retrieving the wave propagation and site effects from the seismic recordings using an empirical Green's function method. They reflect a rather complex rupture with nevertheless a source directivity primarily pointing towards Athens. To further characterize the faulting, we inverted the ASTFs for the kinematic history of the rupture using a damped-least square inversion scheme with inequality constraints, a procedure developed in order to optimize the computation time. The strike and dip of the fault were fixed at 113 and 39 degrees, respectively.
The rupture area was found to be mainly confined into a 10 km along-strike x 15 km along-dip zone with a mean slip amplitude equal to 30 cm which corresponds to a relatively low average stress drop of about 7 bars. The slip concentrates in two patches, both separated from the nucleation point by about 4 km, with amplitudes reaching locally 90 cm. The rupture duration was determined on the instantaneous source time function, and is equal to about 5-6 s. The rise time was found to be equal to about 1.5 s, a rather long duration in contradiction with an asperity model.
To countercheck these results, the slip distributions were also inverted using the SAR and seismic data. However, significant discrepancies were observed especially on the NW part of the fault. These differences could be explained by an important contribution of post-seismic slip to the surface deformation (i.e. one-third of the total slip). Further studies will aim to evaluate the ability of heterogeneous slip models to better predict the spatial aftershock distribution than homogeneous slip models, using the Coulomb failure criteria.

S52F MC: Hall D Friday 1330h

Imaging Mantle Structures Using Surface Waves *(joint with T, DI)*

Presiding: **S Lebedev,** MIT, EAPS

S52F-0693 1330h POSTER

The Unique Dynamics of the Pacific Hemisphere Mantle and its Signature on Seismic Anisotropy

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We will present a recently developed tomography-based model of 3-D mantle convective flow. The radial profile of mantle viscosity and the velocity-density conversion factors are constrained through inversions of a full suite of surface geophysical data associated with mantle convection [*Forte and Mitrovica*, 2001]. We employ a treatment of tectonic plate motions, recently reanalysed by *Gaboret and Forte* [2001], in which the plates are considered as buoyancy-driven rigid bodies coupled to the underlying mantle flow. This mantle flow model yields predictions of velocity, stress, strain rate and flow-induced finite deformation throughout the mantle. The velocity and deformation have been analyzed through observations of mantle seismic anisotropy which is believed to reflect the lattice preferred orientation (LPO) of its constituents and therefore to be a unique signature of the convection-induced flow patterns [*Ribe*, 1989]. Using a new model of seismic anisotropy[*Montagner*, 2001], we compared the observed radial and azimuthal anisotropy with the predicted velocity and maximum rates of horizontal and vertical stretching in the uppermost 400 km of the mantle, where seismic observations are best constrained. We focused our numerical investigations on the relationship between convection and anisotropy underneath the Pacific Ocean basin. In this Pacific Hemisphere, our model [*Gaboret et al.*, 2001] explains the strong asymmetry observed across the East Pacific Rise (EPR) [e.g., *Wolfe and Solomon*, 1998] in terms of a unique flow behaviour, called a "demi-tour" [*Forte et al.*, 2001]. This demi-tour connects a dome-like buoyant upwelling in the deep mantle, which feeds the South Pacific Superswell [*McNutt and Judge*, 1990], and actively drives the vertical transport of material into the upper mantle, ultimately emerging at the EPR. A strong agreement between the observed anisotropies and the inferred flow velocity and deformation is revealed on either side of the EPR axis. These results also confirm that anisotropy does provide a map of the upper-mantle flow field and may thus be used as an observable *in situ* signature of mantle convective flow.

S52F-0694 1330h POSTER

East Asian Mantle Structure From Shear and Surface Waveforms

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The structure of the mantle beneath East Asia down to 800 km depth is investigated using 1600 full waveforms of seismic shear and surface waves with epicentral distances of less than 40 degrees.

In contrast to previous waveform inversions, we use (1) exact 3D waveform sensitivity kernels which correctly reflect off-path sensitivity and the existence of Fresnel zones. We apply (2) an accurate 3D forward modelling technique based on a coupled-mode, multiple forward scattering approach allowing us (3) to iterate the inversion procedure through several 3D-models and (4) to evaluate the true misfit between the data and the synthetics for the 3D-model. Average lateral resolution of the model is 400 km.

