Gulf of Mexico Basin Depositional Synthesis

2019

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Next GBDS Meeting

January 2020

Austin, TX, Pickle Research Campus, ROC 196

Half-day hands-on GBDS GIS Workshop

Full-day of GBDS Research Presentations

GBDS Project Update—John Snedden

With the end of Phase XII fast approaching (January, 2020), it is a good time to reflect upon past efforts and a way forward into Phase XIII, GBDS's 26th year in operation. We have fully rebounded from the 2014-2016 downturn with four new companies and one returning Industrial Associate member company. GBDS students now work at or have internships at many of the IA companies including Chevron, ExxonMobil, Total, Hilcorp, EOG; several continue studies at universities like Stanford, UT-Austin, LSU, Kansas and others.

New GBDS staff and students are introduced in the following pages, injecting new enthusiasm and ideas into our work. Yet we also benefit from the continuing contributions of people like Bill Galloway, Craig Fulthorpe, Jon Virdell, Tim Whiteaker, Robert Cunningham, Ian Norton, Marcie Phillips, and Chris Lowery.

A two-year plus effort, largely in the background (e.g. weekends, evenings, vacations), will be completed with 4Q19 publication of the new Cambridge University Press book, The Gulf of Mexico Sedimentary Basin: Depositional Evolution and Petroleum Applications, by myself and Bill Galloway. We hope this book will serve as a useful reference for those new to and those wanting to learn more about this important basin, as it represents the sum of 26+ years of scientific investigation. It should be mentioned that paleogeographic maps included in the book are, by necessity, a simplified graphical summary of the detailed ARCGIS maps in the GBDS atlas and ARCGIS project.

We are still planning our Phase XIII work and scientific goals and offer some ideas for that new phase to begin in 2020. However, we still encourage your suggestions and feedback as we finalize that list .

Richard T. Buffler Post-Doc

Dr. Zach Sickmann has been selected as the second awardee for The University of Texas at Austin Institute for Geophysics Buffler Post-Doctoral Fellowship. Dr. Sickmann will work with GBDS for a 2-year period starting in June 2019. Dr. Sickmann is an expert in source-to-sink sediment dispersal, detrital signal propagation and basin analysis. He received his Bachelors of Science from Trinity University in 2012 during which time he worked on Cordilleran forearc tectonics and provenance analysis in the Pacific Northwest. After Trinity Dr. Sickmann worked for Southwest Research Institute on the mechanical stratigraphy and sedimentology of the Eagle Ford and Austin Chalk Formations in central and west Texas before beginning his PhD with Dr. Steve Graham at Stanford University in 2013. During his time at Stanford, Dr. Sickmann worked on the tectonic and stratigraphic evolution of the Magallanes-Austral Foreland Basin in southern Patagonia and on source-to-sink sand dispersal along the modern California coast. After graduating from Stanford in 2018, Dr. Sickmann was a postdoctoral research affiliate and a lecturer in the department here at UT before joining UTIG and GBDS this summer.

Recent Graduates

Mario Andres Gutierrez, M.S.

Mario completed his M.S. in Geological Sciences from UT Austin Jackson School of Geosciences in May, 2018. His thesis ***Systematic Lithologic Characterization of Pleistocene Mass-Transport Deposit, Mississippi Canyon of the Northern Gulf of Mexico, USA*** focused on stratigraphic interpretation on the distal Neogene extent of the Mississippi Fan in Southern Gulf of Mexico. He utilized 3D seismic data, multibeam data, and other available geological and geophysical information to evaluate the Pliocene/Pleistocene sediment transport and channels of the Mississippi Fan.

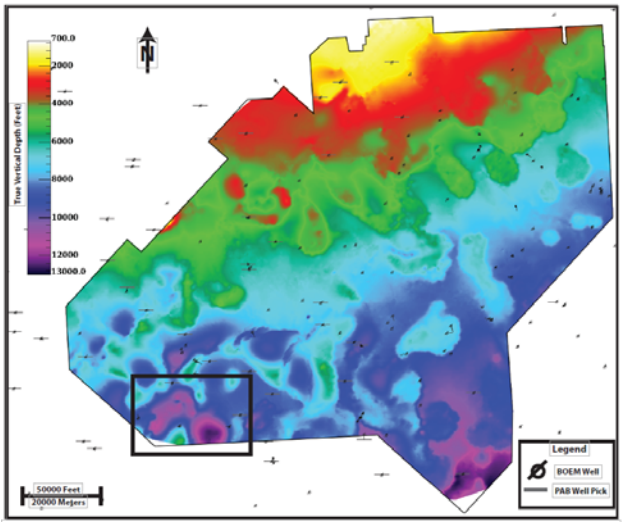


Figure Depth Structure Map of the PAB seismic horizon. Location of BOEM wells and PAB well picks used in this study. The black rectangle outlines the location of the Ursa MTD that is characterized and calibrated in this study.

