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. The resolving power of the inversion has been investigated through a series of checkerboard and other tests, which indicate that the horizontal and vertical resolving lengths of about 700 and 200 km or less in the upper 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). 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 western Pacific upper mantle.

S51B MCC: Hall C Friday 0830h

Seismic Structure in Asia Posters

Presiding: **G Ichinose,** URS Group, Inc.**; M E Pasyanos,** Lawrence Livermore National Laboratory

S51B-1039 0830h POSTER

Velocity and Q structure in and around northeast India

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We used P- and S-wave travel-times recorded by the RRLJ seismic net and those merged from the ISC catalog to relocate earthquakes and investigate the relationship between seismicity and fault lineaments. Events were relocated using the joint hypocentral determination technique. Estimates of M_L and M_d from the RRLJ and NGRI were compared with mb estimated from the USGS. The relationship between mb and M_d from regression analysis is mb = (1.486 ± 0.0149)M_d + (0.6724 ± 0.00073) and between mb and M_L is mb=(0.525 ± 0.274)M_L + (0.9313 ± 0.0013). We also measured the anelastic attenuation from Lg waves using spectral analysis for frequencies between 1 to 6 *Hz*. We examined two northeast India datasets, earthquakes recorded within 1000 *km* from the broadband station at Lhasa, China (LSA), and earthquakes recorded within 400 *km* of the short-period RRLJ local net. The frequency dependence of Lg *Q* for the LSA dataset is $Q = 42\ f^{\ 0.80}$ and for the RRLJ dataset is $Q = 37\ f^{\ 0.89}$. We inverted broadband seismograms recorded at LSA from 10 earthquakes which occurred in northeast India to estimate the depths and focal mechanisms by fitting separate waveform windows of P_{nl} and surface waves using a grid-search technique. We also estimated surface-wave group velocity dispersion between 1 and 50 seconds for six moderate-sized shallow earthquakes. We inverted the dispersion to estimate the 1-D crustal structure surrounding LSA. Synthetic seismograms were generated using these velocity models and validated with recorded data for $f < 1$ *Hz*. Some of the inverted crustal models contain a deep low-velocity zone at depth but they did not indicate influence on the full waveform synthetics, however, the low-velocity channels in the mid to upper-crust were necessary for predicting the complexity of the body and surface-waves. As expected, paths to the southeast have a thinner crust and paths to the northeast across Tibet have thicker crust.

S51B-1040 0830h POSTER

Lg Attenuation in the Tibetan Plateau

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Lg Q_0(Q at 1 Hz) in the Tibetan Plateau is estimated using data from the 1991-1992 PASSCAL Tibetan Plateau and INDEPTH experiments. The dense distribution of stations along the INDEPTH II and III profiles is particularly suited for measurements of the lateral variation of Q. Lg Q_0 is estimated in the frequency domain using a two-station method. Interstation Q_0 values from many station pairs are then used to invert for lateral changes of Lg attenuation along the profiles. In addition, a method for simultaneous inversion of source M_0, fc and path-variable Q_0 and η (the frequency dependence of Lg Q) values is applied to Lg in central Tibet. Lg Q_0 in a broad region in central Tibet is found to be 100-120 with the spectral inversion method, similar to the two-station inversion result of Xie (2002) (Lg Q_0 = 126 ± 9). Using two-station inversion, we find low Lg Q_0 values (80-110) along the INDEPTH III profile. Although there is a major difference in crustal structure between northern and southern Tibet, there is no sudden lateral change in Lg Q_0. We find regions of extremely low Lg Q_0 values in southernmost Tibet. The Lg Q_0 values from the Indus-Yarlung Suture (IYS) to 200 km north of it are very low (60-90), with the lowest Q_0 found in the vicinity of IYS (∼ 60). The crustal structure does not vary significantly north of Kangmar Dome (southern limit of the partially melted middle crust). The very low Q_0 value in southernmost Tibet is probably an effect of intrinsic attenuation and is consistent with the presence of partial melt in the middle crust where bright spots, anomalously conductive layer and a mid-crustal low velocity zone have been found. The southernmost Tibet is also characterized by high heat flow ($> 100mW/m^2$). The very high attenuation in the crust found in southernmost Tibet explains the elimination of Lg when path travels across this region. Previously suggested explanations such as an abruptly change in structure beneath the southern Tibetan Plateau boundary is insufficient for a complete blockage of the Lg signal.

Xie, J., 2002, Lg Q in the eastern Tibetan Plateau, *Bull. Seism. Soc. Am., 92*, 861-867.