Major features of the model are high-velocity slabs along the West Pacific subduction zones, a strong, elongated low-velocity zone between 80 and 250 km depth in the West Pacific backarc regions, a plume-like low-velocity feature beneath the Baikal rift zone extending into the transition zone and thick crust under Tibet reaching its maximum thickness of about 80 km south of 35 N. Tibet is underlain by high-velocity lithosphere both in the south and the north with a gap of much lower velocity in between extending from 33 to 37 degrees North and from 82 to 93 degrees East.

S52F-0695 1330h POSTER

Imaging of the Deep Structure by Long Term Broad Band OBSs – Trans-PHS Profile and NW Pacific WP-2 site –

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As an important part of the Ocean Hemisphere network Project, long term ocean bottom seismic observations have been started and some of their data have been retrieved already. One of them, the trans-Philippine Sea profile observation (15 Long Term OBSs, Nov. 1999 – July 2000) was preliminarily reported at the last AGU fall meeting (S51B-02, 2000). Other long term broad band observations had been performed twice at the northwestern Pacific (Broad Band OBS, NWPAC1: Aug. 1999 – May 2000, NWPAC2: May 2000 – Nov. 2000), where the borehole seismic observatory (WP-2) has been activated in Nov. 2000. The LTOBS and the BBOBS contain a semi broad band sensor (WB2023LP, PMD) which has the pass band from 30s to 50Hz and a broad band sensor (CMG-1T, Guralp) which has the pass band from 360s to 80Hz, respectively. The seismic data is recorded continuously with a sampling frequency of 128Hz by a 20bit ADC on four 2.5 inch 6.5 GB HDDs. The direction of horizontal components are determined from the data of the direct water wave during the airgun shooting or P-SV converted waves at the sediment-basement interface. Running acceleration power spectra (0dB=1m^2/s^4/Hz) of these data during the whole observation period indicate followings; 1) sufficiently low noise band exists in the frequency range of 10–100mHz and the lowest level is close to the NLNM, but the horizontal noise level varies about 20–30dB with a dominant 12 hours interval, 2) high level micro seismic noise in the range of 0.1–1Hz is always near the NHNM and varies about 30–40dB.

In this presentation, preliminary results of the deep structure imaging from these vast data by a receiver function analysis is shown. To perform this analysis with the OBS data, removal of water column reverberations and reduction of high level micro seismic noise should be necessary. The former process has a difficulty in the estimation of the water-sea bottom reflection coefficient and requires the data of higher sampling frequency, more than about 64Hz. For the latter one, the cross correlation between the noise of the vertical component just before the theoretical P arrival and the radial component is subtracted from the cross correlation between the signal (and noise) of the vertical one and the radial one. This analysis is still on the way, but a signature from the 410km interface is able to find in the results. Additionally, a dispersion curve analysis of surface waves is also shown from the data of the trans-Philippine Sea profile. It is expected to reveal the difference of basins with different ages, because Rayleigh waves clearly recognized in the record section for some events from Tonga and Fiji.

S52F-0696 1330h POSTER

Multimode Surface Wave Tomography of Asia and Western Pacific.

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We invert a few tens of thousand long-period seismograms and select about twenty thousand to constrain a large-scale, high-resolution, 3-D model of the upper mantle beneath Asia, Australia, and Western Pacific. Automated Multimode Inversion of surface waves (Lebedev and Nolet, 2000) is used to extract the waveform phase information from the regional S and fundamental mode wavetrains and relate it to structural perturbations in the Earth. Efficient selection of the wavetrains uncontaminated by scattered waves ensures high accuracy of our measurements. Full automation allows us to constrain the tomographic model using a very large waveform data set and to achieve lateral resolution of 300-700 km, varying with the local ray-path coverage.

The tectonically diverse region of study encompasses units ranging from stable Archean cratons and the oldest ocean floor on Earth to currently opening backarc basins. The western half of the Pacific "Ring of Fire" dominates the cross-sections down to 150 km depth. At greater depths, a pattern of prominent high-velocity anomalies is created by the deep roots of Precambrian continental units, oceanic lithosphere subducted in the Western Pacific, and the Indian lithosphere descending beneath Tibet.

