W. Payton Gardner

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Univserity of Montana
Dept. of Geosciences
32 Campus Dr. #1296
Missoula, MT, 59801

Education

Ph.D., Geophysics, 2009
Advisor: Dr. Kip Solomon
University of Utah, Salt Lake City, UT

M.S., Geophysics, 2007
Advisor: Dr. Kip Solomon
University of Utah, Salt Lake City, UT

B.S., Environmental Geology, 2004
University of Montana, Missoula, MT

Research Interests

Regional Hydrology, Environmental Tracers, Groundwater Age Dating, Noble Gas Geochemistry, Multi-phase subsurface flow and transport, Mountain Block Hydrogeology, Hydrogeodesy

Current Projects

1. Stream flow generation in mountain systems
2. Applying natural tracers to appraise fracture networks
3. Investigating regional groundwater discharge to large rivers
4. Mountain block groundwater recharge and circulation
5. Radiogenic noble gases as tracers of mechanical deformation
6. Groundwater flow in volcanic terrains
7. Hydrogeodesy to constrain watershed storage at the intermediate scale
8. Reactive transport model calibration and predictive uncertainty calculation
9. Measurement of cosmogenic ^{39}Ar in rocks

Employment Experience

Guest Professor - Institute for Environmental Physics
University of Heidelberg
August 2021 - Present

Associate Professor - Department of Geosciences
University of Montana
August 2021 - Present

Assistant Professor - Department of Geosciences
University of Montana
August 2015 - August 2021

Expert Consultant - Nuclear Waste Technology Section
International Atomic Energy Agency
Sept. 2014 - February 2015

Senior Member of the Technical Staff - Geological Engineering
Sandia National Labs
Sept. 2011 - August 2015

Office of the Chief Executive - Postdoctoral Fellow — CSIRO Land and Water, May 2009 - Sept 2011

Award and Honors

- Invited Speaker - University of Wyoming Geology and Geophysics Distinguished Lecture Series - 2023
- Institute Colloquium - Institute for Environmental Physics, University of Heidelberg - 2022
- Helen and Winston Cox Educational Excellence Award - 2020
- Invited speaker - Montana State University Earth Science Seminar - 2019
- Invited speaker - Purdue Earth and Environmental Science Seminar - 2018
- Invited speaker - Montana Institute of Ecology - Roughcut Seminar - 2018
- Secretary of Energy - Certificate of Appreciation - 2018
- Invited speaker - AGU Fall Meeting - A Deeper Look at Hydraulic Connectivity - 2016
- Invited Speaker - CUAHSI Biannual Workshop on Critical Zone Hydrology. Isotopes of Helium to Detect Regional Groundwater Discharge in Rivers - 2014.
- Invited Speaker - AGU Fall Meeting - Isotopes of Radon in Groundwater - Stream Water Interactions - 2013.
- Invited consultant to the IAEA - Isotope methods to characterize fluid flow in clay aquitards - 2013.
- Invited Speaker - GSA Fall Meeting - Isotopes of Helium in Groundwater - Stream Water Interactions - 2012.
- Outstanding Groundwater Talk. 11th Australasian Environmental Isotope Conference and 4rth Australasian Hydrogeology Research Conference - 2011.
- Outstanding Groundwater Talk. 10th Australasian Environmental Isotope Conference and 3rd Australasian Hydrogeology Research Conference - 2009.
- Outstanding PhD Student (Geophysics). University of Utah Department of Geology and Geophysics - 2009.
- Outstanding Master's Student (Geophysics). University of Utah Department of Geology and Geophysics - 2007.
- WEST Fellowship. University of Utah Department of Geology and Geophysics. 2005-2006.
- Cooper-Hansen Fellowship. University of Utah Department of Geology and Geophysics. 2004-2005.
- Mortar Board Environmental Geology Senior of the Year. University of Montana Department of Geology - 2002.

