

STEVEN HARDER

Dept. of Geological Sciences
University of Texas at El Paso
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Professional Education:

University of Texas at El Paso, Geophysics, D.Sc. 1986

Dissertation Topic: Inversion of Seismic Velocities for the Anisotropic Elastic Tensor

University of Wyoming, Geology, M.S. 1985

Thesis Topic: Interpretation of wide-angle reflections beneath the Green River Basin,
Wyoming

New Mexico State University, Geological Engineering, B.S. 1976; Surveying, B.S. 1996

Professional Licenses: Professional Geophysicist (License # 3956, Texas), Professional Geologists (License # PG002137)

Professional Societies:

American Geophysical Union, Seismological Society of America, Society of Exploration Geophysicists

Professional Appointments:

10/2013-present Director of the National Seismic Source Facility, Univ. of Texas at El Paso.

9/1996-present Director of the J.W. Miller Geophysical Lab, Univ. of Texas at El Paso.

1/2012-present Research Professor, Univ. of Texas at El Paso.

6/1994-12/2011 Research Specialist, Univ. of Texas at El Paso.

1/1988-6/1994 Visiting Assistant Professor at Texas A&M Univ.

Research Areas: Crustal wide-angle reflection/refraction, explosive seismic source phenomenology, crustal structure in Southeast Asia, East Africa, and western North America, and anisotropic elastic wave propagation.

Service: I spend a large portion of my time supporting the research of others by managing a facility with controlled seismic source instrumentation. I also contribute unique skills to the sources used in controlled source seismology.

Courses Taught: Earthquake Seismology, Introductory Geophysics, Advanced General Geophysics, Engineering Geology, Plane Surveying, Mechanics and Thermodynamics for Engineers (calculus treatment)

Publications:

- Rose, E.J., G.S. Fuis, ... , S.H. Harder, **2013**, Borehole-explosion and air-gun data acquired in the 2011 Salton Sea Seismic Imaging Project (SSIP), southern California: description of survey: Open-File Report 2013-1172, DOI: 10.3133/ofr20131172.
- Hayes, J.L., W.S. Holbrook, D. Lizarralde, H.J.A. van Avendonk, A.D. Bullock, M. Mora, S. Harder, G.E. Alvarado, and C. Ramirez, **2013**, Crustal structure across the Costa Rican volcanic arc: *Geochem., Geophys., Geosystems.*, v. 14, pp. 1087-1103.
- Cox, C., G.R. Keller, and S.H. Harder, **2013**, A controlled-source seismic and gravity study of the High Lava Plains (HLP) of Eastern Oregon: *Geochem., Geophys., Geosystems.*, v. 14, pp. 5208-5226.
- Miller, K.C., L.L. Worthington, S. Harder, S. Phillips, H. Hartse, and A.F. Sheehan, **2012**, Assessment of regional explosion discriminants using data sets of unparalleled spatial sampling: *Air Force Research Lab. RV-PS-TR-2012-0228* 46 p.
- Zhaohui, Y., A.F. Sheehan, W.L. Yeck, K.C. Miller, E.A. Erslev, L.L. Worthington and S.H. Harder, **2012**, Imaging basin structure with teleseismic virtual source reflection profiles: *Geophy. Res. Letters*, v. 39, no. 2.
- Stephenson, A.L., G.D. Spence, K. Wang, J.A. Hole, K.C. Miller, R.M. Clowes, S.H. Harder and G.M. Kaip, **2011**, Crustal velocity structure of the southern Nechako basin, British Columbia, from wide-angle seismic traveltime inversion: *Can. J. Earth Sci.*, v. 48, pp. 1050-1063.
- Harder, S. and V.T. Dinh, **2011**, Collecting deep seismic data in densely populated Vietnam: *Eos*, v. 92, no. 3, p. 21-22.
- Cox, C.M., G.R. Keller, S.H. Harder, and S. Klemperer, **2010**, Raytrace models from the High Lava Plains (HLP) controlled-source experiment, *Seismo. Res. Lett.* 81(2), p.332.
- Hrubcova, P., P. Sroda, M. Grad, W.H. Geissler, A. Guterch, J. Vozar, E. Hegedus, ... S. Harder, ..., **2010**, From the Variscan to the Alpine Orogeny: crustal structure of the Bohemian Massif and the western Carpathians in the light of the SUDETES 2003 seismic data: *Geophy. J. Inter.* v. 183, pp. 611-633.
- Van Avendonk, H.J.A., W.S. Holbrook, D. Lizarralde, M.M. Mora, S. Harder, A.D. Bullock, G.E. Alvarado, and C.J. Ramirez, **2010**, Seismic evidence for fluids in fault zones on top of the subducting Cocos Plate beneath Costa Rica: *Geophy. J. Inter.* v. 181, pp. 997-1016.
- Grad, M., E. Bruckl, M. Majdanski, M. Behm, A. Guterch, ... S. Harder ..., **2009**, Crustal structure of the Eastern Alps and their foreland: Seismic model beneath the CEL10/Alp04 profile and tectonic implications: *Geophy. J. Inter.* v. 177, pp. 279-295.
- Tanio, Ito, Y. Kojima, S. Kodaira, H. Sato, Y. Kaneda, Takayalwasaki, E. Kurashimo, N. Tsumura, A. Fujiwara, T. Miyauchi, N. Hirata, S. Harder, K. Miller, A. Murata, S. Yamakita, M. Onishi, S. Abe, T. Sato and T. Ikawa, **2009**, Crustal structure of southwest Japan, revealed by the integrated seismic experiment Southwest Japan 2002: *Tectonophysics*, v. 472, pp. 124-134.
- Velasco, A.A., V.L. Gee, C. Rowe, D. Grujic, L.S. Hollister, D. Hernandez, K.C. Miller, T. Tobgay, M. Fort, and S. Harder, **2007**, Using small, temporary seismic networks for investigating tectonic deformation: brittle deformation and evidence for strike-slip faulting in Bhutan: *Seismo. Res. Lett.* v. 78, pp. 446-453.

