**Shimin Liu**

The Pennsylvania State University

Department of Energy and Mineral Engineering

224 Hosler Building, University Park, PA 16802

Tel: (814)863-4491; Fax: (814) 865-3248: Email: [szl3@psu.edu](mailto:szl3@psu.edu)

**EDUCATION**

Ph.D. in Engineering Science, 2012

**Southern Illinois University at Carbondale, Illinois, USA**

M.S. in Mineral Processing Engineering, 2007

**China University of Mining & Technology at Beijing, China**

B.S. in Environmental Engineering, 2005

**China University of Mining & Technology at Beijing, China**

**PROFESSIONAL APPOINTMENTS**

7/2018 – present Associate Professor, The Pennsylvania State University

1/2013 – 6/2018 Assistant Professor, The Pennsylvania State University

5/2012 – 12/2012 Research Scientist, Southern Illinois University

8/2007 – 5/2012 Research Assistant, Southern Illinois University

**RESEARCH INTERESTS**

Flow of fluids in porous media (with application to gas flow in coal/shale, coalbed methane reservoir engineering, carbon sequestration in geologic media and abandoned coal mines); imaging (micro-X-ray computed tomography, synchrotron X-ray scattering, neutron scattering/diffracting, scanning/transmission electron microcopy) and analysis to study physical structure of rocks; flow-induced micro-structuring of rocks; geomechanical responses of unconventional reservoirs with depletion, mine ground control and mine ventilation

**HONORS/AWARDS RECEIVED**

* 2021 Energy and Fuels Rising Stars – ACS Energy & Fuels Journal, 2021
* Top 25 Most Cited Article of Energy & Fuels in 2016
* Recognized by Springer Nature for Editorial Excellence, 2020
* Invited Associate Editor, Environmental Science and Pollution Research, 2022
* Invited as Editor-in-Chief, International Journal of Coal Science and Technology, Springer, 2018-present
* The 2017 Freeport-McMoRan Career Development Grant from Society for Mining, Metallurgy & Exploration
* Best Keynote Award, 3rd International Symposium on Unconventional Geomechanics, Wuhan, China, 2016
* Kreutzberger Early Career Assistant Professor, Penn State University 2016
* Gladys Snyder Grant Award, Penn State University, 2015
* Excellent Reviewer Awards:
* Journal of Natural Gas Science and Engineering, 2013, 2017
* Fuel Journal, 2016, 2017
* Beam Time Award, DOE Oak Ridge National Laboratory (ORNL), 2014, 2015
* Wilson Research Initiation Award, Penn State University, 2013
* Doctoral Fellowship, SIU (Fall 2010, Spring and Summer 2011)

**LIST OF PUBLICATIONS**

**A. Peer Reviewed Journal Publications**

**2022**

1. Liu, A., and **Liu, S**., 2022. Mechanical property alterations across coal matrix due to water-CO2 treatments: A micro-to-nano scale experimental study, Energy, v. 248, 123575.
2. Shi, B., Cao, Y., Tian., L, Zhang, J., and **Liu, S**., 2022. CO2 gas fracturing in high dip angled coal seams for improved gas drainage efficiency at Hashatu coal mine, Energy&Fuels, in press.
3. Liu, P., Liu, A., **Liu, S**., and Qi, L., 2022. Experimental evaluation of ultrasound treatment induced pore structure and gas desorption behavior alterations of coal, Fuel, v. 307, 121855.
4. Cao, Y., Zhang, J., Zhang, X., **Liu, S**., and Elsworth, D., 2022. Micro-fractures in coal induced by high pressure CO2 gas fracturing, Fuel, v. 311, 122148.
5. Yang, Y., **Liu, S**. and Clarkson, C., 2022. Quantification of temperature-dependent sorption isotherms in shale gas reservoirs: experiment and theory, SPE Journal, in press.

**2021**

1. Huang, Q., Li, J., **Liu, S**., and Wang, G., 2021. Experimental study on the adverse effect of gel fracturing fluid on gas sorption behavior for Illinois coal, International Journal of Coal Science & Technology, v. 8(6), pp 1250-1261.
2. Chen, S., Yao, S., Wang, Y., **Liu, S**., Wang, X., Zhang, Y., and Wang, H., 2021. Investigation of pore evolution and variation with magma intrusion on Permian Gufeng shale formation and their implications on gas enrichment, Journal of Natural Gas Science and Engineering, v. 96, 104277.
3. Sun, Y., Li, S., Lu, C., **Liu, S**., Chen, W., and Li, X., 2021. The characteristics and its implications of hydraulic fracturing in hydrate bearing clayey silt, Journal of Natural Gas Science and Engineering, v. 95, 104189.
4. Liu, Y., **Liu, S.**, Zhang, R., and Zhang, Y., 2021. The molecular model of Marcellus shale kerogen: Experimental characterization and structure reconstruction, International Journal of Coal Geology, v. 246, 103833.
5. Zhao, Y., Sun, B., **Liu, S.**, Zhang, C., He, X., Xu, D. and Tang, W., 2021. Identification of mining induced ground fissures using UAV and infrared thermal imager: Temperature variation and fissure evolution, ISPRS Journal of Photogrammetry and Remote Sensing, v. 180, pp 45-64.
6. Wang, Z., **Liu, S.**, and Qin, Y., 2021. Coal wettability in coalbed methane production: A critical review, Fuel, v. 303, 121277
7. Zhang, R., and **Liu, S**., 2021. Investigating hierarchical gas confinement in high-rank coal through small-angle neutron scattering, Energy & Fuels, v. 35, pp 13109-13123.
8. Tang, S., **Liu, S**., and Kang, Y., 2021. Multi-scale pore characterization of coal measure reservoirs and gas storage and transport behavior in Yanchuannan gas field of China, AAPG Bulletin, in press.
9. Liu, Y., **Liu, S**., and Kang, Y., 2021. Probing nanomechanical properties of a shale with nanoindentation: heterogeneity and the effect of water–shale interactions, Energy & Fuels, v. 35, pp 11930-11946.
10. Yang, Y., and **Liu, S.**, 2021. Integrated modeling of multi-scale transport in coal and its application for coalbed methane recovery, Fuel, v. 300, 120971.
11. Hou, X., **Liu, S**., Li, G., Zhu, Y., and Liu, A., 2021. Quantifying and modeling of in situ stress evolutions of coal reservoirs for helium, methane, nitrogen and CO2 depletions, Rock Mechanics and Rock Engineering, v. 54, pp 3701-3719.
12. Lu, T., Long, S., Li, Z., **Liu, S**., Liu, Y., Adenutsi, CD., and Peng, Z., 2021. Novel model for rate transient analysis in stress-sensitive shale gas reservoirs, ACS Omega, v. 6, pp 14015-14029.
13. Zhang, K., Meng, Z., **Liu, S**., Hao, H., and Chen, T., 2021. Laboratory investigation on pore characteristics of coals with consideration of various tectonic deformations, Journal of Natural Gas Science and Engineering, v. 91, 103960.
14. Yang, Y., **Liu, S.**, and Chang, X., 2021. Fracture stiffness evaluation with waterless cryogenic treatment and its implication in fluid flowability of treated coals, International Journal of Rock Mechanics and Mining Sciences, v. 142, 104727.
15. Zhang, K., Meng, Z., and **Liu, S**., 2021. Comparisons of methane adsorption/desorption, diffusion behaviors on intact coals and deformed coals: Based on experimental analysis and isosteric heat of adsorption, Energy & Fuels, v. 35(7), pp 5975-5987.
16. Zhang, R., **Liu, S**., and Zheng, S., 2021. Characterization of nano-to-micron sized respirable coal dust: particle surface alteration and the health impact, Journal of Hazardous Materials, v. 413, 125447.
17. Huang, Q., **Liu, S**., Wu, B., Wang, G., Li, G., and Guo, Z., 2021. Role of VES-based fracturing fluid on gas sorption and diffusion of coal: an experimental study of Illinois basin coal, Process Safety and Environmental Protection, v. 148, pp 1243-1253.
18. Liu, A., **Liu, S**., Liu, P., and Harpalani, S., 2021. The role of sorption-induced coal matrix shrinkage on permeability and stress evolutions under replicated in situ condition for CBM reservoirs, Fuel, v. 294, 120530.
19. Liu, A., **Liu, S**., Liu, P., and Wang, K., 2021. Water sorption on coal: effects of oxygen containing function groups and pore structure, International Journal of Coal Science & Technology, v. 8, pp 983-1002.
20. Zhou, X., **Liu, S**., and Zhang, Y., 2021. Permeability evolution of fractured sorptive geomaterials: a theoretical study on coalbed methane reservoir, Rock Mechanics and Rock Engineering, v. 54, pp 3507-3525.
21. Fan, L., and **Liu, S**., Zhao, W., and Hou, X., 2021. Investigation of fluid-injection-induced coal stiffness alteration using a single-core multistage triaxial test, International Journal of Coal Geology, v. 237, 103692.
22. Fan, L., and **Liu, S**., 2021. Respirable nano-particulate generations and their pathogenesis in mining workplaces: a review, International Journal of Coal Science & Technology, v. 8(2), pp 179-198.
23. Fan, L., and **Liu, S**., 2021. Special issue on mine dust research: health effects and control technologies, International Journal of Coal Science & Technology, v. 8(2), pp 177-178.
24. Yang, S., **Liu, S.**, Zhang, N., Li, G., and Zhang, J., 2021. A fully automatic-image-based approach to quantifying the geological strength index of underground rock mass, International Journal of Rock Mechanics and Mining Sciences, v. 140, 104585.
25. Sang, S., and **Liu, S**., 2021. Carbonate caprock-brine-CO2 interaction: alteration of hydromechanical properties and implications on CO2 leakage, SPE Journal, v. 26(05), pp 2780-2792.
26. Tang, S., **Liu, S**., Tang, D., Tao, S., Zhang, A., Pu, Y. and Zhang, T., 2021. Occurrence of fluids in high dip angled coal measures: geological and geochemical assessments for southern Junggar Basin, China, Journal of Natural Gas Science and Engineering, v. 88, 103827.
27. Fan, L., and **Liu, S**., 2021. A novel experimental system for accurate gas sorption and its application to various shale rocks, Chemical Engineering Research and Design, v 165, pp 180-191.
28. Zhang, R., **Liu, S**., San-Miguel, A., Schweins, R., Le-Floch, S., and Pischedda, V., 2021. Nanoscale coal deformation and alteration of porosity and pore orientation under uniaxial compression: An *in situ* SANS study, Rock Mechanics and Rock Engineering, v. 54, pp 3593-3608.
29. Li, Y., Song, D., **Liu, S**., Ji, X., and Hao, H., 2021. Evaluation of pore properties in coal through compressibility correction based on mercury intrusion porosimetry: A practical approach, Fuel, v. 291, 120130.
30. Huang, Q., **Liu, S**., Wang, G., and Cheng, W., 2021. Evaluating the changes of sorption and diffusion behaviors of Illinois coal with various water-based fracturing fluid treatments, Fuel, v. 283, paper 118884.
31. Wang, Y., Wu, C., Qin, Y., **Liu, S**., and Zhang, R., 2021. Multi-angle investigation of the fractal characteristics of nanoscale pores in the lower Cambrian Niutitang shale and their implications for CH4 adsorption, Journal of Nanoscience and Nanotechnology, v. 21(1), pp 156-167.