Current Graduate Students

Fernando Apango

Fernando is working on his M.S. in Energy and Earth Resources at UT Austin Jackson School of Geosciences. His thesis ***Analysis of Hydrocarbon Under-Filled Miocene Deep-Water Reservoirs, Eastern Mexico Offshore*** is focusing on determining the causes for under-filled structures in eastern Mexico offshore Miocene reserves using data from two Pemex wells Kunah-1 and Yoka-1 as case studies. The potential causes that are being investigated are top seal leakage, unmapped shallow spill points, and late trap formation.

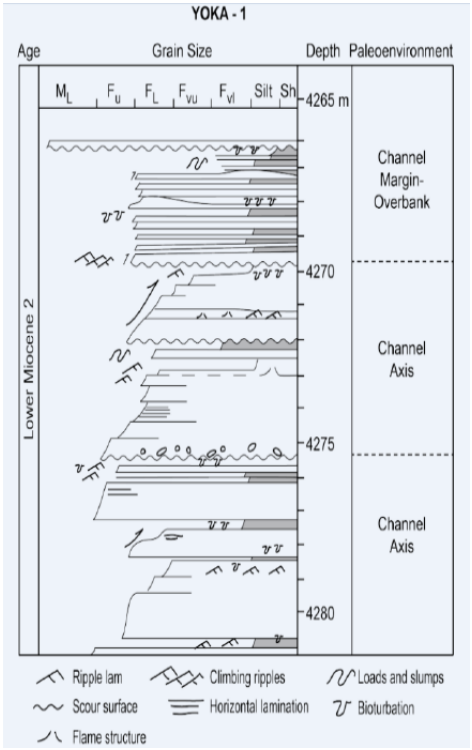


Figure Core description performed for a portion of the Yoka-1 Lower Miocene interval.

Will Waltrip

Will is working on his M.S at UT Austin Jackson School of Geosciences investigating differences in reservoir quality, depositional environment, field structures, and trapping mechanisms of production plays in South Texas within the Wilcox, Olmos, Frio, and Vicksburg formations. The goal of his thesis will be to provide additional insights on how these differences effect the quality and life of a well producing out of these formations.

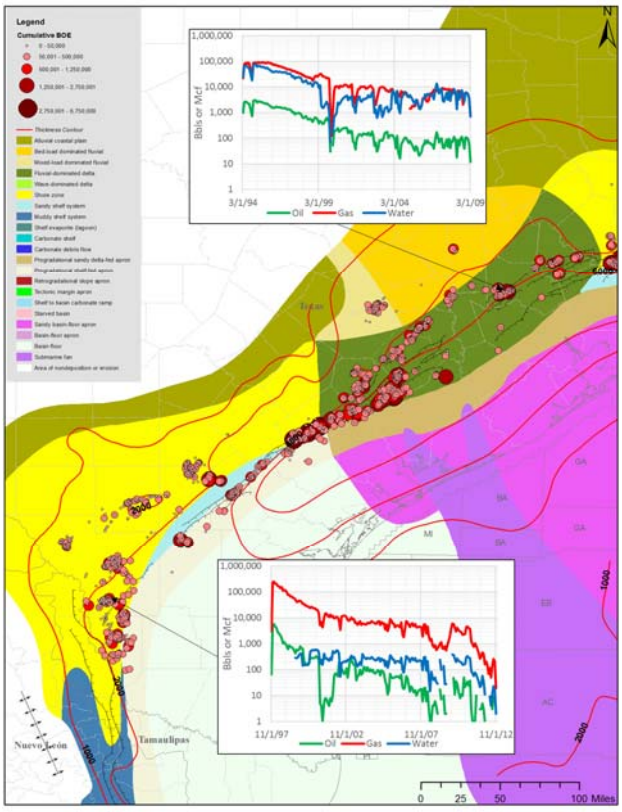


Figure Map and two Lower Wilcox decline curves, one in a shore zone depositional environment and the other in a fluvial-dominated deltaic environment. The fluvial-dominated deltaic decline curve shows a much longer plateau and more water production.

