

# Matthew T. Reagan

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## EDUCATION

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, Cambridge, MA

PhD in Chemical Engineering, September 2000

Thesis Advisors: Jefferson W. Tester, Jonathan G. Harris

UNIVERSITY OF PENNSYLVANIA, Philadelphia, PA

Bachelor of Science in Chemical Engineering (Magna Cum Laude), May 1994

## RESEARCH AND TECHNICAL EXPERIENCE

LAWRENCE BERKELEY NATIONAL LABORATORY, Earth and Energy Sciences Area, Energy Geosciences Division, Berkeley, CA. **Earth Research Scientist, 2010 to present.**

LAWRENCE BERKELEY NATIONAL LABORATORY, Earth Sciences Division, Berkeley, CA. **Term Research Scientist, 2004 to 2010.**

- Performed fundamental and applied research on the thermodynamics, transport, and chemistry subsurface systems, including:
  - The thermodynamics of gas hydrates and the simulation of methane hydrate reservoirs
  - The consequences of ocean warming on methane hydrates, and the links to global climate feedbacks
  - The potential for gas or contaminant release during hydraulic fracturing or complex deepwater drilling
  - Production from fractured shales, tight reservoirs, and other unconventional resources
  - The use of high-performance computing and parallel simulators for large-scale subsurface simulation
  - Simulation of subsurface CO<sub>2</sub> injection for carbon sequestration
  - Data reduction and uncertainty quantification using statistical methods
- Contributed to investigations of the potential impact of hydraulic fracturing within the US and California
- Developer for the TOUGH family of numerical simulation codes
- Developer of programming libraries and public-facing tools for physical property estimation
- Authored or co-authored over 35 peer-reviewed papers, two regulatory studies, and over 30 articles and reports
- Performed 45 technical presentations, including 7 invited talks
- Handled administration and reporting of over \$5M in government- and industry-sponsored research projects
- Supervised 10 scientists, contractors, students, interns, and visitors
- Performed peer review for over 20 journals, scientific publishers, and institutional reports

SANDIA NATIONAL LABORATORIES, Combustion Research Facility, Livermore, CA. **Technical Staff, 2001-2004.**

- Performed research on uncertainty quantification applied to chemical systems modeling and reacting flow
- Developer of statistical/Monte Carlo uncertainty quantification methods and software
- Developer of MPI-based parallel reacting-flow codes
- Authored or co-authored 5 peer-reviewed papers and 5 articles/reports; performed 7 technical presentations

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, **Postdoctoral Associate, 2001.**

- Performed research on the molecular simulation and thermodynamics of multiphase supercritical water solutions
- Co-instructor for introductory graduate thermodynamics course

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, **Research Assistant, 1995-2000.**

- Performed graduate research on the molecular simulation and thermodynamics of hydrothermal water solutions
- Authored or co-authored 5 peer-reviewed papers and 2 articles/reports; performed 4 technical presentations

## AWARDS

2015 Editors' Choice Award, Water Resources Research (paper #15)

2012 LBNL Director's Award (TOUGH Development and Tech Transfer Team).

## REFEREED PUBLICATIONS AND BOOK CHAPTERS

(ResearcherID: D-1129-2015, ORCID: <http://orcid.org/0000-0001-6225-4928>)

1. Zheng, L., Xu, H., Rutqvist, J., Reagan, M.T., Birkholzer, J., “The Hydration of Bentonite Buffer Material Revealed by Modeling Analysis of a Long-Term *In Situ* Test,” submitted to *Applied Clay Science*.
2. Oluwunmi, P.A., Pecher, I., Archer, R., Reagan, M.T., Moridis, G.J., “Meta-Stability of Gas Hydrates during Uplift and its Possible Link to Double BSRs,” submitted to *Geophys. Res. Lett.*
3. Oluwunmi, P.A., Pecher, I., Archer, R., Reagan, M.T., Moridis, G.J., “Possible Influx of Seawater During Gas Production from Unsealed Gas Hydrate Reservoirs,” submitted to *Geophys. Res. Lett.*
4. Moridis, G.J., Reagan, M.T., Queiruga, A.F., Collett, T.S., Boswell, R., “Evaluation of the Performance of the Oceanic Hydrate Accumulation at the NGHP-02-9 Site of the Krishna-Godawari Basin During a Production Test and During Single and Multi-Well Production Scenarios,” *J. Marine and Petroleum Geology, in press*, doi: 10.1016/j.marpetgeo.2018.12.001, 2019.
5. Moridis, G.J., Reagan, M.T., Queiruga, A.F., Kim, S.-J. “System Response to Gas Production from a Heterogeneous Hydrate Accumulation at the UBGH2-6 Site in the Ulleung Basin of the Korean East Sea,” *J. Pet. Sci. Eng.*, **178**, 655-665, doi: 10.1016/j.petrol.2019.03.058, 2019
6. Moridis, G.J., Reagan, M.T., Queiruga, A.F., “Simulation of Gas Production from Multilayered Hydrate-Bearing Media with Fully Coupled Flow, Thermal, Chemical and Geomechanical Processes Using TOUGH+Millstone, Part I: Numerical Modeling of Hydrates,” *Transport in Porous Media*, **128**(2), 405-430, doi: 10.1007/s11242-019-01254-6, 2019.
7. Queiruga, A.F., Moridis, G.J., Reagan, M.T., “Simulation of Gas Production from Multilayered Hydrate-Bearing Media with Fully Coupled Flow, Thermal, Chemical and Geomechanical Processes Using TOUGH+Millstone, Part II: Geomechanical Formulation and Numerical Coupling,” *Transport in Porous Media*, **128**(1), 221-241, 10.1007/s11242-019-01242-w, 2019.
8. Reagan, M.T., Queiruga, A.F., Moridis, G.J., “Simulation of Gas Production from Multilayered Hydrate-Bearing Media with Fully Coupled Flow, Thermal, Chemical and Geomechanical Processes Using TOUGH+Millstone, Part III: Production Simulation Results,” *Transport in Porous Media*, doi: 10.1007/s11242-019-01283-1, 2019.
9. Reagan, M.T., Moridis, G.J., Keen, N.D., Lee, K.J., Natter, M., Bjerstedt, T., Shedd, W.W., “Transport and Fate of Natural Gas and Brine Escaping from a Hydrocarbon Reservoir Through a Failed Deep-Water Well in the Oceanic Subsurface of the Gulf of Mexico,” *Transport in Porous Media*, **127**(2), 459-480. doi: 10.1007/s11242-018-1207-y, 2019.
10. Bjerstedt, T.W., Shedd, W.W., Natter, M., Abadie, P., Moridis, G.J., Reagan, M.T., “Concept of Hydrocarbon Broaching After Underground Containment Failure, Gulf of Mexico,” submitted to *AAPG Bulletin*.
11. Boswell, R., Myshakin, E., Moridis, G.J., Konno, Y., Collett, T.S., Reagan, M.T., Ajayi, T., Seol, Y., “Scientific Results of Numerical Simulation of Gas Hydrate Reservoirs in the Offshore of India: National Gas Hydrate Program Expedition-02,” *J. Marine and Petroleum Geology, in press*. doi: 10.1016/j.marpetgeo.2018.09.026, 2018.
12. Varadharajan, C., Tinnacher, R., Zheng, L., Dafflon, B., Wu, Y., Reagan, M.T., Birkholzer, J., Trautz, R., Carey, J., “A review of studies examining the potential for groundwater contamination from CO<sub>2</sub> sequestration,” in *Geological Carbon Storage* (eds S. Vialle, J. Ajo-Franklin and J. W. Carey). doi:10.1002/9781119118657.ch15.
13. Stringfellow, W.T., Camarillo, M.K., Domen, J., Sandelin, W., Varadharajan, C., Jordan, P., Reagan, M.T., Cooley, H., Heberger, M., Birkholzer, J., “Identifying chemicals of concern in hydraulic fracturing fluids used production,” *Environmental Pollution*, **220**, 413-420, 2017..
14. Reagan, M.T., Moridis, G.J., Seim, K.S., “Fast Parametric Relationships for the Large-Scale Reservoir Simulation of Mixed CH<sub>4</sub>-CO<sub>2</sub> Gas Hydrate Systems,” *Computers and Geosciences*, **103**, 191-203, 2017.
15. Tinnacher, R.M., Dwivedi, D., W.T., Houseworth, J.E., Reagan, M.T., Stringfellow, W.T., Varadharajan, C., “Hydraulic Fracturing from the Groundwater Perspective,” in *Groundwater Assessment, Modeling, and Management*, pp. 99-120, Taylor & Francis, New York, ISBN 9781498742849, 2016.
16. California Council on Science and Technology and Lawrence Berkeley National Laboratory, “An Independent Scientific Assessment of Well Stimulation in California: Volume I, Well Stimulation Technologies and their

