S32E-04 1645h

News from MIDSEA Seismograms on the Upper Mantle of the Eurasia-Africa Plate Boundary Region

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From an extensive study of *P* to *S* converted waves, surface waves, and literature data on crustal thickness in this region, we first mapped the depth to the Moho. Our Moho map extends from relatively well-known southern Europe into northern Africa to the south and the Atlantic ocean to the west. We interpret the western Mediterranean to have considerably extended continental crust, the central Mediterranean to have oceanic crust in the north and standard continental crust in the south, the eastern Mediterranean to have continental crust underlying a thick pile of sediments, and the Atlantic Ocean to have an anomalously thick crust and/or a very low sub-Moho *S* velocity. Mapping this highly heterogeneous crust has helped us to obtain cleaner tomographic images of upper mantle *S*-velocity structure than possible without our Moho map. In addition to well-known high-velocity subducting lithosphere, these images reveal a widespread shallow low-velocity layer beneath the Mediterranean basin that strongly varies spatially. The images also show widespread high-velocity anomalies in the transition zone beneath the Mediterranean region, which we interpret as fragments of subdcuted lithosphere. One such fragment is beneath NE Spain and possibly related to early Cenozoic subduction there. We also investigated mantle discontinuities below the Mediterranean region and find that *P* to *S* converted waves from the 660 km discontinuity are consistent with a sharp discontinuity while those for the 410 km discontinuity indicate that this discontinuity can be 20 to 30 km thick. Our preferred explanation for this anomalously thick 410 km discontinuity is that it was thickened by olivine being hydrated by about 0.05 wt %.

URL: http://www.sg.geophys.ethz.ch/midsea/

S32E-05 1700h

Tomographic modeling of the North American upper mantle

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A large amount of digital seismic data recorded at stations in North America is now available, and the Earthscope project will, over the next decade, increase the amount of data available dramatically. This large amount of high-quality data makes it possible to constrain the three-dimensional velocity structure of the North American upper mantle with a resolving wavelength of several hundred kilometers; improvements in resolution can be expected in the near future. We have collected Love and Rayleigh wave dispersion measurements (T=35–150 s) at stations of the national networks of the U.S. and Canada, as well as at the stations of several temporary networks, using the method of Ekström et al. (1997). These measurements are combined with a similar dataset of global dispersion measurements (T=35–350 s) in an inversion for 3-D, radially anisotropic, S-velocity structure under North America. This modeling follows the approach of Boschi (2002), in which a variable-resolution, global parameterization is used to allow for the simultaneous retrieval of long-wavelength structure globally and shorter-wavelength structure locally. The model we retrieve shows good correspondence with major geological features, with a narrow transition from fast to slow velocities near the edge of the North American craton and a thick ($\sim$275 km) continental root under the Canadian shield. No strong regional variations in radial anisotropy are observed. A second approach to the modeling of seismic velocity structure under the North American continent is to invert for a regional perturbation to a pre-existing global model, with appropriate corrections made for structure encountered by seismic waves along their travel paths outside of North America. Preliminary results suggest that this approach provides an effective and efficient means by which to produce and update a regional or continental-scale model. Such an approach may prove particularly useful as data from USArray begin to arrive during the coming years. In addition to a comparison of results obtained using the two approaches described here, we make a quantitative comparison of our models and previous models of the North American upper mantle (van der Lee, 2002; Godey, 2002) obtained using different datasets and modeling methods.

