



# MONTANA TECH

## GEOPHYSICAL ENGINEERING

June 2014

Volume 1, p. 1

**DEPARTMENT HEAD:**  
**DR. MARVIN SPEECE**  
406-496-4188  
MSPEECE@MTECH.EDU

**FACULTY:**  
**MR. JOHN GETTY**  
406-496-4888  
JGETTY@MTECH.EDU  
**PROF. JAMES GIRARD**  
406-496-4347  
JGIRARD@MTECH.EDU  
**DR. CURTIS LINK**  
406-496-4611  
CLINK@MTECH.EDU  
**DR. KHALID MIAH**  
406-496-4165  
KMIAH@MTECH.EDU  
**DR. XIAOBING ZHOU**  
406-496-4350  
XZHOU@MTECH.EDU  
**ADMINISTRATIVE ASSISTANT**  
**THERESA O'LEARY**  
406-496-4401

**SOCIETY OF  
EXPLORATION  
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**STUDENT ADVISOR:**  
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## LETTER FROM THE CHAIR

This year we welcome two new faculty members to the department. Khalid Miah will arrive in August to replace Curtis Link who retired in 2013. Khalid has a PhD from the University of Texas at Austin and has an interest in signal processing and inversion applied to exploration seismology. In addition, John Getty moves to the Geophysical Engineering Department from the Petroleum Engineering Department at Montana Tech where he runs the Proppant Research Lab. See the faculty section later in this newsletter to find out more about Khalid and John.

We will begin a search this fall to fill our electrical/EM faculty position. Please watch for the advertisements if you are interested.

On Friday, September 19th, we will have our annual Industrial Advisory Board (IAB) meeting in Butte, Montana, to coincide with Homecoming weekend. The IAB provides industry input to our program and this is an important part of our assessment process. Please feel free to contact me if you are interested in serving on the IAB.

The Department recently purchased the materials to build a fluxgate magnetometer to add to our field capabilities. Xiaobing Zhou is directing this project. In addition, we recently purchased a Geometrics Gode 24-channel seismic recording model to compliment the 5 that we already own. This brings our seismic recording capabilities to 144 channels.

In 2010, Montana Tech alumnus Hugo Pulju donated to us 190 miles of vintage seismic data from Flathead County in northwest Montana. These data have been appraised by Montana Tech alumnus Eric Johnson at about \$2.3 million and is the largest in-kind donation to Montana Tech. These data are unique and given the location of where they were collected would be difficult to recollect in today's regulatory climate. Graduate students, Brad Rutherford and Mason Porter, are reprocessing and interpreting these data for publication. These data are available for lease. Contact me if interested.

In 2013, an anonymous alum, donated \$96,000 to the Department. These funds have been used for the purchase of a much needed field vehicle and to create a Department scholarship endowment to provide scholarships to deserving students pursuing a degree in Geophysical Engineering.

If you would like to help us meet our fundraising goals, then please contact me and we can discuss how you might help.

