

Tongwei Zhang

Professional Summary

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Professional Preparation

Academic Background

Postdoctoral Senior Research Fellow Chemistry, California Institute of Technology, January 2007

Ph.D. Isotope Geochemistry, Chinese Academy of Sciences, 1999

M.S. Petroleum Geochemistry, Chinese Academy of Sciences, 1994

B.S. Petroleum and Natural Gas Geology, Northwest University, 1986

Professional Appointments

Present Position: Research Associate/Organic Chemist, Bureau of Economic Geology, The University of Texas at Austin (April 2008 - Present). As PI or Co-PI for several research projects financially supported by ExxonMobil, Shell, ConocoPhillips, and Yanchang Petroleum Group, and also as a key researchers in the MSRL (Mudrock System Research Laboratories), my research focus is on shale gas and tight oil geochemical characterization and integration with geological elements (lithology and geological facies) and pore characterization to evaluate gas and oil storage, petroleum generation and migration, and oil saturation and fluid properties. I also set up a new gas geochemistry laboratory in the Bureau, utilizing startup funds provided by the Jackson School of Geosciences..

Laboratory Manager and Research Geochemist, Power, Environmental & Energy Research Center (PEER center)

Chemistry and Chemical Engineering Division, California Institute of Technology, Pasadena, CA (March 2007 - April 2008). Responsible for geological interpretation of petroleum and natural gas origin and accumulation in sedimentary basins worldwide; research-project, annual-report, final-report, and proposal writing; and effective management of PEER chemistry laboratories.

Postdoctoral Scholar, Chemistry and Chemical Engineering Division, California Institute of Technology, Pasadena, CA

Chemistry and Chemical Engineering Division, California Institute of Technology, Pasadena, CA (September 2001 - February 2007). Focus: integrated geological and geochemical tools for petroleum reserves assessment, geochemical methods for petroleum and natural gas exploration, CO₂ origin and accumulation in sedimentary basins, H₂S and CO₂ risk prediction from TSR prior to drilling.

Professor of Geochemistry, State Key Laboratory of Gas Geochemistry, Lanzhou Institute of Geology, Chinese Academy of Sciences (CAS) (November 1998 - August 2001). As PI or Co-PI, focused on integrating geological observations and geochemistry of natural gas and sources; established a method of composition analysis for oil/gas inclusions trapped in reservoirs by means of ultraviolet laser ablation; reconstructed oil- or gas-filling history in reservoirs and identified oil/gas-filling stages of the trap by combining fluid-inclusion microthermometry in the

Sichuan sedimentary basin, China; conducted field and laboratory measurement of soil gas (including free phase and absorbed phase), soil secondary carbonate, and mercury; established relationship between enrichment of soil secondary carbonate and microseepage hydrocarbon from deep reservoirs; proposed new mechanism of mineralization in soils resulting from hydrocarbon microseepage; built classification of natural gas origins in a depression on the basis of natural gas geochemistry; evaluated a prospective target for unconventional natural gas accumulation within the depression; conducted N₂, CO₂, Hg gas geochemistry and He and Ar noble gas geochemistry in main gas fields of China; discovered close relationship between helium and argon isotopes and fault activity and volcanic activity; developed geochemical criteria to identify mantle-derived CO₂.

Visiting Scientist, Institute of Petroleum and Organic Geochemistry of Juelich Research Center, Germany (January 1999 - July 1999). Quantitative investigation of cap-rock sealing properties of oil and gas for providing important parameters of basin modeling; conduction of gas migration in diffusion to evaluate extent of carbon-isotope fractionation of methane on experimental and geological time scales; establishment of mathematical procedure by which the extent of isotopic fractionation can be estimated on the geological time scale.

