

---

# THE PALEONTOLOGICAL SOCIETY PAPERS

---

Volume 12

October 2006

---



## **GEOCHRONOLOGY: EMERGING OPPORTUNITIES**

Thomas D. Olszewski, Editor

---

Series Editor: Susan H. Butts  
A Publication of the Paleontological Society  
ISSN 1089-3326

---

# THE PALEONTOLOGICAL SOCIETY PAPERS

---

Volume 12

October 2006

---



## **GEOCHRONOLOGY: Emerging Opportunities**

Thomas D. Olszewski, Editor

---

Series Editor: Susan H. Butts  
A Publication of the Paleontological Society  
ISSN 1089-3326

# **GEOCHRONOLOGY: Emerging Opportunities**

Presented as a Paleontological Society Short Course  
at the  
Annual Meeting of the Geological Society of America  
Philadelphia, Pennsylvania

October 21, 2006

*Convened by*

Thomas D. Olszewski  
Texas A&M University

Warren D. Huff  
University of Cincinnati

# **The Paleontological Society Special Publication**

A Publication of the Paleontological Society

*Series Editor*

Susan H. Butts  
Division of Invertebrate Paleontology  
Peabody Museum of Natural History  
Yale University  
170 Whitney Avenue  
New Haven, CT 06520-8118  
<susan.butts@yale.edu>

Copyright © by the Paleontological Society

ISSN 1089-3326

All rights reserved. This entire publication may not be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without permission in written form from the Secretary of the Society. Diagrams, figures, tables, illustrations, and graphs may be reproduced by photocopying and distributing free of charge for educational purposes, if proper credit is given to the author(s) and the Society.

Printed by Yale University Reprographics & Imaging Services, New Haven, Connecticut.

**OFFICERS OF THE PALEONTOLOGICAL SOCIETY  
2006**

*President*

David J. Bottjer, Los Angeles, CA

*President-Elect*

Derek E. G. Briggs, New Haven, CT

*Past-President*

William I. Ausich, Columbus, OH

*Secretary*

Roger D. K. Thomas, Lancaster, PA

*Treasurer*

Mark E. Patzkowsky, University Park, PA

*Program Coordinator*

Mark A. Wilson, Wooster, OH

*JP Editors*

Jonathan M. Adrain, Iowa City, IA  
Christopher A. Brochu, Iowa City, IA  
Ann F. Budd, Iowa City, IA

*Paleobiology Co-Editors*

Tomasz K. Baumiller, Ann Arbor, MI  
Robyn J. Burnham, Ann Arbor, MI  
Philip D. Gingerich, Ann Arbor, MI

*Editor Special Publications*

Susan H. Butts, New Haven, CT

*Education Coordinator*

Michael A. Gibson, Martin, TN

*Councilors*

Jennifer C. McElwain, Chicago, IL  
Anne L. Raymond, College Station, TX

*Student Representative*

Jocelyn Sessa, University Park, PA

*Section Chairs*

Cordilleran: Robert B. Blodgett, Anchorage, AK

North-Central: Lisa E. Park, Akron, OH

Northeastern: Lisa Amati, Potsdam, NY

Rocky Mountain: Forrest J. Gahn, Washington,  
DC

Southeastern: Colin D. Sumrall, Knoxville, TN

South-Central: Elizabeth A. Heise, Brownsville,  
TX

## AUTHORS

SAMUEL A. BOWRING  
Department of Earth, Atmospheric and Planetary  
Sciences  
Massachusetts Institute of Technology  
Cambridge, Massachusetts 02139  
sbowring@mit.edu

JENNIFER M. COLE  
Lamont-Doherty Earth Observatory of Columbia  
University  
P.O. Box 1000  
Palisades, NY 10964-8000  
jcole@ldeo.columbia.edu

DANIEL J. CONDON  
NERC Isotope Geoscience Laboratory  
Keyworth, Nottinghamshire  
NG12 5GG, UK  
dcondon@bgs.ac.uk

