noise from the phase or group velocities of the fundamental mode. However, for the higher modes at short periods, the difference exceeds the observational error for a pronounced LVZ.
We use non-linear inversion to check the set of solutions for the dispersion curves of the different models. As expected, the data is more sensitive to Vs than Vp. The solution space requires a low velocity only when the LVZ is pronounced (> 80 km (40 km) thick for a velocity reduction of 2% (5%)). However, the calculated thickness and velocity contrast are smaller than in the original model.

S31H-04 1105h

The Telltale Moho and Novel Views of the Crust and Upper Mantle in the Gulf of California

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One of the outstanding questions about the Gulf of California remains: what is the composition of the crust; more specifically, is there any continental crust beneath the thick sedimentary layer in the Gulf or is it all new oceanic crust. An answer to this question places bounds on the strength and the mechanical behavior of this actively extending region and may help explain the curious lack of seafloor spreading despite 300 km of upper crustal separation over the last 6 myrs. We use receiver functions (RFs) from teleseismic events recorded by the NARS-Baja array to map crustal thickness in the margins of this newly forming ocean basin and use these results to constrain the amount of continental crust within the Gulf. The RFs show clear P-to-S wave conversions from the Moho beneath the stations. The delay times between the direct P and P-to-S waves indicate thinner crust closer to the Gulf along the entire Baja California peninsula. This approximately W-E shallowing in Moho depths is significant with extremes in crustal thickness of $\sim$ 20 and 40 km. A similar trend on the opposite side of the rift may be established with better spatial data coverage. Similar results have, however, been obtained at the northern end of the peninsula by previous workers, who proposed a mechanism of lower crustal flow associated with rifting in the Gulf Extensional Province for thinning of the crust. We also interpret the Gulf-ward thinning of the crust as related to ductile flow in the lower crust during the early stages of rifting and further suggest that the amount of lower continental crust within the Gulf itself is significant. Besides the conversion from the Moho, a number of interesting lithospheric features above and below the Moho are also prominent in the RFs. These may be an indication of isotropic dipping layers or anisotropic layers. In addition, we observed P-to-S conversions from the 410 and 660 upper mantle discontinuities and were able to map these features over a wide area. In contrast to the 660, which is relatively flat lying and continuous, there is evidence of some topography associated with the 410 discontinuity.

S31H-05 1120h

Teleseismic imaging of upper mantle structures around the Taiwan area

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Teleseismic events that had been clearly recorded across TTSN and CWBSN through the past 7 years (1987-1995) has been identified and compiled. Recorded waveforms of those with epicentral distances 30° 90° away from Taiwan are analyzed by the multichannel cross correlation algorithm to yield a set of consistent relative differential travel times across the area covered by the seismic networks. After careful quality control, 140 events that yield relative differential travel times within the range of 1.5 seconds across the area are retained. These events compose about 2455 rays going through the upper mantle around the Taiwan region. Tomographic inversion of these travel-time residuals are undertaken by assuming that the heterogeneities of the velocity structure of the target area, within 20.5°-26.5° N, 118°-124°E and with the depth above 400 km, is responsible for causing the relative differential travel times. Preliminary model structures obtained from three different inversion strategies, including the damped least squares, the convolutional quelling regularization and the multiscale parameterization, are cross-analyzed to probe for the possible upper mantle structure. Although the data seems to be noisy and the ray coverage is very likely too sparse, there are still some interesting implications for upper mantle structures underneath the Taiwan area. We will discuss some of these preliminary results as well as proposing for directions of future study.

S31H-06 1135h

Seismic Evidence for Accumulated Oceanic Crust Above the 660-km Discontinuity Beneath Southern Africa

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High-pressure assemblages of subducted oceanic crust are denser than the normal upper mantle but less dense than the uppermost lower mantle. Thus subducted oceanic crust may accumulate at the base of the upper mantle. Direct observational evidence for this hypothesis, however, remains elusive. We present an analysis of a negative-polarity shear wave converted from compressional wave at a seismic discontinuity near 570 - 600 km depth beneath southern Africa. The negative polarity of the converted phase indicates a 2.2 $\pm$ 0.2% S-velocity decrease with depth at the seismic discontinuity. This velocity reduction is associated, however, with a low velocity contrast at the 660-km discontinuity. Accumulated oceanic crust at the base of the upper mantle provides a plausible explanation for the apparent paradox between the negative velocity discontinuity and the low velocity contrast at the 660-km discontinuity. Measurements of the elastic constants supplemented by estimates based on systematics and first principles theoretical predictions suggest that subducted oceanic crust has a shear wave velocity 2% lower than that of pyrolite at 530 - 630 km depth. From 600 km depth to the base of the upper mantle, Ca-perovskite exsolution in former oceanic crust could increase the shear wave velocity by 1-2 percent. This scenario is in general agreement with an anomalously large P-wave velocity gradient over a depth range of 80 km around 660 km depth inferred from the travel times and waveforms of direct P waves beneath southern Africa.

