Using the drillship to understand arc magmatic evolution through time by drilling into forearc basement and sampling the tephra record

Brian Jicha, University of Wisconsin-Madison

Columnar basalt, southern Kiska Island, Aleutians, May 2012
What are the physical and chemical conditions that control subduction zone initiation and the development of mature arc systems?
Earth Connections: Deep Processes and Their Impact on Earth’s Surface Environment

CHALLENGES

8 | What are the composition, structure, and dynamics of Earth’s upper mantle?
9 | How are seafloor spreading and mantle melting linked to ocean crustal architecture?
10 | What are the mechanisms, magnitude, and history of chemical exchanges between the oceanic crust and seawater?
11 | How do subduction zones initiate, cycle volatiles, and generate continental crust?

The primary transfer of energy and material from the deep Earth to the surface environment occurs when seafloor volcanism creates oceanic crust, including mid-ocean ridges, seamounts, volcanic islands, massive oceanic plateaus, and island arcs. Melting processes that generate these features leave nuanced records in seafloor rock of the mantle’s thermal

Scientific ocean drilling will:

- Pursue the challenge of penetrating the 5–6 km thick oceanic crust and directly sampling for the first time the underlying mantle from which all oceanic crust, and much of the continental crust, is derived.
- Test three-dimensional models for the...
In order to understand how and when subduction began in the Aleutians, we need to drill into and sample forearc basement.

IBM & Tonga forearc sampling has been very successful.

Progression of Aleutian volcanism is from south to north.

Must sample airfall tephra which can provide unparalleled record of explosive volcanism and magmatic history of an arc segment.
Aleutian magmatism through time

- Geochronologic data is sparse; biased towards plutons
- Episodic vs continues growth of island arc systems
- Boninites?
Izu-Bonin principally from ODP site 782A, Mariana mostly 458 & 459

- Tephra record of Izu-Bonin-Mariana Arc is good example of value of this work
- Tephra studies can complement and fill in gaps in the solid rock record
- Does not provide an accurate estimate of volumetric growth of the arc
Where to drill to recover Aleutian tephra and early arc crust?

Trans-tensional rifting in Near Islands may not provide clues to arc evolution.
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