EUG XI

Symposium MS09

Upper Mantle Structure and Flow

Convenors

Guilhem Barruol
Geoffrey Lloyd
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Wednesday AM Session

MS09 : WEam01 : F6
Reconciling Regional and Global Surface Wave Tomography

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Both regional and global applications of surface wave tomography are commonly carried out as multi-stage processes. In global work the dispersion of mode branches are determined on paths which may encircle the globe. Most work has been done on fundamental mode data, but higher mode data have been included via a “stripping” technique (van Heijst and Woodhouse, 1999). The assemblage of dispersion measurements are then combined, using a path-average approximation, to produce multi-frequency dispersion maps which are then used to develop 3-D models of shear wavespeed for the upper mantle. In contrast in regional surface wave tomography, following the partitioned waveform inversion approach of Nolet (1990), the emphasis has been on matching observed waveforms using multi-mode synthetic seismograms. The resulting 1-D models are then interpreted as path averages. The 3-D shear wavespeed structure can then be extracted by a linear inversion from the 1-D models for the different paths.

An alternative viewpoint for the waveform fitting process is that this is a means of estimating multi-mode dispersion for observed wavetrains and that the 1-D models should be regarded as a summary of dispersion characteristics rather than having a direct physical interpretation. The dispersion estimation is quite robust and simpler than using stripping techniques but does need information on source mechanism. Simple isotropic models can be employed to extract Rayleigh and Love dispersion separately. The dispersion information can then be used, again with the path average approximation, in a linearised inversion for multi-mode phase speed maps as a function of frequency. This inversion can allow for off-great-circle propagation and provides a means of incorporating constraints from polarisation data. The final 3-D model can then be obtained via a cellular inversion of the multimode information which can allow for azimuthal and polarisation anisotropy.

This approach to determining 3-D shear structure in the upper mantle via multi-mode dispersion maps can be applied to both global and regional data. Information can be incorporated from both waveform inversion and direct dispersion measurements on a range of scales to provide an improved definition of the base of the lithosphere and the nature of material anisotropy

van Heijst HJ & Woodhouse JH, *Geophys J. Int*, **137**, 601-620, (1999).
Nolet G, *J. Geophys. Res*, **95**, 8499-8512, (1990).

MS09 : WEam02 : F6
Heterogeneity and Anisotropy of the Australian Upper Mantle

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We have obtained a new shear wave speed model for the Australian upper mantle which includes azimuthal anisotropy.

The inversion presented here was based on 30% more data than used by Simons et al. (1999), but we confirm their conclusions regarding the aspherical variation of isotropic wave speed. In particular, the high correlation between the westward increase in wave speed and lithospheric age, and the fact that this holds for depths less than 200 km only, are confirmed. We have determined the spatial variation of azimuthal anisotropy and investigated its trade off with heterogeneity.

In the top 150 km the inversions yield fairly strong anisotropy (up to 4%) but the orientation of the fast axis changes in a complex manner. In contrast to the wave speed heterogeneity, there is no obvious relationship between anisotropy and the large scale geological domains that we considered, suggesting that the length scale for variation is much smaller than the major crustal elements. The horizontal length scale over which anisotropy changes increases between 150 and 200 km depth, and within the uncertainty of the inferred angles the direction of maximum anisotropy at larger depth cannot be distinguished from the direction of absolute plate motion. This suggests that frozen in anisotropy, which can be related to past and present-day deformation of the continental lithosphere, is confined to the top 150 km and that plate motion controls the anisotropic fabric at larger depth. One would expect, however, that if shearing due to plate motion is the predominant process to produce anisotropy, the signal would be much larger than actually observed. This observation calls for further study of the effect of plate motion on the shear fabric in the subcontinental asthenosphere.

We have used the approach suggested by Montagner et al. (2000) to predict SKS splitting times and directions from our 3-D anisotropy model. The first order difference between our result and previous observations of SKS and SKKS splitting is that the surface waves seem to prefer a higher level of transverse anisotropy than the body waves. This is true, in particular, for the Precambrian shields where shear wave birefringence yielded split times of less than 1 sec whereas the surface wave inversion predicts times that are at least twice that large. Much as the original inversion result, the predicted SKS splitting map does not reveal predominance of a direction parallel to plate motion. In eastern Australia the sinusoidal pattern of fast axes detected by Clitheroe and Van der Hilst (1998) is - within the uncertainties - consistent with the pattern inferred from the Rayleigh waves. The suggestion by these authors that this may be related to asthenospheric flow around the irregular eastern edge of the Precambrian shields of central Australia merits further investigation.

Simons FJ, Zielhuis A & van der Hilst RD, *Lithos*, **48**, 17-43, (1999).
Montagner JP, Griot-Pommera DA, Lave J, *J. Geoph. Res.*, **105**, 19015-19027, (2000).
Clitheroe Gand van der Hilst RD, *Structure and Evolution of the Australian Continent, AGU*, 73-78, (1998).

