

THE GEOLOGICAL CONTEXT AND HISTORY OF THRACE MACULA, EUROPA. Louise M. Prockter¹ and Paul M. Schenk². ¹The Johns Hopkins University Applied Physics Laboratory, Laurel, MD 20723, (Louise.Prockter@jhuapl.edu). ²Lunar and Planetary Institute, Houston, TX 77058.

Background: Thrace Macula is one of the largest chaos regions on Europa, visible in global-scale images because of its large extent and low relative albedo (Fig. 1). Centered at 47.7°S, 180.9°W in the southern hemisphere, Thrace intersects the prominent linear bands Agenor Linea to the northwest, and Libya Linea to the south. It extends for ~220 km in a NNW-SSE direction and ranges in width from 25 - 60 km. Its distinctly lobate margins led to early suggestions that Thrace Macula formed from cryomagmas effusively emplaced on the surface [1], however higher resolution Galileo images showed that Thrace is a type of chaos, a region in which the surface has been significantly disrupted by endogenic processes [e.g., 2].

Preliminary mapping of Thrace Macula by [3] found that it did not exhibit the intense breakup, rotation and translation of plates that has been documented in other prominent chaos regions such as Conamara Chaos [e.g., 4]. [3] noted that the boundary between Thrace and its surroundings is more transitional than at Conamara, and that the background linear fabric can be traced into the macula, indicative of in-situ modification. They suggested that brine mobilization is a candidate process that might account for these observations.

Analysis of a second large chaos region to the west, Thera Macula (Fig. 1), suggests that it likely formed above a melt lens that is currently liquid [5], and a similar origin for Thrace Macula has been invoked [6]. Both maculae are of interest as potential sites for a future landed mission [7] given their relative youth and evidence of emplacement at the surface of material originating from within Europa's interior.



Figure 1: Galileo false-color view of Thrace Macula (right) and Thera Macula (left). Thrace is ~60 km at its widest; Thera is ~70 km at its widest [NASA/JPL].

Approach: We here evaluate the history and context of Thrace Macula by creating a detailed geological map using regional (~220 m/pixel) and high-resolution (44 m/pixel) Galileo images. We also use a regional topographic model created using a combination of stereo and photogrammetry [as described in 8]. We address a number of questions about Thrace Macula, including its age, the sequence by which it has been disrupted, the nature of margin embayment, whether any types of linear landform are more likely to persist inside the chaos than others (thereby perhaps providing clues to their structures), and how different areas of chaos morphology within the macula correspond to topography.

Results: Mapping of the Thrace Macula high-resolution region shows several different morphological units (Fig. 2). The background plains surrounding the chaos region are comprised of dilational bands, ridge complexes, and a small number of double ridges and troughs [e.g., 9, 10 and references therein]. The most prominent feature is Libya Linea, a relatively smooth band against which Thrace truncates to the south. Smaller smooth bands are also present, as well as two types of more heavily ridged band, one of which (*ridged band 2*) has a prominent central axial trough and which appears to stand slightly higher than the surrounding terrain; the second (*ridged band 1*) has no obvious axial symmetry, but has a more prominent ridged texture along the band. Two of the latter bands extend eastward into Thrace, and traces of their topography appear to be more persistent within the chaos than those of other linear features. The oldest bands in the area are ridge complexes, linear features containing adjacent ridges that can be parallel, or sinuous or anastomosing. Most ridges and troughs in the region were disrupted or destroyed by the formation of the chaos; only two troughs appear to be superimposed on both Thrace and the surrounding terrain, showing that it is relatively young by European standards [e.g., 11]. The only other features postdating the formation of Thrace are secondary craters, most likely from Pwyll to the northwest [12].

Thrace Macula is comprised of matrix material and smooth plains, and can be broadly subdivided on the basis of morphology into four units: two matrix units and two plains units. Interior to the macula is a mid-albedo unit (*blocky matrix*) comprised of rough textured blocky material similar to matrix found elsewhere [e.g., 2] but with larger hummocks. Only one small plate is visible within this unit. Topography

across the area suggests that this unit stands higher than the surrounding terrain. Another highly textured unit [*hummocky matrix*] comprises the bulk of the chaos; this unit has a slightly lower relative albedo and smaller-scale hummocks than the blocky matrix unit. The majority of visible preserved preexisting features are found within this unit. Although primarily found within the interior of the chaos, there are a small number of places where this unit appears to have embayed topographic lows along the western margin. Toward the boundaries of the chaos, are two plains units with similar characteristics; low-albedo smooth plains (*low-albedo plains*) found embaying low-lying areas and commonly confined by topographic obstacles; and a related unit (*intermediate-albedo plains*) which appears to have a somewhat higher relative albedo and appears to have a higher density of visible ridges and troughs within it. This unit may

represent regions in which low-viscosity material was extruded onto the surface, but then subsequently drained away, leaving a dark stain over topography, as has been inferred for Castalia Macula [8].

