

CURRICULUM VITAE

David P. Schaff

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EDUCATION

1994 - 2001 Stanford University
Ph.D. Geophysics
Advisor: Greg Beroza

1990 - 1994 Northwestern University
B.A. 4 majors: Integrated Science Program, Geology, Physics, Math
Advisor: Emile Okal
The Integrated Science Program (ISP) is a selective, honors major which focuses on comprehensive, interdisciplinary study of the sciences including the following accelerated courses: 6 physics, 6 math, 4 chemistry, 4 biology, geophysics, and astronomy.

PROFESSIONAL APPOINTMENTS

2010 – present Lamont Assistant Research Professor, **Columbia University**
2004 – 2010 Doherty Associate Research Scientist, **Columbia University**
2001- 2004 Postdoctoral Research Scientist, Advisor: Paul Richards, **Columbia University**
1994 - 2001 Research Assistant, Geophysics, **Stanford University**
1993 - 1994 Research Assistant, Geology, **Northwestern University**

HONORS & AWARDS

Boy Scout Eagle Award
National Merit Scholar
Sigma Pi Sigma – college physics honor society
Sigma Xi

RESEARCH INTERESTS

My research has involved applying massive waveform cross correlation to earthquake location, earthquake detection, repeating events, measuring temporal changes in the crust associated with large earthquakes, testing competing models of foreshock occurrence, studying the earthquake source using empirical Green's functions, and nuclear monitoring.

TEACHING EXPERIENCE AND OUTREACH

1996 – 1997 Teaching Assistant, Geophysics, **Stanford University**

Introduction to Seismology: graded papers/exams, office hours

Advanced Earthquake Seismology: graded papers/exams, office hours, helped develop problem sets

1997 Submitted proposal for museum display to IRIS illustrating focal mechanisms, plate tectonics, and seismic wave generation.

1997 Physics and Math tutor for undergrads

1998 – present Cellist for the “Music of Earthquakes” lecture prepared by Andy Michael, seismologist at the USGS, designed to educate the lay public about earthquakes given various times at Stanford, USGS, AGU, public schools, and the Sigma Xi Forum. Publicity has included coverage by CNN, FOX, NBC, CBS, and several local newspapers.

2002 Mentored a visiting scientist from Russia for one month in cross correlation methods.

2002 & 2003 Prepared a lecture and earthquake wave animation demos for the Lamont Open House.

2003 – 2010 Mentored five graduate students, two postdocs, and one Lamont Research Professor in cross correlation methods.

2010 Mentored an undergraduate summer intern researching statistics of foreshocks

Mentoring

Undergraduate summer intern ~ James Voorhis

Masters student ~ Hannah Abend

PhD students ~ Anyi Li, Jian Zhang, Christos Karamanos, Danielle Sumy

Postdocs ~ Tobias Diehl, Luisa Valoroso

Visiting scientist ~ Alexey Emanov

Lamont Research Professor ~ Won-Young Kim

SERVICE

2001 – 2002 Organizer of SG&T department seminar

2001 Oral session presider, AGU Fall 2001 Meeting, “Patterns of Faulting and Seismicity From Precision Earthquake Locations”

2003 Member of SG&T Library Committee

2003 – present Provided technical support and advice for correlation program to researchers worldwide including several in the U.S., Japan, New Zealand, Greece, Italy, Belgium, Israel, and India

2010 Oral session presider at AGU Fall 2010 Meeting, “Earthquake source processes: what have we learned from recent large earthquakes?”

2010 Outstanding student presentation judge at AGU Fall Meeting

Reviewer for thirty-five papers in various journals including Journal of Geophysical Research, Bulletin of the Seismological Society of America, Geophysical Research Letters, Geophysical Journal International, and IEEE Transactions on Geoscience and Remote Sensing

Reviewer of four National Science Foundation proposals.

FIELDWORK

1999 Deployed electromagnetic recording instruments for aftershocks of the *M* 7.1 Hector Mine earthquake.

2000 Reoccupied campaign-style GPS sites in Long Valley Caldera.

2001 Deployed temporary seismic stations at the Museum of Natural History and at Columbia University for the 2001 Manhattan earthquake.

