(Wark & Watson, 2000). Fujii et al. (1986) pointed out that in the Ol - Opx - basalt system, the connectivity of melt through grain edges was interrupted by Opx grains whose dihedral angle with melt is larger than 60 degree. Processes that control the fluid distribution in multi-phase rocks, however, are not fully understood. In this paper, we report preferential distribution of pore-fluid in the phase-boundaries (PBs), which is caused by the fact that migration of grain boundary of the same phases (GBs) dragging the fluid ceases at PB. We have synthesized wherlites with various forsterite (Fo) / diopside (Di) ratios with 1 - 1.5 wt percent water at 1.2 GPa and 1200 deg.C for 3 days and a week. Preference of aqueous fluid for one phase relative to the other, due to the differences in relative mineral-fluid interfacial energies, was not expected, because dihedral angles of Fo-fluid and of Di-fluid are similar at the experimental conditions. Most of the fluid was distributed in the GBs as pore fluids and no fluid inclusion was observed. We classified the pore fluids into two types, those surrounded by GBs (A-type) and by PBs (B-type). Regardless of Fo/Di ratios, proportion of B-type was larger in 1 week runs than in 3 days runs. The 80-90 percent of pore fluids were B-type in the 1 week runs. This result can be explained by the difference in mobility between GB and PB: namely, the pore fluids are dragged by the GBs much more rapidly than the PBs. During grain-growth of multi-phase rocks, pore fluids dragged by the GBs bump against the other mineral surface. This result leads to the implication that the connectivity of fluid in multi-phase rocks would be strongly affected by properties of the triple junctions composed of two different mineral phases and fluid, i.e., dihedral angle, faceting, and spatial distribution.

T42B MCC: Level 1 Thursday 1330h

The Tectonics of Tibet and East Asia Posters

Presiding: **A Meltzer,** Lehigh University**; A L Ault,** Lehigh University

T42B-0286 1330h POSTER

Tectonic Evolution of South China Coastal Provinces Since the Mid-Mesozoic

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Structural analysis using satellite imageries and detailed field studies with fault-slip data inversions in critical areas in Guangxi and Guangdong Provinces and Hong Kong reveal a polyphase tectonic history in the southeastern margin of South China, which essentially resulted from the passive reaction of the region to relative motions of neigboring plates during various times. Northward subduction of the Paleo Kula-Pacific plate under South China during Middle Jurassic-Early Cretaceous (Yenshanian arc) created a volcanic arc-back-arc setting with left-lateral shear partitioning along ductile fault zones and occasional left-lateral pull apart basins. Subduction was blocked in the late Upper Cretaceous resulting in shortening of the back-arc region and, reactivation of older faults (e.g . Nanxiong B. in Guangdong & Mirs B. in Hong Kong), followed by orogen collapse with local detachment faulting and narrow molasse basins. The extensional setting continued during Eocene-Oligogene with rifting characterized by the formation of offshore basins and expansion of the continental shelves. The extension was accompanied by left-lateral transtensional basins along NW-trending faults transfer faults (Baise B. in Guangxi), probably influenced by the left-lateral motion of the Red River Fault. The area entered a period of relative tectonic quiescence during early Oligocene-mid Miocene when South China Sea formed, with little stratigraphic record preserved on land. Tectonic exhumation in the Red River region at around 20 m.y. produced NW-trending extensional structures in the region. Southerly extrusion of the Kunming Block in the western part and subduction process in the east during the mid-Miocene-Pliocene resulted in E-W extension in the region, and local N-S compression in southern Tonkin. The westward subduction of the Philippine Plate and the reversal to right-lateral motion on the Red River Fault since 5 m.y.b.p. resulted in right-lateral motion and formation of pull-apart basins along NE-trending faults in the region (e.g. Haifeng B. in Guangdong). [Support from HKU and PROCORE programme is gratefully acknowledged].