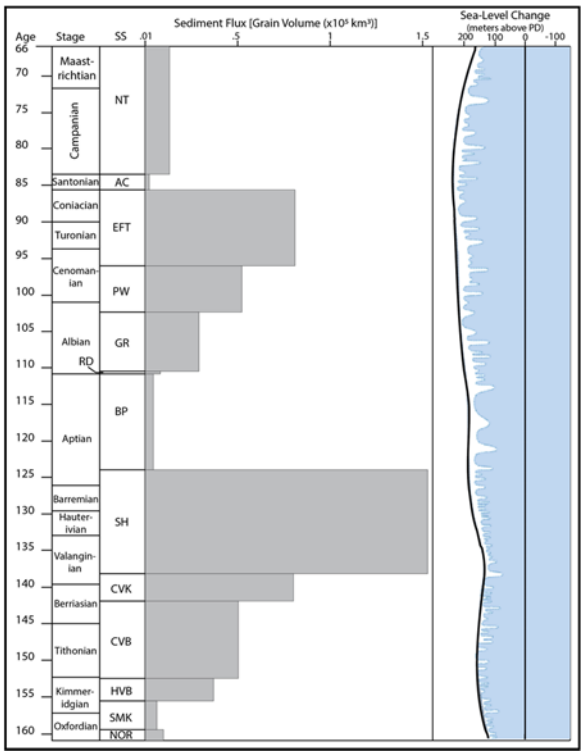


Figure 17 Grain volume results for Mesozoic supersequences plotted against eustatic sea level curve.

Harry Hull

Harry completed his B.S. in Geological Sciences from UT Austin Jackson School of Geosciences in May of 2019. For his undergraduate honors thesis Harry identified and tabulated the volume of siliciclastic sediments for the Northern Gulf during the Mesozoic for 13 supersequences previously defined by seismic and well data by the GBDS project. The goal was to understand temporal fluctuations and spatial variation in sedimentation and to quantify changes in sedimentation to specific geologic events. Using GIS models and tools surfaces were interpolated from sandstone thickness maps to generate porosity surfaces and calculate grain volume.

GoMCarb Project

In the fall of 2018, the GBDS joined the Gulf of Mexico partnership for carbon capture and offshore geologic storage, also known as GoMCarb, to investigate offshore carbon storage potential near the Chandeleur Islands, offshore Louisiana. This research is funded by the Department of Energy (DOE) and the National Energy Technology Lab (NETL) and managed by the Bureau of Economic Geology's (BEG) Gulf Coast Carbon Center (GCCC). GoMCarb is an extensive collaboration that includes multiple academic institutions and energy-related businesses in addition to the GBDS group. The GoM has great potential for carbon capture and storage (CCS) because the offshore geology in the basin is well-understood thanks to decades of data, it's a high-volume regional geologic sink with high-quality seals, and because offshore geologic reservoirs provide the most viable near-term, low-cost and low-risk storage options. The project is examining multiple areas all along the northern Gulf Coast for CCS potential. GBDS is focused particularly on an area called the Chandeleur Island 3D Seismic Survey Area. Initial objectives are the examination of the Chandeleur Island 3D SA biostratigraphy-based interpretations of Cenozoic stratigraphic boundaries, integration with previously interpreted local stratigraphy, and fault interpretation. From this, potential traps and seals will be investigated (with emphasis in the Miocene). Ongoing research includes geological history, oil and gas exploration history, and characterizing the depositional environment.

