

CURRICULUM VITAE

Laurel B. Goodwin

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Education

Ph.D. in Geology, May 1988, *University of California, Berkeley*
Dissertation Supervisors: Hans-Rudolf Wenk and Lionel E. Weiss

M.A. in Geology, June 1983, *University of California, Berkeley*

B.A. in Geology, with Highest Distinction, May 1980, *University of Maine, Orono*

Research Tools

Detailed mapping and field structural analysis; microstructural and petrologic studies using light and electron beam microscopy; stable and radioisotopic analyses designed to understand fluid-rock interaction and constrain both timing of deformation events and time-temperature histories; measurement of a range of material properties that constrain the hydro-mechanical behavior of rocks and sediments.

Research Interests

- The mechanics of faulting and earthquakes, and quantification of recurrence intervals in deep time
- Strain localization at different crustal levels
- Strain partitioning over space and time within major crustal shear systems
- Constraining the timing and time-temperature history of deformation in fault and shear zones
- Fluid / fault interactions
- Petrophysical controls on deformation mechanisms and the link between permeability, diffusivity, and deformation processes
- Petrophysical controls on velocity and material properties of granular porous media
- Fabric development and deformation mechanisms in brittle and ductile shear systems

Professional Experience

Professor of Geoscience, University of Wisconsin - Madison. 2004-present.

Faculty Associate, Science Education Resource Center, Carleton College. 2011-2014

Adjunct Professor, New Mexico Tech, Socorro, NM. 2004-2005.

Professor, New Mexico Tech, Socorro, NM. 2003.

Associate Professor, New Mexico Tech, Socorro, NM. 1996-2003.

Geology / Geochemistry Group Coordinator, 2000-2003.

Chair, Faculty Council, 1996-1997.

Gibson Distinguished Visiting Professor, Univ. of Minnesota, Minneapolis. May - June, 1999.

Assistant Professor, New Mexico Tech, Socorro, NM. 1992-1996.

Lecturer, University of New Brunswick, Fredericton: Structural Geology. 1990.

Postdoctoral Fellow, University of New Brunswick, Fredericton: Detailed structural analysis of tectonostratigraphic terrane boundaries in the Newfoundland Appalachians. 1989-1991. Supervisor: Paul F. Williams.

Postdoctoral Research Associate, Arizona State University, Tempe: Electron microscope and microprobe investigation of opaque assemblages in carbonaceous chondrites. 1988-1989. Supervisor: Peter R. Buseck.

Research Assistant, University of California, Berkeley: Dissertation research. 1984-1988. Supervisor: Hans-Rudolf Wenk.

Geological Consultant, Utah International, Inc., Knoxville, Tennessee: Designed a database management system to store exploration data. Responsible for solving computer-related problems for exploration geologists. 1984. Supervisor: Roland M. Larsen.

Research Assistant, University of California, Berkeley, and Physical Science Technician, U.S.G.S., Menlo Park, CA: Detailed mapping (1:12,000) and structural analysis in the Baboquivari Mtns., Arizona. 1982-83. Supervisors: Gordon B. Haxel and James E. Wright.

Teaching Assistant, University of California, Berkeley: Introductory Geology, Structural Geology, Mineralogy. 1981-1986. Supervisors: Lionel E. Weiss and Walter Alvarez.

Developed a graduate seminar on strain theory. 1982.

Laboratory Assistant, University of California, Berkeley: Assisted preparation of activity diagrams illustrating the behavior of ions of interest in aqueous geochemical systems. 1980-81. Supervisor: Harold C. Helgeson.

