Shear wave velocities in minerals at high-pressures and temperatures determined with synchrotron-based experimental methods

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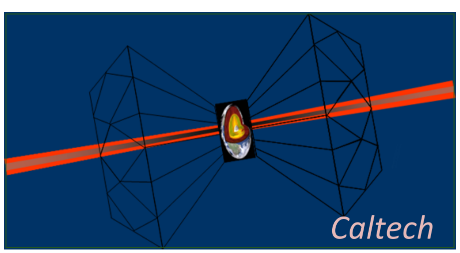
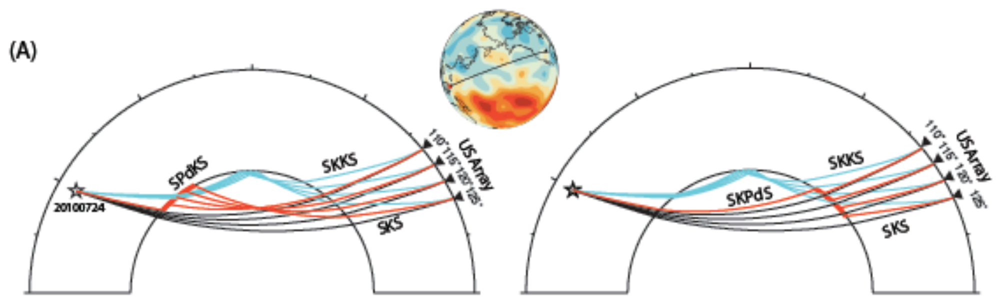
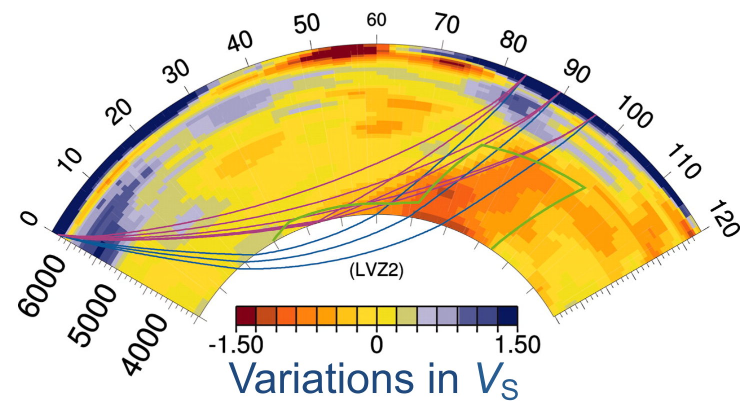
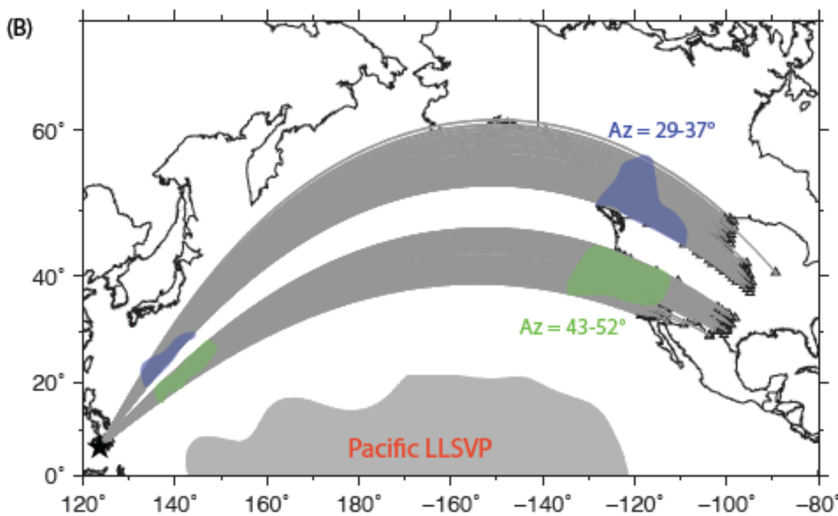


Geophysical observations and modeling require an understanding of material behavior and properties

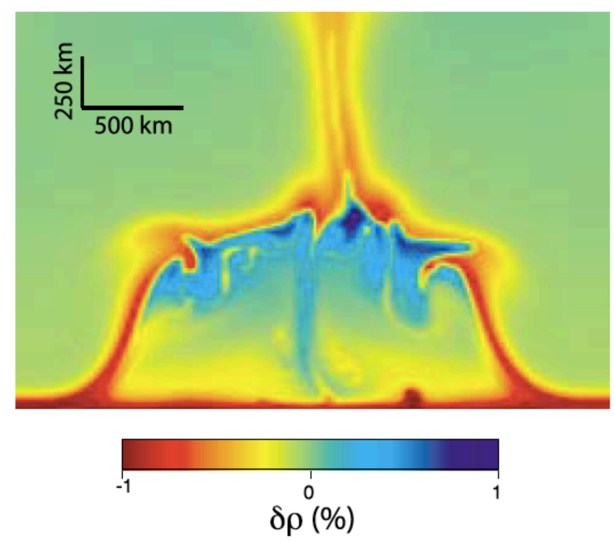




(Helmberger, Lay, Ni, Gurnis. *PNAS* 2005)



