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Distribution and Alignment of Small Volcanic Edifices at Slow-Spreading Mid-Ocean Ridges

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Around seventy percent of the Earth's surface is covered by oceanic crust produced along the 80,000km of mid-ocean ridges. However, despite its prevalence the processes by which ocean crust is built remain poorly understood, particularly at slow-spreading centres. This study uses sidescan sonar images from several volcanic centres along the Mid-Atlantic Ridge and Southwest Indian Ridge to statistically quantify the distribution and structural influence on volcanic edifice emplacement.

Volcanism at slow-spreading mid-ocean ridges is concentrated on Axial Volcanic Ridges (AVRs), elongate topographic highs found within the axial valley. AVRs may reach a kilometre above the seafloor and tens of kilometres in length and are composite piles of volcanics, constructed almost entirely of 'hummocks', small volcanic edifices usually between fifty and several hundred metres across.

In this study we analyse sidescan sonar data from three slow-spreading ridges, two on the Mid-Atlantic Ridge (at 45˚N and 29˚N) and one on the Southwest Indian Ridge (at 64˚E). Nearest neighbour analyses are used to identify statistically significant degrees of cluster of hummocks at the three study areas and maps of areal volcano density are used to asses the distribution of high and low density areas. From these analyses hundreds of small clustered groups can be identified, possibly corresponding to individual sources of melt. Larger areas of lower density can also be identified and appear to be linked to the initiation of new faulting. This implies either a lower melt flux to these areas or a low flux of volcanic cone building material. The initiation of new faulting and the narrowing of the axial valley suggest the first option is more likely.

This study records the presence of lateral volcanic 'spurs' running off either side of the AVR for the first time. Several methods are used to quantify the alignments of both these features and the hummocks on the main body of the AVR. We find that different structural trends can be recognised at different scales for individual hummocks; however the spurs show a strong alignment which doesn't alter with scale, suggesting these features may be structurally controlled rather than gravity driven.

We conclude that volcanic hummock emplacement on axial volcanic ridges is controlled by a combination of the regional stress field and availability of magma supply to the surface. Melt supply appears to be non-uniform to the AVR, with new faults initiating in areas with lower magmatic flux.