**2020**

1. Sang, G., **Liu, S**. Elsworth, D., Zhang, R., and Bleuel, M., 2020. Pore-scale water vapor condensation behaviors in shales: an experimental study, Transport in Porous Media, v 135, pp 713-734.
2. Yang, Y., and **Liu, S**., 2020. Review of shale gas sorption and its models, Energy & Fuels, v 34 (12), pp 15502-15524.
3. Zhao, Y., Liu, T., Danesh N.N., Sun, Y., **Liu, S**., and Wang, Y., 2020. Quantification of pore modification in coals due to pulverization using synchrotron small angle X-ray scattering, Journal of Natural Gas Science and Engineering, v. 84, 103669.
4. Zhao, W., Wang, K., **Liu, S.**, Ju, Y., Zhou, H., Fan, L., Yang, Y., Cheng, Y., and Zhang, X., 2020. Asynchronous difference in dynamic characteristics of adsorption swelling and mechanical compression of coal: Modeling and experiments, International Journal of Rock Mechanics and Mining Sciences, v. 135, paper 104498.
5. Wang, L., Xu, H., Cao, Y., and **Liu, S**., 2020. A poromechanical model of hydraulic fracturing volumetric opening, Engineering Fracture Mechanics, v. 235, paper 107172.
6. Liu, A., Liu, P., and **Liu, S**., 2020. Gas diffusion coefficient estimation of coal: a dimensionless numerical method and its experimental validation, International Journal of Heat and Mass Transfer, v. 162, paper 120336
7. Liu, Y., Zhu, Y., **Liu, S**., and Zhang, C., 2020. Evolution of aromatic clusters in vitrinite-rich coal during thermal maturation by using HRTEM and FT-IR measurements, Energy & Fuels, v. 34, pp 10781-10792.
8. Liu, A., **Liu, S**., Wang, G., and Elsworth, D., 2020. Continuous compaction and permeability evolution in longwall gob materials, Rock Mechanics and Rock Engineering, v 53, pp 5489-5510.
9. Huang, Q., **Liu, S**., Cheng, W., and Wang, G., 2020. Fracture permeability damage and recovery behaviors with fracturing fluid treatment of coal: An experimental study, Fuel, v. 282, paper 118809.
10. Sang, G., **Liu, S**., and Elsworth, D., 2020. Evaluation and modeling of water vapor sorption and transport in nanoporous shale, International Journal of Coal Geology, v. 228, paper 103553.
11. Li, Y., Song, D., **Liu, S**., and Pan, J., 2020. Characterization of ultra-micropores and analysis of their evolution in tectonically deformed coals by low-pressure CO2 adsorption, XRD and HRTEM techniques, Energy & Fuels, v. 34, pp 9436-9449.
12. Liu, A., **Liu, S**., Hou, X., and Liu, P., 2020. Transient gas diffusivity evaluation and modeling for methane and helium in coal, International Journal of Heat and Mass Transfer, v. 159, paper 120091.
13. Zhao, W., Wang, K., Cheng, Y., **Liu, S.**, and Fan, L., 2020. Evolution of gas transport pattern with the variation of coal particle size: Kinetic model and experiments, Powder Technology, v. 367, pp 336-346.
14. Yang, Y., and **Liu, S**., 2020. Laboratory study of cryogenic treatment induced pore-scale structural alterations of Illinois coal and their implications on gas sorption and diffusion behaviors, Journal of Petroleum Science and Engineering, v. 194, 107507.
15. Liu, T., and **Liu, S**., 2020. The impacts of coal dust on miners' health: A review, Environmental Research, v. 190, paper 109849.
16. Liu, A., **Liu, S**., Wang, G., and Sang, G., 2020. Modeling of coal matrix apparent strains for sorbing gases using a transversely isotropic approach, Rock Mechanics and Rock Engineering, v. 53, pp 4163-4181.
17. Liu, T., Lin, B., Fu, X., and **Liu, S**., 2020. Organic geochemical and petrographic characteristics of the coal measure source rocks of Pinghu formation in the Xihu sag of the east China sea shelf basin: Implications for coal measure gas potential, Acta Geologica Sinica-English Edition, v. 94(2), pp 364-375.
18. Liu, T., Lin, B., Fu, X., and **Liu, S**., 2020. A new approach modeling permeability of mining-disturbed coal based on a conceptual model of equivalent fractured coal, Journal of Natural Gas Science and Engineering, v. 79, 103366.
19. Sang, G., **Liu, S**., and Elsworth, D., 2020. Quantifying fatigue-damage and failure-precursors using ultrasonic coda wave interferometry, International Journal of Rock Mechanics and Mining Sciences, v. 131, 104366.
20. Song, C., and **Liu, S.**, 2020. A novel approach of bulk strength enhancement through microbially-mediated carbonate cementation for mylonitic coal, Geomicrobiology Journal, v 37(8), pp 726-737.
21. Liew, M., Xiao, M., **Liu, S.**, and Rudenko, D., 2020. In situ seismic investigations for evaluating geotechnical properties and liquefaction potential of fine coal tailings, Journal of Geotechnical and Geoenvironmental Engineering, v. 146(5), 04020014.
22. Tian, Z., Lu, Y., **Liu, S.**, Shi, S., Li, H., and Ye, Q., 2020. Application of inorganic solidified foam to control the coexistence of unusual methane emission and spontaneous combustion of coal in the Luwa coal mine, China, Combustion Science and Technology, v. 192, No. 4, pp 638-656.
23. Wang, J., Elsworth, D., **Liu, S**., and Cao, Y., 2020. Reach and geometry of dynamic gas-driven fractures, International Journal of Rock Mechanics and Mining Sciences, v. 129, paper 104287.
24. Zhang, R., **Liu, S**., He, L., Blach, T., and Wang, Y., 2020. Characterizing anisotropic pore structure and its impact on gas storage and transport in coalbed methane and shale gas reservoirs, Energy&Fuels, v. 34, pp 3161-3172.
25. Hou, X., **Liu, S**., Zhu, Y.., and Yang, Y., 2020. Experimental and theoretical investigation on sorption kinetics and hysteresis of nitrogen, methane, and carbon dioxide in coals, Fuel, v. 268, paper 117349.
26. Zhao, W., Wang, K., **Liu, S**., and Cheng, Y., 2020. Gas transport through coal particles: Matrix-flux controlled or fracture-flux controlled?, Journal of Natural Gas Science and Engineering, v. 76, paper, 103216.
27. Liu, A., **Liu, S**., Wang, G., and Elsworth, D., 2020. Predicting fugitive gas emissions from gob-to-face in longwall coal mines: coupled analytical and numerical modeling, International Journal of Heat and Mass Transfer, v. 150, paper 119392.
28. Liu, T., **Liu, S**., Lin, B., Fu, X., Zhu, C., Yang, W., and Zhao, Y., 2020. Stress response during in-situ gas depletion and its impact on permeability and stability of CBM reservoir, Fuel, v. 266, paper 117083.
29. **Liu, S**., and Zhang, R., 2020. Anisotropic pore structure of shale and gas injection-induced nanoporealteration: A small-angle neutron scattering study, International Journal of Coal Geology, v. 219, paper 103384.
30. Tian, L., Cao, Y., **Liu, S**., Shi, B., Liu, J., and Elsworth, D., 2020. Coalbed methane reservoir fracture evaluation through the novel passive microseismic survey and its implications on permeable and gas production, Journal of Natural Gas Science and Engineering, v. 76, paper 103181.
31. Chakraborty, N., Karpyn, Z., **Liu, S**., Yoon, H., and Dewers, T., 2020. Experimental evidence of gas densification and enhanced storage in nanoporous shales, Journal of Natural Gas Science and Engineering, v. 76, paper 103120.
32. Wang, Y., Zhu, Y., Zhang, R., Anovitz, L. Bleuel, M., **Liu, S**., and Chen, S., 2020. SANS coupled with fluid invasion approaches for characterization of overall nanopore structure and mesopore connectivity of organic-rich marine shales in China, International Journal of Coal Geology, v. 217, paper 103343.
33. Hou, X., **Liu, S**., Zhu, Y.., and Yang, Y., 2020. Evaluation of gas contents for a multi-seam deep coalbed methane reservoir and their geological controls: In situ direct method versus indirect method, Fuel, v. 265, paper 116917.