S51B-1041 0830h POSTER

Seismic Structure of India from Regional Waveform Matching

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The Indian Institute of Astrophysics, the National Geophysical Research Institute, and Cambridge University have now operated broadband seismographs on the Indian Shield since 1997. We use a neighbourhood algorithm adaptive grid search procedure and reflectivity synthetics to model seismograms from regional earthquakes recorded on these seismographs, FSDN seismographs, and seismographs operated by the Indian Meteorological Department. This procedure results in 1-D path average crust and upper mantle velocity and attenuation models whose propagation characteristics closely match those of the real Earth. The portions of the regional waveform that are most influenced by shallow crust and upper mantle Earth structure are the P_{nl} and the 20–100s period surface waves. We use our adaptive grid search algorithm to match both portions of the seismograms simultaneously. We find that the structure of the Indian shield is both simple and uniform, and that both P_{nl} and the surface wave portions of most of the regional seismograms are well matched by reflectivity synthetics for a halfspace mantle (β ∼4.65 km/s) overlain by a crust with a linear gradient in shear wave velocity between 3.0–3.6 km/s at the surface and 3.8–4.2 km/s at the Moho, which is at 35–40 km depth.

S51B-1042 0830h POSTER

Measurements of Frequency Dependent Lg Attenuation in India

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The Indian Institute of Astrophysics, the National Geophysical Research Institute, and Cambridge University have operated broadband seismographs at several sites on the Indian Shield since 1997. We use seismograms from local and regional earthquakes recorded at these sites, FSDN seismographs, and seismographs operated by the Indian Meterological Department to measure the spatial decay of spectral amplitudes of the higher-mode seismic surface wave train Lg for numerous paths which provide a good average sampling of the shield and northern India. After correction for instrument response and geometrical spreading, we analyze the frequency dependency of Q by measuring the decay of Lg amplitude with epicentral distance over discrete frequency bands in the range 0.5 < f < 10.0 Hz. The average Lg Q for the Indian Peninsular shield region can be expressed as Q(f) = 850 $f^{0.61}$. This preliminary result is comparable to the apparent Q values found by Singh et al., 1999 for the Indian shield and similar to the Lg attenuation observed in eastern North America. We observe anomalous Lg amplitudes and frequency behavior that implies the presence of regional spatial variability in the crustal attenuation structure.

S51B-1043 0830h POSTER

Crustal Structure Beneath the Foreland Spur in Northeastern India

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Northeastern India, one of the most seismically active region of the globe, is wedged between the northern Indo-Tibetan collision zone and the eastern, most likely now inactive, Indo-Burman collision boundary that have jointly carved its remarkably acute angled northeastern extremity. A spur of Precambrian crystalline basement, exposed over a large area in the Shillong plateau and Mikir Hills as well as smaller outcrops in the Brahmaputra valley, is elsewhere covered by gently dipping Tertiary beds that reach prodigious thicknesses of several thousand metres in the eastern Himalayan foreland. We use broadband teleseismic data recorded at 5 sites along a 300 km long N-S profile from stations sited on this foreland spur consisting of the Shillong plateau and other basement exposures across the Brahmaputra, right up to a few Km south of the Main Central Himalayan thrust in the region, to glean the seismic characteristics of the crust underneath. Receiver Functions at the above sites show that crustal thickness under the Shillong plateau changes from about 55 km at its southern extremity at Cheerapoonji to 55 km at Barapani about 70 km north of it. Crustal thickness further north along this profile, at Gauhati and Tezpur in the Brahmaputra valley, is found to be 60 km, and the crust appears to gently dip northward reaching a thickness of 65 km in the Lesser Himalaya at Bomdila which is only a few km south of the Main Himalayan Central thrust in this region.

S51B-1044 0830h POSTER

A Pilot Earthquake Seismic Network in Bhutan: Preliminary Results

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The country of Bhutan lies in a relatively unexplored but geologically significant portion of the eastern Himalayas. Few geologists have even entered the country, yet it lies in a strategic position near the south end of the INDEPTH seismic transect in Tibet. One model for ongoing deformation in the Himalayas has been derived from observations on and southward extrapolation of the INDEPTH profile. This model attributes the high mountains to accommodation of the Tibetan plate as it pushes over bends in a crustal ramp. This model essentially calls for brittle behavior of the entire crust under Bhutan. An alternate model derived from geologic studies in Bhutan calls on the southward extrusion within a channel from mid-crustal depths under Tibet to account for the high relief. This model predicts ductile deformation and thus little mid-crustal seismicity.

