Toti Erik Larson

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Summary

Dr. Toti Larson is a Research Associate and Principal Investigator of the Mudrock Systems Research Laboratory (MSRL) consortium at the University of Texas at Austin, Bureau of Economic Geology. As PI of the MSRL since 2019, Toti coordinates with Energy companies to identify knowledge gaps and develop subsurface geology characterization projects that leverage the MSRL research team strengths. In his own research Toti applies geochemistry, geology, and machine learning tools to develop predictive subsurface characterization models. Toti built a Python package (CorePy) for open source sharing of subsurface characterization tools and geological characterization workflows he has developed.

Appointments

2017 – present	Research Associate, Bureau of Economic Geology, The University of Texas at Austin
2012 – 2017	Research Science Associate, Department of Geological Sciences, The University of Texas at Austin
2005 – 2012	Technical Staff Scientist, Los Alamos National Laboratory, Los Alamos, New Mexico
2003 – 2005	Postdoctoral Fellow, The University of Western ontario, Ontario, Canada
1999 – 2003	Research and Teaching Assistant, The University of New Mexico
1996 – 1999	Research and Teaching Assistant, The University of New Hampshire
1995 – 1996	Geologist, Kennecott Mining Company, Salt lake City, Utah
1993 – 1995	Geologist, Bureau of Land Management, Lake View, Oregon and Salt lake City, Utah

Education

1999 – 2003	Ph.D., Geochemistry, University of New Mexico, Earth and Planetary Sciences
1996 – 1999	M.S., Geology, University of New Hampshire, Department of Earth Sciences
1994 – 1995	non-degree seeking, Mathematics and Statistics, University of Utah
1989 – 1993	B.A., Geology, Albion College, Geological Science

Research and Professional Experience

1) Bureau of Economic Geology, UT-Austin,
   PRINCIPAL INVESTIGATOR - Mudrock Systems Research Laboratory (MSRL) 2019-current
   - Principal investigator of an energy research consortium with 12-16 member companies that are based in the United States, Norway, China, Japan, and Argentina. $500k-$800k funding in annual company-sponsored projects focused on subsurface characterization and oil and gas production. The MSRL team consists of 6 researchers and 4 research staff. Toti provides quarterly and annual presentations, progress reports, workshops and short courses to update consortium sponsors and identify new projects.
2) Bureau of Economic Geology, UT-Austin
   RESEARCH ASSOCIATE 2017-current
   - Conducts detailed geological core-based characterizations across the Permian Basin, Eagle Ford, Austin Chalk, and Vaca Muerta Formations. Applies machine learning classification methods to integrate complex multivariate datasets (i.e., geochemistry, petrophysics, lithological, and organic matter characterization) into machine learning training datasets that can be upscaled to basin-scale models.

Developed CorePy Python package for open source sharing of subsurface characterization tools I have developed.

- Manages a geochemistry laboratory that measures stable isotope ratios in organic matter, solid and aqueous carbonates, and natural gas samples. Data are applied to attribute sources and identify reaction pathways in oil and gas, carbon sequestration, and environmental studies.

3) Department of Geological Sciences, UT-Austin
RESEARCH SCIENCE ASSOCIATE 2012-2017
   - Research projects focused on building experiments to simulate CO_2 transport and storage in aqueous media. Managed a stable isotope geochemical laboratory facility ($1M in equipment). Developed analytical automations, new calibrations, and database storage tools to improve data access and data QA/QC.
4) Los Alamos National Laboratory - Earth and Environmental Sciences Division
TEAM LEADER 2009-2011
   - 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.

   TECHNICAL STAFF SCIENTIST – Earth and Environmental Sciences Division 2005-2012
   - Geochemist – Initiated and led applied studies in carbon sequestration, groundwater contaminant transport, chemical and nuclear forensics, and shale oil tracers. PI and co-PI of Department of Energy and Department of Homeland Security grants.
5) The University of Western Ontario- Department of Geological Sciences
POSTDOCTORAL RESEARCH FELLOW 2003-2005
   - Studied the incorporation of water and carbon isotope signatures into deer bone and teeth. Application was to understand isotopic tracers for forensics purposes
   - Built a database of geochemical data that spanned measurements over a twenty-year period used to develop hydraulic tracer models
6) Kennecott Mining Company – Salt Lake City, Utah.
GEOLOGIST 1995-1996
   - Digitalization of geologic reports, maps, and cross sections
7) Bureau of Land Management – Salt Lake City, Utah and Lakeview, Oregon
GEOLOGIST 1993-1995
   - Conducted field mapping of uranium ore deposits in southern Utah, and abandoned homesteader water wells in central Oregon. Applied GPS and GIS tools in the field, utilized aerial photography, and 1:24,000 scale field mapping to define hazards associated with mining.