- Grad, M., A. Guterch, G.R. Keller, E. Brueckl, ... S. Harder, K.C. Miller, **2007**, Variations in lithospheric structure across the margin of the Baltica in central Europe and the role of the Variscan and Carpathian orogenies: *Memoir Geol. Soc. Am.*, v. 200, pp. 341-356.
- Majdanski, M., E. Kozlovskaya, M. Grad, ... S. Harder, ..., **2007**, 3D structure of the Earth's crust beneath the northern part of the Bohemian Massif: *Tectonophysics*, v. 437, pp. 17-36.
- ten Brink, U.S., A.S. Al-Zoubi, C.H. Flores, Y. Rotstein, I. Qabbani, S.H. Harder, G.R. Keller, **2006**, Seismic imaging of deep low-velocity zone beneath the Dead Sea basin and transform fault: Implications for strain localization and crustal rigidity: *Geophys. Res. Lett.*, v. 33, L24314, doi: 10.1029/2006GL027890.
- Maguire, P.K.H., G.R. Keller, S.L. Klemperer, G.D. Mackenzie, K. Keranen, S. Harder, B. O'Reilly, H. Thybo, L. Asfaw, M.A. Khan, and M. Amha, **2006**, Crustal structure of the northern Main Ethiopian Rift from the EAGLE controlled-source survey; a snapshot of incipient Lithospheric break-up: *Geol. Soc., London, Spec. Pub.*, v. 259, p. 269-291.
- Majdanski, M., M. Grad, A. Guterch, ... S. Harder, ..., **2006**, 2-D seismic tomographic and ray tracing modeling of the crustal structure across the Sudetes Mountains basing on SUDETES 2003 experiment data: *Tectonophysics*, v. 413, pp. 249-269.
- Bleibinhaus, F., E. Brueckl, M. Behm, W. Chwatal, F. Kohlbeck, E.-M. Rumpfhuber, C. Ullrich, ... S. Harder, C.M. Snelson, **2006**, Wide-angle observations of ALP 2002 shots on the TRANSALP profile: Linking the two DSS projects: *Tectonophysics*, v. 414, pp. 71-78.
- Brueckl, E., U. Mitterbauer, M. Behm, ... S. Harder, ..., **2006**, Studies on the crustal structure and gravity in the Eastern Alps: *Geodetic Def. Monitoring: From Geophys. to Engineering Roles*,
- Sato, H., K. Yuji, M. Akihiro, I. Tanio, K. Yoshiyuki, O. Masazumi, ... S. Harder, ..., **2005**, Crustal structure of the outer zone in Southwest Japan revealed by Shikoku and Seto-Inland-Sea seismic profiling in 2002: *Bull. Earthquake Res. Inst., Univ. of Tokyo*, v. 80, pp. 53-71.
- Bonner, J.L., B. Stump, M. Leidig, X. Yang, R. Zhou, T.S. Kim, W.R. Walter, A. Velasco, C. Hayward, D. Baker, C.L. Edwards, S. Harder, H. Hooper, T. Glenn, C. Zeiler, R. Gok, J. Britton, and J.F. Lewkowicz, **2005**, Source phenomenology experiments in Arizona: in 27th *Seismic Research Review: Ground-Based Nuclear Explosion Monitoring Technologies*.
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- Malinowski, M., A. Zelazniewicz, M. Grad, A. Guterch, T. Janik, W. Czuba, E. Gaczynski, P. Sroda, S. Harder, G.R. Keller, **2005**, Seismic and geological structure of the crust in the transition from the Baltica to Palaeozoic Europe in SE Poland—CELEBRATION 2000 experiment, profile CEL02: *Tectonophysics*, v. 410.