Dissertations

Origins of the natural gases in Huanghua depression, China and carbon isotope fractionation of methane during gas migration, 1999

Areas of Expertise

Areas of Expertise

Expertise in nonhydrocarbon gases (CO₂, H₂S, and N₂) risk prediction prior to drilling, especially H₂S risk prediction from thermochemical sulfate reduction

Expertise in the application of noble gas geochemistry and fluid inclusions to the reconstruction of oil- and gas-filling history in reservoirs

Extensive expertise (15 years) in geological interpretation of petroleum and natural gas origins and accumulation in sedimentary basins by integrating petroleum and natural gas geochemistry, geology, and basin evolution

Hands-on knowledge and experience with high-temperature and high-pressure hydrous pyrolysis and the kinetics of petroleum and gas generation

Skills in laboratory water-chemistry measurement and formation-water chemistry prediction by using thermodynamic model

Strong skills in gas and organic compound quantification and isotopic composition analysis with GC, GC/C/MS (MAT252, MAT251); also experienced with FT-IR/IR, UV, and VG-5400 isotope spectrometer

Awards

Awards and Honorary Societies

2015 Wallace E. Pratt Memorial Award

IAGC Hitchon Award (for Applied Geochemistry 27 [12] paper "Experimental investigation of main controls to methane adsorption in clay-rich rocks"), 2016

Scholarship, Chinese Academy of Science, 1999

Fansuquan Fellowship, 1996

Fellowship, Chinese Academy of Science, 1994

Second Award, Science and Technology Advancement, Chinese Academy of Science, 1994

Fellowship, Graduate School, Chinese Academy of Science, 1993

Service

Proposal Review Panels Participation

Acta Sedimentologica Sinica (China) (Articles), 2013

Chinese Science Natural Foundation (Proposals), 2013

Marine and Petroleum Geology, Organic Geochemistry, Journal of Petroleum Science & Engineering, Energy and Fuels, Geochemica et Cosmochemica Acta, AAPG Bulletin, Geology, Journal of Asian Earth Sciences, Basin Research (Articles), 2013

Presentations

Presentations

Gas geochemistry and gas adsorption and preservation in shale gas system: invited lecture presented to Unconventional Energy Resources class of Jackson School of Geosciences, The University of Texas at Austin, Austin, Texas, November 4, 2013.

Liquid hydrocarbon characterization and pore characterization of Eagle Ford shales by using N₂ adsorption and desorption isotherms: presented at Shell/UT Unconventional Research Project Meeting, oral presentation of research progress of Task 7, Austin, Texas, October 22, 2013.

Effect of organic matter properties, clay mineral type and thermal maturity on gas adsorption in organic-rich systems: presented at Unconventional Resources Technology Conference (URTeC), oral talk in Theme 13: Source Rock Characterization, Denver, Colorado, August 12-14 2013.

Geochemical controls on gas adsorption and preservation in organic-rich shale systems: presented at American Association of Petroleum Geologists, 2013 Annual Convention, poster presentation in Theme 1: Unconventionals II (EMD/AAPG), Pittsburgh, Pennsylvania, May 2013.

Integrated hydrocarbon geochemical characterization and pore size distribution analysis for Bakken Shales, Williston Basin, USA: presented at American Association of Petroleum Geologists, 2013 Annual Convention, Oral talk in Theme 1: The Bakken Petroleum System (AAPG/EMD), Pittsburgh, Pennsylvania, May 2013.

Hydrocarbon geochemistry and pore characterization of the Bakken Formation and implications for oil migration and oil saturation: oral presentation at 2013 Meeting of Mudrock Systems Research Laboratory, Austin, Texas, March 2013.

Tight oil resources in United States: invited lecture presented to Petrochina Research Center, Beijing, China, December 2012.

Gas adsorption, gas geochemistry and gas generation kinetics: invited lecture presented to Unconventional Energy Resources class of Jackson School of Geosciences, The University of Texas at Austin, Austin, Texas, November 2012.

Main controls on gas adsorption and canister desorption in organic-rich shale system: presented at annual project meeting with ConocoPhillips, Houston, Texas, September 2012.

Shale gas geochemistry and its application to gas preservation and recovery: invited lecture presented to ExxonMobil Exploration Company, Houston, Texas, June 2012.

