

## Deep crustal structure, processes, and properties from xenoliths and seismic observations in the Rocky Mountains, USA

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Geophysical studies, xenoliths, magmatic records, and rare exposures of once deep rocks provide different perspectives with which to investigate the structure, composition, and properties of lower continental crust. Each has its own inherent biases and/or limitations, making integrated approaches particularly valuable in furthering our understanding of lithospheric evolution. We are comparing the structural, metamorphic, geochronological, thermochronological and petrophysical records from crustal and upper mantle xenoliths from a range of localities across the Rocky Mountain region to seismic observations from EarthScope's USArray and other regional experiments. Examples from three ongoing studies will be highlighted. First, diversity in petrologic and geochronological signatures of deep crustal xenoliths from central Montana as well as variations in calculated bulk seismic velocities support a composite origin for the enigmatic high velocity lower crustal layer ("7.x layer") that is present in parts of the Wyoming craton and southern Medicine Hat block. Heterogeneity of physical properties within the layer (e.g., velocity steps) and a locally reduced contrast in properties across the crust/mantle boundary owing to upper mantle metasomatism may help explain contrasting seismic interpretations of crustal thickness in the region. Second, seismic anisotropy is a potentially powerful tool for imaging deep crustal deformation patterns, and xenoliths from several localities in the Rockies appear to exhibit significantly anisotropic properties. For example, Leucite Hills xenoliths in south-central Wyoming are dominantly two-pyroxene-hornblende-biotite granulites (~1.0 GPa). Microstructure-based calculations indicate V<sub>p</sub> anisotropy of ~10%, due primarily to the combined effects of strongly aligned hornblende and biotite. This magnitude of anisotropy should be readily observable through seismic techniques if the anisotropy persists to km-scale. In the third example, we are asking how subsequent modification of Archean and Proterozoic deep crust during younger tectonic events may have influenced lithospheric properties and mountain building processes. For example, late stage deep crustal hydration of unknown age has been documented from several xenolith localities in the Four Corners region of the Colorado Plateau. Preliminary Th-Pb ion probe monazite geochronology suggests that fluids were added in the Late Cretaceous to Paleocene, potentially sourced via dehydration of shallowly subducted oceanic lithosphere, and thus raises questions about the potential geodynamic influence of garnet-consuming reactions on the density structure of the lower crust. Thermochronological data from accessory minerals also provide independent constraints on the age of all of the seismically imageable structures described above.

