Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SSS28-01 Room:103 Time:May 27 16:15-16:30

On the Ansei-type and the Hoei-type of great Nankai trough earthquakes

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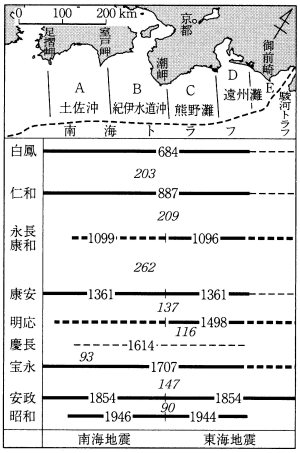
Seno (2012) proposed a new idea for the rupture mode and time series of great interplate earthquakes that have repeatedly occurred along the Nankai trough off southwest Japan. He characterized a fault plane of a great earthquake into a seismic-b.eq, a tsunami-b.eq, and a geodetic-b.eq, in which seismic waves, tsunamis, and crustal deformations are dominantly generated, respectively.

Among his various discussions, Seno compared seismic-b.eqs between the 1944 Showa-Tonankai, 1854 Ansei-Tokai, the 1707 Hoei and other earthquakes, using seismic intensity data and previous studies. As one of his main conclusions, Seno grouped historical great earthquakes into the Ansei-type or the Hoei-type, which has a seismic-b.eq similar to either of the Ansei (seismic-b.eq occupies E but not C in the Figure) or the Hoei (seismic-b.eq occupies C but not E jn the Figure) earthquakes. He interpreted that the Ansei-type earthquakes were the 684 Hakuho, 1096 Eicho, 1498 Meio, and 1854 Ansei earthquakes and recurred with about 400-year period, and that the Hoei-type earthquakes were the 887 Ninna, 1361 ko'an, 1707 Hoei, and 1944 Tonankai-1946 Nankai earthquakes and recurred with about 350-year period.

In this study, I examined Seno's (2012) idea on the Ansei-type and the Hoei-type carefully by means of historical seismology, and concluded that the grouping of historical Nankai trough earthquakes into the two types is difficult.

The figure shows a revised space-time recurrence pattern of the Nankai trough earthquakes after Ishibashi (2014).

Keywords: great Nankai trough earthquakes, historical earthquakes, recurrence pattern, Ansei-type, Hoei-type



Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SSS28-02 Room:103 Time:May 27 16:30-16:45

Pre-1703 Genroku earthquake estimated from coastal geology at the southwestern Boso Peninsula

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We conducted a drilling survey to detect the previous great Kanto earthquake to the 1703 Genroku earthquake at the Tateyama Plain, near the Sagami Trough. In this plain, coseismic uplift events to form the emerged marine terrace and bench were observed during the 1703 and 1923 Kanto earthquakes. Our drilling site was located on the beach ridge marking the coast line before the Genroku event. Considering the Holocene development of the Tateyama Plain (progradation of the strand plain closely relating to the coseismic uplift), emergence of this beach ridge would have a connection with the coastal uplift during the previous Kanto earthquake to the Genroku event.

The cores are composed of very fine-grained sand beds with marine shells (inner bay deposits) in their lower part and an alternation of sand and gravel beds (beach ridge deposits) in their upper part. Rapid sedimentary facies change from the lower to upper parts suggests the occurrence of uplift event. Alternating bed of gravelly sand with molluscan shells and clay is intercalated between the lower and upper parts of the cores. Possible source of this alternating bed is tsunami generated by the great earthquake that caused the coastal uplift. According to the ^{14}C age determination, the coastal uplift event is estimated to have occurred somewhere between the 13th and late of 14th century.

Keywords: Kanto earthquake, Coastal uplift, Tsunami deposit, Paleoearthquake

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SSS28-03 Room:103 Time:May 27 16:45-17:00

Late Holocene uplifts of Shikine Island on the northern Zenisu Ridge off Central Japan

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Emerged marine sessile assemblages are observed on Shikine Island, located on the northern Zenisu Ridge in the northern Philippine Sea plate, Japan. A previous study obtained ^{14}C ages of 1400 years BP from these assemblages by the liquid scintillation counter method and concluded that approximately 3 m of uplift occurred suddenly at 1400 years BP (Ota et al., 1983). The present study examined emerged assemblages at four sites on the island, and dated the assemblages at all four sites, and well as the assemblages reported by Ota et al. (1983), by accelerator mass spectrometry (AMS) ^{14}C dating. The results show that all the specimens are younger than AD 950. The difference in ages between the previous work and this study reflects contamination by dead carbon of the specimens measured in the previous work. By combining the our ^{14}C age data of the emerged sessile assemblages and faunal analysis of present-day rocky intertidal sessile assemblages around the study area, we suggest that uplift events took place at AD 1120-1400, AD 1530-1890, and AD 1858-1950. The amount of uplifts were estimated to be 0.4-1.8 m. It is likely that the modern uplift was due to an earthquake which occurred along south Zenisu fault system at AD 1890. The two older uplift events were caused by either fault motion or igneous activity. Although the timing of the uplift event at AD 1530-1890 corresponds to AD 1605 Keicho earthquake, our fault model did not support relationship between the uplift event and the earthquake. In conclusion, this study do not support possibility that tsunami source areas of AD 1498 Meio and 1605 Keicho tsunamis were located at the northern Zenisu Ridge.

Keywords: Shikine Island, Emerged marine sessile assemblages, Late Holocene, uplifts, ^{14}C dating

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SSS28-04 Room:103 Time:May 27 17:00-17:15

Seismicity of Kanto District for 400 years since 1615

MATSU'URA, Ritsuko S.[1*]

[1]ADEP

Kanto District shows the most active seismicity in Japan due to the subductions of PAC and PHS plates underneath, in addition to the collision of the Izu Peninsula in the western end of Sagami trough. There are 127 events of recorded destructive earthquakes in the area since 1615. Among them, 111 events are intermediate depth earthquakes related to the two oceanic plates, including inter-plate around M8 earthquakes: 1703 Genroku, 1923 Kanto, and 1923 off Katsuura, and intra-plate around M7 earthqukes: 1782 Tenmei Odawara, 1855 Ansei Edo, and 1924 Tanzawa. Only 20 earthquakes are shallow.

There are only 15 events of shallow depth. 6 of them are caused by the liquid motion due to some volcanic activities. 4 of them occurred after the 2011 off Tohoku earthquake in the northeastern part of Kanto. Among remaining 5, 1633 Kanei Odawara and 1853 Kaei Odawara occurred in some shallow part of spray faults around the collision area of the Izu Peninsula. 1683 Tenwa Shimotsuke, and 1931 Western Saitama are rare shallow events in the crust. The rupture zone of 1887 M6.2 shallow Hadano earthquake extended in the east-west direction.

1856 Ansei Musashi remains depth undetermined. If the intensity distributions of various depth events are carefully compared, we realize the difficulty of the depth determination of historical events in Kanto district with limited materials.

The research was done by the contract of MEXT in addition to the priority research project on Tachikawa Fault.