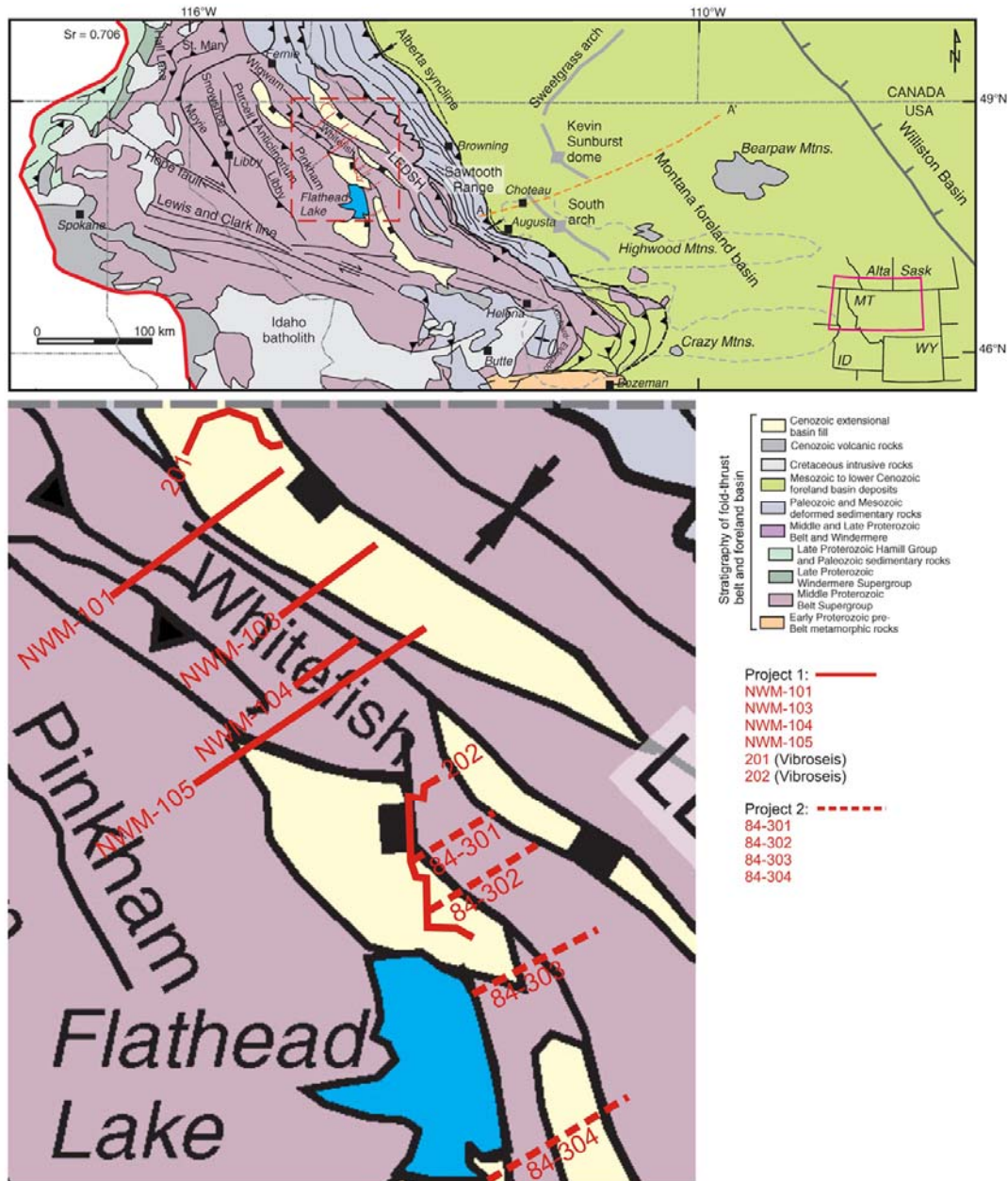
Marvin Speece, Professor and Chair



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Above, simplified tectonic map of northwestern Montana and adjacent areas. The dashed red boxes on the upper of the two figures above shows the location of the inset figure just above. The figure above shows the locations of the 1983 and 1984 seismic reflection profiles that were donated to Montana Tech. (Figure modified after Fuentes, DeCelles, Constenius, and Gehrels, 2011, Evolution of the Cordilleran foreland basin system in northwestern Montana, U.S.A.: GSA Bulletin, 123 (3/4), 507-533, doi: 10.1130/B30204.1.)



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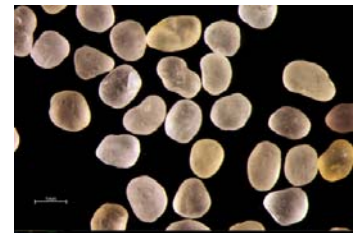
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### MEET THE FACULTY

**John Getty:** I would like to introduce myself as the newest member of the Geophysics team. I graduated in 1977 from Colorado State University with a BS in Physics and went to work for Dresser Atlas—a wireline service company—as an open-hole logging engineer. As was true for many in the oil and gas industry, the mid 80's offered me a change in careers. I joined the newly re-formed Engineering program at the University of Denver, serving as lab director and instructor. After 13 years in academia, and a couple of more in the test and measurement industry, I accepted a position in the Physics Department at Montana State University as an electronic design engineer. While there, I completed a Master of Science in Science Education with a specialization in Physics (2009). For the last 6 years I have been teaching in the Petroleum Engineering Department here at Tech. This fall I will be teaching the algebra-based physics course, *Fundamentals of Physics* as well as *General Physics III (E&M)*.

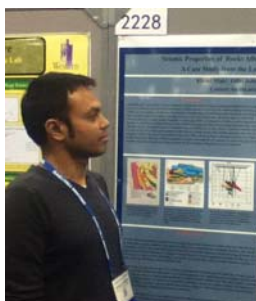


I bring to Geophysics an active, funded research program in proppants used for hydraulic fracture stimulation. I am also actively involved in the Undergraduate Research Program, both as a member of the committee and as a mentor for student researchers. If you have ideas for research projects for our students, please feel free to contact me. Typically, these projects require about 10 hours per week from the students, last two semesters, and have a well-defined end point.