Partnership for carbon capture & offshore geologic storage
GoMCarb

The Gulf of Mexico Sedimentary Basin

Depositional Evolution and Petroleum Applications

John W. Snedden and **William E. Galloway**

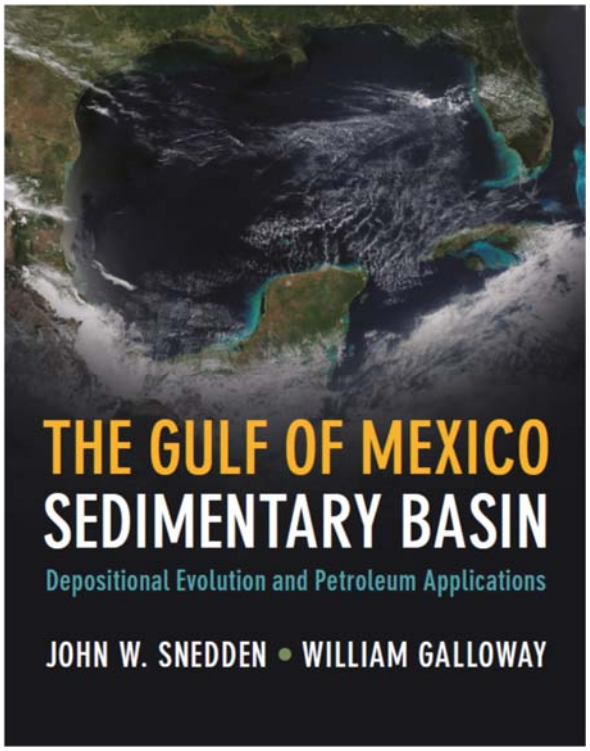
The University of Texas, Austin *The University of Texas, Austin*

The Gulf of Mexico Basin is one of the most prolific hydrocarbon-producing basins in the world, with an estimated endowment of 200 billion barrels of oil equivalent. This book provides a comprehensive overview of the basin, spanning the US, Mexico and Cuba. Topics covered include conventional and unconventional reservoirs, source rocks and associated tectonics, basin evolution from the Mesozoic to Cenozoic Era, and different regions of the basin from mature onshore fields to deep-water subsalt plays. Cores, well logs and seismic lines are all discussed providing local, regional and basin-scale insights. The scientific implications of seminal events in the basin's history are also covered, including sedimentary effects of the Chicxulub Impact. Containing over 200 color illustrations and 50 stratigraphic cross-sections and paleogeographic maps, this is an invaluable resource for petroleum industry professionals, as well as graduate students and researchers interested in basin analysis, sedimentology, stratigraphy, tectonics and petroleum geology.

Part I. Introduction: 1. Introduction: tectonic and stratigraphic framework;

Part II. Mesozoic Depositional Evolution: 2. Post-orogenic successor basin-fill and rifting phase; 3. Middle Mesozoic drift and cooling phase; 4. Late Mesozoic local tectonic and crustal heating phase;

Part III. Cenozoic Depositional Evolution: 5. Cenozoic depositional history 1: Paleogene Laramide phase; 6. Cenozoic depositional history 2: Middle Cenozoic geothermal phase; 7. Cenozoic depositional history 3: Neogene tectono-climatic phase; 8. Cenozoic depositional synthesis; Part IV. Petroleum Habitat: 9. Gulf of Mexico petroleum habitat;



Available October 2019

For more information, and to order, visit:
www.cambridge.org/9781108419024

Mexico

Since the opening of Mexico to international exploration in 2015, GBDS has continued to expand its scientific and practical mapping approach to this important part of the basin. We recently graduated our 3rd MS candidate, Fernando Apango (second UNAM graduate), whose thesis focused on Mexico (see page 3). This has allowed GBDS to build credibility with CNH and other government authorities.

While recent political changes have dampened enthusiasm somewhat, ultimately Mexico will return to exploration. We believe that now is an excellent time to do the regional work that supports play derisking, prospect identification, and maturation. We certainly will learn much from the new set of wells being drilled in the next few years. The May Geological Society of London Conference on Mexico featured a number of important presentations on this evolving work, and I was glad to participate and present two papers.

Toward this end, we are taking a more fundamental approach to the Cenozoic and Mesozoic tectonostratigraphy of Mexico and its implications for sediment routing into the basin. Zach Sickmann (see page 2) brings a wealth of knowledge and experience working active margins of California and Patagonia. Our enhanced relationship with Dr. Daniel Stockli (UT Geothermochronology Lab) will also provide new ideas, as it has already for the Oxfordian of Mexico.

We also believe that insights from the Northern Gulf of Mexico will apply to the southern Gulf and vice-versa. Lessons learned from US Norphlet play drilling will apply to the Mexico Oxfordian sandstone play. Phase 12 completes our work on the US pre-salt play and start of work on the southern GoM Pre-salt play. It is important to note that GBDS works the entire basin, in contrast to projects focused strictly on Mexico. Cross-border plays in the Burgos basin also may become important for Texas onshore operators, as Mexico seeks new ways to reverse production declines.