MS09 : WEam03 : F6
Origin of Continental Roots Inferred from Joint Inversions of Gravity and Seismological Data

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Anomalies of temperature and composition induce anomalies of density and seismic velocities. Recent studies (e.g. Goes et al., 2000) suggest that velocity anomalies depend mainly on temperature. To infer compositional changes, one therefore needs an additional data set. We perform joint inversions of seismological and gravity data for a radial model of scaling factor (ζ), which is defined as the ratio of the relative density anomalies to the relative V_s-anomalies. Gravity anomalies and V_s-anomalies are provided by the global models EGM96 and S16RLBM, respectively. To estimate error bars in ζ, we introduce a-priori errors in the seismological model. Data are filtered for the spherical harmonic degrees 11 to 16, and calculations are made separately for oceanic and continental regions. The resulting model is significantly different for the sub-continental and sub-oceanic mantle. Below continents (oceans), ζ has positive values down to z=220 km (z=140 km). The absolute values of ζ are small, less than 0.05. If one accounts for anelasticity, such values are consistent with the results of experimental mineralogy. At depths greater than 400 km, our model of ζ is not well constrained.

We then invert V_s-anomalies (δV_s) and ζ for anomalies of temperature (δT) and global iron ratio (δFe). Positive δV_s are associated with negative temperature variations and/or iron depletion. As an example, for δV_s=2% and ζ=0.01, we find δT=-100K and δFe=-1.2%. A major concern is the value of parameters such as the reference temperature and the reference compositional model. We investigate the influence of these parameters and estimate error bars on δT and δFe. Finally, we apply these results to the uppermost mantle.

Goes S., Govers R. and Vacher P., *J. Geophys. Res.*, **105**, 11153-11169, (2000).

MS09 : WEam04 : F6
Rayleigh Wave Polarisation Anomalies Reveal Lithospheric Anisotropy at the Kerguelen Hotspot

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Rayleigh waves recorded at the GEOSCOPE station PAF on the Kerguelen Plateau in the Indian Ocean, show strong polarisation anomalies in the period range 20 to 50s, as demonstrated by dispersion analysis of 3-component recordings. The largest and most consistent anomalies are observed on recordings of events located in the southern part of the Java trench, arriving at Kerguelen from the Northeast. At 25s the Rayleigh waves present transverse components with an amplitude of up to 50% of the amplitude of the radial components. The amplitude ratio between the transverse and radial components decreases with increasing period, but still remains as much as 20% at 50s period in some cases. The particle motion of the Rayleigh waves in the horizontal plane is largely elliptical. By comparison, very few and only small polarisation anomalies can be detected at the nearby GEOSCOPE stations AIS and CRZ, situated about 1500 km North and West of PAF.

Wavepath deviations between the epicenter and the station as calculated in tomographic models of the Indian Ocean cannot explain the polarisation anomalies at PAF. Using a multiple-scattering scheme for modelling surface waves in 3-D structures, we show that isotropic lateral variations in the vicinity of the station, related to the structure of the Kerguelen Plateau, cannot explain the polarisation anomalies either.

Anisotropy in the lithosphere to the Northeast of Kerguelen is the only mechanism we have found to be able to explain the polarisation anomalies. 30% oriented olivine crystals in the lithosphere over a region not larger than 500 km produce polarisation anomalies similar to the observed ones, if the olivine crystals are oriented with their fast a-axis dipping at 45 degrees relative to the horizontal plane and in a ENE-WSW direction. This direction is in agreement with the direction of high surface wave phase velocities observed in tomographic studies of the Indian Ocean. The polarisation analysis gives in addition some information on the dip of the fast a-axis, which cannot be obtained from phase velocity analysis only.

We conclude that the structures responsible for the polarisation anomalies are anisotropic bodies with strongly tilting olivine crystals located in the lithosphere between the Kerguelen hotspot and the Southeast Indian Ridge. They testify the presence of a former or present non-horizontal mantle flow in the vicinity of the Kerguelen hotspot.

MS09 : WEam05 : F6
Shear Wave Structure of the Upper Mantle beneath the Horn of Africa

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We present a shear wave velocity model of the upper mantle in the Horn of Africa and surrounding regions from the waveform inversion of fundamental and higher Rayleigh modes. We use data from the permanent IRIS and GEOSCOPE stations, completed with data collected in the field after a deployment of portable stations in the Horn of Africa (INSU experiment), in Tanzania and Saudi Arabia (PASCAL experiments).

Our preliminary 3-D model of shear velocities present strong lateral variations in the uppermost 200 km of the mantle. At 100 km depth, high seismic velocities are found beneath Western Saudi Arabia and the Tanzania craton. Slow velocities are found beneath the Red Sea, the Gulf of Aden, Afar, the Ethiopian plateau and western Saudi Arabia. In eastern Africa, the boundary between the Ethiopian plateau and the Tanzania craton to the south is marked with an abrupt transition from low to high seismic velocities.

Below 200 km depth, these seismic anomalies are strongly attenuated. Within the lateral resolution of our data (few hundred of kilometers), there is no evidence for a deeply rooted low velocity anomaly beneath the Horn of Africa.

The dense ray coverage available in the region allows us to solve the SV wave azimuthal anisotropy together with the lateral variations in shear wave velocity. Preliminary results show a complex pattern of azimuthal anisotropy beneath the Horn of Africa.

