Geophysical Research Abstracts
Vol. 13, EGU2011-14185, 2011
EGU General Assembly 2011

Free oscillations for fun and profit (Beno Gutenberg Medal Lecture)

Thomas Guy Masters
UCSD, United States

Free oscillation seismology is usually considered to be a somewhat arcane and difficult backwater of seismology. In this talk, I will try to persuade you that much has been, and is yet to be, learned from this interesting discipline.

With a few assumptions, it is possible to correct for 3D structure and to make extremely precise measurements of the "degenerate" frequencies of free oscillations (those free oscillation frequencies the Earth would have if it were spherically symmetric). Such measurements are the principal constraints on the 1D structure of the Earth. They provide surprisingly tight constraints on Earth structure and allow some interesting geophysical conclusions to be made. I will illustrate this with some examples. A recent case is the question of how much effect a spin transition in lower mantle materials can have on elasticity and density. Some recent mineral physics experiments predicting extreme modulus weakening due to the spin transition are not consistent with the seismic data.

Of course, 3D structure is of most interest and free oscillations provide a very interesting view of this problem. Free oscillations are natural "low-pass filters" of 3D structure which can be good and bad. As we have demonstrated in the past, it is "good" for a problem like the super-rotation of the inner core where free oscillations can use large-scale structure in the inner core to track inner core rotation. It has been 10 years since we looked at this problem and there have been very many large earthquakes in the interim so we anticipate that new constraints on inner core rotation will be available at the meeting.

Free oscillation data also clearly show the anti-correlation between shear velocity and bulk sound speed in the lower mantle for large-wavelength structure. Such data have also been used to infer an anti-correlation between density and shear velocity in the lower mantle. While free oscillation data on their own do not unambiguously show this effect, the signal appears to be real when free oscillation data are combined with body-wave data. Such observations are very important for understanding thermo-chemical convection in the mantle.

Finally, there are some aspects of Earth structure that we are unlikely to learn about in any other way. An example is the shear velocity structure of the inner core. Observations of shear body waves in the inner core remain rare and controversial, yet observations of free oscillations with some shear energy in the inner core are not uncommon. We will review the current status of such research.