

Early Cenozoic Climate and Carbon Cycling: The Sedimentary Record of Global Warming and Massive Carbon Input

Gerald Dickens
AAPG Distinguished Lecturer
Rice University, Houston, Texas

Funded by the AAPG Foundation

Note: AGS meetings will be at the BP Energy Center for 2008-2009.
Please check the website (www.alaskageology.org) and issues of the AGS newsletter for updates.
This newsletter promotes the February luncheon talk of the Alaska Geological Society,
to be held Thursday, Feb. 19th at the BP Energy Center.

The “Greenhouse Earth” of the late Paleocene and early Eocene was generally characterized by warm temperatures and elevated pCO₂. Climate and carbon cycling were, however, far from equable during this interval, as once believed. Surface temperatures slowly warmed by about 5 °C from 59 Ma to the Early Eocene Climatic Optimum centered about 50 Ma. This long-term warming generally coincided with greater inputs of carbon, presumably caused by volcanism. Superimposed on this background change were a series of “hyperthermals”, the most pronounced corresponding to the Paleocene/Eocene Boundary ca. 55 Ma. These were geologically brief (<200 kyr) events that began with rapid warming across the globe and massive input of 13C-depleted carbon. They were also times of extreme variations in ecosystems and the hydrological cycle.

Our current understanding of the late Paleocene and early Eocene allows us to link disparate and unusual observations in strata from across the globe with a holistic perspective. In particular, the start of the PETM (Paleocene Eocene Thermal Maximum?) is clearly identified in scores of sedimentary records by a prominent negative carbon isotope excursion in carbonate, organic carbon, or both. This excursion precisely coincides with profound mammal and plant migrations in the northern hemisphere, a mass extinction of benthic foraminifera, elevated terrigenous discharge to many continental margins, laminated sediment facies on continental slopes, and a carbonate dissolution horizon in the deep-ocean. Similar changes, though of lesser magnitude, appear to mark the other hyperthermals. Although cause and effect relationships during hyperthermals, as well as links between them, remain uncertain, the hyperthermals and their sedimentary expressions are, without doubt, somehow related to extreme global warming and tremendous additions of carbon to the ocean and atmosphere. Speculative links will be discussed.

Alaska Geological Society Luncheon

Date & Time: Thursday, Feb. 19th, 11:30 am – 1:00 pm

Program: Early Cenozoic Climate and Carbon Cycling

Speaker: Gerald Dickens - AAPG Distinguished Lecturer, Rice University, Houston, Texas

Place: BP Energy Center

Reservations: Please make your reservation before noon Tuesday, Feb. 17th, 2009.

Cost: Seminar only, no meal: Free
Reserve a box lunch: \$13
Nonmember: \$15

Reserve a hot lunch: \$20
Nonmember: \$22

No reservation: add \$5 to the above
(on an “as-available” basis only)

E-mail reservations: vp@alaskageology.org
Or phone (907) 230-1672
(Tom Morahan, AGS VP)

For more information: visit the AGS website:

www.alaskageology.org

ABOUT THE AUTHOR

Education:

- 1989 Bachelors, The University of California at Davis
1993 Masters, The University of at Ann Arbor
1996 Ph.D., The University of at Ann Arbor



Michigan

Michigan

Experience:

- 2008-Present: Professor,
Department of Earth Sciences, Rice University
2001-08 Associate Professor, Department of Earth Sciences, Rice University
1997-2001 Lecturer and Senior Lecturer, Department of Earth Sciences, James Cook University (Australia)

Publications and Awards:

