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

SSS034-01 Room:105 Time:May 23 08:30-08:45

Detailed structure of the locked-sliding transition on the plate boundary beneath the southern part of Kii Peninsula

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The Nankai trough region, where the Philippine Sea Plate subducts beneath the SW Japan arc, is a well-known seismogenic zone of interplate earthquakes. A detailed crustal and upper mantle structure of the subducting Philippine Sea Plate and the overlying SW Japan arc is inevitably important to constrain the physical process of earthquake occurrence. Recently a narrow zone of nonvolcanic tremor has been found in the SW Japan fore-arc, along strike of the arc (Obara, 2002). The epicentral distribution of tremor corresponds to the locked-sliding transition zone. The spatial distribution of the tremor is not homogeneous in a narrow belt but is spatially clustered. Knowledge of lithospheric structure is necessary for an understanding of tremor. However, little is known about the deeper part of the plate boundary, especially the transition zone on the subducting plate. To reveal the detailed structure of the transition zone on the subducting plate, we conducted a deep seismic profiling in the southern part of Kii Peninsula, southwestern Japan. In this experiment, 290 seismometers were deployed on a 60-km-long line in the east-west direction with about 200 m spacing, on which five explosives shots were fired as controlled seismic sources. Charge size of the shots is 200 kg. Each seismograph system consisted of a 4.5 Hz, vertical component seismometer and a single channel data recorder, recording at 250 Hz. We obtained high signal-to-noise ratio data along the entire length of the profile. The most remarkable feature of the record sections is that extremely high amplitude reflections, which are interpreted as a reflected wave from the top of the subducting Philippine Sea plate, can be recognized. To obtain the detailed structure image of the transition zone on the subducting plate, the data recoded on the EW-line were processed using seismic reflection technique. The stacked image shows several features of the deeper part of the crust including the subducting plate boundary at 10-11 sec in two way travel time. Seismic reflection image also shows the lateral variation of the reflectivity along the top of the subducting Philippine Sea Plate.

Keywords: Non-volcanic tremor, transition zone, plate boundary, reflector

Japan Geoscience Union Meeting 2011
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SSS034-02 Room:105 Time:May 23 08:45-09:00

Converted Ps amplitude variations on the dipping slab Moho beneath the Kii Peninsula: 2. Ray parameter dependence

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Receiver functions (RFs) analysis is a very useful method to detect seismic velocity discontinuities beneath a seismic station. One can also evaluate elastic properties at an interface from changes of Ps polarity and Ps amplitude. Ps amplitude depends primarily on the impedance contrast at an interface, but the variation of Ps amplitude on back azimuth (BAZ) of the incoming P wave is affected if the interface is dipping and/or anisotropic rock surrounds the interface. Moreover, difference of incidence angle of incoming P waves also causes the variation of Ps amplitude. Shiomi and Park (2009; AGU FM) defined "standard amplitude (SA)" of a converted phase at a dipping interface beneath a station, based on back azimuth dependence of the Ps amplitude, and applied this analysis to the stations located within the Kii Peninsula, central Japan. However, since precise estimation for an incidence angle to the dipping interface is difficult, ray parameter dependence to the Ps amplitude evaluation was not considered. It becomes a problem for stable estimation of the SAs. In this study, we check ray parameter dependence to the SA estimation, and revise it at each station in the Kii Peninsula.

Teleseismic waveforms recorded at the NIED Hi-net, F-net and AIST seismic stations in the Kii Peninsula are used. We select earthquakes with high signal-to-noise ratio observed from October 2000 to August 2010 with magnitudes 6.0 or greater. Checking distribution of BAZs and incidence angles of every teleseismic waveforms observed at each station, we confirm that 80% of the selected event is located in the south ($120^o \leq$BAZ$\leq 250^o$) of stations. Ray parameters of 10% of the events are larger than 0.077, which corresponds to 37^o of incidence angle to a horizontal interface. In the case of dipping interface, Ps amplitude change with BAZ becomes larger when incoming P waves have larger ray parameters. Since events located in the west or northeast of stations are fewer than other directions, the contribution of events with large ray parameter is not small in these directions. The Philippine Sea slab is subducting to west at the eastern Kii Peninsula and to north at the southern Kii. Therefore, the Ps amplitudes tend to become large for earthquakes occurred in these direction. This means the Ps amplitude may be overestimated when we do not take ray parameter dependence into account. In order to avoid this contamination, we first select events with ray parameter from 0.055 to 0.077. Moreover, we apply amplitude correction coefficients, which are numerically evaluated by the difference of converted phase amplitudes by a horizontal Moho discontinuity. We clearly confirmed that the Ps amplitudes decreases from 11% to 7% of the primary P wave as the oceanic Moho deepens to ˜40 km, and the amplitudes becomes a constant, at 5-7% of the primary P wave. According to the P-T diagram of the Kii Peninsula region, we say that the Ps amplitude decrease likely reflects a phase transition from lawsonite blueschist to lawsonite-amphibole eclogite as water is released to the overlying layer, and this metamorphic fluids likely influence the occurrence of low-frequency nonvolcanic tremor. On the one hand, the regionality of standard amplitude distribution within the Kii Peninsula became unclear. To understand what happens along the subducting slab interface, it is important to construct models to explain the observed SA distribution as the next step.