MS09 : WEam06 : F6
Paleozoic Subduction Imaged by Seismology in a Preserved Segment of the Western European Hercynian Range

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The Hercynian Range is a major object of the european tectonics, however its deep structure remains poorly known. The Armorican Massif is a segment of the Hercynian Range which presents the advantage of beeing preserved from reactivation since the end of the collision. In the framework of the GeoFrance3D-ARMOR2 project, two seismological field experiments has been carried out in 1997 and 1999 in the Armorican Massif. The aims were to image the deep extension and the geometry of the major hercynian features observed at surface. The data collected during the field experiments were used to map seismic anisotropy at depth and to build a three-dimensional model of the P-wave velocity variations in the upper mantle beneath the Armorican Massif. Since the region has not been affected by any important tectono-thermal event for more than 200 My, the velocity variations are more likely related to compositional variations rather than thermal anomalies. Thus, these results are interpreted as the signature of a northward subduction known to have occurred before the continental collision (~400-450 My). The anisotropy can be considered as a lithospheric anisotropy, and reflects the intense transpressive regime which took place in the southern part of the Armorican Massif at the end of the collision (~340-300 My).

MS09 : WEam09 : F6
Seismic Tomography and Anisotropy of the Upper Mantle beneath the Southern Massif Central

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The upper mantle structures and the upper mantle flow beneath the French Massif Central are investigated through seismic tomography and seismic anisotropy. We deployed during the period 1998-2000 25 three component stations (short period, intermediate and broad-band) in southern France, from the Clermont Ferrand volcanic area to the Mediterranean sea. 3-D tomographic models beneath this area have been reconstructed with main objectives of localizing the presence of the mantle plume, its southern extension but also of mapping the lateral variations of the lithosphere thickness. Compared to the tomographic models focused on the northern Massif Central (Granet et al., 1995), the incorporation of recording stations in the southern Massif Central clearly images a southward elongation of the low velocity anomalies previously mapped beneath the Clermont Ferrand volcanic area. Teleseismic shear waves (SKS, SKKS and PKS) were also used to quantify the upper mantle anisotropy beneath each station by measuring the splitting parameters: the fast polarization directions which indicate the mantle flow and the delay times which characterize the magnitude of anisotropy and the thickness of the anisotropic layer. Delay times generally smaller than 1 s are observed at most of the sites. The azimuths of the fast split shear waves trend homogeneously NW-SE in the southern part of the Massif central. This anisotropy pattern clearly differs from the Pyrenean anisotropy further south which trends homogeneously N100°E and which displays statistically higher delay times (Barruol et al., 1998). These regional variations of anisotropy does not favor the present-day motion of the Eurasian plate as the primary source of mantle deformation. Instead, the homogeneous trend of mantle flow beneath the southern Massif Central is rather well correlated to the tertiary extension direction. The rotation of the Corsica block, the roll-back to the SE of the Calabrian subduction and the Tertiary extension of the western Mediterranean during the convergence of Africa and Europe could have deflected the plume ascent toward the south-east and may have induced a pervasive upper mantle flow beneath the southern Massif Central.

Granet M, Stoll G, Dorel J, Achauer U, Poupinet G & Fuchs K, *Geophys. J. Int*, **121**, 33-48, (1995).
Barruol G, Souriau A, Vauchez A, Diaz J, Gallart J, Tubia J & Cuevas J, *J. Geophys. Res*, **103**, 30039-30054, (1998).

MS09 : WEam10 : F6
Seismic Anisotropy of the Upper Mantle beneath the Bohemian Massif

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In co-operation between the geophysical institutions in Prague and Strasbourg, an array of portable digital three-component stations had been running in the Bohemian Massif (BM) for 8 months within a project MOSAIC (programme Barrande). The array consisted of six broad-band and two short-period stations (Plomerova et al., 2000) The study of seismic anisotropy is based on teleseismic body waves and on a joint inversion of anisotropic data (P-residual spheres, the fast shear-wave polarizations and split times). Similarly to previous findings (Plomerova et al., 1998; Babuska et al., 2000), based mainly on data of permanent observatories, we observe that velocity anomalies are strongly affected by different orientations of dipping anisotropic structures within the mantle lithosphere. There are distinct lateral variations of the pattern of P-residual spheres and of the split time dt and orientation of the fast shear waves within the BM (Babuska and Plomerova, 2000). While, e.g., in the central part large dt and a general E-W orientation of the fast split wave prevail, in the eastern part of the BM the dt is smaller and the fast polarization rotates to the WNW-ESE. Smaller dt and similar rotation are indicated also at the southern rim of the Saxothuringian unit. Self-consistent 3D anisotropic models of several domains forming the mantle lithosphere of the BM are presented.

We also present a comparison of the deep lithosphere structure of the BM with other two Variscan units - the Armorican Massif and the French Massif Central, as revealed by recent tomographic studies of seismic anisotropy. The data originate from several field measurements made in temporary arrays of stations. We demonstrate that the mantle lithosphere of the three Variscan massifs appear to consist of at least two parts with different orientation of large-scale fabric. The boundaries of anisotropic lithospheric domains are related to prominent tectonic features recognised on the surface as sutures, shear zones or transfer fault zones, as well as grabens, thus indicating that some of them extend deep through the entire lithosphere.

Babuska V & Plomerova J, *Studia Geophys. Geodaet.*, **44**, 292-306, (2000).
Babuska V & Plomerova J, *Tectonophysics*, **in print**, (2001).
Plomerova J, Babuska V, Sileny Jand Horalek J, 1998, *Pure and Appl. Geophys*, **151**, 365-394, (1998).
Plomerova J, Granet M, Judenherc S, Achauer U, Babuska V, Jedlicka P, Kouba, Dand Vecsey L, *Studia Geophys. Geodaet*, **44**, 195-209, (2000).

