

Planetocentric latitude and positive east longitude coordinate system shown in black. Planetographic west longitude coordinate system shown in red. NORTH POLAR REGION

SCALE 1:8 338 000 (1 mm = 8.338 km) AT 56° LATITUDE

SCALE 1:9 172 068 (1 mm = 9.172 km) AT 90° LATITUDE

POLAR STEREOGRAPHIC PROJECTION

Descriptions of nomenclature

500 400 300 200 100 50 0 50 100 200 300 400 500

Global Geologic Map of Europa

SCALE 1:15 000 000 (1 mm = 15 km) AT 0° LATITUDE

500 400 300 200 100 50 0 50 100 200 300 400 500

Planetocentric latitude and positive east longitude coordinate system shown in black.

Planetographic west longitude coordinate system shown in red.

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Eighteen occurrences; distributed globally, Material ejected as part of the impact Continuous crater-ejecta material—Region found surrounding crater material (unit c) made up of knobby, rounded blocks, usually in association with unit **c**. Superposes process; brightness variations could be due rough on the scale of hundreds of meters. Material typically units pr and b. Superposition relations vary with to entrained non-ice materials, possibly extends as far as ~5 crater radii from unit c. May occur with a units chl, chm, and chh range of relative brightness with respect to the surrounding terrain. Buries existing units. *Type locality*: lat 1° N., long 196° E. Pwyll radial crater-ejecta material—Material with a mottled One occurrence around Pwyll crater (radius ~25 brightness where the high- relative-brightness material is radially km). Superposes units chl, chm, and pr primary impact site; drapes the existing distributed in quasi-linear streaks around units c and ce. This unit pr to create the observed mottled material buries or subdues the existing unit pr. Located ~5–10 crater radii away from unit c. *Type locality*: lat 25° S., long 79° E. Pwyll crater-ray material—Isolated high-relative-brightness patches, One occurrence around Pwyll crater (radius ~25 Distal ejecta deposits that form from >10 crater radii from the unit c, aligned quasi-linearly and km). Associated with secondary craters in secondary impactors and other distributed radially with respect to a central point (Pwyll crater). high-resolution images (Bierhaus and others, 2001). corresponding ejecta from the primary *Type locality*: lat 9° S., long 97° E. Superposes units chl, chm, and pr **CHAOS UNITS** [Disrupted terrain consisting of blocks of existing terrain that have been broken up on a scale of hundreds of meters to kilometers within a matrix material. Outcrops are typically at the scale of thousands of square kilometers. May contain pieces of ridges, bands, and undifferentiated linea. Microchaos becomes a chaos unit when they completely coalesce at map scale] **Low-relative-brightness chaos material**—Low-relative-brightness Primarily occurs on the anti-Jovian hemisphere, The formation of chaos may be due to material with rounded blocks of unit pr (one to tens of kilometers) where radiation affects surface-material activity. The low relative brightness may in a matrix with smooth patches on a scale of one to tens of properties and sulfur is implanted from Io. kilometers or rough texture (containing boulders hundreds of Superposes units pr and b. Morphologically be due to a high percentage of matrix meters to kilometers). Blocks can stand high or low with respect to gradational with units chm and chh. material relative to the disrupted existing the surrounding material. In areas of lower resolution (>1 kilometer Superpositional relations vary with units c and crustal blocks and (or) a high concentraper pixel [km/px]), this terrain appears smooth with low-relativetion of non-ice material and the effects of brightness material punctuated irregularly by small (km-scale)

Relatively low uniform brightness when radiation on this material areas of varying brightness. *Type locality*: lat 1° S., long 105° E. compared to units chm and chh Mottled chaos material—Patchy relative-brightness material that Occurs in close proximity to unit chl on the

The formation of chaos may be due to varies in brightness on a scale of tens of kilometers. Contains anti-Jovian hemisphere but also occurs over all endogenic, possibly cryomagmatic, activity. rounded and angular blocks of unit pr on a scale of one to tens of latitudes and longitudes. Superposes units pr The brightness variations may be due to a kilometers in a matrix with a smooth (one to tens of kilometers) and b. Morphologically gradational with units nearly equal percentage of matrix material or rough texture (containing boulders hundreds of meters to chl and chh. Unclear relation with unit chM. and disrupted existing crustal blocks of unit kilometers wide). The darkest materials (~10 km scale) are Superpositional relations vary with units **c** and **pr** and (or) a result from variations in typically smooth on the kilometer scale. In areas of lower ce. Superposed by units cpre and cpr non-ice content. The patchy brightness resolution (>1 km/px), this terrain has a high degree of mottling could also result from the incomplete (tens of kilometers scale) with material of varying brightness. coalescence of microchaos *Type locality*: lat 23° S., long 276° E. High-relative-brightness chaos material—High-relative-brightness Occurs primarily on the sub-Jovian hemisphere, The formation of chaos may be due to material with angular blocks of unit pr on a scale of tens of where a high degree of radiation processed endogenic, possibly cryomagmatic, activity.

