MELTING OF SEDIMENTARY TARGET ROCKS FROM THE STEEN RIVER IMPACT STRUCTURE: EVIDENCE FROM THE BULK COMPOSITION OF IMPACT MELT.

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Introduction: The Steen River impact structure is a buried complex crater located in northwestern Alberta, Canada. It has a maximum diameter of 25 km and consists of a ~4 km diameter central uplift [1] overlain and surrounded by a unit of impact breccia and associated with disturbed Devonian sedimentary units. The target material at the time of impact was comprised of crystalline basement of the Canadian Shield overlain by 1.6 km of Devonian sedimentary lithologies containing predominantly shales with carbonate, evaporite and sandstone units in order of decreasing abundance [1, 2]. The impact melt within the crater has been described and characterized through studies on the electron microprobe, the scanning electron microscope, and petrographic microscope. The samples studied were taken from a drill core (ST003) that penetrated 164 m of impact breccia and 11 m of crystalline basement from the central uplift; more than 70 thin sections were made from this core and comprise the sample suite for this study.

Description of Melt: Impact melt in the polymict breccia at Steen River is present in a wide range of shapes, colors and sizes. Individual clasts of quenched melt have been subdivided into a matrix component (<1 mm) and larger melt clasts (>1 mm). Of the lithic clasts within the breccia, these being sedimentary in the upper breccia units and granitic in the lower units, only the granitic clasts are directly associated with melt. This occurs as an enrobement or halo of melt around the outer edge of the clast. Spot measurements were collected from matrix melt, melt clasts and melt halos using a JEOL 8900R electron microprobe in order to compare the compositions from each of these melt subgroups.

Results and Discussion: Representative compositions are plotted on a ternary diagram in Fig. 1. The matrix melt composition clusters near to the average shale composition [3], while the melt halo points extend towards a potassic endmember. These results indicate that the matrix melt is predominantly derived from the melting of Devonian shale units, while the melt halos contain a significant proportion of granitic material; this is expected as shales constituted much of the sedimentary target material. The color of the melt clasts is also dependent on composition: lighter-colored clasts are enriched in alkali elements and are likely derived from melted carbonate units, while the dark-colored melt is slightly enriched in ferromagnesian elements and suggests a granitic contribution, from biotite or amphibole. X-ray elemental maps of the melt halos on the granitic clasts provide additional insight into their origin; the melt is banded parallel to the edge of the associated clast and shows compositional gradation perpendicular to the clast edge. This gradation is apparent in the abundance of K and Na present in the halo (also seen in Fig. 1), and suggests that the melt is indeed derived from the associated granitic clast.

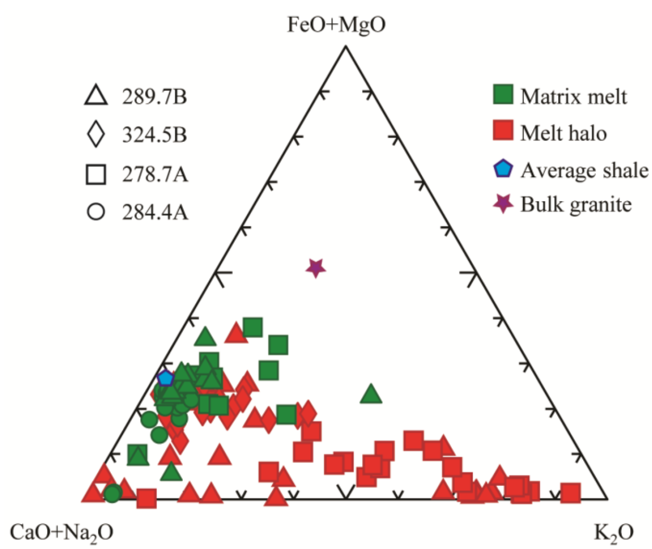

Figure 1. Comparing compositions of matrix melt and melt halos from four thin sections at different depths (in meters) in core ST003.

Conclusion: The high volatile content of the shales, and their inherent brittle nature would have resulted in a high fragmentation rate and the small particle sizes of the matrix melt. The shock energy experienced by the shales would have been higher than that in the underlying crystalline material, and would also have contributed to the increased fragmentation. The granitic clasts would have interacted with the superheated impact melt as it flowed away from the central uplift, resulting in their partial incorporation and later fragmentation in the breccia. The type and abundance of target material greatly influenced the amount and characteristics of the impact melt produced.

References: [1] Winzer, S. R. (1972) *24th International Geological Congress Proceedings* 15: 148-156. [2] Alberta Geological Survey (2015): Alberta Table of Formations; Alberta Energy Regulator. [3] Molak, B., Balzer, S. A., Olson, R. A., and Waters, E. J. (2001) *Alberta Geological Survey, Earth Sciences Report 2001-04*: 91p.