

UC **SANTA BARBARA**
Department of Earth Science

Earth Science Colloquium

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Chasing Helium: Mantle-to-Surface Connections to Water Quality and Geomicrobiology

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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 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.