

## Tao Wen

Postdoctoral Scholar in Brantley Group, Earth and Environmental Systems Institute (EESI)

Penn State University, University Park, PA 16802

(734) 730-8814 | [tzwl38@psu.edu](mailto:tzwl38@psu.edu) | [www.jaywen.com](http://www.jaywen.com)

### EDUCATION

<b>University of Michigan (UM)</b>	Ann Arbor, Michigan
<b>Ph.D.</b> , Earth and Environmental Sciences Department	<i>April 2017</i>
<b>M.S.</b> , Earth and Environmental Sciences Department	<i>April 2014</i>
<b>University of Science and Technology of China (USTC)</b>	Hefei, China
<b>B.S.</b> , School of Earth and Space Science	<i>July 2011</i>

### POSITIONS HELD

- Postdoctoral Scholar, EESI at Penn State University (February 2017 – Present)
- Graduate Student Researcher, Noble Gas Laboratory at University of Michigan (2011 – 2017)
- Undergraduate Researcher, Institute of Polar Environment at USTC (2009 – 2011)
- Undergraduate Researcher, Advanced Laboratory for Environmental Research and Technology at Suzhou, China (2009 Summer)

### GRANTS AND AWARDS

<b>USGS Pennsylvania Water Resources Research Grant 104b, 2018</b>	\$66,000
Title: Data-Driven Models to Assess Water Quality in the Region of Marcellus Shale ( <i>senior personnel – co-written</i> )	
<b>Rackham Conference Travel Grant</b>	Each \$800-\$1,300
University of Michigan, Fall 2012, 2013, 2014, 2015, 2016	
<b>Best Student Poster Presentation</b>	
American Institute of Professional Geologists Michigan Section, December 2016	
<b>Scott Turner Research Awards</b>	
University of Michigan, Department of Earth and Environmental Sciences, Fall 2015, 2016	
<b>Stewart R. Wallace Fellowship</b>	
University of Michigan, Department of Earth and Environmental Sciences, Fall 2012	
<b>Excellent Undergraduate Researcher Award</b>	
University of Science and Technology of China, 2011	
<b>Guanghua Education Scholarship</b>	
University of Science and Technology of China, 2010	
<b>Outstanding Student Scholarship</b>	
University of Science and Technology of China, 2008, 2009	

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**TEACHING****Workshop Instructor in Shale Network Workshop, Penn State University** *May 2018*

- *Computer module demonstration and hands-on exercise*: Created and prepared learning material; taught water chemistry about Marcellus-related spills for over 40 participants.
- *Field trip to mock spill event*: Assisted in organizing the field trip to mock spill.

**Interim Instructor, Penn State University** *April 2017*

- *GEOSC 560 – Kinetics of Geological Processes*: Taught basics of isotope geochemistry.

**Teaching Assistant, University of Michigan** *September 2013 – December 2016*

- *EARTH 100s – multiple introduction classes of earth sciences*.
- *EARTH 477 – Hydrogeology*: Guided 50+ students to understand the fate and transport of contaminants from Underground Storage Tanks via hands-on hydrogeological lab work and the interpretation of stratigraphic information.
- *EARTH 408 – Introduction to GIS in the Earth Sciences*: Taught 24 students to implement 2D & 3D spatial analysis in ArcGIS; received positive teaching evaluation (**rated at 4.5-5.0 out of 5.0**) from students and teachers.

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**STUDENT MENTORSHIP****Penn State University**

- Graduate student mentorship: Josh Woda (isotope fractionation); Callum Wayman (GIS)
- Undergraduate thesis supervision: Marcus Guarnieri (2018; groundwater geochemistry in Pennsylvania)

**University of Michigan**

- Undergraduate student mentorship: Guolei Han (noble gas geochemistry)

