

# **Lianxing Wen**

## **Professor of Geophysics**

**Address**      Department of Geosciences, Stony Brook University  
Stony Brook, NY 11794-2100  
tel#: (631)-632-1726; fax : (631)-632-8240  
e-mail: Lianxing.Wen@ stonybrook.edu

### **Professional Preparation**

- Ph.D. Geophysics, California Institute of Technology, 1998.
- M.S., Geophysics, Chinese Academy of Sciences, 1991.
- B.S., Geophysics, University of Science and Technology of China, 1988.

### **Professional Appointments**

- 2000 - present, Faculty member, Department of Geosciences, Stony Brook University
- 1998 - 2000, Carnegie Fellow, Department of Terrestrial Magnetism, Carnegie Institution of Washington
- 1998 - 1998, Assistant Scientist, Seismological Laboratory, California Institute of Technology
- 1993 - 1998, Research Assistant, Seismological Laboratory, California Institute of Technology
- 1991 - 1993, Assistant Research Fellow, Institute of Geophysics, Chinese Academy of Sciences

### **Honors and Awards**

- James B. Macelwane Medal, American Geophysical Union, 2003.
- Fellow, American Geophysical Union, 2003.

### **Professional Services**

- Working Group for the China Seismological Reference Model project, National Natural Science Foundation of China (team leader), 2016-.
- Geophysics Advisory Panel, National Natural Science Foundation of China, 2011-2014.
- Committee on "Grand Challenges on Earthquake Hazard Mitigation in China" (report lead author), Chinese Academy of Sciences, China Earthquake Administration, and National Natural Science Foundation of China, 2010-2011.

- Associate Editor, Journal of Geophysical Research, 2009-2015.
- Lehmann Medal Committee, American Geophysical Union, 2010-2014.
- Macelwane Medal Committee, American Geophysical Union, 2008-2010.
- Standing Committee of the Global Seismic Network, the Incorporated Research Institutions for Seismology (IRIS), 2003-2006.
- National Research Council Review Committee on NASA's Earth Science 25-year vision, 2004.
- Geophysics Advisory Panel, National Science Foundation, 2004.

### **Research Interests:**

I am a theoretical and observational seismologist and geodynamicist. My main research is directed toward understanding the structure, dynamics, composition and evolution of the Earth and other planets. I use seismic waves to probe the internal structure of the Earth and its change with time, combine seismic, geodetic and mineral physics data to constrain the composition of the Earth and Martian mantle, and develop geodynamical models of how Earth's internal processes govern the Earth's continental drift, surface uplift, surface large igneous province, geochemistry, intra-plate deformation and volcanism. I also have a strong interest in the physical mechanisms of Earth's changing stress and strain, and the detection, relocation and physical mechanism of various un-conventional seismic sources including nuclear tests, induced earthquakes, hurricanes and deep earthquakes. Over the course of research, I have developed many new techniques for simulating mantle viscous flow and seismic wave propagation, detecting/locating small and unconventional seismic sources, and classifying various types of seismic events.

### **Governmental Document**

- **Wen, L.,** Chen, R. and Yu, S. (ed.), Grand challenges on earthquake hazard mitigation in China, A designated report to Chinese Academy of Sciences, China Earthquake Administration, and National Natural Science Foundation of China, 2011.

### **News Commentary**

- **Wen, L.,** Response to "The Planet Inside: scientists are probing the secrets of the inner core—and learning how it might have saved life on Earth", by Pual Voosen, *Science*, 11 April, 2022 (<https://www.science.org/content/article/scientists-probing-secrets-earths-inner-core-saved-life-planet>).

### **Peer-reviewed publications**

- Zhang, X. and **Wen, L.,** PREM-like velocity structure in the outermost core from global SKS and ScS waveform modeling, *Phys. Earth Planet. Inter.*, 344, 107091, <https://doi.org/10.1016/j.pepi.2023.107091>, 2023.

