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Constraining strain in soft sediments at the deformation front of the Hikurangi subduction margin (New Zealand) using magnetic fabric analyses

Annika Greve (1), Lilly Zerbst (2), Myriam Kars (3), Julia Morgan (4), Ake Fagereng (5), Yoshitaka Hashimoto (3), Toshiya Kanamatsu (1), Laura Wallace (6), Demian Saffer (7), Katerina Petronotis (8), and the IODP Expedition 372 & 375 Scientists

(1) Japan Agency for Marine-Earth Science and Technology, Japan (annika.greve@jamstec.go.jp), (2) Karlsruhe Institute of Technology, Germany, (3) Department of Natural Environmental Science, Kochi University, Japan, (4) Department of Earth Science, Rice University, USA, (5) School of Earth and Ocean Sciences, Cardiff University, UK, (6) GNS Science, Lower Hutt, New Zealand, (7) Department of Geosciences, Pennsylvania State University, USA, (8) International Ocean Discovery Program, Texas A&M University, USA

Accretionary prisms form along convergent plate boundaries, where sediments of the incoming plate are off-scraped and accreted to the overriding plate, and subjected to increased horizontal tectonic loading and deformation. Progressive restorations of folding and faulting conducted in accretionary systems worldwide indicate that macroscopic deformation on individual structures accounts for 50% or less of the total lateral shortening, which leaves the remainder to be accounted for by mesoscopic, layer-parallel and ductile deformation through sediment compaction and foliation development. Here, we combine magnetic fabric analyses, remanence measurements and rock magnetic measurements to quantify the style of sediment deformation and the nature of compaction at the deformation front of the Hikurangi subduction margin in New Zealand.

Site U1518 of International Ocean Discovery Program Expedition 375 penetrated approximately 500 m of Pleistocene aged mud- and siltstones in the outer accretionary wedge of the Hikurangi margin. The top of a splay fault zone was penetrated at ca. 300 mbsf, followed by an approximately 60 m thick zone of variable deformation intensity that shows both brittle and ductile deformation features. This zone can be divided into an upper main fault, a basal subsidiary fault, and an intervening zone of lower intensity deformation.

Anisotropy of magnetic susceptibility (AMS), measured on 377 samples, allows a subdivision of the recovered sequence into five zones that are characterized by distinctive differences in deformation: AMS fabrics in the upper hanging wall are dominated by bedding-parallel oblate fabrics, which is typical for foliation developed by lithostatic compaction. In contrast, the lower hanging wall is dominated by more prolate ellipsoids and tilted fabrics, in a zone with markedly steeper bedding tilts. There is no correspondence between the AMS fabrics and the upper strands of the main brittle fault-zone, indicating that faulting may be characterized by localized shear or brittle failure which does not result in discernable pervasive deformation of the surrounding sediments. In contrast, the lower boundary of the fault-zone is marked by a sudden decrease in the corrected degree of magnetic anisotropy (Pj). This observation correlates with an increase in the porosity measured on-board.

In a second step we restored the orientation of the AMS tensor into a geographic refence frame based on magnetic remanence directions. Our preliminary investigations suggest a clear correspondence between the orientation of the principal axes of susceptibility, bedding tilt directions recovered from logging-while drilling resistivity logs, and bore-hole break-outs in the footwall.