International Ocean Discovery Program Expedition 362 Scientific Prospectus Addendum

The Sumatra Subduction Zone:

The role of input materials in shallow seismogenic slip and forearc plateau development

Lisa C. McNeill
Co-Chief Scientist
Ocean and Earth Science
National Oceanography Centre
Southampton
University of Southampton
Southampton S014 3ZH
United Kingdom

Brandon E. Dugan
Co-Chief Scientist
Department of Geophysics
Colorado School of Mines
Golden CO 80401
USA

Katerina E. Petronotis
Expedition Project Manager/
Staff Scientist
International Ocean Discovery Program
Texas A&M University
1000 Discovery Drive
College Station TX 77845
USA

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Introduction

Due to the availability of new site survey data and previous changes that defined proposed Sites SUMA-11C and SUMA-12A as the primary sites for Expedition 362, two new proposed alternate sites have been selected: SUMA-23A and SUMA-24A.

This addendum provides the scientific objectives for proposed Sites SUMA-23A and SUMA-24A, regional and detailed maps (Figures **F1**, **F2**, **F3**, **F4**), and seismic profiles (Figures **F5**, **F6**) for the two sites. The site priorities and drilling and coring strategy remain unchanged from the original Expedition 362 *Scientific Prospectus* (McNeill et al., 2016). The operations time estimates for all alternate sites are presented in Table **T1**.

The new proposed alternate Sites SUMA-23A and SUMA-24A are located above Fracture Zone 7B, which is located south of the current primary and alternate sites (Figure **F1**). The sites are located close to the epicenter of one of the 2012 Mw >8 earthquakes (see Figure F3 in McNeill et al., 2016). These sites are still part of the input section to the southern 2004 earthquake rupture region of the subduction zone.

Proposed Site SUMA-23A provides a section of Unit 1 (thin trench wedge) and a significant part of Unit 2 (Bengal-Nicobar submarine fan deposits and interbedded hemipelagite) overlying Fracture Zone 7B and includes sampling of 10 m of basement atop the basement high.

Proposed Site SUMA-24A provides a section of Unit 1 (thin trench wedge) and a thinner part of Unit 2 (Bengal-Nicobar submarine fan deposits and interbedded hemipelagite) than proposed Site SUMA-23A, which overlies Fracture Zone 7B, and includes sampling of 10 m of basement atop the basement high.

The new site survey data (S. Singh, unpubl. data) were acquired on board the Schmidt Ocean Institute (CA, USA) research vessel (R/V) *Falkor* in 2015 during the MegaTera experiment, an international project between the Earth Observatory Singapore (EOS), the Indonesian Institute of Sciences, Schmidt Ocean Institute (SOI), and Institut de Physique du Globe de Paris (France). SOI provided the R/V *Falkor* for the experiment, and EOS funded the rental of the seismic equipment.

Scientific objectives

The scientific objectives are as follows:

1. *To identify contrasts in sediment physical properties, diagenetic alteration, hydrogeology, and fluid geochemistry above a basement high in the oceanic plate input section.*

Basement topography within the incoming section, in the form of fracture zones and fossil spreading ridge sections, is not common but does play an important role in changing structural development and earthquake rupture processes on this margin. Basement highs will likely generate contrasting thermal and fluid environments impacting the material properties of the overlying sedimentary section, and therefore a site on a basement high (e.g., proposed Sites SUMA-23A and SUMA-24A) offers a complementary section of relevance to the inputs for the margin. This fits primary Objectives 1 and 2 to evaluate the "Properties and evolution of the input materials that control both seismogenic slip and unusual prism development offshore North Sumatra" (McNeill et al., 2016).

2. *To assess the state of stress at a contrasting location relative to the existing primary and alternate sites and in close proximity to the source location of one of the two 2012 earthquakes (Mw 8.2; 11 April 2012), which are the largest strike-slip earthquakes recorded.*

These earthquakes involved complex reactivation of basement structures within the oceanic plate, with multiple fault sources, as yet unexplained by interpretations of the oceanic plate stress regime. This fits secondary Objective 1, "State of stress in the oceanic plate" (McNeill et al., 2016).

3. *By drilling above the basement high, the sedimentary section sampled will include Unit 1 and part of Unit 2 but not pelagic Unit 3. However, this results in a thinner sedimentary section for drilling.*

By drilling at a location distal from the existing primary and alternate sites, we can assess changes in Unit 2 Nicobar Fan with increased distance from its source. This will contribute to secondary Objective 2, "Eastern Indian Ocean records of paleoclimate and regional tectonics" (McNeill et al., 2016).