S31H-07 1150h

Variations in Lithospheric Structure Across the Canadian High Arctic Region.

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The CHASME (Canadian High Arctic Seismic Monitoring Experiment) project began in summer 2000 with the deployment of 7 temporary seismograph stations in communities across the Canadian High Arctic and western Greenland, adding to the sparse network of existing permanent stations in the region. Data from two temporary seismograph stations on central Baffin Island and from the POLARIS seismograph network in the Northwest Territories are also used in the study. Using regional and teleseismic surface waves recorded at pairs of seismograph stations across the Canadian High Arctic, a number of Rayleigh wave phase velocity dispersion curves have been obtained for the region, using the 2-station method of Gomberg et al. (1988). The relationship between phase velocity and wave period is broadly consistent with those for continental shields worldwide, though significant variation in the characteristics of the dispersion curves exists across the region. The average shear wave velocity structure along each of the 2-station paths is obtained using the linearised inversion method of Herrmann (2002). We use the velocity models to investigate the variations in the thickness and character of the seismological lithosphere across the region, and compare our findings with those from previous structural studies of northern Canada and mainland Greenland.

S31H-08 1205h

Crustal Structure and Mantle Anisotropy from Florida to Edmonton

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New constraints on crustal thickness and velocity and mantle anisotropy beneath the east-central United States and southern Canada were obtained using data from the Florida to Edmonton Broadband Seismometer Experiment (FLED). This array included 28 broadband IRIS/PASSCAL seismometers that were in the field from May, 2001 to October, 2002, and adjacent permanent stations from the IRIS/GSN, the USNSN and the CNSN. Crustal properties were determined using Ps phases scattered from the Moho and, where possible, crustal reverberations. Waveforms at each station were corrected with an inverse free surface transform, simultaneously deconvolved, migrated to depth in one dimension, and modeled using migrated propagator matrix synthetic seismograms. Crustal thickness varies from 30 km to 50 km along the array. Significant features include zones of thickened crust beneath the southern Appalachian mountains and the late-Proterozoic Mid-Continent Rift in Iowa. The thickness of the southern Appalachian crustal root relative to surface topography is consistent with the root to topography ratio found in the northern Appalachians of Pennsylvania using data from the Missouri to Massachusetts Broadband Seismometer Experiment. However, both are large when compared to root/topography ratios in young orogens. These results are consistent with global trends in orogenic crustal thickness, mountain topography and gravity anomalies that suggest a systematic decrease with age in the buoyancy of crustal roots relative to the mantle. To constrain anisotropy beneath the FLED array, shear-wave splitting was measured in SKS and other teleseismic core phases. At southeastern stations located between the continental margin and the Appalachian Front and at stations within the central U.S. craton, where the lithosphere defined by tomographic studies is significantly thicker, shear-wave splitting fast directions are roughly parallel to North American absolute plate motion, and splitting times range from 0.6 s to 1.4 s. One exception occurs in the Mid-Continent Rift Zone in Iowa where a significantly different (roughly N) fast direction was obtained. Apart from this latter observation, the measurements are consistent with splitting found elsewhere in the craton and southern Appalachians by previous studies. Fast directions over this broad region may in general be explained by lattice-preferred orientation of olivine in the asthenosphere as it flows beneath and around the base of the lithosphere, although contributions from anisotropy due to past deformation in the lithosphere are also possible. In contrast, the N fast direction in the Mid-Continent Rift is not easily modeled by asthenospheric flow alone and is evidence for a local lithospheric fabric possibly associated with extension at roughly 1.1 Ga.

