CENTER FOR WAVE PHENOMENA

Consortium Project on Seismic Inverse Methods for Complex Structures

CWP Faculty, Students and Staff
Spring 2012
The Center for Wave Phenomena (CWP) is an interdisciplinary research and graduate education program in seismic exploration, monitoring and wave propagation. The focus of the program is on seismic modeling, imaging and inversion methods, as well as on improving the accuracy and efficiency of seismic processing algorithms, especially for application to regions of structural complexity.

Part of CWP is the Consortium Project on Seismic Inverse Methods for Complex Structures (“consortium,”) an international group of industry sponsors. We are associated with the Department of Geophysics at the Colorado School of Mines, a public research university dedicated to engineering and applied sciences.

CWP faculty have a broad range of research interests and thrive on solving problems of practical interest to the exploration industry. Over the years, our research directions have expanded to reflect the talents of our faculty and students, as well as to meet the needs and interests of our consortium sponsors. CWP faculty are: Professors Dave Hale (CWP Director), Paul Sava, Roel Snieder and Ilya Tsvankin. University Emeritus Professors and past CWP Directors Norm Bleistein and Ken Larner continue to work closely with CWP.

Our faculty members represent a broad range of research interests. They are: Professors Dave Hale (CWP director), Paul Sava, Roel Snieder and Ilya Tsvankin. University Emeritus Professors and past CWP directors Norm Bleistein and Ken Larner work closely with CWP.

The Center is strongly committed to quality graduate education in geophysics. CWP students form an international group with a large range of study and research interests. Their backgrounds are primarily in earth sciences, applied mathematics, computer science and physics. CWP graduates are recruited for employment by industry, government or academia following the completion of degrees from the Colorado School of Mines.

Our faculty, students, staff and visiting scholars are introduced in this booklet. For additional information regarding the Center and/or the consortium, please contact Pamela Kraus, CWP program assistant, at pkraus@mines.edu or visit our website at http://cwp.mines.edu.
CWP Faculty

Dave HALE - CWP Director

Dave Hale has served as CWP director since June 2011. He returned to the Colorado School of Mines as the Charles Henry Green Professor of Exploration Geophysics in January 2005. He received his B.S. in physics from Texas A&M University and his Ph.D. in geophysics from Stanford University. Dave worked as a field seismologist and research geophysicist for Western Geophysical, as a senior research geophysicist for Chevron, as an associate professor at the Colorado School of Mines, as a chief geophysicist and software developer for Advance Geophysical, as well as a senior research fellow for Landmark Graphics. Dave received the Virgil Kauffman Gold Medal from the Society of Exploration Geophysicists (SEG) for his work on dip-moveout processing of seismic data. He also received the Society of Exploration Geophysicists awards for Best Paper in GEOPHYSICS in 1992 (imaging salt with seismic turning waves) and Best Paper Presented at the Annual Meeting in 2002 (atomic meshing of seismic images).

Paul SAVA

Paul Sava is an Associate Professor of Geophysics and a member of the Center for Wave Phenomena at Colorado School of Mines. He holds an Engineering degree in Geophysics (1995) from the University of Bucharest, an M.Sc. (1998) and a Ph.D. (2004) in Geophysics from Stanford University where he was a member of the Stanford Exploration Project. His main research interests are in wavefield seismic imaging, stochastic imaging and inversion, computational methods for wave propagation, numeric optimization and high performance computing. He is a recipient of a Stanford Graduate Fellowship (1997-2000) from Stanford University and of a Jackson Young Scientist Fellowship (2006-2007) from the University of Texas (Austin). He is also a recipient of three Awards of Merit for best student presentations at the SEG conventions (1999, 2001 and 2004) and of a Honorable Mention in the category Best Paper in Geophysics (2003) for Angle-domain common-image gathers by wavefield continuation methods, co-authored by Sergey Fomel. The Society of Exploration Geophysicists recognized him in 2007 with the Reginald Fessenden Award for his work on wave-equation angle-domain imaging. He is a member of SEG, EAGE, AGU, SIAM and RSG.