I use the teleseismograms observed at AIST groundwater observation stations. I thank J. Park who provide me a source code for RF stacking analysis.

Keywords: Receiver function, Converted phase amplitude, Ray parameter, Kii Peninsula, Oceanic Moho, Philippine Sea plate

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

SSS034-03 Room:105 Time:May 23 09:00-09:15

Distinct trapped waves of oceanic mantle earthquakes and their relationships to the inter-plate structure

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We have investigated the Hi-net (high sensitivity seismograph network Japan operated by the NIED) seismograms of the intraslab earthquakes occurred within the subducting oceanic mantle of the Philippine Sea plate beneath the Kii Peninsula, southwest Japan. On their seismograms, distinct later phases (X phases) were found within 2-3 seconds after initial P-wave arrivals. Main features of the X phases are as follows: (1) The X phases are observed only in and around the southwestern part of Gifu Prefecture. (2) Amplitudes are a little larger than those of the initial P-waves. (3) Vertical and radial components are dominant. (4) Dominant period is approximately 2-4 Hz and apparent velocity is approximately 8.0 km/s. On the basis of these features, the X phases could not be interpreted as trapped waves within the oceanic crust or direct waves observed by the oceanic crust events (e.g. Fukao et al., 1983; Hori et al., 1985), and pPmP or sPmP phases (Miyoshi and Ishibashi, 2007).

To examine the origin of the X phases, we calculated P-SV seismic wave field in the two-dimensional structure. The structure was constructed on the basis of Kubo et al.(2002) and Miyoshi and Ishibashi (2004). The source was assumed as a point source represented by double-couple model. As an example, we simulated the seismic wave field of the oceanic mantle event located 55 km depth beneath the Kii peninsula along two profiles, profile A (N20E direction from the source) and profile B (N50E direction from the source).

Our results could reproduce successfully the features of the observed seismograms. Along the profile A, distinct later phases were simulated within 2-3 seconds after initial P-wave arrivals at approximately 150 to 200 km epicentral distances. Using cross-sections of the wave field and snapshots of the strain field, we interpreted the later phases are SP converted waves, P-waves converted from S-waves at the plate interface or the oceanic Moho discontinuity, and trapped within the oceanic crust. The trapped SP converted waves propagate through a contact zone between the oceanic crust and the lower island-arc crust and arrive at stations. On the other hand, no distinct later phases were simulated within 2-3 seconds after initial P-wave arrivals along the profile B. In this case, SP converted wave are not trapped within the oceanic crust, because the oceanic crust mostly contacts with the island-arc lower crust along the profile B. As a conclusion, observed X phases could be explained by SP-converted waves generated near the source and propagate within the oceanic crust. Then, the trapped SP phases are only observed above the contact zone between the oceanic crust and the lower island-arc crust. Based on this point, we infer the Isewan-Kohoku slab (Miyoshi and Ishibashi, 2008) contacts directly with the island-arc crust.

The plate interface is the source region of interplate earthquakes included slow events and a material and mechanical boundaries in the subduction zones. It is a quite important problem for seismotectonics to reveal the detail plate boundary structure. Using the SP trapped wave detected in this study and guided waves of the oceanic crust events (Fukao et al., 1983; Hori et al., 1985), we can infer the structure near plate boundary in detail.