S52F-0697 1330h POSTER

Surface Wave Velocity map of the Western Pacific Ocean from the Records of the WP-2 Ocean Borehole and Surrounding Island Stations

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In August 2000, the seafloor borehole seismological observatory WP-2 in the northwestern Pacific basin was installed in the ODP Leg191. The WP-2 observatory is situated to fill the station gap in the northwestern Pacific Basin where no island exists near the station. The WP-2 observatory started observation in November 2000. We recorded broadband seismic data from the borehole station by an offline recorder on the seafloor. In July 2001, we visited the station by an ROV and recovered the recorder to get preliminary seismic data. The period of the preliminary record was 89 days from October 29th, 2000 to January 25th, 2001.

Because the WP-2 station was very quiet at long period range from 10 seconds to 1000 seconds, we were able to identify 118 earthquakes from those globally located in that recording period. The most of the earthquakes are located in the circum pacific seismic zones, so the dataset is suitable to study the mantle structure beneath the Pacific Ocean. We were able to observe many Love and Rayleigh waves because the station is also quiet for the horizontal components in the long period range. The quality of the surface waves records seems so excellent that the Love and Rayleigh waves are clearly separated in the transverse and radial direction toward the event. This quality observation has been very difficult in the ocean because the seismometer installed on the seafloor usually has severe horizontal noise due to the sea floor current.

Great circle paths of the events recorded by the WP-2 station cover very well over the North Western Pacific Ocean. The coverage in the Western Pacific is optimized when we analyze the data with those from surrounding island stations of the Pacific21 network. These island stations and the WP-2 borehole station form a combined network that is characterized by its uniform and dense station coverage in the Western Pacific Ocean. We present a surface wave velocity map of Love and Rayleigh waves in the Western Pacific Ocean from the combined network data.

S52F-0698 1330h POSTER

Full Three-Dimensional Tomography Experiments in the Western Pacific Region

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Two decades of seismic tomography studies have yielded earth models with three-dimensional (3-D) velocity heterogeneities in the mantle on both global and regional scales. With the continuing improvements in inversion techniques, station coverage and computational facilities, seismic tomography has reached a stage at which higher resolution to the structure can only be achieved reliably by employing accurate descriptions between observables and structural parameters, especially in the upper mantle. With this in mind, we have conducted a tomography experiment for the mantle structure beneath the Western Pacific with a **full 3-D** approach: imaging the 3-D structure using true 3-D Fréchet kernels. In our experiment, we use nearly 20,000 delay times measured at eight discrete frequencies between 10mHz and 45mHz from three-component regional *S* waves, including its multiple reflections from the surface and the CMB. The 3-D Fréchet kernels for these delay times are computed by a normal-mode approach (Zhao, Jordan & Chapman 2000) in which coupling between each pair of modes is accounted for with the exception of cross coupling between spheroidal and toroidal modes. The algorithm is implemented with MPI on the 192-node (and expanding) dual-processor Linux-PC cluster at the University of Southern California. The 3-D radially anisotropic shear-speed model is obtained through a Gaussian-Bayesian inversion. A full description of features in our model will be given in a separate presentation (Chen, Zhao & Jordan, this meeting). Here we discuss in detail the issues related to the calculation of a large number of coupled-mode 3-D kernels for the frequency-dependent delay times and their inversion. We also examine the efficacy of this full 3-D approach in regional high-resolution tomography studies by comparing the results with those in our previous work in which the 3-D structure was obtained by inverting the same delay-time measurements but using computationally more efficient 2-D Fréchet kernels approximated from 3-D by an asymptotic stationary-phase integration across the great-circle plane.

