Impactites beyond metamorphism: A plasma origin of vesicles.

C. Bender Koch[1], T. Kasama[2], C. Gundlach[3], and J. Wynn[4], [1]Department of Chemistry, University of Copenhagen, Denmark (cbk@chem.ku.dk), [2]CEN, Technical University of Denmark, Denmark (tk@cen.dtu.dk), [3]Department of Physics, Technical University of Denmark, Denmark (cagu@fysik.dtu.dk) , [4]USGS, Vancouver WA, USA (jwynn@usgs.gov).

Introduction: Vesicles of various size and shape are often observed in impactite melt glasses from both large and small scale impact structures. Particularly, both the so-called white and black silicate-dominated impact glasses found at the very young (app. 300 years), small scale impact site of an iron-meteorite in the desert sand dunes at Wabar, Saudi Arabia exhibit abundant vesicles [see e.g. 1, Fig. 1.]. It is commonly agreed that vesicles in impactites are the result of simple outgassing from a silicate melt controlled by decreasing gas solubility during the decompression phase [1]. The gasses dissolving from the silicate melts are assumed to include both water and carbon dioxide. The morphology of the gas vesicles will reflect the gas-melt interface, approximating a sphere and reflecting the overall dynamic of the melt as it cools to its melting temperature. This is in accordance with the observation of essential circular vesicle cross-sections in thin sections of impactites. Furthermore, we may expect an essentially smooth glass-vesicle interface morphology to freeze-in on cooling, essentially preserving the gas-melt interface as formed at high temperatures.

Results and discussion: To test this assumption we have investigated glass-vesicle interfaces in black Wabar impactites at various resolutions using tomography and microscopy. As an example of the observed interface structures Figure 1 shows a vesicle exposed by cutting through the impactite.

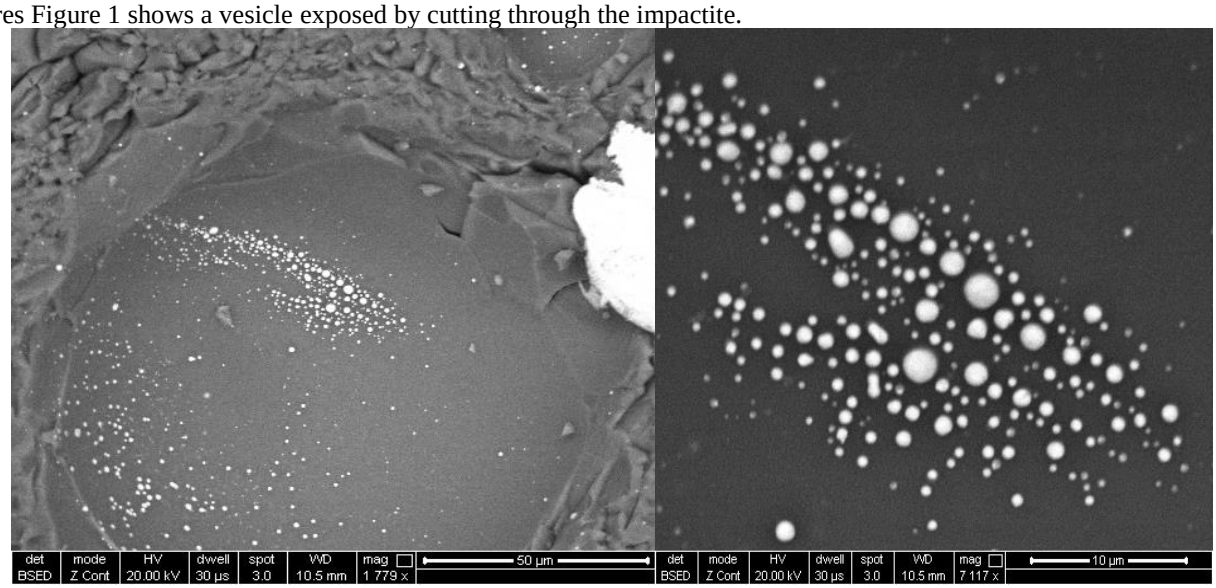

Figure 1. Micrographs of a vesicle from black Wabar impactite glass (backscatter electrons). Left: Overview of the spherical vesicle dominated by a smooth glass-vesicle interface (grey). The white dots are spherules of FeNi metal deposited on the glass in string-like patterns (at the central part) and random patterns (lower left) A few spherules are embedded in the glass. Right: Detail of the central part of the vesicle with string-like deposits of FeNi spherules (white; approx. diameters between 0.1 and 3 µm) on glass (grey). No spherule is in direct contact with adjacent spherules.

The finding of metal spherules deposited at the vesicle/glass interface indicates a sequence of formation where metal spherules precipitation postdates the formation of the vesicle. One consistent scenario for this sequence involves formation of the impactite as a composite structure including droplets of metal-based plasma determining the overall spherical morphology of the vesicles. On cooling the vesicles becomes supersaturated in metal causing nucleation and growth of metal spherules inside the vesicle. Finally, the spherules are deposited on top of the glass-vesicle interface and the cooling of the glass ensures a sufficiently rigid morphology that preserves the vesicle morphology. Thus, exsolution of gas molecules from the melt play no role in the vesicle formation process. Rather, these vesicles are remnants of the highest P,T conditions during impact.

References: [1] Hamann C. *et al*., (2013) *Geochemica et Cosmochemica Acta* 121:291-310.