these results with recent geologic and geophysical studies will attempt to answer some of these unanswered questions.

S62D-12 1635h

Deep Seismic Reflection Signature of Mafic Magmatic Underplates at the Base of Continental Crust

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Seismic reflection images of Precambrian crust in the United States are characterized by diffuse reflectivity in the lower crust and a lack of distinct reflections that mark the crust-mantle transition. By contrast, the base of the crust in extended terranes is commonly marked by pronounced sub-horizontal reflectivity in the lower crust that abruptly terminates at the Moho. Whereas this subhorizontal reflectivity is now known to be characteristic of extended regions globally, the diffuse reflectivity seen at the base of Precambrian crust is not. In fact, seismic reflection images from Canada, Scandinavia, and other Precambrian terranes usually exhibit very strong reflectivity to Moho.

Here I demonstrate that where seismic reflection records have diffuse reflectivity in the lower crust and little reflectivity to mark the Moho, seismic refraction data show that the base of the crust is comprised of a layer of mafic material with velocities greater than 7 km/s. Places where this correlation occurs include Montana, the Colorado Plateau, the southern midcontinent of the United States, north central New Mexico, and the Abitibi Belt of eastern Canada. All of these regions are associated with a period of extended Precambrian magmatism that occurred subsequent to initial assembly of the continent. I propose that the diffuse reflectivity is characteristic of regions where mafic magmas have ponded at the base of the crust, but have not penetrate it in significant volumes. Few reflections occur because impedance contrasts within the mafic layer are small. Extended terranes are also sometimes associated with a layer with velocities greater than 7 km/s. However, the observation of subhorizontal reflectivity in the lower crust of these regions suggests that the mafic magmas have penetrated the crust so that strong impedance boundaries are developed between mafic sills and surrounding felsic crust.

S71A MCC: Hall C Sunday 0830h

Tools of Seismology: Instruments, Networks, and the Internet Posters

(joint with ED)

Presiding: **S Malone,** University of Washington**; R J Willemann,** International Seismological Centre

S71A-1048 0830h POSTER

Instrument Testing and First Results From the MOBB Observatory

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The Monterey ocean bottom broadband station (MOBB) was installed on the sea floor in Monterey Bay, 40 km offshore, and at a depth of 1000m from the sea surface, in April 2002. It is a collaborative project between MBARI (Monterey Bay Aquarium Research Institute) and BSL (Berkeley Seismological Laboratory).

The ocean-bottom MOBB station currently comprises a three-component seismometer package, a current-meter, and a recording and battery package. A differential pressure gauge (DPG) with autonomous recording (e.g. Cox et al., 1984) will be deployed in the vicinity of the seismometer package during the next data recovery dive, in September 2002.

The seismic package contains a low-power (2.2W), three-component CMG-1T broadband seismometer system, built by Guralp, Inc., with a three-component 24-bit digitizer, a leveling system, and a precision clock. The seismometer package is mounted on a cylindrical titanium pressure vessel 54cm in height and 41 cm in diameter, custom built by the MBARI team and outfitted for underwater connection.

Because of the extreme sensitivity of the seismometer, air movement within the pressure vessel must be minimized. We describe the extensive testing and insulation procedures performed at BSL. Among others, the top of the pressure vessel was thermally isolated with two inches of insulating foam and reflective Mylar. The sides were then insulated with multiple layers of reflective Mylar space blanket, and the vessel was filled with argon gas.

The installation was completed during 3 dives (9-11 April, 2002), with the help of the MBARI ROV Ventana and ship Point Lobos. The site was revisited on April 22nd, to check the functioning of the system and 3Mb of data were then retrieved. The ship and ROV returned to the site two months later, on June 27th, and the data recording and battery modules were replaced, in the first of a series of such dives planned over the next 3 years.

Many regional and teleseismic earthquakes have been well recorded and the mass position signals indicate that the instruments are progressively settling. Preliminary analysis of data retrieved during the 2002 summer and fall dives will be presented. In particular, we will discuss long period background seismic noise and how it correlates with signals recorded on the current-meter and DPG, leading to possible improvements.

S71A-1049 0830h POSTER

Deployment of a Long-Term Broadband Seafloor Observatory in Monterey Bay

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MOBB (Monterey bay Ocean floor Broad Band project) is a collaborative project between the Monterey Bay Aquarium Research Institute (MBARI) and the Berkeley Seismological Laboratory (BSL). Its goal is to install and operate a permanent seafloor broadband seismic station as a first step towards extending the on-shore broadband seismic network in northern California to the seaside of the North-America/Pacific plate boundary, providing better azimuthal coverage for regional earthquake and structure studies.

The successful MOBB deployment took place 40km off shore at a water depth of 1000m during three dives on April 9-11, 2002. The seismometer was buried in a 60-cm deep caisson, which was later back filled with glass beads to stabilize the instrument. New tools, including a high-pressure water-jet excavator, were developed for the ROV Ventana to accomplish these tasks.

The ocean-bottom MOBB station currently comprises a three-component seismometer package, a current-meter, and a recording and battery package. Data recovery dives, during which the recording and battery package will be exchanged, are planned every three months for the next three years. A differential pressure gauge (DPG) (Cox et al., 1984) will be deployed as part of the recording package during the next data recovery dive in September 2002.

The station is currently recording data autonomously. Eventually, it will be linked to the planned (and recently funded) MARS (Monterey Accelerated Research System;

URL: http://www.mbari.org/mars/

) cable and provide real-time, continuous seismic data to be merged with the rest of the northern California real-time seismic system. The data are archived at the NCEDC for on-line availability, as part of the Berkeley Digital Seismic Network (BDSN).

This project follows the 1997 MOISE experiment, in which a three-component broadband system was deployed for a period of three months, 40km off shore in Monterey Bay. MOISE was a cooperative program sponsored by MBARI, UC Berkeley and the INSU, Paris, France (Stakes et al., 1998; Romanowicz et al., 1998; Stutzmann et al., 2001). During the MOISE experiment, valuable experience was gained on the technological aspects of such deployments, which contributed to the success of the present MOBB installation.

URL: http://www.seismo.berkeley.edu/seismo/monterey/

S71A-1050 0830h POSTER

Source depth dependence of micro-tsunamis recorded with ocean-bottom pressure gauges and its use for earthquake source parameter studies

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The Japan Marine Science and Technology Center (JAMSTEC) installed a deep seafloor observatory with a 240-km-long fiber optic cable south of Hokkaido, Japan in 1999. Two ocean-bottom pressure gauges on the cabled observatory were deployed at depths of 2283 m and 2248 m. The relative resolution of pressure measurements is approximately 3 Pa, which is approximately equivalent to 0.3 mm in sea level change. Micro-tsunami waves with a maximum amplitude of 4 to 6 mm were detected with the ocean-bottom pressure gauges on the cabled observatory following the January 28, 2000 earthquake (Mw 6.8) in the southern Kuril subduction zone. We model the observed micro-tsunami and estimate the focal depth and other source parameters such as fault length and slip amount using a grid searching algorithm with the least squares minimization. From these parameters, we estimate the seismic moment and stress drop. The focal depth and stress drop for the January 28, 2000 earthquake is estimated to be 50 km and 7 MPa, respectively, with possible ranges of 45 - 55 km and 4 -13 MPa. The fault length is estimated to be 15 km, with possible ranges of 10 - 20 km, which is the same as that from the aftershock distribution previously determined. The corresponding estimate for seismic moment is 2.72 x 10^{19} Nm with possible ranges of 2.25 x 10^{19} - 3.18 x 10^{19} Nm. The focal depth and stress drop strongly suggest that the earthquake was an intra-slab event in the subducting Pacific plate. Standard tide gauges along the nearby coast did not record any tsunami signal. The high-precision tsunami measurements with ocean-bottom pressure gauges offshore thus make it possible to determine fault parameters of moderate-sized earthquakes in subduction zones using open-ocean tsunami waveforms.

