#### **TANDIS BIDGOLI**

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### EDUCATION

Ph.D. Geology, University of Kansas, Lawrence, KS, 2014M.S. Geology, University of Nevada, Las Vegas, NV, 2005B.S. Geology, San Francisco State University, San Francisco, CA, 2002

#### **PROFESSIONAL EXPERIENCE**

Assistant Professor, University of Missouri – Department of Geological Sciences, 2018 Assistant Scientist, University of Kansas – Kansas Geological Survey, 2014-2018 Research & Teaching Assistant, University of Kansas, 2010-2013 Geoscientist, ExxonMobil Corporation, 2005-2013 (on educational leave 2010-2013) Neotectonic Researcher, University of Nevada, Las Vegas, 2004-2005 Teaching Assistant & Instructor, University of Nevada, Las Vegas, 2002-2004 Intern, San Francisco Bay Regional Water Quality Control Board, 2001-2002

### **OTHER APPOINTMENTS**

Adjunct Assistant Professor, University of Cincinnati – Department of Geology, starting Fall 2018 Adjunct Assistant Professor, Kansas State University – Department of Geology, 2016-present Courtesy Assistant Professor, University of Kansas – Department of Geology, 2014-present

# **TEACHING EXPERIENCE**

Instructor, Physical Geology for Scientists and Engineers – Fall 2018 Instructor, Advanced Topics in Geology: Thermochronology and Tectonics – Spring 2017 (1) Co-Instructor, Advanced Geophysics – Spring 2016 (1) Instructor, Special Studies in Geology: (U-Th)/He Thermochronology – Spring 2015 (1) Co-Instructor, Advanced Topics in Geology: Induced Seismicity in Kansas – Spring 2015 (1) Co-Instructor, Geology for Petroleum Engineers – Spring 2015 Instructor, Structural Geology Lab (KU and UNLV) (2) Teaching Assistant and Instructor, Field Camp (Geologic Field Mapping Courses, KU and UNLV) (3) Teaching Assistant, Geophysical Methods (UNLV) (1) Instructor, Historical Geology Lab (UNLV) (1) Co-Instructor, Fundamental Structural and Stratigraphic Concepts Field School (ExxonMobil) (1) Co-Instructor, Extensional Tectonics (Death Valley Field School) (ExxonMobil) (1) Lecturer, Integrated Exploration School (ExxonMobil) (2) Lecturer & Teaching Assistant, Fundamentals of Geoscience Subsurface Interpretation (ExxonMobil) (1) Teaching Assistant, Integrated Basin Analysis (Bighorn Basin Field School) (ExxonMobil) (1) Teaching Assistant, Salt Tectonics (La Popa Basin Field School) (ExxonMobil) (1) () number of times course has been taught

**PUBLICATIONS** (\*indicates student advisee; <sup>†</sup>corresponding author)

### In Preparation

- **Bidgoli, T.S.**, Walker, J.D, and Stockli, D.F., Widespread exhumation in the hinterland of the late Cretaceous to Eocene Sevier orogen and potential links to global climate change: *Geology*.
- **Bidgoli, T.S.** and Taylor, W.J., The Timpahute lineament: East-trending transfer zone between the northern and central Basin and Range: *Tectonics*.
- \*Hollenbach, A., **Bidgoli, T.S.,** \*Ansari, E., and \*Jackson, C.M., Operational practices and their influence on injection-induced earthquakes in Oklahoma and Kansas: *Science*.
- \*Wang, W., **Bidgoli, T.S.**, Möller, A., and Stockli, D., Detrital zircon geochronologic constraints on Late Mississippian-Early Pennsylvanian sediment transport and tectonics, southwestern Kansas and northwestern Arkansas: *Geological Society of America Bulletin*.
- \*Wang, W., **Bidgoli, T.S.**, Möller, A., and Stockli, D., Detrital zircon geochronology: a novel tool for stratigraphic correlation of Late Mississippian-Early Pennsylvanian strata in southwestern Kansas: *AAPG Bulletin.*

# In Review

- \*Ansari, E., <sup>†</sup>Bidgoli, T.S., and \*Hollenbach, A., *in review*, Accelerated fill-up of the Arbuckle Group aquifer and links to US midcontinent seismicity: *Geophysical Research Letters*.
- \*Wang W., Yang, X., <sup>†</sup>**Bidgoli, T.S.,** Ye, J., and Zeng, Z., *in revision*, Detrital zircon geochronology of the Paleogene Zhu 2 depression: Implications for provenance and source-to-sink relations between the Cathaysia Block and Pearl River Mouth Basin, China: Journal of Geophysical Research – Earth Surface.

# **Refereed Publications**

- 1. \*Wang, W., <sup>†</sup>**Bidgoli, T.S.**, Yang, X., Ye, J., and Zeng, Z., 2018, Source-to-sink links between East Asia and Taiwan from detrital zircon geochronology of the Oligocene Huagang Formation in the East China Sea Shelf Basin: Geochemistry, Geophysics, Geosystems.
- <sup>\*</sup>Bidgoli, T.S., \*Tyrrell, J.P., Möller, A., Walker, J.D., and Stockli, D.F., 2018, Conodont thermochronology of exhumed footwalls of low-angle normal faults: A pilot study in the Mormon Mountains, Tule Spring Hills, and Beaver Dam Mountains, southeastern Nevada and southwestern Utah: Chemical Geology, doi: 10.1016/j.chemgeo.2018.06.026.
- 3. Nolte, A., Tsoflias, G., **Bidgoli, T.S.**, and Watney, W.L., 2017, Direct evidence of pore fluid pressure increases inducing seismicity in the US midcontinent through analysis of shear-wave anisotropy: Science Advances, v. 3, e1700443, doi: 10.1126/sciadv.1700443.
- 4. \*Schwab, D.R., <sup>†</sup>Bidgoli, T.S., and Taylor, M.H., 2017, Characterizing the potential for injection-induced fault reactivation through subsurface structural mapping and stress field analysis, Wellington Field, Sumner County, Kansas: Journal of Geophysical Research: Solid Earth, v. 122, doi: 10.1002/2017JB014071.
- \*Wang, W., Ye, J., <sup>†</sup>Bidgoli, T.S., Yang, X., Shi, H., and Shu, Y., 2017, Constraining the depositional response to episodic rifting through detrital zircon provenance of the Paleogene Zhu 1 depression, Pearl River Mouth Basin, China: Geochemistry, Geophysics, Geosystems, v. 18, doi: 10.1002/2017GC007110.
- 6. <sup>†</sup>Bidgoli, T.S., Amir, E., Walker, J.D., Stockli, D.F., Andrew, J.E., and Caskey, J.S., 2015b, Low-temperature thermochronology of the Black and Panamint mountains, Death Valley, CA: Implications for geodynamic controls on Cenozoic intraplate strain: Lithosphere, v. 8, doi:10.1130/L406.
- 7. <sup>†</sup>Bidgoli, T.S., Stockli, D.F., and Walker, J.D., 2015a, Low-temperature thermochronologic constraints on the kinematic histories of the Castle Cliffs, Tule Springs, and Mormon Peak detachments, southeastern Nevada and southwestern Utah: Geosphere, v. 11, doi:10.1130/GES01083.1.