**Jim Girard:** Jim continues to teach physics and manage the physics labs.

**Curtis Link:** Curtis retired from the Department in 2013. He is Professor Emeritus in the Geophysical Engineering Department. After part of a year working for Geolex in Helena, he is back at Montana Tech as Director of the Freshman Engineering Program. In the near term, he directs graduate research in the Department.



**Khalid Miah:** This summer has been eventful with traveling and research for both work and personal purposes. Recently, I attended the EGU (European Geosciences Union) General Assembly to present a paper in the topic of *3D Geological to Geophysical Modeling in the Hardrock Mining Environment* in Vienna, Austria. Currently, I am working on seismic modeling and wave propagation simulation through mineral ore lenses in an attempt of better understanding 3D-multiphase active seismic survey data in a Volcanogenic Massive Sulphides (VMS) mining camp, located in Northern Manitoba. Besides research activities, I am training for some ultra-distance trail running races this summer. I am also looking forward and excited to move to Butte to join in the Department as a faculty member this fall. Go Diggers!



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**Marvin Speece:** This past year, graduate student, Brad Rutherford, processed and interpreted seismic data from the Flathead area that were donated to us by alumnus, Hugo Pulju. Brad will defend his thesis soon and submit a paper detailing his work to the journal *Tectonics*. Graduate student, Mason Porter, has started to process the northern portion of these data and should be ready to present his results next spring. Graduate student, Meltem Akam, is processing and interpreting a Vertical Seismic Profile (VSP) that was collected in 2007 as part of the ANtartic geological DRILLing (ANDRILL) Program. ANDRILL is a multinational collaborative initiative to investigate Antarctic's role in Cenozoic-Recent global environment change through stratigraphic drilling for Antarctic climate, volcanic and tectonic history. More information about research can be found at <http://www.andrill.org>. During the austral summer of 2007, ANDRILL drilled from a sea-ice platform in Southern McMurdo Sound. The drillhole sampled a late Miocene and younger sequence of strata to obtain new information about the Neogene Antarctic cryosphere and evolution of Antarctic rift basins. I participated in the logging portion of this project by collecting a VSP in the new drillhole. I am currently part of an ANDRILL proposal to drill at Coulman High in Antarctica in 2016-2017. This summer, undergraduate, Aaron Mack, is working with me on an archaeological project at a bison-kill site near Phillipsburg, Montana. This work is sponsored by the Montana Tech Undergraduate Research Program. Aaron will collect ground penetration radar data at the site in the hopes to identify areas of probable concentration of artifacts, such as cooking hearths or slaughter areas.



**Xiaobing Zhou:** In the past few years, I continued to teach *Elements of Geophysics, Electronics for Scientists, General Physics III—Electricity, Magnetism and Wave Motion, Gravity and Magnetic Exploration, Electricity & Magnetism*. In the summer, I co-taught the field camp class with colleagues in the Department. For research, I recently finished a DOE project of technology development for CO<sub>2</sub> leakage detection and environment impact assessment due to potential leakage from CO<sub>2</sub> sequestration through controlled CO<sub>2</sub> release at a facility established at Montana State University in Bozeman. Recently we also finished a NASA/Montana Space Grant Consortium project (January 2013 to June 2014) of deriving soil moisture/snow wetness from satellite radar data. In the past few years, I worked on gravity, especially forward modeling and inversion based on the line integral method for heterogeneous sediment basins where mass density varies with space. Based on these results, we recently submitted a proposal to NASA to obtain subglacial sediment thickness and bathymetry from Ice-Bridge air-borne ice-penetrating radar and gravity data in collaboration with Dr. Marvin Speece.

Other news that I want to share with you is that I was recently promoted to Professor from Associate Professor. I recently accepted an invitation to be an Associate Editor for *Journal of Applied Remote Sensing*, one of SPIE's main journals. I was approved to take sabbatical leave for the whole year of 2014, to focus on research (research on magnetic prospecting is a priority) and to streamline class notes for *Gravity and Magnetic Exploration* since there is no appropriate textbook for the course.

