Proceedings of the International Ocean Discovery Program

Volume 391

Walvis Ridge Hotspot

Expedition 391 of the R/V JOIDES Resolution
from and to Cape Town, South Africa
Sites U1575–U1578
6 December 2021–5 February 2022

Expedition 397T of the R/V JOIDES Resolution
from Cape Town, South Africa, to Lisbon, Portugal
Sites U1584 and U1585
10 September–11 October 2022

Volume authorship
Sager, W., Hoernle, K., Höfig, T.W., Blum, P., and the Expedition 391 Scientists
Contents

Expedition reports

Chapters

Expedition 391 summary
W. Sager et al.

Expedition 397T summary
W. Sager et al.

Expedition 391 methods
W. Sager et al.

Site U1575
W. Sager et al.

Site U1576
W. Sager et al.

Site U1577
W. Sager et al.

Site U1578
W. Sager et al.

Site U1584
W. Sager et al.

Site U1585
W. Sager et al.

Core descriptions

Visual core descriptions (VCDs) are presented in PDF files for each site. Thin sections and/or smear slides for each site or hole are presented in CSV or PDF format in the CORES directory and in Excel format in DESC_WKB in Supplementary material. The entire set of core images in PDF is available in the IMAGES directory.

Site U1575: Visual core descriptions · Smear slides · Thin sections
Site U1576: Visual core descriptions · Smear slides · Thin sections
Site U1577: Visual core descriptions · Smear slides · Thin sections
Site U1578: Visual core descriptions · Smear slides · Thin sections
Site U1584: Visual core descriptions · Thin sections
Site U1585: Visual core descriptions · Thin sections

Supplementary material

Supplementary material for the Volume 391 expedition reports includes DESClogik workbooks in Microsoft Excel format. A full list of directories can be found in SUPP_MAT in the volume zip folder or on the Supplementary material for Volume 391 expedition reports web page.

Expedition research results

Data reports

Titles are available in HTML.

Drilling location maps

A site map showing the drilling locations for this expedition and maps showing the drilling locations of all International Ocean Discovery Program (IODP) expeditions, produced using QGIS (http://www.qgis.org), and all Integrated Ocean Drilling Program, Ocean Drilling Program (ODP), and Deep Sea Drilling Project (DSDP) expeditions, produced using Generic Mapping Tools (GMT) of Paul Wessel and Walter H.F. Smith (https://www.generic-mapping-tools.org), are available in PDF.

IODP Expedition 391 site map
IODP map
Integrated Ocean Drilling Program map (Expeditions 301–348)
ODP map (Legs 100–210)
DSDP map (Legs 1–96)
Acknowledgments

This research used samples and data provided by the International Ocean Discovery Program (IODP). We are grateful to the IODP Technical Support staff and the R/V JOIDES Resolution crew for their invaluable assistance and dedication during what was a challenging expedition. The resolve of the Technical Support staff was unmatched. Scientific drilling would be impossible without the efforts of many to collect site survey data. We thank the captain, crews, and science/technical teams of the R/Vs Thomas G. Thompson (Cruise TN373), Polarstern, Maria S. Merian (Cruise ANT23-5), and Meteor (Cruise 49-1). The success of the expedition was also enabled by the support of the IODP Science Evaluation Panel and the Environmental Protection and Safety Panel as well as the National Commission on Research, Science and Technology of Namibia and the Namibian Ministry of Environment, Forestry and Tourism. Support for workshops to develop the expedition objectives was provided by the IODP US Science Support Program. Funding for site survey Cruise TN373 was provided by National Science Foundation Grant OCE1832197. For the ANT23-5 cruise, funding was provided by German Research Foundation Grant JO-191/15-1 within the special program “The South Atlantic Margin Processes and Links with Onshore Evolution.” We thank the German Federal Ministry of Education and Research for funding R/V Sonne Cruise SO233 to obtain data that helped drill sites. The editorial staff at the IODP JOIDES Resolution Science Operator at Texas A&M University is thanked for their help with the publication of this document.
Foreword