Student Advising Experience

Committee member for the following students while I was at the institutions: [1]Department of Geological Sciences, The University of Texas at Austin., [2]Bureau of Economic Geology, The University of Texas at Austin. [3]Los Alamos National Laboratory, Los Alamos, New Mexico

Evan J. Sivil (current - Masters)[2]
Tyler Logie (2021 – undergraduate)
Ahmed Wasel Alnahwi (2018 - PhD)[2]
Colin McNeese (2018 – PhD)[1]
Michael Patson (2015 - Masters)[1]
April Gillens (2011 - undergraduate)[3]
Kiara Gomez (current- PhD) [2]
Ben Smith (2019 - PhD)[2]
Esben Pedersen (2020 - Masters) [2]
Kiran Sathaye (2013-2016 - PhD)[1]
Daria Akhbari (2017 – PhD) [1]
Marlo Gawey (2013 - Masters)[2]

Professional Service and Awards

- Technical Chair and conference VP - GEOGULF2021 Energy Transition, Austin.
- President, Austin Geological Society (AGS) – 2020-2021
- Technical Seminar Coordinator, Bureau of Economic Geology - 2019 - 2020
- Technical Chair, American Association of Petroleum Geologists – AAPG2020
- Technical Chair, American Association of Petroleum Geologists – AAPG2019
- UT Austin JSG Equipment committee member 2019-2020
- AAPG Jules Braunstein Memorial Award - 2019

Education Outreach

- Founded AGS Minorities in the Geosciences Textbook Scholarship, 2020
- UT-Austin JSG GeoForce Outreach Mentor, Andrea Zamarripa – TAMU, 2021
- UT-Austin JSG GeoForce Outreach Mentor, Ana Letícia Batista– Jackson State University, 2021
- UT-Austin, JSG Student Research Symposium, Poster Judge, 2014, 2015, 2017, 2018, and 2019
- Houston Geological Society Student Expo, Career Guidance Speaker, 2020

Teaching Experience

- GEO 390S - Analytical Methods: Mass Spectrometry – Spring, 2014; UT Austin (Graduate course)

Analytical Skills

Geochemist – 20 years of stable isotope geochemistry laboratory development (ThermoElectron GasBench, Conflo, MAT252, DeltaXL. 15 years of Gas Chromatography method development and automation (Agilent 6890 GC-MS), sample loop injection development, high temperature and cryogenic chromatography. 8 years of X-ray Fluorescence analysis (Bruker T5 handheld and benchtop units). Expert in a wide range of liquid, solid, and gas extraction and sample preparation techniques. 15 years of laboratory database development.

Data scientist - 3 years of Python and 8 years of Matlab coding experience. Pandas, Numpy, scikit-learn, json. 1 year of Github and PiP for version control and open source sharing. 15 years Microsoft Access database tools. A minor in mathematics (non-degree seeking, University of Utah) with 20 years of applied multivariate statistics. Past three years have focused on applying machine learning classification XGBoost Decision tree, Deep Neural network models, Principal Component Analysis, and K-means clustering using scikit-learn MLP Classifier, KMeans and PCA.