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**MEDIA COVERAGE**

5. AP News, *Studies show groundwater holding own against drilling boom*, <https://apnews.com/b3cccd15c46d4feb88974b17a033f892>
4. StateImpact NPR, *Study: Bradford County water quality improving despite shale gas drilling*, <https://stateimpact.npr.org/pennsylvania/2018/06/18/study-bradford-county-water-quality-improving-despite-shale-gas-drilling/>
3. Energywire, *Marcellus Shale: Researchers bring new tools to identify methane sources*, <https://www.eenews.net/energywire/2018/06/14/stories/1060084453>
2. Penn State University News, *Bradford County water quality improves; impacts rare near shale gas wells*, <https://news.psu.edu/story/524986/2018/06/12/research/bradford-co-water-quality-improves-impacts-rare-near-shale-gas>
1. Penn State University News, *Data driven dialogue: Scientists bring groups together on water quality concerns*, <https://news.psu.edu/story/503237/2018/01/31/impact/data-driven-dialogue-scientists-bring-groups-together-water-quality>

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**PROFESSIONAL AND FIELD EXPERIENCE**


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**Field work**

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|-----------|---|
| 2017-2018 | Groundwater, surface water, stray gas, and sediment sampling within the Marcellus Shale footprint (monthly) |
| 2013-2014 | Natural gas sampling in the Antrim Shale area (Gas & Oil Wells), MI (1 week)                                |
| 2012      | Groundwater sampling in the Glacial Drift aquifer in Michigan Basin (3 days)                                |
| 2010      | Mountain Huangshan in Anhui, China (4 days)   |
| 2008-2009 | Tai Lake, Chao Lake, Yancheng National Natural Reserve, China (1 month)                                     |

**Public Service**

- Reviewer for *Geochimica et Cosmochimica Acta*, *Water*, *Geological Society of America Today*, *Applied Geochemistry*, *Current Opinion in Environmental Science & Health*, *Advances in Polar Science*
- Session convener and chair at Goldschmidt 2018: Using Geochemistry and Big Data to Understand the Biological-Geological Co-evolution of the Critical Zone - Including Human Impacts
- Session convener and chair at AGU 2018: (V017) Data Science and Geochemistry: Applying a Data-driven Approach in Geochemistry-centric Studies
- Judge for PSU Geosciences Graduate Student Colloquium (2018), 11<sup>th</sup> Annual Postdoctoral Research Exhibition (2018), and AGU student poster and presentation (2018)
- Committee and Instructor for Shale Network Workshop at Penn State (2018)
- President of USTC Alumni Association in Greater Detroit area (2013-2015)
- Co-founder and Vice-president of AAPG student chapter at Uni. of Michigan (2015-2016)

**Professional Development**

- 83rd Annual Field Conference of Pennsylvania Geologists: the Triassic-Jurassic rift system of eastern North America
- GeoDeepDive workshop 2018, UW-Madison, Madison, WI (2018)
- Data Science in Geochemistry workshop attendee, Goldschmidt, Boston, MA (2018)
- Sequence Stratigraphy short course attendee, AAPG, Denver, CO (2015)

**Professional Affiliations**

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|---|----------------|
| • American Geophysical Union (AGU)                    | 2012 – Present |
| • Geological Society of America (GSA)                 | 2014 – Present |
| • American Association of Petroleum Geologists (AAPG) | 2014 – Present |
| • International Association of Hydrogeologists (IAH)  | 2014 – Present |

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**SKILLS**


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Able to learn and understand tasks quickly while performing under pressure, both independently and as part of a team; excellent work ethic and strong ability towards detailing.

- **Expertise:** Strong hands-on experience in water chemistry, stable isotopes and noble gas labs; Proficient in ArcGIS and Microsoft Office suite; Groundwater modeling (MODFLOW); Geochemical modeling (MINEQL+ and PHREEQC); Field work planning and implementation; Collection of groundwater, surface water and shale gas samples; Geological mapping; Data synthesis and analysis; Document preparation including development of text, tables and figures for sampling and analysis plans, conference presentations and scientific papers writing
- **Programming:** R, Python, MATLAB, LabVIEW
- **Other softwares:** Adobe Illustrator and Photoshop
- **Language:** Fluent in English and Chinese