PAPERS (Peer Reviewed)

Simpson, R.W., Oppenheimer, D.H., Bakun, W.H., Graymer, R.W., Waldhauser, F., and **Schaff, D.P.**, A new look at Central Calaveras Fault zonation using double-difference relocated earthquakes, Third Conference on Earthquake Hazards in the Eastern San Francisco Bay Area - Science, Hazard, Engineering and Risk, October 22-24, 2008, 140th Anniversary of the 1868 Earthquake, California State University East Bay, California Geological Survey, Special Publication (in press).

Schaff, D. P., and P. G. Richards (2011), On finding and using repeating seismic events in and near China, *J. Geophys. Res.*, 116, B03309, doi:10.1029/2010JB007895.

Schaff, D.P., and F. Waldhauser (2010), One magnitude unit reduction in detection threshold by cross correlation applied to Parkfield (California) and China seismicity, *Bull. Seism. Soc. Am.*, 100, 3224-3238, doi: 10.1785/0120100042.

Schaff, D. (2010), Improvements to detection capability by cross-correlating for similar events: a case study of the 1999 Xiuyan, China, sequence and synthetic sensitivity tests, *Geophys. J. Int.*, 180, 829-846, doi: 10.1111/j.1365-246X.2009.04446.x.

Schaff, D. P. (2009), Broad-scale applicability of correlation detectors to China seismicity, *Geophys. Res. Lett.*, 36, L11301, doi:10.1029/2009GL038179.

Zhang, J., P. G. Richards, and **D. P. Schaff** (2008), Wide-scale detection of earthquake waveform doublets and further evidence for inner core super-rotation, *Geophys. J. Int.*, 174, 993-1006, doi:10.1111/j.1365-246X.2008.03856.x.

Schaff, D.P. (2008), Semi-empirical statistics of correlation detector performance, *Bull. Seismol. Soc. Am.*, 98, 1495-1507, doi: 10.1785/0120060263.

Waldhauser, F., and **D.P. Schaff** (2008), Large-scale cross-correlation based relocation of two decades of Northern California seismicity, *J. Geophys. Res.*, 113, B08311, doi:10.1029/2007JB005479.

Waldhauser, F., and **D.P. Schaff** (2007), Regional and teleseismic double-difference earthquake relocation using waveform cross correlation and global bulletin data, *J. Geophys. Res.*, 112, B12301 doi:10.1029/2007JB004938.

Richards, P.G., F. Waldhauser, **D.P. Schaff**, and W.-Y. Kim (2006), The applicability of modern methods of earthquake location, *Pure and Applied Geophys.*, 163, 351-372.

Xie, J., Z. Wu, R. Liu, **D.P. Schaff**, Y. Liu, and J. Liang (2006), Tomographic regionalization of crustal Lg Q in eastern Eurasia, *Geophys. Res. Lett.*, 33, L03315, doi:10.1029/2005GL024410.