Keywords: Depth of histrical Earthquake in Kanto District, 1921 Ryugasaki Earthquake, 1855 Ansei Edo Earthquake, 1856 Ansei Musashi Earthquake, 1887 Hadano Eaerthquake, 1924 Tanzawa Earthquake

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SSS28-05 Room:103 Time:May 27 17:15-17:30

Damage in the Chiba Prefecture from the 1855 Ansei Edo earthquake

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The Ansei Edo earthquake occurred on November 11 1855 and caused severe damage in and around Edo City (former Tokyo). Kitahara (2013, Social History of Earthquakes) discussed damage and rescue in Edo City after the Ansei Edo earthquake. Nakamura et al. (2011, Historical Earthquakes) estimated seismic intensity distribution in and around Edo City from damage description in historical literature. The main target for both studies was Edo City and the damage in Chiba Prefecture has not been fully revealed except for a part of Chiba Prefecture such as Sakura and Kisarazu. To reveal the damage in Chiba Prefecture, we conducted survey of historical literature at the Chiba Prefectural Archives, Funabashi Hometown Museum, and department of literature at the Keio University.

For damage in the northwest Chiba, there is a historical document *Watanabe-Toen-Zatsuroku* printed in *History of Narashino City volume 3*. Toen Watanabe, a doctor of Saginuma Village compiled the document which describes events in the vicinity of the village during the period of 1824 – 1859. The document recorded a ground fissure due to the earthquake in Saginuma Village. The casualties and damage of houses are not described and unknown, while the ground shaking was strong enough to cause fissures.

In Funabashi City, *Jishin-Hendo-Hikae* printed in *History in Funabashi City volume 10* described that “there was a large earthquakes in four (former) countries, Musashi, Shimousa, Kazusa, and Hitachi and many houses were collapsed” , while there were no descriptions on damage in Funabashi area. We found a description of earthquake in *Daifuku-cho* of *Muto-ke Monjo* from the survey at the Funabashi Hometown Museum. The house of Muto family was located in the present Miyamoto district, Funabashi City. This document suggests that there was not severe damage such as collapsed houses and injured persons in this area.

While the above one was an only document written in Funabashi City, there is a diary of Maejima Jisuke, a mayor of Daikata Village in Togane City. He left that village toward Edo City on 11th because he was called from a feudal lord. The diary recorded that he started to see collapsed houses around Gyotoku on the way to Edo City. Another document *Edo-Kaicho-Shoyo-Dome* printed in *Archives of Narita-San Shinsho-ji volume 5*, recorded that accommodation place was asked to change in Senju post station due to severe damage, while the accommodation place was not changed in Funabashi post station. This suggests that the damage in Funabashi area was minor compared to that in Edo City.

In the southern part of Chiba, we found a diary of *Hoju-in* temple from replicated documents at the Chiba Prefectural Archives. The diary recorded that the stone monuments, stone lanterns, and Hokyoin-to Pagoda fell over and that the gate *Nio-mon* moved toward west. The diary also recorded that there was damage in surrounding temples. The diary *Nikki-Oboe* in *Kato-Ke Monjo* in Moto-Ori Village next to the village of Hoju-in recorded the Ansei Edo earthquake as “an extremely large earthquake” . These descriptions suggest that the ground shaking was strong in not only Edo City but also the southern part of Chiba Prefecture.

Acknowledgements

This study was supported by the Special project for reducing vulnerability for urban mega earthquake disasters from the Ministry of Education, Culture, Sports, Science and Technology of Japan.

Keywords: 1855 Ansei Edo earthquake, Historical earthquake, Historical document

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SSS28-06 Room:A04 Time:May 28 09:15-09:30

Numerical simulation of long-term earthquake activity on an active-fault cluster in the Japanese island

CHO, Ikuo[1] ; KUWAHARA, Yasuto[1*]

[1]AIST, GSJ

We have conducted numerical simulations of earthquake activity on an active fault cluster in the Japanese island for 50,000 years. Sixty major active faults were embedded into a 3D realistic inhomogeneous rheological structure model of crust and mantle of the central part of Japanese island for FEM simulations. The rheological model has been constructed, considering geophysical and geological data (Cho & Kuwahara, 2013a, b). The model consists of two layers: an upper part is of the elastic layer which has non-uniform thickness and a lower part is of a Maxwell viscoelastic layer whose viscosity is spatially uniform with a value of 10E21Pas. Parameters of active fault geometries, such as strikes and dips, were given with reference to results of fault evaluations by the Headquarters for Earthquake Research Promotion of Japanese government. We incoorporate a 5-km width shear zone and viscous edge zones into the model as deep extension and both lateral edges of each active fault, respectively, with the same Maxwell viscoelastic properties as the lower layer of the structure model. Tectonic stresses assumed in the simulations are a superposition of an E-W compressional stress to an entire body of the model and stresses that are generated by a collision of the Izu Peninsula to the main land of Japan.

Earthquake ruptures on the active faults are triggered on the occasion that a shear stress reaches an assumed level on some monitoring points on the fault plane. Stresses on the monitoring points are a superposition of the tectonic stress above-mentioned and Green's functions beforehand calculated for the rheology structure model from the ruptured fault to the other faults. Thus, we can show the calculation results involving the effects of constant loading of the tectonic stress and the stress perturbations due to inland large earthquakes on an earthquake cycle of each active fault with the present simulation.

References

Cho, I. and Y. Kuwahara, 2013, Modeling of a three-dimensional thermal structure in the lower crust for numerical simulations of crustal deformation of the Japanese Islands, EPS, 65, 855-861.

Cho, I. and Y. Kuwahara, 2013, Numerical simulation of crustal deformation using a three-dimensional viscoelastic crustal structure model for the Japanese Islands under east-west compression , EPS, 65, 1041-1046.

(present affiliation of I. Cho: MEXT)

Keywords: active fault, long-term earthquake activity, numerical simulation, Japanese island, crustal stress, rheology structure

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SSS28-07 Room:A04 Time:May 28 09:30-09:45

Predicted seismic moment based on the length of active fault

SHIMAZAKI, Kunihiko[1*]

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Seismic moment of future earthquake is possibly underestimated with the conventional use of active fault data. Often used empirical relationship is based on seismic fault data that is only available after the occurrence of the earthquake. Careful consideration on the choice of the relationship is desirable for avoiding damage beyond expectations.

Keywords: seismic moment, active fault, seismic fault, prediction, hazard, tsunami

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SSS28-08 Room:A04 Time:May 28 09:45-10:00

Geologic structure across the central part of the western marginal faults of the Kitakami Lowland

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[1]Fac. Eng., Iwate Univ., [2]ERI, Univ. Tokyo, [3]JGI

The western marginal faults of the Kitakami Lowland are active thrust faults, which develop along the eastern margin of the Ou Back-bone range. They have been believed to originate from normal faults caused by E-W extensional stress field during middle Miocene, and to activate as reverse faults under E-W compressional stress field since Pliocene. Though Kato et al. (2006) has shown normal inversion structures in the southern part of the faults, these structures have not been found in the central part. In this study, we modeled two dimensional shallow geological structure across the faults mainly based on gravity survey. And we discussed the structural relationship between the faults and the Tsunatori fault, which trends parallel to the faults, and lies to the west.

The gravity survey was conducted across the faults with a Sintrex gravity meter CG-5 along an E-W survey line, 12 km long. The typical interval of observation sites is 200 m. The elevation of the sites was surveyed with RTK-GPS. 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 2.2 g/cm^3.

