

Curriculum Vitae

MICHAEL H. RITZWOLLER

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Citizenship: U.S.
Date of Birth: July 29, 1954

Research Interests

Theoretical, computational, and observational seismology, geophysical imaging and inversion, seismic tomography, seismic surface waves and normal modes, modeling the Earth's crust and mantle, use of seismology in nuclear monitoring, shallow subsurface imaging using seismic waves and surface NMR, and the use of ambient noise and coda waves for subsurface imaging.

Education

1976 A.B. Marquette University
1980 M.A. University of Illinois
1982 M.S. University of Wisconsin
1987 PhD University of California, San Diego

Positions held

2003 to present Professor, Department of Physics, University of Colorado, Boulder
1999 to present Director, Center for Imaging the Earth's Interior
1997 - 2003 Associate Professor, Department of Physics, University of Colorado, Boulder
1990 - 1998 Fellow, CIRES, University of Colorado, Boulder
1991 - 1993 Co-Director, Joint Seismic Program Center, University of Colorado, Boulder
1990 - 1997 Assistant Professor, Department of Physics, University of Colorado, Boulder
1987 - 1990 Post-Doctoral Fellow, Department of Earth and Planetary Sciences, Harvard University
1987 Post-Doctoral Researcher, Institute of Geophysics and Planetary Physics, UCSD
1982 - 1987 Research Assistant, Institute of Geophysics and Planetary Physics, UCSD
1980 - 1982 Research Assistant, Department of Geology and Geophysics, University of Wisconsin, Madison

Research Mentors

M.S. Charles Bentley (Wisconsin)
Ph.D. Guy Masters, Freeman Gilbert (UCSD)
Post-Doc John Woodhouse (Harvard)

Awards

- 2005 American Geophysical Union, Fellow
- 2004-2005 University of Colorado Faculty Fellowship
- 1998-1999 University of Colorado Faculty Fellowship
- 1990 Fellow, Institute for Theoretical Physics, University of California, Santa Barbara
- 1982-1983 University of California Regents' Fellowship
- 1982-1983 Scripps Director's Fellowship

Professional Societies

- American Association for the Advancement of Science
- American Geophysical Union
- Royal Astronomical Society
- Seismological Society of America
- Society for Exploration Geophysicists

Recent National and International Service

- 2007-present Incorporated Research Institutions for Seismology (IRIS) Data Management System Standing Committee
- 2007 Organizing Committee, CIG/SPICE Joint Workshop, Jackson, NH Oct 2007.
- 2006 Organizing Committee, EarthScope/CIG Computational Seismology Workshop, St Louis, MO Oct 21 - Nov2 2006.
- 2005-2008 Incorporated Research Institutions for Seismology (IRIS) Transportable Array Working Group
- 2004-present Journal of Geophysical Research Solid Earth, Associate Editor
- 2005-present Computational Seismology Working Group of the Computational Infrastructure for Geodynamics
- 2004 Organizing Committee, Summer School on Mathematical Geophysics and Uncertainty in Earth Models, Golden, CO, June 14-25, 2004.
- 2004-2007 Incorporated Research Institutions for Seismology (IRIS) Global Seismic Network Standing Committee
- 2004 Lecturer, Abdus Salam International Centre for Theoretical Physics, Seventh Workshop on 3-D Modeling of Seismic Wave Generation, Propagation and their Inversion, Trieste, Italy, October, 2004.
- 2003 Organizing Committee (Chair), Structure and Evolution of the Antarctic Plate 2003 Workshop, Boulder, CO, March, 2003.
- 2002 Organizing Committee, Ocean Mantle Dynamics Workshop, Snowbird, UT, September, 2002.
- 2001 Colorado School of Mines, Geophysics Department, Advisory Committee
- 2001 Steering Committee, International Workshop on Seismic Tomography and Event Location: Reviews and Latest Developments, Umbria, Italy, June, 2001.
- 2000 Lecturer, Abdus Salam International Centre for Theoretical Physics, Fifth Workshop on 3-D Modeling of Seismic Wave Generation, Propagation and their Inversion, Trieste, Italy, September, 2000.

- 1999 Steering Committee, International Workshop on Tomographic
 Imaging of 3-D Velocity Structure and Accurate Earthquake Location,
 Paphos, Cyprus, 5 - 9 July, 1999.
- 1999 Chair, Workshop on Eurasian Tomography, Boulder, CO, February, 1999.
- 1998 Co-Chair, Workshop on the U.S. Use of Surface Waves for CTBT Monitoring,
 Boulder, CO, March, 1998.
- 1996 - 1997 American Geophysical Union, Editorial Search Committee
- 1996 Lecturer, Abdus Salam International Centre for Theoretical Physics,
 Third Workshop on 3-D Modeling of Seismic Wave, Generation, Propagation
 and their Inversion, Trieste, Italy, September, 1996.
- 1996 USGS, Albuquerque Data Collection Center Evaluation Committee
- 1996 - 2001 Reviews of Geophysics, Associate Editor
- 1994 - 2007 IRIS, Board of Directors and later Institutional Representative

