

CHEMICAL STRATIGRAPHY OF PHOSPHORUS IN AN ARCHEAN IMPACT LAYER. J. M. Sampson¹ Z. Atlas¹, R. Buick², E. Stueeken² N. L. La Cruz¹ and M. A. Pasek¹, ¹School of Geosciences, University of South Florida 4202 E. Fowler Ave. NES 207, Tampa, FL 33620, ²Earth & Space Sciences, University of Washington, Johnson Hall Rm-070, Box 35130, 4000 15th Avenue NE, Seattle, WA 98195-1310.

Introduction: Extraterrestrial impacts are well-recognized as potentially having a huge influence on the development of life on the Earth [1]. However, the impact record on the early Earth is poorly understood. Tectonics and an active hydrological cycle have prevented the preservation of craters throughout the early Earth's history[2][3]. In spite of this lack of preservation potential extraterrestrial impacts can be recorded from the Archean and early Proterozoic in the form of spherule layers[4].

Spherules are a diagnostic and characteristic feature of distal impact ejecta. They are the molten or vaporized rock material that was ejected upon impact that subsequently solidify in the atmosphere in droplet forms. Deposition of spherules occurs rapidly providing an instantaneous time stratigraphic marker with potential for preservation of the thin layers in low-energy settings[5].

Phosphorus (P) is a critical element in modern biochemical systems and presumably was so during the origin of life. The prebiotic formation of these molecules using common terrestrial P minerals such as apatite is impeded by a lack of reactivity and poor solubility[6][7]. The origin of phosphite in early Archean carbonates may thus have resulted from the corrosion of the meteoritic mineral schreibersite[8]. Here we investigate the chemistry of the Bee Gorge impact layer from the Wittenoom Formation in the Hamersley Basin, Pilbara Craton, Western Australia with the goal of determining whether impacts can alter P geochemistry, and whether impacts are plausible sources of phosphite in the Archean.

Method: Twelve samples were reacted with solutions in preparation for analytical analysis using a High Performance Liquid Chromatograph (HPLC) coupled to an Inductively Coupled Plasma-Mass Spectrometer (ICPMS) for the identification of reduced P species. Ten 1x1x0.5 cm³ samples were removed from a 10 cm thick section that encompasses the Bee Gorge spherule layer of the Wittenoom Formation. Each sample is representative of a 1 cm change in depth. Two samples were produced from a sample of synthetic schreibersite that was reacted with two different solutions (seawater (Instant Ocean), and seawater with disodium EDTA).

Results and Discussion: Phosphite is present in the Wittenoom Formation in the carbonate layer immediately above the spherules in sample 4. Smaller

but quantifiable amounts of phosphite are also present in 5, 7, and 8. Sample 4 also contains two unidentified P compounds. Phosphorus speciation resulting from the corrosion of synthetic schreibersite verifies detection of at least 3 of these species by the HPLC-ICP-MS method.

The presence of phosphite near the Bee Gorge impact spherule layer hint of an extraterrestrial origin since few sources of phosphite are found in nature[9]. A plausible origin to the phosphite is the deposition of schreibersite or other reduced P-bearing materials after the impact followed by the slow release of phosphite and phosphate to the surrounding environment. Schreibersite is a phosphide mineral common in iron meteorites and it reacts with water to yield phosphite and phosphate, among other P oxyanions. The origin of phosphite in early Archean carbonates may thus have been extraterrestrial therefore implicating extraterrestrial material in the origin of life on earth.

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