Obtained Bouguer anomaly after trend correction shows lower value around the western marginal faults, and higher value in the eastern and western areas. The difference between these values is about 20 mgal. We assume three layers in our model, which have densities of 2.1 g/cm^3 (layer 1), 2.5 g/cm^3 (layer 2) and 2.7 g/cm^3 (layer 3), respectively. The interpretation of the model is as follows. Layer 1 is correlated to the surface covers, Pliocene and upper Miocene sedimentary rocks, layer 2 middle Miocene sedimentary rocks, and layer 3 basement rocks.

In the model, two half-grabens, filled with middle Miocene, develop below the western sides of the western marginal faults and the Tsunatori fault, both of which constitute listric boundary faults of the half-grabens. And they show thrusting displacement. We will discuss the development of this inversion structure in detail.

References

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Kato et al., 2006, Journal of Structural Geology, 28, 2011-2022.

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

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SSS28-09 Room:A04 Time:May 28 10:00-10:15

Seismic Reflection Survey at Eastern and Western Edge of Aizu Basin

ITO, Shinobu[1*] ; YAMAGUCHI, Kazuo[1] ; UCHIDA, Youhei[1] ; ISHIHARA, Takeshi[1]

[1]GSJ, AIST

We conducted seismic reflection survey at eastern and western edge of Aizu Basin in Kitakata City. The Aizu Basin is located between the Western and Eastern Aizu Basin Fault Zones. It is helpful to reveal detailed structure of the fault zones that segment the edge of the Aizu Basin, in order to understand the whole Aizu Basin. Our purpose of the study is to obtain control data to understand the whole Aizu Basin.

It is deduced that the Western Aizu Basin Active Fault Zone is the source fault of the Keicho Aizu Earthquake, and there are some signs of the earthquake at surface. Regional flexure can be revealed by seismic reflection survey. On the other hand, no clear sign of the Eastern Aizu Basin Active Fault Zone can be seen and the activity history is not clear although it is deduced by surface topography.

The survey for the Western Fault Zone was executed at Keitokucho-Yamashina, Kitakata City (KKY), where a ponded lake appeared by the Keicho Aizu Earthquake. Both source and receivers are set at a dry riverbed of Aga River. The length of the survey line is about 500m. The survey for the Eastern Fault Zone was carried out at Kumakuracho-Oguni, Kitakata City (KKO). In this region, volcanic fan deposits cover the products of Nekoma Volcano. The length of the survey line is about 800m. We used a portable vibrator ElViS III by GEOSYM with S-wave for both survey lines. Spatial intervals of shot points are 2m, sweep frequency is 20 to 160Hz, and sweep duration is 7s. We used single horizontal component geophones with GS32CT(f_O =10Hz) by Geospace, and the intervals are also 2m. We deployed 96 geophones simultaneously, and moved 48 geophones at a time.

We cannot obtain clear profile for the KKY in spite of our hope because of the knowledge of the fault zone. It is possible that the ground at a dry riverbed is not firm, and that seismic wave cannot propagate to the geophone effectively. Unpavement surface may not appropriate to this seismic source. We can see the significant structure regarded as flexure for the KKO although the surface of the survey line is over products of volcano. We are going to continue more detailed processing and analyses.

Keywords: Aizu Basin, active fault, seismic reflection survey

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SSS28-10 Room:A04 Time:May 28 10:15-10:30

Structural characters of active faults in the Toyama sedimentary basin revealed by shallow to deep seismic profiling

ISHIYAMA, Tatsuya[1*] ; SATO, Hiroshi[1] ; KATO, Naoko[1]

[1]Earthquake Research Institute, University of Tokyo

We discuss about structural characters of crustal architectures around the Toyama trough and Toyama sedimentary basin to the south revealed by new seismic reflection and refraction profiles and seismic tomography, and active structures based on Neogene geology and tectonic geomorphology. As revealed by onshore offshore deep seismic reflection profiling across the Toyama trough and Toyama sedimentary basin, crustal architectures are characterized by three domains: (1) crustal thrust wedge comprising the northwestern flanks of the Hida Mountains, (2) Neogene sedimentary basin near the axis of the Toyama trough, and (3) reactivated normal faults as thrust (or obliquely slipping) faults along structural higher domain boundaries between Noto Peninsula and Toyama trough. These structural patterns, permanent, late Quaternary crustal deformation recorded by tectonic geomorphology, and their tectonic origins are quite similar to adjacent Neogene sedimentary basins in the backarc failed rifts in the Sea of Japan, including northern Fossa Magna, Niigata, and Akita sedimentary basins.

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SSS28-11 Room:A04 Time:May 28 10:30-10:45

Blind active fault beneath Shonai plain, NE Japan

SATO, Hiroshi[1*] ; INABA, Mitsuru[2] ; ISHIYAMA, Tatsuya[1] ; KATO, Naoko[1] ; HAKEHANA, Yasuo[2]

[1]ERI, Univ. Tokyo, [2]JAPEX Co., Ltd.

The sedimentary basins along the Sea of Japan coast of northern Honshu, such as Akita-Yamagata, Niigata basins, suggest large amount of subsidence since late Pliocene. Such basin scale subsidence makes it difficult to identify active tectonic movements by tectonic geomorphological method. The Shonai basin has thick Quaternary sediments and the active tectonic feature beneath the plain is poorly understood,including the source fault of the 1894 Shonai earthquake (M7.0). We present the geologic interpretation of seismic sections and suggest an active blind thrust beneath the Shonai plain.

We interpreted the 15-km-long seismic section perpendicular to the Aosawa fault and the eastern boundary fault of the Shonai plain along the River Arase-gawa. CMP seismic reflection data were collected using four vibroseis trucks at 25-m shot and recorder interval. The seismic section was interpreted based on surface geology and drill hole data. The interpreted seismic section was examined using balanced cross sectional method.

The seismic section portrays the fault-related fold system developed by sequential thrust frontal migration from the Aosawa fault, which bounds the western margin of the Dewa Hills, The detachment is developed at the horizon of the Kusanagi and Kitamata formation, which consist of mudstone. The thrust front is located at the eastern flank of the Shonai ridge. The sediments on the western flank of the Shonai ridge suggest growth strata including Quaternary sediments. The structure was produced by thrusting at the western flank of the Shonai ridge. The source fault of the Shonai earthquake is estimated to be the eastern boundary fault of the Shonai plain. However, strongly damaged houses were located just the center of the basin, suggesting that 1894 Shonai earthquake probably produced by the blind active fault beneath the Shonai plain.

Keywords: Blind active fault, Seismic refection profiling, Shonai earthquake, Reverse fault

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SSS28-12 Room:A04 Time:May 28 11:00-11:15

High-resolution sonic survey of the shallow structure of the southern extension of the Kochien fault, Hokkaido

UCHIDA, Yasuhito[1*] ; NISHINA, Kenji[1] ; TAKAMI, Masazo[1]

[1]Geological Survey of Hokkaido, Hokkaido Research Organization

The Kochien fault, located at the southwestern edge of the Tokachi Plains, is a reverse fault characterized by an east-side upheaval. From two trench surveys, Hokkaido (2004) showed an apparent topography displacement on the lower terrace surface, and confirmed this fault to be a high-angle (about 30-60 degrees) reverse fault. A precise interpretation of the trench logs, together with carbon-14 dating results, showed that this reverse fault ruptured at least twice after the Late Pleistocene. An older event occurred at about 17,700±70yBP-12 ka, and a younger event occurred after about 2,160±60yBP. In contrast, the National Institute of Advanced Industrial Science and Technology (AIST) conducted a trench and drilling survey at two sites on this fault to supplement a former result. Based on the AIST surveys results, it was determined that the Kochien fault ruptured only once between 40 ka and 12 ka.

