Trends in Slope and Spreading Rates of the Southern Reykjane Ridge

Rachel Fein, Dr. Leslie Sautter
Department of Geology and Environmental Geosciences, College of Charleston

Abstract

The Southern Reykjane Ridge is a small portion of the Mid-Atlantic Ridge starting at Bight Fracture Zone and extending all the way north to Iceland. Multibeam sonar data were collected in 2013 on the R/V *Marcus G. Langseth* with a Kongsberg EM122. Post-processing of bathymetry was conducted using CARIS HIPS and SIPS 9.1. Five west-east bathymetric profiles were perpendicular to the ridge axis in order to characterize and understand the trends of the ridge flanks. West and east flanks were examined for depth, slope, and distance to the 10.9 Ma magnetic anomaly, and spreading rates were calculated. Characterizing this small southern end of the Reykjanes Ridge revealed that the west flank had steeper slopes and faster spreading rates as compared to the east flank. These methods can be used on other portions of the Mid-Atlantic Ridge to compare and understand ridge geomorphology with spreading rate.

Background

The 900 km Reykjane Ridge is a small segment of the Mid-Atlantic Ridge starting at the Bight Transform Fault and extending northward to Iceland. The ridge is a slow spreading ridge separating the North American and Eurasian plates with an average spreading rate approximately 2cm/yr. The study site is the southern most part of this ridge (figure 1) and was studied to find possible trends in slope and spreading rates. Past studies on the ridge focus on characteristics of the the axial valley, the effects of magnetic anomalies causing a change from oblique spreading to orthogonal spreading, and effects of the Iceland mantle plume on the ridge (Searle et al.,1998). This segment of the Mid-Atlantic Ridge is the largest oblique spreading ridge in the world (Keeton et al., 1994). This study site has a prominent axial valley typical of slow spreading ridges, whereas an atypical feature of this particular segment is the absence of transform faults. Also, the axial valley geomorphology becomes more complex north of the study area where it is closer to the mantle plume under Iceland (Searle et al., 1998). In the five profiles the depth of the axis decreased in depth moving north (figure 4). This trend is seen all the way until Iceland and is hypothesized by scientist that this crustal thickening is due to increase in mantle temperatures caused by the Iceland plume producing greater melting and isostatic uplift. Information that also suggest that the ridge's morphology is not just a result from spreading rate (Searle et al. 1997).

Methods

- Multibeam sonar data was collected using a Kongsberg EM122 and post-processed using CARIS HIPS and SIPS 9.1.
- The region was divided into 5 sections each specified by a depth profile A,B,C,D,E.
- Slope was found for each flank by measuring from the axial valley edge to depth of 2,500m.
- GeoMapApp data from Muller, 1997 was used to find location of the 10.9 Ma magnetic anomaly.
- Overlapping images of the magnetic anomaly and study on Google Earth the distance from ridge axis to the anomaly was found.
- Spreading rate and symmetry of the 5 profiles were calculated.
- Slope and spreading rates were compared to find possible correlations.