Past, Present, and Potential Future Use in California,” Sacramento, CA. ISBN 978-1-930117-97-6. Available from: <http://ccst.us/SB4>

17. California Council on Science and Technology, and Lawrence Berkeley National Laboratory, “An Independent Scientific Assessment of Well Stimulation in California: Volume II, Potential Environmental Impacts of Hydraulic Fracturing and Acid Stimulations,” Sacramento, CA. ISBN 978-1-930117-75-4. Available from: <http://ccst.us/SB4>.
18. Reagan, M.T., Moridis, G.J., Keen, N.D., Johnson, J.N., “Numerical Simulation of the Environmental Impact of Hydraulic Fracturing of Tight/Shale Gas Reservoirs on Near-Surface Groundwater: Background, Base Cases, Shallow Reservoirs, Short-Term Gas and Water Transport,” *Water Res. Res.*, **51**(4), doi: 10.1002/2014WR016086, 2543-2573, 2015.
19. Reagan, M.T., Moridis, G.J., Freeman, C.M., Pan, L., Boyle, K.L., Keen, N., Husebo, J.A., “Field-Scale Simulation of Production from Oceanic Gas Hydrate Deposits,” *Transport in Porous Media*, **108**(1), 151-169, 2015.
20. Freeman, C.M., Boyle, K.L., Reagan, M.T., Johnson J.N., Rycroft, C., Moridis, G.J., “MeshVoro: A Three-Dimensional Voronoi Mesh Building Tool for the TOUGH Family of Codes,” *Computers and Geosciences*, **70**, 26-34, 2014.
21. Moridis, G.J., T.S. Collett, R. Boswell, S. Hancock, J. Rutqvist, C. Santamarina, T. Kneafsey, M.T. Reagan, M. Pooladi-Darwish, M. Kowalsky, E.D. Sloan, and C. Koh, “Gas Hydrates as a Potential Energy Source: State of Knowledge and Challenges,” in: *Advanced Biofuels and Bioproducts*, J.W. Lee (ed.), 977-1035, Springer, New York, Heidelberg, Dordrecht, London, ISBN 978-1-4614-3347-7, doi: 10.1007/978-1-4614-3348-4, 2013.
22. Moridis, G.J., Reagan, M.T., Kuzma, H.A., Blasingame, T.A., Santos, R., Boyle, K.L., Freeman, C.M., Ilk, D., Yang, W., Cossio, M., Bhattacharya, S., Nikolaou, M., “SeTES: A Self-Teaching Expert System for the Analysis, Design, and Prediction of Gas Production From Unconventional Gas Resources,” *Computers and Geosciences*, **58**, 100-115, doi: 10.1016/j.cageo.2013.04.001, 2013.
23. Moridis, G.J., Kim, J., Reagan, M.T., Kim, S.J., “Feasibility of Gas Production from a Gas Hydrate Accumulation at the UBGH2-6 Site of the Ulleung Basin in the Korean East Sea,” *J. Petro. Sci. Eng.*, **108**, 180-210, doi: 10.1016/j.cageo.2013.04.001, 2013.
24. Bhattacharyya, S., Cameron-Smith, P., Bergmann, D., Reagan, M.T., Elliott, S.M., and Moridis, G.J. “Tropospheric impact of methane emissions from clathrates in the Arctic Region,” *Atmospheric Chemistry and Physics*, **12**, 26477–26502, doi: 10.5194/acpd-12-26477-2012, 2012.
25. Reagan, M.T., Moridis, G.J., Elliott, S.M., and Maltrud, M., “Contributions of Oceanic Gas Hydrate Dissociation to the Formation of Arctic Ocean Methane Plumes,” *J. Geophys. Res. Oceans*, **116**, C09014, doi: 10.1029/2011JC007189, 2011.
26. Elliott, S.M., Maltrud, M., Reagan, M.T., Moridis, G.J., Cameron-Smith, P.J., “Marine Methane Cycle Simulations for the Period of Early Global Warming,” LBNL-4239E, *J. Geophysical Res. Biogeo.*, **116**, G01010, 2011.
27. Moridis, G.J., Silpngarmert, S., Reagan, M.T., Collett, T., and K. Zhang, “Gas Production From the Unit D Class 3 Hydrate Deposit at the Mount Elbert Site, North Slope, Alaska,” LBNL-3005E, *Marine & Petroleum Geology*, **28**, 517-534, doi:10.1016/j.marpetgeo.2010.01.005, 2011.
28. Moridis, G.J., and M.T. Reagan, “Estimating the Upper Limit of Gas Production From Class 2 Hydrate Accumulations in the Permafrost: 1. Concepts, System Description, and the Production Base Case,” LBNL-01615E, *J. Petro. Sci. Eng.*, **76**, 194-204, 2011.
29. Moridis, G.J., and M.T. Reagan, “Estimating the Upper Limit of Gas Production From Class 2 Hydrate Accumulations in the Permafrost: 2. Alternative Well Designs and Sensitivity Analysis,” LBNL-04272E, *J. Petro. Sci. Eng.*, **76**, 124-137, 2011.
30. Moridis, G.J., Reagan, M.T., Boyle, K.L., and K. Zhang, “Evaluation of the Gas Production Potential of Some Particularly Challenging Types of Hydrate Deposits,” *Transport in Porous Media*, **90** (1), 269-299, doi: 10.1007/s11242-011-9762-5, 2011.
31. Moridis, G.J., Collett, T.S., Pooladi-Darwish, M., Hancock, S., Santamarina, C., Boswell, R., Kneafsey, T., Rutqvist, J., Kowalsky, M.J., Reagan, M.T., Sloan, E.D., Sum, A.K., and Koh, C., “Challenges, Uncertainties