We report preliminary results from a five-station network deployed as a pilot experiment to examine seismicity patterns and lithospheric structure in central and western Bhutan. The seismic stations, comprised of equipment from the PASSCAL instrument pool, were installed in January of 2002 in cooperation with the Geological Survey of Bhutan. We are currently processing 6 months of data, and have detected both local and regional events. We will locate events that have been recorded across the network, and identify the seismogenic structures in the region. Further analysis will allow for lithospheric studies, including velocity model development and receiver function and shear-wave splitting analysis. With these new results, we hope to gain insight into which deformation model, if either, is appropriate for this region of the Himalayas.

S51B-1045 0830h POSTER

A Study of the Seismicity of the Bhutan Region (1937-1998)and its Tectonic Implications

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Over the past several decades many studies have indicated the presence of a number of seismic gaps in the Himalayan collision zone. The present study area is one of such potential areas for the next great Himalayan earthquake. The absence of seismicity and tectonic deformation studies in the current area is a fundamental problem we are trying to address through ongoing research. The main objective of this study is the earthquake relocation and source parameter determination of the larger events that occurred in the Bhutan Himalayas through first motion polarity and the waveform modeling. Focal mechanisms from first motion polarities indicate that most of the faults have strike-slip motion. We performed waveform modeling for two moderate earthquakes located at 27.42° N and 89.05° E (November 19, 1980) and 27.48°N and 92.62°E (February 17, 1995). Inversion results for the 1980 and 1995 event show hypocentral depths at 100 km and 25 km, respectively. CMT solutions obtained 44 km depth for the 1980 event and 35 km for the 1995 event. The estimated moment tensor solutions reveal strike-slip motion for both the events, which is consistent with the CMT solutions. Thus unlike in the other parts of the Himalayan region where fault motion is predominantly thrust type, most of the earthquakes in Bhutan Himalaya region show strike-slip motion.

S51B-1046 0830h POSTER

Seismic Characteristics of the Southern Indian Granulite Terrane Around Kodaikanal

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The South Indian craton is bordered on the east, south, and southwest by vast stretches of granulites exposing crustal depths of 15-35 km. At least 4 provinces have been distinguished by their chronologies and exhumation histories, but little is yet known of their deeper structure to help resolve the attendant crust stabilizing processes. We use broadband teleseismic waveform data recorded at Kodaikanal (10.23°N, 77.46°E) to determine the velocity structure and anisotropic properties of the Neoproterozoic south Indian granulite crust. This appears to be a fairly representative product of the, now sundered, Pan African (550Ma) granulitic terrane stretching from Sri Lanka to Madagascar. We also compare these results with those obtained from a similar analysis for the Bangalore station on the Dharwar craton to which the granulite terrain were perhaps welded through collision. Receiver function analysis shows that the crust beneath Kodaikanal is 44 km thick and consists of a 27 km thick, Vs 3.6 km/s upper layer and a 17 km thick Vs 3.95 km/s lower layer. In contrast, the crust beneath the southern part of the Dharwar craton can be characterized in terms of a single 35-km thick, Vs 3.78 km/s layer. The average Vp/Vs ratio of the South Indian granulite crust is 1.753 (Poisson's ratio of 0.26) whereas the average Vp/Vs ratio of the Dharwar craton crust is 1.74 (Poisson's ratio of 0.25). A clear arrival time difference in Moho converted phase Ps recorded on radial and tangential components indicates that the crust of both the south Indian granulite terrain and the Dharwar craton are anisotropic. Analysis of splitting of Ps indicates that for the granulitic crust the fast-azimuth is oriented approximately in the EW direction with a time-delay of 0.25 s between the fast and slow components of the shear-waver. Beneath the southern part of the Dharwar craton the fast-azimuth is oriented approximately in the NS direction with a time-delay of about 0.2 s.

