

## 2019 Birdsall-Dreiss Distinguished Lecturer



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[Laura J. Crossey](#) is a professor in the Department of Earth & Planetary Sciences at the University of New Mexico. She received her Bachelor's degree in geology at Colorado College (1977) and Master's degree at Washington University in St Louis (1979). Her master's thesis was on the trace element geochemistry of basalts from the Rio Grande rift as part of the Terrestrial Basaltic Volcanism project in the 1970's (advisor Dr. Larry Haskin). She earned her Ph.D. from the University of Wyoming (Laramie, Wyoming, USA) in 1985 on the Origin and Role of Organics During Burial Diagenesis under the direction of Dr. Ronald C. Surdam. She joined the faculty at UNM in 1986 (first woman tenured, first woman full professor, first woman Chair). Her research group explores applications of low-temperature geochemistry to problems in hydrochemistry, diagenesis, geomicrobiology, and geothermal processes. Her research approach combines field examination of modern environments (water, gas, geomicrobial materials and sediments) with laboratory analysis as well as core and outcrop study to evaluate paleohydrology, spring sustainability and reservoir/aquifer characteristics. Related activities include geoscience outreach, K-12 outreach, and science education research as well as programs to increase the participation of under-represented groups in science. She is a Co-I on the NSF-funded statewide New Mexico Alliance for Participation. Her research on carbonic springs has taken her to the Great Artesian basin of Australia, the Western Desert of Egypt, and the Tibetan Plateau. Laura has served the hydrogeologic and broader geoscience communities on proposal and academic program review panels and volunteer boards. A list of her publications may be found on her public Google Scholar profile. She has been a member of GSA since 1997 and a Fellow since 2012. She was awarded Lifetime Membership to the New Mexico Geological Society on the basis of her service. She has served as President and past-President of the Sedimentary Geology Division, convened many topical sessions at GSA national meetings, and served as Technical Program Chair for the Rocky Mountain Division. She has served as Associate Editor for GSA Bulletin, *Geochimica et Cosmochimica Acta* and *Applied Geochemistry*, and was editor of SEPM Special Publications. She and her husband Karl Karlstrom were awarded an Outstanding Achievement Award by the American Institute of Professional Geologists in 2015 for designing and building the Trail of Time, a geoscience exhibition at the Grand Canyon (funded by the National Science Foundation, and recognized as Best Wayside Exhibit by the National Association for Interpretation in 2011).

**Institutions can schedule a visit by completing the request form at this [link](#). Crossey will present one lecture on one of the topics described below. She is also happy to present brown bags or visit with faculty, staff and/or students on topics such as Inclusion and Diversity in STEM.**

**1. Chasing Helium: Mantle-to-Surface Connections to Water Quality and Geomicrobiology.** The discovery of oceanic black (and white) smokers revolutionized our

understanding of mid-ocean ridges and led to the recognition of new organisms and ecosystems resulting from mixing of fluids. Continental smokers, defined here to include a broad range of carbonic springs, hot springs, and fumaroles that vent mantle-derived fluids in continental settings, exhibit many of the same processes of heat and mass transfer and ecosystem niche differentiation. The application of noble gas geochemistry (specifically helium isotope ( $^3\text{He}/^4\text{He}$ ) analyses) indicates widespread mantle degassing in perhaps unexpected tectonic locales: including the western U.S.A., Great Artesian basin of Australia, Western Desert of Egypt, and the Tibetan Plateau. Our work shows that variations in the mantle helium component measured in groundwaters correlate best with low seismic-velocity domains in the upper mantle and with abrupt lateral contrasts in mantle velocity rather than crustal parameters such as strain rate, proximity to volcanoes, crustal velocity, or composition. Microbial community analyses applied to several of these areas indicate that these springs can host novel microorganisms. Our work yielded the first published occurrence of chemolithoautotrophic Zetaproteobacteria in a continental setting. These observations lead to two linked hypotheses. 1) that mantle-derived volatiles transit through conduits in extending continental lithosphere preferentially above and at the edges of mantle low velocity domains. 2) Elevated concentrations of  $\text{CO}_2$  and other constituents ultimately derived from mantle volatiles drive water–rock interactions and heterogeneous fluid mixing that help structure diverse and distinctive microbial communities. This recognition of the small volume but chemically potent “lower world” contributions to groundwater systems has implications for topics as diverse as tectonics, fluid conduits, water quality, and microbial ecosystems.

**2. Hydrochemistry and Geoscience Education at Grand Canyon and Beyond: Who Knew Groundwater Hydrology Could Be So Complicated?** Springs and associated riparian environments provide critical habitats for both aquatic and terrestrial wildlife in the Grand Canyon region. Springs also provide drinking water for Grand Canyon National Park (GCNP). Grand Canyon springs are fed by world-class karst aquifer systems (both shallow and deep) on the Colorado Plateau, but increasing pressure on groundwater resources from climate change, mining and other development activities pose major challenges to resource managers. The shallow and deep karst systems of the region interact in ways that are revealed by recent studies. General hydrologic models for the Colorado Plateau aquifers highlight the importance of recharge areas (‘springsheds’) for water supply. Ongoing work by several groups is helping to understand these complex relationships using multiple tracer methods. A robust monitoring and geochemical sampling program can provide data for understanding the sustainability of spring-fed water supplies for anthropogenic use. Our ongoing geochemical studies of spring waters (including dissolved gases) have identified the importance of mantle-derived volatiles and  $\text{CO}_2$  that contribute dissolved salts and other products of water-rock interactions at depth to the regional aquifer systems. Faults are important conduits for fluid transport and mixing and hence impart a tectonic influence on water quality. The result is a multi-porosity system resulting from variable ages and mixing of meteoric recharge, karst system transport, matrix sandstone transport, fault connectivity, and endogenic inputs. Quantitative forecasting of the effects of climate change on water quality depends on our understanding of these deep inputs (diminishing surface flows affecting recharge rates), as well as aquifer recharge flowpaths and quantities. Results from Grand Canyon and other spring-supported stream systems in the western U.S. indicate the need for development of hydrologic baselines that recognize these complexities.

This can be accomplished through use of both natural and artificial tracers to unravel mixing and environmental sensors to monitor real time changes. These investments are needed to inform water management decisions that address societal and ecosystem needs.