Geochemical controls on gas adsorption and preservation in organic-rich shale systems: invited lecture presented to Department of Geological Sciences and Engineering, Missouri University of Science and Technology, Rolla, Missouri, March 19, 2012.

Shale gas geochemistry and kinetics of mixed gas adsorption: presented at annual EM/BEG meeting, Austin, Texas, February 14, 2012.

Shale gas development in US and main controls on shale gas chemistry: invited lecture presented to Aachen University, Aachen, Germany, September 22, 2011.

Main controls on gas chemistry in shale gas system: invited oral presentation in Session IB: shale gases and tight gases of AAPG Hedberg Research Conference on Natural Gas Geochemistry: Recent developments, Applications, and Technologies, Beijing, China, May 9-12, 2011.

Experimental gas extraction by rock crushing: Evidence for preservation of methane in core samples from the mudstones of the Eagle Ford Formation: invited oral presentation in Theme 5 (Active and Emerging Plays-Haynesville and Eagle Ford) of AAPG 2011 Annual Convention & Exhibition, Houston, Texas, April 10-13, 2011.

Geochemical identification of free gas and adsorbed gas and its impact to shale gas production. Presented at EM/BEG Quarterly meeting, Austin, April, 2011: April 2011.

Gas geochemistry and its application in shale gas exploration and production: invited talk to Petrochina Lanfang Institute, Lanfang, China, October 17, 2010.

Gas geochemistry and shale gas reservoir characterization: invited lecture for shale gas workshop, Chengdu, Sichuan, China, October 13-14, 2010.

Gas adsorption and gas storage mechanism in shale: invited talk for 2009 AAPG Unconventional Gas Research Committee Meeting, Denver, Colorado, June 9, 2009.

Geochemical kinetics model for gas generation from sources and hydrocarbon oxidation by TSR: invited lecture to Jackson School of Geosciences, Austin, Texas, April 2009.

Origins of natural gases (CH₄, CO₂, H₂S) and geochemical predictive model: invited talk to ExxonMobil Upstream Company, Houston, Texas, December 11, 2008.

Gas geochemistry in shale gas exploration and production: invited lecture for MRSL/BEG shale gas workshop, Houston, Texas, November 20, 2008.

New experiments of hydrogen sulfide initiation: presented to Thermochemical Sulfate Reduction (TSR), at 2007 JIP/Caltech meeting, Pasadena, California, February 2007.

Natural gas geochemistry in the Tarim Basin, China, and its application to gas filling history: Invited lecture presented at AAPG/SEPM's Petroleum Geochemistry Case Studies--Opportunities for Reducing Risk, 2007.

Natural gas geochemistry in Tarim Basin, China, and its indication of gas filling history: presented at the University of Southern California, Los Angeles, California, September 2006.

Natural gas geochemistry in the Tarim Basin, China, and its indication to gas filling history: Invited lecture presented to Environmental and Civil Engineering Department, University of Southern California, Los Angeles, California, September 2006.

Labile organosulfur species formation in Thermochemical Sulfate Reduction (TSR): presented at JIP/Caltech meeting, Pasadena, California, January 2006.

Effect of TSR on hydrocarbon cracking: presented to CNPC (Chinese National Petroleum Cooperation) visitors, Caltech, Pasadena, California, November 2005.

CO₂ origins and its accumulation in sedimentary basin: presented at the University of Southern California, Los Angeles, California, October 2005.

Origins of CO₂ and its accumulation in sedimentary basins: Invited lecture presented to Environmental and Civil Engineering Department, University of Southern California, Los Angeles, California, October 2005.

Mechanism and kinetics of TSR: presented at 15th Annual V.M. Goldschmidt Conference, University of Idaho, Moscow, Idaho, May 2005.

Organosulfur speciation and effect on TSR: presented at JIP/Caltech meeting, Pasadena, California, January 2005.

Hydrogen sulfide prediction kinetics model: presented at AAPG meeting, Dallas, Texas, May 2004.

Effect of TSR on gas generation and hydrocarbon cracking: presented at Caltech, Pasadena, California, January 2004.