## PUBLICATIONS

### Peer Reviewed Publications

15. **Wen, T.**, Liu, M., Zheng, G., Li, Z. and Brantley, S.L., Applying Machine Learning to Predict Missing Methane Data and Detect Anomalous Methane in Groundwater. *In preparation*.
14. Zheng, G., Liu, M., **Wen, T.**, Wang, H., Yao, H., Brantley, S.L. and Li, Z., Targeted Source Detection for Environmental Data. *Under review*.
13. **Wen, T.**, Agarwal, A., Xue, L., Chen, A., Herman, A., Li, Z. and Brantley, S.L., 2019. Assessing Changes in Groundwater Chemistry in Landscapes with More than 100 Years of Oil and Gas Development. *Environmental Science: Processes & Impacts*. <http://doi.org/10.1039/C8EM00385H>.
12. Woda, J., **Wen, T.**, Oakley, D., Yoxthimer, D., Engelder, T., Castro, M.C. and Brantley, S.L., 2018. Detecting and Explaining Why Aquifers Occasionally Become Degraded Near Hydraulically Fractured Shale Gas Wells. *Proceedings of the National Academy of Sciences*, 115(49), pp.12349-12358. <http://doi.org/10.1073/pnas.1809013115>.
11. 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. *Water Resources Research*, 54(9), pp.6024-6041. <http://doi.org/10.1029/2018WR022612>.
10. **Wen, T.**, Niu, X., Gonzales, M., Zheng, G., Li, Z. and Brantley, S.L., 2018. Big Groundwater Data Sets Reveal Possible Rare Contamination Amid Otherwise Improved Water Quality for Some Analytes in a Region of Marcellus Shale Development. *Environmental Science & Technology*, 52(12), pp.7149-7159. <http://doi.org/10.1021/acs.est.8b01123>.
9. Niu, X., **Wen, T.**, Li, Z. and Brantley, S.L., 2018. One Step toward Developing Knowledge from Numbers in Regional Analysis of Water Quality. *Environmental Science & Technology*, 52(6), pp.3342-3343. <http://doi.org/10.1021/acs.est.8b01035>.
8. **Wen, T.**, Pinti, D.L., Castro, M.C., López-Hernández, A., Hall, C.M., Shouakar-Stash, O. and Sandoval-Medina, F., 2018. A Noble Gas and  $^{87}\text{Sr}/^{86}\text{Sr}$  Study in Fluids of the Los Azufres Geothermal Field, Mexico – Assessing Impact of Exploitation and Constraining Heat Sources. *Chemical Geology*, 483, pp.426-441.

- <http://doi.org/10.1016/j.chemgeo.2018.03.010>.
7. Brantley, S.L., Vidic, R.D., Brasier, K., Yoxtheimer, D., Pollak, J., Wilderman, C. and **Wen, T.**, 2018. Engaging over data on fracking and water quality. *Science*, 359(6374), pp.395-397. <http://doi.org/10.1126/science.aan6520>.
  6. **Wen, T.**, Castro, M.C., Nicot, J.P., Hall, C.M., Pinti, D.L., Mickler, P., Darvari, R. and Larson, T., 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 Science & Technology*, 51(11), pp.6533-6541. <http://doi.org/10.1021/acs.est.6b06447>.
  5. **Wen, T.**, Castro, M.C., Nicot, J.P., Hall, C.M., Larson, T., Mickler, P. and Darvari, R., 2016. Methane Sources and Migration Mechanisms in Shallow Groundwaters in Parker and Hood Counties, Texas - A Heavy Noble Gas Analysis. *Environmental Science & Technology*, 50(21), pp.12012-12021. <http://doi.org/10.1021/acs.est.6b01494>.
  4. **Wen, T.**, Castro, M.C., Ellis, B.R., Hall, C.M. and Lohmann, K.C., 2015. Assessing compositional variability and migration of natural gas in the Antrim Shale in the Michigan Basin using noble gas geochemistry. *Chemical Geology*, 417, pp.356-370. <http://doi.org/10.1016/j.chemgeo.2015.10.029>.
  3. **Wen, T.**, Castro, M.C., Hall, C.M., Pinti, D.L. and Lohmann, K.C., 2016. Constraining groundwater flow in the Glacial Drift and Saginaw aquifers in the Michigan Basin through helium concentrations and isotopic ratios. *Geofluids*, 16(1), pp.3-25. <http://doi.org/10.1111/gfl.12133>.
  2. Boucher, C., Pinti, D.L., Roy, M., Castro, M.C., Cloutier, V., Blanchette, D., Larocque, M., Hall, C.M., **Wen, T.** and Sano, Y., 2015. Groundwater age investigation of eskers in the Amos region, Quebec, Canada. *Journal of Hydrology*, 524, pp.1-14. <http://doi.org/10.1016/j.jhydrol.2015.01.072>.
  1. Nie, Y., Liu, X., **Wen, T.**, Sun, L. and Emslie, S.D., 2014. Environmental implication of nitrogen isotopic composition in ornithogenic sediments from the Ross Sea region, East Antarctica:  $\Delta^{15}\text{N}$  as a new proxy for avian influence. *Chemical Geology*, 363, pp.91-100. <http://doi.org/10.1016/j.chemgeo.2013.10.031>.

