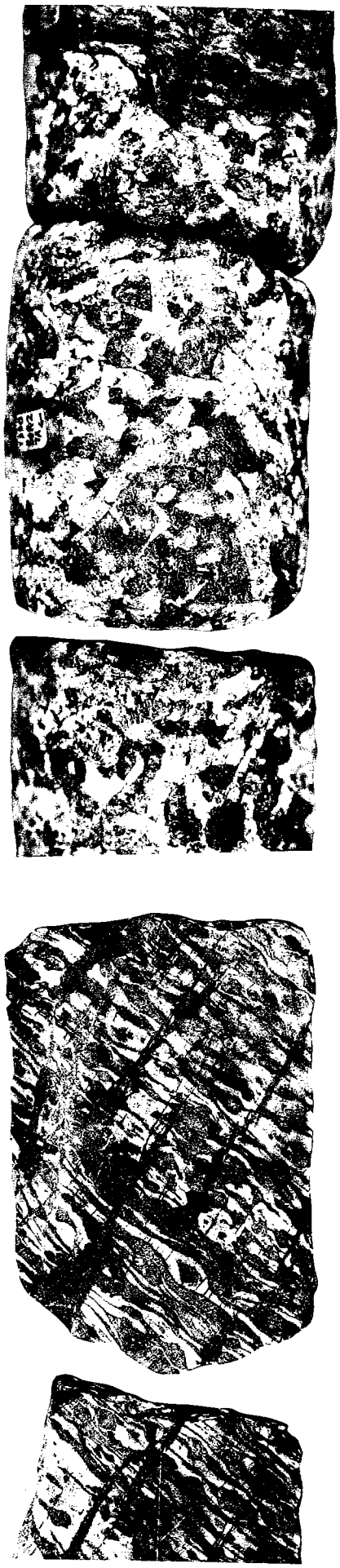

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JOI/USSAC Workshop Report

Drilling The Oceanic Lower Crust and Mantle

A Global Strategy for Exploring
the Deep Oceanic Crust and Mantle in the 1990's

Cosponsored by the WM Keck Geodynamics Program
and the International Lithosphere Project

March 7 - 10, 1989

Woods Hole, Massachusetts

COVER PLATES

On the cover and inside covers of this report are a selection of photographs of rock drilled from Hole 735B in the Indian Ocean. The hole was drilled on a wave cut platform at the crest of a major ridge flanking the Atlantis II Fracture Zone. This platform was an emergent island formed near the ridge-fracture zone intersection some 11 million years ago by faulting and uplift of rock some 3 km from the rift valley of the SW Indian Ridge. Subsequently the island was cut down below sea level by wave action and then subsided some 700 m as sea floor spreading moved it away from the active ocean ridge. It exposes rocks from the deepest layer of the ocean crust consisting of gabbros formed in a magma chamber beneath the floor of the ancestral rift valley. With the 2 km tough brittle carapace of basalt and diabase comprising layer 2 of the ocean crust stripped away by faulting and erosion, the platform presented the opportunity to directly sample the lower ocean crust without first drilling through layer 2: a technical feat yet to be accomplished in the 20 year history of scientific ocean drilling.

The 500 meter section drilled was a continuous undisrupted section of the lowest layer of the ocean crust and provides the first direct look at processes occurring beneath a mid ocean ridge which form two thirds of the ocean crust.