S71A-1051 0830h POSTER

Detection of Mantle and Core P-Arrivals, and Analysis of T-waves, Recorded on Ocean Sound-Channel Hydrophones Along the Mid-Atlantic Ridge (10°-35°N)

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In February 1999, a consortium of U.S. investigators (NSF and NOAA) began long-term monitoring of Mid-Atlantic Ridge (MAR) seismicity between 15°N and 35°N. The experiment uses six NOAA/PMEL autonomous hydrophones moored within the SOFAR channel on the MAR flanks. The hydrophones record the hydroacoustic tertiary phase or *T*-wave of oceanic earthquakes from throughout the Atlantic basin. The low attenuation properties of the SOFAR channel allow for a reduction in the detection threshold (cutoff Magnitude) of MAR earthquakes from M_C=4.7 of the land-based seismic networks to M_C=3.0 with the hydrophones (Bohnenstiehl et al., 2002). The improved

detection capability of the hydrophones allows for a better view of the overall spatio-temporal patterns in MAR earthquakes (Smith et al., 2002).

To assess the waveform analysis capability of the hydrophones we present a preliminary examination of *P*- and *T*-wave arrivals recorded from 84 regional MAR and teleseismic earthquakes. The hydrophones (8 bit resolution) detect upper mantle *Pn* arrivals from regional MAR earthquakes at epicentral distances of 374-1771 km and from events as small as m_b=3.6. The *T*-waves of regional MAR events are also clearly recorded although the signals are significantly clipped when earthquakes are <400 km distant or m_b>5. A surprising result of the waveform analysis was the identification of *P*- arrivals from earthquakes outside the Atlantic Ocean basin. The hydrophones detected *P*-waves from global earthquakes with magnitudes from 5.8 to 8.3 at epicentral distances ranging from 29.6° to 167.2°. Examination of travel times suggests these teleseismic *P*-waves comprise the entire suite of body-wave arrivals from direct mantle *P*- to outer and inner core reflected/refracted phases. These global *P*- amplitudes also exhibit the typical solid-earth wavefield phenomena of a *P*- shadow zone and caustic at a Δ=142°. There is an apparent 2-second delay in expected P- arrival times at the hydrophones consistent with acoustic conversion of seismic phases at the seafloor interface and propagation through the water-column.

One goal of this study is to use the regional *P*- arrivals to estimate *Pn* velocity along the Mid-Atlantic Ridge between 10° and 35°N. The hydrophone arrays provide a unique opportunity to measure *Pn* velocities in the Atlantic Ocean upper mantle due to the difficulty in placing seismometers on the seafloor for an extended period of time. At this time, a preliminary MAR *Pn* velocity of 7.9 ± 0.1 km/sec has been estimated from only 17 *Pn* arrival times. It is anticipated that with more arrival data we will be able to quantify variations in *Pn* velocity along the east and west sides of the MAR and southward along the MAR from the Azore hotspot.

S71A-1052 0830h POSTER

Ambient Seismic Noise Levels of the Seafloor Borehole Broadband Seismic Observatories in the Northwestern Pacific

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In 2000 and 2001, the seafloor borehole seismological observatories WP-1 and WP-2 in the northwestern Pacific were successfully installed. The WP-1 site is in the west Philippine Basin west of the Kyushu-Palau Ridge. The WP-2 observatory is situated on a normal oceanic Mesozoic crust in the northwestern Pacific Basin. Both the observatories fill important observational gaps, since no other land site can replace this site.

Each observatory has two identical broadband seismometers (Guralp, CMG-1T), which are cemented, near the bottom of the hole. All the necessary power for the WP-1 is supplied from the Lithium Battery System with a capacity of 5.2 kAh. For the WP-2 observatory, the Sea Water Battery (SWB) System mainly supplies the power to the system. Additional lithium batteries were used as a backup system. Both seismometers are operational, but we are operating only one seismometer for both the observatories to reduce the consuming power of the system.

The WP-2 observatory was activated in October 2000 using an ROV KAIKO. In August 2001, the KAIKO re-visited the WP-2 site. From the first observation, we obtained about three-months continuous data (Oct. 29th, 2000 - Jan. 27th, 2001). The KAIKO visited the WP-2 site again in June 2002 and approximately eleven-months continuous data (Aug. 3rd, 2001 - Jun. 29th, 2002) were retrieved for second observation period. The KAIKO also recovered the monitoring data for the SWB system. It was confirmed that the SWB system continued working for almost one year. The observation at the WP-1 was started from March 2002. We now have the preliminary data (about 20 minutes long) from during the ROV dive for the activation. A re-visit of the WP-1 site is planned in October 2002.

The long-term variations of broadband seismic noise spectra (3mHz - 10 Hz) in the northwestern Pacific Basin were revealed. The noise level above 10 s is stable all the year round. The vertical component of the WP-2 has the noise level about -145 db (re: 1 m**2/s**4/Hz). The noise level of the horizontal component in the WP-2 is lower than that of the vertical component (-160 db above 100 s). Because there is a possibility that this vertical sensor has damage, we activated the alternative seismometer and shut down the sensor that had been used during the previous ROV visit. Due to the low seismic noise environment, many events were recorded in the records. It is found that the noise level of the vertical sensor at the WP-1 reaches -180 db between 10 s and 100 s from the preliminary data.

S71A-1053 0830h POSTER

Low Magnitude Detection Thresholds for Ocean-Bottom Recording Including Results on Quieting Oceanic Borehole Seismic Data.

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The Ocean Seismic Network Pilot Experiment, conducted February- June 1998, comprises earthquake data collected on 3-component seismometers from three ocean-bottom sensors, located 1) on the seafloor, 2) buried in sediment and 3) in a borehole, and from five Hawaiian Island stations. Threshold detection magnitudes for P-, S- and Rayleigh wave arrivals were calculated to compare the results.