To clarify the distribution of the Kochien fault, we performed preliminary high-resolution sonic surveys using a parametric sub-bottom profiler across the possible active fault on an offshore area of the Tokachi Plains. We located our survey lines in the WSW-ENE direction at 500 m intervals, over a total survey track length of about 75 km.

Results from the high-resolution reflection profiles revealed flexural deformation of the shallow marine sediments. We will give a presentation on the results of this survey.

Keywords: Kochien fault, offshore, active structure, high-resolution sonic survey, Hokkaido

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SSS28-13 Room:A04 Time:May 28 11:15-11:30

Submarine active fault and uplift of the northen part of Sanriku coast

WATANABE, Mitsuhisa[1*]

[1]Toyo Univ.

The coastal area around Kuji city, northern part of Sanriku coast, has been subsided for several decades and a characteristic co-seismic subsidence is observed there in 2011. However, marine terraces are well developed along the coast, which imply that the coastal area has been uplifted since middle Quaternary. The marine terrace surfaces around Kuji city, are classified into H1˜H5 surfaces and M surface. The M surface is correlated with that formed in MIS 5e. The heights of the former shorelines of H2˜H5 and M surfaces are , respectively. A wide flexural scarp tilting toward east is found on H2˜H5 and M surfaces. It is reasonable to assume that west-dipping submarine active fault may dislocate these marine terrace surfaces and play important role in the coastal uplift.

Keywords: submarine active fault, marine terrace surface, flexure, Sanriku coast

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SSS28-14 Room:A04 Time:May 28 11:30-11:45

Active fault investigations in the offshore extension of the Miura Peninsula Faults and the Kamogawa-teichi Fault Zone

ABE, Shintaro[1*] ; SAKAMOTO, Izumi[2] ; MORI, Hiroshi[1] ; ARAI, Ryoyu[3]

[1]AIST, [2]Tokai University, [3]KGE Co.,Ltd.

We conducted marine active fault investigations in the offshore extension of the Miura Peninsula Faults and the Kamogawa-teichi Fault Zone as parts of the offshore active fault survey project promoted by MEXT (Ministry of Education, Culture, Sports, Science and Technology).

In this study, we conducted high-resolution multichannel seismic reflection surveys off the Kamogawa (in the Sotobo side) and off the Hota (in the Tokyo Bay side) in the offshore extension of the Kamogawa-teichi Fault Zone, and off the Kaneda (in the Tokyo Bay side) and off the Hayama (in the Sagami Bay side) in the offshore extension of the Miura Peninsula Faults for the purpose to understand distributions and geometries of active structures in these areas. We also conducted columnar core sampling of mud off the Hota and off the Hayama.

The boundary between the Hota group and Miura group off the Kamogawa are recognized as a fault with displacements on the seafloor. However, the fault is not directly connected to the trace of the Kamogawa-teichi Fault Zone in land area. In addition, the remarkable displacements on the seafloor change to flexural structures with echelon arrangements towards the land area. In contrast, although development of a large-scale submarine canyon is observed off the Hota, no remarkable active structure is recognized in this area.

The extended parts of the uplift zone traversing the Miura Peninsula are recognized off the Kaneda and Hayama as remarkable geological structures. The southern margin of the geological structures is correlated to the offshore extension of the fault zone. Deformed geological layers are also recognized at the deeper parts. In addition, multiple faults are also recognized within the uplift zone.

Keywords: Miura Peninsula Faults, Kamogawa-teichi Fault Zone, marine active fault investigation, high-resolution multichannel seismic reflection survey, offshore extension, active structure

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SSS28-15 Room:A04 Time:May 28 11:45-12:00

Examination of submarine active fault off southeast Izu Peninsular, central Japan

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Faunal compositions and ^{14}C ages of emerged sessile assemblages at four sites in the southern part of Izu Peninsula, central Japan, indicate that co-seismic uplift occurred at 1256-950 BC, AD 1000-1270, AD 1430-1660, and AD 1506-1815 (Kitamura et al., submitted). This study found emerged sessile assemblages at two sites (Kujyuhama and Tarai Cape) which are located at outside of the previous studied area, and examined their faunal compositions and ^{14}C ages. Moreover, we estimated average co-seismic vertical displacement based on combination of previous works and new data obtained in this study. Using these values and source fault model, we examined submarine active fault that caused four uplift events. The results showed that a reversal fault has 12 km length and 15 km width (strike = 70, dip = 25N, slip = 3 m, Mw = 6.7), and is located about 5 km off Shimoda.

Keywords: submarine active fault, southeast Izu Peninsular, coseismic uplift events, fault model

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SSS28-16 Room:A04 Time:May 28 12:00-12:15

The latest event and its fault model of active faults off the northern coast of the Noto Peninsula, central Japan

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The active faults zone on the seafloor off the northern coast of Noto Peninsula are divided into four segments, Monzen-oki, Saruyama-oki, Wajima-oki, and Suzu-oki, from west to east. The eastern half of the Monzen-oki segment corresponds to the active fault that caused the 2007 Noto Hanto earthquake (M_{JMA} 6.9). The average recurrence interval of the Monzen-oki segment was inferred from the relationship between the amount of coseismic vertical displacement and the height of the former shoreline of middle marine terraces. However, there is no data on the latest event for the other segments.

To reveal the coseismic crustal movement of the Saruyama-oki segment to the Suzu-oki segment, we investigated the vertical displacement along northern coast of the Noto peninsula. We chose *Pomatoleios kraussii*, which is one of intertidal sessile organisms for a marker of movement. We obtained 13 fossilized *P. kraussii* in rocky coast, measured the height of them by GPS surveying and dated them using the AMS ^{14}C method.

Since the altitude of the sampled fossilized assemblages includes the effect of a sea level change, it is necessary to remove it. Therefore, we apply an altitude correction based on the millennium sea level change for the northern hemisphere from data on climate changes reported by Grinsted *et al.* (2009). The vertical displacements and the dates at the sites implied that the coastal uplift occurred most likely between 1600 and 1800 AD. The uplift is recognized in a distance range of 20 km along the coast south of the Wajima-oki segment. Historical documents record seismic damages in this area in 1729 AD, although the hypocenter of this event has not been specified.

To confirm that the uplift is caused by the fault movement of the Wajima-oki segment, we constructed a fault model of the segment. In the calculation of displacements, we set rectangular faults in a homogenous elastic half-space. Based on the facts of the 2007 earthquake, the dip is set to be 60 degrees, the depth of the upper fault end is set to be 2 km and the depth of the lower fault end is set to be 15 km. We set the location of the fault based on the fault trace of the Wajima-oki segment. In the western part of the Wajima-oki segment, two faults extend parallel to each other and we selected the southern trace as the location of the rectangular faults. We used rakes of 90 degrees, 105 degrees, 120 degrees and 135 degrees. The rectangular faults consist of three sections. We used the non-linear inversion method to estimate the optimum net slip.

