**APPARENT RESURFACING OF A PULL-APART BAND IN ARGADNEL REGIO, EUROPA, RESULTING FROM TROUGH FORMATION.**
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**Overview:** A distinctive wedge-shaped band within Europa's Argadnel Regio appears to have been resurfaced along its northern portion as the result of the formation of a large regional depression.

**Background:** A recent study by [1] combined Galileo NIMS and SSI data to determine the surface compositions and water ice grain sizes of specific geologic units within a portion of Argadnel Regio (informally known as the "wedges" region), on Europa's anti-Jovian hemisphere. The study area spanned a longitude range from 168º to 185ºW, an area previously mapped in detail by [2] (Figure 1). Using linear mixture modeling employing cryogenic laboratory reference spectra they showed that two specific geological units – ridged plains and smooth, low-albedo plains – differed markedly both in the relative abundance of non-ice hydrated materials and in the abundance and grain sizes of water ice. The older ridged plains were found to consist predominantly of water ice (~46%) with approximately equal amounts of hydrated sulfuric acid (~27%) and hydrated salts (~27%), and to have larger grain sizes. In contrast, the younger smooth low-albedo plains were found to be dominated by hydrated salts (~62%) with relatively little water ice (~10%) and a similar abundance of hydrated sulfuric acid, and to have smaller ice grain sizes. The study noted that specific exposures within the plains exhibited sulfuric acid hydrate abundances up to 33% lower than those found in adjacent exposures, which the authors interpreted as evidence that these materials have undergone less exposure to the Jovian weathering environment and hence were emplaced relatively recently. Similarly, the larger grain sizes modeled for the older ridged plains units are consistent with ice which has undergone enhanced annealing and grain size growth due to longer exposure times [3].

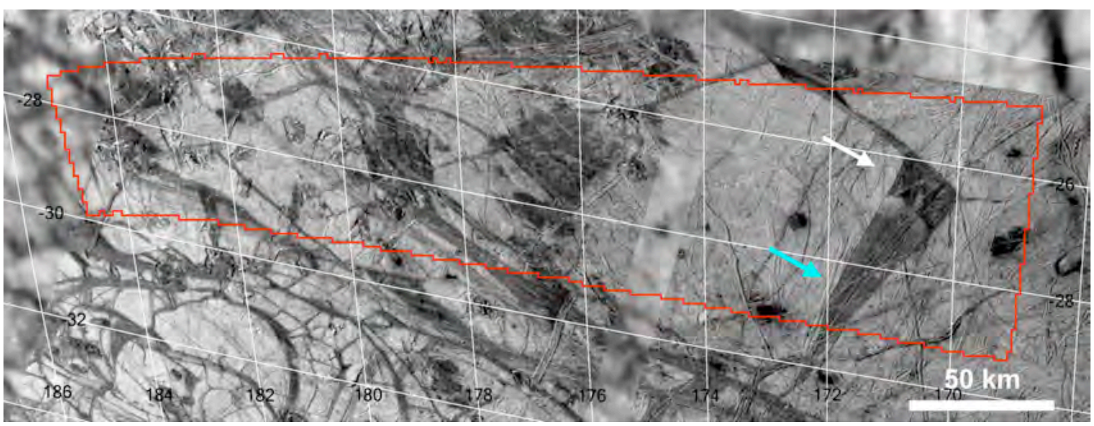


Figure 1a: Study region (red) in Argadnel Regio. SSI data include Galileo E14 and C3 images. The wedge-shaped band in the east of the study area shows distinct relative albedo variations along its length: it is mostly grey (blue arrow), but is darker in the north (white arrow).

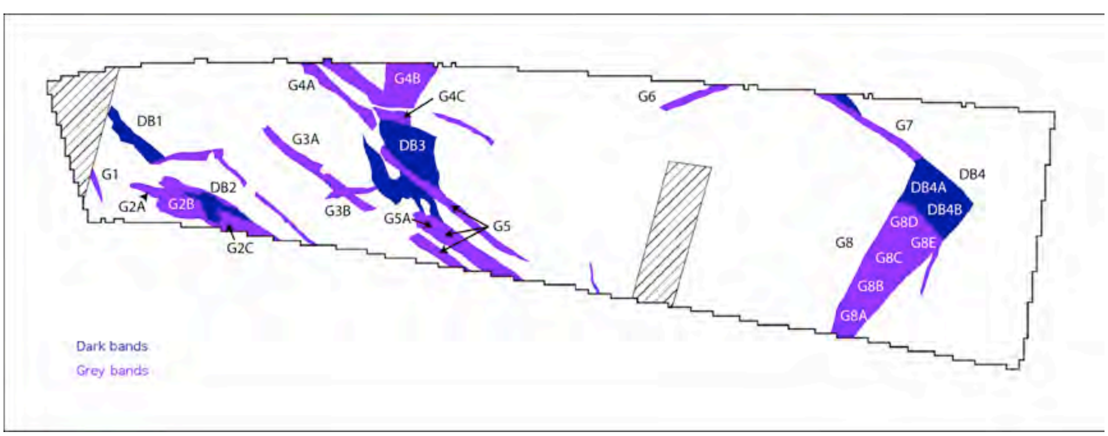


Figure 1b: Sketch map of units used in this study from [2], which includes grey (purple) and low albedo or dark (navy blue) bands. Numbers correspond to different spectral areas sampled using NIMS data.

