IODP Proposal Cover Sheet

Bend-Fault Serpentinization

876 - Pre

Title	Bend-Fault Serpentinization: Oceanic Crust and Mantle Evolution from Ridge through Trench
Proponents	J. Morgan, T. Henstock, D. Teagle, P. Vannucchi, G. Fujie, S. Kodaira, I. Grevemeyer, L. Ruepke, H. Villinger, C. Ranero, B. Ildefonse, K. Johnson, P. Kelemen, M. Schrenk,
Keywords	bend-fault serpentinization, mantle evolution, MoHole
Area	Cocos Plate near Nicaragua

Contact Information

Contact Person:	jason morgan		
Department:	earth sciences		
Organization:	royal holloway, university of london		
Address:	egham hill	egham	tw20 0ex
Tel.:		Fax:	
E-mail:	jason.morgan@rhul.ac.uk		

Abstract

During the past decade, it has become recognized that plate bending near a trench before subduction can be associated with significant chemical hydration-linked reactions in cold lithospheric mantle and overlying ocean crust. Bend-faults appear to play a key role by providing high-permeability pathways for seawater to flow into the oceanic crust and uppermost mantle. Bend-Fault serpentinization (BFS) has now been imaged by seismic reflection and refraction methods at Central American, Alaskan, Japanese, and South American subduction zones. The implications of this process for the exchange of water and carbon between Earth's exosphere and mantle are profound. Offshore Nicaragua where bend-fault serpentinization is best imaged, seismic observations suggest that a ~10-15km-thick layer beneath the Moho has been partially serpentinized by ~10-20%. Serpentinized peridotites exposed on slow-spread ridges and ophiolites commonly contain more than 1% carbonate. If created globally during bend-faulting and then subducted this volume of serpentinized, carbonated mantle would recycle water and CO2 into the mantle comparable to that emitted by plate spreading or consumed by crustal alteration, weathering and mountain building; this would require a total rethink of our basic understanding of Earth's global carbon and water cycles. This will also require us to obtain samples of crust and mantle after bend-faulting to know the ultimate composition of the oceanic crust and mantle recycled during subduction. Furthermore, mantle serpentinization has been linked to hydrogen and methane-generating reactions that are favorably used for chemosynthetic activity by microorganisms. If bend-fault serpentinization is indeed associated with hydrogen and methane production, then this region may be a major unrecognized component of the deep biosphere, and may have been in fact the first and safest place for deep-life to flourish on early Earth. Subducting bend-fault regions could have been a cradle for early life because these would have been the first places where water-ultramafic rock reactions would occur under liquid water-cover that was able to persist through impact events that induced incomplete vaporization of the proto-oceans.

In principle, the Ideal'BFS program would be co-located with MoHole drilling of oceanic crust and mantle on the same lithospheric flowline before the onset of plate-bending and BFS processes. In this way, we would obtain samples that will enable us to unravel how ridge, off-axis, and subduction plate-bending-related processes shape the long-term evolution of Earth's crust and mantle.

generated: Tue Oct 14 19:58:42 2014
by if340_pdf
(user 0.3004)

876 - Pre

Scientific Objectives

Our objective is to drill through the ocean crust in an area of active bend-fault serpentinization that is occurring as the Cocos Plate bends and subducts at the Middle American Trench (MAT). We propose a dual-mode drilling strategy. First, D/V JOIDES Resolution or D/V Chikyu drilling through the upper parts of the Bend-fault system to better understand the chemistry and shallow fluids and fluid flow, and also assess drilling through bend-faults. Second, a MoHole-type drilling strategy to sample an intact crustal and mantle section through 1km below the ~5.5km-deep crust-mantle boundary.
The MAT is a unique site where known Bend-Fault Serpentinization lies beneath seafloor at ~3000-3800m water depths. It is also unique in that we can: (1) study the oceanic crust and mantle created at a modern fast-spreading ridge, the EPR; (2) sample it off-axis by MoHole drilling to obtain a complete crustal and mantle section that constrains the extent of ridge and off-axis processes in shaping the crust and uppermost mantle; (3) resample it at a site on bend-faulted crust that constrains the effects of bend-fault processes and obtains the actual crust and mantle material being recycled into the mantle at this trench.

Non-standard measurements technology needed to achieve the proposed scientific objectives.

MoHole-type drilling in ~3200m water depth

Proposed Sites

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
COCOS-01A	10.703, -87.571	3200	450	6550	7000	Drill through active bend-fault in the sub-Moho mantle, with spot-coring and side-wall core-sampling through oceanic crust/mantle. This would be one of ~3-4 planned drillholes within a ~4km region with almost identical drilling conditions. The shallower holes would be used to gain experience in drilling through an active bend-fault, and also used to study fluid flow, and the character of the bend-fault and its associated fluids and alteration in its sediment portion and mid-crustal regions. Only one hole is mentioned here as its drilling conditions will apply to the others, except their depths would be ~500m, ~2400m, and again ~7000m, respectively

generated: Tue Oct 14 19:58:42 2014
by if340_pdf
(user 0.3004)