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

SSS35-01 Room:303 Time:May 22 09:00-09:15

Bayesian forecast with uncertain occurrence data in a BPT renewal process

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On forecasting recurrent earthquakes in active faults, we often confront with the problem with their occurrence data; one is its scarcity and another is its uncertainty. These problems cause a large error in forecasts, so we should forecast large earthquakes by taking all the possible cases into acount. Thus, we propose a Bayesian renewal process to consider these possibility in the forecast. It gives us probability distributions for model parameters and uncertain data.

For the first problem, the error of parameter estimates, we incorporate a Bayesian procedure into a renewal process to forecast the next earthquake. This model utilizes information on other earthquake series to provide the intrinsic prior distributions of the model parameters. From various prior models, we select the common prior distribution that has the smallest value of the Akaike's Bayesian Information Criterion (ABIC) (Akaike, 1980). We also use geological information, such as single earthquake displacements (U) and deformation rate (V) to calculate mean recurrence time as T = U/V in addition to recurrence intervals obtained directly from historical records and paleoseismic investigations (Rhoades et al., 1994).

For the second problem, we discuss the inference about the uncertainty of the occurrence data and long-term evaluation with this uncertainty about some fault. Since paleoseismic investigation specifies the trace of seismic activities in stratum and infers its occurrence date from radiocarbon age of the surrounding deposits, only the upper and lower limits are specified for the occurrence date. When the estimated ranges for occurrence date are so wide, they affect probability forecast critically. Additionally, it is often the case that it is hard to judge whether earthquake occurred or not in a layer accumulated in some period of age. Even if we could specify the trace of earthquakes, there is a case that it is hard to specify how many earthquakes had occurred. In these cases, the dataset have uncertainty of occurrence itself as well as occurrence date and we have to consider them to analyze the data. To use all information from historical accounts and paleoseismic investigations, these uncertainties should be incorporated into stochastic model. Thus, we consider a likelihood function of data sets with various kinds of uncertainties for previous Bayesian model and forecast next earthquakes by the Bayesian predictive distribution.

We show the results of the analysis in some active faults in this presentation. We can see some of our probabilistic forecasts are rather different from that of the Earthquake Research Commitee of Japan, which also considers the uncertainty of parameters and occurrence data. These results are caused by the probability weight for each possible parameter and data estimated from its likelihood of our model.

Keywords: long-term forecast, recurrent earthquakes, uncertainty of data, Bayesian forecast, BPT distribution, renewal process

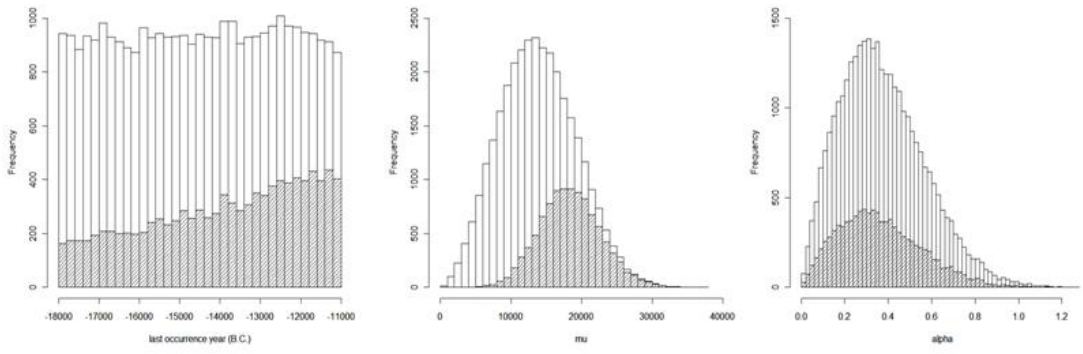

Figure: Samples from prior and posterior distribution for the last occurrence time, the mean inter-event time μ and the aperiodicity of inter-event time α in Tachikawa fault.

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SSS35-02 Room:303 Time:May 22 09:15-09:30

Dynamic rupture scenarios for strong ground motion prediction based on geomorphological and geological data

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Strong ground motion prediction needs realistic earthquake scenarios with characteristics of earthquakes occurring on source faults. We propose that physically reasonable dynamic rupture models under a fault geometry and stress fields based on geological or geomorphological data are used as earthquake scenarios for strong ground motion prediction. We apply our method to possible sources of earthquake occurring on the Uemachi fault zone.

The Uemachi fault zone runs just underneath the central part of Osaka plain, extends about 45 km, and dips 60 degrees to the east. The stress conditions for dynamic rupture simulations are presumed based on a large-scale slip distribution on the fault and small-scale heterogeneities of static stress drop. First, a spatially varied cumulative slip distribution along the strike of the Uemachi fault zone was estimated from reflection surveys, borehole data, and the subsurface structure model of the Osaka sedimentary basin (Horikawa et al., 2003). The borehole data at a site along the fault showed that the vertical slip on the earth's surface due to the last event was between 1.6 to 2.4 m (Sugiyama et al., 2003). Combining these data, we presume a prototype of the slip distribution along strike. A slip distribution along dip is modeled through simulations of spontaneous ruptures under vertically depth-dependent stress conditions to realize spontaneously stopping rupture near the bottom of the seismogenic zone. The large-scale heterogeneous slip distribution is composed of the slip distributions along strike and dip. Second, a stress change caused by the large-scale heterogeneous slip on a fault plane curved along the surface traces, which is a large-scale heterogeneous distribution of static stress drop, is calculated by the formulation of Okada (1992). Onto the large-scale static stress drop model, we add fractal heterogeneities in small-scale created from different random numbers. Finally, the strike and dip components of stress drop are converted to shear and normal stresses, assuming that the heterogeneity of stress drop is caused by a local geometry of the fault plane. We calculate dynamic rupture processes by the finite-difference method (Kase, 2010), assuming the slip-weakening friction law. We run the rupture simulations, changing hypocenter locations within relatively high stress drop area on the fault. The rupture area and rupture time on each point depend on the stress model and the hypocenter location.

Acknowledgment: This research was supported by the Ministry of Education, Science, Sports and Culture, Grant-in-Aid for Scientific Research (C) 21510190.

Keywords: geomorphology, geology, numerical simulation, dynamic rupture

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SSS35-03 Room:303 Time:May 22 09:30-09:45

Estimation of the bed rock fault angle of the earthquake fault which appeared in the 1999 Taiwan ChiChi earthquake using

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An active fault which develops in a plain is often covered with a weak surface stratum. A large-scale fault slip in the bed rock may propagate to a surface stratum, and will often generate the fault rupture on the surface, which is indicated by the generation of a shear belt in the stratum. Depending on the case, a fault slip will sometimes appear on the ground surface not as a shear belt but as a fault flexure. The stratum keeps its continuity without being disrupted by the underground shear belt.

It is impossible to evaluate the fault angle of the bedrock in the fault produced by the fault flexure because no shear belt was generated in the stratum. Nevertheless, it is essential to determine the fault angle of the bed rock in order to predict the character of future earthquakes. For example, the displacement of a fault is H/sin (S), where H is the height of the fault for one event scarp, and S is the fault angle of the bed-rock. The magnitude of an earthquake is proportional to the amount of displacement for one event (Matsuda 1975); therefore, the smaller the S, the larger the earthquake. Moreover, the determination of the fault angle of the bed rock is important for the estimation of the earthquake occurrence probability of active faults using Delta CFF (Coulomb Failure Function).

The September 21, 1999 Chichi earthquake in central Taiwan produced a 95 km long surface rupture (Chen et al. 2007).

Chen et al. (2007) excavated a trench in the earthquake surface rupture area (the Shijia site), and confirmed that the stratum forms a flexure. They also drilled boreholes near the earthquake surface rupture and found shear zones at two places. The shear zones assumed to be on the fault plane of the bed rock. Accordingly, two fault angles of the bed rock 25 and 49 degree estimated from the depth of the shear zones.

In the Shijia site, the stratum was silty sand. When simulating the deformation of sandy soil, it is necessary to take dilatancy into consideration (Johansson and Konagai 2007). Because, it is known that the material that forms the stratum sand or silt changes the appearance configuration of the fault scarp (Kawai and Tani 2003). Therefore, in this research, a simulation using the CIP (Constrained Interpolation Profile) method was performed considering the dilatancy of the stratum, and the fault angle of the bed rock was estimated by calculating the shape of the flexure.

The simulation program used in this research is SDSSC (The Stratum Deformation Simulation System using the CIP method). SDSSC is a program for calculating a deformation of the stratum (Ando 2012).

The fault angle of the bed rock and the maximum slip rate obtained for the Shijia trench were 49 degree and 1.25-1.5 m/s, respectively.

Keywords: stratum deformation simulation, ChiChi earthquake, surface rupture, fault flexure, CIP method, dilatancy

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SSS35-04 Room:303 Time:May 22 09:45-10:00

Relationship of the surface slip plane ruptured by the earthquake in eastern Fukushima on April 11, 2011 and element dis

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Mineralogical and geochemical studies of the recently slipped fault gouges might enable us to specify the recently slipped fault gouges in basement rocks. Usually it is difficult to specify the recent slip plane precisely within a thick fault zone. The surface rupture with the fault gouge has appeared along the Idosawa fault in the M7.0 earthquake in eastern Fukushima on April 11, 2011. The mineralogical and geochemical characteristics of this fault gouge are studied, and their relations to the slip plane are discussed.

The studied site is Kuroda-Betto of Iwaki city in Fukushima prefecture. The Abukuma metamorphic rocks are distributed in this area. The surface rupture has appeared across the road. The slip plane with the fault gouge strikes N6W and dips 80W. This is a normal fault with 1.7m vertical displacement. Four samples of fault gouges have been collected; slip plane to 7mm deep, 7 to 15mm, 15 to 20mm, 20 to 55mm. An intact gneiss sample has been collected outside of the fault zone to compare with the fault gouge samples.

Thin section observation, XRD, XRF, ICP and SEM-EDX analyses were performed using the fault gouge and gneiss samples. Thin section observation and SEM-EDX analysis show that ferropseudobrookite is included in the fault gouge and gneiss samples. Smectite is detected in all fault gouge samples by the XRD. The XRF and ICP results show the decrease of SiO_2 and increase of MnO, MgO, As, Sb and Ge toward the slip plane. The increase of MnO, As and Sb is also recognized in the latest slip plane of the Neodani fault (Kutsuna *et al*., 2011). The increase of MnO in the latest slip plane is interpreted as follows. The Mn^{2+} ions in the groundwater of saturation and reduction zone would rise to unsaturated and oxidation zone along the smectite-rich fault gouge by capillary action. Ikeda *et al*. (2004) revealed that cation exchange capacity and pH on shear plane of smectite become higher by the repeated shear experiment. This suggest that the pH of the slip zone becomes higher due to the seismic slip and the Mn^{2+} ions are precipitated and concentrated in the latest slip plane. The reason of As concentration is that the condition of As precipitation is similar to that of Mn (Yamaguchi *et al*, 2011). As previous seismic slips would be occurred in saturation zone, Mn concentration is not recognized in the fault gouge samples except that near the latest slip plane. The latest slip plane of the Idosawa fault indicates clear relationship between the slip plane and element concentration. This phenomenon expects to apply to the other faults that the paleoseismic records are unknown.

References

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Keywords: Idosawa fault, fault zone, latest slip plane, major elements, trace elements

Japan Geoscience Union Meeting 2012
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SSS35-05 Room:303 Time:May 22 10:00-10:15

Problem to be solved in applying active fault law in Japan

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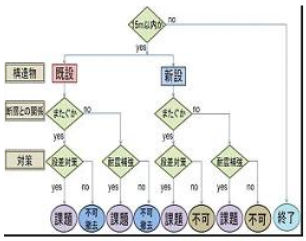
Problem to be solved in applying active fault law in Japan
Shibaura Institute of Technology
Toshiro Okamoto & Unnno Ui

Keywords: active fault, spray fault, flexure, Future activity period, anti-step



Japan Geoscience Union Meeting 2012
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SSS35-06 Room:303 Time:May 22 10:45-11:00

What controls the occurrence of inland earthquakes after the 2011 Tohoku-Oki earthquake?