- **Wen, L. X.**, and Yu, S., The China Seismological Reference Model project, *Earth Planet. Phys.*, 7(5), 521-532. doi: 10.26464/epp2023078, 2023.
- Tian, D. and **Wen, L.**, Comment on "Inner Core Rotation Captured by Earthquake Doublets and Twin Stations" by Yang & Song, 2022, *Geophys. Res. Lett.*, 50 (15), e2023GL103173, <https://doi.org/10.1029/2023GL103173>, 2023.
- Ma, J., Sun, L., Wang, W., Wu, J., Wang, X. and **Wen, L.**, Uppermost mantle seismic Pn-velocity in continental China and its tectonic implications, *J. Geophys. Res. Solid Earth*, 128, e2022JB025667, <https://doi.org/10.1029/2022JB025667>, 2023.
- Xiao, X., Sun, L., Wang, X. and **Wen, L.**, Simultaneous inversion for surface wave phase velocity and earthquake centroid parameters: methodology and application, *J. Geophys. Res. Solid Earth*, 127, e2022JB024018, <https://doi.org/10.1029/2022JB024018>, 2022.
- Mao, Z. and **Wen, L.**, A three-dimensional adaptive receiver function migration method: (I) theory, *J. Geophys. Res. Solid Earth*, accepted.
- Cheng, S., Xiao, X., Wu, J., Wang, W., Sun, L., Wang, X. and **Wen, L.**, Crustal thickness and Vp/Vs variation beneath continental china revealed by receiver function analysis, *Geophys. J. Int.*, 228, 3, 1731-1749, <https://doi.org/10.1093/gji/ggab433>, 2022.
- Lu, Z. and **Wen, L.**, Months-long crustal deformation driven by aseismic slips and pore pressure transients triggered by local and regional earthquakes, *Geophys. Res. Lett.*, 48, 16, e2021GL095148, 2021.
- Zhu, J., Chen, X. and **Wen, L.**, Maximum covariance direction method for unconventional seismic sources, *Geophys. J. Int.*, 227, 2, 813–831, <https://doi.org/10.1093/gji/ggab232>, 2021.
- Xiao, X., Cheng, S., Wu, J., Wang, W., Sun, L., Wang, X. and **Wen, L.**, Shallow seismic structure beneath the continental China revealed by P-wave polarization, Rayleigh wave ellipticity and receiver function, *Geophys. J. Int.*, 225, 2, 998-1019, <https://doi.org/10.1093/gji/ggab022>, 2021.
- Yao, J., Tian, D., Sun, L. and **Wen, L.**, Comment on "Origin of temporal changes of inner-core seismic waves" by Yang and Song (2020), *Earth and Planet. Sci. Letts.*, 553, 116640, 2021.
- Lei, W. and **Wen, L.**, Widespread small-scale anisotropic structure in the lowermost mantle beneath the North American continent and northeastern Pacific, *Seis. Res. Lett.*, 91 (5): 2779-2790, 2020.
- **Wen, L.**, Earth's Structure, Core. In: Gupta H. (eds) *Encyclopedia of Solid Earth Geophysics*. Encyclopedia of Earth Sciences Series. Springer, Cham, 2020.
- Tang, L., Zhang, M. and **Wen, L.**, Support vector machine classification of seismic events in the Tianshan orogenic belt, *J. Geophys. Res. Solid Earth*, doi: 10.1029/2019JB018132, 2020.