Funded Projects

- USGS MT Water Center Seed Grant - "Groundwater contribution and source in the upper Clark Fork River." $20k. 2024. PI
- DOE EPSCoR "Investigating Subsurface Flow in Mountainous Catchments." $750k. 2020. PI
- NSF Frontier Research in Earth Sciences - "Collaborative Research: New science, tools, and observations to couple geodesy with hydrology for modeling, water storage change, ands treamflow forecasting in mountain watersheds." $1.9M. 2020. Co-PI
- NSF Hydrologic Sciences/Geophysics - "Geodetic Lysimetry: GPS/GNSS observations to measure continuous, time-dependent water mass in mountainous watersheds." $488k. 2019. PI

- DOE - Nuclear Engineering University Program - "Using Multiple Environmental Tracers to Improve Reactive Transport Predictions." $724k. 2018. PI
- USGS MT Water Center Seed Grant - "Bedrock Hydrology" $20k. 2016. PI
- USDA - "Understanding the hydrologic and socioeconomic impacts of water use and resource allocation in agricultural regions under different climate and policy scenarios." $499k. 2015. Co-I

Synergistic Activities

- UMBRIDGES Faculty Member - National Science Foundation, National Research Traineeship Program at the Food Energy Water Nexus
- AGU - Hydrology Section Member
- GSA - Hydrogeology Section Member
- American Water Resources Association - Montana Chapter Member
- Associate Editor - Journal of Hydrology

Patents

- Non-Provisional Patent Application Serial No. 16/227,785
  "Systems and Methods for Measuring Material Degradation."
  Stephen J. Bauer and William Payton Gardner
  Filed 12/20/2018
- Patent No. US9719908B1
  "Electrofracturing test system and method of determining material characteristics of electrofractured material samples."
  Stephen J. Bauer, Steven F. Glover, Tom Pfeifle, Jiann-Cherng Su, Kenneth Martin Williamson, Scott Thomas Broome, William Payton Gardner, Gary Pena
  August 01, 2017

Publications (*Student Author)

Bauer, S., Glover, S., Williamson, K., Su, J. C., Broome, S., Gardner, W. P., Rudys, J., Pena, G., White, F., & Horry, M. Electrofracturing of Shale at Elevated Pressure. *Energies*, 2024, 17(11), 2708. https://doi.org/10.3390/EN17112708

Thiros, N. E., Siirila-Woodburn, E. R., Sprenger, M., Williams, K. H., Dennedy-Frank, J. P., Carroll, R. W. H., & Gardner, W. P. Old-Aged groundwater contributes to mountain hillslope hydrologic dynamics. *Journal of Hydrology*, 2024, 635, 131193. https://doi.org/10.1016/J.JHYDROL.2024.131193

Johnson, K.*, Christensen, J. N., Payton Gardner, W., Sprenger, M., Li, L., Williams, K. H., Carroll, R. W. H., Thiros, N., Brown, W., Beutler, C., Newman, A., & Sullivan, P. L. Shifting groundwater fluxes in bedrock fractures: Evidence from stream water radon and water isotopes. *Journal of Hydrology*, 2024, 635, 131202. https://doi.org/10.1016/J.JHYDROL.2024.131202

Clayton, N.*, Knappe, E., White, A. M., Martens, H. R., Argus, D. F., Lau, N.*, Borsa, A. A., Bendick, R., & Payton Gardner, W. Elastic deformation as a tool to investigate watershed storage connectivity. *Nature: Communications Earth & Environment*, 2024, 5(1), 1–9. https://doi.org/10.1038/s43247-024-01264-3

White, A. M., Lajoie, L. J., Knappe, E.*, Martens, H. R., Swarr, M. J.*, Khatiwada, A.*, Oliver, B.*, Perry, M.*, Clayton, N.*, Bendick, R., Borsa, A. A., Argus, D. F., & Gardner, W. P. High-density integrated GNSS and hydrologic monitoring etwork for short-scale hydrogeodesy in high mountain watersheds. *Earth and Space Science*, 2023, 10(10), e2022EA002678. https://doi.org/10.1029/2022EA002678

