

## **The Enigma of the Giant Sudbury Ni-Cu-PGE sulphide ores: what was the source of all the metals?**

REID R. KEAYS<sup>1</sup>

<sup>1</sup> School of Earth, Atmosphere & Environment,  
Monash University, Clayton, VIC, 3800,  
Australia (reid.keays@monash.edu)

There is an overwhelming consensus that the Sudbury Igneous Complex (SIC) and its Ni-Cu-PGE platinum group element (PGE) sulphide ores are the products of a meteorite impact at 1.85 Ga and that the 3 km thick melt sheet produced by that impact was entirely of crustal origin [1]. However, the source of the ore-forming metals within the SIC remains problematic because significant Ni-Cu-PGE sulphide deposits are normally only produced by mantle-derived mafic magmas. In addition, Sudbury is the only example of economic Ni-Cu-PGE sulphide mineralisation that is associated with the products of a meteorite impact.

There is a strong probability that the Ni, Cu and PGEs in the SIC ore deposits were sourced from pre-existing mineralisation and mafic rocks associated with two Large Igneous Provinces (LIPs) within the Proterozoic target rocks. The 2.45 Ga Matachewan Large Igneous Province (LIP) includes the Matachewan and Hearst Dyke Swarms, the East Bull Lake intrusive (EBLI) suite, and bimodal volcanics and felsic plutons that occur in the footwall of the SIC [2]. The 2.2 Ga Nipissing Diabases are comagmatic with the Senneterre Dyke Swarm and represent the remnants of an eroded continental flood basalt province [3]. A number of the mafic intrusive bodies within each of these LIPs host significant Cu-Ni-PGE sulphide mineralisation. For example, the River Valley Intrusion, which is a part of the EBLI suite of intrusions, has a resource of 91 million tonnes averaging 0.02 % Ni, 0.006 % Cu, 0.22 g/t Pt, 0.58 g/t Pd and 0.04 g/t Au [4] and the Shakespeare Intrusion, one of the Nipissing Diabase intrusions, has a resource of 11.3 tonnes grading 0.33 % Ni, 0.35 % Cu, 0.33 g/t Pt, 0.37 g/t Pd and 0.19 g/t Au [3]. All of this suggests that the SIC impact melt may have sourced significant metals from pre-existing LIP-related magmatic sulphide deposits similar to the River Valley and EBLI mineralisation.

[1] Keays & Lightfoot (2004) *Mineral Petrol* **82**, 217-258. [2] James *et al.* (2002) *Econ Geol* **97**, 1577-1606. [3] Sproule *et al.* (2007) *Applied Earth Science* **116**, 188-200. [4] Holwell *et al.* [2003] *Econ Geol* **109**, 689-712.