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- Guterch, A., M. Grad, A. Spicak, E. Brueckl, E. Hegedus, G.R. Keller, H. Thybo, ... S. Harder, **2003**, An overview of recent seismic refraction experiments in Central Europe: *Studia Geophysica et Geodaetica*, v. 47, pp. 651-657.
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- Brocher, T. M., T. L. Pratt, K. C. Miller, A. M. Trehu, C. M. Snelson, C. S. Weaver, K. S. Creager, R. S. Crosson, U. S. ten Brink, M. G. Alvarez, S. H. Harder, and I. Asudeh, **2000**, *Report for Explosion and Earthquake Data Acquired in the 1999 Seismic Hazard Investigation of Puget Sound (SHIPS), Washington, U.S. Geol. Surv. Open- File Report 00-318*.
- Harder, S. and G.R. Keller, **2000**, Crustal structure determined from a new seismic profile in wide-angle southwestern New Mexico: *New Mexico Geol. Soc., Guidebook, 51st Field Conference*, pp. 75-78.
- Guterch, A., M. Grad, H. Thybo, G.R. Keller, W. Czuba, ... S. Harder, ..., **1999**, POLONAISE '97 – International seismic experiment between Precambrian and Variscan Europe in Poland: *Tectonophysics*, v. 314, pp. 101-121.
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- Keller, G.R., B.S. Penn and S.H. Harder, **1998**, Las Cruces Country: A geophysical and remote sensing perspective: *New Mexico Geol. Soc., Guidebook, 49th Field Conference*, pp. 87-91.
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- McCabe, R., S. Harder, J.T. Cole and E. Lumadyo, **1993**, The use of paleomagnetic studies in understanding the complex Tertiary tectonic history of East and South Asia: *J. Southeast Asian Earth Sci.*, v. 8, pp. 257-268.
- Harder, S.H., S.J. Mauri and S. Marshall-Arrazola, **1993**, Gravity modeling of extensional basins in Southeast Asia: *Geol. Soc. Malaysia, Bull.* 33, pp. 153-162.
- Keller, G.R., L.W. Braile, P.M. Davis, R.P. Meyer, W.D. Mooney, and the KRISP Working Group, **1992**, Kenya Rift International Seismic Project, 1989-1990 Experiment: *Eos*, v. 73, no. 33, pp. 345-350.
- KRISP Working Group, **1991**, Large-scale variation in lithospheric structure along and across the Kenya rift: *Nature*, v. 354, p. 223-227.
- Keller, G.R., L.W. Braile, G. A. McMechan, William A. Thomas, Steven H. Harder, Wen-Fong Chang, W.G. Jardine, **1989**, Crustal structure of the Ouachita orogenic belt determined by a PASSCAL wide-angle reflection/refraction experiment: *Geology*, v. 17, pp. 119-122.
- Harder, Steven, **1988**, Analysis of elastic symmetry from velocity measurements with application to dunite and bronzitite: *Geophys. J.*, v. 94, pp. 469-477.
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- Harder, S.H., G.R. Keller, P.H. Daggett, and Y.A. Sinno, **1986**, Cenozoic fill thickness estimated from P-wave delays in the Jornada del Muerto and Palomas basins, *New Mexico Geol. Soc. 37th Field Conf. Guidebook*, pp. 135-138.
- Harder, Steven, **1985**, Inversion of phase velocities for the anisotropic elastic tensor: *J. Geophys. Res.*, v. 90, B12, pp. 10275-10280.