S52F-0699 1330h POSTER

Full Three-Dimensional Seismic Structure of the Mantle Beneath Southwestern Pacific Ocean

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We present a full three-dimensional (3-D) model of the shear-speed structure for the mantle beneath southwestern Pacific Ocean. Over 800 three-component recordings of earthquakes (Mw > 5.5) from the seismic zones around the southwestern Pacific rim to station HON/KIP in Hawaii, MAT/MAJO and ERM in Japan, and GUMO in Mariana Island were processed to obtain ∼20,000 frequency-dependent phase delays for various of seismic waves, including S, SS, upper-mantle guided and surface waves, and ScS reverberations. The 3-D Fréchet kernels for these delay times are computed by the coupled normal mode theory described by Zhao, Jordan, and Chapman (2000), and the measurements were inverted for a 3-D radially anisotropic shear-speed model using a linear Gaussian-Bayesian scheme. The model parameters include shear-speed variations throughout the mantle and perturbations to radial shear-wave anisotropy in the uppermost mantle. Our results for the large-scale variations in the isotropic shear speeds are generally consistent with published global tomographic models. For example, the uppermost mantle (< 200 km depth) shows fast anomalies in the interior of the Pacific plate and slow anomalies in the marginal basins along the Pacific rim, while this pattern is reversed in the transition zone (400-700 km). The amount of large-scale radial anisotropy decreases with depth and near Hawaii the amount of anisotropy is smaller than its surrounding area. Our model reveals greater lateral heterogeneity than the global models, especially in the 200-400 km depth range, suggesting a complex 3-D mantle flow in the southwestern Pacific upper mantle.

S52F-0700 1330h POSTER

Imaging the thermal structure of the continental upper mantle: Joint inversion of heat flow and surface wave dispersion

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The thermal lithosphere (TL) is the region of the crust and uppermost mantle where heat flow is dominated by conductive transport and which presumably does not participate actively in large-scale convection. An accurate estimate of the thickness of the TL, therefore, is necessary to understand the long-term stability of the continental lithosphere. We present and discuss a new thermal model of the subcontinental upper mantle. This model is derived from a shear-velocity model obtained by jointly inverting surface wave dispersion and heat flow data. The surface wave data set consists of broad-band Rayleigh and Love wave group-velocity (CU-Boulder) and phase-velocity (Harvard, Utrecht) data from which we estimate an ensemble of acceptable shear-velocity models by Monte-Carlo inversion. We convert the heat-flow into temperature and then into shear velocity to constrain seismic shear velocity at the top of the upper mantle. A subset of the ensemble of acceptable seismic models is consistent with this constraint within estimated error bars which derive from several sources, including uncertainties in radioactive heat production and thermal conductivity of the crust and in upper mantle composition. Heat-flow is a powerful and important constraint on the vertical velocity gradient in the uppermost mantle, notably across North America and Eurasia where heat flow data are most extensive.

The thermal model of the upper mantle is derived by converting model shear-velocities to temperatures based on laboratory-measured properties of individual minerals, a mineralogical composition model of different tectonic types, and the Voigt-Reuss-Hill averaging scheme. The 3-D temperature field is interpreted in terms of a simple model of the upper mantle geotherm in which the TL is underlain by the convective mantle with an approximately adiabatic temperature gradient. We define the bottom of the TL as the depth of intersection of the conductive and adiabatic geotherms. We provide a model of the 3-D distribution of temperature in the upper mantle and maps of the thickness of the TL across North America and Eurasia. Uncertainties in these quantities are also presented.

S52F-0701 1330h POSTER

GLOBAL PHASE VELOCITY MAPS OF THE FIRST RAYLEIGH HIGHER MODES

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The last two decades have seen an exponential growth of the dataset available to seismologists, in terms of both quality and quantity. As a result, constantly refined global models of the Earth's interior have been proposed. The great majority are realized using body waves traveltime measurements or/and surface waves dispersion measurements. Following the normal mode summation approach, a surface wave long-period seismogram, bandpass filtered between 50s and 500s can be interpreted as a sum of the fundamental mode and the first higher modes or overtones. At first order, phase velocities in each mode branch are governed by lateral heterogeneities of Earth's mantle *S* wave velocities. We present here a new approach to solve the highly nonlinear inverse problem of retrieving the phase velocities of each mode branch, starting from single station measurements. After a large wavelength exploration of all possible models, the difference between the real spectra and the sum of the synthetic mode branches spectra is inverted, following a least square type optimisation, to match the short wavelength phase velocities variations. The simultaneous use of several earthquakes during the inversion procedure leads to a better depth resolution in the transition zone, due to the multi-mode character of our technique. We apply this method using data from the GEOSCOPE and the IRIS networks, and present global phase velocity maps of the Rayleigh fundamental mode and first higher modes.

