On the track of the elusive Sudbury impactor

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The 1.85 Ga Sudbury basin is one of the oldest, largest, and best exposed terrestrial impact structures. As such, it contains a unique record of the processes associated with massive impact events. Despite its recognized importance and more than a century of research towards understanding its genesis, little is known about a fundamental piece of the impact event, namely, the Sudbury bolide. Previous studies have identified moderately elevated siderophile element signatures in the impact crater fill (Onaping Formation) [1] and ejecta [2] attributed to the bolide, however there is no consensus on whether the bolide was an asteroid or comet, let alone the type.

In this study, siderophile and lithophile trace element data for samples from the Sudbury impact crater fill and offset dikes (representing undifferentiated impact melt) help constrain the sources contributing to the anomalous siderophile element signature. The crater fill requires contributions from bulk continental crust, mafic rocks, and a chondritic component. A mantle component is absent, but the involvement of mid to lower crust is implied. The projectile elemental ratios (e.g., [3]) were determined on a robust data subset that was developed by considering the effects of post-impact hydrothermal alteration, melt heterogeneity, and mafic target rock admixture. Chondrite discrimination diagrams of these ratios identify an ordinary or enstatite chondrite as the most probably source of meteoritic material in the Sudbury crater fill. However, when the relative and absolute siderophile element distributions within the impact structure are compared with bolide size and vaporization models, the data are congruent with the bolide being a comet that had a chondritic refractory component.

[1] Mungall *et al*. (2004) *Nature* **429**, 546-548. [2] Pufahl *et al*. (2007) *Geology* **35**, 827-830. [3] Tagle and Berlin (2008) *Meteorit. Planet. Sci*. **43**, 541-559.