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Constraints on oceanic core complex development: the Mid-Atlantic Ridge, 15deg 45'N

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We have surveyed and sampled in detail the corrugated massif exposed at 15deg 45'N on the Mid-Atlantic Ridge (ODP Site 1275) in order to understand better the structure and deformation conditions that operate at oceanic core complexes. Supplemented by 23 dredge hauls, we obtained 63 orientated seabed rock drill cores from the surface and flanks of the 15deg 45'N massif. Fault rocks were recovered everywhere on the corrugated surface of the massif, to which they are restricted. They are dominated by talc-, chlorite- and/or tremolite-schists, predominantly derived from an ultramafic protolith, indicating that high-strain deformation of mantle peridotite occurred in the greenschist facies under conditions of high fluid pressure, fluid flux and silica activity. High temperature deformation is all but absent, and is not associated directly with the detachment fault that evidently forms the surface of the 15deg 45'N massif. Synkinematic emplacement of dolerite dykes into the fault zone from an immediately subjacent gabbro pluton in the footwall is widespread. The gabbro is almost undeformed, implying that it was intruded passively into the mantle lithosphere beneath a detachment that was active at low temperatures and at shallow levels. Our observations require a model different to the 'rolling hinge' concept for oceanic core complex formation. As all the observed deformation is shallow, we conclude that the detachment is rooted at shallow levels, or else that this later deformation has completely overprinted any earlier, deeper, higher temperature deformation. We emphasise the important role played in strain localisation by the weakening of a range of hydrous secondary minerals and the early stage at which this occurred. We discuss the mechanisms by which strain could have been accommodated deeper within the lithosphere and the role of magmatic emplacement in core complex formation.