and Issues Facing Gas Production From Hydrate Deposits in Geologic Systems,” LBNL-4254E, *SPE Res. Eval. & Eng.*, **14**(1), 76-112, 2011.

32. Elliott, S.M., Reagan, M.T., Moridis, G.J., Cameron-Smith, P.J., “Geochemistry of Clathrate-Derived Methane in Arctic Ocean Waters,” LBNL-3389E, *Geophys. Res. Lett.*, **37**, L12607, doi:10.1029/2010GL043369, 2010.
33. Reagan, M. T., and G. J. Moridis, “Large-Scale Simulation of Methane Hydrate Dissociation along the West Spitsbergen Margin,” LBNL-2908E, *Geophys. Res. Lett.*, **36**, L23612, doi:10.1029/2009GL041332, 2009.
34. Moridis, G.J., Collett, T.S., Boswell, R., Kurihara, M., Reagan, M.T., Sloan, E.D., and C. Koh, “Toward Production From Gas Hydrates: Assessment of Resources, Technology, and Potential” LBNL-00161E, SPE 114163, *SPE Journal*, **12**(5), 745-771, doi:10.2118/114163-MS, 2009.
35. Boswell, R., Shelander, D., Lee, M., Latham, T., Collett, T., Geurin, G., Moridis, G., Reagan, M., and D. Goldberg, “Occurrence of gas hydrate in Oligocene Frio sand: Alaminos Canyon Block 818: northern Gulf of Mexico,” LBNL-2541E, *Marine & Petroleum Geology*, **26**, 1499-1512, doi:10.1016/j.marpetgeo.2009.03.005, 2009.
36. Moridis, G.J., Reagan, M.T., Kim, S.J., Seol, Y., and K. Zhang, “Evaluation of the Gas Production Potential of Marine Hydrate Deposits in the Ulleung Basin of the Korean East Sea,” LBNL-63812, *SPE 110859*, *SPE Journal*, **14**(4), 759-781, doi:10.2118/110859-PA, 2009.
37. Reagan, M.T. and G.J. Moridis, “The dynamic response of oceanic hydrate deposits to ocean temperature change,” LBNL-01026E, *J. Geophys. Res. Oceans*, **113**, C12023, doi:10.1029/2008JC004938, 2008.
38. Reagan, M.T. and G.J. Moridis, “Oceanic Gas Hydrate Instability and Dissociation Under Climate Change Scenarios,” LBNL-62999, *Geophys. Res. Lett.*, **34**, L22709, doi: 10.1029/2007GL031671, 2007.
39. Reagan, M.T., Najm, H.N., Pebay, P.P., Knio, O.M., and R.G. Ghanem, “Quantifying Uncertainty in Chemical Systems Modeling.” *Int. J. Chem. Kinetics*, **37**, 6, 368-382, 2005.
40. Reagan, M.T., Najm, H.N., Ghanem, R.G., Knio, O.M., and O.P. LeMaître, “Spectral Stochastic Uncertainty Quantification in Chemical Systems.” *Combust. Theory and Modeling*, **8**, 3, 607-632, 2004.
41. LeMaître, O.P., Reagan, M.T., Debusschere, B.J., Najm, H.N., Ghanem, R.G., and O.M. Knio, “Natural Convection in a Closed Cavity under Stochastic, Non-Boussinesq Conditions.” *SIAM J. Sci. Comp.*, **26**, 2, 375-394, 2004.
42. Reagan, M.T., Najm, H.N., Ghanem, R.G., and O.M. Knio, “Uncertainty Quantification in Reacting Flow Simulations Through Non-Intrusive Spectral Projection.” *Combustion and Flame*, **132**, 3, 545-555, 2003.
43. LeMaître, O.P., Reagan, M.T., Najm, H.N., Ghanem, R.G., and O.M. Knio, “A Stochastic Projection Method for Fluid Flow. II. Random Process.” *J. Comp. Phys.*, **181**, 9-44, 2002.
44. Reagan, M.T. and J.W. Tester, “The Zeno ( $Z=1$ ) Behavior of Water: A Molecular Simulation Study.” *Int. J. Thermophysics*, **22**, 1, 149-160, 2001.
45. Kutney, M.C., Reagan, M.T., Smith, K.A., Tester, J.W., and D.R. Herschbach, “The Zeno ( $Z=1$ ) Behavior of Equations of State: An Interpretation Across Scales from Macroscopic to Molecular.” *J. Phys. Chem. B*, **104**, 10, 9513-9525, 2000.
46. Ciric, A.R., Mumtaz, H.S., Corbett, G., Reagan, M.T., Seider, W.D., Fabiano, L.A., Kolesar, D.M., and S. Widagdo, “Azeotropic Distillation with an Internal Decanter.” *Comp. Chem. Eng.* **24**, 2435-2446, 2000.
47. Reagan, M.T., Harris, J.G. and J.W. Tester, “Molecular Simulation of Dense Hydrothermal NaCl-H<sub>2</sub>O Solutions from Subcritical to Supercritical Conditions.” *J. Phys. Chem. B*, **103**, 37, 7935-7941, 1999.
48. Tester, J.W., Marrone, P.A., DiPippo, M.M., Sako, K., Reagan, M.T., Arias, T.A., and W.A. Peters, “Chemical Reactions and Phase Equilibria of Model Halocarbons and Salts in Sub- and Supercritical Water (200 to 300 bar, 100 to 600 °C).” *J. Supercritical Fluids*, **13**, 225-240, 1998.

