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abstracts

Week

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Presiding Chair: B L.N.Kennett (Research School of Earth Sciences, Australian National University, Canberra, Australia)

MANTLE STRUCTURE AND DYNAMICS

ST4/W/06-B2 Poster **0930-01**

TOWARD FULLY SELF-CONSISTENT MODELING OF AVERAGE CONTINENTAL GEOTHERMS

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The forward modeling of average continental geotherms appears to be a relatively simple task. Given the stability and large lateral extent of the continental crust, one solves a one dimensional conduction equation (in a layered medium) for suitable values of thermal conductivity, internal heat generation and mantle heat flux.
One problem with such a model, however, is that the mantle heat flux is not an independent parameter. Heat from the mantle escapes through convective transport to a surface boundary layer where conduction then dominates. The balance between the convective transport and conduction is a sensitive function of the coupled mechanical and thermal properties of the boundary layer. Furthermore, this balance is inherently not one-dimensional: continual horizontal transport of cooling material along the boundary layer is required to sustain the vertical heat conduction.
In the oceanic case, the lithosphere thermal and mechanical structure is readily modeled (at least when less than ~80Myr old) by a cooling half-space conduction profile attached to a material point in accordance with simple boundary layer theory. However, the presence of buoyant continental crust, and depleted sub-continental mantle lithosphere, prevents convection from determining the thickness of the upper boundary layer. Therefore, the thermal structure of the crust, sub-continental mantle lithosphere, and convecting mantle must be solved as a coupled system in which the convection pattern and associated heat transport is not known in advance. A further complexity is that the continents are finite in extent - the partitioning of mantle heat flow between continents and oceans is another unknown which must be modeled. We present a number of convection simulations in which we incorporate realistic models of the oceanic lithosphere with continental blocks of varying size and shape and with different relative thermal conductivities and heat generation rates. We solve for the velocity and temperature everywhere in the crust and mantle during several mantle overturns. We track geotherms for a number of points within the continental blocks to determine the long-time average profiles, the variance, and the extreme values of the profiles in response to the underlying convection.
As one example we compare geotherms obtained from continental margins with those from the continental interior, and examine the influence of steps in the thickness of the depleted mantle root. Computed geotherms are compared to approximations obtained using 1D conduction modeling to demonstrate the conditions under which the 1D assumption may fail. We also compare the computed geotherms for the continental margin with analytic solutions in 2D for flow under a changing boundary condition.

ST4/W/43-B2 Poster **0930-02**

THE RELATIONSHIP BETWEEN THE RATE OF SUBSIDENCE OF THE OCEANIC LITHOSPHERE AND THE HEIGHT OF THE RIDGE: A CONSEQUENCE OF VARIATIONS IN THE COOLING RATE?

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Previous studies on the dependence of seafloor depth on crustal age have shown a linear relationship between subsidence rate and axial depths. The physical models used to interpret this dependence involve lithospheric cooling by conduction with variations of upper mantle's temperature. The lithosphere associated with high ridges and hot mantle subside more. However, some processes, such as crustal thickness variations, deep mantle temperature variations, sea-mounts, crustal faults etc, can perturb the topography and induce a 'random noise' superimposed on the cooling signal.
We show theoreticaly that such a 'noise' could be responsible of a linear relationship between subsidence rate and axial depth with a slope equal to the average of the age's square root. In order to quantify the influence of this 'noise' and understand what can be linked to the cooling of the lithosphere in the ridge-height versus subsidence-rate relationship, we study the bathymetry versus age in the South-East Indian and the South Atlantic oceans. Profiles along flow lines and profiles along an arbitrary direction diagonal to the flow lines are compared.

ST4/W/35-B2 Poster **0930-03**

IMAGING THE UPPER MANTLE P-WAVE VELOCITY STRUCTURE OF THE APENNINES (ITALY) BY NONLINEAR INVERSION OF TELESEISMIC TRAVEL TIME RESIDUALS

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Over 4,000 handpicked arrival times from high-quality teleseismic waveforms digitally recorded by the stations of the National Seismic Network during the past ten years are used to invert for the aspherical velocity structure of the upper mantle beneath the Apenninic chain. The data used in the tomographic reconstruction are the travel time residuals of P, pP, sP, PcP, PKPdf and PKPbc phases computed with respect to the improved global 1-D velocity model ak135. The imaging algorithm applied employs a three-dimensional minimum travel time ray tracing within a standard nonlinear inversion scheme that repeatedly solve the linearized problem and recalculate the ray trajectories after each iteration. The data kernel matrix computed for a weighted damped least square solution of the problem is inverted by using the singular value decomposition (SVD) method to better test the resolution capabilities of the dataset and the reliability of the inversion result. The resulting lateral heterogeneities delineate a very complex pattern, with the anomalies of the P-wave velocity amplitude reaching 10%. A pronounced high velocity anomaly is imaged beneath the internal part of the northern Apenninic arc from the uppermost mantle down to a depth of about 400 km. Below Central and Southern Apennines a low velocity zone is recognized between 0 and 100 km depth. It overlies a complex shape high-velocity region located beneath the belt between 100 and 300 km depth. Velocity contrasts between this feature and the contiguous mantle are less strong than those characterizing the high velocity zone under the Northern Apennines, suggesting a less dense, probably continental, subducted lithosphere.

