Toti Larson

Professional Summary

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Business address:	The University of Texas at Austin Bureau of Economic Geology 10100 Burnet Rd., Bldg. 130 Austin, TX 78758
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Professional Preparation

Academic Background

PhD, Geological Sciences, University of New Mexico, June 2003

M.S., Geological Sciences, University of New Hampshire, June 1999

B.A., Geological Sciences, Albion College, June 1993

Professional Appointments

Research Scientist, Bureau of Economic Geology (September 2022-Present)

Research Associate, The University of Texas at Austin, Bureau of Economic Geology (November 2017-Present)

Research Associate, The University of Texas at Austin, Department of Geological Sciences (January 2012-October 2017)

Research Scientist, Los Alamos National Laboratory (January 2005-December 2011)

Geologist, Kennecott Mining Company (1995)

Geologist, Bureau of Land Management, Salt Lake City (1994)

Areas of Expertise

Areas of Expertise

Geochemistry and sedimentary systems, stable isotope geochemistry, and machine learning applied to geochemical systems

Awards

Awards and Honorary Societies

AAPG Jules Braunstein Memorial Award, 2018

Service

University Committees

Application Review Committee, Hiring Committee - Laboratory Experimentalist, November-December 2022

Member, The Jackson School of Geosciences Equipment Committee, The University of Texas at Austin, September 2018-September 2021

Co-host, Bureau of Economic Geology - Friday Technical Seminar, September 2019-May 2020

Lead, Bureau of Economic Geology Sedimentologist Hiring Committee, October 2019-March 2020

External Committees Participation

Organizational Committee, Clay Mineral Society 2023 Annual Meeting, Austin, TX

Technical Chair, American Association of Petroleum Geologists - AAPG 2020

Technical Program Coordinator, American Association of Petroleum Geologists - AAPG 2019

Organizing Committee, 38th Annual GCSSEPM Foundation Perkins-Rosen Research Conference: The Cenomanian-Turonian Stratigraphic Interval Across the Americas, Gulf Coast Section SEPM, Houston, Tex., December 5-9, 2022

Co-General Chair, Gulf Coast Association of Geological Societies (GCAGS), October 2019-September 2021

Technical Chair, Gulf Coast Association of Geological Societies (GCAGS), July 2019-September 2021

President, Austin Geological Society, Austin, Tex., August 2020-July 2021

President-elect, Austin Geological Society, Austin, Tex., August 2019-July 2020

Technical Chair, Shale and Stray Gas in Groundwater - Their Characterization and Environmental Concerns, Goldschmidt, Yokohama, Japan, July 2016

Published Interviews

Larson, T., 2023, How geologic hydrogen went from fringe science to potential green fuel

https://www.newscientist.com/article/2393540-how-geologic-hydrogen-went-from-fringe-science-to-potential-green-fuel/

Just a year ago, few people took seriously the idea that we could extract hydrogen from the ground as a clean energy source - but now the US Department of Energy is injecting $20 million into the concept Efforts to extract underground hydrogen for use as a clean fuel have received a huge boost from the US Department of Energy (DoE), which earlier this month announced $20 million in funding to explore the concept. What is behind the rapid rise in interest in this "geologic hydrogen", which was on the fringes of science less than a year ago?

"We're on an exponential curve," says Geoffrey Ellis at the US Geological Survey, whose research has played a role in driving interest in the fuel - in October 2022, he and colleagues presented modelling that suggested Earth contains far more hydrogen than thought. Enthusiasm for geologic hydrogen has also grown with the wider move to use the gas for clean energy.

Now, ARPA-E, the hi-tech R&D wing of the DoE, wants to fund methods of stimulating minerals underground to produce geologic hydrogen. It is also backing research into the extraction of the gas, which emits only water vapour and heat when burned. Ellis says the $20m is the largest funding opportunity for natural hydrogen research he knows of. "It's major."Huge questions remain about whether geologic hydrogen could be a viable source of clean energy, and using lots of hydrogen from any source may have its own climate-warming effects. But getting the gas from underground could be a much less energy and emissions-intensive way to obtain it than making it from methane or using clean electricity to split water molecules.

