Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

SSS34-01 Room:502 Time:April 29 09:00-09:15

Height Distribution of the tsunami of the Ansei North Sanriku-Oki earthquake of August 23, 1856

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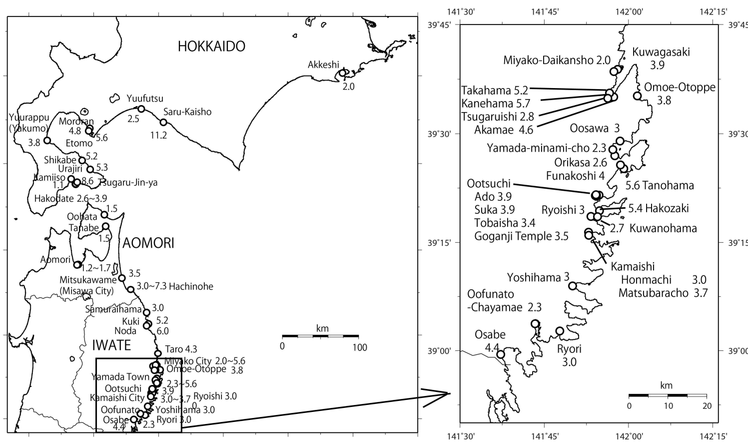
A large earthquake occurred in the sea area between Aomori coast, most northern district of Honshu, and Hidaka coast, Hokkaido, on 23rd August, 1856 (3rd year of Ansei era) . This earthquake is a one of the series of the plate boundary earthquakes at the joint point of the Japan and the Kuril trenches, where the 1968 Tokachi-Oki earthquake occurred. The 1677 Enpo North Sanriku-Oki earthquake is considered also as the same typed one. The tsunami of the 1856 North Sanriku-Oki earthquake hit the coasts of Sanriku districts, the north east part of Honshu, and the pacific coast of Hokkaido. As the total number of victims of the tsunami was only 38 people in all, and it was considered not to be a large natural hazard. So it did not become a lecture for tsunami hazard in the time of the 1896 Great Meiji Sanriku tsunami. The diary kept by a priest of Kokutaiji Temple at Akkeshi in east Hokkaido records that human disturbance broke out there, and tsunami height was estimated at 2.0 m. At Saru-Kaisho office in Monbetsu town, Hidaka district, a strong tide came in front of the building of the office, where sea water rose up to the height of 11.2 meters. At Etomo village in Muroran city, sea water invaded into the residential area (height: 5.6m). On the pacific side of Hakodate peninsula, sea water flooded up to the fort of Tsugaru Clan "Tsugaru-han Jin'ya" where the ground height is 8.6 m. At Same fishery port in the central area of Hachinohe city, residential area was flooded up to 7.3 meters height. At Kanehama village in Miyako city, which is located at the innermost point of the V-shaped bay, inundation height was 5.7 meters. As for the coasts of south part of Iwate Prefecture Tsuji et al.(1995) conducted survey. Together with this result,we have the distribution map of the tsunami height as the figure. The authors of the present study wish to express their thanks to JNES for its financial support in promoting our research.

Keywords: historical earthquake, historical tsunami, Sanriku coast, Hokkaido, Japan trench



Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

SSS34-02 Room:502 Time:April 29 09:15-09:30

Reexamination of 1945 Mikawa earthquake disaster (1) Detailed distribution of earthquake victims

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Iida (1978) organized the Mikawa earthquake disaster under the cooperation of Aichi prefecture, and clarify the whole picture of the disaster. However, he could not discuss the disaster in community level precisely. For example, 46% of 1200 houses were collapsed in Hukuji village, Hazu-gun in 1944 ToNankai earthquake, and additionally 67% of left 650 houses were also collapsed in 1945 Mikawa earthquakes one month later. The reason of strong damages in Hukuji is not discussed enough until now.

It is very important to make clear whole picture of the earthquake disaster in history and in near future as national government. As the earthquake disaster remains a rare event, detailed research of the historical earthquake disasters needful to understand the following disasters. In the presentation, we would like to discuss the disaster of the Mikawa earthquake in local community level.