**2019**

1. Pia., G. Cai, J., Zhang, Z., and **Liu, S**., 2019. Advances in Modelling of Heat and Mass Transfer in Porous Materials, Editorial, Advances in Materials Science and Engineering, 2 pages.
2. Fan, L., and **Liu, S**., 2019. Evaluation of permeability damage for stressed coal with cyclic loading: An experimental study, International Journal of Coal Geology, v. 216, paper 103338.
3. Wang, G., Shen, J., **Liu, S.**, Jiang, C., and Qin, X., 2019. Three-dimensional modeling and analysis of macro-pore structure of coal using combined X-ray CT imaging and fractal theory, International Journal of Rock Mechanics and Mining Sciences, v 123, paper 104082.
4. Sang, G., **Liu, S**., and Elsworth, D., 2019. Water vapor sorption properties of illinois shales under dynamic water vapor conditions: experimentation and modeling, Water Resources Research, article 10.1029/2019WR024992.
5. Fan, L., and **Liu, S**., 2019. Fluid-dependent shear slip behaviors of coal fractures and their implications on fracture frictional strength reduction and permeability evolutions, International Journal of Coal Geology, v. 212, paper 103235.
6. Liu, H., Sang, S., **Liu, S.**, Wu, H., Lan, T., Xu, H., and Ren, B., 2019. Supercritical-CO2 adsorption quantification and modeling for a deep coalbed methane reservoir in the southern Qinshui Basin, China, ACS Omega, v 4, pp 11685-11700.
7. Yang, Y., and **Liu, S.**, 2019. Estimation and modeling of pressure-dependent gas diffusion coefficient for coal: a fractal theory-based approach, Fuel, v 253, pp 588-606.
8. Zhao, W., Cheng, Y., Pan, Z., Wang, K., and **Liu, S.**, 2019. Gas diffusion in coal particles: A review of mathematical models and their applications, Fuel, v 252, pp 77-100.
9. Huang, Q., **Liu, S.**, Wang, G., Wu., B., Yang, Y., and Liu, Y., 2019. Gas sorption and diffusion damages by guar-based fracturing fluid for CBM reservoirs, Fuel, v 251, pp 30-44.
10. Huang, Q., **Liu, S.**, Wang, G., Wu., B., and Zhang, Y., 2019. Coalbed methane reservoir stimulation using guar-based fracturing fluid: a review, Journal of Natural Gas Science & Engineering, v 66, pp 107-125.
11. Zhao, Y., Zhu, G., **Liu, S.**, Wang, Y., and Zhang, C., 2019. Effects of pore structure on stress-dependent fluid flow in synthetic porous rocks using microfocus X-ray computed tomography, Transport in Porous Media, v 128, pp 653-675.
12. Zhao, Y., Song, H., **Liu, S.**, Zhang, C., Dou, L., and Cao, A., 2019. Mechanical anisotropy of coal with considerations of realistic microstructures and external loading directions, International Journal of Rock Mechanics and Mining Sciences, v 116, pp 111-121.
13. Salam, S., Xiao, M., Khosravifar, A., Liew, M., **Liu, S.**, and Rostami, J., 2019. Characterizations of static and dynamic geotechnical properties and behaviors of fine coal refuse, Canadian Geotechnical Journal, v 56, No. 12, pp 1901-1916.
14. **Liu, S.**, Zhang, R., Karpyn, Z., Hongkyu, Y. and Dewers, T., 2019. Investigation of Accessible Pore Structure Evolution under Pressurization and Adsorption for Coal and Shale Using Small-Angle Neutron Scattering, Energy&Fuels, v 33, pp 837-847.
15. Qin, L., Zhai, C., Xu, J., **Liu, S.**, Zhong, C., and Yu, G., 2019. Evolution of the pore structure in coal subjected to freeze−thaw using liquid nitrogen to enhance coalbed methane extraction, Journal of Petroleum Science and Engineering, v. 175, pp 129-139.
16. Zhao, Y., Peng, L., **Liu, S.**, Cao, B., Sun, Y., and Hou, B., 2019. Pore structure characterization of shales using synchrotron SAXS and NMR cryoporometry, Marine and Petroleum Geology, v. 102, pp 116-125.
17. Xu, H., Zhou, W., Zhang, R., **Liu, S.**, and Zhou, Q., 2019. Characterizations of pore, mineral and petrographic properties of marine shale using multiple techniques and their implications on gas storage capability for Sichuan Longmaxi gas shale field in China, Fuel, v. 241, pp 360-371.
18. Yang, Y., **Liu, S.**,Zhao, W.,and Wang, L., 2019. Intrinsic relationship between Langmuir sorption volume and pressure for coal: experimental and thermodynamic modeling study, Fuel, v. 241, pp 105-117.
19. Lu, T., **Liu, S.**,and Li, Z., 2019. A new approach to model shale gas production behavior by considering coupled multiple flow mechanisms for multiple fractured horizontal well, Fuel, v 237, pp 283-297.

**2018**

1. Wang, Y., Qin, Y., Zhang, R., He, L., Anovitz, L., Bleuel, M., Midner, D., **Liu, S.**,and Zhu, Y., 2018. Evaluation of nanoscale accessible pore structures for improved prediction of gas production potential in Chinese marine shales, Energy&Fuels, v 32, pp 12447-12461.
2. Sang, G., **Liu, S.**, Zhang, R., Elsworth, D., and He, L., 2018. Nanopore characterization of mine roof shales by SANS, nitrogen adsorption, and mercury intrusion: Impact on water adsorption/retention behavior, International Journal of Coal Geology, v. 200, pp 173-185.
3. Liu, Y., Zhu, Y., **Liu, S.**,Chen, S., Li, W., and Wang, Y., 2018. Molecular structure controls on micropore evolution in coal vitrinite during coalification, International Journal of Coal Geology, v 199, pp 19-30.
4. Zhi, S., Elsworth, D., Wang, J., Gan, Q., and **Liu, S.**, 2018. Hydraulic fracturing for improved nutrient delivery in microbially-enhanced coalbed-methane (MECBM) production, International Journal of natural Gas Science and Engineering, v. 60, pp 294-311.
5. Zhao, Y., Wang, H., **Liu, S.**, Mu, Z., and Lu, Z., 2018. Dynamic failure risk of coal pillar formed by irregular shape longwall face: A case study, International Journal of Mining Science and Technology, v 28(5), pp 775-781.
6. Abdelmalek, B., Karpyn, Z., **Liu, S.**, Yoon, H., and Dewers, T., 2018. Gas permeability measurements from pressure-pulse decay laboratory data using Pseudo-pressure and Pseudo-time transformations, Journal of Petroleum Exploration and Production Technology, v 8(3), pp 839-847.
7. Liew, M, Xiao, M., and **Liu, S.**, 2018. Characterization of physical and mineralogical properties of anthracite and bituminous coal tailings, International Journal of Coal Preparation and Utilization, in press.
8. Liu, Y., Zhu, Y., **Liu, S.**,and Wu, L., 2018. A hierarchical methane adsorption characterization through a multiscale approach by considering the macromolecular structure and pore size distribution, Marine and Petroleum Geology, v 96, pp 304-314.
9. Xu, J., Zhai, C.,Qin, L., and **Liu, S.**, 2018. Pulse hydraulic fracturing technology and its application in coalbed methane extraction, International Journal of Oil, Gas and Coal Technology, v 19(1), pp 115-133.
10. Wang, Y., **Liu, S.**,and Zhao, Y., 2018. Modeling of Permeability for Ultra-Tight Coal and Shale Matrix: A Multi-Mechanistic Flow Approach, Fuel, v 232, pp 60-70.
11. Liu, P.,Qin, Y., **Liu, S.**,and Hao, Y., 2018. Numerical modeling of gas flow in coal using a modified dual-porosity model: A multi-mechanistic approach and finite difference method, Rock Mechanics and Rock Engineering, accepted.
12. Zhao, Y., Zhu, G., Zhang, C.., **Liu, S.**,Elsworth, D.,and Zhang, T., 2018. Pore-scale reconstruction and simulation of non-Darcy flow in synthetic porous rocks, Journal of Geophysical Research – Solid Earth, v 123, pp 2770-2786, 2017JB015296.
13. Liu, Y., Zhu, Y., **Liu, S.**,Wu, L., and Tang, X., 2018. Temperature effect on gas adsorption capacity in different sized pores of coal: Experiment and numerical modeling, Journal of Petroleum Science and Engineering, v 165, pp 821-830.
14. Wang, Y., Wu, C., Zhu, Y., Chen, S., **Liu, S.**,and Zhang, R., 2018. Morphology and fractal characterization of multiscale pore structures for organic-rich lacustrine shale reservoirs, Fractals, p. 1840013.
15. Fan, L., and **Liu, S.**, 2018. Numerical prediction of in situ horizontal stress evolution in coalbed methane reservoirs by considering both poroelastic and sorption induced strain effects, International Journal of Rock Mechanics and Mining Sciences, v. 104, pp 156-164.
16. Zhai, C., Xu, J., **Liu, S.**, and Qin, L., 2018. Fracturing mechanism of coal-like rock specimens under the effect of nonexplosive expansion, International Journal of Rock Mechanics and Mining Sciences, v. 103, pp 145-154.
17. Meng, Y., **Liu, S.**, and Li, Z., 2018. Experimental study on sorption induced strain and permeability evolutions and their implications in the anthracite coalbed methane production, Journal of Petroleum Science and Engineering, v. 164, pp. 515-522.
18. Qin, L., Zhai, C., Xu, J., **Liu, S.**, Xu, J., Wu, J., and Dong, R., 2018. Fractal dimensions of low rank coal subjected to liquid nitrogen freeze-thaw based on nuclear magnetic resonance applied for coalbed methane recovery, Powder Technology, v. 325, pp 11-20.
19. Zhai, C., Xu, J., **Liu, S.**, and Qin, L., 2018. Investigation of the discharge law for drill cuttings used for coal outburst prediction based on different borehole diameters under various side stresses, Powder Technology, v. 325, pp 396-404.
20. Zhao, Y., Sun, Y., **Liu, S.**, Chen, Z., and Yuan, L., 2018. Pore structure characterization of coal by synchrotron radiation nano-CT, Fuel, v. 215, pp 102-110.
21. Qin, L., Zhai, C., **Liu, S.**, and Xu, J., 2018. Infrared thermal image and heat transfer characteristics of coal injected with liquid nitrogen under triaxial loading for coalbed methane recovery, International Journal of Heat and Mass Transfer, v. 118, pp 1231-1242.
22. Qin, L., Zhai, C., **Liu, S.**, and Xu, J., 2018. Mechanical behavior and fracture spatial propagation of coal injected with liquid nitrogen under triaxial stress applied for coalbed methane recovery, Engineering Geology, v. 233, pp 1-10.
23. Xu, J., Zhai, C., **Liu, S.**, Qin, L., and Dong, R., 2018. Investigation of temperature effects from LCO2 with different cycle parameters on the coal pore variation based on infrared thermal imagery and low-field nuclear magnetic resonance, Fuel, v. 215, pp 528-540.
24. Wang, Y., Zhu, Y., **Liu, S.**, Chen, S., and Zhang, R., 2018. Comparative study of nanoscale pore structure of Lower Paleozoic marine shales in the Middle-Upper Yangtze area, China: Implications for gas production potential, Geological Journal, v. 53(6), pp 2413-2426.
25. Liu, P., Qin, Y., **Liu, S.**, and Hao, Y., 2018. Non-linear gas desorption and transport behavior in coal matrix: Experiments and numerical modeling, Fuel, v. 214, pp 1-13.
26. Guan, C., **Liu, S.**, Li, C., Wang, Y., and Zhao, Y., 2018. The temperature effect on the methane and CO2 adsorption capacities of Illinois coal, Fuel, v. 211, pp 241-250.