The fact that the DoE, one of the world's most sophisticated scientific organisations, is taking geologic hydrogen seriously is significant. "It lends a lot of credibility," says Ellis, who spoke to New Scientist just before departing for a trip to consult with the government of Oman on the potential for geologic hydrogen there.

A gaggle of companies are already exploring for natural reserves, from numerous start-ups in Australia to a US-based company that has raised almost $100 million from Bill Gates and other

well-known clean energy investors. Earlier this summer, a reserve of natural hydrogen was discovered in France that may contain the equivalent of half the world's current production of the gas.

ARPA-E's focus, however, is less on naturally occurring deposits of the gas -- often referred to as "white" or "gold" hydrogen -- and more on ways to harness the geological processes that create it to stimulate its production. "When it comes to geologic hydrogen, we're asking 'are there disruptive ways to access this hydrogen source and explore the potential?'" said the agency's director Evelyn Wang in a press release.

One approach would involve pumping water underground where it would interact with iron-rich minerals to produce hydrogen -- sometimes called "orange hydrogen".

At a workshop on geologic hydrogen hosted by ARPA-E in April, ahead of the funding decision, researchers and industry representatives discussed what was needed to make this process more efficient and productive, what new technologies would be required to store, purify and extract the gas, as well as identifying areas with the right geology.

The agency hasn't yet announced how it will award the new funds, and it isn't clear whether companies have already tried stimulating the production of geologic hydrogen. But researchers are working on this. For instance, Toti Larson at the University of Texas at Austin says his group is searching for catalysts that could reduce the temperatures required to make hydrogen by mixing water and iron-rich rock. "We know how much potential there is if we can stimulate the subsurface," he says.

"Stimulating hydrogen represents many more challenges [than extracting natural hydrogen], but also much more potential," says Viacheslav Zgonnik at Natural Hydrogen Energy, the Colorado-based company behind an exploratory hydrogen well in Nebraska. "This will have an impact not only on the US, but I believe the entire world," he says.

Adam Brandt at Stanford University in California cautions that despite all the buzz, it is unknown how much geologic hydrogen might be available for use. But he is glad to see the attention: "I think this is the perfect time for DoE to support early-stage 'blue sky' work to see if geologic hydrogen will be a material solution."

Larson, T., 2023, What Exxon's deal with Pioneer says about the future of Texas shale

https://www.houstonchronicle.com/business/energy/article/permian-shale-tier-1-exxon-pioneer-18423593.php

Oil companies looking for new petroleum-rich plots to tap are hitting a wall in the Permian Basin of West Texas and New Mexico. The desirable "Tier 1" shale that yields ample oil at relatively low cost and minimal technical challenge is largely spoken for.

That's a challenge for a company with the size and ambition of Exxon Mobil, which plans its growing production decades ahead, and was a key factor in the Spring-based oil giant's $59.5 billion bid to buy Pioneer Natural Resources. The deal, Exxon CEO Darren Woods said Wednesday, pries open access to "the largest undeveloped Tier 1 inventory in the Midland Basin."

"They're not thinking about the next two-to-five years, but 10, 20 years," said Wood Mackenzie shale analyst Ryan Duman, "so, to refill the hopper, so to speak, takes big deals like this. And this firmly moves them into the number one spot with regards to not only Tier 1 inventory, but total inventory."

The megadeal, which is expected to close next year, would make Exxon the largest operator in the Permian, securing it decades of inventory in a time when the future of the nation's most prolific oil basin is uncertain. Squeezing oil from Permian shale could get harder and more expensive in the years ahead for those who run out of higher-quality source rock.

"I think everybody in the room kind of understands where the Permian sweet spots are," Ezra Yacob, CEO of Houston-based oil company EOG Resources, said during an investor conference last month, according to a CapitalIQ transcript. "And that rock is getting drilled up."