Master's Thesis Directed:

Tiffany A. Ohnstad, **1990**, Evidence for cenozoic rifting in Thailand from gravity modeling.

Syed A.A. Zaidi, **1991**, Rayleigh wave filter for three-component seismic data.

Michael G. Riehle, **1991**, Crustal interpretation of three-component seismic data from southwestern New Mexico.

Ali Yildizel, **1992**, Detection of azimuthal anisotropy from 3-D p-wave seismic data.

Said A. Al Zahrani, **1992**, Near-surface seismic attenuation of P-waves in West Texas.

Susan M. Marshall, **1992**, Extensional tectonics in the Gulf of Thailand and South China Sea.

Bernadus S. Sudarmo, **1993**, Analyses of azimuthal seismic anisotropy in the vertically fractured Spraberry and Dean formations, Midland County, Texas.

Christopher J. Peoples, **1993**, An in situ geophone-calibration method for broadband amplitude and phase determination.

Steven J. Mauri, **1993**, Gravity modeling of Cenozoic extensional basins, offshore Vietnam.

Some Recently Published Abstracts:

Moffat, L., J.P. Canales, D. Lizarralde, K. Laletsang, S. Harder, G. Kaip, and M. Modisi, **2015**, Crustal structure across the Okavango rift zone, Botswana: Initial results from the PRIDE-SEISORZ active-source seismic profile, Abstract T43H-08 presented at the 2015 Fall Meeting, AGU, San Francisco, Calif., 14-18 Dec.

Shillington, D., D. Lizarralde, S. Harder, R. Marzen, G. Kaip, N. Accardo, J. Gibson, and A. Nauer, **2015**, Extension and magmatism across the Suwanee suture and South Georgia basin from the SUGAR seismic refraction experiment, Abstract T14A-07 presented at the 2015 Fall Meeting, AGU, San Francisco, Calif., 14-18 Dec.

Davenport, K., J. Hole, B. Tikoff, and S. Harder, **2015**, Evidence for a Moho-penetrating steep accretionary margin from the EarthScope Idaho-Oregon controlled-source seismic survey, Abstract T11D-2919 presented at the 2015 Fall Meeting, AGU, San Francisco, Calif., 14-18 Dec.

Kiser, E., I. Palomeras, A. Levander, C. Zelt, S. Harder, B. Schmant, and S. Hansen, **2015**, Magma reservoirs from the upper crust to the Moho inferred from high-resolution Vp and Vs models beneath Mount St. Helens, Abstract V33E-07 presented at the 2015 Fall Meeting, AGU, San Francisco, Calif., 14-18 Dec.

Worthington, L.L., K.C. Miller, K.R. Chamberlain, E. Erslev, A. Sheehan, M. Anderson, S. Harder, and C.S. Siddoway, **2015**, Paper #181-6 presented at the 2015 Annual Meeting, GSA, Baltimore, MD, 1-4 Nov.