- Schaff, D.P.**, and F. Waldhauser (2005), Waveform cross-correlation-based differential travel-time measurements at the Northern California Seismic Network, *Bull. Seismol. Soc. Am.*, *95*, 2446-2461, doi:10.1785/0120040221.
- Schaff, D.P.** and G.C. Beroza (2004), Coseismic and postseismic velocity changes measured by repeating earthquakes, *J. Geophys. Res.*, *109*, B10302, doi:10.1029/2004JB003011.
- Waldhauser, F., W.L. Ellsworth, **D.P. Schaff**, A. Cole (2004), Streaks, multiplets, and holes: high-resolution spatio-temporal behavior of Parkfield seismicity, *Geophys. Res. Lett.*, *31*, L18608, doi:10.1029/2004GL020649.
- Menke, W., and **D.P. Schaff** (2004), Absolute earthquake location with differential data, *Bull. Seismol. Soc. Am.*, *94*, 2254-2264.
- Waldhauser, F., and **D.P. Schaff** (2004), Lop Nor revisited: underground nuclear explosion locations, 1976-1996, from double-difference analysis of regional and teleseismic data, *Bull. Seismol. Soc. Am.*, *94*, 1879-1889.
- Schaff, D.P.**, and P.G. Richards (2004), Repeating seismic events in China, *Science*, **303**, 1176-1178.
- Schaff, D.P.**, and P.G. Richards (2004), *Lg*-wave cross correlation and double difference location: application to the 1999 Xiuyan, China, sequence, *Bull. Seismol. Soc. Am.*, *94*, 867-879.
- Schaff, D.P.**, G.H.R. Bokelmann, W.L. Ellsworth, E. Zankerka, F. Waldhauser, and G.C. Beroza (2004), Optimizing correlation techniques for improved earthquake location, *Bull. Seismol. Soc. Am.*, *94*, 705-721.
- Schaff, D.P.**, G.H.R. Bokelmann, G.C. Beroza, F. Waldhauser, and W.L. Ellsworth (2002), High resolution image of Calaveras Fault seismicity, *J. Geophys. Res.*, *107*, 2186, doi:10.1029/2001JB000633.
- Schaff, D.P.** (2001), 4D high resolution seismology: repeating events and large scale relocation, *Ph.D. Thesis*, Stanford University, 115 pp.
- Crider, J.G., **D.P. Schaff**, D.D. Pollard, and G.C. Beroza (2001), Considering the third dimension in stress-triggering of aftershocks: 1993 Klamath Falls, Oregon, earthquake sequence, *Geophys. Res. Lett.*, *28*, 2739-2742.
- Schaff, D.P.**, G.C. Beroza, and B.E. Shaw (1998), Postseismic response of repeating aftershocks, *Geophys. Res. Lett.*, *25*, 4549-4552.

PAPERS (Non-Peer Reviewed)

- Schaff, D.P.**, and F. Waldhauser, Improving magnitude detection thresholds using multi-station, multi-event, and multi-phase methods, *Proceedings of the 29th Monitoring Research Review--Ground-Based Nuclear Explosion Monitoring Technologies*, p. 482-490, 2007.
- Schaff, D.P.**, and F. Waldhauser, Improving magnitude detection thresholds using multi-station, multi-event, and multi-phase methods, *Proceedings of the 28th Seismic Research Review--Ground-Based Nuclear Explosion Monitoring Technologies*, p. 493-501, 2006.
- Kim, W.-Y., P. Richards, **D.P. Schaff**, F. Waldhauser, J. Zhang, Evaluation of cross correlation methods on a massive scale for accurate relocation of seismic events, *Proceedings of the 27th Seismic Research Review--Ground-Based Nuclear Explosion Monitoring Technologies*, p. 362-371, 2005.

- Xie, J., **D.P. Schaff**, and Y. Liu, Tomographic Mapping of Lg Q in Eastern Eurasia, *Proceedings of the 27th Seismic Research Review--Ground-Based Nuclear Explosion Monitoring Technologies*, p. 242-248, 2005.
- Kim, W.-Y., **D.P. Schaff**, J. Zhang, F. Waldhauser, and P.G. Richards, Evaluation of cross correlation methods on a massive scale for accurate relocation of seismic events, in *Proceedings of the 25th Seismic Research Review –Trends in Nuclear Explosion Monitoring*, p. 277-286, 2004.
- Richards, P., J. Armbruster, V. Burlacu, V. Cormier, M. Fisk, V. Khalturin, W. Kim, I. Morozov, E. Morozova, C. Saikia, **D.P. Schaff**, A. Stroujkova, and F. Waldhauser, Seismic Location Calibration for 30 International Monitoring System Stations in Eastern Asia: Final Results, in *Proceedings of the 25th Seismic Research Review -- Nuclear Explosion Monitoring: Building the Knowledge Base*, NNSA LA-UR-03-6029, p. 280-290, 2003.
- Armbruster, J., V. Burlacu, M. Fisk, V. I. Khalturin, W.-Y. Kim, I. Morozov, E. Morozova, P.G. Richards, **D.P. Schaff**, and F. Waldhauser, Seismic location calibration for 30 IMS stations in Eastern Asia, in *Proceedings of the 24th Seismic Research Review -- Nuclear Explosion Monitoring: Innovation and Integration*, Vol. 1, DTRA/NNSA LA-UR-02-5048, p. 231-241, 2002.
- Conrad, C., M. Fisk, V.I. Khalturin, W-Y Kim, I. Morozov, E. Morozova, P.G. Richards, **D.P. Schaff**, and F. Waldhauser, Seismic location calibration for 30 International Monitoring System stations in Eastern Asia, in *Proceedings of the 23rd Seismic Research Review: Worldwide Monitoring of Nuclear Explosions*, Vol. 1, DTRA/NNSA LA-UR-01-4454, p. 186-196, 2001.
- Beroza, G.C., **D.P. Schaff**, and G.H.R. Bokelmann, Constraints on fault mechanics from Calaveras fault seismicity, *Proceedings of the 3rd Conference on Tectonic Problems of the San Andreas Fault System*, ed. by G.H.R. Bokelmann and R.L. Kovach, Stanford University Press, 4-5, 2000.
- Waldhauser, F., G.C. Beroza, **D.P. Schaff**, W.L. Ellsworth, and G.H.R. Bokelmann, Fault structure and mechanics from high-resolution earthquake locations on the Hayward and Calaveras faults, *Proceedings of the 3rd Conference on Tectonic Problems of the San Andreas Fault System*, ed. by G.H.R. Bokelmann and R.L. Kovach, Stanford University Press, 7-12, 2000.
- Beroza, G.C., **D.P. Schaff**, G.H. Bokelmann, Waveform-based earthquake locations on the Calaveras fault and their implications for the mechanics of faulting, Int. School of Solid Earth Geophysics, 17th Course: *Fault Interaction by Stress Transfer: New Horizons for Understanding Earthquake Occurrence*, ed. by M. Cocco, J.R. Rice, R.S. Stein, 4 pp., 2000.

