

Superimposition of a Thrust-Transfer Fault System on a Large Impact Structure: Implications for Ni-Cu-PGE Exploration at Sudbury*

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Abstract

A ~2.0-km-wide metamorphic aureole has been mapped beneath the northern margin of the 2.5-km-thick Sudbury Igneous Complex of the 1.85 Ga Sudbury impact structure. The aureole is difficult to observe in the field because it overprints Archean granitoids and high-grade polydeformed gneisses, which do not yield diagnostic thermal minerals at the macroscopic scale. However, detailed petrography and electron microscopy reveal four zones: albite-epidote (1,000 m wide), hornblende (900 m), and pyroxene (200 m) hornfels facies, and an innermost zone of partial melting (25 m). Using metamorphic isograds as markers, we have revealed previously undetected thrust faults between the Sudbury Igneous Complex and the Archean footwall. We demonstrate that, in places, all or part of the aureole has been overthrust and obscured at surface. Thrust units are segmented by northwest-trending strike-slip faults, which together form thrust-transfer fault systems that were active after the impact melt sheet had solidified. This post-impact deformation is attributed to late Penokean (<1.85 Ga) and possibly Grenvillian (~1 Ga) compression. Overthrusting of the footwall by the Sudbury Igneous Complex may conceal sublayer, footwall breccia, and embayment units that are traditionally the hosts of massive Ni-Cu sulfides and related platinum group element deposits. An example is provided by the Ministic offset dike located in the west of the Sudbury basin, which, as an intrusion derived from the impact melt, is atypical in not being associated with an exposed embayment structure.

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