THE SUEVITE CONUNDRUM: THE RIES SUEVITE AND SUDBURY ONAPING FORMATION COMPARED.

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Introduction: The impact breccia lithology termed "suevite" was originally defined from its type occurrence at the Ries impact structure, Germany. The original proposed impact genesis for the main variants of the Ries suevite (RS) was as ballistic ejecta and subsequent "fallout" from an ejecta plume, producing so-called "fallback suevite" in the Ries crater depression and "fallout suevite" in the interior and exterior regions of the rim [1, 2]. This remained the working hypothesis for over four decades until it was proposed that the Ries "fallout" suevite has characteristics more in keeping with a flow-like origin, specifically a matrix consisting of particles of various impact melts [3]. Recently, an alternative hypothesis has been proposed; namely, the genesis of the bulk of the RS (i.e., crater suevite (fallback) and outer suevite (fallout or surficial)) was the result of the explosive molten-fuel-coolant interaction (MFCI) between a temporary impact melt pool with water [4, 5].

This exact MFCI mechanism has been proposed previously as the working hypothesis for the genesis of the 1.4–1.6 km thick series of breccias known as the Onaping Formation (OF) at the Sudbury impact structure, Canada. It was proposed that the bulk of the OF formed as the result of repeated and evolving interaction between inundating seawater and the still molten, impact melt pool, now represented by the Sudbury Igneous Complex (SIC) [6]. Importantly, it was explicitly stated that the basic properties of the OF are not equivalent to what is observed in the RS and it was argued that, in fact, the breccias of the OF are not "suevites" [6]. Thus, a current conundrum exists as to what exactly constitutes "suevite" breccias and how they form, both at the Ries type locality and at other impact structures.

Observations: The basic characteristics of the RS and the OF are documented and compared with the properties of MFCI deposits.

Stratigraphy and lithologies. The OF lies stratigraphically above the Sudbury Igneous Complex (SIC), a 2.5–3 km thick differentiated impact melt sheet. The OF itself is internally layered, with different mappable lithologies. Unlike the OF, the RS do not lie stratigraphically above a known impact melt sheet and, although there are variants, they are determined less by distinct lithological and stratigraphic differences but more by geological context. There is also no internal layering.

Vitric clasts. Vitric material dominates the OF, comprising > 60 vol.% of the Sandcherry Member. The vitric clasts are equant, blocky, fluidal or cuspate in morphology and are typically very similar in shape in a particular lithology. This is similar to MFCI deposits. In contrast, the vitric clasts in the RS have "a wide range of sizes, shapes, and textures", have mineral and lithic clasts, vesicles and schlieren.

Internal structures and sorting. The OF is bedded and graded to various degrees, with bedding becoming better defined and finer with stratigraphic height height [7]. The Ries suevite is generally described as displaying no sorting or grading [8]. A key characteristic of MFCI deposits is that their vitric clasts are well to very well sorted [9, 10]. The degree of sorting in these deposits has been quantified, using the semi-automated image analysis. These results clearly demonstrate that the RS and OF are completely different in terms of the degree of sorting, with the OF being well to very well sorted.

Conclusions: In virtually every instance, there are clear and significant lithological, stratigraphic and petrographic differences between the OF and the RS. It follows from the fundamental principles of geology that these two rocks types cannot, therefore, share the same history and formation mechanism(s). Unlike the RS, the OF shares many similarities with MFCI deposits [9, 10], most important of which are that both these deposits are layered, well sorted, relatively fine-grained, dominated by vitric particles with similar shapes, and deposited at relatively low temperatures. Thus, if MFCI is a viable working hypothesis for the genesis of the OF, these differences argue against the viability of MFCI as a working hypothesis for genesis of the RS.

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