1. Discussion on characteristic disaster based on earthquake victim distribution

Earthquake fault shaped S was appeared in the ground surface at the Mikawa earthquake. However recent researches of fault geomorphology and ground deformation based on geodesy point out two main faults striking with NNW-SSE direction, and an E-W striking fault is tear fault caused by slips on two faults. Additionally, dominant rupture should be occurred at Fukodu fault located in east. The total Mo estimated by ground deformation is the earthquake moment of 1.6x1019Nm(Mw6.7), and the third four of the released one is by slip of Fukodu fault. In our presentation, we discuss earthquake disaster with the local community level based on two N-S striking earthquake faults.

1) Katahara: compact cluster of dead located close to Fukodu fault

Katahara town of Hoi-gun (then-9300 people and 1887 houses) located just on Fukodu fault, lose 227 people and 319 completely destroyed houses (15.2% collapse rate). In the town, the damages are different in each street corner. Numbers of dead and completely destroyed houses within the town are shown as bar charts and color scale in 59 neighborhood blocks. The dead are limited in the narrow zone of 1 km wide along the earthquake fault. There are some communities with no collapsed house, which are located 1 km distance from the fault. Dead are corresponding to 73 % of completely-destroyed houses, and some blocks closing the fault show the rate over 90%. Precisely, people are attacked by strong seismic waves during the hours of sleep, and they had no time to evacuate to outsides from houses. There are many blocks to have no dead and no collapsed houses, which are locating more 1 km far from the fault.

2) Fukuji: Decentralized dead far from fault in river plain

On the one way, Fukuji village (then-673 houses), Hazu-gun locating 5 km southwestward from the Yokosuka Fault, one of main faults, lost 162-350 peoples and 400 houses completely. In one month before, the village also attacked by 1944 ToNankai earthquake, lost 21 people and 550 houses completely. They lost 1000 houses by earthquakes in 1200 houses for one month. The numbers of the dead are shown in each block in Fig.1B.

The dead distributions are obviously different with that in Katahara. They lost many people in almost all blocks in the village. The collapse rate of ToNankai earthquake is by far the worst in Aichi prefecture, because, second worst is 21.3% in Tomiki village, Chita-gun. The Fukuji village is just located in river plain with Yahagi and old-Yahagi rivers. An exist of thick alluvial formation caused the large damages in Fukuji.

The dead by Mikawa earthquake are caused by two reasons. One is there are very strong shaking at the blocks located immediately above the fault, and second is amplitude shaking by alluvial formation in river plain. The former is a case of Katahara and later is a case of Fukuji.

Keywords: Mikawa erathquake, Fukozu fault, Yokosuka fault, earthquake disaster, seismic victim, collapse rate

Japan Geoscience Union Meeting 2014
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SSS34-03 Room:502 Time:April 29 09:30-09:45

Interpretation of an illegible old stone inscription by SfM image analysis at Itsukushima shrine, Nojimazaki

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This study shows that interpretation the illegible old stone inscription by structure from motion (SfM) image analysis. The stone monument built in 1927 for memorial on the 1923 Taisho Kanto Earthquake, the inscribed capitals can hardly read. We captured 158 photographs on the surface of the stone, and processed by SfM to generate 3 D model of it. As a result, illegible capitals became clear on the 3 D model, so visible coated contamination removed by SfM. It is effective method to archive stone inscriptions.

Keywords: structure from motion (SfM), stone inscription, interpretation, historical natural hazard, Nojimazaki

SSS34-04 Room:502 Time:April 29 09:45-10:00

The Evidence of the Uplift associated with the Kanto Earthquakes inferred from the Marine Terrace in the Alluvial Valley

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Recurrent giant earthquakes at the plate boundary along the Sagami Trough have been considered as one of the greatest thread of the Tokyo Metropolitan area. At the southwestern tip of the Miura Peninsula, in south of Tokyo, the tide gauge station records the coseismic uplift amount of 1.4 m and the interseismic subsidence amount of 0.3 m in and after 1923 earthquake, respectively. It is effective to reveal evidences of the past coseismic uplift to know the future earthquake.

Wave-cut benches which emerged in 1923 are widely distributed along the rocky coast. Higher wave-cut benches, good indicators of coseismic uplift prior to 1923, are also recognizable. It is, however, often difficult to spatially compare one another due to the erosion.