Laboratory and Field Assistant, University of Maine, Orono. Effects of acid rain on high altitude lakes with low buffering capacity. 1979-80. Supervisor: Stephen A. Norton

Honors and Awards

Certificate of Excellence in Reviewing, Journal of Structural Geology (2013)

Chadbourne Residential College Honored Instructor Award (2011)

Fellow of the Geological Society of America (2009)

Exceptional Reviewer, Geological Society of America Bulletin (2008)

Top Reviewer, Journal of Structural Geology (2007)

Earth and Environmental Science Outstanding Teaching Award (2001)

New Mexico Tech Distinguished Teaching Award (1996)

Outstanding Graduate Student Instructor, Department of Geology & Geophysics, University of California, Berkeley (1987)

Friends and Associates of the Earth Sciences Fellowship (1980-81)

Phi Beta Kappa (1980); Phi Kappa Phi (1979)

Membership in Professional Organizations

Geological Society of America; American Geophysical Union

Grants

NSF: From Damage Zone to Core: Quantifying Mechanical and Hydrological Coupling During Fault-Zone Structural Evolution: **\$369,406**, 6/1/2020-5/31/2023 (PI Randolph Williams; Co-PI Laurel Goodwin).

NSF: Collaborative Research: Can Low-Angle Normal Faults Produce Earthquakes? Reading a Pseudotachylyte 'Rosetta Stone': **\$290,000** to UW 08/01/16-7/31/20 (UW PI Laurel Goodwin; Co-PI Joshua Feinberg, Univ. of Minnesota)

Mineralogical Controls on Sandstone Hydromechanical Properties: A Foundation for Mitigating the Effects of Subsurface Fluid Sequestration: **\$39,270**, *Wisconsin Alumni Research Fund*, 7/1/17-6/30/18

Rates of Calcite Cementation, Style of Deformation, and Timing of Flow Through the Loma Blanca Fault Zone, Socorro Basin, NM: **\$109,998**, *PRF*, 9/1/15-8/31/17 (with Co-PI Peter Mozley, New Mexico Institute of Mining and Technology)

NSF: Producing a White Paper: Scientific Frontiers, Infrastructure Needs, and Societal Significance of Research in Tectonics and Structural Geology: **\$99,600**, 05/01/15-4/30/17 (PI Basil Tikoff; Co-PIs. Laurel Goodwin, Yvette Kuiper, Colorado School of Mines)

Clumped Isotope Paleothermometry: A Novel Approach to Constraining Fluid Flow Pathways and Fault Permeability in the Rio Grande Rift, New Mexico: **\$58,572**, *Wisconsin Alumni Research Fund*, originally awarded for 6/1/13-5/31/14; revised to 6/1/14-6/30/15

Acquisition of a Modern Electron Microprobe: **\$960,312**, *NSF*, 8/1/13-7/31/16 (PI John Fournelle, Co-PIs John Valley, Laurel Goodwin, Brad Singer, Chang-Boem Eom)

EAGER: Collaborative Research: Can Low-Angle Normal Faults Produce Earthquakes? A Paleoseismic Perspective: *NSF*, **\$72,217** (UW Portion), 4/1/12-3/31/14 (with Co-PI Joshua Feinberg, University of Minnesota Institute for Rock Magnetism)

Student Support for Electron Backscattered Diffraction Topical Conference: *NSF*, **\$10,000**, 5/1/10-12/31/10 (with co-PI and conference convener John Fournelle).

Student Support for Electron Backscattered Diffraction Topical Conference: *NSF*, **\$5,000**, 4/1/08-3/31/09 (with co-PI and conference convener John Fournelle).

Petrophysical Controls on Fault Damage Zone Width and Character: As Important as Displacement?: *PRF*, **\$90,000**, 9/1/07-8/31/09, ext. to 8/31/11 (with Co-PI Harold Tobin).

Using Pore Fluid Pressure Gradients to Test the Relative Importance of Hydrologic Versus Mechanical Heterogeneity in Fracture Formation: *NSF*, **\$86,970** (UW Portion), 8/1/07-7/31/09, ext. to 7/31/11 (with PI D.F. Boutt, U. Mass. Amherst).