Research Grants and Industry Consortium Funding

MSRL Industry Consortium - Toti Larson PI of the MSRL from 2019-present, and researcher from 2018-2019

- Total consortium funding – $3.15M. Toti Larson contribution - $905k
- Total external grant funding - $1.125M (2008 to present)

Year	Title	Total Amount	Larson contribution
2021	MSRL industrial affiliate membership	$550k	$190k
2020	MSRL industrial affiliate membership	$750k	$220k
2019	MSRL industrial affiliate membership	$800k	$220k
2018	MSRL industrial affiliate membership	$600k	$120k
2018	Equinor - Directed Research Project - $127k. Geochemical exploration tools to extend data and observations to basin margins.	$127k	$127k
2018	Amethyst – Develop IR detector	$100k	$100k

2014	Department of Energy (co-investigator) $14.2M. Center for Frontiers of Subsurface Energy Security. Scientific understanding of subsurface characterization at multiple scales to predict the subsurface storage and behavior of CO_2.	$14.2M	$142k
2010	Department of Energy (Principal Investigator): Modeling molecular scale natural abundance isotope signatures for chemical, biochemical, and nuclear (CBN) threat attribution	$125k	$125k
2010	Department of Homeland Security (Principal Investigator): Radiolytic stable isotope effects in solvents during reprocessing.	$115k	$115k
2009	Department of Energy (co-PI): Isotopic tracer for climate relevant secondary organic aerosol	$325k/yr 3 year	$375k
2009	Department of Homeland Security (co-PI): solvent daughter products	$275k/yr 2 years.	$250k
2008	Department of Energy NA-22 (co-PI): stable isotope signatures of nuclear processing	$450k/yr 3 years	$500k
2008	Chevron: Chevron/LANL Oil Shale. Surveillance – in situ processes	$520k	$520k

Recent Presentations

Examples of oral presentations are available on my YouTube channel

- September 17, 2021: "Core-based machine learning characterization of Wolfcamp XY and Third Bone Spring Formation across the Delaware Basin, Texas".

Invited conference/meeting Presentations

1) 2020 IRIS Rock Imaging Summit (November, 2020): "CorePy: Visualizing, integrating, and upscaling core-based geochemistry through neural network-derived chemofacies models"
2) 2018 Elizabeth and Frederick White Conference – Frontiers in Gas-Solid Processes from the Atomic Scale to the Parsec, Canberra, Australia (September, 2018): "Tracing the behaviour of subsurface gas migration with multiple isotope systems"

Invited Academic Presentations

1) 2021 Bureau of Economic Geology Technical Seminar (September, 2021): "Core-based machine learning characterization of Wolfcamp XY and Third Bone Spring Formation across the Delaware basin, Texas
2) 2019 Peking University Technical Series, Beijing, China (October, 2019): "Evaluating unconventional shale oil and gas reservoirs with geochemistry"
3) KIGAM (Korea Institutes of Geology, Mining and Materials), February, 2015, "Using coupled models and experiments to understand complex geochemistry of CO2 storage and transport of fugitive gases and fluids"
4) Yonsei University, Earth System Sciences, February 2015. "Using coupled models and experiments to understand complex geochemistry of CO2 storage and transport of fugitive gases and fluids"
5) 2014, Sandia National Laboratories (October, 2014) "Multiphase transport in porous media: Compounding stable isotope and compositional 'banks' at the gas-water interface"

Book Chapter

- Knapp, J., Larson, T.E., and Sivil, J.E. (in press) Subsurface characterization for energy applications. Chapter in: Royal Society of Chemistry Advances in Portable X-ray Fluorescence Spectrometry.

Publications: (47 peer-reviewed papers, 1087 citations, h-index 19)

Web of Science h-index: 16; total citations: 739
Google Scholar h-index: 19; total citations: 1087

