range, Wisner Township) indicate for the first time that these lithologies are linked by in-situ differentiation, without request for additional assimilation of crustal rocks, or contributions from the contemporaneous sub-continental mantle.

Drill core 70011 - Geochemistry. The concentrations of most elements change continously over the 2.5 km thick SIC. The norite/quartz-gabbro transition, however, is characterized by a relatively sharp increase in TiO_2, P_2O_5, V, Sc and Zr, as well as a sudden drop in SiO_2. This seemingly distinct boundary is not a discontinuity, yet simply reflects cooling of the SIC liquid below a thermal boundary, corresponding to the upper stability of Fe-Ti-oxides, apatite, and sphene. The quartz-gabbro, therefore, compares well with Fe-Ti-oxide - apatite-rich transition zones at true magmatic "layered intrusions". The Fe_2O_3/MgO ratio varies smoothly over the SIC reaching a maximum in the lower third of the granophyre (Fig. 1). All these features are well known from differentiated endogenic magmatic bodies of a homogeneous starting composition. Except for the silica-rich initial composition, and the origin by impact melting of the crust, the evolution of the SIC as delineated by elemental concentration profiles in the drill core 70011, match that of, *e.g.*, the Skaergaard Intrusion [3]. The hypothesis that the felsic (granophyre) and the mafic (quartz-gabbro, norite) units of the SIC have been produced by different processes [4] can clearly be rejected on the basis of our geochemical results.

Typical features of a gravitational differentiation, *e.g.*, cumulate layers, are missing in the case of the SIC. In-situ differentiation, therefore, is assumed as mechanism for the chemical evolution of the impact melt pool.

The Offset Dikes, discussed as "separate magmatic pulse" unambiguously belong to the impact melt system as exemplified by our investigation of the Foy Offset [5]. Total absence of inherited zircons demonstrate that the melt in the dikes was superheated; Sr, Nd isotope parameters as well as geochemical data reveal again crustal precursor material, and a composition close to the norites in the North Range of the SIC. Therefore, the Offset Dikes must have been formed in a late stage of cratering when differentiation of the SIC already had begun. Numerical modeling of the cooling history of the SIC indicates that emplacement of the Offset Dikes occurred not later than 0,25 Ma after the impact event [6, 7].

Fig. 1: Variation of the Fe_2O_3/MgO-ratio [wt %] in samples of the drill core 70011. The maximum value is not correlated to a lithological boundary (Granophyre ≈ 400 to 5000 ft; Quartz-gabbro ≈ 5000 to 6000 ft; Norite ≈ 6000 to 7500 ft; Sublayer ≈7500 to 8000 ft).



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