S32A MCC: Level 2 Wednesday 1330h

Jingle All The Way: Receiver Function Imaging Posters *(joint with MR)*

Presiding: **J Park,** Yale University; **R L Nowack,** Purdue University

S32A-0829 1330h POSTER

Fault Plane Detected Through Receiver Function Analysis

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Unexpected features in teleseismic receiver function reveal the presence of a dipping interface with pronounced seismic velocity contrast in the Campania-Lucania region, Southern Apennines (Italy). Locus of this finding is the Melandro-Pergola basin, located between the maximum intensity areas of two of the most destructive earthquakes reported in the Italian seismic catalogue, the magnitude $\sim$ 7.0 Val d'Agri (1857) and Irpinia (1980) earthquakes. This area is not associated with known historical events and for this reason is currently object of investigation as potential seismic gap, where the probability of future ruptures is higher than in surrounding regions. Could the enlightened interface be the seismogenic source which fills the gap? Could the findings of this study offer a new tool to investigate and constraint the source parameters of historical earthquakes?

S32A-0830 1330h POSTER

Parana Basin Structure from Multi-Objective Inversion of Surface Wave and Receiver Function by Competent Genetic Algorithm

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The joint inversion of receiver function and surface wave is an effective way to diminish the influences of the strong tradeoff among parameters and the different sensitivity to the model parameters in their respective inversions, but the inversion problem becomes more complex. Multi-objective problems can be much more complicated than single-objective inversion in the model selection and optimization. If objectives are involved and conflicting, models can be ordered only partially. In this case, Pareto-optimal preference should be used to select solutions. On the other hand, the inversion to get only a few optimal solutions can not deal properly with the strong tradeoff between parameters, the uncertainties in the observation, the geophysical complexities and even the incompetency of the inversion technique. The effective way is to retrieve the geophysical information statistically from many acceptable solutions, which requires more competent global algorithms. Competent genetic algorithms recently proposed are far superior to the conventional genetic algorithm and can solve hard problems quickly, reliably and accurately. In this work we used one of competent genetic algorithms, Bayesian Optimization Algorithm as the main inverse procedure. This algorithm uses Bayesian networks to draw out inherited information and can use Pareto-optimal preference in the inversion. With this algorithm, the lithospheric structure of Parana basin is inverted to fit both the observations of inter-station surface wave dispersion and receiver function.

S32A-0831 1330h POSTER

Lithospheric Velocity Structure of the Upper Rhine Graben; A new Model for the Development of Europe's Largest Continental Rift.

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The lithospheric structure of the Rhine Graben, part of the European Cenozoic Rift system (ECRIS), is studied with the help of a regional 3D teleseismic travel time tomography. Joint interpretation of the tomography, the SKS anisotropy, and a local earthquake tomographic study leads to a new model for the rifting and development of the Graben. Two seismic campaigns provided 2696 P and PKP travel time residuals of teleseismic events. The two data sets are combined and inverted together. This inversion yields detailed images of the P velocity structure of the lower crust and the lithospheric mantle down to a depth of 125 kilometers. An absence of strong low velocity anomalies in the region confirms that there is no shallow mantle diapir, this demonstrates the passive development of the rift. The observed velocity structures have an orientation 10°-20° oblique to the graben axis and are interpreted as inherited Variscan structures. These structures are thought to have played a dominant role during the Oligocene rifting of the Rhine Graben. Similar structures are known to have influenced the development of the Limagne graben (Massif Central), also part of the ECRIS. An absence of structures that are orientated parallel to the graben axis shows that the Upper Rhine Graben did not form following a traditional McKenzie or Wernicke model. A new model is presented in which strike slip movements on the Variscan structures in the lithospheric mantle are responsible for the extension in the crust. This conceptual model is supported by SKS anisotropy and helps to explain some of the features in the development of the continental rift in the overall compressive setting of the Alpine foreland.

URL: http://eost.u-strasbg.fr

S32A-0832 1330h POSTER

Structural studies beneath Honshu and Hokkaido Japan: integrating refraction studies with receiver function analysis.

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Combining land seismic, offshore seismic, and receiver function structure, allows delineation of the main structural discontinuities beneath the Japanese Islands. The location of the subducting Pacific and Philippine Sea Plates can also be discerned. The focus areas of study are beneath Hokkaido, Northern Japan and the Tokai Region, Southwest/Central Japan. Both regions have detailed offshore/onshore seismic reflection and refraction studies that have been carried out by JAMSTEC (Japanese Marine Science and Technology Center). In this study the seismic crustal study is supplemented with analysis of teleseismic events. Teleseismic data is obtained from NIED (Natural Research Institute for Earth Science and Disaster Prevention) F-net broadband network. Integrating the receiver function study with velocity structure from the seismic experiments allows determination of the depth to the Moho discontinuity and the subducting plate. The non-uniqueness of the receiver function study for shallower structure is removed by the addition of the wide-angle information. The inclusion of shear wave splitting analysis should help remove the influence of shear wave anisotropy in the model. This is a first step in construction of a more accurate 3D structural velocity model for future modeling of geologic processes and earthquake relocation for the Japanese Islands region.