MS09 : WEam11 : F6
Mid-Mantle Anisotropy and Mantle Flow

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Observations of mantle anisotropy have in the past been mainly confined to the uppermost and lowermost boundary layers. Here we present evidence for strong mid-mantle anisotropy in the vicinity of a subduction region. We also investigate the relationship between observed seismic anisotropy and mid-mantle flow. The region we study is the in Southwest Pacific where we use earthquake events in the Tonga, Kermadec and New Hebrides trenches recorded at stations in Australia. Such geometry gives us reasonable azimuthal coverage. Deep-focus earthquakes have been observed to display large amounts of shear-wave splitting at epicentral distances 20° to 60° from the source. As the splitting is more pronounced than that observed in SKS phases at these stations, it suggests that the anisotropy exists in the vicinity of the subduction zone. The anisotropy appears to display a transversely isotropic symmetry. To help guide interpretation of these observations we model waveform effects using Maslov seismograms. Models of anisotropy within the slab involve either a metastable olivine tongue which has a pre-existing anisotropy, or the preferred alignment of an akimotoite phase of enstatite which may exist under slab conditions. Alternatively, the anisotropy may be due to crystal alignment near the 660 km discontinuity and not within the slab itself. It seems unlikely that the anisotropy could be explained by crystal alignment above 660 as ringwoodite is only mildly anisotropic. Below 660, the anisotropy could be due to the preferred alignment of perovskite, periclase or stishovite, all of which are highly anisotropic. We find the predictions for this last model best fit the observations, suggesting that, at least locally, there may be a mid-mantle boundary layer.

MS09 : WEam12 : F6
Subduction Body Force Stresses and Viscosity Structure at the 410 and 660 km Phase Transitions

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Subduction stresses have been calculated using finite element fluid flow modelling for a simple body force model in which the cool subducted slab has a density contrast of 50 kg/m^3. Stresses within both subducted slab and adjacent mantle are highly sensitive to mantle viscosity structure. A model with uniform mantle viscosity produces small deviatoric stresses within transition zone and lower mantle. In contrast for layered mantle viscosity models in which the viscosity rises by x10 across both the 410 and 660 km phase transitions, substantial deviatoric stresses of the order of 50 MPa are predicted within the transition zone and top upper mantle. Horizontal length-scales for these large stresses are ~300 km within the transition zone and ~600 km within the top part of the upper mantle, both biased to underneath the subducting slab. Tensile deviatoric stresses are sub-horizontal and compressive deviatoric stresses are sub-vertical. If subduction cannot penetrate the 660 km phase transition, deviatoric stresses are increased in the transition zone and decreased in the top upper mantle. Seismic rays sampling the large magnitude and length scale of these deviatoric stresses are expected to show substantial shear-wave spitting which may be diagnostic of viscosity structure at the 410 and 660 km phase transitions.

MS09 : WEam13 : F6
Predicted Anisotropic Structure for Plate Boundary Flow Models

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The potential for using measurements of seismic anisotropy to determine the pattern of flow in the upper mantle has been known for a few decades but recent improvements in seismic instrumentation and computational capabilities

provide new impetus for more detailed models of mineral alignment in polycrystalline peridotite. This is most relevant in the vicinity of plate boundaries where the spatial scale of variability in the deformation field is of the order of several tens to a few hundred kilometers. Gradients in deformation across a tectonic boundary and changes in the along-strike boundary geometry or plate motion can generate anisotropic structure that varies significantly, in both azimuthal and vertical planes, on a regional scale. Our aim is to illustrate the nature of variability that could arise from physically reasonable changes in flow/deformation parameters and to show how predictions from these more complete models compare with previous simpler estimates of the symmetry of the anisotropy. This information can guide the design of seismic experiments which may constrain the actual structure.

Calculation of values that can vary throughout the model space for a series of plate boundary flow models include: the magnitude of P-wave anisotropy, the fast-axis orientation, the amount of shear wave splitting and the polarization direction of the fast S-wave. The variation of shear wave properties with incidence angle can be significant. Several wave propagation runs provide travel-time predictions for an array of instruments across the plate boundary. We will discuss results for a fast spreading ridge system that migrates over the deep mantle and these will be compared to data from the MELT experiment at the East Pacific Rise. A second set of results will illustrate the anisotropic structure that may develop due to 2-D or 3-D flow in the vicinity of a subduction zone.

MS09 : WEam14 : F6
Anisotropy of Thermal Diffusivity in the Upper Mantle

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Heat transfer in the mantle is a key process controlling the Earth's dynamics. Thermal diffusivity in the mantle is usually assumed to be isotropic. Yet, recent experimental data on single-crystals shows that, at ambient conditions, the dominant upper mantle phases, olivine (60-70%) and orthopyroxene, display a large anisotropy of thermal diffusivity (Chai et al., 1996). Moreover, upper mantle rocks display an ubiquitous deformation-induced olivine lattice preferred orientation and seismic anisotropy measurements show that this crystallographic orientation is usually coherent on scales of several tens of km or more. If the single-crystal anisotropy is preserved at both lithospheric scales and under mantle P,T conditions, it would have major geodynamic implications, since an anisotropic heat conduction will modify the temperature distribution, and, hence, the mantle rheology and flow patterns. Here we present evidence from laboratory measurements between 298 K and 1273 K and petrophysical modelling of thermal diffusivity in deformed mantle rocks that support that heat diffusion in the uppermost mantle can be highly anisotropic (up to 21%). Preservation of anisotropy of thermal diffusivity at high temperatures, as observed in our experiments, is in good agreement with the anharmonic behaviour of olivine derived from elasticity data (Abramson et al., 1997) and optic vibration modes spectra (Gillet et al., 1997).