Roel SNIEDER

Roel Snieder holds the W. M. Keck Foundation Distinguished Chair in Exploration Science at the Colorado School of Mines. He received a Master’s Degree in geophysical fluid dynamics from Princeton University in 1984 and a Ph.D. in seismology from Utrecht University in 1987. From 1997 to 2000, he was chairman of the Faculty of Earth Sciences at Utrecht University. In 2000, he was elected as a Fellow of the American Geophysical Union (AGU) for important contributions to geophysical inverse theory, seismic tomography, and the theory of surface waves. He has been a member of the Earth Sciences Council of the U.S. Department of Energy from 2003 to 2011. The second edition of his book, A Guided Tour of Mathematical Methods for the Physical Sciences, was published in September 2004. In 2008, Roel worked for the Global Climate and Energy Project at Stanford University on global energy outreach and education. Roel and Ken Larner are co-authors of The Art of Being a Scientist, which was published in August 2009. He serves on the Society of Exploration Geophysicists (SEG) committee, Geoscientists Without Borders, as well as on the Editorial Boards of the Journal of the Acoustical Society of America and the European Journal of Physics. Roel is a foreign member of the Royal Netherlands Academy of Arts and Sciences and he was elected as Honorary Member of the Society of Exploration Geophysicists in 2011. He served as director of CWP from June 2008 to May 2011.
Ilya TSVANKIN

Ilya Tsvankin is a professor of geophysics at the Colorado School of Mines, who served a four-year term (2004-08) as director of CWP. He received his Ph.D. in geophysics from Moscow State University in Russia. Before coming to CWP, Ilya worked as deputy head of the laboratory “Geophysics of Anisotropic Media” at the Institute of Physics of the Earth in Moscow and then as a consultant to Amoco Production Research in Tulsa, OK. His research interests are in seismic wave propagation, fracture characterization, and seismic processing, particularly in developing inversion and processing methods for anisotropic media. The second edition of Ilya’s monograph, *Seismic Signatures and Analysis of Reflection Data in Anisotropic Media*, was published in 2005 by Elsevier. In 2011, he completed a new book, *Seismology of Azimuthally Anisotropic Media and Seismic Fracture Characterization* (SEG, Geophysical References Series), co-authored by his long-time collaborator Vladimir Grechka of Shell. Since 2002, Vladimir and Ilya have been teaching a two-day professional course on seismic anisotropy as part of the SEG Continuing Education Program. Ilya is the recipient of the SEG Virgil Kauffman Gold Medal for outstanding contribution to the advancement of the science of geophysical exploration (1996). In May 2011 he was elected a Fellow of the Institute of Physics (IOP), a leading international physics society.
**University Emeritus Professors**

**Norman BLEISTEIN**

Norman Bleistein was a research leader of the Consortium Project from its inception in 1984 until he retired in 1999, serving as CWP director until 1996. After receiving his Ph.D. in 1965 from the Courant Institute of Mathematical Sciences at New York University, he spent three years as an assistant professor at the Massachusetts Institute of Technology and fourteen years at Denver University before moving to the Colorado School of Mines. After Norm’s retirement from the Department of Mathematical and Computer Sciences in September 1999, he has remained active with CWP as University Emeritus Professor and Research Professor in Geophysics. He continues research in asymptotic analysis of seismic modeling, migration and inversion; his textbook, *Mathematics of Multidimensional Imaging, Migration and Inversion*, co-authored by John Stockwell and Jack Cohen, was published in January 2001. This was his third book, the others being on asymptotic expansions of integrals and on the mathematics of wave phenomena. More recent research has focused on the application of Gaussian beams to modeling, migration and inversion. He visited the University of Karlsruhe as a Senior Alexander von Humboldt American Fellow. In 2005, Norm was awarded the lifetime achievement award of Honorary Membership by the SEG. His presentation at that meeting on modeling with one-way wave equations near caustics was designated as one of the top 25 papers. In 2006, a paper co-authored with Yu Zhang and Guan-quan Zhang received the Best Paper Award in *Geophysics* for 2005. His presentation at the 2008 SEG meeting was ranked among the top 30, the fourth consecutive year for that honor. He continues to present a short course on modeling, migration and inversion with Gaussian beams at the international meetings of the SEG and EAGE and also as a multi-day industrial lab course.

**Ken LARNER**

In 2004, University Professor Emeritus Ken Larner retired as the Charles Henry Green Professor of Exploration Geophysics at the Colorado School of Mines and as CWP director; he remains actively involved with CWP. After receiving his Ph.D. in geophysics from MIT in 1970, he joined Western Geophysical Company where he became vice president for geophysical research in 1979. The recipient of the 1988 Conrad Schlumberger Award of the EAGE, he was Spring 1988 SEG Distinguished Lecturer and SEG president for 1988-89. He received the President’s Award for CSM Outstanding Educator in 1992. In 1996, he received the SEG’s most prestigious honor, the Maurice Ewing Medal. He was the Society of Petroleum Engineers Distinguished Lecturer for 2000-2001. Ken was awarded the P.L. Kapitsa Gold Medal by the Russian Academy of Natural Sciences in 2003. In 2008, he co-authored the book *The art of being a scientist: A guide to graduate students and their mentors* with Roel Snieder.
John STOCKWELL, Jr.