INVITED TALKS

- Schaff, D.P., Tests of competing models of foreshock occurrence with the high precision catalog of northern California, Lamont department seminar, March 2011.
- Schaff, D.P., and P.G. Richards, Studies of repeating earthquakes in China, Kazakhstan, abstract published in *Research and Technology Review*, National Nuclear Center of the Republic of Kazakhstan, Issue 3(43), 149-151, September 2010, presented at International Conference on Nuclear Tests and their Consequences, Kurchatov, Kazakhstan, August 9 to 13, 2010.
- Schaff, D.P., Searching for repeating events in China and California by applying massive waveform cross correlation and relocation, Lamont department seminar, December, 2003.
- Schaff, D.P., Improving the measurement side of the double-difference equation: double whammy high-resolution earthquake locations, ETH, Zurich, June 2002.

Schaff, D.P., 4D high resolution seismology, Lamont department seminar, October, 2001.

Schaff, D.P., F. Waldhauser, G. Bokelmann, E. Zankerka, and G. Beroza, High resolution from an earthquake seismologist's point of view, "Synergies in Geophysical, Medical and Space Imaging" *SEG 2001 summer research workshop*, Newport Beach, CA, July 22-26, 2001.

Schaff, D.P., The double-difference method for locating seismic events, *Experts Group Review*, Lamont, February, 2001.

Schaff, D.P., A "Hubble terrascoper" view of Calaveras Fault seismicity, Caltech department seminar, October, 2000.

Schaff, D.P., High-Resolution Earthquake Location Workshop, University of Wisconsin, Madison, WI, January, 2000.

CONFERENCE PRESENTATIONS

Valroso, L., L. Chiaraluce, R. Di Stefano, D. Piccinini, **D. Schaff**, and F. Waldhauser (2011), A radiography of the 2009 M_w 6.1 L'Aquila normal fault system (Central Italy), European Geosciences Union General Assembly 2011, Vienna, Austria, April 3-8.

Schaff, D.P., F. Waldhauser, and A. Lerner-Lam (2010), Correlation of foreshock occurrence with mainshock depth, rake, and magnitude from the high precision catalog for Northern California, Abstract S53E-07 presented at 2010 Fall Meeting, AGU, San Francisco, Calif., 13-17 Dec.

Waldhauser, F. and **D.P. Schaff** (2010), Real-time cross-correlation and double difference algorithms for event detection and aftershock screening (Invited), Abstract S51D-06 presented at 2010 Fall Meeting, AGU, San Francisco, Calif., 13-17 Dec.