Onshore Well Database Expansion

Recently GBDS hired a new consultant, Annie Walker, who will be focusing on adding and refining GBDS onshore seismic interpretations with emphasis on the South Texas extensional province by tying to and targeting Upper Cretaceous (Olmos, Escondido, San Miguel), Wilcox, and Frio-Vicksburg reservoirs). She will also Identify faults, welds, salt structures, and correlate key seismic stratigraphic surfaces: LW, MW, UW, QC, YC, JS, (and possibly LM1 and LM2) near the modern shoreline. She'll be carrying these correlations through available seismic in the GBDS database from the Texas/Mexico border to the Mississippi/Alabama area. She will also be enhancing the onshore well database by identifying areas of interest needing more control and add well locations by iterating between seismic and logs, correlating to nearby wells, and checking against existing GBDS maps.

Awards

Dr. John Snedden recieved the 2019 University of Texas Institute of Geophysics Directors Circle of Excellence award.

Publications

Snedden, J.W., and Galloway, W.E., in production, **The Gulf of Mexico Sedimentary Basin: Depositional Evolution and Practical Applications**: Cambridge University Press, scheduled for release 4Q19. 160k words, 245 figures, 3 tables and 2 online posters.

Snedden, J.W., Tinker, L.D., and J. Virdell, 2018, **Southern Gulf of Mexico Wilcox Source-to-Sink: Investigating and Predicting Paleogene Wilcox Reservoirs in Eastern Mexico Deep-water Areas**; AAPG Bulletin, v. 102, no. 10 (October 2018), pp. 2045– 2074.

Snedden, J.W., Galloway, W.E., Milliken, K.T., Xu, J., Whiteaker, T., and Blum, M.D., 2018, **Validation of empirical source-to-sink scaling relationships in a continental-scale system: The Gulf of Mexico basin Cenozoic record**: Geosphere, v. 14, no. 2, p. 1–17, doi:10.1130/GES01452.1.

Milliken, K.T., Blum, M.D., Snedden, J.W., and Galloway, W.E., 2018, **Application of fluvial scaling relationships to reconstruct drainage-basin evolution and sediment routing for the Cretaceous and Paleocene of the Gulf of Mexico**: Geosphere, v. 14, no. 2, p. 1–19, doi:10.1130/GES01374.1.

Lowery, C. M., Cunningham, R., Barrie, C. D., Bralower, T., & Snedden, J. W., 2017, **The northern Gulf of Mexico during OAE2 and the relationship between water depth and black shale development**. Paleoceanography, 32, 1316–1335. https://doi.org/10.1002/2017PA003180

Xu, J., Stockli, D.F., and Snedden, J.W., 2017, **Enhanced provenance interpretation using combined U–Pb and (U–Th)/He double dating of detrital zircon grains from lower Miocene strata, proximal Gulf of Mexico Basin, North America**: Earth and Planetary Science Letters, v. 475, p. 44–57.

Blum, M.D., Milliken, K.T., Pecha, M.A., Snedden, J.W., Frederick, B.C., and Galloway, W.E., 2017, **Detrital-zircon records of Cenomanian, Paleocene, and Oligocene Gulf of Mexico drainage integration and sediment routing: Implications for scales of basin-floor fans**: Geosphere, v. 13, no. 6, p. 1– 37, doi:10.1130/GES01410.1.

Kinsland, G. L., K. Shellhouse, E. Muchiri, J. W. Snedden, and J. W. Virdell, 2017, **Midway Shale: Post-Cretaceous /Paleogene boundary deposition**: Gulf Coast Association of Geological Societies Transactions, v. 67, p. 177–185.

Xu, J., Snedden, J.W., Galloway, W.E., Milliken, K.T.,and M.D. Blum, 2016, **Channel-belt scaling relationship and application to early Miocene source-to-sink systems in the Gulf of Mexico basin**: Geosphere, v. 13, mo. 1, p. 179-200.

Xu, J., Snedden, J.W. Stockli, D.F., Fulthorpe, C.S., and W. E. Galloway, 2016, **Early Miocene continental-scale sediment supply to the Gulf of Mexico Basin based on detrital zircon analysis**: Geological Society of America Bulletin, doi: 10.1130/B31465.1

In Review

Cunningham, R., Phillips, M., Snedden, J.W., Norton, I., Virdell, J.W., and Barrie, C., 2019, **The Paleocene-Eocene Thermal Maximum (PETM) in Deepwater Gulf of Mexico: A New Paleogene Source Rock and Basin-scale Paleoceanographic Model:** AGU Paleoceanography and Paleoclimatology.