Selected Bibliography for Michael H. Ritzwoller

Refereed publications sorted by year

119. Moschetti, M.P., M.H. Ritzwoller, and F.C. Lin, Seismic evidence for widespread crustal flow caused by extension in the western USA, submitted to Nature.
118. Bensen, G.D., M.H. Ritzwoller, and Y. Yang, A 3D shear velocity model of the crust and uppermost mantle beneath the United States from ambient seismic noise, *Geophys. J. Int.*, 177(3), 1177-1196, 2009.
117. Lin, F.-C., M.H. Ritzwoller, and R. Snieder, Eikonal Tomography: Surface wave tomography by phase-front tracking across a regional broad-band seismic array, *Geophys. J. Int.*, 177(3), 1091-1110, 2009.
116. Bensen, G.D., M.H. Ritzwoller, and N.M. Shapiro, Broad-band ambient noise surface wave tomography across the United States, *J. Geophys. Res.*, 113, B05306, 21 pages, doi:10.1029/2007JB005248, 2008.
115. Lin, F., M.P. Moschetti, and M.H. Ritzwoller, Surface wave tomography of the western United States from ambient seismic noise: Rayleigh and Love wave phase velocity maps, *Geophys. J. Int.*, doi:10.1111/j.1365-246X.2008.03720.x, 2008.
114. Shapiro, N.M., M.H. Ritzwoller, and E.R. Engdahl, Structural context of the great Sumatra-Andaman Island earthquake, *Geophys. Res. Lett.*, 35, L05301, doi:10.1029/2008GL033381, 2008.
113. Yang, Y. and M.H. Ritzwoller, The characteristics of ambient seismic noise as a source for surface wave tomography, *Geochem., Geophys., Geosyst.*, 9(2), Q02008, 18 pages, doi:10.1029/2007GC001814, 2008.
112. Yang, Y., A. Li, and M.H. Ritzwoller, Crustal and uppermost mantle structure in southern Africa revealed from ambient noise and teleseismic tomography, *Geophys. J. Int.*, doi:10.1111/j.1365-246X.2008.03779.x, 2008.
111. Yang, Y. and M.H. Ritzwoller, Teleseismic surface wave tomography in the western US using the Transportable Array component of USArray, *Geophys. Res. Letts.*, 5, L04308, doi:10.1029/2007GL032278, 2008
110. Yang, Y., M.H. Ritzwoller, F.-C. Lin, M.P. Moschetti, and N.M. Shapiro, The structure of the crust and uppermost mantle beneath the western US revealed by ambient noise and earthquake tomography, *J. Geophys. Res.*, 113, B12310, 2008.
109. Zheng, S., X. Sun, X. Song, Y. Yang, and M. H. Ritzwoller (2008), Surface wave tomography of China from ambient seismic noise correlation, *Geochem. Geophys. Geosyst.*, 9, Q0502, doi:10.1029/2008GC001981, 2008.
108. Bensen, G.D., M.H. Ritzwoller, M.P. Barmin, A.L. Levshin, F. Lin, M.P. Moschetti, N.M. Shapiro, and Y. Yang, Processing seismic ambient noise data to obtain reliable broad-band surface wave dispersion measurements, *Geophys. J. Int.*, 169, 1239-1260, doi: 10.1111/j.1365-246X.2007.03374.x, 2007.
107. Levshin, A.L., J. Schweitzer, C. Weidle, N.M. Shapiro, and M.H. Ritzwoller, Surface wave tomography of the Barents Sea and surrounding regions, *Geophys. J. Int.*, doi:10.1111/j.1365-246X.2006.03285.x, 2007.
106. Lin, F., M.H. Ritzwoller, J. Townend, M. Savage, S. Bannister, Ambient noise Rayleigh wave tomography of New Zealand, *Geophys. J. Int.*, 18 pages, doi:10.1111/j.1365-246X.2007.03414.x, 2007.
105. Moschetti, M.P., M.H. Ritzwoller, and N.M. Shapiro, Surface wave tomography of the western United States from ambient seismic noise: Rayleigh wave group velocity maps, *Geochem., Geophys., Geosyst.*, 8, Q08010, doi:10.1029/2007GC001655, 2007.

104. Yang, Y., M.H. Ritzwoller, A.L. Levshin, and N.M. Shapiro, Ambient noise Rayleigh wave tomography across Europe, *Geophys. J. Int.*, 168(1), page 259, 2007.
103. Villasenor, A., Y. Yang, M.H. Ritzwoller, and J. Gallart, Ambient noise surface wave tomography of the Iberian Peninsula: Implications for shallow seismic structure, *Geophys. Res. Lett.*, 34, L11304, doi:10.1029/2007GL030164, 2007.
102. Zhong, S., M.H. Ritzwoller, N.M. Shapiro, W. Landuyt, J. Huang, and P. Wessel, Bathymetry of the Pacific Plate and its implications for the thermal evolution of lithosphere and mantle dynamics, *J. Geophys. Res.*, 112, B06412, doi:10.1029/2006JB004628, 2007.
101. Lin, F., M. H. Ritzwoller, and N. M. Shapiro, Is ambient noise tomography across ocean basins possible?, *Geophys. Res. Lett.*, 33, L14304, doi:10.1029/2006GL026610, 2006.
100. Shapiro, N.M., M.H. Ritzwoller, and G.D. Bensen, Source location of the 26 sec microseism from cross correlations of ambient seismic noise, *Geophys. Res. Lett.*, 33, L18310, doi:10.1029/2006GL027010, 2006.
99. Shapiro, N.M. M. Campillo, L. Stehly, and M.H. Ritzwoller, High resolution surface wave tomography from ambient seismic noise, *Science*, 307(5715), 1615-1618, 11 March 2005.
98. van Hunen, J., S. Zhong, N.M. Shapiro, and M.H. Ritzwoller, New evidence for dislocation creep from 3-D geodynamic modeling of the Pacific upper mantle, *Earth Planet Sci. Lett.*, doi:10.1016/j.epsl.2005.07.006, 10 pps., 2005.
97. Yang, X., A.R. Lowry, A.L. Levshin, and M.H. Ritzwoller, Toward a Rayleigh wave attenuation model for Eurasia and calibrating a new M_s formula, *Proceedings of the 27th Seismic Research Review – Ground-Based Nuclear Explosion Monitoring*, Palm Springs, CA (Sept 20 - 22, 2005), 2005.
96. Levin, V., N.M. Shapiro, J. Park, and M.H. Ritzwoller, The slab portal beneath the Western Aleutians, *Geology*, 33(4), 253-256, 2005.
95. Levshin, A.L., M.P. Barmin, M.H. Ritzwoller, and J. Trampert, Minor-arc and major-arc global surface wave diffraction tomography, *Phys. Earth Planet. Int.*, 149, 205-223, 2005.
94. Levshin, A.L., M.H. Ritzwoller, and N.M. Shapiro, The use of crustal higher modes to constrain crustal structure across Central Asia, *Geophys. J. Int.*, 160, 961-972, 2005.
93. Shapiro, N.M. M.H. Ritzwoller, J.C. Mareschal, and C. Jaupart, Lithospheric structure of the Canadian Shield inferred from inversion of surface-wave dispersion with thermodynamic a priori constraints, *Geol. Soc. Lond. Spec. Publ., Geological Prior Information*, ed. R. Wood and A. Curtis, 239, 175-194, 2005.
92. Smith, D.B., M.H. Ritzwoller, and N.M. Shapiro, Stratification of anisotropy in the Pacific upper mantle, *J. Geophys. Res.*, 109, B11309, 2004.
91. Butler, R. T. Lay, K. Creager, P. Earl, K. Fischer, J. Gaherty, G. Laske, B. Leith, J. Park, M. Ritzwoller, J. Tromp, and L. Wen, The global seismic network surpasses its design goal, *Eos.*, 85(23), 8 June 2004.
00. Ritzwoller, M.H., N.M. Shapiro, S. Zhong, Cooling history of the Pacific lithosphere, *Earth Planet. Sci. Letts.*, 226, 69-84, 2004.
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88. Shapiro, N.M., M.H. Ritzwoller, P. Molnar, and V. Levin, Thinning and flow of Tibetan crust constrained by seismic anisotropy, *Science*, 305, 233-236, 9 July 2004.
87. Shapiro, N.M. and M.H. Ritzwoller, Inferring surface heat flux distributions guided by a global seismic model: Particular application to Antarctica, *Earth Planet. Sci. Lett.*, 223, 213 - 224, 2004.

