ETH crystallographers explain seismic anisotropy of Earth's D-layer

11 May 2006

Earth from space

ETH Zürich researchers discovered a very unusual mechanism of plastic deformation in the Earth's mantle. Furthermore, they have predicted a new family of mantle minerals. These discoveries shed new light on the plastic flow of mantle rocks inside our planet - the process that controls plate tectonics and the associated earthquakes, volcanism, and continental drift.

Plastic flow in the Earth's mantle is the microscopic process behind plate tecton-ics and the associated continental drift, volcanism and earthquakes. Seismic anisotropy is the main signature of plastic flow inside the Earth. Its character depends on the properties of Earth-forming minerals.

Simulations have provided a new insight that leads to a more consistent picture of the dynamics of our planet. According to seismic observations, the lowermost 150 km of the Earth's mantle, known as the D" layer, possess many unusual properties. Many of these anomalies were explained by the properties of post-perovskite $(Mg,Fe)SiO_3$, the dominant mineral of the D" layer. Still, it remained difficult to explain the observed strong seismic anisotropy of the D" layer. Now, thanks to metadynamics, a novel simulation methodology, ETH researcher Artem R. Oganov and colleagues have explained these seismic observations.

They came up with an unexpected mechanism of plastic deformation of post-perovskite involving the formation of nanoscale slices of the lower-pressure perovskite structure along the (110) planes of post-perovskite. The ETH researchers could show that this mechanism fully explains the observed seismic anisotropy and some geophysical observations are consistent only with this mechanism.

New minerals in the Earth's mantle

Structures containing slices of the perovskite and post-perovskite structures are not only a result of plastic deformation. Researchers have predicted a whole infinite family of minerals of the same composition, $(Mg,Fe)SiO_3$, built of alternating nanoscale slices of the perovskite and post-perovskite structures.

According to quantummechanical calculations of ETH researcher Artem R. Oganov and colleagues, such unusual minerals could become important stable minerals in the Earth's mantle. Several research groups are now trying to synthesize these predicted minerals. If successful, these attempts will lead to a new mineralogical model of the Earth's interior. The research results have been published in the end of 2005 in *Nature*.

Source: ETH Zürich