John Stockwell is a research associate with CWP. He is the principal investigator of the Seismic Unix (SU) project, managing the popular CWP/SU open source software package. SU is the world’s first and most widely used open-source seismic research and processing environments. For his work with SU, John was co-recipient with Jack K. Cohen of the 1994 University to Industry Award from the Technology Transfer Society, and was co-recipient of a Special Commendation Award from the Society of Exploration Geophysicists (SEG), with Einar Kjartannson, Shuki Ronen, and Jack K. Cohen (posthumous). John uses SU as the basis of the Seismic Processing Lab course that he teaches each Fall semester and is presently developing a text book on seismic data processing with SU. John is the CWP consortium contact regarding confidential software packages and manages the CWP computer system that includes several types of Linux systems. John is co-author of *Mathematics of Multidimensional Seismic Imaging, Migration and Inversion*, with Norm Bleistein and Jack Cohen. John teaches the graduate level course Mathematics of Seismic Imaging and Migration using this text. John expresses his ongoing passion for mathematics by teaching an informal seminar in Mathematics for Geophysicists. The notes collected from seven years of this provide the basis of a new textbook that John has just started compiling. John received a Distinguished Volunteer Award from the SEG Foundation in 2005 for his Timelines of Geoscience and Geophysics and of Exploration Geophysics and the Petroleum Industry. He is a Special Editor of *Geophysics*, the Wiki Administrator of the new SEG Wiki and sits on several SEG Committees, including the Online Content board and the Historic Preservation Committee.
Shingo Sean ISHIDA - Communications Specialist

Shingo joined the CWP in April 2011, following a five-year tenure for the State of Colorado as a health communications specialist at the Colorado Department of Public Health and Environment. At CWP, he oversees all aspects of CWP’s communications, marketing/public relations, as well as communications with consortium sponsors. Shingo designs CWP publications, including the Consortium Project on Seismic Inverse Methods for Complex Structures annual project review book, CWP research reports, CWP theses, as well as CWP mini-posters for the Society of Exploration Geophysicists (SEG) annual meetings. He is responsible for creating, launching and managing the new CWP website. Outside of work, Shingo enjoys date-nights with his wife Catherine, family time with his wife and 5-month old son Kento, coaching/playing softball in the Colorado State Employee Softball League, riding his motorbike, making frequent use of his BBQ grill, supporting the Colorado Rockies Major League Baseball team despite them charging atrocious prices for their ballpark hot dogs, as well as various outdoor activities, excluding skyaking. “Shingster the Minister of Sinister” hails from Vancouver, Canada. Shingo and his family reside somewhere in Denver’s vast suburbia. He likes dogs, but doesn’t own one.

Pam KRAUS - Program Assistant

Pam manages the Center for Wave Phenomena office and provides administrative, technical and organizational support for the Center. She coordinates all logistics of the CWP Project Review Meeting and the CWP Semi-Annual Meeting, originates Consortium contracts and oversees all Center budget work. Pam still enjoys being on the Classified Employees Association Council at the School of Mines. Pam came to CWP in January 2009 after transferring from the Mathematical and Computer Sciences Department at the Colorado School of Mines. Since April 1982, she worked at Colorado State University in Fort Collins and joined the Colorado School of Mines in August 2003. Pam is a fourth generation Colorado native. In her spare time, Pam enjoys spending time with her husband Dave, her family and friends going to Colorado Rockies baseball games and watching NASCAR.

Diane WITTERS - Writing Consultant

Diane offers technical writing and oral presentation workshops and supports CWP students as they develop into more confident and effective writers, presenters, and collaborators within our diverse international group. She received a Bachelor of Arts degree in cultural anthropology from Principia College in Illinois and completed a graduate field study (organized through Northwestern University) on the Navajo Reservation in Arizona; this consisted of ethnographic research on bilingual/bicultural education within a Native American community. She also earned a Master of Arts in Language Teaching degree from the School for International Training, Vermont, with certification in English as a Second Language, Spanish and Multi-Cultural Education. She is constantly experimenting with ways to balance a full home life of raising teenage sons with an active career. (So far, so good!) Her current professional interests include encouraging cross-cultural sensitivity on campus and helping international graduate students negotiate various transitions to successfully acculturate within a new academic environment. Diane has a passion for wild spaces and slips into the mountains and canyons for trail running, backpacking, canoeing, biking, and cross-country skiing.
### CWP Students

#### Farhad BAZARGANI

**Degree Program:** Ph.D., Geophysics  
**Country:** USA

Farhad received his Bachelor of Science degree in physics and Master of Science degree in geophysics from the University of Tehran. After graduation, Farhad worked for a few years as a geophysicist with WesternGeco and PGS Inc., then he decided to continue his studies at CWP at the Colorado School of Mines. Farhad's CWP advisor is Prof. Dave Hale.