Our inversion result shows that a rake of 90 degrees, a net slip of the western fault plane of 1.8 m and a net slip of the center and the eastern fault planes of 0.6 m provide the best fit to the estimated vertical displacements. The zones damaged by the 1729 earthquake are included in the area above the fault model. The moment magnitude (Mw) calculated from these parameters with a rigidity of 30 GPa is 6.6 (M_{JMA} 6.7). This is coincident with the magnitude of 6.6 — 7.0 estimated empirically from the area of the damaged zones of the 1729 earthquake.

We, thus, conclude that the latest event of the Wajima-oki segment is the 1729 earthquake.

Keywords: coseismic crustal movement, active fault, intertidal sessile organisms, carbon dating, fault model, the Noto Peninsula

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SSS28-17 Room:A04 Time:May 28 12:15-12:30

Integrated Research for Beppu Haneyama Fault Zone (East part of Oita Plain to Yufuin Fault)

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<Introduction>

Integrated Research for Beppu Haneyama Fault Zone (East part of Oita Plain to Yufuin Fault) in central Kyushu started on 2014 as one of Integrated Research Project for Active Fault Systems of MEXT. We need more precise study on fault distribution, latest event in and around Beppu Bay region and relationship with western end of Median Tectonic Line for understanding of Beppu Haneyama Fault Zone.

<Purpose of project>

We carry out geomorphological, geological and geophysical researches on the basis of existing research findings. Obtained new data on geomorphology and geology will let us know new findings on precise location and activity of fault in and around Beppu Bay area. Moreover, new geophysical data on subsurface structure indicate size and motion of earthquake fault reached to the earthquake occurrence layer, and we also calculate precisely ground motion on the basis of precise subsurface structure and earthquake fault model.

<Research groups and contents of observation and survey>

Research group consists of about 40 researchers of Kyoto University, Kyushu University, Advanced Industrial Science and Technology and related Institutions, and also three sub-groups on the basis of methodology and science target. Subtheme group 1: Research on precise location and shape of active fault, and average slip rate and event age. Subtheme group 2: Research on three dimensional structure and subsurface structure of fault zone and the area. Subtheme group 3: Research on establishment of subsurface structure model and evaluation of ground motion.

The result during 2014 fiscal year will be presented in the session.

Keywords: Beppu Haneyama Fault Zone, Integrated Research Project, Active fault, Fault model, strong ground motion

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SSS28-18 Room:A04 Time:May 28 12:30-12:45

Results of the High-resolution seismic survey for the offshore extension of the Futagawa-Hinagu fault zone

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Futagawa-Hinagu fault zone (mainly right -lateral strike-slip faults) extends from Aso volcano to the Yatsushiro-sea (The Headquarters for Earthquake Research Promotion, 2002). A number of faults exist in the Yatsushiro-sea bottom.

In acroteric part of strike-slip fault annihilation mechanism, develop complex structures (e.g. Kakimi and Kato, 1994). To comprehend these structures, it is necessary construct the research technique with three-dimensionally and high precision (Abe and Aoyanagi, 2004).

We have carried out the high-resolution seismic survey to comprehend the deformation structures of fault at Yatsushiro-sea. Furthermore, we plan to submarine topography survey and piston coring in the future

Keywords: Futagawa-Hinagu fault zone, right-lateral strike-slip fault, High-resolution seismic survey

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SSS28-19 Room:A04 Time:May 28 14:15-14:30

A newly-found active fault in the Izu peninsula: the Kanogawa fault and its seismotectonic implication

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During the past 20 years since the 1995 Mw6.9 Kobe earthquake, many studies have investigated the presence and recent activity of active faults and assessed the seismic hazard associated with the active faults in Japan, but many unknown active faults that triggered the damage earthquakes, such as the 2013 Awajishima Mw5.8 earthquake (Lin et al., 2015). Therefore, it is necessary to do more work for identifying active faults and assessing their recent activity including the slip rate and paleoseismicity and to reassess the seismic hazard associated with active faults in Japan.

It is well known that many active faults developed in the Izu peninsula, central Japan, that triggered large earthquakes caused great damages, e.g., the Tanna fault that triggered the 1930 M 7.3 earthquake, the Ishirozaki fault that triggered the 1974 M 6.9 Izuhandtou-oki earthquake. Besides the 1930 and 1974 earthquakes that triggered by the well-known active faults, there are many other damage earthquakes that caused by unknown active faults in the Izu peninsula during the past half century, e.g.,the 1934 M5.5 Amagijoyama earthquake, 1976 M5.4 Kawatsu earthquake, 1978 M7.0 Izu-Oshima Kinkai earthquake, and 1980 M6.7 Izu-Touhou-oki earthquake. In this presentation, we report the tectonic topography that characterizes recent faulting along a newly-found fault, called the Kanogawa Fault, developed in the central Izu peninsula, parallel to the Tanna fault in the east side. This fault strikes north-south, extends from Mishima City in the north through the Amagi-Touge (Amagi pass) in the south for $>$30 km. The analysis on the tectonic topography and identification of active faults were mainly based on interpretations of aerial photographs, topographical maps of 1:25,000, and 3D perspective images made with Digital Elevation Model (DEM) data with 10-m-contours and field investigations. The analytical results and fieldworks reveal that the distinct fault scarps developed on the low-high terrace risers and alluvial fans, along which the vertical offsets measured in-site range from a few centimeters to $>$10 m. This finding indicates that the offset has been accumulated on the fault in the recent geological time since the formation of the terrace risers and alluvial fans.

Reference:

Lin, A., Katayama, S., and Kubota, Y., 2015. Structural analysis of seismogenic fault of the 2013 Mw5.8 Awaji Island earthquake, NW Japan. Bulletin of Seismological Society of America, in press.

Keywords: Izu peninsula, active fault, Kanogawa fault, tectonic topography, DEM image, Aerial photography

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SSS28-20 Room:A04 Time:May 28 14:30-14:45

Epicenter of the Ansei Hietsu Earthquake in 1858 inferred from ratio of dead persons in each village

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1. Introduction

Historical documents are key data for reconstruct the features of paleo-earthquakes. However, it is still rare to restore the source mechanism and/or location of epicenter of paleo-earthquakes from human damage data. The presenter tries to estimate the epicenter of the first shock during the Ansei Hietsu Earthquake in 1858 (M=7.0˜7.1:Usami et al., 1979) which are considered to be double earthquakes from ratio of dead persons in each village.

2. Features of the 1858 Ansei Hietsu Earthquake

The Ansei Hietsu Earthquake occurred on mid-night on 9 April 1858. Historical documents described that this earthquake is composed of two large shocks on 12PM and on 01AM (Cabinet office, 2008). Damages of human and houses by this earthquake are described by Takayama Gundai (local governor) in detail. We can analyze the damages quantitatively by these documents. They denote that damage of houses were bitter along the Atotsugawa fault, where 50˜100% houses collapsed, damage of houses occurred along the Miboro fault, where 20˜60% houses collapsed, and much less damages occurred in other areas (Usami et al, 2013). Trenching survey (Tsukuda et al., 1986) and detailed dating of active fault outcrops (Doke and Takeuchi, 2009) revealed that the Atostugawa fault is the source of this earthquake.