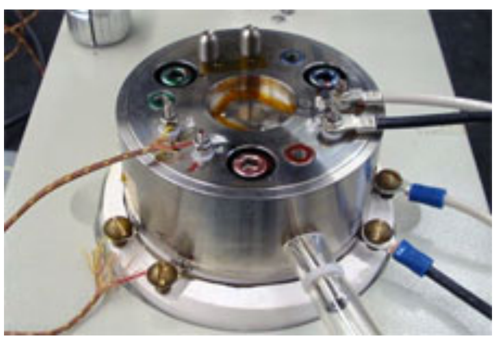
Sun, Helmberger, Jackson, Clayton, Bower.
(2012, in press)



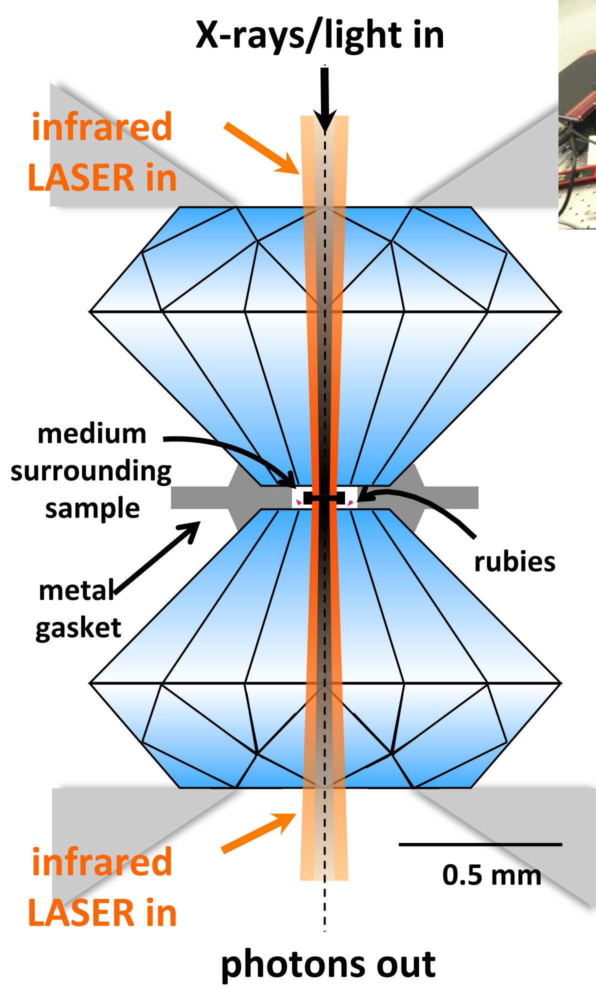
(Sun, Helmberger, Gurnis. *GRL* 2010)

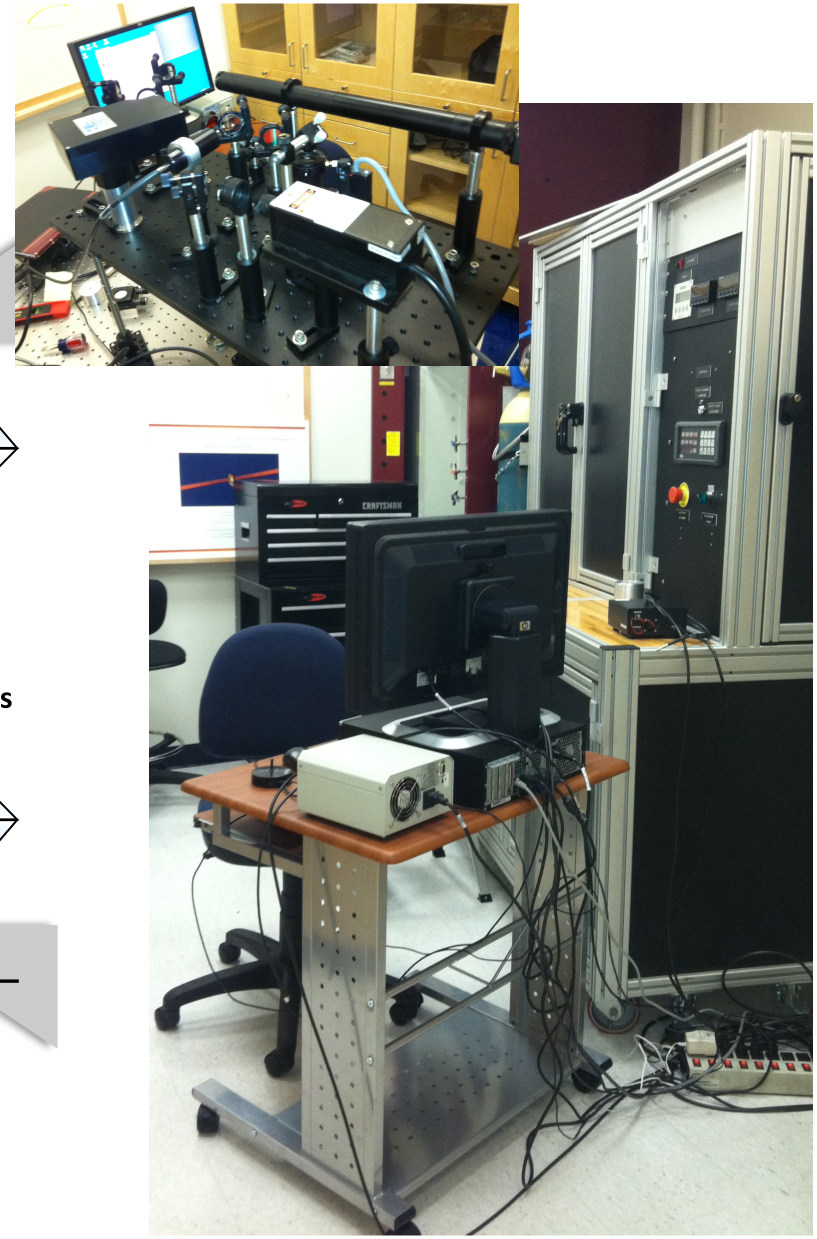
Generating high pressures, temperatures, and atmospheric variations:

