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Oceanic Core Complex die off and generation of enhanced mantle upwelling on the Mid-Atlantic Ridge – 22° N

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Images of crustal construction provide a key to understand the interplay of magmatism and tectonism while oceanic crust is build up. Bathymetric data show that the crustal construction is highly variable. Areas that are dominated by magmatic processes are adjacent to areas that are highly tectonised and where mantle rocks were found. The Mid-Atlantic Ridge at 22° N shows this high variability along the ridge axis, within the TAMMAR segment, and from segment to segment. However, this strong variability occurs also off-axis, spreading parallel, representing different times in the same area of the ridge. A fracture zone, with limited magma supply, has been replaced by a segment centre with a high magmatic budget. Roughly 4.5 million years ago, the growing magmatic active TAMMAR segment, propagated into the fracture zone, started the migration of the ridge offset to the south, and stopped the formation of core complexes.

We present data from seismic refraction and wide-angle reflection profiles that surveyed the crustal structure across the ridge crest of the TAMMAR segment. These yield the crustal structure at the segment centre as a function of melt supply. The results suggest that crust is ∼8 km thick near the ridge and decreases in thickness with offset to the ridge axis. Seismic layer 3 shows profound changes in thickness and becomes rapidly one kilometre thicker approx. 5 million years ago. This correlates with gravimetric data and the observed "Bull's eye" anomaly in that region. Our observations support a temporal change from thick lithosphere with oceanic core complex formation to thin lithosphere with focussed mantle upwelling and segment growing. The formation of 'thick-crust' volcanic centre seems to have coincided with the onset of propagation 4.5 million years ago.