Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

SCG67-01 Room:201A Time:May 25 09:00-09:15

Reevaluation of horizontal crustal strain in the Tohoku District: a possible scale error in the baseline survey

SAGIYA, Takeshi[1*]

[1]Disaster Mitigation Research Center, Nagoya University

One of the causes of underestimating seismic potential of the 2011 Tohoku-oki earthquake (M9.0) was that E-W contraction in the Tohoku district was not clear in the strain distribution for 100 years. For the calculation of strain distribution, the triangulation survey results in the Meiji era was used as the reference coordinates. However, in the triangulation survey, only direction measurements among benchmarks are conducted, and the result may contain significant scale errors. The scale of the triangulation network is defined by baseline surveys. 15 baselines of 3-10 km length were directly measured using a steel baseline rod before the direction measurement. In the Tohoku district, they measured two baselines, the Shionohara baseline in Yamagata prefecture, and the Tsurunokotai baseline in Aomori prefecture. The original record of Shionohara baseline (5172m) exists in the archive of the Geospatial Information Authority of Japan. The maximum difference among 4 repeated measurements is only 14mm, implying a scale error of at most 2ppm. On the other hand, I found that the baseline was measured in May-June of 1894. On October 22, 1894, the Shonai earthquake (M7.0) occurred about 30km to the west of the baseline. A fault model calculation implies that the baseline might be elongated more than 50mm due to the coseismic deformation. In such a case, the scale of the triangulation network for the whole Tohoku district may be underestimated by about 10ppm, which could conceal the tectonic signal of E-W contraction in the strain distribution during 100 years.

Keywords: horizontal crustal strain, triangulation, baseline survey, scale error, Shonai earthquake, Tohoku-oki earthquake

SCG67-02 Room:201A Time:May 25 09:15-09:30

Systematic Errors in the Inversion Analysis of GPS Data to Estimate Interseismic Slip-deficit Rates at Plate Interfaces

NODA, Akemi[1*], MATSU'URA, Mitsuhiro[2]

[1]Kozo Keikaku Engineering Inc., [2]Institute of Statistical Mathematics

Through GPS measurements we can determine the current coordinates of observation points in a geodetic reference frame. To estimate interseismic slip-deficits at plate interfaces, we usually analyze GPS displacement data, that is to say the difference between the current and previous coordinates of observation points. However, the GPS displacement data contain not only intrinsic deformation but also the rigid body translation and block rotation due to intraplate inelastic deformation, which cannot be explained by interplate slip-deficit models based on elastic dislocation theory. In the inversion analysis of interseismic GPS data, unlike coseismic GPS data, we cannot ignore the theoretically unexplainable coherent noise (systematic errors), because they will seriously bias the inversion results. If the intraplate inelastic deformation is caused by fault slip at well-defined block boundaries as in the case of southwest Japan, we can apply the method of simultaneous GPS velocity data inversion for block rotations and block-boundary slip rates, proposed by McCaffrey (2002). In the case of central Japan, however, the cause of intraplate inelastic deformation is the brittle fracture and/or plastic flow at a number of defects spreading over indefinite tectonic zones (Sagiya et al. 2000, Noda & Matsu'ura 2010). So, we cannot apply the method of simultaneous GPS velocity data inversion. Another and more effective way to remove the rigid body translation and block rotation from GPS array data is to transform observed horizontal displacement vectors into average strain tensors for individual triangles composed of adjacent GPS stations. Applying an inversion formula based on Bayesian statistical inference theory (Matsu'ura et al., 2007) to the GPS strain data, we can obtain unbiased slip-deficit rate distribution. In this talk, we show the theoretical basis for the use of the average strains instead of horizontal displacement data, and demonstrate the applicability of the method of GPS strain data inversion through the analysis of interseismic GPS velocity data (1996-2000) in the Japan region (Hashimoto et al. 2009, Hashimoto et al. 2012, Noda et al. 2012), where the North American, Pacific, Philippine Sea, and Eurasian plates are interacting with each other in a complicated way.

Keywords: Systematic errors, Inverse problem, GPS data, Interseismic slip deficit

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

SCG67-03 Room:201A Time:May 25 09:30-09:45

Non-planar Fault Source Modeling of the 2008 Iwate-Miyagi Inland Earthquake (Mw6.9)

ABE, Takahiro[1*], FURUYA, Masato[1], TAKADA, Youichiro[2]

[1]Dept. Natural History Sci., Hokkaido Univ., [2]DPRI, Kyoto Univ.