The declining availability of quality inventory is drawing lines in the oil patch, separating big players such as Exxon from smaller ones that are seeing a shortening runway, analysts said. This sets the stage for consolidation, as merged companies can more easily weather the higher costs necessary to meet engineering challenges associated with trickier source rock.

While supermajors operating in the Permian Basin have enough quality inventory to last an estimated 25 years at the current pace of drilling, private exploration and production companies would have around 11 years remaining at the current pace, said Matthew Bernstein, a senior shale analyst at Rystad.

"If these companies start drilling again at 2022's pace," Bernstein said, "you're going to exhaust that inventory in a shorter period of time. For some E&Ps that could be five years or less."

The moment calls for either a new discovery or new technologies capable of more efficiently extracting tight oil and reducing the financial burden.

Meantime, the hunt is on for less-desirable Tier 2 shale resources, said Toti Larson, principal investigator at the Bureau of Economic Geology's Mudrock Systems Research Laboratory at the University of Texas, which specializes in shale research. He said he is seeing growing interest from oil companies in finding what's left after the prime targets are taken.

This category of source rock tends to be more rich in clay, posing drilling hazards, and rich in natural gas and water, which require additional infrastructure and cost to handle.

"The real question now is how can we continue to make this economic," Larson said. "You can't overlook the importance of water disposal and excess gas."

Still, the basin holds vast amounts of crude waiting to be accessed for those willing to invest the time and money, said Karr Ingham, a petroleum economist for the Texas Alliance of Energy Producers. Plus, he said, a disruptive new technology could always come along.

"I think everybody's pessimistic about a new technology that's as revolutionary as the shale revolution," Ingham said. "But no one expected such a thing to happen in the first place."

Larson, T., 2018, Houston Public Media, Energy and Environment reporter: "No Link between Fracking and Methane in North Texas Groundwater"

https://www.houstonpublicmedia.org/articles/news/2018/09/25/305476/researchers-say-theres-no-link-between-fracking-and-methane-in-north-texas-groundwater/

Larson, T., 2018, KXAN TV (Austin, Tex.), Helium shortage impacts local businesses, researchers,

https://www.kxan.com/news/local-news/helium-shortage-impacts-local-businesses-researchers/1642546340

Outreach Activities

UT Austin Jackson School of Geosciences GeoForce Outreach Mentor: June-August 2021.

UT-Austin Jackson School of Geosciences GEOFORCE Outreach Program
o Project title: Python, Machine Learning, sedimentary systems, geochemistry
o Mentee: Andrea Zamarripa, Texas A&M: presented to UT Austin Jackson School of Geosciences GEOFORCE, June-August 2021.

Houston Geological Society Student Expo, Career Guidance Speaker: presented to Houston Geological Society Student Expo, October 2020.

Judge, Jackson School Research Symposium, The University of Texas at Austin, Jackson School of Geosciences: February 15, 2020.

UT Austin, Jackson School of Geosciences Student Research Symposium, Poster Judge: February 2019.

UT Austin, Jackson School of Geosciences Student Research Symposium, Poster Judge: February 2018.

UT-Austin, Jackson School of Geosciences Student Research Symposium, Poster Judge: 2017.

UT-Austin, Jackson School of Geosciences Student Research Symposium, Poster Judge: 2015.

UT-Austin, Jackson School of Geosciences Student Research Symposium, Poster Judge: 2014.

Austin Geological Society - Initiated the Minorities in the Geosciences Textbook Scholarship Fund: April 2020-Present.

Proposal Review Panels Participation

Department of Energy NA-22 (Nuclear Nonproliferation), 2014

Teaching and Advising

University Courses Taught

GEO 390S - Analytical Methods: Mass Spectrometry - Spring, 2014; UT Austin.

GEO 391 - Geochemical Problem solving with Ions and Atoms - Spring, 2016.