S52F-0702 1330h POSTER

Refining Estimates of the Seismic Velocities of the Crust and Upper Mantle

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We discuss recent efforts to improve a global shear-velocity model of the crust and upper mantle by advancing surface wave methodology as well as by introducing new types of geophysical data in the inversion. The primary data-set used to construct the model consists of broad-band Rayleigh and Love wave group-velocity (CU-Boulder) and phase-velocity (Harvard, Utrecht) dispersion curves. The first step of the inversion is surface wave tomography in which group and phase velocity maps are constructed. We present a new method of surface wave tomography called "diffraction tomography" that is based on a physical model of the surface wave Fresnel zone rather than on ray-theory and ad hoc regularization. Diffraction tomography accounts for path-length dependent sensitivity, wave-form healing and associated diffraction effects, and provides a more accurate assessment of spatially variable resolution than traditional tomographic methods. The second step is Monte-Carlo inversion of the dispersion maps for an ensemble of acceptable shear velocity models of the crust and uppermost mantle. Because surface waves have limited vertical resolution, we apply constraints on the model derived from other types of geophysical observations. We consider two types of additional data: teleseismic receiver functions and heat flow measurements. Receivers functions are formed by P-S converted waves that arise from sharp boundaries close to the Earth's surface, and thus provide important constraints on the crustal structure. Their use in the inversion mitigates the tradeoff between the crust (where surface waves have poor sensitivity) and the deeper part of the model. Heat-flow data constrain mantle shear velocities through the conversion of heat-flow into temperature and subsequently into shear velocity at the top of the upper mantle. We present results from the joint inversion and discuss how the combination of different types of data reduces both uncertainties and systematic bias in the resulting shear velocity model.

S52F-0703 1330h POSTER

Surface Wave Tomography: a Three-Stage Approach

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Most studies of regional surface wave tomography have been based on two-stage inversion processes (e.g., partitioned waveform inversion). The first stage of such an approach is based on the waveform inversions for path-average 1-D models. However the most robust results from such waveform inversions are multi-mode phase speeds as a function of frequency rather than the models themselves. We therefore propose a new multi-stage approach for reconstructing 3-D images of the upper mantle from surface wave inversion based on three separate inversion processes. In the first step, for each path, multi-mode phase speeds of surface waves are measured from waveform fitting or using any other convenient estimator of surface wave dispersion. In the second stage, multi-mode phase dispersion maps are obtained by the iterative use of linear inversions for dispersion maps incorporating with finite-frequency effects of surface wave propagation including the deviation of surface wave paths from the great-circle. The

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influence zone associated with finite frequency surface waves can be obtained using "Fresnel-area ray tracing" so that there is a frequency dependent finite width path for each modal contribution. Azimuthal anisotropy for each mode as a function of frequency can also be extracted from the measured phase speed at this stage. 3-D shear wavespeed structure can finally be recovered by using a set of local 1-D inversions for multi-mode dispersion and anisotropy. The advantage of this three-stage approach is that different styles of information can be brought together in the same framework. Thus multi-mode dispersion, finite-frequency effects and polarisation anomalies of surface waves can be incorporated simultaneously and efficiently to constrain the 3-D Earth model, by working with multi-mode phase speed maps as a function of frequency. The new approach can be applied to both regional- and global-scale inversions and allows the extension of surface wave tomography to regions where wavespeed contrasts are large.

S52F-0704 1330h POSTER

The Lithosphere-Asthenosphere Structure as Seen by Surface Waves: Recent Results From Multimode Waveform Inversion

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Recent developments in seismic imaging techniques allow the automated analysis of large volume of waveforms. We use a time window that encompasses the fundamental mode of surface waves and few higher modes, up to the fourth, in the period range 50-150s. Such data provide sensitivity in the whole upper mantle with a rather good depth resolution.

The use of records from permanent observatories supplemented by temporary field deployments of broadband stations has allowed us to perform several regional tomographic studies at the scale of a tectonic plate. A good azimuthal distribution of criss-crossing paths enables us to resolve lateral changes in shear wave velocity and anisotropy simultaneously. We present results recently obtained for three regions, Australia, South America, and the northeast part of the Afro-Arabian continent.