Kinetics and mechanism of thermochemical sulfate reduction: presented at JIP/Caltech meeting, Pasadena, California, January 2003.

Natural gas generation and accumulation in sedimentary basin: presented at PEER Center, Caltech, Pasadena, California, August 2002.

CO₂ origins in Huanghua Depression, Bohai Bay Basin, China: Invited lecture presented to Organic and Isotope Geochemistry Groups in the Federal Institute for Geosciences and Natural Resources, Hanover, Germany, June 1999.

Natural gas origins in Huanghua Depression, Bohai Bay Basin, China: Invited lecture presented at Institute of Geology and Geochemistry of Petroleum and Coal, RWTH Aachen University, Aachen, Germany, March 1999.

Activities of a Professional Nature

Professional Societies

Geochemical Society

Geological Society of China

Petroleum Geology Association, Gansu Province, China

Sigma Xi, The Scientific Research Society

Funding

Research Support

PI: Lacustrine shale gas reservoir characterization in the yanchang formation by integrated geological facies, geochemistry, chemostratigraphy, SEM pore imaging, petrography and geophysics, Yanchang Petroleum Group (November 2013 - October 2015, \$1,000,000).

PI: Investigation of the oil storage mechanism and variables for oil saturation in organic-rich shales, ExxonMobil (June 2013 - May 2015, \$200,000).

Key researcher: Mudrock Consortium, 25 industrial members (January 2010 - December 2014).

Co-PI: Investigation of oil storage and migration in the eagle ford formation by integrated geochemistry and petrography, Shell (September 2012 - August 2014, \$300,000).

PI: Gas geochemistry laboratory setup, Jackson School of Geosciences (January 2008 - December 2012, \$260,000).

PI: Shale gas geochemistry, ExxonMobil (July 2011 - April 2012, \$110,000).

PI: Investigation of gas chemicals and isotopic variation in shale, ExxonMobil (December 2009 - April 2012, \$268,000).

Publications

Peer Reviewed Journal Articles

Alfi, M., Hosseini, S. A., Enriquez, D., and Zhang, T., 2019, A new technique for permeability calculation of core samples from unconventional gas reservoirs: Fuel, v. 235, p. 301-305, <http://doi.org/10.1016/j.fuel.2018.07.114>.

Hackley, P. C., Zhang, L., and Zhang, T., 2017, Organic petrology of peak oil maturity Triassic Yanchang Formation lacustrine mudrocks, Ordos Basin, China: Interpretation, v. 5, no. 5, p. SF211-SF223, <http://doi.org/10.1190/INT-2016-0111.1>.

