Of Oceans and Watersheds: Novel uses of active-source seismology

In this talk I will present two examples of unusual applications of active-source seismology that reside somewhat outside the IRIS mainstream: seismic oceanography and mountain watershed structure. Both of these applications connect seismology to broader multidisciplinary communities: physical oceanography in one case, and "critical zone" science in the other.

Seismic oceanography is the application of marine seismic reflection profiling to the study of thermohaline fine-structure in the oceans (Holbrook et al., 2003, *Science*). The method relies on the discovery that slight temperature contrasts (~0.03˚C) in the ocean produce impedance contrasts and thus specular reflections in marine seismic reflection data. The small amplitudes of these reflections allowed them to remain hidden in data sets for decades, but simply increasing the gain in processing produces stunning images of all manner of oceanic features, including fronts, eddies, internal tides, and turbulence. And the method yields more than just pretty pictures: wavenumber spectra produced from the images provide quantitative estimates of turbulent diffusivity at unprecedented resolution.

A more recent and landlubberly development is the use of near-surface seismic refraction tomography to image the structure of mountain watersheds at the landscape scale. While seismic refraction has been widely applied in near-surface geophysics at the plot or hillslope scale, landscape-scale transects, which illuminate relationships between topography and subsurface structure, are uncommon. Recent results (St. Clair, Moon et al., 2015, *Science*) show that topographic and tectonic stresses may control the depth of open fractures and chemical weathering in the "critical zone." This implies a previously unappreciated connection between large-scale tectonic stresses and watershed hydrology, with potential implications for landscape evolution, the subsurface storage of plant-available water, and the relationships between precipitation and runoff in mountain watersheds.