Quantifying the Micromechanical Effects of Variable Cement in Granular Porous Media: *DOE*, **\$180,667** (UW portion), 8/15/05-8/15/08, ext. to 8/15/10 (with PI D.F. Boutt, U. Mass. Amherst and PIs T. Buchheit and B.K. Cook, Sandia National Lab).

Acquisition of a Versatile Scanning Electron Microscope: *NSF*, **\$260,000**, 11/01/05-10/31/08. (with Co-PIs J. Fournelle, B. Tikoff, J. Valley, and H. Xu)

Localization of Deformation in Lithologically Heterogeneous Lower Crust, Arunta Block, Central Australia: *NSF*, **\$315,557** (including REU supplement for Paul Kelso, Lake Superior State University), 1/1/05-12/31/08, ext. 12/31/10 (with Co-PI Basil Tikoff).

Using Neutron Computed Tomography to Determine the Influence of Pore Structure and Mineralogy on Two-Phase Flow and Transport in Fractured and Faulted Geologic Media: *IGPP*, **\$22,494** (UW portion), 2004-2005. (University PI L. Goodwin, UW; LANL PIs C. Lewis and P. Reimus; SNL PI J. Fredrich).

Using Neutron Computed Tomography to Determine the Influence of Pore Structure and Mineralogy on Two-Phase Flow and Transport in Fractured and Faulted Geologic Media: *IGPP*, **\$53,676** (NMT portion) 2002-2004. (University PIs L. Goodwin NMT, C. Leshner, U.C. Davis; LANL PIs C. Lewis and P. Reimus).

Characteristics of Faults in Non-Welded Tuffs from the Pajarito Plateau: Implications for Fluid Flow: *IGPP*, **\$92,745**, 2000-2003. (University PI L. Goodwin; LANL PIs C. Lewis and G. Guthrie).

Hydrogeologic Characterization of the Sand Hill Fault Zone, Albuquerque Basin, New Mexico: *NSF*, **\$171,000**, 1998-2001. (PI L. Goodwin; Co-PIs W. Haneberg, P. Mozley, and A. Gutjahr).

Geologic Mapping of the Rosilla Peak Quadrangle, Sangre de Cristo Mountains, New Mexico: *USGS - EDMAP*, **\$7,500**, 1998-1999. (PI L. Goodwin)

Small Displacement Faults in Sand: What Control do they Exert on Saturated and Unsaturated Flow and Transport? *NSF*, **\$157,000**, 1997-2000. (PI J. Wilson, Co-PIs L. Goodwin and P. Mozley).

Development of Fault-Zone Architecture and Permeability within the Sand Hill Fault: *Exxon Production Research*, **\$20,000**, 1997. (PI L. Goodwin; Co-PI P. Mozley).

Development of New Tools to Evaluate Paleoseismicity: *Department of Public Safety*, **\$9,040**, 1997-1998. (PI L. Goodwin; Co-PIs William Haneberg and T. Michael Whitworth).

Permeability Anisotropy in Small-Displacement Faults: Implications for Groundwater Flow and Contaminant Transport: *Waste Management and Energy Consortium (WERC)*, **\$2,500**, 1997. (PI P. Mozley; Co-PIs T.M. Whitworth and L. Goodwin)

Geologic and Geomorphic Mapping: La Joya NW and Sky Village SE Quadrangles: *USGS - EDMAP*, **\$14,000**, 1996-1997 (PI B. Harrison; Co-PI L. Goodwin)

Crack-Anticrack Interactions in Faulting: *NSF*, **\$83,790**, 1996-1999 (PI R. Fletcher; Co-PI L. Goodwin).

Acquisition of an Analytical Scanning Electron Microscope: *NSF*, **\$250,000**, 1994-1999 (PI N. Dunbar; Co-PIs L. Goodwin and P. Kyle).