### Recent publications:

- Florentine, C., Skidmore, M. L., Speece, M., Link, C., Shaw, C., 2013, Geophysical analysis of transverse ridges and internal structure at Lone Peak rock glacier, Big Sky, Montana, USA: *Journal of Glaciology*, **60**(221), 453-462: doi:10.3189/2014JoG13J160.
- Kellogg, C. H., and X. Zhou, 2014, Impact of the construction of a large dam on riparian vegetation cover at different elevation zones as observed from remotely sensed data: *International Journal of Applied Earth Observation and Geoinformation*, **32**, 19–34.
- Lakkaraju, V. R., X. Zhou, M. Apple, A. Cunningham, L. M. Dobeck, K. Gullickson, L. H. Spangler, 2010, Studying the vegetation response to the simulated leakage of sequestered CO<sub>2</sub> using spectral vegetation indices: *Ecological Informatics*, special issue on ecological remote sensing, **5**, 379-389.



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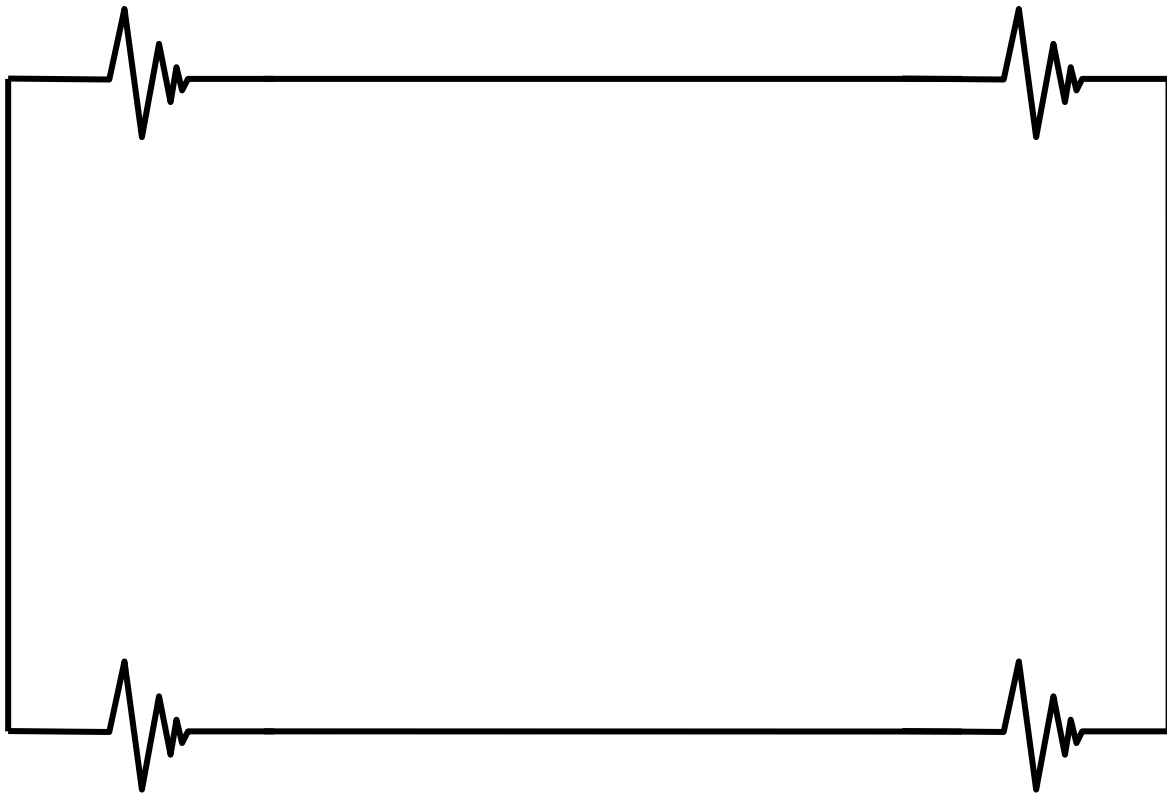
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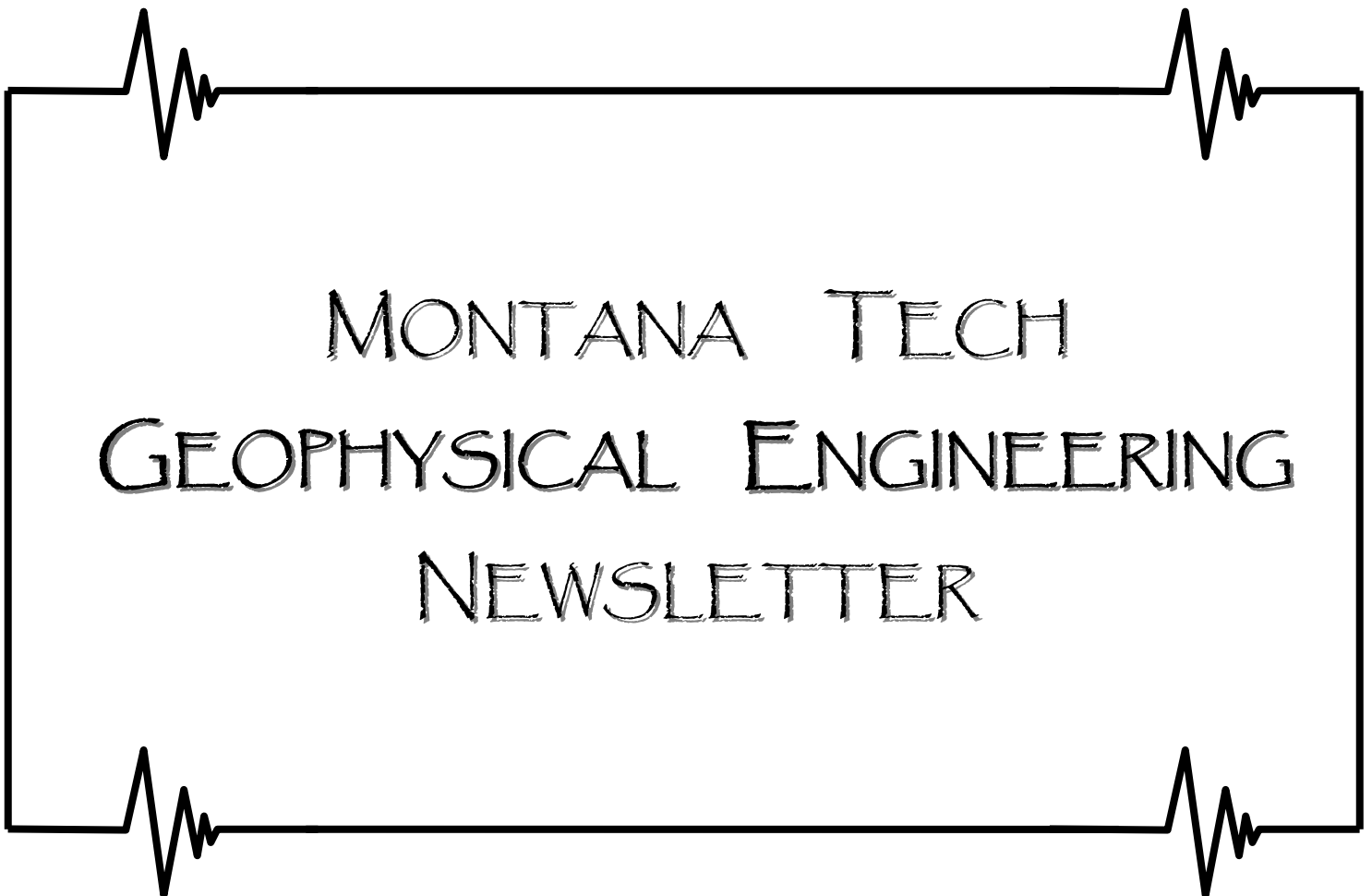
- Pekar, S. F., Speece, M. A., Wilson, G. S., Sunwall, D. A., and Tinto, K. J., 2013, The Offshore New Harbour Project: deciphering the Middle Miocene through Late Eocene seismic stratigraphy of Offshore New Harbour, western Ross Sea, Antarctica: in Hambrey, M. J., Barker, P. F., Barrett, P. J., Bowman, V., Davies, B., Smellie, J. L., Tranter, M. (eds.), *Antarctic Palaeoenvironments and Earth-Surface Processes*, Geological Society of London, Special Publications, **381**, 199-213. First published online April 19, 2013, doi:10.1144/SP381.2.
- Sunwall, D., Speece, M., and Pekar, S., 2010, Latest advances in over-sea-ice seismic reflection surveys: offshore New Harbor, Antarctica: *SEG International Exposition and 80<sup>th</sup> Annual Meeting 2010 Technical Program Expanded Abstracts*, 36-40.