Figure 1. 150m CUBE surface of the of the study site

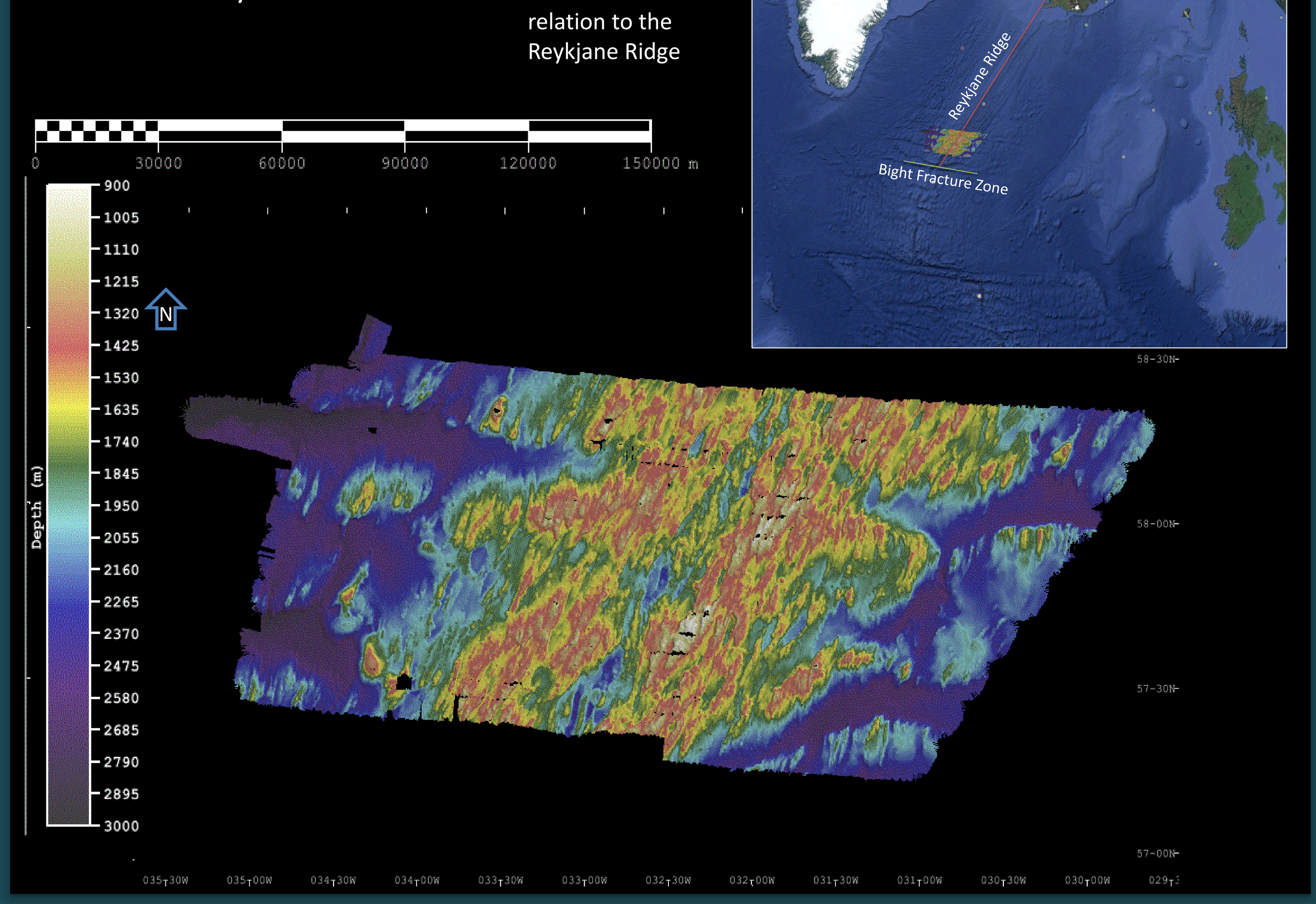


Figure 2. Map of profile lines A,B,C,D,E and 10.9 million year old magnetic anomaly.