#### CONFERENCE PAPERS, PEER-REVIEWED REPORTS, AND OTHER PUBLICATIONS

49. Moridis, G.J., Reagan, M.T., Queiruga, A.F., “Gas Hydrate Production Testing: Design Process and Modeling Results,” *Proc. 2019 Offshore Technology Conference*, Houston, TX, 6-9 May 2019.
50. Moridis, G.M., Reagan, M.T., Queiruga, A.F., “Geomechanical Stability and Overall System Behavior of

- Sloping Oceanic Accumulations of Hydrates Responding to Dissociation Stimuli,” OTC-24896-MS, *Proc.* 2018 Offshore Technology Conference-Asia, 20 March 2018.
51. Moridis, G.J., Reagan, M.T., Queiruga, A.F., “Long-Term System Behavior Following Cessation of Gas Production from Hydrate Deposits,” *Proc.* 9<sup>th</sup> Int. Conference on Gas Hydrates, Denver, CO, 25-30 Jun 2017.
  52. Moridis, G.J., Queiruga, A.F., Reagan, M.T., “The T+H+M Code for the Analysis of Coupled Flow, Thermal, Chemical and Geomechanical Processes in Hydrate-Bearing Geologic Media,” *Proc.* 9<sup>th</sup> Int. Conference on Gas Hydrates, Denver, CO, 25-30 Jun 2017.
  53. California Council on Science and Technology, Lawrence Berkeley National Laboratory, and Pacific Institute. 2014. *Advanced Well Stimulation Technologies in California: An Independent Review of Scientific and Technical Information*. Sacramento, CA. ISBN 978-1-930117-94-5. Available from: <http://ccst.us/BLMreport>.
  54. Reagan, M.T., Moridis, G.J., Kenn, N.D., “Numerical Simulation Of Transport Between Fractured Tight/Shale Gas Reservoirs And Near-Surface Groundwater,” *Proc.* 2015 TOUGH Symposium, Berkeley, CA, 28-30 September 2015.
  55. Moridis, G.J., Reagan, M.T., Kim, J., Kim, S.-J. “System Response During Short- and Long-Term Gas Production from a Gas Hydrate Deposit at the Site of a Planned Field Test in the Ulleung Basin of the Korean East Sea,” OTC 25384, *Proc.* 2014 Offshore Technology Conference, Houston, TX, 5-8 May 2014.
  56. Reagan, M.T., Moridis, G.J., Freeman, C.M., Keen, N., Massively Parallel Simulation of Production from Oceanic Gas Hydrate Deposits,” *Proc.* International Petroleum Technology Conference, Beijing, China, 26-28 March 2013.
  57. Reagan, M.T., Moridis, G.J., Boyle, K.L., Freeman, C.M., Pan, L., Keen, N., Husebo, J.A., “Massively Parallel Simulation of Field-Scale Oceanic Gas Hydrate Deposits,” *Proc.* 2012 TOUGH Symposium, Berkeley, CA, 17-19 September 2012.
  58. Moridis, G.J., Kuzma, H.A., Reagan, M.T., Blasingame, T.A., Santos, R., Boyle, K.L., Freeman, C.M., Ilk, D., Yang, W., Cossio, M., Bhattacharya, S., Nikolaou, M., “SeTES: A Self-Teaching Expert System for the Analysis, Design, and Prediction of Gas Production From Unconventional Gas Resources,” *Proc.* Canadian Unconventional Resources Conference, Calgary, Alberta, Canada, 15–17 November 2011.
  59. Zhao, Y., Kuzma, H.A., Reagan, M.T., Rector, J.W., “Monitoring methane hydrate production in the arctic; a preliminary feasibility study,” *Proc.* Society of Exploration Geologists Annual Meeting, San Antonio, TX, 18-23 Sept 2011.
  60. Kuzma, H.A., Zhao, Y., Reagan, M.T., Rector, J.W., “Polynomial Chaos for Uncertainty Quantification in Geophysics,” *Proc.* Society of Exploration Geologists Annual Meeting, San Antonio, TX, 18-23 Sept 2011.
  61. Reagan, M.T., Moridis, G.J., Elliott, S.M., Maltrud, M., and Cameron-Smith, P.J., “Basin-Scale Assessment of Gas Hydrate Dissociation in Response to Climate Change,” *Proc.* 7<sup>th</sup> International Conference on Gas Hydrates, Edinburgh, Scotland, UK, 17-21 July 2011.
  62. Boswell, R., Moridis, G.J., Reagan, M.T., and Collett, T.S., “Gas Hydrate Accumulation Types and Their Application to Numerical Simulation,” *Proc.* 7<sup>th</sup> International Conference on Gas Hydrates, Edinburgh, Scotland, UK, 17-21 July 2011
  63. Reagan, M.T., Moridis, G.J., Elliott, S.M., and Maltrud, M., “Simulation of Arctic Gas Hydrate Dissociation in Response to Climate Change: Basin-Scale Assessment,” OTC 22153, *Proc.* 2011 Arctic Technology Conference, Houston, Texas, USA, 7–9 February 2011.
  64. Rutqvist, J., Moridis, G.J., Kim, J., Reagan, M.T., “Geomechanical Performance Analysis of Potential Long-Term Tests of Gas Production from Hydrate Deposits in North Slope, Alaska,” OTC 22154, *Proc.* 2011 Arctic Technology Conference, Houston, Texas, USA, 7–9 February 2011.
  65. Moridis, G.J., Reagan, M.T., Kuzma, H.A., Zhao, Y., Boyle, K., Rector, J.W., “Evaluation of the Hydrate Deposit at the PBU L-106 Site, North Slope, Alaska, for a Long-Term Test of Gas Production,” OTC-22152, *Proc.* 2011 Arctic Technology Conference, Houston, Texas, USA, 7–9 February 2011.
  66. Reagan, M.T., Kowalsky, M.B., Moridis, G.J., Silpnngarmert, S., “The Effect of Reservoir Heterogeneity on Gas Production From Hydrate Accumulations in the Permafrost,” SPE 132649, *Proc.* 2010 SPE Western Regional Meeting, Anaheim, CA, 27-29 May 2010.

