Petroleum System Characterization of Terrebonne Mini-Basin Gas Hydrates in NW Walker Ridge Area (Gulf of Mexico)

Laura Dafov*

Co-authors: Allegra H. Scheirer, Ray Boswell, & Yongkoo Seol

Advisor: Professor Stephan Graham

*ldafov@stanford.edu

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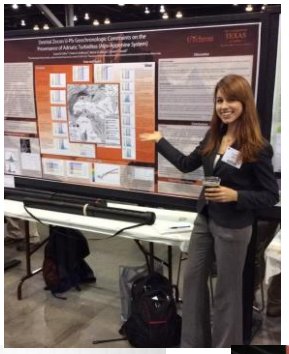
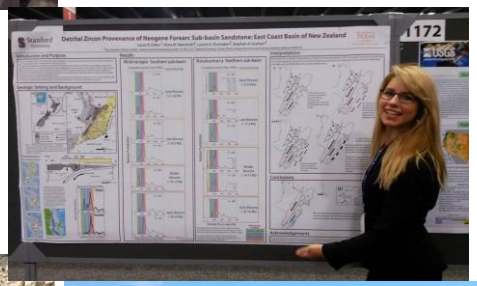
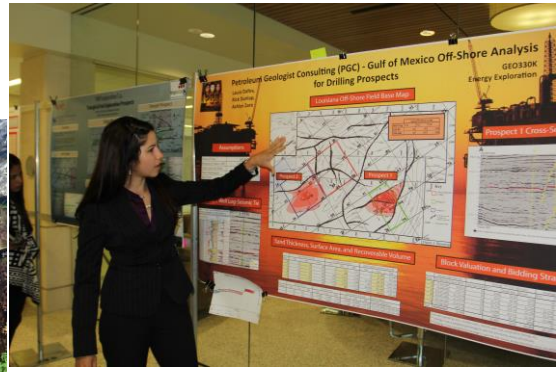
Basin and Petroleum System Modeling (BPSM) Industrial Affiliates Program 2016

About Me

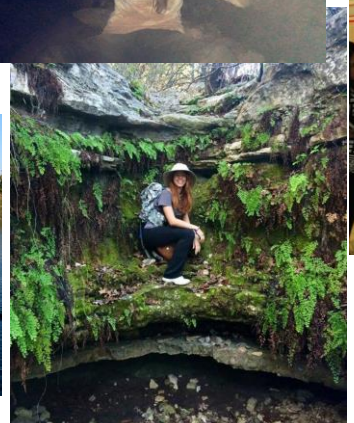
- 2012-2016 Bachelor of Science, with Honors, Geological Sciences. Jackson School of Geosciences (University of Texas at Austin).
- 3 completed research projects. 2 co-authored papers in *Geology* and *Marine and Petroleum Geology*.
- Presented 8 first-author posters of 9 total. Including 3 AGU conferences, GSA, JSG, GSA-Italy meeting.
- NSF-GRFP Honorable Mention, AGU GSA and NSF travel grants, scholarships, and 2 best poster awards.
- Officer of UT Geosciences Leadership Organization for Women.
- Energy Exploration (Prof. Peter Flemings), Construction and Interpretation of 3D Stratigraphy using Kingdom Suite (Prof. David Mohrig), Advances in Unconventional Shale Gas Resources (Prof. Farzam Javadpour).





