SCG64-01 Room:302 Time:May 23 09:00-09:15

Crustal structure imaging around the rupture zone of the 1983 Nihonkai-Chubu earthquake by seismic reflection survey

NO, Tetsuo[1*], SATO, Takeshi[1], TAKAHASHI, Narumi[1], KODAIRA, Shuichi[1], KANEDA, Yoshiyuki[1]

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Large earthquakes have frequently occurred on the eastern margins of the Japan Sea (e.g., the 1983 Nihonkai-Chubu earthquake (M_J 7.7), the 1993 Hokkaido-Nansei-Oki earthquake (M_J 7.8)) causing very strong vibrations, large tsunamis, and serious damage across the coastline of the Japan Sea. The 1983 Nihonkai-Chubu Earthquake was triggered by an east-dipping reverse fault, according to the analyses of aftershock distribution and the focal mechanism of the epicentral area across the western margin of the Okushiri Ridge and Sado Ridge (e.g., Urabe et al., 1985; Sato, 1985). The fracture zone was divided into three regions. The starting point of the fracture is located near the southern end of the epicentral region, which is likely where the crustal structure changes abruptly (Ohtake et al., 2002). In August 2011, we conducted a marine seismic survey around the rupture zone of the 1983 Nihonkai-Chubu earthquake using the *R/V Kairei* of the Japan Agency for Marine-Earth Science and Technology. Within the aftershock area of this earthquake, there was an earthquake of M_J 6.4 in March 2011 following the 2011 off the Pacific Coast of Tohoku Earthquake. The western part of the survey area covered the transition zone of the Yamato Basin and Japan Basin. The seismic exploration data of this survey is important to help us understand the crustal structure of the Japan Sea, particularly its eastern margins. In addition, we carried out seismotectonic and growth structure studies off the coast of Akita and Yamagata.

The multichannel seismic reflection data was acquired along 11 lines with a total length of approximately 1,924 km. The survey lines were curved to avoid the many fishing operations and equipment in the survey area. We shot a tuned air gun array with a spacing of 50 m. This array has a total capacity of 7,800 cubic inches (about 130 l). The standard air pressure was 2,000 psi (approximately 14 MPa). During the shooting, we towed a 444-channel hydrophone streamer cable with a 5700-m maximum offset, and the group interval was 12.5 m. The towing depth of the streamer cable was maintained at 12 m below the sea surface using depth controllers. The sampling rate was 2 ms, and the recording length was 16 s.

We present an outline of the data acquisition and preliminary results of the data processing and interpretations in this study. Asymmetrical anticlines with east-dipping reverse faults are well developed near the rupture zone of the 1983 Nihonkai-Chubu earthquake. Imaging of the crust on the western side of the anticline showed low-frequency reflectors. Though the basement around the source region shows larger deformation in the seismic line on the southern side than the northern side, there is more deformation in the sedimentary layers on the northern side than on the southern side. In the continental shelf off the Oga Peninsula, the basement of the continental shelf off the southern coast of the peninsula becomes rapidly deeper near the eastern end of the survey line and forms a basin with a thickness of more than 4 s. Anticlines have developed in this basin, and the basement of the basin is unclear in the low-frequency image. In the continental shelf of the northern part from the Oga Peninsula, thickness of the deposited layer is about maximum 2 s, and deformation structures has been clearly grown as compared to the southern part, and is formed asymmetrical anticline related with west-dipping reverse fault. In the Japan Basin and Yamato Basin, reflectors of the Moho and the crust below the basement were identified more clearly in the Japan Basin than in the Yamato Basin.

Keywords: the eastern margin of the Japan Sea, strain concentration areas, seismic reflection survey, 1983 Nihonkai-Chubu Earthquake

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SCG64-02 Room:302 Time:May 23 09:15-09:30

Seismic velocity image off the northern Oga Peninsula in the Japan Sea, deduced from the offshore seismic survey

SATO, Takeshi[1*], NO, Tetsuo[1], TAKAHASHI, Narumi[1], KODAIRA, Shuichi[1], KANEDA, Yoshiyuki[1]

[1]JAMSTEC

In the eastern margin of the Japan Sea, some destructive earthquakes occurred and the fault-fold belts developed by the deformation of the extension by the opening of the Japan Sea during the late Oligocene and the shortening since the late Pliocene (e.g., Sato, 1994). However, it is unknown to the relation between the occurrence of these earthquakes and the crustal structures including active faults and folds developed by these deformations in fault-fold belts in this margin. To understand this relation, it is need to clarify the crustal structure from basin areas without this shortening in the Japan Sea (Japan and Yamato Basins) to the fault-fold belts in this margin. For this study, we present the seismic velocity image in the crust from the southern tip of the Japan Basin to off the northern Oga Peninsula across the source area of the 1983 Nihonkai-Chubu Earthquake in this margin deduced from the offshore seismic data using ocean bottom seismographs (OBSs).

In 2011, the offshore seismic refraction/wide-angle reflection survey using 55 OBSs and a tuned air-gun array (7,800 cu. inch) was conducted from the southern tip of the Japan Basin to the continental shelf off the northern Oga Peninsula where Awashima-Oga fault belts locates (Okamura et al., 1998). This survey line has about 283 km length and runs across the source area of the 1983 Nihonkai-Chubu Earthquake. In record sections of several OBSs and land stations, not only the first arrived phases but also later phases reflected from interfaces in the crust and uppermost mantle are visible. To obtain seismic velocity image and reflection one in the crust including sediments and uppermost mantle below this line, we used a seismic refraction tomography using first-arrival phases (Zhang et al., 1998) and a diffraction stack migration approach using picked reflection travel times (Fujie et al., 2006).

The crustal thickness of the southern tip of the Japan Basin is about 9 km. This crust is thinner than those of the Yamato Basin off the northwest Sado-ga-shima island and Awa-shima island. The crust exhibits a quite uniform thickness in the basin area with water depths greater than 3000 m. However, this thickens gently to the land from the area at the water depth of 3000 m. This area where this crust is thickening may correspond to the active fault zone locate to the southwest part of the Okushiri Ridge (Okamura et al., 1998). In the source area of the 1983 Nihonkai-Chubu Earthquake, the crustal thickness is about 19 km and the Moho lies at the depth of about 21 km. Moreover, the P-wave velocity below this area has an anomaly compared to the surrounding area. The boundary of the south-eastern side of this anomaly area may correspond to the fault plane of the 1983 Nihonkai-Chubu Earthquake. In the continental shelf area where active faults and folds have developed, the sedimentary layer and the upper crust have large lateral variations.