References: [1] Wilson L. et al., (1997), *JGR*, 102, 9263-9272. [2] Collins G. and F. Nimmo (2009) in *Europa*, U. Arizona Press, 259-282. [3] Kortz B.E. et al., (2000) *LPS XXXI*, 2052 - 2053. [4] Spaun, N. et al (1998) *GRL*, 25, 4277-4281. [5] Schmidt B.E. et al. (2011) *Nature*, 479, 501-505. [6] Schmidt B.E. et al. (2012) *LPS XLIII*, 2667-2668. [7] Pappalardo R.T. et al. (2013) *Astrobiology*, 13, 740-773. [8] Prockter L. and P. Schenk (2005), *Icarus*, 177, 305-326. [9] Prockter L. and G. Patterson, (2009) in *Europa*, U. Arizona Press, 237-258. [10] Kattenhorn S. and T. Hurford, (2009) in *Europa*, U. Arizona Press, 199-236. [11] Doggett T. et al. (2009) in *Europa*, U. Arizona Press, 137-160. [12] Bierhaus E.B. et al. (2001), *Icarus*, 153, 264-276.

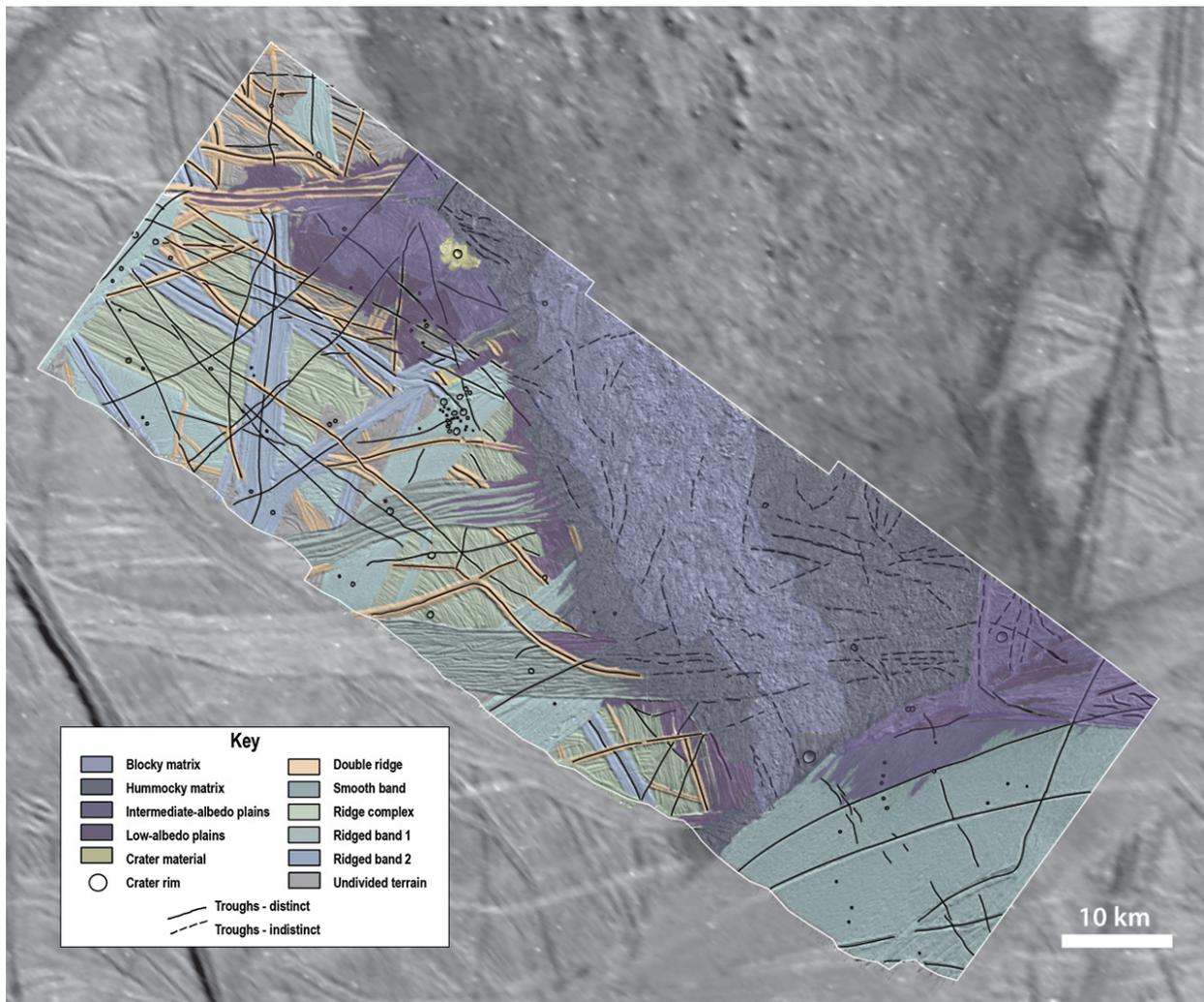


Figure 2: Preliminary geological map of the Thrace Macula area imaged at high resolution by the Galileo mission. (Image mosaics NASA/JPL).v