#### Non-Peer Reviewed Publications

4. **Wen, T.**, 2017. *Development of Noble Gas Techniques to Fingerprint Shale Gas and to Trace Sources of Hydrocarbons in Groundwater* (Doctoral dissertation, University of Michigan).
3. Nicot, JP., et al., 2015. *Understanding and Managing Environmental Roadblocks to Shale Gas Development: An Analysis of Shallow Gas, NORM, and Trace Metals* (Technical Report, <http://www.rpsea.org/projects/11122-56/>).
2. **Wen, T.**, 2014. *Constraining groundwater flow in the Glacial Drift and Saginaw Aquifers in the Michigan Basin through helium concentrations and isotopic ratios* (Master thesis, University of Michigan).
1. **Wen, T.**, 2011. *Analysis on nitrogen species and isotopic composition of the ornithogenic*

*sediments from Cape Bird, Ross Island, East Antarctica* (Bachelor thesis, University of Science and Technology of China).

## CONFERENCE PRESENTATIONS

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30. **Wen, T.**, Liu, M., Woda, J., Zheng, G., Li, Z., and Brantley, S.L., Detecting anomalous methane in groundwater in shale gas production areas using big data. AGU Fall Meeting, Washington, D.C., 12/2018. [Poster]
29. Brantley, S.L., **Wen, T.**, Li, Z., Liu, M., Zheng, G., Herman, A., Gonzales, M., Woda, J., and Niu, X., Using Big Data (and Little Data) to Understand the Effects of Shale Gas Development on Water Quality. AGU Fall Meeting, Washington, D.C., 12/2018. [Invited Talk]
28. Woda, J., **Wen, T.**, Lemon, J., Keeports, C., Zelt, F.B., and Brantley, S.L., Using citizen science and stream methane to locate and understand hydrocarbon-related contaminant sources in Pennsylvania. AGU Fall Meeting, Washington, D.C., 12/2018. [Oral]
27. **Wen, T.**, Zheng, G., Niu, X., Liu, M., Li, Z., and Brantley, S.L., Using Geochemistry Data to Identify Groundwater Quality Issues in Shale Gas Production Area. Health Effects Institute Energy Research Program Workshop, Austin, TX, 09/2018. [Invited Talk]
26. **Wen, T.**, Liu, M., Zheng, G., Brantley, S.L., and Li, Z., Using Machine Learning to Detect Anomalous Methane in Groundwater within Shale Gas Production Areas. Goldschmidt, Boston, MA, 08/2018. [Poster]
25. Brantley, S.L., **Wen, T.**, Niu, X., Zheng, G., Gonzales, M., and Li, Z., Using Big Groundwater Data to Understand Regional Water Chemistry. Goldschmidt, Boston, MA, 08/2018. [Poster]
24. Woda, J., **Wen, T.**, and Brantley, S.L., Distinguishing Recent Methane Migration into Groundwater from Natural Methane Sources in the Marcellus Gas Play. Goldschmidt, Boston, MA, 08/2018. [Oral]
23. **Wen, T.**, Niu, X., Pollak, J., Brazil, L., Li, Z., and Brantley, S.L., Using Shale Network Database to Assess the Water Quality Data in Marcellus Shale Area. UCOWR-NIWR Annual Water Resources Conference, Pittsburgh, PA, 06/2018. [Invited Talk]
22. **Wen, T.**, A Multi-disciplinary and Multi-stakeholder Framework to Evaluate Environmental Impacts of Shale Gas Production. Energy Days Conference, University Park, PA, 05/2018. [Oral]
21. **Wen, T.**, Liu, M., Zheng, G., Niu, X., Gonzales, M., Woda, J., Li, Z., and Brantley, S.L., Applying machine learning in water quality data: implication for controlling factors and occurrence time of elevated methane in groundwater. Shale Network Workshop, University Park, PA, 05/2018. [Poster]
