CHAOS UNITS IN ARGADNEL REGIO, EUROPA: IMPLICATIONS FOR TIMING OF CHAOS FORMATION. Laura M. Parro[1], Javier Ruiz[1] and Robert T. Pappalardo[2], [1]Departamento de Geodinámica, Universidad Complutense de Madrid, 28040 Madrid, Spain (lmparro@ucm.es), [2]Jet Propulsion Laboratory, California Institute of Technology, M/S 321-560, Pasadena, CA 91109.

Introduction: Chaos terrains are among the more prominent landforms of Europa, and are characterized by the disruption of the pre-existing crust, which is broken in plates of various sizes in a dark and rough matrix [1]. Chaos terrains are formed due to endogenic activity, most probably related to solid-state convection and thermal diapirism in the ice shell [2-5], perhaps aided by melting of salt-rich ice bodies below the surface [6]. In chaos areas, a substantial part of the original surface has been destroyed; however, pre-existing structures can be preserved on surviving chaos blocks, which helps us to understanding the previous disposition and movement of these plates [7-9].

Chaos terrains are located towards the top of the stratigraphical sequence of Europa, implying that those terrains are in general among the younger structures recorded in the surface. After the general stratigraphy of Greeley et al. [10], the oldest recognizable unit is the background ridges plains, which are characterized by other structures such as bands and larges ridges, finally chaos terrains are cross-cutting all other units. However, although this general sequence is approximately representative across Europa's surface, there are regional examples of chaos terrains affected by younger landforms [8,11-14].

In this work we analyze the crossing relations between chaos terrains and the other geologic structures (mostly bands), as well as between several units of chaos terrains, in Argadnel Regio (also called the "wedges region") in the anti-jovian hemisphere of Europa. Our aim is placing the events of chaos formation into the general stratigraphic framework of this region of Europa and the implications for the local geological, history of this jovian moon.

Chaos units: Chaos units can be distinguished by texture, morphology, matrix proportion, and relative position with respect to other structures. In our study area, at least two chaos formation events can be characterized. These chaos events can be placed in different positions in the stratigraphic sequence, therefore being of different relative age.

Chaos Unit 1 (Figure 1, dark green) presents an irregular morphology, with a relatively smooth matrix, and with scarce plates or blocks. The chaos boundaries are well defined because they are darker than the surrounding material. This chaos unit is crossed and affected by younger structures: a dark band, a complex band, and a different class of chaos terrain (second chaos unit). The first chaos unit would be equivalent of those defined in previous works as "knobby chaos" [10] or as "modified chaos" [8].

The younger Chaos Unit 2 (Figure 1, light green) is characterized by a more heterogeneous matrix, in which plates (showing the pre-existing surface) and smaller blocks are best preserved. This unit is disrupting dark band material and the first chaos unit. This younger unit is equivalent to those defined as "platy chaos material" [10] and "fresh chaos" [8].

Relationship of units in Argadnel Regio: Figure 1 shows a map of geological units and structures in own study area affecting or being affected by the chaos units described above. The dark band (dark blue) oriented NW-SE is a prominent dark band, formed by three segments separated by dextral strike-slip faults. It likely is a dilational band formed by extension and separation away of the pre-existing crust (for a structural analysis of this band see [15]).

The complex band (Figure 1, light blue) exhibits a complex internal structure, characterized by ridges and lineaments. It is reminiscent of ridge complexes on Europa, most probably originated by in-situ formation of ridges, without separation of previous crust. Other narrower bands (Figure 1, lavendar) of intermediate albedo correspond to those usually referred to as "gray bands" [16].

As other extensional bands on Europa, the dark band can be closed by eliminating the dark material filling the gap created by the opening process, recovering the original surface and reassembling pre-existing structures cut and separated by the band. When the dark material is removed, the bright band is well-restored and their internal lineaments are perfectly joined.

The determination of relative age relation between both bands permits us to define the relationship between the two units of chaos terrain and the other geological units in the study area. The complex band completely transects one of the areas of Chaos Units 1; therefore, this chaos unit must be older than the complex band. Hence, it is clear than this chaos terrain is also older than the dark band.

