

Sea and growth of the Zagros Mountains. We present updated rotations within the Africa-North America-Eurasia plate circuit in conjunction with established poles of rotation describing the opening of the Red Sea to illustrate the direction and rate of subduction of the Neotethyan oceanic lithosphere. Minimum shortening estimates across the Zagros Mountains, Alborz / Kopeh Dagh Mountains, and Central Iran permit reconstructions of the northern margin of Arabia and the southern margin of Eurasia.

Continental margin reconstructions combined with plate motion reconstructions delineate the maximum amount of subducted ocean crust (~1000 km) since 68 Ma and the latest possible time of collision of Arabia and Eurasia. The rate of motion of Arabia to Eurasia has been fairly constant at ~2 to 3 cm/yr since 59 Ma. Perhaps surprisingly, the opening of the Red Sea at ~25 Ma does not significantly alter the rate of convergence, but the direction of motion of Arabia to Eurasia changes from northeast from 59 to ~25 Ma to due north from ~25 Ma to present. The reconstructed margins of Arabia and Eurasia collide at ~10 Ma and mark the onset of continental collision and deformation of Iran from the Zagros to the Alborz at a rate of ~2 cm/year. The slow, steady rate of subduction from 59 Ma to present contrasts with the strong episodicity in accumulation rates of arc magmatism, which are greatest in the interval of ~45 Ma to 25 Ma.

S62B-1199 1330h POSTER

The Crustal Structure of Eastern Turkey from Receiver Function Inversion

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The crustal structure of Eastern Turkey has been analyzed using receiver functions obtained from the teleseismic recording of the V-shaped array of 29 broadband PASSCAL stations [Eastern Turkey Seismic Experiment] deployed by the cooperation of Bogazici University, Kandilli Observatory in Turkey and Cornell University in US. The three component recordings of teleseismic events from a wide range of epicentral distances (25-90) were used to obtain single-event receiver functions. In this study we analyzed the receiver functions by modeling with a grid search algorithm in order to obtain S-wave velocity structure as well as the profiling of the single-event receiver function along the western and eastern transects of the array. The stacking of single-event receiver functions was used to reduce signal generated noise and scattered energy in order to control the effects of lateral structural changes. The stacked receiver functions were modeled by performing a 6-plane layered grid-search scheme in order to model the first-order features in the receiver functions with a minimum degree of trade-off. We found no significant crustal root beneath the western portion of the array, but there is some evidence of crustal thickening in the north. The crust thickens from 44 km in the southern part of the Bitlis Suture Zone to 50 km towards the northern end of the array in the vicinity of the North Anatolian Fault. We found a low velocity zone in the crust beneath the middle part of the array where the crustal thickness is around 46-48 km. In the eastern part the array crustal thickness is increasing from the southern tip of the array where it is 40 km to the middle section of the array where the thickness reaches 48 km. The average crustal p-wave velocities are higher in the east and reach 6.25-6.40 km/s. The crustal thickness in the Arabian plate, south of the Bitlis-Zagros Suture Zone is between 38-45 km/s with the highest average velocities observed (6.40-6.60 km/s).

S62B-1200 1330h POSTER

First Images of the Lithospheric Structure of Western Tibet

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In the framework of the long term cooperation between France and China in the exploration of the lithospheric structure of the Tibetan plateau, a new network of 53 seismic stations have been deployed in western Tibet in 2001. This study was particularly motivated by the relatively lack of informations about the nature and state of the lithosphere in a region where the plateau reaches his highest elevation and is significantly shorter than in its central part. Three strike-slip faults (Altyn Tagh, Gozha and Karakorum) and the Banggong suture are the first order tectonic features of this region. Stations were installed for 5 months, with an average spacing of ~15 km, along the road between Yecheng, at the southern edge of the Tarim basin, and Shiquanhe (Ali), near the Indian border. This network consisted in short, intermediate and long period seismometers, which allows a multi-scale analysis of the crustal and upper-mantle seismic properties of this region.