S32E-06 1715h

Global Travel Time Tomography Using ANSS Real Time Data

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As part of the implementation of the Advanced National Seismic System (ANSS) waveform data of a large, growing number of seismic stations from US regional networks is being received in near real time at the National Earthquake Information Center (NEIC) in Golden, CO. A very large number of these stations are only used for regional earthquake monitoring and therefore do not report routinely arrival times from teleseismic events, which could be very useful for imaging in great detail the upper mantle structure beneath the continental US. The availability of this large volume of waveform data in a single data center allows us to carry out the processing (phase picking) in an efficient and consistent manner. For this purpose we have developed a procedure that combines automatic absolute picking, followed by more accurate relative picking using waveform cross-correlation. The algorithm is automated in order to handle the expected large data flow (currently about 40 monitoring networks operate in the US for a total of 3,000 stations) but also allows for interactive quality control. In its testing phase we have processed 125 events occurred in 2002-2003 which provided 18,688 new P-wave arrival times, more than in most teleseismic experiments. We have used these new travel times in combination with a large global dataset of reprocessed ISC data to obtain a global tomographic model of P-wave velocity structure. Although the model is global, the most visible improvements are in the western US, where the data increase and station density is largest. Preliminary results show a more detailed image of the structure in the upper mantle, also due to the incorporation of regional travel times in the new global dataset. A particularly well-imaged feature is the subducted Juan de Fuca slab beneath the Pacific Northwest. The slab is sharply defined between 100 and 410 km depth, extending from the Puget Sound region through Oregon to Northern California, well south of the Mendocino triple junction. We anticipate that with the incorporation of additional networks and the processing of new events the resulting tomographic models will provide significantly improved images of the upper mantle seismic structure beneath the continental US.

S32E-07 1730h

Source and Receiver Effects on Rayleigh Waves

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Recent studies have greatly advanced knowledge of the three-dimensional structure of the upper mantle, but, up to now, the influence of source and receiver effects on the observed seismic waveforms has received little attention. In addition to the path, surface waves are also affected by source and receiver anomalous local structures and by uncertainties in the source mechanism and hypocenter coordinates. Separating each of these contributions to the seismic wavefield is a major challenge in seismic waveform tomography. We use full surface wave ray theory upon 3-D mantle model S20RTS combined with global crust model CRUST 2.0 to investigate these effects on Rayleigh waves. Since full ray theory allows one to express the seismic wavefield in terms of the product of a source term, a term due to propagation and a receiver term, it is a useful tool to study the relative influence of each of these terms. Besides, we use it in an iterative inversion procedure similar to the Harvard-CMT method to determine earthquake source parameters. We estimate that the influence of the local structure at the receiver on the vertical-component waveforms is negligible compared with the other terms. Likewise, the resulting phase perturbation due to local effects, both at the source and at the receiver, is small. However, theoretical amplitude anomalies due to the local structure at the source and to the deviation in takeoff azimuth of the ray leaving the source are more important than previously thought. These two types of anomalies have similar magnitudes and the resulting perturbation is as important as that produced by focusing and defocusing effects along the propagation path. Moreover, we investigate the impact of the ray theoretical forward modelling in characterising the seismic source of large, global events. Including the overall source anomaly into the modelling improves the fits of the theoretical seismograms to the data, and, hence, our ability to extract additional information from the available data. These effects should be taken into account in the next generations of tomography models.

S32E-08 1745h

A Lithospheric Study of Eastern Asia Using Surface Wave Dispersion

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We have continued our study of surface-wave group-velocity dispersion across Eastern Asia in the vicinity of the Korean Peninsula, Yellow Sea, and Sea of Japan. We primarily use seismic data from permanent stations in South Korea, China, Japan, Taiwan and Russia. We also use data from several IRIS PASSCAL deployments in China and North Korea. 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 Rayleigh wave inversions for periods from 10 to 100 seconds. There is an excellent correspondence between the group velocities and tectonic structure, including large sedimentary features and crustal thickness variations. At long periods ($>$ 50 sec), we find that the inversion has features associated with the subduction of the Pacific and Philippine Plates under the Eurasian continent, including the effects of the subducting slab and magmatic arc. We use the group-velocity results to model the shear-velocity structure of the crust and upper mantle across the region. We employ a grid-search technique to fit the Rayleigh wave group-velocities over the whole period range. This does a very good job at retrieving features in the crust and uppermost mantle. Deeper features in the mantle, however, are harder to model directly using this method. To resolve these features, we will be forwarding modeling the structure by constructing several models of the subduction zone. We will then be testing the various models by comparing the group velocities predicted by the models to the observed group velocities along cross-sections. Preliminary results indicate that the magmatic arc has the largest affect on the long period surface waves, with the subducting slab being a much subtler feature.

