Into the Deep Ocean Crust

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In the early 1970s, scientists defined the architecture of the oceanic crust by comparing the seismic signature of the crust in the oceans to the various pieces of oceanic crust in rocks found on continents (ophiolites). Drilling the entire thickness of the oceanic crust has been a challenge since the very beginning of the scientific oceanic drilling efforts in the early 1960s. Between 1979-1993, ODP drilled Hole 504B to a depth of 2111 meters below the sea floor — making it the deepest scientific hole drilled in the ocean. Drilling has allowed sampling of the upper crust, but the lower crust remains poorly sampled. However, considerable progress has been achieved with the few hundreds of meters cored in tectonically exposed crust: Hess Deep in the Pacific Ocean and the Mid-Atlantic Ridge.

The second deepest hole in the hard rocks of the oceanic crust was drilled at the Southwest Indian Ridge on the Atlantis Bank, a flat-top platform located east of the Atlantis transform fault (Dick *et al.,* 2000). 1.5 km of rock were drilled during two Legs, in 1987 and 1997, with an exceptionally high recovery in hard rocks of about 86.5%. The rocks, dominantly olivine gabbros, recovered at Hole 735B are unique in many aspects. This long section of lower crust contains two main intrusive bodies, which are divided into several smaller units and contain numerous layers, often associated with high-temperature shear zones.

The core displays all types of deformation structures. It shows a continuum of deformation styles, ranging from magmatic flow to low-temperature ductile and brittle flow, which demonstrate the fundamental role of tectonics in the accretion processes at slow-spreading ridges.

The discontinuity of the oceanic crust accreted at slow-spreading ridges has been demonstrated by dredging, submersible investigations, and previous drilling at the Mid-Atlantic Ridge (e.g., Cannat, 1996). The nature of Hole 735B provides evidence for a strongly heterogeneous lower ocean crust, and for the inherent interplay of deformation, alteration and igneous processes at slow-spreading ridges. It is strikingly different from rocks sampled from fast-spreading ridges and at most well-described ophiolite complexes. These findings emphasize the remarkable diversity of tectonic environments where crustal accretion occurs in the oceans.

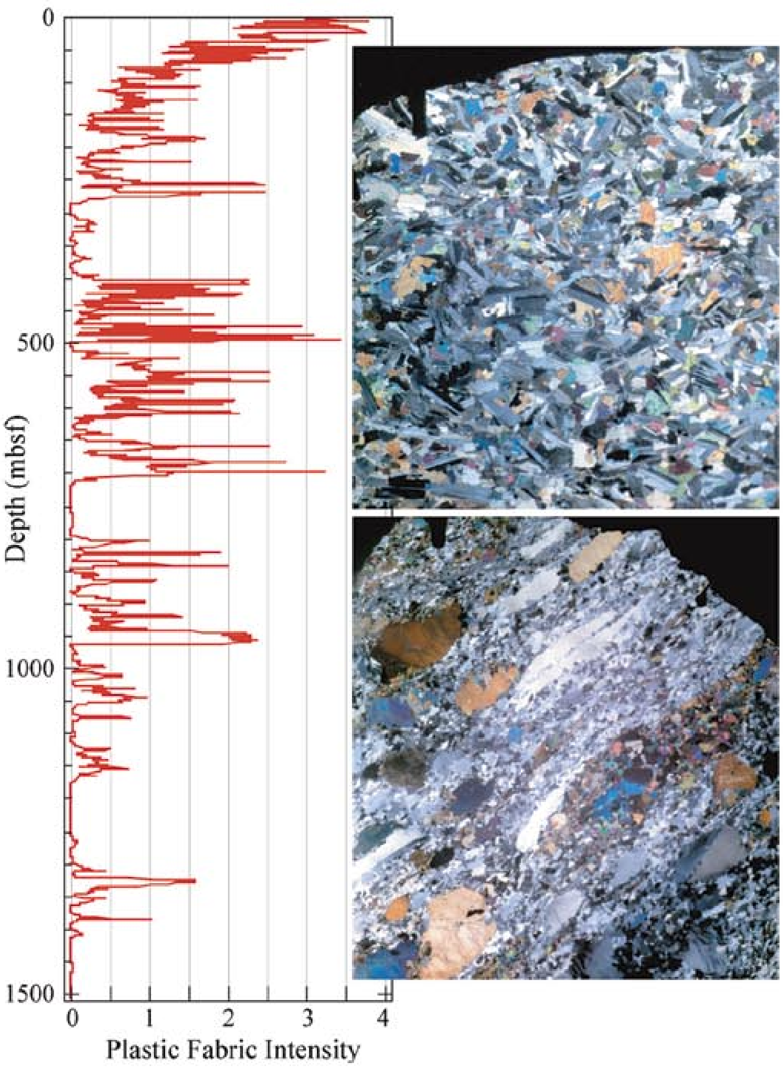

Figure 1. Downhole variations in solid-state deformation intensity, ranging from 1=weakly deformed to 4=highly deformed (mylonite). The microphotographs (width=6 cm) show examples of a magmatic structure (upper photo) and of a high-temperature mylonite (lower photo).