- Wang, Y., He, Y., Lu, G. and **Wen, L.**, Seismic, thermal and compositional structures of the stagnant slab in the mantle transition zone beneath southeastern China, *Tectonophysics*, Article 228208, 2020.
- Yao, J., Tian, D., Sun, L. and **Wen, L.**, Temporal change of seismic Earth's inner core phases: inner core differential rotation or temporal change of inner core surface?, *J. Geophys. Res. Solid Earth*, doi:10.1029/2019JB017532, 2019.
- Xu, Y. and **Wen, L.**, Relative directivity inversion of small earthquake rupture, *Geophys. J. Int.*, 218(1), 631-639, doi:10.1093/gji/ggz179, 2019.
- Lu, Z. and **Wen, L.**, Strong hydro-related localized long-period crustal deformation observed in the Plate Boundary Observatory borehole strainmeters, *Geophys. Res. Lett.*, doi:10.1029/2018GL080856, 2018.
- Yao, J., Tian, D., Lu, Z., Sun, L. and **Wen, L.**, Triggered seismicity after North Korea's 3 September 2017 nuclear test, *Seismol. Res. Lett.*, 89 (6), 2085-2093, doi:10.1785/0220180135, 2018.
- Yao, J., Tian, D., Sun, L. and **Wen, L.**, Source characteristics of North Korea's 3 September 2017 nuclear test, *Seismol. Res. Lett.*, 89 (6), 2078-2084, doi:10.1785/0220180134, 2018.
- Tang, L., Lu, Z., Zhang, M., Sun, L. and **Wen, L.**, Seismicity induced by simultaneous abrupt changes of injection rate and well pressure in Hutubi gas field, *J. Geophys. Res. Solid Earth*, doi:10.1029/2018JB015863, 2018.
- Chen, Y., Meng, L., Zhang, A. and **Wen, L.**, Source complexity of the 2015 Mw 7.9 Bonin earthquake, *Geochemistry, Geophysics, Geosystems*, doi:10.1029/2018GC007489, 2018.
- Tian, D., Yao, J. and **Wen, L.**, Collapse and earthquake swarm after North Korea's 3 September 2017 nuclear test, *Geophys. Res. Lett.*, 45(9), 3976-3983, doi:10.1029/2018GL077649, 2018.
- Lu, Z., Yi, H. and **Wen, L.**, Loading-induced Earth's stress change over time, *J. Geophys. Res. Solid Earth*, 123(5), 4285-4306, doi:10.1029/2017JB015243, 2018.
- **Wen, L.**, Tian, D. and Yao, J., Seismic structure and dynamic process of the Earth's inner core and its boundary. *Chinese J. Geophys. (in Chinese)*, 61(3): 803-818, doi:10.6038/cjg2018L0500, 2018.
- Lu, Z. and **Wen, L.**, Abnormally strong daily-cycle S1 strain tide: observation and physical mechanism, *J. Geophys. Res. Solid Earth*, doi:10.1002/2017JB014383, 2017.
- Tian, D. and **Wen, L.**, Seismological evidence for a localized mushy zone at the Earth inner core boundary, *Nat. Commun.*, 165, doi:10.1038/s41467-017-00229-9, 2017.
- Sun, L., Zhang, M. and **Wen, L.**, A new method for high-resolution event relocation and application to the aftershocks of Lushan Earthquake, China, *J. Geophys. Res. Solid Earth*, 120, doi:10.1002/2016JB012840, 2016.

- Ma, X., Sun, X., Wiens, D.A., **Wen, L.**, Nyblade, A., Anandakrishnan, S., Aster, R., Huerta, A. and Wilson, T., Strong seismic scatterers near the core-mantle boundary north of the Pacific Anomaly. *Phys. Earth Planet. Int.*, 253, 21-30, doi:10.1016/j.pepi.2016.01.007, 2016.
- Yi, H. and **Wen, L.**, Satellite gravity measurement monitoring terrestrial water storage change and drought in the continental United States, *Sci. Rep.* 6, 19909, doi:10.1038/srep19909, 2016.
- Li, Z., Zhao, R., Hu, J. **Wen, L.**, Feng, G., Zhang, Z. and Wang, Q., InSAR analysis of surface deformation over permafrost to estimate active layer thickness based on one-dimensional heat transfer model of soils. *Sci. Rep.* 5, 15542; doi: 10.1038/srep15542, 2015.
- Zhang, M. and **Wen, L.**, Earthquake characteristics before eruptions of Japan's Ontake volcano in 2007 and 2014, *Geophys. Res. Lett.*, doi: 10.1002/2015GL065165, 2015.
- Yao, J., Sun, L. and **Wen, L.**, Two-decades of Temporal Change of Earth's Inner Core Boundary, *J. Geophys. Res. Solid Earth*, doi: 10.1002/2015JB012339, 2015.
- Chen, X., Tian, D. and **Wen, L.**, Microseismic sources during Hurricane Sandy, *J. Geophys. Res. Solid Earth*, doi: 10.1002/2015JB012282, 2015.
- Chen, Y. and **Wen, L.**, Global large deep-focus earthquakes: source process and cascading failure of shear instability as a unified physical mechanism, *Earth Planet. Sci. Lett.*, 423, 134-144, 2015.
- He, Y., **Wen, L.**, Capdeville, Y. and Zhao, L., Seismic evidence for an Iceland thermochemical plume in the Earth lowermost mantle, *Earth Planet. Sci. Lett.*, 417, 19-27, 2015.
- Zhang, M. and **Wen, L.**, An effective method for small event detection: Match and Locate (M&L), *Geophys. J. Int.*, 200 (3): 1523-1537. doi: 10.1093/gji/ggu466, 2015.
- Zhang, M. and **Wen, L.**, Seismological evidence for a low-yield nuclear test on 12 May 2010 in North Korea, *Seismol. Res. Lett.*, 86(1), doi: 10.1785/02201401170, 2015.
- He, Y., **Wen, L.**, and Zheng, T., Seismic evidence for an 850 km thick low-velocity structure in the Earth lowermost mantle beneath Kamchatka, *Geophys. Res. Lett.*, 41, doi:10.1002/2014GL061249, 2014.
- Yao, J., and **Wen, L.**, Seismic structure and ultra-low velocity zones at the base of the Earth's mantle beneath Southeast Asia, *Phys. Earth Planet. Int.*, 233, 103-111, 2014.
- Chen, Y., **Wen, L.** and Ji, C., A cascading failure during the May 24 2013 great Okhotsk deep earthquake, *J. Geophys. Res. Solid Earth*, 119, doi: 10.1002/2013JB010926, 2014.
- Zhang, M., Tian, D. and **Wen, L.**, A new method for earthquake depth determination: stacking multiple-station autocorrelograms, *Geophys. J. Int.*, 197 (2): 1107-1116., doi:10.1093/gji/ggu044, 2014.
- Wang, Y., **Wen, L.** and Weidner, D., Composition of Mars constrained using geophysical observations and mineral physics modeling, *Phys. Earth Planet. Inter.*, 224, 68-76, 2013.