Continuing Education Courses Taught

SEPM - Society for Sedimentary Geology Short Course: Essential for Understanding Unconventional Mudrock Plays, San Antonio, Texas: "Geochemistry: Importance and Limitations of Geochemical Data": May 2019-Present.

Field Trips Leadership

Co-organizer, AAPG - SEPM field trip: "Oceanic Anoxic Events 1A&B in Central Texas", San Antonio, Texas, May 2019.

Co-organizer, Facies architecture and platform demise of the Albian Devils River Trend, Maverick Basin:, The University of Texas at Austin, Bureau of Economic Geology, Reservoir Characterization Research Laboratory, June 2018.

Student Committee Supervision

Senior Honors Thesis, Madison R. Callan, Jackson School of Geosciences, 2023

Ph.D. Committee Adivsor, Kiara Gomez, Evolution of the Toarcian-Aalenian Stratigraphic Interval in the Tampen Spur Area of the Norwegian Continental Shelf in relation to the North Sea Doming Even, 2020

M.S. thesis committee co-advisor, Esben Pedersen, Carbonate factory recovery following oceanic anoxic events; a closer look at the Cow Creek Member in the Pearsall Formation, Department of Geological Sciences, The University of Texas at Austin, 2017

M.S. thesis committee co-advisor, Michael Patson, The behavior of dissolved organic carbon (DOC) at geological sequestration sites, Department of Geological Sciences, The University of Texas at Austin, 2015

M.S. thesis committee co-advisor, Marlo Gawey, Experimental analysis and modeling of perfluorocarbon transport in the vadose zone: implications for monitoring CO2 leakage at CCS sites, Department of Geological Sciences, The University of Texas at Austin, 2013

Student Committee Participation

M.S. thesis committee member, Kiara Gomez, Reconstruction of past paleoenvironment and paleoclimate changes of the Norwegian Continental Shelf using seismic interpretation and geochemical methods, 2023

M.S. thesis committee member, Evan J. Sivil, Sedimentological and geochemical record of the Eagle Ford to Austin Chalk Transition, 2021

Undergraduate honors thesis committee member, Tyler Logie, Multi-proxy Geochemical Analysis of Early Jurassic Marine Carbonates: Insights from the Dadès Valley, Morocco, 2021

M.S. thesis committee member, Esben Pedersen, Carbonate factory response and recovery after Ocean Anoxic Event 1a, Pearsall Formation, Central Texas, 2019

Ph.D. thesis committee member, Benjamin Smith, Depositional Architecture and Geochemical Evolution in Permian Capitan Platforms of the Delaware Basin, Texas and New Mexico, 2019

Ph.D. thesis committee member, Ahmed Wasel Alnahwi, Stratigraphic architecture and associated sedimentological and geochemical variability in the Upper Cretaceous Eagle Ford Group, south Texas, 2018

Ph.D. thesis committee member, Colin McNeece, Ion waves in reactive porous media: coupling acidity and salinity transport through surface chemistry, 2018

M.S. thesis committee member, Nicholas Ettinger, Carbonate platform demise and recovery at the Toarcian Oceanic Anoxic Event: high-resolution data from the Adriatic Carbonate Platform, Department of Geological Sciences, The University of Texas at Austin, 2017

Ph.D. thesis committee member, Daria Akhbari, Under-pressure in the Bravo Dome natural CO2 field and its implications for geological CO2 storage (GCS), 2017

Ph.D. thesis committee member, Kiran Sathaye, Geochemical Dynamics of Bravo Dome Natural CO2 Field, The University of Texas at Austin, Jackson School of Geosciences, 2016

Master's thesis committee member, Michael Patson, The University of Texas at Austin, Jackson School of Geosciences, 2015

Master's thesis committee member, Marlo Gawey, Experimental Analysis and Modeling of Perfluorocarbon Transport in the Vadose Zone: Implications for Monitoring CO2 Leakage at CCS Sites, The University of Texas at Austin, Jackson School of Geosciences, 2013

Presentations

Invited Presentations

The Woodford Formation and distal Mississippi Lime within the Midland Basin: presented to West Texas Geological Society, presented at West Texas Geological Society Fall Symposium, Midland, Tex., September 19-21, 2023.