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Motivation

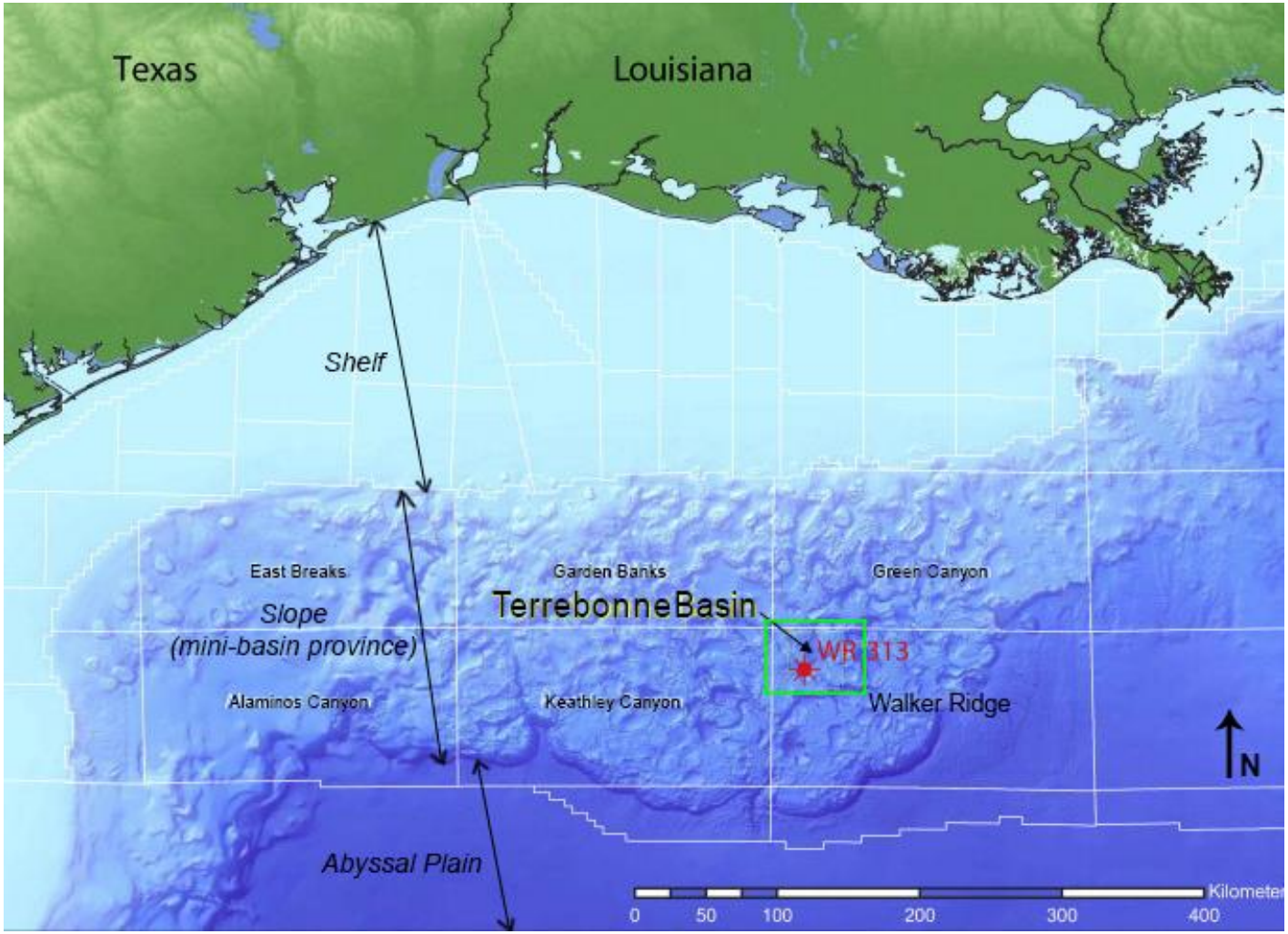
- Gas hydrates hold vast volumes of methane and affect a wide range of scientific interests including drilling hazards, potential future energy resource, global carbon cycling, geohazards, and climate change.

- The Bureau of Ocean Energy Management estimates 607 trillion cubic meters (21,444 trillion cubic feet) of gas hydrates in place in the Gulf of Mexico (GoM) alone (Boswell et al., 2012).

- Although total global estimates of gas hydrate volumes vary, even the most conservative estimates consider methane hydrates to be the world's largest reservoir of fossil fuel with it potentially being at least 3 times larger than all of the world's conventional and unconventional oil, gas and coal combined (Wygrala et al., 2016).

- There is great opportunity for improving our understanding of gas hydrates through the BPSM approach due to its sophisticated treatment of subsurface pressure and temperature through time with very short time steps and very fine spatial resolutions.

