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Complex magmatic plumbing of fast-spreading ridge magma chambers: insights from the sheeted dyke – gabbro transition in Oman Drilling Project Hole GT3A

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ICDP Oman Drilling Project Hole GT3A is a 400m-deep borehole that penetrates the sheeted dyke to gabbro transition in the Oman ophiolite. The overall aim of drilling was to document the magmatic, tectonic and hydrothermal processes and interactions at the top of the axial magma chamber beneath a fast-spreading ridge. In this contribution we present new petrological, geochemical and geophysical data from the GT3A drill core, which we combine to provide new insights into the role of the axial melt lens in the generation of the upper ocean crust.

Located in NW-trending sheeted dykes in Wadi Abdah (Samail massif), Hole GT3A was sited close to field exposures of a complex dyke-gabbro transition zone. Previous studies in this area had emphasised how gabbro intrudes into the base of the sheeted dykes here, with consequent reheating and recrystallisation of the latter, and assimilating dyke material into the uppermost plutonics. Drilling at Site GT3A, however, found relatively little evidence for such processes: instead, the hole penetrated two screens of gabbro (and minor diorite) cut by sheeted dykes, thus demonstrating the small scale of variability and emphasising the complex, dynamic nature of the roof of the sub-ridge axial magma chamber.

We here present comprehensive mineral-scale studies of the Hole GT3A gabbros and of phenocryst assemblages in the dykes. We couple these with an AMS magnetic fabric study of the dykes, reorienting the drill cores with reference to sheeted dyke orientations measured by the authors in a further field investigation of the Wadi Abdah area. Taken together the results show that dykes are not simply fed from the gabbros directly beneath: some must have been derived from primitive magmas from deep in the lower crustal crystal mush, and many dykes were sourced laterally. We emphasise the complex, dynamic, local-scale, essentially four-dimensional nature of the plumbing of the upper ocean crust beneath fast-spreading ridge systems.