Graduate Study in Geoscience at Saint Louis University

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To help you make an informed decision about graduate schools we are providing this description of our faculty, students, research, and facilities. We are proud of, and excited about, our programs and are confident that after reading this information you will seriously consider joining our group. If you still have questions regarding our program after reading this description, please do not hesitate to contact us. And regardless of where you choose to attend graduate school, we wish you the best of luck and we look forward to seeing you at professional meetings and conferences.

SLU Tradition

Saint Louis University has a long tradition in Geoscience education including fundamental contributions to observational and theoretical Geophysics. Our department was founded by Dr. James B. Macelwane, S. J., an exceptional scientist, influential president of the American Geophysical Union, and the namesake of a prestigious national geophysics award for outstanding young scientists. His successors, who were also outstanding scientists, include Dr. William Stauder, S. J., who made important studies of subduction - zone faulting processes during the development of plate tectonics, and Dr. Otto Nuttli, who made fundamental contributions to our understanding of intra-plate earthquakes including the great 1811-1812 New Madrid, Missouri earthquakes.

Our traditional research strength is in Seismology and Geophysics, and we have more than 50 alumni in the petroleum industry, government agencies, and academia. To address a broader range of inter - and multi-disciplinary research challenges we have expanded our research expertise and developed Master's degree programs in the broader discipline of Geoscience. Our energetic faculty includes two recent hires with expertise in global and forensic seismology, plate tectonics, exploration geophysics and waveform modeling.

Our Faculty

The Geoscience Programs at SLU are part of the Department of Earth & Atmospheric Sciences which includes seventeen faculty. All of our faculty contribute to the research environment and support the infrastructure of our graduate programs. This brochure is focused on the Geoscience Programs. We encourage you to visit our web site to obtain information on our activities in Meteorology. For your convenience we have summarized the interest of our Graduate Geoscience Faculty below and we provide more details in the section that follows.

Faculty Member	Electronic Address	Research Interests
David Crossley	crossley@eas.slu.edu	Temporal variations in gravity, physics of the Earth's core, geophysical fluid dynamics, normal modes, global seismology.
Joachim Dorsch	dorsch@eas.slu.edu	Sedimentary geology, tectonics and sedimentation, environmental geology.
John Encarnación	jpe@eas.slu.edu	Igneous and metamorphic petrology, radiogenic isotope geochemistry, geochronology, regional geology, tectonics.
Robert Herrmann	rbh@eas.slu.edu	Strong ground motion, intraplate earthquake processes, computational techniques in seismology.
David Kirschner	dkirschn@eas.slu.edu	Fluid-rock interaction, structural geology, geochemistry, and geochronology.
Keith Koper	koper@eas.slu.edu	Forensic seismology, structure of Earth's core, geophysical applications of evolutionary computing ideas, global optimization, structure and dynamics of subduction zones, verification seismology.
Timothy Kusky	kusky@eas.slu.edu	Precambrian crustal evolution and continental growth, tectonics, structural geology.
Brian Mitchell	mitchell@eas.slu.edu	Earth structure and evolution, seismic wave propagation and attenuation, seismicity, tectonics.
Lupei Zhu	lupei@eas.slu.edu	Waveform modeling, earthquake source depth distribution, lithospheric structure, and nuclear test detection

Faculty Research Interests

Interesting, high quality research are of utmost importance in a graduate student's education. To help you find out more about our individual research interests, each of us has written a brief summary of some of the details of our current research. Please contact us if you wish to discuss any of our work in more detail.

Dr. David J. Crossley (Professor of Geophysics, Ph.D. University of British Columbia, Earth & Atmospheric Sciences Department Chair)

Research: I am interested in all aspects of the Earth's core and global Earth dynamics. The first topic includes fluid dynamics of the liquid core at all periods from seismology (10s of seconds) to time scales of the magnetic field generation (about 10^4 years) and the motions of the inner core at all possible periods, including the hard - to-detect Slichter triplet. With respect to the magnetic field I have worked on the problem of the reversal mechanism, but not the dynamo field generation mechanism that currently requires sophisticated numerical modeling on supercomputers. In the area of global dynamics of the Earth, I am interested in the seismic free oscillations of the Earth and in the wobble and nutation modes associated with the Earth's rotation. At the present time I am heavily involved in the Global Geodynamics Project (GGP), which is a 6 - year campaign to record and analyze the Earth's global gravity field at all period ranges. While my ultimate goal is to use this data to search for core modes, as they affect gravity, there are many interesting problems that arise in modeling the gravity response to environmental effects such as atmospheric pressure and hydrology. I am willing and eager to supervise students in all of the above subjects.