Panoramic diamond-anvil cell (DAC)



Hydrothermal DAC (scale as above)





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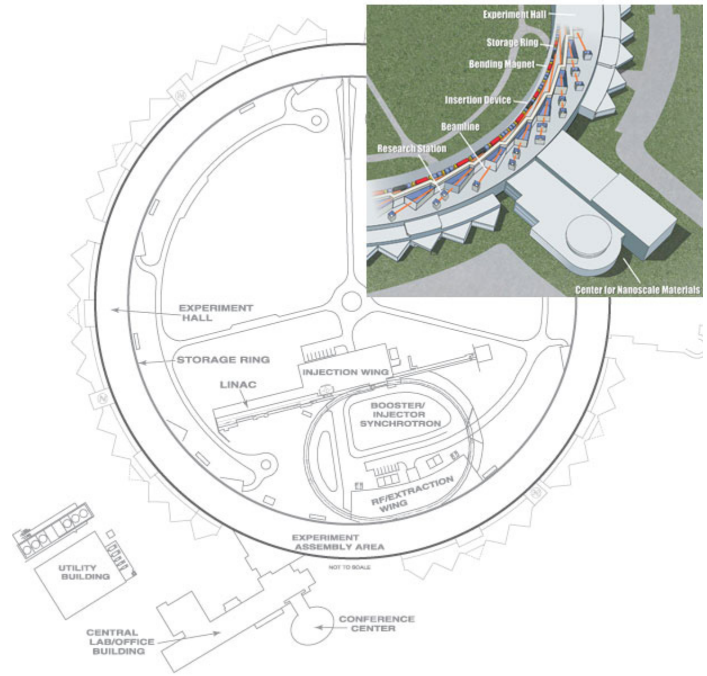
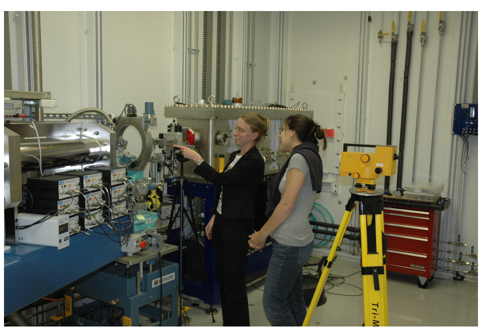
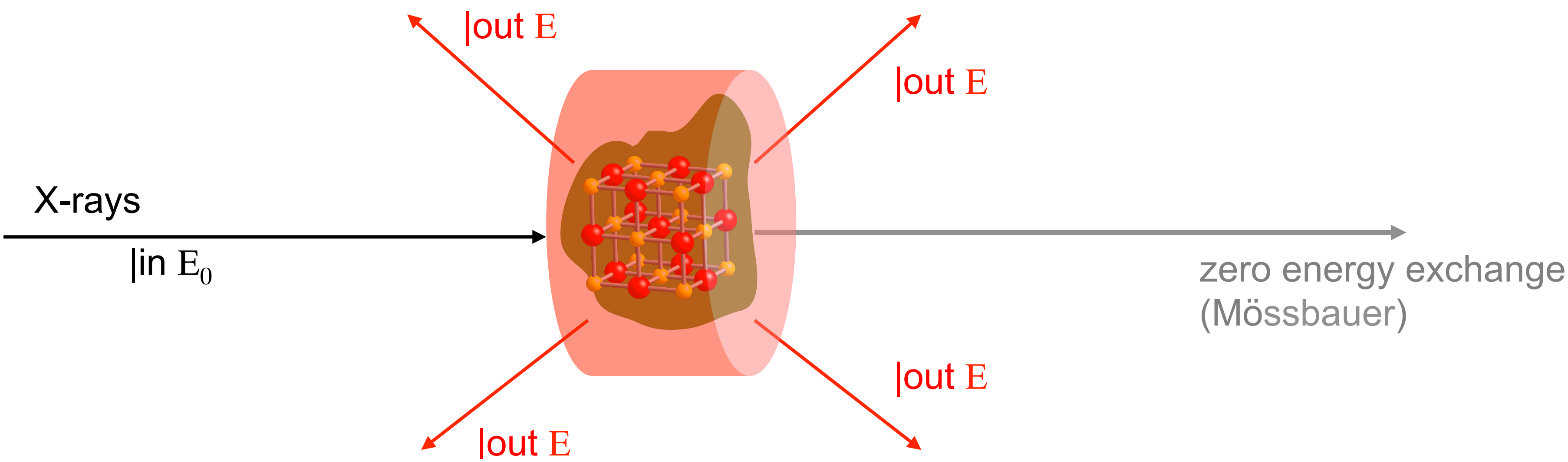
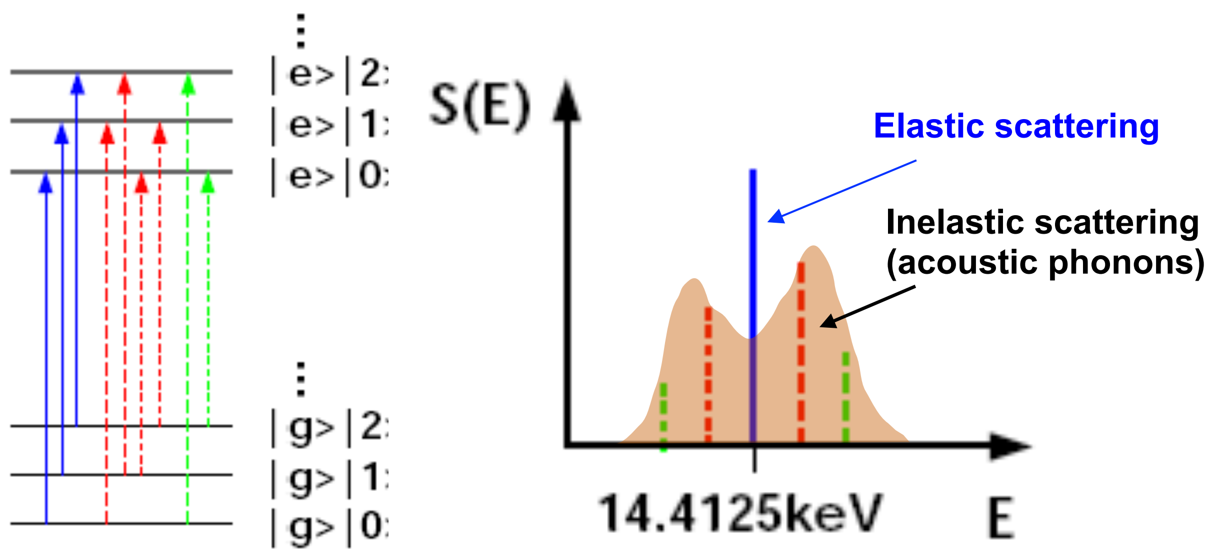
Wave velocity determinations using inelastic x-ray scattering