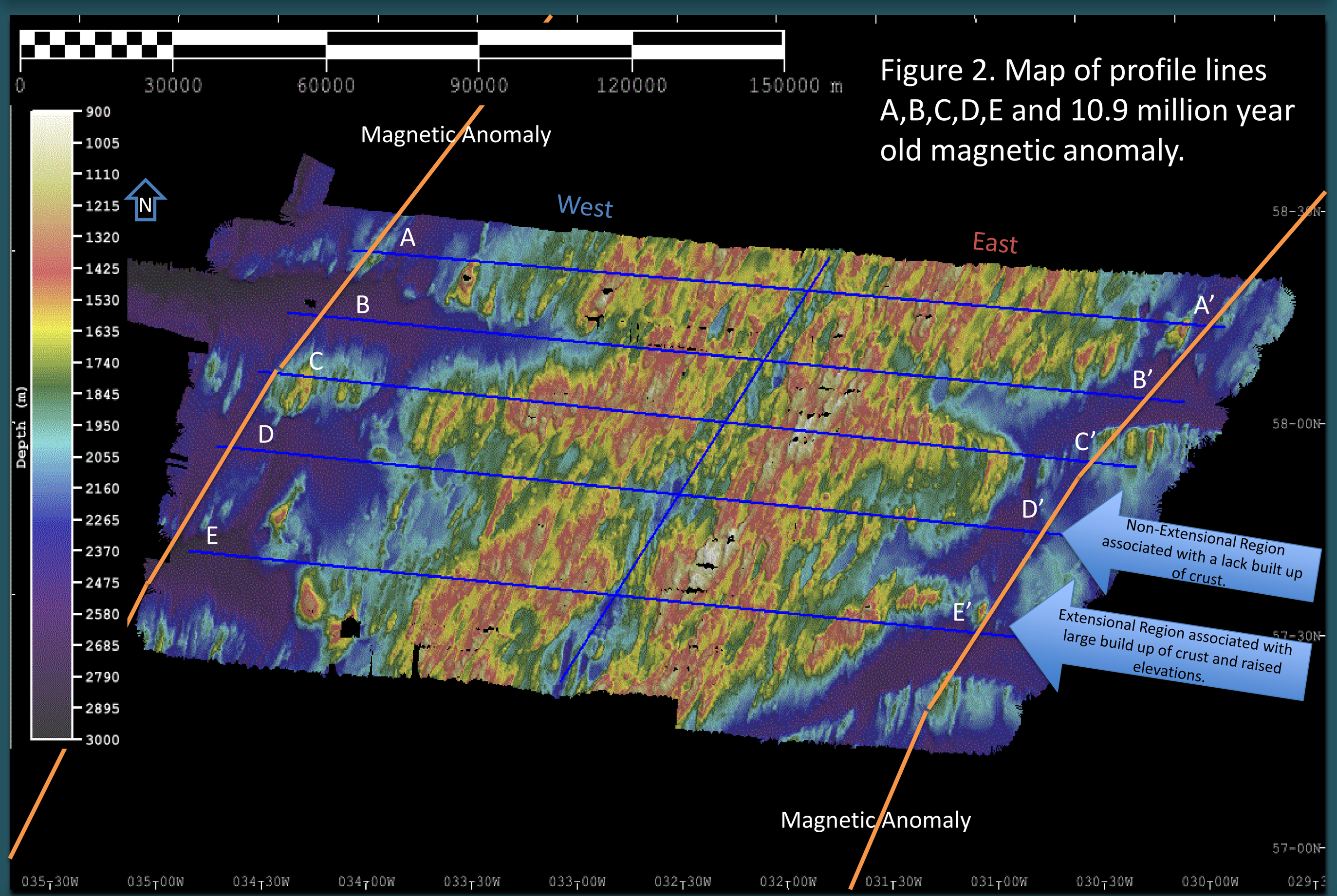