SCG64-03 Room:302 Time:May 23 09:30-09:45

Subsurface image inferred from receiver functions using a dense linear array in Niigata region: Preliminary results

SHIOMI, Katsuhiko[1*], TAKEDA, Tetsuya[1], SEKIGUCHI, Shoji[1]

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NIED installed a dense linear seismic array in Niigata and western Fukushima in 2008 and will continue its operation until fall of 2012. This linear array, which has about 165 km length, is composed of 31 velocity type three-component seismometers with eigenfrequency of 1Hz. This temporal observation is done as a part of the MEXT research project for high-strain rate zone. We can include two NIED Hi-net stations (N.TWAH / N.TSTH) to the linear array. In order to reveal subsurface structure around the high-strain rate zone, we apply the receiver function analysis to the data obtained by this linear array. As a reference, we also estimate the receiver functions at the F-net station N. ADMF in Sado Island.

For temporal stations, we select teleseismic waveforms with high signal-to-noise ratio observed from November 2008 to September 2011. For Hi-net and F-net stations, we choose earthquakes from October 2000 to November 2011. Magnitudes of the target teleseismic events are 5.5 or greater for all stations. Two kinds of low-pass filters (fc = 1 Hz / 2 Hz) are applied to estimate receiver function.

We got pretty good teleseismic records at the stations in the mountain area. In the radial receiver functions, we can find clear positive phase arrivals at 4 to 4.5 s in delay time at these stations. Since this time delay corresponds to 35 km-depth velocity discontinuity existence, these phases may be the converted phases generated at the Moho discontinuity. Seeing the backazimuth paste-ups of the transverse receiver functions, we can find polarity changes of later phases at 4 to 4.5 s in delay time. This polarity change occurs for direction of N0E (north), N180E (south), and N270E (west). Although we have no events in N90E (east) direction, this feature implies that anisotropic rocks may exist around the Moho and that its fast-axis (or slow-axis) directs to N-S or E-W direction. This characteristic is consistent with the fast-axis direction estimated by the S-wave splitting analysis [e.g., Sakakibara, 2004]. At the stations in the edge of Niigata plain, the first pulse, which corresponds to the direct P-wave arrival, delays from zero and its pulse width becomes broad. This feature is caused by the existence of thick sediments. In these cases, Shiomi & Obara (2005) pointed out that arrival time of the Moho converted phase may be contaminated by the multi-reflection phases by sediment layer. Thus, it is hard to discuss the structural feature using receiver function itself.

We will construct a crustal anisotropy model based on the receiver functions and compare it with the results of S-wave splitting analysis as the next step. We also try to construct the geometry of the Moho discontinuity.

Keywords: Receiver function, High strain rate zone, Moho discontinuity, Anisotropy

SCG64-04 Room:302 Time:May 23 09:45-10:00

Some problems on the deformation of the back arc region of Northern Honshu arc, Japan

SATO, Hiroshi[1*], ISHIYAMA, Tatsuya[1]

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Deformation of the overlying plate is mainly controlled by the coupling condition on the plate interface. Next factors are geometry of the lithosphere on the overlying plate, such as cold and strong mantle wedge, thin strong layer in volcanic arc and thick lithosphere in the backarc. However, actual structural data using seismic waves are still not available. If the above mentioned structure has certain reality in northern Honshu, the deformation does concentrate on the volcanic arc. Geological strain is concentrated along the Sea of Japan coast and subordinate along the volcanic front, suggesting the factor of effective thickness is so thin, due to the Miocene rifting and concentration of fault, which produced during rifting. Present shortening deformation has been performed by reactivation of normal faults. However, the zone of reactivation has a western limit. It was produced by the limit of volcano-plutonic influence to the backarc or the eastern limit of underplated mantle lithosphere beneath the Sea of Japan. To reveal this problem, new project of seismic observation in the Sea of Japan will be needed.

There is a big difference on the convergent rate determined by GPS and geological information. Later is much smaller. To understand this phenomena is important to understand the stress and strain build up on the hangingwall of the subduction megathrust. Before the 2011 Tohoku-oki earthquake, the occurrence of the devastative earthquakes were focused in the relation between the existence of high convergent rate zone measured by GPS. However, another high zone was developed just behind the maximum slip area of the 2011 Tohoku-oki earthquake and in this region 2008 Iwate-Miyagi inland earthquake and 2003 Northern Miyagi earthquakes occurred. These phenomena can be understand as stress concentrating processes caused by the 2011 Tohoku-oke earthquake.

For the understanding whole processes of strain and stress build up in the overlaying plate, the budget of the strain rate, including nonelastic deformation of the hangingwall, in the subduction system is very crusial. For this purpose, we need to start construct numerical model, which includes whole subduction system in different time duration.

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SCG64-05 Room:302 Time:May 23 10:00-10:15

Petrological crustal structure model of the northeast Honshu arc, Japan

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After the 2011 Tohoku-Oki M9 earthquake, numerous crustal earthquakes occurred beneath the northeast Honshu arc. However, crustal earthquakes following the 2011 Tohoku-Oki M9 earthquake is not homogeneously distributed throughout the northeast Honshu arc. For example, seismicity rate increase around Iwaki after the 2011 Tohoku-Oki M9 earthquake, and the 11 April 2011 Mj=7.0 Iwaki earthquake, which is one of the biggest crustal earthquakes, produced over 10km of normal faulting along Shionodaira fault in the Abukuma metamorphic belt. The 2011 Tohoku-Oki M9 earthquake induces large stress over a very broad region of northeast Honshu arc, and the relaxation of this stress causes prolonged crustal deformation far away from the rupture zone of the 2011 Tohoku-Oki M9 earthquake.

Because mineral chemistry and rock composition are important factors to control rheological strength of the arc crust, inhomogeneous distribution of the crustal earthquakes is expected to reflect deep crustal inhomogeneity, Our previous study of petrological crustal structure model of the northeast Honshu arc showed that; (1) the high-Vp and Vs regions beneath the Tobishima Basin consist of hornblende-pyroxene gabbro, (2) hornblende gabbro is a predominant rock type beneath the Dewa Hills and Ou Backbone Range, (3) the low-velocity anomalies beneath the active volcano areas may be caused by the existence of partial melts of hornblende gabbro, and (4) the low-Vp and high-Vs regions beneath the Kitakami Mountains consist of quartz-plagioclase-bearing rocks. The study demonstrated that the heterogeneity of seismic velocity in the lower crust of the northeast Japan arc reflects variations in rock composition and temperature that are related to the regional geological history. Thus, we propose to build a new petrological crustal structure model across the northeast Honshu arc from Japan trench to Japan Sea. In order to evaluate the postseismic crustal deformation of the arc in terms of stress relaxation of the arc crust and mantle, it is necessary to estimate the deep crustal viscosity of the northeast Honshu arc.