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84. Ritzwoller, M.H., N.M. Shapiro, A.L. Levshin, E.A. Bergman, and E.R. Engdahl, The ability of a global 3-D model to locate regional events, *J. Geophys. Res.*, 108, no. B7, 2353, ESE 9-1 - ESE 9-24, 2003.
83. Levin, V., N.M. Shapiro, J. Park, and M.H. Ritzwoller, Seismic evidence for catastrophic slab loss beneath Kamchatka, *Nature*, 418, 763-767, 15 Aug 2002.
(**Nature Magazine “News and Views” article by Huw Davies:**
<http://ciei.colorado.edu/pubs/2002/1a.pdf>.)
82. Levshin, A.L. and M.H. Ritzwoller, Application of a global-scale 3-D model to improve regional locations, *Stud. Geophys. Geod.*, 46, 283-292, 2002.
81. Ritzwoller, M.H. and A.L. Levshin, Estimating shallow shear velocities with marine multi-component seismic data, *Geophysics*, 67 (6), 1991-2004, 2002.
80. Ritzwoller, M.H., N.M. Shapiro, M.P. Barmin, and A.L. Levshin, Global surface wave diffraction tomography, *J. Geophys. Res.*, 107(B12), 2335, 2002.
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77. Villasenor, A., M.P. Barmin, M.H. Ritzwoller, and A.L. Levshin, Computation of regional travel times and station corrections for three-dimensional velocity models, report.
76. Weichman, P.B., Lun, D.R., M.H. Ritzwoller, and E.M. Lavelly, Study of surface nuclear magnetic resonance inverse problems, *J. Appl. Geophys.*, 50, 129-147, 2002.
75. Barmin, M.P., M.H. Ritzwoller, and A.L. Levshin, A fast and reliable method for surface wave tomography, *Pure Appl. Geophys.*, 158(8), 1351 - 1375, 2001.
74. Bukchin, B.G., A.Z. Mostinsky, A.A. Egorkin, A.L. Levshin, and M.H. Ritzwoller, Isotropic and nonisotropic components of earthquakes and nuclear explosions on the Lop Nor test site, China, *Pure Appl. Geophys.*, 158(8), 1497 - 1515, 2001.
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72. Levshin, A.L. and M.H. Ritzwoller, Automated detection, extraction, and measurement of regional surface waves, *Pure Appl Geophys*, 158(8), 1531 - 1545, 2001.
71. Levshin, A.L., and M.H. Ritzwoller, Surface waves in seismology and seismic prospecting, Problems in dynamics of the lithosphere and seismicity, *Computational Seismology*, 32, Moscow, GEOS, 27-32, 2001. (in Russian)
70. Levshin, A.L. and M.H. Ritzwoller, Monitoring a Comprehensive Nuclear Test Ban Treaty: Surface Waves, editors, 243 pps., Birkhauser, Basel, Switzerland, 2001.
69. Levshin, A.L., M.H. Ritzwoller, M.P. Barmin, A. Villasenor, and C.A. Padgett, New constraints on the Arctic crust and uppermost mantle: Surface wave group velocities, P_n , and S_n , *Phys. Earth Planet. Int.*, 123(2-4), 185 - 204, 2001.
68. Ritzwoller, M.H. and A.L. Levshin, Monitoring the Comprehensive Nuclear Test Ban Treaty – Introduction, *Pure Appl. Geophys.*, 158(8), 1341 - 1348, 2001.
67. Ritzwoller, M.H., N.M. Shapiro, A.L. Levshin, and G.M. Leahy, The structure of the crust and upper mantle beneath Antarctica and the surrounding oceans, *J. Geophys. Res.*, 106(B12), 30645 - 30670, 2001. (**Science Magazine “Editor’s Choice” selection on 11 Jan. 2002:** http://ciei.colorado.edu/pubs/Antarctica_science2002.pdf.)