The International Ocean Discovery Program (IODP) represents the latest incarnation of almost five decades of scientific ocean drilling excellence and is generally accepted as the most successful international collaboration in the history of the Earth sciences. IODP builds seamlessly on the accomplishments of previous phases: the Deep Sea Drilling Project, Ocean Drilling Program, and Integrated Ocean Drilling Program. The 2013–2023 IODP Science Plan (Illuminating Earth’s Past, Present, and Future) defines four themes and thirteen challenges for this decade of scientific ocean drilling that are both of fundamental importance in understanding how the Earth works and of significant relevance to society as the Earth changes, at least in part in response to anthropogenic forcing. This phase of IODP represents an intense level of international collaboration in bringing diverse drilling platforms and strategies to increasing our understanding of climate and ocean change, the deep biosphere and evolution of ecosystems, connections between Earth’s deep processes and surface manifestations, and geologically induced hazards on human timeframes.

The Proceedings of the International Ocean Discovery Program presents the scientific and engineering results of IODP drilling projects, expedition by expedition. As in the preceding Integrated Ocean Drilling Program, expeditions in the current IODP phase are conducted by three implementing organizations, each providing a different drilling capability. These are the US Implementing Organization (USIO; through September 2014) and the JOIDES Resolution Science Operator (JRSO; as of October 2014), providing the leased commercial vessel JOIDES Resolution for riserless drilling operations; JAMSTEC’s Institute for Marine-Earth Exploration and Engineering (MarE3), providing the drillship Chikyu for riser and occasional riserless operations; and the European Consortium for Ocean Research Drilling (ECORD) Science Operator (ESO), providing “mission-specific” platforms (MSPs) for expeditions that extend the IODP operational range where neither drillship is suitable, for example, in polar environments and in shallow waters. Scheduling decisions for each capability are made by three independent Facility Boards, each of which includes scientists, operators, and platform funding partners: the JOIDES Resolution Facility Board (JRFB), Chikyu IODP Board (CIB), and ECORD Facility Board (EFB). At the beginning of the current IODP, the three Facility Boards agreed to utilize Publication Services at the USIO and now the JRSO for production of all expedition Proceedings volumes and reports.

The current IODP differs from prior scientific ocean drilling programs in that it has neither a central management organization nor commingled funding for program-wide activities. Yet this phase of IODP retains a fundamental integrative structural element: a “bottom-up” evaluation of all proposals for drilling expeditions by a single advisory structure composed of scientists representing all international program partners. International scientists may submit drilling proposals to the Science Support Office; all submitted proposals are then evaluated by a Science Evaluation Panel in the context of the Science Plan.

The current IODP also has an international integrative level for high-level discussion and global consensus-building: the IODP Forum. The Forum is not only charged with assessing program-wide progress toward achieving the current Science Plan, but also with overseeing approaches toward a new bright future of scientific ocean drilling post 2023. At present, IODP involves 22 international funding agencies, including those from the United States, Japan, an Australia/New Zealand consortium (ANZIC), China, India, South Korea, and the 15 members of ECORD (Austria, Canada, Denmark, Finland, France, Germany, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom). The IODP membership represents an unparalleled level of international collaboration; one of the greatest and ongoing strengths of scientific ocean drilling.

Henk Brinkhuis
Chair, IODP Forum
International Ocean Discovery Program

**JOIDES Resolution Science Operator**

Website: [http://iodp.tamu.edu](http://iodp.tamu.edu)

**IODP JRSO**

International Ocean Discovery Program
Texas A&M University
1000 Discovery Drive
College Station TX 77845-9547
USA
Tel: (979) 845-2673; Fax: (979) 845-4857
Email: information@iodp.tamu.edu

**IODP JRSO Curation and Laboratories**

IODP Gulf Coast Repository (GCR)
Texas A&M University
1000 Discovery Drive
College Station TX 77845-9547
USA
Tel: (979) 845-8490; Fax: (979) 845-1303
Email: curator@iodp.tamu.edu

**European Consortium for Ocean Research Drilling, Science Operator (ESO)**

Website: [http://www.ecord.org](http://www.ecord.org)

**IODP ESO Coordinator: Science, Logistics, and Operations**

British Geological Survey
The Lyell Centre
Research Avenue South
Edinburgh EH14 4AP
United Kingdom
Tel: (44) 131-667-1000; Fax: (44) 131-668-4140
Email: eso@bgs.ac.uk