- 8. Walker, J.D., **Bidgoli, T.S.**, Diderickson, B.D., Stockli, D.F., and Andrew, J.E., 2014, Middle Miocene to recent exhumation of the Slate Range, eastern California, and implications for the timing of extension and the transition to transtension: Geosphere, v. 10, doi:10.1130/GES00947.1.
- 9. Andrew, J.E., Rittase, W.M., Monastero, F.M., **Bidgoli, T.**, and Walker, J.D., 2014, Geologic Map of the Northern Lava Mountains and Summit Range, San Bernardino County, California: Geological Society of America Digital Map and Chart Series 19, doi:10.1130/2014.DMCH019.

### Non-Refereed Publications & Datasets

- 1. Holubnyak, Y., Williams, E., Watney, L., **Bidgoli, T.**, Rush, J., FazelAlavi, M., and Gerlach, P., 2017, Calculation of CO2 storage capacity for the Arbuckle Group in southern Kansas: Implications for a seismically active region: Energy Procedia, v. 114, p. 4679-4689, doi:10.1016/j.egypro.2017.03.1599.
- 2. \*Wang, W., Yang, X., **Bidgoli, T.S.**, Ye, J., Shi, H., and Shu, Y., 2017, Detrital zircon U-Pb geochronology of the Paleogene Zhu 1 Depression, Pearl River Mouth Basin, China: IEDA (Integrated Earth Data Applications) GeoChron dataset, http://dx.doi.org/10.1594/IEDA/100721.
- 3. \*Tyrrell, J.P., **Bidgoli, T.S.**, Walker, J.D., and Moller, A., 2016, LA-ICPMS depth profile data for conodonts from Mormon Mountains, Tule Spring Hills, and Beaver Dam Mountains, southeastern Nevada and southwestern Utah : IEDA (Integrated Earth Data Applications) EarthChem dataset, http://dx.doi.org/10.1594/IEDA/100631.
- 4. \*Tyrrell, J.P., **Bidgoli, T.S.**, Walker, J.D., and Moller, A., 2016, Collection of conodont SEM images from the Mormon Mountains, Tule Spring Hills, and Beaver Dam Mountains, southeastern Nevada and southwestern Utah: IEDA (Integrated Earth Data Applications) EarthChem dataset, http://dx.doi.org/10.1594/IEDA/100632.
- 5. **Bidgoli, T.S.**, Stockli, D.F., and Walker, J.D., 2015, Beaver Dam Mountains-Tule Springs Hills-Mormon Mountains Thermochronology: IEDA (Integrated Earth Data Applications) GeoChron dataset, doi:10.1594/IEDA/100520.
- 6. Walker, J.D. and **Bidgoli, T.S.**, 2014, Slate Range Thermochronology: Integrated Earth Data Applications (IEDA), doi:10.1594/IEDA/100424.
- Caskey, J., Bell, J.W., Ramelli, A.R., Adams, K.D., Reheis, M.C., Slemmons, B.D., Wesnousky, S.G., Ford, E.W., Domrose, C.J., Schneider, G., Goebel, M.W., Smith, N.W., Bidgoli, T.S., and Scherer, A.M., 2002, Historical Faulting, Chronostratigraphy, and Paleoseismicity of the Central Nevada Seismic Belt: Friends of the Pleistocene, Pacific Cell, Fieldtrip Guidebook, 114 p.

#### Dissertation & Theses

- **Bidgoli, T.S.**, 2014, Low-temperature thermochronometric constraints on Cenozoic intraplate deformation in the central Basin and Range [Ph.D. dissertation]: Lawrence, Kansas, University of Kansas.
- **Bidgoli, T.S.**, 2005, The role of transverse faults in Great Basin extension: Transfer faults or N-S extension? [M.S. thesis]: Las Vegas, Nevada, University of Nevada.
- **Bidgoli, T.S.**, 2002, Determining the style and rate of uplift from Quaternary marine terraces of the Point Reyes Peninsula, California [Senior thesis]: San Francisco, California, San Francisco State University.

#### Abstracts

### 2018

- 1. \*Ansari, E., **Bidgoli, T.S.**, and \*Hollenbach, A., 2018, The role of pressure diffusion in U.S. midcontinent seismcity: AAPG ACE 2018, Salt Lake City, UT.
- 2. \*Ansari, E., **Bidgoli, T.S.**, and \*Hollenbach, A., 2018, Statistical analysis of Arbuckle pressure and static fluid level: Geological Society of America, South-Central Section Meeting 2018, Little Rock, AR.