Characterization of Pseudotachylyte Formed in an Extensional Tectonic Regime: *NSF*, **\$18,000**, 1993-1995. (PI L. Goodwin)

Development of Pseudotachylyte During Extensional Faulting: *New Mexico Tech Research Council Grant*, **\$3,000**, 1992-1994. (PI L. Goodwin)

The Faulting History and Constraints on Seismic Interpretations of the Dunnage / Gander Zone Boundary, Canadian *Lithoprobe Grant*, 1991-92, (with P. F. Williams, PI).

Detailed Structural Analysis of Tectonostratigraphic Terrane Boundaries in Newfoundland, Canadian *Lithoprobe Grant*, 1990-91, (with P. F. Williams, PI).

The Deformational History of the Santa Rosa Mylonite Zone, Southern California: *Geological Society of America Research Grant*, 1986, *Chancellor's Patent Fund Grants*, 1985 and 1986.

The Structural and Metamorphic Framework of a Late Cretaceous - Early Tertiary Orogenic Event, Baboquivari Mountains, South-Central Arizona: *Geological Society of America Research Grants*, 1982 and 1983.

Professional Activities

Assisted in construction of a community vision document, *Challenges and Opportunities for Research in Tectonics: Understanding Deformation and the Processes that Link Earth Systems, From Geologic Time to Human Time*, for the Tectonics Division of the NSF

2016-2018

Member of Organizing Committee (with Yvette Kuiper and Basil Tikoff) for *NSF-funded Future Directions in Tectonics Workshop*, Madison, WI

May 2016

Research Grants Committee, Geological Society of America

2015-2017

Led 2015 North-Central GSA Field trip: *What's New at Baraboo? A Field Trip For Educators*, with G. Medaris, B. Dott, S. Marshak, D. Czeck, M. Bjornerud, J. Craddock, and C. Ormand.

Currently preparing field trip guidebook for publication

May 2015

Invited participant and speaker at 2013 SCEC Workshop: *Ductile Rheology of the Southern California Lithosphere: Constraints from Deformation Modeling, Rock Mechanics, and Field Observations* May 1-2, 2013

Co-Founder and Leader of *Rock-it Girls* (<http://sconnierockitgirls.wordpress.com/>), NSF-funded initiative to develop outreach programs with 6th and 7th grade girls 2012-2013

Faculty Associate, Science Education Resource Center, Carleton College, for NSF-funded project: *Developing and Testing Materials to Improve Spatial Skills in Upper Division Geoscience Courses* project July 1, 2011-May 31, 2014

Co-convener (with B. Tikoff), First NSF-funded *Structural Geology and Tectonics Forum* May 20-22, 2010

NSF: Tectonics Review Panel 2009-2011

Organized and chaired two GSA Annual Meeting Topical Sessions on *Recognition and Implications of Coseismic Fault-Zone Deformation*, with James P. Evans Oct. 22-23 2007

Invited participant and leader of discussion of “Grain-Boundary Sliding in Nature”, *Grain-Boundary Sliding Workshop, University of Liverpool, England* April 2-4, 2007

NSF: Tectonics Review Panel Spring 2005

Invited participant in NSF-funded workshop on *SAFOD sample characterization* Oct. 8-9, 2004

Editorial Board, Geology 2004-2007

Co-Convener (with C. Lewis and J. Wilson), IGPP-Sponsored Workshop: “Fluid Flow and Transport through Faulted Ignimbrites and other Porous Media” Sept. 8-10, 2003

Invited participant in NSF-funded workshops on *Setting Priorities in the Solid Earth Sciences – broad-based, interdisciplinary research into solid Earth systems* Oct. 26, 2002; Nov. 1, 2003

Invited participant (and group leader) in an NSF-funded workshop that produced a white paper on *New Directions in Structural Geology and Tectonics* Sept. 22-23, 2002

Invited to *NanTroSEIZE* Workshop to assist in developing an integrated Science Plan for the Nankai Trough Seismogenic Zone Experiment July 21-23, 2002