S32A-0833 1330h POSTER

A Teleseismic Study Across the Iapetus Suture Zone in Ireland: ISLE - the Irish Seismic Lithospheric Experiment

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Anomalous travel time residuals were observed in southern Ireland for teleseismic P-waves from earthquakes and nuclear tests during the VARNET-96 controlled source experiment. Heterogeneities in the derived crustal structure cannot explain these so that most of the variation must originate below the crust. This present project is designed to more clearly define the extent of the P-wave residuals, and primarily to test the theory that seismic anisotropy in the sub-crustal mantle is the cause of these residuals. The experiment is designed to observe shear wave splitting, particularly of the S and SKS phases to see if anisotropic effects can be observed. Any resolved anisotropy may be due to transpressive effects resulting from the closure of the Iapetus Ocean at ca 400 Ma, or to the more recent stress history of the lithosphere. Surface waves from regional seismic events will also be studied in addition to wave attenuation. Seismic tomographic imaging with P- and S-waves will determine the 3-D structure of the crust and upper mantle. Additionally, a receiver function analysis will be undertaken to characterise seismic discontinuities at depth. Fourteen broadband seismometers from the Dublin Institute for Advanced Studies and eight short-period instruments from the GFZ Potsdam have been deployed to straddle the supposed line of the Iapetus Suture and the region of the observed P-wave travel-time anomaly. Data examples and preliminary analyses will be shown.

S32A-0834 1330h POSTER

Effects of lateral heterogeneities on receiver-function imaging: the case of subducting slab

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Signal enhancement is an important part of receiver-function imaging. One common technique is CCP (common conversion point) stacking, in which receiver-function traces are gathered based on the locations where P to S conversion occurs. The conversion locations are usually computed using a one dimensional reference velocity model. CCP stacking thus favors horizontally layered structure, and may produce an incorrect image of laterally variable and dipping structures, such as a descending slab of oceanic lithosphere. Here we present an investigation of the consequences of lateral heterogeneities on a CCP image. We chose subducting slabs as our test case for several reasons. Subducting slabs are one of the major lateral heterogeneities in tomographic images of the mantle. The large-scale ($\sim$ 100 km) geometry and physical properties of subducting slabs are reasonably well constrained from travel-time tomographic modeling, and geodynamic considerations, yet the fine features, such as the state and behavior of the oceanic-crust portion of a subducting slab, are still unclear. Such fine-scale structures are crucial to understanding material recycling, melting processes, arc volcanism, continental crust formation, and the uneven distribution of subduction zone seismicity. Water is believed to be involved in all these processes; strong P to S conversion and reflectivity are a good tracer for subsurface water, converted wave imaging thus offers the promise of providing understanding of these processes. We generated synthetic seismograms using a two-dimensional elastic wave finite-difference code. Teleseismic wavefields are approximated by an input plane-wave. In our first test cases, slabs descend from surface to the 660-km discontinuity with various dip angles (30°-60°). The thickness of the slab is assumed to be 100 km, and has a sharp upper boundary but a continuous lower boundary. P-wave velocity within the slab is set to be 2-5% higher than the surrounding mantle, and $\delta lnVs/\delta lnVp$ is fixed to be 1.5. The dipping slabs were illuminated with inputs at a range of incidence angles (20°-45°) equivalent to epicentral distances of 30 to 90 degrees, from both the ocean and back-arc sides. Wave fields generated from back-arc events are generally more complicated than those from earthquakes on the ocean side. In the low frequency (0.15 Hz) band, although images of subducting slabs can be reconstructed from the synthetic seismograms, the dip angle is incorrectly mapped by more than 10° when the CCP stacking technique is applied. It is also impossible to resolve fine structure, such as the oceanic crust, in this frequency band. Artificial structures are also found in the CCP images using back-arc events only. At high frequency, the CCP images are strongly affected by the bin size used, which in turn is directly related to receiver array spacing. A receiver spacing less than 10 km is required in order to obtain an unaliased image. Such a spacing is available in some permanent networks (e.g., the high sensitivity seismograph network, HiNet, in Japan), some PASSCAL experiments, and is possible with the flexible array component of USArray, allowing us to investigate the structural geology of the upper mantle in subduction zones.

