SUDBURY BRECCIA OF THE EAST RANGE: SUDBURY IMPACT STRUCTURE, CANADA. J. R. Weirich[1] and G. R. Osinski[1,2], A. Pentek[3], J. Bailey[3] [1]Dept. of Earth Sciences & Center for Planetary Science and Exploration, Western University, London, ON, N6A 5B7, Canada, [2]Dept. of Physics and Astronomy, Western University, London, ON, N6A 5B7, Canada, [3]Wallbridge Mining Company Limited, Lively, ON, P3Y 1L7, Canada. (weirichjohn@gmail.com)

Introduction: The Sudbury Structure has been interpreted to be a 200-260 km diameter impact crater that formed at about 1.85 Ga [1]. The 60 by 27 km Sudbury Igneous Complex (SIC) is the deformed and eroded remnant of the original impact melt sheet [2]. Sudbury Breccia (SB) is an ubiquitous rock type found exterior to the SIC. How and when the SB forms during the cratering processes is still under debate. Much of the work on SB has focused on outcrops on the North and South Ranges of the crater, which are typically clast supported. To give a potentially different perspective, this project focuses on a matrix supported massive (100's of meter wide) outcrop of SB on the East Range. Here we present our preliminary findings of the area.

Sudbury Breccia description and formation scenarios: Sudbury Breccia (SB) is similar in appearance to pseudotachylite found at the Vredefort crater [3]. It consists of a dark matrix with angular or rounded clasts that are often the same rock type as the surrounding wall rock. SB are mm sized veins to 100's of m wide zones, and contain clasts that are 100 um to several m in size. Typically SB is a breccia at all scales and does not have a single clast size.

The most popular scenarios of SB formation are 1) frictional melting/shearing along super faults during crater collapse [4], 2) injection of SIC into the surrounding footwall [5], or 3) shock induced melting or cataclasis [6]. The supporting arguments for the first scenario are that the matrix is often similar in composition to the host rock, and that occurrences of increased SB abundance exist in "bands" surrounding the SIC. However, no fault system has been discovered that could represent this ring system surrounding the crater. Furthermore, [7] showed frictional sliding cannot create thick melt veins unless the melt is continuously drained/injected into surrounding areas. It has yet to be shown if the properties of this melt allow for this type of fluid behavior, or if a sufficient volume of fissures and pockets exist to accommodate enough to melt to create 100's of m wide zones of SB. While there is geochemical evidence that supports the second scenario (injection of SIC) [5], in at least one location SB lying on a contact between two lithologies has a composition intermediate to these lithologies and is quite different from the SIC [6]. There are no major criticisms of the third scenario (an effect of shock), though there is also no definitive evidence for it either. Shock is suggested when no other mechanisms are viable. The disparate findings of various publications may be indicating multiple generation mechanisms of SB, though one mechanism may be dominate.


Figure 1. Field image of Sudbury Breccia; hammer for scale.

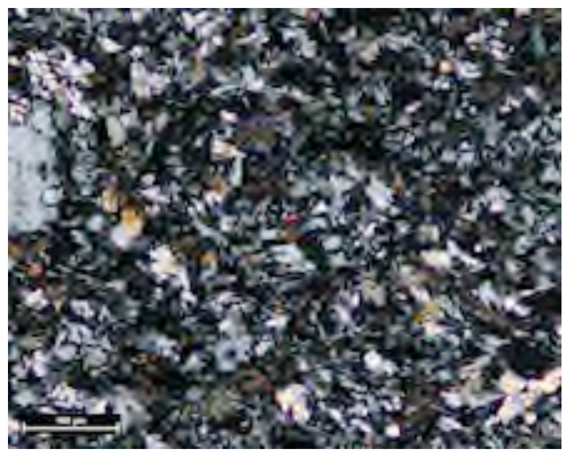
Figure 2. Cross-polar image of matrix. Scale bar in lower left is 100 um

Sample Description: The SB samples in this study come from near Wanapitei Lake off Capreol Rd. The full extent of the SB could not be determined during our time at the site due to dense vegetation, but based upon the exposed outcrops, we know it is at least 50 to 100 m wide. The dense vegetation also prevented us from finding the contact with the host rock, so unfortunately it has not yet been sampled.