66. Villasenor, A., M.H. Ritzwoller, A.L. Levshin, M.P. Barmin, E.R. Engdahl, W. Spakman, and J. Trampert, Shear velocity structure of Central Eurasia from inversion of surface wave velocities, *Phys. Earth Planet. Int.*, 123(2-4), 169 - 184, 2001.
65. Weichman, P.B., E.M. Lavelly, and M.H. Ritzwoller, Theory of surface nuclear magnetic resonance with applications to geophysical imaging problems, *Phys. Rev. E.*, 62, 1290-1312, 2000.
64. James, M.B. and M.H. Ritzwoller, Feasibility of truncated perturbation expansions to approximate Rayleigh wave eigenfrequencies and eigenfunctions in heterogeneous media, *Bull. Seism. Soc. Am.*, 89, 433-442, 1999.
63. Levshin, A.L., M.H. Ritzwoller, and J.S. Resovsky, Source effects on surface wave group travel times and group velocity maps, *Phys. Earth Planet. Int.*, 115, 293 - 312, 1999.
62. Resovsky, J.S. and M.H. Ritzwoller, A degree 8 mantle shear velocity model from normal mode observations below 3 mHz, *J. Geophys. Res.*, 104, 993-1014, 1999.
(**Nature Magazine “News and Views” article by Rudolph Widmer:**
http://ciei/pubs/nature_nandv.pdf.)
61. Resovsky, J.S. and M.H. Ritzwoller, Regularization uncertainty in density models estimated from normal mode data, *Geophys. Res. Lett.*, 26, 2319-2322, 1999.
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59. Weichman, P.B., E.M. Lavelly, and M.H. Ritzwoller, Surface nuclear magnetic resonance imaging of large systems, *Phys. Rev. Lett.*, 82, 4102-4105, 1999. (**Physical Review “Focus” article:** <http://focus.aps.org/v3/st27.html>)
58. Resovsky, J.S. and M.H. Ritzwoller, New and refined constraints on 3-D earth structure from normal modes below 3mHz, *J. Geophys. Res.*, 103, 783 - 810, 1998.
57. Ritzwoller, M.H. and A.L. Levshin, Eurasian surface wave tomography: Group velocities, *J. Geophys. Res.*, 103, 4839 - 4878 1998.
56. Ritzwoller, M.H., A.L. Levshin, L.I. Ratnikova, and A.A. Egorkin, Intermediate period group velocity maps across Central Asia, Western China, and parts of the Middle East, *Geophys. J. Int.*, 134, 315-328, 1998.
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54. Rial, J.A. and M.H. Ritzwoller, Characteristics of Lg propagation across South America, *Geophys. Jour. Int.*, 131, 401-408, 1997.
53. Levshin, A.L. and M. H. Ritzwoller, Characteristics of surface waves generated by events on and near the Chinese nuclear test site, *Geophys. J. Int.*, 123, 131-149, 1995.
52. Resovsky, J.S. and M.H. Ritzwoller, Constraining odd-degree mantle structure with normal modes, *Geophys. Res. Lett.*, 22, 2301-2304, 1995.
51. Ritzwoller, M.H. and E.M. Lavelly, Three-dimensional seismic models of the Earth’s mantle, *Revs. of Geophys.*, 33, 1-66, 1995.
50. Ritzwoller, M.H. and J. Resovsky, The feasibility of normal mode constraints on higher degree structures, *Geophys. Res. Lett.*, 22, 2305-2308, 1995.
49. Lavelly, E.M., A. Rodgers, and M.H. Ritzwoller, Can the differential sensitivity of body wave, mantle wave, and normal mode data resolve the trade-off between transition zone structure and boundary topography?, *Physics Earth Planet. Ints.*, 86, 117-146, 1994.
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47. Resovsky, J. S. and M. H. Ritzwoller, Characterizing the long-period seismic effects of long-wavelength elastic and anelastic models, *Geophys. J. Internatl.*, 117, 365 - 393, 1994.
46. Durek, J., Ritzwoller, M.H., and Woodhouse, J.H., Constraining upper mantle anelasticity using surface wave amplitude anomalies, *Geophys. J. Int.*, 114, 249-272, 1993.
45. Kelly, J.F., and Ritzwoller, M.H., 1993. Helioseismic line-shape estimation given stochastic excitation, *Ap. J.*, 418, 476 - 489, 1993.
44. Lively, E. M. and M. H. Ritzwoller, Average effects of large-scale convection on helioseismic line widths and frequencies, *Ap. J.*, 403, 810-832, 1993.
43. Ritzwoller, M. H. and J. Kelly, Detecting giant cell convection with helioseismic linewidths, *GONG 1992: Seismic Investigation of the Sun and Stars*, (T. Brown ed.), *Astophys. Soc. Pac.*, 42, 261 - 264, 1993.
42. Lively, E. M. and M. H. Ritzwoller, The effect of global-scale, steady-state convection and elastic-gravitational asphericities on helioseismic oscillations, *Phil. Trans. R. Soc. Lond. A*, 339, 431-496, 1992.
41. Ritzwoller, M. H. and E. M. Lively, A unified approach to the helioseismic forward and inverse problems of differential rotation, *Ap. J.*, 369, 557-566, 1991.
40. Ritzwoller, M. H., G. Masters and F. Gilbert, Constraining aspherical structure with low harmonic degree interaction coefficients: Application to uncoupled multiplets, *J. Geophys. Res.*, 93, 6269-6396, 1988.
39. Masters, G. and M. H. Ritzwoller, Low frequency seismology and three dimensional structure: Observational aspects, in *Mathematical Geophysics, A survey of recent developments in seismology and geodynamics*, edited by N. J. Vlaar, G. Nolet, M. J. R. Wortel, and S. A. P. L. Cloetingh, Reidel Publ., Dordrecht, the Netherlands, 1987.
38. Ritzwoller, M. H., G. Masters and F. Gilbert, Observations of anomalous splitting and their interpretation in terms of aspherical structure, *J. Geophys. Res.*, 91, 10203-10228, 1986.
37. Ritzwoller, M. H. and C. R. Bentley, Magsat magnetic anomalies over Antarctica and the surrounding oceans, *Geophys. Res. Lett.* 9, 285-288, 1982.