Research Collaborators: I work most closely with Jacques Hinderer (Institut de Physique du Globe in Strasbourg) and other international colleagues connected with GGP. I have also collaborated recently with the NOAA group in Boulder on the treatment of the data from their superconducting gravimeter. Su Xu, a post-doctoral fellow, worked with me on some of the above problems from 1996-98.

Selected Publications:

Crossley et al. (1998). The Global Geodynamics Project, *submitted to EOS, Transactions of the American Geophysical Society.*

Xu, S. & D. Crossley, (1998). Variations in the Length of Day from inner core gravitational coupling, *submitted to Physics of Earth and Planetary Interiors.*

Xu, S. & D. Crossley (1998). Does gravitational coupling excite inner core super rotation?, *submitted to Physics of Earth and Planetary Interiors.*

Banka, D., and D. Crossley (1998). Noise levels of superconducting gravimeters at seismic frequencies, *submitted to Geophysical Journal International.*

Crossley, D.J., S. Xu, and T. van Dam (1997). Comprehensive analysis of 2 years of SG data from Table Mountain, Colorado, in: *Proc. 13th International Symposium on Earth Tides, Brussels 1997,* 659-668, published by Observatoire Royal de Belgique.

Crossley, D. and J. Hinderer (1995). Global Geodynamics Project – GGP: Status report 1994 in: Proc. 2nd IAG Workshop on non-tidal gravity changes: Intercomparison between absolute and superconducting gravimeters*, Cahiers du Centre European de Geodynamique et de Sismologie, Luxembourg,* **11**, 244-274.

Dr. Joachim Dorsch (Assistant Professor of Geoscience, Ph.D. University of Tennessee)

Research: My research is concentrated in the field of sedimentary geology, its interaction with tectonics, and its application to address environmental problems. Specifically, clastic facies analysis, event stratigraphy and sequence stratigraphy are employed to discern the depositional dynamics and the competing influences of eustatic sea level changes and tectonism on the stratigraphic architecture of foreland-basin deposits. Recent field work is being conducted within the southern and central Appalachians with focus on the Siluro-Ordovician Taconic molasse. A recently established research project is concentrated on possible impact structures in the midcontinental USA and the likely traces these catastrophic "events" left within the stratigraphic record.

Another ongoing research topic is the pore-space characterization of low-permeability sedimentary rocks (mudstone) and their weathering product (mudstone saprolite) using petrophysical measurement techniques. These low-permeability Earth materials are commonly used for the disposal of waste materials. Although hydrogeologists employ manifold modeling techniques, their knowledge of the most crucial parameter, effective porosity, is very often only rudimentary at best. This research is attempting the overcome this deficiency in knowledge. Sedimentary geology techniques are also applied to investigate the architecture and occurrence of

possible flow barriers within clastic aquifers. Research initiated at the Tennessee Valley Authority up until now focused on the alluvial-fluvial depositional system.

Research Collaborators: *Recent collaborators:* Richard K. Bambach, Virginia Polytechnic Institute & State University; RaNaye B. Dreier, Oak Ridge National Laboratory; Steven G. Driese, University of Tennessee; T. J. Katsube, Geological Survey of Canada; Larry D. McKay, University of Tennessee; William E. Sanford, Colorado State University; Peter M. Sheehan, University of Wisconsin-Milwaukee & Milwaukee Public Museum; Gordon D. Wood, AMOCO Production Company; Steven C. Young, Tennessee Valley Authority.

Selected Publications

Dorsch, J., and T. J. Katsube (1998). Porosity characteristics of Cambrian mudrock (Oak Ridge, East Tennessee, U.S.A.) and their implications for contaminant transport. In: Aplin, A. C., and Macquaker, J., eds., Mudrocks at the Basin Scale - Controls and Behaviour. in press*, The Geological Society of London Special Publication.*

Katsube, T. J., J. Dorsch, and S. Connell (1997). Pore-surface area characteristics of the Nolichucky Shale within the Oak Ridge Reservation (Tennessee, U.S.A.): Implication for fluid-expulsion efficiency, *Current Research 1997-E; Geological Survey of Canada*, 117-124.