- 3. \*Ansari, E., **Bidgoli, T.S.**, \*Hollenbach, A., and Nolte, K.A., in review, Interplay between pore pressure and elastic stress induces US midcontinent seismicity: AGU Fall Meeting, Washington, D.C.
- 4. **Bidgoli, T.S.**, \*Wang, W., Möller, A., and Stockli, D., 2018, Detrital zircon geochronology: a novel tool for stratigraphic correlation of Late Mississippian-Early Pennsylvanian strata in southwestern Kansas and northwestern Arkansas: AAPG ACE 2018, Salt Lake City, UT.
- 5. **Bidgoli, T.S.**, \*Wang, W., Yang, X., and Ye, J., in review, Constraining Eocene to Miocene sediment transport from East Asia to Taiwan through detrital zircon provenance analysis of the Huagang Formation, East China Sea Shelf Basin: AGU Fall Meeting, Washington, D.C.
- 6. **Bidgoli, T.S.**, \*Wang, W., Yang, X., and Ye, J., in review, Detrital zircon geochronologic constraints on intra- and extrabasinal sediment sources, Paleogene Pearl River Mouth Basin, northern South China Sea: Geological Society of America Annual Meeting 2018, Indianapolis, IN.
- 7. \*Graham, K., **Bidgoli, T.S.**, Möller, A., Stockli, D.F., and Walker, J.D., in review, Timing and drivers of exhumation in the hinterland of the North American Cordillera from detrital zircon U-Pb and (U-Th)/He double dating: AGU Fall Meeting, Washington, D.C.
- 8. \*Hollenbach, A., **Bidgoli, T.S.**, and \*Ansari, E., 2018, Investigating the link between brine disposal practices and induced seismicity in Kansas and Oklahoma: AAPG ACE 2018, Salt Lake City, UT.
- 9. \*Hollenbach, A., **Bidgoli, T.S.**, \*Ansari, E., and Nolte, K.A., in review, Evaluating controls on US midcontinent seismicity through modeling of wastewater injection into the Arbuckle Group aquifer: AGU Fall Meeting, Washington, D.C.
- 10. \*Hollenbach, A., **Bidgoli, T.S.**, \*Ansari, E., and Nolte, K.A., in review, A spatio-temporally constrained volumetric threshold for inducing seismicity in the midcontinent, USA: Geological Society of America Annual Meeting 2018, Indianapolis, IN.
- 11. Holubnyak, E., Birdie, T., **Bidgoli, T.S.**, and Hollenbach, J., 2018, Methodology for capacity estimation for waste disposal and carbon management: AAPG ACE 2018, Salt Lake City, UT.
- 12. \*Jennings, D., **Bidgoli, T.S.**, Möller, A., and Walker, J.D., in review, Assessing uranium heterogeneity and U-Pb geochronology viability in conodont elements using Kansas outcrop samples: Geological Society of America Annual Meeting 2018, Indianapolis, IN.
- 13. Peterson, A., Smith, J.J., Layzell, A., and **Bidgoli, T.S.**, 2018. Structural mapping in the Humboldt Fault Zone using remote sensing, Chase County, Kansas. Transactions of the Kansas Academy of Science, Abstracts from the 150th Annual Meeting of the Kansas Academy of Science.
- 14. Nolte, A., Tsoflias, G., **Bidgoli, T.S.**, and Watney, W.L., 2018, Temporal change in shear-wave anisotropy linked to pore fluid pressure in Kansas. Kansas Interdisciplinary Carbonates Consortium Annual Meeting, Lawrence, KS, March 12-13, 2018
- 15. Nolte, A., Tsoflias, G., **Bidgoli, T.S.**, and Watney, W.L., 2018, Temporal change in shear-wave anisotropy linked to pore fluid pressure in Kansas: International Induced Seismicity Workshop 2018, Banff, Canada.

#### 2017

- 16. **Bidgoli, T.S.**, Dubois, M., Watney, W.L., Stover, S., Holubnyak, Y., \*Hollenbach, A., \*Jennings, J.C., and Victorine, J., 2017, Is commercial-scale CO2 capture and geologic storage a viable enterprise for Kansas?: AAPG Midcontinent Section Meeting 2017, Oklahoma City, OK.
- 17. **Bidgoli, T.S.**, and \*Jackson, C., 2017, Operational Practices and Their Influence on Injection-Induced Earthquakes: Lessons Learned from a Statewide Survey of Brine Disposal in Kansas: AAPG ACE 2017, Houston, TX.
- 18. Dubois, M., McFarlane, D., and Bidgoli, T.S., 2017, CO<sub>2</sub> Pipeline Cost Analysis Utilizing a Modified FE/NETL CO<sub>2</sub> Transport Cost Model Tool: Mastering the Subsurface Through Technology Innovation, Partnerships and Collaboration: Carbon Storage, Oil and Natural Gas Technologies Review Meeting, DOE-NETL Annual meeting, August 1-3, 2017, Pittsburgh, PA

- 19. \*Graham, K. and **Bidgoli, T.S.**, 2017, Elucidating the development of the basal Tertiary unconformity from regional thermochronologic data synthesis: American Geophysical Union, Fall General Assembly, New Orleans, LA.
- 20. \*Graham, K., **Bidgoli, T.S.**, Möller, A., and Walker, J.D., 2017, Timing and drivers of exhumation in the hinterland of the North American Cordillera from detrital zircon U-Pb and (U-Th)/He double dating: Geological Society of America Annual Meeting, Seattle, WA.
- 21. \*Hollenbach, A., **Bidgoli, T.S.**, and Dubois, M., 2017, Evaluating the Feasibility of CO2 Storage through Reservoir Characterization and Geologic Modeling of the Viola Formation and Arbuckle Group in Kansas: AAPG Midcontinent Section Meeting 2017, Oklahoma City, OK.
- 22. \*Jennings, J. and **Bidgoli, T.S.**, 2017, Identifying Areas at Risk for Injection-Induced Seismicity through Subsurface Analysis: An Example from Southern Kansas: AAPG ACE 2017, Houston, TX.
- 23. \*Jennings, J. and **Bidgoli, T.S.**, 2017, Identifying Areas at Risk for Injection-Induced Seismicity through Subsurface Analysis: An Example from Southern Kansas: AAPG Midcontinent Section Meeting 2017, Oklahoma City, OK.
- 24. Keast, R.T., Lacrois, B., Raef, A., Adam, C., **Bidgoli, T.S.**, Leclere, H., and G. Daniel, in review, Modeling the Proterozoic Basement's Effective Stress Field, Assessing Fault Reactivation Potential Related to Increased Fluid Pressures, and Improved 3D Structural Interpretation of Faulting within Wellington and Anson-Bates Fields, Sumner County, Kansas: American Geophysical Union, Fall General Assembly, New Orleans, LA.
- 25. Newell, K.D., **Bidgoli, T.S.**, Doveton, J.H., and Whittemore, D., 2017, Water Quality and Movement in Saline Aquifers in Kansas: Governor's Conference on the Future of Water in Kansas, November 9, 2017, Manhattan, KS.
- 26. Nolte, A., Tsoflias, G., **Bidgoli, T.S.**, and Watney, W.L., 2017, A new earthquake monitoring method? Change in shear-wave anisotropy as a tool to monitor induced seismicity in Kansas and Oklahoma: American Geophysical Union, Fall General Assembly, New Orleans, LA.
- 27. Nolte, A., Tsoflias, G., **Bidgoli, T.S.**, and Watney, W.L., in review, Temporal changes in shear-wave anisotropy in the US midcontinent: SEG 2017, Houston, TX.
- 28. Nolte, A., Tsoflias, G., **Bidgoli, T.S.**, and Watney, W.L., in review, Understanding injection induced seismicity: Temporal link between pore pressure increase and shear-wave anisotropy: SEG/SPE Workshop on Injection Induced Seismicity, November 6-8, 2017, Dallas, TX.
- 29. Nolte, A., Tsoflias, G., **Bidgoli, T.S.**, and Watney, W.L., 2017, Monitoring seismicity near an active CO2 EOR injection: 2017 Mastering the Subsurface Through Technology Innovation, Partnerships and Collaboration: Carbon Storage, Oil and Natural Gas Technologies Review Meeting, DOE-NETL Annual meeting, August 1-3, 2017, Pittsburgh, PA
- 30. \*Schwab, D.R., **Bidgoli, T.S.**, Taylor, M.H., and Stearns, L.A., 2017, Predicting the Potential for Fluid-Induced Fault Reactivation: An Example from Wellington Field, Sumner County, KS: AAPG ACE 2017, Houston, TX.
- 31. \*Wang, W., **Bidgoli, T.S.**, and Watney, W.L., 2017, Chronology and provenance of Late Mississippian-Early Pennsylvanian clastic influx to the Hugoton Embayment and Arkoma Shelf, constraints on transcontinental sediment transport and regional tectonics: AAPG Midcontinent Section Meeting 2017, Oklahoma City, OK.
- 32. \*Wang, W., **Bidgoli, T.S.**, Möller, A., Stockli, D., and Watney, W.L., 2017, Detrital zircon geo- and thermochronologic constraints on Late Mississippian-Early Pennsylvanian sediment transport and tectonics, southwestern Kansas and northwestern Arkansas: American Geophysical Union, Fall General Assembly, New Orleans, LA.