Here we present the first results derived from a receiver function analysis and a P-wave teleseismic tomography. A joint approach of these two methods is of particular interest since converted waves are more adapted to detect seismic discontinuities, whereas teleseismic tomography is more sensitive to lateral velocity variations. The Moho is clearly imaged all along the profile by the receiver functions analysis, and reach an unusual depth of ~85 km in the central part of the plateau. One other important result that comes out from this study seems to be the key role played by the Altyn-Tagh fault. Indeed, this fault is associated to a ~15 km high jump in the Moho topography and separate a +3% high P-wave velocity lithospheric block to the north (Tarim) from a -3% low velocity block to the south (Tibet). This result confirms that the large strike-slip faults of the Tibetan plateau act as lithospheric boundaries.

S62B-1201 1330h POSTER

Evidence for timing of the initiation of India Asia collision from igneous rocks in Tibet

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Recent studies on igneous rocks in Tibet provide new evidence for timing of the initiation of India-Asia collision. It has been defined that the NeoTethys started to open from middle Triassic (T2) and reached its widest width in J2K1 (177 120 Ma) by petrological and paleontology evidence from IndusYalung Zangbo ophiolites, which marked the suture between south margin of Lhasa block and north margin of Indian block. Andesite-dominated arc volcanic rocks and calcalkaline granitoids in the Gangdese to the north of the ophiolites zone, as indicators of subduction of NeoTethys oceanic plate, formed in 155.7 65 Ma. Petrotectonic assemblages of muscovite-bearing granite, leucogranite and high potassium calcalkaline granite aged from 55.7 Ma to less than 10 Ma are no doubt records of collision and postcollision processes. Wide spreading postcollisional highpotassium volcanic rocks (high-K calcalkaline and shoshonitic series) in Tibet erupted during 40 30 Ma, 25 10 Ma and less than 10 Ma. Therefore, IndiaAsia collision took place during the period between 65 Ma and 55 Ma. More critical evidence, however, came from Linzizong volcanic formation, which widely spread in southern Gangdese magmatic belt. The PaleoceneEocene (aged 63.89 49.2 Ma) subhorizontal terrestrial volcanic strata unconformably overlay on the late Cretaceous sedimentary strata (Shexing Formation) being strongly deformed. Linzizong volcanic formation mainly consists of high-K2O andesite, trachyandesite, trachyte, rhyolite and thick acidic ignimbrite, characterized by high content of K2O and partly peraluminous, especially in the middle to upper parts of the column, showing obvious geochemical signature of collisional postcollisional volcanic rocks. In combination with the stratigraphical and paleontological evidence in southern Tibet that documented dramatic change in sedimentary facies and microfuna content across the Cretaceous Tertiary (K/T) boundary (Wan et al., 2002), it is concluded that the collision between India and Lhasa Continental blocks was most likely initiated at ~ K/T boundary time (~ 65 Ma).

S62C MCC: Hall C Saturday 1330h

Tonga Deep Earthquakes, 19 August 2002 Posters (joint with T, DI, MR)

Presiding: D Wiens, Washington

University; M Brudzinski, University of Wisconsin

S62C-1202 1330h POSTER

Seismicity along Subduction Zones: Visualization with a Physical Basis

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It is a common practice to plot epicenters and hypocenters as symbols of equal sizes on maps and cross-sections. While this representation is effective in relating seismicity to high-angle faults, it lacks a physical basis because equal weights are assigned to events that span several orders of magnitude in seismic moment. Furthermore, for cases such as subducted lithosphere where seismicity does not occur along major, through-going faults, "connecting the dots" leads to erroneous impressions of true seismogenic structures. Another common practice is to plot each event according to its magnitude. In principle, this preserves the size of earthquakes by using the logarithmic magnitude scale. The results, however, are not intuitive and the physical meaning of the magnitude scale is unclear. In contrast, we use simple scaling laws between fault area and seismic moment to plot seismicity in a way that conforms to the true scale of maps and cross-sections. The results are intuitive and often quite distinct from plots produced from common practices. We will illustrate the utility of our approach with examples from several different tectonic settings, including the large (Mw 7.6 and 7.7) August 19, 2002 Tonga deep earthquakes, configurations of sub-horizontal outboard earthquakes and complex Wadati-Benioff zones [Chen and Brudzinski, Science, v. 292, p. 2475, 2001], aftershock productivity of deep earthquakes [Wu and Chen, GRL, v. 26, p. 1977, 1999], and dual, out-of-sequence thrusts at mid- to lower-crustal depths [Kao and Chen, Science, v. 288, p. 2346, 2000].