Dorsch, J., and S. G. Driese (1995). The Taconic foredeep as sediment sink and sediment exporter: Implications for the origin of the white quartzarenite blanket (Upper Ordovician - Lower Silurian) of the central and southern Appalachians, *American Journal of Science*, **295**, 201-243.

Neton, M. J., J. Dorsch, C. D. Olson, and S. C. Young (1994). Architecture and directional scales of heterogeneity of alluvial fan aquifers*, Journal of Sedimentary Research*, **B64**, 245-257.

Dorsch, J., R. K. Bambach, and S. G. Driese (1994). Basin-rebound origin for the "Tuscarora Unconformity" in southwestern Virginia and its bearing on the nature of the Taconic orogeny. *American Journal of Science*, **294**, 237-255.

Dr. John Encarnación (Associate Professor of Geoscience, Ph.D. University of Michigan)

Research: My research is in the area of tectonics, petrology and geochemistry. I use geochronology and the chemistry of rocks to decipher the tectonic and magmatic history of an area. The results of such studies lead not only to a better account of the geologic history of an area, but reveal new insight to processes that have shaped the Earth. In one of my projects we are studying rocks in the Transantarctic Mountains to determine their age as well as their tectonic and geographic setting. This will allow us to evaluate Antarctica's tectonic setting in the Precambrian and test if it was once connected to the ancient North America. It will also help us understand the timing and kinematics of the assembly of the Gondwana supercontinent. In another study we are establishing the timing and structural setting of flood basalts in Antarctica and South Africa. This will hopefully shed light on the origin of flood basalts, their relationship to supercontinent (Gondwana) breakup, and even their significance for mass extinctions. Most recently, I have developed an interest in the problem of subduction initiation. We are addressing this problem from a field, geochemical, and geochronological perspective on the island of Palawan, Philippines, where a young slab of oceanic crust and mantle has preserved the timing and conditions for the initiation of subduction in that area.

Research Collaborators: *Recent collaborators:* Michael Watkeys, University of Natal, South Africa; Anne Grunow, Timothy Paulsen, and David Elliot, Byrd Polar Research Center, Ohio State University; James Mattinson, U.C. Santa Barbara; Larry Snee, U.S.G.S.; Robert Tucker, Washington University.

Selected Publications

Encarnación, J., Mukasa, S.B., and Evans, C., (1999) Subduction components and the generation of second stage melts in the Zambales ophiolite (Philippines): Pb, Sr, Nd isotopic constraints: Chemical Geology, 156, 343-357.

Grunow, A.M. and Encarnacion, J. (2000) Cambro-Ordovician paleomagnetic and geochronologic data from southern Victoria Land, Antarctica: Revision of the Gondwana Apparent Polar Wander Path. Geophysical Journal International, 141, 392-400.

Encarnación, J. and S. B. Mukasa (1997). Age and geochemistry of an 'anorogenic' crustal melt and implications for the origin of I-type granites, Lithos, 42, 1-13.

Encarnación, J. and A. M. Grunow (1996) Changing magmatic and tectonic styles along the paleo-Pacific margin of Gondwana and the onset of early Paleozoic magmatism in Antarctica, *Tectonics*, **15**, 1325-1341.

Encarnación, J., T. H. Fleming, D. H. Elliot, and H. V. Eales (1996). Synchronous emplacement of Ferrar and Karoo dolerites and the early break-up of Gondwana, *Geology*, **24**, 535-538.

Encarnación, J. P., E. J. Essene, S. B. Mukasa, and C. Hall (1995). High-pressure and -temperature kyanite garnet amphibolites generated during initiation of mid-Tertiary subduction, Palawan, Philippines. *Journal of Petrology*, **36**, 1481-1503.

Dr. Robert B. Herrmann (Professor of Geophysics, Ph.D. Saint Louis University)

Research: My recent research emphasis has been directed toward the application of seismology to seismic hazard reduction but I enjoy all aspects of quantitative seismology. Some specific interests include earthquake history, earthquake processes and seismic wave propagation. You might say that I have focused my research on Earth's outer shell, the lithosphere, for my earthquake and Earth structure studies. I have estimated earthquake source parameters using long-period surface-wave spectra and broad-band seismogram modeling using signals recorded at local and regional distances. Recently my students and I have used regional seismic network recordings to examine the propagation of high frequency S-waves in the 10-500 km distance range. I have supervised the operation of our short-period radio-telemetered seismic network and am now installing a 15-station broadband digital network that relies on the Internet for data transmission.