- 33. **Bidgoli, T.S.**, Doveton, J., and Holubnyak, Y., 2016, Far-field reservoir pressure increases and seismicity in south-central Kansas: Geological Society of America Abstracts with Programs, v. 48, n. 7, doi: 10.1130/abs/2016AM-286280
- 34. **Bidgoli, T.S.**, \*Tyrrell, J., Möller, A., Cramer, B.D., Walker, J.D., and Stockli, D.F., 2016, Conodont thermochronology: Expanding the utility of the (U-Th)/He method to marine carbonates and shales: AAPG Datapages/Search and Discovery Article #90259.
- 35. **Bidgoli, T.S.**, Walker, J.D., Andrew, J.E., and McLean, N., in review, Using the Geochron Database for Data Preservation and Exploration of Geothermal Resources: American Geophysical Union, Fall General Assembly 2016, abstract #IN23F-06.
- 36. Holubnyak, Y., Watney, L., and **Bidgoli, T.S.**, 2016, Lessons learned from waste water disposal in Kansas: Applications for CO2 geological storage: 15<sup>th</sup> Annual Conference on Carbon Capture Utilization & Storage, Tysons, VA.
- 37. Holubnyak, Y., Watney, L., Rush, J., **Bidgoli, T.**, Williams, E., and Gerlach, P., 2016, Calculation of CO2 storage capacity for Arbuckle Group in southern Kansas: Implications for a seismically active region: 13<sup>th</sup> International Conference on Greenhouse Gas Control Technologies, Lausanne, Switzerland.
- 38. \*Jackson, C. and **Bidgoli, T.S.**, 2016, Earthquakes in Kansas: A study of brine disposal and injectioninduced seismicity: Geological Society of America Annual Meeting, Denver, Colorado.
- 39. \*Jennings, J. and **Bidgoli, T.S.**, 2016, Mapping subsurface lineaments and present-day stresses in southern Kansas: A new approach for identifying areas at risk for injection-induced seismicity: Geological Society of America Abstracts with Programs, v. 48, n. 7, doi: 10.1130/abs/2016AM-285652.
- 40. \*Tyrrell, J., **Bidgoli, T.S.**, Möller, A., Cramer, B.D., Walker, J.D., and Stockli, D.F., 2016, Challenges associated with the conodont (U-Th)/He method: A case study from the Mormon Mountains, Tule Spring Hills, and Beaver Dam Mountains, southeastern Nevada and southwestern Utah: Geological Society of America Abstracts with Programs, v. 48, n. 7, doi: 10.1130/abs/2016AM-286505.
- \*Wang, W., Yang, X., Ye, J., Bidgoli, T.S., Watney, W.L., Zhu, H., and Wang, Q., 2016, Influence of syndepositional volcanism on Oligocene sandstone diagenesis and quality: A comparison of the BZ34-9 and KL6 fields in the southern Bohai Sea, China: Geological Society of America Abstracts with Programs, v. 48, n. 7, doi: 10.1130/abs/2016AM-286279.
- 42. Watney, W.L., **Bidgoli, T.S.**, Victorine, J., Simpson, P., Holubnyak, Y., Nolte, K., Tsoflias, G. P., Wreath, D., and Birdie, T.R., 2016, Continuous Pressure and Temperature Monitoring in Lower Arbuckle Saline Aquifer in Wellington Field, Sumner County, Kansas Response to the M5.8 Pawnee Earthquake: American Geophysical Union, Fall General Assembly 2016, abstract #S51E-3166.

#### 2015

- 43. **Bidgoli, T.S.**, FazelAlavi, M., and Holubnyak, Y., 2015, Reservoir-geomechanical analysis of fluid injection in the Arbuckle saline aquifer, south-central Kansas: Groundwater Protection Council Annual Forum.
- 44. **Bidgoli, T.S.**, Holubnyak, Y., and FazelAlavi, M., 2015, Evaluating potential for induced seismicity through reservoir-geomechanical analysis of fluid injection in the Arbuckle saline aquifer, south-central Kansas: AAPG Datapages/Search and Discovery Article #90216.
- 45. **Bidgoli, T.S.**, \*Schwab, D.R., Watney, W.L., and Gerlach, P., 2015, Subsurface faults and present-day stresses in southern Kansas: Implications for brine disposal and long-term storage of CO<sub>2</sub>: AAPG Datapages/Search and Discovery Article #90221.
- 46. Birdie, T., Watney, W.L., **Bidgoli**, T.S., Fazelalavi, M., and Holubnyak, E., 2015, Assessing induced seismicity risk associated with CO<sub>2</sub> geologic sequestration: Geological Society of America Abstracts with Programs, v. 47, n. 1, p. 12.