Kiser, E., A. Levander, I. Palomeras, C.A. Zelt, B. Schmandt, S. Hansen, S. Harder, K. Creager, and J.E. Vidale, **2015**, IMUSH: Magma reservoirs from the upper crust to the Moho inferred from high-resolution Vp and Vs tomography beneath Mount St. Helens, Paper #181-7 presented at the 2015 Annual Meeting, GSA, Baltimore, MD, 1-4 Nov.

Shillington, D.J., D. Lizarralde, and S.H. Harder, **2014**, Initial constraints on crustal structure across the Suwanee Suture and South Georgia Basin from the SUGAR seismic refraction experiment, Abstract S33D-02 presented at the 2014 Fall Meeting, AGU, San Francisco, Calif., 15-19 Dec.

- Kiser, E., A. Levander, B. Schmandt, I. Palomeras, S.H. Harder, K.C. Creager, J.E. Vidale, and S.D. Malone, **2014**, Field report on the iMush active source seismic experiment, Abstract S22C-02 presented at the 2014 Fall Meeting, AGU, San Francisco, Calif., 15-19 Dec.
- Davenport, K.K., J.A. Hole, S.H. Harder, and B. Tikoff, **2014**, Contrasting crustal structure across the steep accretionary margin in Idaho-Oregon, illuminated by EarthScope IDOR controlled-source seismic data, Abstract S31B-4402 presented at the 2014 Fall Meeting, AGU, San Francisco, Calif., 15-19 Dec.
- O'Rourke, C.T., G.E. Baker, A.F. Sheehan, and S.H. Harder, **2014**, Explosion-Earthquake discrimination at local distances, Abstract S41B-4473 presented at the 2014 Fall Meeting, AGU, San Francisco, Calif., 15-19 Dec.
- Van Avendonk, H.J., M.B. Magnani, D.J. Shillington, J.B. Gaherty, M.J. Hornbach, B. Dugan, M.D. Long, D. Lizarralde, S.H. Harder, L.S. Wagner, and G.L. Christenson, **2014**, EANM: A community seismic experiment targeting rifting processes and post-rift evolution of the Mid-Atlantic US margin, Abstract T53B-4683 presented at the 2014 Fall Meeting, AGU, San Francisco, Calif., 15-19 Dec.
- Davenport, K.K., J.A. Hole, S. Harder, B. Tikoff, R. Russo, J.D. Vervoort, L. Han, L. Sabey, and K. Wang, **2013**, EarthScope IDOR controlled-source seismic transect across a steep tectonic margin, Idaho-Oregon, Abstract T11C-2454 presented at the 2013 Fall Meeting, AGU, San Francisco, Calif., 9-13 Dec.
- Harder, S.H. and M.B. Magnani, The ENAM explosive seismic source test, **2013**, Abstract S33B-2408 presented at the 2013 Fall Meeting, AGU, San Francisco, Calif., 9-13 Dec.
- Kiser, E., A. Levander, S.H. Harder, G.A. Abers, K.C. Creager, J.E. Vidale, S.C. Moran, and S.D. Malone, **2013**, Theoretical and practical considerations for the design of the iMush active-source seismic experiment, Abstract S21C-2429 presented at the 2013 Fall Meeting, AGU, San Francisco, Calif., 9-13.
- Quinonez, S.M., J.C. Olaya, K.C. Miller, R. Romero, A.A. Velasco, S.H. Harder, and I. Cerda, **2011**, Modeling of the Coast Mountains batholith, British Columbia, Canada with 3D seismic tomography, Abstract T53A-2487 presented at the 2011 Fall Meeting, AGU, San Francisco, Calif., 5-9 Dec.
- Worthington, L.L., K.C. Miller, E. Erslev, S.H. Harder, A.F. Sheehan, and BASE Collaborators, **2011**, Crustal structure and shallow velocity heterogeneity in the Big Horn Mountains, northern Wyoming: Insights into Laramide-style orogenesis, Abstract T11A-2273 presented at the 2011 Fall Meeting, AGU, San Francisco, Calif., 5-9 Dec.
- Fuis, G.S., M. Goldman, R.R. Sickler, R.D. Catchings, M.J. Rymer, E.J. Rose, J.M. Murphy, L.A. Butcher, J.A. Criley, D.S. Croker, I. Emmons, A.J. Ferguson, M.A. Gardner, E.G. Jensen, R. McClearn, C.L. Loughran, C.J. Slayday-Criley, J.F. Svitek, J.A. Hole, J.M. Stock, S.M. Skinner, N.W. Driscoll, A.J. Harding, J.M. Babcock, G. Kent, A.M. Kell, and S.H. Harder, **2011**, The Salton Seismic Imaging Project: Investigating earthquake hazards in the Salton Trough, southern California, Abstract T33G-2495 presented at the 2011 Fall Meeting, AGU, San Francisco, Calif., 5-9 Dec.
- Lizarralde, D., W.S. Holbrook, H.J. van Avendonk, M. Mora Fernandez, G.E. Alvarado, and S.H. Harder, **2010**, Crustal structure along the active Costa Rican volcanic arc, Abstract T31- 2176 2069 presented at 2010 Fall Meeting, AGU, San Francisco, Calif., 13-17 Dec.
- Harder, S.H., K.C. Miller, L.L. Worthington, and C.M. Snelson, **2010**, Bighorns arch seismic experiment (BASE): Amplitude response to different seismic charge configuration, Abstract S43B-2069 presented at 2010 Fall Meeting, AGU, San Francisco, Calif., 13-17 Dec.