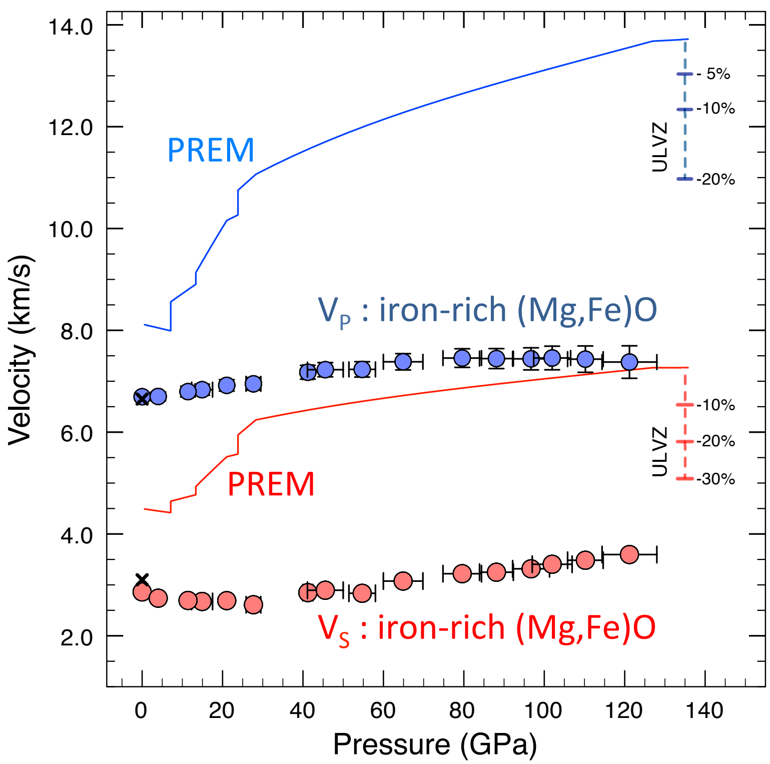


Measuring vibrational properties (e.g., wave velocities) with inelastic x-ray spectroscopy

