Yu Jeffrey Gu

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Employment

2010-present	Associate Professor of Geophysics	Univ. of Alberta
01/2004-2009	Assistant Professor of Geophysics	Univ. of Alberta
06/2003-05/2004	Lamont-Doherty Postdoctoral Fellow	Columbia Univ.
06/2001-05/2003	Postdoctoral Fellow	Harvard Univ.09/2002
06/2000-12/2000	Half-time Software Engineer	Cambridge Interactive Inc.
09/1994-06/2001	Graduate Research Assistant	Harvard Univ.

Education

2001	Ph.D in Geophysics	Harvard Univ.
2000	Msc. in Computer Science	Harvard Univ.
1996	Msc. in Geophysics	Harvard Univ.
1994	Bsc in Physics	Kenyon College

Research Interests

Main Areas of Research Contribution & Interests:

- Seismic imaging of Earth's deep interior
- Earthquake source mechanisms
- Induced earthquakes due to industrial applications
- Signal processing technologies and applications
- Mantle dynamics and composition
- Ultrasound imaging

Editorial and Synergic Contributions

2014- Associate Editor of ***Journal of Seismology***
2008- Associate Editor of ***Surveys in Geophysics***

Supervision of Highly Qualified Personnel

Overview

In the past 5 years, I have contributed to the training of 4 undergraduate students (A. Alhani; K. Kocon; Yuping Li; R. Schultz, later as an MSc. student), 6 Msc graduate students (Y. An, graduated; S. Contenti, graduated; R. Schultz, graduated; L. Shen, graduated; L. Stieglitz, graduated; Y. Chen, ongoing), 4 PhD student (A. Okeler, graduated; I. V. Rodriguez, graduated;

R. H. Dohkt, ongoing; R. Wang, ongoing) and a postdoctoral fellow (A. Okeler). I am currently sponsoring a visiting Ph.D student (Y. Zhang) from the China Petroleum University. I have also sponsored a geophysics technician (L. Duerksen) on broadband seismic deployment. Several students (6) went on to become geophysicists at major Oil/Gas companies (Alhani, Kocon, An, Stieglitz, Rodriguez, Contenti), while other continued to conductive scientific research with high-impact positions. A. Okeler is now a research fellow at **Harvard University**. R. Schultz and L. Shen are now permanent members of the **Alberta Geological Survey (Alberta Energy Regulations, AER)**. Ruijia Wang (Ph.D) received *the Solid Earth's Section's* **Best Student Presentation Award** in the Canadian Geophysical Union Annual 2014 Meeting for her paper "*Detection and analysis of microearthquakes in Alberta using regional broadband arrays*" (Authors: R.Wang and Y. J. Gu) . I truly take pride in training the multitude of successful HQPs at all levels in the past five years.

TRAINING OF HIGHLY QUALIFIED PERSONNEL (HQP)

Name	**Type of Training**	**Years Supervised (S) or Co-supervised (C)**	**Funding Source**	**Present Status**
Yuanyin Zhang	PhD (exchange Student)	C (S. Z. Sun), 2014-presnet	Chinese Scholarship Council	continuing
Ruijia Wang	MSc	S, 2013-present	NSERC, Helmholtz Alberta Initiative	continuing
Ramin Husseiny	MSc	C (Sacchi), 2012-present	NSERC, UA	continuing
Yunfeng Chen	MSc	S, 2012-present (MSc), will start PhD program at the U of A in Sep, 2014.	NSERC, Alberta Geological Survey	continuing
Luyi Shen	MSc	S, summer 2010-2013	NSERC, UA	graduated, now at Alberta Geological Survey
Ryan Schultz	MSc	S, summer 2010-2012	NSERC, UA	graduated, now at Alberta Geological Survey
Ahmet Okeler	PhD	S, 2005-2011 (Ph.D) 2011 (Postdoctoral Fellow)	NSERC, UA	graduated, now at Harvard University
Sean Contenti	MSc	C (Sacchi), 2008-2012	NSERC, UA, STEP	graduated, now at Imperial Oil.
Ismael Vera	PhD	C (Sacchi), 2008-2012	NSERC	graduated, now at Schlumberger, England
Lauren Stieglitz	MSc	C (Le), 2009-2011	NSERC	