20. **Wen, T.**, Zheng, G., Liu, M., Niu, X., Gonzales, M., Woda, J., Li, Z., and Brantley, S.L., Applying Machine Learning to Detect Anomalous Methane in Groundwater. PA Groundwater Symposium, State College, PA, 05/2018. [Oral]
19. **Wen, T.**, Niu, X., Gonzales, M., Li, Z., and Brantley, S.L., Applying Data Mining Techniques to Chemical Analyses of Pre-drill Groundwater Samples within the Marcellus Formation

- Shale Play in Bradford County, Pennsylvania. AGU Fall Meeting, New Orleans, LA, 12/2017. [Poster]
18. Pinti, D.L., **Wen, T.**, Castro, M.C., López-Hernández, A., Hall, C.M., Shouakar-Stash, O. and Sandoval-Medina, Using noble gases and  $^{87}\text{Sr}/^{86}\text{Sr}$  to constrain heat sources and fluid evolution at the Los Azufres Geothermal Field, Mexico. AGU Fall Meeting, New Orleans, LA, 12/2017. [Poster]
  17. **Wen, T.**, Castro, M.C., Nicot, J.P., Hall, C.M., Pinti, D.L., Mickler, P., Darvari, R. and Larson, T., Barnett Shale or Strawn Group: Identifying the Source of Stray Gas through Noble Gases in the Trinity Aquifer, North-Central Texas. AGU Fall Meeting, New Orleans, LA, 12/2017. [Oral]
  16. **Wen, T.**, Niu, X., Gonzales, M., Li, Z., and Brantley, S.L., Using Data Mining Techniques to Assess Water Quality within the Marcellus Shale Play. Geochemistry Forum, State College, PA, 12/2017. [Oral]
  15. Brantley, S.L., Gonzales, M., Guarnieri, M., Niu, X., **Wen, T.** and Li, Z., Investigating Chemical Analyses of Ground Waters Sampled by Shale-gas Industry Consultants Before Gas-well Drilling in Pennsylvania. Pennsylvania Groundwater Symposium, State College, PA, 05/2017. [Oral]
  14. **Wen, T.**, Castro, M.C., Nicot, J.P., Hall, C.M., Larson, T., Mickler, P. and Darvari, R., Methane Sources and Migration Mechanisms in the Shallow Trinity Aquifer in Parker and Hood Counties, Texas – a Noble Gas Analysis. Shale Network Workshop, University Park, PA, 05/2017. [Poster]
  13. **Wen, T.**, Pinti, D.L., Castro, M.C., Hall, C.M., Shouakar-Stash, O. and López-Hernández, A., Fluids in the Los Azufres Geothermal Field, Mexico traced by noble gas isotopes and  $^{87}\text{Sr}/^{86}\text{Sr}$ . GAC-MAC Meeting, Kingston, Canada, 05/2017. [Poster]
  12. **Wen, T.**, Development of noble gas techniques to fingerprint shale gas and to trace hydrocarbons in groundwater. China University of Geosciences, Wuhan, China, 03/2017. [Invited, Oral]
  11. **Wen, T.**, Castro, M.C., Nicot, J.P., Hall, C.M., Mickler, P. and Darvari, R., Methane Sources and Migration Mechanisms in the Shallow Trinity Aquifer in Parker and Hood Counties, Texas – a Noble Gas Analysis. AGU Fall Meeting, San Francisco, CA, 12/2016. [Oral]
  10. **Wen, T.**, Castro, M.C., Nicot, J.P., Hall, C.M., Larson, T., Mickler, P. and Darvari, R., Methane Sources and Migration Mechanisms in the Shallow Trinity Aquifer in Parker and Hood Counties, Texas – a Noble Gas Analysis. AIPG Michigan Section, Ann Arbor, MI, 12/2016. [Poster]
  9. Castro, M.C., **Wen, T.**, Nicot, J.P., Hall, C.M., Mickler, P. and Darvari, R., Methane Sources in Shallow Groundwaters in Parker and Hood Counties, Texas – A Heavy Noble Gas Analysis. Goldschmidt, Yokohama, Japan, 06/2016. [Oral]
  8. **Wen, T.**, Castro, M.C., Nicot, J.P., Hall, C.M., Mickler, P. and Darvari, R., Identifying the Sources of Methane in Shallow Groundwaters in South-central Texas through Noble Gas Signatures. AAPG ACE, Calgary, Canada, 06/2016. [Oral]
  7. **Wen, T.**, Castro, M.C., Ellis, B.R., Hall, C.M. and Lohmann, K.C., Assessing Compositional