Presentations

GoMCarb/SECARB Partnership Meeting 2019, **Investigating offshore carbon storage potential of Chandeleur Island 3D seismic survey area, offshore Louisiana**

AAPG 2019, **Provenance evolution of Paleocene-Miocene Guadalupe-Live Oak deltas in South Texas: Insights from detrital zircon geochronology**

Presentations Cont.

GSL Petroleum Geology of Mexico and the Northern Caribbean 2019, **Analysis of modern Mexico drainage systems: insights and predictions for post-Middle Miocene deepwater reservoir distribution and quality.**

GSL Petroleum Geology of Mexico and the Northern Caribbean 2019, **Paleogeographic and Depositional Reconstruction of Oxfordian Aeolian Sandstone Reservoirs in Mexico offshore areas: comparison to the Norphlet aeolian play of the Northern Gulf of Mexico .**

Phase 13 Proposed Tasks

Past phases of the GBDS research project have emphasized basin wide mapping of the 34 tectonostratigraphic units from Pre-salt to Pleistocene. Now that all petroleum system-relevant Gulf of Mexico large scale units have been identified and mapped, Phase XIII will focus on subdividing, correlating, and mapping deposodes and supersequences at a higher stratigraphic resolution. This will permit more direct ties to reservoirs, seal rocks, and source rocks for both conventional and unconventional systems. For example, the Lower Wilcox deposode (akin to a supersequence) spans a duration of roughly 8 my and clearly is an aggregate of multiple sequences. Seal rocks within the Wilcox often occur at a higher frequency, as several pressure offsets are notable in many Wilcox wells.

New Goals:

- Subdivision of GBDS Units Pleistocene (PS) to Pre-salt (EM) at a higher stratigraphic resolution, documented by well log cross-section and mapping.
- Identification of key reservoir- and seal rocks embedded within the these higher resolution stratigraphic units, Northern and Southern GoM
- Recognition of pressure-barriers within higher resolution units using available MDT, RCI or other pressure datasets, Northern and Southern GoM
- Evaluation of regional trends in production (decline curves, cumulative discoveries resources, creaming curves) for Olmos, Wilcox, Yegua, and Frio/ Vicksburg trends of Texas and Louisiana

Continue current work including:

- Source to sink analyses (ongoing collaboration with UT Geothermochronology Lab)
- Large scale tectonostratigraphy (particularly in Mexico, Zach Sickmann)
- Source rock measurements and mapping (R. Cunningham).
- Evergreen existing ARCGIS database with new well data and published papers from the US and Mexico (Tim Whiteaker and Jon Virdell).

GBDS Core Research Staff

Gulf Basin Depositional Synthesis

The University of Texas at Austin

John Snedden, Director, Principal Investigator, and Senior Research Scientist. Ph.D., Louisiana State University, 1985. His expertise lies in sequence stratigraphy and sedimentology. Past publications include papers on reservoir connectivity, exploration play analysis, unconventional reservoirs, chronostratigraphic designation of sequences, and modern depositional systems. He has over 30 years of industry experience with Mobil and ExxonMobil. jsnedden@ig.utexas.edu

William Galloway, Research Scientist and Professor Emeritus, Ph.D., The University of Texas at Austin, 1971. His interests are sedimentary and mineral resource geology especially that of the geology of the Gulf of Mexico Cenozoic basin. galloway@austin.utexas.edu

Craig Fulthorpe, Senior Research Scientist, Ph.D., Northwestern University, 1988, is interested in the sedimentary geology of continental margins. Much of his work has been in association with the Integrated Ocean Drilling Program. Craig is working on the Cenozoic of the GOM basin. craig@utig.ig.utexas.edu

Tim Whiteaker, Research Scientist, Ph.D., The University of Texas at Austin, 2004; Research interests: GIS in water resources engineering, data modeling and analysis of subsurface systems in both hydrological and geophysical applications. whiteaker@utexas.edu

Jon Virdell, Project Manager, B.A. The University of Texas at Austin, 2014. Supports the management and development of the GBDS database. Experience working with GIS, geophysical well logs, seismic data, and published literature. jvirdell@utig.ig.utexas.edu

Associated Research Staff:

Ian Norton, Senior Research Fellow at UTIG and BEG, Ph.D., The University of the Witwaresrand, South Africa, 1978. His interests are structure and tectonics, especially in extensional domains like the Basin and Range and passive margins of the Gulf of Mexico and South Atlantic. norton@utig.ig.utexas.edu