Reference

McNeill, L., Dugan, B., and Petronotis, K., 2016. *Expedition 362 Scientific Prospectus: the Sumatra subduction zone.* International Ocean Discovery Program. **http://dx.doi.org/10.14379/iodp.sp.362.2016**

Table T1. Alternate sites and time estimates, Expedition 362. mbrf = meters below rig floor. EPSP = Environmental Protection and Safety Panel. HRT = hydraulic release tool.

Proposed site	Location (latitude, longitude)	Seafloor depth (mbrf)	Operations	Drilling, Coring (days)	Logging (days)
SUMA-11B	3°5.7323'N	4177	Hole A - APC/XCB to 800 mbsf with orientation and APCT-3, SET-P/T2P measurements;	8.0	0
	91°40.0758'E		log with triple combo-UBI and FMS-sonic	0	1.4
Depth approved by EPSP to basement + 10 m (1610 mbsf)			Hole B - Reentry system: drill in 10.75" casing with HRT system to 500 mbsf;	3.1	0
			RCB to 1610 mbsf; log with triple combo-UBI, FMS-sonic, and VSI	13.0	2.0
			Subtotal Days On Site: 27.4		
SUMA-16A	2°48.9648'N	4210	Hole A - APC/XCB to 800 mbsf with orientation and APCT-3, SET-P/T2P measurements;	8.0	0
	91°51.2940'E		log with triple combo-UBI and FMS-sonic	0	1.4
Depth approved by EPSP to basement + 10 m (1620 mbsf)			Hole B - Reentry system: drill in 10.75" casing with HRT system to 500 mbsf;	3.1	0
			RCB to 1620 mbsf; log with triple combo-UBI, FMS-sonic, and VSI	13.1	2.0
			Subtotal Days On Site: 27.7		
SUMA-23A	0°47.8247'N	4447	Hole A - APC/XCB to 800 mbsf with orientation and APCT-3, SET-P/T2P measurements;	7.8	0
	92°27.7228'E		log with triple combo-UBI and FMS-sonic	0	1.4
Depth approved by EPSP to basement + 10 m (1375 m)			Hole B - Reentry system: drill in 10.75" casing with HRT system to 500 mbsf;	3.3	0
			RCB to 1375 mbsf; log with triple combo-UBI, FMS-sonic, and VSI	10.2	1.9
			Subtotal Days On Site: 24.5		
SUMA-24A	0°38.3022'N	4464	Hole A - APC/XCB to 800 mbsf with orientation and APCT-3, SET-P/T2P measurements;	7.9	0
	92°25.9850'E		log with triple combo-UBI and FMS-sonic	0	1.4
Depth approved by EPSP to basement + 25 m (860 m)			Hole B - Drill ahead to 500 mbsf and RCB to 845 mbsf;	5.3	1.5
			log with triple combo-UBI, FMS-sonic, and VSI		
			Subtotal Days On Site: 16.1		

Figure F1. Regional map showing regional bathymetric and tectonic setting and locations of new proposed alternate Sites SUMA-23A and SUMA-24A (yellow dots) relative to primary sites SUMA-11C and SUMA-12A (red dots).