I have a strong interest in numerical computations and I am proud of Computer Programs in Seismology, a collection of tools for seismogram analysis and numerical modeling of wave propagation which are available for MS-DOS and UNIX systems. This compilation has extensive documentation and is the result of software-development and software-modification efforts of many of our graduates. The package provides students and researchers worldwide with the tools for doing modern seismological research. This is especially important because of the advances in data due to modern seismological instrumentation.

Research Collaborators: *Current students:* Young-Soo Jeon, Mohammed Fnais *Recent collaborators:* Glenn Rix, Georgia Institute of Technology; Paul Bodin, University of Memphis; Jaime Yamamoto, Universidad Nacional Autónoma de México, Luca Malagnini and Aybige Akinci, ING Rome, Italy.

Selected Publications

Mokhtar, T.A., C.J. Ammon, R.B. Herrmann and H.A.A Ghalib (2000). Lithospheric structure beneath Arabia *PAGEOPH* (in press).

Missouri Seismic Safety Commission, December, 1999. Earthquakes and Missouri: 1999 Report to the Governor, (editor).

Maceira, M., C.J. Ammon and R.B. Herrmann (2000). Faulting parameters of the September 25, 1998 Pymatuning, Pennsylvania earthquake, *Seism. Res. Letters* **71**, No. 6, pp 742-752.

Akinci, A., L. Malagnini, R.B. Herrmann, N.A. Pino, L. Scognamiglio, and H. Eyidogan (2001). Predictive relationships for the ground-motion in the Erzincan region, vicinity of eastern part of the North Anatolian fault zone (Turkey), *Bull. Seism. Soc. Am.* (in press)

Ortega, R., R.B. Herrmann, L Quintina (2002). High frequency earthquake ground motion scaling in central Mexico, (draft).

Malagnini, L., A. Akinci, R.B. Herrmann, N.A. Pino and L. Scognamiglio (2002). Characteristics of the groundmotion in northeastern Italy (draft).

Dr. David L. Kirschner (Associate Professor of Geoscience, Ph.D. University of Minnesota)

Research: My research is focused on documenting and understanding the interaction of fluids and rocks during deformation of the Earth's crust. I am working primarily on seismogenic strike-slip faults and in fold-thrust belts located along the margins of large mountain belts. To date I have worked on the San Andreas strike-slip fault (California) and on the fold-thrust belts of the Alice Springs Orogen (Australia), Alps (Switzerland), Pyrenees (Spain), Apennines (Italy), and Rocky Mountains (Canada and U.S.). The research involves extensive fieldwork, structural analysis, sample collection, and laboratory analyses. These laboratory analyses are needed to document the mineralogy, meso- and microstructures, and geochemistry (stable isotopes, radiogenic isotopes, elemental chemistry) of the deformed rocks. By combining the results of the structural and geochemical analyses, I hope to document the structural pathways fluids (water, oil, natural gas) use to move through the earth's crust, the relative timing between fluid migration and deformation of the crust, the role fluids play in localizing deformation, and the role fluids play in initiating and facilitating earthquakes.

Research Collaborators: *Current students:* David Cuevas. *Recent collaborators*: Fred Chester, Texas A & M; Judith Chester, Texas A & M; Lori Kennedy, University of British Columbia, Canada; Francesca Ghisetti, University of Catania, Sicily; Livio Vezzani, University of Torino, Italy.

Selected Publications

Kirschner, D. and Kennedy, L. (2001). Limited syntectonic fluid flow in carbonate-hosted thrust faults of the Front Ranges, Canadian Rockies, inferred from stable isotope data and structures. *J. Geophysical Research* 106:8827-8840.

Ghisetti, F., Kirschner, D., Vezzani, L., Agosta, F. (2001). Stable isotope evidence for contrasting paleofluid circulation in thrust faults and normal faults of Central Apennines, Italy. *J. Geophysical Research* 106:8811-8825.

Kirschner, D., Masson, H., and Sharp, Z. (1999) Fluid migration through thrust faults in the Helvetic Alps (Western Swiss Alps). *Contrib Mineral Petrol.* 136, 169-183.

