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National Energy Technology Laboratory

Methane Hydrate R&D Program

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Table of Contents

Section I: Publications Related to Methane Hydrate Fellowship Program	6
Papers Authored and Presentations Given by NETL Methane Hydrate Fellows	6
Section II: Publications Related to the Program’s Major Field Projects	12
Alaska North Slope Gas Hydrate Reservoir Characterization (DE-FC26-01NT41332)	12
Gulf of Mexico Gas Hydrates Joint Industry Project (DE-FC26-01NT41330)	25
Gas Hydrate Production Trial (DE-NT0006553)	51
Methane Hydrate Production from Alaskan Permafrost (DE-FC26-01NT41331)	55
Advanced Hydrate Reservoir Modeling Using Rock Physics Techniques (DE-FE0010160).....	59
Planning of a Marine Methane Hydrate Pressure Coring Program for the Walker Ridge and Green Canyon Areas of the Gulf of Mexico (DE-FE0010175)	60
Section III: Publications Related to the Program’s Efforts with Universities and Other Research Institutions	62
Gas Hydrate Characterization in the Gulf of Mexico (DE-NT0005668) and Mapping Permafrost and Gas Hydrate using Marine CSEM Methods (DE-FE0010144).....	62
Assessing the Efficacy of the Aerobic Methanotropic Biofilter in Methane Hydrate Environments (DE-NT0005667).....	67
Characterization of Methane Degradation and Methane-Degrading Microbes in Alaska Coastal Waters (DE-NT0005666).....	70
Source Characterization and Temporal Variation of Methane Seepage from Thermokarst Lakes on the Alaskan North Slope in Response to Arctic Climate Change (DE-NT0005665).....	72
Remote Sensing and Sea-Truth Measurements of Methane Flux to the Atmosphere (HYFLUX project) (DE-NT0005638)	77
Integrating Natural Gas Hydrates in the Global Carbon Cycle (DE-NT0006558)	80
Global Assessment of Methane Gas Hydrates (DE-FE0003060).....	81
Mechanisms Leading to Co-existence of Gas and Hydrate in Ocean Sediments (DE-FC26-06NT43067)	83
Detection and Production of Methane Hydrates (DE-FC26-06NT42960).....	88
Electrical Resistivity Investigation of Gas Hydrate Distribution in Mississippi Canyon Block 118, Gulf of Mexico (DE-FC26-06NT42959).....	95
Gulf of Mexico Sea Floor Stability and Gas Hydrates Monitoring Project (DE-FC26 -00NT40920, DE-FC26-02NT41628, DE-FC26 -06NT42877) and Temporal Characterization of Hydrates System Dynamics beneath Seafloor Mounds: Integrating Time-Lapse Electrical Resistivity Methods and in situ Observations of Multiple Oceanographic Parameters (DE-FE0010141).....	97

Heat Flow and Gas Hydrates on the Continental Margin of India (DE-NT0005669)	127
Methane Recovery from Hydrate-bearing Sediments (DE-FC26-06NT42963) and Hydrate-Bearing Clayey Sediments: Morphology, Physical Properties, Production and Engineering/Geological Implications (DE-FE0009897)	128
Characterizing Marine Gas Hydrate Reservoirs Using 3D Seismic Data and 4C OBS Data (DE-FC26-00NT41024) and (DE-FC26-06NT42667)	133
Sampling and Monitoring Hydrate Mounds in the Gulf of Mexico (DE-AF26-01NT00394).....	137
Investigation of 3D Structure and Physical Properties of Methane Hydrate Deposits at Blake Ridge (DE-FC26-00NT40921)	139
Rock-Physics Modeling of Hydrate-Bearing Sediments (DE-FC26-05NT42663)	140
Investigation of Natural Gas Species Flows from Hydrate Dissociation (DE-FC26-00NT40916)	141
Investigations into the Geomechanical Performance of Hydrate-Bearing Sediments in Offshore Environments (DE-FC26-05NT42664)	142
Investigation of Gas Hydrate Instability in the Southeastern Bering Sea (DE-FC26-05NT42665)	142
Evaluating the Controls on Gas Hydrate Formation and Dissociation in the Gulf of Mexico (DE-FC26-02NT41328).....	143
In Situ Sampling and Characterization of Naturally Occurring Methane Hydrate During IODP legs 204 and 311 (DE-FC26-01NT41329).....	145
Comparative Assessment of Advanced Gas Hydrate Production Methods (DE-FC26-06NT42666)....	152
Seismic Gas Hydrate Quantification by Cumulative Attributes (DE-FC26-06NT42961)	154
Petrophysical Characterization and Reservoir Simulator for Methane Gas Production from Gulf of Mexico Hydrates (DE-FC26-02NT41327)	154
Gas Hydrates Research Database and Web Dissemination Channel (DE-AI26-06NT42938).....	154
Characterization and Qualification of the Methane Hydrate Resource Potential Associated with the Barrow Gas Fields (DE-FC26-06NT42962).....	155
Structural and Stratigraphic Controls on Methane Hydrate Occurrence and Distribution: Gulf of Mexico, Walker Ridge 313 and Green Canyon 955 (DE-FE0009904).....	155
Development of a Scientific Plan for a Hydrate-Focused Marine Drilling, Logging and Coring Program (DE-FE0010195)	156
A New Approach to Understanding the Occurrence and Volume of Natural Gas Hydrate in the Northern Gulf of Mexico Using Petroleum Industry Well Logs (DE-FE0009949)	157
Gas Hydrate Dynamics on the Alaskan Beaufort Continental Slope: Modeling and Field Characterization (DE-FE0010180).....	160