He enjoys classical music, programming, playing the violin, reading, swimming and racquetball.

#### Filippo BROGGINI

**Degree Program:** Ph.D., Geophysics  
**Country:** Italy

Filippo received a Bachelor of Science degree in Telecommunications Engineering from Politecnico di Milano in 2004. He earned a Master of Science degree in 2007 in Applied and Exploration Geophysics from Universita degli Studi di Milano. During his thesis work, he developed software to calculate synthetic seismograms using the reflectivity method. Filippo joined CWP in August 2008 and is working with Professor Roel Snieder. During the summers of 2010 and 2011, he interned with Schlumberger Cambridge Research in the United Kingdom. Filippo's biggest interests are music, travel, computer science and sports. He thinks that Afterhours is the greatest band in the world.

#### Pengfei CAI

**Degree Program:** M.Sc., Geophysics  
**Country:** China

Pengfei completed his Bachelor of Science degree at Tsinghua University in China, where he majored in mathematics and applied mathematics. His thesis described the refined harmonic Arnoldi method for computing interior eigenvalues of large matrices. Advised by Ilya Tsvankin in CWP, Pengfei is currently working on reflection tomography using PP and PS seismic data. His other interests include: basketball, swimming, tennis and climbing. Since arriving in Colorado, he has also acquired an interest in cooking because he never had to cook for himself! Pengfei loves to tell jokes. He likes the following Groucho Marx quote: “Humor is reason gone mad.”

#### Esteban DÍAZ PANTIN

**Degree Program:** M.Sc., Geophysics  
**Country:** Venezuela

Esteban is a geophysical engineer who graduated from the Universidad Simón Bolívar (USB) in Caracas, Venezuela, in 2008. In his undergraduate project, Esteban studied the interaction between South American and Caribbean plates in the northwestern region of Venezuela using tele seismic and gravimetric data. After graduation, Esteban worked in seismic data processing and depth imaging with 3DGeo South America/Stratageo and later, GeolImaging Solutions (GIS). In 2010, he joined the R&D group of GIS and worked on full waveform inversion (FWI). His main interests are: velocity model building, seismic imaging and seismic data processing. At CWP, Esteban continues his work in FWI with his advisor, Paul Sava. Outside geophysics, Esteban enjoys sports, including soccer, tennis and skiing, among others.
CWP Students - continued

Ashley FISH

Degree Program: M.Sc., Geophysics
Country: USA

Ashley graduated from the Colorado School of Mines with a Bachelor of Science degree in geophysical engineering and a minor in McBride Honors Public Affairs. As an undergraduate, she held summer employment with the Aspen Center for Physics, Crystal River Oil and Gas and Cimarex Energy. During the school year, she worked for Cimarex Energy as a Geophysical Analysis Team member and intern. In addition, she enjoyed working as a head student ambassador and resident assistant for CSM. As a member of the CWP Imaging Team, Ashley assisted with the development of an automatic microseismic event detection algorithm for her senior design project. She is excited to have Paul Sava advising her Master of Science research in the field of microseismic imaging. Outside of geophysics, Ashley’s interests include: golf, argentine tango, parkour, self-defense, community volunteering, hiking, travel, foreign languages, cultural immersion, pencil drawing and glider flying.

Clément FLEURUY

Degree Program: Ph.D., Geophysics
Country: France

Clément joined CWP as a visiting scholar in Spring 2009. He completed his Master of Science research project in collaboration with Professor Roel Snieder, while working towards both his “Ecole d’Ingenieur” degree from ESPCI (Ecole Superieure de Physique et Chimie Industrielles) and his Master of Science degree in Physical Acoustics from the University Paris Diderot, in France. Following the successful defense of his thesis in France, Clément returned to CWP in Fall 2009 as a Ph.D. Candidate under Professor Roel Snieder. After completing his first year, he went to the University of Edinburgh during the summer of 2010 for collaborative research. After this fruitful experience, Clément came back to Golden, completed his thesis proposal, and actively worked on advancing his Ph.D. research. During the summer of 2011, he interned at Schlumberger Cambridge Research in England. Back to CWP in Fall 2011, Clément has been focusing his efforts towards the completion of his Ph.D. thesis, while maintaining close collaborations with some industry and academic partners. Clément is expecting graduation during Fall 2012. His hobbies include various sports (volleyball, handball, rugby and skiing, to name a few), live music (including jazz and blues music), traveling, and good food of course!

