

**IODP Proposal Cover Sheet**☐ New☒ Revised☐ Addendum**522-Full5**

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Title:	522-Full5 Superfast 4: Drilling gabbro in intact ocean crust formed at a Superfast spreading rate		
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Keywords: (5 or less)	Ocean crust, gabbro, layer 2-3, hydrothermal, magnetics	Area:	Eastern equatorial Pacific

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Permission to post abstract on IODP-MI Web site: ☒ Yes ☐ No**Abstract: (400 words or less)**

The "Superfast Mission" achieved a major unfulfilled goal of ocean drilling – sampling a complete section from lavas, through dikes to gabbros - by drilling Hole 1256D in crust formed at a superfast spreading rate at the East Pacific Rise. This approach exploits the inverse relationship between spreading rate and the depth of axial low velocity zones, hypothesized to be magma chambers. Drilling occurred on three cruises, ODP Leg 206 and IODP Expeditions 309 and 312. Hole 1256D penetrates to >1500 mbsf and >1250 m sub-basement. Gabbroic rocks were encountered at 1407 mbsf with a further ~100 m of penetration into a complex zone of fractionated gabbros intruded into contact metamorphosed dikes. Major achievements of the superfast mission include: penetration into gabbros that are consistent with seismically imaged melt lenses; confirmation of the inverse relation between spreading rate and depth to axial melt lenses; and documentation of the structure and composition of upper oceanic crust formed at a superfast spreading rate.

Because of the success of the Superfast strategy, the scientific ocean drilling community is now poised to make fundamental advances in understanding the accretion of the oceanic crust. With Hole 1256D open to its full depth and already into gabbros, further deepening will answer major scientific questions:

-Core and wireline measurements indicate that gabbros were encountered within seismic Layer 2. The layer 2-3 transition from seismic refraction at Site 1256 is 1450-1750 mbsf. Thus the transition from layer 2 to layer 3 at Site 1256 occurs below the bottom of the hole, but the geological meaning of this primary seismic transition remains unknown.

-The average gabbro composition from Hole 1256D is evolved relative to primary magmas from the mantle. The chilled margin against the underlying dike screen precludes segregating a crystal residue that subsides to form the lower crust as in the gabbro glacier model, and the fractionated composition requires that crystals were segregated elsewhere. However, a gabbro glacier mode of accretion can not yet be rejected, as fractionated gabbros in the dike-gabbro transition are not unexpected, and cumulate rocks could exist just below the present bottom of the hole.

-Thermal models performed for a superfast spreading rate show clear variations in the time-temperature trajectory with different distributions of magma (single high level sill versus distributed sills) and hydrothermal cooling. The hydrothermal alteration profile of the gabbros and the possibility of magnetic reversals at depth will provide unique constraints on lower crustal cooling rates.

## Scientific Objectives: (250 words or less)

- 1) Deepen Hole 1256D as far as technically possible (>500 m) into gabbro to complete sampling of a complete section of upper oceanic crust
- 2) Test models of mid-ocean ridge crustal accretion in particular the formation of the lower crust by the recrystallization and subsidence of a high level magma chamber (gabbro glacier) versus crustal accretion by intrusion of sills through out the lower crust.
- 3) Establish magmatic, hydrothermal, tectonic processes and interactions. Is the plutonic crust cooled by conduction or hydrothermal circulation?
- 4) Determine the geological nature of layer 3 and the layer 2/3 boundary at Site 1256
- 5) Determine the magnetic contribution of the lower crust?

Please describe below any non-standard measurements technology needed to achieve the proposed scientific objectives.

Only standard RCB coring is required, although basement depths will be greater than typical (to >2000 mbsf)

## Proposed Sites:

Site Name	Position	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
GUATB-03C	6°44.2'N, 91°56.1'W	3635	0 (250 m already cored and cased)	>2000 (1257 m already cored)	>2000	Re-enter ODP Hole 1256D and RCB core further into gabbros
GUATB-03F	6°38.52'N, 91°58.30'W	3590	wash through	>150	>400	Drill to bit destruction. Sample region of LOW seismic velocity to determine rocktype
GUATB-03G	6°40.38'N, 91°48.92'W	3645	wash through	>150	>400	Drill to bit destruction. Verify presence of massive lava flow interpreted from seismic data
GUATB-03H	6°42.22'N, 91°54.28'W	3620	wash through	>150	>400	Drill to bit destruction. Verify presence of massive lava flow interpreted from seismic data