MAPPING EUROPA AT THE REGIONAL SCALE: INSIGHTS FROM CONAMARA CHAOS AND BLOCK SIZE FREQUENCY DISTRIBUTIONS.

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Introduction: Evaluating the potential habitability of Europa requires an understanding of the geology that drives the interaction between the surface and the deeper interior of the body. To this end, we have constructed a global geologic map at the scale of 1:15M [1]. To provide greater insight into the broad global stratigraphic relations, we are currently mosaicking and mapping, with a consistent set of units, the surface imaged at 100-250 m/pixel (~10% of the total surface area) placed in the global-scale context. In this paper, we discuss preliminary results from regional scale mapping (1:2M) of Conamara Chaos, and resulting chaos block size distribution analysis that is ongoing as regional mapping continues.

At the global scale, the Conamara Chaos region consists primarily of Low Relative Brightness Chaos and Regional Plains [1] (Fig. 1a). Within the Conamara Chaos region, initial regional (1:2M) mapping (Fig. 1b) provides greater insight into the global regional plains units where relations between assemblages of key tectonic terrains can be determined. As we map chaos at the regional scale, we show that it is possible to quantify the morphology through block size frequency distribution.

Regional Mapping: Building on the work of Senske [2], the geologic units (Fig. 1c) for the Conamara Chaos regional map include the following: *Ridged Bands* that are made up of several sets of parallel ridges spaced between 0.5 km and 1 km apart with individual bands ranging in width between 2 and 12 km; *Smooth Bands* that are made up of more subtle ridges that are barely resolvable at the resolution of the images; *Ridged/Regional Plains* that have the same definition as at the global scale but in the regional mapping, the texture is now revealed as numerous ridges that range from subparallel to cross-cutting; *Smooth Plains* that are made up of featureless terrain; *Double Ridges* that are composed of two distinct parallel ridges separated by a central trough; *Single Ridges* that are composed of one distinct ridge; and *Troughs* that are single linear depressions that lack discernable raised rims. Fractures are typically through going in nature, and cross cut most other units. Other geologic units include the following: *Chaos* which are complex regions 10s to over 100 km across composed of disrupted pre-existing crustal blocks (*chaos blocks*) and a smoother "matrix" material between the outcrops; *Knobby Chaos* that is chaos but does not contain chaos blocks; and *Smooth Chaos* that is chaos but is made up primarily of the smooth "matrix" material.

Numerous occurrences of Chaos are surrounded by a halo of smooth, dark material (Smooth Chaos) that appears to embay the surrounding terrain (not distinguished at the global scale due to the low data resolution and larger mapping scale at 1:15M Fig. 1a). Our analysis shows that in addition to Conamara Chaos (~75 x 100 km), there are over 80 additional smaller (10's of km across) outcrops of varying types of chaos terrain (Fig. 1b).

Chaos Block Size Frequency Distributions: From our regional mapping, it is apparent that there are distinct differences in the abundance, size, and distribution of elements making up different chaos terrains. We map ten individual areas of chaos at the regional resolution, focusing on blocks—outcrops of pre-existing terrain—down to ~1 km size. The area of each block is measured using ArcGIS, and the representative width is determined by taking the square-root of this block area. Because larger chaos terrains would naturally have more blocks, we normalize the cumulative block count by the total area of the chaos terrain.

Our initial results show that the size-distribution of chaos blocks follow an exponential relationship of the form: $y = A * exp(-mx)$, where x is the characteristic length scale of the chaos block, y is the cumulative count of blocks with a width greater than x, and A and m are constants. This functional form for the data is consistent with block size distribution analyses on Earth and Mars [e.g., 3]. We plot the data points and fits in Figure 4 in the form $y' = -mx + b$ where $y' = \ln y$ and $b = \ln A$. The data distribution is shown in Figure 2. Preliminary analysis indicates that steeper slopes (larger m) relate to more knobby chaos morphologies (Fig. 2). This suggests that chaos morphology may be quantified and used as a direct comparison to any future formation model outputs.

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References: [1] Leonard, E., et al. (2021 *in production*), USGS. [2] Senske, D. (2016). , *47th LPSC*, Abstract 1903, p. 1365. [3] Golombek and Rapp (1997), *JGR*, *102*, 4117-29.