Oscar JARILLO MICHEL

Degree Program: M.Sc., Geophysics
Country: Mexico

Oscar graduated from Instituto Politécnico Nacional, México, in 2010 with a Bachelor of Science degree in geophysical engineering. While an undergraduate, he participated in the Society of Exploration Geophysicist (SEG)’s 3rd Latin American Challenge Bowl held in Manizales, Colombia, in August 2010. He also took part in the 1st Contest of Earth Sciences Knowledge within the framework of the 50th anniversary of the Union Geofísica Mexicana (UGM) in November 2010. Oscar’s main research interest is seismology, especially theoretical seismology and seismic data processing. His CWP advisor is Ilya Tsvankin.

Nishant KAMATH

Degree Program: Ph.D., Geophysics
Country: India

Nishant Nishant received his Bachelor of Science and Master of Science degrees in geophysics at the Indian Institute of Technology-Kharagpur in 2008. He worked as an On Board Processor for WesternGeco for two years before starting graduate studies at CSM. Nishant is currently working on FWI for layer-cake VTI media to estimate interval velocities and anisotropy parameters from reflection data. He is minoring in mathematics. Nishant’s advisor is Prof. Ilya Tsvankin. His hobbies are hiking, reading, playing tennis and experimenting in the kitchen.
Chinaemerem KANU
Degree Program: Ph.D., Geophysics
Country: Nigeria

Kanu received his Bachelor of Science degree in physics from Michael Okpara University of Agriculture, Nigeria. He then earned a post-graduate diploma in earth system physics at the International Center for Theoretical Physics (ICTP) in Italy. In 2008, Kanu began work on his Master of Science degree in geophysics at Indiana University, Bloomington. His research focused on modeling the creep response of the Southern Hayward Fault to the 1989 Loma Prieta earthquake on the San Andreas Fault. His current research interests are in monitoring time-lapse changes in sub-surface reservoirs and microseismicity. He is currently working with Prof. Roel Snieder, his advisor at CWP. Apart from research, Kanu follows and plays various sports and also explore the beautiful mountains within Colorado.

Allison KNAAK
Degree Program: Ph.D., Geophysics
Country: USA

Ali earned a Bachelor of Science degree in physics and mathematics from Presbyterian College in Clinton, South Carolina in 2010. She is working at CWP with Professor Roel Snieder on applying synthetic aperture to controlled-source electromagnetic (CSEM) data. In Fall 2011, she collaborated with Professor Jen Schneider in the Liberal Arts and International Studies (LAIS) Department at Mines to author a chapter titled, "Fractured Rock, Public Ruptures: The Debate over Hydraulic Fracturing and Gasland." The book is currently under review and will be published in late 2012. All’s academic interests are in improving CSEM, communicating science, mathematics, and physics. Her hobbies are road biking, hiking, playing disc golf, reading and volunteering at the local animal shelter. She loves working, playing, and living near the mountains.

Myoung Jae KWON
Degree Program: Ph.D., Geophysics
Country: South Korea

Jae received his Bachelor of Science degree in geology and Master of Science degree in geophysics from Seoul National University in South Korea. His thesis topic was DC resistivity inversion with the application of reciprocity theorem. Jae worked as a geophysical engineer for several years in Korea and Libya, where he participated in many geotechnical, environmental projects. He is a recipient of the SEG scholarship. In summer 2008, he interned at Schlumberger-Doll Research Center and then he interned with ExxonMobil Upstream Research Company in summer 2010. His current research interests are the integration of seismic and electromagnetic data and the application of inverse scattering series for CSEM. Jae’s advisor is Roel Snieder. Jae enjoys listening to music, programming, as well as reading geography and history books.

Luming LIANG
Degree Program: Ph.D., Mathematical and Computer Sciences
Country: China

Luming received his Bachelor of Science (2005) and Master of Engineering (2008) degrees in Computer Science from Central South University, Changsha, China. Luming joined CWP in August 2008 and he is working with Dave Hale, his CWP advisor, in seismic data interpolation, computer graphics and seismic image processing. Luming interned in summer 2009 with Landmark Graphics/Halliburton. Luming’s biggest interests are: playing soccer, reading, listening to music, watching movies and playing computer games with others.
Simon LUO
Degree Program: Ph.D., Geophysics  
Country: USA

Simon graduated from the University of California, Berkeley, with a Bachelor’s degree in physics. He joined CWP in August 2009 and is working with Prof. Dave Hale. His research interests include image processing, seismic imaging and velocity model building, and high-performance computing. In summer 2011, Simon interned with Transform Software in Littleton, Colorado. He enjoys traveling, reading, snowboarding, and golf.

