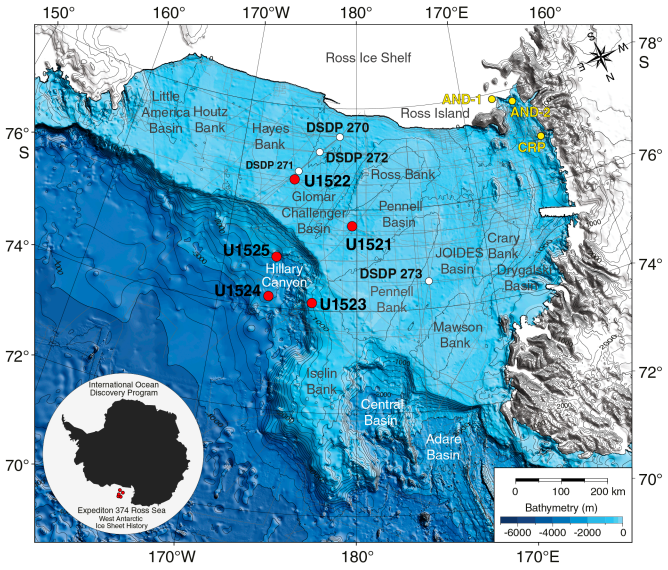
Proceedings of the International Ocean Discovery Program

Volume 374

Ross Sea West Antarctic Ice Sheet History

Expedition 374 of the R/V *JOIDES Resolution*
Lyttelton, New Zealand, to Timaru, New Zealand
Sites U1521–U1525
4 January–8 March 2018

Volume authorship
McKay, R.M., De Santis, L., Kulhanek, D.K., and the Expedition 374 Scientists



Published by
International Ocean Discovery Program

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). 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
Korea Institute of Geoscience and Mineral Resources (KIGAM)
Australia-New Zealand IODP Consortium (ANZIC)
Ministry of Earth Sciences (MoES), India
Coordination for Improvement of Higher Education Personnel (CAPES), Brazil

Any opinions, findings, and conclusions or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of the participating agencies, TAMU, or Texas A&M Research Foundation.

The bulk of the shipboard-collected core data from this expedition is accessible at **http://iodp.tamu.edu/database/index.html**. 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, 1000 Discovery Drive, College Station TX 77845-9547, USA. Tel: (979) 845-8495; Fax: (979) 458-1617; Email: **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, PO Box 1000, 61 Route 9W, Palisades NY 10964, USA. Tel: (845) 365-8343; Fax: (845) 365-3182; Email: **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 the *JOIDES Resolution* and blue icebergs. Photo credit: Bill Crawford, IODP JRSO.

Copyright

Examples of how to cite this volume or part of this volume are available at **http://publications.iodp.org/proceedings/374/374title.html#bib**.

ISSN
World Wide Web: 2377-3189

Volume DOI
https://doi.org/10.14379/iodp.proc.374.2019

Publication date
10 August 2019

Contents

Expedition reports

Chapters

Core descriptions

Visual core descriptions (VCDs) are presented in PDF files for each site. Smear slides and/or thin sections are presented in PDF and/or CSV files for each site and/or hole (CSV files are available in the CORES directory). The entire set of core images in PDF is available in the IMAGES directory.

Site U1521
Visual core descriptions · **Smear slides** · **Thin sections**

Site U1522
Visual core descriptions · **Smear slides** · **Thin sections**

Site U1523
Visual core descriptions · Smear slides

Site U1524
Visual core descriptions · Smear slides · **Thin sections**

Site U1525
Visual core descriptions · **Smear slides**

Supplementary material

Supplementary material for the Volume 374 expedition reports includes DESClogik workbooks in Microsoft Excel format and hand drawn barrel sheets in PDF. A full list of directories can be found in SUPP_MAT in the volume zip folder or on the **Supplementary material for Volume 374 expedition reports** web page.

Expedition research results

Data reports

Titles are available in **HTML**.

Syntheses

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 (**http://gmt.soest.hawaii.edu**), are available in PDF.