- Sunwall, D. A., Williams, B. P., Repasky, T. R., Link, C. A., Speece, M. A., 2011, *Landstreamer and Gimbaleed Geophones Phase II—200 Areas: A High-Resolution Seismic Reflection Survey at the Hanford Site*: Department of Energy Report, SGW-52160, 74 pp.
- Repasky, T. R., Hyde, E. R., Link, C. A., and Speece, M. A., 2009, *Landstreamer/Gimbaleed Geophone Acquisition of High-Resolution Seismic Reflection Data North of the 200 Areas—Hanford Site*: Department of Energy Report, SGW-43746, 74 pp., doi:10.2172/968021.
- Sharma, B., M. E. Apple, X. Zhou, J. M. Olson, C. Dorshorst, L. M. Dobeck, A. B. Cunningham, and L. Spangler, 2014, Physiological Responses of Dandelion and Orchard Grass Leaves to Experimentally Released Upwelling Soil CO<sub>2</sub>: *International Journal of Greenhouse Gas Control*, **24**, 139–148.
- Song, K., X. Zhou, Y. Fan, 2012, Electromagnetic scattering from a multilayered surface with lossy inhomogeneous dielectric profiles for remote sensing of snow: *Progress in Electromagnetics Research M*, **25**, 197-209.
- Song, K., X. Zhou, Y. Fan, 2013, Algorithm for the retrieval of soil moisture from radar backscattering coefficient: *HKIE Transactions*, **20** (2), 124-132.
- Song, K., X. Zhou, and Y. Fan, 2010, Retrieval of soil moisture content from microwave backscattering using a modified IEM model: *Progress in Electromagnetics Research B*, **26**, 383-399.
- Sunwall, D. A., Speece, M. A., and Pekar, S. F., 2012, Advances in on-sea-ice seismic reflection methods using an air gun: McMurdo Sound, Antarctica: *Geophysics*, **77**(1), S19-S30, doi:10.1190/GEO2011-0127.1.
- Hyde, E. R., Speece, M. A., Link, C. A., Repasky, T. R., Thompson, M. D., and Miller, S. F., 2011, A seismic landstreamer survey at the Hanford Site, Washington, U.S.A.: *Environmental and Engineering Geoscience*, **17**(3), 227-239, doi:10.2113/gsegeosci.17.3.227.
