Introduction: Determining the bulk composition of impact-generated melt sheets in impact structures presents a number of difficulties. For small (simple) structures, local splash melts may provide viable indicators. However, there is some debate as to whether melt ejecta represent bulk fused target compositions, or whether they represent specific layers, successfully revealed and removed during penetration and excavation. For ejecta, the latter scenario would appear more likely. For larger (complex) structures, and especially peak-ring and multi-ring basins, there is the likelihood of impact melt differentiation, such that the original bulk melt is not preserved. In these cases, the original impact melt composition can be determined by carefully reassembling individual layer compositions and thicknesses. In the case of the Sudbury impact structure of Ontario, Canada, estimates of the original bulk composition have been determined by several workers over the last century using the reassembly approach. An alternative and more direct method is afforded by the chilled margins of impact melt dykes that penetrate the footwall. Because of their limited dimensions and their juxtaposition with relatively cold country rock, such dykes can effectively isolate impact melt from subsequent differentiation and so retain their more primitive composition. This work concerns the use of chilled margins of certain Offset Dykes at Sudbury to constrain to bulk composition of the original impact melt. These compositions are used to model the evolution of the Sudbury igneous complex (SIC), Sublayer and related economic deposits.

Offset Dykes: Sudbury is distinctive amongst the terrestrial impact structures in that well-developed radial and concentric dykes are now exposed below the remains of what was originally the impact melt sheet. These are referred to as Offset Dikes [1,2]. They are of considerable economic importance as hosts to many of the Ni-Cu-platinum group element (PGE) deposits, for which Sudbury is renowned. Within the impact paradigm, the offset dikes also provide critical insight into the excavation and modification stages of the impact process, which in turn places temporal and spatial constraints on ore genesis and ore distribution. Only Vredefort shows comparable features in the form of the Granophyre dykes that occupy the central uplift and collar regions [3].

Following extensive field work and sampling [4, 5], two chilled margin locations from the Foy Offset Dyke and inclusion-poor quartz diorite samples from the Whistle-Parkin Offset Dyke were selected. Major, trace and rare earth element analysis of these samples facilitates the modelling of fractional crystallization of the melt sheet based on a knowledge of cumulate layer thicknesses, known mineralogy of the cumulate units, and published partition coefficients.

The results yield a more realistic indication of the bulk composition of the Sudbury impact melt body. Moreover, the new data provide bulk trace and rare earth element information that is difficult to extract from averaging layer thicknesses and their compositions. In addition, by carefully modelling the evolution of the impact melt sheet, it is possible to provide constraints on the original volume of Cu-Ni sulfides and platinum-group elements that were precipitated from the melt body. This yields important new information on ore reserves, which has profound economic implications.

Sudbury provides one of the best exposed and best preserved, large (>100 km diameter) impact structures on Earth. Determining the bulk composition of its impact melt sheet through the discovery of well-preserved chilled margins enables us to explore how a large, superheated melt body evolves through time and generates world-class ore deposits.