MICROBIAL TRACE FOSSILS PRESERVED IN IMPACT MATERIALS. H. M. Sapers[1,2], G. R. Osinski[1,2,3], N. R. Banerjee[1,2]. [1]Centre for Planetary Science and Exploration, University of Western Ontario, London, ON, Canada, 1151 Richmond St, N6A 5B7. [2]Department of Earth Sciences, ibid. [3]Department of Physics and Astronomy, ibid.

Introduction: Impact materials represent understudied microbial substrates with the potential to preserve evidence of life from early Earth as well as the potential for life on other planets. Meteorite impact events create unique microbial niches that may have been significant habitats on early Earth and are important astrobiological targets on other rocky bodies such as Mars [e.g. 1, 2]. Given the probable ubiquity of impact glasses in post-impact environments throughout the Solar System, it is important to understand the biological components and potential of such systems on Earth. Recently, microbial ichnofossils were described in meteorite impact glass from the Ries impact structure, Germany [3]. To the best of our knowledge there are only four other studies reporting *potential* fossil evidence of biological activity in impact systems. Here we compare and contrast the evidence from all these studies in an attempt to ascertain the astrobiological potential of meteorite impact structures.

Biosignatures: A biosignature is an observable feature produced through biological processes that cannot be attributed to abiotic phenomena [4]. Characterization of a putative biosignature, such as a morphological microfossil, must involve a suite of complimentary multi-scale, multi-analytical techniques to unambiguously demonstrate that the feature is both indicative of biological activity and that it cannot be formed through abiotic processes [e.g., 4-6]. Both morphological and geochemical evidence of biological process and/or behavior combined with a geological study of the host material illustrating syngenicity and antiquity with the substrate must be demonstrated [4, 6] Despite decades of research establishing biogenicity criteria [e.g., 6-8], demonstrating the unambiguous biogenic origin of putative microfossils remains challenging [e.g., 9].

Trace fossils in impact materials: To date, to our knowledge, there have been five reports of putative trace fossils in impact materials: microbial etching of hydrothermal minerals at the Ries impact structure [10], the presence of rod-shaped biomorphs in post-impact hydrothermally altered sediments from the Chesapeake Bay impact structure [11], evidence of extracellular polymeric substances in a hydrothermally precipitated calcite vein from the Siljan impact structure [1], a report of filamentous 'fossils' hosted in hydrothermally precipitated mineral assemblages within fractured impact breccia from the Dellen impact structure [12], and most recently, microbial tunneling in impact glasses from the Ries impact structure [3].

Three of these five studies; microbial etching at the Ries [10], rod-shaped biomorphs at Chesapeake Bay [11], and filamentous 'fossils' at Dellen [12], fail to recognize both multiple biogenicity criteria as well as a systematic study of the host material underscoring the difficulty in ascertaining the biogenicity of a putative trace fossil and the importance of following a multi-analytical approach to characterizing enigmatic features.

In the Hode et al (2009) study of mineralized EPS at the Siljan impact structure [1], rigorous microscopy and detailed geological context meet biogenicity criteria. It is worth noting, however, that the host material is not unique to an impact structure. The hydrothermal minerals, while precipitated in a impact-generated hydrothermal system, are common in non-impact associated hydrothermal systems. This study does add to a growing body of evidence highlighting the astrobiological significance of impact-generated hydrothermal systems on Earth and Mars [14].

The study of the microbially mediated alteration of impact glass at the Ries impact structure [3] not only presents both morphological and geochemical evidence of biogenicity, but also a systemic and thorough geological study of the host material. This study represents the first report of microbial activity preserved in material unique to the impact cratering process.

Conclusions: The goal of characterizing morphological microfossils is not only to identify attributes as uniquely produced by biological processes, but also to be able to recognize these attributes as unambiguous indicators of life. An understanding of the preservation of past biogeological processes directs our search for life beyond Earth on planets such as Mars.

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