Structural Geology and Tectonics Division Management Board, Geological Society of America
Past Chair 2002-2003

Chair (and member Joint Technical Program, Halbouty Award, and Pardee Symposia Review Committees for the Annual GSA meeting) 2001-2002

First Vice Chair (and member Joint Technical Program and Topical Session Review Committees for the Annual GSA meeting) 2000-2001

Second Vice Chair

1999-2000

Invited to attend a short course for the MARGINS Theoretical and Experimental Institute: *Rheology & Deformation of Lithosphere at Continental Margins*, and develop a science plan for the "Rupturing Continental Lithosphere and Birth of an Ocean" Initiative January 23-28, 2000

Editorial Board, Journal of Structural Geology

1998-present

Field Trip organizer, DOE/BES Research Symposium on Micromechanics and Flow. "The Interaction Between Faulting, Sedimentation, and Fluid Flow" Aug. 13-14, 1998

Co-Convener, Geological Society of America Penrose Conference: "Faults and Subsurface Fluid Flow: Fundamentals and Applications to Hydrogeology and Petroleum Geology", (Convened with W. Haneberg, J. C. Moore, and P. Mozley) Sept. 10-15, 1997

NSF: Hydrologic Sciences Review Panel

Fall 1996

Editorial Board, New Mexico Geology

1995-2003

New Mexico Geologic Mapping Advisory Board, New Mexico Bureau of Mines and Mineral Resources 1994-2002

Selected University Service:

- *Physical Sciences Divisional Committee* 2015-2018 (Vice-Chair 2016-17; Chair 2017-2018)
- *Committee on Women in the University* 2011-2014
- *Geoscience Department Student Ombudsperson*, elected by graduate students, 2016-present
- *Geological Engineering Faculty member* 2004-present

Guest Lectures:

2017 University of Wisconsin - Milwaukee

2014 Soundwaves/ Heavy Metal, Wisconsin Institute for Discovery
University of Vermont, Burlington

2013 Colby College

2011 **Keynote speaker**, Penrose Conference on *Deformation Localization in Rocks: New Advances*, Cadaqués, Spain
Northern Illinois University

2010 University of Cincinnati
University of California, Santa Cruz

- 2006 U.S. Geological Survey, Menlo Park
- 2004 Wisconsin Geological and Natural History Survey
Iowa State University, Ames
- 2003 University of Wisconsin, Madison
University of California, Berkeley
- 2002 University of Wisconsin, Madison
Los Alamos National Lab
Boston University
- 2000 University of Vermont, Burlington
Los Alamos National Lab
- 1999 University of Minnesota, Minneapolis (series of three formal talks, one informal talk)
University of Wyoming, Laramie
University of Colorado, Boulder
- 1997 University of South Florida
- 1996 Utah State University
Exxon Production Research
- 1994 University of New Mexico
Southern Methodist University
- 1992 Northern Arizona University

Books

Haneberg, W.C., Mozley, P.S., Moore, J.C., and Goodwin, L.B., (eds), 1999, *Faults and Subsurface Fluid Flow in the Shallow Crust*, AGU Monograph 113.

NSF-funded reports addressing future of tectonics

Huntington, K.W., and Klepeis, K.A., with 66 community contributors, 2018, Challenges and opportunities for research in tectonics: Understanding deformation and the processes that link Earth systems, from geologic time to human time. A community vision document submitted to the U.S. National Science Foundation. University of Washington, 84 pp., <https://doi.org/10.6069/H52R3PQ5>.

Goodwin, L., Allmendinger, R., Burgmann, R., Evans, J., Pollard, D., Shaw, J., Vendeville, B., Withjack, M., and Wong, T.-F., 2003, The missing link: From earthquakes to orogenesis, *In: New Departures in Structural Geology and Tectonics*, a white paper submitted to the Tectonics Program of the National Science Foundation.