Unrefereed publications sorted by year

36. Ritzwoller, M.H., Ambient noise seismic imaging, *McGraw Hill Yearbook of Science and Technology 2009*.
35. Bergman, E.A., E.R. Engdahl, M.H. Ritzwoller, and S.C. Myers, Crustal structure of the Iran region from in-country and ground truth data, *Proceedings of the 30th Monitoring Research Review of Ground-Based Nuclear Explosion Monitoring Technologies*, 10 pages, Portsmouth, VA (Sept 23 - 25), 2008.
34. Levshin, A.L., M.P. Barmin, X. Yang, M.H. Ritzwoller, Toward a Rayleigh wave attenuation model for Asia and surrounding regions, *Proceedings of the 30th Monitoring Research Review of Ground-Based Nuclear Explosion Monitoring Technologies*, 10 pages, Portsmouth, VA (Sept 23 - 25), 2008.
33. Ritzwoller, M.H., Ambient noise tomography in the western US using data from the EarthScope/USArray Transportable Array, *IRIS's Annual Report 2008*.
32. Ritzwoller, M.H., Y. Yang, M. Pasyanos, and S. Zheng, Short period surface wave dispersion from ambient noise tomography in western China, *Proceedings of the 30th Monitoring Research Review of Ground-Based Nuclear Explosion Monitoring Technologies*, 10 pages, Portsmouth, VA (Sept 23 - 25), 2008.

31. Song, X., X. Sun, S. Zheng, Y. Yang, and M.H. Ritzwoller, Surface wave dispersion measurements and tomography from ambient seismic noise correlation in China, Proceedings of the 30th Monitoring Research Review of Ground-Based Nuclear Explosion Monitoring Technologies, 10 pages, Portsmouth, VA (Sept 23 - 25), 2008.
30. Levshin, A.L., M.P. Barmin, X. Yang, M.H. Ritzwoller, and G.E. Randall, Toward a Rayleigh wave attenuation model for Central Asia and surrounding regions, Proceedings of the 29th Monitoring Research Review of Ground-Based Nuclear Explosion Monitoring Technologies, 10 pages, Denver, CO (Sept 25 - 27), 2007.
29. Ritzwoller, M.H., Y. Yang, R. Richmond, M.E. Pasyanos, A. Villasenor, V. Levin, R. Hofstetter, V. Pinsky, N. Kraeva, and A. Lerner-Lam, Short period surface wave dispersion across the Mediterranean region: Improvements using regional seismic networks, Proceedings of the 29th Monitoring Research Review of Ground-Based Nuclear Explosion Monitoring Technologies, 10 pages, Denver, CO (Sept 25 - 27), 2007.
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27. Ritzwoller, M.H., M.E. Pasyanos, Y. Yang, A.L. Levshin, and N.M. Shapiro, Progress toward broad-band ambient noise tomography in Eurasia, Proceedings of the 28th Seismic Research Review – Ground-Based Nuclear Explosion Monitoring, Orlando, FL (Sept 19 - 21), 2006.
26. Engdahl, E.R., E.A. Bergman, M.H. Ritzwoller, N.M. Shapiro, and A.L. Levshin, A reference data set for validating 3-D models, Proceedings of the 24rd Seismic Research Review – Nuclear Explosion Monitoring: Innovation and Integration, 261-270, 2002.
25. Levshin, A., J. Stevens, M. Ritzwoller, and D. Adams, Short-period (7s-15s) group velocity measurements and maps in Central Asia, Proceedings of the 24rd Seismic Research Review – Nuclear Explosion Monitoring: Innovation and Integration, 98-106, 2002.
24. McLaughlin, K. et al., Seismic location calibration in the Mediterranean, North Africa Middle East, and Western Eurasia, Proceedings of the 24rd Seismic Research Review – Nuclear Explosion Monitoring: Innovation and Integration, 320-329, 2002.
23. Levshin, A.L., M.H. Ritzwoller, M.P. Barmin, and J. Stevens, Short period group velocity measurements and maps in Central Asia, Proceedings of the 23rd Seismic Research Review: Worldwide Monitoring of Nuclear Explosions, 258-269, Oct 2-5, 2001.
22. McLaughlin, K, et al., Seismic location calibration in the Mediterranean, N. Africa, Middle East, and W. Eurasia, Proceedings of the 23rd Seismic Research Review: Worldwide Monitoring of Nuclear Explosions, 270-279, Oct 2-5, 2001.
21. Ritzwoller, M.H. and N.M. Shapiro, Lithospheric inversions and the assimilation of complementary information: Some examples relevant for EarthScope, Proceedings of the EarthScope Workshop, 383-387, Snowbird, Utah, Oct 10-12, 2001.
20. Shapiro, N.M., M.H. Ritzwoller, M. Barmin, P. Weichman, L. Tenorio, W. Navidi, Capturing uncertainties in source-specific station corrections derived from a 3-D model, Proceedings of the 23rd Seismic Research Review: Worldwide Monitoring of Nuclear Explosions, 395-403, Oct 2-5, 2001.
19. Bondar, I. et al., Source specific station correction surfaces (SSSCs) for international monitoring system (IMS) seismic stations in N. Africa, N. East, and W. Asia, Proceedings of the 22nd Seismic Research Symposium for Monitoring a CTBT, New Orleans, LA, 10pp., 12 - 15 September, 2000.
18. Levshin, A.L., M.H. Ritzwoller, B.G. Bukchin, A.Z. Mostinsky, and A.A. Egorkin, Isotropic and nonisotropic components of earthquakes and nuclear explosions on the