troughs. Some craters contain blocks or other slumped material. relations vary with units chl, chm, and chh

Floors can range from roughly flat to bowl-shaped. Some contain

a central peak structure

Type locality: lat 10° N., long 290° E.

removed. *Type locality*: lat 14° S., long 163° E.

locality: lat 32° S., long 143° E.

Moytura chaos material—Contains a smooth material, on a The only identified location is in Moytura The formation of chaos may be due to kilometer scale, that stands topographically higher than the Regio in the southern leading hemisphere. endogenic, possibly cryomagmatic, activity. surrounding terrain. Broken up by blocks of unit pr on a scale of Superposes unit pr. Unclear relationship to unit The large-scale texture may be a result of ~20–50 km and curvilinear depressions. *Type locality*: lat 46° S., chm local ice shell thickness variations or due to a different of deformation mechanism than units chl, chm, and chh. The height of the terrain may be a result of uplift BAND UNIT

kilometers in a matrix with a rough texture (containing angular surface materials. Superposes units pr and b. The higher relative brightness may contain boulders hundreds of meters to kilometers in scale). In areas of Morphologically gradational with unit chm. a low percentage of matrix material relative lower resolution (>1 km/px), this terrain appears smooth with Unclear relation to unit chl. Superpositional to the existing crustal blocks and (or) high-relative-brightness material punctuated irregularly every relations vary with units c and ce. Relatively indicate a higher degree of radiation ~10–100 km by small (kilometer scale) areas of low brightness. high uniform brightness when compared to units processing of the ice and, possibly, non-ice

> pr. Superposed by units chl, chm, and chh REGIONAL PLAINS UNIT

places, surrounding terrain may be reconstructed when band is as a result of chaos formation. Superposes unit grain-size variations

Regional plains material—Many subparallel to cross-cutting ridges Distributed over all latitudes and longitudes. Primitive ice crust that has been deformed and troughs (~hundreds of meters wavelength) are evident in Some regions exhibit offsets in existing ridges through multiple generations of tectonic higher resolution data (<250 meters per pixel). In areas of lower and troughs that are then cross-cut by other processes resolution (>1 km/px), this is an undivided terrain of relatively ridges, trough, or other linea. Superposed by smooth, uniform material with high apparent brightness. *Type* every other unit

Band material—Linear to curvilinear zones, 15 to ~60 km in width,

Distributed over all latitudes and longitudes but

Terrain that has been pulled apart by

with a distinct, abrupt relative-brightness change (typically darker) concentrated in the leading and trailing hemi-

than the surrounding terrain. Brightness can also change within a spheres. Although pieces or peninsulas of unit b brightness variations relative to the

band along its width. Interior texture ranges from smooth to may be found with units chl, chm, and chh, they surrounding terrain or within a band may

corrugated, with ridges on a kilometer-scale wavelength. In some appear broken up and (or) degraded, presumably be due to concentration of non-ice or

Figure 1. U.S. Geological Survey global image mosaic (*A*) showing white boundary around supplementary image mosaic and black boxes that refer to locations of histograms in figure 4. The supplementary image mosaic (B) is used to aid unit identification but not used to draw unit contacts. UNITS IMPACT CRATER UNITS LINEAR FEATURES LOCATION FEATURES [Arrow delineates feature] REGIONAL PLAINS UNIT [Arrows delineate unit] [Arrows delineate linear features] Figure 3. Images of type localities for units, linear features, and location features defined in this global map in approximate stratigraphic order. A, regional plains material (unit pr); B, band material (unit b); *C*, low-relative-brightness chaos material (unit chl); D, mottled chaos material (unit chm); *E*, high-relative-brightness chaos material (unit chh); F, Moytura chaos material (unit chM); G, continuous crater-ejecta material (unit ce); H, Pwyll radial crater-ejecta material (unit cpre); I, Pwyll crater ray material (unit cpr). Linear features: *J*, undifferentiated linea; *K*, ridge linea *L*, band linea; *M*, high-relative-brightness band linea; N, cycloid; O, multi-ring structure (inset box is ~35 kilometers wide); *P*, trough; *Q*, depression margin. Location features: *R*, central peak structure; S, microchaos material. Left image in the image pairs is ~100 kilometers on a side and sourced from U.S. Geological Survey basemap; location cited at bottom of image. Box in left image shows location of right image. Right image in the image pairs is a high-resolution example (listed in meters per pixel [m/px]) showing more detail of the terrain; and image number and resolution are cited below the image. Not all type localities include a right image.