Papers (student authors with asterisks, research scientists with pound signs)

#Williams, R.T., Mozley, P.S., Sharp, W.D., and Goodwin, L.B., 2019, U-Th dating of syntectonic calcite veins reveals the dynamic nature of fracture cementation and healing in faults, *Geophysical Research Letters*, v. 46, p. 12,900-12,908. <https://doi.org/10.1029/2019GL085403>

Williams, R.T., Davis, J.R., and Goodwin, L.B., 2019, Do large earthquakes occur at regular intervals through time? A perspective from the geologic record, *Geophysical Research Letters*, v. 46, p. 8074-8081. <https://doi.org/10.1029/2019GL083291>

Williams, R.T., Beard, B. L., Goodwin, L.B., Sharp, W.D., Johnson, C.M., and Mozley, P.S., 2018, Radiogenic isotopes record a ‘drop in a bucket’ – a fingerprint of multi-kilometer-scale fluid pathways inferred to drive fault-valve behavior, *Journal of Structural Geology*, v. 125, p. 262-269. <https://doi.org/10.1016/j.jsg.2018.07.023>

Ormand, C.J., Shipley, T.F., Tikoff, B., Dutrow, B.L., Goodwin, L.B., Hickson, T.A., Atit, K.R., Gagnier, K., and Resnick, I., 2017, The spatial thinking workbook: developing students' spatial thinking skills in upper-level undergraduate geology courses through curricular materials based on cognitive science research, *Journal of Geoscience Education*, Vol. 65, p. 423-434. <https://doi.org/10.5408/16-210.1>

#Williams, R.T., Goodwin, L.B., Sharp, W.D., and Mozley, P.S., 2017, Reading a 400,000-year record of earthquake frequency for an intraplate fault, *Proceedings of the National Academy of Science*, www.pnas.org/cgi/doi/10.1073/pnas.1617945114.

*Williams, R.T., Goodwin, L.B., and Mozley, P.S., 2017, Diagenetic controls on the evolution of fault-zone architecture and permeability structure: Implications for episodicity of fault-zone fluid transport in extensional basins, *Geological Society of America Bulletin*, v. 129, p. 464-478. doi:10.1130/B31443.1 <https://doi.org/10.1130/B31443.1>

*Williams, R.T., Goodwin, L.B., Mozley, P.S., Beard, B.L., and Johnson, C.M., 2015, Tectonic controls on fault zone flow pathways in the Rio Grande rift, New Mexico, USA, *Geology* doi: 10.1130/G36799.1.