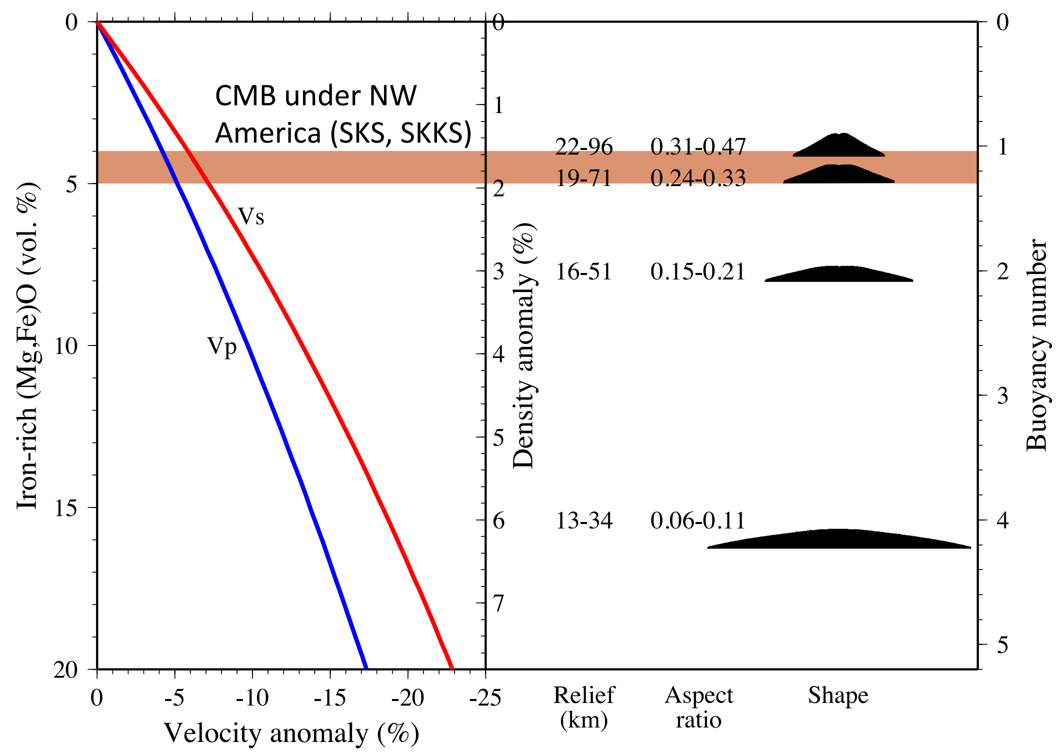




Combining velocity **determinations** with **seismic observations** and **geodynamics**: *Rolling hills resting on Earth's core-mantle boundary*

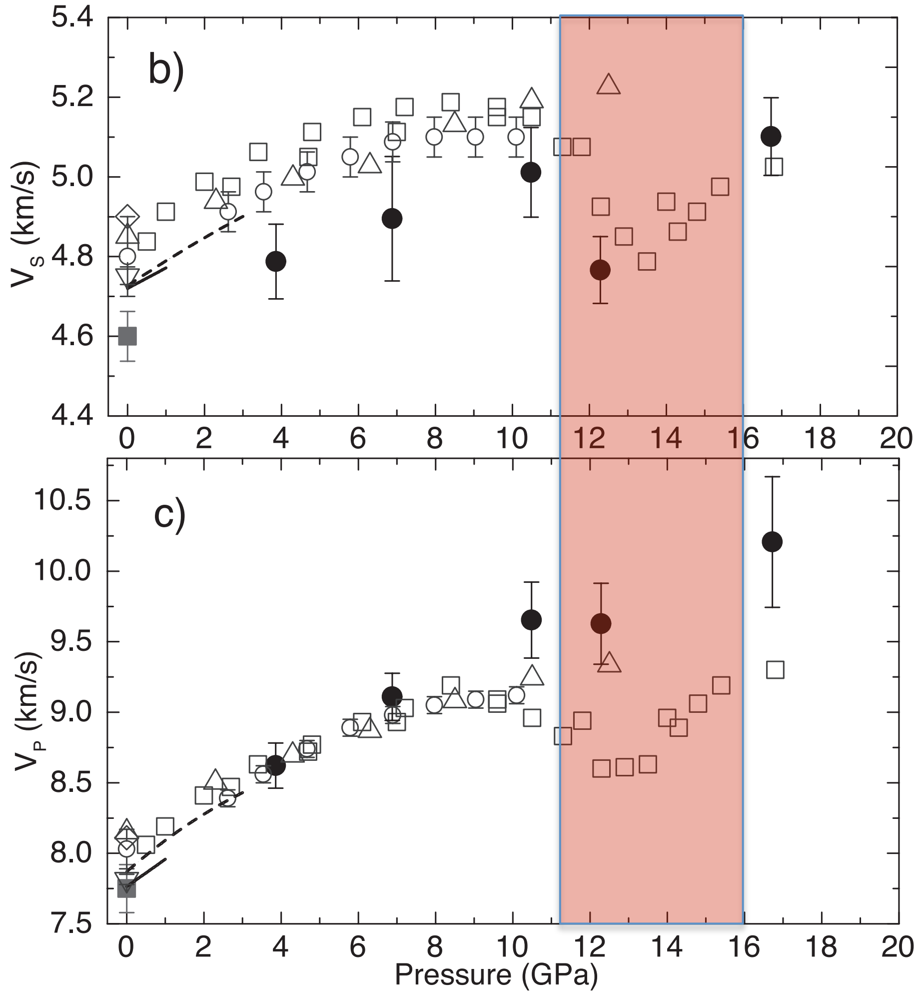


Wicks, Jackson, Sturhahn. Geophys. Res. Lett. (2010)