Chai M, Brown JM & Slutsky LJ, *Phys. Chem. Min*, **23**, 470-475, (1996).
Abramson EH et al, *J. Geophys. Res*, **102**, 12253-12263, (1997).
Gillet P, Daniel I & Guyot F, *Eur. J. Miner*, **9**, 255-262, (1997).

Wednesday PO Session

MS09 : WEpo01 : PO
Dynamics of Crustal Formation in an Oceanic Environment in the Early Earth

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In the early Archean the earth's upper mantle may have been hotter than today by several hundred degrees. As a consequence, partial melting in shallow convective upwellings would have produced a layering of basaltic crust and underlying depleted (lherzolitic-harzburgitic) mantle peridotite, much thicker than found under modern day oceanic ridges. When the basaltic crustal layer becomes sufficiently thick, a phase transition to eclogite may occur which would cause delamination of the dense, crustal layer and recycling of dense eclogite into the upper mantle.

This delamination and also intra-crustal convective circulation are facilitated by a brittle-ductile, pressure and temperature dependent crustal rheology which exhibits a strong viscosity minimum at lower crustal level (Hoffman and Ranalli, 1988). This recycling mechanism may have contributed significantly to the early cooling of the earth during the Archaean (Vlaar et al., 1994). The delamination mechanism which limits the build-up of a thick basaltic crustal layer is switched off after sufficient cooling of the upper mantle has taken place. We present results of numerical modelling experiments of mantle convection including pressure release partial melting together with a simple approximate melt segregation mechanism and basalt to eclogite phase transition, to account for the dynamic accumulation and recycling of the the crust in an upper mantle subject to secular cooling.

The model uses finite element methods to solve for the viscous flow field and the temperature field. Lagrangian particle tracers are used to represent the evolving composition due to partial melting and accumulation of the basaltic crust.

Hoffman PF & Ranalli AG, *Geophys. Res. Lett.*, **15**, 1077-1080, (1988).
Vlaar NJ, Van Keken PE & Van den Berg AP, *Earth and Planetary Science Letters*, **121**, 1-18, (1994).

MS09 : WEpo02 : PO
Transition Zone Thickness Inferred from Circulation Models

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We present estimations of the transition zone thickness based on circulation models of mantle flow. Various global tomographic models have been used to infer the thermal structure of the mantle. The density distribution that drives the convective flow includes the thermal anomalies and those due to topographies of upper mantle phase changes at 400 and 670 km depth. The latter enable us to achieve a good fit to the long wavelength geoid and to predict a low amplitude surface topography in agreement with observations (a few hundred meters). In our model, the boundary topographies depend on the temperature anomalies (through the Clapeyron slopes of the phase diagram) and on the convective flow pattern in the transition zone (through the kinetic effects). At 670 km, since the phase change is endothermic, the kinetic effects will tend to amplify the boundary topography. On the other hand, at 400 km depth, the phase change is exothermic, and the topography estimated through the phase diagram enhances the convective currents. However, the kinetic effects always counteract the flow. Thus both the shape and the amplitude of the 400 km discontinuity topography might be significantly modified This is a possible explanation for the "de-correlation" between the topographies of the two phase change observed in numerous seismological studies.

We use a classical circulation model with imposed plate motions at the top. We carry out a sensitivity study for the conversion factors between seismic velocity anomalies and thermal anomalies, and the delay time for the phase change occurrence (kinetic effects). The results obtained with the different global tomographic models are discussed and compared with the seismologically inferred discontinuity topographies and transition zone thicknesses.

MS09 : WEpo03 : PO
An Experimental and Numerical Study of Microstructural Parameters Contributing to the Seismic Anisotropy of Rocks

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It has long been observed that structurally ordered rocks generally show a directional dependence of compressional and shear wave velocities. Types of structural ordering that can have an influence on seismic velocities include the presence of aligned fractures, of mineralogical layering, or of a lattice preferred orientation in the constituent phases of the rock. In a rock free of any of these types of structural ordering, the seismic velocities may be readily calculated using the Voigt, Reuss or Hill methods or some other such scheme for averaging the single crystal elastic properties. However, these averaging methods are of limited utility in structurally ordered materials because they are rather restricted in the extent to which they can accommodate different types of structural ordering explicitly. Consequently, other calculation schemes are needed for such materials. In order to optimize and test such schemes it is important that the relative significance of the various microstructural parameters on the elastic properties be quantified. The aim of this work is to attempt such a quantification by combining laboratory seismic velocity measurements made at ambient conditions with detailed microstructural analyses and numerical calculations of the seismic velocities of the experimental material using a variation of the homogeneous effective medium method of Ponte Castaneda and Willis (1993). The numerical method of Ponte Castaneda and Willis (1993) was adapted for including as many microstructures as possible and is now a powerful tool for the determination of the elastic properties of rocks. Ideally, in a study of this kind, one requires a suite of rocks encompassing a range of textures but which have a relatively low-fracture density so that the effect of the fractures does not overwhelm the effect of the other microstructural variables. In our study we have used a number of ultramafic rocks that fulfil these conditions, and which have allowed us to investigate the effect (1) of rock composition, (2) of different crystallographic preferred orientations (3) of grain size and shape (4) of grain boundary properties, and (5) of oriented intragranular- and transgranular fractures. The greatest influence on seismic velocities in these rocks at ambient conditions has been found to be, in order of significance (1) the presence of high aspect ratio fractures along the grain boundaries (2) the properties of the grain boundaries and (3) the presence of low aspect ratio intragranular fractures. According to this study, we suggest that seismic modelling using the complete elastic properties combined to destructive/constructive microstructural interferences will give a more realistic view on the geological character of the reflecting surfaces since it allows to distinguish between geometrical effects related to physical, structural and lithological properties. Forthcoming work will enable us to study the influence of pressure and temperature on the elastic properties of rocks as a function of the microstructures.