We use the same technique to investigate potential compositional and grain size variations among a different geological feature type in the study area, known as pull-apart bands. These are dark or grey features which formed as a result of the pulling apart of cracks in Europa's surface, allowing new material to be emplaced into the newly-formed gaps [4] (Fig. 1b), and which appear to be sites of extensive resurfacing [5]. Europan bands appear to have brightened over time, although the exact cause is not known [6]. Thus the relative albedo of a band can be used as a proxy for age [5], as is observed in our region of interest, where the darkest bands crosscut lighter, or "grey" bands [2]. We here investigate variations in composition and ice grain size in order to search for correlations with the relative albedos of bands in our region. Small ice grain sizes would indicate relatively young bands, while large grain sizes are predicted for older bands.

**Results:** Preliminary results show that the abundnace of salts modeled in the grey bands tend to be less than those in the dark bands (from ~19 to ~38% and ~38 to 47% respectively). Consistent with the hypothesis that the grey bands predate the dark bands, no small ice grain sizes are observed in the grey bands, which are predominantly comprised of 50- and 75-µm ice. The dark bands contain a generally smaller amount of smaller grained ice, mostly 25- and 50-µm, as might be expected if they were younger. All the bands contain less large-grained ice than the surrounding ridged plains.

Of particular interest is a wedge-shaped feature in the eastern portion of the study area. The main body of the wedge is grey (blue arrow, Fig. 1), while the widest part near the top of the crack is darker (white arrow, Fig. 1). Given the brightening of materials on Europa's surface over time, it is difficult to explain this albedo pattern: since bands appear to spread from a central axis, in a manner not dissimilar to mid-ocean ridge formation [5, 7], a lower albedo unit would be expected along the axis of the band, not across one end. The albedo variations correlate with variations in composition and grain. The grey part (labeled collectively G8 in Fig. 1b) has about equal amounts of 50- and 75-µm ice grains (31.8% total) in our model and 26.5% salts, while the dark portion (Db4 in Fig. 1b) is best modeled with only 50-µm ice (24.8% total) and 38.2% salts. These results could imply that the northern part of the wedge is younger. We hypothesize that this apparent difference in age along the wedge is due to some resurfacing event related to the formation of a large depression, which formed after the wedge and downdropped its northern part. Large arcuate depressions have been documented on Europa's leading and trailing hemispheres, measuring up to hundreds of kilometers long and <1500 m deep, and interpreted to result from stresses caused by an episode of ~80º true polar wander [8]. Some of these depressions are found close to our study region (Fig. 2). We note a shallow depression in our region that was not mapped by [8], but which shares similar characteristics and is visible in high incidence angle Galileo images (Fig 2). The southwestern margin of the depression cuts through the wedge-shaped band, corresponding to the change in relative albedo along the wedge from grey in the southwest (preexisting, high-standing topography) to dark in the north (low topography), and to our model results suggesting different compositions and ice grain sizes for the dark portion of the wedge. We speculate that this variation in composition could be due to some kind of resurfacing across the northern portion of the wedge, due to processes such as (1) the removal of frost due to surface shaking during the tectonic event, resulting in lower albedo material being revealed; (2) the emplacement of fine-grained plume or similar material due to a cryovolcanic eruption on the wedge floor; or (3) because the fault forming the southwestern margin of the depression intersected a near-surface briny reservoir, such as has been suggested to exist on Europa [9], enabling low-albedo material to be emplaced onto the floor of the depression, thereby darkening the wedge and modifying its surface composition.

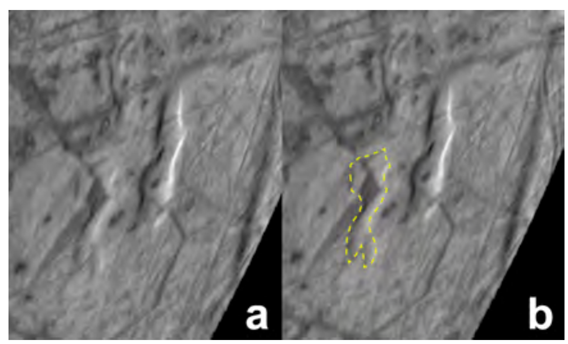


Figure 2: View of some of the depressions that have been labeled "Europa's crop circles" [8] under oblique solar illumination (a) Original unprojected Galileo image. The two arcuate depressions in the middle and right hand side of the image were mapped by [8]. (b) Dashed yellow line outlines a basin which appears to cut across the wedge-shaped feature in our study area; the western margin of this depression appears to correspond to the northern lower albedo segment of the wedge.

**References:** [1] Shirley J.H. et al. (2010) *Icarus, 210,* 358-384. [2] Prockter L.M. et al. (1998) *Icarus, 135*, 317–344. [3] Clark R.N. et al. (1983) *Icarus, 56,* 233-245; Johnson R.E. & Quickenden T.I. (1997) *J. Geophys. Res., 102,* 10985-10996. [4] Schenk P.M. & McKinnon W.B. (1989) *Icarus, 79,* 75–100. [5] Prockter et al. (2002) *J. Geophys. Res. 107,* doi:10.1029/2000JE001458. [6] Geissler P. E. (1998) *Icarus 135*, 107–126. [7] Sullivan R. et al. (1998) *Nature, 391*, 371–373. [8] Schenk P. et al., (2008) *Nature, 453,* 368. [9] Collins G. and Nimmo F. (2009) in *Europa*, (Univ. Arizona Press,Tucson, 2009), pp. 259–282; Schmidt B. et al. (2011) *Nature, 479,* 502–505.