S51B-1047 0830h POSTER

Seismic Evidence for a Moderately Thick Lithosphere Beneath the Siberian Platform

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We have built a $Sv-$wavespeed tomographic model for the upper mantle beneath the Siberian platform and the surrounding regions derived from the analysis of ~15,000 fundamental and higher mode regional Rayleigh waveforms. We construct the 3D upper mantle model by first determining the 1D path-average upper mantle velocity models compatible with the observed waveforms, and then combining the 1D velocity models in a continuous tomographic inversion to obtain the local $Sv-$wavespeed at each depth. Depending on the signal-to-noise ratio, fundamental mode are analysed in the period range between 50 and 160 s while higher modes are considered up to the fourth mode in the period range between 60 and 90 s. We evaluate the horizontal and depth reliability of our model using synthetic experiments. These synthetic tests confirm that the dense path coverage and rich higher mode content allow us to achieve a horizontal resolution of a few hundred kilometers down to at least 400 km depth. The high velocity lid is about 200 km thick beneath most of the Siberian platform but may extend to ~250 km depth beneath small areas. The $Sv-$wavespeed in the seismic lid is 5-7% higher than that found at the same depth in PREM. High seismic velocities also underlie a large region west of the Siberian platform. At 250 km depth there are no significant $Sv-$wavespeed anomalies with respect to PREM except beneath the subduction zones in the northwest Pacific. Our observation of a ~200 km thick high velocity lid beneath the Siberian platform on the slow-moving Eurasian plate, similar to previous observations beneath Precambrian terrains on the fast-moving Australian plate, suggests that a moderately thick seismic lithosphere beneath Precambrian terrains may be more common than previously supposed.

S51B-1048 0830h POSTER

Coincident Deep Seismic Refraction and Reflection Studies in a Northern Segment of Southern Granulite Terrain, India

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The Southern Granulite Terrain of India is one of the few terrains in the world that has preserved Archean crust with extensive granulites, believed to be of lower-crustal origin. The region is a mosaic of high-grade granulite massifs separated by shear zones. Such a terrain provides ample opportunity to understand the nature of the deep continental crust, as well as the geological processes involved in the formation and evolution of this unusual area. A coincident deep seismic reflection and refraction/wide-angle reflection experiment was carried out along a 300-km-long transect in the Southern Granulite Terrain (SGT). The aim of the study is to provide velocity structure from refraction/wide-angle reflection data, and a reflectivity pattern from reflection data. The transect covers important geological units and tectonic elements of the region.

S51B-1049 0830h POSTER

Structure of the Tibetan Plateau and the Ordos Block

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As a consequence of its rapid uplift, the Tibetan Plateau exerts a lateral force on the adjacent crustal blocks. The Ordos Block, located NE of the plateau, is one of these blocks. The Ordos block is rigid and stable, as evidenced by the fact that there are no moderate or strong earthquakes within the block. Thus, an important question is, what happens when the active but soft Tibetan Plateau compresses the passive but solid Ordos Block? The 1920 M=8.6 Haiyuan earthquake occurred at the junction of these two blocks, thus this question is also an important one for understanding seismic hazards. To investigate this question, a 1000-km-long geophysical profile was recorded. This profile incorporated deep seismic sounding, teleseismic observation, and magnetotelluric sounding profiles. This "tri-combintion profile" is the first profile of its kind in China.

Here we present results from the interpretation of the deep seismic sounding data. The crust is well stratified into two primary parts: an upper crust and a lower crust, with interface "C" as the boundary. From NE to SW the crust gradually thickens, mainly due to increased thickness of the lower crust. At the same time, the average crustal velocity decreases and the number of reflecting interfaces becomes greater. There are strong anomalies observed, including very low-average-crustal velocities, a low-velocity layer, and complexity of the Pc and PmP waveforms. These anomalies clearly indicate the complex crustal structures in these two regions due to the strong interaction between the Tibetan Plateau and the Ordos Block.

S51B-1050 0830h POSTER

Tectonics of Central Tibet from Seismicity and Focal Mechanisms: New Results from Project INDEPTH III

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Nearly 300 local earthquake locations and 50 focal mechanisms have been determined from INDEPTH III seismic recordings. The event locations indicate significant activity associated with mapped normal and strike-slip faults, with the highest levels of seismicity corresponding to the Pumqu Xianza and Muga Purou rift systems in southern and central Tibet, respectively. Locations also indicate activity along northeast and southeast trending strike-slip faults in the northern Lhasa block and southern Qiangtang terrane. The focal mechanisms computed in this study are consistent with north-south compression and east-west extension. The majority of the focal mechanisms indicate normal and strike-slip faulting. Normal faulting is observed in many of the grabens. Left-lateral slip prevails on northeast trending strike-slip faults, while right-lateral slip prevails on strike-slip faults that trend southeast, in good agreement with regional kinematics. A few mechanisms, however, indicate thrust events, a rare occurrence in the high plateau. Most of the thrust events appear to result from bends or stepovers in strike-slip faults.