Chris Lowery, Research Associate, Ph.D. University of Massachusetts, 2015. Chris is a biostratigrapher interested in how marine life responds to major changes in its environment. He is particularly interested in the development of anoxia in the Gulf of Mexico during Cretaceous Oceanic Anoxic Events like the mid-Cretaceous OAE2, as well as how primary productivity recovered after the Cretaceous Paleogene mass extinction. He is also studying Holocene sea level rise along the Texas coast. cmlowery@utexas.edu

Post Doc:

Zach Sickmann, Buffler Postdoctoral Fellow, Ph.D. Stanford University, 2018. Zach is an expert in source-to-sink sediment dispersal, detrital signal propagation and basin analysis. He worked at Southwest Research Institute on the mechanical stratigraphy and sedimentology of the Eagle Ford and Austin Chalk Formations in central and west Texas. For his Ph.D. Dr. Sickmann worked on the tectonic and stratigraphic evolution of the Magallanes-Austral Foreland Basin in southern Patagonia and on source-to-sink sand dispersal along the modern California coast.

Consultants:

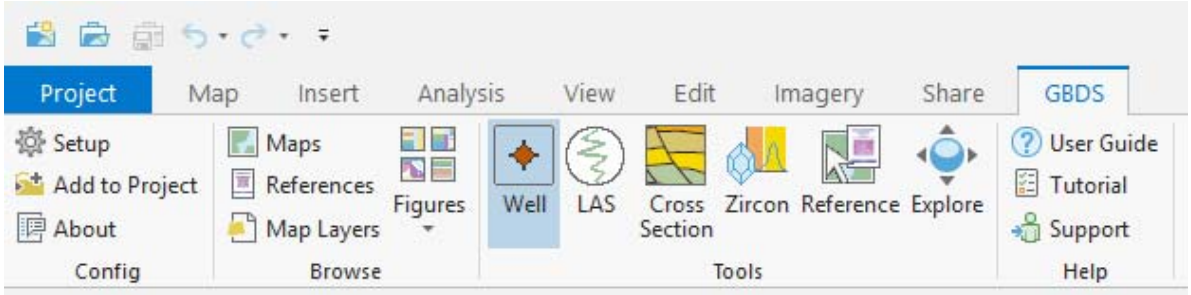
Robert (Bob) Cunningham, Consultant ChargeSearch, LLC; Ph.D., The University of Texas at Dallas, 1980. He has global experience in applying basin modeling and petroleum geochemical technologies in evaluating charge risk. Bob retired from ExxonMobil in 2011 after 31 years in research and exploration. rcunningham.cs@gmail.com

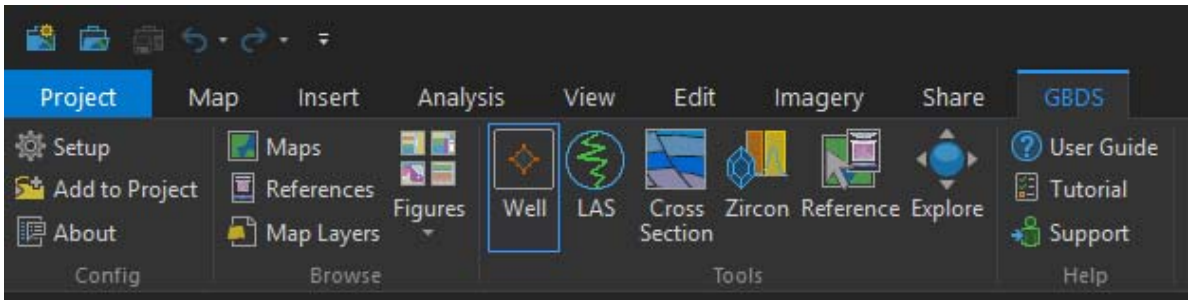
Marcie Purkey Phillips, Biostratigraphy Consultant GBDS & ALS Oil & Gas; M.S., University of Nebraska-Lincoln, 2013. Has global experience analyzing and integrating biostratigraphy data to determine geologic age, characterize depositional environment and target zones, identify drilling hazards and interpret regional correlation in order to optimize drilling trajectory to target.

Annie Walker, Research Associate & Consultant, Freelance Scientific; M.Sc., University of TN–Knoxville, 2013. Annie is a structural geologist specializing in fold-thrust environments, orogenic tectonics, and terrane analysis. She's interested in how and why rocks accommodate strain from micro to tectonic scales, as well as the creation & reorganization of crust during the Wilson Cycle. She also studies volcanology & glacial geomorphology, and actively supports science communication, outreach, and mentorship.