3. Estimated epicenter of the first shock of the Ansei Hietsu Earthquake inferred from the human damages described in Ansei Go Uma-no-toshi Hishu Muramura Jishin Ikken (A report on the aspects of damages by the Ansei Hietsu Earthquake)

This earthquake occurred in mid-night, the almost all peoples would be in the houses at the first shock. So peoples near the epicenter of the first shock were thought to be hard to escape from collapsing houses, on the other hand, peoples near the epicenter of the second shock would be able to escape from the damages by largest shock.

The ratio of dead persons is high (4˜54%) along the central part of the Atotsugawa fault (from Amou village to Suganuma village), and it is low (less than 4%) along the eastern part of the Atotsugawa fault. All villages along the Miboro fault is 0% in the ratio of dead persons.

This fact indicates the first shock occurred on the central part of the Atotsugawa fault, and epicenter of the second (or later) shock was near the Miboro fault.

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Doke and Takeuchi (2009) The Quaternary Research, 48, 11-17.
Tsukuda et al.(1986)Active Fault Research, 3, 59-64.
Usami et al.,(1979) Report of the coordinating committee for earthquake prediction, 21, 115-119.
Usami et al.,(2013) Materials for Comprehensive List of Destructive Earthquakes inJapan,599-2012, Univ. of Tokyo Press.

Keywords: Ansei Hietsu Earthquake, historical earthquake, human damage, Atotsugawa fault, epicenter

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SSS28-21 Room:A04 Time:May 28 14:45-15:00

Reevaluated age of the latest activity of Ushikubi fault with ESR method using calcite proportion in calcareous gouge

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The Ushikubi fault with a recurrence interval of 4-5 ka (Miyashita et al., 2004b) is a 52 km long, NE-SW dextral trending fault and composes of a complex network of active faults in central Japan. Because active faults in Japan have become a major threat to the location and re-running of the nuclear power plants in the country, various methods have been employed to unravel their fault histories and to determine ages of their recent activities. According to previous radiocarbon dating of overlying contact, the latest activity of this fault is about 1 ka while a close age of 1.9 Ka has been obtained directly from calcareous fault gouge using the ESR method (Fantong et al., 2013).

Although ESR ages obtain from defect centers in quartz grains are always greater than 10,000 yrs, age determination of the recent movement of the Ushikubi fault using calcite proportion in the mixture could give a relatively younger and more precise age. This is because defects from calcites have a younger dating range and therefore may be appropriate for determining the age of the most recent fault activities. Accordingly, the main aim of this investigation is to reevaluate the age of the Ushikubi fault based on the proportion of calcite in the samples and also to verify additive dose rate dependency on the ESR signal intensities.

The calcite proportion from the mixture was estimated using calibration curves constructed from known concentrations of pure quartz and calcite obtained from XRD diffractograms. The equivalent doses were estimated using the additive dose method and the annual dose rates (adopted from Fukuchi et al., 2002) were calculated from the concentrations of radioactive elements. Calibration curves revealed that the proportion of calcite in the samples range from 26-37% and 9-17% in the central and eastern part of the Ushikubi fault respectively. Although no great discrepancy was observed in the equivalent dose and the signal intensity upon addition of artificial irradiation (50 Gy/hr and 20 Gy/hr), the equivalent dose determined from some of the samples irradiated at 20 Gy/hr was slightly larger. The average age obtained from these proportion range from 0.75 - 1.15 ka (50 Gy/hr) and 0.88 - 1.2 ka (20 Gy/hr). These ages are in good agreement with that determined by radiocarbon dating (1 ka) (Miyashita et al., 2004b).

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Miyashita, Y., Yoshioka, T., Nikaido, M., Takase, N. and Tachibana, T., (2004b): Paleoseimological surveys of the Northeastern part of Ushikubi fault on Toyama/Gifu prefectural border-A trench excavation survey at kamishirakimine site. Annual Report on Active Fault and Paleoearthquake Research, 4: 131-142 (In Japanese with English abstract).

Keywords: ESR, Calcareous fault gouge, Calcite proportion, Ushikubi fault, Active fault

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SSS28-22 Room:A04 Time:May 28 15:00-15:15

Surface trace and latest activities of the Kurehayama Fault through the urban area of Toyama City, north-central Ja

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The Krehayama fault zone is an active, high-angle reverse fault running through the central part of urban area in Toyama City. The surface-fault trace and the fault history are still unclear because of much limitation for geological surveys in such an urban area. Recently, however, boring investigation has been carried out along the National highway No. 8 for the construction of bridge in the segment from Awashima-machi to Toyoda-honmachi, Toyama City. Descriptive reports on stratigraphy of boring investigation and core-samples were available and quite useful for the five sites of boring investigation (T7, T8, T2, T3 and T9 from west to east) were offered by the Toyama Office of River and National Highway, Hokuriku Regional Development Bureau, MLIT, Japan.

This study utilized those samples and records to clarify the location of fault trace and to determine the age of latest activities of Kurehayama Fault by visual observation and age determination using carbon isotope analysis of core samples. Seven radiometric carbon ages were also obtained from T7, T8, and T9 for time-stratigraphy.

Analytical results of this study suggest that the surface trace of Kurehayama Fault across the survey line between T3 and T9 and displaced at least twice after 9680calBC with approximately 4.7 m in accumulated displacement. The latest activity occurred within the interval after 4960calBC and before 1360calBC with approximately 2.5 m vertical displacement. Regarding the estimated range in the neighbor segments of Kurehayama Fault, this study limited the evaluated span of fault activity into a narrow range ca.2285BC- ca.1360BC.

The second latest activity occurred within the span from ca.9500calBC to ca.8380calBC, and its vertical displacement was evaluated 2.54m, suggesting a moment magnitude 7.2 if the whole fault were activated to generate earthquake. The time interval between the first and second latest events was calculated as about 7100 years.

Since the net-slip rate becomes 0.5m kyr-1 and the activity of Kurehayama Fault is classified into B class.

It is necessary to explain the geomorphological development of target area is necessary in the future.

Keywords: active fault, reverse fault, Kurehayama Fault, Toyama Plain, latest activity, fault trace

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SSS28-23 Room:A04 Time:May 28 15:15-15:30

Offset clusters on the Haiyuan Fault and its implications to earthquake rupture pattern

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Abstract We use airborne LiDAR data to re-evaluate the single-event offsets of the 1920 Haiyuan Ms 8.5 earthquake and the cumulative offsets along the western and middle segments of the co-seismic surface rupture zone. Our LiDAR data indicate the offset observations along both the western and middle segments fall into groups. The group with minimum slip amount is associated with the 1920 Haiyuan Ms 8.5 earthquake, which ruptured both the western and middle segments. Our research highlights two new interpretations: firstly, the previously reported maximum displacement of the 1920 Earthquake is likely to due to at least two earthquakes; secondly, Our results reveal that the Cumulative Offset Probability Density (COPD) peaks of same offset amount on western segment and middles segment did not corresponding to each other one by one. We suggest that any discussion of the rupture pattern of a certain fault based on the offset data should also consider fault segmentation and paleoseismological data; Therefore, using the COPD peaks for studying the number of palaeo-events and their rupture patterns, the COPD peaks should be computed and analyzed on fault sub-sections and not entire fault zones.