MS09 : WEpo04 : PO
The Effect of 'Asthenospherization' on the Seismic Properties of the Mantle Lithosphere: Constraints from Lattice Preferred Orientations in Peridotites from the Ronda Massif

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In continental rifts and above mantle plumes, one critical issue for the interpretation of seismic anisotropy measurements and tomography models is to know to what extent the preexisting crystallographic fabric and related seismic properties are preserved during melting and/or thermal erosion of the mantle lithosphere. The Ronda massif (S. Spain) preserves a fossil melting front ('the coarsening front') separating a deformed lithospheric mantle composed of porphyroclastic peridotites from coarse-granular peridotites produced by partial melting and annealing of the lithospheric peridotites. To investigate the effect of 'asthenospherization' on seismic properties of lithospheric peridotites at length-scales of several kilometers, we have measured the LPO of olivine, Opx and Cpx of peridotite samples at both sides of the Ronda coarsening front, then computed the seismic properties of these samples. The strength of olivine fabric is moderate in the porphyroclastic peridotites; [100] and [001] axes are distributed within the flow plane, with a maximum of [100] parallel to the flow direction, and [010] axes are concentrated around the normal to the flow plane. No drastic variation of olivine LPO is observed across the recrystallization front and toward the coarse-grained peridotite domain. The main effect of melting and textural coarsening on the olivine LPO of coarse-grained peridotites is a slight weakening and a more 'orthorhombic' symmetry. On the other hand, the strength of orthopyroxene LPO increases toward the melted domain. The consistency of the olivine LPO translates to similar seismic properties of peridotites in the two domains. Despite melting and textural coarsening, the calculated P- and S-waves anisotropy of coarse-granular peridotites (the melted domain) are comparable to those of porphyroclastic peridotites (the fossil lithosphere). Our results indicate that heating and partial melting do not erase the inherited crystallographic fabric of the lithospheric mantle, which retains its seismic anisotropy as long as the process remains static. Indeed, in various areas of active asthenosphere-lithosphere interaction, seismic tomography studies have inferred a thin lithosphere from the presence of a shallow low velocity anomaly, whereas S-wave splitting measurements yield delays between arrivals of the fast and slow waves that require a thicker lithosphere. This apparent discrepancy may be resolved in the light of our results, considering the existence of a 'ghost lithosphere' that preserves the anisotropy characteristics of the lithosphere and has an asthenospheric signature in tomographic models

MS09 : WEpo05 : PO
Seismic Anisotropy and Upper Mantle Deformation in Continental Plates

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A large amount of the evergrowing (due to the multiplication of portable experiments in recent years) seismic anisotropy dataset has been obtained in continental domains. The usually good correlation between seismic anisotropy parameters (polarization direction of the fast wave and delay time for splitted SKS waves, fast propagation direction for Pn and surface waves...) suggests that the measured anisotropy largely records the deformation of the lithospheric mantle during the tectonic episodes (continental collisions, rifting...) that shaped the plates. Yet the interpretation of these data is not straightforward. A fundamental question is: Does seismic anisotropy allows to discriminate between the various deformation regimes typical of continental deformation zones? We use forward numerical models to investigate the effect of deformation regime on the development of olivine lattice preferred orientations (LPO) and associated seismic anisotropy within continental deformation zones. LPO predicted to form by pure shear, simple shear, transpression, or transtension are compared to a database comprising ca. 200 olivine LPO from naturally deformed upper mantle rocks. Seismic properties, calculated using the modeled olivine LPO, suggest that seismic anisotropy data may carry information on the deformation regimes active in the lithospheric mantle, although not all deformation regimes are characterized by a distinct seismic anisotropy signal. Simple shear (wrench) or transpression in vertical deformation zones and pure shear (horizontal extension) result in similar seismic anisotropy parameters. On the other hand, transtensional deformation in continental rift systems should result in a characteristic pattern marked by fast S-wave polarization and P-wave propagation directions oblique to the rift trend. There is a good agreement between model predictions and seismic anisotropy data in strike-slip, transtensional and transpressional zones, suggesting coupled deformation of the crust and mantle. In contrast, most thrust belts display fast S-waves polarized parallel to the trend of the belt. One possible interpretation is that the upper mantle is decoupled from the crust in these areas.

