STRUCTURAL ANALYSIS OF THE KNIPOVICH RIDGE, 74-78N, NORTH ATLANTIC OCEAN.

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Structural analysis of side-scan sonar data is used to interpret the plate-tectonic framework of the Knipovich Ridge, 74-78N, North Atlantic Ocean. Fracture density, fault tortuosity, and derived plate motion vectors correlate roughly with ridge axis bathymetry. Axial highs are sites of lower fracture density and tortuosity; derived plate motion vectors correspond to NUVEL-1A predictions. Axial lows are sites of higher fracture density and tortuosity; derived plate motion vectors diverge from model predictions. These observations suggest that axial highs are spreading segment centers, while axial lows are the sites of non-transform discontinuities.

The Knipovich Ridge is an ultra-slow-spreading (~1.5 cm/yr, full rate) mid-ocean ridge located between 74 and 78 N in the North Atlantic Ocean, near the Eurasian continental margin. The ridge axis trends north-northwest (~350 deg) from 74 to 76 N, and trends north from 76 to 78 N. The NUVEL-1A plate motion vector trends west-northwest (~307 deg), making the Knipovich Ridge an oblique spreading center. The ridge axis is characterized by a 10-15 km wide rift valley with steep, high relief (1-2 km) rift valley walls. The rift valley floor is highly faulted, and is interrupted by widely spaced (40-80 km) volcanic highs with relief on the order of 0.5 to 1 km.

In fall 2000, we collected ~400 km of 30 kHz side scan sonar data along the rift axis of the Knipovich Ridge using the ORETech system on the R/V Logachev (VNIIO, St. Petersburg, Russia). Track width was 2.5 km and resolution was ~5 m. These data were interpreted and a preliminary analysis of the imaged faults is discussed in terms of ridge axis structure and regional tectonic setting.

Faults were identified based on: 1) linear high-reflectance features cutting across lower-reflectance regions, 2) linear acoustic shadows obscuring or hiding bottom morphology, and 3) disruptions or offsets in geological or morphological features. The structural maps were analyzed on several scales; we analyzed the entire map as a unit and then analyzed the data using a 5-km-wide moving window. The data collected consist of four parameters: 1) fault trace length - the total length of the line representing the fault scarp, 2) tip-to-tip length - the straight line distance from one termination of the fault trace to the other, 3) fault trace azimuth, and 4) map area. From these data we calculated: 1) fracture density - total fault length divided map area, 2) fault tortuosity - fault trace length divided by tip-to-tip length, and 3) predicted plate motion vector - spreading direction calculated from fault orientations (based on published experimental and observational studies of oblique rifting). The results of our analysis show broad correlation between along-axis bathymetry and the parameters outlined above, and are outlined in the following paragraphs.

Fracture density tends to decrease or show local minima near axial highs. This may indicate that faults are covered by lava flows, or that these relatively younger rocks have not yet developed a mature tectonic fabric. Higher fracture density in axial lows may indicate older crust that has had time to become more highly fractured.

Fault orientation and derived plate motion vectors coincide with NUVEL-1A predictions near axial highs. This may be because these are the centers of mantle-controlled spreading segments. Plate motion in these areas is accommodated by dike intrusion and normal faulting in orientations compatible with the mechanical relationship between spreading direction and ridge axis orientation. In axial lows the derived plate motion vectors do not coincide with NUVEL-1A models; these may be sites of non-transform discontinuities, or accommodation zones between adjacent spreading segments.

Fault tortuosity is higher in axial lows and lower on axial highs. Tortuosity is thought to be an indication of linkage of multiple faults as they nucleate, grow, and join. Higher tortuosity in axial lows may indicate more mature fracture systems than on axial highs, suggesting that the crust in axial lows is older and/or colder than on the highs.

These preliminary results indicate that volcanic axial highs are sites of lower tortuosity, lower fracture density, and derived plate motion vectors corresponding to NUVEL-1A prediction. Conversely, axial lows have higher fracture density, higher tortuosity, and plate motion vectors divergent from model results. These results support the inference that axial highs are the centers of spreading segments and axial lows are areas of accommodation between spreading spreading segments.