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SSS28-24 Room:A04 Time:May 28 15:30-15:45

Active thrust faulting and paleoseismic records of the Longquanshan Fault in the interior of the Sichuan Basin, China

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The Longquanshan Fault (LQSF), located in the interior of the Sichuan basin, China, defines the east boundary of the Longmen Shan fold-and-thrust belt. Previous studies have shown the geometry and kinematic of the LQSF that formed above the shallow (3-5 km) detachment within the Triassic evaporite sequences within the basin. Despite its location near the metropolitan of Chengdu, and total length of about 230 km, evidences for active faulting and paleoseisimic records of the LQSF are quite unknown. Here we define the fault activity of the LQSF by integrating seismic reflection profiles, geomorphic observations, and trench survey. Analysis of seismic refection data and focal mechanism solution show that the 1967 Ms 5.5 Renshou earthquake ruptured the back-thrust of the structural wedge system in the LQSF, causing 7 deaths and 57 injuries. By using high-resolution satellite images combined with the field observations, we mapped the active fault traces of the back-thrust of the LQSF. We excavated the trench across the ˜5 m high fault scarp that formed on the alluvial fan. Based on the indentification of the colluvial wedges and the uplift and folding of the paleosoil, we infer that there are at least two paleoearthquake events are recorded in the trench wall. These findings confirm the cumulative of uplift of river terraces are produced by the LQSF through repeated paleoearthquake events. Our study shows that the LQSF represents a significant seismic hazard in the center of the high densely inhabited area in the Sichuan basin.

Keywords: Active tectonics, thrust fault, paleoseismic, seismic reflection profile, trench survey, Sichuan basin

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SSS28-25 Room:A04 Time:May 28 16:15-16:30

The surface rupture of the 22 November 2014 Nagano-ken-hokubu earthquake (Mw 6.2), Nagano prefecture, central Japan

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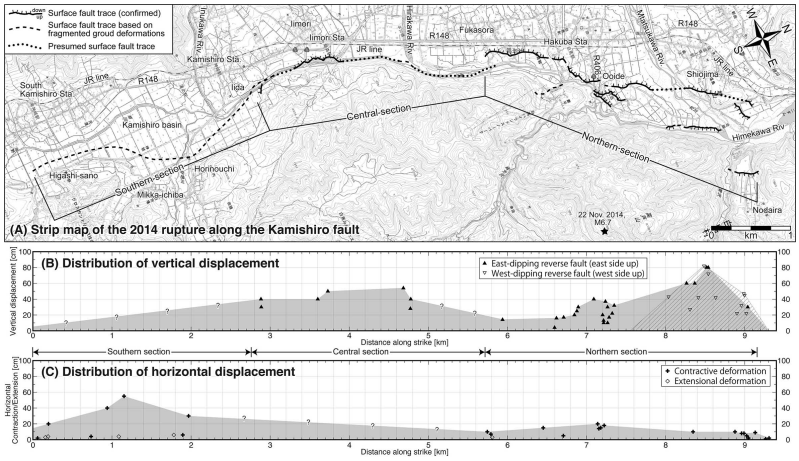
The Nagano-ken-hokubu earthquake (Mw = 6.2) occurred on 22 November 2014 and the surface rupture due to the earthquake appeared along the Kamishiro fault (Sawa et al., 1999; Togo et al., 1999). To reveal features of the surface ruptures, we carried out surface exploration from 23 November to 26, and from 29 November to 3 December. In this survey, we observed ground deformations, recorded location data of fault traces with handy GPS, and carried out simple measurement of vertical displacement and horizontal shortening. As a result, we confirmed 9.2-km-long surface ruptures and ground deformations along the Kamishiro fault. These surface ruptures and their distributions indicate that NW-SE compressive east-dipping reverse fault (east side up) slipped at depth, which is consistent with fault-plane solution of main shock (JMA, 2014) and deformation pattern using SAR interferograms (GSI, 2014). In our surface exploration, we confirm flexural deformation that has contractive deformation near the fault tip and extensional deformation in the hanging wall side. These deformations show that the reverse fault change to low-angle at shallow depth and deform unconsolidated sediments in the basin.

Keywords: surface rupture, the 22 November 2014 Nagano-ken-hokubu earthquake, Itoigawa-Shizuoka Tectonic Line, Kamishiro fault



Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SSS28-26 Room:A04 Time:May 28 16:30-16:45

Ground penetrating radar survey across the surface rupture generated by the 2014 Northern Nagano Earthquake

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[1]GSI of Japan

Surface ruptures emerged over 9 kilometers or more length intermittently along Kamishiro fault caused by the Northern Nagano Earthquake on November 22, 2014 (hereafter is "the 2014 Northern Nagano Earthquake") (Hirouchi et al., 2014; Kondo et al., 2014; Okada et al., 2014 etc.). The surface ruptures have about 90 and 40 centimeters vertical displacements in Hokujo Shiojima and Hokujo Ooide section, northern Hakuba Village respectively (Hirouchi et al., 2014), and these ruptures emerged linearly. On the other hand, crooked surface ruptures with horizontal shortening displacement emerged along topography around Kamishiro Iida and Kamishiro Horinouchi section in the southern Hakuba Village. The cause is presumed that dip angles of subsurface ruptures are high around the northern area and low around the southern area. At the Kamishiro Horinouchi section, Okumura et al. (1998) indicated almost horizontal active fault (subsurface rupture) by the past trench survey. In order to confirm these conditions, we tried to detect shallow underground structure of the surface ruptures by ground penetrating radar (GPR) survey at the Hokujo Ooide and Kamishiro Iida section.

The survey was conducted on December 2, 2014. At the Hokujo Ooide section, the GPR survey was performed along the Route 406 (Line Oi-1) and on the cultivated land 10 meters south from the Route 406 (Line Oi-2). At the Kamishiro Iida section, the GPR survey was performed on the path between the paddy fields (Line Id-1). The GPR device used, was "Noggin plus" with 250 MHz antenna manufactured by Sensors & Software Inc.

The GPR survey profile of Line Oi-1 showed the characteristics as follows. 1) A clear horizontal reflection patterns displaced near the position of surface rupture were approximately at the depth of 0.5-1.0 meter. These displacements had 20-30 centimeters uplift on the east side. The displacement tendency shown here roughly correspond to the vertical displacement of ground surface. 2) A vertical linear gap of reflection with displacement appeared at the position of 1-2 meters west from surface rupture and at the depth from 0.5 to 2 meters. It conforms to the reflection pattern at the active fault reported by Nakano and Sakai (2007). 3) A whole reflection intensity at the west side of surface rupture was strong, while reflection intensity at the east side of surface rupture was weak. It depends on a difference of the dielectric properties on both sides of the surface rupture.

The dip angle of subsurface rupture estimated from GPR survey profile is high at the Line Oi-1. However, similar pattern cannot be identified clearly on the GPR survey profile of Line Oi-2.

The pattern of subsurface rupture like the GPR survey profile of Line Oi-1 is not clear on the GPR survey profile of Line Id-1, although Okumura et al. (1998) reported almost horizontal active fault (subsurface rupture) about 4 meters deep by the past trench survey nearby Line Id-1. This is because the detectable depth (skin depth) of GPR survey at the Line Oi-1 was about 2 meters deep.

Consequently, the GPR survey could detect the subsurface rupture of high dip angle at the Hokujo Ooide section. However, the subsurface rupture of low dip angle could not be detected at the Kamishiro Iida section. In the future, it is preferable to perform the GPR survey by more survey lines and different antenna frequencies with simple boring.