S32F MCC: 3009 Wednesday 1600h

Stress Transfer, Triggered Earthquakes, and Time-Dependent Seismic Hazard IV *(joint with G, T, NG)*

Presiding: **S A Miller,** Geophysics Institute, ETH-Hoenggerberg**; R Shcherbakov,** University of California, Davis

S32F-01 1600h

A Seismic-Wave-Induced Fluid Pressure Increase: An Alternative Hypothesis for the Strain Transient at Long Valley Caldera Following the 1992 M7.3 Landers, California Earthquake

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Microseismicity at Long Valley caldera triggered by the 1992 M7.3 Landers, California, earthquake was accompanied by a transient contractional strain change recorded by the borehole dilatometer (POPA) just outside the caldera rim. The exact mechanism of the strain transient has not been established. Within Long Valley caldera, large distant earthquakes, including the Landers earthquake, have induced fluid pressure drops in non-thermal wells and fluid pressure increases in thermal wells. At each responding well, the fluid-pressure changes have a characteristic time history that is well matched by the diffusion of an abrupt pore pressure change near, but not at, the observation well. The transient contractional strain change induced by the Landers earthquake has a similar time history, suggesting that the contractional strain signal could be due to earthquake-induced fluid pressure changes near the Devil's Postpile. This hypothesis can be evaluated using fluid pressure data collected since November, 1999, in a borehole 30 m from the strainmeter. The POPA strainmeter exhibits a seasonal signal with an amplitude of 2 - 5 x 10^{-6}, reaching peak annual extension between November and March and peak annual contraction between May and July. Fluid pressure also varies seasonally about 2 m every year, and peak contractional strain occurs within a few weeks of peak fluid pressure. The seasonal increase in fluid pressure due to spring snowmelt also coincides with increased rates of contraction at POPA each year. These data indicate that the strainmeter records contractional strain in response to increasing subsurface fluid pressure, with a ratio of approximately 1.5 x 10^{-6}/m H_2O. Comparison of the strain data with time series of snow water content at Mammoth Pass shows that snowpack loading contributes 10% or less of the seasonal variation at POPA. The strain transient induced by the Landers earthquake was approximately 0.25 x 10^{-6}, and could have been produced by a fluid pressure increase of 0.17 m, about half the size of water level changes inside Long Valley caldera induced by the same earthquake. Increasing fluid pressure compresses the relatively impermeable strainmeter and surrounding grout, producing a contractional output, which under these circumstances does not represent the undrained extensional strain in the formation. Co-located fluid pressure and strain measurements are necessary in order to understand the physical effects of seismic waves at locations of remotely triggered seismicity.

S32F-02 1615h

Strong Tidal Modulation of Earthquakes by Strong Tides

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We observe tidal triggering of shallow, thrust events by strong tidal normal stresses. The dataset consists of 9350 global earthquakes of M 5.5 or greater from 1977 to 2000 in the Harvard CMT catalog. A previous study of this dataset by Tanaka et al. (2002) using only phase information showed no significant tidal correlation over the entire catalog; however, slight tidal phase correlation was seen in some subsets of events grouped by tectonic regions and type of faulting (Tanaka et al., 2002; 2003). Other previous studies have seen, at best, a slight correlation of tectonic earthquakes with tidal phase, while most show no significant correlation. The majority of these studies only examine correlation of earthquake origin times with phase, i.e., peaks in tidal stress. Few studies include amplitude, in addition to phase, when examining tidal correlations. In this study, we examine the dependence of earthquake-tide correlation on the amplitude of tidal stress. Tidal stress is resolved into the normal and shear components acting on each of the two possible fault planes. We sort the catalog by the average of the peak stress amplitudes before and after each event. For the 1% of events with the highest averaged peak normal stress we find significant tidal correlation, with a corresponding phase near the peak extensional stress. A slight correlation was seen for shear stress, which tends to have amplitudes approximately half as large as normal stress. Tidal correlation is strongest for reverse faulting, and stronger still in the case that the shallower-dipping fault plane is assumed. Most of the high-tidal-stress events are in subduction zones near coastlines where ocean loading tends to be largest and low-angle thrust events are most common, so our final choice of the shallower-dipping fault plane is justified. We see high significance for the 20 events with highest average peak normal stress amplitude (above 2.7E+04 Pa, or 0.27 bars) and a slightly lower significance for the 40 events with average peak amplitude between 2.7E+04 Pa and 1.6E+04 Pa. These 60 events are all shallow thrust events above 25 km depth. A surprising 85% of the top 20 events and 63% of the next 40 occur in the half of the time with encouraging stress (-90° to 90° phase). In addition to the global dataset, 27,464 strike-slip events from California were found to have roughly 1-2% more events during times of encouraging tidal stress of a few hundreths of a bar. We have thus calibrated earthquake triggering over a wide range of tidal stress amplitudes. Tidal stress amplitudes required to strongly trigger earthquakes are similar to limits suggested for static and dynamic triggering of aftershocks of a few tenths of a bar. Tidal stress is static rather than dynamic, so we are better resolving conditions needed for effective trigger of earthquakes.