Kirschner, D., M. Cosca, H. Masson, and J. Hunziker (1996). Timing and duration of deformation in low-grade mylonites using staircase $^{40}Ar/^{39}Ar$ spectra, *Geology*, **24**, 747-750.

Kirschner, D., Z. Sharp, and H. Masson (1995). Oxygen isotope thermometry of quartz-calcite veins - unraveling the thermal history of structural events for low metamorphic grades, *Geology Society of America Bulletin*, **106**, 1145-1156.

Kirschner, D., C. Teyssier, R. Gregory, and Z. Sharp (1995). Effect of deformation on oxygen isotope exchange in the Heavitree Quartzite, Ruby Gap duplex, central Australia, *Journal of Structural Geology*, **17**, 1407-1423.

Dr. Keith Koper (Assistant Professor of Geophysics, Ph.D., Washington University)

Research: My current research activities fall into three broad categories. The first is determination of deep Earth structure from analysis of seismic body waves. Such data provide extremely high resolution constraints on interesting problems such as aspherical inner core structure, topography on the inner core-outer core boundary, topography on the core-mantle boundary, possible asphericity in the liquid outer core, and the nature of lower mantle heterogeneities (chemical, thermal, partial melt ?). Second, I work quite a bit on analysis of exotic seismic sources such as truck bomb attacks, pipeline explosion, and submarine accidents. Seismic investigation of such incidents often provides info that is useful to investigative agencies, insurance companies, and the general public. This type of work is known as forensic seismology. Third, I am interested in developing and applying global optimization techniques to geophysical problems. I feel that iterative, matrix methods of inversion will continue to give way to global schemes (such as Monte Carlo methods, genetic algorithms, and simulated annealing) as computational power increases. Most recently I have been applying a niching genetic algorithm to inversion of waveforms and receiver functions for crustal and upper mantle structure.

Research Collaborators: Rick Aster, Susan Beck, Megan Flanagan, Hans Hartse, Bob Reinke, Steve Taylor, Terry Wallace, Doug Wiens, Michael Wysession, George Zandt

Selected Publications:

Al-Eqabi, G.I., K.D. Koper, and M.E. Wysession, Source characterization of Nevada Test Site explosions and Western U.S. earthquakes using Lg waves: Implications for regional source discrimination, Bull. Seismol. Soc. Am., **91**, 140-153, 2001.

Koper, K.D., M.E. Wysession, and D.A. Wiens, Multimodal function optimization with a niching genetic algorithm: A seismological example, Bul. Seismol. Soc. Am., **89**, 978-988,1999.

Koper, K.D., T.C. Wallace, and D. Hollnack, Seismic analysis of the 7 August 1998 truck-bomb blast at the American Embassy in Nairobi, Kenya, Seismol. Res. Lett., **70**, 512-521, 1999.

Koper, K.D. and D.A. Wiens, The waveguide effect of metastable olivine in slabs, Geophys. Res. Lett., **27**, 573-576, 2000.

Koper, K.D., T.C. Wallace, S.R. Taylor, and H.E. Hartse, Forensic seismology and the sinking of the Kursk, EOS Trans., AGU, **82**, pp. 37,45-46, 2001.

Koper, K.D., T.C. Wallace, R.E. Reinke, and A. Leverette, Empirical scaling laws for truck bomb explosions based on seismic and acoustic data, Bull. Seismol. Soc. Am., submitted, 2001.

Dr. Timothy Kusky (Assistant Professor, Ph.D., Johns Hopkins University)

Research: My research is in the areas of tectonics, structural geology, and growth of the continental crust. Two of the main themes of my research are 1) unraveling the evolution of orogenic systems through integrated structural, tectonic, geophysical, petrologic, geochronologic, paleogeographic, and plate kinematic studies, and 2) geodynamic modeling of the role that plate margin processes have played in the growth of continental crust, partly through comparison between the styles of Precambrian and younger orogens and continental margin accretionary processes. I use these data to estimate how plate tectonics, which is the surface expression of planetary heat loss, has evolved from a period of higher heat flow from the early Earth to its present state. This knowledge is essential to our understanding of how the surface and interior of the planet has evolved with time,

and how previous interactions of the lithosphere, atmosphere, hydrosphere, and biosphere have been driven by the fundamental heat loss from the interior of the earth.