Thiros, N. E.*, Siirila-Woodburn, E. R., Dennedy-Frank, P. J., Williams, K. H., & Gardner, W. P. Constraining Bedrock Groundwater Residence Times in a Mountain System With Environmental Tracer Observations and Bayesian Uncertainty Quantification. *Water Resources Research*, 2023, 59(2), e2022WR033282. https://doi.org/10.1029/2022WR033282

Thiros, N. E.*, Gardner, W. P., Maneta, M. P., and Brinkerhoff, D. J., "Quantifying Subsurface Parameter and Transport Uncertainty Using Surrogate Modeling and Environmental Tracers." *Hydrological Processes*, 2022, https://doi.org/10.1002/HYP.14743

Argus, D. F., Martens, H. R., Borsa, A. A., Knappe, E., Wiese, D. N., Alam, S., et al., "Subsurface Water Flux in California's Central Valley and Its Source Watershed From Space Geodesy." *Geophysical Research Letters*, 2022, 49(22), e2022GL099583. https://doi.org/10.1029/2022GL099583

White, A. M., Gardner, W. P., Borsa, A. A., Argus, D. F., and Martens, H. R., "A Review of GNSS/GPS in Hydrogeodesy: Hydrologic Loading Applications and Their Implications for Water Resource Research." *Water Resources Research*, 2022, 58(7), e2022WR032078. https://doi.org/10.1029/2022WR032078

Smerdon, B. D. and W. P. Gardner. "Characterizing groundwater flow paths in an undeveloped region through synoptic river sampling for environmental tracers." *Hydrological Processes*, 2021. https://doi.org/10.1002/hyp.14464

Gardner, W. P., S. J. Bauer, and S. Broome, "Investigating Fracture Network Deformation Using Noble Gas Release." *Geofluids*, 2021, 6697819.

Thiros, N. E.*, W. P. Gardner, and K. L. Kuhlman, "Utilizing Environmental Tracers to Reduce Groundwater Flow and Transport Model Parameter Uncertainties." *Water Resources Research*, 2021, 57(7), e2020WR028235.

Gardner, W. P., K. Jensco, Z. Hoylman, R. Livesay*, and M. Maneta, "A Numerical Investigation of Bedrock Groundwater Recharge and Exfiltration on Soil Mantled Hillslopes", 2020 *Hydrological Processes*, 34(15), 3311–3330.

Wurster, P.*, M. Maneta, S. Begueria, K. Cobourn, B. Maxwell, N. Silverman, S. Ewing, K. Jensco, W. P. Gardner, J. Kimball, Z. Holden, J. Xinde, S. M. Vicente-Serrano, "Characterizing the impact of climatic and price anomalies on agrosystems in the northwest United States", 2020, *Agricultural and Forest Meteorology.*

Naftz, D. L., K. Walton-Day, W. P. Gardner, M. C. Duniway, and D. Bills, "Natural and anthropogenic processes affecting radon releases during mining and early stage reclamation activities, Pinenut uranium mine, Arizona, USA", *Journal of Environmental Radioactivity*, 2020, 220–221(May).

Gardner, W. P. and D. D. Susong, "Helium in Stream Water as a Volcanic Monitoring Tool", *Geochemistry, Geophysics, Geosystems*, 2019, 20(12).

Bauer, S. J., Gardner, W. P., & Lee, H.*, "Noble Gas Release from Bedded Rock Salt during Deformation" *Geofluids*, 2019.

Hoylman, Z. H.*, K. G. Jencso, J. Hu, Z. A. Holden, J. T. Martin, and W. P. Gardner, "The climatic water balance and topography control spatial patterns of atmospheric demand, soil moisture and shallow subsurface flow", *Water Resoures Research*, 2019, doi:10.1029/2018WR023302.

Knappe, E.*, R. Bendick, H. R. Martens, D. F. Argus, and W. P. Gardner, "Downscaling Vertical GPS Observations to Derive Watershed-Scale Hydrologic Loading in the Northern Rockies", *Water Resources Research*, 2019, 55(1), 391-401, doi:10.1029/2018WR023289.