- Variability and Migration of Natural Gas in Antrim Shale in the Michigan Basin Using Noble Gas Geochemistry. AGU Fall Meeting, San Francisco, CA, 12/2015. [Poster]
6. Castro, M.C., **Wen, T.**, Nicot, J.P., Hall, C.M., Mickler, P. and Darvari, R., Identifying the Sources of Methane in Shallow Groundwaters in Parker and Hood Counties, Texas through Noble Gas Signatures. AGU Fall Meeting, San Francisco, CA, 12/2015. [Oral]
  5. **Wen, T.**, Castro, M.C., Ellis, B.R. and Hall, C.M., Using Noble Gases to Assess the Compositional Variability and Sources of Natural Gas in the Antrim Shale, Michigan Basin, USA. AAPG Eastern Section Meeting, Indianapolis, IN, 09/2015. [Poster]
  4. **Wen, T.**, Castro, M.C., Ellis, B.R., Hall, C.M., Lohmann, K.C. and Bouvier, L., Assessing the Compositional Variability and Migration of Natural Gas in Antrim Shale in the Michigan Basin Using Noble Gas Geochemistry. AAPG ACE, Denver, CO, 06/2015. [Oral]
  3. **Wen, T.**, Castro, M.C., Ellis, B.R., Hall, C.M., Lohmann, K.C. and Bouvier, L., Noble Gas Signatures in Antrim Shale Gas in the Michigan Basin-Assessing Compositional Variability and Transport Processes. AGU Fall Meeting, San Francisco, CA, 12/2014. [Poster]
  2. **Wen, T.**, Castro, M.C. and Hall, C.M., Constraining Groundwater Flow in the Michigan Basin Through Helium Concentrations and Isotopic Ratios in the Saginaw Aquifer, Southern Michigan. AGU Fall Meeting, San Francisco, CA, 12/2012. [Poster]
  1. **Wen, T.**, Liu, X. and Sun, L., Variations of  $\delta^{15}\text{N}$  values in ornithogenic sediments on tropical Dongdao Island of South China Sea and their influencing factors. The 18th International Conference on Environmental Indicators, Hefei, China, 2010. [Poster]

*Updated on 01/07/2019*