**2017**

1. Tong, S., Dong, Y., Zhang, Q., Elsworth, D., and **Liu, S.**, 2017. Quantitative Analysis of Nano-pore Structural Characteristics of Lower Paleozoic Shale, Chongqing (Southwestern China)-Combining FIB-SEM and NMR Cryoporometry, Energy&Fuels, v. 31(12), pp 13317-13328.
2. Sang, G., Elsworth, D., **Liu, S.,** and Harpalani, S., 2017. Characterization of swelling modulus and effective stress coefficient accommodating sorption-induced swelling in coal, Energy&Fuels, v. 31(9), pp 8843-8851.
3. Xu, J., Zhai, C., **Liu, S.**, and Wu, S., 2017. Pore variation of three different metamorphic coals by multiple freezing-thawing cycles of liquid CO2 injection for coalbed methane recovery, Fuel, v. 208, pp 41-51.
4. Zhang, R., **Liu, S.**, and Wang, Y., 2017. Fractal evolution under in situ pressure and sorption conditions for coal and shale, Scientific Reports, v. 7, Article number 8971.
5. Zhai, C., Wu, S., **Liu, S.**, Qin, L., and Xu, J., 2017. Experimental study on coal pore structure deterioration under freeze–thaw cycles, Environmental Earth Sciences, volume 76(15), 507.
6. Qin, L., Zhai, C., **Liu, S.**, and Xu, J., 2017. Factors controlling the mechanical properties degradation and permeability of coal subjected to liquid nitrogen freeze-thaw, Scientific Reports, v. 7, Article number; 3675.
7. Zhang, R., **Liu, S.**, Bahadur, J., Elsworth, D., Wang, Y., Hu, G., and Liang, Y., 2017. Changes in pore structure of coal caused by coal-to-gas bioconversion, Scientific Reports, v. 7, Article number; 3840.
8. Li, S., Tang, J., Ding, Y., **Liu, S.**, Liu, G., and Cai, B., 2017. Recovery of low permeability reservoirs considering well shut-ins and surfactant additivities, Energies, v. 10(6), Article number; 1279.
9. Xu, J., Zhai, C., **Liu, S.,** Qin, L., and Sun, Y., 2017. Feasibility investigation of cryogenic effect from liquid carbon dioxide multi cycle fracturing technology in coalbed methane recovery, Fuel, v. 206, pp 371-380.
10. Zhao, Y., Xue, S., Han, S., Chen, Z., **Liu, S.,** Elsworth, D., He, L., Cai, J., Liu, Y., and Chen, D., 2017. Effects of microstructure on water imbibition in sandstones using X‐ray computed tomography and neutron radiography, Journal of Geophysical Research - Solid Earth, v. 122, 2016JB013786.
11. Zhang, Q., Dong, Y., **Liu, S.,** Elsworth, D., and Zhao, Y., 2017. Shale pore characterization using NMR Cryoporometry with octamethylcyclotetrasiloxane as the probe liquid, Energy&Fuels, v. 31(7), pp 6951-6959.
12. Wang, L., Chen, E., **Liu, S.**, Cheng, Y., Cheng, L., Chen, M., and Guo, H., 2017. Experimental study on the effect of inherent moisture on hard coal adsorption–desorption characteristics, Adsorption, v. 23(5), pp 723-742.
13. Cao, Y., Zhang, J., Zhai, H., Fu, G., Tian, L., and **Liu, S.**, 2017. CO2 gas fracturing: A novel reservoir stimulation technology in low permeability gassy coal seams, Fuel, v. 203, pp 197-207.
14. Fan, L., and **Liu, S.**, 2017. A conceptual model to characterize and model compaction behavior and permeability evolution of broken rock mass in coal mine gobs, International Journal of Coal Geology, v. 172, pp 60-70.
15. Wang, L., **Liu, S.**, Cheng, Y., Yin, G., Zhang, D., and Guo, P., 2017. Reservoir reconstruction technologies for coalbed methane recovery in deep and multiple seams, International Journal of Mining Science and Technology, v. 27(2), pp 277-284.
16. Chakraborty, N., Karpyn, Z., **Liu, S.**, and Yoon, H., 2017. Permeability evolution of shale during spontaneous imbibition, Journal of Natural Gas Science and Engineering, v. 38, pp 590-596.
17. Zhang, R., and **Liu, S.**, 2017. Experimental and theoretical characterization of methane and CO2 sorption hysteresis in coals based on Langmuir desorption, International Journal of Coal Geology, v. 171, pp 49-60.
18. Qin, L., Zhai, C., **Liu, S.**, Xu, J., Yu, G., and Sun, Y., 2017. Changes in the petrophysical properties of coal subjected to liquid nitrogen freeze-thaw–A nuclear magnetic resonance investigation, Fuel, v. 194, pp 102-114.
19. Wang, L., **Liu, S.**, Cheng, Y., Yin, G., Guo, P., and Mou, J., 2017. The effects of magma intrusion on localized stress distribution and its implications for coal mine outburst hazards, Engineering Geology, v. 218, pp 12-21.
20. Zhao, Y., Sun, Y., **Liu, S.**, Wang, K., Jiang, Y., 2017. Pore structure characterization of coal by NMR cryoporometry, Fuel, v. 190, pp 359-369.
21. Wang, S., **Liu, S.**, Sun, Y., Jiang, D., and Zhang, X., 2017. Investigation of coal components of Late Permian different ranks bark coal using AFM and Micro-FTIR, Fuel, v. 187, pp 51-57.