Beisner, K., Gardner, W. P., and Hunt, A., "Geochemical Characterization and Modeling of Regional Groundwater Contributing to the Verde River, Arizona Between Mormon Pocket and the USGS Clarkdale Gage." *Journal of Hydrology*, 2018.

Woelber, B.*, M. P. Maneta, J. Harper, K. G. Jencso, W. P. Gardner, A. C. Wilcox, and I. López-Moreno, "The influence of diurnal snowmelt and transpiration on hillslope throughflow and stream response", *Hydrolology and Earth System Science*, 2018, 22(8), 4295-4310, doi:10.5194/hess-22-4295-2018.

Gardner, W. P.; Bauer, S. J.; Kuhlman, K. L. and Heath, J. E., "Modeling Dynamic Helium Release as a Tracer of Rock Deformation." *Journal of Geophysical Research: Solid Earth*, 2017, DOI 10.1002/2017JB014376.

Bauer, S. J.; Gardner, W. P. and Lee, H.*, "Release of radiogenic noble gases as a new signal of rock deformation." *Geophysical Research Letters*, 2016, 43, 10,688-10,694

Hokr, M., H. Shao, W. P. Gardner, A. Balvín, H. Kunz, Y. Wang, and M. Vencl. "Real-case benchmark for flow and tracer transport in the fractured rock." *Environmental Earth Sciences*, 2016, 75, no. 18.

W. Payton Gardner; Hokr, M.; Shao, H.; Balvin, A.; Kunz, H. and Wang, Y. "Investigating the age distribution of fracture discharge using multiple environmental tracers, Bedrichov Tunnel, Czech Republic." *Environmental Earth Sciences*, 2016, 75, 1374

Bauer, S. J.; Gardner, W. P. and Heath, J. E. "Helium release during shale deformation: Experimental validation." *Geochemistry, Geophysics, Geosystems*, 2016, 17, 2612-2622

W. Payton Gardner; Hammond, G., Lichtner, P. "High Performance Simulation of Environmental Tracers in Heterogeneous Domains." *Groundwater*, 2015, 53, 71-80

Hendry, M. J.; Solomon, D. K.; Person, M.; Wassenaar, L. I.; Gardner, W. P.; Clark, I. D.; Mayer, K. U.; Kunimaru, T.; Nakata, K., Hasegawa, T. "Can argillaceous formations isolate nuclear waste? Insights from isotopic, noble gas, and geochemical profiles." *Geofluids*, 2015, 15, 381-386

Smerdon, B. D.; Smith, L. A.; Harrington, G. A.; Gardner, W. P.; Piane, C. D., Sarout, J. "Estimating the hydraulic properties of an aquitard from in situ pore pressure measurements." *Hydrogeology Journal*, 2014, 22, 1875-1887

W. Payton Gardner, David D. Susong, D. Kip Solomon, and Henry P. Heasler. " Using environmental tracers and numerical simulation to investigate regional hydrothermal basins – Norris Geyser Basin area, Yellowstone National Park, USA.", *Journal of Geophysical Research: Solid Earth*, 2013, Vol. 118, 1-11, doi:10.1002/jgrb.50210.

Glenn A. Harrington, W. Payton Gardner, Brian D. Smerdon, and M. Jim Hendry. "Palaeohydrogeological insights from natural tracer profiles in aquitard porewater, Great Artesian Basin, Australia.", *Water Resources Research*, 49, 2013.

Glenn A. Harrington, W. Payton Gardner and Tim J. Munday. "Tracking groundwater discharge to a large river using tracers and geophysics." , *Groundwater*, 2014, Vol. 52, No. 6,

837-852

Stanley D. Smith, D. Kip Solomon, and W. Payton Gardner. "Testing helium equilibrium between quartz and pore water as a method to determine pore water helium concentrations". *Applied Geochemistry*. 2013. doi:10.1016/j.apgeochem.2013.04.010.