ArcGIS Pro GBDS Tools

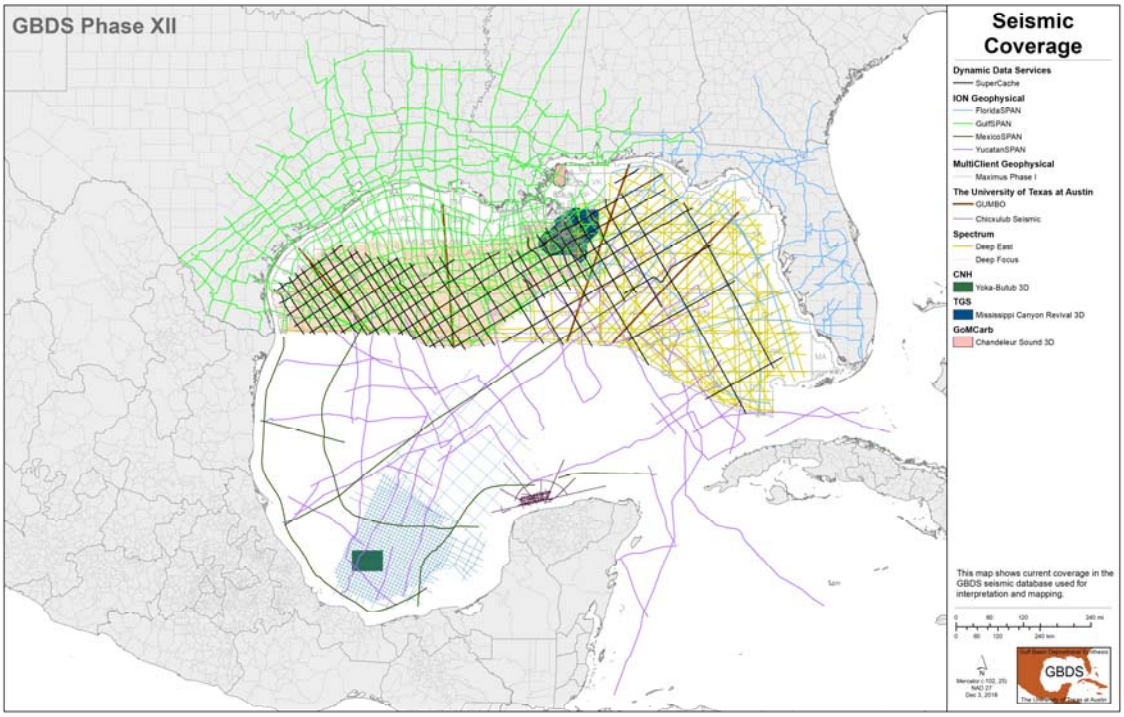
GBDS will augment its support for ArcGIS Pro in Phase XIII, including the first official release of an ArcGIS Pro GBDS add-in. Users will see a GBDS tab in the ArcGIS Pro ribbon with some familiar tools from the ArcMap add-in. But this isn't just a quick port from the ArcMap version. Rather, these tools will be extensively rewritten to operate seamlessly in the ArcGIS Pro environment, including easier setup, more intuitive tool operation, and support for the Pro dark theme. Once Phase XIII is underway, expect a beta version as early as the first quarter. For now, enjoy the mockups of the GBDS tabs we've shared here.





GBDS project information, data, and ArcGIS tools are available online from our password protected site accessible from the member link on our web page:

https://ig.utexas.edu/energy/gbds/



The GBDS project greatly benefits from the loan of seismic datasets from seimic vendors for our use in our research and mapping the GoM. We are continually adding coverage to our growing seismic database.

Thank you to all our Industrial Associates and third party data and software contributors!

GBDS Industrial Associates

Anadarko Petroleum Corporation, bhpbilliton, bp, BOEM Bureau of Ocean Energy Management, Chevron, ecopetrol America, equinor, eog resources, ExxonMobil, Fieldwood Energy, INPEX, JOGMEC, KOSMOS ENERGY, MEPUSA Mitsui E&P USA LLC, Hilcorp, HESS CORPORATION, MURPHY OIL CORPORATION, CNOOC nexen A CNOOC LIMITED COMPANY, noble energy, REPSOL, Ridgewood Energy, TALOS ENERGY, TOTAL

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