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

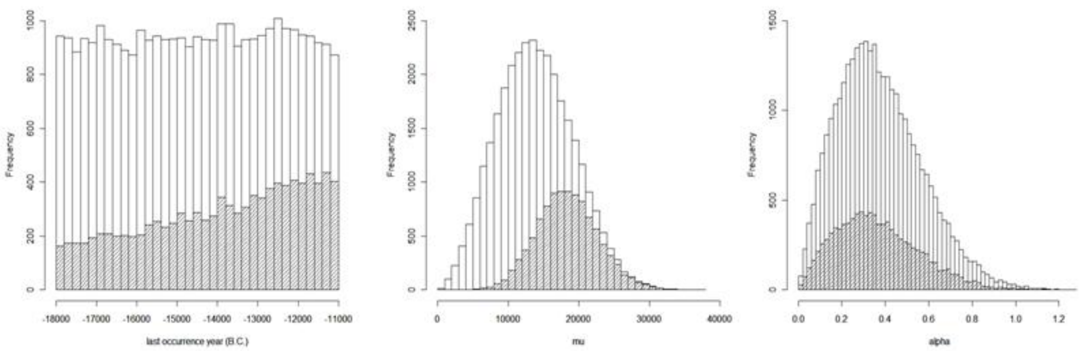

Figure: Samples from prior and posterior distribution for the last occurrence time, the mean inter-event time μ and the aperiodicity of inter-event time α in Tachikawa fault.

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

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.

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Keywords: geomorphology, geology, numerical simulation, dynamic rupture

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

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

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

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.

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

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

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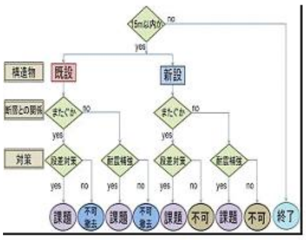
Problem to be solved in applying active fault law in Japan
Shibaura Institute of Technology
Toshiro Okamoto & Unnno Ui

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



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

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

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.

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

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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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.

References

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Okami et al., 1988, J. Geol. Soc. Japan, 94, 141-143.

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

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)

SSS35-10 Room:303 Time:May 22 13:45-14:00

Magnitudes of historical intra-plate earthquakes in Tokai area

KANDA, Katsuhisa[1*], Masaki Kamata[2], TAKEMURA, Masayuki[1]

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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

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

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]

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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

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

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

Japan Geoscience Union Meeting 2012
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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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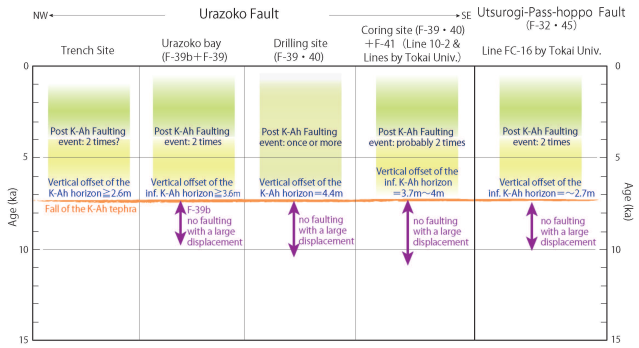
We have evaluated the Holocene faulting and displacement of the Urazoko fault system in and around Tsuruga Bay on the Sea of Japan, based on our own high-resolution sonic survey and coring results, as well as exisiting survey data disclosed from the Japan Atomic Power Company (JAPC), complying with our 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
(May 20-25 2012 at Makuhari, Chiba, Japan)

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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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

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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

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

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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

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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