S32F-03 1630h

Using Seismicity Rates to Assess Coulomb Stress Transfer Models

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One of the major goals of stress transfer studies has been to calculate changes in earthquake probabilities following a moderate to large event. Previous studies have demonstrated that stress transfer models utilizing the Coulomb failure criterion are often successful in predicting where aftershocks are likely to be triggered or suppressed. However, few studies have attempted to determine if Coulomb stress-changes affect the long-term seismicity rate of the regions surrounding the causative event. In addition, most studies comparing seismicity rate and Coulomb stress have been largely qualitative. In this study the dense seismic networks of Southern California and Southwestern Japan are used to test the correlation of static Coulomb stress changes due to the 1992 Landers and 1995 Kobe earthquakes and the observed changes in seismicity rate in the regions. First, the elastic Coulomb stress change on optimally oriented faults at a specified depth is calculated. Then, seismicity rate-changes over 8-to-10-year periods before and after the main shock are determined using the z-value (Habermann, 1987). The z-value represents significance between two different means. Finally, a quantitative comparison of the changes in static (elastic) Coulomb stress and seismicity rate is made to determine the correlation between the two. In addition, it allows us to examine changes in correlation with depth, for optimal planes versus specified planes and allows us to assess variations in correlation with time to determine if inelastic stress transfer processes become important over time. Specifically, we hope to use this approach to assess the relative impacts of post-seismic relaxation, poroelastic effects, and rate and state friction on seismicity rates, and thus incorporate all of the appropriate physical processes when attempting to compute earthquake probability changes following an initial earthquake.

S32F-04 1645h

The 1997 Kagoshima (Japan) Earthquake Doublet: A Quantitative Analysis of Stress Interaction

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Understanding how the nucleation of earthquakes is affected by sudden changes in the state of stress in their immediate vicinity may provide insight into the elusive relationship between static stress changes and earthquake occurrence. As working hypothesis, we assume that if aftershocks are in part caused by stress changes from their mainshock, changes in their decay rate may reflect changes in the state of stress induced by nearby large earthquakes. The 1997 Kagoshima (Japan) earthquake doublet provides a unique opportunity to analyze this hypothesis for two moderate M6 events that occurred on adjacent faults with the epicenters located in a distance of about 5 km from each other. We map the Omori law parameters on an equally spaced grid for the time period between the two mainshocks (the learning period of 47.8 days) using four Omori law type models with increasing complexity. The best fitting model is found using the corrected Akaike Criterion Information. We then forecast the number of aftershocks for the next 50 days and compare it to the actual observed number. Uncertainties in the rate forecasts are obtained by a bootstrap approach, allowing us to compute a detailed map of the significance of the relative rate changes. We find four regions with highly significant relative rate changes, three negative and one positive, which are a consequence of the activation and deactivation of aftershock activity due to the second mainshock, respectively. While our results confirm a relative rate drop in the Western part of the aftershock sequence that is in agreement with the stress triggering hypothesis (Stein, 2003), the other changes cannot be readily explained. Because of the importance of rate changes for the evaluation of the stress triggering hypothesis as well as for rate and state friction models, we consider our quantitative analysis technique introduced here important and a step forward in the process of understanding the behavior of aftershocks.