Xie, J. and **D.P. Schaff** (2010), Studying regional wave source time functions using a massive automated EGF deconvolution procedure, Abstract S53B-1968 presented at 2010 Fall Meeting, AGU, San Francisco, Calif., 13-17 Dec.

Diehl, T., F. Waldhauser, J.R. Cochran, K.R. Kattoju, L. Seeber, **D.P. Schaff**, and E.R. Engdahl (2010), Back-arc extension in the Andaman Sea: magmatic and tectonic processes imaged by high-precision teleseismic double-difference relocation of earthquake swarms, Abstract S21B-2020 presented at 2010 Fall Meeting, AGU, San Francisco, Calif., 13-17 Dec.

Waldhauser, F., and **D. Schaff** (2010), Real-time double-difference location and monitoring of fine-scale seismic properties, SSA 2010 Annual Meeting, *Seis. Res. Lett.*, **81**, No. 2, 377

Diehl, T., F. Waldhauser, **D. P. Schaff**, and E. R. Engdahl (2009), Seismotectonic analysis of the Andaman Sea region from high-precision teleseismic double-difference locations. *Eos Trans. AGU*, Fall Meet. Suppl., Abstract T24B-05.

Waldhauser, F., **D. P. Schaff**, E. R. Engdahl, and T. Diehl (2009). Streaks of Aftershocks Following the 2004 Sumatra-Andaman Earthquake, *Eos Trans. AGU*, Fall Meet. Suppl., Abstract T24B-04.

Schaff, D.P., and F. Waldhauser, F. Broad-Scale Applicability of Correlation Detectors to China and Parkfield, California, Seismicity, Annual SSA meeting, Eastern section, Palisades, New York, October 2009.

Schaff, D.P. and P.G. Richards, A second study of repeating earthquakes in China, IASPEI General Assembly, Cape Town, South Africa, January 2009.

- Schaff, D.P.**, and F. Waldhauser, F. (2008), Broad-Scale Applicability of Correlation Detectors to China and Parkfield, California, Seismicity, *Eos Trans. AGU*, 89(53), Fall Meet. Suppl., Abstract S13B-1799.
- Lin, G., C. H. Thurber, H. Zhang, E. Hauksson, P.M. Shearer, F. Waldhauser, J. Hardebeck, T.M. Brocher, and **D.P. Schaff** (2008), A California Statewide Three-dimensional Seismic Velocity Model From Both Absolute and Differential Times, *Eos Trans. AGU*, 89(53), Fall Meet. Suppl., Abstract S22A-02.
- Schaff, D.P.** and P.G. Richards, A Second Study of Repeating Earthquakes in China, 2008 Bi-lateral workshop under the Sino-US earthquake studies protocol, Boulder, Nov. 11-14, 2008.
- Waldhauser, F. and **D. Schaff**, Seismic Monitoring Using Long-Term Archives: New Directions and Opportunities, 2008 Bi-lateral workshop under the Sino-US earthquake studies protocol, Boulder, Nov. 11-14, 2008.
- Simpson, R., Oppenheimer, D., Bakun, W., Graymer, R., Waldhauser, F., and **Schaff, D.P.**, 2008, A new look at Calaveras Fault zonation using double-difference relocated earthquakes: Conference Program with Abstracts, Third Conference on Earthquake Hazards in the Eastern San Francisco Bay Area - Science, Hazard, Engineering and Risk, October 22-24, 2008, 140th Anniversary of the 1868 Earthquake, California State University East Bay.
- Schaff, D.P.**, Improving magnitude detection thresholds using multi-event, multi-station, and multi-phase methods, *Program Review*, Hanscom AFB, Massachusetts, June 2008.
- Schaff, D.P.**, Correlation Detectors Applied to China Seismicity, *Annual SSA Meeting*, Big Island, Hawaii, 2007.
- Zhang, J., Waldhauser, F., Richards, P.G., and **Schaff, D.P.**, Double-Difference Relocation of an Earthquake Nest at Bucaramanga, Columbia: Revelation of a Vertical Fault at Intermediate-Depth, *Annual SSA Meeting*, Big Island, Hawaii, 2007.
- Menke, W., P. G. Richards, W.-Y. Kim, F. Waldhauser, and **D. P. Schaff** (2007), Testing models of North American seismic velocity structure with traveltimes from well-validated sources, *Eos Trans. AGU*, 88(52), Fall Meet. Suppl., Abstract S11B-0565.
- Zhang, J., F. Waldhauser, P. G. Richards, and **D. P. Schaff** (2007), Double-difference relocation of an earthquake nest at Bucaramanga, Columbia: interaction between two slabs? *Eos Trans. AGU*, 88(52), Fall Meet. Suppl., Abstract T31A-0272.
- Waldhauser, F. and **D. P. Schaff** (2007), Back to the future: long-term seismic archives revisited, *Eos Trans. AGU*, 88(52), Fall Meet. Suppl., Abstract U23C-1447.
- Sandvol, E., X. Bao, E. Zor, J. Xie, B. J. Mitchell, and **D. P. Schaff** (2007), Lg and Pg Attenuation in the Middle East, *Eos Trans. AGU*, 88(52), Fall Meet. Suppl., Abstract S41A-0253.
- Schaff, D.P.**, Improving magnitude detection thresholds using multi-event, multi-station, and multi-phase methods, *Program Review*, Hanscom AFB, Massachusetts, June 2007.
- Waldhauser, F. and **D. P. Schaff** (2006), Massive-scale Waveform-based Double-difference Event Relocation in Northern California, *Eos Trans. AGU*, 87(36), West. Pac. Geophys. Meet. Suppl., Abstract S14B-02.