- 47. Holubnyak, Y., **Bidgoli, T.S.**, and Watney, W.L., 2015, Evaluating risks of induced seismicity for CO<sub>2</sub> geological storage in the Arbuckle saline aquifer, south-central Kansas: 14th Annual Conference on Carbon Capture Utilization & Storage, Pittsburg, PA.
- 48. Holubnyak, Y., FazelAlavi, M., **Bidgoli, T.S.**, Watney, L., 2015, Permeability estimations for the Arbuckle Formation in south-central Kansas: AAPG Datapages/Search and Discovery Article #90216.
- 49. Holubnyak, Y., Watney, L., FazelAlavi, M., Rush, J., **Bidgoli, T.S.**, Williams, E., Gerlach, S., and Datta, S., 2015, Regional assessment of reservoir properties and waste disposal modeling for Arbuckle Formation in south central and southwestern Kansas: AAPG Datapages/Search and Discovery Article #90242
- 50. Holubnyak, Y., Williams, E., FazelAlavi, M., Gerlach, P., **Bidgoli, T.S.**, 2015, Regional CO2 storage capacity estimations for the Arbuckle Saline Aquifer in south-central and southwestern Kansas: AAPG Datapages/Search and Discovery Article #80486.
- 51. Miller, R., Peterie, S., **Bidgoli, T.**, Fontana, J., Watney, W.L., Buchanan, R., 2015, Elevated seismicity in southern Kansas: Symposium on the Application of Geophysics to Environmental and Engineering Problems 2015, p. 294-305.
- 52. Peterie, S.L., Miller, R.D., Intfen, J., **Bidgoli, T.**, and Buchanan, R., 2015, A geologically based approach to mitigate potentially induced seismicity in Kansas: SEG Technical Program Expanded Abstracts 2015, p. 4871-4876.
- 53. \*Schwab, D.R., **Bidgoli, T.S.**, Taylor, M.H., and Stearns, L.A., 2015, Characterizing the potential for fault reactivation related to CO<sub>2</sub> injection through subsurface structural mapping and stress field analysis, Wellington Field, Sumner County, KS: American Geophysical Union, Fall General Assembly, abstract S13B-2822.
- 54. \*Schwab, D.R., **Bidgoli, T.S.**, Taylor, M.H., and Stearns, L.A., 2015, Determining the risk for induced seismicity associated with pilot-scale CO<sub>2</sub> injection at Wellington Field, Sumner County, Kansas: Geological Society of America Abstracts with Programs, v. 47, p.80.
- 55. \*Schwab, D., **Bidgoli, T.**, and Taylor, M., 2015, Characterizing CO2 injection using subsurface structural mapping and stress field analysis, cGPS, and InSAR, Wellington Field, Sumner County, KS: Kansas Environmental Conference, August 17-20, Topeka, KS.

#### 2014 and earlier

- 56. **Bidgoli, T.S.**, Walker, J.D., and Stockli, D.F., 2014, Two-phase development of the Nevadaplano from low-temperature thermochronology: American Geophysical Union, Fall General Assembly, abstract EP21B-3534.
- 57. **Bidgoli, T.S.**, Watney, W.L., Gerlach, P.M., and \*Nguyen, M.C., 2014, Episodic reactivation of criticallystressed basement faults in southern Kansas: Implications for wastewater disposal and long-term storage of CO<sub>2</sub>: Geological Society of America Abstracts with Program, v. 46, p. 317.
- 58. **Bidgoli, T.S.**, Amir, E., Walker, J.D., Stockli, D.F., Andrew, J.E., and Caskey, J.S., 2014, Space-time patterns and geodynamic drivers of Miocene to Pliocene strain in Death Valley, CA from low temperature thermochronology: Geological Society of America Abstracts with Programs, v. 46, p. 442.
- Birdie, T., Watney, L., Gerlach, P., Killion, M., Holubnyak, E., Raney, J., Bidgoli, T., Williams, G., \*Nguyen, M., and Wilson, B., 2014, Impacts of carbon dioxide storage in the saline Arbuckle aquifer on freshwater aquifers in Kansas: 59<sup>th</sup> Annual Midwest Ground Water Conference.
- 60. **Bidgoli, T.S.**, Walker, J.D., and Stockli, D.F., 2012, Refining the space-time strain path of the central Basin and Range through low-temperature thermochronology: Implications for geodynamic controls on Cenozoic intraplate deformation: 34th International Geological Congress, Paper #1272, p. 271.
- 61. **Bidgoli, T.S.**, Stockli, D.F., and Walker, J.D., 2012, Low-temperature thermochronology of the Castle Cliffs, Tule Springs, and Mormon Peak detachment faults: New constraints on the timing, magnitude, and spatial pattern of Miocene strain: 34th International Geological Congress, Paper #2736, p. 2716.

- 62. **Bidgoli, T.S.**, 2012, Low-temperature thermochronometric constraints on Cenozoic intraplate deformation in the central Basin and Range: AAPG Search and Discovery Article #90157.
- 63. **Bidgoli, T.S.**, Stockli, D.F., and Walker, J.D., 2011, Low-temperature thermochronologic constraints on the kinematic histories of the Mormon Peak, Tule Springs, and Castle Cliffs detachments, southeastern Nevada and southwestern Utah: Geological Society of America Abstracts with Programs, v. 43, p. 276.
- 64. Corbin, N., Walden, J.W., **Bidgoli, T.S.**, Thompson, J., Stockli, D.F., Hernandez Goldstein, E.J., Biel, S. Fry, T.L., Wiese, S., and Weiland, C.C., 2010, Late Miocene to Pliocene left-lateral reactivation of middle Miocene right-lateral faults in the Mina Deflection a detailed stratigraphic, structural, fault-kinematic, and geochronological investigation in the Coaldale Junction area, Walker Lane, Nevada: Geological Society of America Abstracts with Programs, v. 42, p. 133.
- 65. **Bidgoli, T.S.** and Taylor, W.J., 2008, The Timpahute Lineament: Transfer zone between the northern and central Basin and Range: Geological Society of America Abstracts with Programs, v. 40, p. 155.
- 66. **Bidgoli, T.S.** and Taylor, W.J., 2004, The role of transverse faults in Great Basin extension: Transfer faults or N-S extension?: Geological Society of America Abstracts with Programs, v. 36, p. 424.
- 67. **Bidgoli, T.S.**, Fossett, E., Knudsen, T.R., Kubart-Dano, R.K., McEwan, D.J., And Taylor, W.J., 2003, Surface rupture, paleoseismology, and seismic hazard assessment of the Holocene California Wash Fault, southern Nevada: Implications For Risk To Greater Las Vegas Area: Geological Society of America Abstracts with Programs, v. 35, p. 426.
- 68. **Bidgoli, T.** and Grove, K., 2002, Determining uplift rates and patterns from Quaternary marine terrace of the Point Reyes Peninsula, California: Geological Society of America Abstracts with Programs, v. 34, n. 5.
- 69. Caskey, S.J., Domrose, C.J., Ford, E.W., Goebel, M.W., Smith, N.W., **Bidgoli, T.S.**, Scherer, A.M., 2002, Tectonic and isostatic deformation of latest Pleistocene shorelines, Dixie Valley: Geological Society of America Abstracts with Programs, v. 34, p. A-100.