Iwate-Miyagi Inland earthquake (Mw6.9) occurred on 14 June, 2008, in the northeastern Honshu, Japan. The epicenter is located along Ou mountain areas and the mechanism is reverse faulting. Geodetic observations such as GPS and SAR show the maximum of displacements greater than 2m, and their spatial distributions are quite complex. Especially, the Kurikoma2, one of the GEONET observation station, indicates localized large displacements that was difficult to reconcile with SAR-based observation data. Although fault models based either GPS or SAR have already been published (e.g., Ohta et al., 2008, Takada et al., 2009), no unifying models have yet to be proposed that can explain both GPS and SAR data We estimate a non-planar fault model that can explain both data. We reported the non-planar fault model based on GPS and SAR data in the meetings last year (JpGU, Seismological Society of Japan, The Geodetic Society of Japan). However, the model cannot explain the GPS data at Kurikoma2. As a result of trial and error, at last, we developed the fault model that can largely explain all data.

We first developed a non-planar fault model that explains the GPS data alone. The maximum dip slip is ~5 m and that of strike slip is nearly 0.5 m. The slip components are localized under Kurikoma2. These slip distributions are consistent with a reverse fault motion and GCMT solution. The moment magnitude inferred from this model is ~6.9. Thus, this model can well explain the displacements acquired by GPS, and it may suggest that east-dipping fault is unnecessary.

Using the geometry and the slip parameters, we performed an inversion analysis and confirmed whether or not the fault model could explain the SAR data. There are significant misfit residuals greater than 50 cm in radar LOS. Moreover, the calculated range-offset data reveal notable discontinuities in the misfit residuals. These results strongly suggest that the GPS-based co-seismic displacements do not capture what the SAR-based displacement data sets tell us. Besides the pixel-offset data around the epicenter, aftershock distribution data also support the existence of an east-dipping fault segment.

Adding the east-dipping segment, we finally developed the non-planar fault model that explains the GPS and SAR data. The differences from the model based on GPS data alone are slip distribution and its maximum magnitude. While the dip slip component distributed broadly in the west-dipping segment, it is rather localized in the southern part of the east-dipping segment, and few dip slips are derived in the northern part. The maximum dip-slip of east-dipping and west-dipping segment is ~3.5m and ~2.5m, respectively, and that of strike slip is ~1.5m on both segments. These inferred slip distributions are quite consistent with the lack of east-dipping lineament in the aftershock distribution. The total moment magnitude including east and west-dipping segments is ~6.9. Moreover, the location of top edge on the east-dipping fault matches to the steep gradient of Bouger gravity anomaly.

SCG67-04 Room:201A Time:May 25 09:45-10:00

Frictional properties of the Bungo Channel slow slip region deduced from geodetic data

WAKASUGI, Takahiro[1*], SAGIYA, Takeshi[1]

[1]Nagoya University Graduate School of Environmental Sciences

Although slow slip events are detected in many of subducting plate convergence zones, they have various slip, slip rates, magnitudes, periods of duration and occurrence intervals and it is considered that they are controlled by frictional properties on sliding surface. There were some researches that estimated the relationships between slip and stress change or slip rate and stress change by spatiotemporal slip distribution of slow slip until now, but that analyses of them lacked credibility themselves and they had problems with the interpretations as frictional properties because they analyzed only one event. Therefore, we analyzed slow slip events that occur with a period of about six years in Bungo Channel by use of the identical estimation method and intended to estimate frictional properties in slow slip occurring area by affirming the reproducibility of the results. Three slow slip events in 1996~1998, 2003~2004 and 2010 were detected in Bungo Channel, and we analyzed all of these events. We used the daily positions of F3 components of GEONET that were eliminated secular velocities and seasonal changes estimated from the period with no large seismicity (2007~2008) as the data. We estimated spatiotemporal slip distributions of each event by the time-dependent inversion method (Segall and Matthews, 1997). Based on estimated results, we calculated stress change on the plate interface by using the elastic dislocation theory (Okada, 1992). We considered that the relations of slip and stress change, slip rate and stress change represented frictional properties and compared those results each other. In the result, we obtained similar spatial distributions of eventual slip with the maximum slip of 20cm in 40km-depth although the slip, slip rates and periods of duration were different in each event. In the first event we found the center of slip migrated from 25km-depth to deeper area, but this slip migration was not seen in the other events. The area with large stress drop corresponded to that with large slip and maximum stress drop were 0.1-0.12MPa. The areas that had little stress change or increase of stress were extended around stress drop area. The plots of slip and stress change of three events were almost in a linear manner in common, and they did not vary with time, therefore this indicates that the estimated results represented the properties of the field. The relationships between slip and stress change were negative gradient in the area of large slip and it means that the area has a property of weakening. On the other hand, the area with zero or positive slope, that is, the area in which stress change was nearly zero or decreased extended around the negative-gradient-area. That area with a property of strengthening inhibits the expansion of slip, so it is suggested that slow slip events occur in episodic manner in Bungo Channel area because of such a spatial variation of frictional properties.