**IODP ESO Curation and Laboratories**

IODP Bremen Core Repository (BCR)
Center for Marine Environmental Sciences (MARUM)
University of Bremen
Leobener Strasse
28359 Bremen
Germany
Tel: (49) 421-218-65560; Fax: (49) 421-218-98-65560
Email: bcr@marum.de

**IODP ESO Petrophysics**

European Petrophysics Consortium
Department of Geology
University of Leicester
Leicester LE1 7RH
United Kingdom
Tel: (44) 116-252-3611; Fax: (44) 116-252-3918
Email: sjd27@leicester.ac.uk

**Japan Agency for Marine-Earth Science and Technology (JAMSTEC)**

Website: [http://www.jamstec.go.jp/chikyu/e](http://www.jamstec.go.jp/chikyu/e)

**IODP Japan Science Operator**

Institute for Marine-Earth Exploration and Engineering (MarE3)
Japan Agency for Marine-Earth Science and Technology
Yokohama Institute for Earth Sciences
3175-25 Showa-machi
Kanazawa-ku, Yokohama
Kanagawa 236-0001
Japan
Tel: (81) 45-778-5643; Fax: (81) 45-778-5704
Email: mare3-exp@jamstec.go.jp

**IODP Japan Curation and Laboratories**

IODP Kochi Institute for Core Sample Research (KCC)
Japan Agency for Marine-Earth Science and Technology
200 Monobe Otsu
3175-25 Showa-machi
Nankoku City, Kochi 783-8502
Japan
Tel: (81) 88-864-6705; Fax: (81) 88-878-2192
Email: kcc.contact@jamstec.go.jp
Expedition 391 participants*

Expedition 391 scientists

William Sager  
Co-Chief Scientist  
Earth and Atmospheric Sciences  
University of Houston  
USA  
wwsager@uh.edu

Kaj Hoernle  
Co-Chief Scientist  
GEOMAR Helmholtz Centre for Ocean Research Kiel  
Germany  
khoernle@geomar.de

Tobias W. Höfig  
Expedition Project Manager/Staff Scientist  
International Ocean Discovery Program  
Texas A&M University  
USA  
hoenig@iodp.tamu.edu  
Now at:  
tobias.hoenig@gmail.com

Aaron J. Avery  
Micropaleontologist (nannofossils)  
Department of Geology  
University of South Florida  
USA  
aaronavery@usf.edu

Rajneesh Bhutani†  
Alteration Petrologist  
Department of Earth Sciences  
Pondicherry University  
India  
rbhutani@gmail.com

David M. Buchs  
Sedimentologist/Volcanologist  
School of Earth and Environmental Sciences  
Cardiff University  
United Kingdom  
buchsd@cardiff.ac.uk

Claire A. Carvallo  
Paleomagnetist  
Institut de Minéralogie, de Physique des Matériaux et de Cosmochimie  
Sorbonne Université  
France  
claire.carvallo@sorbonne-universite.fr

Cornelia Class†  
Igneous Geochemist  
Lamont-Doherty Earth Observatory  
Columbia University  
USA  
class@ldeo.columbia.edu

Yuhao Dai  
Inorganic Geochemist  
Department of Geology  
Lund University  
Sweden  
yuhao.dai@geol.lu.se

Giacomo Dalla Valle†  
Sedimentologist  
Institute for Marine Sciences  
National Research Council  
Italy  
giacomo.dalla.valle@bo.ismar.cnr.it

Arianna V. Del Gaudio  
Micropaleontologist (foraminifera/nannofossils)  
Institute of Earth Sciences  
University of Graz  
Austria  
arianna.del-gaudio@uni-graz.at

Kevin M. Gaastra  
Paleomagnetist  
Department of Earth, Environmental and Planetary Sciences  
Rice University  
USA  
kmg9@rice.edu

Seunghee Han  
Inorganic/Organic Geochemist  
School of Earth Sciences and Environmental Engineering  
Gwangju Institute of Science and Technology  
Republic of Korea  
shan@gist.ac.kr

Stephan Homrighausen†  
Igneous Geochemist  
Dynamics of the Ocean Floor  
GEOMAR Helmholtz Centre for Ocean Research Kiel  
Germany  
shomrighausen@geomar.de