Keywords: crust, elastic wave velocity, seismic velocity, Tohoku, island arc

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SCG64-06 Room:302 Time:May 23 10:15-10:30

Basement structures and lower crustal rocks of the NE Japan arc

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NE Japan arc is one of the typical example of trench-arc-back arc basin system. Combined geological, petrological, and geophysical studies have become a valuable tool in revealing intra-crustral structures of the NE Japan. Sato et al. (2004) presented a crustal cross-section of NE Honshu arc based on the geology and the deep seismic profiling and recognized two rift systems, the Yamato basin rift system and the northern Honshu rift system. Nishimoto et al. (2005) interpreted that the lower crust of the NE Honshu arc are composed of hornblende bearing mafic rocks based on the laboratory measurements of Vp of the Ichino-megata xenoliths under high P-T conditions, to use these data in conjunction with the results of seismic tomography for evaluating the petrological characteristics of the heterogeneous lower crust of the NE Japan arc. Nakajima et al. (2008) have shown the detailed 3D seismic velocity structure estimated by travel-time tomography around Sendai, NE Honshu, and explained the complex velocity structure using its Vp, Vs and Poissons ratio as Cenozoic sedimentary pile, shallow fluid-rich plutonic rocks under cooling, H2O-filled vein fractures, mafic plutonic rocks, and partially molten lower crust. The resulted view of crustal structure of NE Honshu is closely related with the Cenozoic tectonic and magmatic evolution of the arc having three prominent stages of volcanic activity; continental margin, back-arc basin, and island-arc stages. Huang et al. (2010) determined a preliminary Vp structure and P-wave anisotropy in the eastern margin of the Japan Sea, and Zhao et al. (2011) have determined detailed 3-D Vp, Vs, and Poissons ratio structures beneath the Amur-Okhotsk plate boundary zone using a large number of arrival-time data from many earthquakes under the Japan Sea that are relocated with sP depth-phase data. Their results show that strong lateral heterogeneities exist in the crust and upper mantle under the Amur-Okhotsk plate boundary zone. We examined the compositions of the crustal rocks based the Vp, Vs values using mineral physics studies (Nishimoto et al., 2005, 2008), and the relationship between the geological basement structures and the resulted 3-D structures of the area.

Keywords: Japan Sea, 3-D velocity structure, Tanakura tectonic line, Continental crust

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SCG64-07 Room:302 Time:May 23 10:45-11:00

Seismic structures below the Japan Sea complied from results of ocean bottom seismographic observations

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The Japan Sea is one of back-arc basins in the northwestern Pacific, and is believed to be formed in association with subduction of an oceanic plate below the Japan island arc. Because seismic structure below the Japan Sea is important for revealing the formation of the Japan Sea and the present tectonics of the Japan island arc system, numerous seismic survey using ocean bottom seismometers and controlled seismic sources have been carried out since 1980's. As a result, the Japan Sea becomes one of the most well studied back-arc basins in the world. The northeastern area of the Japan Sea (the Japan Basin) has an oceanic crust. The crustal structures which are neither a typical oceanic nor continental crust were found in the Yamato Basin and the Tsushima Basin in the central part of the Japan Sea. The crustal thicknesses of both the basins are approximately twice that of the oceanic crust. The Kita-Oki Bank which is a topographic high in the southern Japan Sea comprises. In eastern margins of the Japan Sea, it is found that the crusts become thicker toward the Japan island and a variation of thickness of the upper crust is larger than that of the lower crust. It is also essential to obtain the deep seismic structure beneath the Japan Sea. From 2001 to 2004, long-term seismic observations were performed in the Sea using OBSs including broadband type to estimate the deep structure. The broadband OBS data enable an analysis of surface waves, and the estimated S-wave model does not have a large low-velocity zone in the upper mantle. In addition, travel time tomography analysis shows a high velocity anomaly in the mantle wedge extends down to a depth of approximately 150 km beneath the Yamato Basin. To obtain a variation of thickness of the lithosphere of the Japan Sea is necessary to elucidate the formation of the Sea and the dynamics of the arc-trench system at the present. Therefore sea floor long-term seismic observations using broadband seismic sensor are needed.

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SCG64-08 Room:302 Time:May 23 11:00-11:15

Long-term permanent strain accumulation in southern Northeast Japan estimated from seismic reflection data and rates of

ISHIYAMA, Tatsuya[1*], SATO, Hiroshi[1]

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We calculated amounts of permanent strain rates accommodated by active faults in southern Northeast Japan based on recently obtained deep to shallow seismic reflection data, and rates of slip determined by shallow borehole stratigraphy drilled across fault and /or fold scarps. Strain rates accommodated by active structures are an order of 10-8/yr for each. Their spatial distribution shows that strain rates in back arc region are apparently larger than in fore arc region by an order of ten. Margin-normal variation of permanent strain rates in hangingwall block in the Northeast Japan is similar to previous studies.

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SCG64-09 Room:302 Time:May 23 11:15-11:30

The Research of Historical Earthquakes on the Eastern Margin of Japan Sea - 1762 Horeki Sado Earthquake etc.

MATSU'URA, Ritsuko S.[1*], FURUMURA, Mitsuko[1], IWASA, Koji[1], SEKINE, Mayumi[1], SUZUKI, Yasunori[1]

[1]ADEP, ERC

We have been systematically examining Japanese destructive earthquakes from early modern times to the present. For the concentrated deformation zone project, we analyzed 1762 Horeki Sado earthquake in 2011. We also added the analysis of newly printed historical materials for 15 earthquakes, which we had analyzed before the current research project started in 2008. The source area of 1762 Horeki Sado earthquake is the part of the area north off Sado island in the long term evaluation of the seismic hazard by HERP. For 1670 Western Kanbara earthquake, Ishibashi(2011) pointed out the diary of Nobumitsu Nakura mentioned the damage of Aizu-Wakamatsu instead of Edo. The change of that point reinforced our estimation of the focal area just north of 1828 Sanjo earthquake. Our compiled result will be utilized to set source regions of future events in the eastern margin of the Sea of Japan.

Keywords: the concentrated deformation zone, Eastern Margin of Japan Sea, historical earthquakes, 1762 Horeki Sado earthquake, 1670 Kanbun Nishi-Kanbara earthquake

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SCG64-10 Room:302 Time:May 23 11:30-11:45

Strong ground motion, ambient noise, and GPS continuous observation in southern Niigata prefecture, JAPAN

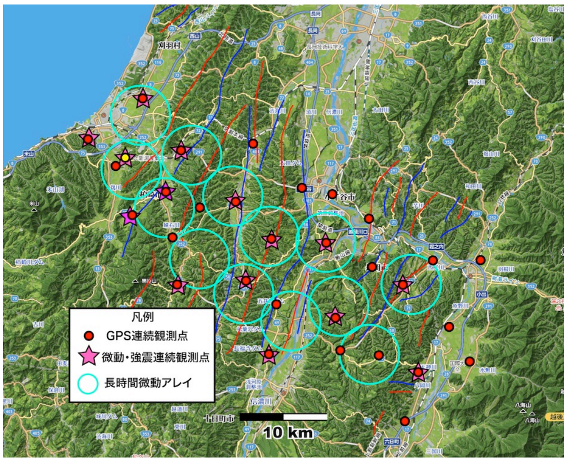
YOSHIMI, Masayuki[1*], HAYASHIDA, Takumi[1], OKAMURA, Yukinobu[1], HORIKAWA, Haruo[1], SAOMOTO, Hidetaka[1]

[1]Geological Survey of Japan, AIST

We have developed seismic and GPS station arrays respectively composed of 15 velocimeters and 31 GPS receivers in southern Niigata prefecture. See detail in Japanese version.

