Seismology is the most fruitful method of probing the detailed structure of the deep Earth. Much of my work exploits this property of elastic waves to learn about earthquakes, volcanoes, unusual seismic sources (including explosion, ice, and oceanic microseism signals), and to use the propagation attributes of seismic waves to image Earth structure. Virtually all of my projects support Ph.D. and/or M.S. graduate students.

I am currently a co-P.I. on a large passive broadband PASSCAL seismic experiment, CREST (Colorado Rockies Experiment and Seismic Transect) which is probing the structure of the upper mantle beneath the Rocky Mountains to shine light on the nature and impact of deep thermal and other anomalous structure. The southwestern and Rocky Mountain region of the U.S is unusual in that it consitutes one of Earth's great plateau provinces (the Colorado Plateau) and includes a mixture of ancient (Proterozoic) and recent (for example, the approximately 30 million-year old, and still active, Rio Grande rift) crustal and mantle structures (e.g., see MantlePlumes.org web page for a synopsis of a recent paper in the region on small-scale convection at the edge of the Colorado Plateau). I am also a co-P.I. on the POLENET project, which is incorporating new data collection and seismic imaging to produce new tectonic and ice sheet insights in west Antarctica as part of the International Polar Year.

My deep Earth imaging and other research efforts are supported by the National Science Foundation and by the Institute of Geophysics and Planetary Physics at Los Alamos National Laboratory.
Volcano seismology is another area of study that I have been active in for many years. Along with professor Philip Kyle, at NMT, I am co-principal investigator on the Mount Erebus Volcano Observatory (MEVO; the photograph at right was taken at Fang camp on Mount Erebus). MEVO, funded by the National Science Foundation Office of Polar Programs, performs geophysical and geochemical research on the active Erebus Volcano from McMurdo Station, Antarctica. Volcanoes produce a wide range of complex seismic signals due to interacting stress-release and fluid-movement sources. For example, at Erebus, signals from seismometers as close as 700 m to the active vents showing the flexing of the volcano summit region from moving magma before and after the volcano's spectacular Strombolian eruptions, and infrasound propagating through the atmosphere provides unique information on eruptions. Along with Allan Sanford and Susan Bilek, with assistance from EES staff and students, I assist in the processing and interpretation of data to examine the seismic activity of New Mexico and the southwest U.S. using a regional network of seismic stations operated by NMT. The greatest concentration of seismic activity in New Mexico is concentrated in the Socorro region due to the presence of an inflating mid-crustal (approximately 19 km) magma body beneath the Rio Grande rift, discovered by Dr. Sanford and his students at New Mexico Tech. The effect of the magma body is very noticeable in many local earthquake seismograms through the presence of reflected phases from its top surface. A recent research project, supported by Los Alamos National Laboratory, uses GPS and broadband seismometers to further probe the structure and ongoing activity of the Socorro Magma Body. Another area of recent interest for me has been the utilization of Earth's seismic background noise to assess storm intensities and other possible indicators of climate change and climate cycles. I am the principal investigator, in association with NMT Research and Economic Development of the on-campus Program for Array Seismic Studies of the Continentall Lithosphere (PASSCAL) Instrument Center, a National Science Foundation facility of the IRIS Consortium, supporting seismological research for seismologists both here at NMT and from many other research institutions throughout the world. IRIS is a critical consortium of over 100 universities and other institutions involved in seismological research. The PASSCAL Instrument Center at NMT currently supports over 35 professional staff, and provides unique opportunities for Tech students to involve themselves in cutting-edge seismological research and gain experience with state-of-the-art instrumentation. The PASSCAL Instrument Center operates in close association with the co-sited EarthScope Program's USArray Array Operations Facility. EarthScope is a major NSF facilities and science initiative to understand the fundamental structure, processes, and evolution of continents using North America as a natural laboratory. I recently co-chaired the workshop activities and writing of a Long-range Science Plan for Seismology for the National Science Foundation in association with IRIS and a number of national and international colleagues. I have strong enthusiasm for and commitment to general education and outreach on behalf of seismology and science, and give regular public lectures at primary and secondary schools, universities, museums, and community groups. One way that we work with colleagues across the nation to encourage promising young scientists pursuing careers in Earth Science is through the IRIS Internship Program, which incorporates an orientation week held each spring at New Mexico Tech. During 2009-2010 I presented a series of public lectures in a variety of cities as an IRIS/SSA Distinguished Lecturer. From 2009-2011 I served as president of the Seismological Society of America (SSA) and am currently on the SSA Board.