EPSC Abstracts
Vol. 13, EPSC-DPS2019-944-1, 2019
EPSC-DPS Joint Meeting 2019

EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

The Moon as a Thanatocoenosis: Is there any hope for Lunar Paleontology?

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Abstract

The definition of a thanatocoenosis is an assemblage of fossil materials that exists in a particular deposit because they were transported there by some natural process, e.g. a river, a predator, wind, etc. The dominant characteristic of such assemblages is that they are a mixture of species that mostly did not live together in life but found themselves with new fossil friends post-mortem. In the case of possible biosignature-containing Earth ejecta that may have made its way to the Moon, the transport mechanism is the dramatic result of major impacts taking place on Earth and potentially gifting the Moon with such materials. This idea has been advanced before [1], [2], [3] but in light of a potentially imminent enhanced cadence of human and robotic lunar exploration opportunities as we approach the second quarter of the 21st Century, the authors propose a concerted assessment of the potential practical ways in which such searches for fossil/biogeochemical/mineralogical evidence from Earth's biosphere might be found.

1. Relevant Scientific Advances

In order to detect a hypothetical lunar thanatocoenosis, several conditions must be met. First, either life-containing or fossil-containing material from the Earth must be ejected from its parent body with sufficient energy so as to receive escape velocity, and without entire disruption of its structure (e.g., through complete melting) in so doing. Second, this material must impact the Moon and in so doing, not have its structure and thus evidence of fossil matter destroyed. Third, the material must either survive on the lunar surface (e.g., not be impacted and turned into regolith) or be uplifted to the lunar surface through lunar processes prior to detection. Finally, the material must be sufficiently different from lunar material to be detectable either through *in-situ* instrumentation or via sample return.

Over the past decade or so, significant plausibility experiments have been conducted to test the survivability of organics and microorganisms to various environmental challenges that would beset transfer of biologically significant materials from Earth to the Moon (e.g. [4], [5]). Very recently, the claim of a potential Earth-originating portion of an Apollo sample has been made [6]. If true, this lends credence to the notion that early Earth materials of significance to origins of life on Earth and astrobiology in general may be found on the Moon.

2. Analysis

We present a comprehensive review of relevant lunar science in combination with the latest understanding of organic and organismic survivability to predict where and how such materials can be sought on the moon during a future era of significant lunar exploration activity.

Acknowledgements

The authors would like to thank Ian Crawford for early discussions and inspiration related to the subject topic as well as David Kring for additional relevant discussions.

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