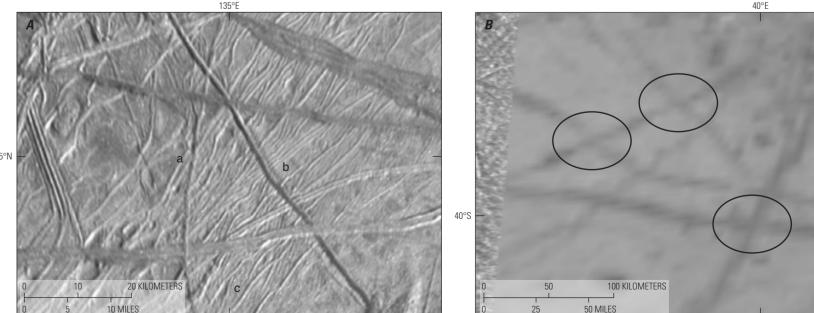
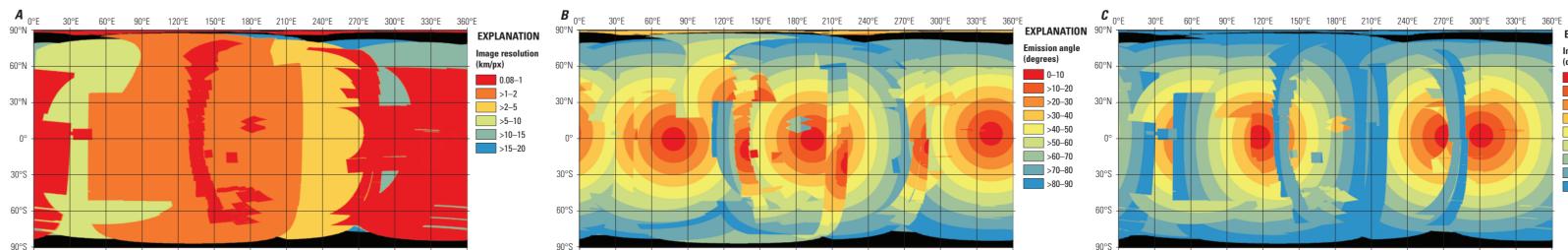
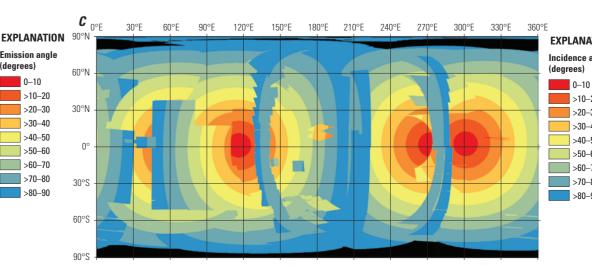
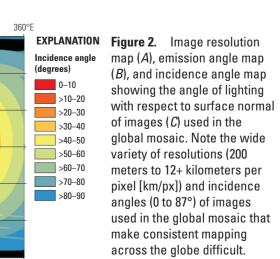
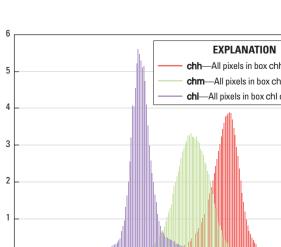


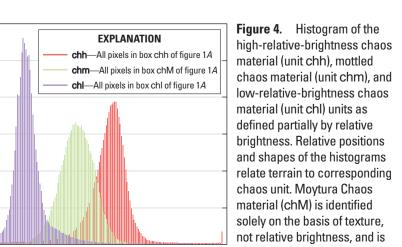
Figure 5. Images showing examples of how using superposition to determine relative age is not always applicable on Europa. Three lineaments that form a triangle in image A have conflicting, or at least ambiguous, superposition relations: lineament a is younger than c and older than b (b, a, c); lineament b is younger than a and older than c (c, b, a); lineament c is younger than b and older than a (b, c, a). Lineaments in image B have indecipherable superposition relations because of low-resolution











high-relative-brightness chaos material (unit chh), mottled low-relative-brightness chaos material (unit chl) units as defined partially by relative brightness. Relative positions and shapes of the histograms relate terrain to corresponding chaos unit. Moytura Chaos material (chM) is identified solely on the basis of texture, not relative brightness, and is ²⁵⁵ not included on this diagram.

Pamphlet accompanies map