resolved, beneath the Pilbara region we see a grading back towards faster velocities in the very North.

S31E-0818 0830h POSTER

Seismic Structure of India from Regional Waveform Matching

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We use a neighborhood adaptive grid search procedure and reflectivity synthetics to model regional distance range (500-2000 km) seismograms recorded in India and to determine the variation in the crust and uppermost mantle structure across the subcontinent. The portions of the regional waveform which are most influenced by the crust and uppermost mantle structure are the 10-100 s period Pnl and fundamental mode surface waves. We use the adaptive grid search algorithm to match both portions of the seismogram simultaneously. This procedure results in a family of 1-D path average crust and upper mantle velocity and attenuation models whose propagation characteristics closely match those of the real Earth. Our data set currently consist of ~20 seismograms whose propagation paths are primarily confined to the Ganges Basin in north India and the East Dharwar Craton of south India. The East Dharwar Craton has a simple and uniform structure consisting of a 36±2 km thick two layer crust, and an uppermost mantle with a sub-Moho velocity of 4.5 km/s. The structure of northern India is more complicated, with pronounced low velocities in the upper crustal layer due to the large sediment thicknesses in the Ganges basin.

S31E-0819 0830h POSTER

Thermal and compositional anomalies beneath the North American continent

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The determination of the temperature and composition of the mantle is still a remaining challenge. This issue has important implications in understanding the stability of continental roots and evaluating their extent. Nowadays, seismic tomography models have reached a resolution allowing their interpretation in terms of thermal and compositionnal variations. Seismic velocities are primarily sensitive to temperature perturbations but chemical perturbations can not be neglected. However, velocity models can not solely constrain both unknows. And an extra set of data is needed. In this study, density anomalies are used to constrain the structure of the upper mantle beneath North America and the Caribbean region. The velocity data consist of a new regional shear wave velocity model obtained by surface wave tomography, realised by inversion of 7700 fundamental mode Rayleigh wave phase velocity measurements in the period range 40-150 s. The density data are estimated using a relative density-to-shear velocity scaling factor computed for continents by combining regionally filtered seismic and gravity data. The mineralogical variations in the mantle are expressed in terms of the global volumic fraction of iron, the parameter which has the strongest influence on density and velocity. The inferred thermal and iron content anomalies are well constrained by the data and show an age dependence down to a depth of 230±50 km. Below the North American craton, the mantle is colder than average and depleted in iron. Maximum values are found at 100 km with $\overline{\delta T} = -440K$ and $\overline{\delta Fe} = -4\%$, relative to the average mantle. Such a compositional depletion is also reported in other geophysical studies using heatflow measurements or xenolith observations. These chemical and thermal characteristics induce opposite buoyancy forces which could explain the longevity of cratonic lithosphere. In stable continental areas, the signal is of lower amplitudes and beneath the western Cordillera, a tectonically active region, we see no significant thermal or chemical anomaly.

S31E-0820 0830h POSTER

Joint Analysis of Regional Broadband Waveforms and Travel Times for Crustal Structure Using the Genetic Algorithm

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A method is proposed to estimate crustal velocity structures using regional broadband waveforms and travel times. This method makes up for the weak point of waveform inversion that could produce distorted crustal stuructures in the case of low signal-to-noise ratio (SNR) of seismic data. Travel time data can complement waveform data in inverse problems for crustal structure, because P wave arrivals (e.g., Pg, PmP, and Pn) are generally clear in spite of low SNR. In addition, short-period seismograms that have nothing to do with broadband waveform modeling can be used to get travel time data. The genetic algorithm, a global optimization method, is adopted as a forward-modeling approach to avoid trapping in local minima in nonlinear problems. After updating the epicenter, focal depth, and focal mechanism based on the resulting crustal model, we update the model performing the forward computation again. We iterate this procedure until the synthetics from the estimated crustal model has no more improvement.

S31E-0821 0830h POSTER

Finite Difference Calculations of Banana-Doughnuts

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The development of banana-doughnut sensitivity kernels (Dahlen et al., 2000) promises improvement in tomographic imaging. However, the theory used to calculate them is not valid near the source or receiver, making them of limited use in regional tomography. We have developed sensitivity kernels that are valid in these areas using finite difference full wavefield calculations. Preliminary 2-D results confirm the results of Dahlen et al. to within several wavelengths, i.e., to within 30 km for a 0.5 Hz wave. For a 0.5 Hz plane wave, the kerenel has a total width of approximately 100 km at a depth of 200 km, illustrating their importance. Three-dimensional computations are underway.

