



# **PROCEEDINGS OF THE INTEGRATED OCEAN DRILLING PROGRAM**

## **VOLUME 335 EXPEDITION REPORTS SUPERFAST SPREADING RATE CRUST 4**

Expedition 335 of the riserless drilling platform  
Puntarenas, Costa Rica, to Balboa, Panama  
Site 1256  
13 April–3 June 2011

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Abbreviations for names of organizations and publications in IODP reference lists follow the style given in *Chemical Abstracts Service Source Index* (published by American Chemical Society).

The bulk of the shipboard-collected core data from this expedition is accessible from Integrated Ocean Drilling Program U.S. Implementing Organization (IODP-USIO) Science Services, Texas A&M University (TAMU), at [iodp.tamu.edu/database/index.html](http://iodp.tamu.edu/database/index.html). If you cannot access this site or need additional data, please contact:

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A complete set of the logging data collected by IODP-USIO Science Services, Lamont-Doherty Earth Observatory (LDEO), is available at [brg.ldeo.columbia.edu/logdb/](http://brg.ldeo.columbia.edu/logdb/). If you have problems downloading the data, wish to receive additional logging data, or have questions regarding the data, please contact:

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Supplemental data were provided by the authors and may not conform to IODP publication formats.

Some core photographs have been tonally enhanced to better illustrate particular features of interest. High-resolution images are available upon request.

Cover photograph shows photomicrograph of a granoblastic basalt, probably the hardest rock type encountered in more than four decades of scientific ocean drilling. These contact metamorphosed rocks form the thermal boundary layer between mid-ocean ridge magma chambers and the hydrothermal circulation of seawater that drive black smoker systems.

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# Foreword

## By Integrated Ocean Drilling Program Management International, Inc.

The Integrated Ocean Drilling Program (IODP) is now in the latter half of its decadal program (2003–2013). As envisioned in the Initial Science Plan (ISP), IODP expeditions take advantage of three scientific ocean drilling platforms that enable us to cover unprecedented areas of wide oceans, from ice-covered shallow water to full ocean depths. Drilling miles of depth below seafloor, now part of IODP capabilities, is the major advance from the program predecessors, the Deep Sea Drilling Project and the Ocean Drilling Program. The living Earth is a dynamic system that is continuously evolving. IODP seeks to understand this complex and unique system through scientific ocean drilling, sampling, and experimenting in deep holes, along with advancement of related scientific disciplines. IODP is an international collaboration among scientists and nations with keen aspirations to attain the scientific goals of the ISP. IODP currently includes participating members from 24 nations.

The *Proceedings* present the scientific and engineering results of IODP drilling projects, each designed to better understand the past, present, and future of the Earth system.

IODP expeditions begin with scientists who submit research drilling proposals to test new and innovative ideas, then the proposals progress to international scientific advisors (Science Advisory Structure) who nurture, evaluate, rank, and prioritize proposals. Scientists also schedule the science operations, select science party members from scores of international scientists qualified to participate, plan platform operations, ready the drillship, and choose borehole locations. The science party, collectively and individually, conducts science on board and on shore. The co-chief scientists on each expedition are responsible for synthesizing the scientific results as hallmark of expedition.

Ocean-drilling achievements help us to understand and interpret phenomena in various parts of the Earth system. Achievements in the two legacy drilling programs have validated the scientific concepts behind plate tectonics, contributed to the understanding of ocean circulation changes, and extended our knowledge of long- and short-term climate change. IODP is truly an expansion and extension of the scientific research conducted by the legacy programs, engaging in cutting-edge research concerning topics of global importance.

IODP drilling platform operations are conducted by three Implementing Organizations (IOs). Riserless platform operations are conducted by the U.S. Implementing Organization (USIO), comprising the Consortium for Ocean Leadership, Inc., Texas A&M University through the Texas A&M Research Foundation, and Lamont-Doherty Earth Observatory of Columbia University. Riser platform operations are conducted by the Japan Agency for Marine-Earth Science and Technology through Japan's Center for Deep Earth Exploration in cooperation with the Center for Advanced Marine Core Research at Kochi University. Mission-specific platform operations are conducted by the European Consortium for Ocean Research Drilling (ECORD) Science Operator (ESO), comprising the British Geological Survey, the University of Bremen, and the European Petrophysics Consortium. The European IO currently represents the ocean-drilling efforts of 16 nations in Europe, plus Canada.

