EUROPA'S MANANNÁN IMPACT CRATER: SURFACE COMPOSITION OF THE CRATER FLOOR AND EJECTA FROM GEOLOGIC MAPPING AND LINEAR MIXTURE MODELLING

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Introduction: The 22-km diameter Manannán impact crater (Fig. 1) was imaged by Galileo's Near-Infrared Mapping Spectrometer (NIMS) during the 3rd orbital encounter of the Galileo Mission. We have registered a despiked version of the NIMS observation with available images from the Galileo Mission, and we have performed new geologic mapping for the study area thus defined. Nine distinctive geologic surface units and morphological features are mapped. Near-infrared spectra for separate exposures were obtained and subjected to a linear mixture model compositional analysis as described in Dalton (2007) and Shirley et al. (2010). The crater and its ejecta blanket exhibit a high abundance of water ice in comparison with regional trends. Exposures associated with Belus Linea, a prominent triple band crossing the study area, exhibit abundant magnesium sulfate brines. Prior work has highlighted a hemispheric-scale "patina" of hydrated sulfuric acid (Carlson et al. 2005), that is likely exogenic in origin and is largely independent of the underlying geology (Shirley et al. 2010, Dalton et al. 2011). The acid hydrate shows increasing abundance toward the apex of Europa's trailing side. The Manannán impact penetrated this veneer, disrupting the hemispheric trend. The crater floor is deficient in acid hydrate by >15% relative to its surroundings. Reduced mean abundance of H_2SO_4 hydrate is also noted for exposures that include discontinuous ejecta, out to distances of several crater diameters. We will discuss the implications of these results.

Geologic mapping is a powerful tool for the interpretation of remotely sensed images of planetary surfaces. Geologic mapping of Europa (Greeley et al. 2000, Doggett et al. 2009) has made many contributions to the debate concerning the nature, geologic age, and activity of the surface of this enigmatic satellite. Prior geologic mapping of the Europan impact craters Tyre Macula (Kadel et al. 2000) and Manannán (Moore et al., 2001) has yielded valuable insights. However, no specific compositional information has previously been available to supplement the structural and morphological information obtained from mapping. Cryogenic reflectance spectroscopy (Dalton 2007) applied to despiked NIMS observations (Shirley et al. 2010) now allows us to resolve distinctive compositional mixtures that are characteristic to specific geologic units and landforms.

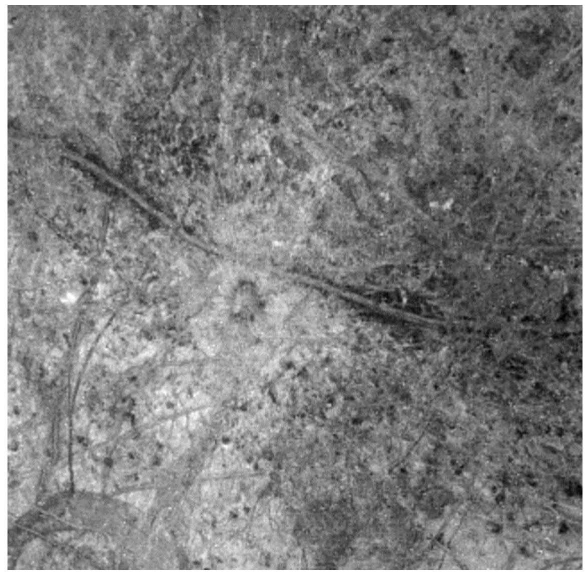

Figure 1: Oblique view of the Manannán impact crater at latitude 4° N, longitude 240° W. Discontinuous ejecta lie atop and obscure Belus Linea, which passes immediately to the north.

Geologic Mapping and surface composition: Our geologic map of the Manannán study area is provided in Fig. 2. One focus of our study is to obtain compositional information for geologic unit types that include discontinuous ejecta deposits. While areas including discontinuous ejecta are not explicitly noted on the geologic map, they are easily identified on false-color versions of the NIMS image planes (not shown). Thus in most cases we have been able to obtain and compare surface compositions for particular units "with and without" the discontinuous ejecta. Our presentation will explore these differences.

A first-order finding of our study is that the abundance of water ice is generally very low throughout the study area, outside the areas affected by the discontinuous ejecta. However, within those areas, the abundance of water ice decreases systematically with distance from the crater itself.

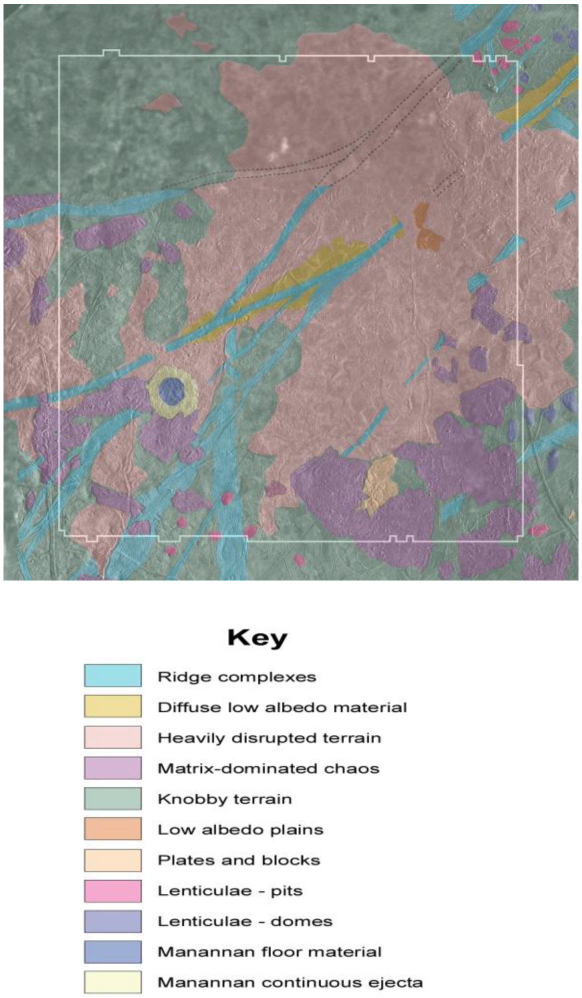

Figure 2: Geologic map of the study area. North is up. Due to the variable resolution of the underlying imagery, extensive outlying areas in the north are mapped in lesser detail.

A second finding is that the crater floor and continuous ejecta unit have very low abundance of hydrated sulfuric acid (~50%), in comparison to the background for this region (≥ 60%; see Carlson et al. 2005, Dalton et al. 2011, 2012). Production of hydrated sulfuric acid by radiolysis is considered to occur quite rapidly (Carlson et al. 2005). The deficit of hydrated H_2SO_4 within the crater thus suggests that the impact may have occurred very recently in geologic time.

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