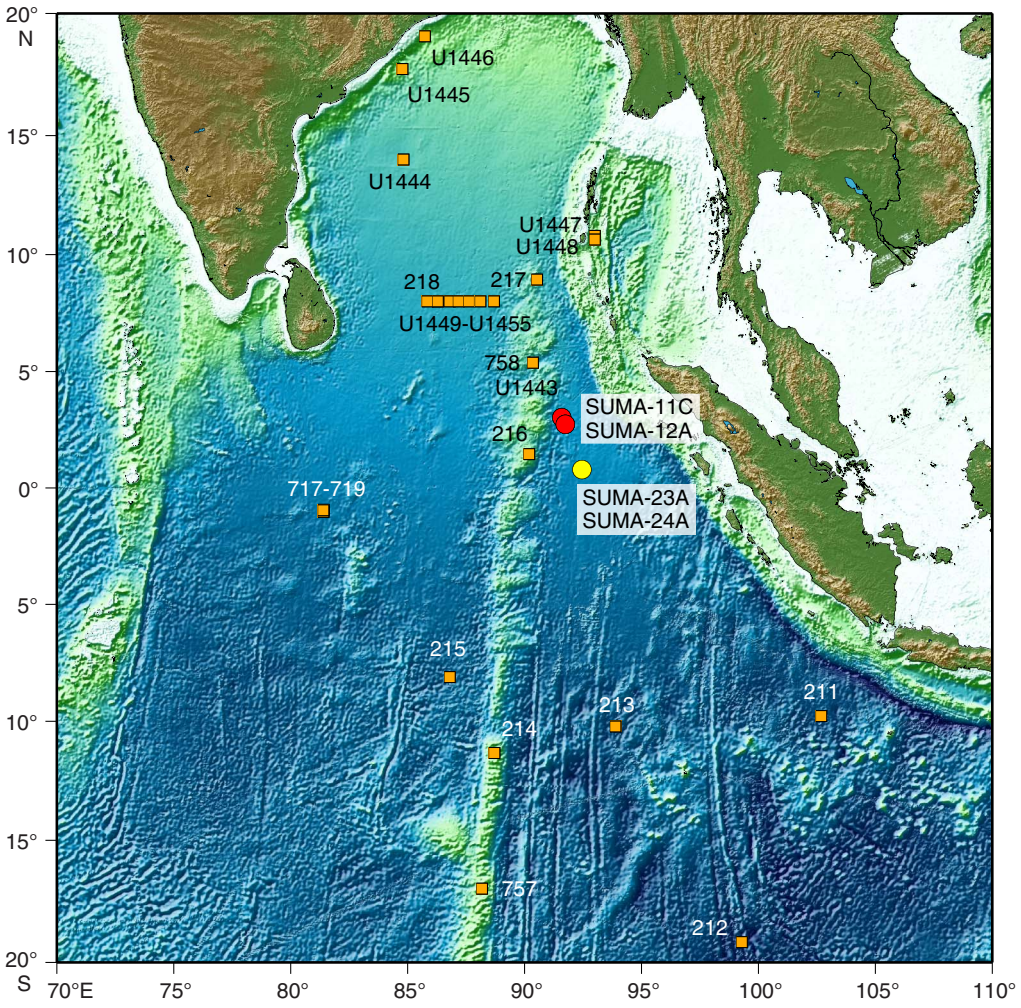


Figure F2. Bathymetric map showing local setting, track lines, and locations of new proposed Sites SUMA-23A and SUMA-24A (S. Singh, unpubl. data). FZ = fracture zone. The 2012 Mw 8.2 earthquake ruptured part of FZ7B at this location; star = National Earthquake Information Center (NEIC) epicentral location.

