IMPACT FOSSILIZATION: THE REPSONSE OF EXTANT LIFE TO ULTRA-HIGH TEMPERATURE CONDITIONS. R. S. Harris[1], P. H. Schultz[2], S.J. Clemett[3] and K.L. Thomas-Keprta[3], [1]Fernbank Science Center, Atlanta, GA 30307 (gageologist@gmail.com), [2]Department of Geological Sciences, Brown University, Providence, RI 02912, [3]Jacobs Technology Inc., Houston, TX 77058.

Introduction: Despite the harsh circumstances of their creation, impact melt ejecta have been demonstrated to preserve delicate skeletal and biochemical remains of flora that likely were living or recently deceased at the time of the collisions [1]. We also have identified the remains of vertebrate fauna in some impact glasses (Fig. 1A-B). Although equally complex organisms may not be anticipated on the early earth or other planetary surfaces, the experimental study of the conditions and mechanisms by which impact fossilization occurs is important for understanding the processes involved and accessing what types of biological signatures can be recorded by impact ejecta in the geologic record. Furthermore, the preservation, survival, and possible evolution of the microflora living within and on the surfaces of these higher-order organisms are relevant directly to astrobiological investigations. We have observed vitrified bacteria-like forms (e.g., Fig. 2) in these melt ejecta. Finally, the organic remains, along with extant water and other volatiles trapped in some melts by the rapid heating and quenching of wet sediments [2] (Fig. 1A), could provide nutrients for the diversification or establishment of new microbial communities.

Ultra-High Temperature Experiments: Experimental glasses produced at temperatures between 1000 and 1700 °C have been used to demonstrate that ultra-high temperatures (>1500 °C) and rapid quenching are necessary to reproduce the fossilization of plant material observed in natural impact melt breccias [1]. We have continued those experiments to investigate the preservation of other biological materials, including vertebrate cartilage (Fig. 1C). We have found similar results suggesting that ultra-high temperatures and relatively-low oxygen fugacity are required to preserve the structures observed in the natural samples.

We also are accessing in more detail the changes in preservation of biochemical remains as a function of temperature, fugacity, and volatile concentrations in the impact environment. And we are investigating the indigenous microflora on the plant and cartilage surfaces before and after entrainment in the melts. We are applying laboratory-grade *E. coli* bacteria to some samples to monitor their preservation. Additionally, the bacteria are applied to some freshly created glasses in order to observe to what degree they utilize the glass as food or habitat.

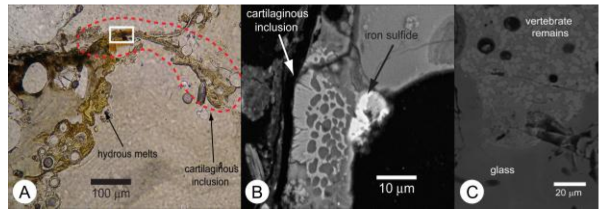

Figure 1. A) Plane-polarized light photomicrograph of mid-Pleistocene impact glass containing inclusions of hydrous melt and cartilaginous remains of vertebrates that were living in a fluvial environment. B) Backscattered electron (BSE) photomicrograph showing a section of the cartilaginous material. C) BSE photomicrograph of preserved shark cartilage in andesitic glass produced experimentally at 1600ºC.

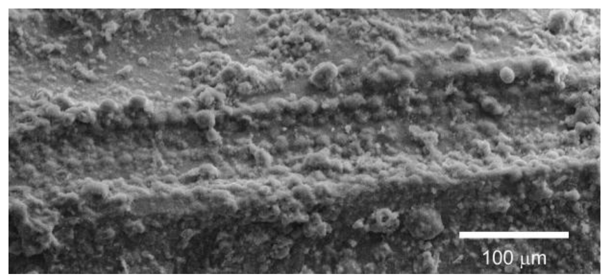

Figure 2. BSE photomicrograph showing the surface of an impact-fossilized leaf. The skeleton of the leaf has been preserved as quenched vitreous silica containing some remnants of the original organic matter [1]. The leaf surface is coated by structures reminiscent of bacterial colonies in a biofilm.

References: [1] Schultz P. H. et al. (2014) *Geology, 42*, 515-518. [2] Harris R. S. et al. (2007) *LPI Contr. No. 1360*, 8051.

Acknowledgements: We appreciate the assistance of Alberto Patiño-Douce and Chris Fleisher and access to ultra-high temperature metamorphism and electron microscopy facilities at the University of Georgia.