- Zhang, J., P. G. Richards, and **D. P. Schaff** (2006), High-quality earthquake doublets used for study of inner core motion and earthquake catalog precision, *Eos Trans. AGU*, 87(36), West. Pac. Geophys. Meet. Suppl., Abstract S11C-0142.
- Schaff, D.P.**, Improving magnitude detection thresholds using multi-event, multi-station, and multi-phase methods, *Program Review*, Hanscom AFB, Massachusetts, June 2006.
- Schaff, D.P.**, and F. Waldhauser, Improving magnitude detection thresholds using multi-event, multi-station, and multi-phase methods, *Annual SSA meeting*, San Francisco, California, April 2006.
- Richards, P.G., **D.P. Schaff**, J. Zhang, A Global Search for Repeating Earthquakes: Preliminary Results and Application to the Inner Core, *Annual SSA meeting*, San Francisco, California, April 2006.
- Abend, H., D. Bohnenstiehl, W.-Y. Kim, P.G. Richards, **D.P. Schaff**, M. Tolstoy, F. Waldhauser, Fine-scale Seismicity of Earth's Interior: Regional- and Global-scale Double-difference Applications to Study Plate-tectonic Processes, *Annual SSA meeting*, San Francisco, California, April 2006.
- Waldhauser, F., and **D.P. Schaff** (2005), Regional-scale seismic event relocation in Northern California, *EOS Trans. AGU* 86(52), Fall Meet. Suppl., Abstract S53C-06.
- Waldhauser, F., and **D.P. Schaff**, Progress in waveform based wide area event relocation in Northern California, *Annual SCEC meeting*, Palm Springs, California, September, 2005.
- J Xie, Z. Wu, R. Liu, **D.P. Schaff** and J. Liang, Estimation of Radiated Energy from Earthquakes in China and Surrounding Regions Using the Lg Spectra, *AGU Chapman Conference on Radiated Energy and the Physics of Earthquake Faulting*. Portland, Maine, June 13-17, 2005.
- Schaff, D.P.**, What fraction of seismicity can be located using cross-correlation and multiple-event relocation algorithms? *Program Review*, Hanscom AFB, Massachusetts, June 2005.
- Richards, P., W.-Y. Kim, F. Waldhauser, and **D.P. Schaff**, What fraction of seismicity can be located using cross-correlation and multiple-event relocation algorithms?, *Annual SSA meeting*, Lake Tahoe, April 2005.
- Schaff, D.P.**, W.-Y. Kim, F. Waldhauser, and P.G. Richards, Comparison of waveform cross correlation performance across different broad area seismic source regions, *EOS Trans. AGU*, 85(47), Fall Meet. Suppl., Abstract S11B-1026, 2004.
- Waldhauser, F., **D.P. Schaff**, W.-Y. Kim, and P.G. Richards, Improved characterization of seismicity and fault structure by wide area event relocation, *EOS Trans. AGU*, 85(47), Fall Meet. Suppl., Abstract S53D-07, 2004.
- Schaff, D.P.**, and F. Waldhauser, Characterization of waveform similarity across northern California, *Annual SCEC meeting*, Palm Springs, California, September 2004.
- Richards, P.G., F. Waldhauser, **D.P. Schaff**, and W.-Y. Kim, Prospects for widespread implementation for better methods for source location, *EOS Trans. AGU*, 85(17), Jt. Assem. Suppl., Abstract S32A-01, 2004.
- Schaff, D.P.**, F. Waldhauser, and P.G. Richards, Applying massive waveform cross correlation and double-difference location to northern California and China, *EOS Transactions Fall AGU meeting*, 2003.
- Richards, P.G., J. Armbruster, V.I. Khalturin, W. Kim, **D.P. Schaff**, F. Waldhauser, V. Burlacu, M. D. Fisk, I. Morozov, E. Morozova, V. Cormier, A. Stroujkova, C. Saikia, Location calibration in East Asia: final results of a consortium project, and lessons learned, *EOS Transactions Fall AGU meeting*, 2003.

