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Palaeomagnetic evidence for tectonic rotation during the evolution of the Atlantis Massif oceanic core complex (IODP Expedition 304/305, Mid Atlantic Ridge, 30˚N)

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IODP Expedition 304/305 to Atlantis Massif, Mid Atlantic Ridge, sampled a 1.4 km faulted and complexly layered section that is dominated by gabbroic lithologies with minor ultramafic rocks. The core (U1309D) reflects the interplay between magmatism and deformation prior to, during, and subsequent to a period of footwall displacement and denudation associated with detachment faulting and the development of an oceanic core complex. Palaeomagnetic analyses demonstrate that the gabbroic sequences at Atlantis Massif carry highly stable remanent magnetizations that provide valuable information on the timing and style of tectonic exhumation of the section.

Thermal demagnetization experiments recover high unblocking temperature components of reversed polarity (R1) throughout the gabbroic sequences. In a number of intervals, however, the gabbros exhibit a complex remanence structure with the presence of intermediate temperature normal (N1) and lower temperature reversed (R2) polarity components, suggesting an extended period of remanence acquisition during different polarity intervals. Sharp break-points between different polarity components suggest that they were acquired by a thermal mechanism. There appears to be little or no correlation between remanence structure and either the igneous stratigraphy or the distribution of alteration in the core. Instead, the remanence data are more consistent

with a model in which the lower crustal section acquired magnetizations of different polarity during a protracted cooling history spanning two geomagnetic reversals.

The three-component samples show a systematic difference in the declination of the lowest temperature (and hence youngest) R2 component relative to the higher temperature N1 and R1 components. When the R2 components are restored to a southerly (reversed) declination, N1 and R1 components are found to be broadly antipodal with NE and SW declinations, respectively. This indicates an episode of tectonic deformation of the section after acquisition of N1 but prior to acquisition of R2 magnetizations, i.e. within polarity chron C1r.1r (but potentially also part of C1r.1n if the N1 component was acquired early in this chron). A fully quantitative interpretation of the rotation requires (on-going) core reorientation using borehole wall imagery. However, the data are broadly compatible with tilting around a near-ridge parallel axis, consistent with flexural rotation of a sampled section during exhumation in the footwall of the Atlantis Massif detachment fault.