Bureau of Economic Geology Technical Seminar: "Core-based machine learning characterization of Wolfcamp XY and Third Bone Spring Formation across the Delaware Basin, Texas: September 2021.

CorePy: Visualizing, integrating, and upscaling core-based geochemistry through neural network-derived chemofacies models: presented to iRIS-2020 Rock Imaging Summit, November

16, 2020.

Peking University Technical Series, Beijing, China: "Evaluating unconventional shale oil and gas reservoirs with geochemistry": October 2019.

Tracing the behaviour of subsurface gas migration with multiple isotope systems: presented to Australia Academy of Science, presented at Elizabeth and Frederick White Conference, Canberra, Australia, September 5-7, 2018.

KIGAM (Korea Institutes of Geology, Mining and Materials): "Using coupled models and experiments to understand complex geochemistry of CO2 storage and transport of fugitive gases and fluids": February 2015.

Yonsei University, Earth System Sciences: "Using coupled models and experiments to understand complex geochemistry of CO2 storage and transport of fugitive gases and fluids": February 2015.

Sandia National Laboratories: "Multiphase transport in porous media: compounding stable isotope and compositional 'banks' at the gas-water interface": October 2014.

Presentations

Facies Characterization of Wolfcamp D along a transect from the Eastern Shelf to the Midland Basin: presented to Southwest Section - AAPG, presented at SWS-AAPG Annual Convention, Wichita Falls, Tex., May 9, 2023.

Lithologic response to OAE2 across the drowned Comanche Platform, South Texas: presented to GCSSEPM Foundation, presented at 38th Annual Perkins-Rosen Research Conference, Houston, Tex., December 5-9, 2022.

High resolution facies stacking and reservoir attributes across the Wolfcamp and Third Bone Spring intervals, Delaware Basin: A machine learning approach to integrate core and wireline measurements: presented to West Texas Geological Society, Odessa, Tex., September 21, 2022.

Targeting the Leonardian Basinal Bone Spring Carbonates in the Southern Delaware Basin: Example from Upper 2nd Lime, Pecos Co., TX: presented to Unconventional Resources Technology Conference (URTeC), presented at 2022 Unconventional Resources Technology Conference (URTeC), Houston, Texas, June 20-22, 2022.

Comparative studies of gas geochemistry and oil migration in 3rd Bone Spring and Wolfcamp A, Delaware Basin: presented to MSRL consortium members, presented at MSRL Annual Meeting, Houston, Tex., April 11-12, 2022.

Facies and Associated Reservoir Quality of the 3rd Bone Spring Siliciclastics & Wolfcamp A and B, Pecos Co., southern Delaware Basin, west Texas: presented to MSRL consortium members, presented at MSRL Annual Meeting, Houston, Tex., April 11-12, 2022.

Facies and Associated Reservoir Quality of the Basinal Leonardian 2nd and 3rd Bone Spring Carbonates, Delaware Basin, west Texas: presented to MSRL consortium members, presented at MSRL Annual Meeting, Houston, Tex., April 11-12, 2022.

Informing drill cuttings analysis with core-based measurements - a cost effective approach to expand reservoir characterizations where core is unavailable: presented to MSRL consortium members, presented at MSRL Annual Meeting, Houston, Tex., April 11-12, 2022.

Informing drill cuttings analysis with core-based measurements - a cost effective approach to expand reservoir characterizations where core is unavailable: presented to 2022 MSRL Annual Meeting, Houston, Tex., April 11-12, 2022.

Mobile oil estimate with integrated method of geochemistry and N2 adsorption in mudrocks of 3rd Bone Spring Sand and Wolfcamp X, Delaware Basin: presented to MSRL consortium members, presented at MSRL Annual Meeting, Houston, Tex., April 11-12, 2022.