Application of Crunch-Flow Routines to Constrain Present and Past Carbon Fluxes at Gas-Hydrate Bearing Sites (DE-FE0010496) and Assessing the Response of Methane Hydrates to Environmental Change at the Svalbard Continental Margin (DE-FE0013531)	162
Verification of Capillary Pressure Functions and Relative Permeability Equations for Gas Production (DE-FE0009927)	164
Measurement and Interpretation of Seismic Velocities and Attenuations in Hydrate-Bearing Sediments (DE-FE0009963).....	166
THCM Coupled Model for Hydrate-Bearing Sediments: Data Analysis and Design of New Field Experiments (Marine and Permafrost Settings) (DE-FE0013889).....	167
Controls on Methane Expulsion During Melting of Natural Gas Hydrate Systems (DE-FE0010406)....	171
Fate of Methane Emitted From Dissociating Marine Hydrates: Modeling, Laboratory, and Field Constraints (DE-FE0013999)	171
Hydrate Evolution in Response to Ongoing Environmental Shifts (DE-FE0013565).....	173
Deepwater Methane Hydrate Characterization and Scientific Assessment (DE-FE0023919).....	173
Mechanisms for Methane Transport and Hydrate Accumulation in Coarse-Grained Reservoirs (DE-FE0013919)	180
Characterizing the Response of the Cascadia Margin gas Hydrate Reservoir to Bottom Water Warming Along the Upper Continental Slope (DE-FE0013998)	187
<i>Borehole Tool for the Comprehensive Characterization of Hydrate-Bearing Sediments (DE-FE0013961)</i>	189
<i>Impact of Clays on the Compressibility and Permeability of Sands During Methane Extraction from Gas Hydrate (DE-FE0028966)</i>	190
<i>A Multi-scale Experimental Investigation of Flow Properties in Coarse-grained Hydrate Reservoirs during Production (DE-FE0028967)</i>	192
<i>Characterizing Ocean Acidification and Atmospheric Emission Caused by Methane Released from Gas Hydrate Systems along the US Atlantic Margin (DE-FE0028980)</i>	194
<i>Advanced Simulation and Experiments of Strongly Coupled Geomechanics and Flow for Gas Hydrate Deposits: Validation and Field Application (DE-FE0028973)</i>	195
Section IV: Publications Resulting from Work with the Dept. of Energy’s National Labs	196
Brookhaven National Laboratory.....	196
Pacific Northwest National Laboratory.....	199
Los Alamos National Laboratory.....	206
Lawrence Berkeley National Laboratory.....	207
<i>Lawrence Livermore National Laboratory</i>	228
<i>Oak Ridge National Laboratory</i>	231

<i>Idaho National Laboratory</i>	236
<i>National Energy Technology Laboratory</i>	239
Section V: Publications Resulting from Interagency Agreements	251
<i>Department of Defense, Office of Naval Research, Naval Research Lab</i>	251
<i>The United States Geological Survey (DE-FE0002911/ DE-AI26-05NT42496/ DE-AT26-97FT34343/ DE-FE0022898, DE-FE0023495)</i>	259
Section VI: Programmatic Reports	313

Section I: Publications Related to Methane Hydrate Fellowship Program

Papers Authored and Presentations Given by NETL Methane Hydrate Fellows

Papers Authored

- Brothers, L. L., Kelley, J. T., Belknap, D. F., Koons, P. O., Barnhardt, W. A., (2011). "Pockmarks: Self-scouring seep features?" *Proc. of the 7th International Conference on Gas Hydrates (ICGH 2011). Edinburgh, Scotland, United Kingdom, July, 17-21, (2011).* Paper 326.
- Brothers, L., Hart, P. E., and Ruppel, C. R., (2012). "Minimum distribution of subsea ice-bearing permafrost on the U. S. Beaufort Sea continental shelf." *Geophysical Research Letters*, vol. 39, L15501, doi:10.1029/2012GL052222.
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- Cook, A. and Goldberg, D., (2009). "Two Kinds of Gas Hydrate Reservoirs: Pore-filling Sand vs. Fractured Clay," *Eos Trans. AGU* 90(52), Fall Meet. Suppl. Abstract OS31A-1174.
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- Solomon, E. A., Spivack, A. J., Kastner, M., Torres, M., Borole, D. V., Robertson, G., Das, H. C., (2008). Hydrogeochemical and Structural Controls on Heterogeneous Gas Hydrate Distribution in the K-G Basin Offshore SE India. Proceedings of the 6th International Conference on Gas Hydrates (ICGH 2008), Vancouver, B. C., July 6-10, (2008).
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- Wagner, K. S., McEntee, M. H., Brothers, L. L., German, C. R., Kaiser, C. L., Yoerger, D. R., and Van Dover, C. L., (2013). Cold-seep habitat mapping, High-resolution spatial characterization of the Blake Ridge Diapir seep field. *Deep Sea Research II: Topical Studies in Oceanography*, v. 92, pp. 183-188, August, (2013).
<http://dx.doi.org/10.1016/j.dsr2.2013.02.008>
- Wilson, R. M., Macelloni, L., Simonetti, A., Lapham, L., Lutken, C., Sleeper, K., D'Emidio, M., Pizzi, M., Knapp, J., and Chanton, J., (2014). Subsurface methane sources and migration pathways within a gas hydrate mound system, Gulf of Mexico, *Geochemistry, Geophysics, Geosystems*, v. 15, pp. 89-107, January, (2014).

Presentations

- Brothers, L. L., Hart, P. E., Ruppel, C., (2011). Subsea permafrost mapped across the US Beaufort Sea using multichannel seismic data, AGU Fall Meeting 2011
- Brothers, L. L., Van Dover, C. L., German, C. R., Kaiser, C. L., Yoerger, D. R., Ruppel, C. D., Lobecker, E., Skarke, A. R., Wagner, K. S., (2012). Evidence for extensive methane venting on the southeastern U. S. Atlantic margin., AGU Fall Meeting 2012
- Brothers, L. L., Hart, P. E., and Ruppel, C., (2013). Subsea permafrost on the US Beaufort Sea Margin, Permafrost & Gas Hydrates Workshop, Helsinki Finland, (2013).
- D'Emidio, M, M Ingrassia, CB Lutken, L Macelloni, A Simonetti, M Pizzi, LL Lapham, R Wilson, P Hsing, and C Fisher, (2012). Biogeophysical classification of seafloor seeps at a carbonate-hydrate mound, Northern Gulf of Mexico. Poster. The Gordon Research Conference on Natural Gas Hydrate Systems, Ventura, California. March 18th-23rd
- Pohlman, J. W., Kessler, J. K., Maue, C., Ruppel, C. D., Brothers, L. L., Yvon Lewis, S. A., Sparrow, K., Bergeron, E., Worley, C., (2012). Methane fluxes to the atmosphere in an area of possibly dissociating gas hydrate in the shallow Alaskan Beaufort Sea, *Eos Trans. AGU* 87(36), Ocean Sciences Meet. Supplement, Abstract OS35E 02
- Ruppel, C., Brothers, L. L., Hart, P. E., Worley, C., (2011). The distribution of subsea permafrost and shallow methane on the central U. S. Beaufort Inner Shelf from newly acquired geophysical data, AGU Fall Meeting
- Ruppel, C., Brothers, L., Hart, P., Pohlman, J., (2012). Warming driven dissociation of gas hydrates on the continental shelf and upper continental slope of the US Beaufort Sea, for Arctic Frontiers, Tromso, Jan 2012.
- Wilson, R. M., Lapham, L. L., and Chanton, J. P., (2012). Chemical and physical controls on hydrate stability probed with field and laboratory experiments. Presented at the American Geophysical Union Fall Meeting, Dec. 3-7, San Francisco, CA.