- Zhang, M. and **Wen, L.**, High-precision location and yield of North Korea's 2013 nuclear test, *Geophys. Res. Lett.*, 40 (12), 2941-2946, doi:10.1029/grl.50607, 2013.
- Ghosh, A., Holt, W., and **Wen, L.**, Predicting the lithospheric stress field and plate motions by joint modeling of lithosphere and mantle dynamics, *J. Geophys. Res.*, 118, 346-368, doi:10.1029/2012JB009516, 2013.
- He, Y., and **Wen, L.**, Geographic boundary of the "Pacific Anomaly" and its geometry and transitional structure in the north, *J. Geophys. Res.*, 117, B09308, doi:10.1029/2012JB009436, 2012.
- Long, H., and **Wen, L.**, Using repeated sources to quantitatively determine temporal change of medium properties: theory and an example, *J. Geophys. Res.*, 117, B09303, doi:10.1029/2012JB009302, 2012.
- Dai, Z., Wang, W. and **Wen, L.**, Irregular topography at the Earth's inner core boundary, *Proc. Natl. Acad. Sci.*, doi:10.1073/pnas.1116342109, 2012.
- Yu, W. and **Wen, L.**, Deep-focus repeating earthquakes in the Tonga-Fiji subduction zone *Bull. Seis. Soc. Am.*, doi:10.1785/0120110272, 102, 1829-1849, 2012.
- He, Y. and **Wen, L.**, Seismic velocity structures and detailed features of the D" discontinuity near the core-mantle boundary beneath eastern Eurasia, *Phys. Earth and Planet. Int.*, 189, 176-184, 2011.
- **Wen, L.**, Structure of Earth's core, *Encyclopedia of Solid Earth Geophysics*, Ed. Gupta, H., 2011.
- **Wen, L.** and Long, H., High-precision location of North Korea's 2009 nuclear test, *Seism. Res. Lett.*, 81 (1), 26-29, 2010.
- Wang, Y., **Wen, L.** and Weidner, D., Array triplication data constraining seismic structure and composition in the mantle, *Surveys in Geophys.*, vol. 30 (4), 355, doi:10.1007/s10712-009-9073-3, 2009.
- He, Y. and **Wen, L.**, Structural features and shear-velocity structure of the "Pacific Anomaly", *J. Geophys. Res.*, 114, B02309, doi:10.1029/2008JB005814, 2009.
- Zhao, L., **Wen, L.**, Chen, L. and Zheng, T., A two-dimensional hybrid method for modeling seismic wave propagation in anisotropic media, *J. Geophys. Res.*, 113, B12307, doi:10.1029/2008JB005733, 2008.
- Ghosh, A., Holt, W. E., **Wen, L.**, Flesch, L. M., Haines, A. J., Joint modeling of lithosphere and mantle dynamics elucidating lithosphere-mantle coupling, *Geophys. Res. Lett.*, 35, L16309, doi:10.1029/2008GL034365, 2008.
- Wang, Y., **Wen, L.** and Weidner, D., Upper mantle SH- and P-velocity structures and compositional models beneath southern Africa, *Earth Planet. Sci. Lett.*, 267, 596-608, 2008.
- Wang, Y. and **Wen, L.**, Complex seismic anisotropy near the border of a very low velocity province at the base of the Earth's mantle, *J. Geophys. Res.*, 112, B09305, Doi:10.1029/2006JB004719, 2007.