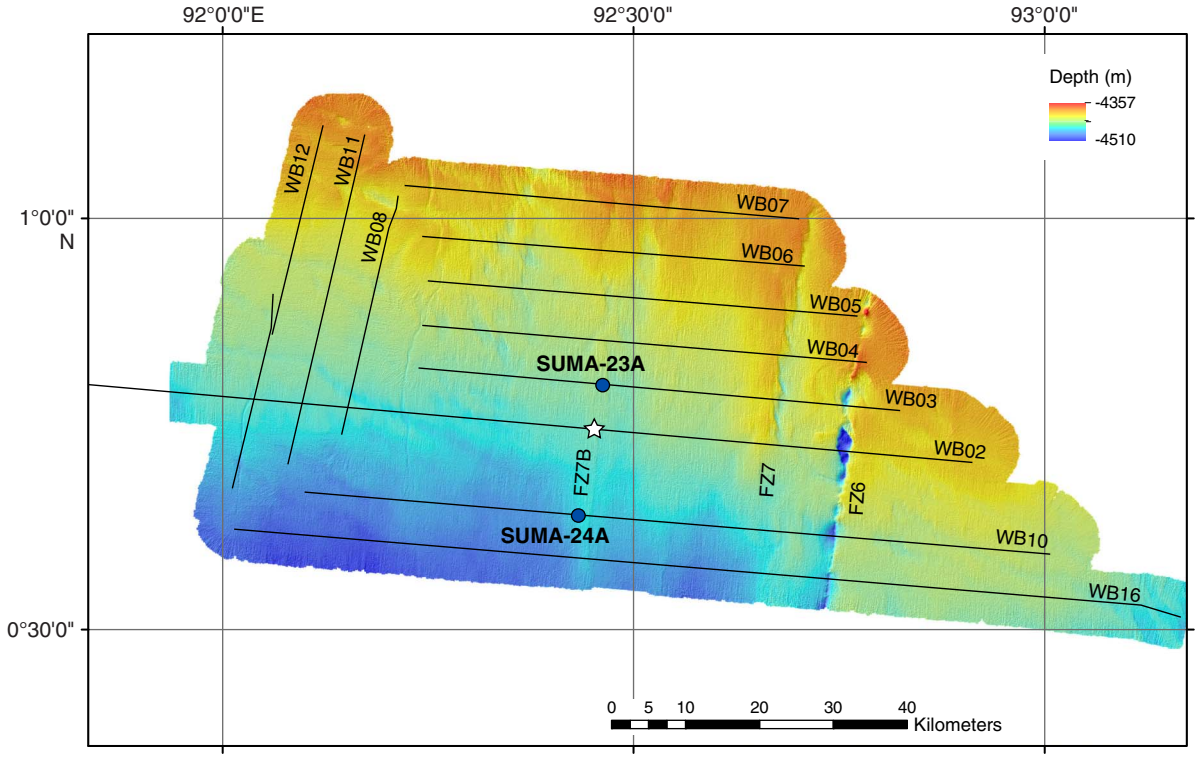


Figure F3. Bathymetric contour map of the seafloor surrounding proposed Site SUMA-23A (S. Singh, unpubl. data). Numbers below track lines are shotpoint (SP) numbers within the navigation file; numbers above Profile WB03 are Field File Identification (FFID) numbers on seismic data.

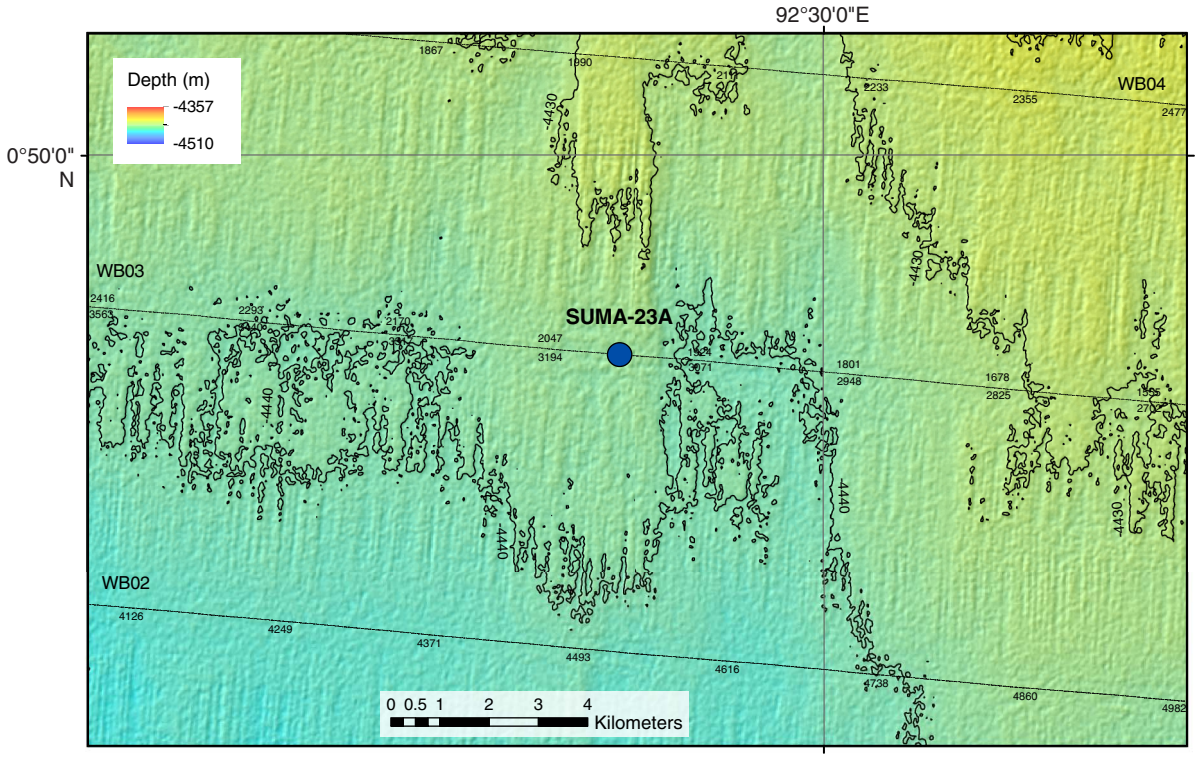


Figure F4. Bathymetric contour map of the seafloor surrounding proposed Site SUMA-24A (S. Singh, unpubl. data). Numbers below track lines are SP numbers within the navigation file; numbers above Profile WB10 are FFID numbers on seismic data.