- Lop Nor test site, Proceedings of the 22nd Seismic Research Symposium for Monitoring a CTBT, New Orleans, LA, 10pp., 12 - 15 September, 2000.
17. Levshin, A.L. and M.H. Ritzwoller, Use of the Kyrgyz seismic network to assess the performance of the international monitoring system in and around Kyrgyzia, Report to DTRA and ACDA, 25 pp., 2000.
 16. Ritzwoller, M.H. and A.L. Levshin, Estimating shallow shear velocities with marine multi-component seismic data, Proceedings of Seismic Inverse Methods for Complex Structures, 125 - 142, Center for Wave Phenomena, Vail, CO, 9 - 13 May, 2000.
 15. Ritzwoller, M.H., M.P. Barmin, A.L. Levshin, A. Villasenor, and E.R. Engdahl, Estimates of P_n and S_n across Eurasia, Proceedings of the 22nd Seismic Research Symposium for Monitoring a CTBT, New Orleans, LA, 10pp., 12 - 15 September, 2000.
 14. Ritzwoller, M.H., M.P. Barmin, A.L. Levshin, A. Villasenor, and E.R. Engdahl, Estimates of P_n and S_n across Eurasia, Proceedings of the 22nd Seismic Research Symposium for Monitoring a CTBT, New Orleans, LA, 10pp., 12 - 15 September, 2000.
 13. Levshin, A.L., M.P. Barmin, and M.H. Ritzwoller, Evaluation of uncertainties and bias in surface wave tomographic maps and travel time correction surfaces, 21st Seismic Research Symposium, 1999.
 12. Ritzwoller, M.H., A. Villasenor, A., A.L. Levshin, E.R., Engdahl, M.P. Barmin, W. Spakman, and J. Trampert, Construction of a 3-D P and S model of the crust and upper mantle to improve regional locations in W. China, Central Asia, and parts of the Middle East, 21st Seismic Research Symposium, 1999.
 10. Levshin, A.L., M.H. Ritzwoller, M.P. Barmin, L.I. Ratnikova, and C.A. Padgett, Automated surface wave analysis using phase-matched filters from dispersion maps, 20th Annual Seismic Research Symposium on Monitoring a CTBT, Proceedings, September 21-23, 1998.
 9. Walter, W. and M.H. Ritzwoller, Workshop Report on the U.S. Use of Surface Waves for Monitoring the Comprehensive Test Ban Treaty, Results and recommendations from the Boulder Surface Wave Workshop, March 19 and 20, 1998.
 8. Levshin, A.L., M.H. Ritzwoller, L.I. Ratnikova, M. Silitch, R. Kelly, and B. O'Sullivan, Intermediate period group velocity maps across Central Asia and parts of the Middle East, Proceedings of the 19th Seismic Research Symposium on Monitoring a CTBT, 67 - 76, 1997.
 7. Levshin, A.L., M.H. Ritzwoller, and S.S. Smith, Group velocity variations across Eurasia, Proceedings of the 18th Seismic Research Symposium on Monitoring a CTBT, 70 - 79, 1996.
 6. Ritzwoller, M.H., A.L. Levshin, L.I. Ratnikova, and D.M. Tremblay, High resolution group velocity variations across Central Asia, Proceedings of the 18th Seismic Research Symposium on Monitoring a CTBT, 98 - 107, 1996.
 5. Levshin, A.L. and M.H. Ritzwoller, Surface wave group velocity measurements across Eurasia, Proceedings of the 17th Seismic Research Symposium on Monitoring a CTBT, 226-236, 1995.
 4. Ritzwoller, M.H., Deja Q: Anelasticity of the Earth's Deep Interior, Deep Earth Dialog, 9, 14-16, 1995.
 3. Ritzwoller, M.H., A.L. Levshin, S.S. Smith, and C.S. Lee, Making accurate continental broadband surface wave measurements, Proceedings of the 17th Seismic Research Symposium on Monitoring a CTBT, 482-490, 1995.
 2. Ritzwoller, M. H. and D. Harvey, IRIS's Joint Seismic Program Center (JSPC) opens, IRIS Newsletter, XI, 3, 5-8, 1992.

1. Ritzwoller, M. H. and C. R. Bentley, Magnetic anomalies over Antarctica measured from Magsat, in: Antarctic Earth Science (R. L. Oliver, P. R. James and J. B. Jago, eds.), Proc. IVth Int. Sympos. Antarctic Earth Sciences, Australian Acad. Sci., pp. 504-507, 1983.

Grants and Contracts While at CU

Accepted:

- *IRIS' Joint Seismic Program Center*; IRIS, PI M. Ritzwoller, Co-PI D. Harvey, \$192,000; 8/1/91 - 12/31/91.
- *IRIS' Joint Seismic Program Center*; IRIS, PI M. Ritzwoller, Co-PI D. Harvey, \$400,000; 1/1/92 - 12/31/92.
- *Theoretical and Observational Studies of Giant-Cell Convection with Helioseismology*; NSF, Atmospheric Sciences, Solar Terrestrial Program, ATM-9122571, PI M. Ritzwoller, \$96,929, 5/15/92 - 5/14/94.
- *IRIS' Joint Seismic Program Center*; IRIS, PI M. Ritzwoller, Co-PI D. Harvey, \$550,000; 1/1/93 - 12/31/93.
- *Operational and Programmatic Research in Support of the Joint Seismic Program*, IRIS, PI C. Archambeau, co-PI M. Ritzwoller, \$213,282, 7/1/94 - 6/30/95.
- *Eurasian Surface Wave Phenomenology and Inversion for Crustal and Upper Mantle Structures*, AFOSR, PI M. Ritzwoller, Co-PI A. Levshin, \$186,724, 4/1/95 - 10/31/96.
- *Development of Discrimination, Detection and Location Capabilities in Central and Southern Asia Using Middle-Period Surface Waves Recorded by a Regional Array*, AFOSR - AFTAC, PI M. Ritzwoller, Co-PI A. Levshin, \$133,573, 6/1/95 - 5/30/97.
- *Normal mode studies of even and odd degree elastic and anelastic structures of the mantle and core*, NSF - Earth Sciences - Geophysics, PI M. Ritzwoller, \$109,991, 6/1/95 - 5/30/97.
- *Surface wave stacking of JSP data*, IRIS, PI M. Ritzwoller, \$19,400, 7/1/95 - 6/30/96.
- *Modeling and analysis of GONG line shapes*, Co-PI R. Stebbins, NSF - Solar and Stellar Astrophysics, PI M. Ritzwoller, co-PI R. Stebbins, \$248,000, 4/1/96 - 3/30/99.
- *Seismic source studies for monitoring a comprehensive test ban treaty, NATO Linkage Grant*, \$20,000, Ritzwoller PI and Project Director, PI M. Ritzwoller, co-PI's: Anatoli Levshin (Project Coordinator) and B.G. Bukchin, Lead Researcher from the Russian Academy of Sciences. 6/1/96 - 6/30/98.
- *Acquisition of a global geophysics compute server*, NSF - Facilities and Instrumentation, PI M. Ritzwoller, co-PI John Wahr, \$34,200, 1/1/97 - 12/31/97.
- *The structure of the crust and lithosphere of the Antarctic Plate*, NSF - Office of Polar Programs, PI M. Ritzwoller, \$180,000, 3/1/97 - 12/31/99.
- *Normal mode studies of the mantle and core*, NSF - Earth Sciences - Geophysics, PI M. Ritzwoller, \$120,000, 6/1/97 - 5/30/99.
- *Discrimination, detection, depth, location, and wave propagation studies using intermediate period surface waves in the Middle East, Central Asia, and the Far East*, DSWA, PI M. Ritzwoller, co-PI Anatoli Levshin, \$362,000, 10/1/97 - 9/30/00.
- *Feasibility of use of 3D models to improve regional locations in W. China, C. Asia, and parts of the Middle East*, DTRA, PI M. Ritzwoller, \$625,000, 2/12/99 - 8/31/02.