S62C-1203 1330h POSTER

State of Strain in Sub-horizontal Slabs

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Fault plane solutions of earthquakes in subducted lithosphere typically show down-dip compression (DDC) or down-dip extension (DDE): the axes of maximum compression (P-axes) or extension (T-axes) closely follow the dip of slab as revealed by the distribution of seismicity. This pattern is strong evidence for slabs acting as a stress guide in the mantle: a uniform strain field develops within the cold, strong slab as it sinks ("slab-pull") and encounters increasing resistance at greater depths [Isacks and Molnar, Nature, v. 233, p. 1121, 1969]. We use a database of 1600 fault plane solutions to explore the limit of this time-tested paradigm in situations where the slab is sub-horizontal. Two well-known cases occur beneath northern Argentina and southern Peru, where seismicity concentrates near depths of 100 km over large areas of about 400 x 400 km². In each case, there is no obvious clustering of the T-axes. This is expected in that slab-pull has little horizontal component when the slab is sub-horizontal. Meanwhile, a clear pattern of DDE is evident for slab dips as small as 10 degrees, setting an empirical limit of the paradigm. At depths greater than 300 km, large regions of outboard earthquakes occur beneath Vanuatu and Fiji where P-axes do not follow a distinct pattern of DDC observed in surrounding zones of active subduction. In the latter case, seismic anisotropy and lateral heterogeneities of P- and S-wave speeds indicate that in fact a buoyant petrologic anomaly accompanies the outboard earthquakes, offering a dynamic process that explains the sub-horizontal configuration of seismicity and its deviation from DDC.

S62C-1204 1330h INVITED POSTER

Source Characteristics of the August 19, 2002 Tonga Deep Earthquakes

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On August 19, 2002, two large deep earthquakes occurred about 7 minutes apart in the central and southern region of the deep Fiji-Tonga subduction zone, respectively. The second earthquake occurred at 680 km depth, and is with a magnitude M_W 7.7 the largest deep event in the Fiji-Tonga subduction zone ever recorded. It is also the deepest event of this size known. The earthquakes were followed by about 10 and 4 aftershocks, respectively, reported as of mid-September. We are locating both earthquake sequences using a combination of teleseismic arrival times and regional data of the SPANET network, operating in several islands in the Southwest Pacific. We are also investigating the rupture history of the mainshocks using a waveform inversion of P , S and depth phases recorded by the Global Seismic Network. Our preliminary results suggest that the first earthquake (O.T.= 11:01:03.8 UT) consists of three shocks with variable focal mechanisms and a total moment release of 3.1×10^{20} Nm. This event lasted about 16 s and ruptured predominantly towards north with an average velocity of 3 km/s. Most of the aftershocks align along the steeply dipping nodal plane of the average mechanism, suggesting that rupture likely occurred along this plane. The second earthquake (O.T.= 11:08:25.9 UT) lasted ~11 sec, and rupture proceeded southward with a rupture velocity of 3 km/s. Our analysis suggests that the subhorizontal nodal plane is probably the one that ruptured. For both events, the focal process seems to be confined within the seismically active portion of the slab. The moderately fast rupture velocities of both earthquakes is consistent with those inferred for other large Fiji-Tonga deep events, and differ from the rupture velocity generally observed for earthquakes in the warmer South American slab.