Our results show that the borehole seismometer exhibited noise levels similar to Hawaiian Island stations and produced high quality high and low frequency body and surface wave data. Shallow burial of the seismometer in the sediments had no effect on higher frequencies, but significantly reduced low frequency noise levels so that data for S and Rayleigh waves were of high quality. In fact, the buried seismometer was characterized by the lowest noise levels at very low frequencies (< 20 mHz; Collins et al., 2001). Low-frequency noise (< 40 mHz) was present on the horizontal components of the borehole instrument, and subsequent tests have found that the noise can be eliminated by placing glass beads around the sonde in the borehole. There are two possible candidates for this noise- either flow/convection in the borehole or poor clamping of the instrument to the borehole, but further testing is needed to verify. The ocean-floor seismometer was consistently noisy and the data produced were always of lower quality than any other station.

Both observed magnitudes and calculated threshold magnitudes were much lower by more than an order of magnitude than those observed in previous studies using seafloor seismometers. Results for short-period body waves in particular were much better than have been previously found for any ocean-bottom recording. The borehole instrument had a P-wave detection threshold of around magnitude 4.3, and both borehole and buried instruments had S- and Rayleigh wave threshold magnitudes of around 4.0 for teleseismic earthquakes up to 60 degrees away.

Reference: Collins, J.A., F.L. Vernon, J.A., Orcutt, R.A. Stephen, K.R. Peal, F.B. Wooding, F.N. Speiss, and J.A. Hildebrand., Broadband Seismology in the Oceans: Lessons from the Ocean Sesimic Network Pilot Experiment. Geophys. Res. Lett., 28, 49-52, 2001.

S71A-1054 0830h POSTER

Enhanced Attenuation of Spatially Uncorrelated Noise

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Spatial prediction filtering attenuates random noise uncorrelated from trace to trace. Linear events are predictable and they are kept. The prediction is formulated as a least-squares problem in either the *t-x* or the *f-x* domain. The methods are casually known as "*t-x* decon" and "*f-x* decon". Besides the signal, they pass spuriously coherent noise patterns. Adding the results of the two methods boosts the signal-to-noise ratio and causes the noise patterns to interfere, destroying their coherency and rendering them vulnerable to a new filtering pass of either *f-x* or *t-x* decon. Spatially uncorrelated noise is absent in the result of filtering again the sum of the two filtering results.

URL: http://sepwww.stanford.edu/sep/nick/research/stanford/noise

S71A-1055 0830h POSTER

Broadband Seismic Noise Analysis of the Himalayan Nepal Tibet Seismic Experiment

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A background noise analysis is conducted as part of the Himalayan Nepal Tibet Seismic Experiment (HIMNT), a Passcal broadband seismic deployment involving 28 seismometers deployed in eastern Nepal and southern Tibet from Fall 2001- Fall 2002. The noise study was performed in order to assess experimental vault construction design, determine noise variations with time of day and season, to determine site characteristics and response, and to identify sites of seismometer placement for future experiments. Power Spectral Density (PSD) estimates of background noise are calculated for each component of the fifteen Streckeisen STS2 broadband seismometers deployed in Nepal, and then compared to the High Noise Model (HNM) and Low Noise Model (LNM) of Peterson (1993). All waveforms from designated day and night local time windows for twenty-one day time periods are included in the calculation without parsing out events. Noise levels are found to be considerably higher for the first month of the experiment (October 2001) relative to later times (January 2002). The time period needed for the site to stabilize will be investigated. Preliminary estimates from the January time period show moderate noise levels with all stations falling within the HNM and LNM bounds, except for the southern Nepal (Terai) stations, which exceed the HNM at frequencies greater than 1 Hz. Vaults in the high water table area of southern Nepal were installed in specially constructed above ground vaults. The noise characteristics of two different site designs for the Terai relative to each other and to the other stations of the array will be discussed.

URL: http://cires.colorado.edu/people/sheehan.anne/nepal_project.html

S71A-1056 0830h POSTER

The effect of noise on response spectra

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In a low to intermediate seismicity region, construction of response spectra is hampered by lack of strong-motion database. A weak-motion database may serve for the construction of response spectra in such a region. However, the use of weak ground motions can result in a serious distortion of the response spectra due to noise. This paper analyzes the effect of noise on the response spectra for small earthquakes or for large earthquakes at large distance.

To measure the effect of noise, Background noises and earthquake signals were separately simulated, then added both to form the noise-contaminated earthquake signals. Two sets of response spectra were calculated: one for pure earthquake signals and the other for noise-contaminated earthquake signals. The normalized distortion (%) of response spectra due to noise is measured by the differences between the two sets of response spectra for AA (absolute acceleration), RV (relative velocity), and RD (relative displacement), respectively. Then, they were correlated with the S/N (signal-to-noise) ratio in terms of ensemble averages over 300 simulations.

The distortion turned out to be correlated very well with the S/N ratio. Two features are worth noting when we compare the distortions of AA, RV, and RD. First, the distortion of RD is much larger than that of AA or RV - about 20 to 100 times larger for magnitude 4.5. The difference between the distortion of RD and those of the others decreases as the magnitude increases. The difference becomes negligible as the magnitude approaches 6.0. Second, the distortions of AA and RV are barely dependent on the magnitude while the distortion of RD shows a strong dependency on the magnitude as well as the S/N ratio. Consequently, the S/N ratio, by itself, can be used as a criterion to examine the ground motion quality for the calculation of AA and RV response spectra, but need be combined with the magnitude for the RD response spectra.

S71A-1057 0830h POSTER

Low Noise Results From IMS Site Surveys: A Preliminary New High-Frequency Low Noise Model

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Since the establishment of the Provisional Technical Secretariat (PTS) of the Comprehensive Nuclear-Test-Ban Treaty (CTBT) Organization, a vigorous seismic site survey program has been carried out to identify locations as necessary for International Monitoring System (IMS) primary and auxiliary seismic stations listed in Annex 1 to the Protocol to the CTBT. The IMS Seismic Section maintains for this purpose a small pool of seismic equipment comprised of Guralp CMG-3T and CMG-3ESP and Streckeisen STS-2 broadband seismometers, and Reftek and Guralp acquisition systems.

Seismic site surveys are carried out by conducting continuous measurements of ground motion at temporary installations for approximately five to seven days. Seismometer installation methods, which depend on instrument type and on local conditions, range from placement within small cement-floored subsurface vaults to near-surface burial. Data are sampled at 40 Hz. Seismic noise levels are evaluated through the analysis of power spectral density distributions. Eleven 10.5-minute-long representative de-trended and mean-removed segments each of daytime and night-time data are chosen randomly, but reviewed to avoid event contamination. Fast Fourier Transforms are calculated for the five windows in each of these segments generated using a 50% overlap for Hanning-tapered sections ∼200 s long. Instrument responses are removed.

To date, 20 site surveys for primary and auxiliary stations have been carried out by the IMS. The sites surveyed represent a variety of physical and geological environments on most continents. The lowest high frequency (>1.4 Hz) noise levels at five sites with igneous or metamorphic geologies were as much as 6 dB below the USGS New Low Noise Model (NLNM) developed by Peterson (1993). These sites were in Oman (local geology consisting of Ordovician metasediments), Egypt (Precambrian granite), Niger (early Proterozoic tonalite and granodiorite), Saudi Arabia (Precambian metasediments), and Zimbabwe (Archaean granite).