- Wilson, RM, LL Lapham, B Anderson, N Garapati, and J Chanton, (2012). Laboratory experiments probe hydrate dissolution rates. Poster. The Gordon Research Conference on Natural Gas Hydrate Systems, Ventura, California. March 18th-23rd
- Wilson, RM, LL Lapham, CS Martens, JP Chanton, H Mendlovitz, K Sleeper, and M Riedel, (2012). Time-series methane monitoring in gassy sediments and the benthic boundary layer. Ocean Sciences Meeting, Salt Lake City, Utah. February 20th-24th
- Wilson, R. M., Lapham, L. L., and Chanton, J. P., (2013). Integrating seismic data and geochemical profiles to identify methane provenance, cycling, and migration pathways. Presented at American Chemical Society National Meeting, Apr. 8-12, New Orleans, LA.

Section II: Publications Related to the Program's Major Field Projects

With private companies, state and local governments, universities, and research institutions

Alaska North Slope Gas Hydrate Reservoir Characterization (DE-FC26-01NT41332)

BP Exploration Alaska, Inc.

Peer-Reviewed Publications

- Anderson, B., Hancock, S., Wilson, S., Enger, C., Collett, T., Boswell, R., Hunter, R., (2010). "Formation pressure testing at the Mount Elbert Gas Hydrate Stratigraphic Test Well, Alaska North Slope: Operational summary, history matching, and interpretations," *Marine and Petroleum Geology, Vol. 28, Iss. 2, Thematic Set on Scientific results of the Mount Elbert Gas Hydrate Stratigraphic Test Well, Alaska North Slope*, pp. 478-492, ISSN 0264-8172, doi: 10.1016/j.marpetgeo.2010.02.012.
- Anderson, B. J., Kurhiara, M., Wilson, S. J., Pooladi-Darvish, M., White, M., Moridis, G., Gaddipati, M., Masuda, Y., Collett, T. S., Hunter, R. B., Narita, H., Rose, K., Boswell, R., (2010). "Regional long-term production modeling from a single well test, Mount Elbert Gas Hydrate Stratigraphic Test Well, Alaska North Slope," *Marine and Petroleum Geology, Vol. 28, Iss. 2, Thematic Set on Scientific results of the Mount Elbert Gas Hydrate Stratigraphic Test Well, Alaska North Slope*, pp. 493-501, ISSN 0264-8172, doi: 10.1016/j.marpetgeo.2010.01.015.
- Boswell, R., Collett, T. S., Hunter, R. B., and Anderson, B. J., Editors, (2010). Scientific Results of 2007 USDOE-BP-USGS "Mount Elbert Gas Hydrate Stratigraphic Test Well, Milne Point, Alaska North Slope," *Journal of Marine and Petroleum Geology Special Thematic Volume*.
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Planning of a Marine Methane Hydrate Pressure Coring Program for the Walker Ridge and Green Canyon Areas of the Gulf of Mexico (DE-FE0010175)

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Section III: Publications Related to the Program's Efforts with Universities and Other Research Institutions

Gas Hydrate Characterization in the Gulf of Mexico (DE-NT0005668) and Mapping Permafrost and Gas Hydrate using Marine CSEM Methods (DE-FE0010144)

Scripps Institution of Oceanography, University of California – San Diego

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Assessing the Efficacy of the Aerobic Methanotropic Biofilter in Methane Hydrate Environments (DE-NT0005667)

University of California – Santa Barbara

Peer-Reviewed Publications

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University of Delaware

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Remote Sensing and Sea-Truth Measurements of Methane Flux to the Atmosphere (HYFLUX project) (DE-NT0005638)

Texas A&M University - Corpus Christi

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Rock Solid Images

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Oklahoma State University

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A New Approach to Understanding the Occurrence and Volume of Natural Gas Hydrate in the Northern Gulf of Mexico Using Petroleum Industry Well Logs (DE-FE0009949)

Ohio State University

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Gas Hydrate Dynamics on the Alaskan Beaufort Continental Slope: Modeling and Field Characterization (DE-FE0010180)

Southern Methodist University, Oregon State University, U. S. Geological Survey

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- Hornbach, M. J., (2016). "Methane Hydrates and Slope Failure on the U. S. East Coast: After 40 Years, What Have We Learned and What's Next?" *Gordon Research Conference*, Galveston, TX, March 29th.
- Hornbach, M. J., Phrampus, B. J., Ruppel, C. D., and Hart, P. E., (2012). "The role of ocean circulation on methane hydrate stability and margin evolution," *American Geophysical Union Fall Meeting*, San Francisco, CA, Dec. 3-7.
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- Ruppel, C. D., Hart, P. E., Moore, E., Worley, C., and Brothers, L., (2012). "Mapping subsea permafrost, relict methane hydrate, and gas migration: New cross-shelf multichannel seismic surveys on the central US Beaufort Shelf," *The American Geophysical Union Fall Meeting*, San Francisco, CA, Dec. 3-7.
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Application of Crunch-Flow Routines to Constrain Present and Past Carbon Fluxes at Gas-Hydrate Bearing Sites (DE-FE0010496) and Assessing the Response of Methane Hydrates to Environmental Change at the Svalbard Continental Margin (DE-FE0013531)

Oregon State University

Peer-Reviewed Publications

- Hong, W. L., Torres, M. E., Kim, J.-H., Choi, J., and Bahk, J.-J., (2013). "Carbon cycling within the sulfate-methane-transition-zone in marine sediments from the Ulleung Basin," *Biogeochemistry*, pp. 1-20.
- Hong, W. L., Torres, M. E., Kim, J.-H., Choi, J., and Bahk, J.-J., (2014). "Towards quantifying the reaction network around sulfate-methane-1 transition-zone in the Ulleung Basin, East Sea, with a kinetic modeling approach," *Geochimica Cosmochimica Acta*, v. 140, pp. 127-141.
- Hong, W. L., Torres, M. E., Johnson, J., Verba, C., and Phillips, S., (2015). "Source and diagenetic impact of methane at southern Hydrate Ridge over the past 120 ky," *Earth and Planetary Science Letters*.

