Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

SCG062-P01 Room:Convention Hall Time:May 26 16:15-18:45

Comparisons of source characteristics among recent disastrous inland earthquake sequences in Japan (2)

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We have investigated seismic scaling relationship for recent M7-class inland earthquake sequences in Japan to discuss source characteristics between five sequences occurring in the high strain rate zone and three sequences occurring in others. There was no obvious difference between stress drops of them (Somei *et al*., 2010, JpGU, SCG088-P18). In terms of fault type of the sequence characterized by that of mainshock, however, those earthquakes which occurred in the high strain zone were reverse-faulting, whereas strike-slip faulting occurred in others. In this study, we investigate source characteristics for earthquake sequences in the high strain rate zone with strike-slip faulting (the 1995 Hyogo-ken Nanbu earthquake) to discuss different characteristics between fault-type and high strain rate zone, and we also investigate with other three earthquake sequences (the 1996 Miyagi-ken Hokubu earthquake, the Yamaguchi-ken Hokubu earthquake, the 2003 Miyagi-ken Hokubu earthquake).

Then, we obtain stress drops of 324 events (M_w: 3.1-6.9) in twelve earthquake sequences using S-wave coda spectra of nationwide strong motion records. S-wave coda spectral ratio between large and small event records gives source spectral ratio. 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 no obvious difference between stress drops of events in the high strain rate zone and others, and there are also no different source characteristics between strike-slip faulting type and reverse faulting type those are characterized by the fault type of mainshocks. However, f_cs for several large earthquakes as mainshocks are estimated out of the fitting frequency range. We should examine source spectral ratios and fcs for these earthquakes using F-net (Full range seismograph network) strong motion records. The other test is comparison of the crack size from f_c with total rupture area or combined area of asperity characterized by the slip model from waveform inversion. We also evaluate the effect of the station selection for f_cs that are estimated by source spectral ratio.

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

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Resistivity structure around the Ishikari-teichi-toen fault zone, Hokkaido, Japan (2)

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In order to understand source processes of inland earthquake, it is an important element to reveal a crustal structure and behavior of fluids around the fault zone. Resistivity sounding using magnetotelluric (MT) method can detect resistivity structure down to a few dozen km, depending on a frequency band that is used for analysis, and resistivity is a sensitive quantity to the presence of fluids. MT survey is one of the best approaches to resolve this problem. Ishikari-teichi-toen fault zone is located in the eastern edge of Ishikari Lowland of Hokkaido, Japan. The main part of this active fault zone has a potential to cause an earthquake of M 7.9 (The Headquarters for Earthquake Research Promotion, 2003). MT survey around this fault zone was concluded in order to reveal the fluid distribution beneath the fault zone and to investigate the correlation between the faults and the crustal structure. Four parallel survey lines crossing the fault zone were extended to the ENE-WSW direction with approximately 80 km long. We obtained the wideband-MT data from new 30 stations along these lines.

The 2-D resistivity inversion code developed by Ogawa and Uchida (1996) estimated resistivity sections that were perpendicular to the fault zone. These sections were consistent to the seismic reflection profile and represented the complicated structures that due to development of thrust faults. The supposed resistivity sections approximately corresponded to geological units. The surface of the study area indicated relatively high resistivity, corresponding to the Quaternary sediments. A resistivity beneath the fault zone was detected lower than that of surroundings, associated with the thrust zone of the Tertiary system. The Neogene sediments that occupied the lowland had extremely low resistivity ($<$10 ohm-m), and extended to NS direction, keeping its thickness of more than 4 km. Seismic hypocenters were distributed within and the edge of resistive bodies at deeper than 5 km. This positional relation suggested a stress concentration to the structural boundaries.

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

Japan Geoscience Union Meeting 2011
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SCG062-P03 Room:Convention Hall Time:May 26 16:15-18:45

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

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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) measurements in the northeastern margin of Japan sea tectonic zone since 2008. We estimated an eastward dipping low resistivity zone probably along the eastern Shonai plane active fault from 2D analysis. However, the whole feature of the low resistivity zone was not clear in the measurements.

To elucidate the spatial extent of the low resistivity zone, additional three lines of MT measurements over 50 km long were performed in the northwestern part of Tohoku region in 2009. The measurements have been continued about 20 days at each site by using 15 measurement devices. The source of electromagnetic induction was very weak during the period because of the very weak solar activity. However, we are able to obtain enough quality impedance responses because of using the advanced robust code of BIRRP (Chave and Thomson, 2004) for the impedance response and done the long period measurements. In this presentation, we will discuss the whole feature of the low resistivity zone and also the mechanism in the tectonic zone from estimated 2D resistivity structures of all measurement lines.