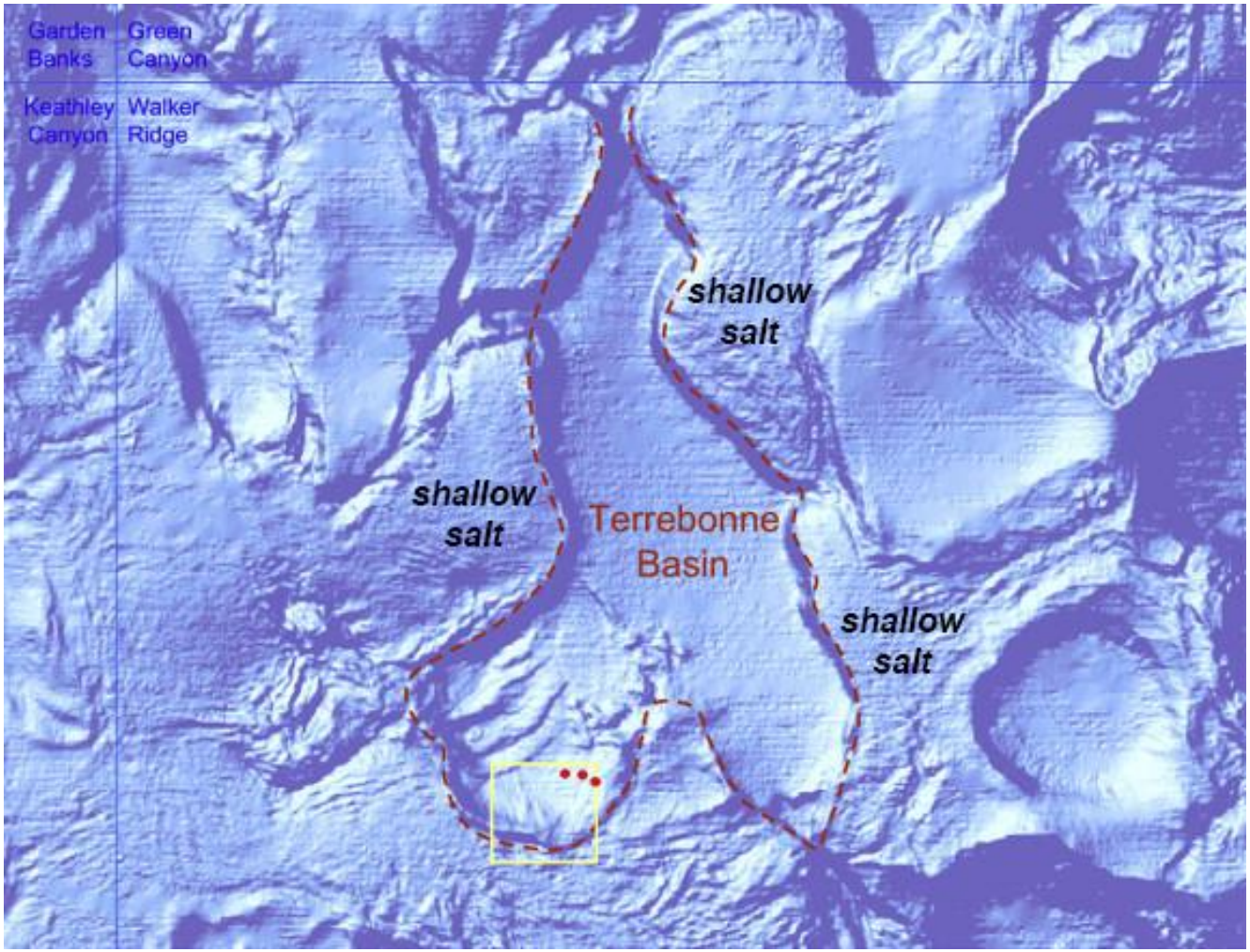
Study Area



The Terrebonne Basin in the northern GoM continental slope, a salt-withdrawal mini-basin in northwest Walker Ridge (WR) Area, including WR Block 313.