- Yu, W. and **Wen, L.**, Complex seismic anisotropy in the Earth's inner core beneath Africa, *J. Geophys. Res.*, 112, B08304, Doi:10.1029/2006JB004868, 2007.
- Wang, Y. and **Wen, L.**, Geometry and P- and S- velocity structure of the "African anomaly", *J. Geophys. Res.*, 112, B05313, Doi:10.1029/2006JB004483, 2007.
- Flesch, L. M., Holt, W. E., Haines, A. J., **Wen, L.**, Shen-Tu, B., The dynamics of western North America: stress measurements and the relative role of gravitational potential energy, plate interaction at the boundary and basal tractions, *Geophys. J. Int.*, 169, 866-896, 2007.
- **Wen, L.**, Localized temporal change of the Earth's inner core boundary, *Science*, 314, 5801, 967 - 970, DOI: 10.1126/science.1131692, 2006.
- Yu, W. and **Wen, L.**, Seismic velocity and attenuation structures in the top 400 km of the inner core along the equatorial paths, *J. Geophys. Res.*, 111, B07308, doi:10.1029/2005JB003995, 2006.
- Wang, Y., **Wen, L.**, Weidner, D. and He, Y., SH velocity and compositional models near the 660-km discontinuity beneath South America and Northeast Asia, *J. Geophys. Res.*, 111, B07305, doi:10.1029/2005JB003849, 2006.
- **Wen, L.**, A compositional anomaly at the Earth's core-mantle boundary as an anchor to the relatively slowly-moving surface hotspots and as source to the DUPAL anomaly, *Earth Planet. Sci. Lett.*, 246, 138-148, 2006.
- Yu, W. and **Wen, L.**, Inner core attenuation anisotropy, *Earth Planet. Sci. Lett.*, 245, 581-594, 2006.
- He, Y., **Wen, L.**, and Zheng, T., Geographic boundary and shear velocity structure of the "Pacific anomaly" near the core-mantle boundary beneath western Pacific, *Earth Planet. Sci. Lett.*, 244, 302-314, 2006.
- Chen, L, **Wen, L.**, and Zheng T., A wave equation migration method using receiver functions: (II) application to the Japan subduction zone, *J. Geophys. Res.*, 110, B11310, doi:10.1029/2005JB003666, 2005.
- Chen, L, **Wen, L.**, and Zheng T., A wave equation migration method using receiver functions: (I) Theory, *J. Geophys. Res.*, 110, B11309, doi:10.1029/2005JB003665, 2005.
- Yu, W., **Wen, L.**, and Niu, F., Seismic velocity structure in the Earth's outer core, *J. Geophys. Res.*, 110, B02302, doi:10.1029/2003JB002928, 2005.
- Wang, Y. and **Wen, L.**, Mapping the geometry and geographic distribution of a very-low velocity province at the base of the Earth's mantle, *J. Geophys. Res.*, 109, B10305, doi:10.1029/2003JB002674, 2004.
- Butler, R., Lay, T., Creager, C., Earl, P., Fischer, K., Gaherty, J., Laske, G., Leith, B., Park, J., Ritzwoller, M., Tromp, J., and **Wen, L.**, The Global Seismographic Network surpasses its design goals, *EOS*, 85, 225-232, 2004.