Third Bone Spring and Wolfcamp XY - Loving, Ward and Reeves Counties. Machine learning core to wireline reservoir characterizations and integration of porosity into chemofacies models: presented to 2022 MSRL Annual Meeting, Houston, Tex., April 11-12, 2022.

Characteristics of the Leonardian Second Bone Spring Sand and Third Bone Spring Lime, Reeves County, southern Delaware Basin, Texas: presented to MSRL members, presented at 2021 MSRL Core Workshop, Houston Core Research Center, December 7, 2021.

Characteristics of the Leonardian Third Bone Spring Lime, Reeves County, southern Delaware Basin, Texas: presented to MSRL members, presented at 2021 MSRL Core Workshop, Houston Core Research Center, December 7, 2021.

Integrating lithofacies and chemofacies characterizations for the Permian Basin Wolfcamp XY and Third Bone Spring Formation, Delaware Basin, Texas: presented to American Association of Petroleum Geologists (AAPG-ACE), Denver, Colorado, October 2021.

Integrating lithofacies with geochemical and petrophysical properties of the Tithonian-Valanginian Vaca Muerta Fm., central Neuquén Basin, Argentina: presented to AAPG, presented at International Meeting for Applied Geoscience & Energy (IMAGE), Online oral presentation, September 27-29, 2021.

Estimating Lithologic Facies in Argillaceous and Carbonate-Rich Mudrocks Using X-Ray Fluorescence Measurements and Multivariate Statistics: presented to American Association of Petroleum Geologists (AAPG-ACE), San Antonio, Tex., May 2019.

Geochemical insights into highstand and transgressive system tracts of the late Albian Pecos and Devil's River, Texas: presented to Bureau of Economic Geology, presented at RCRL Annual Meeting, Austin, Texas, October 22, 2018.

From Carbonate Factory Collapse to Recovery: Insights Through Box Modeling of Carbon Isotope Excursions of Oceanic Anoxic Events (OAEs): presented to American Association of Petroleum Geologists (AAPG-ACE), Salt Lake City, Utah, July 2018.

Attribution of Natural Gas in Shallow Groundwater Using Dissolved Nitrogen and Alkane Chemistry in Parker County, Texas: presented to Goldschmidt Conference, presented at Yokohama, Japan, July 2016.

Tracing natural gas transport into shallow groundwater using dissolved nitrogen and alkane chemistry in Parker County, Texas: presented to American Geophysical Union (AGU) Annual Meeting, San Francisco, Calif., December 2015.

Identifying Methane Sources in Groundwater; Quantifying Changes in Compositional and Stable Isotope Values during Multiphase Transport: presented to American Geophysical Union (AGU), San Francisco, Calif., December 2014.

Helium enrichment during convective carbon dioxide dissolution: presented to American Geophysical Union (AGU), San Francisco, Calif., December 2013.

Modeling experimental stable isotope results from CO2 adsorption and diffusion experiments: presented to American Geophysical Union (AGU), San Francisco, Calif., December 2012.

Activities of a Professional Nature

Professional Societies

American Association of Petroleum Geologists

Austin Geological Society

Program and Project Management

PRINCIPAL INVESTIGATOR - Bureau of Economic Geology, UT-Austin, Mudrock Systems Research Laboratory (MSRL). The MSRL energy research consortium is focused on subsurface characterization and oil and gas production in mudrock plays. The MSRL team consists of 6

researchers and 4 research staff. 2019-Present.

PROJECT CO-PI: "Center for Frontiers of Subsurface Energy Security. Scientific understanding of subsurface characterization at multiple scales to predict the subsurface storage and behavior of CO2." Department of Energy. 2014

PROJECT PI, "Modeling molecular scale natural abundance isotope signatures for chemical, biochemical, and nuclear (CBN) threat attribution," Department of Energy. 2010

PROJECT PI: "Chevron: Chevron/LANL Oil Shale. Surveillance - in situ processes," Chevron. Developed flow-through column experiments to measure gas-solid partitioning of natural gas (methane through propane) and perfluorocarbon tracers. The project goal was to estimate surface area of fractures using a combination and conservative and non-conservative tracers. 2008.