T42B-0287 1330h POSTER

A Lower Paleozoic Plate Tectonic Model for the North Qilian Mountains, NW China

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Abstract The north Qilian mountains are a strongly-lineated Caledonian fold belt. Their mountain ranges, major rivers, fold axes, fault lines, and the spatial distribution of major rock types are all more or less parallel to one another and trend in NWW-SEE direction. The Caledonian plate tectonic structures have still been well preserved despite modifications by the Indosinian and Himalayan crustal disturbances. The north Qilian mountains may be considered as a plate suture zone which sutured the Alashan craton and the central-south Qilian craton in the lower Paleozoic time. This suture zone consists of an active continental margin, a passive continental margin, and an intervening oceanic domain. The southern margin of the Alashan craton was an active continental margin in the lower Paleozoic time, on which continental margin arcs, forearc basin, forearc ridge, and accretionary prism were very well developed. The northern margin of the central-south Qilian craton was chiefly a passive continental margin, but might be active locally in the lower Paleozoic time. The intervening oceanic domain consists of oceanic island arcs, oceanic islands, oceanic ridges, major oceanic floor, and backarc basin ocean floor. A Paleo-Qilian ocean with well-developed oceanic islands and oceanic ridges is presumed to have existed during the late Proterozoic-early Cambrian period. It started to contract in the mid-Cambrian and a Mariana type subduction occurred to have formed an oceanic island arc and a backarc basin. The Andean type subduction followed in the late-Cambrian through the Silurian periods, during which the paleo-Qilian oceanic lithosphere obliquely subducted northward beneath the southern margin of the Alashan craton, converting it from passive to active, and produced continental margin arc, forearc basin, forearc ridge, and accretionary prism, accompanied by the abundant granitoid intrusions. During the same period of time, the northern margin of the central-south Qilian craton had remained largely as a passive continental margin, but the paleo-Qilian oceanic lithosphere might have also subducted southward locally probably in the middle section of the north Qilian mountains. The cessation of the northerly oblique subduction in the late Silurian-Devonian period resulted an arc-continent collision and formed a backarc basin in the eastern section, and also left behind a segment of mid-oceanic ridge, an oceanic island arc, the enclosed remnant ocean, and a backarc basin on the surface of the earth in the western section. In summary, the lower Paleozoic plate tectonic structures of the north Qilian mountains are characterized by the orderly-arranged, well preserved mid-oceanic ridges, oceanic island arcs, accretionary prism, continental margin arcs, and backarc basins, and by the occurrence of Mariana-type and Andean-type subductions, dipolar subduction, and continental reworking and reactivation.

T42B-0288 1330h POSTER

Geochemical and Geochronologic Constraints on the Tectonic Evolution of Southeastern Tibet

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The eastern syntaxis of the Himalayas is expressed in the crust as a rotation of topographic, structural, and lithologic features from dominantly east-west to approximately north-south trends. The axis of rotation of geologic features is coincidental with the high topography of the Namche Barwa region, the exposure of granulite-grade metamorphic rocks, and a major bend in the Tsangpo River. Within the Namche Barwa and subjacent terranes are numerous granitoids that are associated with various events contributing to the tectonic development of southeastern Tibet. Our combined geochronologic and geochemical investigation of these granitoids provides insight into mechanisms of granite formation and helps to constrain the distribution of terranes, timing of assembly, and magmatic processes operative in each. U-Pb SHRIMP ages establish a complex tectonic history for southeastern Tibet, with the presence of at least five magmatic episodes: ~250 Ma, ~120 Ma, 40-70 Ma, 18-25 Ma, and 3-10 Ma. Two lines of evidence suggest that the Namche Barwa massif is a product of local feedbacks between tectonic and surficial processes: 1) exceptionally young zircon ages (2.8–9.5 Ma) for samples collected from the Tsangpo river gorge correspond to a period of rapid denudation; 2) granitoid geochemistry within the massif core reveals high Rb/Sr ratios (>1.4), suggesting a fluid-absent (decompression) melting regime dominates near the core of Namche Barwa.

URL: http://www.ees.lehigh.edu/groups/corners/corners.html

T42B-0289 1330h POSTER

Tectonic Evolution of Mirs Bay Basin in Guangdong, South China

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Comprehensive structural analysis based on extensive field mapping and LANDSAT TM imageries indicates that several coastal basins in Guangdong Province of South China, including Mirs Bay, Daya Bay and Honghai Bay, are Late Cretaceous pull-apart basins structurally controlled by the NE-trending Linhuashan Fault Zone (LHFZ). A detailed study of Mirs Bay reveals a series of NW-trending high-angle normal faults dipping eastward on the southwestern margin of the basin and a broad NNW-striking fault zone on the eastern margin. The overall basin geometry is comparable to one at the mature stage of a classical pull-apart basin. The basin intersects the 500 m-wide NE-striking Tolo Channel Fault Zone, which displays a positive flower structure probably formed during the oblique subduction of the Paleo-Kula Plate under South China. Detailed study reveals a right-lateral motion postdating an earlier ductile deformation with a sinistral sense of motion along the fault zone. A southward facing thrust sheet exposed at the southern margin of the basin probably represents a detachment that formed during the collapse of the volcanic arc. Analysis of satellite images shows that the two basins located east of Mirs Bay are comparable to ones in the transitional stage of the pull-apart basin model. These three left-stepping basins are evidence for the predominantly strike-slip nature of the LHFZ during the subduction event, which has probably experienced several changes in the sense of motion during the Late Cretaceous through Tertiary in response to changes in the geodynamic setting of the surrounding blocks. (Support from HKU and PROCORE programme is gratefully acknowledged.)