MODIFIED FROM FRYE ET AL., 2012 AND BOSWELL ET AL. 2012.

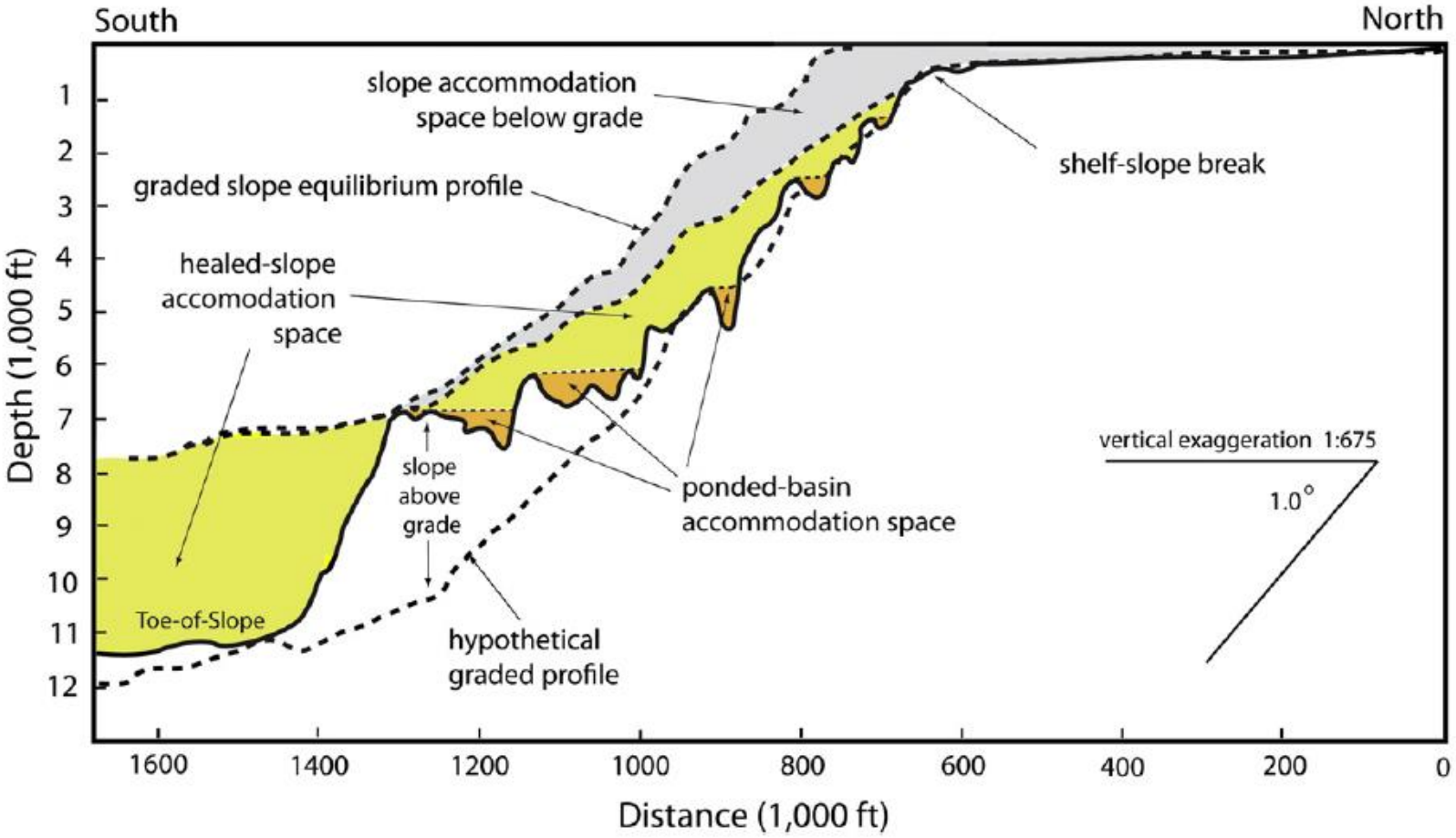
Study Area



The 2009 GoM Gas Hydrates Joint-Industry-Project (JIP) Leg II drilling program provides much of the background data necessary for constructing an Earth model of the region for gas hydrate modeling.