We investigated the distribution of the tidal-flat deposits and the 1923 wave-cut benches at two small bays in the southwestern and southern parts of the Peninsula. The aggradation of the coastline associated with the 1923 uplift was identified by the comparison between the 1:25,000 topographic maps before and after the 1923 earthquake. Observations of outcrops and drilling cores at the 1923-formed marine terrace showed that the tidal-flat deposits consist of shelly sand and gravels. The elevation of tidal-flat deposits indicates the coseismic uplift in 1923 and the interseismic subsidence after 1923. The uplift amount was estimated approximately 0.9 m and 2.1 m at the southwestern and southern parts of the Miura Peninsula, respectively. The uplift amount inferred from the tidal-flat deposits is concordant with that inferred by the wave-cut benches.

Keywords: Kanto Earthquake, Paleo-earthquake Record, Alluvial Valley, Microlandform, Tide-zone Deposits, Miura Peninsula

Japan Geoscience Union Meeting 2014
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SSS34-05 Room:502 Time:April 29 10:00-10:15

Coseismic uplifts of the southern Izu Peninsula and the coastal area of Shimizu Plain

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We examined coseismic uplift events in the coastal area of the Shimizu Plain, and at the southern end of the Izu Peninsula. On the basis of lithologies, fossil contents, and radiocarbon dating, we identified geological and paleontological evidence for abrupt changes in depositional environments related to coseismic uplift associated with the AD 1854 Ansei-Tokai earthquake. We estimated a maximum coseismic uplift of 1.2 m and post-earthquake gradual subsidence of ca. 0.6 m. Radiocarbon dating of the emerged sessile assemblages at the southern end of the Izu Peninsula, central Japan suggest that at least four coseismic uplift have occurred in the area, during 3387-2485 cal yr BP, AD 570?820, AD 1000?1270, and AD 1430?1660.

Keywords: Coseismic uplifts, southern Izu Peninsula, Shimizu Plain, Holocene, Ansei-Tokai earthquake

Japan Geoscience Union Meeting 2014
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SSS34-06 Room:502 Time:April 29 10:15-10:30

Former shoreline height and Active Faulting around Obama Bay, Fukui, Central Japan

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I examined the distribution of marine terrace surface assigned to the oxygen isotope stage 5e along the coast around Obama Bay, Fukui Prefecture, central Japan. The marine surface is recognizable on the western and southern coast of Obama bay, which indicates only southwestern coast has progressively uplifted. There is no marine terrace surface along the NE coast of the bay. This strongly suggests that an active fault divides the bay just on the extension of the FO-A fault and the Kumagawa fault. The FO-B and FO-A fault are left-lateral active fault trending NW-SE direction. The Kumagawa fault trending WNW-SES direction display the same vertical displacement as them and SW hanging-wall uplift. These active faults composing of an extensive active fault ca. 65-km long across Obama bay displaying distinct trace jog close to the mouth of the bay (Nokogiri-zaki point). Height distribution of the former shoreline on the marine terrace surface shows the uplift pattern in this area. Comparing the uplift pattern with calculated displacement based on the dislocation theory, the fault model mentioned above explains the general features of the crustal deformation.

Keywords: marine terrace surface, former shoreline, submarine active fault, caclculated displacement, Obama bay

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SSS34-07 Room:502 Time:April 29 11:00-11:15

Comparison of the fault zones of the fault activity terminated until the Early Pleistocene and the active fault

OHTANI, Tomoyuki[1*] ; KONO, Masahiro[1] ; KOJIMA, Satoru[1]

[1]Gifu Univ.

In the active fault surveys without younger sedimentary layers, it is desired that the new method is developed to assess the fault activity using the fault rocks in the basement rocks. To achieve this, it is important to understand the characteristic features of the fault zones not only active faults, but also the faults terminated their activity recently. We studied the fault zone of the Median Tectonic Line (MTL) in Yoshino, Nara, and compare its results with those of active faults.

The MTL is the active fault in the west of the central part of the Kii peninsula, in which the fault activity is terminated recently in the east. In this eastern area, Okada and Togo (2000) show the fault which terminated its activity until 300 ka in the active fault maps. Sangawa and Okada (1977) reported an exposure of fault zone that makes a border of the Early Pleistocene Shobudani Formation and the Cretaceous Izumi Group, and that is covered by the Middle Pleistocene Gojo Formation unconformably. Based on the sedimentary ages of their formation, the MTL in this area is terminated until 1 to 1.2 Ma. The fault exposure reported by Sangawa and Okada (1977) is covered by concrete presently, we studied the fault exposure 13 km east away from the previous exposure.