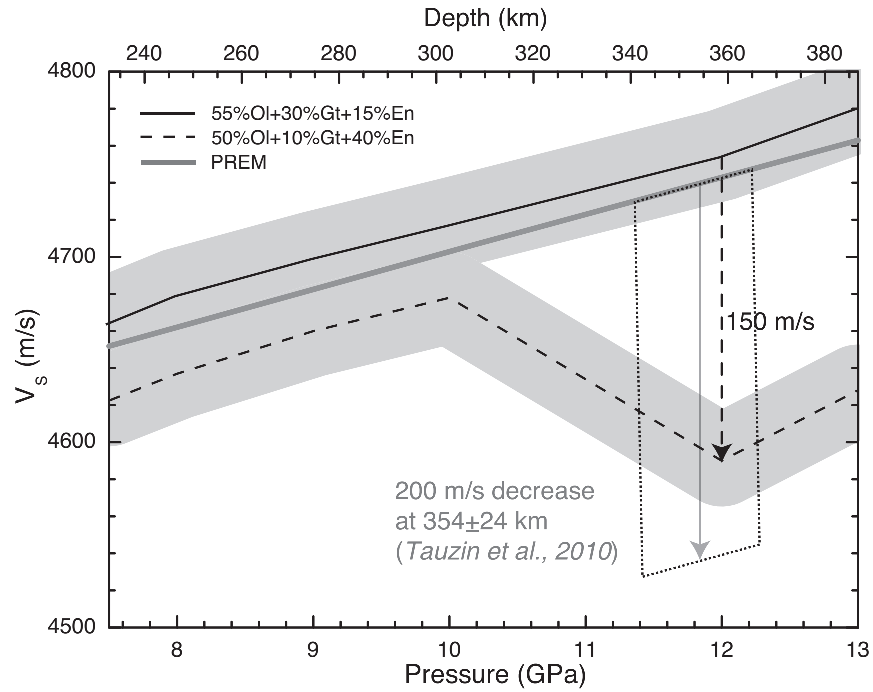


Sun, Helmberger, Jackson, Clayton, Bower. (2012, in press)

Velocity measurements of $(Mg,Fe)_2Si_2O_6$ enstatite: Low shear velocity zone due to structural transition



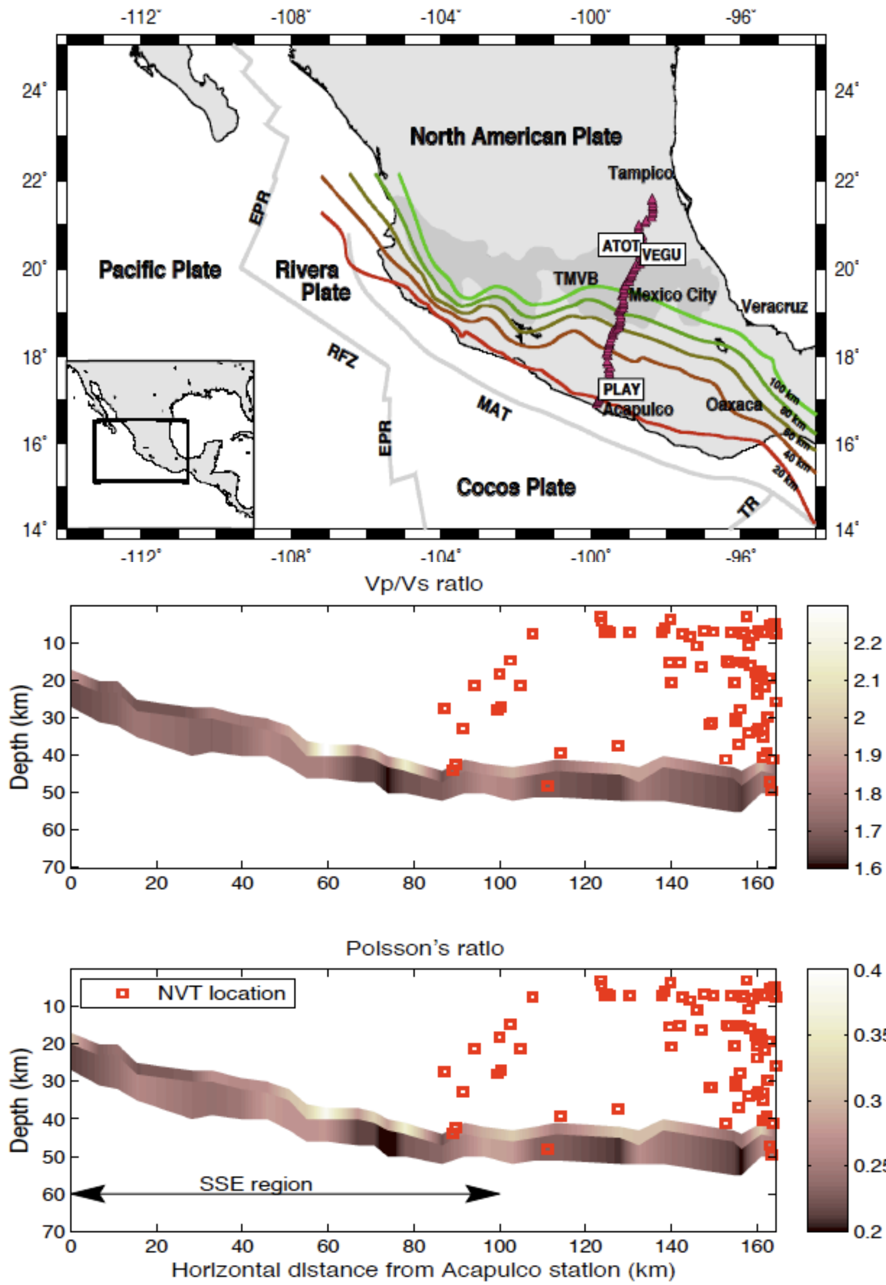
Zhang, Jackson, *et al.*
J. Geophys. Res. (2012, under review)



