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Hidden tectonics beneath the seafloor at mid-ocean ridges: constraints from the Troodos ophiolite, Cyprus.

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Seafloor spreading at mid-ocean ridges (MOR) is accommodated by a combination of magmatism and tectonic stretching of the crust. Recent investigations of mid-ocean ridges show evidence for large offset normal faults or detachments that accommodate a significant fraction of the plate separation. Once thought of as rarities along the global spreading system, detachment faults are now considered to play an integral role in seafloor spreading at slow spreading ridges. Estimates of the proportion and extent of tectonic spreading however vary widely; some authors suggest as much as 50% of the Mid Atlantic Ridge is underlain by active detachment faults. The lack of consensus is in part a consequence of the difficulty in documenting the extent of tectonic stretching and detachment faulting, especially from surface morphology alone. On the modern seafloor tectonic activity may potentially be under-estimated if lava flows blanket and obscure the faulting below.

In this contribution we present field observations from the Troodos ophiolite, Cyprus, which is believed to be a slow-spreading ridge analogue. Our interdisciplinary approach utilises structural mapping, palaeomagnetism and geochemistry to investigate estimates of the extent and effects of detachment faulting within the ophiolite. We document significant extensional faulting and rotation within the crust above a detachment fault at the level of the sheeted dyke complex, yet show that the lavas at the surface are sub-horizontal and unaffected by the deformation beneath. Unconformities in the lava section demonstrate progressively greater rotations deeper in the extrusive pile. We show these rotations to be controlled by tectonic stretching and tilting of the underlying dykes rather than rotation by loading and/or subsidence within the lava pile.

Our results show that syn-tectonic volcanism fills half-graben on the seafloor such that minimal tectonic stretching is evident at the surface, but blankets tens of per cent tectonic extension at depth.
We discuss the implications of these findings for modern slow-spreading mid-ocean ridge systems.