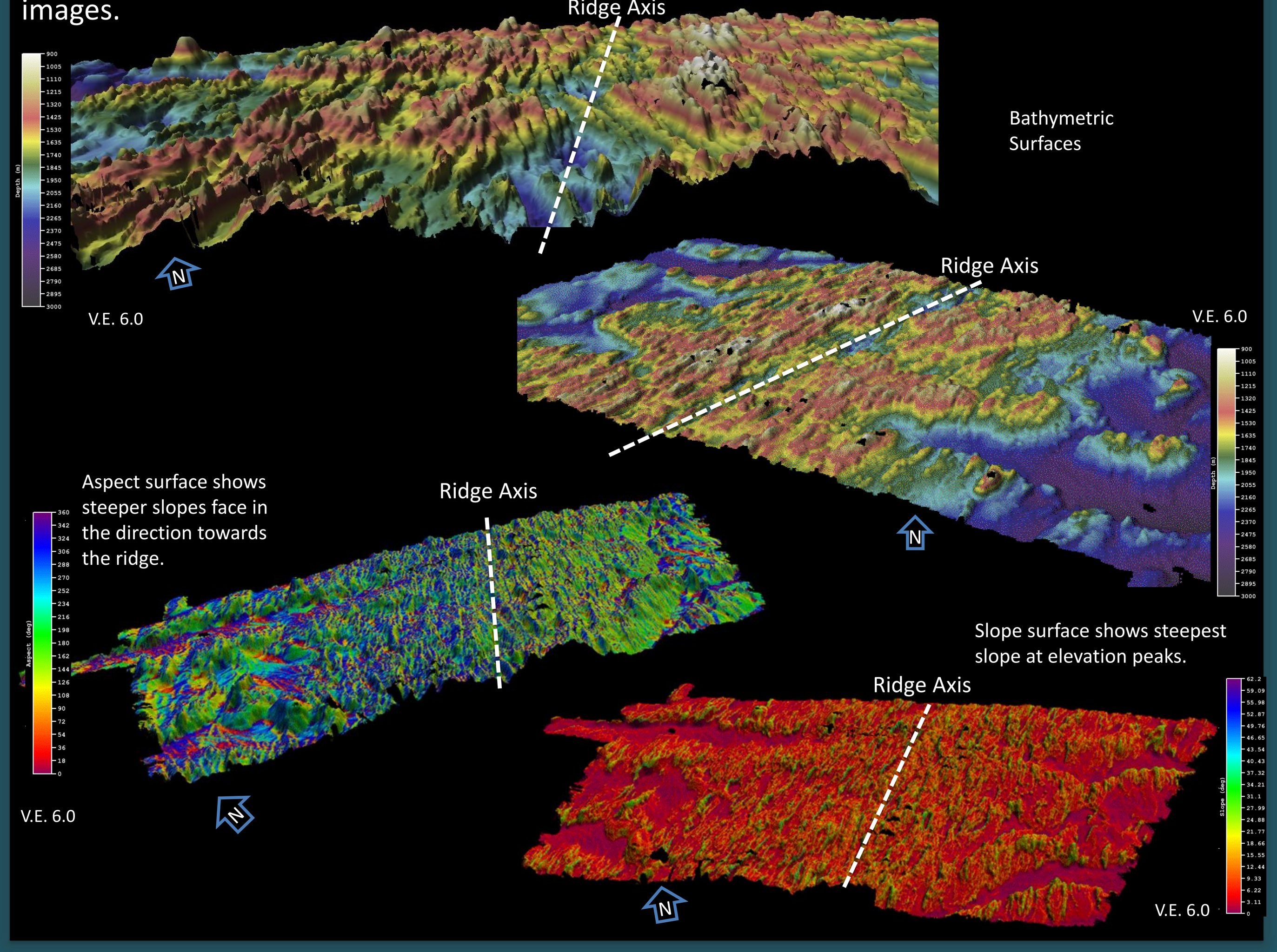