Based on a composite of the results from these five surveys, we propose a preliminary IMS Low-Noise Model (pIMS-LNM) consisting of a revision downward of Peterson's NLNM in the passband from 0.1 to about 0.7 s and an extension of Peterson's NLNM above 0.1 to 0.07 s. As these low noise results are derived from data recorded at temporary installations, improved resolution of this model will be possible when data from final installations become available.

Preliminary International Monitoring System Low Noise Model (pIMS-LNM) for periods from 0.07 to 0.70 s. Decibels are relative to ground acceleration $((m/s^2)^2/Hz)$. Values presented in (Period, dB) format. Figure in bold is from Peterson's NLNM.

[(0.07,-167.0),(0.08,-168.0),(0.09,-169.0),(0.10,-169.5),
(0.11,-170.5),(0.13,-171.0),(0.14,-171.5),(0.17,-172.0),
(0.20,-172.5),(0.25,-173.0),(0.30,-173.5),(0.40,-173.0),
(0.50,-172.0),(0.60,-171.0),(0.70,-170.0),**(0.80,-169.2)**]

Reference

Peterson, J., 1993. Observations and Modeling of Seismic Background Noise, U.S. Geological Survey Open-File Report 93-322, 47 p.

S71A-1058 0830h POSTER

A new Automatic Phase Picker for the National Earthquake Information Center

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The increasing need for rapid accurate earthquake locations for timely notification and damage assessment has placed greater demands on automatic phase picking technology. We are developing a new automatic phase picker for use by the National Earthquake Information Center (NEIC). Since the NEIC provides rapid notification for all felt earthquakes in the US and significant events worldwide, the picking algorithm must provide accurate arrival times for the wide range of waveforms generated by local, regional, and teleseismic events. The current picker applies a Short-Term-Average over Long-Term-Average algorithm (STA/LTA) to vertical-component records that have been narrow band filtered into two data streams with peaks at 1.5 Hz and 3.0 Hz. The use of this relatively high-frequency narrow-band data provides accurate arrival-time estimates. The travel-time residuals for 10,000 teleseismic P-wave picks have a spread (scaled median average deviation) of 1.3 seconds; this is similar to the spread of human made picks. Additionally, at these high-frequencies teleseismic picks are generally limited to compressional waves. This aids identification of arrival type and therefore simplifies the association of picks to events.

Although the current picker works well, plans to improve the accuracy, reliability, and detection threshold of automatic locations require the picking of secondary phases and analysis of a larger frequency band. Several previous studies have presented picking methods but few published studies test them on numerous seismograms selected from a wide range of distances and magnitudes. Published techniques include: STA/LTA, auto-regressive, cross-correlation, and neural networks. We will present comparisons of several methods and discuss their fitness for implementation on our realtime system. Preference will be given to methods that provide the most reliable and accurate earthquake locations, not necessarily those which best reproduce human picks.

S71A-1059 0830h POSTER

Automatic re-picking and re-weighting of first arrival times from the Italian Seismic Network waveforms database

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The high resolution P-wave tomography of the Italian Peninsula and surrounding regions from crustal to upper mantle depths is the aim of a joint project between INGV (Roma) and ETH (Zurich). The project is subdivided into two steps, first of which is to establish a 3D P-wave velocity model for the crust, using both passive and active seismic sources. Getting a reliable high resolution model is of fundamental importance since the 3D crustal model will be used in the second step to correct teleseismic travel times following a method successfully applied in the last years to the Alps (Waldhauser et al. 2002). In the present work we focus on the passive sources dataset (local and regional events) to complement the CSS crustal information. Our keywords being high-resolution and detailed model we followed the idea, based on the experience of previous works in this area, that a large number of high quality pickings and a high level of consistency in the dataset represent the first goals. The Italian region (Western Mediterranean) is characterized by a high rate of seismicity including important seismic sequences. Since 1988, digital recordings for about 40,000 local and regional earthquakes are available, which INGV bulletin readings have been used in previous local earthquake tomography works. To increase the sampling power and to better locate some border events we will integrate Italian National Seismic Network data with recordings from other local and regional networks. Due to the large amount of data thus collected, a manual re-picking of all first arrivals would ask for a too long time while it would not prevent from human readings errors and inconsistencies. This would partially contrast the positive effect of a high-quality pickings. To meet the quality and consistency requests, we applied an advanced automatic re-picking procedure, the MannekenPick (MP), recently developed by F. Aldersons as a fast, reliable and consistent picker. We tested the whole procedure on a subset of 700 waveforms that can be considered to be representative of the Italian seismicity recordings by the INGV seismic network. In this work we present the results of these tests and of the application of MP to INGV database in production mode. Tests and preliminary results of MP from local network data (OGS, Trieste, and ERGA, Tuscany) are included.

S71A-1060 0830h POSTER

The Global Seismographic Network

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The Global Seismographic Network (GSN) is an international scientific program to monitor the Earth and explore its interior. In 1986, the GSN started with three experimentally upgraded stations in the conterminous United States. Over the past 15 years, the GSN has grown to include 130 broadband high-fidelity stations with global coverage and real-time communication, thus reaching or surpassing many of its original design goals. To mark the development of the GSN, the IRIS Consortium and the US Geological Survey have produced a poster highlighting the architecture, instrumentation, history, and applications of this unique scientific resource.

The poster shows GSN stations superimposed on a high resolution map of the world. Five years of global seismicity is plotted to indicate plate boundaries and show areas of high earthquake activity. Poster text includes a brief history of the GSN, detailed information about each station, and a technical description of the instrumentation. Copies of the poster will be available.

S71A-1061 0830h POSTER

The effect of station density on completeness of worlwide earthquake monitoring

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Readings from well over 2000 seismic stations each year help to ensure reliability of the ISC Bulletin, but the density of reporting stations varies widely. It can be hard to distinguish between true changes in seismicity and artifacts from changes among reporting stations, especially without magnitude for some events. The capability can be characterised in a general way by the distance beyond which one must go to find stations making an secondary azimuthal gap less than 180°. Since smaller earthquakes usually can be detected only at nearer distances, the maps of this statistic suggest where smaller earthquakes are most likely to be missing from the ISC Bulletin.

Unsurprisingly, detection at teleseismic distances is required to reliably locate events in the oceans. But island stations have been effective and essential to monitor seismicity off shore from some extensive continental networks. Coverage is understandably sparse in parts of some continents where large earthquakes occur infrequently, such as eastern South America and Saharan Africa. In addition, however, reporting stations have sometimes been insufficient for good coverage in parts of western South America, northernmost Africa, and much of central Asia.