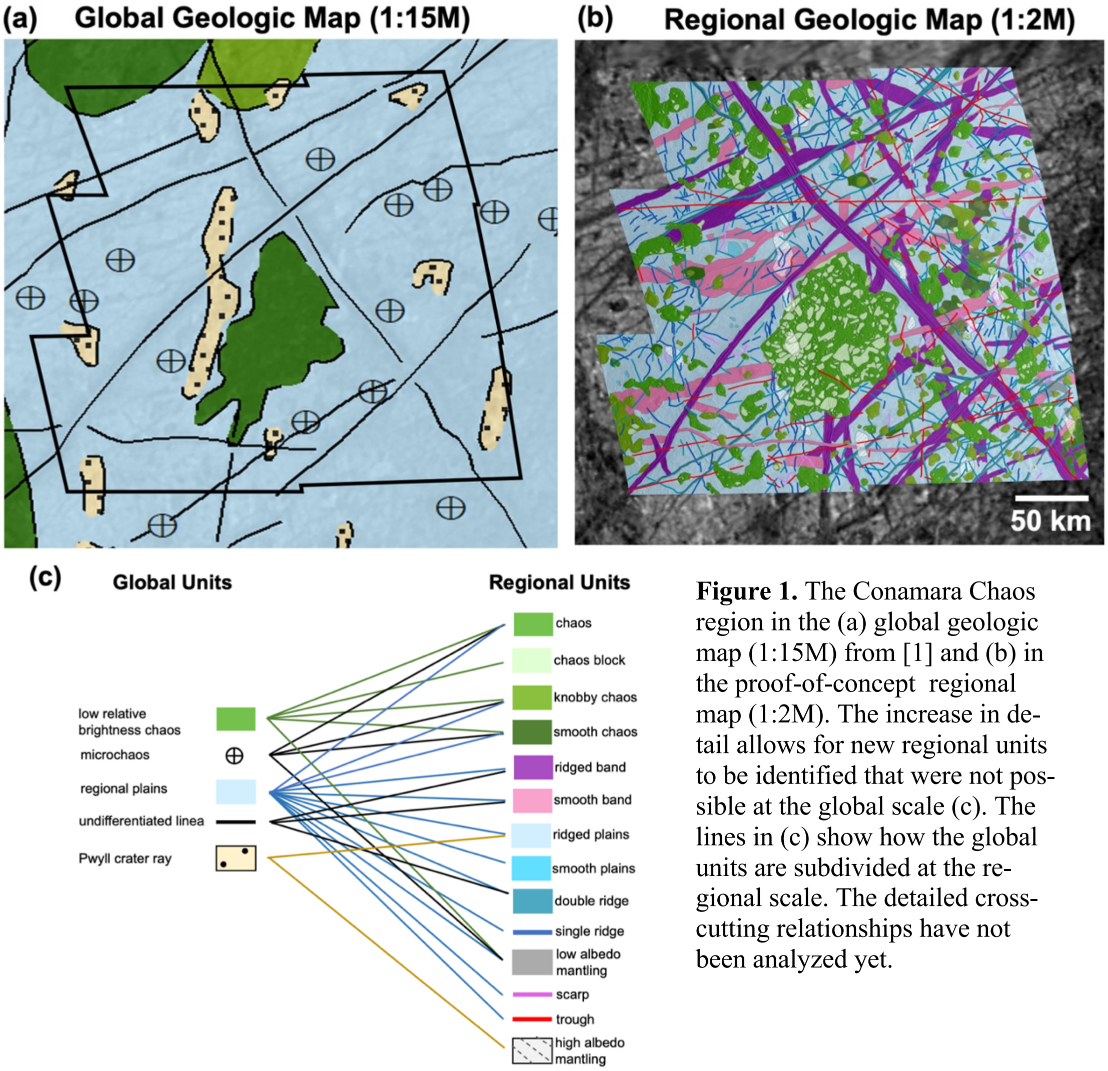

Figure 1. The Conamara Chaos region in the (a) global geologic map (1:15M) from [1] and (b) in the proof-of-concept regional map (1:2M). The increase in detail allows for new regional units to be identified that were not possible at the global scale (c). The lines in (c) show how the global units are subdivided at the regional scale. The detailed cross-cutting relationships have not been analyzed yet.

Figure 2. Chaos block size-distributions for ten different chaos regions that we are mapping at the regional scale. The x-axis is the representative width of a chaos block (square root of the area) and the y-axis is the natural log of the cumulative block count (blocks greater than width of x) normalized by the chaos size.