Acknowledgement
We borrowed the GPR device from Prof. Yasuhiro Suzuki, Nagoya University. We appreciate his assistance very much.

Keywords: the 2014 Northern Nagano Earthquake, Kamishiro fault, surface rupture, Ground penetrating radar (GPR), shallow underground structure

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SSS28-27 Room:A04 Time:May 28 16:45-17:00

Outcrops around the Kamishiro fault, Nagano Prefecture, Central Japan

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We observed active fault outcrops considered to be related to the 2014 Nagano-Ken Kamishiro fault earthquake (M6.7). Altered tuff breccia (Miocene Iwato-Yama Formation) overlies Middle terrace deposits. Bounding thrust plane is dipping SE. Based on the observed Y-P-R1 fabric and slickenlines, reverse sense with a minor sinistral slip are determined.

Keywords: Nagano Prefecture, Hakuba Village, Kamishiro fault, active fault, outcrop, fault gouge

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SSS28-28 Room:A04 Time:May 28 17:00-17:15

Paleoseismic study on the Kamishiro Fault that triggered the 2014 Mw 6.2 Nagano earthquake, Japan

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The Mj 6.8 (Mw 6.2) Nagano (Japan) earthquake of 22 November 2014 ruptured the preexisting Kamishiro Fault along the Itoigawa-Shizuoka Tectonic Line, in the northern Nagano Prefecture, central Japan. Field investigations reveal that the earthquake produced a 9.3-km-long surface rupture zone with a thrust-dominated displacement that is characterized by distinct fault scarps with vertical offsets of up to 1.5 m, that are duplicated on the preexisting fault scarps (Lin et al., 2015).

Historical and instrumentally-records show that five large earthquakes of M >6.0 occurred in the study area around the Matsumoto Basin during the past 1200 years, which were almost located upon the active Kamishiro Fault (841 M 6.5, 1714 M 6.3, 1791 M 6.8, 1918 M 6.5 and M 6.1 (Headquarters for Earthquake Research Promotion, 2000), in which the 1918 M 6.5 earthquake caused the ground deformation along the active fault with a high dip angle, the northern part of the ISTL (Tada and Hashimoto, 1988). Based on geologic and seismic data, it is inferred that the active faults developed in the eastern margin of the Matsumoto and Kamishiro basins have a potential to trigger a large earthquake of M >8.0 (Headquarters for Earthquake Research Promotion, 2000).

To better understand the nature of the Kamishiro Fault, we carried out paleoseismic study immediately on the seismogenic fault by fieldworks including fault outcrop investigations within one week after the earthquake. Field investigations and analyses of excavated outcrops reveal that at least two morphogenic earthquakes have occurred on the Kamishiro Fault in the past millennium. Paleoseismic evidence, historical records, and radiocarbon age data show that (1) the penultimate large-magnitude earthquake (i.e., prior to the 2014 Nagano earthquake) occurred within the past 400 yr, probably corresponding to the 1918 M 6.5 or 1791 M 6.8 earthquake; and (2) the third most recent event occurred between A.D. 550 and A.D. 1000, probably corresponding to the 841 M 6.5 earthquake, suggesting at least three large earthquakes associated with surface rupture of the Kamishiro Fault in the past ˜1500 years with an average recurrence interval of ˜300-500 years. Our results reveal that the style and magnitude of thrust displacements indicate that the present-day shortening strain on the Itoigawa-Shizuoka Tectonic Line, the Eurasian-North American plate boundary in the study area, is released mainly by seismic thrust displacements along the active Kamishiro Fault.

Keywords: 2014 Mw 6.2 Nagano earthquake, paleoearthquake, Kamishiro fault, Itoigawa?Shizuoka Tectonic Line, plate boundary, thrust

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SSS28-29 Room:A04 Time:May 28 17:15-17:30

Surface rupture and slip distribution of the 22 Nov. 2014 Mw 6.2 earthquake at Nagano Prefecture, central Japan

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The 22 November 2014 Mw 6.2 Nagano-ken Hokubu earthquake occurred on the Kamishiro fault, consisting of the northern most segment of the Itoigawa-Shizuoka Tectonic Line active fault system (ISTL). The moderate-sized earthquake is associated with a 9-km-long surface rupture, which extends from the northern margin of Hokujyo Basin to the middle of Kamishiro Basin from north to south.

We mapped surface rupture and other related deformation produced by the earthquake, and measured coseismic displacement at 42 localities. The results of detailed mapping show that the surface rupture extends mostly along the previously-mapped Kamishiro fault (e.g. Active Fault Research Group, 1990; Shimokawa et al., 1995; Sawa et al., 1999; Togo et al., 1999; Nakata and Imaizumi eds., 2002). All the data at measurement localities exhibit pure reverse fault or thrust component with relative uplift at the eastern side, except for a back thrust and a pop-up structure. The surface rupture consists of main and additional fault sections. The main section of the surface rupture extends from Shiojima to Iida for ca. 6 km long. The general strike of the fault section is N25E. The amount of displacement generally increases to the north on the main section, and the maximum vertical displacement is 90cm at Shiojima. The northern termination of the main section is accompanied by the back thrust and the pop-up structure. Meanwhile, the additional section of surface rupture shows the general strike from N20E to N20W, extending from Iida to Mikkaichiba for ca. 2 km long. The amount of displacement and shortening along this section is less than ˜30 cm.

The main shock epicenter is located near the northern most termination of the surface rupture. However, the aftershock distribution exhibits that the seismogenic fault plane extends to the north from the epicenter for >5km long (e.g. The Headquarters for Earthquake Research Promotion, 2014), though significant surface rupture has been reported yet along this fault section. Tectonic landforms associated with the Kamishiro fault are clearly observed at the northern and southern extensions of the surface rupture. Therefore, the earthquake was caused by a part of the Kamishiro fault. Moreover, four paleoseismic events were identified by a pre-existing trench study, and the recurrence interval was estimated to be about 1100 to 2400 years (Okumura et al., 1998). Based on the maximum coseismic displacement of the 2014 earthquake and the average recurrence interval, the vertical slip rate of the Kamishiro fault is presumably at 0.4-0.8 m/kyr. However, it is much smaller than geologic vertical slip rate of 1.5-2.7m/kyr during the late Pleistocene (Shimokawa and Yamazaki, 1987; Imaizumi et al., 1997; Matsuta et al., 2001). To understand the recurrence of the irregular earthquakes on the Kamishiro fault, the reconstruction of displacements during paleoseismic events are necessary.

Keywords: active fault, inland earthquake, ISTL active fault system, Kamishiro Fault, coseismic slip

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SSS28-30 Room:A04 Time:May 28 17:30-17:45

Issues posed by the 2014 Kamishiro Fault Earthquake, central Japan

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The 2014 Kamishiro Fault Earthquake was generated by reactivation of the northern part of the Itoigawa-Shizuoka Tectonic Line, one of the ”110 major active faults” chosen by the Headquarters for Earthquake Research Promotion. Surface rupture has emerged just on the active fault lines shown on the pre-existing active fault maps. As the source fault was located shallower, strong ground motion occurred along the fault lines. However, it is clearly ”one scale smaller earthquake” than the earthquake that was predicted by the Headquarters for Earthquake Research Promotion.

Keywords: active fault, earthquake fault, Kamishiro Fault Earthquake