Yong MA
Degree Program: Ph.D., Geophysics  
Country: China

Yong received his Bachelor of Science and Master of Science degrees in acoustics in 2004 and 2007, respectively, from the Institute of Acoustics, Nanjing University (NJU), China. His thesis work at NJU focused on nonlinear ultrasound propagation in biologic tissue and applications of nonlinear ultrasound to medical imaging and therapy. Yong joined CWP in August 2007 and has worked on multi-scale velocity heterogeneity effects on wave-equation migration with Paul Sava. He is working on image-guided full waveform inversion under his current advisor Dave Hale. In summer 2009, 2010 and 2011, Yong interned at ConocoPhillips in Houston, Texas, to work with geophysicists in the Seismic Velocity Modeling group on a full waveform inversion project.

Andrew MUÑOZ
Degree Program: M.Sc., Geophysics  
Country: USA

Andrew graduated from Texas A&M University in December 2010 with a Bachelor of Science degree in Geophysics. While at Texas A&M, Andrew participated in undergraduate research involving potential field geophysics and three-dimensional tsunami modeling using GPUs. He held an internship with Devon Energy and two internships with Newfield Exploration as a geophysicist. Andrew accepted a full-time offer to work at Newfield Exploration as a geophysicist upon completion of his Masters degree at the Colorado School of Mines. Andrew’s hobbies include: running, swimming, cycling, ultimate frisbee, hiking, snowboarding, and cooking.

Norimitsu (Nori) NAKATA
Degree Program: Ph.D., Geophysics  
Country: Japan

Nori received his Bachelor of Engineering (2008) and Master of Engineering (2010) degrees from Kyoto University. During 2008 to 2010, he interned at JGI, Inc. in Japan for total 6 months for a carbon capture and storage (CCS) project. He was a research fellow of the Japan Society for the Promotion of Science (JSPS) in 2010-2011 and worked for developing the method to monitor the velocity structure throughout Japan by applying seismic interferometry to earthquake records. After twice visiting CWP (January - March 2009 and August 2010 - October 2011), he returned to CWP as a Ph.D. student in Spring 2012. His research topics are across exploration geophysics and crustal seismology using seismic interferometry, and his advisor is Prof. Roel Snieder. His hobbies are skiing, basketball, and playing the violin.
Natalya PATRIKEEVA
Degree Program: undeclared
Country: Russia

Natalya studied geophysics at Rice University in Houston, Texas. She held summer internships at the National Aeronautics and Space Administration (NASA) and the Search for Extraterrestrial Intelligence (SETI) Institute, where her project was to study carbonates on Mars. Natalya participated at the 2009 Society of Exploration Geophysicists (SEG) meeting in Houston, Texas with Halliburton. She will be working with Ilya Tsvankin at the Center for Wave Phenomena. Natalya's professional interests range from developing new geophysical software, seismic anisotropy, inversion problems, physics of earthquakes to energy policy and space exploration. Her favorite activities include: rock climbing, running, sailing and completing biathlons. She also loves traveling around the globe, cooking, Russian literature, science-fiction, graphic novels, live music concerts, ska, folk, Spanish guitar music and Bob Dylan.

Francesco PERRONE
Degree Program: Ph.D., Geophysics
Country: Italy

Francesco received his Bachelor of Science degree in telecommunication from Politecnico di Milano, Italy, in 2004, from where he also earned a Master of Science degree in 2007. During his master’s studies, he worked with the geophysical research team and his thesis dealt with high-resolution imaging in Kirchhoff migration by means of least-squares inversion and sparsity constraint. Francesco joined CWP in August 2008 under advisor Paul Sava. In CWP he has worked on shot-encoding for fast wave-equation depth migration and his current interests are in numerical modeling and migration velocity analysis. During the summers of 2009 and 2010, he worked in Milan at Eni S.p.A. on his research project on migration velocity analysis in the shot-domain. Included in Francesco’s interests are listening to and playing classical music, swimming and reading novels.

Bharath SHEKAR
Degree Program: Ph.D., Geophysics
Country: India

Bharath graduated in 2008 from the Indian Institute of Technology, Kharagpur, with an Integrated Master of Science degree in exploration geophysics. He joined CWP in August 2008 and is working with Prof. Ilya Tsvankin. Past projects at CWP included the estimation of interval shear-wave anisotropic attenuation in VTI and orthorhombic media using the PP + PS =SS and velocity-independent layer stripping methods. His current project is titled “Attenuation estimation for heterogeneous transversely isotropic media.” His other research interests are VSP, microseismic and surface seismic imaging/processing. He has interned with ExxonMobil Upstream Research Center where he worked on multicomponent processing.