OKADA, Tomomi[1*], YOSHIDA, Keisuke[1], SHIKASHO, Kenta[1], TAKAGI, Ryota[1], HASEGAWA, Akira[1], Group for the aftershock observations of the 2011 Tohoku-Oki earthquake[1]

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Shallow seismic activity in the crust of the overriding plate west of the source area changed significantly after the 2011 M9.0 Tohoku-Oki earthquake which ruptured the plate boundary east off northern Japan beneath the Pacific Ocean.

In order to understand the cause of the distinctive seismicity change of inland earthquakes, Okada et al. (2011) [1] precisely relocated earthquake hypocenters for several earthquake sequences following the Tohoku-Oki earthquake using the double-difference method. Hypocenter distributions were used to discriminate the fault plane from the auxiliary plane of the focal mechanisms for those earthquake sequences. Some of the plausible fault planes are not correlated the previously-known active faults around them. Some earthquake sequences were swarm-like and spatio-temporal migration of hypocenters of some earthquake sequences were observed.

We calculated Coulomb stress change on those fault planes caused by the Tohoku-Oki earthquake. In all cases, the estimated Coulomb stress changes at the plausible fault planes for those post-Tohoku-Oki sequences are positive. The positive Coulomb stress change is mainly due to the reduction of normal stress on the fault plane of the earthquake sequences caused by the large, low-angle thrust fault of the Tohoku-Oki earthquake. The present observations suggest the static stress transfer possibly triggered those post-Tohoku-Oki earthquake sequences.

We also estimated stress fields in inland areas of eastern Japan before and after the Tohoku-Oki earthquake by inverting focal mechanism data (Yoshida et al., 2011 [2]). Before the earthquake, sigma-1 axis was oriented EW in Tohoku but NW-SE in Kanto and Chubu regions. The stress fields changed after the earthquake in northern Tohoku and in southeastern Tohoku, where the orientations of the principal stresses seem to be approximately the same as the orientations of the static stress change associated with the earthquake. This indicates that differential stresses in these areas before the earthquake were very small. In Kanto and Chubu regions, principal axes of the stress perturbations caused by the M9 earthquake are almost parallel to the respective axes of the background stress field. This is probably the reason why conspicuous seismicity increase was observed there.

Okada et al. (2010) [3] estimated a detailed seismic velocity structure in the central part of NE Japan using data obtained from a dense temporary seismic network. They found distinct seismic low-velocity zone below the seismically active areas (the seismic belt) along the volcanic front and fore-arc region.

The post-Tohoku-Oki events were also relocated using the three-dimensional velocity structure. The post-Tohoku-Oki events also tend to be distributed above the edge of the seismic low-velocity zone in the lower crust. This seismic low-velocity zone in the lower crust corresponds to the high seismic attenuation zone (Shikasho et al. [2011] [4]). This suggests that inhomogeneous structure of viscoelastic structure and overpressured fluid distribution which appear as the seismic low-velocity / high attenuation in the lower crust are spatially related to the distribution of the post-megathrust events. Small background differential stress inferred from the stress change analyses could be due to the high fluid pressure. Spatio-temporal migration of hypocenters of some earthquake sequences can be interpreted as the result of fluid diffusion.

Not only the elastic stress transfer/change but also the inelastic deformation and/or fluid distribution are possibly important for understanding the interaction between the large subduction thrust ruptures and seismicity of inland earthquakes.

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SSS35-07 Room:303 Time:May 22 11:00-11:15

Constructing source fault models for the crustal earthquakes in Japanese Islands

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Constructing source fault model is significant for estimation of strong ground motion and evaluation of crustal activity, including seismicity and crustal deformation. Surface ruptures and crustal deformation associated with large earthquakes produces tectonic geomorphology and geologic structure. Thus, using active fault and fold data, we can estimated seismogenic source faults. However, in some cases, no surface ruptures are observed associated with large earthquakes, such as 2004 Chuetsu earthquake, 2008 Iwate-Miyagi inland earthquake. Recent progress on the blind active fault is as follows:

1. seimogenic source fault beneath the fold-and-thrust belt in Niigata. The existence of shallow detachment in the Neogene post rift mudstone, makes the relationship between deep sited seismogenic source fault and near surface active fault complicated due to thin-skinned deformation processes. Present days seismogenic source faults in this area are reactivated normal faults, formed in Miocene rifting period and transfer and trans current fault formed backarc opening processes plays significant role on segmentation of source faults.

2. Blind fault covered by young volcanic products: 2008 Iwate-Miyagi earthquake manifested the significance of blind fault covered by young volcanic products. As a similar example, we found possible active faults beneath the flank of Mt. Fuji by seismic reflection profiling (Sato et al., 2012; Ishiyama et al., 2012 JpGU).

For constructing a source fault model, an integrated, multi-deciplinary approach is needed, including geologic and crustal architecture and seismicity. We need to examine the tectonic geomorphological data, with geologic structure, gravity anomaly data, seismicity. We constructed rectangular fault models in Northern Honshu as a first step (Sato et al., 2012 JpGU). It will be updated by the increased information in the future.

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SSS35-08 Room:303 Time:May 22 11:15-11:30

Shallow geological structure in the northern part of the western marginal faults of the Kitakami Lowland, Japan

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[1]Fac. Engineering, Iwate Univ., [2]Miyagi Prefectural Government, [3]ERI, Univ. of Tokyo, [4]JGI, Inc.

The western marginal faults of the Kitakami Lowland are comprised of subparallel active faults along the eastern rim of the Ou Back-bone Range, northeast Honshu, Japan. The hanging wall of their most western fault includes basement rocks and lower Miocene. To the east of the faults, the lower Miocene is found 1000 m deep in boring cores (Okami et al., 1988), so the vertical displacement of the faults is more than 1000 m. We modeled two dimensional shallow geological structure across the faults mainly based on gravity survey.

The gravity survey was conducted with a G-type gravity meter (G497; LaCoste and Romberg Inc.) along two E-W survey lines, one of which is ca. 6 km long, across the faults (line 1), and the other of which is ca. 5.3 km long (line 2). Along line 1, a rock body of Pliocene andesite is distributed.

Each interval of observation sites is about 200 m. The elevation of observation sites was surveyed with a total station. Error of elevation is up to 40 mm. Acquired gravity data was processed to obtain Bouguer anomaly mostly according to the methodology of Geological Survey of Japan, AIST (2004). We assumed that the density for Bouguer and terrain corrections were 2100 kg/m^3.

The Bougeur anomaly in line 2 monotonically decreases from east to west. The anomaly in line 1 similarly decreases 20 mgal to the east, and increases near the andesite body. It then decreases around the faults and increases to the west in the Ou Back-bone Range. After trend correction using the anomaly along line 2, we assume three layers in our model, which have densities of 2650 kg/m^3 (layer 1), 2500 kg/m^3 (layer 2) and 2100 kg/m^3 (layer 3), respectively.

The Interpretation of the model is as follows. (1) Layer 1 is correlated to the basement rocks and the lower Miocene distributed in the hanging wall. (2) Layer 2 is to Pliocene sedimentary rocks. And (3) Layer 3 includes middle Miocene andesitic pyroclastic rocks and Pliocene andesite. We will discuss the shallow structure across the faults in detail.

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Keywords: the western marginal faults of the Kitakami Lowland, gravity anomaly, active fault

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SSS35-09 Room:303 Time:May 22 11:30-11:45

Application of GPR and discontinuity analysis of bed distribution to a survey for hidden fault, Sannomiya, Kobe

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There are many active faults in the northern Osaka Bay and the Rokko Mountains. However, the hidden fault in the urban area of Kobe between the two is not yet known. Hitherto, we analyzed the bed-distribution discontinuity for the marine beds, Ma 12 (˜135 kyr.) and Ma13 (˜9 kyr.), using the database, Kobe JIBANKUN (Kobe City), in order to grasp a hidden fault in the southwestern part of Sannomiya, Kobe. In addition, we carried out the ground-penetrating radar (GPR) investigation along seven survey lines in the area, showing the vertical drop of the Ma12 bed and/or Ma13 bed on a profile of boring logs.

On GPR sections, the pattern of reflector signals changes from a horizontal line to a southward decline, like a flexure. This place is supported with the vertical drop obtained from a discontinuity analysis of the distribution of the Ma12 and Ma13 beds. These anomalous parts distribute along two lines; one corresponds to a NNE-directional hidden fault, and the other can be interpreted as a north-directional hidden fault. Therefore a combined use of the GPR and discontinuity analysis of bed distribution is very useful for grasping a hidden fault in an urban area.

Keywords: Combined use of GPR and discontinuity analysis of bed, hidden fault, flexure-like structures, marine clay beds, Sannomiya (Kobe)

Japan Geoscience Union Meeting 2012
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SSS35-10 Room:303 Time:May 22 13:45-14:00

Magnitudes of historical intra-plate earthquakes in Tokai area

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Tokai region of Japan increases the possibility of an impending great earthquake due to the Coulomb stresses induced by the 2011 off the Pacific coast of Tohoku Earthquake [Toda et al. (2011)]. If major interplate earthquakes such as the Hoei and Ansei Tokai are excluded from historical damage earthquakes in the Tokai region, we find several intra-slab damage earthquakes in history. Recently, the damage earthquake (M6.4) at the Suruga Bay on August 11, 2009 drew attention as one of intra-slab earthquakes along the area of Niijima-Irozaki-Shizuoka tectonic line. Since a lot of earthquake data including seismometer observations and historical records are available, we try to reevaluate the magnitude of historical earthquakes based on seismic intensity data in order to obtain important findings useful for structure design and earthquake disaster prevention in this region.

The magnitudes of historical intra-slab earthquakes tend to be estimated larger than true value based on seismic intensity data inferred from old documents due to their high-frequency rupture characteristics. We and our collaborated researchers have re-evaluated the magnitudes of historical earthquakes occurring in the subducted slab of the Philippine Sea plate at several areas such as the Akinada and Iyonada (Geiyo) [Takahashi et al. (2008)], the Bungo Channel [Kanda et al. (2008)], and near Kyushu and South-east Islands [Takemura et al. (2009)]. We dealt with intra-slab earthquakes occurring the Tokai region in this study and re-evaluated their magnitude in the same way. We selected six earthquakes as historical intra-slab events in this region, those occurrence date (original magnitude) were 1589/3/21 (M6.7), 1686/10/3 (M7.0), 1841/4/22 (M6.25), 1855/11/7 (M7.0-7.5), 1857/7/14 (M6.25), 1861/3/24 (M6.0) [Usami(2003)]. Though the 1855 event had the possibility of an interplate event as the aftershock of the 1854 Ansei Tokai earthquake, it was assumed to be an intra-slab earthquake just like other events in this analysis.

At first, the seismic intensity attenuation relationship and site correction factors at observation site were estimated using recent measured intensity data of intra-slab events in this region. Secondly, the fault plane for each earthquake was assumed based on the fault mechanism data and other findings of recent major events. Finally, the seismic intensity inversion and forward analysis was carried out to estimate the most adequate magnitude.

The obtained attenuation relationship estimates seismic intensity for earthquakes of M6.5-7.0 in this area lower than those of the intra-slab earthquakes of other area in the subducted slab of the Philippine Sea plate. It shows the difference due to the high-frequency rupture characteristics. We infer that the effect of focal depth may be one of the important factors.

The most adequate magnitudes obtained by the seismic intensity inversion and forward analysis are less than M=6.7 except the 1855 event with the potentiality of an interplate earthquake.

Keywords: seismic intensity, inversion analysis, historical earthquake, high frequency, intra-slab earthquake, magnitude

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SSS35-11 Room:303 Time:May 22 14:00-14:15

The damage of the medieval port town Anotsu by earthquake in 1498 from historical materials in Mie Prefecture

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We show that the medieval port town Anotsu had already suffered heavy damage from the earthquake of June 30, 1498 and not the 1498 Meio Tokai earthquake.