67. Moridis, G.J., Reagan, M.T., Boyle, K., Zhang, K., "Evaluation of a Deposit in the Vicinity of the PBU L-106 Site, North Slope, Alaska, for a Potential Long-Term Test of Gas Production from Hydrates," SPE 133601, *Proc. 2010 SPE Western Regional Meeting*, Anaheim, CA, 27-29 May 2010.
68. Moridis, G.J., Reagan, M.T., Boswell, R., Collett, T.S., Zhang, K., "Preliminary Evaluation of the Production Potential of Recently Discovered Hydrate Deposits in the Gulf of Mexico," OTC 21049, *Proc. 2010 Offshore Technology Conference*, Houston, Texas, USA, 3-6 May 2010.
69. Moridis, G.J., Collett, T.S., Pooladi-Darwish, M., Hancock, S., Santamarina, C., Boswell, R., Kneafsey, T., Rutqvist, J., Kowalsky, M.J., Reagan, M.T., Sloan, E.D., Sum, A.K., and Koh, C., "Challenges, Uncertainties and Issues Facing Gas Production From Hydrate Deposits in Geologic Systems," SPE-131792A, *Proc. SPE Unconventional Gas Conference*, Pittsburgh, Pennsylvania, USA, 23-25 February 2010.
70. Moridis, G.J., Reagan, M.T., Boyle, K.L., and K. Zhang, "Evaluation of the Gas Production Potential of Challenging Hydrate Deposits," *Proc. TOUGH Symposium 2009*, Lawrence Berkeley National Laboratory, 14-16 Sept. 2009.
71. Reagan, M.T., Moridis, G.J., and K. Zhang, "Large-Scale Simulation of Oceanic Gas Hydrate Dissociation in Response to Climate Change," *Proc. TOUGH Symposium 2009*, Lawrence Berkeley National Laboratory, 14-16 Sept. 2009.
72. Reagan, M.T., Moridis, G.J., Zhang, K., "Modeling of Gas Hydrate Instability and Methane Release in Response to Climate Change," LBNL-00712E, *Proc. 6<sup>th</sup> International Conference on Gas Hydrates*, Vancouver, BC, July 6-10, 2008.
73. Moridis, G.J., Reagan, M.T., Zhang, K., "The Use of Horizontal Wells in Gas Production from Hydrate Accumulations," *Proc. 6<sup>th</sup> International Conference on Gas Hydrates*, Vancouver, BC, July 6-10, 2008.
74. Reagan, M.T., Moridis, G.J., and K. Zhang, "Sensitivity Analysis of Gas Production from Class 2 and Class 3 Hydrate Deposits," LBNL-01657E, *OTC 19554, Proc. 2008 Offshore Technology Conference*, Houston, Texas, USA, 5-8 May 2008.
75. Moridis, G.J., Reagan, M.T., and K. Zhang, "Field-Scale Studies on the Enhanced Performance of Class 2 and Class 3 Hydrate Deposits Through Co-Production With Conventional Gas" *OTC 19435, Proc. 2008 Offshore Technology Conference*, Houston, Texas, USA, 5-8 May 2008.
76. Moridis, G.J., Kneafsey, T., Kowalsky, M., and M.T. Reagan, "Numerical, Laboratory and Field Studies of Gas Production from Natural Hydrate Accumulations in Geologic Media," OSTI Report 918665 (Dec. 2007).
77. Moridis, G.J. and Reagan, M.T., "Strategies for Gas Production From Oceanic Class 3 Hydrate Accumulations," LBNL-62758, *OTC 18865, Proc. 2007 Offshore Technology Conference*, Houston, Texas, USA, 30 April - 3 May 2007.
78. Moridis, G.J. and Reagan, M.T., "Gas Production From Oceanic Class 2 Hydrate Accumulations," LBNL-62757, *OTC 18866, Proc. 2007 Offshore Technology Conference*, Houston, Texas, USA, 30 April - 3 May 2007.
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80. Reagan, M.T., Najm, H.N., Knio, O.M., Ghanem, R.G., "Uncertainty Quantification in Reacting Flow Modeling," *Proc. WSS/CI Spring Meeting, 2004*, Davis, CA, USA, 29-30 March 2004.
81. Najm, H.N., Reagan, M.T., Knio, O.M., Ghanem, R.G., and O.P. LeMaître, "Uncertainty Quantification in Reacting Flow Modeling." Technical Report SAND2003-8598, Sandia National Labs, Livermore, CA, 2003.
82. Najm, H.N., Reagan, M.T., Debusschere, B.J., Knio, O., Ghanem, R., Le Maître, O.P., "Modeling Reacting Flow with Uncertainty Quantification," *Proceedings of the 19th International Colloquium on the Dynamics of Explosions and Reactive Systems (ICDERS)*, Hakone, Japan, July 27-August 1, 2003.
83. Reagan, M.T., Najm, H.N., Ghanem, R.G., Knio, O.M., LeMaitre, O.P., "A Spectral Method for Uncertainty Quantification in Reacting-Flow Simulations," *Proc. Third Joint Meeting of the US Sections of the Combustion Institute*, Chicago, IL, USA, 16-19 March 2003.
84. Reagan, M.T., Najm, H.N., Ghanem, R.G., and O.M. Knio, "Analysis of Parametric Uncertainty Propagation in Detailed Combustion Chemistry." *Proceedings of the 2<sup>nd</sup> MIT Conf. on Computational Fluid and Solid Mechanics*, Cambridge, MA, 1501-1505, 2003.