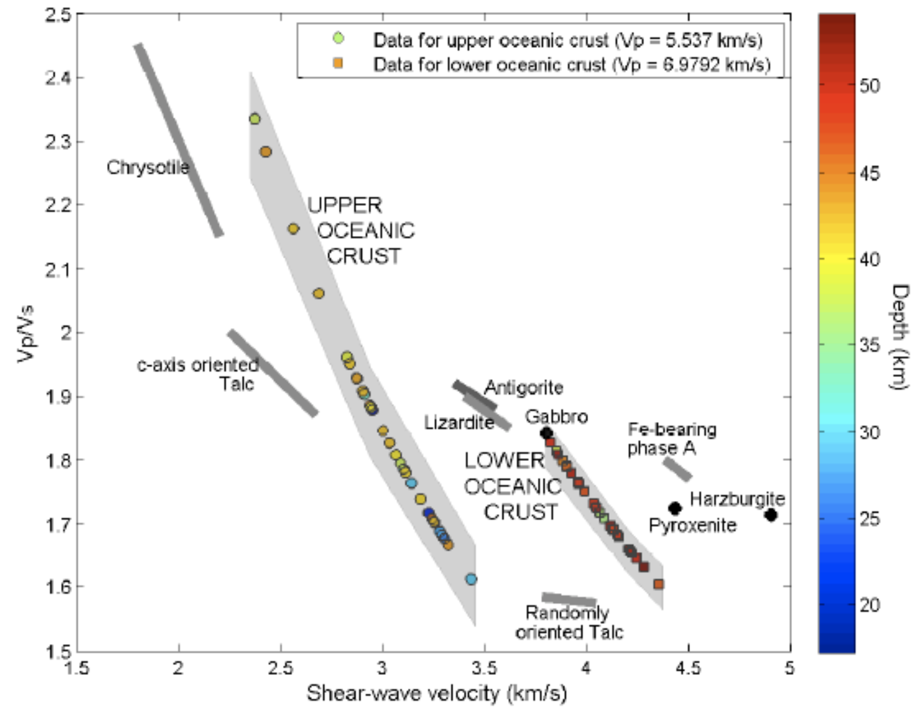
Enstatite (pyroxene): Component of Earth's upper mantle and depleted lithosphere of subducting slabs