A few historical materials in Mie Prefecture mention that the earthquake of June 30 had submerged the Anotsu region. In addition, 'Jinja Meisaicho' which is an official document of the Meiji era, mention that 'Sakanami' had covered this region with water. The expression 'Sakanami' indicates this submergence is connected with the existence of 'Tsunami'.

Considering the existing results and this discovery, it may be inferred that these two earthquakes in 1498 had caused extensive damage in Mie Prefecture by great shock and tsunami twice more than two months.

It is necessary to consider of the pattern like this when taking measures against earthquakes in Mie Prefecture.

Keywords: Anotsu, Sakanami, The earthquake of June 30, 1498

Japan Geoscience Union Meeting 2012
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SSS35-12 Room:303 Time:May 22 14:15-14:30

Discussion on the tectonic landform in and around the Enshu and Kumano trough

SUZUKI, Yasuhiro[1*], SUGITO, Nobuhiko[1], WATANABE, Mitsuhisa[2], ISHIGURO, Satoshi[1], MATSUTA, Nobuhisa[1], NAKATA, Takashi[3], Yoshimichi Senda[1]

[1]Nagoya University, [2]Toyo University, [3]Hiroshima University

We investigated tectonic landforms in and around Enshu and Kumano trough and discuss their implications to understand the co-seismic movement . The outer edge of continental shelf located this area has clearly deformed by active flexure, which is called Enshu-nada and Kumano-nada flexure. Around the extension of this flexure to the west, typical coastal landform can be found at Onigajo in Kumano city. We measured the detail topography by using LiDAR, and discuss the development of this topography.

Keywords: Submarine active fault, flexure, co-seismic uplift, coastal landform, Nankai trough

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SSS35-13 Room:303 Time:May 22 14:30-14:45

Newly identified gigantic plate-boundary earthquakes occurring along the Sagami Trough, central Japan

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[1]Graduate School of Science, Chiba University

M8-M9 class earthquakes generally repeated through the stress release process in subduction plate boundaries. Along the Sagami Tough where Philippine Sea plate is subducting under the Eurasia plate, 1703 Genroku Kanto earthquake (M8.1) and 1923 Taisho Kanto Earthquake (M7.9) occurred, accompanying distinct coastal uplift in the Boso peninsula on the overriding plate. Referring to these crustal movements, Holocene paleoseismology has been deduced from emergent coastal topography analysis. However, the report of 25 m high marine cave dated at ca.5200 yBP by Ishida (2001) led us to reconsider the previous paleoshoreline chronology. We carefully made more detailed air-photo reading and radiocarbon-dated coral and shell fossils sampled from several paleo-tidal zones. Based on their fruitful results, we report the latest Holocene paleoseismological table and newly identified types of gigantic plate-boundary earthquakes along the Sagami Trough.

(1) Uchibo coast: At least 7 paleo-tidal levels (Tii to Tviii in descending order) stepped in several meters apart are recognized. Tiv-related sediments, 20m above sea level (asl), product shell fossil dated 2540 yBP, underlain by marine sediments including in-situ corals dated 6820 yBP which lived in about 10 m deeper than that paleo-sea level. This suggest that ca.7000 yBP shoreline height is 30 m asl. This higher position of 7000 yBP is supported by the evidence that the boring shell fossil is dated 5420 yBP was collected in the archaeological Idenoo marine cave 25 m asl.

(2) Sotobo coast: At least 5 paleo-tidal levels (T2 to T7 in descending order) stepped in several meters apart are recognized. T3 is correlated with the previous Numa I and its height attain to 30 m asl.

(3) Correlative paleoshoreline levels between Uchibo and Sotobo coat are at most four and the residuals are limitedly distributed in each coast. This chronology and configuration of paleoshorelines indicates three types of earthquakes at which mainly uplifted area of coast are different one another, that is named Uchibo type, Sotobo type and Boso type here.

Keywords: plate-boundary earthquake, Sagami Trough, Holocene emerged shoreline topgraphy, coral and shell fossil, radiocarbon date, paleoseisimology

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SSS35-14 Room:303 Time:May 22 14:45-15:00

Holocene faulting of the Urazoko Fault in Fukui Prefecture on the Sea of Japan

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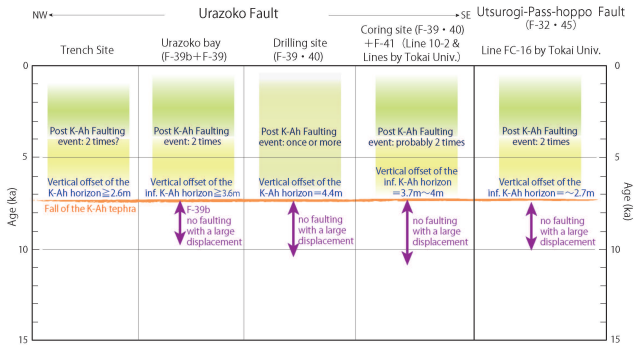
We have evaluated the Holocene faulting and displacement of the Urazoko fault system in and around Tsuruga Bay on the Sea of Japan, based on our own high-resolution sonic survey and coring results, as well as exisiting survey data disclosed from the Japan Atomic Power Company (JAPC), complying with our request. We obtained important information about the age of faulting and vertical displacement of several key stratigraphic horizons such as the Kikai-Akahoya volcanic ash fall of ca.7300 years BP, at four points/areas along the fault system. Results obtained at each point/area are consistent, and we finally identified two faulting events after the fall of the Kikai-Akahoya volcanic ash. The vertical displacement per event is esimated to be around 2 meters, and the netslip may have attained 3 m because the fault system is considered to be a strike-slip-dominant fault based on the rake of slickenlines measured by JAPC on the fault plane at the excavation site.

Keywords: Active fault, Urazoko fault, Tsuruga Bay



Japan Geoscience Union Meeting 2012
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SSS35-15 Room:303 Time:May 22 15:00-15:15

Fault distribution and activity on an offshore extension of the Goumura fault zone

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We carried out a marine geological investigation on an offshore extension of the Goumura fault zone. In this area, the Kita-tango earthquake occurred in 1927. This study is the request from Ministry of Education, Culture, Sports, Science and Technology. The main purpose of this study is to clarify the following four points; (1) offshore continuity of the fault zone; (2) the total length of the fault zone; (3) division of the fault segments; and (4) characterization of recent faulting. In the present investigation, 20 lines of high-resolution multichannel seismic reflection surveys were carried out across the Tango Peninsula northwest offshore fault to recognize detailed structures of shallow strata. In addition, the high accuracy topography survey was executed in the coast region where the basement rock was exposed. Furthermore, the sampling of sediments with the pistoncoring was conducted to constrain the sedimentation age. The reflection profiles depict the faults with extremely clear images. The displacement of sea floor and the deformation of Quaternary layer were recognized, and the intermittent displacement of sea floor was identified in the place where basement rock is exposed. Many faults extend to the NNW-SSE direction, and some of the faults extend to the NE-SW or E-W direction. They may conjugate fault. Given the existing data and the results of these surveys, on an offshore extension of the Goumura fault zone, active structure extends to about 40km length is estimated.

Keywords: Goumura fault, Kita-tango earthquake, offshore, active structure, high-resolution multichannel seismic reflection surveys, high accuracy topography survey

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SSS35-16 Room:303 Time:May 22 15:30-15:45

Coseismic surface rupture length produced by the 2008 Mw 7.9 Wenchuan earthquake, the Longmen Shan Thrust Belt, China

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The magnitude (Mw) 7.9 (Ms 8.1) Wenchuan earthquake occurred on 12 May 2008 and ruptured active faults of the Longmen Shan Thrust Belt (LSTB), which marks the boundary between the eastern margin of the Tibetan Plateau and the Sichuan Basin. Although many studies of the 2008 Mw 7.9 Wenchuan earthquake have described the ground deformation features, rupture mechanism, and structural features of the seismogenic fault zone associated with this event, debate remains concerning the total length of the co-seismic surface rupture zone and whether the earthquake ruptured the Qingchuan Fault in the northeastern segment of the Longmen Shan Thrust Belt (LSTB), China. Based on our initial fieldwork carried out 2 days after the 2008 Wenchuan earthquake, we reported that the earthquake produced a ˜285-km-long surface rupture zone along the LSTB, at the eastern margin of the Tibetan Plateau, dominated by thrust slip and right-lateral displacement along the central and northeastern segments of the zone, and by left-lateral displacement along the southeastern segment (Lin et al., 2009, 2010). However, other field-based studies have reported that the total length of the co-seismic surface rupture zone is 200?240 km and that the Qingchuan Fault was not ruptured by the Wenchuan earthquake (e.g., Liu-Zeng et al., 2009; Xu et al., 2009; Yin, 2010; Zhang et al., 2010). The length of surface rupture produced by large, individual earthquakes is a key parameter in assessing the seismic moment, the rupture mechanism, the degree of seismic hazard, and the activity of a seismogenic fault, including the recurrence interval of large earthquakes and the long-term slip rate. Therefore, additional work is needed to constrain the length of the co-seismic surface rupture and the location of rupture termination at the northeastern segment of the LSTB, in order to accurately assess the nature of the seismic hazard in the densely populated Sichuan region of China.

In this study, we present new field evidence that the Qingchuan Fault was ruptured by the 2008 Wenchuan earthquake and that the total length of the co-seismic surface rupture zone is up to 285?300 km. Field investigations reveal that the earthquake produced a ?60-km-long surface rupture zone along the pre-existing Qingchuan Fault, with the offset being mainly right-lateral strike-slip and a distinct component of vertical slip. Co-seismic surface ruptures are characterized by faults and extensional cracks. Field measurements indicate co-seismic right-lateral strike-slip displacements along the Qingchuan Fault of 0.3?0.6 m and vertical offsets of 0.2?0.5 m, which differs to the displacements observed along the central and southwestern segments of the Wenchuan surface rupture zone in the displacement amount and sense. The change in slip sense from thrust-dominated slip in the central and southwestern segments of the LSTB to right-lateral strike-slip-dominated displacement along the Qingchuan Fault (northeastern segment of the LSTB) reflects a change in the orientation of compressive stress along the LSTB, associated with eastward extrusion of the Tibetan Plateau as it accommodates the ongoing penetration of the Indian Plate into the Eurasian Plate.

Reference:
Lin, A., Rao, G., and Yan, B., 2012. Field evidence of rupture of the Qingchuan Fault during the 2008 Mw7.9 Wenchuan earthquake, northeastern segment of the Longmen Shan Thrust Belt, China. Tectonophysics, DOI: 10.1016/j.tecto.2011.12.012 (in press).

Keywords: 2008 Wenchuan Earthquake, coseismic surface rupture, Qingchuan Fault, Longmen Shan Thrust Belt, active fault, Tibetan Plateau

Japan Geoscience Union Meeting 2012
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SSS35-17 Room:303 Time:May 22 15:45-16:00

Along-strike variation of seismic behavior of the Philippine fault

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The Philippine fault is a 1250-km-long, left-lateral strike-slip fault extending NNW parallel to the Philippine archipelago. This fault has been very active in the past 100 years with several destructive earthquakes accompanied by surface rupture. There is notable along-strike variation in historical- and paleo-seismicity of the Philippine fault that seems to be composed of locked, transition, and creeping sections. The along-strike variation of seismic behavior of the Philippine fault may be in part controlled by variation of thickness and rigidity of seismogenic crust along the fault. The Philippine fault crosses the volcanic front related to the Philippine Sea plate subduction at the latitude of Leyte Island where there are many geothermal fields along the fault. The seismogenic brittle crust in Leyte Island may be thin and thus elastic strain may not accumulate to produce large earthquakes.