Beneath the fast-moving Australian plate, upper mantle seismic anisotropy organizes in two layers. In the uppermost layer, about 100 km thick, seismic anisotropy is interpreted as due to anisotropy frozen in the lithosphere, while in the lower layer it would be related to present day deformation due to the northward motion of the Australian plate. However, beneath slower continental plates, such a two layer anisotropic model is less obvious. At 200 km depth, a small anisotropy is found beneath South America while in India, the anisotropy directions would be in better agreement with a return flow model, assuming a low viscosity channel is present beneath the rigid lithosphere. For the cratons we have studied up to now, the high velocity lid thickness as determined from seismic heterogeneities shows no evidence for deep continental roots extending deeper than 250 km.

In regions where a dense coverage in higher modes is available, evidences for smaller scale structure start to accumulate in the transition zone. Beneath the northeastern Afro-Arabian continent, the deployment of four broad-band stations in Ethiopia and Yemen has allowed us to detect the presence of a small low shear velocity anomaly which persists in the transition zone down to the 660 km discontinuity. This would support the idea that upwelling of hot material is still present in the region, a long time after the initial breakup of the continental lithosphere.

S52F-0705 1330h POSTER

Upper-Mantle Seismic Structure along Fiji-California Corridor

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A high resolution seismic velocity structure is very important for understanding tectonic, geochemical and geodynamic processes, however, the upper mantle seismic structure of the Pacific region remains poorly determined due to sparse station coverage. We propose a new technique to study the upper mantle seismic structure by modeling multi-bounce S waves, taking advantage of high-quality broadband seismic data accumulated at the Trinet array, Southern California from events at the edge of the Pacific. In particular, we present results from modeling several events with different mechanisms, at different depths sampling the same profile from Fiji. The three-component records are used which contain various multi-S triplications along with P branchs and surface waves. These triplication patterns are enhanced by introducing a stacking procedure. However, contamination of surface waves over the triplicated SSSS on the transverse component presents difficulty in this study. To overcome this, we separate the surface waves that bottom out above the depth of 300km from the deeper penetrating multi-bounce S phases and allow some differential shifting to account for laterally varying crust and lid structure. Such a hybred technique produces remarkable fit for the complete seismograms. The resulted path-averaged, layered SH model via a grid-search like procedure contains a 80km thick lid, a well-developed low velocity zone and a high gradient zone between the depth of 150km to 400 discontinuity with no evidence for the 220km discontinuity specified in PREM. While a distinctly slower SV model (roughly 4% slower than SH model down to a depth of 150km) is required to fit the SV data where both triplicated SSSS and SSSSS are observed, which indicates the existence of polarization anisotropy. Our model is compatible with Gaherty and Jordan[1996]'s results along the Fiji-Hawaii corridor, which is about the first half of our profile.

S52F-0706 1330h POSTER

Semi-automatic Surface Wave Phase Velocity Measurements Using Small-Aperture Arrays

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Surface waves provide a useful means of estimating the lateral variations in lithospheric structure. However, there is increasing evidence that such variations can occur over very short distances (for example tens of kilometers), hence being unresolved by classical two-station phase velocity measurements or by regional, ray-based, surface wave tomography. We present a procedure for semi-automatic phase velocity measurements in small aperture arrays with a diameter down to a tenth of a wavelength. One dispersion curve is measured for each array, and lateral variations can therefore be obtained by studying differences of dispersion curves between different arrays. Each step of the procedure is classical in signal-processing, but are optimized for outlier control and reduction of random noise. Firstly, for each event Wiener filtering is used to measure time delays between stations as a function of frequency. Secondly, for each frequency these time delays are inverted to estimate the best fitting slowness vector. The inversion is carried out by minimizing the absolute deviation rather than by least squares fitting, to minimize the influence of random noise at any particular station. Once the slowness vector is estimated, the distances between pairs of stations are projected upon the slowness vector to obtain a series of (distance,delay) couples. Finally, for each frequency all such measurements from a set of well-distributed events are combined and classical least squares linear regression is performed to obtain the phase velocity. Numerical tests were carried out on full waveform synthetic seismograms, and the method is applied to arrays in the French Alps. To obtain a stable measurement, 10-20 well distributed and good quality events are required, which is an obtainable objective in temporary passive experiments aimed at probing the lithosphere.