SCG67-05 Room:201A Time:May 25 10:00-10:15

The 2011 Megathrust Earthquake off Northeast Japan and Multiple Earthquake Cycles in Subduction Zones

MATSU'URA, Mitsuhiro[1*]

[1]Institute of Statistical Mathematics

The occurrence of earthquakes is the sudden release of tectonically accumulated stress by faulting. In the case of interplate earthquakes, the stress accumulation is caused by the interseismic gradual increase of slip deficits in source regions, and so the occurrence of earthquakes can be also regarded as the sudden recovery of the slip deficits. Since the crustal deformation due to the interseismic slip-deficit increase is detectable by GPS array observations as well as that due to the coseismic slip-deficit recovery, we can now monitor the slip-deficit and -recovery processes at plate interfaces through the inversion analysis of GPS array data. On March 11th of 2011, the Mw9.0 mega-thrust earthquake occurred at the North American and Pacific plate interface off Tohoku, Japan. The inversion analysis of GPS data for an interseismic period (1996-2000) before this earthquake has shown the five remarkable slip-deficit zones distributed on the plate interface along the southern Kuril-Japan trench. On the other hand, from the inversion analysis of coseismic GPS data, we revealed that the fault slip of the 2011 mega-thrust earthquake has a bimodal distribution with the northern main peak of 25 m and the southern sub peak of 6 m, which correspond to the Miyagi-oki and Fukushima-oki slip-deficit zones, respectively. In the Miyagi-oki slip-deficit zone, ordinarily large (M7.5) earthquakes with about 3 m coseismic slip have repeated every 40 years in the past two centuries. The occurrence of extraordinarily large earthquake with 25 m coseismic slip in the same slip-deficit zone suggests a possibility of scale-dependent multiple earthquake generation cycles, and leads to the conclusion that the so-called asperity is not a physical substance but a concept representing the spatial irregularity in frictional properties of faults.

Keywords: subduction zone, megathrust earthquake, stress accumulation, slip deficit, multiple earthquake cycle, scale dependence

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

SCG67-06 Room:201A Time:May 25 10:15-10:30

Absolute stress release in the 2011 Tohoku-oki earthquake and pseudo-cyclic behavior of gigantic interplate earthquakes

FUKAHATA, Yukitoshi[1*], YAGI, Yuji[2], MITSUI, Yuta[3]

[1]DPRI, Kyoto Univ., [2]Life Environ. Sci., Univ. Tsukuba, [3]Sci., Hokkaido Univ.

The rupture process of the 2011 Tohoku-oki earthquake is characterized by a large maximum slip (50 m), long slip duration (90 s), and a large stress drop (20 MPa). The long slip duration, large stress drop, extensional (normal faulting) aftershocks in a previously compressional stress regime, and low-angle normal slips at approximately the depth of the plate interface suggest that the earthquake released roughly all of the accumulated stress on the plate interface. In order to release roughly all of the accumulated stress, significant weakening of frictional strength on the fault plane must occur due to some mechanisms, such as thermal pressurization of pore fluid on the fault plane. Such dynamic weakening mechanisms of frictional strength are considered to be highly non-linear, and so strongly depends on the parameter conditions just before the earthquake. Then, the periodic occurrence of large interplate earthquakes (megaquake super-cycle) may be questioned. In fact, the most well-known sequence of large interplate earthquakes along the Nankai trough, Japan, shows repeated occurrence of them, but the periodicity is not good; the minimum interval is 90 years and the maximum 264 years [Ando, 1975]. Large variance of the recurrence interval (100 - 800 years) of outsized tsunami deposits along the Pacific coast of Hokkaido, Japan [Sawai, 2009] is also reported. Such pseudo-cyclic behavior of large interplate earthquakes can be understood by constant accumulation of stress due to steady plate motion and accidental release of stress due to dynamic weakening that strongly depends on initial conditions. If so, prediction of M9 events may be fundamentally difficult.

Keywords: 2011 Tohoku-oki earthquake, rupture process, absolute stress, megaquake, super-cycle

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

SCG67-07 Room:201A Time:May 25 10:45-11:00

The October 23, 2011 Van-Ercis Earthquake (Eastern Turkey, Mw=7.2) and Characteristics of its Aftershocks

PINAR, Ali[1*], Timur Ustaomer[2], KUGE, Keiko[3]

[1]Istanbul University, Department of Geophysics, [2]Istanbul University, Department of Geology, [3]Kyoto University, Department of Geophysics

The intraplate Van-Ercis earthquake took place about 100 km to the north of a suture zone undergoing N-S shortening resulting from the ongoing convergence of Arabian and Eurasian plates. The earthquake caused significant damage and loss of life in the cities of Ercis located on the hanging wall, 20 km to the north of the rupture zone, and Van, lying on the foot wall. No significant surface rupture was observed associated with the earthquake except some discontinuous displacements along a 20-25 km long trace extending N250E, between the Lakes Van and Ercek, where the northern block is uplifted a few centimeters.

Despite the large magnitude and the complex source region the teleseismic body waves are rather simple. The aftershock distributions and the finite source modeling depict a 60 km long rupture zone with average strike, dip and rake of 248, 36 and 56 degrees, respectively. The location of the epicenter and the extent of the aftershock area suggest that the rupture propagated bilaterally for about 30 km eastward and westward, mostly confined between the depth range of 20 km and just below the surface. The western part of the finite fault model zone show predominantly pure thrusting while the rest shows oblique reverse faulting that is approved by the mechanisms of the major aftershocks.