Keywords: Philippine fault, historical earthquakes, trenching, size and interval of surface-rupturing earthquakes, creeping

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SSS35-18 Room:303 Time:May 22 16:00-16:15

Evidence of Late Holocene subsidence and tsunami deposit from west coast of Andaman Island, Andaman and Nicobar Islands

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[1]IIT KANPUR

Evidence of Late Holocene subsidence and tsunami deposit from west coast of Andaman Island, Andaman and Nicobar Islands

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The Tirur village located about 1.5-2.0 km inland along the western coast of Andaman experienced marginal subsidence during 2004 Sumatra-Andaman earthquake. The area was found inundated during 2005. In 2009-10 we observed that the area was transformed to tidal-marsh. To identify the signatures of past seismic events if any preserved in sediment stratigraphy 2-3 trenches were dug and 3 geoslice sections were obtained from Tirur. At Tirur the exposed stratigraphic section in trenches and geoslices revealed occurrence of a thick (˜40 cm) peaty unit - probable represents tidal-marsh or wetland. At places the peaty unit is disturbed by intrusion of sand dykes, caused by liquefaction due to strong ground shaking during Event (I) as well as bio-turbation. About 12-15 cm thick poorly stratified unit comprised of peat+medium-fine sand above peaty unit suggests deposition during subsequent phase of deposition after the event, probably in a tidal-marsh/intertidal environment (?). The area experienced subsidence which could be justified by the overlying silty-clay unit suggestive of intertidal condition. The sediment sequence in the upper section with silty-sand and a peaty unit suggests gradual change from intertidal to tidal and to marsh or wetland. This could be related to gradual emergence of the area during interseismic period. Finally the area was again subsided during 2004 Sumatra-Andaman earthquake, again getting converted to tidal-marsh. AMS of rhizome and charcoal, OSL age of the sediments suggests that the Event-I occurred during 3000-3500 yr BP and a gradual uplift during 1100-230 yr BP. Two geoslices samples obtained from Collinpur-char village located along the coast of South Andaman Island revealed occurrence of multiple layered tsunami events. Our preliminary inference suggests that at least 2-tsunami (??) events that occurred during 3800 yr BP and 1200 yr BP.

Keywords: Earthquake, Tsunami, Andaman, Sediment, Subsidence, OSL Dating

Japan Geoscience Union Meeting 2012
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SSS35-19 Room:303 Time:May 22 16:15-16:30

Active tectonics and paleoseismology of the Himalayan front in the Kangra–Dharmsala area

OKUMURA, Koji[1*], MALIK, Javed N.[2], DIKSIT, Onkar[2], KATO, Teruyuki[3], SAHOO, Santiswarup[2], PASARI, Sumanta[2], MOHANTY, Asmia[2], TAKEMOTO, Hitomi[1]

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Along the Himalayan front in India, the giant earthquakes from the plate-boundary megathrust and the hanging-wall intra-plate earthquakes just north of the boundary are significant threat to the great popolation and industries. Recent economic growth of India has raised the vulnerability of the reagion much higher, but there is not enough information to prepare for earthquake hazards. It is due to the lack of historic and geologic information on past earthquakes. In order to improve the preparedness and to reduce hazards from the earthquakes along the Himalayan front, we have been collecting information on past earthquakes in the region. In 2010–2015, the research is carried out within a research project of the SATREPS: Science and Technology Research Partnership for Sustainable Development by the Japan Science and Technology Agency (JST) and the Japan International Cooperation Agency (JICA). The project titled ”Information Network for Natural Disaster Mitigation and Recovery” aims at better preparedness and emergency response for severe natural hazards in India. Indian Institute of Technology at Kanpur, Tokyo University, and Hiroshima University jointly carried out the study on active tectonics and paleoseismology of the region. In 2010 and 2011 we conducted survey in Kangra–Dharmshala area, Pinjaur area, Hajipur area, and Ramnagar area. In the Kangra–Dharmshala area, a newly found active fault, Kangra Valley fault was surveyed into details using RTK-GPS and GPR. The results will be reported together with the results from trenching in March, 2012.

Keywords: paleoseismology, active fault, India, Himalay, trenching

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SSS35-P01 Room:Convention Hall Time:May 22 18:00-19:30

Color analysis of a fault rock aiming at the new dating method of a fault

MURAKAMI, Masaki[1*], SATO, Fumi[1], MARUYAMA, Michiko[1], Kanae Kaida[2], Takafumi Uzawa[2], Shotaro Sezaki[2], Jun-ichi Uchida[3], Yoko Michiguchi[3], Hideaki Tsutsumi[3]

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Color analysis of rocks was first performed by Nagano and Nakashima (1989) in order to measure degrees of weathering on the surfaces of granitic rocks. Because color change depends on degree of alteration, color analysis has been applied in studies of landslides, weathering in borehole samples, and so on. Miyashita et al. (JPGU, 2011) applied color analysis to fault rocks in Tottori-ken Seibu area, and found the differences of color trend in the a∗-b∗ color maps between two linearments in the area. They presumed that the differences depended on the activity of faults. In this study, color analysis was performed in four fault zones (Awaji, Goumura, Yamasaki and Kego-Nishiyama) in Japan. As a result, distributions of obtained color data were different among four fault zones.

Keywords: fault rocks, dating, color analysis

Japan Geoscience Union Meeting 2012
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SSS35-P02 Room:Convention Hall Time:May 22 18:00-19:30

Surface fault traces of isolated short faults and their subsurface structure

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Length of active faults are one of the important parameters for the evaluation of the size of earthquakes. In some case, longer seismogenic faults may exist beneath the isolated short faults. Here ”Isolated short fault” is defined as 1) separated from other active faults $>$ 5 km and 2) its length is shorter than 15 km. Affected faults are picked up from the active faults maps of Japan published by the Research Group for Active Fault of Japan (1991) and Nakata and Imaizumi (2002). We checked the surface fault trace using large scale airphotos and the relationships in the length between the surface trace of active faults (Ls) and subsurface structures inferred from the geological faults (Lgl) and the gravity anomaly distributions (Lgv). Based on the surface trace analysis, 47 faults could be elongate than those in previous maps and average of ”Extended Ratio” is calculated as 1.64. About the subsurface structures, average of ”Extended Ratio” is 1.69 (Lgl/Ls) and 2.01 (Lgv/Ls), respectively. These value means average ratio of the part of the indistinct surface fault trace along the isolated short faults. This study was apart of the project supported by JNES in 2010FY.

Keywords: active fault, isolated short fault, subsurface structure, size of earthquake, active fault evaluation

Japan Geoscience Union Meeting 2012
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SSS35-P03 Room:Convention Hall Time:May 22 18:00-19:30

Geological evidence of development of fault related fold in and around Horonobe hill

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[1]JAEA Horonobe unit

Evaluation of effect of fault zone is one of the important issues in the geological isolation of high-level radioactive wastes. Based on the result of the geological data in and around the northern Hokkaido Horonobe hill, the outline is examined about changes of the depositional environment in the past about 3 million years, and the relation with the development process of a fault related fold is considered.

Keywords: fault related fold, facies, fault and fold zone, anticline, syncline

Japan Geoscience Union Meeting 2012
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SSS35-P04 Room:Convention Hall Time:May 22 18:00-19:30

Paleoseismological survey on the seaward extension of the active fault along the western margin of the Hakodate Plain

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Active reverse fault zone including the Oshima-Ono Fault and the Tomikawa Fault locate between the Kamiiso Hills and Hakodate Plain. Late Quaternary marine terraces in several levels are distributed along the southwest coast of the Hakodate Plain. Their heights of marine terraces show the amount of uplift since the late Quaternary. We have conducted an integrated survey of the coastal area of Hakodate Bay, as a part of the 2011 offshore active fault survey project funded by MEXT, in order to understand distribution and paleo-seismicity of offshore active fault and fold in Hakodate Bay. The survey comprises high-resolution multichannel sonic survey, ultra-high-resolution single-channel sonic survey and paleoseismological vibro coring. The stacked time sections show that the submarine active faults with west-side-up extend NW-SE to NS trend in the Hakodate Bay. These characteristics of the submarine active faults suggest that the faults are southern extension of the Tomikawa Fault. Precise interpretation of the sonic profiles tied with core leads to an inference that the paleoseismic event occurred during the Holocene.

Keywords: offshore active fault, Hakodate Bay, high-resolution sonic survey, coring, Paleoseismicity

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SSS35-P05 Room:Convention Hall Time:May 22 18:00-19:30

Active fault segmentation and structural development of the eastern flank of the Ou Backbone Range, northeast Japan

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The Kitakami Lowland fault zone (KLFZ) is an active reverse fault zone that extends for more than 70 km in length. KLFZ can be classified into south and north areas, bordering around the Waga River. In the north area, active faults developed along the eastern flank of the Ou Backbone Range (OBR). In the south area, active faults are divided into along the eastern flank of the OBR and in the Kitakami Lowland. Several deep seismic profilings have proved structural development intersect at right angles to the arc. But structural development direction parallel to the arc has been little investigated.

In light of recent E-W trend stress field since Pleistocene time in the northeast Japan arc, geomorphological and geological maps showing the detailed distribution since Pliocene time are keys to show the changes of the structural development. In order to connect geomorphic and geologic data to crustal deformation, it is important that the shallow branched fault is investigated, in that many active reverse fault zones form branched fault in the shallow depth and a variety of surface deformation. The objectives of this thesis are: 1) investigation geomorphology and Geology at the surface of several active fault traces consisting the active fault zone, 2) estimation of subsurface structure and its development associated with active fault trace, and 3) discussion of the difference of crustal deformation between the north and the south area.

Active faults were mapped on the basis of geomorphological and geological maps. Investigation of tectonic geomorphology and fault outcrop provided a variety of surface deformation and activity of the active faults. Subsurface geological structure and its development of the active faults were interpreted, based on shallow seismic reflection profiling, gravity survey in some location. Subsurface geometry of fault model was constructed from amount of shortening and shape of deformation using area balancing method. Strike, location and range of the fault model were inferred from tectonic geomorphic and geologic structure.

As a result, KLFZ and active fault around it are consisted two categories in the north area and four categories in the south area. Location and structure of the fault models should be studied further, but the results of subsurface structure and its development indicate that consecutive active fault zone of the surface is composed by several fault formed by different structural development.

1) In comparison with those (shortening: $<$0.5 km/2 Ma, length: 10-15 km) in the Kitakami Lowland, amount of shortening and length of the fault model below the OBR (shortening: 1-2 km/2 Ma, length: 10-20 km) are large. This different indicates that displacement due to faulting along the volcanic front (OBR), have accumulated at a rate of 101 orders than that of the Kitakami Lowland.

2) In comparision with those in the south area, amount of shortening and length of the fault model in the north area are large. It should be noted that the largest fault model (Uwandaira fault group and Yokomoriyama fault, 1896 Rikuu Earthquake; M7.2) is located the area which the Quaternary volcano is not distributed in the volcanic front.

3) Main active fault is distributed along a steep Bouguer anomaly gradient, northern part of the Morioka-Shirakawa tectonic line, and in and around the low velocity zone of the lower crust by seismology.

Structural development difference between the north and south area, seismogenic fault of historic earthquake, Bouguer anomaly map, distribution of Quaternary volcano, and crustal heterogeneity suggest that development of active fault is controlled by basement structure, distribution of Quaternary volcano, and crustal heterogeneity. It is suggested that segment of active fault of the surface is controlled by these factors.

Keywords: Kitakami Lowland fault zone, seismic reflection profiling, area balancing method, slip rate, amount of shortening

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SSS35-P06 Room:Convention Hall Time:May 22 18:00-19:30

Long-term activity and paleoseismicity of the Warikurayama fault along the southeastern foot of the Mahiru Mountains, no

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We conducted geological and topographical surveys of the Warikurayama fault along the southeastern foot of the Mahiru Mountains in northeast Honshu, Japan, to examine its structure, long-term activity and palesoseismicity. We confirmed that the fault is a reverse fault of 17 km-long. The fault having a 5 km-long south-central section, which is predominant in reverse fault component, and 9 km-long northern and north-central, and 3 km-long southern segments predominant in flexure component. A cumulative vertical displacement along the fault shows bow-shaped distribution up to 1,100 - 1,400 m since the late Pliocene or early Pleistocene. Terrace surfaces in the middle to late Pleistocene and Holocene are also cumulatively deformed and faulted along the 11 km-long central section of the fault. Terrace surfaces of 20 ka and 30-35 ka show about 4 m of vertical offset, and terraces younger than 3 ka show about 2 m of vertical offset. We conclude that the Warikurayama fault is a single behavioral segment, which has ruptured twice since 20 ka with 2 m of vertical slip per event. The most recent event of the fault probably occurred after 3 ka, and possibly in 16th century or later. An average slip rate of the fault since the late Pliocene or early Pleistocene is 0.5 to 0.9 m/ky or larger, whereas the slip rate since 30-35 ka decreases at 0.1m/ky.