Chaos Unit 1 is crossed to the NE by the dark band. Older lineaments of the background plains are visible in this part of the chaos terrain, and those lineaments are well reconstructed by closing the dark band. This suggests that this part the ridged plains are covered by

dark cryomagmatic materials, rather than being disrupted.

Chaos Unit 1 does not seem to cross-cut terrains other than the ridged background plains, which reinforces our interpretation of that this unit formed early in the stratigraphic sequence of Argadnel Regio. On the other hand, Chaos Unit 2 is cross-cutting other geologic terrains, specifically the dark band and Chaos Unit 1.

Implications for the history of chaos formation on Europa: The geological history generally applicable for Europa, with the formation chaos terrains and lenticulae being the younger recorded events, is not strictly the case in Argadnel Regio, considering our observations of two stages of chaos formation, where one of the chaos units clearly predates band formation.

We propose the following stages in the geological history of this region: (1) emplacement of bright ridges plains; (2) formation of Chaos Unit 1 affecting and disrupting the plains; (3) formation of the complex band by in-situ generation of parallel ridges; (4) dilation of the crust and formation of the dark band; and finally, (5) formation of Chaos Unit 2, which disrupts both the dark band and Chaos Unit 1.

Thus, Chaos Unit 1 is clearly older than Chaos Unit 2, and the geological processes occurred imply a substantial lap time between the formation of these chaos units.

surface disruption, have a different surface texture, and the boundary between them is well demarcated.

Our observations, therefore, reveal a complex geologic history for this region of Europa. Future works on chaos formation in Argadnel Regio should help to better understand the geological history of this region, and to refine the general stratigraphic framework of Europa.

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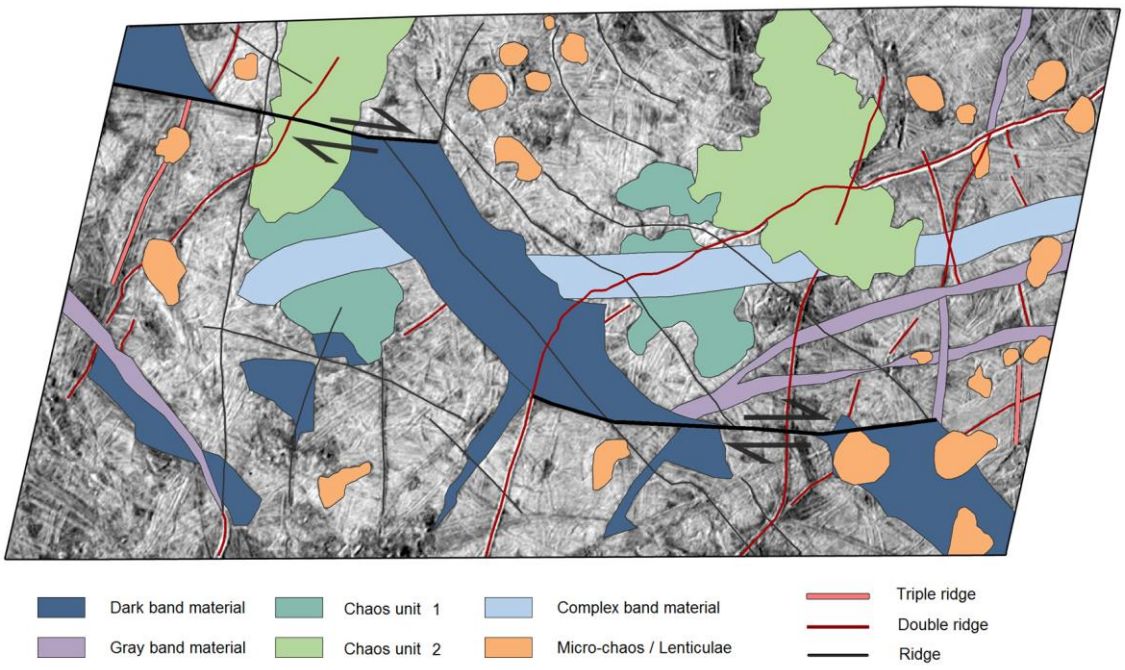

Figure 1: *Geological map of Europa with the different chaos units (green toned) and their relations with other geologic units. The section corresponds to the mosaic of images E14ESWEDGES01 (14th Galileo orbit).*