This research is funded and supported by Japan Nuclear Energy Safety Organization (JNES).

Keywords: ground motion, ambient noise, GPS, Niigata, continuous observation



SCG64-P01 Room:Convention Hall Time:May 23 13:45-15:15

Resistivity structure around the Ishikari-teichi-toen fault zone, Hokkaido, Japan (3)

YAMAYA, Yusuke[1*], MOGI, Toru[2], HONDA, Ryo[2], HASE, Hideaki[1], Atsuo Suzuki[2], HASHIMOTO, Takeshi[2], UYESHIMA, Makoto[1]

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In order to understand source processes of inland earthquake, it is important to reveal a crustal structure and distribution of fluids beneath the fault zone. Resistivity sounding using magnetotelluric (MT) method can detect resistivity structure down to a few dozen km, depending on a frequency band, and resistivity is a sensitive quantity to the presence of fluids. The Ishikari-teichi-toen active fault zone is located on the eastern edge of Ishikari lowland. This region corresponds to the geological and tectonic boundary between the central and southwestern Hokkaido, and is realized as a strain concentration zone compressed in the E-W direction. In order to image a resistivity structure including the lower crust, the MT survey was carried out in this region.

Prior to a 2-D analysis, we calculated MT responses by 3D resistivity model assuming the ocean and conductive sediments, in order to estimate the effect due to low resistivity of the ocean. As a result, a significant effect was clarified in TE mode at a frequency band below 0.03 Hz. Therefore, 2-D analysis treated the TM mode of a whole frequency band and TE mode above 0.03 Hz. The 2-D resistivity inversion code developed by Ogawa and Uchida (1996) estimated resistivity sections along four survey lines that were perpendicular to the fault zone.

The four inverted resistivity sections indicated a similar tendency, which consisted of three layers; resistive (0-2 km), conductive (2-7 km) and resistive (>7 km). The structure shallower than 7 km was consisted with seismic velocity structure, showing characteristics of the detachment and fold due to the thrusting activity. The conductive layers are significant (<10 ohm-m) below the middle part of the lowland but they do not extend to the east beyond the fault zone. This boundary can correspond to the extension of the main fault and be interpreted as a detachment of thrusting structure. The deeper part was almost uniform resistivity of a few ohm-m, except the conductor at the southwestern part, which was probably related to the activity of the Shikotsu caldera. On the other hand, the conductor implying fluids in the crust was not found beneath the fault zone. However, the MT response including such structure (i.e. deep conductor) could be removed during the 2-D analysis, because we reduced the MT data to prevent the sea effect, which was caused by the conductive seawater surrounding the study area. A full 3-D inversion analysis can resolve this problem effectively.

Keywords: high strain rate zone, Ishikari-teichi-toen fault zone, resistivity structure, magnetotelluric

SCG64-P02 Room:Convention Hall Time:May 23 13:45-15:15

Resistivity structure in southern Tohoku region inferred from Wide-band MT surveys (2)

HASE, Hideaki[1*], SAKANAKA, Shin'ya[1], KOYAMA, Takao[1], UYESHIMA, Makoto[1], WATANABE, Atsushi[1], Koji Miyakawa[1], Masato Serizawa[1], Shigeru Koyama[1], YAMAYA, Yusuke[1]

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In the tectonic zone, dehydrated fluid from a subducted oceanic plate is estimated to be localized in the crust and the upper mantle. It is considered that identifying the localized fluid is the critical key to clarify the mechanism of tectonic zone. Therefore, measuring of electrical resistivity structure which is highly sensitive to fluid, is thought to be contributing to clarify the mechanism of the tectonic zone. We started wideband magnetotelluric (MT) surveys in the northeastern margin of Japan sea tectonic zone since 2008. In 2010, we performed 27 MT surveys on YNZ line (Murakami, Niigata <-> Soma, Fukushima) from east to west in the southern part of Tohoku region.The surveys have been continued about 20 days at each site by using 12 measurement devices(11 of ADU07[Metronix Geophysics] and a MTU[Phoenix Geophysics]). We obtained impedance responses by using the robust code of BIRRP (Chase and Thomson, 2004), and estimated 2D resistivity structure by using a 2D inversion code (Ogawa and Uchida, 1996). 2D models from TE and TM modes show a conductive part (C1) between two resistive parts(R1, R2) in the middle of the survey line. The C1 is located at the volcanic front, which can image that the C1 is partial melts or hydrothermal area.

Keywords: MT survey, resistivity structure

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SCG64-P03 Room:Convention Hall Time:May 23 13:45-15:15

Spatial distribution of stress field around Niigata prefecture inferred from a marine and land seismic network

SHINBO, Takashi[1*], MACHIDA, Yuya[1], SHINOHARA, Masanao[1], YAMADA, Tomoaki[1], MOCHIZUKI, Kimihiro[1], KANAZAWA, Toshihiko[1]

[1]ERI

The Niigata-Kobe Tectonic Zone (NKTZ) (Sagiya et al., 2000) is placed in the eastern margin of the Japan Sea, many large earthquakes occurred within NKTZ. To understand the generation mechanism of these earthquakes and a formation of the NKTZ, it is important to obtain detailed hypocenter distribution around the NKTZ and to estimate stress field around the region. From focal mechanisms of aftershocks of the 2004 Chuetsu earthquake and the 2007 Chuetsu-oki earthquake, the stress fields around the source regions were estimated (Kato et al., 2006; Imanishi et al., 2006; Imanishi and Kuwahara, 2009). It is difficult to estimate stress fields in the marine region around Niigata prefecture precisely, because it is difficult to locate precise hypocenters in offshore regions only land seismic stations. Precise hypocenter locations determined by using oceanic bottom seismometers enable us to estimate precise stress fields in marine area. Shinbo et al. (2010) determined hypocenters by using 10 long-term ocean bottom seismometers off Joetsu, Niigata prefecture and land seismic stations from Dec., 2008 to Oct., 2009 and estimated focal mechanism solutions. In this study, we examine stress tensor inversion using these focal mechanism solutions and investigate spatial distribution of stress field from source region of 2004 Chuetsu earthquake to the marine region around Niigata prefecture.

