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Dirty Little Crusts for Science - Preparing Samples for BioSign

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In the context of the search for life on other bodies of the solar system, much time has been invested in research and discourse about what constitutes a good biosignature. Ideally, we would want something that is unique to life (has no abiotic origin), is easily detectable and is not prone to false positives (from *eg.* forward contamination). It seems to be consensus now that no single biosignature (apart from actually meeting an extraterrestrial organism) can fulfill all these criteria, and that we need to look at a bigger picture with different techniques to decide whether any signature qualifies as an identifier of past or present life.
In their 2015 Astrobiology Strategy paper, NASA has compiled a list of ten possible classes of biosignatures to look for.^[1] One of those classes are organic molecules that play a role in Earthly biology. These seem to be a very good candidate for chemical biosignatures. One problem that could arise, however, is that the conditions on the surface of Mars, or Enceladus, or any other body of the solar system are much different from those inside a cell of an organism on Earth. Simple molecules that we find in all living cells could be broken down rapidly when exposed to vacuum, radiation, temperature extremes, or all of the above.
In order to understand the changes that chemical biomarkers undergo in these conditions, experiments are needed. One such experiment is the BioSign project hosted at DLR. In it, several biosignatures such as whole bacteria, fossils, sediments, various molecules and others will be irradiated with the full solar spectrum on the outside of the ISS.
In preparation of these experiments and to establish experimental protocols with regards to sample preparation and analysis, we present here first attempts to produce films of Riboflavin (Vitamin B2) in pure form or in different salt matrizes, the re-solvation of these films and finally quantification of the substance amount recovered throughout the whole process.
One of the easiest and surprisingly powerful techniques for quantification is UV/VIS spectroscopy. In the case of Riboflavin, which is distinctly colored and has an even stronger absorption in the UV, this is easily done by comparing spectra of solid films as well as solutions to a standard calibration curve. In order to increase specificity and prepare for eventual analysis of photolysis products, an analytical protocol using HPLC/MS was also developed.
Interestingly, the reproducible preparation of uniform solid films proved to be very challenging. Not only does the inclusion of different salt matrizes call for different preparation protocols, we also found out that the surface properties of the sample carrier material had an enormous effect on crystal deposition. This proves that there need to be individual developments of not only analytical protocols for different substances but also for every combination of target biosignature molecule and sample carrier surface.

There will be many more colored salt crusts, before we can fly to the ISS.

[1] L. Hayes (ed.), NASA Astrobiology Strategy 2015, Chapter 5.4 II

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