ST4/W/11-B2 Poster **0930-04**

REFLECTION OF MANTLE AND LITHOSPHERIC HETEROGENETIES IN SEISMIC FIELD OF KAMCHATKA REGION

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Properties and stuctural organisation of shallow seismicity (H < 50km) in North-West sector of Pacific Ocean in joint region of Kuril-Kammchatka and Aleutian Islands arc are analysed with the use of data of detailed seismological observations during 1962 - 1997. The maps of seismicity paramers distribution, of kinematic and dissipative peculiarities of elastic waves propagation including their azimuthal characteristics were made. At least two hierachic systems of lineaments were distinguished. The main one repeats configuration of the main morphological structures of the region and is represented by interchange of three belts, the distance between extremums varies from 60 - 80km at the south to 40 - 60km at the north. Anomalies intensity decreases towards the ocean. The sub-meridional zones of low viscosity of material (low velocity and high attenuation of elastic waves, predominance of comparatively weak earthquakes etc.) were distinguished with the use of a complex of parameters. Positive relief structures continuing headlands of East Kamchatka, and magnetic anomalies, which are traced on the land and beyond the trench as well, correspond to these zones. Areas where the azimuthal dependence of velocity and attenuation of elastic waves are most obvious coincide with the selected system of lineaments as a whole. Maximum velocity values and increased attenuation of elastic waves are typical for the tracks along Kamchatka (except the region of Kronotsky peninsula), and as a whole they coincide with the extension of the planes of motion in the local earthquakes foci. It allows one to connect the origin of azimuthal dependence of the parameters under study with the tectonic deformations. The monotonous character of the parameters under study alteration through the area and coincidence of the anomalous zones according to different data suggest their connection with lateral variations of the composing substance properties caused by geotectonic development of the region.

ST4/L/04-B2 Poster **0930-05**

TRAVEL TIME TOMOGRAPHY FOR UPPER LITOSPHERE VELOCITY STRUCTURE OF THE RUSSIAN FAR EAST

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During 1975-1990 years on a continental part of Far East of Russia the network of regional seismic stations operated. The data, obtained by them, about seismic waves arrival times are used for specification of upper litosphere velocity structure. I used an iterative two-stage algorithm for definition of 3D velocity model. At the first stage, proceeding from a previously determined velocity model, the specified situations of earthquakes and origin times are determined. Initialy is used the standard velocity model. At the second stage the task of definition of abnormal velocities is solved. Usual methods of linear inversion were used. This sequence repeats up to achievement of a required error. Travel paths are calculated by numerical solution of the eikonal equation for an inhomogeneous medium. For till completion of solution the common error of the computing scheme is estimated. With this objective the initial datas about a situations of hipocenters and origin times are distorted by casual noise according to an error of their definition. The difference of definitions on the source and deformed data characterizes stability of a method. The definition of a model is executed for both P and S- waves, though data about travel times of S-waves is significant less. Therefore for S- waves the simplified scheme is used.

ST4/E/66-B2 Poster **0930-06**

SHEAR-WAVE SPLITTING IN THE UPPER MANTLE BENEATH THE AEGEAN AREA

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The Aegean Sea is a region characterized by subduction and back-arc spreading. In this study, data on the deformations and flow in the upper mantle of the region are presented. These data are obtained from a temporary broadband seismological network installed over the Aegean. The network was in operation for six months (February-July 1997). In spite of the relatively short time span and the high noise level at some stations, we were able to detect teleseismic SKS and SKKS phases coming from different azimuths and with a high signal to noise ratio. The inversion of the recorded particle motions for shear-wave splitting indicates that the dominant direction of polarization of the fast shear wave is close to North-South. This anisotropy indicates an approximately North-South extension in the upper mantle, slightly different from the geodetic data on the deformations in the region. The obtained anisotropy directions are possibly related with the internal deformation of the Aegean. At some stations a complicated pattern of shear-wave splitting was observed, which suggests that anisotropy in the subcrustal lithosphere and asthenosphere could be different.

ST4/E/46-B2 Poster **0930-07**

A SEISMIC ANISOTROPY OF THE LITHOSPHERE AROUND THE TRANS-EUROPEAN SUTURE ZONE (TESZ) BASED ON SHEAR-WAVE SPLITTING DATA OF THE TOR EXPERIMENT

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The Trans-European Suture Zone (TESZ) is the most prominent tecto-geological boundary within Europe separating mobile Phanerozoic terranes in the western part from the Precambrian East-European Platform in the eastern part. Distinct changes of seismic anisotropy of the mantle lithosphere are related to this intra-continetal suture. The effect is observable in various wavelengths as well as seismic wave types. In the long-periond range, the radial anisotropy of surface waves differs distinctly in the lithosphere on both sides of the TESZ. In the short-period range of body waves, the P residual spheres detected changes in the lithospheric anisotropy related the various blocks around the TESZ as well. A passive teleseismic field experiment -TOR- traversing the northern part of the TESZ in Germany, Denmark and Sweden was conducted during 1996-1997. The array recorded data for teleseismic tomography of the upper mantle with a high lateral resolution, about few tens of km, including data for seismic anisotropy studies. Our analysis of shear-wave data recorded at broad-band stations during the field measurements aims at retrieving a 3D orientation of anisotropy around the TESZ and mapping lateral changes of the 3D orientation of anisotropic structures along the TOR antenna. An interpretation of the observed seismic anisotropy by the