S32A-0835 1330h POSTER

Correlation Migration of Scattered Teleseismic Body Waves With Application to the 1993 Cascadia Experiment

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We investigate the application of seismic migration, using both Born and Gaussian beam approaches, to the imaging of scattered teleseismic waves. Direct P to S conversions, as well as free surface reflected waves, are used for the imaging. Tests are initially performed using a lithospheric suture zone model similar to that constructed by Shragge et al. (2001), and ray methods are used to compute the synthetic data. Finite difference synthetics are also available for the original model of Shragge. For the case of an incident source time function which is impulsive, the migration operators image the structure with both direct P to S conversions and free surface reflected phases. Surface reflected phases have the advantage of higher imaging resolution than directly scattered waves, but also have greater contamination with other later arrivals. As a result, the stacking of different migrated phases improves the imaging results. We next apply the migration imaging operators to different auto and cross correlations of the seismic data. This avoids explicitly constructing receiver functions and allows for the use of vertical components for the imaging without a separate estimation of the incident source time function. To test the correlation migrations, we convolved the impulse response synthetics for our lithospheric suture model with observed vertical component seismograms from the 1993 Cascadia experiment. We then performed auto and cross correlations of the vertical and horizontal components of the convolved synthetic data. Migrated images of the correlated data were then obtained using different imaging conditions. It was found that seismic images can be obtained from the correlated data for the different scattered wave imaging conditions, but the images have less resolution than the impulsive data. We are now investigating different techniques for pre-whitening the correlated data to provide higher resolution of the migrated images. Nonetheless, stacking of images with different imaging conditions is still required to reduce artifacts in the correlation data images. Finally, we have obtained the unprocessed observed data from the 1993 Cascadia experiment and are using these data to test the different migration algorithms.

S32A-0836 1330h POSTER

Anomalous Deep Moho and Low S-velocities in the Lower Crust of an Early Archaean Greenstone Belt: Western Dharwar Craton, South Indian Shield

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We present a shear velocity image across the early Archaean (>3.4-3.0 Ga) granite-greenstone crust of the western Dharwar craton of the south Indian shield. We determine this image through a receiver function analysis of teleseismic waveforms recorded at six broadband seismographs deployed for a year along a 200 km long profile across the granite-greenstone belt. We analyze more than 60 high signal-to-noise ratio seismograms from each station. All stations are sited on amphibolite facies rock with ~6 kb paleo-pressure indicating about 10 km of erosion. Results from a grid search over the H-Vp/Vs domain and from a formal inversion of the receiver function waveforms reveals that the crustal thickness increases from ~35±2 km in the late Archaean terrain (~2.5 Ga) of the east Dharwar craton (SE India) to ~53±2 km in the early Archaean greenstone belt of the west Dharwar craton (SW India). We find significantly reduced S-velocity (3.2-3.4 km/s) and high Poisson's ratio (~0.3) in the lower crust of the deepest part of the greenstone belt. The anomalous deep Moho and very low-velocity, lower crustal layer in the early Archaean nucleus suggest hydrated mantle condition and subduction of ocean lithosphere at ~3.4 Ga. This is the oldest evidence known to us for plate tectonics in the Archaean.

S32A-0837 1330h POSTER

Illuminating the Socorro Magma Body from Below using Deep Teleseismic Events

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The Socorro Magma Body (SMB) is a large, sill-like magma body located ~19 km beneath Socorro, NM. The SMB was discovered in 1962, and its current areal extent ($\lesssim$5000 km^2) was mapped in 1979, using reflected phases from the local events whose hypocenters were shallower than the SMB itself. Investigating the interior of the SMB is difficult, both due to the large impedance contrast between the upper SMB and the host rock, which severely limits the energy that can be transmitted into it from above, and because of its apparent thinness. Previous work using modeling of stacked, reflected P phases from shallow microearthquakes associated with the magma body has estimated a thickness of ~130 m for the SMB, while a receiver function study obtained estimates for a thickness of 50 m and an S-wave velocity of 0.4 km/s (both with large error bounds). In this study, we attempt to better characterise the interior of the SMB using normalized amplitude spectra of teleseismic P-waves. We currently have digital waveforms of P phases from more than 30 deep (>200 km) teleseismic events collected by the local network of vertical, short period seismometers. Finite element analysis will be used to model the SMB and to find a best fit to the spectral signatures. This work is ongoing; however, preliminary results of simple modeling of the SMB using Kennett's 2-D wave propagation method shows promising similarities with the averaged spectral signature.

