

Proceedings of the International Ocean Discovery Program

Volume 401

Mediterranean–Atlantic Gateway Exchange

Phase 1 (offshore sites) of the IMIMAGE Land-2-Sea project

Expedition 401 of the R/V *JOIDES Resolution*

Amsterdam, Netherlands, to Napoli, Italy

Sites U1385 and U1609–U1611

10 December 2023–9 February 2024

Volume authorship

Flecker, R., Ducassou, E., Williams, T., and the Expedition 401 Scientists



Publisher's notes

This publication was prepared by the *JOIDES Resolution* Science Operator (JRSO) at Texas A&M University (TAMU) as an account of work performed under the International Ocean Discovery Program (IODP). This material is based upon work supported by the JRSO, which is a major facility funded by the National Science Foundation Cooperative Agreement Number OCE1326927. Funding for IODP is provided by the following international partners:

National Science Foundation (NSF), United States
Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japan
European Consortium for Ocean Research Drilling (ECORD)
Ministry of Science and Technology (MOST), People's Republic of China
Australia-New Zealand IODP Consortium (ANZIC)
Ministry of Earth Sciences (MoES), India

The JRSO is supported by the NSF. Any opinions, findings, and conclusions or recommendations expressed in this material do not necessarily reflect the views of the NSF, the participating agencies, TAMU, or Texas A&M Research Foundation.

The bulk of the shipboard-collected core data from this expedition is accessible at <https://zenodo.org/communities/iodp> (see list of [available data sets](#)). If you cannot access this site or need additional data, please contact Data Librarian, International Ocean Discovery Program *JOIDES Resolution* Science Operator, Texas A&M University (database@iodp.tamu.edu).

A complete set of the logging data collected during the expedition is available at http://mlp.ldeo.columbia.edu/logdb/scientific_ocean_drilling. If you have problems downloading the data, wish to receive additional logging data, or have questions regarding the data, please contact Database Administrator, Borehole Research Group, Lamont-Doherty Earth Observatory of Columbia University (logdb@ldeo.columbia.edu).

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

JRSO expedition photos are the property of IODP and are public access.

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

Cover photograph shows SEA1 crew member on the derrick at sunset. Photo credit: Patty Standring and IODP JRSO.

Copyright

Except where otherwise noted, this work is licensed under the Creative Commons Attribution 4.0 International (CC BY 4.0) license (<https://creativecommons.org/licenses/by/4.0/>). Unrestricted use, distribution, and reproduction are permitted, provided the original author and source are credited.



Examples of how to cite this volume or part of this volume are available at <http://publications.iodp.org/proceedings/401/401title.html#bib>.

ISSN

World Wide Web: 2377-3189

ISBN

978-1-954252-94-3

Volume DOI

<https://doi.org/10.14379/iodp.proc.401.2025>

Publication date

7 July 2025

Contents

Expedition reports

Chapters

[Expedition 401 summary](#)

R. Flecker et al.

[Expedition 401 methods](#)

R. Flecker et al.

[Site U1609](#)

R. Flecker et al.

[Site U1610](#)

R. Flecker et al.

[Site U1385](#)

R. Flecker et al.

[Site U1611](#)

R. Flecker 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 tab-separated value (TSV) or PDF format in the CORES directory and in TSV format in GEODESC in Supplementary material. The entire set of core images in PDF is available in the IMAGES directory.

