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Physics of the Earth and Planetary Interiors 153 (2005) 1–2
PHYSICS OF THE EARTH AND PLANETARY INTERIORS
www.elsevier.com/locate/pepi

Editorial

Studies of the Earth's Deep Interior—Eighth Symposium

The Eighth Symposium on the Study of the Earth's Deep Interior (SEDI) was held at Garmisch-Partenkirchen, Germany, in the Bavarian Alps, from 4 to 9 July 2004. The meeting attracted about 150 participants to a varied program that expanded the range of topics from previous meetings, with somewhat more emphasis on the mantle, in addition to mantle–core interaction, and core studies. On this occasion attention was also turned to the deep interior of other planets as well as the Earth.

To decipher the internal structure and dynamics of the Earth and other planets, remote sensing is required, as the depths of planetary interiors remain inaccessible to our laboratories. Subsequently, predictive tools play a key role in interpreting such data. The Eighth SEDI came at a time following (and during) significant expansions in data quantity and/or quality in the geophysical sciences community. This added to the excitement in the air at the conference, as we are in a period of witnessing increasing documentation of how the dominant depth shells within Earth, for example, likely play important roles in planet-wide processes, i.e., the whole Earth thermal, chemical, and dynamical *system*, e.g., see Fig. 1.

The great benefit of SEDI meetings is to bring together expertise from a range of different disciplines that bear on illumination of Earth (and planetary) interiors, and to foster interaction and understanding of the information provided by different disciplines. In many cases, the multidisciplinary nature of Earth and planetary interior investigation is pivotal to facilitating discovery, as well as minimizing the often significant uncertainties.

The 2004 Symposium covered a broad range of topics with sessions on

(1) Physical properties of Earth materials.
(2) Earth's magnetic field: constraints on deep processes.
(3) Core dynamics and the geodynamo.
(4) Structure and interactions in the system inner core, outer core and mantle.
(5) Interaction of plate tectonics and deep mantle processes.
(6) High resolution images of the Earth's interior.
(7) Physical and chemical discontinuities and reservoirs in the Earth's mantle.
(8) Deep interiors of other planets.

Each session had a limited number of invited papers, accompanied by contributed papers which were discussed in lively poster sessions, with a directed discussion session to finish. This format led to extensive interaction between the participants over the entire meeting and good cross-linking between topics to provide an inter-disciplinary perspective on the interior of the Earth (and other planets).

We are fortunate that now there is a wealth of high-quality seismological data and a good historical database for magnetic studies that provide greatly improved constraints on structure just above and within the Earth's core. Computer modelling, with cluster computers, has reached the point where Earth-like regimes are accessible for convection and crystal properties in the mantle and core. The complexities of the fluid and electromagnetic interactions in the dynamo action of the core are also being tackled with physical models; two different approaches are represented among the papers collected here.

The papers appearing in this special issue provide a good reflection of the breadth of studies of the Earth's deep interior. Although there is a concentration of attention on problems relating to the nature of the lowermost mantle and core, we also include general mantle convection issues and the properties of the moon.

0031-9201/$ – see front matter
doi:10.1016/j.pepi.2005.08.003

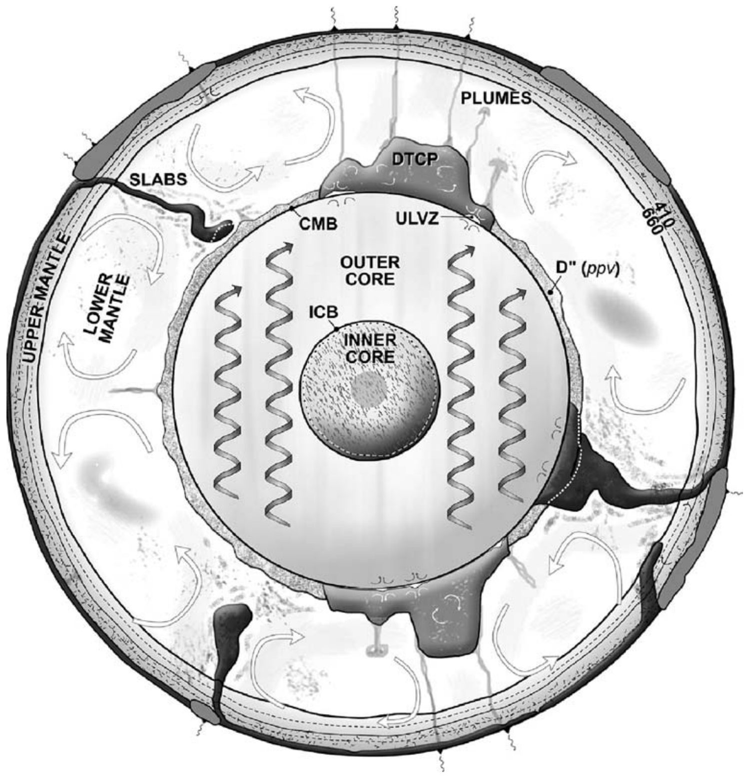

Fig. 1. Schematic cross-section of the Earth's interior displaying several recent ideas, many of which were highlighted at the Eighth SEDI Symposium. The mantle is shown with large scale convective motions (large arrows), primarily driven by subduction of dense, cold lithosphere (darker outer layer and dark slabs). Whole mantle plumes are most likely to form near or above the hottest deep regions, possibly guided by topographical features in the DTCP. The dominant upper mantle phase boundaries near 410 and 660 km depth are deflected by thermal and/or chemical heterogeneity (e.g., slabs and plumes). Other boundaries have also been detected (e.g., the 220 and 520 km discontinuities, dashed). Lower mantle dense thermo-chemical piles (DTCP) may be reservoirs of incompatible elements and preferentially locate beneath large scale return flow in the overlying mantle. Seismological studies characterize significant shear velocity reductions in the DTCP, which may be the hottest zones in the lowermost mantle, and thus related to partially molten material that comprises ultra-low velocity zones (ULVZ) right at the core–mantle boundary (CMB). The dominant lower mantle mineral structure, magnesium-silicate perovskite, is predicted to transform to a denser phase, post-perovskite (ppv) in the lowermost few hundred km of the mantle (D″); if slabs have a dominantly Mg–Si perovskite chemistry, then subducted material may independently transform to ppv (white dashed lines near D″ in slabs), though this depends on the poorly constrained Capeyron slope of this phase boundary. Thus, heterogeneity in the mantle appears multi-scaled, from the km level (or smaller) to 1000s of km. Convective motions throughout the planet are likely similarly multi-scaled. Abundant evidence now exists for seismic wave speed anisotropy (stippled or grainy areas) near key boundary layers: in the 100s of km below the surface, in the lowermost few hundred km of the mantle (the D″ region), and in the inner core. The onset of anisotropy in the inner core (dashed line) may be displaced some 100–200 km below the inner core boundary (ICB), and has been characterized as having a fast propagation direction aligned similar to, but slightly offset from Earth's rotation axis. The innermost inner core may have its own unique subdivision (slightly darker shading). Taylor roll convection is depicted in the outer core (spiral arrows), and lower mantle heterogeneity may affect heat flow from and hence convective flow within the core. Copies of this figure in various formats can be downloaded from: http://www.garnero.asu.edu/pepi2005.

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