KINEMATIC EVOLUTION OF THE SUDBURY BASIN INFERRED FROM SCALED ANALOGUE MODELLING AND STRUCTURAL GROUND TRUTH. U. Riller[1], D. Boutelier[2], A.R. Cruden[2] and C. Schrank[2], [1]Museum für Naturkunde, Invalidenstrasse 43, Germany, ulrich.riller@museum.hu-berlin.de, [2]University of Toronto, Department of Geology, 22 Russell St., Toronto M5S 3B1, Canada.

Objectives: Crustal-scale domes and basins are ubiquitous, yet kinematically poorly understood structural elements in orogenic belts of all ages. This pertains also to the Paleoproterozoic Eastern Penokean Orogen of the southern Canadian Shield hosting the Sudbury impact structure, the central portion of which is the 60 km x 26 km Sudbury Basin. The Basin is delineated by the deformed, synformal Sudbury Igneous Complex (SIC), the relic of an impact melt sheet that is overlain by impact melt breccia, the Onaping Formation, and post-impact sedimentary rocks. In order to assess the distribution and orientation of imact-induced structures and lithologies in terms of the cratering process, the kinematics of post-impact deformation and mechanism of large-amplitude, non-cylindrical folding of the SIC needs to be understood [1]. Therefore, we conducted a series of scaled analogue experiments using viscous and granular materials, which are compared with structural ground truth of the Sudbury Basin.

Method: The experimental set-up of analogue models consists of a rectangular tank filled with layers of corn syrup, polydimethylsiloxane (PDMS), PDMS blended with plasticene and various fillers, and granular materials with Mohr-Coulomb rheology. These layers represent respectively the lithospheric mantle, lower crust, middle crust and sedimentary cover rocks. Bulk horizontal shortening of the layers is imposed by a piston moving at a constant rate.

Observations: Analogue modelling shows that deformation style depends strongly on the distribution and thickness of sedimentary cover rocks, the mechanically strongest layer in the system. More specifically, the wavelength and amplitude of folds in the middle crust increase with decreasing thickness of the sedimentary cover. Thicknesses of cover rocks exceeding 10 km in nature significantly inhibit the formation of mid-crustal folds. Moreover, reverse faults and thrusts in the sedimentary cover generally nucleate in the hinge zones of mid-crustal model synforms.

The importance of sedimentary cover rocks in controlling the style of mid-crustal folds and the localization of thrust faults is well evident in the Sudbury area. Here, the impact removed a 10 km thick sequence of Huronian cover rocks, thereby exhuming mid-crustal granitoid basement rocks in a circular area ~ 130 km in diameter. Omission of granular material in an equivalent area in the model induced a pronounced mechanical inhomogeneity of the model crust.

Analogue modelling of post-impact deformation of the model impact structure and its environs generated remarkable geometric and kinematic similarities with the natural prototype. These include the formation of a non-cylindrical basin consisting of a larger, shallowly dipping flank, on the opposite side of the piston, and a smaller, steeply dipping flank of the free surface of the model basement rocks. The flanks correspond respectively to the North Range and the South Range of the SIC in nature. Furthermore, a prominent reverse fault nucleated in the hinge zone of the deformed model impact structure and displaced the steeper flank over the shallowly dipping one. This zone corresponds spatially and kinematically to the South Range Shear Zone, well known from the surface structure of rocks and geophysical imaging. Finally, the geometry of higher-order discontinuities outside the model impact structure corresponds well with mineral fabric and fault patterns in equivalent positions of the natural prototype.

Results: Analogue modelling indicates that the geometry of the South Range Shear Zone and mineral fabric patterns in the Sudbury Basin are due to the crustal-scale mechanical inhomogeneity created by impact. More specifically, the shear zone formed as a consequence of deformation of the SIC and does not seem to have accomplished displacements larger than a few kilometres in nature. This places significant limits as to the estimated volume of the Onaping Formation contained within the Sudbury Basin. Moreover, the North Range was affected largely by rigid rotation indicating that impact-induced structures such as pseudotachylitic breccia zones, faults and shock-metamorphic features, although locally rotated up to 40°, were not distorted by post-impact deformation. Collectively, these kinematic characteristics of post-impact deformation are critical for estimating the original size of the Sudbury impact structure.

Scaled analogue experiments using viscous and granular materials provide a significant step forward in understanding the dynamic evolution of crustal structures such as the Sudbury Basin.

References: [1] Riller U. (2005) *Meteoritics & Planet. Sci., 40,* 1723-1740.