COVER

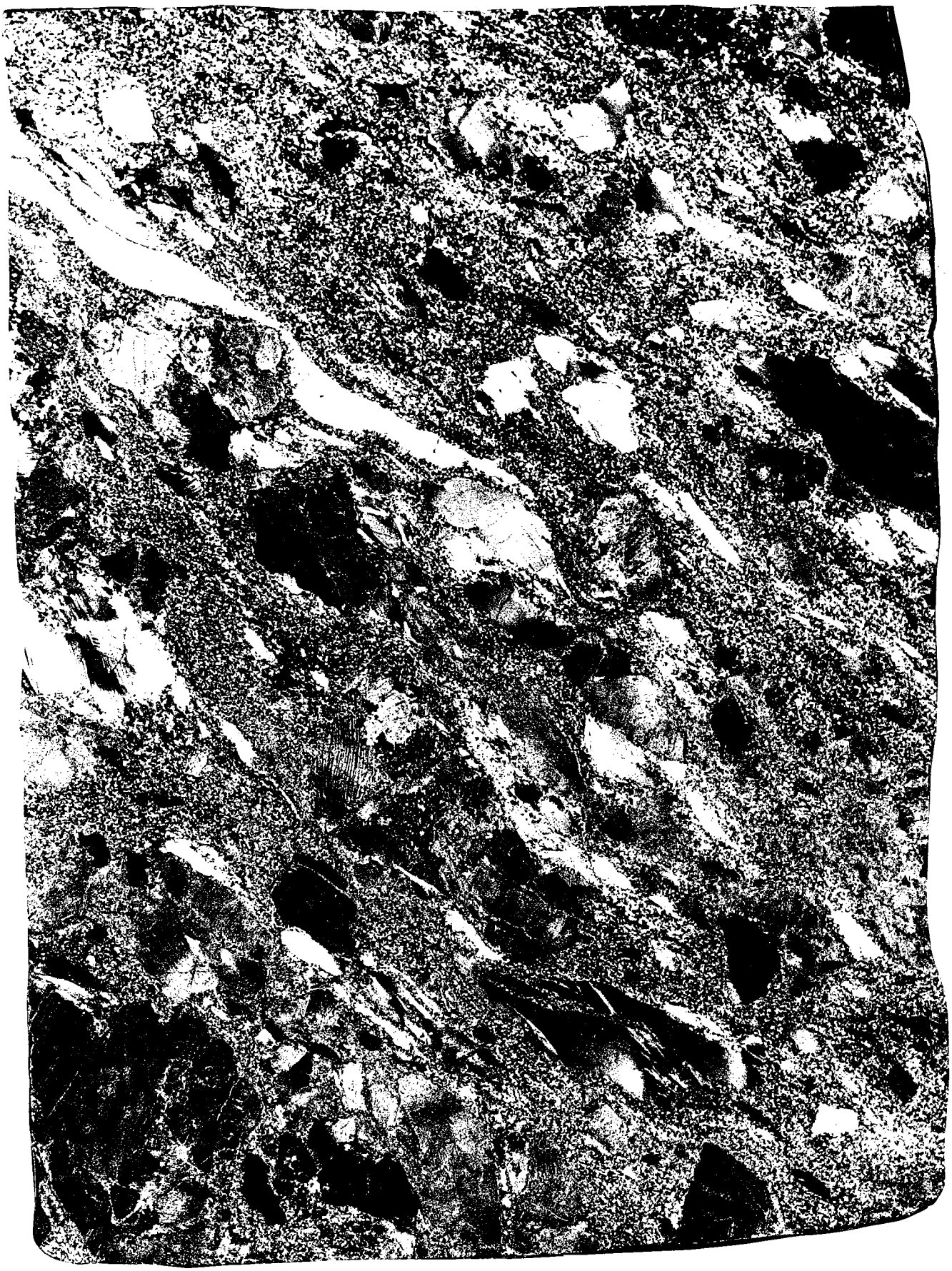
Top: 15 cm long section of coarse grained olivine gabbro displaying characteristic equigranular subophitic texture of the most common rock type drilled (over 300 m). Nearly free of alteration and undeformed, the sample is typical of material that can be studied to understand crystallization of magmas in the deep crust.

Bottom: Oxide-olivine gabbro gneiss formed by ductile deformation and shearing during extension and lithospheric necking below the rift valley floor during rift valley formation. Ductile deformation zones occur locally throughout the core and extend from syn to post magmatic deformation as the crust formed and cooled even as it was extended. Black veins formed orthogonal to the foliation are amphibole filled and are typical of the principle alteration phase found in the core. Low temperature greenschist facies alteration is conspicuously absent.

