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Evolutionary biomarkers on the icy galilean satellites: from bacteria to metazoans

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We discuss whether sulfur traces on Jupiter's moon Europa could be of biogenic origin, whether biomarkers for the single-cell stage of evolution, or especially for further stages of evolution, can be identified with feasible instrumentation. The compounds detected by the scientifically successful Galileo Mission (1995-2003) have been conjectured to be endogenic, most likely of cryovolcanic origin, due to their non-uniform distribution in patches. The Galileo space probe first detected the sulfur compounds, as well as revealing that this moon almost certainly has a volcanically heated and potentially habitable ocean hiding beneath a surface layer of ice.
There are options for identifying the source of the surficial sulfur in the exploration of Europa. It is possible to return to this world with the Europa Jupiter System Mission (EJSM) in a collaboration of ESA, JAXA, NASA and Roscosmos (Grasset et al., 2009). The question of habitability by the identification of reliable bioindicators is a major priority. We have gained reliable information on the surface of satellites of the Solar System. For instance, Europa, Ganymede, and Callisto—the icy Galilean moons of Jupiter—and Io, the volcanic Jovian satellite, have been main objectives of the Galileo mission. Two of the icy Galilean satellites, namely Europa and Ganymede will be the main focus of EJSM. The icy surface of the Jovian moon Europa is mysteriously striated by cracks and streaks. From extensive Galileo data it has been inferred that a subsurface salty ocean might exist on Europa. What is most relevant though, oceans may be present on other Galilean moons, but we are only aware of a single Jovian moon— Europa— that has its ocean in direct contact with its silicate mantle. However, if terrestrial microbes can thrive in extreme environments, similar microorganisms might also be extant on some of the icy Galilean satellites. Extremophiles have not only succeeded in establishing themselves in the most unlikely terrestrial ecosystems (Chela-Flores and Seckbach, 2010), but in addition these microorganisms have thrived with chemosynthesis of a stunning suite of chemical elements, consequently the following question is forced upon us: Why would they not thrive as well in oceans of the Galilean satellites? We discuss exclusively the habitability of Europa and Ganymede, the present major objectives of EJSM. We review briefly the selection of the right instrumentation, notably the penetrators that are being improved by the British Penetrator Consortium for the search of well-established biomarkers of microbial life that would be compatible with the possible payloads (Gowen et al., 2010, Chela-Flores, 2010). We now add some preliminary considerations on how the same instrumentation can be complemented for the simultaneous and feasible identification of biomarkers of the higher stages of evolution (De Vladar and Chela-Flores, 2011), especially eukaryogenesis and the emergence of metazoans. These searches have not been possible on the Earth analogs of the icy surface of Europa, such as the bacterial surficial sulfur on Ellesmere Island's supraglacial spring system, or in the Antarctic dry-valley lakes.

References

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