

Europlanet Science Congress 2022
Palacio de Congresos de Granada, Spain
18 September – 23 September 2022

EPSC Abstracts

Vol. 16, EPSC2022-874, 2022

<https://doi.org/10.5194/epsc2022-874>

Europlanet Science Congress 2022

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Unravelling icy Planetary Surfaces: Insights on their tectonic DEformation from field Survey - UPSIDES

Costanza Rossi et al.

The icy satellites of the Solar System, such as Europa, Ganymede and Enceladus, show widespread evidence for brittle morphotectonic structures (fractures/faults) that provide insights to infer the kinematics and the mechanical properties of their crusts. Their investigation is pivotal for the understanding of the tectonic regimes responsible for their formation. In addition, stress-related structures represent potential conduits or enhanced pathways for fluid migration thus connecting the surface and the sub-crustal layers. Such processes are significant to understand internal processes of icy bodies. Their investigation is constrained at regional-scale coverage of the remote sensing imagery.

Glaciers and ice sheets represent optimal terrestrial analogues, showing deformation styles similar to those in the icy satellites, and being the excellent sites to further explore, verify and confirm what observed through remote sensing on the geology of icy satellites. Although the formation processes differ, the similarity of their structures at surface allows quantifying and predicting the state of deformation in the icy satellites at different scales of investigation.

The UPSIDES project aims to investigate and compare the tectonic structures of the glaciers with those on the icy satellites, by means of multi-scale approach of both remote-sensing and field survey.

We propose a structural investigation in the Russell and Isunguata Sermia glaciers, located at the western margin of the Greenland Ice Sheet. Their investigation attempts: i) to identify scaling laws between the tectonic structures measured in the glacier outcrops and their equivalent mapped on satellite images; ii) to relate and compare such scaling laws with structures mapped on deformed areas of the icy satellites; and iii) to infer the tectonic styles at local-scale on the icy satellites. The knowledge of the tectonic setting at local-scale and its comparison with that at regional-scale, allow us to better understand the tectonic process and to characterize structures that are exclusively identified at regional-scale (such as in the icy satellites).

In this contribution we present the preliminary results of the analyses of data collected during the field campaign conducted on July 2021 in Greenland, at the Russell and Isunguata Sermia Gl., in the Europlanet 2024 RI's Transnational Access field analogue in Kangerlussuaq.

Field measurements include the characterization of the ice brittle deformation (e.g., fractures and fault) by the quantification of their azimuth, dip, length, width, throw and spacing. This allow us to recognize the tectonic settings and regimes responsible for their formation. In parallel, we performed a structural mapping on satellite images, which cover the locations where the investigated outcrop occur, and we derived the attributes of the mapped structures. We performed then paleo-stress analyses of the data from both local- and regional-scale, which in turn have been related. The obtained results are consistent and suggest strike-slip kinematics. Such results are compared with areas that show similar tectonic setting on Ganymede and Europa and support the understanding of the possible local-scale setting at surface. In addition, the field data allow us to identify the structures that ease the fluid migration.

The obtained results from this project aim to contribute to advance the study of icy surface tectonics and will support the preparation of planetary programs, such as JUICE mission, for dedicated observations and target areas.

Acknowledgments: This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 871149. The activity has been realized under the ASI-INAF contract 2018-25-HH.0.

How to cite: Rossi, C., Cianfarra, P., Lucchetti, A., Pozzobon, R., Penasa, L., Munaretto, G., and Pajola, M.: Unravelling icy Planetary Surfaces: Insights on their tectonic DEformation from field Survey - UPSIDES, Europlanet Science Congress 2022, Granada, Spain, 18–23 Sep 2022, EPSC2022-874, <https://doi.org/10.5194/epsc2022-874>, 2022.



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