T42B-0290 1330h POSTER

Rising the Himalayan-Tibetan plateau: A 3-D finite element model

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More than 2000 km of the Earth's crust has been telescoped by the continuous Indo-Asian collision in the past 50-70 million years. Some models suggest that

the shortened crustal material was taken up mainly by crustal thickening in the Himalayan-Tibetan Plateau and surrounding regions, whereas other models emphasize lateral extrusion of Asian continent along strike-slip faults as a way to accommodate the shortened crust. Here we present a fully three-dimensional finite element model to simulate the uplift history of Himalayan-Tibetan plateau. The model predicts a spatially variable pattern of uplift in the Himalayan-Tibetan Plateau even when a simple, flat pre-collision crust was assumed. The uplift generally propagated from south to north and from west to east. Most of the plateau reached the elevation of 3-km 10-20 Myr ago. Ductile flow in the lower crust is shown to be critical for producing the observed Tibetan topography. Inclusion of major strike-slip faults enhanced the lateral extrusion of the Asian continent. Partitioning of the shortened crustal material among thickening, lateral extrusion, and erosion changes with time. During the early history of the Indo-Asian collision, crustal thickening was the dominant mechanism for accommodating the telescoped crust material. However, its role peaked 10 Myr ago, and lateral extrusion and erosion has become increasing important.

URL: http://www.missouri.edu/~yangyo

T42B-0291 1330h POSTER

Rapid Erosion at the Tsangpo Knickpoint and Exhumation of Southeastern Tibet

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The Tsangpo River flows east along the Indus-Tsangpo Suture Zone (ITSZ) into the eastern Himalayan syntaxis but then abruptly reverses direction across the Namche Barwa antiformal massif and turns southwest towards the foreland. Associated with the change in the Tsangpo's direction is a large knickpoint within the massif that displays a 2,000 m elevation change. The abrupt change in the direction of the river at the massif suggests a past capture event. One proposed origin for the Namche Barwa massif involves tectonic and erosional feedbacks which in turn may be linked to relatively recent capture of the Tsangpo River into the Brahmaputra system. In this model, the river is responsible for vigorous erosion that distorts local stress fields and focuses strain, thereby causing localized weakening of the crust and rock uplift. We have measured a suite of U-Th/He zircon and Ar-Ar mica and K-feldspar ages from around this region. The zircon helium ages range from only 0.22 Ma near this knickpoint to over 12 Ma at distal and higher-elevation locations. This zone extends across mapped terranes and structures and it appears to define a regional-scale partial-retention zone (PRZ) with an inflection at 3,000 m elevation and 1-2 Ma in age. If additional data confirm the presence of this zircon PRZ, this inflection would suggest at least several kilometers of erosion within the past few million years, consistent with the capture of the Tsangpo and propagation of incision into the SE Tibetan plateau. Further work will be directed at determining whether this incision is a transient wave or is pinned by growth of the Namche Barwa antiform.

T42B-0292 1330h POSTER

The Eastern Syntaxis Seismic Experiment

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Across the northeastern margin of the Indian plate in southeastern Tibet, the Himalayan orogen terminates abruptly as collisional processes responsible for the elevation of Tibet and the tectonics of the main Himalayan range are replaced by the strike-slip tectonics of the eastern Himalayan syntaxis. Modeling suggests that the syntaxis is a crustal manifestation of complex lithospheric dynamics associated with an 'indentor corner.' Incoming Indian lithosphere is partitioned into at least two components: deeper Indian lithosphere that continues north beneath Tibet, and shallower lithosphere that decelerates and, together with overthrust Asian lithosphere, enters the clockwise deformation regime of the eastern syntaxis. We are conducting a seismic experiment as part of a multidisciplinary study to better understand the interaction between surface processes and tectonics at an indentor corner, the control of rheology on topography and lithospheric mechanics, and partitioning of deformation within the lithosphere. In July 2003 we deployed a 50 station broadband array across southeastern Tibet. The region is seismically active as evidenced in part by the recent M 5.6 event near Namche Barwa in the core of the syntaxis. The array will record local, regional, and teleseismic events over a 12 month period. The regional broadband array will be used to determine crustal and upper mantle structure and dynamics at the plate edge, to develop a more complete model of coupled crustal deformation and mantle flow in the syntaxial region. Nested within the regional array we deployed a dense, 20 station short period array to determine fault kinematics, and crustal structure and rheology in the immediate vicinity of the Namche Barwa Massif. Ultimately data analysis will include tomographic inversions for velocity and attenuation structure to constrain rheology, receiver-function analysis to determine primary structural boundaries, and earthquake location and focal-mechanism solutions, seismic moment analysis, and determination of shear-wave splitting parameters to look at strain.

