THERMAL METAMORPHIC SIGNATURE IN MELT-BEARING POLYMICT BRECCIAS FROM THE STEEN RIVER IMPACT STRUCTURE, CANADA.

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Introduction: Melt-bearing polymict breccia, similar to so-called "crater suevite" described from Ries, has been documented from other small to medium size impact craters and those formed in mixed targets [1-3]. This breccia type typically forms a volumetrically significant portion of allochthonous impactites; however, their mechanism(s) of formation is still debated, with recent studies calling on fuel-coolant interaction to explain certain characteristics [3]. Detailed petrographic studies of these and related impactites can help to shed light on their genesis. In this study we describe a 127 m thick, remarkably uniform deposit of polymict breccia containing co-genetic impact melt clasts from the Steen River impact structure (SRIS) in NW Alberta, Canada.

Materials and Analytical Methods: The SRIS is a 25-km diameter buried complex crater. One continuous but shallow diamond drill core, ST003, which penetrated the side of the central uplift, has been sampled as part of this study, from which 72 thin sections were prepared. The mineralogy, texture and composition of impactites between 240–367 m depth were examined using optical microscopy, BSE imaging, X-ray elemental mapping, electron microprobe analysis and Raman spectroscopy.

Results: All of the impactites encountered in the ST003 core can be classified as what has previously been referred to as suevite. The matrix contains ~60 vol% crystals, embedded in a groundmass of secondary alteration products (clays), representing alteration products of primary glass. The mineralogy is dominated by clinopyroxene + sanidine + albite (3-60 μm). All crystals have a poikilitic texture. Clinopyroxene occurs as prismatic, euhedral to subhedral hedenbergite and diopside ($En_{18-48}Fs_{3-33}Wo_{42-50}$) enclosing tiny 5 μm to ≤1 μm euhedral crystals of feldspar and Fe-Ti oxides. Plagioclase ($An_{1-42}Ab_{54-99}Or_{0-7}$) and sanidine ($An_{1-4}Ab_{9-29}Or_{66-88}$) also occur as larger euhedral to subhedral single crystals enclosing euhedral clinopyroxene and ilmenite. Ilmenite forms a volumetrically minor but ubiquitous component of the samples studied, observed as tabular crystals (12–45 μm) enclosing or partially enclosing smaller grains of clinopyroxene and feldspars. In addition to these poikilitic crystals disseminated throughout the matrix, heterogeneous crystal clusters occur as coronas surrounding clasts (subsequently replaced by clays). These include euhedral magnetite, titanite, garnet and pyroxene + plagioclase + ilmenite assemblages. Garnets are equant 10–60 μm size crystals of grossular $(Ca_{2.97}Mg_{0.03})(Al_{1.2}Fe^{3+}_{0.80})(Si_{2.96}Al_{0-04})O_{12}$, zoned to andradite $(Ca_{2.96}Fe_{0.02}Mn_{0.01})(Fe^{3+}_{1.82}Al_{0.15}Fe^{2+}_{0.01}Si_{0.01})\ Si_3O_{12}$.

Conclusions: The assemblage of pyroxene + sanidine + plagioclase + oxides + titanite + garnet in the matrix of allochthonous impactites at the SRIS could have formed by a high degree of thermal recrystallization of a fine-grained superheated clastic matrix. The unique nature of the matrix represents a previously unrecognized impactite type, which may require a new term for such deposits as a variety of melt-bearing polymict breccia.

References: [1] Grieve 1978. *Proc, 9th LPSC* pp. 2579-2608. [2] Claeys et al. 2003. *MAPS* 38:1299-1317. [3] Stöffler et al. 2013. *MAPS* 48:515-589.