S52F-0707 1330h POSTER

Small-Scale Heterogeneities in the Lithosphere do not Bias the Love-Rayleigh Discrepancy

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The information we have on the anisotropy in the lithosphere comes for a large part from measurements of surface wave phase velocities, and in particular of the Love-Rayleigh discrepancy, which expresses that the lithosphere appears usually faster to the Love waves than to the Rayleigh waves. In some regions, this discrepancy is however so large that the question arises as to whether part of it could be an artefact related to the presence of heterogeneities in the lithosphere.

Using a multiple-scattering scheme to model surface wave propagation in 3-D structures, we analyse the influence of small-scale heterogeneities in the lithosphere on the Love-Rayleigh discrepancy in the period range 25 to 60s. We show that small-scale heterogeneities tend to lower the apparent phase velocity of the surface waves, and have a larger effect on the Love waves than on the Rayleigh waves. This is not due to mode-coupling, which plays a negligible role here, but to the interference of the primary field with the one backscattered twice. For models with S-wave velocity variations of rms 2.5%, and spatial correlations at distances of 20 to 100km, we find that the Love waves are on the average slower than the Rayleigh waves by at most 0.1%. This apparent Love-Rayleigh discrepancy varies linearly with the variance of the S-wave velocity variation in the structure. For realistic levels of small-scale heterogeneities in the lithosphere, it is therefore too small to contribute significantly to the large Love-Rayleigh discrepancies of 4 to 9% observed in some regions, and we note in additon that it has the opposite sign.

Intrinsic anisotropy, possibly biased by the effect of large-scale heterogeneities, must be responsible for the observed values.

S52F-0708 1330h POSTER

Oscillation of a Mountain Root Structure due to a Rayleigh Wave Incidence

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Spectral amplitudes of Rayleigh waves across a mountain root in the continental crust were studied by the use of the finite difference technique. The crust has a mountain root structure like that of the Tien Shan in China, and a maximum thickness of about 50 km. The waves are numerically simulated by implementing a plane Rayleigh wave incidence on the front of the mountain root structure. The spectral amplitudes of the vertical (W) component are shown to be strongly amplified by the mountain for periods from 20 to 50 s, with a maximum of about 7 %, whereas those of the radial (U) component show a slight increase with an increase in period. For the mountain structure with small-scale low velocity zones (LVZ) in the bottom of the root and in the upper mantle, amplitudes of the W-component are enriched at periods slightly longer than those for the structure without the LVZ. For the mountain structure with a double large-scale LVZ in the lower crust and the upper mantle, amplitudes of the W-component are extensively amplified in a wide period range beyond 50 s. The period range from 20 to 50 s with high amplifications of the W-component for the mountain root structure with or without the LVZ is consistent with periods, in which the Rayleigh to Love wave conversion is dominant in observed surface waves across the Tien Shan (Pedersen et al., 1998).

S52G MC: 306 Friday 1330h

Characteristics and Dynamics of Intraplate Versus Interplate Seismicity II *(joint with G, T)*

Presiding: **C Powell,** The University of Memphis**; M Antolik,** Harvard University

S52G-01 1330h INVITED

The 2001 Bhuj Earthquake: Interplate, Intraplate, or Moot?

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On January 26, 2001, Republic Day in India, a Mw 7.7 earthquake occurred in the Kachchh region, in the state of Gujarat, India. Four red flags were waved almost immediately. First, the earthquake occurred many hundreds of kms away from the nearest plate boundary. Second, the earthquake was felt from Calcutta to Madras to Katmandu, an area 16 times that of the 1906 San Francisco earthquake. Third, the Bhuj earthquake occurred in a failed rift that is in part seismically active, and last but not least, despite the relatively shallow hypocenter and large magnitude, the earthquake appeared to have no surface rupture. Each of these strongly bring to mind the great New Madrid earthquakes of 1811-1812, and so the debate began: was Bhuj an intraplate or interplate earthquake? Or is this a mootish red herring?

The debate was fueled by early analyses of aftershock data collected by the Center for Earthquake Research and Information (CERI) that shows aftershocks