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A comprehensive examination of previously derived focal mechanisms from the Tibetan Plateau indicates an abrupt change in dominant focal mechanism type from normal faulting south of about 32° to strike-slip faulting in the central and northern plateau. This change occurs near the surface expression of the Banggong-Nujiang Suture Zone (BNSZ), which separates the Lhasa block from the Qiang Tang terrane. Some previous authors have suggested tractions on the base of the Eurasian lithosphere created by oblique subduction of Indian mantle lithosphere along the curved Himalayan Arc are the driving force behind the development of the large normal faults and rift systems of southern Tibet. In this model, the northern limit of the these normal faults, i.e. the BNSZ, could be interpreted as the northern limit of mechanical coupling between the Indian and Eurasian lithospheres. This change in focal mechanism type may also correspond with changes in shear-wave splitting parameters, Pn velocity, crustal shear-wave velocity, and upper mantle P-wave velocity estimates from INDEPTH III data. Taken together, these data are consistent with ascribing the change in tectonic regime at the surface to the decoupling of Indian lithosphere from Tibetan crust in the middle of the Tibetan plateau.

S51B-1051 0830h POSTER

A Surface Wave Dispersion Study of the Yellow Sea and Korean Peninsula

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We have performed a study of surface-wave group-velocity dispersion across the Yellow Sea and Korean Peninsula. We primarily use seismic data from stations INCN and KSAR in South Korea, BJT, MDJ, and SSE in China and INU in Japan. We measure group-velocity using multiple narrow-band filters on deconvolved displacement data. We use a conjugate gradient method to perform a high-resolution group-velocity tomography over the region. Our current results include both Love and Rayleigh wave inversions for periods from 10 to 100 seconds. There is an excellent correspondence between the group velocities and tectonic structure. Our findings indicate that short periods are sensitive to slow velocities associated with large sedimentary features such as the Yellow Sea and Bohai Bay. We find our long period Rayleigh wave inversion is sensitive to crustal thickness, such as fast velocities under the oceanic crust of the Sea of Japan and slow along inland continental crust. We also find slower velocities under portions of the Sino-Korean Paraplatform where the upper mantle has been affected by the back-arc of the subduction of the Pacific and Philippine Plates under the Eurasian continent. In contrast, we generally find fast velocities under the rest of the Cathaysian Craton. Finally, we use the group-velocity results to model the shear-velocity structure of the crust and upper mantle for a few tectonic regions. We employ a grid-search technique to simultaneously fit the Love and Rayleigh wave group-velocities over the whole period range. We are testing and refining these velocity models by waveform modeling some of the larger events using reflectivity generated synthetics.

S51B-1052 0830h POSTER

Surface Wave Tomography in Central Asia

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The improvement of broadband station coverage across most of Asia during the last years, together with the fact that this continent is the one with the most significant intracontinental seismicity, make Asia an ideal site to perform surface wave tomography. This study focuses in the region limited by longitudes 70 E and 95 E and latitudes 35 N and 50 N. We analyzed broadband waveforms from about 1,100 events from 1997 through May 2002 recorded at 13 seismic stations. These seismic records produced about 6,500 paths for which individual dispersion curves were estimated performing a multiple-filter analysis. The estimated group velocity curves have been inverted to compute group velocity maps in the period band between 5 s and 30 s. The resulting maps reveal geologic and tectonic features as never displayed before in similar studies. Our maps delineate clearly the Tien Shan between the sedimentary basins of Tarim and Jungger. More over, the results of this study will improve the resolution of the shear-velocity structure of the crust underlying this part of Asia. They will also contribute to the improvement of regional magnitude estimations, which are so important for seismic discrimination problems.

S51B-1053 0830h POSTER

Pn tomography of China

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Pn travel times are affected by crustal velocity and thickness and by mantle velocity and anisotropy, thus useful to study crustal and uppermost mantle structure and regional tectonics. We obtained over 51810 Pn travel-time picks from 5660 earthquakes and 199 stations in Chinese national and provincial earthquake bulletins, to invert for Pn velocities beneath China. Checkerboard tests suggest that the resolution is about 1 by 1 degree, but in some areas where ray coverage is dense, such as Yunnan and Sichuan, the resolution is higher than 0.5 by 0.5 degrees. Our main results are as follows. (1) Assuming crustal velocity of 6.3 km/s, the average crustal thickness of China is about 45 km and the average Pn velocity is 8.0 km/s. (2) The delay times of stations and events suggest large variations in crustal thickness. The average thickness for western China is 49 km; the average for eastern China is 39 km. Almost all stations in the eastern China have negative delays, indicating a relatively thinner crust in the east. High elevations of Tibetan Plateau and Tian Shan are associated with large positive station delays of a thicker crust. (3) The Pn velocities are high in major basins (Sichuan, Qaidam, Junggar, and western Tarim) and low in areas of active volcanoes (Tengchong) and quaternary volcanisms in northern Tibet, and the tectonically active areas of the North China Platform. (4) The Pn anisotropy appears to have a rotational pattern near the eastern margin of the Tibetan Plateau, which may be related to the deformation of the region.