We calculated the stress field by applying method of Hardebeck and Michael (2006) and estimated the principal axes. As the result, azimuth of maximum principal stress is from NW-SE to WNW-ESE and its dip is close to be horizontal. Dip of minimum principal stress is close to be horizontal near the mainshock of 2007 Chuetsu-oki earthquake and is close to be vertical near the mainshock of 2004 Chuetsu earthquake and in the marine region around Niigata prefecture. This result show the stress field becomes the strike-slip type near the mainshock of 2007 Chuetsu-oki earthquake and becomes the reverse fault type in other regions. We suggest the local variation in stress field.

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SCG64-P04 Room:Convention Hall Time:May 23 13:45-15:15

P-wave velocity structure model in a shallow part around the source area of the 1964 Niigata earthquake

MACHIDA, Yuya[1*], SHINBO, Takashi[1], SHINOHARA, Masanao[1], MOCHIZUKI, Kimihiro[1], YAMADA, Tomoaki[1], KANAZAWA, Toshihiko[2]

[1]ERI, Univ. Tokyo, [2]NIED

At the eastern margin of the Japan Sea, large earthquakes have been occurred (e.g., 1964 Niigata earthquake, the 1983 Japan Sea earthquake, the 2004 Chuetsu earthquake and the 2007 Chuetsu-oki earthquake) along the Niigata-Kobe Tectonic Zone (NKTZ). The NKTZ is recognized as a region of large strain rate along the Japan Sea coast and in the northern Chubu and Kinki distinct. Among these events, the 2004 Chuetsu earthquake and the 2007 Chuetsu-oki earthquake is triggered by reactivation of pre-existing faults within ancient rift systems by stress loading through a ductile creeping of the weak lower crust (Kato et al., 2008). Because the tectonic zone is thought to be spread in offshore region, it is difficult to understand a precise activity of the tectonic zone from only land-base observations. To compare the seismic activity with the crustal structure in the region is indispensable to understand the stress field in the tectonic zone and the tectonics in the eastern margin of the Japan Sea. In order to understand precise seismic activities in the NKTZ, especially in offshore region, we installed Ocean Bottom Cabled Seismometers (OBCSs) in the source region of the 1964 Niigata earthquake in 2010 (Shinohara et al., 2010). The OBCS system has a length of 25 km and 4 OBCSs were developed with 5 km interval. The OBCSs have three accelerometers as seismic sensor. In 2011, a seismic survey using airguna and OBCSs was carried out to obtain a seismic velocity model. To understand a precise crustal structure is necessary for precise earthquake locations. The precise seismic activities may contribute to understand a current state of the source region of the 1964 Niigata earthquake. In this study, we construct a P-wave velocity model below each OBCS using the tau-p mapping and the tau-sum inversion method (Stoffa et al., 1981; Shinohara et al., 1994). Then we estimate proper station corrections each OBCS for earthquake location.

Keywords: High strain rate zone in Japan, The 1964 Niigata earthquake, Ocean Bottom Cabled Seismometer (OBCS), Crustal structure

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SCG64-P05 Room:Convention Hall Time:May 23 13:45-15:15

Crustal structure of the fold-and-thrust belt, Chuetsu, central Japan: result of 2012 Muikamachi-Naoetsu seismic survey

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Associated with the opening of the Japan Sea, volcanic rift-basins have been developed along the Japan Sea coast of northern Honshu. The Niigata basin, central Japan, is one of such basins and filled by thick (< 8 km) Neogene sediments. By subsequent convergence since the Pliocene, an arc-parallel fold-and-thrust-belt has been developed along the Miocene rift-basins. In this belt devastative earthquakes, such as 1964 Niigata (M7.5), 2004 Chuetsu (M6.8) and 2007 Chuetsu-oki (M6.8) earthquakes, occurred by reverse faulting. Due to thick Neogene sediments, relationship between active faults/folds at near the surface and deep-sited seismogenic source faults is poorly understood. To reveal the crustal architecture, in particular geometry of source faults, onshore-offshore integrated deep seismic profiling was undertaken since 2008 for five-years-project. The 2011 Muikamachi-Naoetsu seismic line cut through the south of the epicentral area of the 2007 Chuetsu-oki earthquake.The seismic sources were air-gun (3020 cu. inch), four vibroseis trucks and explosives (100 kg) and seismic signals were recorded by ocean bottom cables, cable-connected-recording system and offline recorders, forming a maximum 2040 channels receiver array. The velocity profile obtained by P-wave refraction tomography portrays the depth of the top of Mesozoic metasedimentary rocks (Vp>5.4 km/s). Pre-Neogene rocks cropping out at near surface in the Echigo Mountain area and increasing its depth on the hanging wall of the Muikamachi fault.As the Muikamachi fault is a reverse active fault, the vertical offset of the top of pre-Neogene suggests that the fault reactivation since the Pliocene. The base of Neogene fill under the Higashikubiki hills ranges from 5 to 7 km below the sea level and shows swell beneath the western part of the hills.Based on the velocity profile and pattern of reflectors, the relationship between deep-sited source faults and active faults and folds, are clearly identified. Shallow detachment commonly developed in the lower Teradomari Formation.Due to this detachment, a source fault in the thick-skinned part does not connect straight to a fault in the thin-skinned part.

SCG64-P06 Room:Convention Hall Time:May 23 13:45-15:15

High-resolution seismic reflection profiling in the eastern margin of Takada plain, central Japan

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Mapping of seismogenic source fault beneath a fold-and-thrust belt is significant for the estimation of seismic hazard. To reveal seismogenic source faults, deep seismic reflection profiling was undertaken along the Muikamachi-Naoetsu seismic line (Sato et al., 2012: JPGU). The deep seismic profiling aims crustal scale image and for the imaging of shallow fine-scale structure its resolution is not enough. To obtain complete image of the active-seismogenic source fault system, we carried out the high-resolution seismic reflection profiling in the eastern margin of the Takada basin for 7-km-long seismic line. Seismic data were acquired using two vibrator trucks (IVI, EnviroVib). The sweep signals (8-80Hz; reflection profiling) were recorded with 4.5 & 10 Hz geophones deployed at 12.5 m intervals, off-line recorder (ERI LS8200SD, JGI MS2000). The seismic data were processed using conventional CMP-reflection methods. The obtained seismic section portrays the seismic image and velocity structure down to 2 km. The seismic section demonstrates an asymmetric fold with steeper eastern limb and gentle western limb. The thrust forms a small-scale wedge-thrust. As the main anticline was formed by the deep-sited thrust, this shallow thrust played a secondary role for this anticline.