PROJECT PI: "Geochemical exploration tools to extend data and observations to basin margins," Equinor. Research project applied geochemical exploration tools to extend data and observations from basin centers to basin margins. The project funded a Master's level graduate student for two years to study up-dip facies equivalents of the Pearsall Formation in South Texas. 2018-2019.

PROJECT PI: "Radiolytic stable isotope effects in solvents during reprocessing", Department of Homeland Security. 2010.

PROJECT PI: "Research Technology Center for Calibration Excellence", Bruker Corporation. Project goal is to improve inorganic chemistry measurements and mineralogical modeling for mudrocks. 2018 - Present

TEAM LEADER - Los Alamos National Laboratory - Earth and Environmental Sciences Division. Director of the Geochemical and Geomaterials Research Laboratory (GGRL): a team of 12 geologists and an analytical facility that conducts geological, material science, carbon sequestration, groundwater contaminant, and atmospheric measurements. Analytical equipment includes gas and liquid chromatography, scanning electron microscopy, X-ray diffraction, organic matter characterization, and stable isotope mass spectrometry. 2009-2011.

Activities of a Professional Nature

AAPG ACE Technical Session Chair: Theme 3: Geochemistry Application in Petroleum Systems II (September 29, 2020)

Publications

Peer Reviewed Journal Articles

Gomez, K. J., Sahoo, S. K., Panteli, E., Moscardelli, L., Anthonissen, E., Larson, T. E., Howie, A., and Rush, W. D., 2023, Partial paleobathymetric restriction from the local North Sea Dome in the Viking Corridor during the Early-Middle Jurassic: Global and Planetary Change, v. 230, no. 104255, 16 p., http://doi.org/10.1016/j.gloplacha.2023.104255.

Larson, T. E., Loucks, R. G., Sivil, J. E., Hattori, K. E., and Zahm, C. K., 2023, Machine learning classification of Austin Chalk chemofacies from high-resolution x-ray fluorescence core characterization: AAPG Bulletin, v. 107, no. 6, p. 907-927, http://doi.org/10.1306/09232220095.

Larson, T. E., Sivil, J. E., Periwal, P., and Melick, J., 2023, A machine-learning workflow to integrate high-resolution core-based facies into basin-scale stratigraphic models for the Wolfcamp and Third Bone Spring Sand, Delaware Basin: Interpretation, v. 11, no. 4, p. SC91-SC104, http://doi.org/10.1190/INT-2023-0009.1.

Sahoo, S. K., Gilleaudeau, G. J., Wilson, K., Hart, B., Barnes, B. D., Faison, T., Bowman, A. R., Larson, T. E., and Kaufman, A. J., 2023, Basin-scale reconstruction of euxinia and Late Devonian mass extinctions: Nature, v. 615, p. 640-645, http://doi.org/10.1038/s41586-023-05716-2.

Sharman, G. R., Covault, J. A., Flaig, P. P., Dunn, R., Fussee-Durham, P., Larson, T. E., Shanahan, T. M., Dubois, K., Shaw, J. B., Crowley, J. L., and Shaulis, B., 2023, Coastal response to global warming during the Paleocene-Eocene Thermal Maximum: Palaeogeography, Palaeoclimatology, Palaeoecology, v. 625, no. 111664, 15 p., http://doi.org/10.1016/j.palaeo.2023.111664.

Corrêa, R. S. M., Ukar, E., Laubach, S. E., Aubert, I., Lamarche, J., Wang, Q., Stockli, D. F., Stockli, L. D., and Larson, T. E., 2022, Episodic reactivation of carbonate fault zones with implications for permeability--an example from Provence, Southeast France: Marine and Petroleum Geology, v. 145, no. 105905, 21 p., http://doi.org/10.1016/j.marpetgeo.2022.105905.