Site U1609: [Visual core descriptions](#) · [Smear slides](#) · [Thin sections](#) · [GEODESC files](#)

Site U1610: [Visual core descriptions](#) · [Smear slides](#) · [Thin sections](#) · [GEODESC files](#)

Site U1385: [Visual core descriptions](#) · [Smear slides](#) · [GEODESC files](#)

Site U1611: [Visual core descriptions](#) · [Smear slides](#) · [Thin sections](#) · [GEODESC files](#)

Supplementary material

Supplementary material for the Volume 401 expedition reports includes age model sedimentation rate calculations in Microsoft Excel and Word format, hand drawn logs in PDF, paleomagnetism data in Microsoft Excel format, and synthetic logs in EPS format. A full list of directories can be found in SUPP_MAT in the volume zip folder or on the [Supplementary material for Volume 401 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 401 site map](#)

[IODP map](#)

[Integrated Ocean Drilling Program map](#) (Expeditions 301–348)

[ODP map](#) (Legs 100–210)

[DSDP map](#) (Legs 1–96)

Acknowledgments

Expedition 401 is the offshore phase of the Investigating Miocene Mediterranean–Atlantic Gateway Exchange (IMMAGE) Land-2-Sea drilling project. It would never have happened without the extensive contributions, support, and encouragement of the original proponents. Onshore International Continental Scientific Drilling Program (ICDP) drilling will take place in Spain and Morocco in the future; therefore, to help forge the partnerships required to achieve this, JRSO supported the participation during Expedition 401 of the first Moroccan scientist to sail on the R/V *JOIDES Resolution*.

Expedition 401 benefited from the scrutiny of the Environmental Protection and Safety Panel on four separate occasions before the expedition, as well as consulting them twice during it. The expedition required permission to drill in Portuguese and Spanish waters, which was sought and obtained by the JRSO team. Postcruise support from the teams associated with X-ray fluorescence (XRF) scanning, sampling, curation, and publications has been exemplary, particularly with the added challenges associated with developing and navigating new protocols and processes suitable for Land-2-Sea projects.

Expedition 401 was the antepenultimate IODP expedition before the decommissioning of *JOIDES Resolution*. Consequently, for almost all the technical team on board and many of the SEA1 crew, this was their last scientific drilling expedition. Despite this, their support for the scientists and enthusiasm for the science was extraordinary. They truly are a remarkable group of people with whom it has been a privilege to work.

An enormous amount of work and expertise goes into turning a drilling proposal into a successful offshore expedition. Much of this happens before the ship ever sets sail and is largely invisible to the science party. Sailing on *JOIDES Resolution* has been an exceptional opportunity. Thank you to all those that made that possible.

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 scientific 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>

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>

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>

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 401 participants*

Expedition 401 scientists

Rachel Flecker

Co-Chief Scientist

Department of Geography
University of Bristol
United Kingdom
r.flecker@bristol.ac.uk

Emmanuelle Ducassou

Co-Chief Scientist

Environnements Paléoenvironnements Océaniques et
Continentaux, UMR CNRS 5805
Université de Bordeaux
France
emmanuelle.ducassou@u-bordeaux.fr

Trevor Williams

Expedition Project Manager

International Ocean Discovery Program
Texas A&M University
USA
williams@iodp.tamu.edu

Udara Amarathunga

Micropaleontologist (planktonic foraminifers)

The Department of Geosciences
Princeton University
USA
udara.amar@princeton.edu

Barbara Balestra

Micropaleontologist (nannofossils)

Environmental Science Department
American University
USA
balestra@american.edu

Melissa A. Berke

Organic Geochemist

Department of Civil and Environmental Engineering and Earth
Sciences
University of Notre Dame
USA
mberke@nd.edu

Clara L. Blättler

Inorganic Geochemist

Department of the Geophysical Sciences
University of Chicago
USA
cblattler@uchicago.edu

Shamar Chin

Micropaleontologist (nannofossils)

Earth and Environmental Sciences
University of Iowa
USA
shamar-chin@uiowa.edu

Moumita Das

Micropaleontologist (benthic foraminifers)

Geology Section, MMV
Banaras Hindu University
India
mdas.mmv@bhu.ac.in

Kosuke Egawa

Sedimentologist

Department of Earth Resources Engineering
Kyushu University
Japan
egawa.kosuke.394@m.kyushu-u.ac.jp