- *Cook, J.E., Goodwin, L.B., Boutt, D.F., and Tobin, H.J., 2015, The effect of systematic diagenetic changes on the mechanical behavior of a quartz-cemented sandstone, *Geophysics* 80(2), D145-D160. doi: 10.1190/geo2014-0026.1
- Boutt, D.F., *Plourde, K., and *Cook, J.E., Goodwin, L.B., 2014, Cementation and the hydromechanical behavior of siliciclastic aquifers and reservoirs, *Geofluids*. doi: 10.1111/gfl.12062.
- *French, M.E., Boutt, D.F., and Goodwin, L.B., 2012, Sample dilation and fracture in response to high pore fluid pressure and strain rate in quartz-rich sandstone and siltstone, *Journal of Geophysical Research* 117: B03215, <http://dx.doi.org/10.1029/2011JB008707>
- *Bonamici, C., Tikoff, B., and Goodwin, L.B., 2011, Anatomy of a 10-km-scale sheath fold, Mt Hay ridge, Arunta Region, central Australia: The structural record of deep crustal flow: *Tectonics* 30: TC6015, doi:10.1029/2011TC002873.
- *Cook, J.E., Goodwin, L.B., and Boutt, D.F., 2011, Systematic diagenetic changes in the grain-scale morphology and permeability of a quartz-cemented quartz arenite: *AAPG Bulletin* 95: 1067-1088.
- *Gage, J.R., Goodwin, L.B., and Tikoff, B., 2011, Metamorphism and deformation on western Mt. Chapple, Australia: A record of multiple high-grade tectonic events: *Australian Journal of Earth Sciences* 58: 261-272.
- *Riley, P.R., Goodwin, L.B., and Lewis, C.J., 2010 Controls on fault damage zone width, structure, and symmetry in the Bandelier Tuff, New Mexico: *Journal of Structural Geology* 32: 766-780.
- *Waters-Tormey, C., Goodwin, L.B., Tikoff, B., *Staffier, K., and Kelso, P., 2009, A granulite facies normal shear zone exposed in the Arunta Inlier of central Australia: Implications for deep crustal deformation during oblique divergence: Miller, R.B. and Snoke, A.W. (eds) *Crustal Cross Sections from the Western Cordillera and Elsewhere: Implications for Tectonic and Petrologic Processes*, *Geological Society of America Special Paper* 456, p. 267-286.
- Boutt, D. F., Goodwin, L.B., and McPherson, B.J.O.L., 2009, Role of permeability and storage in the initiation and propagation of natural hydraulic fractures: *Water Resources Research*, 45, W00C13, doi:10.1029/2007WR006557.
- *Cooper, S.P., Goodwin, L.B., and Lorenz, J.C., 2006, Fracture and fault patterns associated with basement-cored anticlines: The example of Teapot Dome, Wyoming: *AAPG Bulletin* 90: 1903-1920.
- *Sanders, R.E., Heizler, M.T., and Goodwin, L.B., 2006, $^{40}\text{Ar}/^{39}\text{Ar}$ thermochronology constraints on the timing of Proterozoic basement exhumation and fault ancestry, southern Sangre de Cristo Range, New Mexico: *Geological Society of America Bulletin* 118: 1489-1506.
- *Rawling, G.C. and Goodwin, L.B., 2006, Structural record of the mechanical evolution of mixed zones in faulted poorly lithified sediments, *Journal of Structural Geology* 28: 1623-1639.
- *Wilson, J.E., Goodwin, L.B., and Lewis, C.J., 2006, Diagenesis of deformation-band faults: The record and mechanical consequences of vadose-zone flow and transport in the Bandelier Tuff, Los Alamos, NM: *Journal of Geophysical Research* 111, B09201, doi:10.1029/2005JB003892.