Satyan SINGH
Degree Program: Ph.D., Geophysics
Country: Trinidad and Tobago

Satyan graduated from the University of West Indies in 2008, with a Bachelor of Science degree in petroleum geosciences. While an undergraduate, he had a summer internship with BP Trinidad and Tobago, which was followed by his employment as an exploration geophysicist at BG Group Trinidad and Tobago. After one year of employment in the oil and gas industry, he decided to pursue a Master of Science degree in geophysics at Texas A&M University. Satyan joined CWP in August 2011 and his advisor is Prof. Paul Sava. His current research interests are high performance computing and seismic imaging. Apart from academic research, Satyan enjoys playing table tennis, cricket and football.
Steven SMITH

Degree Program: Ph.D., Geophysics
Country: USA

Steve holds a Master of Science degree in Acoustics from Penn State (his thesis was titled “Wavenumber-domain virtual acoustic source synthesis”). He received his Bachelor of Science and Bachelor of Arts degrees, respectively, in Engineering Physics and Music (saxophone), from the University of Colorado. Steve worked as an R&D engineer on intelligent beam formers and speech recognition systems for Shure microphones and audio electronics and as a professional seismic analyst for the Theoretical Geophysics Group at the University of Colorado, Boulder. While at CWP, Steve interned with CGGVeritas and ExxonMobil Upstream Research, working on multicomponent modeling, and anisotropic inversion of reflection and VSP data. His previous CWP research includes modeling and waveform/velocity inversion around superheated nuclear waste disposal tunnels. He is currently working on compaction-induced (time-lapse) anisotropic seismic signatures, and seismic-based stress/strain inversion for producing reservoirs. Steve’s interests also include migration/imaging and seismic applications of rock physics. His advisor is Ilya Tsvankin and his co-advisor is Roel Snieder. When not working, Steve practices judo.

Xiaoxiang WANG

Degree Program: Ph.D., Geophysics
Country: China

Xiaoxiang earned his Bachelor of Science and Master of Science degrees in geophysics from the University of Science and Technology of China (USTC). He joined CWP in August 2006, and has worked with Prof. Ilya Tsvankin on some projects of parameter estimation for anisotropic media. In summer 2008, Xiaoxiang interned with Chevron Energy Technology Company, where his work involved testing and streamlining workflows of anisotropic tomography. He also interned with the Subsurface Technology group at ConocoPhillips in summer 2009, and his internship experience there helped to kick off his Ph.D. thesis study on tomographic velocity analysis in TTI media. After he graduates from CWP, he will start working at Shell. During his spare time, Xiaoxiang enjoys playing tennis and ping-pong, swimming, and hiking and skiing in colorful Colorado.

Tongning (Tony) YANG

Degree Program: Ph.D., Geophysics
Country: China

Tongning earned his Bachelor of Science degree in geophysics from Tongji University, Shanghai, China. During his undergraduate study, he completed a project on velocity analysis using Kirchhoff prestack time migration. His thesis was titled “High-resolution Parabolic Radon Transform Seismic Interpolation.” At CWP, he is working with Prof. Paul Sava on wave-equation migration velocity analysis (WEMVA), using extended imaging conditions. In summer 2009, Tongning interned with Statoil in Norway, working on the implementation of WEMVA based on the time-shift imaging condition. In summer 2010, Tongning interned with ConocoPhillips in Houston. His project mainly focuses on differential semblance optimization with common-image-point gathers. In his spare time, Tongning likes climbing, swimming and playing soccer. He also loves to cook, especially Chinese food.
CWP Visitors

**Michael BEHM**  
Country: Austria  

Michael is a post-doctoral CWP student who received his Master of Science (2002) and Doctor of Philosophy (2006) degrees from the Technical University of Vienna, where he also held a post-doctoral position until April 2011. His research work included modeling of the crustal and upper mantle structure based on active and passive seismic data, as well as near surface studies with ground penetrating radar. He also gave lectures on seismic processing and held courses in applied geophysics. He moved to the Colorado School of Mines in the summer of 2011 to work with Roel Snieder in an Exxon-funded project, which focuses on passive seismology. Michael enjoys hiking, backcountry skiing, caving and music.

**Jyoti BEHURA**  
Country: India  

Jyoti graduated from the Indian Institute of Technology, Kharagpur, with a Bachelor of Science degree and a Master of Science degree in Exploration Geophysics. As he was not yet done with the student lifestyle, he decided to pursue a Ph.D. degree with CWP at the Colorado School of Mines. For his doctoral thesis, he worked with Prof. Ilya Tsvankin on the “Estimation and analysis of attenuation anisotropy.” During his time at CWP, Jyoti also worked with Prof. Roel Snieder on seismic interferometry. He also spent a year in the basement of the Green Center at CSM with Prof. Mike Batzle, crushing unconventional hydrocarbon rocks where he simultaneously discovered that geophysics can be fun. After graduating from CSM, Jyoti joined the Advanced Seismic Imaging Team at BP America Inc. in Houston, Texas, where he collaborated with Uwe Albertin on developing waveform inversion and parameter estimation in anisotropic media. Jyoti returned to CWP in October 2011 as a post-doctoral fellow to further his research interests. His current research interests revolve around waveform inversion, internal multiple prediction and microseismicity. When he is not geeked out, Jyoti spends his time with Farnoush and Shayan playing tennis, hiking, golfing, salsa-ing, skating or skiing.