Keywords: Mahiru-sanchi Toen fault zone, active fault, long-term slip rate, slip per event, paleoseismicity, 1896 Rikuu earthquake

Japan Geoscience Union Meeting 2012
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SSS35-P07 Room:Convention Hall Time:May 22 18:00-19:30

Source fault model of Northern Honshu, Japan

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Constructing source fault model is significant for estimation of strong ground motion and evaluation of crustal activity, including seismicity and crustal deformation. Surface ruptures and crustal deformation associated with large earthquakes produces tectonic geomorphology and geologic structure. Thus, using active fault and fold data, we can estimated seismogenic source faults. However, in some cases, no surface ruptures are observed associated with large earthquakes. Particularly, in the fold-and-thrust belt of Northern Honshu, the existence of shallow detachment in the Neogene post rift mudstone, makes the relationship between deep sited seismogenic source fault and near surface active fault complicated due to thin-skinned deformation processes. Present days geologic structure is strongly controlled by old geologic structure. In case of Northern Honshu, Miocene rifting associated with the opening of the sea of Japan, strongly controlled the geometry of sesimogenic source fault. It is indicative by the recent result of the deep seismic profiling in the Niigata area and investigation of source fault associated with the 2003 Northern Miyagi earthquake. For constructing a source fault model, an integrated, multi-deciplinary approach is needed, including geologic and crustal architecture and seismicity. Here, we examined the active fault data, with geologic structure, gravity anomaly data, seismicity and constructed rectangular fault models in Northern Honshu. It is a first attempted to provide regional models by integrated way of approach. It is a very first version and it will be updated by the increased information in the future.

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SSS35-P08 Room:Convention Hall Time:May 22 18:00-19:30

Estimation of causative faults producing crustal warping in the Nishi-tsugaru Coast, Northeast Japan

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The Nishi-tsugaru Coast, Northeast Japan, has experienced co-seismic shoreline uplifts associated with two historic earthquakes (either M6.9)which occurred in 1704 AD and 1793 AD (Imamura,1920; .Usami,2003). Although each offshore causative fault model was proposed to explain the height distribution of co-seismically emerged abrasion platforms by Nakata et al. (1976) and the small tsunami generation (Sato, 1980), neither models did not coincide with active tectonic structures and topography. We renewed Quaternary paleoshoreline data and reconsidered their uplift processes. The obtained results are as follows.

(1) Warping of Holocene and Pleistocene shorelines is not necessarily concordant with that of historical coseismic uplifted abrasion platforms, and is accompanied with at least 6 upwarped units having short wavelength, bounded by height discontinuities. This suggests the accumulative process by activities of plural fault segments.

(2) Geologic faults exist at boundaries of warped units. This indicates that those fault activities is related to warping and height discontinuities. Especially, the deformation is possibly produced by the growth of fault-related fold.

(3) At least 7 reverse fault segments are required in and around coastal areas, to create warped units. Calculating the dislocation by each fault, paleoshoreline warping is nearly reproduced.

(4) Several A- and B- class active source faults are newly recognized in land and below the offshore sea bottom. Re-assessments and to those faults and the caution to next hazardous earthquakes are necessary.

Keywords: paleoshoreline, warping, hisitorical earthquake, causative fault, fault-related fold, Nishi-tsugaru coast

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SSS35-P09 Room:Convention Hall Time:May 22 18:00-19:30

High resolution seismic reflection profiling in Gotemba, central Japan

ISHIYAMA, Tatsuya[1*], KATO, Naoko[1], SATO, Hiroshi[1], IMAIZUMI, Toshifumi[2], TODA, Shigeru[3], KATO, Hajime[4], ECHIGO, Tomoo[5]

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We collected and processed shallow high-resolution seismic reflection data in Oyama Town and Gotemba City, Shizuoka Prefecture, in order to resolve structures andactivity of shallow blind thrust faults buried beneath thick volcaniclastics deposits derived from the Hakone and Fuji volcanoes. We deployed 200 seismic channels, 10-Hz geophones, and mini-vibrator as a seismic source along about 8-km-long seismic line. Common midpoint stacking by use of initial velocity analysis successfully illuminates subsurface geometries of active fault-related fold to 1-1.5 two-way time. Detailed seismic reflection analyses including refraction and residual statics, migration, deconvolution, and time-space variant bandpass filters, and depth-conversion by use of stacking velocities enable to obtain subsurface depth section of these thrust structures. The high-resolution depth section shows that Southwestern extension of the Tanzawa group is thrust over Pleistocene Ashigara Group and younger sediments buried between the Fuji and Hakone volcanoes. Upper tip of the thrust is located at ca 25 m deep beneath the Gotemba mudflow deposits and is possibly active during the late Quaternary. In addition, Ashigara Group is also thrust over the younger sediments (uQt) speculatively correlated with middle to upper Pleistocene Ikudo Formation, Suruga gravel deposits and undefined younger deposits. Angular unconformity between these units is recognized in the seismic section. Additionally upward-decreasing dips in the uQt over the forelimb indicates recent activity of this blind thrust fault during the deposition of the uQt.

Keywords: active fault, Izu collision zone, blind thrust fault, Fuji volcano, Hakone volcano, seismic reflection profile

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

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Numerical simulation of Kureha-hill formation by means of discrete element modeling

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The Kureha-hill is characterized by anticline structure and it is known that the hill formed by inversion tectonics of the Kureha-yama fault. The Kureha-yama fault is located at the eastern edge of the Kureha-hill and had acted as normal fault (middle Miocene) and reverse fault (Pleistocene). In the late Miocene, the fault had not acted and thick sedimentary layer was formed on its hanging wall. In this study, we employed the software PFC 2D (2 dimensional particle flow code) based on 2D discrete element method, and attempted to discuss the forming processes of the Kureha-hill given by geological studies from the viewpoint of mechanics.

As a soft sedimentary layer, we prepared the modeled layer that the particles (rigid disk) having density and radius of 2000kg/m^2 and of 9.0 - 9.75 m were packed with porosity of 0.1 in the area where width and depth are 4000 m and 400 m. We assumed Young's modulus of 161 MPa, Poisson's ratio of 0.28, compressive strength of 20 MPa, tensile strength of 1 MPa and shear strength of 2 MPa, as elastic constants and strength of the soft sedimentary layer. Thus, we set up the normal stiffness of 5 x 10^{7}N/m, the shear stiffness of 7 x 10^{8}N/m, the frictional coefficient of 0.6 and the contact bound of 1 MN. And we assumed that the bottom part of the sedimentary layer is basement and it behaves as rigid body. The Kureha-yama fault was modeled as a simple fault with constant dip angle of 50 degrees because it is found by previous geological survey and geophysical prospecting.

As a result, it was found the basic structures of the Kureha-hill could be restored by numerical simulation and that geological discussion on formation of the hill was correct mechanically. In addition, we found (1) top of the Kureha-yama fault would have reached at the surface when the fault had acted as normal fault, and (2) large deformation of the basement is required for forming anticline structure.

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Holocene surface faulting on the western segment of the Tonami-heiya fault zone, Toyama Prefecture

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Constraining the timing and characterizing the deformation style of individual past surface-rupturing earthquake events, particularly those of the recent events are important for better evaluating future probability of large earthquakes generated from inland active fault zone and for assessing seismic hazard. The western segment of the Tonami-heiya fault zone (active fault zone along the western margin of the Tonami Plain), which composed of two NNE-SSW-trending west-dipping reverse faults; the Horinji fault on the south and Isurugi fault on the north, is one of the major active fault zones in Hokuriku region. Late Quaternary faulting is delineated by tectonic geomorphic expression and Plio-Pleistocene stratal deformation, but its Holocene faulting behavior is poorly known. In order to clarify the Holocene activity we have conducted detailed geologic and tectonic geomorphic investigations at selected sites, including trenching and arrayed drilling helped by archeologists for age determination of pottery shards incorporated into strata. On the trench walls across the Horinji fault at Horinji site, Nanto City, distinct west dipping main thrust faults with a series of east-dipping back thrusts displacing late Pleistocene to Holocene strata were exposed. Principal deformation in the trench walls is incremental rotation and/or warping of strata on the hanging wall side of the main thrust associated with horizontal shortening. Multiple paleoseismic events were identified based on stratigraphic and structural evidence of paleoearthquake events such as angular unconformity and cross cutting relations of strata and faults. Cross cutting relations of two sets of oppositely dipping faults and radiocarbon dates from faulted strata suggest that the at least two paleoearthquakes occurred after ca 5.7 ky ago, which raises the possibility that this fault was responsible for the enigmatic 1586 Tensho earthquake. Detailed examination of back thrusts exposed in the trench walls at Kamimukuta site, Takaoka City, reveals first direct evidence of the late Holocene faulting on the Isurugi fault. One of three subparallel strands of back thrust displaces channel-fill sediments containing abundant pottery fragments and covered by black soil layer. Archeological examination and radiocarbon dating indicate that the latest faulting on this strand occurred between ca 4 ka and ca 2 ka. These new findings would contribute to refine evaluation of future probability of earthquakes generated from this fault zone. This research was conducted as an entrusted project from Ministry of Education, Culture, Sports, Science and Technology.

Keywords: paleoseismology, active fault, Holocene, Horinji fault, Isurugi fault, Toyama Prefecture

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Comprehensive research on the Uemachi fault zone (2)

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The Uemachi fault is running beneath the Osaka sedimentary basin, which is the secondary large populated area in Japan. Our research group has started to study the Uemachi fault zone in detail to get the information for developing the long-term earthquake evaluation and the strong ground motion prediction. Our research group consists of four sub-research groups for (1) research on detail trace for fault segments, (2) research on three-dimensional source fault and crustal velocity structure, (3) research on fault activity and average dislocation velocity, and (4) research on strong ground motion prediction. We introduce the research plan of this study for FY2010-2012 (SSJ fall meeting, 2011). Here we will show several research results till this period.

Keywords: Uemachi fault zone, active fault survey, long-term evaluation, strong motion evaluation

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SSS35-P13 Room:Convention Hall Time:May 22 18:00-19:30

Preliminary results of tectonic geomorphological and geological researches on the Uemachi fault zone in Osaka, Japan

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We re-examined the distribution and shallow fault structure of the Uemachi fault zone. The Uemachi fault zone extends in the densely built-up area of Osaka and surrounding region, therefore, the long-term forecast of the future large earthquake and the strong ground motion prediction is necessary to evaluate various aspects for seismic hazards assessment. We conducted precise mapping of tectonic geomorphological features by tectonic geomorphological and geological survey including airphoto interpretations, geomorphological analysis using high-resolution LiDAR DEMs, extensive field work and re-evaluation of previous data. The newly-found evidence for tectonic geomorphic features is summarized as follows. Firstly, the high-resolution DEMs and related field works successfully revealed the distribution of uplifted delta relief along the northern portion of the Uemachi fault zone, which was estimated as concealed active faults in precious studies. The carbon 14 ages obtained from the top-set delta deposits, ~2500 y.B.P, probably postdate the timing of the most recent paleoearthquake. Secondly, previous studies mapped the distribution of the Sakuragawa flexure and the Suminoe flexure beneath the city central of Osaka as two blanching faults apart from the main Uemachi fault zone, however, we proposed these flexures are connected into single shallow structure as a sub-parallel frontal flexure zone along the main fault zone. The spatial distribution of flexures and the shallow fault structure are inferred from the borehole stratigraphy data as well as probable uplifted alluvial lowland shown in the high-resolution DEMs relief images. Thirdly, we re-examined the existence of the inferred active fault along the present coast line, extending far southwest from the southern termination of the Uemachi main fault zone. Along the estimated fault trace, the deformed fluvial/marine terraces are partly recognized as fault bulge or pressure ridge and back-tilt toward the mountain side. These tectonic geomorphic features support the existence of the inferred active fault along the coast line, in accordance with the cumulative deformation of anticline/monocline in Plio-Quaternary sediments imaged by P-wave seismic reflection survey. The spatial extent of the fault trace along the coast line and deeper fault structure is necessary to be further explored for seismic source models and the following strong ground motion simulations.