#### **OTHER PRESENTATIONS**

- Speaker, 2018 Mastering the Subsurface Through Technology Innovation, Partnerships and Collaboration: Carbon Storage, Oil and Natural Gas Technologies Review Meeting, DOE-NETL, "Integrated CCS for Kansas", 08/18
- 2. Speaker, Eastern Kansas Oil and Gas Association Mid Year Meeting "Integrated Carbon Capture, Utilization and Storage for Kansas", 05/08/18 (Invited)
- 3. Colloquium Speaker, Boone Pickens School of Geology, Oklahoma State University, 04/27/18 (Invited)
- 4. KU Environment Engineering Conference, "Integrated CCS for Kansas", 04/15/18 (Invited)
- 5. Colloquium Speaker, Department of Geological Sciences, University of Missouri, 03/7/18 (Invited)
- 6. Colloquium Speaker, Department of Earth & Atmospheric Sciences, Central Michigan University, 02/01/18 (Invited)
- 7. Speaker, 2017 Mastering the Subsurface Through Technology Innovation, Partnerships and Collaboration: Carbon Storage, Oil and Natural Gas Technologies Review Meeting, DOE-NETL, "Integrated CCS for Kansas", 08/01/17
- 8. Speaker, Oklahoma Corporation Commission, Arbuckle web conference, 7/6/17 (Invited)
- 9. Kansas Geologic Mapping Advisory Committee, "What's shaking Kansas?", 5/15/17
- 10. Kansas Next Step, Oil and Gas Seminar, "What's shaking Kansas? Causality assessment approaches for injection-induced earthquakes", 05/02/17-05/03/17 (Invited)
- 11. Kansas Geological Survey Advisory Council Meeting, "Integrated CCS for Kansas (ICKan)", 04/21/17
- 12. Colloquium Speaker, Department of Geology, Kansas State University, "What's shaking Kansas? Causality assessment approaches for injection-induced earthquakes", 03/16/2017 (Invited)
- 13. Panelist and Presenter, National Academies of Sciences, Engineering, & Medicine, Academies

Roundtable on Unconventional Hydrocarbon Development, 12/1/16-12/2/16 (Invited)

- 14. Governor's Conference on the Future of Water in Kansas (Manhattan, Kansas) "Lessons learned from a statewide survey of brine disposal and seismicity in Kansas" 11/15/2016
- 15. Society of Independent Professional Earth Scientists (Denver, Colorado), "Evaluating potential for induced seismicity through reservoir-geomechanical analysis of fluid injection in the Arbuckle saline aquifer, south-central Kansas", 05/26/16 (Invited)
- 16. Kansas Geological Survey Advisory Council Meeting, "Investigating injection-induced seismicity through reservoir-geomechanical modeling of the Arbuckle saline aquifer, south-central Kansas", 04/26/16
- 17. SPE/SEG Workshop: Induced Seismicity Engineering Integration, Evaluation, and Mitigation Workshop (Fort Worth, Texas), "Investigating injection-induced seismicity through reservoirgeomechanical modeling of the Arbuckle saline aquifer, south-central Kansas", 03/29/16 (Invited)
- 18. Speaker, KU University Scholars Seminar on Energy, 02/23/16 (Invited)
- 19. Joint Meeting of the Groundwater Protection Council, National Rural Water Association, and Interstate Oil and Gas Compact Commission (Oklahoma City, Oklahoma), "Reservoir-geomechanical analysis of fluid injection in the Arbuckle saline aquifer, south-central Kansas", 09/28/15 (Invited)
- 20. San Francisco State University Speaker Series (San Francisco, California), "Low-temperature thermochronology of the central Basin and Range", 09/08/15 (Invited)
- 21. Kansas Environmental Conference (Topeka, Kansas), "Earthquakes in Kansas: An Update of Research at the Kansas Geological Survey, 08/20/15
- 22. Kansas Geological Society (Wichita, Kansas), "Earthquakes in the southern midcontinent: What we know and what we need to know Current research at KU and the Kansas Geological Survey", 12/2/14
- 23. Kansas Geological Survey (Lawrence, Kansas), "Low-temperature thermochronometric constraints on Cenozoic intraplate deformation in the central Basin and Range", 05/08/13 (Invited)
- 24. ConocoPhillips (Houston, Texas), "Low-temperature thermochronometric constraints on Cenozoic intraplate deformation in the central Basin and Range", 02/18/13 (Invited)
- 25. AmericaView Fall Technical Meeting, USGS EROS Center (Sioux Falls, South Dakota), "Comparison of Absolute and Relative Radiometric Corrections for Atmospheric Attenuation", 09/25/11
- 26. Kansas Geographic Information Systems Policy Board Meeting (Topeka, Kansas), "Project GeoHawk", 03/11/11

# **RESEARCH GRANTS**

Total Awarded to Date as PI: \$3.04 million

# Current Support

- 1. U.S. Department of Energy, 07/01/18 06/31/20, "Integrated Midcontinent Stacked Storage Hub", **\$1,375,717** (PI for KU subaward)
- American Chemical Society Doctoral New Investigator Grant, 09/01/17 08/31/20, "Conodont thermochronology: Expanding the utility of the (U-Th)/He method to marine carbonates and shales", \$110,000 (Principal Investigator)
- 3. U.S. Department of Energy, 03/15/2017 09/15/2018, "Integrated CCS for Kansas (ICKan)", **\$1,484,096** (Joint PI with M. Dubois)