T42B-0293 1330h POSTER

Preliminary results of 10Be analyses from the eastern Himalayan syntaxis: evidence for unsteady erosion on two spatial scales.

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In-situ 10Be concentrations in quartz sediments sands collected from the beds of seven small (10-100 km2), unglaciated tributaries of the Parlung River, a tributary of the Tsangpo River in southeastern Tibet, indicate suggest basin-wide erosion rates between 0.40 +/- .02 and 2.99 +/- .45 mm/yr. This six-fold variation in erosion rate is not explained by differences in climate, morphology, or lithology among the basins. We interpret the variation in 10Be concentrations, instead, to be a reflection of the extremely stochastic nature of sediment delivery in these steep, high relief catchments. Two fluvially polished quartzite surfaces above the Po Tsangpo River near the town of Parlung exhibit nearly identical 10Be ages of 3105 +/- 415 yr (30 m above modern river level) and 3155 +/- 275 yr (15 m above modern river level), despite a 15 m vertical difference in elevation above the river level. This apparent absence of an age elevation trend suggests that incision on this river is not steady and incremental, but rather is characterized by infrequent, large erosive events. Large floods have occurred at least twice in the last century on the Parlung river, with a 35 meter increase in stage during the most recent flood in 2000, and may contribute to punctuated erosion.

T42B-0294 1330h POSTER

Kinematic modeling of Neotectonic velocity field of the Persia-Tibet-Burma Orogen

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New kinematic finite-element program NeoKinema has been applied to compute the long-term-average velocity field and fault slip rates in the Persia-Tibet-Burma orogen using the Maximum-likelihood criterion. The orogen extends from east Turkey on the west, to Burma and Laos on the south, to east and southeast China on the east, and to Mongolia on the north. We use three data sets in our modeling: 1497 GPS benchmark solutions compiled from published sources, 366 geologic slip rates with standard deviations, 876 most compressive horizontal principal stress directions from the World Stress Map 2003 [Mueller et al., 2003]. Faults and potentially active faults are included. But faults of less constrained slip rates, e.g., faults in Iran, are assigned with large uncertainty. An iterative procedure is used to correct for transient fault locking effects on geodetic data. We use an updated plate model PB2002 to approximate the velocity boundary conditions from surrounding rigid plates (Anatolia, Arabia, India, Burma, Sunda, Yangtze, Amur) and the rigid part of the Eurasia plate in a Eurasia-fixed reference frame [Bird, 2003]. We also test various Sunda-Eurasia Euler poles and their effects on our modeling results. The F-E grid has 1564 nodes and 1964 triangular elements. So far 26 models have been computed with various background strain rates and weighting of GPS data. Initial results show a good correspondence between predicted strain rate and Harvard CMT earthquake catalogue with m>5.5. The preferred fault slip rates in central and southeast Asia are generally less than the geologic estimates but within $\pm 2\sigma$ error bounds. The strain rate field and optimal fault slip rate estimates suggest that crustal deformation in the Persia-Tibet-Burma orogen is a mixture of distributed and quasi-rigid block deformation. A few such blocks are central Iran and southern Caspian basin, Tarim basin and Gobi platform, Qaidam basin, Ordos block and north of Tienshan in central Asia.

T42B-0295 1330h POSTER

Source Mechanisms, Velocity Structures and Himalaya Tectonics

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The Himalayan Nepal-Tibet Seismic Experiment (HIMNT; in a region bounded by 26.7 and 29.5 degrees N latitudes and 85 and 88 degrees E longitudes) produced, for the first time, broadband seismic data appropriate for determining earthquake and lithospheric characteristics with a local network astride as well as along the high Himalaya. A suite of studies are being conducted in an attempt to gain subsurface information for a better understanding of the orogenic processes that produced the mountain range. First, it is somewhat surprising that of the 20 earthquakes (M>3.5) for which we are able to use waveform inversion to derive focal mechanisms the great majority of them are tensile types with generally EW oriented T-axes. Some of these events are shallow (20 km) crustal events and a few are deeper crustal or even upper mantle ones (50-80 km). Several of them appear to be related to the N-S trending graben structures at the surface. Initial attempts at tomography yield structures that generally agree with the the results of receiver function analyses (Schulte-Pelkum, this meeting), with a crust of about 45 km under southern Himalaya and much thicker under the Nothern Himalaya in Tibet. The relocated seismicity using hypoDD (this paper and Monsalve et al., this meeting) lie in well-defined zones. In the region around Mount Everest a zone dips at shallow angle (< 10 degrees) from the Greater Himalaya toward the south can be seen. Under the low foothills in south Nepal steep dipping zones between 30 and 60 km are found in some sections. The seismicity in the upper crust (<30 km) under the high Himalayan range is notable in places but under the eastern part of our network deeper crustal (60 < h < 80 km) concentrate without much shall seismicity. While the shallow (20 km) reflector from the receiver function analyses can be interpreted as the presence of Indian lithosphere and lends support to the INDEPTH model, the interpretation of seismicity and focal mechanisms indicate that a more complicated model may be needed. Since we have only recorded relatively small (M < 4.5) events in the region, are we just taking a glimpse of the ongoing processes in between large events? Would the large events produce major underthrusting consistent with some of the current models?

