EPSC Abstracts
Vol. 13, EPSC-DPS2019-57-1, 2019
EPSC-DPS Joint Meeting 2019

EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

Global and Regional scale Geologic Mapping of Europa

Erin J. Leonard (1), Dave A. Senske (1), and D. Alex Patthoff (2)
(1) Jet Propulsion Laboratory, California Institute of Technology (2) Planetary Science Institute
(Erin.J.Leonard@jpl.nasa.gov)

Abstract

We have generated a global geologic map of Europa at the 1:15M scale, which is currently under revision and will be published by the United States Geologic Survey (USGS). The map units encompass craters, chaos, bands, and regional plains. To quantitatively assess unit relations, we are performing clustering analyses of the chaos subunit of microchaos along with analysis of global lineament trends. We are expanding our mapping to include higher resolution (<250 m/pixel), regional scale data and are incorporating these results into the global map.

1. Introduction

Evaluating the potential habitability of Europa requires an understanding of the geologic processes that drive 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 (Fig. 1) [1]. To provide greater insight into the global stratigraphic relations, we are currently mosaicking and mapping, with a consistent set of units, ~10% of the surface imaged at the 100-220 m scale placed in the global-scale context (Fig. 1 and 2). In this paper, we discuss the general results of our global mapping and preliminary results from regional scale mapping of the Conamara Chaos region.

2. Global Map

Our geologic mapping [1] has established four primary global material unit types, crater material, chaos, bands, and regional plains (Fig. 1). These units are divided into subunits of: (1) continuous (ce) and discontinuous (dce) crater ejecta, crater ray material (cr), and central peak structure (cp)—materials associated with impact craters including the primary impact crater (c); (2) various morphological types of chaos materials identified as high albedo chaos (chh), mottled chaos (chm), low albedo chaos (chl) and knobby chaos (chk). Small, 10 to 75 km in diameter, outcrops of microchaos (mch), possess textures that vary in relative brightness that ranges from high to low and are ubiquitous and significant enough to be identified on the map as a point; (3) Bands (b), linear to curvilinear belts that are greater than 15 km in width that can have a distinct, abrupt apparent brightness change relative to the surrounding terrain; and (4) regional plains (pr) that possess high-relative brightness compared to the surrounding terrain and are smooth at the global scale. We also identify structures that are too small be mapped aerially but are significant enough to be mapped as linear features (Fig.1).

Based on the relationships among the various map units, we have established a general stratigraphic chronology for Europa. The first and oldest period is dominated by the formation of regional plains, ridges, and undifferentiated linea, an epoch characterized by tectonic ridge forming processes. The second, or middle, period is dominated by band and undifferentiated linea formation. The band unit generally appears younger and cross-cuts the regional plains unit. Cycloids also appear to have formed during this period. The third, and most recent period, is dominated by chaos terrain formation including the emplacement of microchaos. At the global-scale, chaos terrain does not appear to have any cross-cutting units besides craters and their ejecta, troughs in the northern leading hemisphere, and potentially depression margins. Likewise, microchaos appears to have broken up previously formed bands, ridges, cycloids and other features, indicating that it is generally younger.

3. Regional-scale Mapping

By expanding our mapping to the regional scale, as shown here for Conamara Chaos (Fig. 2) [2], it is possible to gain deeper insight into the make-up of the regional plains unit and establish relations between assemblages of key tectonic terrains. The regional-scale units consist of: Wide bands (bw) that are made up of parallel ridges spaced between 550 m and 1.25 km apart with the overall width of the band assemblages ranging from 4 to 10 km; Bands (b) that are made up of several sets of parallel ridges spaced

between 525 m and 950 m apart with individual bands ranging in width between 2 and 4 km (narrower than wide bands); Double ridges (rd) that are composed of two distinct parallel ridges separated by a central trough; and fractures (f) that are single troughs that lack discernible raised rims. Fractures are typically linear, through going, and cross cut most other units. Other geologic units include: Chaos (c) which are complex regions 10s to over 100 km across composed of disrupted pre-existing crustal blocks and a smoother "matrix" material between the outcrops and microchaos (mch). In comparison with the global units, the regional plains and band units can be subdivided into a wider array of outcrop units showing that a more detailed set of stratigraphic relationships can be identified.

4. Figures

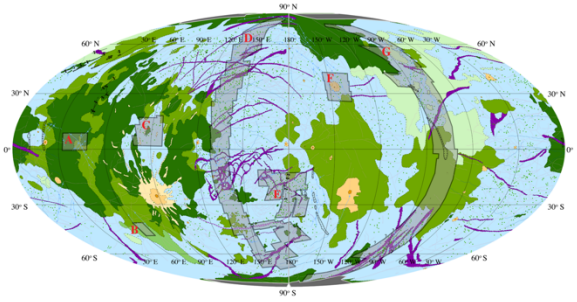

Figure 1: Global geologic map of Europa in a molliwede projection. See description of map units in Fig. 2

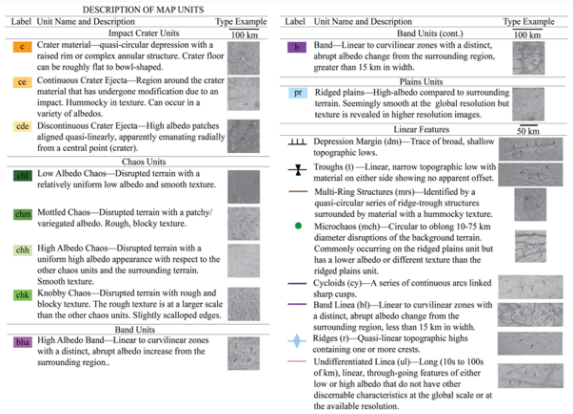

Figure 2: Description of map units (DOMU) for the Europa global map.

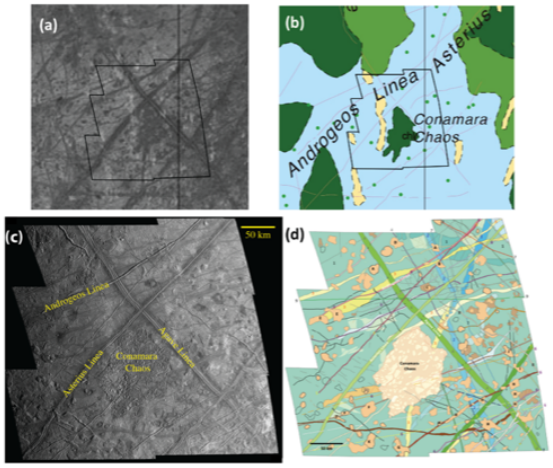

Figure 3: Conamara Chaos region (a, outlined on the USGS basemap), the global map (b), the high-resolution images (c), and the corresponding regional map (d).

5. Summary

The final revisions of the global map will be completed by May 2019 and will be presented. The initial results of our regional unit definition [e.g. 4], image mosaics, and a preliminary map will be shown. In addition, the global map forms a basis to quantitative examine on the global-scale relations between units. We will discuss microchaos which are not uniformly distributed and band/lineament trends. The results will provide greater insight into how the icy crust of Europa formed and evolved.

Acknowledgements

Portions of this research were carried out at the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.

References

[1] Leonard, E. J. et al. (2018) *USGS* in review.

[2] Senske, D. A. (2016) *LPSC XLVII*, 1365-1366.

[3] Figueredo, P. H. and Greeley, R. (2004) *Icarus*, 287-312.

[4] Greeley R. et al. (2000) JGR, 22559-22578.