85. Reagan, M.T. and J.W. Tester, "The Zeno ( $Z=1$ ) Behavior of Water: A Molecular Simulation Study," *Proc. 14<sup>th</sup> Symposium on Thermophysical Properties*, Boulder, CO, June 2000.
86. Reagan, M.T. and J.W. Tester, "Molecular Modeling of Dense Sodium Chloride-Water Solutions Near the Critical Point." *Proc. Steam, Water, and Hydrothermal Systems*, Toronto, Ontario, 525-533, 1999.

#### **SUMMARIES, ABSTRACTS, AND FEATURES**

- "Massively Parallel Simulation of Oceanic Gas Hydrate Production," *J. Petroleum Technology* (July 2013).
- "Long-Term Gas Hydrate Production Test, North Slope, Alaska," *J. Petroleum Technology* (November 2012).
- "As Climate Changes, Methane Trapped Under Arctic Ocean Could Bubble to the Surface," *Today at Berkeley Lab*, May 5, 2011.
- "'Arctic Armageddon' Needs More Science, Less Hype," *Science*, **329**, 5992, 620-621, doi: 10.1126/science.329.5992.620 (August 2010).
- "Dissociation of Oceanic Hydrates in Response to Climate Change and the Biogeochemical Consequences," *Fire in the Ice*, DOE Methane Hydrates Program Bulletin.
- "Getting to the Bottom of Methane," (guest) PRI's Living On Earth, March 12, 2010.
- "A Sleeping Giant?" *Nature Reports Climate Change*, doi:10.1038/climate.2009.24 (April 2009).
- "The Hydrate Hazard," *Nature Reports Climate Change*, **3**, 14, doi:10.1038/climate.2009.11 (February 2009).
- "Toward Production from Gas Hydrate: Status, Technology, and Potential," *J. Petroleum Technology* (July 2008).
- "Gas Production from Oceanic Class 2 Hydrate Accumulations," *J. Petroleum Technology* (August 2007).

#### **INVITED PRESENTATIONS**

1. "Modeling at the Reservoir and Field Scales," (invited) Keynote Session, Gordon Research Conference on Natural Gas Hydrates, Galveston, TX, 25 February-2 March 2018.
2. "Massively Parallel, Field-Scale Simulation of Production from an Oceanic Gas Hydrate Deposit, and the Assessment of Production Challenges," (invited) Statoil Research Summit 2012, Trondheim, Norway, 15-17 Oct 2012.
3. "The Response of Marine Clathrates to Climate Change: Beyond the 'Clathrate Gun,'" (invited) Climate Sensitivity on Decadal to Century Timescales: Implications for Civilization, Aspen Global Change Institute, Aspen, CO, 24 May 2012.
4. "Simulation of Arctic Gas Hydrate Dissociation in Response to Climate Change: Basin-Scale Assessments" (invited) USGS/DOE Climate-Hydrates Research Workshop, Boston, MA, 15-16 March 2011.
5. "Climate Change and the Response of Oceanic Hydrate Accumulations," (invited) European Geosciences Union General Assembly, Vienna, Austria, 7 May 2010.
6. "Arctic Methane, Hydrates, and Global Climate" (invited), DOE Laboratory Energy R&D Working Group (LERDWG) Meeting, Washington, DC, 17 Feb 2010.
7. "Dynamic Response Of Oceanic Hydrate Deposits To Ocean Temperature Change" (invited), USGS Methane Hydrates Symposium, MIT, Cambridge, MA, 25-26 February 2008.

#### **PRESENTATIONS**

8. "Transport and Fate of Gas and Oil Escaping Through Failed Deep-Water Wells in the Oceanic Subsurface of The Gulf of Mexico," 2018 TOUGH Symposium, Berkeley, CA, 8-10- Oct 2018.
9. "Numerical Studies for the Characterization of Recoverable Resources from Methane Hydrate Deposits," Mastering the Subsurface, Carbon Storage and Oil and Natural Gas Conference, Pittsburgh, PA 13-16 August 2018.
10. "Numerical and Laboratory Investigations for Maximization of Production from Tight/Shale Oil Reservoirs: From Fundamental Studies to Technology Development and Evaluation," Mastering the Subsurface, Carbon Storage and Oil and Natural Gas Conference, Pittsburgh, PA 13-16 August 2018.