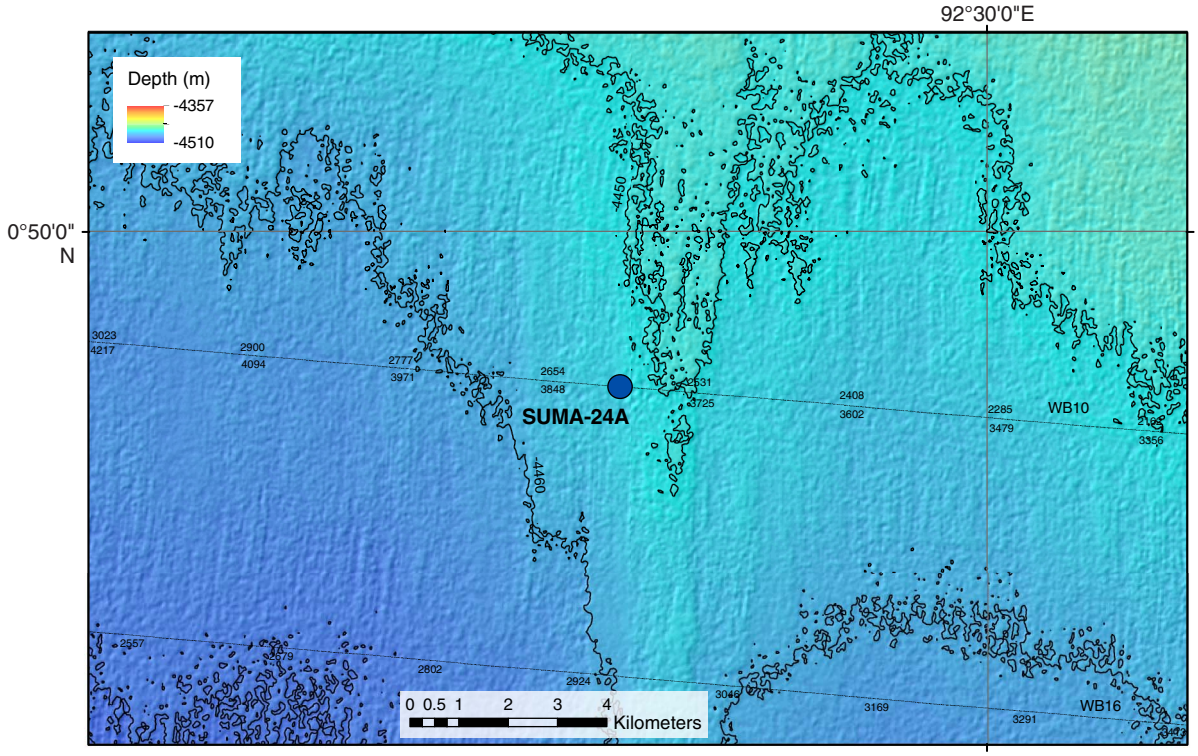


Figure F5. Interpreted seismic Profile WB03 in the vicinity of proposed Site SUMA-23A (S. Singh, unpubl. data; vertical exaggeration = 2). Depth-migrated section (with interpretation: red = minor sedimentary faults, green dashed line = Unit 2/3 boundary [pelagic sediments to Nicobar fan sediments]), example buried channels, and top of basement also indicated.