IODP Expedition 374 site map
IODP map (Expeditions 349–357, 359–372, 374, and 381)
Integrated Ocean Drilling Program map (Expeditions 301–348)
ODP map (Legs 100–210)
DSDP map (Legs 1–96)

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 a renewed 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 new IODP 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 Center for Deep Earth Exploration (CDEX), 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 new 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 new 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 new IODP also has a second internationally integrative level for high-level discussion and consensus-building: the IODP Forum. The Forum is charged with assessing program-wide progress toward achieving the Science Plan. At present, IODP involves 26 international financial partners, including the United States, Japan, an Australia/New Zealand consortium (ANZIC), Brazil, China, India, South Korea, and the eighteen members of ECORD (Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Israel, Italy, the Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, and the United Kingdom). This enhanced membership in the new IODP represents a remarkable level of international collaboration that remains one of the greatest ongoing strengths of scientific ocean drilling.

James A. Austin Jr.
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: **rumford@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 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**

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**

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

Website: **http://www.jamstec.go.jp/chikyu/e**

IODP Japan Science Operator
Center for Deep Earth Exploration (CDEX)
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: **cdex@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 374 participants*

Expedition 374 scientists

Robert M. McKay
Co-Chief Scientist
Antarctic Research Centre
Victoria University of Wellington
New Zealand
robert.mckay@vuw.ac.nz

Laura De Santis
Co-Chief Scientist
Geophysics Division
Instituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS)
Italy
ldesantis@inogs.it

Denise K. Kulhanek
Expedition Project Manager/Staff Scientist
International Ocean Discovery Program
Texas A&M University
USA
kulhanek@iodp.tamu.edu

Jeanine L. Ash
Sedimentologist
Department of Earth, Environmental and Planetary Sciences
Rice University
USA
jeanine.ash@rice.edu

François Beny
Physical Properties Specialist
Laboratoire d'Océanologie et de Géosciences
Université de Lille I
France
beny.francois@gmail.com

Imogen M. Browne
Physical Properties Specialist
College of Marine Science
University of South Florida, St. Petersburg
USA
imogenbrowne@mail.usf.edu

Giuseppe Cortese
Paleontologist (radiolarians)
Paleontology Department
GNS Science
New Zealand
g.cortese@gns.cri.nz

Isabela M. Cordeiro de Sousa
Sedimentologist
Instituto de Geociencias
Universidade de Brasília
Brazil
isabelasousa@unb.br

Justin P. Dodd
Inorganic Geochemist
Geology and Environmental Geosciences
Northern Illinois University
USA
jdodd@niu.edu

Oliver M. Esper
Palynologist
Marine Geology
Helmholtz Centre for Polar and Marine Research
Alfred Wegener Institute
Germany
oliver.esper@awi.de

Jenny A. Gales
Physical Properties Specialist/Downhole Measurements
School of Biological & Marine Sciences
Plymouth University
United Kingdom
jenny.gales@plymouth.ac.uk

David M. Harwood
Paleontologist (diatoms)
Earth and Atmospheric Sciences
University of Nebraska, Lincoln
USA
dharwood1@unl.edu

Saki Ishino
Sedimentologist
Department of Earth and Planetary Sciences
Nagoya University
Japan

Present affiliation (8 May 2019):
Research Institute of Geology and Geoinformation
Geological Survey of Japan
National Institute of Advanced Industrial Science and Technology (AIST)
Japan
ishino.saki@aist.go.jp

Benjamin A. Keisling
Sedimentologist
Department of Geosciences
University of Massachusetts, Amherst
USA
bkeisling@geo.umass.edu

Sookwan Kim
Physical Properties Specialist
Division of Polar-Earth System Sciences
Korea Polar Research Institute
Republic of Korea
skwan@kopri.re.kr

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

Sunghan Kim
Sedimentologist
Division of Polar Paleoenvironment
Korea Polar Research Institute
Republic of Korea
delongksh@kopri.re.kr

Jan Sverre Laberg
Sedimentologist
Department of Geosciences
University of Tromsø - the Arctic University of Norway
Norway
jan.laberg@uit.no

R. Mark Leckie
Paleontologist (foraminifers)
Department of Geosciences
University of Massachusetts, Amherst
USA
mleckie@geo.umass.edu

Juliane Müller
Organic Geochemist
Marine Geology
Helmholtz Centre for Polar and Marine Research
Alfred Wegener Institute
Germany
juliane.mueller@awi.de

Molly O. Patterson
Sedimentologist
Geological Sciences and Environmental Studies
Binghamton University, State University of New York
USA
patterso@binghamton.edu

Brian W. Romans
Physical Properties Specialist/Downhole Measurements
Department of Geosciences
Virginia Tech
USA
romans@vt.edu

Oscar E. Romero
Paleontologist (diatoms)
MARUM—Center for Marine Environmental Sciences
University of Bremen
Germany
oromero@uni-bremen.de

