EUROPA’S NORTHERN TRAILING HEMISPHERE: LINEAMENT STRATIGRAPHIC FRAMEWORK.
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Introduction
Knowledge of the global distribution of Europah geologic units in time and space is a necessary step for the synthesis of the results of the Galileo mission and in preparation for future exploration (namely, by JIMO) of the satellite. We have initiated the production of the first Global Geological Map of Europa. As a base map, we use the recently published global photomosaic of Europa (U.S.G.S. Map I-2757) and additional Galileo SSI images at their original resolution. The map is being produced entirely on GIS format for analysis and combination with other datasets [1]. One of the main objectives of this project is to establish a global stratigraphic framework for Europa. In the absence of a well-developed cratering record, this goal will be achieved using the satellite’s global network of lineaments (ridges, ridge complexes and bands; cf. [2]). Here we present the preliminary stratigraphic framework synthesized from the sequence of lineaments derived for the northern trailing hemisphere of Europa (Figure 1, below), and we discuss its significance and some emerging implications.

Methodology
At this stage, we focus our analysis to the region located between 140° and 250° longitude (about 1/3 of the satellite), on the northern trailing hemisphere of Europa. This region has the best image coverage of Galileo and Voyager data and allows us to draw from the results of previous mapping projects [3-6]. Before mapping, we identified and processed all the available observations, and expanded the Europa nomenclature with 14 lineaments and one region that are key for stratigraphic studies [1]. Given the uneven resolution of the base photomosaic, we first mapped and established crosscutting and superposition relationships of lineaments within all high-resolution Galileo observations in the area of study. We consider only the most prominent lineaments, those that extend for 100 km or more, and any lineament that determines the timing between prominent features. The stratigraphic relationships derived from the high-resolution mosaics are then extrapolated onto the global, lower resolution context.

Figure 1. Lineament nomenclature and numbering.
**Results and discussion**

Stratigraphic information is synthesized and displayed in a correlation chart with nearly 200 lineaments (Figure 2). In our analysis we assume—unless evidence indicates otherwise—that lineaments formed relatively quickly as a single event and that there were no reactivations. Lineaments without official nomenclature were assigned an arbitrary catalog number; the location of many of these lineaments can be seen in Figure 1. We are also developing and testing a GIS routine tailored to automatically generate lineament-by-lineament stratigraphic charts. Our results will be contrasted with the GIS output in order to expose hidden inaccuracies as part of an iterative revision process. We stress that this basic framework is preliminary, and is being expanded and modified with information from the ongoing mapping of the other regions of Europa.

Even at this preliminary stage, the chart enables an assessment of the relative timing of lineaments on distant regions of Europa. For example, we can determine for the first time that the Tyre impact event occurred before Ino Linea developed, and that the southern branch of Autonoe Linea is much younger than Arigiope Linea. At this point we see no evidence of “patchy” resurfacing, where tectonic activity moves from one area to another. In this sense, we note that currently the chart incorporates no stratigraphic constraints from impact craters (with exception of Tyre) and chaos regions. After their incorporation, we should be able to determine, for example, whether there were one or more major episodes of chaotic resurfacing.


**Figure 2.** Preliminary correlation chart of lineaments in the northern trailing hemisphere, from youngest to oldest, top to bottom. Included are some lineaments beyond the extent of Figure 1. Only the crosscutting relationships that constrain the stratigraphic position are shown as vertical lines, and lineaments can “float” within their respective vertical lines. At this time, lineaments labeled blue are locally the most recent; lineaments labeled red are locally the oldest; lineaments labeled green extend horizontally elsewhere in the chart. Question marks indicate uncertain relationships.