**2016**

1. Wang, S., and **Liu, S.**, 2016. Estimation of pressure-dependent diffusive permeability of coal using methane diffusion coefficient: laboratory measurements and modeling, Energy&Fuels, v. 30(11), pp 8968-8976.
2. Qin, L., Zhai, C., **Liu, S.**, Xu, J., Tang, Z., and Yu, G., 2016. Failure mechanism of coal after cryogenic freezing with cyclic liquid nitrogen and its influences on coalbed methane exploitation, Energy&Fuels, v. 30(10), pp 8567-8578.
3. Zhai, C., Qin, L., **Liu, S.**, Xu, J., Tang, Z., and Wu, S., 2016. Pore structure in coal: Pore evolution after cryogenic freezing with cyclic liquid nitrogen injection and its implication on coalbed methane extraction, Energy&Fuels, v. 30(7), pp 6009-6020. (\*Top 25 Most Cited Article of the Energy&Fuels Journal)
4. Wang, Y., Zhu, Y., **Liu, S.**, and Zhang, R., 2016. Pore characterization and its impact on methane adsorption capacity for organic-rich marine shales, Fuel, v 181, pp 227-237.
5. **Liu, S.**, Harpalani, S., and Wang, Y., 2016. Anisotropy characteristics of coal shrinkage/swelling and its impact on coal permeability evolution with CO2 injection, Greenhouse Gases: Science and Technology, v 6, pp 1-18.
6. Wang, Y., Zhu, Y., **Liu, S.**, and Zhang, R., 2016. Methane adsorption measurements and modeling for organic-rich marine shale samples, Fuel, 172, 301-309.
7. Zhao, Y., **Liu, S.**, Jiang, Y., Wang, K., and Huang, Y., 2016. Dynamic tensile strength of coal under dry and saturated conditions, Rock Mechanics and Rock Engineering, v. 19, pp 1709-1720.

**2015**

1. Zhang, R., **Liu, S.**, Bahadur, J., Elsworth, D., Melnichenko, Y., He, L., and Wang, Y., 2015. Estimation and modeling of coal pore accessibility using small angle neutron scattering, Fuel, v. 161, pp. 323-332.
2. Wang, L., Cheng, L., Cheng, Y., **Liu, S.**, Guo, P., Jin, K. and Jiang, H., 2015. A new method for accurate and rapid measurement of underground coal seam gas content, Journal of Natural Gas Science and Engineering, v. 26, pp. 1388-1398.
3. Wang, Y., **Liu, S.**, and Elsworth, D., 2015. Laboratory investigations of gas flow behaviors in tight anthracite and evaluation of different pulse-decay methods on permeability estimation, International Journal of Coal Geology, v. 149, pp 118-128.
4. Lu, C., Dou, L., Zhang, N., Lutynski, M. and **Liu, S**.. (2015). Shock and vibration induced by mining extraction. *Shock and Vibration* – *Special Issue on Mining* *Induced Mine Vibration.* DOI: http://dx.doi.org/10.1155/2015/320804
5. Deng, C., Tang, D., **Liu, S.**, Xu, H., and Tao, S., 2015. Characterization of mineral composition and its influence on microstructure and sorption capacity of coal, Journal of Natural Gas Science and Engineering, v. 25, 46-57.

**2014**

1. **Liu, S.**, and Harpalani, S., 2014. Evaluation of *in situ* stress changes with gas depletion of coalbed methane reservoirs, Journal of Geophysical Research – Solid Earth, v. 119(8), pp 6263-6276.
2. Zhao, Y., **Liu, S.**, Zhao, G., Elsworth, D., Jiang, Y., and Han, J., 2014. Failure mechanisms in coal: dependence on strain-rate and microstructure, Journal of Geophysical Research – Solid Earth, v. 119(9), pp. 6924-6935.
3. Zhao, Y., **Liu, S.**, Elsworth, D., Jiang, Y., and Zhu, J., 2014. Pore Structure Characterization of Coal by Synchrotron Small-Angle X‑ray Scattering and Transmission Electron Microscopy, Energy&Fuels, v. 28(6), pp. 3704-3711.
4. **Liu, S.**, and Harpalani, S., 2014. Compressibility of sorptive porous media: part I – background and theory, AAPG Bulletin, v. 98, No. 9, 1761-1772.
5. **Liu, S.**, and Harpalani, S., 2014. Compressibility of sorptive porous media: part II – experimental study on coal, AAPG Bulletin, v. 98, No. 9, pp. 1773-1788.
6. **Liu, S.**, and Harpalani, S., 2014. Determination of the effective stress law for deformation in coalbed methane reservoirs, Rock Mechanics and Rock Engineering, v. 47(5), pp. 1809-1820.

**2013**

1. **Liu, S.**, and Harpalani, S., 2013. Permeability prediction of coalbed methane reservoirs during primary depletion, International Journal of Coal Geology, 113, pp. 1-10.
2. **Liu, S.** and Harpalani, S. 2013. A new theoretical approach to model sorption induced coal shrinkage and swelling, AAPG Bulletin, v. 97, No. 7, pp. 1033-1049.

**2012**

1. Mitra, A., Harpalani, S., and **Liu, S**., 2012. Laboratory measurement and modeling of coal permeability with continued methane production: part 1 – laboratory results. Fuel, v. 94, pp. 110-116.
2. **Liu, S.**, Harpalani, S., and Pillalamarry, M., 2012. Laboratory measurement and modeling of coal permeability with continued methane production: part 2 – modeling results, Fuel, v. 94, pp. 117-124.

**2011**

1. Pillalamarry, M., Harpalani, S., and **Liu, S.**, 2011. Gas diffusion behavior of coal and its impact on production from coalbed methane reservoirs, International Journal of Coal Geology, v. 86(4), pp. 342-348.
2. Ma, Q., Harpalani, S., and **Liu, S.**, 2011. A simplified permeability model for coalbed methane reservoirs based on matchstick strain and constant volume theory, International Journal of Coal Geology, v. 85(1), pp. 43-48.

**Google Scholar Page:** [**https://scholar.google.com/citations?user=o7ViyhYAAAAJ&hl=en**](https://scholar.google.com/citations?user=o7ViyhYAAAAJ&hl=en)

**B. Final Technical Reports**

1. **Liu, S.**, Liu, A., Sang, G., and Elsworth, D., 2021. Building capacity and enhancing long-term coal mine weak roof stability through characterization and modeling of time-dependent and moisture-sensitive failure in shale. Final Technical Report to National Institute for Occupational Safety & Health (Grant Number: 2016-N-17733). Page 269.
2. **Liu, S.**, Elsworth, D., and Harpalani, S., 2020. Control of Hazardous Gas Emissions to Longwall Face and Bleeder System: Laboratory Experiments, Modeling and Field Monitoring. Final Technical Report to Alpha Foundation for The Improvement of Mine Safety and Health (Grant Number: AFC719-27). Page 97.
3. **Liu, S.**, Kohler, J., Fan, L., and Zeglen, E., 2019. Development of Guidance for The Selection and Use of Atmospheric Monitoring Systems to Improve Decision-Making during Routine and Post-Accident Operations. Final Technical Report to Alpha Foundation for The Improvement of Mine Safety and Health (Grant Number: AFC215-01). Page 61.
4. Xiao, M., Liew, M., Salam, S., **Liu, S.**, and Rostami, J., 2019. Field Investigation and Stability Analysis of Coal Slurry Impoundments. Final Technical Report to US Department of Interior – Office of Surface Mining Reclamation and Enforcement (Rep. No. S16AC20074). Page 249.