The SB in this area is matrix supported (<50% clasts) and contains mostly diabase and granite clasts (Fig. 1), with minor amounts of other clasts such as gneiss. The limited clast diversity will make the analysis straightforward. Since the SB is matrix supported, it will provide a good test of whether large amounts of matrix can be generated in-situ from host rock and clasts or if it has a contribution from the SIC or other melt volume. The matrix is fine grained as can be seen in Fig. 2 and Fig. 3. No reaction rim was found on any of the clasts or inclusions

Results: The matrix is mostly clino-pyroxene, Na-rich feldspar ($Or_{0-16}Ab_{82-97}An_{2-12}$), and K-rich feldspar ($Or_{95-99}Ab_{1-4}An_{0-1}$), with minor amounts of iron sulfides, apatite, zircon, and chlorite. Two feldspars were also found in the granite ($Or_{0-1}Ab_{91-98}An_{2-9}$ and $Or_{98-99}Ab_{1-2}An_{0}$) and diabase ($Or_{0}Ab_{90-99}An_{1-10}$ and $Or_{98-99}Ab_{1-2}An_{0}$). Although the composition of the matrix feldspar is similar to the granite and diabase feldspar, the matrix Na-rich feldspar has a wider range of compositions, suggesting the matrix has an igneous origin and was not created by cataclasis of the granite or diabase.

The high abundance of clino-pyroxene in the matrix makes it quite mafic and definitively rules out granite as a source rock. A nice disparity between the composition of the matrix and granite can be seen in Fig. 3, which shows a matrix vein in a large granite clast. Filling of a facture or other hole in a clast as seen in Fig. 3 is difficult via catalasis and indicates an igneous origin. Furthermore, the grain size of the matrix is fairly uniform, making a cataclastic source unlikely. The composition of the matrix is more similar to that of the diabase clasts. In fact, a sharp boundary could not be determined between the diabase and matrix. This possibly indicates a similar composition and texture. The distinguishing characteristic between the diabase and breccia is the lack of granite clasts within the diabase. Since the diabase makes up a small portion of the clast content, it is less likely to be the host, however it cannot be ruled out as the source.

The classification scheme of [8], categorizes SB as Clastic (clastic matrix with flow features), Pseudotachylite (aphanitic matrix), and Microcrystalline (undergone contact metamorphism with the SIC). Flow features were not seen, and biotite was minor to absent (which would indicate metamorphism). So we have classified this SB as pseudotachylitic.

Future Work: More field work will be performed in an attempt to find and sample the host for the SB. XRF, LA-ICPMS, and/or EMPA will be utilized to further characterize the geochemistry of the SB and country rock. Previous papers on the geochemistry of SB have analyzed bulk breccia that minimized the clast content. However, it is almost impossible to remove all clasts, even with picking, so those results may be on a mixing line of the matrix and clasts/source. To circumvent this limitation, we will attempt to determine the geochemistry with a combination of EMPA data and matrix mineral abundance, as well as use LA-ICPMS to avoid clasts.

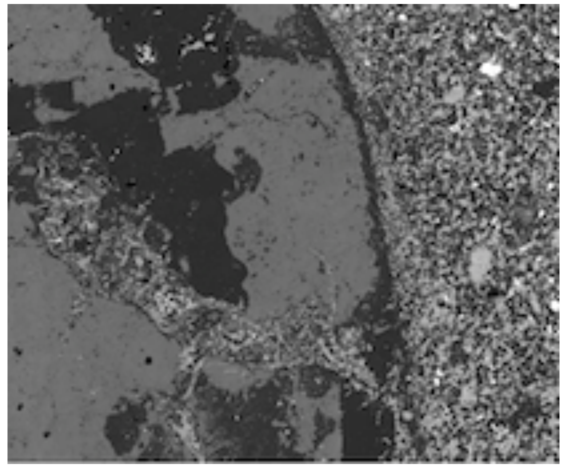

Figure 3. BSE image of Sudbury Breccia matrix (right) penetrating a granite clast (left). Most of the high Z grains in the matrix are pyroxene (bright gray), but some are iron-sulfide (white). FOV is 2.7 mm across.

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