Francesca Sangiorgi
Palynologist
Department of Earth Sciences
Utrecht University
The Netherlands
f.sangiorgi@uu.nl

Osamu Seki
Organic Geochemist
Institute of Low Temperature Science
Hokkaido University
Japan
seki@pop.lowtem.hokudai.ac.jp

Amelia E. Shevenell
Sedimentologist
College of Marine Science
University of South Florida, St. Petersburg
USA
ashevenell@usf.edu

Shiv M. Singh
Sedimentologist
Polar Biology Lab
National Centre for Antarctic and Ocean Research (NCAOR)
India
smsingh@ncaor.gov.in

Also at
Department of Botany
Institute of Science
Banaras Hindu University
India
drshivmohansingh@gmail.com

Saiko T. Sugisaki
Paleomagnetist
Marine Geology Research Group
Geological Survey of Japan, AIST
Japan
s.sugisaki@aist.go.jp

Tina van de Flierdt
Inorganic Geochemist
Department of Earth Science & Engineering
Imperial College London
United Kingdom
tina.vandeflierdt@imperial.ac.uk

Tim E. van Peer
Paleomagnetist
National Oceanography Centre Southampton
University of Southampton
United Kingdom
T.E.vanPeer@soton.ac.uk

Wenshen Xiao
Paleontologist (diatoms)
State Key Laboratory of Marine Geology
Tongji University
China
wxiao@tongji.edu.cn

Zhifang Xiong
Inorganic Geochemist
First Institute of Oceanography
State Oceanic Administration
China
zhfxiong@fio.org.cn

Observer

John L. Powell
Weather/Ice Observer
Canada
jpowell@ns.sympatico.ca

Education and outreach

Rosa Hughes-Currie
Educator
Massey High School
New Zealand
rosahughescurrie@gmail.com

Agnès Pointu
Educator
Lycée Louis de Broglie
France
agnes.pointu@gmail.com

Kimberly A. Kenny
Videographer
USA
kimberlyannekenny@gmail.com

Operational and technical staff

Siem Offshore AS officials

Terry Skinner
Master of the Drilling Vessel

Sam McLelland
Drilling Supervisor

JRSO shipboard personnel and technical representatives

Gary D. Acton
Manager of Technical and Analytical Services

Alexis Armstrong
X-ray Laboratory

Heather Barnes
Assistant Laboratory Officer

Timothy Blaisdell
Applications Developer

Michael Cannon
Marine Computer Specialist

Etienne Claassen
Marine Instrumentation Specialist

William Crawford
Senior Imaging Specialist

Seth Frank
Thin Section Laboratory

Sheryl Frazier
Physical Properties Laboratory

Edwin Garrett
Paleomagnetism Laboratory

Rachael Gray
Core Laboratory

Margaret Hastedt
Assistant Laboratory Officer

Brittany Martinez
Curatorial Specialist

Zenon Mateo
Underway Geophysics Laboratory

Stephen Midgley
Operations Superintendent

Erik Moortgat
Chemistry Laboratory

Chieh Peng
Laboratory Officer

Vincent Percuoco
Chemistry Laboratory

Kerry Swain
Logging Engineer (Schlumberger)

Steven Thomas
Marine Computer Specialist

Rui Wang
Applications Developer

Jean Wulfson
Publications Specialist

IODP Publication Services staff*

Douglas Cummings
Graphics Specialist II

Gudelia ("Gigi") Delgado
Publications Coordinator

Ekanta Desai
Graphics Specialist II

Patrick H. Edwards
Production Editor IV

Jaime A. Gracia
Supervisor of Production and Graphics

Jenni Hesse
Editor IV

Rhonda Kappler
Graphics Specialist IV

Shana C. Lewis
Editor III

Ginny Lowe
Reports Coordinator

Amy McWilliams
Supervisor of Editing

Julie Myers
Production Editor II

Lorri Peters
Manager of Publication Services

Kenneth Sherar
Production Editor III

Alyssa Stephens
Graphics Specialist III

Crystal Wolfe
Production Editor III

Jean Wulfson
Graphics Specialist III

Ann Yeager
Distribution Specialist

*At time of publication.

