

Using Microstratigraphy and Stromatolite Clastic Behavior to Characterize the Emplacement of the Sudbury Impact Layer in Ontario and Minnesota. J.P. Reed, M.L. Maslowski, T.J. Stromback, W.L. Beatty, C.L. Kairies Beatty, and J.L.B. Anderson, Department of Geoscience, Winona State University, Winona, MN. (corresponding author: J.LAnderson@winona.edu)

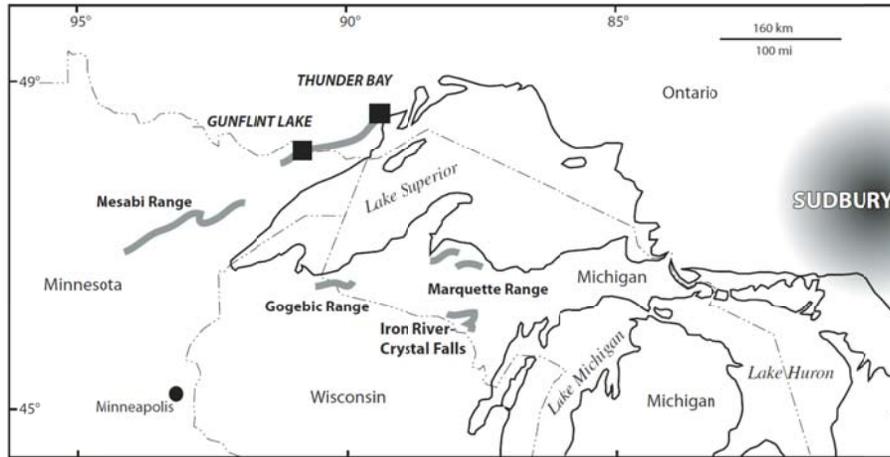


Figure 1. Location of Sudbury Impact Layer (SIL) deposits discussed in this paper (black squares) relative to the Sudbury impact site. (From [1])

Introduction: The Sudbury Impact Layer (SIL) was deposited 1.85 Ga as ejecta from the Sudbury impact event in Sudbury, Ontario, was deposited over the upper Midwest and Canada [2]. The SIL has been identified in outcrop and core samples up to 950 km away from the Sudbury crater in southern Ontario [2], northern Minnesota [2,3], and the upper peninsula of Michigan [4,5] (Figure 1). Following the general description of [1], a typical SIL sequence includes a shocked mega- and meso-breccia at its base comprised of deformed country rock (in the outcrops we observed, banded iron formations sometimes including stromatolites), a gritstone boundary layer, and a thinner ejecta layer with larger lapillistones (Figure 2) beneath smaller spherules (Figure 3). The SIL is unique in that the unit (up to 30 m thick in some places) formed in less than one day and preserves an incredibly detailed record of distal ejecta emplacement from one of the largest known impact events on Earth.

We are currently working on two lines of research at the SIL outcrops in Thunder Bay, Ontario, and near Gunflint Lake in northern Minnesota. First, we are examining the behavior of lithified stromatolites as “quasi-clasts” during the deformation, brecciation, and mixing of local banded iron formations as the shock wave passed and ejecta was deposited. Second, we are analyzing the microstratigraphy of the lapilli-bearing ejecta layers at two outcrops near Gunflint Lake, MN, to better define the processes at work when the ejecta was deposited.



Figure 2. Example of larger lapilli found near Gunflint Lake, MN, some with concentric zoning. These are generally observed above the breccia and below the spherules (Figure 3).



Figure 3. Example of spherules found near Gunflint Lake, MN. Scale bar is 1 cm.

Methods – Stromatolites: Stromatolite-bearing SIL deposits in the Thunder Bay, Ontario area were noted by previous researchers [1,2], but the stromatolites in these outcrops were not examined in detail. For this investigation, stromatolites at three outcrops were cataloged. High-resolution panoramas of two of the outcrops were captured using a GigaPan Epic robotic camera mount. Samples were collected from float at two of the outcrops.

