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 (∼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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We are investigating the utility of short-period, high-resolution surface-wave slowness maps for lowering detection thresholds and allowing for discrimination of explosions and earthquakes at lower magnitudes (3.0-4.8). We focus on the region of central Asia between 69 and 108 degrees east longitude and 29 and 54 degrees north latitude. We retrieved broadband waveform data from more than 1,100 events that occurred between January 1997 and May 2002. Waveforms were obtained from four different networks comprising 13 individual stations. Using multiple-filter and phase-matched filter techniques, we measured the dispersion characteristics of the signals between 6 and 30 seconds. These Rayleigh-wave group velocity dispersion curves were used to compute high-resolution, half a degree cell size, slowness tomographic maps for each period. We adopted a Bayesian tomography method to solve the equation that relates travel-time data with the slowness structure. We used a declustering technique to minimize the effect of event clusters on the results. Our model is similar, to some extent, to the a priori model, but contains more structure and the cell size is smaller (0.5 compared to 1 degree cell size for the a priori model). The tomographic patterns correlate well with known geologic and tectonic features in the area. Accumulations of relatively young sediments across Eurasia are greater than on any other continent due to the continuing rapid uplift across much of central Asia. The short periods are primarily sensitive to upper crustal structures. The tomographic images display low velocities associated with the known sedimentary basins - Tarim, Junggar and Quaidam basins - in the area of central Asia under study. High velocities are associated with mountainous tectonic features such as the Tien Shan. We validated our maps using Rayleigh group-velocity dispersion curves for 640 events that occurred on the region of interest between January 1993 and December 1996. We analyzed group velocity residuals between the new model and the a priori model using these independent measurements. The overall refined model predictions are good. More over, they show a significant improvement at short and intermediate periods (6 to 15 s) with respect to the a priori model. The refined model also shows a 15 percent improvement in the detection of surfaces waves with respect to previous 1D models. Therefore, these improved high-resolution, short-period tomography maps can be used to lower the Ms detection thresholds to be used for construction of regional mb:Ms discriminants.

S32B-0848 1330h POSTER

A Comparative Study of Intermediate-Period Surface Waves From Kiloton-Size Mining Explosions in Northeast China and Western United States

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Kiloton size mining explosions are typically used to remove overburden or to fragment rocks for resource recovery. Large mining explosions are conducted with delays between individual charges in an array resulting in source durations as great as several seconds. The total size of the explosion, its time duration and spatial characteristics can generate short- to intermediate-period (2-20 sec) surface waves. These intermediate period surface waves provide the opportunity to constrain upper crustal shear structure and attenuation. We report on a comparative study using regional seismic data generated by mining explosions in Northeast China and Western United States. The regional surface waves from the Western US were generated by a large-scale cast blast in a Wyoming coal mine. The intermediate-period surface waves in Northeast China were generated by a mining explosion in an iron mine. Two seismic networks with STS-2 broadband seismometers were deployed around the coal-mine and close to the iron-mine at regional distances. Fundamental mode Rayleigh waves were generated by these two mining explosions and are utilized to constrain the crustal structure in each region regions. The group velocities of fundamental mode Rayleigh wave were determined by using the multiple filter analysis and refined by phase matched filtering technique. The surface wave dispersion curves covered the period range of 2 to 18 sec for the coal-mine explosion with group-velocities range from 1.3 to 3.0 km/sec and 1.5 to 10 sec from the iron-mine explosion with the group-velocities range from 2.6 to 3.3 km/sec, respectively. Station specific velocity models were determined for each station and are consistent with the known shallow crustal structure in each area.

S32B-0849 1330h POSTER

Site Effect for KNET Stations in Middle Asia: the Directional Dependence of *P*-Wave Energy From Results on Magnitude *mb* Residual

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We present results on site effects for the determination of magnitude *mb*. We collected data from teleseismic events ($30^\circ < \Delta < 80^\circ$) recorded by the Kyrgyz Digital Seismic Network (KNET) in northern Tien Shan from 1991 to 1998. Our results show *mb* residual with respect to reference data from PDE catalog has significant directional variation, from -0.1 to -0.8 unit of *mb* scale. We discuss the alternative sources of directional dependence of *P*-wave energy in terms of seismic attenuation and local bedrock topography structure beneath KNET.