URL: http://www.isc.ac.uk

S71A-1062 0830h POSTER

Earthquake Catalog Completeness

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Complete earthquake catalogs are often required in studies of seismicity. This assessment is not simple because seismicity varies in both time and space. Several issues and problems related to estimating the completeness of earthquake catalogs will be discussed. We investigate two specific methods of analysis for completeness: (1) a method based on the assumption that the Gutenberg-Richter, or b-value, curve is linear and (2) a method that relies on the day-to-night modulation of the noise threshold. In the first method departures from a linear fit to the b-value at small magnitudes are believed to be due to missed events because of an incomplete catalog. In the second method it is assumed that the number of recorded events will exhibit a day-to-night modulation as the seismic detection threshold approaches the noise background. Both methods have implicit assumptions and limitations associated with their proper use and reliability. In particular, at low magnitudes the effects of swarms and quarry blasts must be taken into account. The completeness levels of seismic catalogs from Hokkaido, Japan and Parkfield, California will be investigated using these methods of analysis. A comparison of results shows that there may be a significant difference in the level of completeness obtained from these methods.

S71A-1063 0830h POSTER

Recent Developments in the IDA Component of the IRIS Global Seismographic Network

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The IRIS Global Seismographic Network (GSN) is leaving a period of rapid expansion to its present extent of nearly 140 stations worldwide and entering a phase in which emphasis is placed upon developing efficient operations and maintenance procedures as well as improving telemetry capabilities to the most remote GSN sites. We describe some of the efforts being made to exploit the rapid development of the Internet around the globe and how that development can be used to establish or improve data transmission from GSN sites once far less accessible. These are achieved with modest modifications to the IDA Near Real Time System (NRTS), a body of software developed at UCSD with funding from IRIS to provide GSN stations with Internet access and data request management capabilities. We also discuss how concurrent innovation in wireless technology impacts the so-called last kilometer problem, and show how new wireless devices coupled with the growing capabilities of seismic data acquisition equipment are changing how GSN stations at key sites can be reconfigured to become more accessible and reliable. Finally, we discuss the shared use of GSN facilities with cooperating organizations and how these associations can be used to reduce overall maintenance costs.

S71A-1064 0830h POSTER

Influence of Local, Regional and Teleseisic S on ISC Hypocenters

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For earthquakes from 2001 January and on, the ISC is using local, regional and teleseismic S arrival times to compute hypocenters in addition to the local, regional and teleseismic P that it has always used. S times are used with one half the weight of P times to allow for the greater variance of reported S arrival times. The hypocenters are computed using the Jeffreys-Bullen travel time tables, but without correcting for the well-known difference between baseline shifts in teleseismic P and S. The principal benefit is that local and regional S times allow the ISC to compute hypocenters where the ISC previously had to adopt a reported hypocenter, or to invert for depth where previously the ISC had to fix depth at a reported or standard value. For earthquakes recorded well enough to compute a hypocenter with a free depth using P times alone, the use of local and regional S times usually does not signifcantly change epicentres, depths or origin times. Teleseismic S is reported only infrequently, and usually only for well-recorded earthquakes where the hypocenter is already well constrained by P arrival times.

URL: http://www.isc.ac.uk

S71A-1065 0830h POSTER

The Internet Quick Report of the CISN Engineering Strong Motion Data Center

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The CISN Engineering Strong Motion Data Center (CEDC) provides data for engineering applications, ranging from the ShakeMap to distribution of the data and calculated parameters. The California Department of Conservations Strong Motion Instrumentation Program (CSMIP) in cooperation with the USGS/National Strong Motion Program (NSMP) operates the CEDC. The CEDC is currently at http://www.conservation.ca.gov/cisn-edc/, but reflecting the dual-agency nature of the EDC, it will be operating in parallel at a USGS address later in 2002.

The Internet Quick Report (IQR) is the tool used by the CEDC to rapidly disseminate strong-motion data over the Internet after major earthquakes. The IQR and the ShakeMap interact with each other with the time series plots of the IQR directly linked from the ShakeMap. Currently the CEDC is under development and is serving strong motion data for both CGS and NSMP. With the completion of the CISN Intranet and the standard protocols for exchange of strong motion data, the CEDC will assemble strong-motion data sets for the earthquake engineering community incorporating data from all CISN stations.

S71A-1066 0830h POSTER

New Tools for Quality Assessment of Modern Earthquake Catalogs: Examples From California and Japan.

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Earthquake catalogs provide a comprehensive knowledge database for studies related to seismicity, seismotectonic, earthquake physics, and hazard analysis. We introduce a set of tools and new software for improving the quality of modern catalogs of microseismicty. Surprisingly little research on detecting seismicity changes and analyzing the causes has been performed in recent years. Especially the discrimination between artificial and natural causes responsible for transients in seismicity, such as rate changes or alternations in the earthquake size distribution (b-value), often remains difficult. Thus, significant changes in reporting homogeneity are often detected only years after they occurred. We believe that our tools, used regularly and automatically in a ?real time mode?, allow addressing such problems shortly after they occurred.

Based on our experience in analyzing earthquake catalogs, and building on the groundbreaking work by Habermann in the 1980?s, we propose a recipe for earthquake catalog quality assessment: 1) Decluster as a tool to homogenize the data; 2) Identify and remove blast contamination; 3) Estimate completeness as a function of space and time; 4) Assess reporting homogeneity as a function of space and time using self-consistency and, if possible, comparison with other independent data sources. During this sequence of analysis steps, we produce a series of maps that portray for a given period the magnitude of completeness, seismicity rate changes, possible shifts and stretches in the magnitude distribution and the degree of clustering.

We apply our algorithms for quality assessment to data sets from California and Japan addressing the following questions: 1) Did the 1983 Coalinga earthquake change the rate of small events on the Parkfield segment of the San Andreas system? 2) Did the Kobe earthquake change the rate of earthquakes or the b-value in nearby volumes?

S71A-1067 0830h POSTER

Observations and simulations of rotational motions recorded by a ring laser

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The general motion of a body is uniquely specified by 3 components of displacement (those determined by classical seismometers) plus 3 components of rotation. While it is standard to observe translational motions the study of rotations had little attention, partly because rotational effects generated by earthquakes were thought to be small compared to the corresponding translational effects, and partly because no instruments existed which directly measure absolute rotations. Recently, there has been a revival of interest for rotations due to a growing body of observational evidence that, at least in some cases, rotational motions are indeed strong. At present instruments are being developed directly measuring rotational motions with respect to inertial space. Very large ring lasers are such a class of rotational seismometers, which take advantage of a frequency shift between too counter-rotating beams inside the (rotating) laser cavity. We present the basics of ring laser interferometry and show data from regional and distant earthquakes recorded by a very high sensitivity ring laser installed in Southern Germany, originally designed to monitor earth rotation. The rotational motion is compared with the recordings of a collocated broadband seismometer. We also show some preliminary numerical simulations and discuss various effects of medium heterogeneity and anisotropy on rotational motions.

S71A-1068 0830h POSTER

The SCEC Borehole Instrumentation Program

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The Uniform Building Code used in the design of structures by the engineering community places a great deal of emphasis on the average shear wave velocity in the upper 30 meters to classify sites and to assign site response correction factors. The emphasis on characterization of the near-surface properties in California, especially at sites with strong motion instrumentation, provides a wealth of new information for site response studies. Borehole instrumentation coupled with site characterization data allow for direct estimation of the effects of surface geology on seismic ground motions and the ability to calibrate and improve our physical models of soil response for different levels of ground motion.