I am currently working on Archean rocks from North China, Zimbabwe, the Slave and Superior Cratons of the Canadian Shield, and Proterozoic rocks of the Arabian/Nubian Shield in Egypt, Saudi Arabia, Madagascar, and Oman. Much of my recent work on young orogens has been concentrated on the southern Alaska accretionary margin, which has experienced episodes of subduction of very young oceanic lithosphere, including ridge subduction, and has a suite of rocks that very much resembles those found in Archean granite-greenstone terraines. I have an active NSF- and USGS- funded research program investigating these processes along the Cordilleran margin of North America. In the area, structurally complex greywacke/argillite turbidites, tectonically mixed with basalts and gabbros, are intruded by several generations of tonalitic-granodioritic plutons, and underwent a high temperature, low-pressure metamorphic event. This work serves as a modern analog for processes possibly responsible for the present character of many Archean granite-greenstone terraines. Additionally, I have been working in the Appalachians for more than 10 years.

Research Collaborators: Mohamed El-Shafei and Imbarak Hassan, Suez Canal University; Mohamed Matsah and Mohamed Qari, Kin AbdulAziz University; Mohamed Yehia, Hasan El-Etr, and Mohamed, Ramadan, National Authority for Remote Sensing and Space Sciences, Egypt; Ibrihan Himida and Salal Adel-Mogeeth, Desert Research Center, Cairo; W.C. McLelland, University of Idaho; Jim M. McLelland, Colgate University; Ahmed Al-Malki, Said Al-Hattaly, Alai Al-Marjeby, Said Al Khamisi, Ministry of Water Resources, Sultanate of Oman, Katherine Dietrich and Rachael Huson, St. Louis University.

Selected Publications:

Kusky, T.M., and Polat, A., in press, Growth of Granite-Greenstone Terranes at Convergent Margins and Stabilization of Archean Cratons, invited for Special Issue of Tectonophysics on Tectonics of Continental Interiors, edited by S. Marshak and B. van der Pluijm.

Kusky, T.M., and Bradley, D.C., 1999 Kinematics of melange fabrics: Examples and Applications from the McHugh Complex, Kenai Peninsula, Alaska. Journal of Structural Geology, v. **21**, no. 12, p 1773-1796.

Kusky, T.M., and Hudleston, P.J., 1999, Growth and Demise of an Archean carbonate platform, Steep Rock Lake, Ontario Canada. Canadian Journal of Earth Sciences, v. **36**, p. 1-20.

Kusky, T., and Young, C., 1999, Emplacement of the Resurrection Peninsula phiolite in the southern Alaska Forearc During a Ridge-Trench Encounter, Journal of Geophysical Research, v. **104**, no. B12, p. 29,025-29,054.

Kusky, T.M., 1998, Tectonic setting and terrane accretion of the Archean Zimbabwe craton, Geology, v. **26**, 163-166.

Dr. Brian Mitchell (Professor of Geophysics, Ph.D., Southern Methodist University, Reinert Chair in the Natural Sciences)

Research: My current research utilizes various seismic waves to study the structure and evolution of the Earth's crust and upper mantle. I have measured the attenuation of both fundamental-mode and higher-mode seismic surface waves in various parts of the world and found that the attenuation rate of both types of waves with distance is proportional to the time that has elapsed since the most recent episode of major tectonic or orogenic activity in any region. I am currently developing methods by which regional variations of seismic wave attenuation can be determined on a much finer scale, so that individual fault zones, segments of plate boundaries, sub-surface structure of volcanoes, or other smaller structure can be studied.

I have also recently studied the velocity and attenuation structure of the New Madrid seismic zone. My research of two decades ago (with Cheng-chuan Cheng and Fr. William Stauder) showed that seismic wave velocities were considerably reduced beneath the active portion of the New Madrid seismic zone relative to regions at the same depth outside that zone. More recently Haydar Al-Shukri and I obtained a detailed tomographic velocity map of the New Madrid region and found that seismic velocities were lowest in regions of greatest seismic activity. Lianli Cong, Jorge Mejia and I have measured the dispersion in first-arriving P waves (waves that are usually assumed to be non-dispersive) in the New Madrid region and we will soon be conducting research on methods by which these measurements can be improved. Currently I am investigating methods by which regional variations of seismic-wave attenuation can be measured in oceanic regions.