- **Larson, T.E.,** Loucks, R.G., Sivil, J.E., Zahm, C.K., and Hattori, K.E. (accepted) Machine learning classification of Austin Chalk chemofacies from high-resolution x-ray fluorescence core characterization. AAPG Bulletin
- Peng, J., and **Larson, T.E.,** Fu, Q. (in press) A novel integrated approach for chemofacies characterization of organic-rich mudrocks. AAPG Bulletin
- Loucks, R.G., Reed, R.M., Ko, L., Zahm, C.K., **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
- Peng, J., Fu, Q., Larson, T.E., 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, American Association Petroleum Geology Bulletin, v. 133, pp. 57-73
- Zhao, H. Liu, C., **Larson, T.E.,** McGovern, G.P., 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 122, 104659
- Loucks, R.G., **Larson, T.E.,** Zheng, C.Y., Zahm, C.K., Ko, L.T., Sivil, J.E., Sheng, P. (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 104 (10), 2209-2245
- Ettinger, N., **Larson, T.E.,** Kerans,C. Thibodeau,A.M., HattoriK.E., Kacur, S.M. (2020) Ocean acidification and photic-zone anoxia at the Toarcian Oceanic Anoxic Event: Insights from the Adriatic Carbonate Platform. Sedimentology
- Peng,J., Fu, Q., **Larson, T.E**., Janson, X. (2020) 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
- **Larson,T.E.,** Perkins,G.B., Williams,R.F., Fessenden,J.E., Clegg, S.M. (2020) Partitioning of oxygen isotopes during the aqueous solvation of nitric acid. Fluid Phase Equilibria 506, 112364
- Smith, B.P., **Larson,T.E.,** Martindale, R.C, 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 530, 115876
- RP Currier, TB Peery, MF Herman, RF Williams, R Michalczyk, **Larson, T.E.** (2020) Azeotropic isotopologues. Fluid Phase Equilibria 493, 188-195
- Caldwell,T.G., Bongiovanni, T., Cosh, M.H., Jackson,T.J., Colliander, A., Abolt, C.J., Casteel, R., **Larson,T.E.**, Scanlon, B.R., Young, M.H. (2019) The Texas soil observation network: a comprehensive soil moisture dataset for remote sensing and land surface model validation. Vadose Zone Journal 18 (1), 1-20
- **Larson, T.E.,** Nicot, J.-P., Mickler, P., Castro, M.C., Darvari, R., Wen, T., and Hall, C.M. (2018) Monitoring stray natural gas in groundwater with dissolved nitrogen. An example from Parker County, Texas. Amer. Water Resources Research.
- Nicot, J.-P., **Larson, T.,** Darvari, R., Mickler, P., Uhlman, K. and Costley, R. (2017), Controls on Methane Occurrences in Aquifers Overlying the Eagle Ford Shale Play, South Texas. Groundwater. doi:10.1111/gwat.12506
- Nicot, J.-P., Mickler, P., **Larson, T.**, Clara Castro, M., Darvari, R., Uhlman, K. and Costley, R. (2017), Methane Occurrences in Aquifers Overlying the Barnett Shale Play with a Focus on Parker County, Texas. Groundwater. doi:10.1111/gwat.12508