**C. Conference Proceedings and Posters**

1. Yang, Y.,**Liu, S.**, and Liu, A., 2022. Evaluating The Pressure-Dependent Equivalent Permeability Evolutions for Shale Matrix: Experiments and Modeling. SPE Western Regional Meeting. Bakersfield, California, USA, April 26-28, 2022, SPE-209291.
2. Yang, Y.,**Liu, S.**, 2021. Quantification of Temperature-Dependent Sorption Kinetics in Shale Gas Reservoirs: Experiment and Theory. SPE Annual Technical Conference and Exhibition, Dubai, UAE, September 21-23, 2021, SPE-205897-MS.
3. Liu, A.,**Liu, S.**, 2021. Development of Time-Dependent Rock-Fluid-Geomechanics Model and Software Suites: Application for Time-Dependent Shaly Roof Stability Analysis. The 2021 International Conference on Ground Control in Mining, Canonsburg, PA, USA, July 27-29, 2021.
4. Gendrue, N.,**Liu, S.**, Bhattacharyya, S., Spellman, C., 2021. Field Survey of Mine Ventilation System for Large Opening Underground Mines: Pressure, Relative Humidity and Temperature. The 18th North American Mine Ventilation Symposium, June 12-17, 2021, Rapid City, South Dakota, USA (Virtual).
5. Sang, G.,**Liu, S.**, 2020. Carbonate caprock-brine-CO2 interaction: Alteration of hydromechanical properties. SPE Annual Technical Conference and Exhibition, 26-29 October 2020. Virtual Meeting, SPE-201353-MS.
6. Liu, A.,**Liu, S.**, Sang, G., 2020. Characterizing gas-water transport behavior in tight shale and its application on the well productivity. SPE Annual Technical Conference and Exhibition, 26-29 October 2020. Virtual Meeting, SPE-201651-MS.
7. Liu, P.,**Liu, S.**, Yin, G., 2019. A numerical approach to upgrade the estimation of gas diffusion coefficient in coal matrix. The 53th US Rock Mechanics/Geomechanics Symposium, New York, NY, USA, 22-26 June 2019. Paper 19-1847.
8. Fan, L., and **Liu, S.**, 2019. Gas saturated coal failure envelope establishment through single core multistage triaxial loading tests. The 53th US Rock Mechanics/Geomechanics Symposium, New York City, NY, USA, 23-26 June 2019. Paper 19-450.
9. Yang, Y., and **Liu, S.**, 2019. Micropore volume modification for coal using non-contaminating cryogenic liquid nitrogen and its impact on sorption and diffusion behaviors. The 53rd US Rock Mechanics/Geomechanics Symposium, New York City, NY, USA, 23-26 June 2019. Paper 19-A280.
10. Liu, A., and **Liu, S.**, 2019. Modeling of anisotropic sorption-induced coal deformations. The 53th US Rock Mechanics/Geomechanics Symposium, New York, NY, USA, 23-26 June 2019. Paper 19-506.
11. Huang, Q., and **Liu, S.**, 2019. Permeability damage of coal for guar gel fracturing operation. The 53rd US Rock Mechanics/Geomechanics Symposium, New York, NY, USA, 23-26 June 2019. Paper 19-293.
12. Sang, G., **Liu, S.**, and Elsworth, D., 2019. Dynamic water vapor sorption on Marcellus shales: equilibrium, thermodynamic and kinetic analyses. The 53rd US Rock Mechanics/Geomechanics Symposium, New York City, USA, 23-26 June 2019. Paper 19-339.
13. Zhang, R., and **Liu, S.**, 2019. Nanoscale coal deformation and its geomechanics effect on pore structure evolution under hydrostatic and uniaxial compression conditions. The 53th US Rock Mechanics/Geomechanics Symposium, New York City, NY, USA, 23-26 June 2019. Paper 19-442.
14. Wang, G., Xu, H., **Liu, S.**, and Fan, L., 2018. A novel SEM-based heterogeneous coal micro-structure reconstruction and its application on modeling of deformation and failure behaviors. The 52th US Rock Mechanics/Geomechanics Symposium, Seattle, WA, USA, 17-20 June 2018. Paper 18-387.
15. Yang, Y., **Liu, S.**, Zhao, W., and Wang, L., 2018. Gas sorption and diffusion characteristics of tectonically deformed coals and their implications on gas drainage and outburst control. The 52th US Rock Mechanics/Geomechanics Symposium, Seattle, WA, USA, 17-20 June 2018. Paper 18-786.
16. Sang, G., **Liu, S.**, Zhang, R., and Elsworth, D., 2018. Pore characterization of mine shales by low pressure nitrogen adsorption and mercury intrusion porosimetry: Implication on water retention behavior of shales. The 52th US Rock Mechanics/Geomechanics Symposium, Seattle, WA, USA, 17-20 June 2018. Paper 18-318.
17. Xiao, M., Liew, M., and **Liu, S.**, 2018. Field investigation of in-situ seismic characteristics of coal slurry using seismic survey. International Foundations Congress and Equipment Exposition, Orlando, FL, USA, 5-10 May, 2018.
18. **Liu, S.**, 2017. US deep coalbed methane: why do we overlook its potential?. Proceedings of International Academic Symposium on Deep Coalbed Methane, Beijing, China, 22-25 September, 2017. Edited by Tang, D. Li., S., Tang, S., Wu, S., Xu, H., and Tao, S.
19. Sang, G., **Liu, S.**, and Fan, L., 2017. Moisture-induced swelling of Illinois mine roof shales: A visualized method. The 36th International Conference on Ground Control in Mining, Morgantown, WV, USA, 24-27 July, 2017.
20. Yang, S., **Liu, S.**, and Zhang, H., 2017. The relationship between ultrasonic velocities and mechanical damage in sandstone under cyclic loading. The 36th International Conference on Ground Control in Mining, Morgantown, WV, USA, 24-27 July, 2017.
21. Fan, L. and **Liu, S.,** 2016. The Compression Model and Permeability of Broken Rocks. The 50th US Rock Mechanics/Geomechanics Symposium, Houston, TX, USA, 26-29 June 2016. Paper 16-598
22. Abdelmalek, B., Karpyn, Z., and **Liu, S.**, 2014. Structure, mechanics and flow properties of fractured shale: core-scale experimentation and in-situ imaging. AGU Fall Meeting, San Francisco, CA, USA, December 15-19, 2014. Poster MR11B-4323
23. **Liu, S.**, Harpalani, S., and Wang, Y., 2013. Deformation Characteristics of Coal and Its Impact on Permeability during CO2 Sequestration. Proceeding of International Conference on Coal Science & Technology, State College, PA, USA, Sept. 29-October 3, 2013. Paper 297
24. **Liu, S.** and Harpalani, S. 2012. Gas Production Induced Stress and Permeability Variations in Coalbed Methane Reservoirs. The 46th US Rock Mechanics/Geomechanics Symposium, Chicago, IL, USA, 24-27 June 2012. Paper 12-643
25. Harpalani, S. and **Liu, S.**, 2011. Sequestration of Carbon Dioxide in Deep Rocks/Coal, Proceeding of 22nd World Mining Congress, Istanbul, Turkey, September, 2011.
26. **Liu, S.**, Harpalani, S., and Pillalamarry, 2009. Flow Behavior in Deep Coals at Carbon Sequestration Pilot Sites, The second Thailand Rock Mechanics Symposium, Pattaya, Chonburi, Thailand, March 12-13, 2009.

**D. CONFERENCE PRESENTATIONS AND ABSTRACTS**

1. Fan, L., **Liu, S.**, 2021. Fluid-dependent Shear Slip Behaviors of Coal Fractures and Their Implications on Fracture Frictional Strength Reduction and Permeability. The 11th Asian Rock Mechanics, Beijing, China, October 21-24, 2021.
2. Fan, L., **Liu, S.**, Sang, G., Liu, A., Zhang, R., 2021. Moisture-induced Modulus Reduction of Roof Rocks and Its Implication on Future Mine Support Design. The 2021 International Conference on Ground Control in Mining, Canonsburg, PA, USA, July 27-29, 2021.
3. **Liu, S.**, 2021. Characterization of Nano-to-Micron Sized Respirable Coal Dust: Particle Surface Alteration and the Health Impact. The 1st International Symposium on Mine Dust and Aerosol Research (ISMDAR), Virtual, University Park, PA November 15-16.
4. **Liu, S.**, 2020. Keynote Speaker. Micropore dilation and its enhancement of gas diffusion through waterless cryogenic treatment. International Webinar on Frontiers in Mining & Geosciences with special focus on Remote Sensing, Geotechnics, Mine Planning & Operation, Virtual, November 7-8.
5. **Liu, S.**, Xiao, M., Liew, M., and Salam, S., 2020. Keynote Speaker. Geotechnical properties and liquefaction potential of coal tailings evaluated using multichannel analysis of surface waves, seismic refraction and seismic monitoring. Re:Con 2020 – Conference for Managing Blasting Risk, Key West, FL, USA, 12-15 January 2020.
6. **Liu, S**., 2019. Keynote Speaker. Micromechanics of coal and shale under various loading condition. 6th International Conference on Unconventional Geomechanics, Beijing, China, October 11-13, 2019
7. **Liu, S**., 2019. Keynote Speaker. Stress depletion behavior with continuous gas extraction of CBM reservoir. Subsurface Unconventional Energy Extraction Technology Summit, Jiaozuo, Henan, China, October 17-20, 2019
8. Zhang, R., and **Liu, S**., 2019. Alteration of shale anisotropic pores under uniaxial compression condition: An investigation using small-angle neutron scattering. AGU Fall Meeting, San Francisco, CA, USA, December 9-13, 2019. Poster H33N-2173.
9. Sang, G., **Liu, S**., Elsworth, D., and Zhang, R., 2019. Water Vapor Condensing in Anisotropic Pores of Shales by Neutron Scattering. 2019 AAPG Eastern Section Meeting: Energy from the Heartland, Columbus, Ohio, USA, October 12-16, 2019.
10. Zhang, R., and **Liu, S**., 2018. Gas densification and adsorption in rock nanopores. International Small-Angle Scattering Conference, Traverse City, MI, US, October 7-12, 2018
11. Zhang, R., **Liu, S**., Chen, Y., Elsworth, D., Feng, Z., Zhao, X., and An, K., 2018. Investigation of shale matrix heterogeneity, anisotropy and strain using X-ray and in-situ neutron diffraction. Goldschmidt Conference, Boston, MA, US, August 12-17, 2018
12. Zhang, R., **Liu, S**. and He, L., 2018. Observation of anisotropic nanoscale accessible pore structure for anthracite and shale using small-angle neutron scattering. American Conference on Neutron Scattering, College Park, MD, US, June 24-28, 2018
13. Chakraborty, N., Karpyn, Z., **Liu, S**. and Yoon, H., 2018. Experimental evidence of gas storage and phase densification in ultra-tight shale. Gordon Research Conference on Flow & Transport In Permeable Media, Newry, ME, US, July 8-13, 2018
14. **Liu, S.**, 2018. Gas sorption, diffusion and permeability behaviors for Marcellus shale and their impacts on long-term well production. International Workshop on l Geomechanics of Shale Gas and Energy Storage, Wuhan, China, May 15-17, 2018
15. **Liu, S.**, 2016. In situ stress evolution with continuous gas depletion in coalbed methane reservoirs and its implication on permeability and production. 3rd International Symposium on Unconventional Geomechanics, Wuhan, China, May 21-22, 2016
16. **Liu, S.**, 2015. A study of gas adsorption and transport in ultra-tight shale using neutron scattering and *in-situ* experimentation. AAPG/SEG International Conference & Exhibition, Melbourne, Australia, September 13-16, 2015
17. **Liu, S.**, 2015. Gas flow and geomechanics in coal: A multiscale and multiphysics approach, International Workshop on Coal Mine Safety, Wollongong, Australia, September 11-12, 2015
18. **Liu, S.**, 2015. Apparent permeability variation for stressed shale with sorbing gas injection. China Shale Gas Conference, Wuhan, China, September 6-8, 2015
19. **Liu, S.**, and Wang, Y., 2015. Shale core apparent permeability characterization with CO2 injection under stress-controlled condition. 14th Annual Carbon Capture, Utilization & Storage Conference, Pittsburgh, PA, USA, April 28-May 1, 2015.
20. **Liu, S.**, 2014. Keynote speaker. Compressibility of coal and its implication in coalbed methane development, 2014 ISRM Conference on Soft Rocks, Beijing, China, 6-7 June, 2014.
21. **Liu, S.**, and Harpalani, S., 2009. Measurement of cleat and matrix shrinkage compressibilities under best field replicated conditions, 2009 Asia Pacific Coalbed Methane Symposium, Xuzhou, Jiangsu, China, September 24-26.
22. Harpalani, S., and **Liu, S.**, and Mitra, A., 2009. Evaluation of critical flow parameters for CBM modeling under stress/strain controlled condition, 2009 International Coalbed Methane & Shale Gas Symposium, Tuscaloosa, Alabama, USA, May 18-22.