S31F MCC: Level 2 Wednesday 0830h

Slabs and Wedges Posters *(joint with T)*

Presiding: **G A Abers,** Boston University**; K C Creager,** University of Washington

S31F-0822 0830h POSTER

Estimation of the average rate for subducting Pacific plate near Kamchatka related to earthquake deformation

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The Pacific plate moves toward the Euroasia plate at an average velocity of about 8 cm/year. This movement consists of the deformation connected with subduction zone earthquakes and with slow deformation that can be the result of both creep on the plate border and of viscous relaxation in the upper mantle. In order to know the role of slow deformation, it is need necessary to estimate the deformation caused by earthquakes. The average rate of the Pacific plate toward Euroasia related to earthquake deformation can be estimated from Harvard CMT (Centroid Moment Tensor) catalog which has information for earthquakes with Mw≥4.5 for the East Coast of Kamchatka from 1976 to the present. From these earthquakes, we chose the initial time, hypocenter position, scalar moment M0 and strike, dip and slip values. For the north, central and south parts of the Kamchatka subduction zone, we estimated the average strike and dip value for all earthquakes. The values of the strike and dip for the south and central parts respectively ranged from 204°-237° and 11°-52°. For the north part, related to the junction between the Kamchatkan and Aleutian arcs, the strike and dip ranges are very large, which can be the result of a complicated fault system. For the south and central part, we found average strike and dip values of 217° and 25° respectively. For this plane we calculated the average motion per year for each area as follows: $B=\Sigma M_{0i}/\mu ST0$, where M_{0i} = scalar seismic moment for ith earthquake, S = square of averaging, μ = shear module, T0 = time of averaging. The shear module was estimated as: $\mu = \rho C^2/3$, where C= 7km/c (velocity of P-wave), $\rho = 3$ g/cm^3, $T_0 = 20$ years. The B-value (rate of subduction related to earthquakes) was calculated as 0.9 cm/year for the south part of subduction zone and 1.4 cm/year for the central part. For the north part, we are unable to make an estimation, because it was not found the common plane (dip value) for all earthquakes.

These rate estimates don't reflect the real ratio between slow or creep deformation and deformation released by earthquakes, because of the limited time of observation. In the case of the central part of the subduction zone, however, we believe that the rate in 1.4 cm/year is realistic, because an earthquakes of M_w = 7.9 occurred in this area on December 5, 1997.

S31F-0823 0830h POSTER

Configuration of the Subducting Philippine Sea Plate and the Crustal and Upper Mantle Structure Beneath the southwestern Japan arc, Revealed by Seismic Refraction/Wide-angle Reflection Profiling

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The Nankai trough region, where the Philippine Sea Plate is subducted beneath the SW Japan arc, is a well-known seismogenic zone of interplate earthquakes. A detailed crustal and upper mantle structures of the subducted Philippine Sea Plate and the overlying SW Japan arc is inevitably important to constrain the physical process of earthquake occurrence as well as the evolution process of this margin. In the summer of 2002, we conducted an onshore-offshore seismic experiment across the SW Japan arc. In this experiment, about 2,300 seismometers were deployed on a 235-km-long onshore line with NS direction, on which 10 explosives shots were fired. Data collected from on the onshore line have high signal-to-noise ratios, from which we can easily recognize prominent wide-angle reflections from the deep crust and the subducted plate boundary.

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Analyzing these explosive data, we could obtain a detailed configuration of the subducting Philippine Sea plate and the crustal and upper mantle structure beneath the SW Japan arc. Beneath the southern edge of the land profile, the top of the subducting Philippine Sea plate is located at a depth of about 18 km with a dip angle of approximately 12 degrees. The top of the subducting plate can be traced to a depth of about 35 km. The island arc Moho is about 33 km deep beneath northeastern Shikoku Island and the crustal thickness is thinning toward the north.