S32B-0850 1330h POSTER

Investigation of crustal structure throughout Middle East, North Africa and Southern Europe using receiver functions and surface-wave dispersion

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Mapping Earth's structure remains an important, challenging problem. Although, considerable research has been devoted to map lithospheric structure with different data sets, less attention has been given to estimating Earth's structure using multiple data sets. The aim of this research is to estimate lithospheric structure of diverse tectonic environments by applying joint inversion of receiver functions and surface-wave dispersion methods to provide constraints on the character of the lithosphere (crustal velocities and thickness, crust-mantle transition velocity contrast). We included data from 49 more permanent and temporary three-component broadband seismic stations located in the research areas. We computed over 4900 receiver functions for 69 stations for the period of 1990-2003. Many of the sites have been carefully investigated by other researchers using receiver functions that provide good benchmarks for comparing our results. We first applied the thickness-Vp/Vs ratio estimation procedure of Zhu and Kanamori [2000] to estimate crustal thickness and Poisson's ratio. For most stations crustal thickness estimates are consistent with previous geophysical and or seismological work but several stations produce some differences from standard models. For the joint receiver-function surface-wave-dispersion inversions, we use localized group velocities for both Love and Rayleigh waves from tomographic analyses with a 2-degree resolution in the period of 10 to 100 seconds. We present results from the thickness-Vp/Vs stacking procedure and joint inversions for select stations.

URL: http://eqseis.geosc.psu.edu/˜cammon/ AGUF03B

S32C MCC: 3011 Wednesday 1340h

Splitting and Anisotropy II *(joint with T, MR)*

Presiding: **M D Long,** Massachusetts Institute of Technology**; S Y Schwartz,** University of California, Santa Cruz

S32C-01 1340h

Shallow Anisotropy in the Mediterranean Mantle From Surface Waves

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In this study, we advance new evidence for the existence of the Love-Rayleigh discrepancy in the Mediterranean region and provide information on the average polarization anisotropic structure of the Mediterranean mantle. Using PWI (Nolet, 1990), we analysed about 1800 Rayleigh and Love waveforms from regional events recorded at 3-component broad band seismic stations of the MIDSEA and other networks in this region. Not one of the 3-component seismograms showing both Rayleigh and Love waveforms with an acceptable quality could be fit with a single 1D isotropic model characterized by a velocity smoothly varying with depth. However, satisfactory fits for individual Rayleigh and Love waveforms could often be obtained using realistic 1D velocity models. These 1D path-average velocity structures have been used in the framework of PWI to derive 3D *S*-velocity models for the Mediterranean region. The uppermost mantle velocity structure retrieved from Rayleigh waveforms is consistently slower than velocities obtained from Love wave data. We suggest that the observed Love-Rayleigh wave incompatibility is most likely caused by radial anisotropy. However, the Love wave data are not only incompatible with the Rayleigh wave data but are also internally less compatible than the Rayleigh wave data set. This difference in internal compatibility and the non-uniqueness of tomographic inversions prevent a meaningful quantitative comparison of the 3D *SV*- and *SH*-velocity models independently derived from Rayleigh and Love wave data, respectively. Instead we study the *SH*-*SV* velocity difference necessary to fit both Love and Rayleigh data with a smoothly varying velocity model, by inverting the Love wave data relative to the 3D *SV*-velocity model EAV03 derived from the Rayleigh wave data set. This procedure leads to remaining Love data residuals that are comparable to those obtained in an independent inversion of the Love wave data and to 3D *SH*-velocity models that have more similarities with the better constrained *SV*-velocity model EAV03. Our preferred 3D *SH*-velocity model has been obtained in a strongly damped inversion towards EAV03, which ensures that it shows only the minimum deviation from EAV03 and thus the simplest anisotropic structure necessary to fit all data. Our results show that Love waves require higher velocities (about 200 m/s) compared to Rayleigh waves in the sub-Moho mantle, between 30 and 120 km depth. Deeper anisotropy could exist, but is not necessary to explain our data. We relate the observed anisotropy to lattice-preferred orientation of crystallographic axes of elastically anisotropic minerals such as olivine, as suggested, throughout the Mediterranean region, by *SKS* splitting measurements. Due to the strongly heterogeneous upper mantle structure and to the complex lateral variation of the lithosphere-asthenosphere boundary in this region, it is not possible to discriminate between frozen-in preferred orientation of olivine in the lithosphere or alignment of olivine crystals in a present-day asthenospheric flow.

S32C-02 1355h

Lateral Variations in Radial Anisotropy Down to 1200 km Depth

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