# Pending Support

 National Science Foundation – EAR "Collaborative Research: Construction and destruction of the southern Nevadaplano: Uplift and erosion history of the southern Sevier orogenic plateau", 05/15/19-05/14/22 \$190,997 (MU portion) (Co-PI with Wanda Taylor,UNLV and Dan Surmer, UCinn)

- United States Geological Survey Earthquake Hazards Program, 05/18/19 to 05/17/20, "Developing a physics-based earthquake hazard model for injection-induced seismicity in the US midcontinent", \$77,112 (Principal Investigator)
- 3. United States Geological Survey Earthquake Hazards Program, 05/18/19 to 05/17/20, "A novel technique to identify regions at higher risk of pore pressure-induced earthquakes in northern Oklahoma and southern Kansas: Collaborative Research with University of Kansas and University of Missouri, \$35,091 (Principal Investigator)

# Past Support

- 4. United States Geological Survey STATEMAP, 07/01/17 06/31/18, "Geologic Mapping in Kansas for FY17", **\$155,731** (PI: Greg Ludvigson)
- U.S. Department of Energy, 10/01/2011 12/31/2017, "Small scale field test demonstrating CO<sub>2</sub> sequestration in Arbuckle saline aquifer and by CO<sub>2</sub>-EOR at Wellington Field, Sumner County, Kansas", \$10,747,494 (PI: W.L. Watney)
- United States Geological Survey Earthquake Hazards Program, 05/01/16-04/30/17, "Mapping subsurface lineaments, present-day stresses, and brine disposal data in southern Kansas: A new approach for identifying areas at risk for injection-induced seismicity, \$75,091 (Principal Investigator)
- 7. U.S. Department of Energy, 10/01/2009 09/30/2014, "Modeling CO<sub>2</sub> sequestration in saline aquifer and depleted oil reservoir to evaluate regional CO<sub>2</sub> sequestration potential of Ozark Plateau Aquifer System, south-central Kansas", **\$9,974,352** (PIs: W.L. Watney and J. Rush)

# STUDENT RESEARCH GRANTS & SCHOLARSHIPS (\$91,750 total awards)

Joseph M. Patterson Fellowship, 2011-2013, \$32,000/yr D.A. McGee Geology Scholarship, 2013, \$2000 Phillips Petroleum Scholarship, 2013, \$750 Geological Society of America/ IUGS, Early Career Scientist Grant, 2012, \$3000 American Association of Petroleum Geologists, Grants-In-Aid, 2003 & 2012, \$3000 total Geological Society of America, Student Research Grant, 2003 & 2012, \$5000 total University of Kansas, Doctoral Research Scholarship, 2012, \$2000 Ernest E. Angino Geochemistry Scholarship, 2012, \$3000 Encana Energy Scholarship, 2011, \$1500 University of Kansas, Travel Scholarship, 2011, \$500 University of Nevada, Las Vegas, GREAT Assistantship, 2004, \$3000 Bernada E. French, Geoscience Scholarship, 2003 and 2004, \$3000 total University of Nevada, Las Vegas, Graduate Student Association, Research Grant, 2003, \$500 SF State University, College of Science and Engineering, Student Project Fund Award, 2001, \$500

# AWARDS & HONORS

American Association of Petroleum Geologists, Award of Excellence, Top 10 Oral Presentation, 2015 KU, Erasmus Haworth Graduate Honors in Geology, 2014 KU, Geology Department, Ph.D. Final Examination, Pass with Honors, 2014 International Union of Geological Sciences, Hutchison Young Scientist Award, 2012 KU, Geology Department, Ph.D. Oral Comprehensive Examination, Pass with Honors, 2011 UNLV, College of Science, Outstanding Thesis Award, 2006 UNLV, Graduate and Professional Student Association Poster Award, 1<sup>st</sup> Place, 2004 Geological Society of America, Cordilleran Section, Student Paper Award, 2002 Association for Woman Geoscientists, Outstanding Student Award, 2002 SF State University, College of Science and Engineering, Outstanding Project Award, 2002

#### SERVICE AND OUTREACH

Organizing Committee, 2019 AAPG Midcontinent Section Meeting in Wichita, Kansas, 2017-2019 Co-convener, "Injection-induced seismicity in the US midcontinent: Where are we after a decade", Geological Society of America, Joint Section Meeting, 2019 Co-convener, "Holistic Approaches to Coping with Induced Seismicity in the Midcontinent", Geological Society of America, South-Central Section Meeting, 2018 Co-convener, "Induced Seismicity in the USA and Canada: Novel Approaches to Causality Assessment", American Geophysical Union, Fall General Assembly, 2017 Mentor, CLAS Faculty Mentor Program, University of Kansas, 2017-2018 Search Committee, University of Kansas, Energy Research Section – Petroleum Geoscientist, 2017 Induced Seismicity Presentation, Wichita Rotary Club, "What's shaking Kansas?", 4/17/2017 (invited) Geology Field-based Show and Tell with 7<sup>th</sup> grader's Fairfield Middle School, 10/24/2016 Resume Workshop, University of Kansas, Department of Geology, 2016 & 2017 Speaker, KU – Geology 101: "Are humans causing earthquakes?", 09/06/2016 (Invited) Seismic Waves Presentation, Heartland Elementary - 4<sup>th</sup> Grade Class, 2016 (invited) Merriam Research Award Selection Committee, 2015 to present Volunteer, KGS – Earth Day Booth, 2015 State of Kansas – Induced Seismicity Taskforce, 2014-present American Association of Petroleum Geologists, Grant-In-Aid Committee, 2014-present American Association of Petroleum Geologists, Education Committee, 2014-present Search Committee, University of Kansas, KGS Outreach Coordinator, 2014 Teaching Aid, Core Workshop for KU – OSHER Lifelong Learning Institute, 2014 President, KU Student Chapter, American Association of Petroleum Geologist, 2010-2011 Geoscience Recruiter, ExxonMobil, 2007-2009 Instructor, Harris Foundation Summer Science Camp, 2008 Coordinator, ExxonMobil, New Hire Skill Area Forums, 2006-2008 Co-Chair, Short Courses Committee, Annual Meeting of Association of Engineering Geologist, 2005 Lead, Geoscience Track of UNLV Summer Career College (U.S. Dept. of Education - GEAR UP), 2004