We retrieved 350 moment tensors for the aftershocks in the magnitude range $3.5<Mw<5.9$. We investigate the source characteristics of the aftershocks and their kinematic and dynamic relation with the mainshock. The spatial distribution of the aftershocks and their focal mechanism portrays distinct features. In total, about 45% of the CMT solutions of the aftershocks show predominantly reverse faulting or transpression; 40% of them show predominantly strike-slip faulting; and, 15% show normal faulting or transtension. The aftershocks in the NE corner of the rupture zone experienced mostly strike slip faulting pointing out conjugate strike-slip fault system at the lower crust reaching 30-35 km depth range. We determined tens of aftershocks showing normal faulting mechanism or transtension. Most of them are to the west and to the south of the epicenter. The southern aftershocks reflect transtension within the foot wall. The largest aftershock in the transtensional region took place on November 9, 2011 with magnitude Mw=5.7 just a few km away from the city Van. It generated rather complex waveforms which we modeled with two subevents one of them showing normal faulting.

Keywords: Arabia-Eurasia Convergence, Eastern Turkey, 2011 Van earthquake, mainshock, aftershocks

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

SCG67-08 Room:201A Time:May 25 11:00-11:15

Three dimensional deformation of accretionary wedge: insights from wide sandbox experiments

HORI, Takane[1*], MIYAKAWA, Ayumu[1], SAKAGUCHI, Hide[1], YAMADA, Yasuhiro[2]

[1]IFREE, JAMSTEC, [2]Kyoto Univ.

Wide sandbox experiments are used to study the three dimensional deformation processes of accretionary wedge. In previous studies, they mainly focus on two dimensional deformation in depth and subduction directions or introduce intentional heterogeneity in the incoming plate such as seamounts. Although we do not introduce any intentional heterogeneity, the results show that wedge front shape is spontaneously curved as seen in the real subduction zones.

SCG67-09 Room:201A Time:May 25 11:15-11:30

The crustal viscosity gradient measured from post-seismic deformation: a case study of the 1997 Manyi (Tibet) earthquake

YAMASAKI, Tadashi[1*], Gregory A. Houseman[1]

[1]COMET+, University of Leeds

It is by now widely accepted that viscosity in the lithosphere has a significant variation with depth because of its temperature dependence, which should be involved for studying viscous relaxation in a geodetically observed post-seismic deformation. Using 3-D finite element model, we previously described the surface displacement history of a linear Maxwell visco-elastic model with depth-dependent viscosity (DDV) following a strike-slip fault event, in comparison of a uniform viscosity (UNV) model behaviour, showing that an apparent UNV (Eta_u) that best-fits the DDV model displacement at each surface point decreases with distance from fault, and the rate of the change of Eta_u with distance from fault reflects the vertical gradient of the viscosity. In the present study, we analyse an InSAR dataset of the surface deformation in a three year period following the 1997 Manyi (Tibet) earthquake [Ryder et al., GJI, 169, 1009 - 10027, 2007] in order to estimate the vertical viscosity gradient beneath the region. We first adopt UNV model to the surface displacements observed after an initial period ($t > 165$ days) in which post-seismic slip is probably significant, which reveals a clear signature of the vertical viscosity gradient in the crust: Eta_u with which the UNV model prediction best-fits the observed displacement decreases with distance from fault. The rate of the change in Eta_u with distance from fault then derives a crustal DDV structure which indicates that the 1997 Manyi event occurs within an upper layer that effectively deforms in elastic on the time-scale of the inter-seismic period, ˜ 420 - 850 yrs [van der Woerd et al., GRL, 27, 2353-2356, 2000] and whose vertical gradient is consistent with the empirically derived steady-state power law creep of the upper crustal materials. The viscosity structure of the Tibetan crust constrained in this study advances the knowledge of the crust and assist in better understanding of the stress redistribution during the earthquake cycle.

Keywords: Post-seismic deformation, Viscous relaxation, Linear Maxwell visco-elasticity, Depth-dependent viscosity, Effective elastic thickness

SCG67-10 Room:201A Time:May 25 11:30-11:45

Paleo shoreline profiles of lake Nam Co and the rheology of the Tibetan mid crust

WALLIS, Simon[1*], MORI, Hiroshi[1], SAGIYA, Takeshi[2], OZAWA, Kazuhiro[1], NAKAMURA, Toshio[3]

[1]Department of Earth and Environmental Sciences, Faculty of Environmental Studies, Nagoya University, [2]Disaster Mitigation Research Center, Nagoya University, [3]Center for Chronological Research, Nagoya University