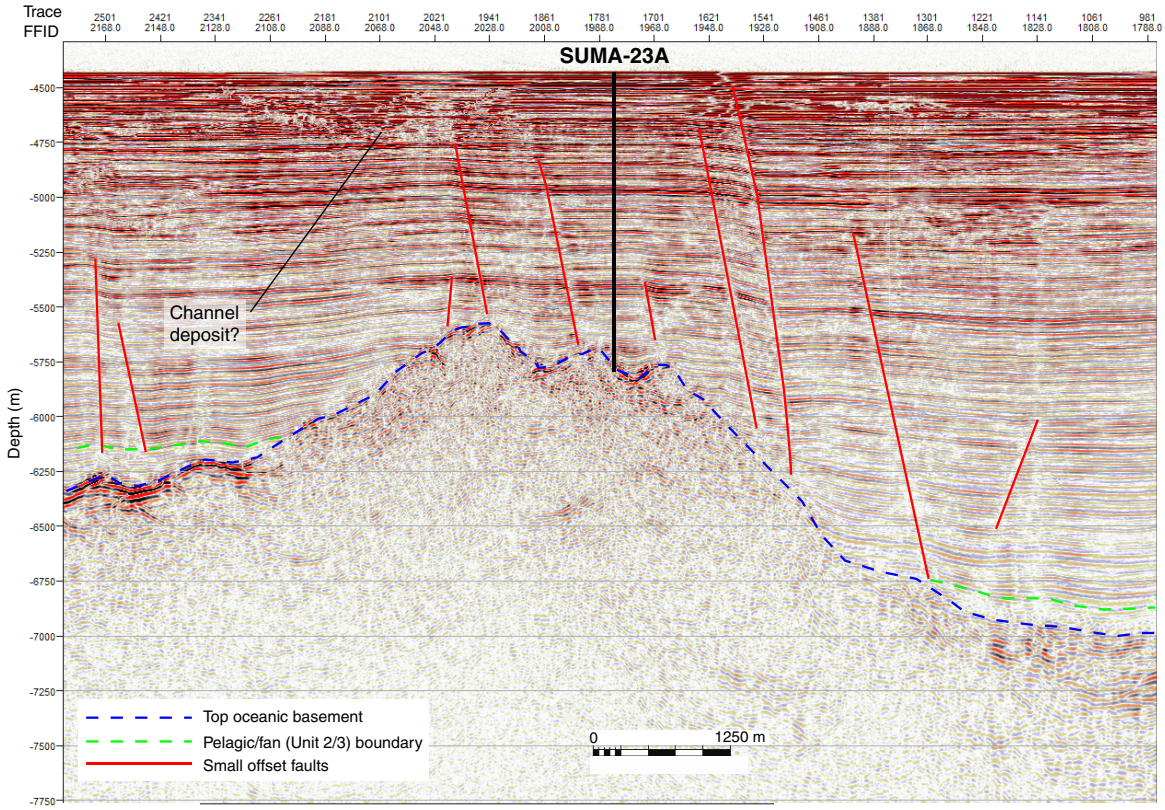
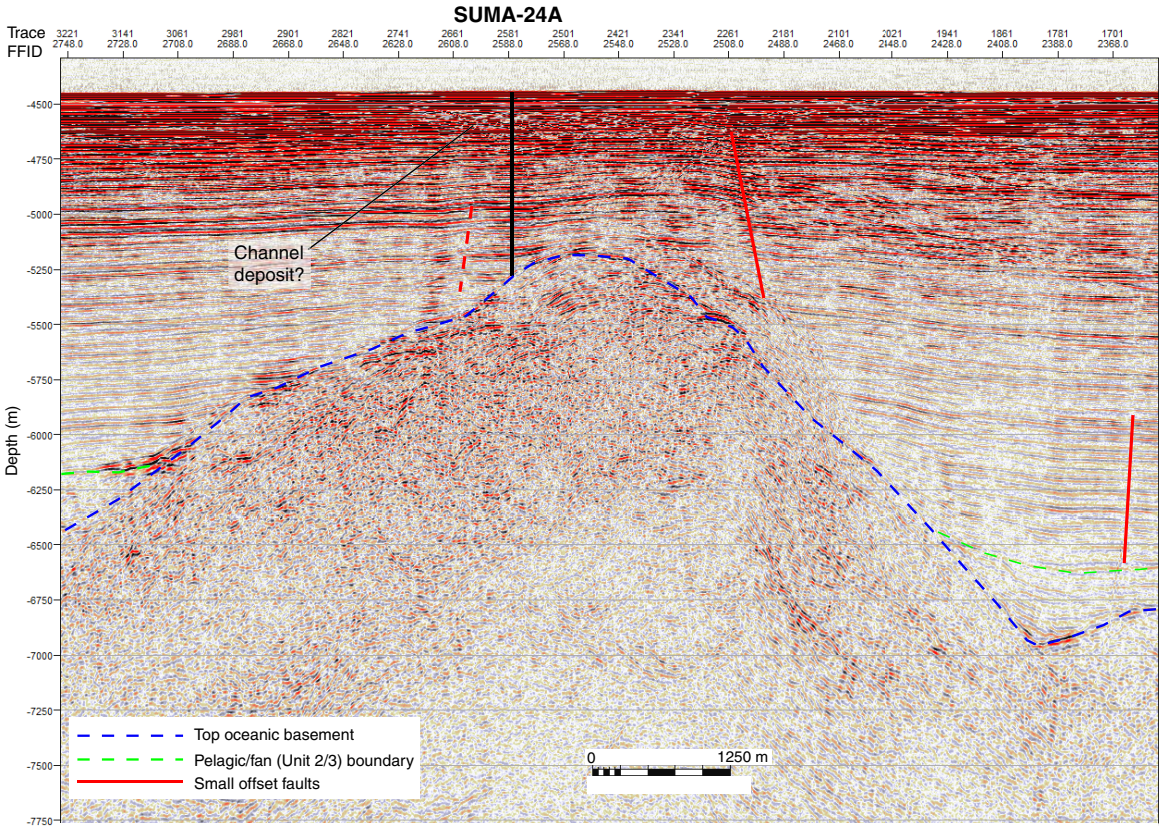