MS09 : WEpo06 : PO
Observations of Subduction Retroarc Dynamic Topography and Implications for Mantle Viscosity Structure

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The magnitude of surface dynamic topography generated by subduction mantle flow has been measured from stratigraphy using flexural backstripping for three retroarc basins: the Cretaceous Western Interior Basin USA; the Miocene Barinas-Apure Basin Venezuela; and the Miocene sub-Andean Basin N. Argentina. Upper bounds of air-loaded retroarc dynamic topography measured from stratigraphy are 900 ±75 m at 500 km from the trench, 650 ±75 m at 750 km from the trench, and 250 ±75 m at 1500 km from the trench. Subsidence from thrust sheet loading cannot be ambiguously distinguished from that due to subduction dynamic topography, however an upper bound of dynamic topography may be determined if it is assumed that thrust sheet loading is negligible. These upper bounds of subduction retroarc dynamic topography are consistent with oceanic residual bathymetric anomalies above subduction systems. A simple finite-element fluid-flow model of subduction has been used to examine the sensitivity of surface dynamic topography to the viscosity structure of the mantle. The model uses prescribed slab density representing the extreme upper bound of slab mass excess. The observed amplitudes of subduction retroarc dynamic topography at distances greater than ~1000 km from the trench are not consistent with predictions of models with uniform mantle viscosity or an impenetrable 660 km phase transition; these models predict insufficient dynamic topography at large wavelengths. The observed dynamic topography at trench distances greater than ~1000 km requires an increase in mantle viscosity with depth. Layered mantle viscosity models in which the viscosity rises by x10 across both the 410 and 660 km phase transitions predict longer wavelength dynamic topography. The observed long-wavelength dynamic topography of the Cretaceous Western Interior Basin may also require slab subduction through the 660 km phase transition into the lower mantle.

MS09 : WEpo07 : PO
Deep Anisotropy beneath the Western Pacific and Australia Recorded by Source-Side S Wave Splitting

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Seismic anisotropy beneath the western Pacific and beneath Australia is investigated by direct S-wave splitting of events occuring in the western Pacific subduction zones (Fidji, Tonga, New Hebrides, Marianas, Java, New Guinea) and recorded in Australia and India by permanent IRIS (CTAO, NWAO, WRAB, TAU) and Geoscope (CAN, HYB) stations. Systematic inspection of events of magnitude larger than Mb=6.0 occurring at distance larger than 85 degrees did not allow to find any reliable SKS splitting at the Australian and Indian stations. We therefore used these 'isotropic' stations to characterize source-side splitting of direct S waves without any station-side correction. A selection of events of magnitude (Mb) larger than 5.3 and occurring at depth larger than 40 km during the period 1988 to 1997, allowed to perform several tenths of splitting measurements of good quality using the method of Silver and Chan (1991). We observe at most of the stations clear splitting of the S phases with delay times often above 3.0 s and in some cases up to 6.0 s. Assuming the upper mantle beneath the station is isotropic, the observed S-wave splitting may occur either close from the source, i.e., within or beneath the slab, or along the path from the source to the receiver. Although part of anisotropy is likely frozen in a metastable olivine wedge within the slab, the absence of clear evidence of variation of the delay times with the event depth does not favor a slab origin of the anisotropy. Instead, clear shear wave splitting observed for events deeper than 600 km, favor an anisotropy within or beneath the transition zone sampled by the S phase along its way to the stations. Such anisotropic layer already suggested by Montagner and Kennett (1996) could be induced by a plastically deformed perovskite layer at the top of the lower mantle.

Silver PG & Chan W, *J. Geosphys. Res*, **96**, 16429-16454, (1991).
Montagner JP & Kennett BLN, *Geophys. J. Int*, **125**, 229-248, (1996).

MS09 : WEpo08 : PO
Anisotropy beneath the Dead Sea Transform from SKS Splitting at Short Periods

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As part of the DESERT 2000 experiment 86 seismic stations equipped with short period sensors (1 Hz) were deployed along a 100-km profile crossing the Dead Sea Transform about 75 km south of the Dead Sea. During the experiment an earthquake from the Vulcano Islands region (Δ=94°) of magnitude 7.3 (M_S) was recorded with a sufficiently high signal-to-noise ratio of the SKS phase. Routine shear wave splitting measurements yield delay times of about 1.5 seconds with fast polarization directions ranging between N5W and N15E - approximately parallel to the strike of the fault. The observed high-frequency SKS waveforms exhibit an unusually strong transverse displacement component in a narrow 40 km-wide zone with fast polarizations close to N15E. We show that this effect can occur for single anisotropic layers whenever $\delta t/T$=1/2, where δt is the delay time of the layer and T is the period of the incoming wave. At lower frequencies, the particle motion exhibits the characteristics of conventional shear wave splitting with a dominant radial displacement component. While the waveforms vary considerably with frequency, the corresponding splitting parameters are relatively uniform. This indicates that, to first order, the anisotropic effects can be described by a single anisotropic layer in the upper mantle beneath the stations. However, in addition to some random scattering, a coherent, laterally variable pattern of the splitting parameters can be observed. We attribute this to small-scale variations of anisotropy at shallow depth (within the crust). Synthetic seismograms are used to derive plausible models of the corresponding anisotropic variations.

