COLLEGE OF COMPUTER, MATHEMATICAL, & NATURAL SCIENCES

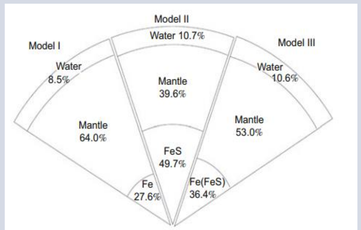
Strike Slip Faults of Europa

May 2017

Geology 393
By: Jeffrey Adams
Mentor: Vedran Lekic

Background

- Europa is a Galilean moon of Jupiter, the fifth planet from the sun
- Surface of this moon is an icy crust on top of an ocean of liquid water
- Silicate mantle beneath the H_2O layers
- Core models consistent with an Iron Sulfate (FeS) core
- Icy crust broken up by cracks and faults
- Termed "lineaments," these faults show as darker lines and formations
- Lineaments formed by tidal forces
- Precession, obliquity, non- synchronous rotation outlined by A. Rhoden (2012)
- These factors result in tidal force that is recorded by surface faults
- Strike slip faults in particular show movement of adjacent surfaces
- Slip vector shows how force propagates on crust
- Laterality and hemisphere have shown correlation in past studies (Hoppa, 2000)



Three different models showing percentages of each layer by volume. The total radius shown is between 1562 km (model I) and 1569 km (model III).

Model and image constructed by (Jin, 2012).

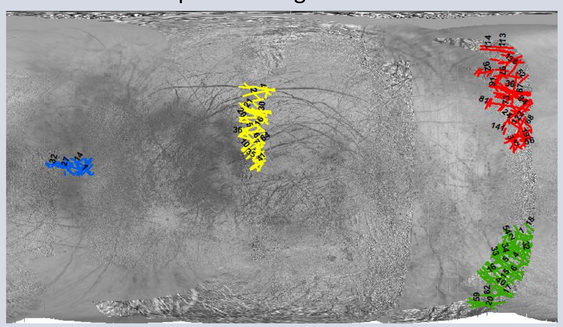
Hypothesis

For strike slip faults on the surface of Europa, there exists a correlation between the geodesic length of the fault and the azimuth of the strike vector

Available Resources

- Currently, the only detailed map images available of Europa are collected from the Galileo (1989) and Voyager (1977) missions
- Stitched together from images taken in north-south bands
- Distinct bands of higher and lower resolution depending on orbit of probe
- Four regions determined to be feasible for mapping
- Name of each section based on hemisphere or region

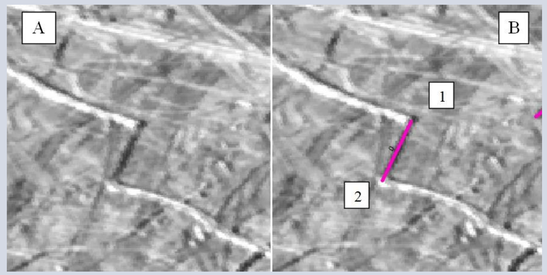
The map of Europa, with areas to be mapped shown by colored lines. Sections are northern and southern leading , north trailing, and western equatorial region.



Methodology

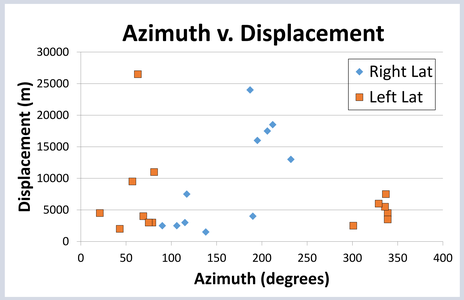
- The feasibility study was conducted on the northern leading hemisphere
- ArcGIS is used to map lines onto the digital version of the map
- From these lines, programs can be run to collect location, length, and azimuth information about each fault
- Challenge to record the data is preserving the laterality (Right or left lateral) in a consistent manner
- Always beginning with the left-leading crack so laterality can be inferred from azimuth

An example of a strike slip fault is shown in (A), with the strike vector overlaid in (B). The start of the vector is shown as (1), with the end displayed as (2). For reference, this vector is 17,500 m long, with an azimuth of 206 degrees.

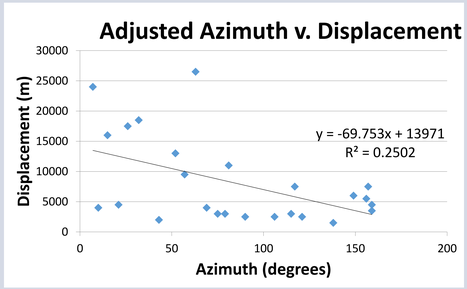


Collected Fault Data

- In this graph, the azimuth is plotted against the displacement
- There are distinct groupings shown with each laterality
  - Low slip, high angle left lateral faults
  - Variable range right lateral faults
- 14 left lateral faults and 11 right lateral



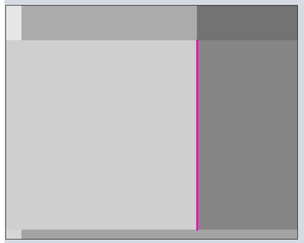
- "Adjusted" refers to all azimuth values above 180° being reduced to below 180°
- Displays an R^2 value of 0.25
- Correlation Coefficient of 0.5
- This method removes significance of laterality



Error Analysis

- Spatial resolution across the entire available map is low
- Areas chosen to be mapped have the highest spatial resolution
- Certain regions have pixel sizes of multiple kilometers, these are unable to be used in this project
- Temporal resolution is also nonexistent, as these photographs are product of a single orbit sequence
- All data has an inherent error of at least 500 meters due to spatial resolution

An extreme close up of the individual pixels, in order to measure an accurate spatial resolution. The pink line is exactly 500 m, and the pixels are all square.



Conclusions

- Past studies have established a correlation of more left lateral faults in the northern hemisphere, and this is consistent with collected fault data
- A weak correlation exists between azimuth and displacement distance
- If right or left lateral faults are an even binomial probability distribution, there exists a 13% chance to acquire these results

Future Goals

- Three other regions exist which are yet to be mapped
- Similar analysis will be carried out upon these remaining regions
- This fault information can be compared to laterality data compiled by G. Hoppa (2000) and Sarid (2006)
- To prove a statistically significant correlation, more data must be collected
- This would assist in determining what influences the tidal forces acting on the icy crust

Citations

•Hoppa, Gregory, et al. "Distribution of strike-slip faults on Europa." *Journal of Geophysical Research: Planets* 105.E9 (2000): 22617-22627.
•Jin, S., & Ji, J. (2012). The internal structure models of Europa. *Science China Physics, Mechanics And Astronomy*, *55*(1), 156-161. doi:10.1007/s11433-011-4573-9
•Rhoden, Alyssa Rose, et al. "Shell tectonics: A mechanical model for strike-slip displacement on Europa." *Icarus* 218.1 (2012): 297-307.
• Sarid, Alyssa Rose, Richard Greenberg, and T. A. Hurford. "Crack azimuths on Europa: Sequencing of the northern leading hemisphere." *Journal of Geophysical Research: Planets* 111.E8 (2006).