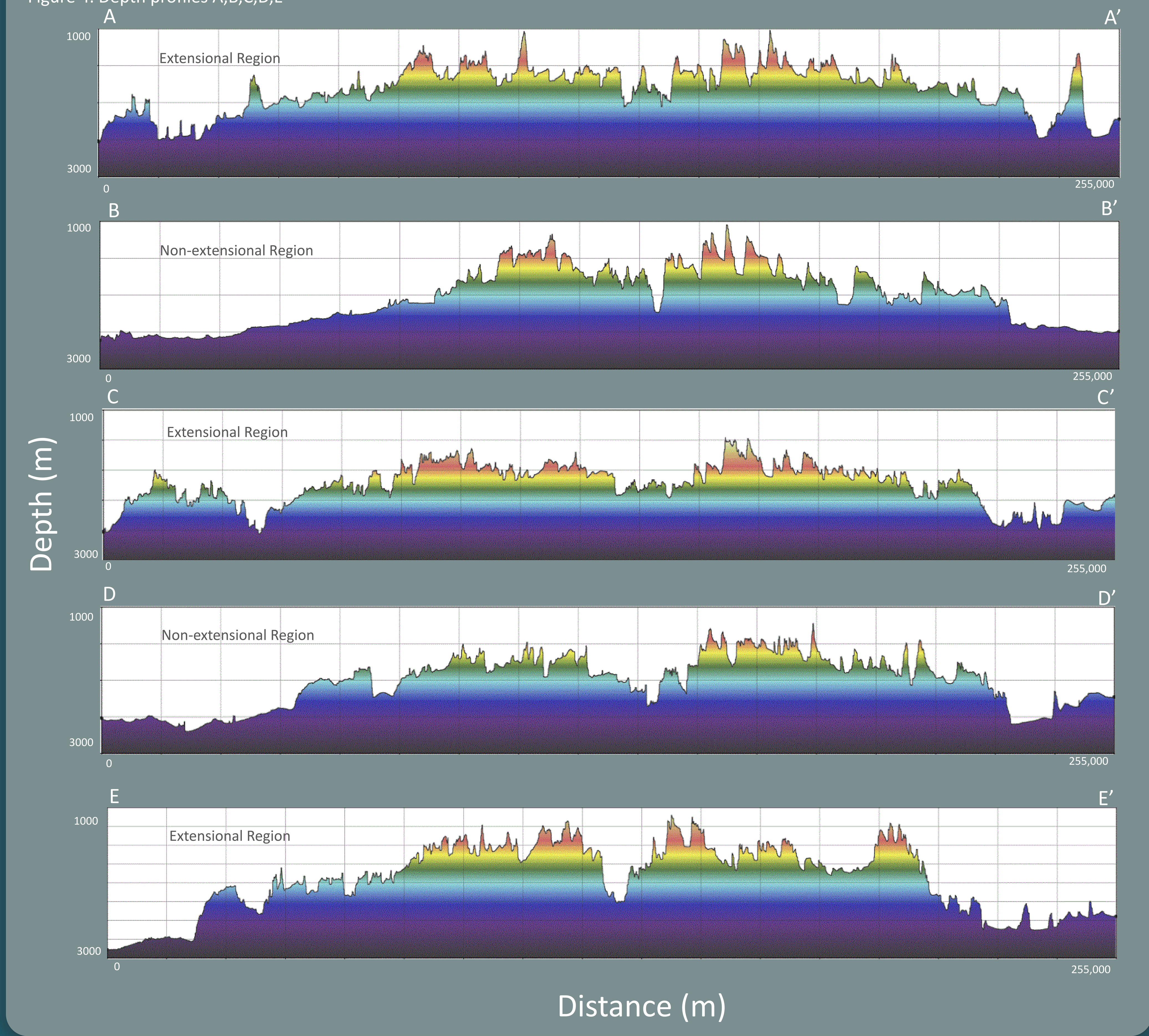
Figure 3. 3D bathymetric images of study site, as well as aspect surface and slope surface images.



