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Spreading ridge lower order segmentations effect on large scale fault heave

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The interplay between magma supply and spreading rate is believed to play a major role in determining large-scale seafloor morphology. Here we use bathymetry near an ocean spreading ridge to test this relationship in a region of intermediate to fast spreading rate but differing magma supplies. We have developed a repeatable, automated method for categorising and estimating total apparent fault heave from the bathymetry data and then compare this estimate to a proxy for magma supply. We demonstrate the approach both along axis and off-axis at the Costa Rica Ridge on the Cocos-Nazca constructive boundary in the Panama Basin.
We use ship board bathymetry and acoustic backscatter collected during cruise JC114 in 2015 as part of the Oceanographic and Seismic Characterisation of heat dissipation and alteration by hydrothermal fluids at an Axial Ridge (OSCAR) project. We analysis this dataset using two methods:
1) we combine bathymetric slope, slope direction and seafloor backscatter into a fault probability map. This map is used to delineate fault polygons. Multiple forty-kilometre long transects are aligned into windows over the width of the spreading segment. The mapped faults that intersect each transect are used to calculate a total apparent heave which is then divided by the length of the transect and scaled to give the percentage of brittle tectonic extension (T%). These windows overlap in an off-axis direction so that variation of T% can be calculated with respect to crustal age.
2) we calculate residual bathymetry by first removing the affect of loading from sediment deposition by isotatically adjusting for sediment thickness determined from coincident seismic reflection profiles and density determined from ODP borehole 504B, then compensating subsidence caused by the density increase as a result of off-axis cooling where the crustal age is determined from the magnetic isochrons. We use the resulting bathymetry anomaly map as a proxy for melt supply by assuming Airy isostasy, hence differences in topography are the result variations in crustal thickness, where thicker crust is formed by higher melt supply.
We apply our analysis to the Costa Rica Ridge out to a crustal age of 40 Ma, the point where the sediment thickness causes a significant under-estimate of the fault heave. Our results reveal the magmatic asymmetry between the Nazca and Cocos plate at the Ridge and we identify two new second order spreading segments which are consistent with the location of an axial magma lens at the Ridge.

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