Plume-Ridge Interaction in the Galapagos: Insights Provided by New Gravity and Magnetic Measurements

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1. Abstract
Investigations along the Galapagos Spreading Center (GSC) reveal geophysical and geochemical anomalies that increase in magnitude as the ridge approaches the Galapagos Archipelago (GA), an indication of strengthening plume influence. At the GA and along the GSC these anomalies indicate elevated mantle temperatures, enhanced crustal thickness, and an enriched mantle source. Despite such evidence for communication between an upwelling mantle plume beneath the GA and the nearby GSC, very little is known about the nature of the interaction between the ridge and the hotspot. To explore this question, the FLAMINGO cruise (VR10505) surveyed a region to the west and to the east of the 90° 50'W transform fault. High-resolution EM122 multi-beam bathymetry, MB1 sidescan sonar, and gravity and magnetic measurements were collected over a ~42,000 km² area and exhibit significant variations across the study area. To the west, the Nazca plate is dominated by numerous seamounts aligned along 3 volcanic lineaments. These lineaments extend from the archipelago toward the ridge axis, perhaps following the stress pattern in the lithosphere. To the east, on the Cocos plate, there is very little evidence of constructive volcanism. However, we observe several linear, ridge-parallel, faulted features separating sedimentary basins, and two large bathymetric highs with up to 1 km of relief. Gravity anomalies also display significant differences between the Nazca and Cocos plates. Mantle Bouguer Anomaly (MBA) lows closely contour the volcanic lineaments on the Nazca plate with maxima at the centers of the largest volcanics along the Wolf-Darwin Lineament. On the Cocos plate, the MBA at a given distance from the ridge axis is generally more negative than similar locations on the Nazca plate. In addition, two very negative MBA regions are observed, both of which are slightly elongate in a direction sub-parallel to the Eastern GSC. To better quantify these differences, magnetic anomaly picks are used to create a detailed near-transform kinematic reconstruction. Using this reconstruction as a constraint, we develop an upper mantle thermal model and calculate the ridge jump history of the region and variations in crustal thickness.

2. The Northern Galapagos Volcanic Province

3. Sediment Thickness

4. Magnetic Models

5. Conclusions
- Expressions of plume-ridge interaction in the Galapagos differ significantly between the Cocos and Nazca Plates. On the Nazca Plate, south of the GSC, anomalous volcanism is observed in the form of volcanic lineaments. On the Cocos Plate, north of the GSC, we observe very little anomalous off-axis volcanism, however, the plate is scarred by fossil ridge axes.
- Large Mantle Bouguer Anomaly lows suggest that ridge jumps may have been accompanied by increases in melt flux from the plume.
- The Galapagos Transform Fault was likely created in stages as a consequence of ridge jumps to the south, toward the plume center.