T42B-0296 1330h POSTER

Mechanisms for creating accommodation space during early Tertiary sedimentation in Tibet.

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The Tibetan plateau is for the most part underlain by rocks of pre-Cenozoic age, a fact that has hindered the identification of Cenozoic shortening structures that can be unequivocally related to the effects of India-Asia collision. Notably, however, the Qiangtang block contains a number of small, short wavelength basins filled with terrestrial sediments of early Tertiary age. Where these basins have been well studied, sedimentation is recognized as having occurred coevally with compressional deformation. The classic treatment of compressional basins appeals to accommodation space created by the flexure of an elastic plate in response to loads created by adjacent thrust fault bound ranges. It is unlikely that the Tertiary basins of the Qiangtang block formed in this manner. The wavelength of a classically modelled flexural basin is a basically a function of the thickness of the elastic plate and the density difference between sedimentary fill and ductile material underlying the plate. Assuming a model of elastic flexure, the very small wavelengths (5 - 30km) characteristic of Qiangtang basins would then imply extremely thin (1-5 km) effective elastic plate thicknesses. These very low values are difficult to reconcile with any reasonable characterization of crustal rheology. Instead, these relatively small basins likely record the creation of accommodation space created by differential uplift across the strike of folds and faults. Stratal geometries and sedimentation rates reflect the kinematics and geometries of local compressional structures and the mechanical basis for the creation of accommodation space remains uncertain. Finally, the origin of these basins makes it unlikely that early Tertiary sedimentation represents a significant fraction of the upper crust of Tibetan plateau.

T42B-0297 1330h POSTER

Age of Initiation of the India-Asia Collision in the eastern Himalayas

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We report on the provenance of the Jidula and Zongpubei Formations, located in the early Tertiary terrigenous sediments of the Tingri region, southern Tibet, which were deposited on the former northern margin of the Indian continent. Petrographical analysis of sandstones reveals that the monocrystalline quartz grains of cratonic origin are dominant in the Paleocene (Danian) Jidula Formation; in contrast there are significant amounts of immature framework grains with a distinct ophiolitic and volcanic arc influence present in the Eocene (Lutetian) Zongpubei Formation. Bulk sample major, trace and rare earth element concentrations in both sandstones and shales complement the petrographical data indicating that the source of the Jidula Formation primarily consisted of quartzose basement rocks, probably of Indian continental origin, while the Zongpubei Formation samples are mainly derived from an arc-trench system indicating the start of obduction of the Asian arc/subduction complex (Gangdese-Xigaze) during the deposition of the Zongpubei sedimentary rocks. The probe compositions of Cr-rich spinels in the Zongpubei sandstones are closely similar to those from fore-arc peridotites, so are most likely derived from the arc and ophiolite rocks along the Yarlung-Zangbo suture to the north. No spinels have been observed in the Jidula sandstones. These early Tertiary detrital clastics in the Tingri region record a marked change in provenance and sediment character starting with the deposition of the Zongpubei Formation. This change indicates that the onset of India-Asia collision and development of the foreland basin on the Indian passive margin started at 47 Ma in the eastern part of the Himalayas. This is about 4 Ma younger than the age determined by Garzanti et al.(1987, 1996) in the Zanskar section of the western Himalayas.

T42B-0298 1330h POSTER

Mesozoic-Cenozoic history of subduction within the Tethyan region as inferred from seismic tomography and plate tectonic reconstructions

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We have studied the large-scale history of subduction within the Tethyan region, the Alpine-Himalayan-Indonesian mountain chain that stretches from the Mediterranean to Southeast Asia. From tomographic images of the present mantle structure, the volumes and locations of the positive seismic velocity anomalies are determined. The large tomographic volumes, and the large depths at which they are found, indicate that they must have resulted from long periods of subduction in Cenozoic and Mesozoic times. We therefore examine the large-scale surface motions within the region since 200 Ma, the time window that is thought to be necessary to explain the inferred tomographic anomalies. From plate tectonic reconstructions, the amount of convergence and velocities, both relative and absolute, are determined using the relevant poles of rotation. In general, we find the tomographic volumes in the upper mantle in the eastern Mediterranean and Middle East to be similar to the tectonic volumes that are expected to have subducted during the Cenozoic. On the contrary, the results indicate that the Cenozoic amount of shortening in the Indian region was probably not accompanied by lithosphere subducting into the mantle. For all regions, the tomographic volumes found in the lower mantle are larger than the tectonic volumes expected to have subducted during mainly Mesozoic times. The volumes in the Indian region and the Middle East approximately differ a factor 1-2. However, the results suggest that much more material must have been subducted in the eastern Mediterranean than is calculated for the African-Eurasian convergence alone. This points to a major role of oceanic spreading during lithospheric subduction in the area.