Keywords: active fault, paleoseismology, Uemachi fault zone

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Deep subsurface structure of the Uemachi fault zone inferred by 3-dimensional balancing geological structural analysis

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We constructed a 3-dimensional fault model of the Uemachi fault zone based on 3-dimensional balancing geological structural analysis. The Uemachi fault zone is located in the center of the Osaka Plain in central Japan. We analyzed the deformation of the strata in the study area using the 3DMove in Move2011 (Midland Valley Exploration Ltd.).

Keywords: active fault, reverse fault, Uemachi fault zone, Osaka Group, fault-related fold, 3-dimensional balancing

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SSS35-P15 Room:Convention Hall Time:May 22 18:00-19:30

Subsurface flexure of Uemachi Fault

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[1]Kyoto Univ., [2]Geo-Reserch Institute, [3]Osaka City Univ., [4]Osaka Prefecture Univ.

In Osaka, Uemachi Fault is one of the famous active faults. It across the center of Osaka and lies in N?S direction mainly and is more than 40 km in length. Pliocene to Quaternary sediment 'Osaka Group' and terrace sediment are found to be deposited in the Osaka Plain and Holocene marine clay layers (Ma13) are covered these plains in order to sea level change. These sediment are very thick layers over 1000m therefore, fault structure are appeared as flexure zone (only vending the strata) and hidden the fault displacement around the surface. The up side on the fault (east side) is modified by erosion and urban development however, many seismic reflection surveys information the fault trace line on a piecemeal basis.

GI database collects more than 40,000 boreholes and includes both geological information and soil properties around Osaka by the Geo-database Information Committee of Kansai Area. In this study, we try to show the flexure zone around central Osaka area and decided the site of borehole drilling site and carried out the survey in order to decide the displacement rate of Uemachi fault. About 2500 borehole data exist in the fault area and made many section using GI base.

In this study, we carried out the drilling the borehole and sampling the core samples in the Sakuragawa flexure zone. About 120m deep core sample were analyzed by tephrochronological method, and correlated around borehole data. Ma5, Ma6 and Ma8 marine clay layers are correlated. The result of compare with the neighbor area, the average displacement speed indicates more active the Sakuragawa flexure rather than Uemachi fault zone. And the results of this drilling indicate the good information to correlate other borehole data around this area.

Acknowledgment: This research is funded by the integrated research project for the Uemachi active fault system in FY2011 by MEXT.

Keywords: Osaka, Uemachi Fault, marine clay, flexture structure

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Deformation of a thick sedimentary layer caused by dip-slip motions of the faults reaching to an interior of the layer

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We employed the software Particle Flow Code in 2D (PFC 2D) based on discrete element modeling and attempted to simulate deformations of a thick sedimentary layer caused by dip-slip fault motions. In this study, we discussed (1) effects of which the dip-slip motions of the faults reaching from the basement to an interior of sedimentary layer deform an interior and surface of the layer, and (2) effects of frictional coefficient between the fault plane and the particles.

The 2D discrete element modeling represents an arbitrary medium by an aggregate of rigid disks and its elasticity is described by connecting each disk by elastic springs. Young's modulus and Poisson's ratio are decided by spring constants in a computer. In 2D analysis, magnitudes of spring constants and contact bonds are set by the biaxial compression test. In this study, because we evaluate behaviors of soft sedimentary layers, we assumed Young's modulus of 207 MPa, Poisson's ratio of 0.24 and the compressive strength of 13 MPa. In order to represent these elastic constants and strength, we set each spring constant (normal direction and shear direction) of 500 MN/m, frictional coefficient of 0.6, the contact bond of 1 MN.

In the simulations, the sedimentary layer modeled with depth of 900 m and width of 5000 m was assumed and the basement under the layer is the rigid body. We moved the basement to vertical direction till depth of 600m from the surface. We considered the cases that the fault will reach to the depth of 810m, 720m, 530m, 450m, 180m and 0m from the surface, in the simulations. And, we assumed 0.6 and 0.06 as the frictional coefficient between the fault plane and the particles in each case.

As a result, it was found that the depth of tip of the fault affected the geometry of sedimentary layer and the deformation zone at the surface. If the fault tip reaches to thickness (450 m) of 50 % of the sedimentary layer from the basement rock, the fault motion made the interior deformation field that is different from the field caused by the motion of the fault without its extension to the layer. If the fault tip reaches to thickness more than 80 % of the sedimentary layer from the basement rock, the fault motion made the interior and surface deformation field that are different from the field caused by the motion of the fault without its extension to the layer. And, the difference of the frictional coefficient between the fault plane and the particles also affected the geometry of sedimentary layer and the deformation zone at the surface. If the fractional coefficient is large, it was found the structures of which the sedimentary layers around the fault were dragged toward the directions of the fault motions. If the fractional coefficient is small, it was not found the structures mentioned above. These characteristic structure described here appeared only under the condition of which the fault tip reaches to thickness more than 50 % of the sedimentary layer from the basement rock. If the fault tip reaches to thickness less than 50 % of the sedimentary layer from the basement rock, these structures did not appear in the sedimentary layer simulated.

Acknowledgement: This research is funded by the integrated research project for the Uemachi active fault system in FY2011 by MEXT.

Keywords: Numerical simulation, Discrete element method, PFC 2D, Fault reaching to an interior of sedimentary layer, Fault motion

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Stratigraphy about UHM22-1 core and activity of Uemachi Fault

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[1]Geo-Research Institute, [2]Kyoto Univ., [3]Osaka City Univ.

In Osaka, Uemachi Fault is one of the famous active faults. It across the center of Osaka and lies in N?S direction mainly and is more than 40 km in length. Pliocene to Quaternary sediment 'Osaka Group' and terrace sediment are found to be deposited in the Osaka Plain and Holocene marine clay layers (Ma13) are covered these plains in order to sea level change. These sediment are very thick layers over 1000m therefore, fault structure are appeared as flexure zone (only vending the strata) and hidden the fault displacement around the surface. The up side on the fault (east side) is modified by erosion and urban development however, many seismic reflection surveys information the fault trace line on a piecemeal basis. One of the subway construction project across the fault, are carried out the many borehole drilling survey around the fault. It is the good case to understand the subsurface structure around fault.

KG-Net borehole database has more than 20,000 borehole data around Osaka. At first, we examined the borehole data along the seismic reflection line. And then consider the surrounded area. As a result, folding zone is distributed in the west side of Osaka area. We carried out the drilling the borehole and sampling the core samples in the Sakuragawa flexure zone near JR Nanba station (UMH22-1). About 120m deep core sample were analyzed by tephrochronological method, and correlated around borehole data. Ma5, Ma6 and Ma8 marine clay layers are correlated. The result of compare with the neighbor area, the average displacement speed indicates more active the Sakuragawa flexure rather than Uemachi fault zone

Acknowledgment: This research is funded by the integrated research project for the Uemachi active fault system in FY2011 by MEXT.

Keywords: Osaka, Uemachi Fault, marine clay, Osaka Group, tephra

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Relationship between displacement and gravity change of Uemachi Faults and surrounding faults of Osaka basin, Southwest

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The Osaka basin surrounded by the Rokko and Ikoma Ranges is one of the typical Quaternary sedimentary basins in Japan. The Osaka basin has been filled by the Pleistocene Osaka group and the later sediments. Several large cities and metropolitan areas, such as Osaka and Kobe are located in the Osaka basin. The basin is surrounded by E-W trending strike slip faults and N-S trending reverse faults. The N-S trending 42-km-long Uemachi faults traverse in the central part of the Osaka city. The Uemachi faults have been investigated for countermeasures against earthquake disaster. It is important to reveal the detailed fault parameters, such as length, dip and recurrence interval, so on for strong ground motion simulation and disaster prevention. For strong ground motion simulation, the fault model of the Uemachi faults consist of the two parts, the north and south parts, because of the no basement displacement in the central part of the faults.

The Ministry of Education, Culture, Sports, Science and Technology started the project to survey of the Uemachi faults. The Disaster Prevention Institute of Kyoto University is carried out various surveys from 2009 to 2012 for 3 years. The result of the last year revealed the higher fault activity of the branch fault than main faults in the central part. Kusumoto et al. (2001) reported that surrounding faults enable to form the similar basement relief without the Uemachi faults model based on a dislocation model.

We performed various parameter studies for dislocation model and gravity changes based on simplified faults model, which were designed based on the distribution of the real faults. The model was consisted 7 faults including the Uemachi faults. The dislocation and gravity change were calculated based on the Okada et al. (1985) and Okubo et al. (1993) respectively. The results show the similar basement displacement pattern to the Kusumoto et al. (2001) and no characteristic gravity change pattern. The Quantitative estimation is further problem.

This research is funded by the Comprehensive Research on the Uemachi Fault Zone (in FY2011) by MEXT.

Keywords: Uemachi fault, gravity anomaly, dislocation model

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Paleoseismicity on the Sami and Shirakawa faults in the Atera fault system, eastern Gifu prefecture, central Japan

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The Atera fault zone in the eastern Gifu prefecture consists of the Hagiwara, Gero, Yugamine and Atere faults extending in the NW-SE direction with left-lateral stike slip, and the Sami and Shirakawa faults extending in the NE-SW direction with right-lateral strike slip. The Earthquake Research Committee evaluated that the probability of the earthquake occurrence in the future on the Sami and Shirakawa fault zones is unknown because of the luck of paleoseismological data. We carried out paleoseismological studies on the Sami and Shirakawa faults to evaluate the rupture probability in the future of these faults, using the fund of the Ministry of Education, Culture, Sports, Science and Technology. Three trenches were excavated at the Kono site on the Sami fault, and one trench on at the Nishibora site on the Shirakawa fault. V-shaped small faults and cracks were obserbed on the east wall of Kono C trench on the Sami fault. Radiocarbon dates of samples from inside of the cracks are about 1,100 years ago, and this indicate that the last faulting event occurred in these 1,100 years. At the Nishibora site, a clear vertical boundary between bedrock and soft sediment including many wood fragments and plant remains. However, Radiocarbon dates of samples from this sediment are almost modern, and this means this sediment are an artificial buried soil.

Keywords: Atera fault, Sami fault, Shirakawa fault, Gifu prefecture, trench excavation, paleoseismology

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High resolution geostratigraphic survey of the Urazoko Fault in Turuga Bay on the Sea of Japan

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High-resolution geostratigaraphic survey was carried out for Urazoko Yanagase-yama fault group around the Turuga bay in 2011. We have planed a NE-SW survey line (total 123.5Km) with 2-5km lengths and 500m intervals, also planed short survey line (total 57km) with 1km length and 20m intervals for detail exploration. Some clear reflector that estimated formed after the alluvium plain observed at the Turuga-bay. Theses reflector have fitted together with the result of sediment corer survey, which carried out around the central part of Turuga-bay. Five reflectors ranges in age from 7300 to 9600yBP were confirmed. We have described the height of fault step using the reflectors. The main fault (F-39-40) of Urazoko group with 1.7 to 2m in heights has observed over a range of 1km around the detailed exploration area. There is no accumulating formation for displacement component from the basement of Alluvium plain to K-Ah layer. At the edge of this fault, the step decreases toward the southern part. And this fault diverged in another fault, which presented the same structure in the southern part of Turuga-Bay.