In this exposure, the fault gouge zone with ca. 1 m thickness strikes E-W. The Izumi formation is in the northern side of the fault zone, in which no exposure in the southern side. The Izumi Formation in this exposure is mainly mudstone. Bedding plane is subholizontal in the host rock, in which foliation is subvertical in cataclasite near the fault gouge. Composite planar fabric in foliated cataclasite indicates the uplift of the southern side.

The powder X-ray diffraction and X-ray fluorescence analyses were performed using the samples from this fault exposure. The results of the powder X-ray diffraction analysis shows disappearance of mica and formation of chlorite in the foliated cataclasite close to the fault gouge, and decomposition of plagioclase and formation of calcite in foliated cataclasite and fault gouge. The altered minerals indicate a remarkable alteration in foliated cataclasite rather than fault gouge. Smectite is not detected in fault gouge and cataclasite.

The results of the X-ray fluorescence analysis show the increase of TiO2, Al2O3, MgO, K2O and P2O5 toward the fault gouge and the decrease of CaO, Na2O and MnO in foliated cataclasite and fault gouge. The decrease is especially in foliated cataclasite rather than fault gouge.

The studied feature is compared by that of the active faults. In the active fault zone, the latest fault gouge is characterized by the formation of smectite and concentration of Mn. Smectite is the mineral formed under lower temperature. Mn deposits under the oxidized condition. These are consistent with recent near-surface condition of the active fault zone. The studied fault zone would be displaced in the deeper part because its activity has been terminated and present surface exposure should be exhumed from 1 to 1.2 Ma to present. Mn is difficult to concentrate in the deeper reduction condition.

Keywords: Early Pleistocene, fault zone, active fault

SSS34-08 Room:502 Time:April 29 11:15-11:30

Analysis for deformation structures, mineral composition, and elemental composition in the Atera fault

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The Atera fault is an active fault extended 70 km along southern — central Gifu Prefecture, Japan, which is considered to slip at 1586 Tensho earthquake based on the field outcrop and trenching survey by previous researches. However, the seismic slip behavior along the fault has been understood. In this study, we performed the field observation on the Tase outcrop of the Atera fault, microscopic observation, X-ray diffraction, trace element analysis by using ICP-MS for investigating the deformation structure, mineral assemblage, and geochemical anomaly in the Atera fault. We will present their preliminary results.

Keywords: Active fault, Fault gouge, Trace element

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SSS34-09 Room:502 Time:April 29 11:30-11:45

Deformation simulations by the discrete element method controlling basement motions by the dislocation solutions

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In previous studies on deformation of sedimentary layer due to fault motions within the basement by means of the discrete element modeling, the basement has been treated as rigid body. In this study, we attempted to control motions of the basement by dislocation analytical solutions based on the elasticity in order to discuss the deformation field of the sedimentary layer in connection with fault parameters.

As a result, we found tilt of deformed sedimentary layer which did not appear in the rigid basement model. And, shapes of deformed sedimentary layer around the fault tip were different from rigid basement model, and even in the elastic basement model it was shown that their shapes will be varied by the fault parameters selected in the modeling.

Since sedimentary layers deform by following to shape of deformed basement, and the basement controlled by the dislocation analytical solutions deforms by the fault parameters, it was shown that not only shape of deformed sedimentary layers but trishear and its propagation processes will be able to be discussed in connection with the fault parameters. In the future, we will accumulate some know-how on practical analyses method by applying our modeling procedure to interpretations of topography, geological structures and seismic survey data, and we would like to hasten quantitative discussions on tectonics and/or forming processes of geological structures.

Keywords: Discrete Element Method, Dislocation analytical solutions, Displacement of sedimantary layer, PFC

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SSS34-10 Room:502 Time:April 29 11:45-12:00

The reproductive experiments of stratum deformation on the trench for the Kushibiki fault using numerical experiments

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Introduction

The Quaternary regional stress field in eastern-central Japan tend to be east and west compaction force. Therefore, a number of thrust faults develop in this area. These faults sometimes indicate complex features, such as back thrusts or branches above 3 km depth.

