CONTRIBUTIONS TO THE SUDBURY IGNEOUS COMPLEX AND THE DEPTH OF EXCAVATION: EVIDENCE FROM ONAPING FORMATION ZIRCON. J. A. Petrus[1], J. A. Ayer[1], D. G. F. Long[1], P. C. Lightfoot[2], and B. S. Kamber[3], [1]Laurentian University, Sudbury, Canada (jpetrus@laurentian.ca), [2]Vale, Sudbury, Canada, [3]Trinity College Dublin, Dublin 2, Ireland.

Introduction: It is now generally accepted that the Sudbury Igneous Complex (SIC) is a differentiated melt sheet [1] created by a large meteorite impact 1.85 Ga ago [2]. However, there remains considerable debate over the depth of excavation and the target lithologies that contributed to the SIC [3,4]. Recent work by Darling et al. showed that the Pb isotope composition of offset dykes in the South Range of the impact structure could be explained as a mixture of 80% Huronian metasediment (HMS) and 20% Superior Province gneisses [3]. From this, they concluded that the depth of excavation was shallow, implying that the impact must have been oblique. Earlier work by Mungall et al. argued on the basis of geochemical data that the depth of excavation was much deeper, requiring a significant contribution from lower continental crust [4].

In this study, zircon from the Onaping Formation (OF) (Sudbury impact crater-fill sequence, rich in target rock lithic fragments [5]) are compared to those found in HMS, Superior Province granitoids, South Range gneisses (SRGs), and other target lithologies in terms of their U-Pb geochronology in an effort to identify which rocks contributed to the SIC.

Samples and Methods: The OF was sampled in four localities, covering a wide geographic area and different members of the formation. The HMSs are represented by samples from the Mississagi and Gowganda Formations, and a quartzite block in the OF. Hitherto unreported lithologies are the SRGs, which were sampled in the vicinity of Lively (2 from outcrop, one from drill core). On the northern side of the impact structure, a variety of Superior Province granitoids were also analyzed. The OF, HMS and SRG zircon were analyzed by LA-ICP-MS, while the Superior Province granitoids were analyzed by SHRIMP.

Results: In total, more than 2700 zircon were analyzed. The U-Pb geochronology of each group is summarized below.

Huronian Metasediments. Detrital zircon in these samples form a tight distribution around 2720 Ma with several Mesoarchean grains.

Superior Province Granitoids. The granitoids have discrete and tight age clusters, ranging from 2729 Ma to 2621 Ma. There is a general N to S younging trend.

Onaping Formation. The majority of zircon yielded Neoarchean ages. Populations outside of this main group tend to be small and correspond to the age of the impact itself or known Paleoproterozoic target rocks. Although a proportion of the Neoarchean grains can be explained as contributions from HMS and Superior Province gneisses, there are many 2550-2650 Ma zircon that are not so easily attributed to previously known target rocks.

South Range Gneisses. Two of the samples analyzed yielded ages similar to the Creighton granite (2390 Ma and 2430 Ma) and therefore probably represent more strongly deformed varieties of this intrusion type. One sample (SRG-A), however, appears to be approximately 2600 Ma old with evidence for thermal overprinting (possibly from the emplacement of the Murray and Creighton granites), as well as partial resetting at ca. 1 Ga due to the Grenville orogeny. This particular specimen is the only known 2600 Ma rock in the immediate impact area and could be a piece of basement to the HMSs.

Discussion: The abundance of 2550-2650 Ma zircon found in the OF cannot be accounted for by contributions from any previously known lithology. However, the distribution of zircon in one of the newly reported SRGs matches this otherwise unexplained but prominent group of zircon. In an earlier study, Ames et al. also noted 2600 Ma zircon in the OF and suggested that they were derived from the lower crust, but due to their limited dataset, these authors did not recognize how widespread they were [6]. Thus, it appears that a previously unrecognized lithology has contributed significantly to both the OF and presumably the SIC.

In light of this discovery, Pb isotope data were acquired for SRG-A and were found to be very similar to HMS, lending further support to the idea that SRG-A could represent the otherwise unexposed Southern Province basement. Furthermore, the similarity of Pb isotope composition between SRG-A and HMS complicates the assessment of contributions to the SIC via Pb isotope data. Finally, if SRG-A is truly basement material for the HMSs, the depth of excavation likely exceeded the estimates of Darling et al. [3], alleviating the requirement for an oblique impact. A more detailed petrological and geochemical study of gneissic basement in the South Range is required.

References: [1] Therriault A. M. et al. (2002) *Econ. Geol.*, 97, 1521-1540. [2] Davis D. W. (2008) *Geology*, 36, 383-386. [3] Darling J. R. et al. (2010) *Geochim. Cosmochim. Acta*, 74, 5680-5696. [4] Mungall J. E. et al. (2004) *Nature*, 429, 546-548. [5] Grieve R. A. F et al. (2010) *Meteoritics & Planet. Sci.*, 45, 759-782. [6] Ames D. E. et al. (1998) *Geology*, 26, 447-450.