- Authored or co-authored over 90 scientific papers
Stuijs, A., Brinkhuis, H., Schouten, S., Bohaty, S.M., John, C.M., Zachos, J.C., Reichert, G.-J., Sinninghe-Damste, J.S., Crouch, E.M. and DICKENS, G.R. (2007). Environmental precursors to rapid light carbon injection at the Palaeocene/Eocene boundary. *Nature*, v. 450, p. 1218-1221
Nicolo, M.J., DICKENS, G.R., Hollis, C.J. and Zachos, J.C. (2007). Multiple early Eocene hyperthermals: Their sedimentary expression on the New Zealand continental margin and in the deep-sea. *Geology*, v. 35, p. 699-702
Snyder, G.T., Hiruta, A., Matsumoto, R., DICKENS, G.R., Tomaru, H., Takeuchi, R., Komatsubara, J., Ishida, Y. and Yu, H. (2007). Pore water profiles and authigenic mineralization in shallow marine sediments above the methane-charged system on Umitaka Spur, Japan Sea. *Deep-Sea Research (II)*, v. 54, p. 1216-1239
Hancock, H.J.L., DICKENS, G.R., Thomas E., and K.L. Blake, K.L., (2007). Reappraisal of early Paleogene CCD curves: foraminiferal assemblages and stable carbon isotopes across the carbonate facies of Perth Abyssal Plain. *International Journal of Earth Sciences*, DOI 10.1007/s00531-006-0144-0.
Bhatnager, G., Chapman, W.G., DICKENS, G.R., Dugan, B. and Hirasaki, G.J. (2007). Generalization of gas hydrate distribution and saturation in marine sediments by scaling of thermodynamic and transport processes. *American Journal of Science*, v. 307, p. 861-900
2006-present Chief editor *Paleoceanography*
2002-03 JOI/USSAC Distinguished Lecturer
- ### Professional Interests:
- Cretaceous and Cenozoic Paleooceanography
The submarine methane cycle
Sedimentary responses to climate and sea-level change

The Alaska Geological Society

LUNCHEON SCHEDULE 2008 - 2009

Updates on the web at:

<http://www.alaskageology.org>

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| September 2008 | Thurs., Sept. 11 th Tom Homza
An Introduction to the Petroleum Geology of Part of the 'Western Beaufort Sea |
| October 2008 | Thursday, Oct. 23 rd Peter Haeussler, USGS, Submarine Slope Failures Near Seward and Valdez, Alaska, During the 1964 Earthquake, and Implications for Local Tsunami Generation |
| November 2008 | Thursday, Nov. 13 th , Kirk Sherwood, MMS, Chukchi Sea, Alaska – Exploration History and Petroleum Potential |
| December 2008 | Thursday, Dec. 11 th , David Houseknecht, USGS, Brookian Sequence, Arctic Alaska |
| January 2009 | Thursday, Jan. 15 th , Tina Neal, USGS / AVO, 2008 Eruption of Okmok Volcano |
| February 2009 | Thursday, Feb. 19 st , Gerald Dickens, AAPG Dist. Lect. / Rice University, Early Cen. Climate and Carbon Cycling: The Sed. Record of Global Warming and Massive Carb. Input |
| March 2009 | Thursday, March 19 th , Trond Torsvik, Centre for Geodynamics, Geol. Surv. of Norway, Large Scale Plate Tectonics in the Circum Arctic from Palaeozoic to Recent |
| April 2009 | Wednesday, April 22 nd , Steve Jones, BP, Liberty Field Development |
| TECH CONFERENCE – April 24 th (Fairbanks)
Keynote – Dr. Gary Fuis, USGS
The Trans-Alaska Crustal Transect and Continental Evolution Involving Subduction Underplating and Synchronous Foreland Thrusting | |
| May 2009 | Thursday, May 21 st , Rocky Reifenhohl, DGGs, and Paul Decker, DOG, Bristol Bay – Alaska Peninsula Region: Overview of Final Report 2004-2007 DNR Geologic and Petroleum Systems Research |

PLEASE NOTE SECOND TALK BY GERALD DICKENS, NEXT PAGE

Second talk by Gerald Dickens, AAPG Distinguished Lecturer:

The Global Carbon Cycle with Seafloor Methane

February 19th, 2009 at 3:30 PM

ConocoPhillips Building, 700 G Street

Room ATO-1 (first floor lecture room through the elevator lobby)

Note: for ease of entry, please pre-register

with Tom Morahan (vp@alaskageology.org or 230-1672, specify afternoon lecture)

Large quantities of methane occur as dissolved gas, gas hydrate and free gas in the pore space of sediment along continental margins. This methane is habitually omitted from discussions of carbon cycling, despite obvious fluxes to and from the ocean. At the most basic level, carbon enters the seafloor methane cycle through the breakdown of solid organic compounds, and leaves as dissolved bicarbonate, solid carbonate or methane.