T42B-0299 1330h POSTER

Variations of Standard Deviation of Gravity Anomalies in Chugoku District, Japan: Relationship with Distributions of Topographic Lineaments

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Relationship between distribution of topographic lineaments and variation of standard deviation of gravity anomalies in Chugoku district, Japan is investigated. Tectonic movement may disturb lateral continuities of crustal structures at weak zones. Lateral discontinuities of the density structure cause undulations of gravity anomaly field over them. Therefore, complexities of the gravity anomaly field might be an indicator of the past crustal instability. On the other hand, topographic lineaments are formed along zones of inherent crustal weakness, and the gravity anomaly complexity relates to distribution of surface lineaments. In order to verify this conjecture, we investigated gravity anomaly complexities in relation to the spatial distributions of topographic lineaments.

As an index of complexity of gravity anomaly field, we employed standard deviation (SD) of Bouguer anomalies. We divided the survey area into a set of regular grid cells with a mesh size of 1 km x 1 km, to the centers of which we assigned a representative SD value calculated from Bouguer anomalies inside a given search area. In this study, the nodes are centered in the regular grid cells and we used a circled search area centering at each node. We also need to revise the array data in a point-registered file of topographic lineaments because the distance between two neighboring points along each lineament does not have a constant value. The average distance is 186 m, and the standard deviation is 294 m. These deviations of the distances between neighbor points may cause implausible results. In order to import this lineament data into a statistic analysis, we reproduced a new set of array data with the constant value of 10 m for the distance between them. Then, we made a statistical analysis by referring the Bouguer anomaly SD values to the numbers of the lineament data points within 3 km from each node. Thus, we repeated the present method while the search radii for the SD determination are 5, 10, 15 and 20 km.

Frequency distribution of the lineament data points to SD values showed that locations of the lineaments tend to overlap the high SD areas of gravity anomaly field. These results imply an applicability of SD of Bouguer gravity anomalies in order to discuss the crustal weakness and the instability. Furthermore, this index derived from gravity anomaly might be effective even over the area covered by thick sediments and/or volcanic products, where fault-like structures are hard to be detected.

T42B-0300 1330h POSTER

Active Continental Growth During Transpressional Tectonics: Example from Southeastern Taiwan

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Based on structural analysis and regional kinematics data from GPS measurements, we propose a tectonic evolution model for the active continental growth in the southeastern Taiwan. The deformation structures in the Miocene deposits of the southeastern Central Range exhibit characteristics of early-stage orogenic processes. These brittle-ductile deformation features indicate complex tectonic processes involved, including underthrusting, exhumation, and left-lateral transpressional movements. The observed deformation processes in the southeastern Central Range evidently combine together and interact within a single, complex framework. In the E-W transects across the Central Range, regional foliation orientations generally display a fan-shaped pattern with dips to the mountain core on both sides. In addition, kilometer-scale overturned structures were mapped at the eastern flank of the southern Central Range, the earlier foreland thrust and fold structures were largely overturned. This overall upward flower structure is consistent with an early-proposed exhumation and vertical accretion model. In general, the kinematics data suggest left-lateral transpressional tectonic movement is currently important process in the southeastern Taiwan. And under such tectonic movement, we highlight the contribution of the Luzon arc accretion to the continental growth of East Asia.

T42B-0301 1330h POSTER

Preliminary Identification of Major Faults in the Namche Barwa: Results from a NASA Shuttle Radar Topography Mission (SRTM) DEM Calibrated With Field Mapping and Seismicity