MS09 : WEpo09 : PO
Seismic Waveform Tomography of the Iranian Region

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The tectonics of the Middle East is mostly understood in terms of the collision of the Arabian continent and southern Eurasia, with the subsequent westwards motion of the Anatolian block. However, surprisingly little is known about the detailed velocity structure of the region. Previous studies have concentrated mainly on fundamental mode surface wave dispersion measurements (e.g. Asudeh, 1982; Cong & Mitchell, 1998; Ritzwoller et. al, 1998), and the propagation characteristics of crust and upper mantle body waves (e.g. Hearn & Ni 1994; Rodgers et. al 1997). We use the partitioned waveform inversion method of Nolet (1990) on regional waveforms crossing the Iranian region to produce a 3-D seismic velocity map for the crust and upper mantle of the area. The method consists of using vertical component seismograms from earthquakes with well determined focal mechanisms and depths to constrain 1-D path averaged shear wave models along regional distance paths crossing Iran. The constraints imposed on the 1-D models by the seismograms are then combined with independent constraints from other methods (e.g. Moho depths from reciever function analysis etc.), to solve for the 3-D seismic velocity structure of the region. A dense coverage of fundamental mode rayleigh waves at a period of 100 s ensures good resolution of lithospheric scale structure. We also have good coverage of 20 s period fundamental mode rayleigh waves, which permit us to make estimates of crustal thickness variations and average crustal velocities, and some (less dense) coverage of higher mode rayleigh waves and mantle S waves, which sample to the base of the upper mantle. Our crustal thickness estimates range from 45 km in the southern Zagros mountains, to 40 km in central Iran and 35 km towards the north of the region. The velocity structure resulting from this tomographic study will be compared to the regional tectonics, and may provide further insights into the structure and history of the region.

Asudeh I, *Geophys. J. R. astr. Soc*, **71**, 715-730, (1982).
Cong L & Mitchell BJ, *Pure appl. geophys*, **153**, 503-538, (1998).
Ritzwoller MH, Levshin AL, Ratnikove LI & Egorkin AA, *Geophys. J. Int*, **134**, 315-328, (1998).
Hearn TM & Ni J, *Geophys. J. Int*, **117**, 273-283, (1994).
Rodgers AJ, Ni J & Hearn TM, *Bulletin of the Seismological Society of America*, **87**, 396-413, (1997).
Nolet G, *J. geophys. Res*, **95**, 8499-8512, (1990).

MS09 : WEpo10 : PO

Body Wave Observations in Fennoscandia Related to Seismic Anisotropy

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Seismic anisotropy is being observed as almost ubiquitous property of the continental lithosphere. Compared to tectonically active regions, where an asthenospheric flow can significantly contribute to observed anisotropic effects, a systematic olivine orientation within the subcrustal lithosphere seems to be a major source of seismic anisotropy observed beneath the Fennoscandia (Babuska et al., 1998). Distinct changes of patterns of the P-residual spheres, as well as the shear-wave splitting parameters, reflect lateral changes of anisotropic structure of the mantle lithosphere, related to prominent sutures or other intracontinental boundaries (Plomerova et al., 2001). Joint inversion and/or interpretation of anisotropic parameters derived from body waves, result in a self-consistent 3D image of the anisotropic domains of the mantle lithosphere of the Baltic Shield (Plomerova et al., 1996). The lithosphere thickness beneath the central Fennoscandia is estimated at about 200 km. Analyses of different P-residual datasets (e.g., ISC: 1988-1992) map high-velocity directions, which we interpret by wave propagation through anisotropic structures within large tectonic units of Fennoscandia - Sveconorwegian in the south and southwest of Scandinavia, Caledonian, Svecofennian and Archean in Finland. A new dataset extracted from observations of permanent observatories in Finland consists of P-arrival times measured for this study for a period of 26 months between 1997-1999. The residuals show a distinct bipolar pattern of the P-residual spheres reflecting propagation through dipping anisotropic structures of individual lithospheric domains, namely in the Archaean (KJN, SDF, KEV). The P-residual pattern at stations in the Proterozoic is more scattered, especially at stations on the coast. But in general, the fast velocities seem to prevail for propagation from SW. Shear-wave splitting times about 1s were evaluated at permanent observatories in central Finland and they thus detected presence of anisotropy in the Proterozoic mantle lithosphere. The deep suture between the Archaean and Proterozoic represents important boundary in observed anisotropic patterns, similarly to, e.g., the Protogine Zone in south-central Sweden.

Babuska V, Montagner J-P, Plomerová J & Girardin N, *Tectonophysics*, **151**, 257-280, (1998).
Plomerova J, Sileny J & Babuska V, *Phys. Earth Planet. Inter.*, **95**, 293-309, (1996).
Plomerova J, Arvidsson R, Babuska V, Granet M, Kulhanek O, Poupinet G, Sileny J, *Tectonophysics*, in print, (2001).

MS09 : WEpo11 : PO

A 3D Shear Velocity Model for the Upper Mantle of South America

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We study the 3D upper mantle structure of South America using a waveform inversion of Rayleigh waves fundamental mode and overtones. Data are from the permanent IRIS and GEOSCOPE stations available in South America, Antarctica and in Africa. Regional earthquakes from the Mid Atlantic Ridge, the Andean Cordillera, Carribean and Sandwich Islands trenches have been selected. A good azimuthal coverage is thus achieved, and therefore structures with horizontal wavelength of a few hundred of kilometers can be solved for both SV-waves heterogeneities and anisotropic directions. In addition, the dispersion of fundamental and higher modes Rayleigh waves allows us to constrain the depth variations of the anisotropic directions with a vertical resolution that can not be achieved in typical SKS studies. Preliminary results show no evidence for large scale deformation induced by the present day motion of the South American plate. Anisotropy is present in the upper 200 km of the model and seems to organize in a single lithospheric layer. In SE Brazil, we find a low velocity anomaly at depths larger than 200 km that may be associated to the “fossile mantle plume” previously imaged by VanDecar et al. (1995) using body wave data.