Expedition-related bibliography*

IODP publications

Scientific Prospectus

McKay, R.M., De Santis, L., and Kulhanek, D.K., 2017. *Expedition 374 Scientific Prospectus: Ross Sea West Antarctic Ice Sheet History.* International Ocean Discovery Program. **https://doi.org/10.14379/iodp.sp.374.2017**

McKay, R.M., De Santis, L., and Kulhanek, D.K., 2017. *Expedition 374 Scientific Prospectus Addendum: Ross Sea West Antarctic Ice Sheet History*. International Ocean Discovery Program. **https://doi.org/10.14379/iodp.sp.374add.2017**

Preliminary Report

McKay, R.M., De Santis, L., Kulhanek, D.K., and the Expedition 374 Scientists, 2018. *Expedition 374 Preliminary Report: Ross Sea West Antarctic Ice Sheet History*. International Ocean Discovery Program, 374. **https://doi.org/10.14379/iodp.pr.374.2018**

Proceedings volume

McKay, R.M., De Santis, L., Kulhanek, D.K., and the Expedition 374 Scientists, 2019. *Ross Sea West Antarctic Ice Sheet History*. Proceedings of the International Ocean Discovery Program, 374: College Station, TX (International Ocean Discovery Program). **https://doi.org/10.14379/iodp.proc.374.2019**

Expedition reports

McKay, R.M., De Santis, L., Kulhanek, D.K., Ash, J.L., Beny, F., Browne, I.M., Cortese, G., Cordeiro de Sousa, I.M., Dodd, J.P., Esper, O.M., Gales, J.A., Harwood, D.M., Ishino, S., Keisling, B.A., Kim, S., Kim, S., Laberg, J.S., Leckie, R.M., Müller, J., Patterson, M.O., Romans, B.W., Romero, O.E., Sangiorgi, F., Seki, O., Shevenell, A.E., Singh, S.M., Sugisaki, S.T., van de Flierdt, T., van Peer, T.E., Xiao, W., and Xiong, Z., 2019. Expedition 374 summary. *In* McKay, R.M., De Santis, L., Kulhanek, D.K., and the Expedition 374 Scientists, *Ross Sea West Antarctic Ice Sheet History.* Proceedings of the International Ocean Discovery Program, 374: College Station, TX (International Ocean Discovery Program). **https://doi.org/10.14379/iodp.proc.374.101.2019**

McKay, R.M., De Santis, L., Kulhanek, D.K., Ash, J.L., Beny, F., Browne, I.M., Cortese, G., Cordeiro de Sousa, I.M., Dodd, J.P., Esper, O.M., Gales, J.A., Harwood, D.M., Ishino, S., Keisling, B.A., Kim, S., Kim, S., Laberg, J.S., Leckie, R.M., Müller, J., Patterson, M.O., Romans, B.W., Romero, O.E., Sangiorgi, F., Seki, O., Shevenell, A.E., Singh, S.M., Sugisaki, S.T., van de Flierdt, T., van Peer, T.E., Xiao, W., and Xiong, Z., 2019. Expedition 374 methods. *In* McKay, R.M., De Santis, L., Kulhanek, D.K., and the Expedition 374 Scientists, *Ross Sea West Antarctic Ice Sheet History.* Proceedings of the International Ocean Discovery Program, 374: College Station, TX (International Ocean Discovery Program). **https://doi.org/10.14379/iodp.proc.374.102.2019**

McKay, R.M., De Santis, L., Kulhanek, D.K., Ash, J.L., Beny, F., Browne, I.M., Cortese, G., Cordeiro de Sousa, I.M., Dodd, J.P., Esper, O.M., Gales, J.A., Harwood, D.M., Ishino, S., Keisling, B.A., Kim, S., Kim, S., Laberg, J.S., Leckie, R.M., Müller, J., Patterson, M.O., Romans, B.W., Romero, O.E., Sangiorgi, F., Seki, O., Shevenell, A.E., Singh, S.M., Sugisaki, S.T., van de Flierdt, T., van Peer, T.E., Xiao, W., and Xiong, Z., 2019. Site U1521. *In* McKay, R.M., De Santis, L., Kulhanek, D.K., and the Expedition 374 Scientists, *Ross Sea West Antarctic Ice Sheet History.* Proceedings of the International Ocean Discovery Program, 374: College Station, TX (International Ocean Discovery Program). **https://doi.org/10.14379/iodp.proc.374.103.2019**