In March of 1997 a workshop was held to discuss the initiation of a borehole instrumentation program within the Southern California Earthquake Center. Shortly after the workshop the program was approved. SCEC provided the resources for three sites in 1998, and two sites per year in 1999 and 2000. Using the SCEC resources as leverage, collaboration and cost sharing with multiple agencies and programs has produced the resources for a dozen borehole installations. Ten of these are currently in place in southern California, and 9 are providing real-time data back to the California Integrated Seismic Network (CISN). The remaining two sensors are to be deployed within the next year.

Some highlights of the SCEC borehole program include: the observations of earthquakes with magnitude as small as M1.8 to as large as M7.1 using a single strong motion accelerometer coupled with high resolution digitizers; Correlation between larger ground motions and lower shear-wave velocity; and variability over short distances in both surface and borehole observations emphasizing the importance of not only surface geology, but also shallow crustal structure.

S71A-1069 0830h POSTER

Improved Data Access From the Northern California Earthquake Data Center

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The NCEDC is a joint project of the UC Berkeley Seismological Laboratory and the USGS Menlo Park to provide a long-term archive and distribution center for geophysical data for northern California. Most data are available via the Web at http://quake.geo.berkeley.edu and research accounts are available for access to specialized datasets. Current efforts continue to expand the available datasets, enhance distribution methods, and to provide rapid access to all datasets.

The NCEDC archives continuous and event-based seismic and geophysical time-series data from the BDSN, the USGS NCSN, the UNR Seismic Network, the Parkfield HRSN, and the Calpine/Unocal Geysers network. In collaboration with the USGS, the NCEDC has archived a total of 887 channels from 139 sites of the "USGS low-frequency" geophysical network (UL), including data from strainmeters, creep meters, magnetometers, water well levels, and tiltmeters. There are 336 active continuous data channels that are updated at the NCEDC on a daily basis.

Geodetic data from the BARD network of over 40 continuously recording GPS sites are archived at the

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NCEDC in both raw and RINEX format. The NCEDC is the primary archive for survey-mode GPS and other geodetic data collected in northern California by the USGS, universities, and other agencies. All of the BARD data and GPS data archived from USGS Menlo Park surveys are now available through the GPS Seamless Archive Centers (GSAC), and by FTP directly from the NCEDC.

Virtually all time-series data at the NCEDC are now available in SEED with complete instrument responses. Assembling, verifying, and maintaining the response information for these networks is a huge task, and is accomplished through the collaborative efforts of the NCEDC and the contributing agencies.

Until recently, the NCSN waveform data were available only through research accounts and special request methods due to incomplete instrument responses. In the last year, the USGS compiled the necessary descriptions for for both historic and current NCSN instrumentation. The NCEDC and USGS jointly developed a procedure to create and maintain the hardware attributes and instrument responses at the NCEDC for the 3500 NCSN channels. As a result, the NCSN waveform data can now be distributed in SEED format.

The NCEDC provides access to waveform data through Web forms, email requests, and programming interfaces. The SeismiQuery Web interface provides information about data holdings. NetDC allows users to retrieve inventory information, instrument responses, and waveforms in SEED format. STP provides both a Web and programming interface to retrieve data in SEED or other user-friendly formats. Through the newly formed California Integrated Seismic Network, we are working with the SCEDC to provide unified access to California earthquake data.

URL: http://quake.geo.berkeley.edu

S71A-1070 0830h POSTER

Local Seismological Networks in Northern Baja California: Some Interpretation of Results.

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Since 1997, we have installed local seismological networks in northern Baja California (Reftek stations, three digital components, one to four months operation, covering areas of about 50 km x 50 km) for detailed microseismicity surveys of several fault systems in the region: Cerro Prieto, San Miguel, Agua Blanca, Sierra Juarez, and areas in between. Immediate results are location of about 1500 hypocenters, determination of about 400 focal mechanisms, and some structural information on the crust. In this presentation, we focus on: a) a summary of the spatial distribution of the hypocenters, focal mechanisms, and P and T axes; b) the role of the Ojos Negros Valley in the regional seismotectonics, and c) the existence of orthogonal alignments of epicenters not necessarily associated with mapped fault traces. Most of the activity is not clearly associated with fault traces: the exception is the SE segment of the San Miguel fault, the same one where destructive earthquakes occurred in 1954 and 1956. Most of the activity appears to be correlated with valleys (Ojos Negros, Trinidad-San Matias), or to simply occur between fault traces, or to belong to epicenter alignments of 15 km or more in length which are part of longer segments that are apparent in regional seismicity maps (SCSN and RESNOM catalogs). This regional and local alignments show an orthogonal pattern. In a simple interpretation, they could represent a very new fracture proccess in a still mostly homogeneous material, not yet expressed as fault ruptures.

All P and T axes azimuthal distributions from the various areas of study show a well defined global maximum consistent with the direction of regional stresses (about NS and EW, for P and T axes, respectively). However, the P axes are distributed on the focal sphere as an almost NS strip, particularly for the Ojos Negros Valley, indicating an extensional regime.

S71A-1071 0830h POSTER

Local Site Effects at the Nevada Seismic Array (NVAR)

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In most cases array processing techniques are based on homogeneous structure assumptions, which is not always true. The output of a frequency-wave number analysis, based on the Fourier Transform, that is often used in processing raw data, will be strongly biased if all the stations do not have the same frequency content. In spite of the evidence that individual station corrections must be applied, corrections are not widely used. Often a simple relief correction is believed to account for all the local site effects.

The goal of this study is to present and explain the anomalous amplitude variations that are recorded at the Nevada Seismic Array (NVAR). Narrow band frequency dependent amplitudes were measured for both regional and teleseismic phases. Differences in source function and attenuation account for the frequency content of different phases. Typically regional events allow observation from 0.5 to 16 Hz (0.5-1 Hz, 2-4 Hz, 4-8 Hz and 8-16 Hz) and teleseismic from 0.12 to 4 Hz (0.12-0.25 Hz, 0.25-0.5 Hz, 0.5-1 Hz, 1-2 Hz and 2-4 Hz). Although there are differences, particularly at high frequency, similar patterns are recognized for all phases. The most striking feature is the much larger amplitude exhibited by NV04 at frequencies 1-2 Hz and 2-4 Hz. Across the whole array the variation in this frequency band can be higher than a factor of 8. The amplitude variation between NV04 and NV01, stations located only five hundred meters apart can reach a factor of six. At higher frequency, 4-8 Hz and 8-16 Hz, NV09 dominates, its amplitude being occasionally more than one order of magnitude larger than the rest of the stations. No azimuth and distance dependence was found for these effects, which implies the absence of any organized dipping structure.

Taking advantage of the collocated seismic and experimental infrasound array, the seismic responses for propagating pressure waves were also analyzed. The effects are larger, possibly because of the higher frequency (shorter wavelength) of the infrasound signals. The presence of the same amplitude effects leads to the conclusion that the structure responsible for these effects is shallow, being up to a few tens of meters.