S62C-1205 1330h INVITED POSTER

Remote triggering and aftershocks of deep earthquakes

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The August 19, 2002 deep Tonga earthquakes, in which an Mw 7.7 earthquake occurred 7 minutes and 23 seconds following a 7.6 earthquake at a distance of 310 km, clearly demonstrates remote triggering for deep earthquakes. Other prominent examples of remote triggering for deep earthquakes include triggered aftershocks of the 1994 Tonga and Bolivia deep earthquakes and the May 26, 1986 Tonga sequence. In this case, an Mw 7.1 event occurred 25 minutes following a Mw 6.8 event at a distance of 200 km. The delay times of the triggered events do not correspond to arrivals of major phases, nor do they define a consistent stress pulse velocity. In most of these cases, the triggered event occurred in a nearly aseismic region, either below or displaced laterally from the active seismic zone. We speculate that the events are triggered by nonlinear effects in regions where high stress may predominate, but where small earthquakes have difficulty nucleating without external influences.

We also discuss the overall controls on deep earthquake aftershock occurrence. The Tonga deep events support the previous suggestion that the Tonga subduction zone shows more aftershocks than warmer slabs such as South America [Wiens and Gilbert, 1996]. The occurrence rate of deep earthquake aftershocks is proportional to the background seismicity rate for smaller earthquakes in the region, as would be expected from rate-state constitutive laws [e.g. Deterich, 1994]. Since the occurrence rate of small earthquakes varies vastly between various subduction zones, aftershock occurrence varies also.

S62C-1206 1330h POSTER

Source Time Functions of the August 19, 2002, Tonga Deep Earthquakes Compared With a Global Deep Earthquake Catalog

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The August 19, 2002, Tonga M_W 7.6 and 7.7 earthquakes were two of the largest deep-focus earthquakes of the past decade. Their proximity in time and space is unusual, so it is informative to compare them with the global population of large deep events, as well as with each other, to check if other properties are exceptional.

We compute a source time function (STF) for each event by stacking P -waves recorded teleseismically. To compare earthquakes over a wide range of magnitudes, we scale STFs to a reference event size. Examination of the STFs reveals the two events had different character of moment-release. The earlier event had at least two significant subevents, with the second beginning about four seconds after initiation. The later event had an unusually large amount of late moment-release, reaching its peak moment-rate well over halfway through rupture.

We measure durations of 15.1 and 11.6 seconds for the earlier and later events, respectively, yielding scaled durations of 4.6 and 3.5 seconds. We have previously computed STFs for 111 deep earthquakes with $M_W \geq 6.5$ and depth ≥ 100 km, including 13 from Tonga with depths greater than 550 km. We observe an abrupt decrease in scaled durations of earthquakes deeper than 550 km, for which we measure an average of about 6 seconds. Tongan deep earthquakes generally have short durations, but the recent events are among the shortest in our catalog. We find an inverse relationship between the thermal parameter and scaled duration, suggesting that rupture propagates more quickly in colder slabs.

We also analyze path- and source-corrected spectra of teleseismic P -waves to obtain estimates of radiated energy for the August 19 events: 4.8×10^{15} J (earlier) and 3.9×10^{16} J (later). These yield energy-to-moment ratios of 1.4×10^{-5} and 10.6×10^{-5} . The second event has an unusually large energy-to-moment ratio for a deep earthquake, which suggests a high seismic efficiency.

S62C-1207 1330h POSTER

Depth-Dependence of Aftershock Productivity of Deep Earthquakes

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It has long been known that deep earthquakes tend to have far fewer aftershocks than shallow ones. We find evidence for strong variations in aftershock productivity with depth. We examined the aftershock productivity of 281 mainshocks with $M_w \geq 6.4$ and depth ≥ 100 km from the Harvard CMT catalog. We searched the PDE catalog for aftershocks within varying times and distances of the mainshocks and with various minimum magnitudes. To facilitate comparison, the number of aftershocks of each mainshock was normalized according to the mainshock size, using both a standard normalization scheme (i.e., scale by moment to the two-thirds power) and an empirical scheme. In all cases a notable depth-dependence of productivity occurs. For aftershocks within 20 days and 50 km of the mainshock, with a minimum magnitude of 4.5, mainshocks in the depth range 100-350 km have an average of 12 normalized aftershocks (when normalized to Mw 8.3), compared to 5 for mainshocks in the depth range 350-550 km and 35 for events in the 550-700 km range. The recent pair of large earthquakes that occurred in the Tonga slab on August 19, 2002 have relatively high aftershock productivities consistent with the global trends. The first event (Mw 7.6) had 7 aftershocks that met the criteria above, which is equivalent to 35 normalized aftershocks. The second event (Mw 7.7) which followed 7 minutes later had 1 such aftershock, which is equivalent to 4 normalized aftershocks. The aftershock productivity is generally consistent with that of the Mw 7.6 Tonga earthquake of March 9, 1994.