McKay, R.M., De Santis, L., Kulhanek, D.K., Ash, J.L., Beny, F., Browne, I.M., Cortese, G., Cordeiro de Sousa, I.M., Dodd, J.P., Esper, O.M., Gales, J.A., Harwood, D.M., Ishino, S., Keisling, B.A., Kim, S., Kim, S., Laberg, J.S., Leckie, R.M., Müller, J., Patterson, M.O., Romans, B.W., Romero, O.E., Sangiorgi, F., Seki, O., Shevenell, A.E., Singh, S.M., Sugisaki, S.T., van de Flierdt, T., van Peer, T.E., Xiao, W., and Xiong, Z., 2019. Site U1522. *In* McKay, R.M., De Santis, L., Kulhanek, D.K., and the Expedition 374 Scientists, *Ross Sea West Antarctic Ice Sheet History.* Proceedings of the International Ocean Discovery Program, 374: College Station, TX (International Ocean Discovery Program). **https://doi.org/10.14379/iodp.proc.374.104.2019**

McKay, R.M., De Santis, L., Kulhanek, D.K., Ash, J.L., Beny, F., Browne, I.M., Cortese, G., Cordeiro de Sousa, I.M., Dodd, J.P., Esper, O.M., Gales, J.A., Harwood, D.M., Ishino, S., Keisling, B.A., Kim, S., Kim, S., Laberg, J.S., Leckie, R.M., Müller, J., Patterson, M.O., Romans, B.W., Romero, O.E., Sangiorgi, F., Seki, O., Shevenell, A.E., Singh, S.M., Sugisaki, S.T., van de Flierdt, T., van Peer, T.E., Xiao, W., and Xiong, Z., 2019. Site U1523. *In* McKay, R.M., De Santis, L., Kulhanek, D.K., and the Expedition 374 Scientists, *Ross Sea West Antarctic Ice Sheet History.* Proceedings of the International Ocean Discovery Program, 374: College Station, TX (International Ocean Discovery Program). **https://doi.org/10.14379/iodp.proc.374.105.2019**

McKay, R.M., De Santis, L., Kulhanek, D.K., Ash, J.L., Beny, F., Browne, I.M., Cortese, G., Cordeiro de Sousa, I.M., Dodd, J.P., Esper, O.M., Gales, J.A., Harwood, D.M., Ishino, S., Keisling, B.A., Kim, S., Kim, S., Laberg, J.S., Leckie, R.M., Müller, J., Patterson, M.O., Romans, B.W., Romero, O.E., Sangiorgi, F., Seki, O., Shevenell, A.E., Singh, S.M., Sugisaki, S.T., van de Flierdt, T., van Peer, T.E., Xiao, W., and Xiong, Z., 2019. Site U1524. *In* McKay, R.M., De Santis, L., Kulhanek, D.K., and the Expedition 374 Scientists, *Ross Sea West Antarctic Ice Sheet History.* Proceedings of the International Ocean Discovery Program, 374: College Station, TX (International Ocean Discovery Program). **https://doi.org/10.14379/iodp.proc.374.106.2019**

McKay, R.M., De Santis, L., Kulhanek, D.K., Ash, J.L., Beny, F., Browne, I.M., Cortese, G., Cordeiro de Sousa, I.M., Dodd, J.P., Esper, O.M., Gales, J.A., Harwood, D.M., Ishino, S., Keisling, B.A., Kim, S., Kim, S., Laberg, J.S., Leckie, R.M., Müller, J., Patterson, M.O., Romans, B.W., Romero, O.E., Sangiorgi, F., Seki, O., Shevenell, A.E., Singh, S.M., Sugisaki, S.T., van de Flierdt, T., van Peer, T.E., Xiao, W., and Xiong, Z., 2019. Site U1525. *In* McKay, R.M., De Santis, L., Kulhanek, D.K., and the Expedition 374 Scientists, *Ross Sea West Antarctic Ice Sheet History.* Proceedings of the International Ocean Discovery Program, 374: College Station, TX (International Ocean Discovery Program). **https://doi.org/10.14379/iodp.proc.374.107.2019**

Supplementary material

McKay, R.M., De Santis, L., Kulhanek, D.K., and the Expedition 374 Scientists, 2019. Supplementary material, **https://doi.org/10.14379/iodp.proc.374supp.2019**. *Supplement to* McKay, R.M., De Santis, L., Kulhanek, D.K., and the Expedition 374 Scientists, *Ross Sea West Antarctic Ice Sheet History*. Proceedings of the International Ocean Discovery Program, 374: College Station, TX (International Ocean Discovery Program). https://doi.org/10.14379/iodp.proc.374.2019

*The Expedition-related bibliography is continually updated online (**http://publications.iodp.org/proceedings/374/374title.html#bib**). Please send updates to **PubCrd@iodp.tamu.edu**.