Natacha Fabregas

Sedimentologist

Department of Earth Science
University of Bergen
Norway
natacha.fabregas@uib.no

Sarah J. Feakins

Organic Geochemist

Department of Earth Sciences
University of Southern California
USA
feakins@usc.edu

Simon C. George

Sedimentologist

School of Natural Sciences
Macquarie University
Australia
Simon.George@mq.edu.au

F. Javier Hernández-Molina

Sedimentologist

Department of Earth Science
Royal Holloway University of London
United Kingdom
javier.hernandez-molina@rhul.ac.uk

Wout Krijgsman

Paleomagnetist

Department of Earth Sciences
Utrecht University
The Netherlands
W.Krijgsman@uu.nl

Zhiyang Li

Sedimentologist

College of Arts and Sciences
Texas A&M International University
USA
zhiyang.li@tamiu.edu

*Affiliations at time of expedition, except where updated by participants.

Jiabo Liu

Paleomagnetist

Institute of Geophysics and Geomatics
China University of Geosciences
China
liujiabo@cug.edu.cn

Danielle Noto

Sedimentologist

CENEX, Department of Geology and Geophysics and Museum of
Natural Science
Louisiana State University
USA
notodanielle1@gmail.com

Fadl Raad

Physical Properties Specialist/Downhole Measurements

Department of Geosciences
Università di Corsica Pasquale Paoli
France
raad_f@univ-corse.fr

Francisco Javier Rodríguez-Tovar

Sedimentologist

Department of Stratigraphy and Paleontology
University of Granada
Spain
fjrtovar@ugr.es

Francisco Javier Sierro

Micropaleontologist (planktonic foraminifers)

Department of Geology
University of Salamanca
Spain
sierro@usal.es

Patricia Standring

Sedimentologist

Institute for Geophysics
University of Texas at Austin
USA
patty.standring@utexas.edu

Outreach

Erin Winick Anthony

Outreach Officer

Freelance Science Communicator
STEAM Power Media
USA
erin.winick@gmail.com

Jonathan Stine

Physical Properties Specialist

Department of Earth and Environmental Sciences
University of Minnesota Twin Cities
USA
jstine@umn.edu

Erika Tanaka

Inorganic Geochemist

Marine Core Research Institute
Kochi University
Japan
erikat@kochi-u.ac.jp

Manuel Teixeira

Physical Properties Specialist/Observer

Instituto Dom Luiz, Faculty of Sciences
University of Lisbon
Portugal
macteixeira@ciencias.ulisboa.pt

Xunhui Xu

Physical Properties Specialist

Department of Urban Management
Kyoto University
Japan
xu.xunhui.72x@st.kyoto-u.ac.jp

Shaoru Yin

Physical Properties Specialist

Second Institute of Oceanography
Ministry of Natural Resources
China
shaoru2017@outlook.com

Mohamed Zakaria Yousfi

Micropaleontologist (planktonic foraminifers)/Observer

Office National des Hydrocarbures et des Mines
Morocco
yousfi@onhym.com

Kellan Moss

Outreach Officer

Freelance Artist
Rochester Institute of Technology
USA
mossartworks99@gmail.com

Operational and technical staff

SEA1 Offshore AS officials

Harm Cornelis Theodoor Nienhuis
Master of the Drilling Vessel

Curtis Wayne Lambert Jr.
Drilling Supervisor

JRSO shipboard personnel and technical representatives

Timothy Blaisdell
Applications Developer

Erick Bravo
Marine Laboratory Specialist

Michael Cannon
Marine Computer Specialist

Oscar Cavazos
Marine Laboratory Specialist

Bridgette Cervera
Marine Laboratory Specialist

Etienne Claassen
Marine Instrumentation Specialist

Douglas Cummings
Publications Specialist

Kirby Garrett
Logging Engineer (Schlumberger)