Organic carbon landing on the seafloor passes through a gauntlet of microbially mediated reactions during burial. In regions with a sufficiently high flux of organic carbon, large quantities reach a methanogenic zone where approximately equal portions of dissolved bicarbonate and methane are produced. The bicarbonate is enriched in ¹³C while the methane is extremely depleted in ¹³C. With continual production of methane, gas concentrations can surpass solubility conditions to precipitate gas hydrate or free gas, depending on local pressure, temperature and salinity conditions. Gas hydrate overlies free gas in many deep ocean settings because of the geotherm. Carbon cycles between dissolved gas, gas hydrate and free gas through several pathways, including burial of all three phases, upward advection of dissolved gas and free gas, diffusion of dissolved gas, dissociation of gas hydrate, and dissolution of gas hydrate. Carbon leaves the seafloor methane cycle as bicarbonate or methane, the latter of which can involve reaction with sulfate in the sediment or venting into the water column. Excess production of bicarbonate, from either methane production or consumption, can lead to formation of authigenic carbonate, which provides another means to remove carbon.

All of the fluxes depend on external conditions such as temperature or seawater chemistry. Given that oceanographic conditions have changed significantly over time, it is speculated that the amount and fluxes of various components of the seafloor methane cycle have also varied through time substantially.

Meeting Information:

These links were all active as of 03/08/08. Please send updates to the editor: Greg Wilson 263-4748, or e-mail to Gregory.c.wilson@conocophillips.com

The **American Geological Institute** provides a comprehensive list of national and international geoscience meetings at: <http://calendar.agiweb.org>

Local Meetings:

American Water Resources Association—Alaska Section

<http://www.awra.org/state/alaska/index.html>

Alaska Geological Society

<http://www.alaskageology.org>

Lunch meetings are held monthly September through May in Anchorage. For more information, contact Jim Clough, 451-5030.

Alaska Miners Association

<http://www.alaskaminers.org/>

The Anchorage branch of the AMA holds weekly meetings at 7 AM every Friday at the Denny's on Northern Lights and Denali. They hold regular luncheon meetings in association with SME. For more information, contact the AMA office at 563-9229.

American Institute of Professional Geologists

<http://www.aipg.org>

AIPG holds regular quarterly evening Section meetings in Anchorage and Fairbanks. For more information contact Mark Lockwood, President, at Shannon & Wilson, Inc., in Fairbanks, 907-460-7239.

Chugach Gem & Mineral Society

<http://www.chugachgms.org>

CG&MS holds all meetings at the First United Methodist Church on 9th Avenue. Contact their hotline at 566-3403 for information on regular monthly business meetings, monthly potlucks, and guidebook sales, including the new Alaska Rockhound Guidebook.

Geophysical Society of Alaska

<http://gsa.seg.org/>

Luncheon meetings are held monthly September through May at the ConocoPhillips Tower. For more information, contact Monte Mabry, 265-1653

Society of Petroleum Engineers

<http://alaska.spe.org/>

For more information, contact Jack Hartz at 375-8239.

UAS Environmental Science Program

<http://www.uas.alaska.edu/envs>

National Association of Geology Teachers (NAGT)

<http://www.nagt>

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A spreadsheet file of wells and curves is available from Daniel E. Shier, dan@rockypine.com, www.rockypine.com

From the President's Desk

Dear AGS Members,

As we head into spring (wishful thinking?) I'd like to bring everyone up to date on a number of ongoing AGS activities. Patrick Druckenmiller has placed an announcement in this news letter for the April 24 Technical Conference in Fairbanks. Stay tuned for more information on that. Following the December membership vote to approve the AGS bylaw changes, Sue Karl has sent our 501c3 non-profit application to the Internal Revenue Service. We are hoping for a fast approval for the change in status. Thanks Sue! Also, in the process of looking at our bylaws, the AGS Board decided that it was time to review the bylaws and see where there might be a need to bring them up to date or make revisions. Sue Karl is the Bylaws committee chair and she has enlisted the help of at least one of the early members to ensure that we don't change the original intent of the AGS founders. We are hoping to have some revisions to present

to the membership at the May meeting. The AGS scholarship committee is taking an in depth look at our scholarship program and will be meeting in early February to brainstorm. They will present their ideas to the board at our February meeting scheduled for the 17th. Our AGS Board meetings are generally held the Tuesday before the monthly luncheon and all are welcome to attend. This year we have been meeting monthly at the Alaska Div. of Oil and Gas conference room on the 8th floor of the Atwood Building, 550 W. 7th, Anchorage, from 11:30 AM to 1:00 PM. I encourage all to volunteer your energy and skills to any and all of the AGS activities. The committee chairs are listed in the newsletter and on the AGS website. If you have an idea, suggest it at any meeting or to a board member. Equally, we welcome your comments. Volunteerism is the backbone of this society.