# BIDGOLI RESEARCH GROUP STUDENTS

#### Current Advisees

Wei Wang, Post-doctoral Researcher (Univ. of Missouri; starting October 2018) Begum Kurtoglu, M.S. (Univ. of Missouri; expected May 2020) Esmail Ansari, Post-doctoral Researcher (KU; August 2017-June 2019) Deserae Jennings, Ph.D. (KU; expected December 2019) Andrew Hollenbach, M.S. (KU; expected December 2018) Jeff Jennings, M.S. (KU; expected December 2018) Kathleen Graham, M.S. (KU; expected December 2018)

# Past Advisees

Wei Wang, Ph.D. Visiting Scholar (China University of Geosciences; September 2015-October 2017; graduated June 2018) Drew R. Schwab, M.S. (KU; September 2014-December 2016) – Geoscientist with Chevron

James P. Tyrrell, M.S. (KU; September 2014-December 2016) – Geoscientist with Concho Resources

Kesley Lamer, KGS Intern (May 2017-August 2017) Christa M. Jackson, KGS Intern (May 2015-June 2016) Minh C. Nguyen, KGS Intern (May 2014-May 2015) – Ph.D. Candidate at University of Wyoming

### Funding and Honors Awarded to Bidgoli Research Group Students

William W. Hambleton Student Research Award to Alex Nolte, 2018
Norman Plummer Outstanding Student Award to Deserae Jennings, 2018
First Runner Up, Houston Geological Society, Mudrocks Conference, to Jeffrey Jennings, 2018
Kansas Geological Foundation Grant to Jeffrey Jennings, 2018
Norman Plummer Outstanding Student Award to Jeffrey Jennings, 2017
Capitol Graduate Research Summit Invitation to Jeffrey Jennings, 2017
American Association of Petroleum Geologists, Grants-In-Aid to Katie Graham, 2017
Association for Woman Geoscientists Research Scholarship to Katie Graham, 2017
Kansas Geological Foundation Grant to Katie Graham, 2017
Association of Earth Science Clubs of Greater Kansas City Scholarship to Katie Graham, 2017
KU Frederick T. Holden Scholarship to Katie Graham, 2017
Chevron Student Research Award to Deserae Jennings, 2017
Lee C. and Darcy Gerhard Field Research Student Award to Alex Nolte, 2017
Geological Society of America, Student Research Grant to Drew Schwab, 2015

### Graduate Thesis Committee

Alex Nolte, Ph.D. (KU; expected 2021) Clay Campbell, Ph.D. (KU; expected 2021) Adam Jones, M.S. (Univ. of Cincinnati; expected 2019) Brandon Graham, M.S. (KU; did not complete) Ryan Keast, M.S. (Kansas State Univ.; May 2018)

# PRESS COVERAGE

- 1. "KU researchers take steps toward predicting earthquakes", article in the Topeka Capital Journal, http://cjonline.com/news/state-government/2017-12-14/ku-researchers-take-steps-towardpredicting-earthquakes
- "Geologists report new discoveries about Kansas, Oklahoma earthquakes", 12/14/2017, article on Science Advances paper, https://phys.org/news/2017-12-geologists-discoveries-kansasoklahoma-earthquakes.html
- 3. "KU geologists report new discoveries about Kansas, Oklahoma earthquakes, 12/13/2017, KU press release, https://news.ku.edu/ku-geologists-report-new-understanding-may-one-day-enable-them-manage-risk-induced-earthquakes
- 4. "Filling in the Blanks to Limit Earthquake Risks", 09/01/2017 interview and article for the Journal of Petroleum Technology, https://www.spe.org/en/jpt/jpt-article-detail/?art=3285
- 5. "Kansas Geological Survey receives grant to test new thermal dating process for rock", WIBW News, 07/21/17, radio interview & news article, https://www.wibwnewsnow.com/kansas-geological-survey-receives-grant-test-new-thermal-dating-process-rock/
- 6. "Wastewater injection well application triggers opposition", AP News, 04/27/17 interview & news article, https://www.apnews.com/74959ef790644212a9844094684a09fb
- 7. "Quake numbers drop, but issue lingering", Hutchison News, 04/08/16 interview & news article, http://www.hutchnews.com/kansas\_earthquakes/quake-numbers-drop-but-issue-lingering/article\_74099f70-a6ac-5622-a616-851f2ff01c8c.html
- 8. "Earthquakes in the Heartland: Shake, Rattle and Responsibility", profile article for AAPG

Explorer, 12/01/16

- 9. "Can states stop man-made earthquakes?", Stateline Pew Charitable Trusts interview & news article, 07/14/16, http://www.pewtrusts.org/en/research-and-analysis/blogs/stateline/2016/07/14/can-states-stop-man-made-earthquakes
- 10. "Scientists study link between U.S. oil drilling and rise in earthquakes", PBS Newshour, 07/14/16, http://www.pbs.org/newshour/rundown/scientists-study-link-u-s-oil-drilling-rise-earthquakes/
- 11. Interview with Scott Canon on injection induced earthquakes, KC Star, 07/06/2016
- 12. "Kansas Geological Survey scientist: 'Strong relationship' between earthquakes and saltwater injection", Topeka Capital-Journal article (reprinted in Hutchinson News and Salina Journal), 08/20/15, http://cjonline.com/news/2015-08-20/kansas-geological-survey-scientist-strong-relationship-between-earthquakes-and
- 13. "Kansas Geologists Probe Decrease in Kansas Earthquakes", KPR news article and radio spot, 08/10/15, http://kansaspublicradio.org/kpr-news/kansas-geologists-probe-decrease-kansas-earthquakes
- 14. "Activity Tied to Fracking Scrutinized for Link to Quakes", WIBW News article and radio interview, 08/07/15, http://www.wibwnewsnow.com/activity-tied-to-fracking-scrutinized-for-link-toquakes/
- 15. "Installation of seismic monitoring stations could link quakes to fracking-related activity" WIBW News article and radio interview, 01/05/15, http://www.wibwnewsnow.com/four-seismic-monitoring-stations-installed-south-central-kansas/
- 16. Channel 12 News Wichita Kansas, interview on seismicity and relationship to brine disposal, 12/02/14

### **PROFESSIONAL AFFILIATIONS**

American Association of Petroleum Geologists American Geophysical Union Geological Society of America Kansas Geological Society