Luyi Shen	BSc	2008, 2009 summers	IW, AI	continuing

Note: *AI = Alberta Ingenuity, UA = University of Alberta matching or start-up funds, STEP=Summer Temporary Employment Program, IW=International Student Work Study Program, SCP=Summer Calling Program*

Most Significant Contributions to Research

1. Broadband Seismic Array in Alberta (CRANE): With the help of technicians and students, our group established the first broadband seismic array in Alberta, Canada. This array is now the backbone for earthquake detection and crust/mantle seismic structure analysis in Alberta, Canada. It now consists of ~30 broadband seismic stations, some are co-owned by the Alberta Geological Survey (AGS) of Alberta Energy Regulator (AER), and is mainly responsible for the detection of induced seismic events in Alberta. This array has been featured more than 20 television and radio appearances (e.g., CBS news, Alberta Primetime TV) as well as featured news articles (the Edmonton Journal, the Tyee). The details of this array and some of its finding could be found in YJ Gu, **A Okeler**, **L Shen**, and **S Contenti**. The Canadian Rockies and Alberta Network (CRANE): New constraints on the Rockies and Western Canada Sedimentary Basin. *Seism. Res. Lett.*,82, 575-588, 2011.

2. YJ Gu, Eds. *Arrays and array methods in global seismology*, 1st Edition, VI, 274 pages, 103 illus., ISBN: 978-90-481-3679-7, Springer, 2010. This is a new book that reviews the assumptions, algorithms and applications of several important methodologies in today's global and regional seismic surveys. A key objective is to review array methods that improve our ability to determine seismic structures across all spatial scales. Contributions from some of the experts in the respective areas include data migration (Rost and Thomas), PP and SS precursors (Deuss), the Radon transform (Gu and Sacchi), mantle triplication (Wang, Wen and Weidner), P-to-S and S-to-P converted waves (Rondenay), shear-wave splitting (Long and Silver), seismic tomography (Boschi, Fry, Ekström and Giardini), and ambient-noise interferometry (Snieder, Miyazawa, Slob, Vasconcelos and Wapenaar). This book has received endorsing reviews by experts in the field of Geophysics, for example,

- *"Arrays – not individual stations – are now seismology's standard observational tool. Here is a book that cogently presents the methods that can turn the resulting explosion of data into creative insights about the Earth."* (William Menke, Professor of Earth and Environmental Sciences, Columbia University).
- *"Dr. Gu has put together both a broad and in-depth source of information on modern array seismology. It is the first source I would recommend for new researchers planning to use that tool."* (Brian Mitchell, Reinert Professor of Earth Sciences, Saint Louis University).

3. Q Liu and YJ Gu. Seismic imaging: from classical to adjoint tomography. *Tectonophys.*, 110, doi:10.1016/j.tecto.2012.07.006, 2012. This is an invited review article by *Tectonophysics* to provide a detailed account of the development, current state and future prospect of seismic tomography. The review, which is 35 journal pages long with a preamble and page index, is dubbed "one of the most comprehensive review of seismic tomography ever written" by both reviewers. This study provided detailed account of the origin of seismic tomography, the key formulations, its connection with medical imaging to the future of adjoint tomography, the most

popular present-day high resolution, accurate approaches. *It was ranked in the top 30 most downloaded articles by Tectonophysics during 2013-2014.*

4. YJ Gu, A. Okeler, and R. Schultz. **Tracking slabs in western Pacific subduction zones. *Earth. Planet. Sci. Lett.*, 331-332, 269-280, 2012.** This study analyzed the mantle reflections from seismic discontinuities and provide a high-resolution, despite relatively long wavelengths, imaging of subduction slabs and dynamics in the western Pacific region. The study provides a new explanation for gaps in seismic reflection at the base of the upper mantle as a consequence of slab penetration. This study compares and contrasts the different styles of convection between Kuril and Honshu slabs and provides explanations for their impact on the regional seismic structure and heat flow. It sheds new lights into the discontinuity topography vs. phase transition relationship and properly accounts for the lack of expected correlation on the global scale. *This article made the list of top 30 most downloaded articles of EPSL in 2012-2013, reaching as high as top 10*.