11. "Numerical and Laboratory Investigations for Maximization of Production from Tight/Shale Oil Reservoirs: From Fundamental Studies to Technology Development and Evaluation," Mastering the Subsurface, Carbon Storage and Oil and Natural Gas Conference, Pittsburgh, PA 1-3 August 2017.
12. "Long-Term Fate of Hydrate-Bearing Reservoirs During and After Production," (poster) B21G-0510, AGU Fall Meeting 2016, San Francisco, CA, 12-16 Dec 2016.
13. "Simulation of the Shale Oil System: from Molecular Fluid Dynamics to Reservoir Scale," Mastering the Subsurface, Carbon Storage and Oil and Natural Gas Conference, Pittsburgh, PA 16-18 August 2016.
14. "Numerical Simulation of Transport Between Fractured Tight/Shale Gas Reservoirs and Near-Surface Groundwater," 2015 TOUGH Symposium, Berkeley, CA 27-30 September 2015.
15. "Numerical Simulation of Subsurface Transport and Groundwater Impacts from Hydraulic Fracturing of Tight/Shale Gas Reservoirs," H51Q-07, AGU Fall Meeting 2014, San Francisco, CA, 15-19 Dec. 2014.
16. "Subsurface HF Migration Modeling," EPA-DOE-USGS Hydraulic Fracture Webinar Series, 27 Jan 2014.
17. "Analysis of the Potential Environmental Impact of Hydraulic Fracturing on Groundwater: Investigations of Coupled Flow, Geomechanics, and Contaminant Transport," A54H-05, AGU Fall Meeting 2013, San Francisco, CA, 9-13 Dec 2013.
18. "Thermodynamic and Geological Constraints to Climate-Driven Hydrate Dissociation Under Various Climate Change Scenarios," (poster) B33K-0620, AGU Fall Meeting 2013, San Francisco, CA, 9-13 Dec 2013.
19. "Unconventional Oil & Gas Program: Flow & Transport Overview," GE/DOE National Labs Unconventional Gas Summit, 16-18 April 2013.
20. "Unconventional Oil & Gas Program: Geomechanics Overview," GE/DOE National Labs Unconventional Gas Summit, 16-18 April 2013.
21. "Field-Scale, Massively Parallel Simulation of Production from Oceanic Gas Hydrate Deposits," OS34A-07, AGU Fall Meeting 2012, San Francisco, CA, 9-13 December 2012.
22. "Massively Parallel Simulation of Field-Scale Oceanic Gas Hydrate Deposits," 2012 TOUGH Symposium, Berkeley, CA, 17-19 September 2012.
23. "Massively Parallel Simulation of Field-Scale Oceanic Gas Hydrate Deposits," AIChE Spring Meeting, Houston, TX, 1-5 April 2012.
24. "Consequences of Hydrate Dissociation in Response to Climate Change," (poster) 2<sup>nd</sup> Gordon Research Conference on Natural Gas Hydrates, Ventura, CA, 18-23 March 2012.
25. "SeTES: A Self-Teaching Expert System for the discovery and production of natural gas in shales," Poster 1N51A-1571, AGU Fall Meeting 2011, San Francisco, CA, 5-9 December 2011.
26. "Basin-Scale Assessment of Hydrate Dissociation in Response to Climate Change," DOE Climate Science Meeting, Washington, DC, 19-21 Sept 2011.
27. "Basin-Scale Assessment of Hydrate Dissociation in Response to Climate Change," 7B.2, 7<sup>th</sup> International Conference on Gas Hydrates, Edinburgh, UK, 18-22 July 2011.
28. "A Self-Teaching Expert System (SeTES) for the Analysis, Design and Prediction of Gas Production From Unconventional Gas Resources," RPSEA Unconventional Gas Conference 2011, Denver, CO, 19-20 April 2011.
29. "Advanced Computation in Energy Science," LBNL Advisory Board—Early Career Panel, 29 March 2011.
30. "Simulation of Arctic Gas Hydrate Dissociation in Response to Climate Change: Basin-Scale Assessment," OTC 22153, 2011 Arctic Technology Conference, Houston, Texas, USA, 7–9 February 2011.
31. "Basin-Scale Simulation of Oceanic Gas Hydrate Dissociation in Response to Climate Change," AGU Fall Meeting 2010, San Francisco, CA, 13-17 December 2010.
32. "Oceanic Hydrates, Methane, Ocean Chemistry, and Climate," (poster) Gordon Research Conference on Natural Gas Hydrates, Colby College, Waterville, ME, 6-10 June 2010.
33. "The Effect of Reservoir Heterogeneity on Gas Production From Hydrate Accumulations in the Permafrost," SPE 132649, 2010 SPE Western North American Regional Meeting, Anaheim, California, 27-29 May 2010.



34. "Arctic Methane, Hydrates, and Global Climate," Environmental and Energy Technology Division Seminar, 17 March 2010.
35. "LBNL Research Program on Gas Production from Hydrates: Numerical Simulation Studies," NETL Methane Hydrates Program Symposium, Atlanta, GA, 25-29 Jan 2010.
36. "Interrelation of Global Climate and the Response of Oceanic Hydrate Accumulations," NETL Methane Hydrates Program Symposium, Atlanta, GA, 25-29 Jan 2010.
37. "Large-Scale Simulation of Oceanic Gas Hydrate Dissociation in Response to Climate Change," AGU Fall Meeting 2009, San Francisco, CA, 14-18 December 2009.
38. "Regional Simulation of Oceanic Gas Hydrate Dissociation in Response to Climate Change," (poster) TOUGH Symposium 2009, Berkeley, CA, 14 September 2009.
39. "Consequences of Methane Hydrate Destabilization," (poster) Climate Change Prediction Program Workshop, Bethesda, MD, 9 April 2009.
40. "Oceanic Gas Hydrate Dissociation In Response To Climate Change And The Fate Of Hydrate-Derived Methane," (poster), AGU Fall Meeting 2008, San Francisco, CA, 15-19 December 2008.
41. "Modeling Of Oceanic Gas Hydrate Instability And Methane Release In Response To Climate Change," (poster) 6<sup>th</sup> International Conference on Gas Hydrates, Vancouver, BC, 6-10 July 2008.
42. "The Use of Horizontal Wells in Gas Production from Hydrate Accumulations," (poster) 6<sup>th</sup> International Conference on Gas Hydrates, Vancouver, BC, 6-10 July 2008.
43. "Sensitivity Analysis of Gas Production from Class 2 and Class 3 Hydrate Deposits," OTC 19554, 2008 Offshore Technology Conference, Houston, Texas, U.S.A., 5-8 May 2008.
44. "Oceanic Gas Hydrate Instability And Dissociation In Response To Climate Change" GC14A-06, AGU Fall Meeting 2007, San Francisco, CA, 9-14 December 2007.
45. "Strategies for Gas Production From Oceanic Class 3 Hydrate Accumulations," OTC 18665, 2007 Offshore Technology Conference, Houston, Texas, U.S.A., 1-3 May 2007.
46. "Gas Hydrates and Global Climate: Dynamic Simulation Of Oceanic Gas Hydrate Dissociation And The Possible Consequences," Earth Sciences Division Seminar, 6 April 2007.
47. "Uncertainty Quantification in Reacting Flow Modeling," Western States Section of the Combustion Institute, Davis, CA, March 2004.
48. "Uncertainty Propagation in Reacting Flow Simulations Through Spectral Analysis," American Physical Society, Division of Fluid Dynamics, East Rutherford, NJ, November 2003.
49. "Spectral Methods for Uncertainty Quantification in Reacting Flow Systems," 7<sup>th</sup> US National Congress on Computational Mechanics, Albuquerque, NM, July 2003.
50. "Analysis of Parametric Uncertainty Propagation in Detailed Combustion Chemistry," 2<sup>nd</sup> MIT Conference on Computational Fluid and Solid Mechanics, Cambridge, MA, June 2003.
51. "A Spectral Method for Uncertainty Quantification in Reacting-Flow Simulations," 3<sup>rd</sup> Joint Meeting of the US Sections of the Combustion Institute, Chicago, IL, March 2003.
52. "Uncertainty Quantification through Spectral Projection," American Physical Society, Division of Fluid Dynamics, Dallas, TX, November 2002.
53. "Uncertainty Quantification through Non-Intrusive Spectral Projection," American Physical Society, Division of Fluid Dynamics, San Diego, CA, November 2001.
54. "The Zeno ( $Z=1$ ) Behavior of Water: A Molecular Simulation Study," 14<sup>th</sup> International Symposium on Thermophysical Properties, Boulder, CO, July 2000.
55. "Molecular Modeling of Dense Sodium Chloride-Water Solutions Near the Critical Point," 13<sup>th</sup> Annual Conference on the Properties of Water and Steam, Toronto, Ontario, September 1999.
56. "Molecular Dynamics Modeling of Supercritical Water Solutions," Oak Ridge National Laboratory, Dec. 1997.
57. "Molecular Dynamics Modeling of Supercritical Water Solutions," University of Tennessee at Knoxville,