**COMPLETED AND CURRENT PROJECTS**

**A. Current:**

*External Research Grants*

1. Co-PI of CDC – The National Institute for Occupational Safety and Health (CDC-NIOSH) funding “Understanding and Design of Ventilation Systems and Their Optimization for Large Opening Underground Mines.” 09/01/2019 to 8/31/2024, total funding: $1,250,000. PI: Dr. Sekhar Bhattacharyya and Dr. Derek Elsworth (PSU)
2. PI of CDC – The National Institute for Occupational Safety and Health (CDC-NIOSH) funding “Characterization of Submicron-/Nano-scale Coal Dusts and Their Effects on Miners’ Pneumoconiosis and Lung Cancer for Underground Coal Mines.” 09/01/2019 to 8/31/2022, total funding: $400,000. Co-PIs: Dr. Sekhar Bhattacharyya (PSU) and Dr. Siyang Zheng (CMU)
3. PI of Alpha Foundation for the Improvement of Mine Safety and Health, Inc. funding “Control of Hazardous Gas Emissions to Longwall Face and Bleeder System: Laboratory Experiments, Modeling and Field Monitoring.” 07/01/2018 to 12/31/2019, total funding: $250,000. Co-PIs: Dr. Derek Elsworth (PSU) and Satya Harpalani (SIUC)
4. Sole-PI of Society for Mining, Metallurgy and Exploration (SME) funding “The 2017 Freeport-McMoRan Career Development Grants.” Funded by SME, 08/15/2017 to 08/14/2020, total funding: up to $300,000.
5. PI of CDC – The National Institute for Occupational Safety and Health (CDC-NIOSH) funding “Building Capacity and Enhancing Long-Term Coal Mine Weak Roof Stability through Characterization and Modeling of Time-Dependent and Moisture-Sensitive Shale Rock Failures.” Funded by NIOSH (2016-N-17733), 09/01/2016 to 08/31/2021, total funding: $1,346,522. Co-PIs: Drs. Derek Elsworth (PSU)

*Internal Research Grants (None)*

**B. Completed**

1. PI of IEE funding “Experiment and Modeling of Multi-physics Gas Flow Dynamics through Multi-Scale Shale Pores.” Funded by Penn State Institutes of Energy and the Environment, 03/15/2018 to 06/30/2019, total funding: $25,000. Co-PIs: Drs. Zi-Kui Liu, Shun-Li Shang, Ming Xiao (PSU) and Dr. Lilin He (ORNL).
2. PI of Penn State Human Health and the Environment funding “Investigating the Effect of Nano-Coal-Dusts on Worker’s Health and Its implications on Pneumoconiosis and Lung Cancer.” Funded by Penn State HHE seed grant, 07/01/2018 to 06/30/2020, total funding: $50,000. Co-PIs: Drs. Siyang Zheng, Zhiwen Liu, Chandra Belani (PSU) and Dr. Lilin He (ORNL).
3. Co-PI of United States Department of the Interior – Office of Surface Mine (OSM) funding “Field investigation and stability analysis of coal slurry impoundments.” Funded by OSM (S16AC20074), 10/01/2016 to 09/30/2019, total funding: $200,000. PI(s): Dr. Ming Xiao (PSU)
4. Co-PI of DOE National Energy Technology Laboratory funding “A Scaling Study of Microbially-Enhanced Methane Production from Coal (MECBM): Optimizing Nutrient Delivery for Maximized Methane Production.” 10/01/2015 to 06/30/2018, total funding: $564,201. PI: Dr. Derek Elsworth (PSU)
5. Co-PI of Alpha Foundation for the Improvement of Mine Safety and Health, Inc. funding “Development of Guidance for the Selection and Use of Atmospheric Monitoring Systems to Improve Decision-making during Routine and Post-accident Operations.” 09/01/2015 to 07/31/2019, total funding: $588,213. PI: Dr. Jeffery Kohler (PSU)
6. Co-PI of DOE Sandia National Laboratories funding “Shale Poromechanics: Heterogeneity, Flow, Failure and Creep.” 10/01/2014 to 09/30/2018, total funding: $480,508. PI: Dr. Zuleima Karpyn (PSU)
7. PI of NSF funding “Characterization and Modeling of Multimechanistic Flow Behaviors from Nano- to Macro-scale in Shale Matrix.” Funded by NSF CBET Fluid Dynamics program (CBET 1438398), 07/01/2014 to 06/30/2018, total funding: $330,000. Co-PIs: Drs. Derek Elsworth and Ming Xiao (PSU)
8. Single PI of an industrial funding “Water Sensitive Rock Core Swelling Investigation”, funded by DZL Corporation, 01/01/2017 to 12/31/2017, total funding: $11,200.
9. Single PI of an industrial funding “Dulles Corridor Metrorail – Rock Mechanics Tests”, funded by Schnabel Engineering, LLC, 07/01/2016 to 01/31/2017, total funding: $1,520.
10. Single PI of an industrial funding “ReWa Conveyance Tunnel Project – Rock Mechanics Tests”, funded by Bunnell-Lammons Engineering, Inc, 07/01/2016 to 01/31/2017, total funding: $9,600.
11. Single PI of an industrial funding “Three River Protection Overflow Reduction Tunnel System (3RPORT – P2)”, funded by 7NT Engineering and Testing, 07/01/2016 to 01/31/2017, total funding: $10,800.
12. PI of PSIEE funding “Investigation of Flow Behaviors in Shales during Primary Gas Depletion and CO2 Sequestration.” Funded by Penn State Institutes of Energy and the Environment, 03/15/2014 to 06/30/2015, total funding: $25,000. Co-PIs: Drs. Derek Elsworth and Ming Xiao (PSU)
13. Single PI of Gladys Snyder funding “Coal Mine Gas: Clean Energy for the World; Research and Education.” Funded by Penn State – College of Earth and Mineral Sciences, 01/01/2015 to 12/31/2015, total funding: $5,000.
14. Single PI of Wilson Research Initiation Grant “Analysis of Production Induced Stress Changes and Its Implications for Seismicity during Gas Shale Production.” Funded by Penn State – College of Earth and Mineral Sciences, 07/01/2013 to 06/30/2014, total funding: $10,000.
15. Single PI of Open Research Project funding “The Dynamic Strength change of Coal in Sorbing Gases Environment under Dynamic Stressing Condition.” Funded by State Key Laboratory of Coal Resources and Safe Mining, China (SKLCRSM13KFA01), 01/01/2014 to 12/31/2015, total funding: $15,000.