Keywords: Magnetotelluric method, tectonic zone, resistivity structure

Japan Geoscience Union Meeting 2011
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SCG062-P04 Room:Convention Hall Time:May 26 16:15-18:45

Detailed seismic attenuation structure in the focal area of the 2008 Iwate-Miyagi Nairiku earthquake (M7.2), NE Japan

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The Iwate-Miyagi Nairiku earthquake with a magnitude of 7.2 occurred in the southwestern part of Iwate Prefecture and the northwest part of Miyagi Prefecture on June 14, 2008. The earthquake occurred in the zone of concentrated deformation along of the Ou Mountain Range. After the quake, the dense temporary seismic network was deployed by the group for the aftershock observations of the 2008 Iwate-Miyagi Nairiku earthquake. From the aftershock distribution, it seemed westward dipping aftershock alignment, and the earthquake was shallow intraplate earthquake with the high-angle reverse-type focal mechanism (Okada et al., 2010).

In this study, we estimated the detailed seismic attenuation structure by using t$*$ (Eberhart-Phillips and Chadwick, 2002). But, it's difficult to estimate the correct t$*$ because there is the tradeoff between t$*$ and the corner frequency (Scherbaum, 1990). In this study, asShikasho et al. (2010, SSJ) supposed, we assume the range of stress drop of the earthquakes.As the result, the data variance could become decreased.

We used the data obtained by the temporary aftershock seismic network, the routine network (JMA and Hi-net) and the other temporary network (JNES and temporary seismic stations installed for "Intensive Surveys and Studies on the High Strain-Rate Zones" sponsored by MEXT). In this study We used the data obtained by the temporary aftershock seismic network, the routine network (JMA and Hi-net) and the other temporary network (JNES and temporary seismic stations installed for "Intensive Surveys and Studies on the High Strain-Rate Zones" sponsored by MEXT). In this study, we added the data of the hizumi temporary network and estimated the seismic attenuation structure in the western part of the focal area, especially around Mt. Choukai volcano. As a result, we found the high attenuation anomalous area below the Chokai volcano. It seems that this anomalous area is separately distributed from the high attenuation area below the focal area. The distribution of high attenuation area seem to similar with the low seismic velocity area (e.g. Okada et al., 2010).

The spectral ratio method enables us to estimate the corner frequency without the trade-off between t$*$ and the corner frequency. We compared the corner frequency by the spectral ratio method to the one by the simultaneous estimation with t$*$. As a result, we cannot found the remarkable difference between them.This suggest that we could estimat the almost correct t$*$ by the simultaneous estimation.

This study is a part of "Multidisciplinary research project for high strain rate zone" promoted by the Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japan.

Keywords: Inland earthquake, seismic attenuation, spectral ratio

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SCG062-P05 Room:Convention Hall Time:May 26 16:15-18:45

Shallow seismic profiling across the Sakata Uplift, the eastern margin of the Sea of Japan

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The Sakata-oki uplifts with the strike of NNE-SSW, are located to the off-coast of Sakata, the eastern margin of the Sea of Japan, and are believed to be anticlines of fault-related folds whose causative fault is active and dipping to west. We obtained five seismic profiles across the uplifts to reveal the shallow fault-related structure. We used a boomer as acoustic seismic source, and received reflected acoustics with 12-channel streamer. Each seismic profile is about 16 km long, and the profiles are about 6 km away from the neighbors. Fault-related structures were commonly identified on all profiles, but the structure varies along the strike of the uplifts. On the two profiles of the northern profiles, uplift with the width of about 500 m was identified at the sea bottom. Well-developed fault-related structure was also identified on one of the profiles. Flexure was found below the uplift, and a layer boundary in the hanging wall was clearly inclined to the flexure. On the two southern profiles, flexure was commonly identified on the sea bottom.

Keywords: seismic profiling, Sataka-oki Uplifts, eastyern margin of the Sea of Japan, flexure

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SCG062-P06 Room:Convention Hall Time:May 26 16:15-18:45

High resolution seismic reflection profiling across the western Aizu basin fault zone, northeast Japan

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We show a new seismic reflection profile across active thrusts and folds along the western Aizu basin. We deployed 220 seismic channels, 10-Hz geophones, and mini-vibrator as a seismic source along a7.3-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. More detailed analyses including refraction and residual statics, migration, deconvolution, and time-space variant bandpass filters, and depth-conversion by use of stacking velocities will enable to obtain subsurface depth section of these active structures. In addition we will correlate reflectors with surface geology and boreholes to discuss their subsurface geometry and rates of fault slip.

This study was supported by the Ministry of Education, Culture, Sports,Science and Technology (MEXT) of Japan, under its Observation and Research Program for Prediction of Earthquakes and Volcanic Eruptions.