Peng, J., and Larson, T. E., 2022, A novel integrated approach for chemofacies characterization of organic-rich mudrocks: AAPG Bulletin, v. 106, no. 2, p. 437-460, http://doi.org/10.1306/05112120210.

Ettinger, N. P., Larson, T. E., Kerans, C., Thibodeau, A. M., Hattori, K. E., Kacur, S. M., and Martindale, R. C., 2021, Ocean acidification and photic-zone anoxia at the Toarcian Oceanic Anoxic Event: insights from the Adriatic Carbonate Platform: Sedimentology, v. 68, no. 1, p. 63-107, http://doi.org/10.1111/sed.12786.

Loucks, R. G., Reed, R. M., Ko, L. T., Zahm, C. K., and Larson, T. E., 2021, Micropetrographic characterization of a siliciclastic-rich chalk; Upper Cretaceous Austin Chalk Group along the onshore northern Gulf of Mexico, USA: Sedimentary Geology, v. 412, no. 105821, 19 p., http://doi.org/10.1016/j.sedgeo.2020.105821.

Loucks, R. G., Zahm, C. K., Larson, T. E., Zahm, L. C., and Peng, S. [erroneously credited as "Peng Zeng"], 2021, Stratal architecture, lithofacies, environmental setting, depositional processes, and associated geological characteristics of the Upper Cretaceous Austin Chalk in Louisiana: GCAGS Journal, v. 10, p. 47-75.

Peng, J., Fu, Q., Larson, T. E., and Janson, X., 2021, Trace-elemental and petrographic constraints on the severity of hydrographic restriction in the silled Midland Basin during the late Paleozoic ice age: Geological Society of America Bulletin, v. 133, no. 1-2, p. 57-73, http://doi.org/10.1130/B35336.1.

Larson, T. E., Perkins, G. B., Williams, R. F., Fessenden, J. E., Clegg, S. M., and Currier, R. P., 2020, Partitioning of oxygen isotopes during the aqueous solvation of nitric acid: Fluid Phase Equilibria, v. 506, no. 112364, 5 p., http://doi.org/10.1016/j.fluid.2019.112364.

Loucks, R. G., Lambert, J. R., Patty, K., Larson, T. E., Reed, R. M., and Zahm, C. K., 2020, Regional overview and significance of the mineralogy of the Upper Cretaceous Austin Chalk Group, onshore Gulf of Mexico: GCAGS Journal, v. 9, p. 1-16.

Loucks, R. G., Larson, T. E., Zheng, C. Y. C., Zahm, C. K., Ko, L. T., Sivil, J. E., Peng, S., Ruppel, S. C., and Ambrose, W. A., 2020, Geologic characterization of the type cored section for the Upper Cretaceous Austin Chalk Group in southern Texas: a combination fractured and unconventional reservoir: AAPG Bulletin, v. 104, no. 10, p. 2209-2245, http://doi.org/10.1306/04222019197.

Smith, B. P., Larson, T., Martindale, R. C., and Kerans, C., 2020, Impacts of basin restriction on geochemistry and extinction patterns: a case from the Guadalupian Delaware Basin, USA: Earth and Planetary Science Letters, v. 530, no. 115876, 11 p., http://doi.org/10.1016/j.epsl.2019.115876.

Zhao, H., Liu, C., Larson, T. E., McGovern, G. P., and Horita, J., 2020, Bulk and position-specific isotope geochemistry of natural gases from the Late Cretaceous Eagle Ford Shale, south Texas: Marine and Petroleum Geology, v. 122, no. 104659, 11 p., http://doi.org/10.1016/j.marpetgeo.2020.104659.

Caldwell, T. G., Bongiovanni, T., Cosh, M. H., Jackson, T. J., Colliander, A., Abolt, C. J., Casteel, R., Larson, T., Scanlon, B. R., and Young, M. H., 2019, The Texas Soil Observation

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