- Chang, J.C., K.M. Keranen, G.R. Keller, G. Qu, and S.H. Harder, **2010**, Three-dimensional seismic tomography beneath Tangshan, China, Abstract T21A-2136 presented at 2010 Fall Meeting, AGU, San Francisco, Calif., 13-17 Dec.
- Stephenson, A.L., G. Spence, K. Wang, J.A. Hole, K.C. Miller, R.M. Clowes, S.H. Harder, and G.M. Kaip, **2010**, Crustal velocity structure of the South Nechako basin, British Columbia, from wide-angle seismic traveltime inversion, Abstract S13A-1961 presented at 2010 Fall Meeting, AGU, San Francisco, Calif., 13-17 Dec.
- Terbush, B.R., L.L. Worthington, K.C. Miller, S.H. Harder, E. Erslev, M.L. Anderson, and C.S. Siddoway, **2010**, Preliminary results of the active source portion of the Bighorns array seismic experiment (BASE), north-central Wyoming, USA, Abstract T51C-2070 presented at 2010 Fall Meeting, AGU, San Francisco, Calif., 13-17 Dec.
- Miller, K.C., E. Erslev, A.F. Sheehan, M.L. Anderson, C.S. Siddoway, S.H. Harder, L.L. Worthington, W.L. Yeck, V. Schulte-Pelkum, and K. Aydinian, **2010**, Genesis of basement-cored foreland arches: Insights from the EarthScope Bighorns Project, Abstract T42C-08 presented at 2010 Fall Meeting, AGU, San Francisco, Calif., 13-17 Dec.
- O'Rourke, C.T., A.F. Sheehan, Z. Yang, S.H. Harder, K.C. Miller, and L.L. Worthington, **2010**, Implementing dense arrays of single-channel seismic recorders to detect global teleseismic events, Abstract T51C-2074 presented at 2010 Fall Meeting, AGU, San Francisco, Calif., 13-17 Dec.
- Wang, K., J.A. Hole, A.L. Stephenson, G. Spence, K.C. Miller, S.H. Harder, G.M. Kaip, and R.M. Clowes, **2010**, Controlled-source seismic investigation of the generation and collapse of a batholith complex, Coast Mountains, western Canada, Abstract T11A-2059 presented at 2010 Fall Meeting, AGU, San Francisco, Calif., 13-17 Dec.
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