S32A-0838 1330h POSTER

Receiver Function Imaging of the Crustal and Uppermost Mantle Structure Beneath Southern California

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We analyzed receiver functions for 30 large events recorded on the high-sample rate channels (100 sps) of TriNet stations in the Transverse Ranges and Mojave Desert, California. Stations in Mojave Desert show a clear Moho interface around 3.8 sec (30 km depth). For stations in a line across the San Gabriel Mountains we found: (1) A mid crustal interface exists around 20-25 km. A bright spot right above this interface is imaged under Mt. Wilson, which is close to the location of the bright spot imaged from seismic reflection surveys by Fuis et al. (Geology, 2001). (2) From south to north, the Moho has a classic mountain root shape with the deepest point at 40 km at a horizontal point approximately 10 km to the south-west of the San Andreas Fault. The root is shifted to the NW relative to the topography. (3) A continuous deep shallow-dipping interface is imaged beneath the San Gabriel Mountains at depths around 80-90 km. The layer dips down to the NW. Its location indicates this layer is probably related to the subducted Farallon slab. Deep Moho is also imaged for stations in San-Bernardino Mountains, and at the junction of the Garlock and San Andreas Faults (i.e., both ends of the 'Big Bend').

S32A-0839 1330h POSTER

Imaging the Structure of the Subduction Zone Between Acapulco and Mexico City, Mexico

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The Mexican Subduction Zone exhibits a complex behavior with its dip angle varying from a steep angle at its northern end, to almost horizontal in Central Mexico, and then again to a steep angle at the southern end. A key factor in the variation is thought to be the shape and viscosity of the mantle wedge. Various earthquake location and refraction studies have mapped the slab interface and obtained velocity models along the Pacific Coast and the transect between this coast and Mexico City. In this study, we image the shape of the wedge and trace the slab using receiver functions. We analyze receiver functions from teleseismic earthquakes recorded only at six stations located between Acapulco and Mexico City. We are able to identify the converted P-to-S phase from the Moho as well as other converted phases that could be attributed to the slab. Along this profile the Moho depth varies; it is shallow closer to the coast and deeper below Mexico City. Also the slab has an initial dip angle that later becomes almost horizontal, as observed in previous work. Furthermore, the geometry of the mantle wedge is illuminated below three of the stations located in Central Mexico.

S32A-0840 1330h POSTER

Modeling of receiver functions for laterally heterogeneous structures using a 2.5D FDM

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Receiver function analysis is one of the important and popular methods for study of the crust and upper mantle structures using teleseismic waveform data. In this analysis it is often necessary to calculate synthetic waveforms for the structure models. For this purpose horizontally layered structure models have been assumed, because the response of such a simple structure model to teleseismic P wave (plane wave) can be calculated easily and accurately by a semi-analytical method such as the propagator matrix method. However, for structures with strong lateral heterogeneity such as subduction zones, it is often difficult to consider horizontally layered media for modeling the receiver functions observed above such complex structures. Full 3D modeling of seismic wave propagation is still computationally intensive. Recently, 2.5D methods for calculating 3D elastic wavefields in 2D varying media have been developed, which are an economical approach for calculating 3D wavefields, and require storage only slightly larger than those of the corresponding 2D calculations. Takenaka and Kennett (1996) proposed a 2.5D elastodynamic equation in the time domain for seismic wavefields due to obliquely incident plane waves in a 2D varying models. The azimuthal directions of the incident plane wave can be arbitrarily chosen from zero to 360 degrees. Nevertheless, the method requires only as small computation time as the 2D modeling. Takenaka and Okamoto (1997) used a finite-difference implementation of this 2.5D equation to simulate teleseismic seismograms at ocean-bottom stations for assessing the effect of sea-bottom topography. Here we apply this 2.5D finite- difference method (FDM) to modeling receiver functions for laterally heterogeneous structures. We demonstrate the efficiency of this approach with examples including a profile across a realistic model of subduction zone structure, and asses the effects of a subducting slab on the receiver function waveform observed at subduction zone.

S32A-0841 1330h POSTER

Receiver Function Analysis of the Crust and Uppermost Mantle Structure beneath Kyushu, Japan

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Kyushu is one of the typical active subduction zones where the Philippine Sea plate goes northwestward beneath the Eurasian plate. For understanding its tectonic features we studied seismic structure of the crust and uppermost mantle beneath Kyushu, Japan by use of receiver function analysis. The method of receiver function analysis uses P-to-S converted waves generated by interfaces beneath a seismometer to estimate interface depth and seismic impedance contrast. The data used for receiver function are three-component broadband records of the teleseismic events occurring in the epicentral distance of 30-100 degree observed by 17 stations in and around Kyushu. We obtained 10-80 high quality receiver functions for each station. And we applied SVD filtering to the receiver functions of multichannel for each station to emphasize the coherent