Although a majority of the mainshocks in each depth range have no aftershocks at all, the variation in number of scaled aftershocks together with the variation in the fraction of events which have aftershocks is sufficient to constitute a significant depth-dependence. A bootstrap resampling analysis indicates that aftershock productivity in the 350-550 km depth range is indeed much lower than that in the 550-700 km depth range at 99% confidence; it also appears lower than

that in the 100-350 km range at about 95% confidence. Thus, a similar mainshock stress change induces far fewer aftershocks in the 350-550 km depth range, suggesting that this low level of aftershock productivity (and seismicity in general) are more likely due to difficulty nucleating earthquakes than to lack of stress in the slab at that depth.

We previously reported that the durations and shapes of earthquake source time functions change abruptly at ~550 km depth, becoming briefer and simpler below that depth. Further issues concerning the implications of various properties for the physical mechanisms of deep earthquakes will be explored.

S62C-1208 1330h POSTER

Rupture features of the Aug 19, 2002 Tonga deep earthquake doublet

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Two of the largest earthquakes in 2002 occurred in the Tonga subduction zone on Aug. 19. The seismic moments and depths are similar for these two events, and although they are separated by a few hundred kilometers along the strike of the subduction zone, their origin times are just over 7 minutes apart. The possibility of wave triggering of the second event in quite enticing, though difficult to ascertain since random seismicity occurrence can also produce a doublet. Here we focus on the rupture characteristics of these events to determine if there is any obvious unusual feature in either earthquake. In the 8-year time period from 1994 to 2002, there are seven events with $M_w > 7.2$ and depth greater than 70 km. Certainly the occurrence of two more large deep events in the same day is unusual. The source time functions (STF) for the two largest deep earthquakes (1994 Bolivia and 1996 Flores Is.) are "complex" with relatively long durations (42 and 21 seconds respectively). In contrast, the STF for the previous large deep earthquake in Tonga (March 9, 1994) displays a relatively short duration of 11 sec and a large value of peak moment rate. The STF for the first event on Aug. 19 also displays a relatively short duration (about 10 seconds) and the consequent large value for peak moment rate. Results for the second earthquake in the doublet are unclear at this point. It is possible to interpret the initial slope of the STF as the initial dynamic stress drop of the earthquake. With this interpretation, the first event of the Aug. 19 doublet has a relatively large dynamic stress drop, which translates into larger peak velocity of the teleseismic waves. This aspect is attractive for advocates of dynamic triggering of the second event. However, one caveat is that the dynamic stress drop of the 1994 Tonga event is even larger, yet the 1994 event did not trigger another nearby large earthquake.

S62C-1209 1330h POSTER

Rheological constraints on deep earthquakes

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Rheological properties of minerals will have a profound influence on the existence and properties of intermediate and deep earthquakes. Our recent laboratory data are used in exploring these constraints with two specific assertions. The first is that the boundaries of the seismogenic region are defined by material strength becoming too weak to support the requisite stress for earthquakes. The second is that the earthquake process is a plastic instability. Three types of flow mechanisms for olivine and ringwoodite: obstacle-controlled flow law, low-temperature dislocation glide and power law creep, are considered as the competing process. The maximum differential stress sustainable for plastic instability is defined based on the above three flow laws for the temperature structure in the downing going slab. We can estimate the minimum strength that is required for the region to be seismogenic with estimations of the slab seismogenically generated strain rate of 10^{-15} s⁻¹. Our model shows that obstacle-controlled flow mechanism limits the sensibility of stress to temperature. Thermal diffusion can either assist or compete with flow localization to define the limiting dimensions of a successful event. Plastic instability can be promoted by a small amount of local temperature or stress perturbation under the condition

