Microstratigraphy of Two Outcrops within the Sudbury Impact Layer in Northern Minnesota. J.L.B. Anderson, W.L. Beatty, and C.L. Kairies Beatty, Winona State University; Winona, MN (JLAnderson @winona.edu).

Introduction: The Sudbury Impact Layer (SIL) was deposited 1.85 Ga as ejecta from the Sudbury impact in Sudbury, Ontario, fell over southern Ontario [1] and the upper Midwest [1,2,3,4,5]. Following the general description of [2], a typical SIL sequence includes a shocked mega- and meso-scale breccia at its base composed of deformed country rock, a gritstone boundary layer, and a thinner ejecta-bearing layer with larger lapilli stones beneath smaller spherules. The SIL is unique in that the unit (up to 30 m thick in some places) formed in less than one day and preserved an incredibly detailed record of distal ejecta emplacement from one of the largest known impact events on Earth.

Microstratigraphy and Methods: Two outcrops located 1.7 km apart in northern Minnesota (Stops 3 and 5 from [2]) showing the transition from ejecta-absent to ejecta-bearing layers within the SIL were selected for this study. Our goals were to (1) correlate two closely spaced SIL outcrops, (2) search for evidence of processes acting during SIL emplacement, and (3) assess whether the lapilli and/or spherules were warm or cold when deposited. Each outcrop was carefully measured, described in detail and sampled. A high-resolution panorama of each outcrop was captured using a GigaPan Epic robotic camera mount. In the lab, hand samples were cut and scanned at high resolution and thin sections were prepared.

Results: *Correlating the outcrops.* While all of the major units described in [2] were present between the two outcrops, each outcrop was missing one of the major units, although not the same one. Despite being so close to one another, the two outcrops were more diverse than expected. The microstratigraphy will be discussed in more detail in the presentation.

Evidence of emplacement processes. At both outcrops the deposition of ejecta, especially that of the spherules, appears less orderly than might be expected from ballistic emplacement but more orderly than might be expected from a ground-surge or debris cloud [e.g., 6]. At Stop 3, the spherules form centimeter-scale lenses or thin beds within the surrounding finer-grained ash matrix (Fig. 1) that repeat for at least 10 cm. This suggests a cyclical or pulsating mechanism that separated the spherules from the rest of the ejecta-bearing material as they were deposited.

Lapilli temperature when deposited. We initially set out to determine whether the lapilli were cold or warm when deposited by looking for cracks or softening features in hand sample and thin section. We instead observed pressure solution features in the lapilli-bearing layers, including stylolites, volume loss within lapilli (Fig. 2), and concave-convex grain contacts. We suggest that these are the result of intrusion of the Logan Sill at 1.115 Ga which thermally metamorphosed the SIL in northern Minnesota. SIL deposits observed in Thunder Bay, Ontario, do not show comparable evidence of pressure solution and are stratigraphically further away from the Logan intrusion than the SIL in northern Minnesota.

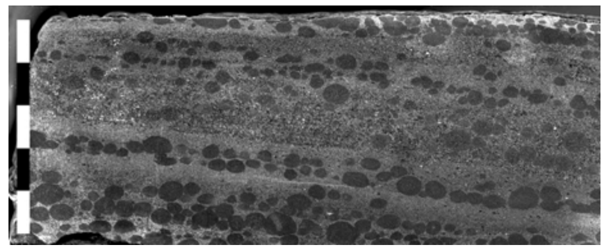

Figure 1. Cross-section of spherule layers outcrop interbedded with fine-grained ash matrix at Stop 3. Scale is 5 cm.

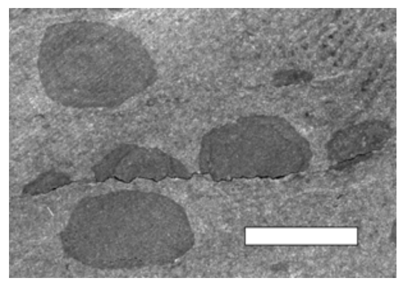

Figure 2. Pressure solution features including stylolites and volume loss in Gunflint Trail lapilli found at Stop 3. Scale is 5 mm.

Conclusions: Deposition of the ejecta-bearing units within the Sudbury Impact Layer in northern Minnesota shows moderate lateral variation on a kilometer scale. At the same time, the spherule-rich layers show centimeter-scale vertical bedding. Models for the emplacement of this deposit may predict the lateral variation but must also explain the small-scale layering of ejecta. Lastly, the lapilli in northern Minnesota have been modified after deposition, potentially by thermal metamorphism from the overlying Logan Intrusion, and cannot be used to infer the immediate post-impact condition of the ejecta in this region.

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