- Williams, B. P., Speece, M. A., and Powell, R. D., 2011, A high-resolution, multi-channel, over-sea-ice seismic reflection survey over the Mackay Sea Valley, Granite Harbor, Antarctica: *Marine Geophysical Research*, **32**, 383-395, doi:10.1007/s11001-011-9115-3.
- Zhou, X., M. Apple, L. M. Dobeck, A. B. Cunningham, L. H. Spangler, 2013, Observed response of soil O<sub>2</sub> concentration to leaked CO<sub>2</sub> from an engineered CO<sub>2</sub> leakage experiment: *International Journal of Greenhouse Gas Control*, **16**, 116-128.
- Zhou, X., 2012, Gravity inversion of 2D bedrock topography for heterogeneous sedimentary basins based on line integral and maximum difference reduction methods: *Geophysical Prospecting*, **60** (3), 1-15.
- Zhou, X., V. R. Lakkaraju, M. Apple, L. M. Dobeck, K. Gullickson, J. A. Shaw, A. B. Cunningham, L. Wielopolski, L. H. Spangler, 2012, Experimental observation of signature changes in bulk soil electrical conductivity in response to engineered surface CO<sub>2</sub> leakage: *International Journal of Greenhouse Gas Control*, **7**, 20-29.
- Zhou, X., 2010, Analytical solution of gravity anomaly of irregular two-dimensional (2D) masses with density contrast varying as a 2D polynomial function: *Geophysics*, **75** (2), I11-I19.

### Recently completed M.S. theses:

- Bradley S. Rutherford, M. S., Geophysical Engineering, 2014, *Geophysical Evidence for the Tectonic Development of the Swan Range and Adjacent Basins, Northwestern Montana*.
- Deven R. Vignali, M. S., 2014, Geophysical Engineering, *Seismic Numerical Modeling of Geothermal Resources*.
- Gerard C. Favi, M. S., 2013, Geophysical Engineering, *Fracture Detection of the Elm Coulee Bakken Field using 3D Seismic Methods*.



Montana Tech of the University of Montana  
Geophysical Engineering Department  
1300 West Park Street  
Butte, MT 59701



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