Results

- All east profiles (averaging 0.0119 degrees) have steeper flank slopes than their west counterparts (averaging 0.119 degrees) except B to B' (figure 5).
- All west profiles (averaging 111,671 m) are a farther distance to the 10.9 Ma anomaly than their east counterparts (averaging 126,531 m) (figure 6).
- All west profiles (averaging 1.1608 cm/yr) show a faster spreading rate than their eastern counterparts (averaging 0.0119 cm/yr) (figure 7).
- The west and east side of the ridge show an association between slope and spreading rate (figure 8).
- The extensional vs. non-extensional regions showed no significant observable relationship in slope or spreading rate (figure 10).

Figure 4. Depth profiles A,B,C,D,E



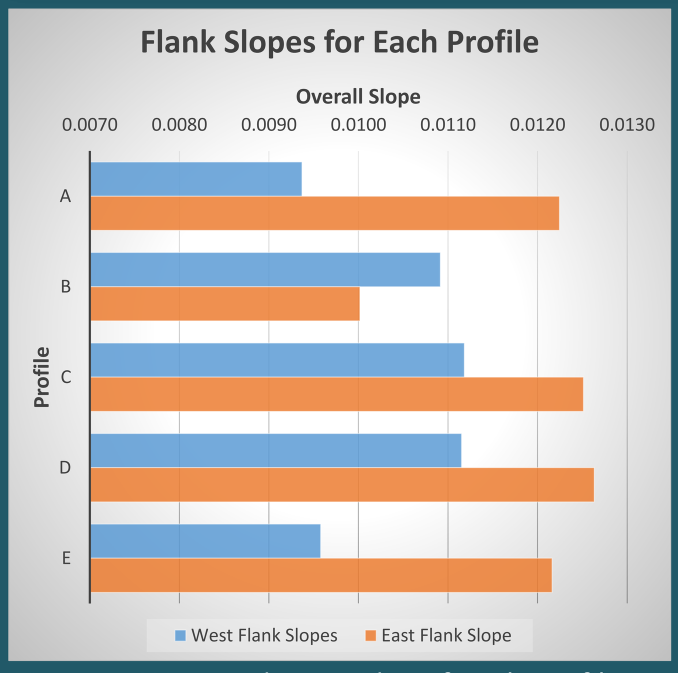


Figure 5. West and east sides of each profile flank slope

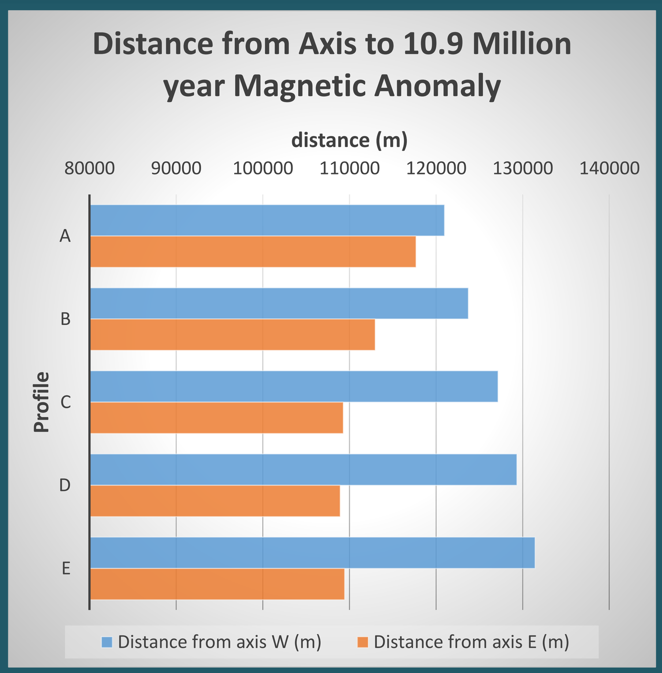


Figure 6. West and east sides of each profile distance from axis to magnetic anomaly

Figure 7. East and west side of each profile spreading rate.

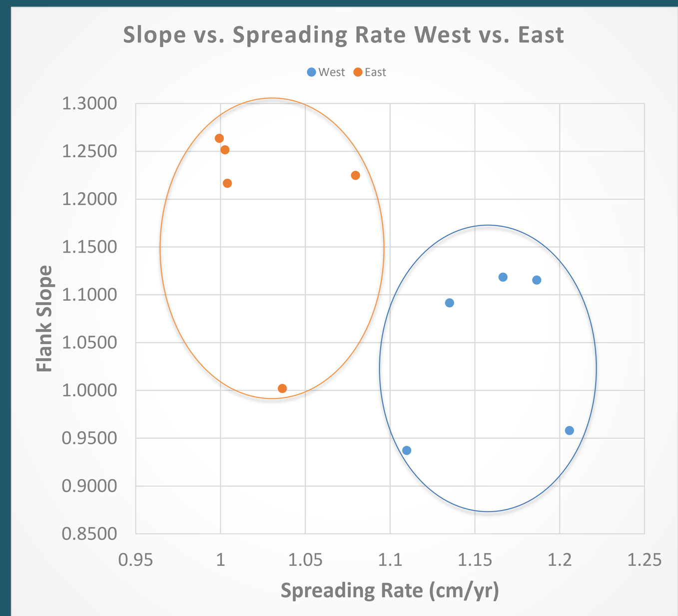


Figure 8. East and west side of each profile flank slope compared to spreading rate.

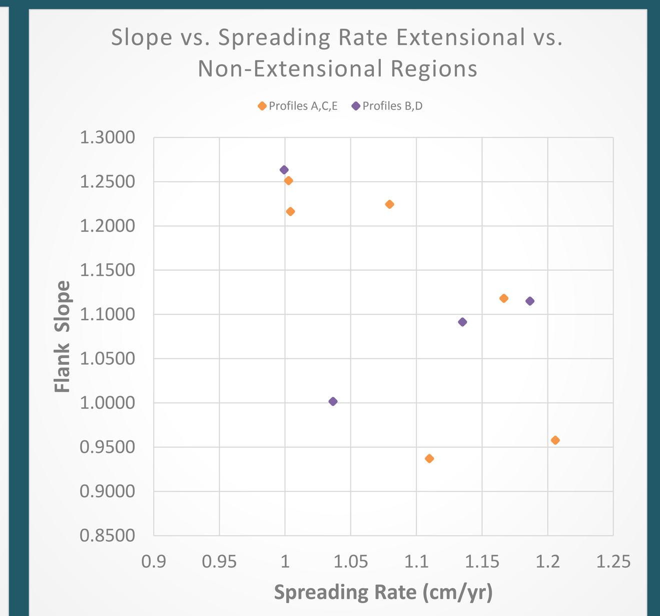


Figure 10. Extensional vs. non-extensional profile flank slope compared to spreading rate.

Discussion

Although only five cross-sections were studied, there is an obvious similarity among all west ridge flanks and among all east ridge flanks. The west side of the ridge is spreading from the axis at a faster rate (averaging 1.1608 cm/yr) as compared to the eastern side (averaging 1.0245 cm/yr), and has a lower slope (averaging 0.01046 degrees) compared to the east flank (averaging 0.0119 degrees). The east profiles have steeper flank slopes than the western counterparts because of the profile's slower spreading rates which causes the crust to build up while faster spreading rates on the west cause a more drawn out landscape pulling on the crust. No specific association between the extensional and non-extensional regions in this study was found, though further study is necessary. Asymmetry is typical of slow spreading ridges which tectonic and volcanic activities vary temporally and spatially rather than steadily (Honsho et al. 2009).

References

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