DISCOVERY OF SPHERULE LAYERS AND SUEVITIC BRECCIAS AT THE BASE OF THE MISTASSINI GROUP, PALEOPROTEROZOIC, NORTHERN QUEBEC, CANADA.

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Introduction: The Mistassini Group (MG) encompasses clastic units confined to the Papaskwasati Embayment (PE) located northeast of Lake Mistassini and a sequence of dolomite, locally with stromatolites, overlain by an iron formation both pertaining to the Mistassini Basin (MB). The clastic sediments were thought to be transitional with the dolomitic units [1] but until now it remained speculative. Nevertheless, a common feature of PE and MB is the deeply fractured and altered archean basement that underlies the sediments, a character that has been assimilated to a regolith [1] [2]. The spherule layers and the suevitic breccias reported here are all located above the unconformity at the base of the sedimentary units of MB and PE respectively. A genetic relationship with the regolith is suspected.

Geological framework: The MG lies on archean granitoids and gneisses of the Superior Province. The same settlement is observed with the Otish Basin (OB) located to the northeast and for which correlations have been proposed based on the clastic units of the PE [1] [2]. Together, MB and OB constitute a wedge of paleoproterozoic sediments which is nearly 40 km wide and 350 km long. This wedge strikes northeasterly, is defined to the northwest by an erosion limit, thickens toward the southeast and is limited by the Grenville Province (GP). Both MB and OB display a well expressed longitudinal lystric faulting of their sedimentary pile, including the gabbro sheet in OB. That structural style has been induced by a tectonic transport toward the southeast, a transport governed by the uprightness of the units and a deformation likely synchronous with the uplifting of the basement rock units.

Age constraints: The archean shield has been intruded by the Mistassini dike swarm which extends over 400 km northwestward and fans on nearly 35 degrees of arc. Its apex is virtually located some 280 km to the southeast in the GP. Those dikes did not intrude the MG. One dike has given an age of 2515 Ma (U-Pb on baddeleyites) [3]. Given the correlation established between the clastic units of the PE and the OB [1] [2] and the intruding character of the Otish gabbro which has been dated at 2169 Ma [4], the spherule layers and the suevitic breccias have likely been emplaced between 2515 and 2169 Ma.

Spherule layers: Two spherule layers 40 km apart have been discovered while performing a regional survey in the area of Lake Mistassini. The westernmost layer is made of millimeter-size spherules embedded within a dolomite-rich matrix. A dissolved sample has revealed splash forms characteristic of meteorite impact ejecta. Some of the spherules are very rich in phosphorus compared to the matrix. The aggregated thickness of the layer is presently roughly estimated to one meter and it has been dismembered by the carbonate melt. Larger debris are also observed in the vicinity of the spherule layer, among those:1) a carbonado-like carbon allotrope of extreme toughness, and 2) partly melted granitoid fragments showing vitrification of plagioclases. Both spherules and larger clasts are literally welded to the dolomite and display a reaction rim. We tentatively correlate the present layer with the distal spherule layer observed in South Greenland [5]. It is thought that Greenland was in the neighborhood at that time. The easternmost spherule layer, not studied yet, is used as a substrate for the stromatolites.

Suevitic breccias: Outcrops of suevitic breccias are observed at two localities 12 km apart within the PE. Decorated PDFs have been observed in a quartz grain contained in one breccia. The glass fragments content can reach 65% locally. Spherules and accretionary lapillis are observed within the two outcropping areas observed until now. Diamond drilling has been performed in between those two outcropping areas. The cores confirm the extension of that suevitic breccia which is intimately related to a melt sheet looking like a quartz feldspar porphyry.

Conclusion: Lake Mistassini is 130 km long, its arcuate shape has been noticed since a long time, a feature often inferred to an impact structure. The present discovery strengthens such an interpretation, especially if one considers that the origin of the arcs, defined by the shorelines, coincides with the apex of the Mistassini dike swarm which is 280 km to the southeast. If those features are relevant to a meteorite impact, the final crater has a minimum outer diameter of 560 km. Based on the physical parameters of the Greenland spherule layer, the impactor has a diameter ranging between 46 and 73 km [6]. Such an impactor, depending on the physical parameters used for the modeling, can create a transient crater 125 km deep and a final crater of 800 km in diameter [7]. These new findings support the existence of a huge meteorite impact structure, here named Mistassini-Otish, and will shed light on many unresolved conundrums of the Paleoproterozoic. The shatter cones of the Rouleau Island likely just found their parents.

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