- *Abbott, J., Goodwin, L.B., Kelley, S., Maynard, S.R, and McIntosh, W.C., 2004, The anatomy of a long-lived fault system: Structural and thermochronologic evidence for Laramide to Quaternary activity on the Tijeras Fault, New Mexico: Cather, S., McIntosh, W.C., and Kelley, S. (eds) *Tectonics, Geochronology, and Volcanism of the Southern Rocky Mountains and Rio Grande Rift, New Mexico Bureau of Geology and Mineral Resources Bulletin* 160: 113-138.
- *Behr, R.-A., Goodwin, L.B., and Kelley, S., 2004, Structural and thermochronological constraints on the movement history of the Montosa fault, New Mexico: Cather, S., McIntosh, W.C., and Kelley, S. (eds) *Tectonics, Geochronology, and Volcanism of the Southern Rocky Mountains and Rio Grande Rift, New Mexico Bureau of Geology and Mineral Resources Bulletin* 160: 139-160.
- *Wilson, J. E., Goodwin, L.B., and Lewis, C. J., 2003, Deformation bands in nonwelded ignimbrites: Petrophysical controls on fault-zone deformation and evidence of preferential fluid flow: *Geology* 31: 837-840.
- *Rawling, G.C. and Goodwin, L.B., 2003, Cataclasis and particulate flow in faulted, poorly lithified sediments: *Journal of Structural Geology* 25: 317-331.
- Goodwin, L.B. and Tikoff, B., 2002, Competency contrast, kinematics, and the development of foliations and lineations in the crust: *Journal of Structural Geology* 24: 1065-1085.
- *Waters, C.L., Tikoff, B., Goodwin, L.B., and Little, T.A., 2002, Geological framework for deformation patterns and deformation-induced heterogeneity in the crust. In: Goff, J.A. and Holliger, K. (eds) *Small Scale Heterogeneity*, Kluwer Press, New York, p. 1-36.
- *Rawling, G.C., Goodwin, L.B., and Wilson, J.L., 2001, Internal architecture, permeability structure, and hydrologic significance of contrasting fault-zone types: *Geology* 29: 43-46.
- Person, M., Goodwin, L.B., Rawling, G., Connell, S., 2000, The evolution of fault-zone permeability and groundwater flow patterns within the Albuquerque Basin of the Rio Grande Rift, NM: *Journal of Geochemical Exploration* 69: 565-568.
- *Marcoline, J., Ralser, S., and Goodwin, L.B., 2000, Field and microstructural observations from the Capilla Peak area, Manzano Mountains, central New Mexico: *New Mexico Geology* 22, 57-63.
- Goodwin, L.B., 1999, Controls on pseudotachylite formation during tectonic exhumation in the South Mountains metamorphic core complex, Arizona: In: Ring, U., Brandon, M.T., Lister, G.S., and Willett, S.D. (eds) *Exhumation Processes: Normal Faulting, Ductile Flow, and Erosion, Geological Society, London, Special Publications* 154.
- *Heynekamp, M.R., Goodwin, L.B., Mozley, P.S., and Haneberg, W.C., 1999, Controls on fault-zone architecture in poorly lithified sediments, Rio Grande rift, New Mexico: Implications for fault-zone permeability and fluid flow: In Haneberg, W.C., Mozley, P.S., Moore, J.C., and Goodwin, L.B. (eds) *Faults and Subsurface Fluid Flow in the Shallow Crust, AGU Monograph* 113, 27-49.
- *Marcoline, J., Heizler, M., Goodwin, L.B., Ralser, S., and Clark, J., 1999, Thermal, structural, and petrologic evidence for 1.4 Ga metamorphism and deformation in central New Mexico: *Rocky Mountain Geology* 34: 3-16.
- *Sigda, J.M., Goodwin, L.B., Mozley, P.S., and Wilson, J.L., 1999, Permeability alteration in small-displacement faults in poorly lithified sediments: Rio Grande rift, central New

- Mexico: In Haneberg, W.C., Mozley, P.S., Moore, J.C., and Goodwin, L.B. (eds) *Faults and Subsurface Fluid Flow in the Shallow Crust, AGU Monograph 113*, 51-68.
- Whitworth, T.M., Haneberg, W.C., Mozley, P.S., and Goodwin, L.B., 1999, Solute sieving by pulverized quartz sand -- Experimental results and implications for the membrane behavior of fault gouge: In Haneberg, W.C., Mozley, P.S., Moore, J.C., and Goodwin, L.B. (eds) *Faults and Subsurface Fluid Flow in the Shallow Crust, AGU Monograph 113*, 149-158.
- Waldron, J.W.F., Anderson, S.D., Cawood, P.A., Goodwin, L.B., Hall, J., Jamieson, R.A., Palmer, S.E., Stockmal, G.S., Williams, P.F., 1998, Evolution of the Appalachian Laurentian margin: Lithoprobe results in western Newfoundland: *Canadian Journal of Earth Science* 35: 1271-1287.
- Goodwin, L.B. and Williams, P.F., 1996, Deformation path partitioning within a transpressive shear zone, Marble Cove, Newfoundland: *Journal of Structural Geology* 18: 975-990.
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- *Abbott, J. C. and Goodwin, L.B., 1995, A spectacular exposure of the Tijeras fault, with evidence for Quaternary motion: *New Mexico Geological Society Guidebook* 46: 117-125.
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