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One of the most striking features of the Himalayan eastern syntaxis, Tibet, is the Tsangpo River Gorge, whose erosive power has created over 7000 m of local relief in the region of Namche Barwa. The erosion rate at Namche Barwa is rapid relative to other parts of the Himalaya, and the geodynamic/surface interaction is hypothesized to be very similar to the tectonic aneurism identified in the western syntaxis (Nanga Parbat and the Indus River, Pakistan) by Zeitler et al. (2001). Although the Namche Barwa is rapidly eroding, most of the active faults that accommodate exhumation have not been mapped. Based on the hypothesis that underlying tectonic processes are recorded in distinct topographic signatures, this study utilizes the NASA seamless Shuttle Radar Topography Mission (SRTM) digital elevation model (DEM) in conjunction with seismicity and field mapping to identify potential locations of active faults in this rapidly-eroding region for further field investigation. This type of calibration of remote-sensed DEM and TM (ETM+) data with field mapping and seismicity can by applied to identify active faults in other regions, such as the politically- and

geographically-restricted southeastern portion of Namche Barwa or other remote sites on Earth, a critical first step in forming topographic descriptions that can determine where and how the landscape is responding to underlying geodynamic processes. Globally, unprecedented opportunities for remote studies of topography will arise as more 90-m SRTM and data of similar resolution are released, and it is timely to further characterize their uses and limits.

URL: http://ees.lehigh.edu

T42B-0302 1330h POSTER

Wavelet-based Fusion Of Panchromatic ETM+ And Multispectral ASTER Images Covering The Neoproterozoic Allaqi-Heiani Suture,Southeastern Egypt

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The Allaqi-Heiani Suture is a WNW-ESE trending deformation zone defined by a S-verging fold and thrust belt and is dominated by volcano-sedimentary rocks, dismembered ophiolites, and syn- and post-tectonic granitoids. The Advanced Space-borne Thermal Emission and Reflection Radiometer (ASTER) data covering this area is processed by performing the Optimum Index Factor (OIF) analysis for the purpose of selecting the optimum Red-Green-Blue (RGB) color cpombinations. ASTER data have fourteen bands; 3 in Visible and near infrared (VNIR) with 15 m spatial resolution; 6 Short wave infrared (SWIR) with 30 m spatial resolution, and 5 in the Thermal infrared (TIR) with 90 m spatial resolution. Therefore, the selected RGB color combinations from ASTER data are sometimes have poor spatial resolution. The Enhanced Thematic Mapper Plus (ETM+) panchromatic band with 15 m spatial resolution covering the same area is used to enhance the spatial resolution of ASTER images. The ETM+ panchromatic bands and the multispeectral RGB color combinations from ASTER data are fused together to incorporate the higher spatial resolution of the ETM+ panchromatic band (high frequency information) and the better spectral characteristics (low frequency) of the ASTER bands. Two- and multi-band wavelet transformations are performed for three newly generated ETM+ panchromatic bands based on three histograms that corresponds to those of the three ASTER bands used in the fusion. Three approximation, low frequency images and numerous exact, high frequency images are obtained each time from the ETM+ panchromatic bands. The low frequency information in the ASTER bands (better spectral information) and the high frequency information in the ETM+ panchromatic band (better spatial resolution) are fused together. Hence, the 3 approximation (low frequency) images obtained from the two-band wavelet or multi-band wavelet for the ETM+ panchromatic band are replaced by the three selected ASTER bands, respectively. Three new bands are generated by performing the inversed wavelet transformation for the approximation images from ASTER bands and the corresponding detailed bands from the ETM+ band are used to generate new RGB color combination images. The results from the two-band wavelet and multi-band wavelet are compared with each other and also with other fusion techniques such as RGB-Hue-Saturation-Intensity (HSI-RGB and Color Normalization Transformation (CNT). Wavelet-based fusion proved to be advantageous in retaining better spectral characteristics of multi-spectral ASTER data and incorporating the better spatial resolution of the panchromatic ETM+ data. geological features which were not obvious in either images or images produced by RGB-HSI-RGB and CNT fusion techniques were revealed more clearly in images generated by wavelet-based fusion.

T42C MCC: 2002-2004 Thursday 1340h

At the Seismogenic Front: Dynamic Processes at Convergent Margins III

(joint with G, S)

Presiding: **D Saffer,** University of Wyoming**; D Cardace,** Washington University

T42C-01 1340h INVITED

Geodetic and Seismic Constraints on some Seismogenic Zone Processes in Costa Rica