**INVITED TALKS**

1. “Mining and Mineral Engineering Research & High Impact Publishing in International Journal of Coal Science & Technology”, Colorado School of Mines, Mining Engineering Seminar, Virtual, April 28th, 2021.
2. “Anisotropy of Nanoscale Pore Deformations of Coal and Shale under Far-Field Uniaxial Stress Conditions”, University of Queensland, Virtual, June 10, 2021.
3. “Hydrogen Sorption and Diffusion in Coal”, 11th Asian Rock Mechanics Symposium, Challenges and Opportunities in Rock Mechanics, Virtual, October. 21-25, 2021.
4. “Size-reduction Induced Coal Dust Surface Alteration and its Potential Health Impact”, 2021 Fall Workshop of the Air-Microfluidic Group (AMFG), University of Illinois - Chicago, November 18, 2021.
5. “Study of Localized Coal Failure in Sorbing Gas Environment and its Application for Understanding Coal-Gas Outburst Mechanisms”, State Key Laboratory of Coal Mine Disaster and Control, Chongqing University, November 22, 2021.
6. “Characterizing Water-Mudstone Interaction Behaviors and Their Implications on Time-Dependent Mechanical Reduction and Long-Term Mine Roof Stability”, The Technische Universität Bergakademie Freiberg, Seminar at Faculty of Geosciences, Geoengineering and Mining, November 29, 2021.
7. “Characterization of Submicron-/Nano-scale Coal Dusts and Their Effects on Miners’ Pneumoconiosis for Miners”, 2nd International Symposium on In-situ Modification of Deposit Properties for Improving Mining 2020 (IMDPIM2) and 7th International Symposium on Unconventional Geomechanics (UG7), Virtual, November 7-8, Taiyuan, Shanxi, China.
8. “Predicting Fugitive Gas Emissions from Gob-to-Face in Longwall Coal Mines: Coupled Analytical and Numerical Modeling”, PCMIA Joint Virtual Webinar Series, December 17, 2020
9. “Microscale Gas Transport and Its Implication on the Production for Marcellus Shales”, Saint Francis University, Loretto, PA, USA, April 6, 2018.
10. “Fracked gas shale well flowback water analysis and its implication on reservoir property estimations”, Jianghan Oil Company, Sinopec, Fuling, China, January, 2017.
11. “Flow and geomechanics behaviors of coalbed methane reservoir under *in situ* condition”, Henan Polytechnic University, Jiaozuo, China, July, 2016.
12. “Complex gas flow dynamics in coal and its implication on mine gas control”, Anhui University of Science and Technology, Huainan, China, July, 2016.
13. “A multiscale and multiphysics gas flow and geomechanics in coalbed methane reservoirs - how laboratory research and modeling add values to cbm exploration and production”, PetroChina Coalbed Methane Company Limited, Beijing, China, July, 2016.
14. “Flowback data analysis for stimulated shale wells and its implication on evaluation of stimulation effectiveness”, Sinopec Tech Houston, Houston, TX, USA, June 27, 2016.
15. “Coal-Bio-Gasification – Geomechanics and best practice for reservoir stimulation”, Shanxi Lanyan Coalbed Methane Co Ltd, Jinchen, Shanxi, China, May 26-27, 2016.
16. “A multi-laboratory evaluation of micro-scale gas matrix interactions and its impact on gas transport and mechanical properties”, Institute of Rock and Soil Mechanics, Chinese Academy of Sciences, Wuhan, China, May 20, 2016.
17. “CBM well gas production optimization: well stimulation and secondary enhancement”, PetroChina Huabei Oilfield Company, Renqiu, China, May, 2016.
18. “Gas dynamics in ultra-tight shales and its implication of gas production”, School of Safety Engineering, China University of Mining and Technology, Xuzhou, China, June 22, 2015.
19. “Multiscale and multimechanistic flows in tight shales”, The State Key Laboratory of Nonlinear Mechanics, Chinese Academy of Sciences, Beijing, China, June 18, 2015.
20. “Intricacies of flows in shale rocks”, Department of Industrial & Systems Engineering, Rutgers, The University of New Jersey, New Brunswick, NJ, March 10, 2015.
21. “Flow behaviors in unconventional reservoirs and geomechanical responses with depletion”, Battelle-NETL R&D Potential Collaboration Meeting, Energy Institute, Penn State University, University Park, PA, August 19, 2014.
22. “Flow and geomechanics behaviors of coalbed methane reservoir under in situ conditions”, State Key Laboratory of Coal Resources and Safe Mining, China University of Mining and Technology, Beijing, China, June 9, 2014.
23. “Coalbed methane – nightmare for coal miners, clean energy for the world”, Workshop for Coal-Mining Safety, National Engineering Research Center of Coal Gas Control, China University of Mining and Technology, Xuzhou, Jiangsu, China, May 27, 2014.
24. “Coalbed methane exploration and related research”, Graduate seminar, Department of Energy and Mineral Engineering, Penn State University, State College, PA, April, 24, 2014
25. “Coal mine methane (CMM), coalbed methane (CBM) and shale gas development” invited presentation for delegation of State of Administration of Coal Mine Safety (SACMS) P.R. of China, 2013.

**SERVICE to Discipline and Profession**

1. Member of Technical committee, 18th North American Mine Ventilation Symposium (NAMVS), Society for Mining, Metallurgy & Exploration, 2020-2021.
2. Thesis Examination for Indian Institute of Technology

* Ph.D. Thesis Evaluation, IIT-Dhanbad, 2020

1. Invited Reviewer and Panel for The Canada First Research Excellence Fund (CFREF), 2020
2. Invited Reviewer and Panel for The Canada Foundation for Innovation, 2020
3. Thesis Examination for Australian Universities

* Patrick Booth, Ph.D. Thesis Evaluation, University of Wollongong, 2019
* Ph.D. Thesis Evaluation, Curtin University, 2019

1. Organizer for Coal, CBM and Gas Hydrate Geomechanics sessions in 53rd US Rock Mechanics/Geomechanics Symposium at New York City, US, June 23-26, 2019.
2. Member of Scientific Committee for International Conference of Innovative Mining Technologies , Poziomkowa, Poland, March 25-27, 2019
3. Editor-in-Chief, International Journal of Coal Science and Technology, Springer, 2019-present
4. Scientific Editor for Earth and Environmental Sciences, Nature Scientific Report, Springer, May 2018-present
5. Scientific Editor, Journal of Rock Mechanics and Geotechnical Engineering, Elsevier, 2018-present
6. Guest Editor, Advances in Materials Science and Engineering: Special Issue on Advances in Modeling of Heat and Mass Transfer in Porous Materials, 2018.
7. Organizer for International Workshop on Geomechanics of Shale Gas and Energy Storage at Wuhan, China, May 15-17, 2018.
8. Invited Reviewer for UK NERC, 2017
9. Organizer for International Workshop on Grand Challenges in Mining Engineering at Beijing, China, June 19-22, 2017.
10. Invited Reviewer for German Research Foundation (DFG), 2016
11. Organizer for International Workshop on Coal Mine Safety at Wollongong, Australia, September 2015
12. Treasurer, Central PA Subsection of Society for Mining, Metallurgy & Exploration (SME), 2016 to 2019.
13. NSF Panelist for CBET – Fluid Dynamic Program, 2015
14. Invited proposal reviewer for American Chemical Society Petroleum Research Fund, Summer 2014.
15. Guest Editor, Shock and Vibration: Special Issue on Shock and Vibration Induced by Mining Extraction, 2014-2015, 2015-2016.
16. Memberships

* Society for Mining, Metallurgy & Exploration (SME), Member: 2007-Present.
* American Association Petroleum Geologists, member: 2015-present.
* American Rock Mechanics Association, Lifetime member
* International Society for Rock Mechanics, Lifetime member
* The Society of Core Analysts, Lifetime member

1. Record of pursuit of advanced degrees and/or further studies

* 2-day short course on “Shale gas geoengineering”, American Rock Mechanics Association (ARMA), Houston, TX, USA. By Professor Maurice B. Dusseault, University of Waterloo, Canada (June 2016)
* ABET Workshops at Penn State University

1. Workshop 1, “Learning ABET Accreditation.” by Jenny Amos, UIUC (May 2015)
2. Workshop 2, “ABET Data Collection and Compilation.” by Thomas Litzinger, Penn State (June 2015)
3. Workshop 3, “ABET Common Problems – Common Solutions.” by Thomas Litzinger, Penn State (July 2015)

* Computer modeling group, Ltd. “2-day training course on CMG simulation for coalbed methane and gas shale reservoirs.” By Anjani Kumar (June 2011)

1. Reviewer for professional journals:

International Journal of Coal Geology, Energy & Fuels, International Journal of Greenhouse Gas Control, International Journal of Rock Mechanics and Mining Sciences, Fuel, International Journal of Coal Preparation and Utilization, Energy Exploration and Exploitation, Greenhouse Gas Measurement & Management, Fluid Phase Equilibria, SPE Journal, Journal of Natural Gas Science & Engineering, Natural Hazard, International Journal of Oil, Gas and Coal Technology, Arabian Journal of Geosciences, Engineering Failure Analysis, The Journal of Unconventional Oil and Gas Resources, Journal of Energy Chemistry, Greenhouse Gases: Science and Technology, Tunneling and Underground Space Technology, International Journal of Coal Science & Technology, ASTM Journal of Testing and Evaluation, Mining Engineering Magazine, Fuel Processing Technology, Journal of Geotechnical and Geoenvironmental Engineering, Rock Mechanics and Rock Engineering, Transport in Porous Media, Journal of Geophysical Research – Solid Earth, Environmental Science & Technology, ACS-Omega, Journal of CO2 Utilization, Nature – Scientific Reports, Colloids and Surfaces A: Physicochemical and Engineering Aspects, Process Safety and Environmental Protection,

1. Conference Session Chair:

* 53rd US Rock Mechanics/Geomechanics Symposium, New York City, US, June 23-26, 2019.
* China Shale Gas Conference 2015, Wuhan, China, September 6-8, 2015
* 14th International Conference on Coal Science & Technology, State College, PA, Sept. 29-Oct. 3, 2013.

**SERVICE to the University and Society**

1. IEE Seed Grant Review Panel, 2021
2. Chair of Graduate Admission Committee, 2020-2021
3. Member of Strategic Planning Committee for EMS Energy Institute, 2020
4. Chair of Search Committee for Professor in Practice in Mining Engineering (Spring 2020).
5. Chair of Search Committee for Mining Engineering Chair (Spring 2019).
6. Member of Search Committee for Mining Engineering Instructor (2019).
7. Chair of Departmental Lab and Space Committee (Fall 2018-Summer 2019)
8. Member of the EME P&T Committee, 2018-2019
9. Member of the Water Research and Education at Penn State (WREAPS) Committee, 2017
10. Member of Efficient Teaching Committee, 2017
11. Member of Faculty Activity Analysis Committee, 2017, 2018
12. Member of Hosler Building Renovation Committee, 2015-2016
13. Penn State Institutes of Energy & the Environment Seed Grant Panelist, 2015
14. Member of Search Committee for The Geoge H. and Anne B. Deike Endowed Chair in Mining Engineering (Fall 2013 - Spring 2014).
15. Faculty advisor for Mine Mucking Student Club (supervise and train the team members for the Annual International Collegiate Mining Competition).
16. Faculty advisor for Student Mine Rescue Team (train and assist student team for national and regional mine rescue contests)
17. Member of Graduate committee of the EME department.

Department of Energy and Mineral Engineering/College of Earth and Mineral Sciences