S31F-0824 0830h POSTER

Seismic structure of uppermost mantle and crust beneath West Philippine Basin and Kyusyu-Palau ridge by seafloor borehole seismometer, OBS and airgun experiment

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The western Pacific area including the Philippine Sea plate is characterized by many island-arc and trench systems and back-arc basins, which are estimated to correspond to subduction of oceanic plates. The Philippine Sea plate is divided into two regions by the Kyushu-Palau Ridge running from north to south. There are the Shikoku basin and the Parece-Vela basin in the eastern part, and the West Philippine basin exists in the western part. It is important to study an uppermost mantle and crustal seismic structure of the Philippine Sea plate to consider the formation process and to estimate the development process of an island-arc and trench system. In addition, the borehole broadband seismic station (WP-1) was installed in the easternmost part of the West Philippine basin in 2001 and is in operation. To obtain the seismic structure is also important for analyses of the data retrieved from the WP-1. We conducted seismic surveys with ocean bottom seismometers (OBS), the WP-1 and controlled sources to obtain the seismic crustal structure around the WP-1 observatory March 2002, October 2002 and May 2003 using the R/V KAIREI, JAMSTEC. The total length of the profile parallel to the ridge (NS line) is about 100 km. The profile perpendicular to the ridge (EW line) has approximately 120 km long in total and crosses the ridge and the WP-1 borehole seismometer. As the controlled sources, we used a GI gun (3 liters) and Bolt 1500LL type (1500cu.in.) airguns. Number and kind of airguns differed in each experiment. Total 12 OBSs were deployed at an average interval of 10km(NS line) and 15km (EW line) for the experiments. A seismic velocity model for shallow structure is derived from using a tau-p inversion of individual OBS records. A deep structure beneath the profile is estimated by using a two-dimensional ray tracing method. The preliminary results for the NS line are obtained. P-wave velocity of the sedimentary layer is 2.7 km/s and the thickness is about 500 m. These results are consistent with the results from drilling of ODP Leg 195. The P-wave velocity of the top of the igneous layer is about 4.7km/s. The crust around the WP-1 is thought to be thinner than the typical oceanic crust.

S31F-0825 0830h POSTER

Deep seismic structure in the margin of the southwestern Yamato Basin, Japan Sea by ocean bottom seismographic experiment

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To reveal the formation process of the southwestern Yamato Basin in the Japan Sea, which is a back-arc basin in the northwestern Pacific, it is important to obtain the detailed deep seismic structure of the transition area between the Japan Island arc and the southwestern Yamato Basin. However, there are few seismic structures in the transition area of the southwestern Japan Sea. In this study, we investigate the detailed transitional structure and discuss the formation process of the southwestern Yamato Basin. This study is a part of an integrated onshore-offshore wide-angle seismic experiment conducted from the Shikoku Island to the southwestern Japan Sea in 2002. Thirty-five ocean bottom seismographs (OBSs) were deployed with a spacing of about 6 km along the offshore survey line (approximately 170 km) spanning the Oki Trough, Oki Ridge and the southwestern Yamato Basin in the southwestern Japan Sea. Seismic signals from an airgun array (12,000 cu. inch) and ten land-explosives were recorded by the OBSs. Also, multi-channel seismic (MCS) reflection data were acquired along the offshore survey line. The results indicate that the thickness of the crust beneath the southwestern Yamato Basin and the Oki Ridge is estimated approximately 13 km and 20 km, respectively. The sedimentary layer has approximately 1 to 1.5 km thick in the Basin area and approximately 0.3 km in the Ridge area. Two crustal layers are identified beneath the sedimentary layer. The upper and lower crustal layers have approximately 4 km and 8 km thick, respectively, in the Basin area, whereas those have approximately 9 km and 11 km thick, respectively, in the Ridge area. From the southwestern Yamato Basin toward the Oki Ridge, the upper crustal layer thickens steeply, however, the lower crustal layer thickens gently. This suggests that the role of the upper crustal layer seems to be different from that of the lower crustal layer during the formation of the southwestern Yamato Basin.

S31F-0826 0830h POSTER

Dense Earthquake Observation and Deep Seismic Reflection Survey in Hypocental Region of the 2000 Tottori-ken Seibu Earthquake in Japan.