Research Collaborators: *Current students:* Alemayehu Jemberie, Beshara Sholy, and Hongyi Li. *Recent collaborators*: Andrzej Kijko, Council of Geosciences, South Africa; G.-Akis Iselentis, University of Patras, Greece; Antonio Correig, University of Barcelona, Spain; Zoltan Der, ENSCO Inc., Ray Buland, USGS.

Selected Publications

Cong, L., J. Mejia, and B.J. Mitchell (2000). Attenuative dispersion of P waves in and near the New Madrid seismic zone, *Bull. Seism. Soc. Am*., **90**, 679-689.

Mitchell, B.J., and R. Buland (1999). BILLIKEN, *Seism. Res. Lttrs*., **70**, 341-347.

Mitchell, B.J., and L. Cong (1999). Lg coda Q and its relation to the structure and evolution of continents: A global perspective, in *Q of the Earth: Global, Regional, and Laboratory Studies*, Special Topical Issue of Pure and Applied Geophysics, edited by B.J. Mitchell and B.A. Romanowicz, 655-663.

Mitchell, B.J. (1998). What's under Europe and Asia – Seismic waves map Eurasia's tectonic history, *Science Spectra*, **13**, 56-61.

Mitchell, B.J., Y. Pan, J. Xie, and L. Cong (1998). The variation of Lg coda Q across Eurasia and its relation to crustal evolution, *Journal of Geophysical Research*, **102**, 22767-22779.

Xie, J., B. J. Mitchell, and L. Cong (1996). Complexities in high-frequency seismic waveforms due to three-dimensional structure in the New Madrid seismic zone, *Journal of Geophysical Research*, **101**, 27779-27789.

Dr. Lupei Zhu (Assistant Professor of Geophysics, Ph.D., California Institute of Technology)

Research: Waveform modeling is the seismological tool of choice for providing detailed descriptions of Earth structure, and my interests and specialties lie in utilizing the waveform information carried in regional broadband recordings to image structural features within the Earth's crust and lithospheric mantle. The information about the Earth which can be gleaned from a modern, broadband seismogram is truly prodigious, and my research provides first order information and constraints on all aspects of solid Earth science, including plate tectonics, geodynamics, and the source processes in seismic nucleation and propagation. My interests have revolved around developing new computational techniques which take advantage of the growing ubiquity of broadband arrays and the ever-increasing computational power of desktop computers. With these tools I generate 1-D and 3-D seismic velocity models, determine source mechanisms, and invert waveforms for the fine scale lithospheric structure which are unresolvable with other techniques, such as travel time tomography.

Current research projects include high resolution imaging of deep crustal structure across plate boundary (e.g. the San Andreas Fault), the study of lithospheric structure of the Tibetan Plateau and related tectonics of the India-Eurasia continental collision and determining sedimentary basin structure and estimating strong ground motion produced by big earthquakes. Other projects include rapid earthquake moment tensor determination using regional broadband seismic network, locating earthquake and estimating its magnitude in real-time and generating early warning for damaging earthquake, and nuclear test detection and CTBT verification.

Selected Publications:

L. Zhu, Crustal Structure across the San Andreas Fault, Southern California from Teleseismic Converted Waves, *EPSL* **179**, 183-190, 2000

L. Zhu, H. Kanamori, Moho Depth Variation in Southern California from Teleseismic Receiver Functions, *J. Geophys. Res.* **105**, 2969-2980, 2000

L. Zhu, D.V. Helmberger, Moho offset across the northern margin of the Tibetan Plateau, *Science* **281**, 1170-1172, 1998

L. Zhu, D.V. Helmberger, C.K. Saikia, and B.B. Woods, Regional waveform calibration in the Pamir-Hindu Kush region, *J. Geophys. Res.* **102**, 22799-22813, 1997

L. Zhu and D.V. Helmberger, Advancement in source estimation techniques using broadband regional seismograms, *Bull. Seismol. Soc. Am.* **86**, 1634-1641, 1996

L. Zhu and D.V. Helmberger, Crustal and upper mantle structure of the Tibetan Plateau, in J.F. Lewkowica et al. (eds.), Proc. 18th Annual Seismic Research Symposium on Monitoring a Comprehensive Test Ban Treaty, 1996.

Contacting Our Current Graduate Students for Information

As faculty we can answer many of the questions you may have about graduate school, and we have tried to anticipate some of these by providing the information in this brochure. However, for some information about student life, the intellectual environment, and the quality of our education, you may want to seek the opinions of our students. Here is a list of our current students. Many of these students also maintain a web site with information on themselves and their research. Please feel free to contact them with any questions about our program.