5. Regional seismic source and structure analysis: A major part of my research efforts in the past few years have centered on the structure of the western Canada sedimentary basin and the induced seismicity in Alberta. A key motivation for this work is the establishment of the CRANE seismic array, which greatly enhances the data coverage in Alberta. Key studies, which rank among the most important studies on regional seismic structure in the past 5 years, are coming into fruition from years of field deployment. An incomplete list includes noise correlation tomography of the crustal structure (***Gu and Shen., 2015a, Geophys. J. Int., Accepted, 2015***), P-to-S converted wave analysis of the crust (***Chen et al., 2015, J. Geophys. Res.***) and mantle (***Gu et al., 2015b, J. Geophys. Res***.), as well array seismology and instrumentation (***Gu et al., 2011, Seism. Res. Lett***.). These studies greatly improves our understanding of the tectonic history as well as the current temperature and composition of the crust in Western Canada Sedimentary Basin.

Our group also collaborated with Alberta Geological Survey (AER) to understand the occurrences and nature of induced earthquakes. ***Schultz et al.* (2014)** represents the first report of induced earthquake in Alberta due to wastewater disposal. A follow-up study is accepted as well on the Crooked Lake earthquake sequence (***Schultz et al., 2015a, b***), which contains the the largest fracking induced earthquake in the world. A number of studies are currently underway in collaboration with the University of Western Ontario and Alberta Geological Survey (Alberta Energy Regulators). These findings accentuate the importance of earthquake monitoring, and will play a critical role in provincial and national energy regulations.

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** List of key collaborators (with published results) in the past 5 years:
Spahr Web, Arthur Lerner-Lam, Mike Steckler (Columbia University), Jeroen Ritsema (University of Michigan), Shu-Huei Hung (Taiwan National University), Ahyi Kim (Yokohama City University), Gail Atkinson (University of Western Ontario), Lawrence Le, Mauricio Sacchi, Dave Eaton (University of Calgary), Dinu Pana, Ryan Schultz (Virginia Stern (Alberta Geological Survey)

Note*: *Highlighted are the names of student authors

Research Contributions and Practical Applications

Practical Applications

The availability of the first Alberta-based array opens up many new opportunities in seismic monitoring, structural analysis, and training of highly qualified personnel. The array has attracted

regional and national attention, as the data and related research projects have been supported and highlighted by the Alberta Geological Survey, Alberta Research Council, and Geological Survey of Canada. **It is the driving force behind the first regional earthquake catalogue as well as the first official, peer-reviewed study (Schultz et al., 2014) on induced earthquake due to wastewater injection in Alberta, Canada.** The network is also critical for regional earthquake (Stern et al., 2013) and microseismicity monitoring (*see collaborative, province-based projects with Alberta Geological Survey [AGS]*). Overall, the analysis of the regional seismic data could improve the knowledge of the history and stability of Alberta, thereby directly impacts the environmental policies and sustained economical growth of Alberta.

The array project presents many opportunities for increasing the public awareness of seismic risks in this region. As an example, some stations are fruitful collaboration between university (U of A), provincial governing body (AGS and Alberta Environment Agency), industry (e.g., Nexen Inc.) and First Nations. It also offers great training opportunities for students (both at the graduate and undergraduate levels), research associates and technicians. The data from the array has been a focus of several summer research projects and possible thesis projects for incoming Msc. students (*see section on Highly Qualified Personnel*). The array has recorded over thousands of earthquakes and mine blast.. Similar seismic methods have recently been applied to bore-hole monitoring (*see thesis project by Ismael Vera)* for risk analysis and seismic source recovery.