Keywords: active fault, Urazoko fault, High resolution geostratigraphic surveyc

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Coring survey of the Urazoko Fault in Tsuruga Bay on the Sea of Japan

SUGIYAMA, Yuichi[1*], SAKAMOTO, Izumi[2], yoshiyuki Takino[2], Takuya Usami[3], Masanori Shimazaki[3], Nobukatsu Takeda[4], Takahiro Nagata[4], Kota Shimogama[4], Kazuma Matsuyama[4]

[1]AFERC, AIST, GSJ, [2]School of Marine Science and Technology, Tokai Univ., [3]Sogo Geophysical Exploration Co., Ltd., [4]Dia Consultants Co., Ltd.

We have conducted coring survey of F-39/40 fault, one of the two branch faults of the Urazoko fault system in the central part of Tsuruga Bay on the Sea of Japan, in order to reveal the Holocene faulting history of the fault system. In our presentation, main results of core observation, 14C dating and volcanic ash analyses are reported. We finally estimate about 2-meter vertical displacement of the Kikai-Akahoya volcanic ash horizon of 7300 years BP by the F-39/40 fault. The faulting history of the fault system is discussed in our oral presentation, integrating our high-resolution sonic survey and coring results with reexamination results of the existing survey data.

Keywords: Urazoko fault, Tsuruga Bay, Coring, Active fault

Table 1. Correlative horizons, their estimated ages and depth differences between the both sides of F-39/40 fault.

Correlative horizon	Stratigraphic unit	**Estimated age in core DA-7 (cal yBP)**	Depth (bsl, m) in core DA-7 (downthrown side)	Depth (bsl, m) in core UA-5 (upthrown side)	**Depth difference between the both sides**
	a				
1		7300	38.6	36.7(erosion surface)	1.9
K-Ah tephra		**7300**	**38.6**	**36.5 (estimated)**	**2.1 (estimated)**
Z	b	8900	39.5	37.2	2.3
A		9100	40.1	37.7	2.4
2		9300	40.8	38.2	2.6
3		9400	41.3	38.6	2.7
B	c	9600	42.0	39.4	2.6
4	d	10200	≧42.9	39.5	≧3.4

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Seismic reflection profiling across the Mikata fault, Kinki district

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We present high-resolution seismic reflection profiling acquired by the hammer and 24-channnel recording system. A 1.0 meter source and geophone spacing give a 0.5 meter CMP spacing on the profile. The normal CMP stacking fold had 24 traces used by the same shot point. The location and continuity of active faults comprising a part of the Kinki region are clearly expressed in terms of topography. This area is the so-called Kinki Triangle. This study presents the results of seismic reflection surveys across the Fukurojou Maiseki Valley in the northern part of the Kinki Triangle. The subsurface configurations of the active faults are correlated with geomorphological fault trace and are related with the fault strikes.

Keywords: Seismic Reflection Survey, Mikata Fault

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Crustal movement during the late Quaternary in the Ise Bay and Ohmi Basin, based on terraces and subsurface geology

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This study aims to reveal distribution of crustal movement during the late Quaternary. Yoro-Kuwana-Yokkaishi fault zone and Biwako-seigan fault zone consisting of west dipping reverse faults is one of the largest active fault zones in southwest Japan. However, the pattern and distribution of vertical deformation around the fault trace are not revealed quantitatively. Thus, amounts of uplift and subsidence were estimated based on terrace surfaces and subsurface geology.

Keywords: Crustal movement, Ohmi Basin, Ise Bay, Active fault, Terrace

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Tectonic geomorphology and late Pleistocene activity of western marginal faults of the Suzuka Mountains, central Japan

MIZUMOTO, Tadaki[1*], AZUMA, Takashi[2], NAKATA, Takashi[3], TSUTSUMI, Hiroyuki[4], GOTO, Hideaki[5], TAJIKARA, Masayoshi[1], MATSUDA, Tokihiko[1], MATSU'URA, Ritsuko S.[1]

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This study focuses on the tectonic geomorphology in small scales derived from precise aerial photograph interpretation of tectonic landforms. Marginal fault zone at the western foot of the Suzuka mountain range is one of major active faults in Japan. This fault zone, composed of east-dipping thrust faults trending N to S, is about 44km long containing many presumed active faults. One of a recent previous work have carried out a seismic reflection profiling and boring survey across the presumed zone of faults to be along the Uso River, but have not clear the late Pleistocene to Holocene activity of faults because of no detailed data on the recent deposits.

This work shows that surface fault traces are recognized in the northern half of the fault zone. It extends at least 9km in length. At the site of the Uso River, small tectonic scarp recognized on young terraces developed along the river are well accord with the assumed sites of the fault by the seismic reflection records. Based on reported data on geomorphological history in central Japan, it is reasonable to assume that the latest faulted terraces formed after the late Pleistocene by geomorphological evidences. A possible interpretation of tectonic geomorphology can be such that the small fault scarp identified on such terraces adjoining a flood plain is the movement of the fault associated with the most recent event of surface rupture during the Holocene time.

Though Seismic reflection profiling also plays an important role in the understanding of the relationship between underground seismogenic and surface faults in order to clarify the regional characteristics of the faults, it is needed to attach the highest importance on the tectonic landforms on everything from large to small scales for them. In particular, recent fault activity can be seen such as the small displacement of landforms and can be clearly differentiated as compared to those from earlier times. To identify the recent fault activity on the surface is highly effective subjects for mitigation of seismic hazards, simulation of earthquakes associated with active faults.

This research was funded by grants from the Ministry of Education, Culture, Sports, Science and Technology in Japan.

Keywords: active fault, tectonic geomorphology, suzuka mountain range, aerial photograph

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SSS35-P25 Room:Convention Hall Time:May 22 18:00-19:30

Active tilting along the eastern margin of the southern part of Kyoto Basin, central Japan

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1. Introduction

The presenter describes the newly discovered late Quaternary flexure that divides the Kyoto Basin and its surrounding hills. The Kyoto Basin is bounded by active faults, however there is only a little knowledge on the geologic structure of the eastern margin of its southern part.

2. Features of higher terraces and their deposits

There are higher river terraces along the Uji River that run from east-ward hills to the Kyoto Basin. These terraces are useful to horizons of late Quaternary crustal movement. The higher terraces are subdivided into two surfaces.

The highest terrace called the higher 1 terrace consist of thin (less than several meter) hard-weathered gravel and sand, and it is covered with reddish soil that accompanied with reticular texture. These reticular texture in surface soil are major index to identify the higher 1 terrace. The higher 1 terrace forms hill-top flat land, and is continuously distributed in the southern side of the Uji River.

The higher 2 terrace deposits comprise thick (over 50 m at the thickest point) weathered gravel, sand and mud, and its surface is covered with reddish soil. This thick fill deposits and reddish soil that not accompanied with reticular fabric are index to identify the higher 2 terraces. The higher 2 terrace is discontinuously distributed along the Uji river.

No geo-chronological samples are gotten in this study area, however color of the surface soil and weathering degree of sediments indicates these two terraces are late middle Pleistocene in age.

3. Deformation of horizons and description of the late Quaternary tectonic movement

These two wide-spreading river terraces have west-ward gradient. The inclination of higher 1 terrace and the higher 2 terrace are 35/1000 and 17/1000 respectively on the projection to N70W direction in 2 km section. The inclination of the higher 2 terrace is 28/1000 in 5 km section, and relative height of this section is 140m. On the other hand, inclination of the recent river bed of the Uji river is about 1/1000.

These facts indicate the cumulative west-ward tilting have occurred during the late Quaternary, and mean vertical displacement rate of this tilting movement would be ranked to B class (0.1 to 1 mm/yr) in activity. This activity would be comparable to the other given active faults surrounding the Kyoto Basin. The length of this geologic structure is thought to be longer than 3km according to the width of the higher terrace. This late Quaternary geologic structure is called the Uji flexure.

The deepest subsidence has occurred near the Oguraike marsh in the Kyoto basin during Quaternary (e.g. Kansai Geo-information Application Committee, 2002).About 800m Quaternary Basin-fill deposits have piled in this area. This distinct subsidence area locates just west of the Uji flexure. This fact also supports that the Uji flexure is active structure during late Quaternary.

4. Re-examination of the continuity of active fault zone

The former studies had not recognized active fault in the southern end of the Kyoto Basin. And there is about 7km-long gap of active fault between the Kyoto Basin and the Nara Basin. The Headquarters for Earthquake Research Promotion (HERP;2005) summed up that the Kyoto bonchi toen fault zone (eastern marginal fault of the Kyoto Basin) has to be evaluate different segment from the Nara bonchi toen fault zone. The presenter thinks that at least northern 3km of this active fault gap is not exist. And activity of newly discovered active flexure would be comparable to the other active fault. This suggests necessity of re-examine the long-term fault evaluation.

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Kansai Geo-information Application Committee(2002) Shin-Kansai jiban ?Kyoto bonchi-. Kansai Geo-information Application Committee,196p.

Keywords: active tilting, active fault, Kyoto Basin, higher terrace, Uji Flexure

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The outcrops of the fracture zone along the Gomura Fault in Kyoto, Japan

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The Gomura fault is 13km-long northeast-trending left lateral active fault in Kyoto, Japan. Kita-Tango earthquake was occurred on March 7th 1927 and formed surface ruptures along the Gomura fault. The part of this ruptures is received certification of the natural monument on 1929. This preservation of historic spots selected one of the Geosite of Saninkaigan Geopark plays an important role especially for the tourist attractions and educational resources.

The purposes of this study were to find the way to estimate the fault activities using the characteristic of the fault fracture zones. We performed a geomorphological and geological survey of this fault.

As a result, We found 11 outcrops along the Gomura fault, Amino-cho Go, Ikunouchi, Mineyama-cho Yasu. These outcrops located on the main trace of Gomura fault zone drawn by Okada and Matsuda (1997) . We found the fracture zones in basement rock (Granite) distributed in this area. We will present here the details of the fracture zones.

Keywords: Gomura Fault, Surface ruputure, Fault fracture zone, Geo-park

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Relationship of fracture zone and tectonic landform in the Yasutomi falut of the Yamasaki falut zone, in southwest Japan

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We studied the fault zone in the area around the Yamasaki fault zone, one of the active faults in southwestern Japan. The Yamasaki fault zone is a left-lateral strike slip fault. The investigation of outcrops, pits and trench indicated palaeoseismic evnt and fracture zone associated with the Yamasaki falut zone.

Keywords: Yamasaki fault, Yasutomi fault, fault zone

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SSS35-P28 Room:Convention Hall Time:May 22 18:00-19:30

Distribution and occurrence of the fault rocks associated with the Nojima fault, Central Japan

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Investigation of the trenching and fault outcrop observation of active fault at the Nojima fault the surface fault ruptures associated with the 1995 Hyogo-Ken Nanbu earthquake , Central Japan around the Nojima fault, interpreted paleoseismic event and fault feature.

Multitle fault is exposed in the trench. We identified at last 2 , and possibly more ,late Pleistocene- Holocene paleoseismic event , based on the upword termination of fault

Keywords: Nojima fault, the 1995 Hyogo-Ken Nanbu earthquake, Central Japan, paleoseismic event, active fault, fracture zone

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SSS35-P29 Room:Convention Hall Time:May 22 18:00-19:30

Gravity Measurement around source region of 2000 Tottoriken-seibu earthquake

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The 2000 Tottoriken-seibu earthquake was occurred in the area where no active faults were mapped before the earthquake (Active Faults Research Group, 1991). The detailed analysis of aerial photograph revealed several new active faults and lineaments (Tsutsumi et al., 2000; Inoue et al., 2002; Takada et al., 2003). In the southwestern part of the seismogenic source fault of the 2000 Tottoriken-seibu earthquake, several short lineaments were revealed. The Bouguer anomaly, which indicated the subsurface density structure, indicated relatively steep gradient zone around the newly recognized lineaments. The Bouguer anomaly of 1-km gridded data of the Gravity CD-ROM published from the Advanced Industrial Science and Technology was the high gravity anomaly region around the seismogenic source faults. The similar relation was recognized in the 2002 Kagoshimaken-hokuseibu earthquake (Miyamachi et al., 2004). The detailed gravity map derived from data which published by Gravity Database of Southwest Japan (CD-ROM)(Gravity Research Group in Southwest Japan, 2001) indicated the narrow gravity low zone around the lineaments. We carried out gravity measurement cross surface rupture with station interval of 50 - 250m. The measured detailed gravity anomaly indicated the relative low anomaly around area where the small lineaments and ruptures were recognized.