- Ko, L. T., Loucks, R. G., Milliken, K., Liang, Q., Zhang, T., Sun, X., Hackley, P. C., Ruppel, S. C., and Peng, S., 2017, Controls on pore types and pore-size distribution in the Upper Triassic Yanchang Formation, Ordos Basin, China: implications for pore-evolution models of lacustrine mudrocks: *Interpretation*, v. 5, no. 2, p. SF127-SF148, <http://doi.org/10.1190/INT-2016-0115.1>.
- Ko, L. T., Loucks, R. G., Ruppel, S. C., Zhang, T., and Peng, S., 2017, Origin and characterization of Eagle Ford pore networks in the south Texas Upper Cretaceous shelf: *AAPG Bulletin*, v. 101, no. 3, p. 387-418, <http://doi.org/10.1306/08051616035>.
- Li, Y. F., Zhang, T., Ellis, G. S., and Shao, D., 2017, Depositional environment and organic matter accumulation of Upper Ordovician-Lower Silurian marine shale in the Upper Yangtze Platform, South China: *Palaeogeography, Palaeoclimatology, Palaeoecology*, v. 466, p. 252-264, <http://doi.org/10.1016/j.palaeo.2016.11.037>.
- Loucks, R. G., Ruppel, S. C., Wang, X., Ko, L., Peng, S., Zhang, T., Rowe, H. D., and Smith, P. L., 2017, Pore types, pore-network analysis, and pore quantification of the lacustrine shale-hydrocarbon system in the Late Triassic Yanchang Formation in the southeastern Ordos Basin, China: *Interpretation*, v. 5, no. 2, p. SF63-SF79, <http://doi.org/10.1190/INT-2016-0094.1>.
- Peng, S., Zhang, T., Loucks, R. G., and Shultz, J., 2017, Application of mercury injection capillary pressure to mudrocks: conformance and compression corrections: *Marine and Petroleum Geology*, v. 88, p. 30-40, <http://doi.org/10.1016/j.marpetgeo.2017.08.006>.
- Rowe, H. D., Wang, X., Fa, B., Zhang, T., Ruppel, S. C., Milliken, K., Loucks, R. G., Shen, Y., Zhang, J., Liang, Q., and Sivil, J. E., 2017, Chemostratigraphic insights into fluvio-lacustrine deposition, Yanchang Formation, Upper Triassic, Ordos Basin, China: *Interpretation*, v. 5, no. 2, p. SF149-FS165, <http://doi.org/10.1190/INT-2016-0121.1>.
- Sun, X., Liang, Q., Jiang, C., Enriquez, D., Zhang, T., and Hackley, P., 2017, Liquid hydrocarbon characterization of the lacustrine Yanchang Formation, Ordos Basin, China: organic-matter source variation and thermal maturity: *Interpretation*, v. 5, no. 2, p. SF225-SF242, <http://doi.org/10.1190/INT-2016-0114.1>.
- Zhang, T., Sun, X., Milliken, K., Ruppel, S. C., and Enriquez, D., 2017, Empirical relationship between gas composition and thermal maturity in Eagle Ford Shale, south Texas: *AAPG Bulletin*, v. 101, no. 8, p. 1277-1307, <http://doi.org/10.1306/09221615209>.
- Zhang, T., Wang, X., Zeng, H., Fishman, N., Katz, B. J., Milliken, K., Wei, M., Loucks, R. G., and Ghanizadeh, A., 2017, Introduction to special section: Lacustrine shale characterization and shale resource potential in Ordos Basin, China: *Interpretation*, v. 5, no. 2, p. SFi-SFii, <http://doi.org/10.1190/INT-2017-0314-SPSEINTRO.1>.
- Zhang, T., Wang, X., Zhang, J., Sun, X., Milliken, K., Ruppel, S. C., and Enriquez, D., 2017, Geochemical evidence for oil and gas expulsion in Triassic lacustrine organic-rich mudstone, Ordos Basin, China: *Interpretation*, v. 5, no. 2, p. SF41-SF61, <http://doi.org/10.1190/INT-2016-0104.1>.
- Gilbert, K., Bennett, P. C., Wolfe, W., Zhang, T., and Romanak, K. D., 2016, CO₂ solubility in aqueous solutions containing Na⁺, Ca²⁺, Cl⁻, SO₄²⁻ and HCO₃⁻: the effects of electrostricted water and ion hydration thermodynamics: *Applied Geochemistry*, v. 67, p. 59-67, <http://doi.org/10.1016/j.apgeochem.2016.02.002>.
- Ko, L. T., Loucks, R. G., Zhang, T., Ruppel, S. C., and Shao, D., 2016, Pore and pore network evolution of Upper Cretaceous Boquillas (Eagle Ford-equivalent) mudrocks: Results from gold tube pyrolysis experiments: *AAPG Bulletin*, v. 100, no. 11, p. 1693-1722, <http://doi.org/10.1306/04151615092>.
- Sun, X., Zhang, T., Sun, Y., Milliken, K., and Sun, D., 2016, Geochemical evidence of organic matter source input and depositional environments in the lower and upper Eagle Ford Formation, south Texas: *Organic Geochemistry*, v. 98, p. 66-81, <http://doi.org/10.1016/j.orggeochem.2016.05.018>.