JAMES L. CROWLEY  
Department of Earth, Atmospheric and Planetary  
Sciences  
Massachusetts Institute of Technology  
Cambridge, Massachusetts 02139  
jlcrowle@mit.edu

DOUGLAS H. ERWIN  
Department of Paleobiology, MRC-121  
Smithsonian Institution  
PO Box 37012  
Washington, D. C. 20013-7012  
erwind@si.edu

GEORGE GEHRELS  
Department of Geosciences  
University of Arizona  
Tucson, AZ 85721  
ggehrels@geo.arizona.edu

FELIX M. GRADSTEIN  
Geology Museum  
University of Oslo  
POB 1172 Blindern  
N-0318 Oslo Norway  
felix.gradstein@nhm.uio.no

BRENT V. MILLER  
Texas A&M University  
Dept. Geology & Geophysics  
MS 3115, Halbouty Geosciences Building  
College Station, TX 77843-3115  
bvmler@geo.tamu.edu

HEIKO PÄLIKE  
School of Ocean & Earth Science  
University of Southampton  
National Oceanography Centre  
Southampton, European Way  
Southampton SO14 3ZH, UK  
heiko@noc.soton.ac.uk

ALEX PULLEN  
Department of Geosciences  
University of Arizona  
Tucson, AZ 85721  
apullen@email.arizona.edu

JAHANDAR RAMEZANI  
Department of Earth, Atmospheric and Planetary  
Sciences  
Massachusetts Institute of Technology  
Cambridge, Massachusetts 02139  
ramezani@mit.edu

E. TROY RASBURY  
Department of Geosciences  
SUNY Stony Brook  
Stony Brook, NY 11794-2100  
erasbury@notes.cc.sunysb.edu

## AUTHORS

PAUL R. RENNE  
Berkeley Geochronology Center  
2455 Ridge Rd.  
Berkeley, CA 94709  
prenne@bgc.org

PETER M. SADLER  
Department of Earth Science  
University of California  
Riverside, California 92521 USA  
peter.sadler@ucr.edu

BLAIR SCHOENE  
Department of Earth, Atmospheric and Planetary  
Sciences  
Massachusetts Institute of Technology  
Cambridge, Massachusetts 02139  
schoene@mit.edu

VICTOR VALENCIA  
Department of Geosciences  
University of Arizona  
Tucson, AZ 85721  
victorv@email.arizona.edu

# **GEOCHRONOLOGY: Emerging Opportunities**

Thomas D. Olszewski, Editor

## **Contents**

Introduction to Radiometric Dating .....	1
<i>Brent V. Miller</i>	
High-Precision U-Pb Zircon Geochronology and the Stratigraphic Record: .....	25
Progress and Promise	
<i>Samuel A. Bowring, Blair Schoene, James L. Crowley, Jahandar Ramezani, and Daniel J. Condon</i>	
Progress and Challenges in K-Ar and $^{40}\text{Ar}/^{39}\text{Ar}$ Geochronology .....	47
<i>Paul R. Renne</i>	
Detrital Zircon Geochronology by Laser-Ablation Multicollector ICPMS.....	67
at the Arizona LaserChron Center	
<i>George Gehrels, Victor Valencia, and Alex Pullen</i>	
Directly Dating Sedimentary Rocks .....	77
<i>E. Troy Rasbury and Jennifer M. Cole</i>	
The Geological Time Scale.....	107
<i>Felix M. Gradstein</i>	
Incorporation of Geologic Cycles in Establishing Geologic Timescales: Exercise Notes .....	125
<i>Heiko Pälike</i>	
Composite Time Lines: A Means to Leverage Resolving Power from Radioisotopic .....	145
Dates and Biostratigraphy	
<i>Peter M. Sadler</i>	
Opportunities and Challenges of a Highly Resolved Geological Timescale .....	171
<i>Douglas H. Erwin</i>	