It is considered that seismic waves are generated by fault activity below 3 km depth. Therefore, indirect earthquake surface faults which branch off from a earthquake source fault not generate seismic waves. Additionally, earthquake surface faults which directly connect to a earthquake source fault specify crustal movements around these faults. Therefore, we must distinguish between indirect earthquake surface faults and faults which directly connect to a earthquake source fault.

According to the approach of foam rubber models and dynamic lattice model simulations, it is known that a fault slip velocity accelerates toward a ground surface (e.g., Oglesby *et al.*, 2000; Ma and Hirakawa, 2013). According to numerical calculations which base on dynamic models, peak slip velocities of thrust faults with dip angles of 30-45 degree are 2.5-4.0 m/s (e.g., Oglesby *et al.*, 2000; Ma and Hirakawa, 2013). On the other hand, according to the numerical calculation, the peak slip velocity of the back thrust which was the indirect earthquake surface fault from the 2008 Iwate-Miyagi Nairiku earthquake in Japan was 0.05 m/s (Ando and Yamazaki, 2013). Therefore, we may be able to distinguish between indirect earthquake surface faults and faults which directly connect to a earthquake source fault, from peak slip velocities. Thus I estimated the peak slip velocity of the Kushibiki fault which is considered as indirect back thrust of the Fukaya fault, from numerical experiments.

Relation between the Kushibiki fault and the Fukaya fault

Sugiyama *et al.* (2009) described that the Kanto-heiya-hokuseien fault zone is active fault zone which intervenes between the Kanto mountain terrain and the Kanto plain with NW-SE strike. The Kanto-heiya-hokuseien fault zone which is SW dipping thrust consists chiefly of fault groups along the Fukaya fault and the Fukaya fault.

The Hirai-Kushibiki fault zone which is considered as back thrust of Fukaya fault except the Hirai fault, consists of the Hirai fault, the Kushibiki fault and Kamikawa fault. In addition, the Kushibiki fault is bedding fault of Neogene sediments which have a dip angle of about 20 degree (Sugiyama *et al.*, 2009b; Shintani *et al.*,2009).

Methods

In this study, I performed numerical experiments about stratum deformation by faulting of the Kushibiki fault, and these experiments were executed by SDSSC (Strata Deformation Simulation System using CIP method) Ver 4.09. The model which feeds into SDSSC is modeled by the stratigraphy, the dip angle and the unit displacements from drilling surveys (Sugiyama *et al.*, 2009b) and trenching study (Shintani *et al.*, 2009).

Numerical experiments were performed with taking into account the erosional vacuity and the sedimentation for stratum by the faulting at the trenching area, and the peak slip velocity was estimated by comparison between experimental results and trenching results.

I adopted CWFS (cohesion weakening and frictional strengthening) model (Hajiabdolmajid *et al.* 2002) as the deformation characteristic about the stratum.

Result and Discussion

I estimated the peak slip velocity of the the Kushibiki fault at 1-1.5 m/s. Therefore, this conclusion leads to the suggestion that the peak slip velocity of the indirect back thrust is slower than the thrust faults.

Achnowlegement

For this study, I have used the computer systems of the Earthquake and Volcano Information Center of the Earthquake Research Institute,the University of Tokyo.

Keywords: Kushibiki fault, earthquake surface faults, back thrust, fault slip velocity, numerical experiment, CIP method

SSS34-11 Room:502 Time:April 29 12:00-12:15

Spatial Variation on Recurrence-time Distribution of Paleoearthquakes and Its Influence for Long-term Forecast

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The Earthquake Research Commitee (ERC) of Japan performs and publishes the long-term forecast of major paleoearthquakes in Japan. The ERC adopts renewal processes assuming that the recurrence intervals of paleoearthquakes are independently and identically distributed as the BPT (Brownian Passage Time) distribution. When applying this model, we need to estimate the mean and coefficient of variation (CV) on recurrence times. The estimation error in CV occationally affect so much on the long-term forecast. However, while the mean parameter can be estimated with a certain precision from only the number and approximate ages of historical activities,the estimates of CV parameter have quite large errors without plentiful and accurate data. So the ERC assumes a common estimate for all active faults in Japan to ensure a certain reliability for the estimate.But as the historical paleoseismic data are accumulated by investigations, some active faults show significantly large variation in recurrence times.