**Hongxun PAN**  
Country: China  

Hongxun received his Bachelor of Science degree in Geological Survey and his Master of Science degree in Structural Geology (2000) from Jilin University, China. His thesis was on the structural characteristics and evolution of the Altun fault zone. During his graduate work, he did some geological research in Tibet and on the QiLian Mountain orogenic belt. Hongxun has worked as a geophysical engineer for eleven years at China Petrochemical Corporation (SINOPEC), where he participated in projects related to relative refraction static, MPI parallel computation, velocity analysis, migration velocity model building, etc. Currently, he is focusing on research in migration velocity analysis and model building and pre-stack time/depth migration imaging application in complex areas. For six months in 2011-2012, he is a visiting scholar at CWP, working with Profs. Roel Snieder and Paul Sava on migration velocity model building. Hongxun’s interests include table tennis, basketball, travel, music, reading, running and climbing.

**Kaoru SAWAZAKI**  
Country: Japan  

Kaoru received his Master of Science and doctorate degrees in geophysics from Tohoku University, Japan, in 2007 and 2010, respectively. He is currently a postdoctoral fellow of the Japan Society for the Promotion of Science (JSPS) and is affiliated with the National Research Institute for Earth Science and Disaster Prevention (NIED). He was a visiting scholar at CWP from April to May 2011 and he will visit CWP again from September 2011 for about one year. During his visit at CWP, he collaborates with Roel Snieder and the researchers of the National Earthquake Information Center (NEIC). His research interest lies with seismology, especially on earthquake source and earth structure revealed from high-frequency seismic records. Kaoru enjoys a simple and slow lifestyle and being surrounded by nature.
CWP Visitors - continued

Cornelis (Kees) WEEMSTRA

Country: The Netherlands

Kees received his Bachelor of Earth Sciences (majoring in Geology/Geophysics) and Master of Geophysics degrees from Utrecht University in 2007 and 2010, respectively. His Master's degree research was conducted at the Royal Netherlands Meteorological Institute (KNMI) and it focused on the array analysis of low frequency atmospheric sound (also called infrasound). He then used this infrasound research to study the calving behavior of glaciers in Greenland. Kees is currently enrolled as a Ph.D. student in the geophysics program at the Swiss Federal Institute of Technology (ETH) in Zurich, Switzerland. While visiting at CWP, Kees works with Professor Roel Snieder on surface waves obtained from ambient noise cross-correlations, mainly focusing on the ability to obtain estimates of anelastic attenuation. His project is supported by Spectraseis as a partner institution within the European Commission-funded ‘QUantitative Estimation of Earth's Seismic Sources and STructure’ (QUEST) Initial Training Network. Kees' hobbies include various sports, including: soccer, skiing and cycling, as well as literature and backpacking.

CWP Undergraduate Students

Johannes DOUMA

Degree Program: B.Sc., Geophysical Engineering
Country: The Netherlands

Johannes is an undergraduate in Geophysics at the Colorado School of Mines. His strong interest in wave phenomena research led him to join the Center for Wave Phenomena. Johannes' advisor is Prof. Roel Snieder and his co-advisor is Prof. Paul Sava. He recently finished a project on optimization of time reversal focusing through deconvolution for acoustic waves with Roel Snieder and Los Alamos National Laboratory researchers TJ Ulrich and Brian E. Anderson. Johannes is currently working on applying his deconvolution method to microseismic event locating with Roel Snieder and Paul Sava. In his free time, Johannes likes to mountain bike, wakeboard, surf and play soccer.

Detchai (Pock) ITTHARAT

Degree Program: B.Sc., Geophysics
Country: Thailand

Pock is a sophomore student in the Geophysics department at the Colorado School of Mines with a minor in Mathematic and Computer Science. He received a scholarship to attend the Mines from PTT Exploration and Production Public Company, Ltd. (PTTEP), the exploration and production oil and gas company of Thailand. His research interest is in wavefield seismic imaging and inversion methods. Pock is employed by CWP as a research assistant in the I-(Imaging) team, working with Paul Sava on the Foundations of Radar and Seismic Imaging of Asteroids and Comets, a NASA-funded project. During the school year, Pock keeps himself busy as a Mines Associated Student Representative and as a Resident Assistant at Maple Hall, a campus dormitory. Outside of school, Pock loves to play classical guitar, swim, play basketball, soccer and go snowboarding in Colorado's mountains.
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