S

phases. Most of the filtered functions show the Moho-boundary phase converted from P to S. We also found the phases of negative amplitude which means the existence of low-velocity layers in the crust and uppermost mantle. We applied the receiver function inversion using GA to estimate the detailed velocity structures beneath the stations. For estimating the both of shallow and deep structures with high accuracy we applied a new approach by separately using the high-frequency and low-frequency receiver functions. After calculating the receiver function inversion for each station, we estimated the three-dimensional velocity structures beneath Kyushu by using a migration technique. The results reveal the followings. (1) The depths of the Moho beneath Kyushu are 25-35 km. The Moho of western Kyushu in backarc tends to be shallower, whereas the Moho of northeastern Kyushu and western Chugoku which locate at the junction of the Southwest Japan Arc and the Ryukyu Arc are deeper. The Moho depths beneath the active volcanoes tends to be slightly deeper. (2) The top of the subducting Philippine Sea plate is imaged clearly in the range of depth from 40 to 70 km beneath eastern Kyushu. (3) Low velocity layers are visible at the crust and uppermost mantle beneath the active volcanoes in Kyushu; for instance, at the upper crust under northern Kuju and eastern Aso volcanos, at the lower crust and uppermost mantle under western Aso volcano, and at the upper crust and uppermost mantle near Sakurajima volcano. (4) A low velocity layer is visible in the uppermost mantle beneath Fukuejima island in the western Kyushu. It may show the partially melting by the mantle upwelling in the backarc of Kyushu.

S32A-0842 1330h POSTER

Azores Crustal Structure Derived From Receiver Functions

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During the last two decades efforts have been put together to understand the processes responsible for the Azores plateau formation. The geodynamics of this plateau, located at the triple junction between America, Africa and European plates, is dominated by the tectonics of the triple junction and by hotspot activity. But, the relationship between islands volcanism and a possible plume beneath the Azores is still not well understood and the triple junction exact location is also under debate. From October 2000 to September 2002, temporary broadband seismic stations have been deployed in the Azores archipelago in the framework of the COSEA Memoradum of Understanding. These broadband data have been used to compute receiver functions and estimate the crustal structure beneath the islands. Radial receiver functions where analyzed by both inverse and forward modeling in order to obtain 1-D S-wave profile. Crustal receiver functions exhibit local effects and the stations can be separated into 2 groups. Flores and Corvo islands, that are located at the west of the ridge axis and central islands (Faial and Pico) display slow crustal S-wave velocity whereas the eastern island of Santa Maria is associated with fast crustal S-wave velocity. These results will be discussed in the Azores geodynamic context.

S32A-0843 1330h POSTER

Refining the Southern California 3D Model in the Los Angeles Area Using Seismic Waveforms

RISHENG CHU

LUPEI ZHU

A standard three-dimensional (3D) reference model is under development by the southern California Earthquake Center (SCEC) to provide realistic seismic velocity models for better simulation of ground motion from damaging earthquakes, path and site effects, and for precise location of earthquake source. In this model, P velocities of major southern California sedimentary basins (Los Angeles basin, Ventura basin, San Gabriel Valley, San Fernando Valley, Chino basin, San Bernardino Valley, and the Salton Trough) are determined from maximum burial depth and age of the sediments following certain empirical rules. S velocity and density are then derived from the P velocity. Because the velocities are indirectly determined and there are large uncertainties in those empirical rules and the input geologic parameters, it is necessary to validate and refine the 3D model using observed seismic records. In this study, we computed teleseismic receiver functions of southern California basin stations using an iterative time-domain deconvolution. P-to-S conversions from the bottom of basins were clearly identified. Their amplitudes and delays with respect to the direct P wave vary strongly with incident directions, which are presumed caused by basin geometry. We used a 4th-order 3-D finite-difference code to compute synthetic receiver functions to compare with observations. Parameters to be determined by the forward modeling include shape of the base and velocity contrast. The results will provide an independent verification and, most likely, improvement of the SCEC 3D model in the metropolitan Los Angeles region.

S32B MCC: Level 2 Wednesday 1330h

Judgment Day: Explosion Detection and Discrimination Posters *(joint with PA)*

Presiding: **C A Langston,** Center for Earthquake Research and Information, University of Memphis**; C K Saikia,** URS Group, Inc.