Renewal processes with the BPT distribution are based on an physical model that assumes a cyclic mechanism where stress on a fault surface is accumulated by tectonic forces until an earthquake occurs that releases the accumulated stress to a basal level. In this model, the mean recurrence time represents the rate of stress accumulation by tectonic motionand the CV implies the strength of stress perturbation caused by nearby seismicity. Therefore, these parameters are supposed to have regional trends as seen in the analysis of Nomura et al. (2011). In our study, we estimate the spatial variation of these parameters on the BPT distribution in Japanand apply it to the long-term forecast on the active faults with very few historical data. In addition, we compare our forecast with the forecast by the ERC to discuss the influence of parameter estimation on earthquake prediction.

Keywords: long-term forecast, BPT distribution, renewal process, coefficient of variation, spatial model

SSS34-12 Room:502 Time:April 29 14:15-14:30

Spatial distribution of faults and folds in the offshore extension of the western margin fault zone of the Takada plain

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We carried out a marine geological investigation on an offshore extension of the western margin fault zone of the Takada plain. The main purpose of this study is to clarify the total length of the fault zone and characterization of recent faulting. The western margin fault zone of the Takada plain is west dipping reverse fault, and the total length of this fault zone is 30 km from land to sea are based on the existing material.

We conducted 31 lines of high-resolution multichannel seismic reflection survey to recognize the detailed structure of the faults and folds. The reflection profiles depict the geological structure with extremely clear images.

The reflection profiles showed that the geological structure of the offshore area is characterized by the fold belt along the northern margin of the sedimentary basin that is formed in front of Takada plain. The shape of the fold is asymmetric weakly, and suggesting the fault related fold that has been deformed by west or north west dipping blind reverse fault as with land. This fault related fold zone is continuous to the Northern Kashiwazaki-oki Anticline from the Naoetsu-oki fault while changing asymmetry on the way. The North Kashiwazaki-oki Anticline is an active structure that has been pointed out the relevance of the source fault of the Chuetsu-oki earthquake.

Keywords: The western margin fault zone of the Takada plain, offshore, fault, fold, active structure, high-resolution seismic reflection survey

SSS34-13 Room:502 Time:April 29 14:30-14:45

Geologic structures and their activities around junction of main part and southern part of the active eastern boundary f

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A 130-km-long N-S trending active fold and thrust zone (eastern boundary fault zone of Ishikari lowland) occurs in the Ishikari lowland and off the Yufutsu plain. This fault system is one of the boundary faults between the Kuril arc and the Northeast Japan arc. This fault system consists of east-dipping thrusts accompanying with fault-related folds. This fault system is subdivided into two parts with gap and echelon arrangement around the Yufutsu plain. The main part is 72 km-long and its mean vertical displacement rate is larger than 0.4 m/ky since the late Pleistocene. The south part is 86-km-long and its mean vertical displacement rate is 0.2-0.3 m/ky since the late middle Pleistocene. The southern part of this fault zone includes discontinuous structures such as short-axis anticlines and short monocline in the terrestrial part. This discontinuity of geologic structure would be related to irregularity of basement rocks underlying the southern part of Ishikari Lowland.

Keywords: Eastern margin fault zone of Ishikari Lowland, fold and thrust belt, active fault, mean displacement rate, geographical information system

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SSS34-14 Room:502 Time:April 29 14:45-15:00

Revisited most recent paleoearthquakes along the ISTL active fault system, central Japan

KONDO, Hisao[1*] ; TANIGUCHI, Kaoru[1] ; SUGITO, Nobuhiko[2]