Yusuke Kubota  
Igneous Geochemist  
Department of Earth and Planetary Sciences  
Tokyo Institute of Technology  
Japan  
kubota.y.al@m.titech.ac.jp

Chun-Feng Li†  
Structural Geologist  
Ocean College  
Zhejiang University  
China  
cfl@zju.edu.cn

*Affiliations at time of expedition, except where updated by participants.  
†Shore-based participant.

https://doi.org/10.14379/iodp.proc.391.2023
**Expedition 397T scientists**

William Sager  
**Co-Chief Scientist**  
Earth and Atmospheric Sciences  
University of Houston  
USA  
wwsager@uh.edu

Peter Blum  
**Expedition Project Manager**  
International Ocean Discovery Program  
Texas A&M University  
USA  
blum@iodp.tamu.edu

Rajneesh Bhutani  
**Alteration Petrologist**  
Department of Earth Sciences  
Pondicherry University  
India  
rbhutani@gmail.com

Claire A. Carvallo  
**Paleomagnetist**  
Institut de Minéralogie, de Physique des Matériaux et de Cosmochimie  
Sorbonne Université  
France  
claire.carvallo@sorbonne-universite.fr

**Expedition 397T outreach**

Maya Pincus  
**Outreach Officer**  
Bushwick Leaders High School  
New York City Department of Education  
USA  

Present affiliation (5 December 2022):  
Lamont-Doherty Earth Observatory  
Columbia University  
USA  
maya.pincus@gmail.com

**Expedition 397T observer**

Mbili Tshiningayamwe  
**Igneous Petrologist**  
Geology Department  
University of Namibia  
Namibia  
mtshiningayamwe@unam.na
Operational and technical staff

Siem Offshore AS officials

Expedition 391

Jacob C. Robinson  
Master of the Drilling Vessel

Mark Robinson  
Drilling Supervisor

Expedition 397T

Harm Cornelis Theodoor Nienhuis  
Master of the Drilling Vessel

Curtis Wayne Lambert Jr.  
Drilling Supervisor

JRSO shipboard personnel and technical representatives

Expedition 391

Alejandro Avila Santis  
Marine Laboratory Specialist

Myriam Kars  
Marine Laboratory Specialist

Susan Boehm  
Marine Laboratory Specialist

Carel Lewis  
Curatorial Specialist

Emily Britt  
Marine Laboratory Specialist

Daniel Marone  
Assistant Laboratory Officer

Lisa Crowder  
Laboratory Officer

Aaron Mechler  
Marine Laboratory Specialist

Douglas Cummings  
Publications Specialist

Stephen Midgley  
Operations Superintendent

Clayton Furman  
Schlumberger Engineer

Beth Novak  
Assistant Laboratory Officer

Fabricio Ferreira  
Marine Laboratory Specialist

Brian Swilley  
Marine Laboratory Specialist

Randi Gjøvsland  
Marine Instrumentation Specialist

Steven Thomas  
Marine Laboratory Specialist

Sandra Herrmann  
Imaging Specialist

Chris Visser  
Marine Instrumentation Specialist

Mark Higley  
Marine Laboratory Specialist

Hai (James) Zhao  
Applications Developer

Michael Hodge  
Marine Computer Specialist

Expedition 397T

James Brattin  
Applications Developer

Andrew Howard  
Engineer

Michael Cannon  
Marine Computer Specialist

David Kratz  
Marine Computer Specialist

Oscar Cavazos  
Marine Laboratory Specialist

Nicholas Logan  
Marine Computer Specialist

Bridgette Cervera  
Marine Laboratory Specialist

Brittany Martinez  
Curatorial Specialist

Etienne Claassen  
Marine Instrumentation Specialist

William Mills  
Laboratory Officer

Kirby Garrett  
Schlumberger Engineer

Eric Moortgat  
Assistant Laboratory Officer

Luan Heywood  
Marine Laboratory Specialist

Algie Morgan  
Applications Developer
Expedition-related bibliography*

Citation data for IODP publications and journal articles in RIS format

IODP publications

Scientific Prospectus

Preliminary Report

Proceedings volume

Expedition reports

*The Expedition-related bibliography is continually updated online (http://publications.iodp.org/proceedings/391/391title.html#bib). Please send updates to PubCrd@iodp.tamu.edu.

Supplementary material