- Schaff, D.P.**, and F. Waldhauser, Progress in massive waveform cross correlation and wide area event relocation in northern California, *Annual SCEC meeting*, Oxnard, California, September, 2003.
- Schaff, D.P.**, *Lg* cross correlation and double-difference location, *DTRA Calibration Project Program Review & Workshop*, Rosslyn, Virginia, March, 2003.
- Schaff, D.P.**, Correlation of *Lg*-waves for improved regional event location, *EOS Transactions Fall AGU meeting*, 2002.
- Waldhauser, F., P.G. Richards, **D.P. Schaff**, A. Li, Improved location of earthquake and nuclear explosion clusters using teleseismic and regional phase data, *EOS Transactions Fall AGU meeting*, 2002.
- Rubinstein, J.L., G. Beroza, G. Bokelmann, and **D.P. Schaff**, Near surface damage cause by the *M* 6.9 Loma Prieta and *M* 5.4 Chittenden earthquakes, *EOS Transactions Fall AGU meeting*, 2002.
- Armbruster, J., V. Burlacu, M. Fisk, V.L. Khalturin, W.-Y. Kim, I. Morozov, E. Morozova, P.G. Richards, **D.P. Schaff**, and F. Waldhauser, Seismic location calibration for 30 International Monitoring stations in Eastern Asia, *24th Seismic Research Review: Nuclear Explosion Monitoring: Innovation and Integration*, Ponte Vedra Beach, Florida, September, 2002.
- Waldhauser, F., **D.P. Schaff**, P.G. Richards, and W.-Y. Kim, IMS Station Calibration and Earthquake Relocation in China, *Fourth Workshop on IMS Location Calibration and Screening*, Oslo, Norway, April 2002.
- Waldhauser, F., **D.P. Schaff**, P.G. Richards, and W.-Y. Kim, Spatial clustering of seismicity and precise event locations in China, *Seismological Society of America, 97th annual meeting*, 2002.
- Cole, A.T., W.L. Ellsworth, F. Waldhauser, **D.P. Schaff**, Earthquake recurrence in the big streak near Parkfield, *Seismological Society of America, 97th annual meeting*, 2002.
- Schaff, D.P.**, F. Waldhauser, W.-Y. Kim, and P.G. Richards, Cross-correlation measurements and the double-difference earthquake location technique, *EOS Transactions Fall AGU meeting*, 2001.
- Beroza, G.C., and **D.P. Schaff**, New evidence for nonlinearity in strong ground motion, *EOS Transactions Fall AGU meeting*, 2001.
- Waldhauser, F., W.-Y. Kim, P.G. Richards, and **D.P. Schaff**, Double-difference location of underground nuclear explosions at the Lop Nor Test Site, *EOS Transactions Fall AGU meeting*, 2001.
- Michael, A., S. Ross, and **D.P. Schaff**, Music of earthquakes, Plenary lecture presented at the 2001 Sigma Xi Forum: *Science, the Arts and the Humanities: Connections and Collisions*, Raleigh, North Carolina, November 8-9, 2001.
- Conrad, C., M. Fisk, V.L. Khalturin, W.-Y. Kim, I. Morozov, E. Morozova, P.G. Richards, **D.P. Schaff**, and F. Waldhauser, Seismic location calibration for 30 International Monitoring stations in Eastern Asia, *23rd Seismic Research Review: Worldwide Monitoring of Nuclear Explosions*, Jackson Hole, Wyoming, October, 2001.
- Ellsworth, W.L., G.C. Beroza, L. Chiaraluce, E. Fukuyama, K.-F. Ma, S. Prejean, K. Richards-Dinger, T. Sagiya, **D.P. Schaff**, F. Waldhauser, Double-difference earthquake locations and their implications for hazards and earthquake physics, *25th Anniversary of the Friuli, Italy, Earthquake Workshop*, Udine, Italy, September, 2001.
- Waldhauser, F., P.G. Richards, **D.P. Schaff**, Future directions for global bulletins of seismicity, *IAGA-IASPEI Joint Scientific Assembly*, Hanoi, Vietnam, August, 2001.