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- Torres, M., (2016). "Assessing the response of methane hydrates to environmental change at the Svalbard continental margin," *DOE Award No.: DE-FE0013531, Quarterly Progress Report (Jan-March, 2016)*, April 2016.
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- Torres, M., (2013). "Application of Crunch-Flow Routines to Constrain Present and Past Carbon Fluxes at Gas-Hydrate Bearing Sites," *DOE Award No.: DE-FE0010496, Quarterly Progress Report (October-December, 2012)*, February 2013.
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Verification of Capillary Pressure Functions and Relative Permeability Equations for Gas Production (DE-FE0009927)

Wayne State University

Peer Reviewed Publications

- Mahabadi, N., Zheng, X., and Jang, J. (2016). "The effect of hydrate saturation on water retention curves in hydrate-bearing sediments," *Geophysical Research Letters*, 43, doi: 10.1002/2016GL068656.
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- Mahabadi, N., Zheng, X. and Jang, J. (2016). "Water retention curve in THF hydrate-bearing sediments," *Gordon Research Conference – Natural Gas Hydrate Systems*, Galveston, TX, Feb. 28-Mar. 4.
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- Mahabadi, N., Dai, S., Seol, Y. and Jang, J. (2014). "Water Retention Curve and Relative Permeability for Gas Production from Hydrate-Bearing Sediments," *American Geophysical Union meeting*, San Francisco, CA, Dec. 15-19.

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Measurement and Interpretation of Seismic Velocities and Attenuations in Hydrate-Bearing Sediments (DE-FE0009963)

Colorado School of Mines, Geophysics Department

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Pohl, Mathias, Rydzy, Marisa, and Batzle, Mike, Colorado School of Mines, (2013). "Investigating the Influence of Clay Content on Ultrasonic Velocities in THF-bearing sediments" *The 2nd International Workshop on Rock Physics*, South Hampton, UK.

Rydzy, M, Batzle, M., Hester, K., Howard, J., and Stevens, J., (2013). "Effect of initial water saturation on the elastic properties of hydrate-bearing sediment," *The Unconventional Resources Technology Conference*, Denver, CO, Aug. 12-14.

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THCM Coupled Model for Hydrate-Bearing Sediments: Data Analysis and Design of New Field Experiments (Marine and Permafrost Settings) (DE-FE0013889)

Texas A&M University

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- McCartney, J., Sánchez, M., and Tomac, I., (2016). "Energy Geotechnics: Advances in Subsurface Energy Recovery, Storage, Exchange, and Waste Management." *Computers and Geotechnics*, v. 75, pp. 244–256, May 2016. doi:10.1016/j.compgeo.2016.01.002.
- Sánchez, M., Flacao, F., Mack, M., Pereira, J-M., Narsilio, G., and Guimaraes, L., 2016. "Salient Comments and Discussions from a Geo-Energy Panel." *Environmental Geotechnics*. doi: 10.1680/jenge.16.00008.
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- Sánchez, M. and Gai, X., (2016). "Geomechanical and numerical modeling of gas hydrate sediments," *1st International Conference on Energy Geotechnics (ICEGT 2016)*, Kiel, Germany, August 29-31.
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Controls on Methane Expulsion During Melting of Natural Gas Hydrate Systems (DE-FE0010406)

University of Texas at Austin

Government Reports

- Flemings, P. B., (2013). "Controls on Methane Expulsion During Melting of Natural Gas Hydrate Systems: Topic Area 2," *Quarterly Research Performance Progress Report (Period Ending 12/31/2012)*. DOE Award No.: DE-FE0010406, January 2013.
- Flemings, P. B., (2014). "Controls on Methane Expulsion During Melting of Natural Gas Hydrate Systems: Topic Area 2," *Phase 1 Report*. DOE Award No.: DE-FE0010406, March 2014.
- Flemings, P. B., (2016). "Controls on Methane Expulsion During Melting of Natural Gas Hydrate Systems: Topic Area 2," *Phase 2 Report*. DOE Award No.: DE-FE0010406, January 2016.
- Flemings, P. B., (2016). "Controls on Methane Expulsion During Melting of Natural Gas Hydrate Systems: Topic Area 2," *Final Scientific Report*. DOE Award No.: DE-FE0010406, February 2016.

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- Meyer, D., and Flemings, P. B., (2013). "In situ gas hydrate saturation and salinity of hydrate-bearing sediments through well log analysis (Poster)," *Society of Petrophysicists and Well Log Analysts Conference*, New Orleans, LA, June 22-26.

Fate of Methane Emitted From Dissociating Marine Hydrates: Modeling, Laboratory, and Field Constraints (DE-FE0013999)

Massachusetts Institute of Technology

Peer-Reviewed Publications

- Brothers, D. S., Ruppel, C., Kluesner, J. W., ten Brink, U. S., Chaytor, J. D., Hill, J. C., Andrews, B. D. and Flores, C., (2014). "Seabed uid expulsion along upper slope and outer shelf of the U. S. Atlantic continental margin," *Geophys. Res. Lett.*, doi: 10.1002/2013GL058048.
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- Juanes, R., (2016). "Fate of Methane Emitted From Dissociating Marine Hydrates: Modeling, Laboratory, and Field Constraints," *Quarterly Research Performance Progress Report* (Period Ending 12/31/2015). DOE Award No.: DE-FE0013999. January 2016.