SCG64-P07 Room:Convention Hall Time:May 23 13:45-15:15

Late Pleistocene uplift rate across the eastern margin fault zone of the Takada-heiya based on borehole drillings

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japanese text only

Keywords: the eastern margin fault zone of the Takada-heiya, sliprate, active fault, Takada-plain, borehole drillings

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SCG64-P08 Room:Convention Hall Time:May 23 13:45-15:15

High resolution seismic reflection profiling across the Torigoe fault, central Japan

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We collected and processed shallow high-resolution seismic reflection data across the Torigoe fault in Niigata sedimenrary basin, 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. We deployed 200 seismic channels, 10-Hz geophones, and mini-vibrator as a seismic source along about 7-km-long seismic line. Common midpoint stacking by use of initial velocity analysis successfully illuminates subsurface geometries of active fault-related fold to 1-1.5 two-way time. Detailed seismic reflection analyses including refraction and residual statics, migration, deconvolution, and time-space variant bandpass filters, and depth-conversion by use of stacking velocities enable to obtain subsurface depth section of these active structures. The high-resolution depth section shows that upward extension of the west-dipping thrust imaged in the deeper section is consistent with emergent thrust fault defined by middle Pleistocene conglomerates, sand- and mudstone are thrust over younger fluvial sediments. It is of interest that several active fault/fold scarps on the footwall side of the emergent thrust are underlain by west dipping thrusts marked by fault cutoffs recognized by discontinuities of reflectors. These west-dipping thrusts are interpreted to merge into sedimentary layers shallower than 1 km. Gently upward geometries of the footwall strata show that they are upward folded at northward propagation of a right stepping en echelon active anticline to the south. These observations suggest that interactions between adjacent en echelon, lateral propagating active folds strongly controls styles of faulting at structural highest levels, manifested by topographic fault or fold scarps.

Keywords: Torigoe fault, active fault, active fold, seismic reflection profile, Niigata

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SCG64-P09 Room:Convention Hall Time:May 23 13:45-15:15

Improved, high-resolution underground velocity structure in the Niigata region and its relation with seismicity

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Niigata area is part of a broader region, located in the central and north-eastern part of Japan, known for its high strain rates (Sagiya et al., 2000). To have a detailed understanding of the seismotectonic characteristics in the Niigata region, we have installed a dense temporary network of 300 seismic stations, which started functioning from 2008. In a previous tomography analysis (Enescu et al., 2011) we have revealed the undulated surface of the basement rock, hidden under a thick low-velocity layer of Neogene sediments and volcanic extrusions that form the Niigata basin. The earthquake locations, inverted together with the velocity structure, became systematically shallower, in agreement with results reported before (e.g., Kato et al., 2009).

In this study, we have used additional very deep earthquakes to better constrain the basement structure. The data consists of 1805 crustal events that have 151,780 P-wave and 169,696 S-wave arrivals, recorded at 434 temporary and permanent seismic stations. We have also manually picked deep earthquakes, with magnitudes larger than 3.5, which occurred within the subducting Pacific plate and have depths between 80 and 280 km. We have given ten times additional weight to the deeper events. The tomography inversion is conducted using the tomoDD software (Zhang and Thurber, 2003). The horizontal and vertical grid spacing were of 5 ~ 10 km and 2 ~ 10 km, respectively.

Due to the inclusion of deep earthquake picks, the velocity image of middle to lower crust was improved. The clearest feature of our velocity model is the undulated surface of the basement rock extending from SW to NE. Compared with the results we have reported previously, the undulated structure could be imaged further to the north-east, beneath the Niigata basin. The obtained results indicate that the majority of the earthquakes are located in regions where the P-wave velocity ranges from 5.5 to 6.5 km/sec. Most of the events occur on the flanks of the low-velocity region; in the basin area (of low-velocity) and the undulated basement underneath there is almost no seismicity. However, a few earthquakes do occur in the deeper region (at depths below 15 km). The earthquake activity from 2001 to present (Hi-net catalog) confirms these features. In particular, the aftershocks of the 2004, M6.8 and 2007, M6.8 Niigata earthquakes, as well as the more recent seismic activity following the M6.7 Nagano earthquake (April, 2011) are all located either on the flanks of the low-velocity region or slightly further apart. A high velocity body (i.e., P-wave velocity larger than about 6.5 km/s) is imaged below the central axis of the rift-like structure, similar with results reported by Kato et al. (2009). However, the high velocity body appears to be present only in the central part of our study region, in-between the aftershock distributions of the 2004 and 2007 Niigata aftershock sequences. Only a few earthquakes occur within the higher velocity region. The existence of the higher velocity body constrains the lower limit of the seismogenic region. The detailed mapping of the rift-like structure helps understanding where and why large earthquakes nucleate.

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SCG64-P10 Room:Convention Hall Time:May 23 13:45-15:15

Crustal movement of North Nagano earthquake and seismotectonics of the Sakae - Tsunan - Matsunoyama district

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On March 11th in 2011, off the Pacific coast of Tohoku Earthquake (M9.0) occurred off Miyagi. Next day, on March 12th in 2011, North Nagano earthquake (M6.7) occurred on the boundary between Nagano and Niigata prefecture. This area is located in Shinanogawa seismic belt (Ohmori, 1907) and Niigata-Kobe tectonic zone (Sagiya et al., 2000).

By GEONET GPS analysis, Matsunoyama (0244) displaced 39.3 cm toward the northeast and Naganosakae (0982) displaced 4.2 cm toward the north. But, on Niigata-Kobe tectonic zone maximum shortening occurs in an E-W trend.

In this study, in order to reveal temporal change in displacement field at and around the time of those earthquakes and to examine characteristics of the earthquake source fault, to elucidate a cause of displacement, I analyzed the GEONET GPS data by using GAMIT software (ver.10.42) and RTD software (ver.3.5). Also I presumed characteristics of the source fault inferred from aftershock distribution by utilizing Seis-PC software (Nakamura et al., 2005), and estimated ground surface deformation due to shear and tensile faults by using DCSTN software (Okada, 1992).

Concluding remarks resulted from the study are as follows.

At the moment when the North Nagano earthquake occurred, Matsunoyama (0244) performed 40.3 cm displacement northeastward, while Naganosakae (0982) displaced 11.8 cm northwestward. The North Nagano earthquake caused a large of displacement to epicenter surrounding area, but postseismic crustal movement due to the Tohoku -Pacific Earthquake progress remarkably after the North Nagano earthquake.

There is a possibility that an unknown fault was active by aftershock distribution. Displacement of GPS permanent stations have been not necessarily affected with faulting direct. Coseismic development of the fold structure is implied as the cause.

