Interdisciplinary FIAS Colloquium

Thursday, June 17, 2010, 14:30
FIAS, Ruth-Moufang-Str. 1, 60438 Frankfurt am Main, Lecture Hall 0.100

**Speaker:**  
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**Title:**  
*Planet Earth's Dynamics: Volcanism, Earthquakes, Plate Tectonics*

Modern society is under daily threat from natural disasters. The common hazards include earthquakes, volcanoes, floods, storms and coastal surges etc. Two types of natural hazards, earthquakes and volcanoes, can be explained by the process of plate tectonics. Plate tectonic concept states that the Earth's strong outer layer, called the lithosphere, is broken into a mosaic of plates that slowly move over a mechanically weaker layer, the asthenosphere. Where these plates interact, major geological processes take place, such as the formation of mountain belts, earthquakes, and volcanic eruptions. Plate tectonics was once regarded as passive motion of plates on top of mantle convection cells but it now appears that continents and plate tectonics organize the flow in the mantle and that the mantle is the passive element possessing an adiabatic central core. The mantle flow is driven by instability of the cold surface layer (lithospheric plate) and near-surface lateral temperature gradients such as imposed by slabs and continents. Plate tectonics may be a self-driven, far-from-equilibrium system that organizes itself by dissipation (entropy production) in and between the plates. The mantle may simply be a provider of energy and material. Iron in magnesium- and iron-bearing minerals with the perovskite structure in the lowermost mantle has the ability to adopt different electronic configurations, and transitions in its spin state can significantly influence mantle properties and dynamics. The transition of ferrous iron from the high-spin to the intermediate-spin state occurs at approximately 30 GPa, and that high temperatures favour the stability of the intermediate-spin state. Recent experimental data at high-pressure (up to 110 GPa) and high-temperature (up to 1,000 K) show significant anisotropic compression of lower-mantle perovskite containing intermediate-spin ferrous iron, which correlates strongly with the spin phase transition. Spin-state heterogeneities in the uppermost part of the lower mantle may be associated with sinking slabs and regions of upwelling. These may affect local properties, including thermal and electrical conductivity, deformation (viscosity) and chemical behaviour, and thereby affect mantle dynamics and plate tectonics.

Finally, mankind is becoming ever more susceptible to natural disasters like devastating earthquakes and catastrophic volcanic eruptions, but largely as a consequence of population growth and globalization. It is likely that in the future, we will experience several natural disasters per year that kill more than 10 000 people. This situation is mainly a consequence of increased vulnerability.