Modified from Frye et al., 2012 and Boswell et al. 2012.

Background- GoM Slope

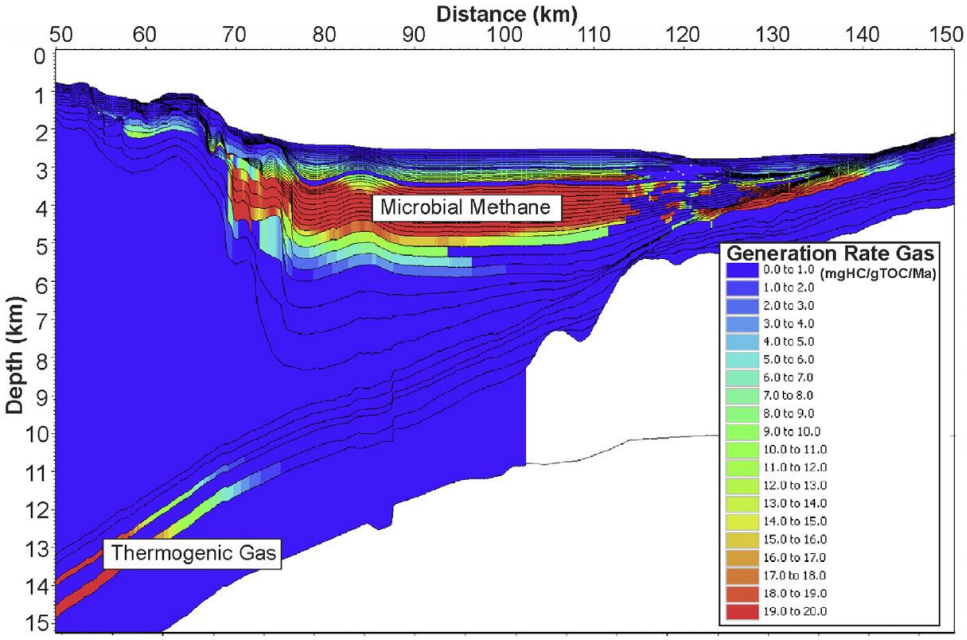


BOSWELL ET AL. 2012.

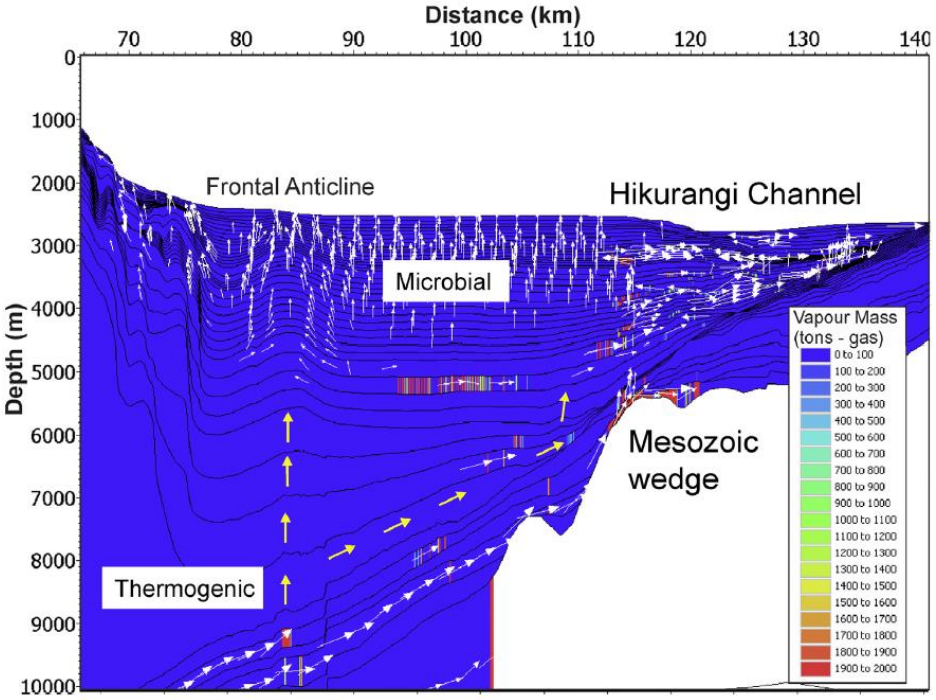
In the northern GoM, high sedimentation rates and salt tectonics result in modification of the basin topography from the idealized profile for a passive continental margin. The resultant mini-basins produce depositional gradient changes that enhance the potential for coarse-grained sediment deposition within the slope (from Prather, 2000).