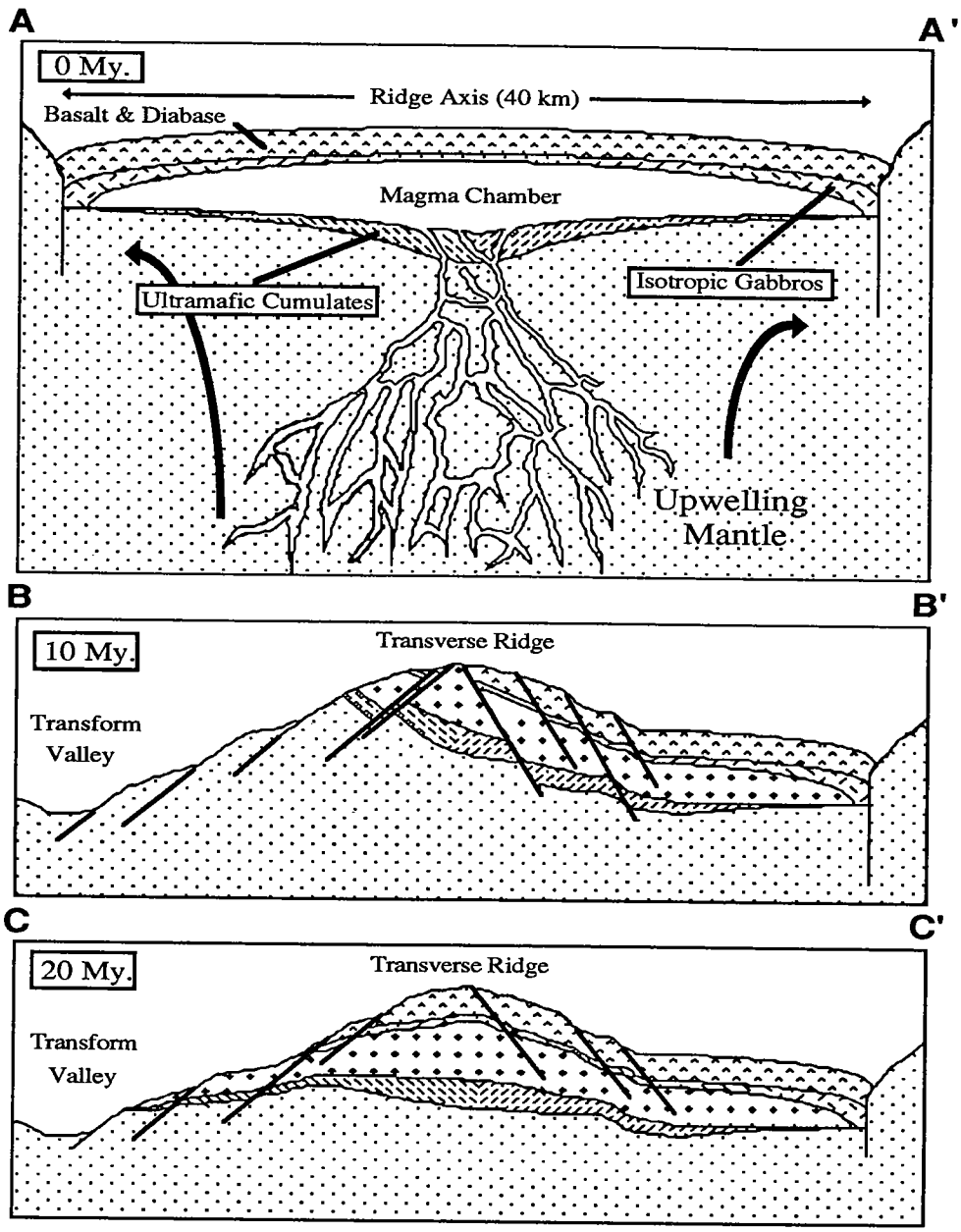
INSIDE COVER

Top: Foliated oxide olivine gabbro cut by a late undeformed trondjhemite illustrating the syn-magmatic character of deep crustal deformation.

Bottom: Hydrothermal breccia zone with rotated fragments of gabbro in a matrix of hydrothermal plagioclase representing a high temperature upflow zone, providing a first look at the deep plumbing of seawater circulation in the ocean crust.



Two by three inch thin section between crossed polarizers of gneissic gabbro showing extensive recrystallization of feldspar and formation of deformation bands during ductile shearing of layer 3 gabbros.



Hypothetical sections of ocean crust generated at a ridge segment adjacent to a slow-slipping large offset transform fault all drawn parallel to the ridge axis. A: crust and upwelling mantle at zero age. B: cross-section after unroofing at the ridge-transform intersection and emplacement into a transverse ridge flanking a transform. C: cross-section of a different section of crust with less drastic initial unroofing. 'A' modified from T. Sisson (pers. comm.), 'B' and 'C' modified from Dick et al. (in prep.). Figure shows various possibilities for drilling in tectonically exposed deep crustal and shallow mantle rocks on transverse ridges flanking major large offset fracture zones. Site 735B, where Leg 118 drilled a half kilometer of layer 3 gabbros is believed similar to the tectonic setting at the top of the transverse ridge in section B-B'.