A major point of dispute in the tectonics of the Tibetan Plateau is whether the mid crust is weak enough to flow decoupled from the upper crust. Flow of the mid crust over distances of 100s or 1000s kilometers has been proposed and inflow of relatively low viscosity (no more than 10^{19} Pa s) rock from beneath the high plateau into the mid crust of the surrounding lower-lying regions has been proposed as a key process in the lateral growth of the plateau. However, different assumptions about the properties of the crust lead to the opposite conclusion: active deformation of the Plateau is better explained if the mid and upper crust of the plateau deform together and are not decoupled. Paleo lake shorelines offer a way to test these contrasting models and to contribute to our understanding of crustal rheology. Prominent shorelines developed around Lake Nam Co in central Tibet are excellent markers of the paleo horizontal in this region. Real time kinematic GPS surveys of these markers show there is no significant uplift despite a water level drop of several 10s meters. ^{14}C dating of lake tufa deposits shows the the age of a prominent shoreline at 20m above the present lake level to be between 10 and 20 ka. The lack of any isostatic response to water level drop over a time scale of more than 10,000 years implies either a high viscosity mid crust ($>10^{20}$Pa s) or a large elastic thickness to the crust. In either case these results imply that there is no continuous low viscosity mid crustal layer beneath Tibet in this area. We suggest that evidence for partially molten-and hence low viscosity-mid crust only reflects conditions of localized patches of crust. The lack of a continuous weak mid crustal layer argues against large-scale decoupling of the mid and upper crust. This implies that large-scale inflow of mid crustal rocks is unlikely to play a significant role in the expansion of the Tibetan plateau and that the mid crust can sustain significant stresses even on geological time scales.

Keywords: Tibet, Lakes, Mid crust, Rheology, Age

SCG67-11 Room:201A Time:May 25 11:45-12:00

Uplift and denudation histories of mountainous areas of the Japanese Islands based on low-temperature thermochronology

SUEOKA, Shigeru[1*]

[1]Earth & Planetary Sci., Sci., Kyoto Univ.

We used low-temperature thermochronology to provide quantitative constraints on the denudation and uplift history of some mountainous areas in the Japanese Islands. Quantitative analysis of uplift/denudation history requires estimate of uplift/denudation (rates) for a period of longer than 10^6 years, but only a few methods are available for its achieving. Over the last 40 years, thermochronometric methods have been successfully applied to major orogenic mountains, such as the Alps and Himalaya, to reveal their uplift/denudation histories. However, thermochronometric methods have hardly been able to make a significant contribution in revealing denudation history of mountains in young and low-relief orogens, such as the Japanese Islands because of precision and applicability of the methods. Over the past decade, the applicability of low-temperature thermochronology has extended considerably by practical use of (U-Th)/He thermochronometry, a rigorous understanding of annealing kinetics of the apatite fission-track system, and the improvement in inversion techniques for reconstructing thermal histories. In this study, currently available low-temperature thermochronometric methods, such as fission-track and (U-Th)/He methods, were comprehensively applied to the Rokko Mountains (Sueoka et al., 2010), Kiso Range (Sueoka et al., in press), and Akaishi Range (Sueoka et al., 2011) to reveal their uplift and denudation histories and to verify applicability of low-temperature thermochronometric methods to mountainous areas in a young orogen.

Keywords: low-temperature thermochronology, fission-track method, (U-Th)/He method, Rokko Mountains, Kiso Range, Akaishi Range

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

SCG67-P01 Room:Convention Hall Time:May 25 13:45-15:15

Tectonic geomorphology and surface exposure dating of the Kumkol basin in the north-eastern margin of the Tibetan Plateau

SHIRAHAMA, Yoshiki[1*], IKEDA, Yasutaka[1], Honglin HE[2], Bihong Fu[3], KANO, Ken-ichi[4], ECHIGO, Tomoo[5], MIYAIRI, Yosuke[6], YOKOYAMA, Yusuke[6]

[1]Earth & Planetary Science, The University of Tokyo, [2]Institute of Geology, China Earthquake Administration, [3]Institute of Geology and Geophysics, Chinese Academy of Sciences (IGGCAS), [4]Faculty of Science, Shizuoka University, [5]Geo-Research Institute, [6]Atmosphere and Ocean Research Institute, The University of Tokyo

The Tibetan Plateau has been growing due to the collision of the Indian plate against the Eurasian plate. The plateau is now expanding laterally by invading stable continental plates surrounding it. However the growth mechanism is still a debate, especially in the northeastern margin, which is the boundary between the Kunlun Range and Qaidam basin. The Kumkol basin, which is bounded by the East Kunlun, Altyn Tagh and Qiman Tagh Ranges, has been uplifted rapidly and now being morphologically incorporated into the Tibetan Plateau. In the central part of Kumkol basin, there is a nearly E-W trending huge Kumkol Anticlinorium, which is over 40 km wide. The large-scale Kumkol Anticlinorium is likely to be a crustal-scale structure and give an important clue to understanding the growth mechanism of the Tibetan Plateau.