S32F-05 1700h

Stress Evolution and Intraplate Seismicity in the Central-Eastern North America

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Intraplate earthquakes within the stable interior of the North America plate are surprisingly common, large, and poorly understood. The New Madrid Seismic Zone (NMSZ), with three large events (M=7.0-7.5) in 1811-1812, is the most prominent intraplate seismic zone within the stable North American plate. However, most of the post 1811-1812 events (M>5) occurred not within the NMSZ but in the surrounding regions. We have simulated the stress evolution in the NMSZ and surrounding regions following the 1811-1812 events in a visco-elastic finite element model. Our results show that re-accumulation of stress within the NMSZ following the 1811-1812 events is slow and lags behind that in the surrounding regions, because the released stress may be supported by the relatively strong surrounding crust. The regions with the predicted highest deviatoric stress are found in southern Illinois and eastern Arkansas, consistent with the distribution of moderately sized (M>5) earthquakes following the 1811-1812 NMSZ events. To better understand the stress evolution and intraplate seismicity in the rest of the stable North American plate, we have developed a regional visco-elastic geodynamic model and systematically investigated the impact of major lithospheric rheological changes, such as ancient rifts and lithospheric thickness variation, on the crustal stress field. Our model predicts higher deviatoric stress in the edge surrounding the North America craton than within the craton. This is consistent with the observation of most seismicity being concentrated around and not within the North America craton.

S32F-06 1715h

The Absence of Remotely Triggered Seismicity in Japan from 1997 to 2002

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Observations of increased seismicity following the Landers, Hector Mine, Izmit, and the Denali, earthquakes suggests remote seismic triggering occurs in geothermal locations as far as 3150 km. This study attempts to determine if the same effects occur in Japan, a geothermal region of high seismicity. For the period of 1997 to 2002, we searched for significant increases in the seismicity levels following earthquakes with $M_w \geq$ 6.5 at distances larger than conventionally associated with aftershocks. Additionally, we examined available waveform data in order to detect uncataloged events hidden by the coda of the mainshock. Five events had associated waveform data: March 24, 2001 Geiyo, M_w = 6.8; March 28, 2000 Volcano Islands, M_w = 7.6; July 30, 2000 Honshu, M_w = 6.5; October 6, 2000 Tottori, M_w = 6.7; and the January 28, 1999 Kuril Islands, M_w = 6.8 earthquake. Located 260 km from the Geiyo epicenter, station TKO recorded one possible triggered event within 65 km during the hour following the mainshock. However, the TKO data contains many anomalous spikes, and we are not confident the record is clear enough to differentiate small local events from noise. An ambiguous, two-day, regional seismicity increase followed the Volcano Islands event. We interpret the swarm associated with the signal as coincidental because no similar swarms occurred at the same location following Tottori or Geiyo, both of which had an order of magnitude larger shaking. Both waveforms and cataloged events indicate no triggering occurred following the Honshu, Tottori and Kuril Islands mainshocks. We do not interpret the one indefinite local event recorded by TKO as evidence for mid range dynamic triggering, implying that the 2.5 cm/s shaking at TKO did not exceed the local triggering threshold. Additionally, the lack of triggering following Honshu, Tottori, and Kuril Islands suggests that the 1, 2.5 and 2.6 cm/s shaking at distances of 182, 238, and 267 km, respectively, creates lower bounds for the dynamic triggering thresholds at the respective locations. This assumes the bound is frequency independent. In none of the cases were thresholds exceeded over a large enough region or by large enough amplitude to produce a statistically significant increase in the cataloged rate of seismicity during the period from 1997 to 2002. All previously documented examples of triggering have occurred following shallow earthquakes with $M_w > 7$. With the exception of Volcano Islands, all of the events of this study have $M_w < 7$, and have no triggering associated with them. This suggests two possibilities: either events with $M_w > 7$ are required to produce sufficient shaking to trigger seismicity, or Japan is less susceptible to triggering than the western US or Greece. We assume that the depth of the Volcano Islands earthquake prohibits any substantial surface shaking. We conclude that more data is required associated with shallow, crustal events with $M_w > 7$ in order to determine whether or not Japan is susceptible to regional triggering.