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The Tottori-ken Seibu earthquake of October 6, 2000 was a large earthquake exceeding Mj 7. However, active fault was not pointed out on the existing map in hypocental region of this earthquake. This fact is very important in order to argue about the validity of predicting the magnitude of great or large earthquakes generated in the target area based on the results of earth scientific investigation. We carried out dense earthquake observation in which we installed 44 points in order to grasp the detailed form of earthquake source fault. Furthermore, we carried out seismic reflection prospecting of 3 observation lines which cross the earthquake source fault of main shock. We clarify the relevance of earthquake source fault and lineament. We interpreted S-P interval of the seismic wave obtained by earthquake observation, and carried out velocity analysis using travel time seismic tomography method. Low velocity zone was detected in the depth of about 2 km of hypocental region as a result of the analysis. The low velocity zone is distributed on earthquake source fault presumed from aftershock distribution. Generally fall in seismic wave velocity is caused by fall of rigidity. That is, it is thought that the low velocity zone was formed from destruction of the crust by fault activity. In the place where lineament and an observation line cross, two faults have been recognized in seismic reflection prospecting line-B. These faults seem to converge toward the depths. This geological structure is called flower structure, and it is characteristic underground structure formed of accumulation of lateral displacement. In this area, we were also carrying out aerial photograph interpretation and trench excavation. As a result, the geological proof that the lineaments were formed of left-lateral fault was acquired. That is, both underground structures and deformations of surface have lateral fault features. Faults recognized by seismic reflection prospecting and region crushed by the faults are located in the upper part of earthquake source fault presumed from aftershock distribution. However, the scale is too large if this crushed region was formed only by fault activity of the 2000 Tottori-ken Seibu earthquake. That is, it suggests that earthquakes with the same mechanism as the 2000 Tottori-ken Seibu earthquake occurred in this area repeatedly in the past. We calculated crustal movement when main shock occurs. The calculation technique is the stress deformation analysis which used the finite element method. We give rupture propagation of earthquake source fault as forced displacement to the elastic model of crustal structure in hypocental region. We solved process in which earthquake source fault forms lineament, based on this examination.

URL: http://criepi.denken.or.jp

S31F-0827 0830h POSTER

Could Scattering from an Accretionary Wedge Look Like a Slab?

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The existing depth imaging approaches using multichannel teleseismic receiver functions (RF) assume predominance of mode-converted waves in the P-wave coda and treat the noise as primarily caused by the surface waves. However, high-resolution RF studies of the crust and uppermost mantle utilize short periods (<3 s) at which the lithosphere is highly conducive to numerous types of guided body waves, such as the multiple PmP, Pg, and Lg. Disregarding these modes could result in misinterpreting the signal-generated noise as dipping structures within the mantle. This is particularly important in the vicinities of linear crustal structures with strong sub-Moho expressions, such as subduction zones, that should create strong and coherent slab-like noise arrivals. A synthetic example of broadside scattering within the crust in the acquisition geometry of the 1993 Cascadia teleseismic experiment shows that scattering of the primary P-wave arrivals from an accretionary wedge could produce RF arrivals close to those observed in the records.Conventional interpretations of these arrivals based on assumptions of their mantle origin would lead to images of spurious slabs with a broad range of landward dips steeper than 10 deg. Such features might be very difficult to distinguish from the true mantle structures. Raw amplitudes of the observed CASC93 arrivals decay with distance from the trench and support their scattered wave interpretation. Detailed pre-RF, pre-stack analysis is thus required for correct identification of the signal-generated noise and validation of the resulting depth images. Identification of coherent scattered events in RF records could also help locate major crustal structures, such as crustal sutures and subduction fault zones.

URL: http://w3.uwyo.edu/~seismic/ibm/ST.pdf

S31F-0828 0830h POSTER

Evidence of a Subducting Slab Beneath Taiwan From a Joint Observation of Seismic Waveforms and Travel Times

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We propose that the effects of a near-receiver slab is straightforward to observe with a seismic array. While this proposal is globally applicable, the application on data of the "Broadband Array in Taiwan for Seismology (BATS)" is significant for local studies. The Tonga-Kermadec earthquakes exhibit consistently negative travel time anomalies and reduced P wave amplitudes for stations in central Taiwan, suggesting the presence of an aseismic subducted slab. This suggestion is enhanced by the correlations of amplitude ratios with earthquake latitudes, which can be seen for station as north as 24.3^{o}(TDCB). The more reduction in amplitudes for earthquakes with more negative latitudes is consistent with the southward propagation of the "arc-continent collision". In an attempt to seek for the "equivalent planar slab", we model the joint observations of travel time anomalies and amplitude reductions for stations SSLB and TPUB, using 2-D pseudospectrum method. The probable range of slab extent to produce the observations (without corrections for station effects) of both stations is 400 km long, 4% velocity anomalies to 500 km long, 3% velocity anomalies.