Our preliminary investigations based on the analysis of remote sensing data suggested that the Kumkol Anticlinorium is formed as a set of fault-propagation folds that developed near the up-dip edges of north dipping crustal-scale thrust faults. Uplifted and deformed fluvial terraces (Kaxaklik terraces) develop along the.Kaxaklik He (= River), which comes from the Kunlun range and crosses the Kumkol Anticlinorium from the south to the north. It was inferred that the highest terraces were formed in the penultimate glacial period (ca.140 ka) and their uplift rate is about 2.0 mm/yr by our climatic-geomorphological study.

Instead of climatic-geomorphologically inferred ages, we need reliable absolute ages to discuss more precise development history of the Kumkol Basin. To get some absolute ages we conducted field investigations and sampling. As there is almost no vegetation and therefore 14C samples rarely exist in this area, the surface exposure dating was applied. We could not access the core area of the Kaxaklik terraces because of bad road condition. Fortunately, we have investigated the Bazarak terraces in the eastern edge of the Kaxaklik terraces. The Bazarak terraces are formed on the Kumkol Anticlinorium and they are uplifted and tilted to the north probably caused by the north-dipping thrust fault. The highest step of the Bazarak terraces continues westward to the highest step of the Kaxaklik terraces, implying that these terraces are almost the same age. In this presentation, we report the result of the field investigation and some surface exposure ages of the Bazarak terraces.

Keywords: Tibetan Plateau, Qaidam Basin, Tectonic Geomorphology, Surface Exposure Dating, Late Quaternary

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

SCG67-P02 Room:Convention Hall Time:May 25 13:45-15:15

Uplift and denudation history of the Akaishi Range, central Japan: Constraints from low-temperature thermochronology

SUEOKA, Shigeru[1*], Barry P. Kohn[2], IKEDA, Yasutaka[3], KANO, Ken-ichi[4], TSUTSUMI, Hiroyuki[1], TAGAMI, Takahiro[1], HASEBE, Noriko[5], TAMURA, Akihiro[6], ARAI, Shoji[7]

[1]Earth & Planetary Sci., Sci., Kyoto Univ., [2]Earth Sci., Melbourne Univ.,, [3]Earth & Planetary Sci., Tokyo Univ., [4]Geosci., Sci., Shizuoka Univ., [5]Nature & Envir. Tech., Kanazawa Univ., [6]Frontier Sci., Kanazawa Univ., [7]Nature Sys., Sci. & Eng., Kanazawa Univ.

Zircon He, zircon U-Pb, and additional fission-track (FT) analyses are used to identify the denudational history and pattern of the Akaishi Range, which has been uplifted since the late Pliocene. Zircon He grain ages from nine samples range from 21.5 to 3.0 Ma, while the ages are systematically younger to the east. These ages are interpreted to reflect the uplifting of the Akaishi Range because the youngest ages are consistent with the age at which uplifting was initiated according to the depositional ages of gravel. The decreasing ages to the east can be explained by subsequent denudation of the uplifted Akaishi Range, assuming a westerly tilting uplift of the region west of the Itoigawa-Shizuoka Tectonic Line (ISTL). Although denudation cannot be identified exactly because of a lack of precise estimates of the paleo-geothermal gradient of the study area, it is certain that the entire area between the Median Tectonic Line and ISTL has been denuded by a few kilometers since the onset of the range uplift. This implies that the topography of the Akaishi Range reflects post-uplift factors, e.g., spatial distribution of bedrock uplift rates and various denudation processes, rather than inherited geometry from the pre-uplift topography. Considering younger apatite FT ages previously reported in the southern part of the Akaishi Range, the Akaishi Range is considered to have had at least two uplifting stages, i.e., uplifting of the northern part since the late Pliocene and uplifting of the southern part since ~1 Ma, probably attributable to faulting of ISTL and collision of the Izu block to the south Fossa Magna area, respectively.

Keywords: low-temperature thermochronology, (U-Th)/He method, fission-track method, U-Pb method, denudation, Akaishi Range

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

SCG67-P03 Room:Convention Hall Time:May 25 13:45-15:15

3D crustal deformation of Japan by GEONET

HARADA, Yasushi[1*], KATO, Tadayoshi[1]

[1]School of Marine Science and Technology, Tokai University

Japan was originally created by subduction zones. The volcanic front and accretionary prisms are the result of convergence of plates, and the plate convergence make mountain area higher by the push force. Without subduction zones, earthquakes, crustal motions and Japan itself would never exist.

The GPS observation made it much easier to understand the crustal motions. The Geographical Survey Institute of Japan(GSI) has about 1400 GPS stations(GEONET) over Japan for observing Japanese crustal deformations, and the GEONET enabled us to watch how Japan continuously deforming. However, time series plotting or vector arrow figures of the GPS data are sometimes not easy to understand the three dimensional deformation with time.

In this study, we created 3D animations for Japanese crustal deformation using GPS data obtained by GSI, and make it easier to understand the Japanese crustal motions. The GSI already had created animation of Japan for horizontal motion of only limited time and area, whereas we can make animations for three dimensional deformation of any given time and area if the GPS data are available. The newly created animations revealed the detailed crustal deformation in Japan.