S32F-07 1730h

Expected Spatio-temporal Aftershock Patterns for Different Tectonic Regimes

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Co-seismic damage created through shear rupture provides a high permeability fracture zone through which high pressure fluid pulses can propagate. In regions where fluids are trapped at high pressure by a geologic seal, the co-seismic rupturing of that seal allows the instant communication of high (lithostatic) and low (hydrostatic) pressure regions. The amplitude of the pressure difference depends on the depth but can be very large (for example, the difference is 170MPa for a trapped source at 10 km). The propagation of such a large pressure pulse will open fractures in the damage zone, travel at very high velocity, and trigger aftershocks by significantly reducing the effective normal stress in the regions through which it propagates. If aftershocks are driven by this mechanism, then aftershock distributions in space and through time should show a spatial distribution that depends on the type of faulting. Expected aftershock distributions are shown from modeling results for strike-slip, normal, and thrust fault events. The pressure pulse is modeled as a non-linear diffusion process where permeability is a strongly non-linear function of the effective normal stress acting on fractures. Results are compared with measured aftershock sequences.

S32F-08 1745h

Stress transfer and aftershocks

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The earthquakes that are most readily associated with stress transfer are aftershocks. There are three important "laws" associated with aftershocks: (1) They satisfy Gutenberg-Richter frequency-magnitude scaling, (2) they decay in time according to Omori's law, and (3) they satisfy Bath's law. Bath's law states that the difference in magnitude between main shocks and their largest aftershocks is approximately constant, independent of the main shock magnitude. We propose a modified form of Bath's law by extrapolating the frequency-magnitude statistics of measured aftershocks of a given main shock to infer the largest aftershock. We consider eight earthquakes that occurred in southern and Baja California between 1987 and 2002 with magnitudes equal to or greater than 5.5. The difference in magnitude between main shock and largest aftershocks were 1.23+0.046 (Bath's law) and the difference in magnitude between main shock and inferred largest aftershocks were 1.21+0.27 (our modified Bath's law). We show that the applicability of the modified Bath's law implies that the fractional stress transfer responsible for aftershocks is a constant independent of main shock magnitude and that this scaling varies by about 25%. We find that about 95% of the energy dissipation due to an earthquake is associated with the main shock and 5% with the aftershocks.

S41A MCC: 3011 Thursday 0800h

Subduction and Lithospheric Deformation in South America I *(joint with G, T)*

Presiding: **L Wagner,** University of Arizona**; A Tassara,** Institut für Geologische Wissenschaften, Freie Universitat Berlin

S41A-01 0800h

Measuring Active Faulting in Bolivia: the 1998 Aiquile Earthquake

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The Aiquile region of central Bolivia is situated in the core of the actively deforming Bolivian Orocline. Palaeomagnetic data show that differential rotations consistent with oblique convergence have continued over the past 10 Myr. Structural mapping of the sub-Andean fold-and-thrust belt to the east shows that the majority of this convergence has occurred there as shortening; however there exists a significant transverse component of motion which must be accommodated as strike-slip faulting elsewhere. Many topographic lineations assumed to be related to strike-slip faulting have been identified in the area around Aiquile, however none has been associated with large earthquakes or demonstrated to be active over the past million years. On 22nd May 1998, a $M_W = 6.5$ earthquake struck the region, the largest shallow earthquake to occur in Bolivia for 50 years, resulting in over 105 fatalities and rendering thousands homeless in the towns of Aiquile and Totora and their surrounding villages. Seismic observations of the event are inconclusive; the correct orientation and style of the faulting – either right-lateral strike-slip on a N–S fault, or left-lateral on an E–W fault – cannot be determined as large uncertainties in earthquake location mean we do not know *a priori* which of the two nodal planes in the focal mechanism is the fault plane, or upon which structure the earthquake occurred. We present here the first study of a Bolivian earthquake using InSAR. Despite the rugged nature of the terrain in the Aiquile region, with its sharp changes of relief ($\sim$ 3000 m over 20 km) – a consequence of its location between the high Altiplano to the west and the foreland basin to the east – we demonstrate that by using freely-available SRTM digital elevation data we can correct for topographic artifacts and generate a clear deformation signal. Our preferred model is for slip on a N–S-striking fault, with a location which validates Modified Mercalli Intensity maps constructed from field observations and local damage reports.