Name	Home	Electronic Address	Current Research Project
Beshara Sholy	Lebanon	sholy@eas.slu.edu	Surface wave attenuation
Alemeyahu Jemberie	Ethiopia	jemberie@eas.slu.edu	Seismic attenuation in the east African Rift system (with Mitchell)
Jorge Mejía	Colombia	mejia@eas.slu.edu	Structure of Tibet
Young-Soo Jeon	South Korea	sooy@eas.slu.edu	High frequency ground motion
Mohammed Fnais	Saudi Arabia	fnaism@eas.slu.edu	Structure of Arabian Plate
Rachael Huson	USA	husonrl@eas.slu.edu	Geochemical analysis of late Archean oceans
Hongyi Li	China	hongyi@eas.slu.edu	Surface wave polarization
David Ceuvas-Miranda	Puerto Rico	dcuevas@eas.slu.edu	Heat-flow constraints of seismogenic faulting
Yusuf Mousa	Saudi Arabia	mousay@eas.slu.edu	Geophysics

Graduate Employment Information

Another way to gauge the success of a graduate program is to examine the positions secured by former graduates. You can find more information on our alumni on our web site but here we list some of their employers to give you an idea where our former students have established careers: Lamont-Doherty Earth Observatory, University of Arkansas, University of Kentucky, University of Barcelona, Ankara University, Shell, Mobil, CONOCO, British Petroleum, Geological Survey of Spain, Multimax Inc, Woodward-Clyde Consultants, Scientific Applications Incorporated, and the Air Force Technical Applications Center.

Research Facilities

Our department maintains a UNIX local area network with about 30+ Sun Microsystems workstations. These machines are equipped with software packages for scientific computing, map construction, and seismogram analysis, as well as tools for software development in Fortran, C, C++, and Java. We also maintain a set of Macintosh and Windows NT microcomputers designed for scientific computing and document/graphics preparation. We have state-of-the-art mineral separation facilities, which include a large jaw crusher and disc mill housed in a room with a dust-collection system; a Wilfley heavy mineral separation table, fume hood and glassware for heavy mineral separation with heavy liquids; Franz magnetic barrier separator; and research-grade petrographic and binocular microscopes. In addition, we have an oxygen isotope extraction line for carbonates. Our most recently hired faculty are in the process of developing research laboratories.

Saint Louis University has a long tradition of seismic observation including a seismogram collection dating back to the early part of the century and involvement in a number of seismic networks. Currently, we are involved in two regional seismometer networks: the BILLIKEN network and the Cooperative New Madrid Seismic Network. Together these regional networks contain about 20 seismometers distributed throughout the central conterminous United States. Data are collected and archived in-house, as part of the IRIS (Incorporated Institute for Seismology) global seismic network, or along with the US Geological Survey's National Seismic Network.

Financial Aid

Without a doubt you are wondering about the costs of a graduate education. In the Geoscience program we customarily provide financial support to those students in the research programs. At present, our research is supported by a number of external agencies including the U.S. Geological Survey, the U.S. National Science Foundation (Geophysics, Tectonics, Polar Research), the Department of Energy, the Defense Special Weapons Agency, and the Petroleum Research Fund. Additional funds from the University help us maintain the equipment necessary for research and support a number of students on teaching assistantships. All of our current full-time graduate students are supported by scholarships which include full-time tuition waivers and approximately $1000 per month plus medical coverage.

How To Contact Us

Please don't hesitate to contact us by email or phone if you have more specific questions about our research and opportunities for graduate study:

Attn: Geoscience Graduate Program Director
Department of Earth & Atmospheric Sciences
Saint Louis University
3507 Laclede Ave
St. Louis, MO 63103
Phone: (314) 977-3131 and Fax: (314) 977-3117
http://www.eas.slu.edu

How To Apply

Formal applications materials are available from the Graduate School, Saint Louis University:

The Graduate School - Saint Louis University
Verhaegen Hall
3634 Lindell Boulevard, Suite 117
St. Louis, MO 63108
Phone: (314) 977-2240 and Fax: (314) 977-3943

You can request an application using the World-Wide Web at:

http://www.slu.edu/colleges/gr/grad03.html