Background- Gas Hydrate Modeling, Pegasus Basin

Integrated 2D model of thermal and microbial generation of methane, migration into the gas hydrate stability zone, and formation of methane hydrates.



Predicted generation rates for microbial and thermogenic methane. Note that generation of oil has not been modelled. Shallow (<200 m) methanogenesis is not shown.(K.F. Kroeger et al., 2015).



Results of the 2D model (K.F. Kroeger et al., 2015).

Purpose

Proposed work:

1) New method development- Construct a 4D basin model and integrate with a high-resolution deep-water sediment flow model.

2) Identify and characterize the petroleum system(s) of gas hydrate rich basin.

3) Geochemical analyses of gas hydrates and related source rock(s).

Questions addressed:

1) What is the actual history of these deposits with respect to the gas hydrate stability zone (GHSZ), recognizing that this area is not one characterized by simple continuous sedimentation and subsidence, but instead by periodic uplift, tilting, plate rotation, sea-level change, salt tectonics, and evolution of temperature gradients.

2) Do you need deep source/long migration to achieve the observed result.

1) 4D Basin model of entire Terrebonne mini-basin

- We are not aware of a published 4D BPSM of the Terrebonne.
- Submarine channel and fan architecture.
- Look at sea-level change, tilting of plates, and tectonic reconstruction.
- Characterize the depositional system.
- Use seismic of entire mini-basin.
- New method development: Integrate high-resolution deep-water sediment flow modeling with BPSM 4D basin model.

2) Identify and characterize petroleum system(s)

- Using Les Magoon method.
- Identify deep Jurassic (and other) source rocks, pathways, reservoirs, traps all leading to and related to the gas hydrates.
- Name the petroleum system(s).
- Ideally, collect supplementary data and geochemical analyses to support interpretations…

3) Geochemical analyses of gas hydrates and source rock

- Permeability, porosity, water-saturation, pore pressure, biomarker fingerprints, and more. Adjust to horizons (GHSZ).
- Possible participation on future research cruise to collect pressurized core, LWD, and/or MWD in key area(s) of interest based off insight gained from parts 1) and 2) to support (prove or disprove) interpretations.
- Integrate above data analyses with parts 1) and 2) to add clarity to final, big picture, 4D BPSM product.
- Overall, use conventional geology/geophysics exploration methodology to further show that conventional exploration methods work for gas hydrates exploration.

Conclusion

- Tentative project is in early development (started 1 month ago). Subject to change.
- BPSM can capture the temporal (and thus spatial) variability in gas hydrate deposits as well as changing conditions in the water column that can affect the gas hydrate stability zone. BPSM has been called the ‘great integrator’ in petroleum exploration (Hosford Scheirer, 2014).
- Development of a BPSM model of gas hydrates in the Terrebonne mini-basin of the northern GoM will provide a vehicle within which to integrate other early exploration and assessment research being conducted on gas hydrates, a resource likely to provide many decades of energy if proven to be commercially producible in the future.
- Basin model may benefit from incorporating results from the comprehensive gas hydrate task at NETL.
- Great opportunity for integration of experimental and numerical modeling.
- Please feel free contact me if you’d like to give me feedback, collaborate, contribute data, ask questions, talk science, etc. ☺

2016 BPSM Affiliates

with special thanks to Schlumberger and NETL