Figure F6. Interpreted seismic Profile WB10 in the vicinity of proposed Site SUMA-24A (S. Singh, unpubl. data; vertical exaggeration = 2). Depth-migrated section (with interpretation: red = minor sedimentary faults, green dashed line = Unit 2/3 boundary [pelagic sediments to Nicobar fan sediments]), example buried channels, and top of basement also indicated.



Site summaries

Site SUMA-23A

Priority:	Alternate
Position:	0°47.8247′N, 92°27.7228′E
Water depth (m):	4436
Target drilling depth (mbsf):	1375
Approved maximum penetration (mbsf):	1375 (to basement + 10 m)
Survey coverage:	MCS Profile WB03, FFID 1983 (navigation SP 3130) • Track map (Figure **F2**) and detailed bathymetry (Figure **F3**) • Seismic profile (Figure **F5**)
Objective:	Core and wireline log ocean basin input sediments (Unit 1, upper part of Unit 2, and fracture zone basement): • Age; lithology; biological, physical, and thermal properties; sedimentation history of lower section input sediments on the Indian oceanic plate (Nicobar Fan), overlying a fracture zone • Postexpedition experimental and numerical analysis of changing sediment material properties and mechanical behavior with increased burial both pre- and postaccretion • State of stress within the oceanic plate
Drilling, coring, and downhole measurements program:	• Hole A: APC/XCB to 800 mbsf • Hole B: reentry system with single casing string • Hole B: RCB from 500 to 1375 mbsf • IceField core orientation measurements • Formation temperature and pressure (APCT-3, SET, SETP, and T2P) • Wireline logging (triple combo-UBI, FMS-sonic, and VSI).
Nature of rock anticipated:	Hemipelagic, pelagic, sediment gravity flow (including turbidite) muds, thin silts and sands, and basalt

Site SUMA-24A

Priority:	Alternate
Position:	0°38.3022′N, 92°25.9850′E
Water depth (m):	4453
Target drilling depth (mbsf):	845
Approved maximum penetration (mbsf):	860 (to basement + 25 m)
Survey coverage:	MCS profile WB10, FFID 2587 (navigation SP 3781) • Track map (Figure **F2**) and detailed bathymetry (Figure **F4**) • Seismic profile (Figure **F6**)
Objective:	Core and wireline log ocean basin input sediments (Unit 1, upper part of Unit 2 and fracture zone basement): • Age; lithology; biological, physical, and thermal properties; sedimentation history of lower section input sediments on the Indian oceanic plate (Nicobar Fan), overlying a fracture zone • Postexpedition experimental and numerical analysis of changing sediment material properties and mechanical behavior with increased burial both pre- and postaccretion • State of stress within the oceanic plate
Drilling, coring, and downhole measurements program:	• Hole A: APC/XCB to 800 mbsf • Hole B: RCB from 500 to 845 mbsf • IceField core orientation measurements • Formation temperature and pressure (APCT-3, SET, SETP, and T2P) • Wireline logging (triple combo-UBI, FMS-sonic, and VSI).
Nature of rock anticipated:	Hemipelagic, pelagic, sediment gravity flow (including turbidite) muds, thin silts and sands, and basalt