S41A-02 0815h

Comparison of co-seismic and post-seismic slip of large earthquakes in southern Peru and northern Chile

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We use InSAR, GPS, and seismic data to constrain the location of co-seismic and post-seismic slip on the subduction interface in southern Peru and northern Chile. We focus on the July 30, 1995, M_W 8.1 and the January 30, 1998, M_W 7.1 northern Chile earthquakes as well as the November 12, 1996, M_W 7.7 and June 23, 2001, M_W 8.4 southern Peru earthquakes. For all four earthquakes, we invert body-wave seismic waveforms and geodetic data (InSAR for all earthquakes and GPS where available) both jointly and separately for co-seismic slip. In northern Chile, we constrain the temporal and spatial evolution of post-seismic after-slip using about 30 interferograms spanning 1995-2000 and GPS data from the German SAGA array (spanning 1995-1997, including vertical displacements). In southern Peru, we use InSAR data, and GPS data from the Arequipa station to constrain post-seismic after-slip. Comparison of these events provides insight into the rupture process of large subduction zone earthquakes and the mechanisms of post-seismic after-slip. The plate tectonic setting for all the earthquakes is similar (convergence rate, plate age, etc.), but the amount of post-seismic after-slip is different. There is significant slip after the 2001 earthquake (equivalent to approximately 20% of the co-seismic moment), but compared to other recent subduction zone earthquakes, there is little slip following the other three events. The different amounts of post-seismic slip are not obviously related to differences in the dynamic ruptures of each event, but might be related to along-strike variations in material properties (like sediment thickness).

S41A-03 0830h

CASA GPS Results: Lithospheric Deformation and the Earthquake Cycle in the Ecuador-Colombia Subduction Zone

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The Ecuador-Colombia subduction zone is a potentially important laboratory for observing the effects of variations in lithospheric buoyancy on seismic coupling. Subduction of the aseismic Carnegie Ridge is associated with pronounced margin-parallel variations in crustal thickness and buoyancy of the downgoing lithosphere. The subduction zone has been ruptured repeatedly in 1906 (Mw = 8.8), 1942 (Mw = 7.9), 1958 (Mw = 7.8), and 1979 (Mw = 8.2). The 1958 and 1979 ruptures have been linked to asperities on the interplate surface. Simple elastic boundary element and viscoelastic models were used to simulate CASA (Central And South America) GPS-observed surface deformation. The results suggest that interseismic elastic strain accumulation is occurring evenly (50% apparent elastic locking) throughout the Ecuador-southern Colombia forearc. However, on-going postseismic relaxation of a viscous upper mantle (10E19 Pa S) following the 1979 earthquake masks the true total strain rate in southern Colombia. In southern Ecuador south of the ridge-trench intersection, despite apparent uniform interseismic elastic locking, no large historic earthquakes (Mw>7) have been recorded. The relationship between subducting lithospheric buoyancy and seismic coupling cannot be resolved yet because of the paradox of apparently uniform elastic locking but non-uniform historic seismicity restricted to asperities north of the ridge. The CASA observations of lithospheric deformation associated with the earthquake cycle in the Ecuador-Colombia subduction zone are tantalizing but tentative at this point, because of limited spatial resolution (>100 km average spacing) and limited temporal resolution (only one continuous GPS station in the Ecuador-southern Colombia forearc).

URL: http://estrella.geol.sc.edu/~agl/Projects.htm

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S41A-04 0845h

The Seismogenic Coupling Zone in Central Chile - Amphibious Experiments SPOC (Subduction Processes Off Chile)

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Nearly all interplate megathrust earthquakes occur in the seismogenic coupling zone between converging plates. In the area of the 1960 Chile earthquake (Mw = 9.5), we aim at a quantitative understanding of the seismicity and its relation to processes operating at depth and at the surface. As a first step, the offshore experiment SPOC with RV SONNE was combined with an