Lastly, seismic imaging methods developed by our group have been successfully applied to studies of bone structure using ultrasound (see Le et al., 2010). This represents a major improvement to existing methods in dissecting and utilizing ultrasound waves. Our approach could aid patients with osteoporosis by offering safe diagnosis of bone structure and properties.

Fully Refereed Journal Publications

Y Chen, YJ Gu, **RH Dohkt** and M Sacchi. Crustal imprints of Precambrian orogenesis in western Laurentia. *J. Geophys. Res*., **Revised**, 2015.

YJ Gu, **Y Zhang**, M Sacchi and **Y Chen**. Sharp mantle transition from cratons to Cordillera in southwestern Canada. *J. Geophys. Res.*, **Revised**, 2015.

R Schultz, VH Stern, **M Novakovic**, G. Atkinson and YJ Gu,Hydraulic fracturing and the Crooked Lake sequence: insights gleaned from regional seismic networks. *Geophys. Res. Lett.*, doi: 10.1002/2015GL063455, 2015b.

R Schultz, VH Stern, YJ Gu and DW Eaton. Detection threshold and location resolution of the Alberta Geological Survey earthquake Catalogue. *Seis. Res. Lett.*, 86, doi: 10.1785/0220140203, 2015a.

YJ Gu and **L Shen**. Noise correlation tomography of Southwest Western Canada Sedimentary Basin. *Geophys. J. Int*., 202, 142-162, 2015.

R Schultz, VH Stern and YJ Gu, An investigation of seismicity clustered near the Cordel Field, west central Alberta, and its relation to a nearby disposal well. *J. Geophys. Res*., 119, 3410-3423, DOI:10.1002/2013JB010836, 2014.

R Schultz and YJ Gu. Multi-resolution imaging of mantle reflectivity structures using SS and P'P' precursors. Geophys. J. Int., doi:10.1093/gji/ggt266, 2013a.

VH Stern, V. H., R Schultz, L Shen, YJ Gu and D Eaton, Alberta Earthquake Catalogue, Version 1.0: September 2006 through December 2010, *Open File Report 2013-15*, Alberta Geological Survey, 2013b.

T Tran, **L Stiglitz**, YJ Gu and L Le. Propagation of Ultrasound Guided waves in a bone plate with and without overlying soft tissue. *Ultrasound in Medicine and Biology*, doi:10.1016/j.ultrasmedbio.2013.06.007, 2013c.

R Schultz and YJ Gu. Flexible, inversion-based Matlab implementation of the Radon transform. *Compu. Geosci*., 52, 437-442, 2013d.

IV Rodriguez, M Sacchi, YJ Gu. Compressed domain inversion of the seismic source parameters. *Geophys. J. Int*., doi:10.1111/j.1365-246X.2012.05659.x, 2012a.

YJ Gu, A Okeler and **R Schultz**. Tracking Slabs in Western Pacific Subduction Zones. *Earth. Planet. Sci. Lett*., 331-332, 269-280, 2012b.

Q Liu and YJ Gu. Seismic imaging: from classical to adjoint tomography. *Tectonophysics*, doi:10.1016/j.tecto.2012.07.006, 2012c.

S. Contenti, YJ Gu, A Okeler and M Sacchi. Shear wave reflectivity imaging of Nazca-South America subduction zone: stagnant slab in the mantle transition zone? *Geophys. Res. Lett*., 39, L02310, doi:10.1029/2011GL050064, 2012.

YJ Gu and **L Shen**. Microseismic noise from large ice-covered lakes. *Bull. Seis. Soc. Am*., 102, doi:10.1785/0120100010, 2012.

IV Rodriguez, M Sacchi and YJ Gu. Simultaneous recovery of origin time, hypocenter location, and seismic moment tensor using sparese representation theory. *Geophys. J. Int*., 188, 1188-1202, 2012.