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- Brothers, D. S., Ruppel, C. D., Kluesner, J. W., Chaytor, J. D., ten Brink, U. S., and Hill, J. C., (2013). "Pervasive evidence for seabed fluid expulsion on the U. S. Atlantic continental margin," *American Geophysical Union Fall Meeting*, San Francisco, CA, Dec. 9-13.
- Kodis, M., Skarke, A., Ruppel, C., Weber, T., Lobecker, E., and Malik, M., (2013). "U. S. Atlantic margin methane plumes identified from water column backscatter data acquired by NOAA ship Okeanos Explorer," *American Geophysical Union Fall Meeting*, San Francisco, CA Dec. 9-13.
- Ruppel, Weber, Kessler, Pohlman, and Skarke. "Methane hydrate dissociation and gas seepage on global upper continental slopes driven by intermediate ocean warming," *EOS Trans. AGU, OS11C-01, AGU Fall Meeting*.
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Hydrate Evolution in Response to Ongoing Environmental Shifts (DE-FE0013565)

University of Oregon

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- Rempel, A., (2014). "Hydrate Evolution in Response to Ongoing Environmental Shifts," *Quarterly Research Performance Progress Report (Period Ending 3/31/2014)*. DOE Award No.: DE-FE0013565. April 2014.
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Deepwater Methane Hydrate Characterization and Scientific Assessment (DE-FE0023919)

University of Texas at Austin

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- Cook, A. and Sawyer, D., (2015). "The mud-sand crossover on marine seismic data," *Geophysics*, v. 80, no. 6, pp. A109-A114, 10.1190/geo2015-0291.1.
- Cook, A.E., and Waite, W.F., (2018). Archie's saturation exponent for natural gas hydrate in coarse-grained reservoirs. *Journal of Geophysical Research*. DOI: 10.1002/2017JB015138
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- You, K., and Flemings, P. B. (2018). Methane Hydrate Formation in Thick Marine Sands by Free Gas Flow. Presented at Gordon Research Conference on Gas Hydrate, Galveston, TX. Feb 24- Mar 02, 2018.

Mechanisms for Methane Transport and Hydrate Accumulation in Coarse-Grained Reservoirs (DE-FE0013919)

University of Texas at Austin

Peer-Reviewed Publications

- Cook, A.E. and Sawyer, D., (2015). The mud-sand crossover on marine seismic data. *Geophysics*, v. 80, no. 6, A109-A114. 10.1190/geo2015-0291.1.
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- Malinverno, A., (2015). "Monte Carlo inversion applied to reaction-transport modeling of methane hydrate in continental margin sediments," *Abstract OS23B-2003, American Geophysical Union Fall Meeting*, San Francisco, CA, December 14-18 .
- Malinverno, A., (2016). "Modeling gas hydrate formation from microbial methane in the Terrebonne basin, Walker Ridge, Gulf of Mexico," *Gordon Research Conference on Natural Gas Hydrate Systems*, Galveston, TX, Feb 28-March 4.
- Malinverno, A., Cook, A., and Daigle, H., (2016). "Modeling the formation of methane hydrate-bearing intervals in fine-grained sediments," presented at *Gas in Marine Sediments Conference*, Tromsø, Norway, 19-22 September 2016.
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- Malinverno, A., Cook, A. E., Daigle, H., Oryan, B. (2017). Methane Hydrate Formation from Enhanced Organic Carbon Burial During Glacial Lowstands: Examples from the Gulf of Mexico. EOS Trans. American Geophysical Union, Fall Meeting, New Orleans, LA.
- Meazell, K., Flemings, P. B., Santra, M., and the UT-GOM2-01 Scientists (2018). Sedimentology of the clastic hydrate reservoir at GC 955, Gulf of Mexico. Presented at Gordon Research Conference on Natural Gas Hydrate Systems, Galveston, TX.
- Meazell, K., & Flemings, P.B. (2016). Heat Flux and Fluid Flow in the Terrebonne Basin, Northern Gulf of Mexico. Presented at American Geophysical Union, Fall Meeting, San Francisco, CA.
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- Morrison, J., Flemings, P., and the UT-GOM2-1 Expedition Scientists (2018). Hydrate Coring in Deepwater Gulf of Mexico, USA. Poster presented at the 2018 Gordon Research Conference on Natural Gas Hydrate Systems, Galveston, TX.
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- Oti, E., Cook, A. (2018). Non-Destructive X-ray Computed Tomography (XCT) of Previous Gas Hydrate Bearing Fractures in Marine Sediment. Presented at Gordon Research Conference on Natural Gas Hydrate Systems, Galveston, TX.
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- Phillips, S.C., Borgfedt, T., You, K., Meyer, D., and Flemings, P. (2016). Dissociation of laboratory-synthesized methane hydrate by depressurization. Poster presented at Gordon Research Conference and Gordon Research Seminar on Natural Gas Hydrates, Galveston, TX.

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- Santra, M., Flemings, P., Scott, E., Meazell, K. (2018). Evolution of Gas Hydrate Bearing Deepwater Channel-Levee System in Green Canyon Area in Northern Gulf of Mexico. Presented at Gordon Research Conference and Gordon Research Seminar on Natural Gas Hydrates, Galveston, TX.
- Treiber, K, Sawyer, D., & Cook, A. (2016). Geophysical interpretation of gas hydrates in Green Canyon Block 955, northern Gulf of Mexico, USA. Poster presented at Gordon Research Conference, Galveston, TX.
- Wei, L., (2016). "A 1D mass balance model for the formation of gas hydrate in marine sequences," *Gordon Research Conference on Natural Gas Hydrate Systems*, Galveston, TX, Feb 28-March 4.
- Worman, S. and, Flemings, P.B. (2016). Genesis of Methane Hydrate in Coarse-Grained Systems: Northern Gulf of Mexico Slope (GOM²). Poster presented at The University of Texas at Austin, GeoFluids Consortia Meeting, Austin, TX.
- Yang, C., Cook, A., & Sawyer, D. (2016). Geophysical interpretation of the gas hydrate reservoir system at the Perdido Site, northern Gulf of Mexico. Presented at Gordon Research Conference, Galveston, TX, United States.
- You, K.Y., DiCarlo, D. & Flemings, P.B. (2015), Quantifying methane hydrate formation in gas-rich environments using the method of characteristics. Abstract OS23B-2005 presented at 2015, Fall Meeting, AGU, San Francisco, CA, 14-18 Dec.
- You, K., Flemings, P.B. (2016). Methane Hydrate Formation in Thick Sand Reservoirs: Long-range Gas Transport or Short-range Methane Diffusion? Presented at American Geophysical Union, Fall Meeting, San Francisco, CA.
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Theses/Dissertations