We compared our results to a 100 years leveling data of Japan and the geological data for about two million years. In spite of time differences, a lot of similarities can be seen on the pattern of deformation of Japan, and amount of crustal motions were comparable between GPS data and leveling data.

Keywords: GEONET, crustal deformation, 3D, GPS

SCG67-P04 Room:Convention Hall Time:May 25 13:45-15:15

Deviation of directions of rakes of thrust-type earthquakes along the MAT from subduction direction of the Cocos plate

KATAYAMA, Naoko[1*], YOSHIOKA, Shoichi[2]

[1]Dept.of Earth and Planetary Sci., [2]RCUSS,Kobe Univ.

The Cocos plate is subducting beneath the North America plate along the Middle America Trench (MAT), and many subduction zone earthquakes have occurred there.In this study, we investigated relation between subduction directions of the Cocos plate and directions of rakes of thrust-type earthquakes.We extracted thrust-type earthquakes from the Harvard CMT catalogue, amouting to 184 events with Mw ranging from 4.8 to 8.0, which occurred from 1976 to 2010, and depth ranges from 10 to 50km. Plate motions of the Cocos plate with respect to the North America plate are determined by the plate motion models, such as NUVEL-1A and MORVEL.Directions of rakes of thrust-type earthquakes which occurred in this region are rotated by counterclockwise 5~15 degree from directions predicted from the plate motion models.Furthermore, in order to select earthquakes which occurred on the plate boundary more rigorously, we extracted 32 earthquakes which occurred at depths less than +-10 km from the upper surface of the subducting plate. Using a rose diagram, although we investigated whether directions of rakes of these earthquakes are dependent on depth of hypocenters, Mw, time, and the region, we could not find any dependency.

In order to consider the cause of the difference between subduction directions determined by the plate motion models and the directions of rakes of thrust-type earthquakes which occurred on the plate boundary along the MAT, it may be important to compare the result with those which occur in the regions with forearc sliver and oblique subduction, such as Nicaragua, Cascadia, the Nankai Trough, and Indonesia.

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

SCG67-P05 Room:Convention Hall Time:May 25 13:45-15:15

About the 18.6-year periodicity observed in the occurrence of huge earthquakes of the plate convergence zones near Japan

SUE, Yoshiki[1*], SOUCHAY, Jean[2]

[1]No institution affiliation, [2]Observatoire de Paris

1. Introduction

It has been understood that tidal force driven by the Moon and the Sun works as a trigger of earthquakes (Tanaka et al., 2004). The related function is called the tidal triggering. Since move of the celestial bodies have periodicities, then the earthquakes which are triggered by such forces should have these same periodicities. In fact, in the case of long periods, the presence of a 18.6-year cycle have already been reported by such several researchers for instance concerning the Southern California (Kilston and Knopoff, 1983), several regions in the Pacific-rim (Petukhin and Gusev, 2007) and the Vrancea zone in Romania (Souchay and Stavinschi, 1999).

2. Investigation of the 18.6-year periodicity for the case of earthquakes in Japan

In this paper we investigate the 18.6 y cycle for the earthquakes occurring in Japan.

2.1 Method

The time intervals of the largest earthquakes in the plate convergence zones near Japan, and more specifically the regions of the Sanriku-Oki of the Japan trench, of the Sagami trough, and of the Nankai trough are investigated. The results are shown below.

2.2 Results

In the following we present the name of each historical earthquake, their date (Y/M/D), as well as the corresponding fraction of the 18.6 y cycle.

Sanriku-Oki region

(Tested Earthquakes: Meiji-Sanriku earthquake 1896/06/15 M8.5, Showa-Sanriku earthquake 1933/03/03 M8.1, 2011Tohoku earthquake 2011/03/11 M9)

1933/03/03 - 1896/06/15 = 13409 days = 36.71 yrs = 1.97 x 18.6 yrs

2011/03/11 - 1933/03/03 = 28497 days = 78.02 yrs = 4.20 x 18.6 yrs

Sagami trough

(Tested Earthquakes: Genroku earthquake 1703/12/31 M8.2, Taisho Kanto earthquake 1923/09/01 M7.9)

1923/09/01 - 1703/12/31 = 80232 days = 219.67 yrs = 11.81 x 18.6 yrs

Nankai trough

(Tested Earthquakes: Hoei earthquake 1707/10/28 M8.4, Ansei Nankai earthquake 1854/12/24 M8, Showa Nankai earthquake 1946/12/21 M8)

1854/12/24 - 1707/10/28 = 53748 days = 147.16yrs = 7.91 x 18.6 yrs

1946/12/21 - 1854/12/24 = 33599 days = 91.99 yrs = 4.94 x 18.6 yrs

3. Conclusion

All the 5 studied cases show close to integer multiple of 18.6 years, which suggests a real periodicity of the events. The errors are 18.6 years x 0.2 = abt. +/- 4 years for the Sanriku-Oki and the Sagami trough, while for the Nankai trough it is 18.6 years x 0.1 = abt. +/- 2 years. From the viewpoint of physics, this means that same amount of tidal forces work on the regions from same direction.