- Schaff D.P.**, and G.C. Beroza, Co-seismic and post-seismic velocity changes measured by repeating earthquakes, *Seismological Society of America, 96th annual meeting*, 2001.
- Waldhauser, F., W.L. Ellsworth, G. Beroza, G. Bokelmann, **D. Schaff**, and E. Zankerka, A double-difference earthquake location algorithm: method and results from the San Andreas Fault System, *EGS, Annales Geophysicae*, Nice, 2000.
- Ellsworth, W.L., B.R. Julian, F. Klein, A.J. Michael, D.H. Oppenheimer, S.G. Prejean, K. Richards-Dinger, S.L. Ross, **D.P. Schaff**, and F. Waldhauser, Seismicity of the San Andreas Fault system in central California: application of the double-difference location algorithm on a regional scale, *EOS Transactions Fall AGU meeting*, 2000.
- Zankerka, E.E., **D.P. Schaff**, F. Waldhauser, and G.C. Beroza, A high resolution look at pore fluid mediated seismicity in the Landers aftershock sequence, *EOS Transactions Fall AGU meeting*, 1999.
- Bokelmann, G.H.R., G. Beroza, A. Cole, W. Ellsworth, **D. Schaff**, F. Waldhauser, and E. Zankerka, Bringing seismicity into focus: new insights into fault behavior from accurate earthquake locations, *Plate Boundary Observatory Workshop*, Snowbird, Utah, 1999.
- Schaff, D.P.**, F. Waldhauser, G. Bokelmann, and G.C. Beroza, Ultra-high resolution image of Calaveras Fault seismicity, *EOS Transactions Fall AGU meeting*, 1999.
- Ellsworth, W.L., G.C. Beroza, G.H. Bokelmann, A.T. Cole, **D.P. Schaff**, and F. Waldhauser, Streaks, multiplets and holes: a new view of the San Andreas Fault, *EOS Transactions Fall AGU meeting*, 1999.
- Crider, J.G., W.J. Bosl, and **D.P. Schaff**, Modeled stress changes, fluid diffusion and the triggering of aftershocks: 1993 Klamath Falls, Oregon, earthquake sequence, *EOS Transactions Fall AGU meeting*, 1998.
- Schaff, D.P.**, and G.C. Beroza, Coseismic and postseismic velocity changes measured by repeating earthquakes, *EOS Transactions Fall AGU meeting*, 1998.
- Beroza, G.C., **D.P. Schaff**, W.L. Ellsworth, A.T. Cole, and D.A. Dodge, Temporal Changes in Seismic Velocities Observed in the Shear Wave Coda Related to the 1989 Loma Prieta, California, Earthquake, *EOS Transactions Fall AGU meeting*, 1997.
- Schaff, D.P.**, and G.C. Beroza, Studying earthquake recurrence using micro-earthquakes, *Seismological Society of America, 92nd annual meeting*, 1997.
- Schaff, D.P.**, D.A. Dodge, and G.C. Beroza, An automated search for repeating earthquakes, *EOS Transactions Fall AGU meeting*, 1996.

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