- Andris, R., (2016). "The effect of restrictive diffusion on hydrate growth," *M.S. thesis*, University of Texas at Austin.
- Bihani, A., (2016). "Pore size distribution and methane equilibrium conditions at Walker Ridge Block 313, northern Gulf of Mexico," *M.S. thesis*, University of Texas at Austin.
- Shushtarian, A., (2016). "Effect of a discrete three-phase methane equilibrium zone on the bottom-simulating reflection," *M.S. thesis*, University of Texas at Austin.

Smart, K (2018) Modeling Well Log Responses in Hydrate Bearing Silts. Ohio State University. Undergraduate Thesis.

Characterizing the Response of the Cascadia Margin gas Hydrate Reservoir to Bottom Water Warming Along the Upper Continental Slope (DE-FE0013998)

University of Washington

Peer-Reviewed Publications

- Johnson, H. P., Miller, U. K., Salmi, M. S., and Solomon, E. A., (2015). "Analysis of bubble plume distributions to evaluate methane hydrate decomposition on the upper continental slope," *Geophys. Geochem. Geosyst.*, v. 16, pp. 3825-3839, doi:10.1002/2015GC005955.
- Philip, B. T., Denny, A. R., Solomon, E. A., Kelley, D. S., (2016). "Time-series measurements of bubble plume variability and water column methane distributions above Southern Hydrate Ridge, Oregon," *Geochem. Geophys. Geosyst.*, 17, pp. 1182-1196.

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- Solomon, E., (2016). "Characterizing the Response of the Cascadia Margin Gas Hydrate Reservoir to Bottom Water Warming Along the Upper Continental Slope," *Quarterly Research Performance Progress Report* (Period Ending 3/31/2016). DOE Award No.: DE-FE0013998. May 2016.
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- Embley, R.W., Merle, S.G., Raineault, N., Baumberger, T., Seabrook, S.A., Johnson, H.P., Trehu, A.M., Lupton, J.E., Thurber, A.R., Hammond, S.R., Solomon, E.A., and Salmi, M., (2016). "Numerous bubble plumes mapped and new seeps characterized on the Cascadia margin," Abstract OS41A-1939, American Geophysical Union Fall Meeting, San Francisco, CA, December 12-16.

- Graw, M. F., Solomon, E. A., Treude, T., Pohlman, J., Colwell, F. S., (2015). "Towards biogeochemical modeling of anaerobic oxidation of methane: Characterization of microbial communities in methane-bearing North American continental margin sediments," **Abstract OS33A-1993, American Geophysical Union Fall Meeting, San Francisco, CA, December 14-18.**
- Johnson, H. P., Miller, U. K., Salmi M. S., Solomon, E. A., (2015). "Analysis of bubble plume distributions to evaluate methane hydrate decomposition on the Cascadia margin," *Abstract OS23B-1990, American Geophysical Union Fall Meeting, San Francisco, CA, December 14-18.*
- Salmi, M. S., Harris, R. N., Johnson, H. P., Solomon, E. A., (2015). "High resolution thermal model of the Washington margin of the Cascadia subduction zone," *Abstract T21D-2870, Presented at American Geophysical Union Fall Meeting, San Francisco, CA, December 14-18 .*
- Solomon, E.A., Kowalski, L., and Whorley, T.L., (2017). "Chronic downward flow of seawater in bacterial mats at Hydrate Ridge—Mechanisms and biogeochemical significance." *Ninth International Conference on Gas Hydrates, Denver, CO.*
- Whorley, T. L., Solomon, E. A., Torres, M. E., Johnson, H. P., Berg, R. D., Philip, B. T., (2015). "Evaluating active methane hydrate dissociation along the Washington margin in response to bottom water warming," *Abstract OS23B-2015, American Geophysical Union Fall Meeting, San Francisco, CA, December 14-18.*
- Whorley, T. L., Solomon, E. A., Torres, M. E., Johnson, H. P., Berg, R. D., Philip, B. T., (2016). "Evaluating water and methane sources at the upslope limit of methane hydrate stability along the Washington margin." *Gordon Research Conference on Natural Gas Hydrate Systems, Galveston, TX, Feb 28-March 4.*
- Whorley, T.L., Solomon, E.A., Philip, B.T., Torres, M.E., and Johnson, H.P., (2017). "Investigating the response of methane hydrates to modern bottom water warming along the upper continental slope of the Cascadia margin," *Ninth International Conference on Gas Hydrates, Denver, CO.*

***Borehole Tool for the Comprehensive Characterization of Hydrate-Bearing Sediments
(DE-FE0013961)***

Georgia Institute of Technology

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- Santamarina, J. C., (2014). "Borehole Tool for the Comprehensive Characterization of Hydrate-Bearing Sediments," *Quarterly Research Performance Progress Report* (Period Ending 12/31/2013). DOE Award No.: DE-FE0013961. January 2014.
- Santamarina, J. C., (2014). "Borehole Tool for the Comprehensive Characterization of Hydrate-Bearing Sediments," *Quarterly Research Performance Progress Report* (Period Ending 3/31/2014). DOE Award No.: DE-FE0013961. April 2014.
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- Santamarina, J. C., (2016). "Borehole Tool for the Comprehensive Characterization of Hydrate-Bearing Sediments," *Quarterly Research Performance Progress Report* (Period Ending 9/30/2016). DOE Award No.: DE-FE0013961. October 2016.

