Determining a Relationship between Gravity Roughness, the Spreading Rate, and Relative Crustal Thickness of Transitional Crust

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The final stages of continental breakup and initiation of seafloor spreading are recorded at continental margins by “transitional basement”, which lies between continental crust and “normal” oceanic crust. The predominant processes governing the formation of transitional basement at rifted margins are still poorly understood. To better understand this crust, we seek to compare it with oceanic crust, which is better understood. Relationships between basement roughness, gravity roughness, spreading rate, and crustal thickness are well established for oceanic crust. By establishing relationships between these parameters for transitional crust, the relative importance of different processes such as spreading rate and the magmatic productivity will be made clear. This experiment determines the relationship between gravity roughness, spreading rate, and crustal thickness (magmatic productivity). The experiment first calculated a positive correlation between basement roughness of transitional crust measured by profiles of multichannel seismic reflection data and gravity roughness measured by profiles of satellite gravity anomaly data. The multichannel seismic reflection data is much more costly than satellite data because it involves taking measurements on cruises, and satellite gravity data is much more widespread than the seismic profiles, which are confined to the lines traveled by cruises. Satellite gravity data was proven to be an accurate substitution for gravimeter data taken on cruises.

To determine the relationships between gravity roughness, spreading rate, and crustal thickness, data was extracted from global grids of the three parameters within regions of the North Atlantic. After comparing the gravity roughness versus spreading rate of the line profiles and regions of the North Atlantic to the relationship already determined for oceanic crust by Sandwell et al. and Whittaker et al., it appears that gravity roughness is inversely proportional to spreading rate. The range of roughnesses, however, increases at slower spreading rates, and the correlation appears to be less sensitive than that found in oceanic crust. There is also a similarly inverse relationship between gravity roughness and residual zero-age depth, which is used as a proxy for crustal thickness. The correlation, however, is weak, and there is a higher variability of gravity roughness than in thicker crust, or magma-rich regions. The relationship between gravity roughness and residual basement depth may also be weak because we have not taken into account other process that affect basement depth, such as dynamic topography caused by mantle flow. In summary, the roughness of transitional basement appears to be influenced by both magmatic productivity and spreading rate, but the relationships between both parameters appear to be less strong than for oceanic crust. The spread of roughness values is particularly large for slow spreading rates and small crustal thicknesses, implying a large range of process might be at work in the formation of this topography.