Careful geologic survey of the area revealed the presence of a Tertiary tuffaceous layer which we believe is responsible for the unusual high site amplification recorded. Although the tuffaceous layer does not outcrop close to NV04, in the vicinity of the area it was found an outcropping sequence which contained the Lunning formation (site NV01), the tuffaceous sedimentary rock probably responsible for the high amplification (Tertiary) and the Tertiary gravel (site NV04). There are reasons to believe that such a sedimentary column is lying beneath NV04. Future work will identify the velocities of the geological formations and the depth of the anomalous layer.

S71A-1072 0830h POSTER

Reliably Powering Remote Seismic Stations in a Harsh Environment

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Three decades of experience in the operation of remote seismic stations in Alaska has demonstrated the need for reliable power systems in a harsh arctic environment. Legacy remote power systems have included Edison Aircells, a primary battery; Gel Cells, a secondary (rechargeable battery) and photovoltaic panels; wind generators; and propane TEG (thermal electric generators). The most reliable were the primary battery system but they were expensive, needed replacement every year and increasingly became a hazardous waste disposal problem. We have combined several of these power technologies to provide reliable, cost effective power for our current generation of analog and digital remotely powered seismic stations in Alaska with the use of a power controller. The features of the power controller are: to provide redundant power system control, solar panel voltage regulation, secondary battery charge regulation, state-of-heath output, and a primary battery fuel gauge. Results of operations are presented.

S71A-1073 0830h POSTER

CISN Display - Reliable Delivery of Real-time Earthquake Information, Including Rapid Notification and ShakeMap to Critical End Users

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The California Integrated Seismic Network (CISN) Display is part of a Web-enabled earthquake notification system alerting users in near real-time of seismicity, and also valuable geophysical information following a large earthquake. It will replace the Caltech/USGS Broadcast of Earthquakes (CUBE) and Rapid Earthquake Data Integration (REDI) Display as the principal means of delivering graphical earthquake information to users at emergency operations centers, and other organizations. Features distinguishing the CISN Display from other GUI tools are a state-full client/server relationship, a scalable message format supporting automated hyperlink creation, and a configurable platform-independent client with a GIS mapping tool; supporting the decision-making activities of critical users.

The CISN Display is the front-end of a client/server architecture known as the QuakeWatch system. It is comprised of the CISN Display (and other potential clients), message queues, server, server feeder modules, and messaging middleware, schema and generators. It is written in Java, making it platform-independent, and offering the latest in Internet technologies. QuakeWatchs object-oriented design allows components to be easily upgraded through a well-defined set of application programming interfaces (APIs).

Central to the CISN Displays role as a gateway to other earthquake products is its comprehensive XML-schema. The message model starts with the CUBE message format, but extends it by provisioning additional attributes for currently available products, and those yet to be considered. The supporting metadata in the XML-message provides the data necessary for the client to create a hyperlink and associate it with a unique event ID. Earthquake products deliverable to the CISN Display are ShakeMap, Ground Displacement, Focal Mechanisms, Rapid Notifications, OES Reports, and Earthquake Commentaries.

Leveraging the power of the XML-format, the CISN Display provides prompt access to earthquake information on the Web. The links are automatically created when product generators deliver CUBE formatted packets to a Quake Data Distribution System (QDDS) hub (new distribution methods may be used later). The feeder modules tap into the QDDS hub and convert the packets into XML-messages. These messages are forwarded to message queues, and then distributed to clients where URLs are dynamically created for these products and linked to events on the CISN Display map. The products may be downloaded out-of-band; and with the inclusion of a GIS mapping tool users can plot organizational assets on the CISN Display map and overlay them against key spectral data, such as ground accelerations. This gives Emergency Response Managers information useful in allocating limited personnel and resources after a major event.

At the heart of the systems robustness is a well-established and reliable set of communication protocols for best-effort delivery of data. For critical users a Common Object Request Broker Architecture (CORBA) state-full connection is used via a dedicated signaling channel. The system employs several CORBA methods that alert users of changes in the link status. Loss of connectivity triggers a strategy that attempts to reconnect through various physical and logical paths. Thus, by building on past application successes and proven Internet advances the CISN Display targets a specific audience by providing enhancements previously not available from other applications.

S71A-1074 0830h POSTER

Broadband Array for Regional Tectonics (BART) Research in Big Beijing Area

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North China is always known for its high seismic activity and destructive damage caused by intra-plate earthquakes. Especially around the Capital Circle, with dramatically increasing trend of urbanization, the shadow of potential seismic risk - even a moderate

earthquake may cause great social losses, urges a detailed study of the regional structure and active source under this area. On Oct 1 2001, a digital seismic network was set up and operated to monitor earthquakes in the Capital Circle Region (E38.5 41.0, N114.0 120.0), namely Big Beijing. The network contains 107 seismic stations with continuous records, including 43 broadband seismometers, 59 short-period seismometers and 5 very-broadband seismometers. Four data acquisition centers are located at Beijing, Tianjin and Shijiazhuang, which receive DDN signals from 75 stations and satellite signals from the other 32 stations. Based on this new built seismic network, a research of Broadband Array for Regional Tectonics (BART) is carried on from March this year. The primary scientific goals of BART are: to investigate the crustal and upper mantle structure under Big Beijing area; to construct a detailed 3-D model of the lithospheric structure in the study area; to relocate earthquakes using the new constructed detailed model; with the combined data of relocated earthquakes, high-resolution crustal structures, tectonics and other geophysical data, to delineate the major active tectonics and other active source and try to interpret the mechanism of intra-plate earthquake in North China. From 23 to 24, April, 6 shots with chemical charges of 2000 C 2500kg were conducted near Beijing, with 3 of them along the famous Zhangjiakou C Bohai Sea seismic belt. The distance between every 2 shots are less than 60km. In addition to 107 settled stations, 196 portable short-period seismometers were deployed in the area for these shots, and 96 of them formed a combined array of aperture of 30-40 km within the network, and the other 100 seismographs were deployed along three profiles with one of them across the Zhangjiakou-Bohai tectonic regime. Until now, thousands of records have been obtained and processed. And initial results show that, the structure in the west part of Big Beijing is different from that of East part, and this may be an indicator of the boundary of East Asia Rift.

S71B MCC: Hall C Sunday 0830h

Shake, Rattle, and Roll I: Earthquake Hazard Posters *(joint with PA)*

Presiding: **S H Hickman,** U.S. Geological Survey**; L K Fenton,** California Institute of Technology

S71B-1075 0830h POSTER

Stochastic Finite Fault Modeling of Strong Ground Motions From the 1999 Chi-Chi, Taiwan, Earthquake

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The stochastic method for simulating strong ground motion from finite faults is applied to the case of the 1999 Chi-Chi, Taiwan, earthquake. The method involves discretization of the fault plane into smaller parts (subfaults), each of which is assigned an ω^2 spectrum. The contributions from all subfaults are empirically attenuated to the observation sites and summed to produce the synthetic acceleration time history.
The method is first applied to reproduce strong-motion data recorded at 36 rock sites, located within 7-142 km from the mainshock epicenter. At this stage, the parameters of the synthetic model are calibrated to obtain the best fit between synthetics and observations. The goodness of fit is evaluated through the model bias, which is calculated as the difference between the logarithms of the observed and simulated spectra, averaged over all stations.
The calibrated model for the Chi-Chi event has a near-zero average bias in reproducing ground motions at rock sites in the frequency range from 0.1 to 20 Hz. An unusually low value is found for parameter sfact, which controls the high-frequency radiation, compared to the mean value found for Californian earthquakes. This result reflects the low-PGA character of the examined event, which physically probably means lower-than-usual slip velocities during the rupture.
The calibrated model is subsequently combined with the generic transfer functions for soil sites to simulate the soft-site recordings under the linear-response assumption. This analysis reveals possible reduction in amplification that occurred during the main shock, relative to weak-motion amplification.