Keywords: Western Aizu basin fault zone, active fault, shallow seismic reflection profiling, southern northeast Japan

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SCG062-P07 Room:Convention Hall Time:May 26 16:15-18:45

Subsurface density structure of eastern Nagaoka city in the Niigata plain based on gravity survey,central Japan

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We conducted gravity survey with LaCoste and Romberg Model-G824 gravity meter in the Nagaoka Plain, Niigata Prefecture. Each interval of observation sites is about 100 m or 200m. Error of measurement at each site is less than or equal to 0.03 mGal. The elevation of each site is leveled with RTKGPS.

Bouguer anomaly has the smallest westernmost of survey line (about 13 mGal). It suddenly increases from the 1.0km to the east and it is the maximum at about 8.5km (35mGal). It gradually decreases at about 8.5km and it is about 33 mgal at easternmost.

We employed a 2-D gravity field modeling software 2MODTM (FUGRO-LCT Inc.) to develop the subsurface density model. Taking account of the results due to the reflection survey performed together with this study, we assumed two layers in the model, the densities of which are 2.67 and 2.00g/cm3 in ascending order.

Keywords: Nagaoka city, gravity survey, Yukyuzan fault, Bouguer anomaly

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SCG062-P08 Room:Convention Hall Time:May 26 16:15-18:45

Estimation of stress field in the Niigata-Kobe Tectonic Zone by a marine and land seismic network

Takashi Shinbo[1*], Yuya Machida[1], Masanao Shinohara[1], Tomoaki Yamada[1], Kimihiro Mochizuki[1], Toshihiko Kanazawa[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 (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 340 focal mechanism solutions. In this study, we examine the focal solutions of the microearthquakes in detail and estimate stress field in the study region from the focal solutions.

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Seismicity and crustal structure in the tectonic zone off the Joetsu region as revealed by LT-OBSs

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At the eastern margin of the Japan Sea, large earthquakes have been occurred along a tectonic zone (e.g., 1964 Niigata earthquake, the 1983 Japan Sea earthquake, the 2004 Chuetsu earthquake and the 2007 Chuetsu-oki earthquake). Kato et al. (2008) suggested that reactivation of pre-existing faults within ancient rift systems by stress loading through a ductile creeping of the weak lower crust triggered the 2004 Chuetsu earthquake and the 2007 Chuetsu-oki earthquake. Because a source region of the 2007 Chuetsu-oki earthquake is distributed under the Japan Sea, aftershock observation using Ocean Bottom Seismometers were carried out (Shinohara et al., 2008). It is necessary to estimate precise aftershock distribution in order to understand the mechanism of earthquake generation. In addition, a seismic refraction survey was carried out to reveal crustal structure in the region (Nakahigashi et al., submitted). They indicated that most of aftershocks were occurred in the upper crust. 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 investigate a seismic activity in the tectonic zone, 10 Long-Term Ocean Bottom Seismometers (LT-OBS) were deployed from December, 2008, to October, 2009, in the off Joetsu region. First we estimated hypocenters of events using a location program for finding a maximum likelihood solution using a Bayesian approach (Hirata and Matsu'ura, 1987). The velocity structure for the location was modeled from a previous refraction survey conducted in the same region. Foci of over one thousand and two hundreds earthquakes were estimated with high spatial resolution during the observation period. In general, seismic waves recorded by OBSs arrive later than those estimated from the average structure model due to unconsolidated sediments just below sea floor. Therefore we adjusted estimated P- and S-wave arrivals for each station. The hypocentral distribution revealed that most of events are occurred within the upper crust. It is consistent with a result of Shinohara et al. (2008). Our precise locations of the events are useful for crustal structure studies. For example, reliability of results from tomographic study is thought to increase by using our precise locations of the events as initial locations of the inversion. We can compare the seismic activity with heterogeneity in crust of the tectonic zone off the coast of Joetsu region.

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Strong Ground Motion Validation for the 1828 Sanjo Earthquake (2)

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The strain concentrated belts have been suffered from a number of earthquake disasters in history. For example, the 2004 Niigata-ken Chuetsu earthquake is still fresh in our mind. It is important to evaluate future earthquakes and their ground motions toward the seismic hazard assessment in this area. As a first step, we attempted to reconstruction of the seismic intensity of the 1828 Sanjo earthquake to understand the characteristics of the earthquakes occurred in the strain concentrated belts.

In our previous study [Ishise et al., 2010], we assumed the southeast-dipping fault plane based on the seismic profiles [MEXT, 2008] and estimated distribution of the seismic intensity at the ground surface using the attenuation relationship [Si and Midorikawa, 1999]. Although the predicted intensity roughly explained the historical seismic intensities, and the fault plane was located outside of the hypocenters of the target event suggested by a number of historical earthquake studies [e.g., Usami, 2003; Matsu′ura et al., 2006]. In this study, therefore, we set an alternative fault plane almost conjugate to that of Ishise et al. [2010], and calculated distribution of the seismic intensity based at the ground surface based on the attenuation relationship.