- Tian, H., Li, T., Zhang, T., and Xiao, X., 2016, Characterization of methane adsorption on overmature Lower Silurian-Upper Ordovician shales in Sichuan Basin, southwest China: Experimental results and geological implications: *International Journal of Coal Geology*, v. 156, no. 15, p. 36-49, <http://doi.org/10.1016/j.coal.2016.01.013>.
- Hu, H., Zhang, T., Wiggins-Camacho, J. D., Ellis, G. S., Lewan, M. D., and Zhang, X., 2015, Experimental investigation of changes in methane adsorption of bitumen-free Woodford Shale with thermal maturation induced by hydrous pyrolysis: *Marine and Petroleum Geology*, v. 59, p. 114-128, <http://doi.org/http://dx.doi.org/10.1016/j.marpetgeo.2014.07.029>.
- Peng, S., Yang, J., Xiao, X., Loucks, R. G., Ruppel, S. C., and Zhang, T., 2015, An integrated method for upscaling pore-network characterization and permeability estimation: example from the Mississippian Barnett Shale: *Transport in Porous Media*, v. 109, no. 2, p. 359-376, <http://doi.org/10.1007/s11242-015-0523-8>.
- Wolaver, B. D., Coogan, J. C., Horton, B. K., Bermudez, L. S., Sun, A. Y., Wawrzyniec, T. F., Zhang, T., Shanahan, T. M., Dunlap, D. B., Costley, R., and de la Rocha, L., 2015, Structural and hydrogeologic evolution of the Putumayo basin and adjacent fold-thrust belt, Colombia: *AAPG Bulletin*, v. 99, no. 10, p. 1893-1927, <http://doi.org/10.1306/05121514186>.
- Gasparik, M., Rexer, T. F., Aplin, A. C., Billefont, P., DeWeireld, G., Gensterblum, Y., Henry, M., Krooss, B. M., Liu, S., Ma, X., Sakurovs, R., Song, Z., Staib, G., Thomas, M., Wang, S., and Zhang, T., 2014, First international inter-laboratory comparison of high-pressure CH₄, CO₂ and C₂H₆ sorption isotherms on carbonaceous shales: *International Journal of Coal Geology*, v. 132, p. 131-146, <http://doi.org/http://dx.doi.org/10.1016/j.coal.2014.07.010>.
- Yang, C., Treviño, R. H., Zhang, T., Romanak, K. D., Kerstan, W., Lu, J., Mickler, P., and Hovorka, S. D., 2014, Regional assessment of CO₂-solubility trapping potential: a case study of the coastal and offshore Texas Miocene interval: *Environmental Science and Technology*, v. 48, p. 8275-8282, <http://doi.org/10.1021/es502152y>.
- Zhang, T., Yang, R., Milliken, K., Ruppel, S. C., Pottorf, R. J., and Sun, X., 2014, Chemical and isotopic composition of gases released by crush methods from organic rich mudrocks: *Organic Geochemistry*, v. 73, p. 16-28, <http://doi.org/http://dx.doi.org/10.1016/j.orggeochem.2014.05.003>.
- Milliken, K., Rudnicki, M., Awwiller, D. N., and Zhang, Tongwei, 2013, Organic matter-hosted pore system, Marcellus Formation (Devonian), Pennsylvania: *AAPG Bulletin*, v. 97, p. 177-200.
- Ji, L., Zhang, T., Milliken, K., Qu, J., and Zhang, X., 2012, Experimental investigation of main controls to methane adsorption in clay-rich rocks: *Applied Geochemistry*, v. 27, p. 2533-2545.
- Lu, J., Cook, P. J., Hosseini, S. A., Yang, C., Romanak, K. D., Zhang, T., Freifeld, B. M., Smyth, R. C., Zeng, H., and Hovorka, S. D., 2012, Complex fluid flow revealed by monitoring CO₂ injection in a fluvial formation: *Journal of Geophysical Research*, v. 117, B03208, doi:10.1029/2011JB008939.
- Milliken, K. L., Esch, W. L., Reed, R. M., and Zhang, T., 2012, Grain assemblages and strong diagenetic overprinting in siliceous mudrocks, Barnett Shale (Mississippian), Fort Worth Basin, Texas: *AAPG Bulletin*, v. 96, no. 8, p. 1553-1578.
- Zhang, T., Ellis, G. S., Ma, Q., Amrani, A., and Tang, Y., 2012, Kinetics of uncatalyzed thermochemical sulfate reduction by sulfur-free paraffin: *Geochimica et Cosmochimica Acta*, v. 96, p. 1-17.
- Zhang, T., Ellis, G. S., Ruppel, S. C., Milliken, K., and Yang, R., 2012, Effect of organic-matter type and thermal maturity on methane adsorption in shale-gas systems: *Organic Geochemistry*, v. 47, p. 120-131.
- Amrani, Alon, Zhang, Tongwei, Ma, Qisheng, Ellis, G. S., and Tang, Yongchun, 2008, The role of labile sulfur compounds in thermochemical sulfate reduction: *Geochimica et Cosmochimica*