S71B-1076 0830h POSTER

Seismic Hazard Increase in Intramountain Basins: the Case Study of Colfiorito, Central Italy

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During the Umbria-Marche seismic sequence (September 1997 to April 1998) two small-aperture array experiments were performed in the Colfiorito basin. The diameter of the basin is 3 km, approximately. The array sites, which are 700 m from each other, are in the middle and at the eastern edge of the basin. Aftershock recordings show a completely different behavior between the two sites. In the middle of the basin, a strong focalisation of energy is observed around 1 Hz. S-wave synchronism lasts for few seconds, then low-apparent-velocity quickly-varying-backazimuth wavetrains cross the array for minutes even at magnitudes as low as 3. The energy increase exceeds a factor of 1,000 compared with a rock reference site. Seismograms of the array at the basin edge show the same predominat frequency, approximately, but smaller amplifications and durations; the low apparent velocity even during direct S waves suggests that the incoming wave field is strongly distorted by interference at the basin edge. Persistent backazimuths from E-SE indicate that, close to the edge, the largest amplitude ground motions are composed of edge-diffracted surface waves.

An attempt is made to interpret observations in terms of source-to-receiver geometry and bedrock topography structure as inferred through seismic and geoelectrical surveys. Since weak and strong motions recorded in the basin indicate a tremendous local increase of the shaking level, the research efforts are now addressed to understand wheter the effects found in Colfiorito are a peculiarity of this basin or can be recognized as a possible common behavior of other intramountain basins.

S71B-1077 0830h POSTER

Uncertainties in Deterministic Earthquake Scenarios

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In areas of low to moderate seismicity, where the overall earthquake hazard is often dominated by a few strong earthquakes in the past, earthquake scenarios are the only way to find out more about possible consequences and impacts on society related to strong earthquakes. One of the most important drawbacks of earthquake scenarios for such areas is however the lack of data. No observational data on damage is available and the only sources of information are historical documents.

In our work we thus concentrate on the sensitivity and uncertainty of input parameters in earthquake scenarios. Using straightforward calculation techniques for deterministic earthquake scenarios we treat the variability of input parameters, such as source location, amplification of ground motion or vulnerability of buildings, with a Monte Carlo approach. The definition of ground motion is based on EMS98 (European Macroseismic Scale) intensities, which has the advantage of bypassing the discussion about linking physical ground motion parameters to damage. In addition it is a method to catch existing historic ground motion information from pre-instrumental times. Being a modern macroseismic scale, EMS98 expresses the probabilistic nature of damage distributions for any intensity, which is important for the transition from hazard to risk.

We present results of earthquake scenarios for sample areas in Basel (Switzerland), where the last stronger earthquake (epicentral intensity IX) dates back to pre-instrumental times at 1356. The scenarios are based on a microzonation study and a building inventory assessed on different levels of detail.

The general uncertainty features in our scenario modeling can be applied to other regions where long return period events dominate the overall seismic hazard.

S71B-1078 0830h POSTER

Precarious Rock Evidence for Low Ground Accelerations Associated with Normal Faults and Extensional Strike-Slip Faults

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Preliminary measurements of the quasi-static toppling acceleration of a number of precarious rocks about 5 kilometers from the San Jacinto fault south of Beaumont, California, provide upper limits on ground motions of about 0.4 g, suggesting low ground accelerations associated with the 1899 and 1918 M7 extensional strike-slip earthquakes. Similar observations of the Fort Sage Mountains precarious rocks in the Honey Lake region of northeastern California, suggest an upper limit on ground motions of about 0.2-0.3 g (Intensity VIII), whereas, the recent USGS-CDMG hazard maps predict 2%-in-50yr (5000 yr recurrence times) accelerations of about 0.8 g (Intensity XI). Recent evidence from physical and numerical models and data regressions has indicated that ground motion from extensional strike-slip earthquakes may be considerably lower than for transpressional strike-slip faults and thrust faults. Data from transpressional strike-slip and thrust earthquakes dominate the database used in most determination of regression curves for ground acceleration, and in the calculation of current probabilistic hazard maps. Therefore, estimates of ground accelerations on these seismic hazard maps may be too high for extensional regimes. Verification of these preliminary results might eventually allow reduction of the current estimates of seismic hazard from strike-slip faults in extensional regimes. This could be important for estimates of seismic hazard in cities such as San Jacinto, Hemet, El Centro, Indio, Lone Pine, and Bishop, California, and to any other cities near extensional strike-slip faults.

S71B-1079 0830h POSTER

Gravity and Magnetic Expression of the San Leandro Gabbro with Implications for the Geometry and Evolution of the Hayward Fault Zone, Northern California

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The Hayward Fault, one of the most hazardous faults in northern California, trends NNW and extends for about 90 km along the eastern margin of the San Francisco Bay region. At numerous locations along its length, distinct and elongate gravity and magnetic anomalies correlate with mapped mafic and ultramafic rocks. The most prominent of these anomalies reflects the 16-km long San Leandro gabbroic block. Inversion of magnetic and gravity data constrained with physical property measurements is used to define the subsurface extent of the San Leandro gabbro body and to speculate on its origin and relationship to the Hayward Fault Zone.

Modeling indicates that the San Leandro gabbro body is about 3 km wide, dips about 75-80o northeast, and extends to a depth of at least 6 km. One of the most striking results of the modeling, which was performed independently of seismicity data, is that accurately relocated seismicity, that extends to a depth of about 12 km, is concentrated along the western edge or stratigraphically lower bounding surface of the San Leandro gabbro. The western boundary of the San Leandro gabbro block is the base of an incomplete ophiolite sequence and represented by Late Cretaceous to early Tertiary, a low-angle roof thrust related to the tectonic wedging of the Franciscan Complex. After repeated episodes of extension and attenuation, the strike-slip Hayward Fault probably reactivated or preferentially followed this pre-existing feature in the late Tertiary.

Because earthquakes concentrate near the edge of the San Leandro gabbro but tend to avoid its interior, this massive igneous block may influence the distribution of stress. The microseismicity cluster along the western flank of the San Leandro gabbro leads us to suggest that this stressed volume may be the site of future moderate to large earthquakes. Improved understanding of the three-dimensional geometry and physical properties along the Hayward Fault will provide additional constraints on seismic hazard probability,

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