IMPORTANCE OF TRISHEAR DEFORMATION FOR MINERAL EXPLORATION IN THE SOUTHERN SUDBURY BASIN, ONTARIO, CANADA. I. Lenauer[1] and U. Riller[2], [1]SRK Consulting Inc. (Canada), Suite 1300 151 Yonge St, M5C 2W7 Toronto Canada, iris.lenauer@gmail.com, [2]Institut für Geologie, Universität Hamburg, Bundesstrasse 55, 20146 Hamburg, Germany.

Objective: Understanding post-impact shape change of the 1.85 Ga Sudbury Igneous Complex (SIC), the relic of a deformed impact melt sheet, and its host rocks, is paramount for Ni-, Cu- and PGE-mineral exploration in the periphery of the Sudbury Basin. Non-cylindrical folding and northwest-directed reverse faulting are commonly accepted as the main deformation processes that caused the synformal and asymmetric geometry of the SIC. In the southern Sudbury Basin, greenschist-facies metamorphic tectonites make up the South Range Shear Zone, which accommodated northwest-directed reverse shearing and structural uplift of the southern SIC. The southern SIC is characterized by large variations in the dip of inclined SIC-host rock contacts and foliation surface as well as layer thicknesses and observed strain gradients. By contrast, impact-induced quartz-dioritic dikes in host rocks, so-called Offset Dikes, appear to have experienced little rotation, evident by vertical ore-rich fingers within the Dikes, believed to have formed under the influence of gravity [1]. These observations call for a deformation mechanism that can account for considerable variation in the rotational components of the southern SIC and its host rocks.

Background information: The ca. 2.5 km thick Main Mass of the SIC is composed from base to top of norite, quartz-gabbro and granophyre layers and is underlain by shocked Archean basement and Paleoproterozoic cover rocks. The basal layers of the SIC, notably the so-called Sublayer, the Offset Dikes and the immediate host rocks of the SIC are the prime target of current mining activity. Lithological contacts of the SIC generally dip toward the centre of the Basin and indicate substantial departure, i.e., rotation, of SIC segments from the original subhorizontal impact melt sheet geometry. Removal of the rotational component of the southern SIC requires tilting of these rocks to the SE by approximately 50 degrees. However, such magnitude of wall rock tilting appears to conflict with the subvertical orientation of ore-rich fingers in the Offset Dikes and excludes solid-body rotation of the southern SIC and its host rocks as a single coherent unit.

Trishear deformation of the southern SIC:

We present evidence that the orientation of layers and foliation surfaces in the southern SIC can be explained by trishear fault propagation folding. A key characteristic of trishear deformation is the transfer of localized displacement on a basal thrust fault to distributed deformation within a triangular zone, the trishear zone. Outside the trishear zone the hanging wall is translated without internal distortion. Trishear deformation of the southern SIC accounts for: angular discordances between the upper and basal contact of the SIC, local overturning of the southern SIC, steepening of planar mineral fabrics from northwest to southeast, thickness variations in the SIC layers, and the presence of the South Range Shear Zone as a zone of enhanced strain fabric intensity.

Significance of trishear deformation for mineral exploration: Although the SIC and its Paleoproterozoic host rocks deformed simultaneously after the impact event, a considerable strain gradient is observed between the granophyre and norite layers of the southern SIC and adjacent host rocks. Evidently, layer thickness was affected by post-impact strain and thus, tectonic thinning. Rotation of lithological contacts is largely controlled by simple-shearing and bulk thinning. Layer rotation in the SIC is greatest within the zone of trishear deformation, causing overturned SIC-host rock contacts. Proterozoic rocks south of the SIC show lower intensity of post-impact deformation and smaller quantities of deformation than is apparent in the SIC. This can be explained by trishear deformation in which the Paleoproterozoic rocks chiefly form the hanging wall which was translated without being affected by large strains. Depending on the location of mineral deposits relative to the South Range Shear Zone, rotation and strain vary significantly in mineral deposits. Accordingly, Offset Dike segments located at large distances to the SIC are expected to show little amounts of internal deformation and rotation. This has important consequences for assessing the geometry of sulfide-rich fingers in Offset Dikes.

References:

[1] Lightfoot, P.C., and Farrow, C.E.G., (2002). *Econ. Geol., 97,* 1419-1446.