Can biogenic metallic nanoparticles serve as biosignatures?

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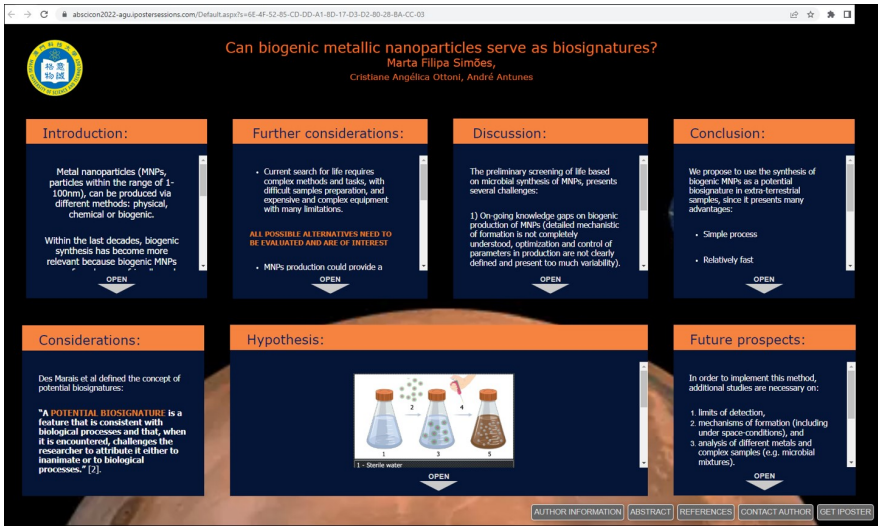
Abstract

The search for evidence of existing or extant Life (biosignatures) is a growing research topic and one of the main pillars of Astrobiology. There is significant interest in the search and exploration of new biosignatures, and increasing relevance of Potential Biosignatures. These are specific features that although consistent with biological processes can also be attributed to inanimate processes. Biogenic Metallic nanoparticles (MNPs), have been intensively studied and explored, yet their synthesis is not yet fully understood. Despite the lack of a systematic survey on this topic, it is well known that many microbes produce molecules with the capability of reducing metal ions. Given the wide diversity of such molecules, we can assume that all microbial life is capable of synthesizing them and, consequently, producing MNPs. Researchers agree that any existing or extant life on Mars or on other parts of the solar system, is (or was) likely microbial. Therefore, the detection of MNPs formation, when analyzing extraterrestrial samples (e.g., sediments, rocks), could be used to infer the presence of biological molecules and thus be employed as a new potential biosignature. Therefore, in short: yes, biogenic metallic nanoparticles have a great potential of being used as biosignatures.



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Introduction:

Metal nanoparticles (MNPs, particles within the range of 1-100nm), can be produced via different methods: physical, chemical or biogenic.

Within the last decades, biogenic synthesis has become more relevant because biogenic MNPs

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Further considerations:

- Current search for life requires complex methods and tasks, with difficult samples preparation, and expensive and complex equipment with many limitations.

ALL POSSIBLE ALTERNATIVES NEED TO BE EVALUATED AND ARE OF INTEREST

- MNPs production could provide a

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Discussion:

The preliminary screening of life based on microbial synthesis of MNPs, presents several challenges:

1) On-going knowledge gaps on biogenic production of MNPs (detailed mechanistic of formation is not completely understood, optimization and control of parameters in production are not clearly defined and present too much variability).

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Conclusion:

We propose to use the synthesis of biogenic MNPs as a potential biosignature in extra-terrestrial samples, since it presents many advantages:

- Simple process
- Relatively fast

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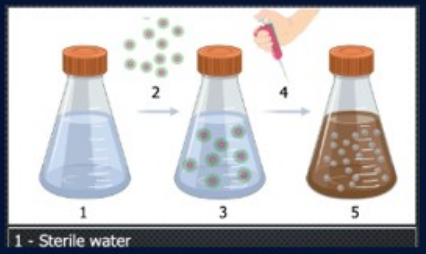
Considerations:

Des Marais et al defined the concept of potential biosignatures:

"A POTENTIAL BIOSIGNATURE is a feature that is consistent with biological processes and that, when it is encountered, challenges the researcher to attribute it either to inanimate or to biological processes." [2].

Hypothesis:



1 - Sterile water

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Future prospects:

In order to implement this method, additional studies are necessary on:

1. limits of detection,
2. mechanisms of formation (including under space-conditions), and
3. analysis of different metals and complex samples (e.g. microbial mixtures).

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