Keywords: North Nagano earthquake, GEONET, faults, Matsunoyama dome, geopressure

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SCG64-P11 Room:Convention Hall Time:May 23 13:45-15:15

GNSS continuous observation network in sourthern Niigata Prefecture

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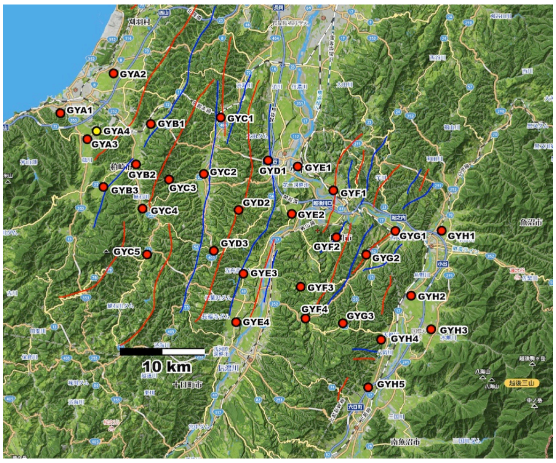
Continuous GNSS observation network is deployed in southern Niigata prefecture expanding an area of 50km to 15km. This is comprises of 30 GNSS stations (Leica GR10 with AR10 anntenna) attached on buildings or fixed on the ground.

GPS data of the network are analysed combined with 21 of the GEONET stations (GPS Earth Observation Network) and far stations of IGS (international GNSS service). GPS 24 hour data are analyzed everyday by means of Bernese GPS software (version 5.0) (Hugentobler et al., 2001), using the IGS precise ephemeredes and Earth orientation parameters. Troposphere delays are estimated at each station for every one-hour period. Also, GPS/GLONASS analysis is conducted.

This research is funded and supported by Japan Nuclear Energy Safety Organization (JNES).

Keywords: GPS, crust deformation



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SCG64-P12 Room:Convention Hall Time:May 23 13:45-15:15

Construction of integrated velocity model of shallow and deep structure in the high strain rate zone

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In this study, the microtremor investigation was carried out in the Yamagata whole region and Shallow and deep integrated model (initial geological model) were created. Moreover, in the Niigata whole region, an initial geological model and S wave velocity structure were improved, and shallow and a deep integrated structure model were developed. In order to overcome the above problem, we executed a lot of microtremor measurements in and around the sedimentary basins. About the Niigata area, the initial structure model (shallow structure model J-SHIS model) which was being created until now deviated greatly with the phase velocity obtained by microtremor observation. The theoretical phase velocity by the added speed structural model is as harmonic as observation phase velocity, and the convergency of the joint inversion calculation which unites the periodic characteristic became very good. Moreover, results, such as the periodic characteristic calculated from a model, have checked that a harmonic result was obtained as compared with results, such as the periodic characteristic by seismic observation record.

Keywords: Integrated structure model, strong-motion, microtremor measurements, Geology stratigraphy, S-wave velocity

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SCG64-P13 Room:Convention Hall Time:May 23 13:45-15:15

Microtremor Measurement at Large Seismic Intensity Regions of the 1828 Sanjo Earthquake

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The 1828 Sanjo earthquake is considered to be a crustal event with around M6.9 (Usami, 2003). The source region seems to be located in the Niigata-Kobe tectonic zone. The numbers of fatalities and damaging houses were 1,681 and 13,149, respectively (Usami, 2003). The Sanjo earthquake is one of the well documented historical earthquakes to validate strong ground motions using the seismic intensities.

According to the historical seismic intensities by Yada and Urabe (2010), large seismic intensities were estimated inside and eastern edge of the Echigo basin. Senna et al. (2011) performed dense microtremor measurement and constructed deep and shallow velocity structure models inside the basin. Therefore, we set our objective to measure microtremor in large seismic intensity regions located at the basin edge near the Higashiyama hill in Mitsuke, along the eastern edge of the basin from Mitsuke to Sanjo, and western part of the basin near Yahiko.

We performed microtremor measurement during the daytime between 28 to 30 Novmeber 2011. The portable strong motion seismometer consists of three components of acceleration sensor SMAR-6A3P with data logger LS-7000XT. We surveyed 30 min for each station and recorded the data with 100 Hz sapling. From the preliminary analyses of H/V spectral ratios, there were several stations of seismic intensity 7 with a dominant frequency of 1 Hz. Other stations with less seismic intensity showed dominant frequencies of 3-5 Hz. Although most stations were located in the back marsh, variations were significantly seen in the amplification factors.

Keywords: Sanjo earthquake, historical earthquake, microtremor measurement, H/V spectral ratio

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SCG64-P14 Room:Convention Hall Time:May 23 13:45-15:15

The trial edition of historical earthquake data base in high strain rate zone

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There are many historical documents in Japan and these are analyzed by historical researchers. The descriptions of the occurrence times and damage of historical earthquakes in and around Japan are included in these historical documents. However, the analyses of these historical documents require technical knowledge and therefore, it is not straightforward for unprofessional researchers to directly utilize these historical documents. A historical earthquake document data base was made by Ishibashi et al. for ancient and medieval ages (until around AD 1600). For early modern, or Edo, period, the amount of historical documents is significantly larger and quality of documents is variable, hence quality check is important.

We are making historical earthquake data base, which is composed of the historical earthquake document data base and seismic intensity data base, for a few earthquakes in Edo period. The 1751 Echigo-Takada and 1828 Echigo-Sanjo earthquakes, which occurred in Echigo (the present Niigata Prefecture) and caused extensive damage, were selected for the trial edition of historical earthquake data base. We selected historical documents with high reliability, formatted them as XML data, and created historical earthquake document data base. Incidentally, pictures which describe damage of these historical earthquakes are also contained in this data base, and the damage can be visually shown.

We selected historical documents which describe both the total number of houses and the number of collapsed houses in each village or town at the occurrence time of these earthquakes because the number of houses varies in time. Then, we calculated the ratio of collapsed houses and estimated seismic intensities in the Japan Meteorological Agency (JMA) scale based on Usami (1986)'s table as described below.

JMA seismic intensity 7 (XII on Modified Mercalli (MM) intensity scale): 81-100% ratio of collapsed houses.
JMA seismic intensity 6 (X-XI on MM intensity scale): 71-80% ratio of collapsed houses.
JMA seismic intensity 5+ (IX on MM intensity scale): 1-70% ratio of collapsed houses.
JMA seismic intensity 5- (VIII on MM intensity scale): 0% ratio of collapsed houses.

We created the trial edition of seismic intensity data base by using Google Earth as a platform. We plan to make a similar data base in other area, and try to make seismic intensity data base by enriching historical documents for the other earthquakes.

Acknowledgment: This study is supported by "Multidisciplinary research project for high strain rate zone" of the MEXT, Japan.

