IAF SPACE EXPLORATION SYMPOSIUM (A3)
Solar System Exploration including Ocean Worlds (5)

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# STRATEGIES FOR OCEAN WORLDS SURFACE EXPLORATION

**Abstract**

Enceladus and Europa are the two main ocean world targets for future exploration as they are identified in the ESA report “Voyage 2050. Final Recommendations for the Voyage 2050 Senior Committee”. The study of their present or past habitability, the search for potential biosignatures, the identification of prebiotic chemistry, or the energy transmission mechanisms from interior to the surface, are some of the key scientific topics for the exploration of these bodies. The information regarding these processes are essential to understand the origin and evolution of a complex chemistry that could have ended up creating large (bio)polymers, which are the base for any form of life.

The Voyage 2050 Senior Committee recommendations end with a suggestion of an in situ element *”to characterize the local surface and subsurface environment”*. Different strategies can be envisioned, such as the use of several penetrators to study different sites, a lander with capabilities to sample the surface and near surface, a grasshoper-lander to explore different sites, or mini rovers accompanying a lander just to sample in nearby places and perform analysis with the lander instrumentation. All those alternatives are feasible nowadays with the current technologies but it requires many specific developments to be operative on the extreme environments expected on those bodies.

The mass and power restrictions expected for this kind of mission imply the development of a new generation of instruments that can work with very limited resources in an extreme environment. An effort on identifying the key instruments required for the foreseen investigations is mandatory to stablish a development roadmap. In a preliminary list are: i) cameras to identify the surface context; ii) a drill with sampling capabilities to get access to subsurface; iii) infrared and/or Raman spectrometers are very relevant to determine surface mineralogy (working remotely or in proximity), iv) ideally, some kind of borehole inspection device could help to study the near surface and identify chemical gradients; v) a mass spectrometer for low molecular weight compounds, and complemented with a bio-affinity-based

(e.g. immunoassay) detection system for large polymers; vi) a Raman spectrometer would complete the organic detection suite to detect organic compounds from small to large ones; vii) sensors for determining soil mechanical and chemical properties would also be relevant as well as some capability to study the subsurface structure by a ground penetration radar or some kind of electromagnetic sounding.