The period when the same stresses will be loaded to the Sagami trough and the Nankai trough regions are shown below. The more specific value of 18.613 yrs is used for the calculation. It should be noted that the following figures only show highly stressing periods, but not forecast occurrence of large earthquakes, because stress situations in each regions are not known today.

Sagami trough

1923/09/01(Taisho Kanto eq)+ 5 x 18.613yrs = 2016/09/24 +/- 4yrs

Nankai trough
1946/12/21(Showa Nankai eq)+ 4 x 18.613yrs = 2021/06/03 +/- 2yrs

We know that this work must be considered as a preliminary report, and more specific tests are necessary to confirm the effect.

References:

Tanaka, S., M. Ohtake, and H. Sato, 2004, Tidal triggering of earthquakes in Japan related to the regional tectonic stress, Earth Planets Space, 56(5), 511-515.

Kilston, S., Knopoff, L., 1983, Lunar-solar periodicities of large earthquakes in southern California, Nature, 303, 21-25.

Petukhin, A., Gusev, A., 2007, Timing of large earthquakes - Statistical test for the perturbation of stress accumulation by the 18.6-year lunar cycle, SSJ 2007 Fall meeting, P2-103.

Souchay, J. and M. Stavinschi, 1999, Study of the correlations between long-periodic terrestrial tides and occurrence of earthquakes in the Vrancea site, Earth, Moon, and Planets, 77(2), 105-124.

Keywords: tidal triggering, 18.6 years

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

SCG67-P06 Room:Convention Hall Time:May 25 13:45-15:15

The power to form and maintain oceanic basin and island arc

MASE, Hirofumi[1*]

[1]none

The hot things of both sides that place a cold thing to the center are mutually pulled.(1) Globally the belts of high temperature located on upper and lower both sides of the subducting plate of low temperature always tighten it.(2) In addition, the electromagnetic radiation generated by the belt of high temperature at this time converts into heat and there is a possibility of maintenance and reinforcing the high temperature.(3) I have insisted that the mainspring of the phenomenon that happens in the seam of the plates is this while reinforcing it by the result of the experiment.(4)

I will use the earth internal structure by seismic wave tomography (Zhao, 2009) in (5) as a references cited.

Pacific Plate (B) that sinks in Japan Trench, Izu-Ogasawara Trench is accompanied by the belt (A) of high temperature the upper part of (B). And (B) is accompanied by the belt (C) of high temperature along the inclining part on the other side of (B). The appearance is different in the north and the south on the boundary of north latitude 36degrees. (B) sinks from Japan Trench in the cross section that passes the Tohoku region, and the point exceeds Korean peninsula and reaches the continent.

However, the part of (B) that is sure to exist in about 300-400km in depth is lacked in north latitude 35degrees. The inclination of (B) becomes sudden by going south on the boundary of this, and it enters the state that hangs down below from the trench.

If this(5) is analyzed, the theory can be reinforced, and it can explain the raison d'etre of geographical features.

I want to think for the first time how the power generated in (A)(C) transforms (A)(B)(C).

[X] Because (A) and (C) compress (B), (B) has the possibility of collapsing and thinning. In the cross section that passes the Tohoku region, the vicinity at the center of (B) within the range placed between (A) and (C) is thin actually.

[XX] In the cross section that passes the Tohoku region, the power to pull (A) downward as a whole for the east works in (A). (A) is sure to rise on the slope along (B) because (A) cannot advance downward in the eastern edge of (A). The part that corresponds under the soil in the Sea of Japan is a blood red. I think that the fact that the Sea of Japan keeps the sinking geographical features depends on the power to pull downward for the east. Moreover, the mantle of high temperature that rises on the slope along (B) generates the magma, and causes the volcano exactly. I think that the rise of this mantle is the mechanism that creates the land and supports it. The above is the cause of oceanic basin and island arc.

[XXX] Then, why does not West Japan sink and become a basin? The power to pull downward for the east in the west of east longitude 137degrees is not generated immediately, remarkably, because as previously stated (B) lacks part in north latitude 35degrees. This might be one of the big reasons.

works cited

(1)Mase http://wwwsoc.nii.ac.jp/jepsjmo/cd-rom/2005cd-rom/pdf/s050/s050-004.pdf
(2)Mase http://wwwsoc.nii.ac.jp/jepsjmo/cd-rom/2007cd-rom/program/pdf/S149/S149-005.pdf
(3)Mase http://jglobal.jst.go.jp/public/20090422/200902266622105618
(4)Mase http://jglobal.jst.go.jp/public/20090422/201002269192904325
(5)Suzuki http://imss-sympo.kek.jp/2009/oral_ppt/03_5suzuki.pdf