close to the subduction zone. In the depth shallower than 400 km, the increase of seismic activity is to be expected at temperature of 500-600 °C with differential stress less than 1 GPa. In the depth deeper than 400 km, the properties of the olivine high-pressure polymorphs (wadsleyite and ringwoodite) control the seismicity. Higher temperatures (> 650 °C) are required of these phases to access the plastic instability process, thus allowing seismicity to increase in this region. This model may well represent the plastic instability for intermediate and deep earthquakes.

S62C-1210 1330h POSTER

Multitaper Multiple-ScS Analysis Beneath the Southwestern Pacific

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The pair of deep Tonga-Fiji earthquakes on August 19, 2002 provide a unique opportunity to measure mantle-attenuation properties beneath the Equatorial Pacific. Deep earthquakes in this region are common, but the large size and focal mechanisms of both events create favorable conditions for the generation of ScS phases. Multiple-ScS phases recorded in French Polynesia and BATS (Broadband Array in Taiwan for Seismology) stations are used with additional data from IRIS stations (when it becomes available). Because the earthquakes occurred approximately eight minutes apart, ScS phases for each event are evenly spaced in teleseismic records and we use phases from both events when possible. An estimate of an attenuation quality factor (Q_{ScS}) was determined by a modified spectral-ratio method for successive ScS phases. Our modification to this classical technique is in estimating the spectra with the multitaper method to control spectral variance without arbitrarily smoothing the estimate.

We use multiple-ScS phases from the August 19th events to measure Q_{ScS} for mantle structures west of the source region along the Solomon Islands and to the east beneath the South Pacific Superswell. Similar to previous studies, we measure low Q_{ScS} between the Tonga-Fiji events and stations in French Polynesia. We identify a range of Q_{ScS} values from 60 to approximately 160 throughout the South Pacific Superswell. These results support the existence of high-temperature anomalies in the upper mantle. Measurements for stations in the BATS network produce less consistent and, generally, higher Q_{ScS} values that range from 120 to above 400. This result is expected since they sample a more diverse geologic setting including subducting slabs and oceanic plateaus.

S62C-1211 1330h POSTER

Preliminary results of field survey, 2002 PNG earthquake at Wewak

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We report on field observations taken in the immediate aftermath of the PNG earthquake of 08 Sept. 2002 (09 Sept. local time). This event occurred about 100 km ESE along the coast from the location of the 1998 tsunami disaster. The 2002 event had a significantly larger magnitude (7.4), but triggered a much more benign tsunami. Fortunately, it resulted in only a handful of casualties.

The following is a summary of preliminary observations during field surveys taken in the week following the event: The islands facing the coast (Mussu, Kairiru, Walis) were uplifted from 20 to 50 cm, and suffered a number of local aerial landslides. By contrast, along the main New Guinea coast, sea level change was barely detectable, but that part of the coast suffered many instances of liquefaction. The runup of the tsunami is estimated at 1.5 to 2 meters along the coast and on the islands.

A more complete report, inclusive of observations posterior to the abstract, will be presented.

S62C-1212 1330h POSTER

Seismological Aspects of the 2002 Papua New Guinea and Andaman Earthquakes and Tsunamis

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On September 8 and 13, 2002, two earthquakes resulted in minor tsunamis with preliminary reports of a few casualties in Papua New Guinea (PNG) and the Andaman Islands, respectively. Of particular interest is the PNG event which occurred just 100 km from the catastrophic 1998 tsunami. By contrast the 2002 source has a much larger moment, but generated only a moderate tsunami. We present the results of quasi-real time processing of its source characteristics ($M_m = 7.4$ and $\Theta = \log_{10} E^E / M_0 = -4.82$) which characterizes the earthquake as having a regular source slowness. The minor 2002 tsunami gives additional support to the interpretation of the 1998 tsunami as generated by a triggered underwater landslide. We will present results of an ongoing survey of felt intensities.