December 1997.

## **SOFTWARE DEVELOPMENT AND TOOLS**

*TOUGH+* family of codes (HYDRATE, RealGasBrine, OilGasBrine)

*pTOUGH+*, massively parallel flow and transport in porous media.

*RealGasEOS/RealGasProperties*, package for multicomponent gas-phase equations of state

*WebGasEOS*, <http://esdtools.lbl.gov/gaseos/>

*TOUGH+Input*, <http://esdtools.lbl.gov/input/>

*TOUGH+MeshMaker*, <http://esdtools.lbl.gov/meshm/>

*SeTES*, (A Self-Teaching Expert System for the Prediction of Production from Unconventional Resources)

## **COLLABORATIONS, ADMINISTRATION, AND SERVICE**

Supervisor of 1 scientist, 2 postdocs, 3 LBNL contractors, 4 students (3 student assistants, 1 DOE pre-service teacher).

Managed finances, subcontracting, and reporting for 2 DOE-funded projects (~\$1.8M funding).

Managed finances, subcontracting, and reporting for 2 RPSEA-funded projects (~\$4.6M funding).

Session Chair, 2017 9<sup>th</sup> International Conference on Gas Hydrates (Denver, CO, 25-30 June 2017).

Member of TOUGH Symposium Organizing Committee (2015, 2018).

Member of organizing subcommittee and Session Chair, 2011 Canadian Unconventional Resource Conference (Calgary, AB, 15-17 Nov. 2011).

Organizer, RPSEA Workshop “Accessible Software Developed for Application to Unconventional Resources,” June 30, 2011, Houston, TX.

Peer reviewing (papers and proposals):

*Research Council of Norway (PETROMAKS 2016, 2017)*

*Geophysical Research Letters*

*Journal of Geophysical Research*

*Nature Geoscience*

*Earth and Planetary Science Letters*

*SPE Journal*

*Water Resources Research*

*Geochimica et Cosmochimica Acta*

*Journal of Petroleum Science and Engineering*

*Advances in Water Resources*

*Journal of Marine and Petroleum Geology*

*Polar Research*

*American Chemical Society*

*Applied Energy*

*Industrial & Engineering Chemistry Research*

*Chemical Engineering Science*

*Energy & Fuels*

*Journal of Natural Gas Science & Engineering*

*Journal of Supercritical Fluids*

*Chemical & Biochemical Engineering Quarterly*

External Collaborations:

Ingo Pecher, Paul Oluwummi, Rosalind Archer, University of Auckland (Methane hydrates and sea-level change)

Scott Elliott, Mathew Maltrud, and Philip Jones, Los Alamos National Laboratory (Methane hydrates and climate change)

Thomas Blasingame, Texas A&M University (Shale gas production simulation and resource estimation)

Philip Cameron-Smith, Dan Bergmann, Lawrence Livermore National Laboratory (Methane hydrates and atmospheric chemistry)

Ian MacDonald, Florida State University (Methane hydrates in the Gulf of Mexico)

Michael Nikolaou, Univ. of Houston (Statistical data reduction and expert system development)

Heidi A. Kuzma, East Donner Research (Uncertainty Quantification, Expert System software development)

Olivier Le Maître, Université d'Evry Val D'Essoné, Evry, France and Omar M. Knio, Dept. of Mechanical Engineering, Johns Hopkins University (Intrusive reformulation of reacting flow simulations and applications of non-intrusive spectral projection methods)

## TEACHING EXPERIENCE

LAWRENCE BERKELEY NATIONAL LABORATORY, **Instructor**, TOUGH+Hydrate Training Course, **2006, 2009, 2012, 2014, 2015**, TOUGH+Shale Training Course, **2014**.

LAWRENCE BERKELEY NATIONAL LABORATORY, **Mentor**, Pre-Service Teaching program (UC/CalTeach), **Summer 2009**.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, **Postdoctoral Teaching Fellow**, graduate thermodynamics. **Fall 2000**.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, **Teaching Assistant**, advanced graduate thermodynamics and statistical mechanics. **Spring 1999 and Spring 2000**.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, **Teaching Assistant**, graduate thermodynamics. **Fall 1996**.

## REFERENCES

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