Myriam Kars
Marine Laboratory Specialist

Jan Kotze
Marine Instrumentation Specialist

Carel Lewis
Curatorial Specialist

IODP Publication Services staff*

Molly Blaisdell
Production Editor II

Douglas Cummings
Graphics Specialist III

Keith Dupuis
Graphics Specialist III

Anthony Eason
Graphics Specialist II

Patrick H. Edwards
Supervisor of Production

Willow S. Grosz
Editor III

Jennifer Hertzberg
DAM Administrator

Nick Logan
Marine Computer Specialist

Zenon Mateo
Marine Laboratory Specialist

Eric Moortgat
Assistant Laboratory Officer

Chieh Peng
Laboratory Officer

Doris Pinero Lajas
Assistant Laboratory Officer

William Rhinehart
Operations Superintendent

Alexander Roth
Marine Laboratory Specialist

Johanna Suhonen
Marine Laboratory Specialist

Kara Vadman
Marine Laboratory Specialist

Maximilian Witek
Marine Laboratory Specialist

Hai Zhao
Applications Developer

Jenni Hesse
Editor IV

Rhonda Kappler
Graphics Specialist IV

Amy McWilliams
Supervisor of Editing

Julie Myers
Production Editor IV

Lorri Peters
Manager of Publication Services

Alyssa Stephens
Supervisor of Graphics

*At time of publication.

Expedition-related bibliography*

Citation data for IODP publications and journal articles in RIS format

IODP publications

Scientific Prospectus

Flecker, R., Ducassou, E., and Williams, T., 2023. Expedition 401 Scientific Prospectus: Mediterranean Atlantic Gateway Exchange. International Ocean Discovery Program. <https://doi.org/10.14379/iodp.sp.401.2023>

Preliminary Report

Flecker, R., Ducassou, E., Williams, T., and the Expedition 401 Scientists, 2024. Expedition 401 Preliminary Report: Mediterranean–Atlantic Gateway Exchange. International Ocean Discovery Program. <https://doi.org/10.14379/iodp.pr.401.2024>

Proceedings volume

Flecker, R., Ducassou, E., Williams, T., and the Expedition 401 Scientists, 2025. Mediterranean–Atlantic Gateway Exchange. Proceedings of the International Ocean Discovery Program, 401: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.401.2025>