This research was commissioned by the Japan Nuclear Energy Safety Organization (JNES).

Keywords: 2000 Tottoriken-seibu earthquake, Gravtiy measurement, lineament

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SSS35-P30 Room:Convention Hall Time:May 22 18:00-19:30

Tectonic geomorphology along the Yasaka Fault Zone: a long active fault in the area of dense population of active faults

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In the western Chugoku district (Yamaguchi prefecture, western Hiroshima Prefecture, western Shimane Prefecture), it has been thought that distribution of active faults is very sparse. However, several active faults were newly mapped by several researchers in recent years. We have been mapped active faults in the whole area of the Chugoku District by detailed air photograph analysis during the last two years. As a result, we revealed that many active faults are densely distributed in this area. In this presentation, we report tectonic geomorphology along the Yasaka Fault Zone as an example of such active faults, and discuss the characteristics of distribution pattern of this Fault Zone.

Although distribution of active fault traces in our result is similar to those of the published data in large scale view, some active fault traces are mapped in different location and some active faults traces are newly mapped. Active fault traces in our map have a tendency that shorter traces are distributed in en echelon pattern. Along the previously mapped active faults traces, many tectonic landforms (lateral offset streams, offset hills, uphill-facing fault scarplet, beheaded stream, dammed stream) are newly mapped. As a result, we clarified that the Yasaka Fault Zone is an active fault system with 55 km in length, and that the Yasaka Fault Zone have a capability of causing M7.5 earthquake.

Keywords: Yasaka Fault Zone, active fault, aerial photograph, inland earthquake, Chigoku region

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SSS35-P31 Room:Convention Hall Time:May 22 18:00-19:30

Arrayed boring survey across the eastern extension of the Kawakami fault of the Median Tectonic Line active fault zone i

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We drilled four cores across the estimated fault line of the Kawakami fault at Yokoguro in Saijyo-city to obtain geological evidence for the eastern extension of the Kawakami fault. The drilled length of each core is core A: 27 m, B: 25 m, C: 30 m and core D: 28 m in the direction of N to S. Then we conducted geological observation, recognition of volcanic ash, color measurement, pollen analysis, measurement of magnetic susceptibility value, and microfossil analysis.

The observation and analyses results are as follows.

(1) Core samples are divided four units (Unit 1 to 4 in descending order) based on geological characteristics. Unit 4 and 3 are channel deposits composed of pebbles in late Pleistocene. Unit 2 is brackish water environment to marine deposits in late Pleistocene to Holocene. Unit 1 is channel deposits composed of pebbles in Holocene.

(2) The all four units are recognized on the cores A, B and C, but the core D does not reach the Unit 4.

(3) The upper horizon of the K-Ah volcanic ash on cores A, B and C is 2 m shallower than core D. The boundary between the Unit 3 and Unit 4, which are beneath the K-Ah volcanic ash layer, on the core C is 9 m or over shallower than core D. Therefore, the depth differences of each correlation layer between the core C and D increase towered to the deeper part.

(4) The thicknesses of each unit on the core C are thinner than core D. For instance, the thickness of the Unit 2 is 2.8 m on the core C and 4.5 m on the core D. The thickness of the Unit 3 is 10.15 m on the core C and 16.5 m or over on the core D.

These results indicate that there is probably the Kawakami fault between the core C and D, and the Kawakami fault has caused repeatedly fault displacements downthrown to the south. The average slip-rate in vertical sense of the Kawakami fault is calculated as about 0.27 mm/yr at the research point based on the amounts of fault displacements (2 m) after the eruption age (ca. 7300yBP) of the K-Ah volcanic ash.

Keywords: Median Tectonic Line active fault zone, Kawakami fault, fault distribution

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SSS35-P32 Room:Convention Hall Time:May 22 18:00-19:30

Trench excavation surveys on the Otake fault and the Hatakitoge fault, Iwakuni fault zone, Yamaguchi Prefecture, Japan

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The NE-SW trending Iwakuni fault zone in southwest Japan consists of many right-lateral strike-slip faults, which are considered to be low activity ones. We conducted two trench excavation surveys on the Otake fault and the Hatakitoge fault in the Iwakuni City in order to obtain the paleoseismological parameters and related fault gouges for evaluating earthquake potential. Based on the trench wall observation and radiocarbon dating, the latest faulting event of the Otake fault is after 2,800 cal yBP. This work was supported by Japan Nuclear Energy Safety Organization.

Keywords: Iwakuni fault zone, trench excavation survey, active faults, paleoseismology, Yamaguchi Prefecture

Japan Geoscience Union Meeting 2012
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SSS35-P33 Room:Convention Hall Time:May 22 18:00-19:30

Recent surface faulting events of the Nishiyama fault zone, Fukuoka Pref.: a preliminary report of trenching surveys

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The Nishiyama fault zone is NW-SE trending left-lateral strike-slip fault located on North Kyushu. We performed geomorphological and geological surveys along the whole of the fault zone and its extending area to obtain the paleoseismological parameters for evaluating earthquake potential cased by the fault zone. The most valuable information was come from the Uruno trench site in Iizuka City. It revealed that the surface rupturing events of the fault occurred more than five or six times in recent several ten thousands years on the basis of the trench wall observation and preliminary radiocarbon dating.

Keywords: Nishiyama fault zone, trench excavation survey, active faults, paleoseismology, Fukuoka Prefecture

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SSS35-P34 Room:Convention Hall Time:May 22 18:00-19:30

Development of the measuring method for the deformation by photogrammetry, A case study of the Chelungpu fault, Taiwan

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We have tried to estimate the amount of coseismic displacements on a fault, analyzing the tectonic geomorphology along an active fault. We tried to measure topography profiles on photogrammetry method in order to compare the deformation pattern and amount of the surface rupture and long term geomorphology, and then calculate the coseismic deformation. However, coordinates of GCP positions before the earthquake which are very important for accurate measurement are unknown. We tried to orient the GCP on aerial photograph before the earthquake by following three methods.

The 1999 Chichi earthquake was selected as a case study. We used aerial photograph taken in 1987 and stereoscopic SPOT satellite imagery taken in 2004.

Method 1: Reading coordinates on large scale photographic map.

We measure GCPs positions on the 1/5,000 photographic map by hand. Because the photographic map is based on 1987 aerial photograph, it has good resolution for vertical. But it has poor accuracy for horizontal coordinates, because it is difficult to indicate the exact location of GCP on the map.

Method 2: Reading coordinates on SPOT satellite imagery.

Since there is little distortion in each SPOT satellite image as compared with an aerial photograph, we can read coordinates on Spot image relatively accurate. However these data are coordinates of after the earthquake and it include coseismic deformation. In order to decrease the error of measurement near by the active fault, we set the GCP far away from the active fault.

3: Reading coordinates on SPOT satellite imagery and then correct it with observed deformation data.

As for this method, GCPs in the method 2 are added offset by observation data, which are measured across the surface rupture or crustal movement by GPS observation.

The aerial photograph was oriented by each method, and the surface profile on the same line was measured on each oriented aerial photograph and compared. There is not much difference between the three. Next, the same profile was measured on the SPOT image and calculated difference between aerial photograph and SPOT profiles. The displacement values are largely similar to observed displacement in the field.

Then, distribution of the amount of displacement along a Chelungpu fault was measured by this method, and the amount of average slip rate was estimated.

Keywords: active fault, surface rupture, Chelungpu fault, photogrammetry, SPOT image, Taiwan

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Paleoearthquake Investigations of the Mae Hong Son Fault in Mae Hong Son, northern Thailand

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The collision between Indian and Eurasian plates since the late Paleogene causes the NW-SE and NE-SW strike-slip faults and the N-S dip-slip faults in the Indochina region. In Mae Hong Son, northern Thailand, several fault lines trend in the NE-SW, NW-SE and N-S directions, and are temporally and spatially associated with Cenozoic basin. Previous remote sensing investigation reveals many lines of morphotectonic evidence along the Mae Hong Son Fault which suggest an active tectonic zone. In order to clarify tectonic activity of this region, we selected the Mae Hong Son Fault as a target (fault) for paleoearthquake investigation.

We applied remote sensing techniques and aerial photograph interpretation to a study of the Mae Hong Son Fault. The quarry with the Cenozoic strata was used for fault geometry analysis. The Mae Hong Son Fault mainly strikes N-S, with the NW-SE conjugate faults and some minor NE-SW faults. The N-S faults show a normal dip-slip, and bound the margins of the N-S elongate basins which might result from the movement of large-scale strike-slip fault in this region. The NW-SE faults show right-lateral strike-slip movement. Nevertheless, the NE-SW faults show left-lateral strike-slip movement. Essential morphotectonic landforms associated with the Mae Hong Son Fault are fault scarps, offset streams, linear valleys, shutter ridges, triangular facets, hot springs, and linear mountain fronts.

We observed the significant morphotectonic landforms along the NE-SW Mae La Noi segment of the Mae Hong Son Fault, suggesting oblique movement. We recognized two paleoearthquake events of this fault segment in the quarry using results on OSL age dating data; the older event occurred before 20,000 years ago, and the younger event occurred between 8,300 and 7,800 years ago. An average rate of the last fault movement was 0.14 mm/yr. Therefore, it is concluded that the Mae Hong Son Fault is still active till present, and the Mae La Noi segment is regarded as the active segment with the oblique movement.

Keywords: Mae Hong Son Fault, Northern Thailand, Mae La Noi, Paleoearthquake

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Systematical deflections and offsets of the Yangtze River drainages along the Xianshuihe Fault, Tibetan Plateau

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During the past two decades, the integration of geologic, geomorphic, seismic, and geophysical information has led to increased recognition and understanding of the tectonic significance of geomorphic features caused by strike-slip along active strike-slip faults. Tectonic landforms developed along active strike-slip faults are mainly characterized by systematic deflections and offsets of streams and terraces, and fault sags which are regarded as reliable displacement markers useful for reconstructing the long-term activity of active faults. It has been demonstrated that stream offsets and fault-bounded geologic structures such as pull-apart basins have resulted from repeated large strike-slip earthquakes. The study of tectonic geomorphology will provide a new insight into the seismic activity, longevity and structural evolution of active strike-slip faults.

The Ganzi-Yushu-Xianshuihe Fault Zone is a typical strike-slip active fault, which triggered the 2010 Mw 6.9 Yushu earthquake in the central Tibetan Plateau. This fault zone extends for >800 km from the central to the southeastern margin of the Tibetan Plateau, which changes its strike from WNW-ESE to NNW-SSE. In this study, we investigated the systematical deflections and offsets of the Yangtze River and its main branches as well as small stream channel systems along the fault traces of the Ganzi-Yushu-Xianshuihe Fault Zone. The analysis of deflected small stream channels is carried out using Google earth images, 15m-resolution ETM+ L8 images, 30m-resolution ETM+ Mosaics images, and 0.5-1m high resolution World View images. The analytical results show that i) the drainage system of the Yangtze River and its branches have been systematically sinistrally-deflected; ii) the main river channels of the Yangtze River have been sinistrally offset 60-85 km; iii) the offset amount are cumulated on the offset river channels along the fault zone. Geomorphic and geologic evidence confirms that the systematical offsets of streams and gullies are the results of repeated large earthquakes and these topographic features are reliable indicators of seismic displacements accumulated on active strike-slip faults. Our findings support the idea that the strike-slip faults developed in the Tibetan Plateau have played an important role in the eastward extrusion of the Tibetan Plateau and accommodate the ongoing northward penetration of the Indian plate into the Eurasian plate.

Keywords: Tibetan Plateau, Ganzi-Yushu-Xianshuihe Fault Zone, Yangtze River system, systematical deflections and offsets, sinistral strike-slip fault