- Nicot, J.-P., **Larson, T**., Darvari, R., Mickler, P., Slotten, M., Aldridge, J., Uhlman, K. and Costley, R. (2017), Controls on Methane Occurrences in Shallow Aquifers Overlying the Haynesville Shale Gas Field, East Texas. Groundwater. doi:10.1111/gwat.12500
- Wen, T., Castro, M.C., Nicot, J.-P., Hall, C.M., Pinti, D.L., Mickler, P., Darvari, R., **Larson, T.E.** (2017) Characterizing the noble gas isotopic composition of the Barnett Shale and Strawn Group and constraining the source of stray gas in the trinity aquifer, North-Central Texas. Environmental Sci. and Tech., v.51, pp 6533-6541
- Bergel, S.J., Carlson, P.E., **Larson, T.E.,** Wod, C.T., Johnson, K.R., Banner, J.L., Breecker, D.O. (2017) Constraining the subsoil carbon source to cave-air CO2 and speleothem calcite in central Texas. Geochim. Et. Cosmo. Chim., v.217, 112-127
- Sturrock, C.P., Catlos, E.J., Miller, N.R., Akgun, A., Fall A., Gabitov, R.I., Yilmaz, I.O., **Larson, T.E.,** Black, K.N. (2017) Fluids along the North Anatolian Fault, Niksar basin, north central Turkey: Insight from stable isotopic and geochemical analysis of calcite veins. Jour. Struct. Geo., v.101, pp 58-79
- Wen, T., Castro, M.C., Nicot, J.P., Hall, C.M., **Larson, T.E.,** Mickler, P., Darvari, R. (2016) Methane Sources and Migration Mechanisms in Shallow Groundwaters in Parker and Hood Counties, Texas. A Heavy Noble Gas Analysis. Environmental Science and Technology, v.50, 21, pp.12012-12021.
- Sathaye, K.J., **Larson, T.E.,** and Hesse, M.A. (2016) Noble gas fractionation during subsurface gas migration. Earth and Planetary Science Letters, v. 450, p 1-9
- Hooker**, J.N., Larson, T.E.,** Eakin, A., Laubach, S.E., Eichhubl, P., Fall, A., and Marrett, R. (2015) Fracturing and fluid flow in a sub-decollement sandstone; or, a leak in the basement. Journal of the Geological Society. doi:10.1144/jgs2014-128
- Lu, J., **Larson, T.E.**, Smyth, R.C. (*2015*) Carbon isotope effects of methane transport through Anahuac Shale —a core gas study. Journal of Geochemical Exploration, 148, 138-149
- Liu, Y., **Larson, T.E.,** Nicot, J.P. (2015) Theoretical and experimental study of controls on CO2 dissolution and CH4 outgassing. Energy Procedia, v.63, 4773-4781
- Cassel, E.J., Breecker, D.O., Henry, C.D., **Larson, T.E.**, Stockli, D.F., (*2014*) Profile of a paleo-orogen: High topography across the present-day Basin and Range from 40–23 million years ago. Geology, 42, 1007-1010.
- Breecker, D.O., Bergel, S., Nadel, M, Trembley, M., Osuna-Orozco, R., **Larson, T.E.,** Sharp, Z.D. (2015) Minor stable carbon isotope fractionation between respired carbon dioxide and bulk soil organic matter during laboratory incubation of topsoil. Biogeochemistry
- Cisneros-Dozal, LM, Hunag, Y., Heikoop, JM, Fawcett, PJ, Fessenden, J., Anderson, S.,Meyers, P., **Larson, T.E.,** Perkins, G., Toney, J., Werne, J.P., Goff, F., WoldeGabriel, G., Allen, C.D., Berke, M.A. (2014) Assessing the strength of the monsoon during the late Pleistocene in southwestern United States. Quaternary Science Reviews, 103, 81-90
- Newell, D.L., **Larson, T.E.,** Perkins, G., Pugh, J.D., Stewart, B.W., Capo, R.C., Trautz, R.C. (2014) Tracing CO_2 leakage into groundwater using carbon and strontium isotopes during a controlled CO_2 release field test. International Journal of Greenhouse Gas Control. 29, 200-208
- Eiler, J.M., Bergquist,B., Bourg, I., Cartigny, P., Farquhar, J., Gagnon, A., Guo, W., Halevy, I. Hofmann, A., **Larson, T.E.**, Levin, N., Schauble, E.A., Stolper, D. (2014) Frontiers of Stable Isotope Geoscience. Chemical Geology, 372, 119-143.
- **Larson, T.E.,** Breecker, D. (2014) Adsorption isotope effects for carbon dioxide from illite- and quartz-packed column experiments. Chemical Geology. 370, 58-68.
- Barnes, J.D., Prather, T.J., Cisneros, M., Befus, K., Gardner, J.E., **Larson, T.E.** (2014) Stable chlorine isotope behavior during volcanic degassing of H_2O and CO_2 at Mono Craters, CA
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- Ding, Z., Sanchez, T., Labouriau, A., Iyer, S., **Larson, T.,** Currier, R., Zhao, Y., Yang, D. (2010) Characterization of reaction intermediate aggregates in aniline oxidative polymerization at low proton concentration. J. Physical Chemistry B, v.114, p.10337-10346.
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- Cisneros-Dozal, L.M., Heikoop, J.M., Fessenden, J., Anderson, S.R., Meyers, P.A., Allen, C.D., Hess, M., **Larson, T.,** Perkins, G., Rearick, M. (2010) A 15,000-yr Record of Climate Change in Northern New Mexico, USA, inferred from isotopic and elemental contents of bog sediments. Journal of Quaternary Science. V.25, p.1001-1007
- Ding, Z., Sanchez, T., Labouriau, A., Iyer, S., **Larson, T.E.,** Currier, R., Zhao, Y., Yang, D. (2010) Characterization of reaction intermediate aggregates in aniline oxidative polymerization at low proton concentration, 114, 10337-10346
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- Russell, S.D., Longstaffe, F.J., King, P.L., **Larson, T.E.** (2010) The oxygen-isotope composition of chondrules and isolated forsterite and olivine grains from the Tagish Lake carbonaceous chondrite. Geochimica et Cosmochimica Acta, 74, 2484-2499
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