Preliminary results on the Andaman Island event of September 13th also confirms a regular source slowness ($\Theta = -4.73$).

We will present updated results on the interpretation of the reportedly minor tsunami.

S62C-1213 1330h POSTER

Preliminary Modeling of Tsunami Waves Generated by the Earthquake of 9 September 2002 Offshore of Northern Papua New Guinea

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On September 9, 2002 at 0444 local time (September 8, 2002 1844 UTC) an earthquake struck the northern coast of Papua New Guinea near 3.3 degrees south and 143.1 degrees east. Preliminary estimates centered the earthquake offshore some 100 km northwest of the town of Wewak with a moment magnitude of 7.5. Initial news reports stated that the earthquake generated a moderate tsunami which killed 4 people and damaged waterfront structures along the north coast and on offshore islands. Preliminary tsunami simulations based on a simple fault model suggest runup values of up to 1.5 m along the open coast Papua New Guinea west of Wewak. A preliminary field survey immediately after the event confirmed the tsunami and reported runup heights of generally less than 1 m with some locations receiving up to 1.5 m of runup and one unconfirmed report of over 3 m runup. Tsunami waves were reported over 200 km of coast from Aitape in the west to the mouth of the Sepik River in the east, consistent with preliminary models based on a seismic source.

URL: <http://www.usc.edu/dept/tsunamis/>

S62D MCC: 106 Saturday 1330h

Lithospheric Structure in North America and Europe: Comparisons and Recent Results II (joint with T, V)

Presiding: A Guterch, Polish Academy
of Sciences; G R Keller, University of
Texas at El Paso

S62D-01 1330h

Deep Crustal Structure underneath British Isles and Links with Surface Uplift and Denudation

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We present a new crustal and upper mantle model constructed by modelling wide-angle data from the Caledonian Suture Seismic Project and its Irish extension, both acquired in 1982. The line is oriented NE-SW and crosses the British Isles from offshore Northumberland to the Shannon Estuary. We are specially interested in the fact that this line crosses a zone of major Cenozoic denudation. Combined 2D velocity models were developed by forward and inverse modelling of 3000 travel-time picks of the principal seismic phases. The most striking feature of these models is the existence of a high velocity (7.27.7 kms-1) layer at the base of the crust, which exhibits a very low velocity gradient. The top interface of this layer is extensively sampled by lower crustal reflections, whereas the base of this layer (which corresponds to the Moho interface at 33 km) is bounded by upper mantle diving rays. The velocity of the layer is constrained by refracted energy through the layer. Moho reflections are also observed, but the majority is believed to be masked by an early arriving, high amplitude seismic coda generated by resonance of the seismic energy within the layer. The high velocity layer has a maximum thickness of 82 km beneath the Irish Sea and it wedges out towards the northeast and southwest, giving a minimum width of 600 km. Amplitude modelling was carried out using 1D full waveform and 2D ray-tracing codes and corroborates the travel-time modelling. The crustal structure along the combined profile was confirmed by gravity modelling. The high velocities and densities of the lower crust are probably underplated igneous rocks, which can be associated with the break-up of the North Atlantic Ocean. This result is tested by comparing the magnitude and wavelength of modeled denudation with those predicted by the presence of underplating in the lower crust. Predicted and observed denudation profiles are in a good agreement. This agreement together with the regional long-wavelength gravity field is used to predict the three-dimensional distribution of underplating across the British Isles. The results of this study are, finally, integrated with other regional studies in an attempt to understand the spatial and temporal evolution of the Ireland plume. These findings support the hypothesis that the Iceland plume has formed at the conjunction of a tetrad hot, subvertical, convective sheets. The impingement of these hot sheets at the base of the lithosphere has triggered the episodic injection of substantial quantities of melt.

S62D-02 1345h

Structure and Dynamics of the Dead Sea Transform in the Middle East

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