Keywords: historical earthquakes, 1751 Echigo-Takada earthquake, 1828 Echigo-Sanjo earthquake, ratio of collapsed houses

SCG64-P15 Room:Convention Hall Time:May 23 13:45-15:15

Seismic acitivity at southern part of Kusatsu-Shirane volcano

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We examined seismic activity at southern part of Kusatsu-Shirane volcano with our seismic network supported by temporary stations. We have observed seismic activity of the volcano since 2001. Currently six stations are concentrated within about 1 km from the main crater lake, Yugama. Based on past seismic network, Mori et al. (2006) pointed out two seismic clusters, one at Yugama and the other at Ainomine, an old volcanic cone 1.5 km to the south of Yugama. Mori et al. (2006) also pointed out that seismic activity at the latter zone is comparable to the former. There used to be a station at Ainomine till few years ago, and current capability of event detection is relatively low. In response to the crustal deformation event on May 27, 2011, we constructed a temporal seismic station to the south of Ainomine. The station is equipped with a L-4C three-component seismometer by Mark Products Corporation and LS-7000 data logger by Hakusan Corporation. Seismic data are stored on site and periodically collected. Collected data are then combined with our data of real time seismic network. Now seismic events are detected based on variation of seismic amplitude.

SCG64-P16 Room:Convention Hall Time:May 23 13:45-15:15

Spatial distribution of coda Q around the Atotsugawa fault zone

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We investigate a detailed spatial distribution of coda Q around the Atotsugawa fault zone in a high strain rate zone, central Japan, using waveform data from a dense seismic observation. Low coda Q at lower frequencies is localized along the fault zone, showing a good spatial correlation with the strain rate. On the other hand, we find no characteristic spatial distribution of coda Q at higher frequencies. The spatial distribution of coda Q at lower frequencies shows a good correlation with the S-wave velocity structure from the base of the upper crust to the lower crust reported by Nakajima and Hasegawa (2007). We, therefore, suggest that the coda Q at lower frequencies is the parameter that reflects the ductile deformations below the brittle-ductile transition zone of the crust. We estimate a spatial variation in stressing rate using those of coda Q in the analyzed region based on the procedure of Hiramatsu et al. (2010). The estimated variations of 15 kPa/year at the 1.5 Hz band and 18 kPa/year at the 2.0 Hz band are slightly larger than that estimated from the result of Jin and Aki (2005). This result suggests that the spatial variation in stressing rate around the Atotsugawa fault zone is possibly to be larger than the average one in the Niigata-Kobe high strain rate zone.

Keywords: the Atotsugawa fault zone, coda Q, stressing rate, high strain rate zone

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Stress field and pore-pressure distribution in seismogenic zone of Kyushu, Japan inferred from and focal mechanisms

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In the upper crust of Kyushu district, Japan, an area with high seismic activity is found in the middle part. This area is called Beppu-Shimabara graben (B-S area) because of existence many normal faults in this region. Many active volcanoes exist (i.e. Unzen, Aso, Kuju, Beppu), and historical large earthquakes occurred in this region. The major mechanism of earthquakes in the Kyushu district is strike slip type. Generally, extensional (minimum principal) stress is in north-south direction in Kyushu. On the other hand, microearthquakes normal faulting also occurs in B-S area. Basic question is why seismic activity is high and stress field changes in B-S area.

Elastic and inelastic feature of crust could be inferred from both of stress and strain field. We performed stress tensor inversion by using polarity data of first motion at direct P wave arrival. The data were obtained at stations operated by NIED, JMA and Kyushu University. In addition, we deployed more than 35 temporal seismic stations around the graben in order to determine the stress field. Directions of principal stresses are obtained at spatially distributed grid points every 20 km interval. The minimum axes of the principal stress are generally oriented in NNW-SSE direction. The maximum axes are almost in WSW-ENE direction. The stress rates are greater than 0.75 at most of the point in B-S area, implying the maximum stress is close to the moderate principal value. In addition, the minimum axes in the graben rotate counterclockwise. This stress field change requires a mechanism either relaxing the stress in east west direction or vertically loading in this region.

Following Terakawa et al. (2010), we estimated average pore-pressure at each grid point

They estimated fluid pressure from variation of the fault plane under the uniform stress field. Assuming fault slip controlled by Coulomb failure criterion, we obtain the pore fluid pressure distribution and its average value at the each grid point. The high pressure area is found around the fault zones. On the other hands, B-S area is in the low pressure condition. Two major high seismicity regions in Kyushu district have different feature each other. The seismic activity in B-S area is under the high stress ratio and the low average pore-pressure. On the other hand, the fault zones have opposite feature to B-S area. This suggests the possibility that the high seismic activity in B-S area is caused by low strength of the medium

Keywords: stress field, pore-pressure, seismic activity, Kyushu

SCG64-P18 Room:Convention Hall Time:May 23 13:45-15:15

Comparisons of source characteristics among recent disastrous inland earthquake sequences in Japan (3)

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Toward strong motion prediction for earthquakes in high strain rate zone in Japan, Somei et al. (2010, 2011) have investigated seismic scaling relationship for M7-class inland earthquake sequences in Japan to discuss source characteristics between eight sequences occurring in the high strain rate zone and five sequences occurring in others. They showed that there was no obvious difference between stress drops of them.

After the great Tohoku earthquake (M_w9.0) occurred, several large inland crustal earthquakes occurred in the high strain rate zone (the 2011 North Nagano prefecture earthquake; M_w6.7 and the 2011 West off Aomori prefecture earthquake; M_w6.1) and outside of the zone (the 2011 East Shizuoka prefecture earthquake; M_w5.9 and the 2011 East Fukushima prefecture earthquake; M_w6.6). In this study, we continued to investigate source characteristics for these crustal earthquake sequences. Then, we obtained stress drops of events (M_w: 3.1-6.9) in sixteen earthquake sequences using S-wave coda spectra of strong motion network (K-NET and KiK-net) records. S-wave coda spectral ratio between large and small event records gives source spectral ratio. For a number of event pairs including large earthquakes such as mainshocks, we also used F-net (Full range seismograph network) records. As these records have high SN ratios in the lower frequency range, we can obtain the full-range source spectral ratios, whereas we could not obtain full-range spectral ratios when we used the strong motion records. Because the source spectra of large earthquakes have the lower corner frequencies, the full-range spectral ratios are available to estimate the corner frequencies of those earthquakes. Most of source spectra obey omega-square source spectra. Stress drops are estimated by the corner frequency f_c from observed source spectral ratio and the seismic moment M_0 given by the moment tensor solution of F-net. In results, there is also no obvious difference between stress drops of events in the high strain rate zone and others.

Acknowledgements
We would like to sincerely thank CEORKA, NIED (K-NET, KiK-net) for providing the strong motion data. The hypocenter information was providing by JMA and moment tensor by F-net of NIED. Prof. Kato permits us to use relocated hypocenter information of the 2007 Noto and the 2004 Chuetsu earthquakes.

Keywords: High strain rate zone, S-wave coda, Source spectral ratio, Corner frequency, Scaling