CHAOS TERRAINS DEVELOPMENT: INITIAL RESULTS FROM PATTERNS AT DIFFERENT SCALE.

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Introduction: The launch of the ESA JUICE mission will be marked in the calendar for the new year 2023. The event is tabled for April and spacecraft is expected to reach the Jovian system at the beginning of the next decade. JUICE plans include to study Europa with two flybys. Nevertheless, NASA´s mission that bears its name, Europa Clipper Mission, will be the one which will devote the entire timeline to this moon.

Europa is a geologically active ocean world. In 2012 NASA/ESA Hubble Space Telescope observations revealed evidence of spotted ejections of material from the surface of south pole to outer space [1]. This was not the first time plumes were presumably detected [2, 3]. Perturbations in the magnetic data of the Galileo spacecraft were linked to the occurrence of this phenomenon [4, 5]. Plumes provide a window of opportunity to study the current geochemistry and astrobiology of the europan ocean interior. In addition, Europa shows a slightly cratered crust because of successive events of crustal ice reworking [6].

In the most recent period of the evolutional history of Europa a greater formation of chaos terrains took place [7], defined as fractured areas in polygonal blocks. Some blocks of this geological terrain underwent some kind of vertical and/or horizontal displacement and resulting space was filled by hummocky-textured matrix [8, 9]. Generally for the latter case, the surface is characterized by a lower albedo materials in relation to the undisrupted surroundings [10] due to a higher non-water-ice mineral content such as sulfates, sulfuric acid hydrates, sodium chloride and/or Na-carbonates [11, 12].

Although there is still no consensus on the mechanism driving chaos terrain formation, it is accepted that it may involve vertical processes of endogenous material transfer to the surface. Thus chaos terrains are turned into targeted areas for habitability evaluation because the existence of life is closely bound up to energy flux and material exchange with the aqueous environment.

To date studies have focused on both the qualitative and quantitative description of morphology as well as geographic distribution of chaos terrains [11 and references therein]. In this work we analyzed and classified chaos terrains by their geomorphological pattern according to two main parameters: fracture state with or without block displacement and blocks:matrix ratio. The aim is to identify changes in the crustal behaviour that affect the morphology and distribution of these structures (i.e., gradational transitions in the fracture terrains, zonation, etc.), that is, whether geomorphological pattern of chaos terrains responds to partial melting gradients and/or is due to heterogeneities in the composition of the crust.

Methodology: Cartographic work and analysis were carried out with the QGIS software. Galileo SSI images were used as global map base. We constrained mapping of chaos terrains at 250 and 500 m/pixel regional resolution. We defined the outer boundaries of chaos terrains and then divide and classify the mapped area of each chaos terrain into facies according to the disruption and melting of surface. We established up to four facies typologies:

1. Fractured blocks without shift nor melting at the surface
2. Fractured blocks with shift and melting at the surface.
3. High blocks:matrix ratio.
4. Low blocks:matrix ratio.

Results: Identified chaos terrains consist of one or more facies. In some cases, the facies within the same chaos feature are arranged in such a way that they appear to follow an increasing order of disruption-melting of the crust. This is the case of the central chaos terrain in the image above (Fig. 1A). Shifted fractured blocks, with the exception of blocks of the southwest extension that have kept their position, border an agglomeration of smaller blocks. These blocks are contained in a matrix and at this resolution it is difficult to recognize the identity of preexisting terrain on its surface. In other cases, the facies set of a chaos terrain shows no apparent order in the disruption-melting gradient. As an example, the Fig. 1B shows a chaos terrain with an elongated shape. It is formed by three different facies in lateral contact. The facie located to the northeast is a level 4, which is distinguished by the predominance of the amount of matrix over the number of blocks. This facie is contiguous to facie of a level 2. However, on the regional scale these facies along with other ones of an adjacent chaos group might show a type of organization that could be correlated with certain mechanical or thermodynamic properties of the crust.

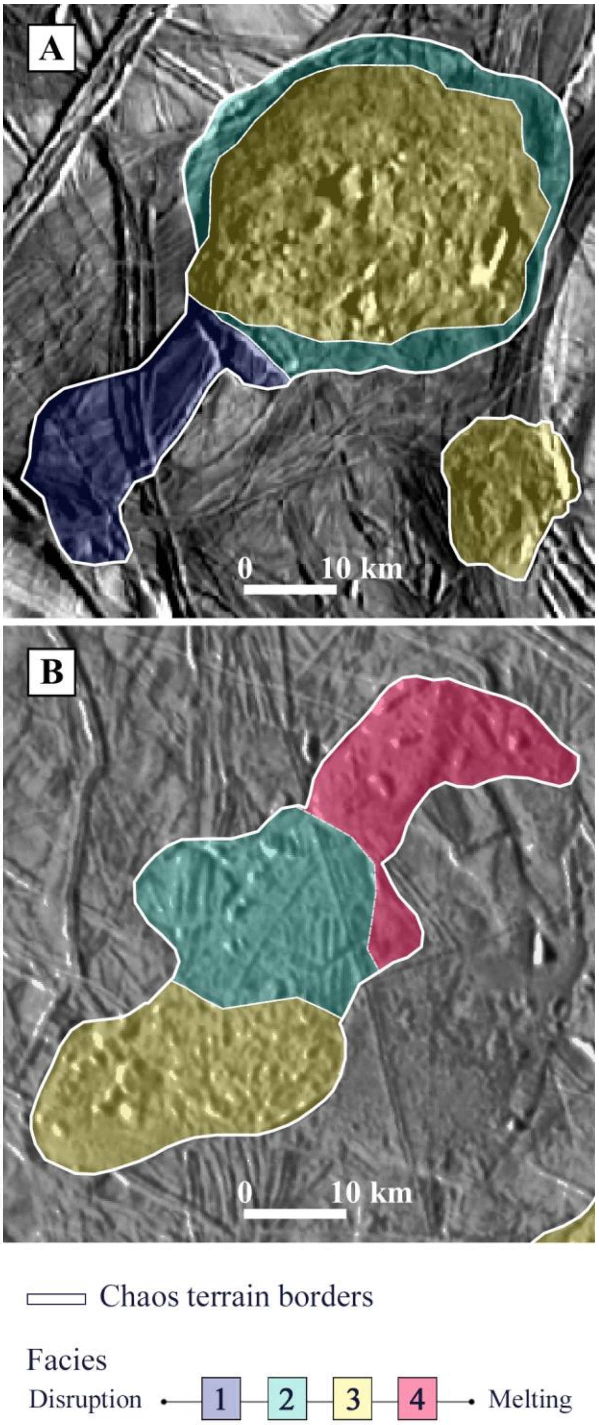

Figure 1. Three entire chaos features are represented into the geomorphological map in accordance with the specified methodological criteria, the first two belong to trailing antijovian hemisphere (A) while the other one is in the leading hemisphere of Europa (B).

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