



2005-06 AAPG Distinguished Lecture

Abstract

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Funded by the AAPG Foundation

Overpressure, Hydrocarbon Entrapment, Seafloor Venting, and Slope Stability: The Dynamic Flow Regime Beneath the Seafloor

Sedimentation, overpressure, fluid flow, seafloor venting, and submarine landslides are intimately related. Sandstone buried rapidly by low permeability mudstone has a characteristic pressure regime: the sandstone has a hydrostatic pore pressure gradient whereas the bounding low permeability mudstone can have a lithostatic pressure gradient. This simple behavior drives a myriad of exciting geological processes. In the deepwater Gulf of Mexico, reservoir pore pressures at the crest of the Popeye Genesis minibasin equal the least principal stresses and fluids are venting today. Mud volcanoes, gas hydrates, and biological

communities overlie this leak point. In the Ursa Basin, Pleistocene sedimentation from the ancestral Mississippi River was so rapid that we find overpressure within a few meters of the seafloor. Permeable sand bodies transmitted this pressure laterally and these pressures contributed to large submarine landslides. The coupled study of stratigraphy and hydrodynamics can be used to predict pressure, estimate trap integrity and migration pathways, predict slope failure, and design safe and economic drilling programs.

American Association of Petroleum Geologists

An International Geological Organization

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Peter B. Flemings

Education

- 1984 Dartmouth College, B.A.
Geology
1987 Cornell University, M.S.
Geology
1990 Cornell University, Ph.D.
Geology: minors in structural
mechanics and geodynamics



Appointments

- 2003-present Professor of
Geosciences, The
Pennsylvania State University
2002-2003 Visiting Scientist, M.I.T., Dept. of Civil
and Env. Engineering
1998-present Director of the GeoSystems Initiative, The
Pennsylvania State University
1997-2003 Associate Professor of Geosciences, The
Pennsylvania State University
1994-2000 Adjunct Associate Research Scientist, -
Lamont-Doherty Earth Observatory
1993-1997 Assistant Professor of Geosciences, The
Pennsylvania State University
1993-1997 Shell Young Faculty Fellow, The
Pennsylvania State University
1992-1993 Research Scientist and Crosby Lecturer, -
Massachusetts Institute of Technology
1991-1992 Associate Research Scientist, Lamont-
Doherty Geological Observatory
1991 Visiting Scientist, Exxon Production
Research Company
1990-1991 Post-Doc. Associate, Lamont-Doherty -
Geological Observatory

Professional Interests

Crustal fluid flow at human and geological timescales.
Integration of reflection seismology, petrophysics, and
geotechnical analysis to study stress, pressure and fluid
flow in basins. Interaction between sedimentation,
flow, hydrocarbon migration/entrapment, slope
stability, and seafloor venting.

Relevant Publications

- Dugan, B., Flemings, P.B., 2000, Overpressure and Fluid
Flow in the New Jersey Continental Slope:
Implications for Slope Failure and Cold Seeps,
Science, V. 289, p. 288-291.
Finkbeiner, T., Zoback, M., Stump B.B., Flemings, P.B.,
2001, Stress, Pore Pressure, and Dynamically
Constrained Hydrocarbon Columns in the South
Eugene Island 330 Field, Gulf of Mexico, *American
Association of Petroleum Geologists Bulletin*, V. 85,
no. 6, p. 1007-1031.
Flemings P.B., Stump, B.B., Finkbeiner, T., Zoback, M.,
2002, Overpressure and Flow-Focusing in the Eugene
Island 330 field (Offshore Louisiana, U.S.A.): Theory,

Examples, and Implications, *American Journal of
Science*, V. 302, p. 827-855.

Flemings, P.B., Liu, X., 2003, Critical Overpressure and
Multiphase Flow in Blake Ridge Hydrates, *Geology*,
V. 31, no. 12, p. 1057-1060.

Seldon, B., Flemings, P.B., 2005, Reservoir Pressure and
seafloor venting: Predicting trap integrity in a Gulf of
Mexico deepwater turbidite minibasin, *AAPG
Bulletin*, v. 89, No. 2, pp. 193-209

Trehu, A., Flemings, P.B., et al., 2004, Feeding methane
vents and gas hydrate deposits at south Hydrate Ridge,
Geophysical Research Letters, v. 31, L23310, 4 pages.

Flemings, P.B., Lupa, J., 2004, Pressure prediction in the
Bullwinkle Basin through Petrophysics and Flow
modeling (Green Canyon 65, Gulf of Mexico), *Marine
and Petroleum Geology*, v. 21, p. 1311-1322.

Flemings, P.B., and Grotzinger, J.P., 1996, STRATA:
Freeware for Solving Classic Stratigraphic Problems.
GSA Today, vol. 6, no. 12, p. 1-7.

Burkhart, T.D., Hoover, A.R., Flemings, P.B., 2000,
Time-lapse seismic monitoring of the K8 and K40
reservoirs, South Timbalier block 295, offshore
Louisiana, *Geophysics*, V. 65, no. 2, p. 351-367.

Committees and Activities

Director Penn State GeoFluids Consortium: 10 company
consortium to study fluid flow in basins

Chairperson Integrated Ocean Drilling Program
Engineering Development Panel.

Co-Director the Petroleum GeoSystems Initiative
(<http://hydro.geosc.psu.edu/geosystems.html>), a
cooperative effort between Penn State and industry to
train the next generation of engineers and geoscientists
for leadership in industry.

Participated in 5 Ocean Drilling Program research cruises
Co-Chief Scientist IODP Expedition 308: Gulf of Mexico
Hydrogeology.

Associate Editor, *GeoFluids*, Basin Research

Honors

- 2003 Penn State EMS College Mitchell Award for
Innovation in Teaching
2001 Best Paper Award, Computers and
Geosciences
1994-1997 Shell Faculty Fellow
1996 Penn State EMS College Wilson Teaching
Award
1995 Best Paper, J.C. Cam Sproule Memorial
Award.
1992 Crosby Distinguished Lecturer at M.I.T.
1991 Best Paper Award, Mountain Geologist

Memberships

American Association of Petroleum Geologists
American Geophysical Union
Geological Society of America