IMPLICATIONS FOR CRATERING MECHANICS FROM BRECCIAS IN THE BASEMENT OF THE SUDBURY IMPACT CRATER, CANADA; Lakomy, R. Institut f. Planetologie, Wilhelm-Klemm-Str. 10, D-4400 Münster, F.R.G.

The Sudbury Structure in the Canadian Shield represents the tectonically deformed remnant of a multi-ring impact basin (1), which is structurally analogous to lunar impact basins. Based on isotopic data (2 to 4) and theoretical considerations (5, 6), all units of the Sudbury "Igneous" Complex and the overlaying impact melt breccias (Sudbury melt system) were derived 1.85 Ga ago (7) by direct shock melting of Precambrian crustal rocks (1). The Sudbury melt system in the central depression of the structure is overlain by a thick layer of suevitic breccias (8). In the North Range of the Sudbury crater the downward succession beneath the melt system is: (I) an irregular and discontinous breccia layer of up to 150 m thickness (Footwall Breccia), which grades into (II) fractured and moderately shocked basement rocks. This subcrater basement consists of large blocks intersected by dikes of fine grained breccias known as "Sudbury Breccia" extending up to ~80 km from the present outer rim of the Sudbury melt system (12).

Clast population statistics of the **Footwall Breccia**, major and trace elemental considerations along with Sr-Nd model parameters point to a parautochthonous origin of this breccia. The incomplete mixing of fragments in this breccia layer indicates that no large scale movement of clasts occurred relative to their source lithologies (9, 10). Thermal annealing by the Sudbury melt system resulted in partial melting of the originally fine grained breccia matrix material and caused the development of a variety of igneous textures of the matrix. This is also indicated by a Rb-Sr isochron age of 1.825 $\pm$0.021 Ga for this matrix (10, 11). Fragments of reworked dikes of fine grained breccias in the Footwall Breccia show some of these dike breccias have been formed prior to the parautochthonous clastic breccia within the subcrater basement. The **subcrater basement** is a megabreccia (9). Fragments in the Footwall Breccia layer and the country rocks adjacent to this breccia layer (Fig. 1) reveal peak shock pressures of less than ~20 GPa (9 to 11).

For the cratering model calculations presented in this paper, a cover of 10 km of metasedimentary rocks (Huronian Supergroup) in the Sudbury region on top of high-grade gneisses (Superior Province) at the time of impact is assumed (Fig. 1). This figure was derived using the following constraints: (I) major proportions of fragments in suevitic breccias of the crater fill consist of metasedimentary rocks from the Huronian Supergroup. Therefore, these units must have been present in the Sudbury area at the time of the impact. Today, the Huronian rocks in the South Range have a thickness of up to 11 km (13). (II) Paleomagnetic data indicate an erosional removal of > 10 km in the Sudbury area since 1.85 Ga (14). The radial extent of the subcrater megabreccia ("Sudbury Breccia"), of shatter cones, and of shock features in quartz in the subcrater basement (9, 10) point to an original main rim diameter of the apparent crater between 180 and 200 km. Comparing the radial extent of shock-induced phenomena in basement rocks of Sudbury with equivalent shock features in other complex craters (LAKOMY, this volume) resulted in a transient cavity diameter (D_t) of 100 km (Fig. 1). Using these constraints, an impact melt volume of 12500 to 22500 km^3 of the Sudbury crater has been computed according to models of (5, 15 to 17) and a modified shock attenuation model of (18). The calculated melt volume is consistent with an estimate of the present volume of the Sudbury melt system given by (19). Z-model calculations (20, 21), the above mentioned constraints, and the geometric cratering model of (22) resulted in a maximum depth of excavation (d_e) of ~12 km and a depth of the transient cavity of ~35 km for Sudbury (Fig. 1). Under the assumption of validity of the predictions of (5, 17) and of the applied shock

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attenuation the maximum depth of shock melting in the Sudbury crater must have been ~27 km (Fig. 1). This depth is in accordance with a crustal origin of the Sudbury melt system as required from the Nd isotope composition (2, 3; Deutsch et al., this volume). The configuration of dike breccias and megablocks in the subcrater basement (9) suggests that this megabreccia had been established at the end of the transient cavity modification. Observations in other complex impact structures, the application of cratering models (5, 18, 20, 21), and field relations of impact melt sheets in complex craters (23) suggest that the Footwall Breccia layer must represent a part of the uplifted crater floor directly beneath the Sudbury melt system.

The available data along with the calculations presented here result in the following original dimensions of the Sudbury basin: an apparent crater diameter of 180 to 200 km; a transient crater diameter of 100 km; a maximum depth of excavation d_e of 12 km; a depth of the transient crater of 35 km; and an impact melt volume of 12500 to 22500 km^3.

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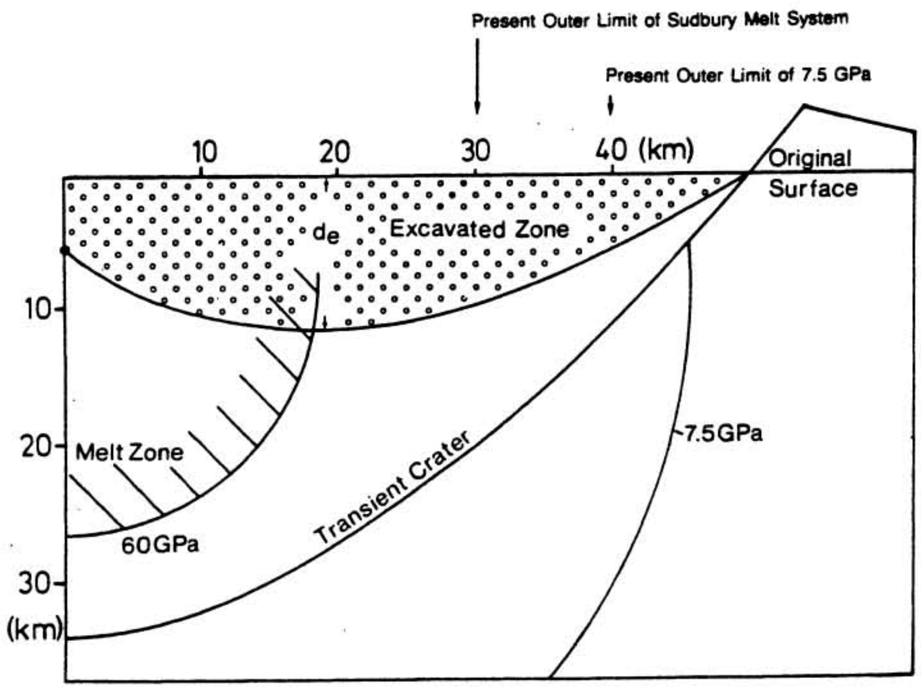

Fig. 1: Transient cavity during the formation of the Sudbury crater. Cratering model has been corrected for tectonic deformation.