W. Payton Gardner. "Preliminary formation analysis for compressed air energy storage in depleted natural gas reservoirs: A study for the DOE energy storage systems program.", Technical Report SAND2013-4323, Sandia National Laboratories, June 2013. Unclassified Unlimited Release.

W. Payton Gardner, Glenn Harrington and Brian Smerdon. "Using excess ^{4}He to quantify variability in aquitard leakage", *Journal of Hydrology*, 2012, 468, 63-75

Brian Smerdon, W. Payton Gardner and Glenn Harrington. "Identifying the contribution of regional groundwater to the base flow of a tropical river (Daly River, Australia)", *Journal of Hydrology*, 2012, 464, 107-115

W. Payton Gardner, David D. Susong, D. Kip Solomon and Henry P. Heasler. "A multitracer approach for characterizing interactions between shallow groundwater and the hydrothermal system in the Norris Geyser Basin area, Yellowstone National Park", *Geochem. Geophys. Geosyst.*, 2011, 12, Q08005

W. Payton Gardner, Glenn Harrington, D. Kip Solomon and Peter Cook. "Using Terrigenic ^{4}He to Identify and Quantify Old Groundwater Discharge to Streams". *Water Resources Research*, 2011, 47, W06523

W. Payton Gardner, David D. Susong, D. Kip Solomon and Henry P. Heasler. "Using noble gases measured in spring discharge to trace hydrothermal processes in the Norris Geyser Basin, Yellowstone National Park, U.S.A." *Journal of Volcanology and Geothermal Research*, 2010, 198, 394-404

W. Payton Gardner, David D. Susong, D. Kip Solomon and Henry P. Heasler. "Snowmelt hydrograph interpretation: revealing basin scale hydrologic characteristics of the Yellowstone Volcanic Plateau." *Journal of Hydrology*, 2010, 383, 209-222

W. Payton Gardner and D. Kip Solomon. "Advanced passive diffusion samplers for the collection and determination of aqueous dissolved gas concentrations." *Water Resources Research*, 45, 2009

Matt V. Vitale, W. Payton Gardner, Nancy W. Hinman. "Surface water – groundwater interaction and chemistry in a mineral-armored hydrothermal outflow channel, Yellowstone National Park, USA." *Hydrogeology Journal*, 2008, 16, 1615 - 1627

Courses Taught

2015
GEO420 – Hydrogeology, Spring 2016, 4 credits, 20 students.

2016
GEO420 – Hydrogeology, Spring 2017, 4 credits, 18 students.
GEO595 – Subsurface Transport, Fall 2016, 3 Credits, 10 students.

2017
GEO595 – Watershed Hydrology Seminar, Fall 2017, 2 Credits, 12 students

GEO103 – Environmental Geology, Fall 2017, 3 Credits, 20 students
GEO420 – Hydrogeology, Spring 2018, 4 credits, 17 students
NRSM594 – Hydrology of Critical Zone, Spring 2018, 2 credits, 8 students
GEO391– Surface Processes, Spring 2018, 1.5 credits, 6 students

2018
GEO103 – Environmental Geology, Fall 2018, 3 credits, 31 students
GEO572 – Advanced Hydrogeology, Fall 2018, 3 Credits, 4 students
GEO420 – Hydrogeology, Spring 2019, 4 credits, 12 students

2019
GEO491 – Careers in Geosciences, Fall 2019, 1 credits, 29 students
GEO572 – Advanced Hydrogeology, Fall 2019, 3 Credits, 8 students
GEO420 – Hydrogeology, Spring 2020, 4 credits, 12 students
GEO391– Surface Processes, Spring 2020, 1.5 credits, 16 students

2020
GEO491 – Careers in Geosciences, Fall 2020, 1 credits, 9 students
GEO572 – Advanced Hydrogeology, Fall 2020, 3 Credits, 4 students
GEO420 – Hydrogeology, Spring 2021, 4 credits, 7 students
GEO202– Water Planet, Spring 2021, 1.5 credits, 9 students