Expedition reports

- Flecker, R., Ducassou, E., Williams, T., Amarathunga, U., Balestra, B., Berke, M.A., Blättler, C.L., Chin, S., Das, M., Egawa, K., Fabregas, N., Feakins, S.J., George, S.C., Hernández-Molina, F.J., Krijgsman, W., Li, Z., Liu, J., Noto, D., Raad, F., Rodríguez-Tovar, F.J., Sierro, F.J., Standring, P., Stine, J., Tanaka, E., Teixeira, M., Xu, X., Yin, S., and Yousfi, M.Z., 2025. Expedition 401 summary. In Flecker, R., Ducassou, E., Williams, T., and the Expedition 401 Scientists, Mediterranean–Atlantic Gateway Exchange. Proceedings of the International Ocean Discovery Program, 401: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.401.101.2025>
- Flecker, R., Ducassou, E., Williams, T., Amarathunga, U., Balestra, B., Berke, M.A., Blättler, C.L., Chin, S., Das, M., Egawa, K., Fabregas, N., Feakins, S.J., George, S.C., Hernández-Molina, F.J., Krijgsman, W., Li, Z., Liu, J., Noto, D., Raad, F., Rodríguez-Tovar, F.J., Sierro, F.J., Standring, P., Stine, J., Tanaka, E., Teixeira, M., Xu, X., Yin, S., and Yousfi, M.Z., 2025. Expedition 401 methods. In Flecker, R., Ducassou, E., Williams, T., and the Expedition 401 Scientists, Mediterranean–Atlantic Gateway Exchange. Proceedings of the International Ocean Discovery Program, 401: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.401.102.2025>
- Flecker, R., Ducassou, E., Williams, T., Amarathunga, U., Balestra, B., Berke, M.A., Blättler, C.L., Chin, S., Das, M., Egawa, K., Fabregas, N., Feakins, S.J., George, S.C., Hernández-Molina, F.J., Krijgsman, W., Li, Z., Liu, J., Noto, D., Raad, F., Rodríguez-Tovar, F.J., Sierro, F.J., Standring, P., Stine, J., Tanaka, E., Teixeira, M., Xu, X., Yin, S., and Yousfi, M.Z., 2025. Site U1609. In Flecker, R., Ducassou, E., Williams, T., and the Expedition 401 Scientists, Mediterranean–Atlantic Gateway Exchange. Proceedings of the International Ocean Discovery Program, 401: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.401.103.2025>
- Flecker, R., Ducassou, E., Williams, T., Amarathunga, U., Balestra, B., Berke, M.A., Blättler, C.L., Chin, S., Das, M., Egawa, K., Fabregas, N., Feakins, S.J., George, S.C., Hernández-Molina, F.J., Krijgsman, W., Li, Z., Liu, J., Noto, D., Raad, F., Rodríguez-Tovar, F.J., Sierro, F.J., Standring, P., Stine, J., Tanaka, E., Teixeira, M., Xu, X., Yin, S., and Yousfi, M.Z., 2025. Site U1610. In Flecker, R., Ducassou, E., Williams, T., and the Expedition 401 Scientists, Mediterranean–Atlantic Gateway Exchange. Proceedings of the International Ocean Discovery Program, 401: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.401.104.2025>
- Flecker, R., Ducassou, E., Williams, T., Amarathunga, U., Balestra, B., Berke, M.A., Blättler, C.L., Chin, S., Das, M., Egawa, K., Fabregas, N., Feakins, S.J., George, S.C., Hernández-Molina, F.J., Krijgsman, W., Li, Z., Liu, J., Noto, D., Raad, F., Rodríguez-Tovar, F.J., Sierro, F.J., Standring, P., Stine, J., Tanaka, E., Teixeira, M., Xu, X., Yin, S., and Yousfi, M.Z., 2025. Site U1385. In Flecker, R., Ducassou, E., Williams, T., and the Expedition 401 Scientists, Mediterranean–Atlantic Gateway Exchange. Proceedings of the International Ocean Discovery Program, 401: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.401.105.2025>
- Flecker, R., Ducassou, E., Williams, T., Amarathunga, U., Balestra, B., Berke, M.A., Blättler, C.L., Chin, S., Das, M., Egawa, K., Fabregas, N., Feakins, S.J., George, S.C., Hernández-Molina, F.J., Krijgsman, W., Li, Z., Liu, J., Noto, D., Raad, F., Rodríguez-Tovar, F.J., Sierro, F.J., Standring, P., Stine, J., Tanaka, E., Teixeira, M., Xu, X., Yin, S., and Yousfi, M.Z., 2025. Site U1611. In Flecker, R., Ducassou, E., Williams, T., and the Expedition 401 Scientists, Mediterranean–Atlantic Gateway Exchange. Proceedings of the International Ocean Discovery Program, 401: College Station, TX (International Ocean Discovery Program). <https://doi.org/10.14379/iodp.proc.401.106.2025>

Supplementary material

Flecker, R., Ducassou, E., Williams, T., and the Expedition 401 Scientists, 2025. Supplementary material, <https://doi.org/10.14379/iodp.proc.401supp.2025>. In Flecker, R., Ducassou, E., Williams, T., and the Expedition 401 Scientists, Mediterranean–Atlantic Gateway Exchange. Proceedings of the International Ocean Discovery Program, 401: College Station, TX (International Ocean Discovery Program).

*The Expedition-related bibliography is continually updated online (<http://publications.iodp.org/proceedings/401/401title.html#bib>). Please send updates to PubCrd@iodp.tamu.edu.

Site map