- Niu F. and **Wen, L.**, Difference in seismic velocity between the eastern and western hemispheres in the top of the earth's inner core, *Global Tectonics and Metallogeny*, 8, 109-111, 2003.
- **Wen, L.**, Inner core anisotropy and hemisphericity, *McGraw-Hill 2003 Yearbook of Science and Technology*, McGraw-Hill, New York, 192-195, 2003.
- **Wen, L.**, and Niu, F., Seismic velocity and attenuation structures in the top of the Earth's inner-core, *J. Geophys. Res.*, 107 (B11), 2273, doi:10.1029/2001JB000170, 2002.
- Niu, F. and **Wen, L.**, Seismic anisotropy in the top 400 km of the inner core beneath the "eastern" hemisphere, *Geophys. Res. Lett.*, 29, No 12, 10.1029/2001GL014118, June 29, 2002.
- **Wen, L.**, An SH hybrid method and shear velocity structures in the lowermost mantle beneath the central Pacific and South Atlantic oceans, *J. Geophys. Res.*, 107, B3, 10.1029/2001JB000499 29 March 2002, 2002.
- **Wen, L.**, Seismic evidence for a rapidly-varying compositional anomaly at the base of the Earth's mantle beneath the Indian ocean, *Earth Planet. Sci. Lett.*, 194, 83-95, 2001.
- Niu, F. and **Wen, L.**, Strong seismic scatterers near the core-mantle boundary west of Mexico, *Geophys. Res. Lett.*, 28, 3557-3560, 2001.
- **Wen, L.**, Silver, P., James, D. and Kuehnel, R., Seismic evidence for a thermo-chemical boundary layer at the base of the Earth's mantle, *Earth Planet. Sci. Lett.*, 189, 141-153, 2001.
- Niu, F. and **Wen, L.**, Hemispherical variations in seismic velocity at the top of the Earth's inner-core, *Nature*, 410, 1081-1084, 2001.
- **Wen, L.**, Intense seismic scattering near the Earth's core-mantle boundary beneath the Comoros hotspot, *Geophys. Res. Lett.*, 27, 3627-3630, 2000.
- Helmberger, D.V., Si, N., **Wen, L.** and Ritsema, J., Seismic evidence for ultra low velocity zones beneath Africa and the Atlantic Ocean, *J. Geophys. Res.*, 105, 23,865-23,878, 2000.
- Helmberger, D.V., **Wen, L.** and Ding, X., Seismic evidence that the source of the Iceland hotspot lies at the core-mantle boundary, *Nature*, 396, 251-255, 1998.
- **Wen, L.** and Helmberger, D.V., Ultra-low velocity zones near the core-mantle boundary from broadband PKP precursors, *Science*, 279, 1701-1703, 1998.
- **Wen, L.** and Helmberger, D.V., A 2D P-SV hybrid method and its application to localized structures near the core-mantle boundary, *J. Geophys. Res.*, 103, 17,901-17,918, 1998.
- **Wen, L.** and Anderson, D.L., Present-day plate motion constraint on mantle rheology and convection, *J. Geophys. Res.*, 102, 24,639-24,654, 1997.
- **Wen, L.** and Anderson, D.L., Layered mantle convection: a model for Geoid and topography, *Earth Planet. Sci. Lett.*, 146, 367-377, 1997.



- **Wen, L.** and Anderson, D.L., Slabs, hotspots, cratons and mantle convection revealed from residual seismic tomography in the upper mantle, *Phys. Earth Planet. Int.*, 99, 131-143, 1997.
- **Wen, L.** and Helmberger, D.V., Propagational corrections for basin structure: Lander's earthquake, *Bull. Seism. Soc. Am.*, 87, 782-787, 1997.
- **Wen, L.** and Anderson, D.L., The fate of the slabs inferred from seismic tomography and 130 Ma subduction, *Earth Planet. Sci. Lett.*, 133, 185-198, 1995.
- **Wen, L.** and Yao, Z.X., A study of the effects of the Feitsui canyon topography on the ground strong motion -using 2.5-D SH hybrid method and the strong motion records at a station, *ACTA, Geophysica Sinica*, 38, 64-70, 1995.
- **Wen, L.** and Yao, Z.X., Theory and application of hybrid method seismograms, *ACTA, Geophysica Sinica*, 37, 211-219, 1994.
- Yao, Z.X., Zheng T.-Y. and **Wen, L.**, Moment Tensor inversion method for determining the earthquake process by the use of P-Wave from data, *ACTA, Geophysica Sinica*, 37, 36-44, 1994.

#### **Some writing may be of value**

- Water, WR and **Wen, L.**, Preface to the focus section on North Korea's September 2017 nuclear test and its aftermath, *Seismol. Res. Lett.*, 89 (6): 2013–2016, <https://doi.org/10.1785/0220180281>(2018).