S32B-0844 1330h POSTER

Development of a Suite of Seismic Discriminants for Characterizing Mining Explosions in Southeastern Arizona

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Effectively monitoring a nuclear testing moratorium requires the ability to discriminate between earthquakes and explosions. At small magnitudes (below mb 3.5), it is especially crucial to further refine source characterization, distinguishing between different types of explosions, specifically mining explosions from nuclear and chemical events. The characteristics of mining explosions and their respective seismic signatures can be quite variable due to blasting procedures and source geometry. It becomes important, then, to develop a set of regional discriminants that can account for such variability and are robust, reliable, and globally transportable. To examine this problem, we initially focus on mining explosions at Morenci, Arizona. Two recent experiments (Source Phenomenology Experiments (2003) and Morenci Delay-Fired Experiments (2001)) provide ground truth information for different types of mining explosions: single-fired, delay-fired, and overlapping multiple explosions that occur in different geometric configurations and in different mine locales. Regional waveforms from Morenci illustrate a number of issues that must be taken into consideration when developing discriminants. First, high scatter due to source timing effects is seen in regional amplitudes; large, long duration shots produce smaller high frequency amplitudes as compared to smaller, shorter duration shots. This effect makes the establishment of magnitude-yield relationships for mining explosions problematic. Second, closely spaced shots ($\sim$100 m) can produce different waveforms due to source timing effects, as can shots with similar timing patterns detonated in different parts of the mine (distance ranges from 1 to 3 km).

S32B-0845 1330h POSTER

Lithospheric Structure Beneath Asia From Surface-Waves and Receiver Functions

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We report on our investigations into the seismic structure of the lithosphere in central Asia using surface waves and receiver functions. We are relying on global and regional tomographic analyses for long-period surface-wave dispersion constraints on the structure, which we supplement with short-period observations measured directly from regional signals (when available). The combination of receiver functions and surface-wave dispersion information provides a complementary joint data set under certain conditions. Particularly troublesome are stations with strong, local near-surface heterogeneity, which masks the deeper structure in the receiver function. Stations with strong lateral variations in receiver response are also a challenge when the surface-wave information is restricted to a broad local average as a result of necessary smoothing of tomographic results. We present an overview of receiver function complexity across the region using receiver functions from many permanent and temporary stations. We have surveyed receiver functions from the INDEPTH III experiment and estimated Poisson's ratio variations across the south-central Plateau using the single-station stacking method of Zhu and Kanamori [2000]. Our results are consistent with those from earlier studies. We will illustrate the combined inversion of surface-waves and receiver functions using a variety of model constraints focusing on select stations including MAKZ, KURK, BRVK, CHTO, ULN, TLY, ABKT as well as stations from the NCDSN. We will present initial shear-velocity inversions obtained using dispersion estimates extracted from Eurasian tomographic models.

URL: http://eqseis.geosc.psu.edu/˜cammon/AGUF03A

S32B-0846 1330h POSTER

Rg-Lg coupling as a Lg-wave excitation mechanism

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Regional phase Lg is predominantly comprised of shear wave energy trapped in the crust. Explosion sources are expected to be less efficient for excitation of Lg phases than earthquakes to the extent that the source can be approximated as isotropic. Shallow explosions generate relatively large surface wave Rg compared to deeper earthquakes, and Rg is readily disrupted by crustal heterogeneity. Rg energy may thus scatter into trapped crustal S-waves near the source region and contribute to low-frequency Lg wave. In this study, a finite-difference modeling plus the slowness analysis are used for investigating the above mentioned Lg-wave excitation mechanism. The method allows us to investigate near source energy partitioning in multiple domains including frequency, slowness and time. The main advantage of this method is that it can be applied at close range, before Lg is actually formed, which allows us to use very fine near source velocity model to simulate the energy partitioning process. We use a layered velocity structure as the background model and add small near source random velocity patches to the model to generate the Rg to Lg coupling. Two types of simulations are conducted, (1) a fixed shallow explosion source vs. randomness at different depths and (2) a fixed shallow randomness vs. explosion sources at different depths. The results show apparent couplings between the Rg and Lg waves at lower frequencies (0.3-1.5 Hz). A shallow source combined with shallow randomness generates the maximum Lg-wave, which is consistent with the Rg energy distribution of a shallow explosion source. The Rg energy and excited Lg energy show a near linear relationship. The numerical simulation and slowness analysis suggest that the Rg to Lg coupling is an effective excitation mechanism for low frequency Lg-waves from a shallow explosion source.

S32B-0847 1330h POSTER

Bayesian Approach to Short Period Slowness Tomography in Central Asia

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