2021
GEO572 – Advanced Hydrogeology, Fall 2021, 3 Credits, 7 students
GEO420 – Hydrogeology, Spring 2022, 4 credits, 14 students
GEO391– Computational Methods in Earth and Environmental Sciences, Spring 2022, 3 credits, 16 students

2022
Fundamentals of Hydrogeology Lecture - University of Heidelberg Masters Lecture Environmental Physics Masters Seminar - University of Heidelberg Couple Physics of Subsurface Flow and Transport - University of Heidelberg PhD Graduate Days Seminar
2023
GEO420 Hydrogeology - 11 students

2024
GEO323 - Computational Methods in Earth and Environmental Sciences, Spring 2024, 3 credits, 12 students
GEO597 - Hydrologic Modeling, Spring 2024, 3 credits, 3 students

PhD Theses Supervised

2022
Nicholas Thiros – "Using Environmental Tracers to Reduce Uncertainty in Groundwater Flow and Transport Simulations."

Master Theses Supervised

2016
Christine Brissette – "Stream restoration effects on hydraulic exchange storage, and alluvial aquifer discharge." * - Co-Advisor

2017

Isabellah VonTrapp – "Using multiple environmental tracers to investigate the relative role of soil and deep groundwater in stream water generation for a snow-dominated headwater catchment."

Derek Goble – "Estimating Groundwater Inflow and Age Characteristics in an Alluvial Aquifer Along the Little Wind River, Wyoming."

Robert Livesay – "An Inter-Watershed Comparison Study of Bedrock Controls on Shallow Subsurface Flow and Stream Flow Response." * - Co-Advisor

2021
Kimberly Bolhuis - "Quantifying Bedrock Recharge in Two Paired Mountainous Watersheds."

Noah Clayton - "Using GPS Vertical Displacement to Investigate Watershed Scale Storage-Discharge Relationships."

2022
Casey Kleppel - "Using Environmental Tracers to Constrain Field Scale Dispersivity."

Jenna Rolle - "Using Stable Isotopes of Water to Trace Snowmelt Recharge and Discharge."

2023
Andrew Nordberg - "Evaluating the Use of Environmental Tracers to Reduce Conceptual Model Uncertainty of Hydrogeologic Models."

2024
Brett Oliver - "Evaluating the Sensitivity of Crustal Deformation to Bedrock Hydrology in a Mountain Watershed."

David Baude - "Characterizing Mountainous Bedrock Groundwater Systems across Gradients in Topography and Lithology in Western Montana."

Undergraduate Theses Superv.

2016
Matt Thomas – "Remote Sensing of Soil Hydraulic Parameters"

Melinda Thorne – "Using 222Rn to map groundwater discharge to the Clark Fork River between Milltown and Frenchtown."

2019
Dan Forsland – "Detecting Groundwater Discharge in the Clark Fork River near Stone Container Using Spectral Alpha Decay Detection for Dissolved Radon in Surface Water Samples."
2022
Rachel Grena - "Investigating the Effect of Forest Roads on Shallow Groundwater Flow in Packer Creek Meadow, Idaho."

Student Awards Honors

- Melinda Thorne - Don Winston Field geology scholarship 2016
- Matt Thomas - MTSGC Undergraduate fellowship 2016
- Matt Thomas - UMCUR Outstanding Research Award 2016
- Isabellah Von Trapp - Outstanding Student Poster – American Water Resources Association, Montana Chapter – Fall Meeting 2017

- Isabellah Von Trapp - Outstanding Student Presentation – American Geophysical Fall Meeting 2017
- Derek Goble - New Fields Environmental Scholarship 2017
- Kimberly Bolhuis - Outstanding Student Presentation – American Water Resources Association, Montana Chapter – Fall Meeting 2020
- Noah Clayton - Outstanding Student Presentation – American Water Resources Association, Montana Chapter – Fall Meeting 2021
- Nick Thiros - U.S. Dept. of Energy, Office of Science Graduate Research Fellowship 2021