Impact of Clays on the Compressibility and Permeability of Sands During Methane Extraction from Gas Hydrate (DE-FE0028966)

Louisiana State University

Peer-Reviewed Publications

- Cao, S.C., Jang, J., Jung, J., Waite, W.F., Collett, T.S., Kumar, P., 2018. 2D micromodel study of clogging behavior of fine-grained particles associated with gas hydrate production in NGHP-02 gas hydrate reservoir sediments. *Journal of Marine and Petroleum Geology*. <https://doi.org/10.1016/j.marpetgeo.2018.09.010>.
- Jang, J., Cao, S., Stern, L.A., Jung, J., Waite, W.F., 2018. Impact of pore-fluid chemistry on fine-grained sediment fabric and compressibility. *Journal of Geophysical Research, Solid Earth: Solid Earth*, 123, 5495–5514. <https://doi.org/10.1029/2018JB015872>.
- Jang, J., Dai, S., Yoneda, J., Waite, W.F., Stern, L.A., Boze, L.-G., Collett, T.S., Kumar, P., 2018. Pressure core analysis of geomechanical and fluid flow properties of seals associated with gas hydrate-bearing reservoirs in the Krishna-Godavari Basin, offshore India, *Journal of Marine and Petroleum Geology*. <https://doi.org/10.1016/j.marpetgeo.2018.08.015>.
- Jang, J., Waite, W.F., Stern, L.A., Collett, T.S., Kumar, P., Impact of fine-grained sediment on the nature and development of a gas hydrate reservoir system investigated during NGHP-02 in the Krishna-Godavari Basin, offshore eastern India (in review), *Journal of Marine and Petroleum Geology*.

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- Jung, J., (2016). "Impact of Clays on the Compressibility and Permeability of Sands During Methane Extraction from Gas Hydrate," *Quarterly Research Performance Progress Report* (Period Ending 12/31/2016). DOE Award No.: DE-FE0028966. December 2016.
- Jung, J., (2017). "Impact of Clays on the Compressibility and Permeability of Sands During Methane Extraction from Gas Hydrate," *Quarterly Research Performance Progress Report* (Period Ending 03/31/2017). DOE Award No.: DE-FE0028966. March 2017.
- Jung, J., (2018). "Impact of Clays on the Compressibility and Permeability of Sands During Methane Extraction from Gas Hydrate," *Quarterly Research Performance Progress Report* (Period Ending 03/31/2018). DOE Award No.: DE-FE0028966. March 2018.
- Jung, J., (2018). "Impact of Clays on the Compressibility and Permeability of Sands During Methane Extraction from Gas Hydrate," *Quarterly Research Performance Progress Report* (Period Ending 06/30/2018). DOE Award No.: DE-FE0028966. June 2018.
- Jung, J., (2018). "Impact of Clays on the Compressibility and Permeability of Sands During Methane Extraction from Gas Hydrate," *Quarterly Research Performance Progress Report* (Period Ending 09/30/2018). DOE Award No.: DE-FE0028966. September 2018.

Other Publications

- Cao, S.C., Jang, J., Jung, J., Waite, W.F., Collett, T.S., and Kumar, P., 2018b. 2D Micromodel studies of pore-throat clogging by pure fine-grained sediments and natural sediments

from NGHP-02, offshore India: *U.S. Geological Survey data release*, <https://doi.org/10.5066/P9PZ5M7E>.

Jang, J., Cao, S. C., Stern, L. A., Waite, W. F., and Jung, J., 2018. Effect of pore fluid chemistry on the sedimentation and compression behavior of pure, endmember fines: *U.S Geological Survey Data Release*, <https://doi.org/10.5066/F77M076K>. 13

Jang, J., Dai, S., Yoneda, J., Waite, F. W., Collett, T. S. and Kumar, P. (2018-b). Pressure Core Characterization Tool Measurements of Compressibility, Permeability, and Shear Strength of Fine-Grained Sediment Collected from Area C, Krishna-Godavari Basin, during India's National Gas Hydrate Program Expedition NGHP-02: *U. S. Geological Survey data release*, <https://doi.org/10.5066/P91XJ7DP>

Jang, J., Waite, F. W., Stern, L. A., Collett, T. S. and Kumar, P., 2018b. Dependence of sedimentation behavior on pore-fluid chemistry for sediment collected from Area B, Krishna-Godavari Basin during India's National Gas Hydrate Program, NGHP-02: *U. S. Geological Survey data release*, <https://doi.org/10.5066/P9FXJ1VX>.

Presentations

Cao, S.C., Jang, J., Waite, W.F., Jafari, M., Jung, J., 2017. A 2D micromodel study of fines migration and clogging behavior in porous media: Implications of fines on methane extraction from hydrate-bearing sediments [Abstract]. Talk presented at the 2017 Fall Meeting of the American Geophysical Union Conference, New Orleans, LA. December 11-15, 2017.

Jang, J., Waite, W.F., Jung, J., (2017). "Pore-fluid sensitivity of clays and its impacts on gas production from hydrate-bearing sediments." Ninth International Conference on Gas Hydrates, June 25-30, 2017, Denver, Colorado.

Jang, J., Cao, S., Waite, W.F., Jung, J., (2017). Impact of pore-water freshening on clays and the compressibility of hydrate-bearing reservoirs during production. Ninth International Conference on Gas Hydrates, June 25-30, 2017, Denver, Colorado.

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A Multi-scale Experimental Investigation of Flow Properties in Coarse-grained Hydrate Reservoirs during Production (DE-FE0028967)

University of Texas at Austin

Peer-Reviewed Publications

- Chen, X. and Espinoza, D. N., (2018). Ostwald ripening changes the pore habit and spatial variability of clathrate hydrate. *Fuel*, 214, 614–622. <https://doi.org/10.1016/j.fuel.2017.11.065>
- Chen, X., Verma, R., Nicolas Espinoza, D., and Prodanović, M. (2018). Pore-Scale Determination of Gas Relative Permeability in Hydrate-Bearing Sediments Using X-Ray Computed Micro- Tomography and Lattice Boltzmann Method. *Water Resources Research*, 54(1), 600-608. <https://doi.org/10.1002/2017WR021851>
- Chen, X. and Espinoza, DN (2018), Surface area controls gas hydrate dissociation kinetics in porous media, *Fuel*, 234, 358-363. <https://doi.org/10.1016/j.fuel.2018.07.030>
- Meyer, D.W., Flemings, P.B., DiCarlo, D., You, K., Phillips, S.C., and Kneafsey, T.J. (2018), Experimental investigation of gas flow and hydrate formation within the hydrate stability zone. *Journal of Geophysical Research- Solid Earth* <https://doi.org/10.1029/2018JB015748>