Acta, v. 72, p. 2960-2972.

Ma, Qisheng, Ellis, G. S., Amrani, Alon, Zhang, Tongwei, and Tang, Yongchun, 2008, Theoretical study on the reactivity of sulfate species with hydrocarbons: *Geochimica et Cosmochimica Acta*, v. 72, p. 4565-4576.

Wang, Kang-shi, Zhang, Tongwei, Ellis, G. S., Walters, C. C., Kelemen, S. R., and Tang, Yongchun, 2008, Geochemical signatures of thermochemical sulfate reduction in controlled hydrous pyrolysis experiments: *Organic Geochemistry*, v. 39, p. 308-328.

Zhang, T., Ellis, G. S., Walters, C. C., Kelemen, S. R., Wang, K., and Tang, Y., 2008, Geochemical signatures of thermochemical sulfate reduction in controlled hydrous pyrolysis experiments: *Organic Geochemistry*, v. 39, p. 308-328, <http://doi.org/doi:10.1016/j.orggeochem.2007.12.007>.

Zhang, Tongwei, Amrani, Alon, Ellis, G. S., Ma, Qisheng, and Tang, Yongchun, 2008, Experimental investigation on thermochemical sulfate reduction by H₂S initiation: *Geochimica et Cosmochimica Acta*, v. 72, p. 3518-3530.

Zhang, Tongwei, Zhang, Mingjie, Bai, Baojun Wang, Xianbin, and Li, Liwu, 2008, Origin and accumulation of carbon dioxide in the Huanghua depression, Bohai Bay Basin, China: *AAPG Bulletin*, v. 92, no. 3, p. 341-358.

Zhang, Tongwei, Geoffrey, S. E., Wang, Kenny, Walters, C. C., Kelemen, S. R., Gillaizeau, Buruno, and Tang, Yongchen, 2007, Effect of hydrocarbon types on thermochemical sulfate reduction: *Organic Geochemistry*, v. 38, no. 6, p. 897-910.

Yang, R., Zhang, M., and Zhang, T., 2003, Gas geochemistry of fluid inclusions in carbonate reservoirs of southwestern Sichuan Basin: *Acta Sedimentologica Sinica*, v. 21, no. 3, p. 522-527.

Zhang, Tongwei, and Krooss, Bernhard, 2001, Experimental investigation of carbon isotopic fractionation of methane during gas migration in diffusion through sedimentary rocks: *Geochimica et Cosmochimica Acta*, v. 65, no.16, p. 2723-2742.

Non Peer Reviewed Journal Articles

Ko, L., Zhang, T., Loucks, R. G., Ruppel, S. C., and Shao, D., 2014, Boquillas (Eagle Ford) Formation pore evolution results from laboratory heating experiments: *Unconventional Resources Technology Conference*, no. 7, <http://doi.org/10.15530/urtec-2014-1935124>.