- *Jim*

**2009 Alaska Geological Society
Technical Conference
April 24, 8:30 AM to 5:00 PM
Fairbanks, Alaska**



Please join us for the Alaska Geological Society's 2009 Technical Conference to be held April 24th in Fairbanks. The event will be held on the campus of the University of Alaska – Fairbanks, with morning presentations at the Reichardt Building and an afternoon poster session hosted next door at the University of Alaska Museum of the North.

The keynote talk, *The Trans-Alaska Crustal Transect and continental evolution involving subduction underplating and synchronous foreland thrusting* will be given by Dr. Gary Fuis, USGS – Menlo Park. The morning session will consist of five talks, followed by a catered lunch. The keynote presentation will be after lunch. The remainder of the afternoon (from 2:00 to 5:00 PM) will be devoted to a poster session, which will highlight graduate student work at UAF and other recent research in Alaska. Please plan to stay for an offsite happy hour to follow the technical session.

Registration Fees:

Alaska Geological Society member- \$20

Non-AGS member- \$25

Student AGS member- Free

Student non-AGS member- \$5

Student AGS membership is \$5, forms will be available on site

If you plan to attend the AGS tech conference please send an email by April 17 to ags.2009@alaska.edu

CALL FOR ABSTRACTS

Deadline for Abstract submission is March 27, 2009, 5:00 PM

Abstracts are restricted to 1 page in length including text and any illustrations. Please include title, authors, affiliations and contact information for the corresponding author. Use 12 point Times Roman font, with standard 1.25" margins left and right, 1" margin top and bottom. More detailed information will be distribute soon. Please submit your abstract in MS Word (.doc) to: ags.2009@alaska.edu

Please contact the organizers with any questions:

Dr. Patrick Druckenmiller, University of Alaska Museum and Department of Geology and Geophysics, University of Alaska - Fairbanks, ffpsd@uaf.edu, (907) 474-6954

Dr. Shirish Patil, Petroleum Engineering, College of Engineering and Mines, University of Alaska– Fairbanks



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The Alaska Geological Society is an organization which seeks to promote interest in and understanding of Geology and the related Earth Sciences, and to provide a common organization for those individuals interested in geology and the related Earth Sciences.

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MEMBERSHIP INFORMATION

AGS annual memberships expire November 1. The annual membership fee is \$15/year. You may download a membership application from the AGS website and return it at a luncheon meeting, or mail it to the address above.

Contact membership coordinator Mark Olson with changes or updates (e-mail: mark.a.olson@conocophillips.com; phone: 907-263-4250)

All AGS publications are now available for on-line purchase on our website. Check to see the complete catalogue.

<http://www.alaskageology.org/publications>

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1mo rate=(9mo rate/9)+\$40 (rounded up).

Contact Tim Ryherd (907) 269-8771 for advertising information.

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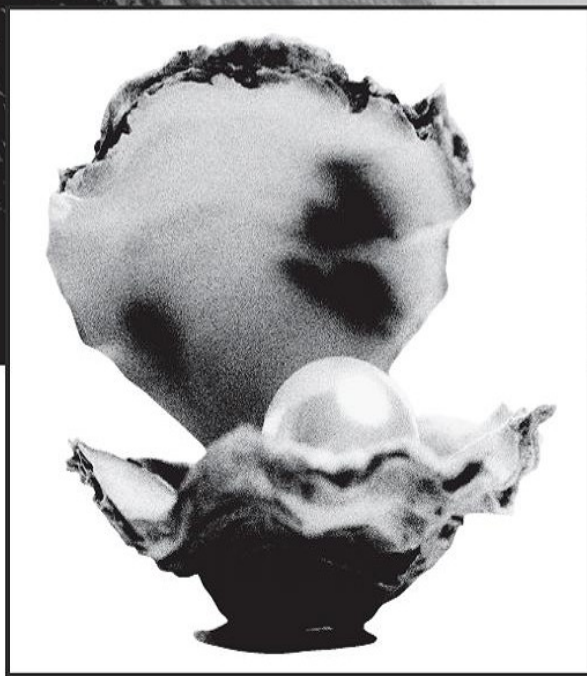
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Note: e-mail addresses now contain "at" instead of "@" Please change to @ when typing.

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