[1]AIST AFERC, [2]Hosei University

The ISTL active fault system, central Japan, is well-known as one of the most hazardous fault systems based on the previously-reported paleoseismological works. Since the first paleoseismic trench survey was performed in 1980s, the number of paleoseismic sites becomes over 44 sites along the 150-km-long fault system, that is the highest density on active fault zone in Japan. In those studies, the timing of the most recent paleoearthquake had been reported around 1200 y.B.P., and the events had been longly estimated to be correlated with one muti-segment earthquake either 762 A.D. or 841 A.D. historical earthquakes. On the other hands, the recent result of geoslicer survey at the middle section of the ISTL indicate that the most recent event occurred around 2300 y.B.P., contradicting with the correlations with the historical earthquakes. Thus the most recent earthquakes on the ISTL is still ambiguous, therefore, we carried out systematic paleseismic surveys around the largest segment boundary, Lake Suwa segment boundary, at the middle of the ISTL active fault system. The Lake Suwa segment boundary is structural Quarternary basin formed by left fault step-over between left-lateral strike slip faults. At three paleoseismic sites inside of the Suwa basin, we revealed the most recent events occurred a few thousands years before ~1200 y.B.P. and those are not correlatable with the historical earthquakes. These data indicate that the most recent earthquake along the ISTL did not rupture through the Lake Suwa segment boundary. In addition with this, the compiled timing of the most recent event along the entire the ISTL suggest that spatial clustering of the most recent earthquake. One large earthquake ruptured between the Kamishiro fault and the Gofukuji fault or possibly up to the Okaya fault, and another event ruptured between the Kamanashi-Yama faults and the Shimotsutaki fault. These two events will be correlated with either the 841 A.D. and the 762 A.D. earthquakes along with more reliable historical document surveys. Furthermore, this paleoseismic scenario during the most recent earthquake cycle do not deny the possibly that the larger multi-segment earthquake rupturing through the Lake Suwa segment boundary. In fact, paleoseismic event occurred between 2000 y.B.P. and 2300 y.B.P. was identified at the sites on the Gofukuji fault, the Okaya fault, and the Chino fault. Since those faults have left-lateral-strike slip component forming the pull-apart basin, the 2000-2300 y.B.P. event might have ruptured through the Lake Suwa segment boundary. To be testified this possibility, further investigation on the slip per event around the segment boundary is necessary.

Keywords: active fault, paleoearthquake, historical earthquake, ISTL active fault system

SSS34-15 Room:502 Time:April 29 15:00-15:15

High resolution seismic reflection profiling across the Kurehayama fault, Otokawa Line, central Japan

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We collected and processed shallow high-resolution seismic reflection data in order to resolve shallow structures and to understand structural linkage between active faults and folds recognized at ground surface and deeper, complicated fold and thrust structures along the Kurehayama fault, Toyama Prefecture, central Japan. We deployed more than 800 seismic channels, 10-Hz geophones, and Enviro-Vib (IVI, Inc) 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 1.5 two-way time in time section and up to about 1.5 km in depth section. 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 active structures.

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SSS34-16 Room:502 Time:April 29 15:15-15:30

Active faults in and around the Yoshinogari Heritage

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The normal faults are distributed around the boundary line of between Saga Plain and Sefuri Mountains (The Research group for Active tectonics in Kyushu, 1989, etc.). Shimoyama (2010) suggested that this normal fault zone relatively uplift the north side block, based on the displacement of boundary between Aso-4 and Mitagawa Formation. According to the Regional evaluation of the active fault (Kyushu), the Headquarter of Earthquake Research Promotion evaluated that the normal fault zone (Saga Heiya Hokuen Fault Zone) can be traced about 22 km from Ogi City to Yoshinonogari Town, based on the feature of gravity anomaly and tectonic geomorphology. However, the distribution and activities of active fault are not understood well. Yoshinogari Heritage, one of the Japan's important heritages, is on a terrace that is formed by Aso-4 pyroclastic flow deposits. Many relics during the Paleolithic era and Early-modern era have been excavated from here. Especially, it is famous for moat-surrounded settlements of the Yayoi period. The prospered moat-surrounded settlements were abandoned in the late third century. In the Nara period, Kando (ancient road) and government agencies which extend to Hizen Province (Saga and Nagasaki Prefecture) from Dazaifu,were established in the northern Saga Plain including the Yoshinogari Heritage. Yoshinogari Heritage and surrounding areas are regions where the civilizations of the many periods remain. Therefore, in this area that records man's activity for a long time, it is expected that influences of fault activities on civilizations can be known. To clarify the time and spatial relationships between active faults and ruins, we described the distribution map on active faults and ruins in and around the Yoshinogari Heritage, based on interpretation of topography using large-scale maps, aerial photograph, 5m DEM and results of field and archaeological surveys, and also conducted several very shallow seismic reflection profiles across clear tectonic scarps.