Hovorka, S. D., Meckel, Timothy, Treviño, R. H., Lu, Jiemin, Nicot, J. -P., Choi, Jong-Won, Freeman, D., Cook, P. G., Daley, Tom, Ajo-Franklin, J., Freifeld, Barry, Doughty, C. A., Carrigan, C. R., La Brecque, D., Kharaka, Yousif, Thordsen, J. J., Phelps, Tommy, Yang, Changbing, Romanak, Katherine, Zhang, Tongwei, Holt, R. M., Lindler, J. S., and Butsch, R. J., 2011, Monitoring a large volume CO₂ injection: year two results from SECARB project at Denbury's Cranfield, Mississippi, USA, in *Energy Procedia*, v. 4, Proceedings of 10th International Conference on Greenhouse Gas Control Technologies GHGT10, September 19-23, Amsterdam, The Netherlands, p. 3478-3485.

Tang, Junhong, Zhang, Tongwei, Bao, Zhengyu, and Zhang, Mingjie, 2005, Component and carbon isotope characteristics of organic inclusions in reservoirs and its tracing to oil and gas source: *Geological Review*, v. 51, no. 1, p. 100-106.

Tang, Junhong, Zhang, Tongwei, Bao, Zhengyu, and others, 2004, Study of organic inclusions in the carbonate reservoirs of the Weiyuan gas field in the Sichuan basin, China: *Geological Review*, v. 50, no. 2, p. 210-214.

Zhang, Mingjie, Tang, Junhong, Zhang, Tongwei, and others, 2004, Application of the fluid inclusions in petroleum and natural gas geology and geochemistry: *Geological Review*, v. 50, no. 4, p. 397-406.

- Tang, Junhong, Zhang, Tongwei, Bao, Zhengyu, Zhang, Mingjie, and Yang, Rongsheng, 2003, Hydrocarbon fluid inclusion and its application in petroleum geology: Geological Science and Technology Information, v. 22, no. 4, p. 60-64.
- Yang, Yongsheng, Zhang, Mingjie, Zhang, Tongwei, and others, 2003, Gas geochemistry of fluid inclusions in the carbonate reservoirs, Southwest Sichuan basin, China: Acta Sedimentologica Sinica, v. 21, no. 3, p. 522-527.
- Zhang, Tongwei, Wang, Xianbin, Chen, Jianfa, and others, 1999, Chemical composition of gases as a geochemical tracer of natural gas migration: Acta Sedimentologica Sinica, v. 17, no. 4, p. 623-632.
- Zhang, Tongwei, Wang, Xianbin, and Feng, Jiang, 1998, Implication to mantle-derived CO₂ in natural gases of Huanghua depression using helium and argon isotope tracer: Chinese Science Bulletin, v. 43.
- Zhang, Tongwei, 1997, Non-hydrocarbons in natural gas and its implication to medium-large size gas field formation: Bulletin of Natural Gas Research Advancement, v. 4.
- Zhang, Tongwei, Wang, Xianbin, Chen, Jianfa, and others, 1997, Hydrocarbon alteration caused by migration: Journal of Northwest Petroleum and Gas Exploration, v. 9, no. 4, p. 20-25.
- Shen, Ping, Chen, Jianfa, Tao, Mingxin, and Zhang, Tongwei, 1996, The source of natural gas and geochemical characterization for natural gas migration in Yinggehai Basin: Natural Gas Geoscience, v. 1.
- Wen, Oibin, Shao, Bo, Zhang, Tongwei, and others, 1996, GC/C/MS on-line carbon isotope analysis and study on carbon isotope composition of natural gases from the Jiyan depression: Chinese Science Bulletin, v. 47, no. 17, p. 1597-1600.
- Xu, Yanqian, and Zhang, Tongwei, 1996, Study on organic nitrogen compounds in sediments basin: Natural Gas Geoscience, v. 4.
- Zhang, Tongwei, Wang, Xianbin, Shen, Qixian, and others, 1996, Carbon isotope composition of acidolysis hydrocarbons and its application to gas-source correlation in Ordos basin, China: Chinese Science Bulletin, v. 41, no. 9, p. 754-758.
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