The discoveries presented in this volume build upon layers of knowledge and science developed over roughly the last fifty years. Expedition *Proceedings* are published by IODP Management International for IODP under the sponsorship of the U.S. National Science Foundation (NSF), Japan's Ministry of Education, Culture, Sports, Science and Technology, and other IODP members. The material is based upon research supported under Contract OCE-0432224 from NSF.

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Expedition 335 Scientists

## Core descriptions

Visual core descriptions (VCDs), visual rock descriptions, thin sections, and core images are included in this section. VCDs, visual rock descriptions, and thin sections are combined into PDF files for each site. The entire set of core images in PDF is available in the IMAGES directory.

#### [Expedition 335, Site 1256](#)

[Visual core descriptions](#) · [Visual rock descriptions](#) · [Thin sections](#)

#### [Expedition 335\(312\), Site 1256](#)

[Visual core descriptions](#) · [Thin sections](#)



# Expedition research results

## Data reports

Titles are available in [HTML](#).

## Syntheses

See “[Syntheses](#)” in the Expedition-related bibliography.

## Supplementary material

Supplementary material for this volume includes DESClogik workbooks, structure logs and sketches, and thin section data in Microsoft Excel and Adobe PDF formats; close-up photos in a browser-based viewer, thin section images in Adobe PDF and JPEG formats, and thin section lists in comma-separated value and Microsoft Excel formats; an operations summary table in Microsoft Excel format and re-entry movies in MP4 format; Physical Properties data in Microsoft Excel format and whole-round image code; expedition-related reports in Adobe PDF format; volume data tables in Microsoft Excel format; and XRF data in Microsoft Excel and Word formats. See [README.TXT](#) in the SUPP\_MAT directory for a full listing of directories and files.

## Drilling location maps

A site map showing the drilling locations for this expedition and maps showing the drilling locations of all Integrated Ocean Drilling Program (IODP), Ocean Drilling Program (ODP), and Deep Sea Drilling Project (DSDP) drilling sites are available in PDF format. These maps were produced using Generic Mapping Tools (GMT) of Paul Wessel and Walter H.F. Smith ([gmt.soest.hawaii.edu/](http://gmt.soest.hawaii.edu/)).

[IODP Expedition 335 site map](#)

[IODP map](#) (Expeditions 301–335)

[ODP map](#) (Legs 100–210)

[DSDP map](#) (Legs 1–96)



# Expedition-related bibliography

## IODP publications

### *Scientific Prospectus*

Teagle, D.A.H., Ildefonse, B., and Blum, P., 2010. Superfast spreading rate crust 4. *IODP Sci. Prospr.*, 335. doi:[10.2204/iodp.sp.335.2010](https://doi.org/10.2204/iodp.sp.335.2010)

### *Preliminary Report*

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## Syntheses\*

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<b>335.PDF</b> (Preliminary pages and table of contents)	
<b>README.TXT</b> (ASCII information about the Expedition Reports DVD-ROM)	
<b>ACROREAD</b> (Acrobat Reader installation software and instructions for different platforms)	<b>MAC_OS</b> <b>WINDOWS</b> <b>UNIX</b> <b>README.TXT</b>
<b>EXP_REPT</b> (Expedition Reports section of <i>Proc. IODP</i> , 335)	<b>CHAPTERS</b> (Expedition Reports chapters)  <b>CORES</b> (Visual core descriptions, visual rock descriptions, thin section data tables, and digital core images)  <b>Tables</b> (ASCII files of data tables)
	<b>335_101.PDF</b> (Expedition 335 summary) <b>335_102.PDF</b> (Methods) <b>335_103.PDF</b> (Site 1256) <b>335_104.PDF</b> (Deep drilling of intact ocean crust) <b>335_105.PDF</b> (Appendix: Superfast Spreading Crust acronyms)  <b>COR1256_1.PDF</b> (Expedition 335, Site 1256) <b>COR1256_2.PDF</b> (Expedition 335(312), Site 1256) <b>IMAGES</b> (PDF files of core images)  <b>335_101</b> (Expedition 335 summary files) <b>335_102</b> (Methods files) <b>335_103</b> (Site 1256 files) <b>335_104</b> (Deep drilling files)
<b>MAPS</b> (Drilling location maps)	<b>335_MAP.PDF</b> (Expedition 335 site map)  <b>IODPMAP.PDF</b> (IODP map, Expeditions 301–335)  <b>ODPMAP.PDF</b> (ODP map, Legs 100–210)  <b>DSDPMAP.PDF</b> (DSDP map, Legs 1–96)
<b>SUPP_MAT</b>	<b>README.TXT</b>

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