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- Flemings, P.B., (2017). "A Multi-scale Experimental Investigation of Flow Properties in Coarse-grained Hydrate Reservoirs during Production," *Quarterly Research Performance Progress Report* (Period Ending 12/31/2016). DOE Award No.: DE-FE0028967. January 2017.
- Flemings, P.B., (2017). "A Multi-scale Experimental Investigation of Flow Properties in Coarse-grained Hydrate Reservoirs during Production," *Quarterly Research Performance Progress Report* (Period Ending 3/31/2017). DOE Award No.: DE-FE0028967. May 2017.
- Flemings, P.B., (2017). "A Multi-scale Experimental Investigation of Flow Properties in Coarse-grained Hydrate Reservoirs during Production," *Quarterly Research Performance Progress Report* (Period Ending 6/30/2017). DOE Award No.: DE-FE0028967. July 2017.
- Flemings, P.B., (2017). "A Multi-scale Experimental Investigation of Flow Properties in Coarse-grained Hydrate Reservoirs during Production," *Quarterly Research Performance Progress Report* (Period Ending 9/30/17). DOE Award No.: DE-FE0028967. October 2017.
- Flemings, P.B., (2018). "A Multi-scale Experimental Investigation of Flow Properties in Coarse-grained Hydrate Reservoirs during Production," *Quarterly Research Performance Progress Report* (Period Ending 12/31/17). DOE Award No.: DE-FE0028967. January 2018.
- Flemings, P.B., (2018). "A Multi-scale Experimental Investigation of Flow Properties in Coarse-grained Hydrate Reservoirs during Production," *Quarterly Research Performance Progress Report* (Period Ending 3/31/2018). DOE Award No.: DE-FE0028967. April 2018.

- Flemings, P.B., (2018). "A Multi-scale Experimental Investigation of Flow Properties in Coarse-grained Hydrate Reservoirs during Production," *Quarterly Research Performance Progress Report* (Period Ending 6/30/18). DOE Award No.: DE-FE0028967. July 2017.
- Flemings, P.B., (2018). "A Multi-scale Experimental Investigation of Flow Properties in Coarse-grained Hydrate Reservoirs during Production," *Quarterly Research Performance Progress Report* (Period Ending 9/30/18). DOE Award No.: DE-FE0028967. October 2018.

Presentations

- Chen, X., Espinoza, N., Verma, R., and Prodanovic, M., 2017. X-Ray Micro-CT Observations of Hydrate Pore Habit and Lattice Boltzmann Simulations on Permeability Evolution in Hydrate Bearing Sediments (HBS). Presented at the 2017 AGU Fall Meeting, December 11-15, 2017, New Orleans, LA.
- Chen, X., D. Nicolas Espinoza, Nicola Tisato, Peter B. Flemings (2018). X-ray Computed Micro-Tomography Study of Methane Hydrate Bearing Sand: Enhancing Contrast for Improved Segmentation, Gordon Research Conference – Natural Gas Hydrate Systems, Galveston, TX
- Chen, X., D. Nicolas Espinoza, Nicola Tisato, Rahul Verma, Masa Prodanovic, Peter B. Flemings, (2018). New Insights Into Pore Habit of Gas Hydrate in Sandy Sediments: Impact on Petrophysical and Transport Properties, Gordon Research Conference – Natural Gas Hydrate Systems, Galveston, TX
- Dong, T., Lin, J. F., Flemings, P. B., Polito, P. J., 2016. Pore-scale study on methane hydrate dissociation in brine using micro-Raman spectroscopy. Presented at the 2016 Extreme Physics and Chemistry workshop, Deep Carbon Observatory, Palo Alto, Calif., 10-11 Dec.
- Dong, T., Lin, J.-F., Flemings, P.B., Gu, J.T., Liu, J., Polito, P.J., O'Connell, J. (2017) Pore-scale study on gas hydrate formation and dissociation under relevant reservoir conditions of the Gulf of Mexico, presented at the 2017 Extreme Physics and Chemistry workshop, Deep Carbon Observatory, November 4-5, Tempe, AZ.
- Dong, T., Lin, J.-F., Gu, J.T., Polito, P.J., O'Connell, J., Flemings, P.B. (2017), Spatial and temporal dependencies of structure II to structure I methane hydrate transformation in porous media under moderate pressure and temperature conditions, Abstract OS53B-1188 Presented at 2017 Fall Meeting, December 11-15, New Orleans, LA.
- Dong, T., Lin, J.-F., Gu, J.T., Polito, P.J., O'Connell, J., Flemings, P.B. (2018), Transformation of metastable structure-II to stable structure-I methane hydrate in porous media during hydrate formation, poster presented at 2018 Jackson School of Geosciences Symposium, Feb. 3, 2018, Austin, TX.
- Dong, T., Lin, J.-F., Flemings, P.B., Gu, J.T., Polito, P.J., O'Connell, J. (2018), Pore-scale methane hydrate dissociation in porous media using Raman spectroscopy and optical imaging, poster presented at Gordon Research Conferences on Natural Gas Hydrate Systems, Feb. 25-March 2, 2018, Galveston, TX.
- Lin, J. F., Dong, T., Flemings, P. B., Polito, P. J., 2017. Characterization of methane hydrate reservoirs in the Gulf of Mexico, presented at the Third Deep Carbon Observatory International Science Meeting, St. Andrews, Scotland, 23-25, March.

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Characterizing Ocean Acidification and Atmospheric Emission Caused by Methane Released from Gas Hydrate Systems along the US Atlantic Margin (DE-FE0028980)

University of Rochester

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Advanced Simulation and Experiments of Strongly Coupled Geomechanics and Flow for Gas Hydrate Deposits: Validation and Field Application (DE-FE0028973)

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Section IV: Publications Resulting from Work with the Dept. of Energy's National Labs

Additional publications produced by the National Labs in association with the Program's major field projects are included within Section II.

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Section V: Publications Resulting from Interagency Agreements

Additional publications by agencies are included under major field projects where appropriate.

Department of Defense, Office of Naval Research, Naval Research Lab

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