Methods – Microstratigraphy: Two outcrops near Gunflint Lake, MN, showing the transition from ejecta-absent to ejecta-bearing layers within the SIL were selected for this study. Each outcrop was carefully measured and described in detail. Representative samples from the transition and ejecta-bearing layers were collected. A high-resolution panorama of each outcrop was captured using a GigaPan Epic robotic camera mount. Hand samples were cut and scanned at high resolution to observe the structural characteristics of the transition from ejecta-absent to ejecta-bearing units as well as the number, size and shape distribution of lapilli (Figure 4). Petrographic thin sections of these samples are also being prepared.

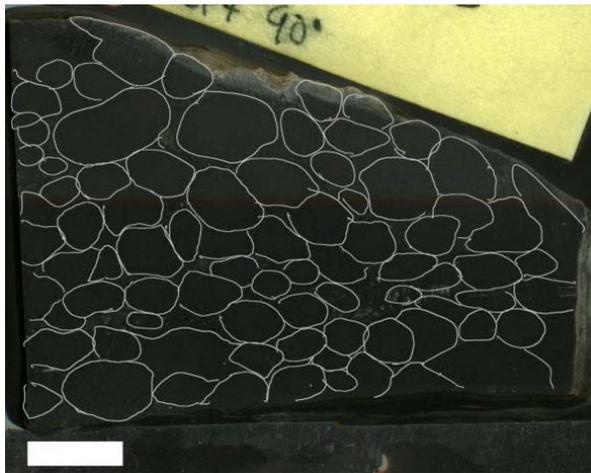


Figure 4. Cross-section of a lapilli-bearing sample (Gunflint Lake, MN) with outlined lapilli. Scale bar is 1 cm.

Preliminary Results – Stromatolites: We observed two types of stromatolite growth forms: laterally linked hemispheroids (LLH) and stacked hemispheroids (SH), after [6]. At two of the outcrops we observed stromatolites *in situ* showing evidence of truncation. A hemispheroidal stromatolite in one of the hand samples appears to have been truncated abruptly and covered with a mix of lapilli and mm-scale breccia (Figure 5). Other stromatolites of both morphologies appear to have been entrained in the ejecta curtain and deposited as clasts in the SIL.



Figure 5. Cross-section of a hemispheroidal stromatolite from the SIL (Thunder Bay, Ontario) showing sharp truncation (arrows). Note large lapilli and breccia above truncation. Scale bar is 1 cm.

Preliminary Results – Microstratigraphy: Most lapilli observed in hand samples appear to be oval-shaped rather than spherical (Figure 4). Lapilli in some hand samples also appear to be somewhat imbricated.

Future work – Stromatolites: We will examine petrographic thin sections of the stromatolite shown in Figure 5 to better characterize the planed boundary and ejecta deposit. We will also investigate the distribution of stromatolites within the SIL breccia to discern possible patterns of deposition based on clast size and morphology.

Future Work – Microstratigraphy: We will complete an analysis of the size and shape distribution of lapilli and spherules in thin section. We will also prepare large- and small-scale stratigraphic sections of the SIL outcrops and attempt to correlate the two.

References: [1] Jirsa, MA, et al. (2011) *GSA Field Guide 24*, p. 147-169, doi:10.1130/2011.0024(08). [2] Addison, WD, et al. (2005) *Geology*, v. 33, doi:10.1130/G21048.1. [3] Jirsa, MA (2010) *Inst. of Lake Superior Geology: 56th Annual Meeting*, v. 56. [4] Pufahl, PK, et al. (2007) *Geology*, v. 35, p. 827-830. [5] Cannon, WF, et al. (2010) *GSA Bull.*, v. 122, doi:10.1130/B26517.1. [6] Logan, BW, et al. (1964) *The Journal of Geology*, p. 68-83.

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