S51B-1054 0830h POSTER

Crustal structure of the northern margin of the Tien Shan, China and its Tectonic Implications for the 1906 M = 7.7 Manas Earthquake

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We describe an 86-km-long, N-S-trending deep seismic reflection profile, which passes through the Urumqi depression (southern Junggar basin) of the northern Tien Shan piedmont. Two distinct anticlines beneath the northern margin of the Tien Shan are clearly imaged in the seismic section. In addition we have imaged two detachment surfaces at depths of about 10 km and about 20 km. The detachment surface at 20 km depth corresponds to the main detachment that converges with the steep angle fault (the Junggar Southern Marginal Fault) on which the M = 7.7 1906 Manas earthquake occurred. A 12-14 km thick sedimentary basin is imaged beneath the southern Junggar basin near Shihezi. The crust beneath the northern margin of the Tien Shan is about 50 km thick, and decreases beneath the Junggar basin to about 45 km thick. The image on the deep seismic reflection profile is consistent with models from seismic refraction data and Bouguer gravity anomalies in the same region. The faulting associated with the 1906 Manas earthquake can be explained in the framework of this crustal model, which suggests that both a high-angle fault and a sub-horizontal detachment surface moved during that event.

Present day micro-seismicity shows a hypocentral depth-distribution between 5 and 35 km, with a peak at 20 km. We suggest that the 1906 Manas earthquake initiated at a depth of about 20 km and propagated upwards to cause northward slip on the sub-horizontal detachments beneath the southern Junggar basin.

S51C MCC: 121 Friday 0830h

Welcome to the Machine: Advances in Seismic Waveform Simulation

Presiding: **G Nolet,** Princeton University**; I M Tibuleac,** Weston Geophysical Corporation

S51C-01 0830h

Simulation of the Planar Free Surface in Media with Near-surface Lateral Discontinuities in the 3D 4th-order Staggered-grid Finite-difference Modeling of Seismic Motion

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Recently, Kristek et al. (2002) have developed a new technique to simulate planar free surface in the 3D 4th-order staggered-grid finite-difference (FD) modeling of seismic motion. The technique directly prescribes zero values of the stress-tensor components Tzx and Tzy at the free surface (in one formulation or zero value of Tzz at the free surface in the alternative formulation), applies adjusted 4th-order FD approximations to the z-derivatives at the grid points at and below the free surface, and uses neither virtual values above the free surface nor stress imaging. Numerical tests for a homogeneous halfspace and 1D layered models against the DWN (discrete wavenumber) method proved very good accuracy (also for Rayleigh waves) and efficiency of the technique which requires not more than 6 grid spacings per wavelength in the range of epicentral distances up to 22 times the wavelength.

Because in the modeling of the earthquake ground motion material discontinuities reaching the free surface have to be included, we performed numerical tests of our technique for models with vertical and oblique material discontinuities reaching the planar free surface. We compared the synthetics with those calculated by the standard finite-element (FE) method. We used the FE method because, unlike the FD method, satisfying boundary conditions at the free surface and at internal material discontinuities poses no problem for the FE method. The numerical comparisons demonstrate level of accuracy of our technique for simulating the planar free surface in media with lateral discontinuities.

We also compare synthetics obtained using our technique with those calculated using the standard stress-imaging technique of Levander (1988).

S51C-02 0845h

Simulations of Strong Ground Motion in the Los Angeles Basin Using the Spectral-Element Method

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We use the spectral-element method (SEM) to simulate strong ground motion in the Los Angeles basin. Our basin velocity model was constructed using sonic log and stacking velocity information provided by oil industry sources. The method includes effects due to attenuation, topography and bathymetry. The basin model is embedded into the regional model of Hauksson (2000).

Our mesh honors the bottom part of the 8.5 km deep sedimentary pocket underneath downtown Los Angeles, as well as topography and bathymetry. We double the mesh twice in the vertical direction based upon a conforming doubling 'brick'. This allows us to increase the