- *Surface wave tomography of the Arctic*, NSF - OPP (Arctic), \$199,000, PI M. Ritzwoller, 3/1/99 - 3/28/02.
- *Improvement of detection and discrimination using short period (7-15 s) surface waves in W. China, N. India, Pakistan, and environs*, DTRA, PI M. Ritzwoller, co-PI Anatoli Levshin, \$414,000, 3/1/00 - 2/28/03.
- *IMS location calibration - W. Asia and Africa*, DTRA subcontract from SAIC, PI M. Ritzwoller, \$499,000, 3/1/01 - 12/31/02.
- *Collaborative research: Active tectonics at the Aleutian - Kamchatka corner: A lithospheric perspective*, NSF - OPP (Arctic), PI M. Ritzwoller, co-PI N. Shapiro, \$60,000, 3/1/02 - 2/28/04.
- *Refinements and interpretation of images of the Antarctic crust and upper mantle*, NSF - OPP (Antarctic), PI M. Ritzwoller, co-PI N. Shapiro, \$240,000, 6/1/02 - 5/30/05.
- *Modeling the Middle American lithosphere: Illuminating the enigma of Cocos Plate subduction*, NSF - EAR, PI M. Ritzwoller, co-PI N. Shapiro, \$60,000, 7/1/02 - 6/30/03.
- *Structure and evolution of the Antarctic Plate (SEAP) 2003 Workshop*, NSF - OPP (Antarctic), PI M. Ritzwoller, \$53,000, 8/1/02 - 7/31/03.
- *CMG Training: Summer School on Mathematical Geophysics and Uncertainty in Earth Models*, PI R. Snieder (Colo School of Mines), co-PI M. Ritzwoller, NSF-ATM, \$180,000, 2/1/04 - 1/31/05. (All money to Colorado School of Mines to run the summer school.)
- *Structure of the Tibetan crust and upper mantle and its geodynamic implications*, NSF - EAR, PI M. Ritzwoller, \$240,000, 1/1/04-12/31/06.
- *Seismic and geodynamic investigation of the interaction between the oceanic lithosphere and upper mantle*, NSF joint award from EAR and OCE, PI M. Ritzwoller, \$230,000, 7/1/04-6/30/07.
- *New physics-based methodology for optimizing tracking ATR performance via feature-level fusion of multi-sensor data*, subcontract from AlphaTech Inc., PI Ritzwoller, \$110,000, 6/1/04-12/31/05.
- *New method of calibrating surface-wave path effects in North Africa, the Middle East, and Central Asia*, DoE/NNSA, PI Ritzwoller, \$303,488, 6/1/05-5/31/08. (Collaborative proposal with Lawrence Livermore National Laboratory.)
- *Rayleigh wave attenuation model for Eurasia and calibrating a new M_s formula*, DoE/NNSA, PI Ritzwoller, \$300,520, 6/1/05-5/31/08. (Collaborative proposal with Los Alamos National Laboratory.)
- *Seismic observations from the random wavefield: A new tool for high-resolution seismology in the context of EarthScope*, NSF-EAR (EarthScope), PI Ritzwoller, \$245,000, 5/1/05-4/30/08.
- *Surface wave dispersion measurements and tomography from ambient seismic noise in China*, DoE/NNSA, PI Ritzwoller, sub-contract from University of Illinois (X. Song, PI), \$115,429, 12/20/06-12/15/09.
- *Acquisition of a PC cluster for geophysical modeling*, NSF-EAR, co-PI Ritzwoller, \$90,940, 5/1/07-4/39/10.
- *Ambient noise and teleseismic tomography to infer the physical state and structure of the crust and upper mantle in the western US*, NSF-EAR, PI Ritzwoller, \$276,554, 7/1/07-5/31/10.
- *A US-China partnership in research and education on intraplate earthquakes*, NSF-PIE, PI-Ritzwoller, sub-contract from University of Missouri (M. Liu, PI), \$100,729, 8/1/07-7/31/10.

- *Crustal structure of the Iran region from in-country and ground truth data*, co-PI Ritzwoller, \$613,239, 4/21/08-4/20/11.
- *Subsurface characterization beneath the Coso geothermal field by ambient noise and coda wave interferometry*, DoD-Navy, PI Ritzwoller, \$254,223, 7/3/08-3/31/10.
- *Crustal and uppermost mantle anisotropy from seismic ambient noise data observed on EarthScope/USArray*, NSF-EAR, PI Ritzwoller, \$234,830, 1/1/09-12/31/11.
- *A novel method of regional location and discrimination based on empirical Green's functions from ambient noise*, DOE/NNSA, PI Ritzwoller, \$365,826, 6/1/09-5/31/12.

