

IODP Proposal Cover Sheet

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Tohoku Petit-Spot Magmatism

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Title	Impact of Petit-Spot Magmatism on Global Geochemical Cycles and Subduction Zone Seismicity		
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Keywords	petit-spot, subduction zone, geochemical cycle	Area	Outer rise of the Japan Trench

Proponent Information

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Abstract

We plan to explore the nature of the acoustic basement in the outer rise area of the NW Pacific subduction system, where layer-1 pelagic sediment of the subducting old (120–130 Ma) Pacific Plate is exceptionally thin. We hypothesize that the acoustic thin sediment cover can be attributed to basalt sill intrusions or sheet lava extrusions in and on the pelagic sediment package by the basalts fed by petit-spot magmatism. We test the hypothesis that the petit-spot magmatism at the outer rise is widely distributed than previously thought. Existence of widely-distributed petit-spots causes strong impacts on the subduction system, including rupture nucleation and slip propagation of plate boundary megathrust earthquakes, as well as changes to the geochemical cycle of arc magmatism and the global volatile cycle due to the differing materials associated with the subducted oceanic plate. Testing this hypothesis will shed light on the impacts of subduction inputs and help to determine the global role of petit-spot magmatism, both of which are important elements of the scientific objectives of the International Ocean Discovery Program (IODP).

Scientific Objectives

The goal of this project is to elucidate the existence of widely-distributed petit-spot volcanism that may significantly impact the generation of megathrust earthquakes and the earth's geochemical cycles. Only ocean drilling can assess the nature of the acoustic basement beneath regions of anomalously thin sediment cover. For this purpose, we also plan to sample the sediment cover, including the noble gases in its pore fluids.

(1) Nature of the acoustic basement in regions of thin sediment cover

If the acoustic basement consists of extrusive rocks, then lavas or volcanic breccias will be sampled. In the case of intrusive rocks, fragments of thermally affected sediment are also recoverable.

(2) Impact of petit-spots on compositions of pelagic sediments

We will determine the ages of all recovered sediments using magnetostratigraphy, tephrochronology, and biostratigraphy. If Miocene smectite-rich pelagic clay is deficient in the thin sediment cover, it could inhibit coseismic slip propagation at shallow depths yet facilitate rupture nucleation at seismogenic depths, with a significant impact on megathrust earthquake segmentation.

(3) Geochemical estimation of fluxes related to petit-spot volcanism

Geochemistry for the basalt samples will characterize the geochemical signature of this petit-spot magmatism and allow us to better assess its influence on subduction zone magmatism. Volatile contents in the basalts and adjacent sediments, along with the isotope geochemistry of noble gases, will be used to determine the nature of volatiles released at the outer rise.

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

For He analysis, a ~10 cm long whole round section from an adjacent area will be sampled from every core. The section for He analysis will be kept frozen during transport to the laboratory in order to avoid significant diffusion of He. At the laboratory, pore fluids in the section will be released in metal vacuum containers at room temperature. Thereafter, the fluids will be frozen again by refrigerating the containers, and He isotopes in free-gas phases will be measured using a noble gas mass spectrometer.

Proposed Sites (Total proposed sites: 5; pri: 1; alt: 4; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
TPC-01A (Primary)	37.9218 144.9548	5485	60	100	160	Recover sediment/basement boundary and further drill down to ~100 m below the basement to penetrate through petit-spot lava or sill.
TPC-02A (Alternate)	37.9612 144.7218	5555	50	100	150	Recover sediment/basement boundary and further drill down to ~100 m below the basement to penetrate through petit-spot lava or sill.
TPA-01A (Alternate)	39.4345 144.3667	6820	40	100	140	Recover sediment/basement boundary and further drill down to ~100 m below the basement to penetrate through petit-spot lava or sill.
TPA-02A (Alternate)	39.4037 144.2952	6908	60	100	160	Recover sediment/basement boundary and further drill down to ~100 m below the basement to penetrate through petit-spot lava or sill.
TPA-03A (Alternate)	38.8530 144.2272	7273	80	100	180	Recover sediment/basement boundary and further drill down to ~100 m below the basement to penetrate through petit-spot lava or sill.