As a result, the predicted surface intensity satisfies both the distribution pattern and the value of the intensity reported by a number of historical earthquake studies [e.g., Tomita et al., 1986; Matsu′ura et al., 2006; MEXT, 2008]. Moreover, the northwest-dipping fault plane assumed in this study includes the reported hypocenters and dips same direction as adjacent active faults. This means maybe the alternative fault model is more likely than previous southeast-dipping fault model.

Keywords: The 1828 Sanjo earthquake, strong ground motion prediction, the strain concentrated belts

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Examination of integrated velocity model of shallow and deep structure in Niigata Prefecture using microtremor measureme

Shigeki Senna[1*], Nobusuke Hasegawa[1], Syohei Naito[1], Takahiro Maeda[1], Hiroyuki Fujiwara[1]

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It is one of the important problems to construct about the ground model who is appreciable of seismic ground motion characteristics of the wideband of about 0.1-10 seconds to upgrade the estimation of strong ground motion. It is indispensable to integrate the shallow and deep structure model by whom modeling has been separately executed up to now, and to advance making of the model who can reproduce the record of seismic observations. In order to overcome the above problem, we executed a lot of microtremor measurements in and around the sedimentary basins. And we are studying the upgrade of the integrated subsurface structure model by using the phase velocities of the Rayleigh waves and H/V spectrum ratio obtained from the microtremor measurements together with the establishment of the technique itself. In this study, the S wave velocity structure, Q value, and the amplification characteristic were examined in detail.

Keywords: Integrated structure model, strong-motion, microtremor measurements, S-wave velocity, Q-value

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An exploration of temporal change of crustal structure at Kusatsu-Shirane volcano by cross-correlation of seismic noise

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Mt. Kusatsu-Shirane is an active volcano in the central part of Japan. The volcano has repeated phreatic explosions at several decade interval. The last eruption occurred in 1983. Current activity consists of several fumaroles and small but persistent seismicity around the main crater lakes. We have monitored the seismic activity of the volcano including 3 borehole stations since 2001. Continuous seismic record is available for most of the period.

Recent advance data analysis has enabled us to obtain Green's function between two stations by cros-correlating their data. The Green's function should reflect crustal structure between the stations. In a hope of detecting temporal change of the crustal structure due to the future eruption, we cross-correlate the continuous record at the borehole stations to obtain Green's function at one station due to the source at the other. One-day-long data since 2008 are used for the analysis. Low pass filter and binarization are applied before the cross-correlation. As a whole, obtained functions have common peaks for each station combination. Dominance of long period or short period wave is observed alternately at a few day interval. We have not observed correlation of such alternating feature with other data such as ground tilt.

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Three-dimensional velocity structure around Sakurajima and Aira caldera

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Explosive eruptions of Sakurajima volcano at the summit crater began in 1955 and the eruptions have frequently occurred, producing more than 7800 explosive eruptions as of the end of 2010. And, eruptions at Showa crater on east flank of this volcano started from June 2006 and eruptive activity gradually increased. The Ground deformation and volcanic earthquakes are observed, accompanied with rapid accumulation and release of magma. It is considered that high strain rate around magma chamber is generated by the magma accumulation and release. Ground around Aira caldera started to inflate after 1992. The inflation source is located at 10 km beneath center of the Aira caldera, from observations of GPS and leveling measurements. Generation of A-type earthquakes beneath the Minamidake crater increased from 2003 and volcano-tectonic earthquakes at southwest part of Sakurajima and northeast part of Aira caldera also increased. Strain accumulation may become active because the magma is accumulated beneath the Aira caldera.

Seismic experiment was carried in November 2008 in order to research structure and magma supply system of Sakurajima volcano and Aira caldera. Research depth of tomography analysis of velocity structure was until 3-4 km. The structure around magma chamber beneath the Aira caldera was not clear from the seismic experiment. So, we observe natural earthquakes by temporary seismic stations, in order to clarify three-dimensional seismic velocity structure at deeper part of the Aira caldera. 17 temporary stations were installed at Kagoshima and Miyazaki prefectures. And, 3 ocean bottom seismographs were installed in Kagoshima bay. We analyze the velocity structure around the Aira caldera and hypocenter distribution and source mechanism of the natural earthquakes, from data of the temporary stations including permanent stations equipped by Kyoto University, Kagoshima University and NIED. We estimated three-dimensional seismic velocity structure using data of arrival times of P- and S-waves and seismic experiment data.

Keywords: Sakurajima volcano, Aira caldera, velocity structure