Keywords: Normal fault zone, Saga Plain, Yoshinogari Heritage, DEM, Very shallow seismic reflection profiling

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Study on great palaeoearthquakes and the decline of the Sanxingdui and Jinsha civilizations, Sichuan basin, China

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The ruins of ancient civilizations damaged by large palaeoearthquakes, which have been reported worldwide, are often used as surface markers for Holocene tectonic and palaeoseismic events. Previous studies have demonstrated that recurring palaeoearthquakes have caused repeated soil liquefaction at the same site, leaving a record in both sediments and ancient ruins; such records can reveal a great deal about earthquakes that occurred prior to human-recorded observations or measurements5?10.

The Sanxingdui civilization, which developed on the Sichuan Plain, central China, during the Bronze Age (ca. 4800 years ago), flourished from ca. 4200 to ca. 3500 years ago until its sudden disappearance ca. 3200 years ago. Subsequently, the Jinsha civilization arose in the area around Chengdu city, ca. 40 km southwest of the Sanxingdui site, but it too suddenly disappeared ca. 2500?2200 years ago. It has been speculated that floods or regime changes might explain the collapse of both civilizations, but no solid evidence for such causes has so far been reported.

In this study, to search for a link between palaeoearthquakes and the abrupt unexplained falls of the Sanxingdui and Jinsha civilizations, we investigated the liquefaction induced by great palaeoearthquakes that occurred repeatedly in the past 5000 years on the Sichuan Plain, central China, in the region of the former Sanxingdui and Jiasha civilizations. Here, we present evidence that great palaeoearthquakes may have caused the collapse of both the Sanxingdui and Jinsha civilizations, as the cultures flourished in the periods during ca. 4200?3500 years and ca. 2800?2300 years ago, respectively, on an active fault zone of the Longmen Shan Thrust Belt (LSTB) that triggered the 2008 Mw 7.9 Wenchuan earthquake. Field observations, archaeological evidence, and radiocarbon dating reveal that at least four great palaeoearthquakes have induced liquefaction in wide areas around the Sanxingdui and Jinsha civilization sites during the past 5000 years, with an average recurrence interval of ca. 1000 years. We suggest that palaeoearthquakes occurring ca. 3300 and ca. 2200 years ago caused the fall and disappearance of the Sanxingdui and Jinsha civilizations, respectively, by causing extensive damage to infrastructure and manufacturing facilities, as well as numerous deaths.

Keywords: palaeoearthquake, Sanxingdui civilization, Jinsha civilization, Yangtze River civilization, Longmen-Shan Thrust Belt, Sichuan Basin

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Active thrusting beneath an alluvial terrace in the southern Longmen Shan range front, Sichuan basin, China

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The devastating 2008 Mw7.9 Wenchuan earthquake, China, demonstrates that the central and northern parts of the Longmen Shan are currently active. However, evidence for active faulting and folding in the southern Longmen Shan remains poorly documented. In this paper, we define the structural geometry, fault kinematics, and seismic hazard of the Qiongxi thrust fault system (QTF) along the southern Longmen Shan range front by integrating deep and shallow seismic reflection data and geomorphic observations. The QTF is a 50-km-long, N-S-trending set of faults and associated folds that exhibit geomorphic evidence of Quaternary surface deformation. Geomorphic observations and seismic reflection data reveal that these faults dip steeply to the east and merge at depth with a blind, west-dipping thrust ramp. The trend and reverse sense of slip along the QTF indicates that the structure accommodates east-west crustal shortening. Based on uplift of stratigraphic horizons across the fault zone, we define a late Pliocene to early Pleistocene fault slip rate of 0.2-0.3mm/yr, and a middle Pleistocene to present rate of 0.4-1.2 mm/yr on the west-dipping thrust ramp.. This ramp soles to a basal detachment in the Triassic section at a depth of 4.5-5.5 km. To the west, this detachment steps down onto a blind, northwest-dipping thrust termed the Range Front Thrust. A rupture of the QTF in combination with the Range Front Thrust could generate a Mw7.8 earthquake with averages displacement of 5.7m. This type of earthquake source poses significant hazards to the adjacent, highly populated Sichuan basin.