Local Service

University Committees:

- 1990 - 1991: Graduate Committee (Phys), Geophysics Committee (Phys), Recruitment Committee (Phys, Nauenberg, Chair), CIRES Fellows Committee
- 1991 - 1992: Computer Committee (Phys), Geophysics Committee Chair (Phys), Condensed Matter Search Committee (Phys), Reappointment Committee (CIRES), Promotion Committee (Phys), CIRES Fellows Committee
- 1992 - 1993: Computer Committee (Phys), Geophysics Committee Chair (Phys), Geophysics Comprehensive Exam Committee Chair (Resovsky, Solheim), CIRES Fellows Committee
- 1993 - 1994: Geophysics Committee Chair (Phys), Junior Faculty Steering Committee (Phys), CIRES Fellows Committee
- 1994 - 1995: Geophysics Committee, Chair (Phys), Junior Faculty Steering Committee, (Phys) CIRES Fellows, Physics Faculty Evaluation Committee (Phys), Physics Graduate Committee (Phys), Chair's Special Committee on the Future of Computing (Phys)
- 1995 - 1996: Graduate Committee, Chair (Phys), Geophysics Committee, Chair (Phys), Junior Faculty Steering Committee (Phys), CIRES Fellows, Plasma Physics Junior Faculty Search Committee (Phys)
- 1996 - 1997: Graduate Committee, Chair (Phys), Geophysics Committee, Chair (Phys), Junior Faculty Steering Committee (Phys), CIRES Fellows, Reappointment Committee (CIRES), Boulder Faculty Committee on Classified Research
- 1997 - 1998: Graduate Committee, Physics Faculty Evaluation Committee, Physics Reallocation/Reinvestment Committee, Physics H-Wing Committee, CIRES Fellows, Boulder Faculty Committee on Classified Research
- 1998 - 1999: Faculty Evaluation Committee, Boulder Faculty Committee on Classified Research
- 1999 - 2000: Geophysics Faculty Search Committee (Chair), Boulder Faculty Committee on Classified Research
- 2000 - 2001: Chair's Advisory Committee (CAC), Colloquium Committee, Boulder Faculty Committee on Classified Research
- 2001 - 2002: Colloquium Committee (Chair), Boulder Faculty Committee on Classified Research
- 2002 - 2003: High Energy Theory Faculty Search Committee, Boulder Faculty Committee on Classified Research
- 2003 - 2004: Faculty Evaluation Committee, Honors and $\Sigma\Pi\Sigma$, Boulder Faculty Committee on Classified Research
- 2004 - 2005: Faculty Evaluation Committee (Chair), Honors and $\Sigma\Pi\Sigma$ (Chair), Boulder Faculty Committee on Classified Research
- 2005 - 2006: Boulder Faculty Committee on Classified Research

2006 - 2007: Undergraduate Committee (Chair), Physics Evaluation Committee
2007 - 2008: High Energy Faculty Search Committee, Physics Self-Study Committee (Chair)
2008 - 2009: Chair's Advisory Committee, Geophysics Faculty Search Committee

Thesis Committee Membership and Advising

Graduated

1991 - M. Glaser (Physics).
1993 - B. Kohl (Physics), M. Kohl (Physics), D. Han (Geophysics), A. Rodgers (Physics)
1994 - F. Creamer (Geology), E. Perlman (APAS)
1995 - B. Hindman (APAS), J. Orrey (Physics, Titular Advisor), H. Bump (Geology, M.S.)
1996 - J. Worden (Physics), S. Makoski (Physics, M.S.)
1997 - J. Resovsky (Geophysics, Advisor), B. Williams (Physics, Titular Advisor), J. Schneider (Geology, M.S.)
1998 - J. Garten
1999 - O. Vdovin (Physics, Advisor), M. James (Physics, Advisor, M.S.), S. Kraut (Physics, Titular Advisor), M. Gourley (Physics)
2000 - M. Tamisiea (Physics), G. Francis (Physics)
2008 - G. Bensen (Geophysics, Advisor), Rachelle Richmond (Geophysics, Advisor, M.S)

Undergraduate Honors Committees

1994 - Steve Dutton (Physics, Summa Cum Laude)
1996 - Mark James (Physics, Advisor, Magna Cum Laude)
2001 - William Landuyt (Physics, Advisor, Magna Cum Laude)
2002 - Garrett Leahy (Physics, Advisor, Magna Cum Laude)
2004 - Nick Bunch (Physics, Magna Cum Laude), Jeremiah Goodson (Physics, Magna Cum Laude), Michelle Stempel (Physics, Magna Cum Laude), Daniel Smith (Physics, Advisor, Summa Cum Laude)

Ungraduated

M. Moschetti (Physics, Advisor, working toward Ph.D.), F.Lin (Physics, Advisor, working toward Ph.D.), W. Shen (Physics, Advisor, working toward Ph.D.)

Teaching

<i>Class</i>	<i>Position</i>	<i>Semester</i>
PHYS 1000 – Preparatory Physics	Teacher	Fall, 1995 Spring, 1997
PHYS 1110 – General Physics I	Recitation Instructor	Fall, 1990 Fall, 1992
PHYS 1120 – General Physics II	Recitation Instruction	Fall, 1994 Spring, 2001
PHYS 2010 – General Physics I	Lab Instructor	Spring, 1993 Fall, 1993 Spring, 1996
PHYS 2010 – General Physics I	Teacher	Spring, 2009
PHYS 2020 – General Physics II	Lab Instructor	Spring, 1994
PHYS 2130 – General Physics III	Teacher	Fall, 2001 Fall, 2002
PHYS 2140 – Methods in Theoretical Physics	Teacher	Spring, 1991 Spring, 1992 Spring, 1998 Fall, 2003 Spring, 2004
PHYS 2170 – Foundations of Modern Physics	Teacher	Fall, 1991 Fall, 1992
PHYS 3070 – Energy and the Environment	Teacher	Spring, 2002 Spring, 2003
PHYS 3210 – Analytical Mechanics	Teacher	Spring, 1995 Fall, 1997 Fall, 1999 Spring, 2000
PHYS 5030 – Intermediate Mathematical Physics I	Teacher	Fall, 2007 Fall, 2008
PHYS 5040 – Intermediate Mathematical Physics II	Teacher	Spring, 2007 Spring, 2008
PHYS/GEO/ASTR 6610 – Earth and Planetary Physics I	Teacher	Fall, 1994 Fall, 1996 Fall, 2004 Fall, 2006 Fall, 2008
PHYS 7830 – Seminar in Seismology	Teacher	Spring, 1991 Fall, 1991 Fall, 1993