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E. Norabuena (UM/RSMAS), S. Schwartz and H. DeShon (UCSC) L. Dorman (SIO), E. Flueh (GEOMAR), P. Lundgren (JPL), A. Newman, F. Pollitz (USGS), M. Protti (OVSICORI). We report results from joint seismic (on-land PASCAL and offshore OBS) and geodetic (GPS) observations in Costa Rica designed to elucidate seismogenic zone processes related to subduction of the Cocos plate beneath the western edge of the Caribbean plate. For the Nicoya peninsula, where our seismic deployment was longer, the seismic data are used to constrain the geometry of the plate interface for purposes of modeling the geodetic data. Seismogenic zone events here show significant updip variability, corresponding to changes in subducted oceanic crust origin and heat flow. Inversion of the GPS data here suggests a patchy distribution of locked zones, with two relatively small, elliptically shaped locked zones elongated parallel to the trench (centered on 14 and 38 km depth) within a larger region of low locking (or possibly freely slipping), as well as northeast motion of a coastal "sliver block" at 8 plus/minus 3 mm/yr associated with oblique convergence. In contrast, for the Osa peninsula, there is no evidence of trench-parallel motion (convergence here is orthogonal) and the entire plate interface to a depth of about 50 km appears to be fully locked. In addition, the southwest-dipping block boundary on the Caribbean coast separating the Panama block and Caribbean plate also appears to be fully locked and accumulating strain, with shortening rates of about 1-2 cm/yr. The large zone of locked slip on the main plate interface beneath the Osa Peninsula, as well as the associated "back-arc" deformation, is presumably related to subduction of the shallow Cocos Ridge and consequent high compressive stress in the direction of plate convergence. Over geologic time, this may promote crustal shortening in the region, and uplift of the Cordillera Talamanca in southern Costa Rica.

T42C-02 1355h

Inter-plate coupling in Nicoya Peninsula, Costa Rica, as deduced from trans-peninsula GPS experiment

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We investigate state of plate coupling at the subduction zone beneath Nicoya Peninsula, northwestern Costa Rica, from 1.5-years of trans-peninsula GPS campaign measurement. Inter-plate coupling zone beneath Nicoya Peninsula is recognized as a clear seismic gap named "Nicoya seismic gap". In this area, Cocos plate is subducting beneath the Caribbean plate from the Mid American Trench with large convergence rate about 90mm/yr, and because of this, large earthquakes have occurred in 1853, 1900, and 1950 at this segment, and two large earthquakes occurred around Nicoya peninsula (M_W 7.0 in 1990 to the SE and the 1992 M_W 7.6 off Nicaragua to the NW). In the Nicoya seismic gap, a strong coupling of the two plates is manifested by low background seismicity, the sharp edge of aftershock zone of the 1990 and 1992 earthquakes, and the northeastward movement of the Nicoya peninsula recorded with GPS observations.
We started a new GPS survey program in Nicoya peninsula in 2001 to obtain new knowledge about the seismic coupling and the potential earthquake. 7 new benchmarks for GPS campaign observation were installed completing a 10-sites transect across Nicoya peninsula. We have done 3 times of GPS campaign observation on this array.
Crustal deformation on inter-seismic period above Nicoya seismic gap is estimated from 1.5 years of GPS observations. Obtained velocity field suggests that the forarc sliver motion along the pacific coast of Nicoya peninsula produces 8.5mm/yr of northwestward motion parallel to the Mid American Trench.
We performed an inversion analysis to infer inter-plate coupling at Nicoya seismic gap. The result of the inversion shows that upper and lower limits of coupling zone are corresponding with ones of seismogenic zone, which was investigated by Newman *et al.* (2002) with seismological methods. Accumulated strain in the Nicoya seismic gap is able to bring earthquake whose moment magnitude is larger than 7.5.

T42C-03 1410h

Aseismic Slip and Stress Transfer in Guerrero, Southern Mexico

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Geodetic measurements from Guerrero, southern Mexico, show evidence for at least four large transient slip events in 1995, 1998, 2002 and 2003. Inverse modeling of the data suggests that the steady-state slip on the plate-boundary thrust includes partial frictional coupling at depths greater than 25 km, producing a slip deficit which is partially or completely relieved during aseismic slip events, and strong frictional coupling on the shallow thrust which is not relieved aseismically. Slip events have been observed down-dip of the seismogenic zone at several other subduction zones including New Zealand, Japan, Alaska and Cascadia. In many cases, these are interpreted as repeating events that activate a similar area on the thrust at regular intervals. In Guerrero, however, the behavior is more complex: Quiescent intervals range from one to four years, and moment release in these four events varies by up to an order of magnitude. Spatial distributions also vary substantially between events. Perhaps the most consistent feature of the events is the timescale: Significant anomalous slip lasted about three to four months during all three events observed by continuous GPS. The events are also characterized by widespread activation of slip. The current network of continuous GPS sites covers an area of about 480 km strike-parallel by 270 km strike-perpendicular, but in all events there remains the possibility that slip extended well beyond the instrumental coverage. In this presentation, we will examine the potential role of these slip events as agents for stress transfer, and assess the possibility that they are initiated by stress changes during seismic events of magnitude 6 and higher on or near the thrust.

T42C-04 1425h

Episodic Forearc Uplift Related to Subduction of the Woodlark Basin, Western Solomons Arc: Intermittent Aseismic Slip or Multi-Century Earthquake Recurrence Intervals?

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