Phase transition indicates shear velocity softening at high-pressures

Flat slab subduction of the Cocos plate under Mexico

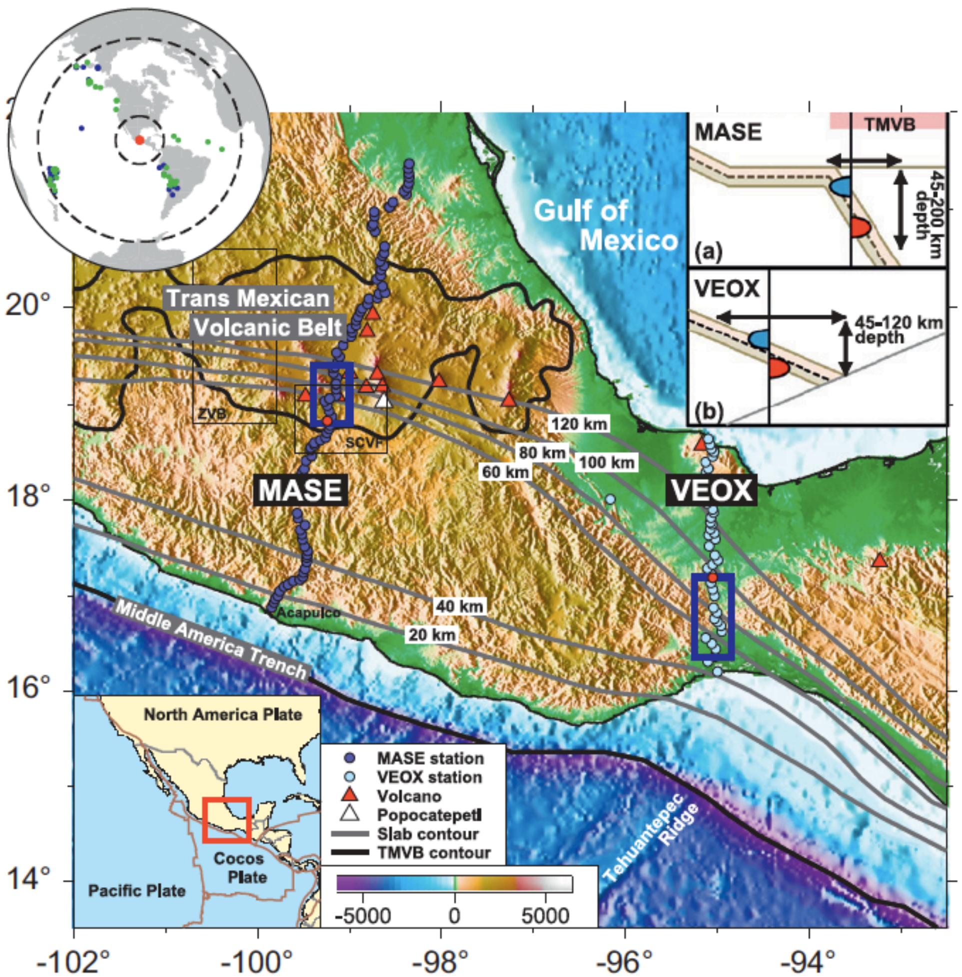


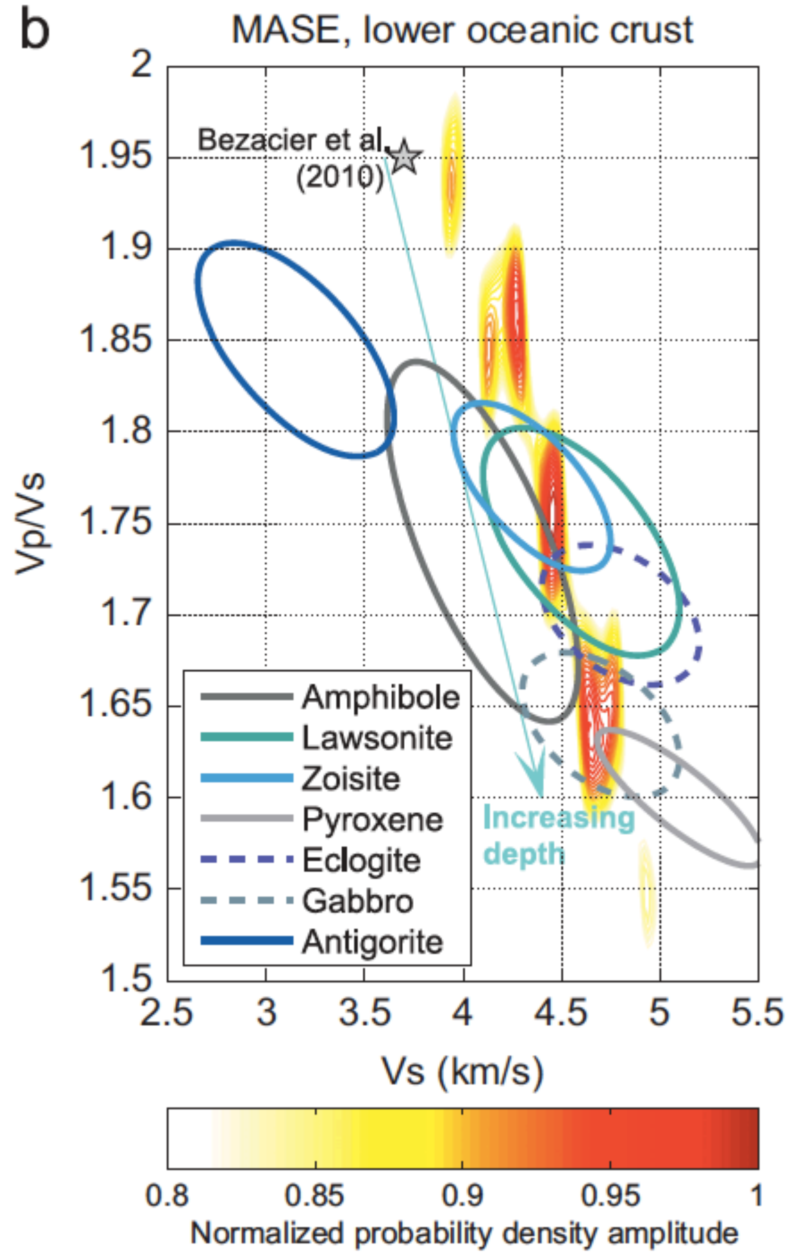
Comparing observations with mineral physics



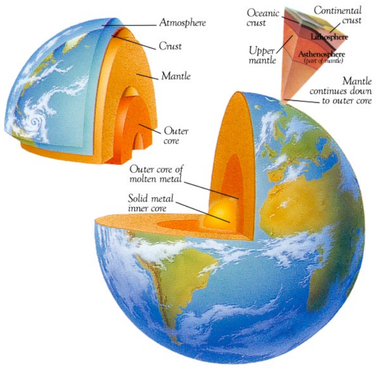
Kim, Clayton, Jackson. *J. Geophys. Res.* (2010)

Deeper regions of the Cocos plate under Mexico





Kim, Clayton, Jackson, *Earth Planet. Sci. Lett.* (2012)



Summary and conclusions

- ✧ Recent progress in pressure cells, advanced radiation sources, and inelastic x-ray scattering methods enable wave velocity measurements of minerals subjected to their plausible environment(s) inside Earth.

- ✧ By combining an interdisciplinary framework with a multi-scale understanding of the chemical and physical processes that occur inside the Earth, and improvements in data resolution and modeling capabilities, it is possible to better understand the evolution of the earth system.