YJ Gu, **A Okeler**, **L Shen**, and **S Contenti**. The Canadian Rockies and Alberta Network (CRANE): New constraints on the Rockies and Western Canada Sedimentary Basin. *Seism. Res. Lett*.,82, 575-588, 2011.

L Le, YJ Gu, **Y Li** and **C Chan**. Probing long bones with ultrasonic body waves. *Appl. Phys. Lett*., 96, 114102, 2010.

IV Rodriguez, MD Sacchi and YJ Gu. Continuous hypocenter and source mechanism inversion via a Green's function-based matching pursuit algorithm. *The Leading Edge*, 29, 334-337; DOI:10.1190/1.3353731, 2010a.

YJ Gu and MD Sacchi, Radon transform methods and their applications in global Seismology. *Surveys in Geophys*., 28 pages, doi: 10.1007/s10712-009-9076-0, 2009.

YJ Gu, **A Okeler**, **K Brzak**, **S Contenti**, **K Kocon** and **L Shen**. Broadband seismic array deployment and data analysis in Alberta, *CSEG Recorder*, Sept., 37-44, 2009b.

A Okeler, YJ Gu, M Steckler and A Lerner-Lam. Seismic structure and anisotropy at the base of the crust beneath the Southern Apennines. *Geophys. J. Int*., 20 pages, doi: 10.1111/j.1365-246X.2009.04229.x, 2009.

YJ Gu, **Y An**, MD Sacchi, **R Schultz**, and J Ritsema. Mantle reflectivity structure beneath oceanic hotspots. *Geophys. J. Int*., 17 pages, doi:10.1111/j.1365-246X. 2009.04242.x, 2009a.

K Brzak, YJ Gu, **A Okeler**, M Steckler and A Lerner-Lam. Migration imaging and forward modeling of microseismic noise sources near southern Italy. *Geochem, Geophys, Geosys*., 17 pages, doi:10.1029/2008GC002234, 2009.

Books and Other Publications

V. Stern and YJ Gu. Documenting Alberta seismicity with Boulder Real Time Technologies (BRTT) Antelope software. *Geohazard5 -- 5th Canadian conference on Geotechnique and natural hazard*, 7 pages, May, 2011.

* YJ Gu, Eds. *Arrays and array methods in global seismology*, 1st Edition, VI, 274 pages, 103

illus., ISBN: 978-90-481-3679-7, Springer, 2010.

A Okeler and YJ Gu. Reflectivity imaging beneath Europe and the Mediterranean region. *Geocanada*, 4 pages, Calgary, May 2010.

D Pana, YJ Gu, MJ Unsworth, **G. Nieuwenhuis**, **A. Okeler** and **L. Shen**. Geomapping for energy and minerals (GEM): New teleseismic and magnetotelluric arrays in Alberta. *GeoCanada*, 4 pages, Calgary, May 2010.

L Shen and YJ Gu. Source and Structure Imaging in Alberta Using Ambient Seismic Wavefields. *Geocanada*, 4 pages, Calgary, May 2010.

IV Rodriguez, MD Sacchi and YJ Gu. Toward a nearly real-time system for event hypocenter and source mechanism recovery via compressive sensing. *SEG, 4 pages*, Calgary, 2010.

YJ Gu. Preface, Special Issue "Arrays and array methods in global seismology." *Surv. Geophys.*, 2009.

******In all of the above, names in bold are those of students.***

Teaching

PHYS 234 - Introductory computational physics
GEOPH 421 – Internal Structure of the Earth
GEOPH 426 – Signal Processing in Seismology
GEOPH 624 – Theoretical Seismology
PHYS 144 - Newtonian mechanics and relativity

Average Teaching Load: 2.5 half-courses per year
Average Student Evaluations: PHYS 234 (4.0/5)
GEOPHYS 224 (3.9/1)
GEOPHYS 421 (4.6/6)
GEOPHYS 426 (4.3/5)
GEOPH 624 (4.6/6)
PHYS144 (4.1/5)

The numbers indicate the average teaching evaluations out of 5 (outstanding).