Keywords: later phases, trapped waves, oceanic crust, Philippine Sea plate

Japan Geoscience Union Meeting 2011
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SSS034-04 Room:105 Time:May 23 09:15-09:30

Multiple collision and subduction structure of the Izu-Bonin arc revealed by active source seismic data

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Since the middle Miocene, the Izu-Bonin arc has been colliding with the Honshu arc in central Japan. This collision process is responsible for an extremely complex crustal structure of the Izu collision zone. Geological studies suggested that Koma, Misaka, Tanzawa and Izu blocks were accreted onto the Honshu arc at different ages in the process of collision (e.g. Amano, 1991). In recent years, collision and subduction structure in the Izu collision zone has been revealed by seismic experiments which were performed in 2003 and 2005 as a part of Special Project for Earthquake Disaster Mitigation in Urban Areas (Sato et al., 2005; Sato et al., 2006; Arai et al., 2009). They showed a wedge-like structure of the Tanzawa block and its delamination from the subducted slab in the eastern part, and the aseismic slab subducted beneath the collision zone in the western part. Based on refraction/wide-angle reflection analysis of 2005 Odawara-Yamanashi profile in the western part, this study aims to reveal the whole structure formed by the multiple collision and subduction and to establish the model of crustal deformation process.

A 75-km-long seismic line in NW-SE direction crossed several collision boundaries such as the Sone-Hills Faults, the Tonoki-Aikawa Tectonic Line and the Kozu-Matsuda Faults. Seismic waves from 115 shots were recorded at 1642 stations with an average interval of 50 m. Data quality was so good in the whole profile that not only P wave first arrivals but also P wave reflections and S wave first arrivals were recorded. Refraction tomography analysis (Zelt and Barton, 1998) and forward modeling using ray tracing method (Iwasaki, 1988; Cerveny and Psencik, 1983) were applied to the data set to construct P and S wave velocity models.

The obtained structural models showed strong crustal heterogeneities associated with the multiple collision and subduction processes. One of the important features characterizing the collision structure is that the Sone Hills Faults, located at the northern end of the Izu-Bonin arc, has a southeastward dip, which contrasts with northwestward dips of the Tonoki-Aikawa Tectonic Line and Kozu-Matsuda Faults. Multiple collision and subduction structure of the Misaka, Tanzawa and Izu blocks is summarized as follows.

1)The Misaka blocks is obducted onto the Honshu arc along the southeastward dipping Sone Hills Faults, and forms a pop-up structure bounded by reverse faults on both sides.

2)The Tanzawa block is characterized by crustal stacking bounded by northwestward dipping boundaries.

3)Crustal delamination occurred in the middle crust of Misaka and Tanzawa. The delaminated middle/lower crust of the Izu-Bonin arc was accreted at the bottom of the Honshu crust or subducted deep into the mantle.

4)The whole crustal block of Izu was subducted beneath the Tanzawa block without delamination in the upper and middle crustal level.

5)There exists a northwestward dipping reflector at the depth of 25-35 km beneath the Misaka and Tanzawa blocks, which is interpreted to be the top of the subducted lower crust of the Izu-Bonin arc.

6)Due to a small velocity contrast inferred from amplitude modeling, it is expected that a low velocity layer does not exist at the top of the slab beneath the collision zone, which contrasts with the case of the Nankai subduction zone where the oceanic crust is subducted.

Keywords: Izu collision zone, Seismic wave velocity structure, Refraction/wide-angle reflection analysis, Misaka Mountains, Tanzawa Mountains, Izu Peninsula

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

SSS034-05 Room:105 Time:May 23 09:30-09:45

Shear-wave splitting in the Tokai region

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In Tokai region, the Philippine Sea plate is descending to the N-W direction. The configuration of the subducting slab has been revealed by the seismic tomography and refraction/reflection studies. Those studies suggested that the top of the slab was not smooth. The subducting ridges were detected. The asperity is one of the important topics to know the mechanism of the inter plate earthquakes. There are many discussions for the relationship between the subducting sea mount and asperity. The Tokai region is one of the good fields to know the relationship. The configurations of the subducting ridges have been revealed by the refraction and reflection studies. If the effect of the subducting ridge to the stress pattern is large, it will be detected by the shear wave splitting at the seismic station just above the ridge. We did temporal seismic observation with about 70 seismic stations in Tokai region. The shear wave splitting is researched using the array.

The spatial variation of the sear wave splitting values was obtained. But, we could not find any close relationship between the topography of the subducting ridge and spatial variation of shear-wave splitting. It is expected that the effect of the subducting ridge to the stress pattern in the crust seems to be small.

Keywords: anisotropy, Tokai, asperity

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

SSS034-06 Room:105 Time:May 23 09:45-10:00

Crustal structure in Japan inferred from receiver functions and comparison with those of travel time tomography

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Investigation on the crustal structure and configurations of the subducting plates is the key to understanding the stress and strain concentration process. Recently, many researchers have elucidated crustal structures in the Japansese Islands from travel time tomography analyses. However, they show different features in some areas. In this study, we estimated the seismic velocity structure and seismic velocity discontinuities of the crust and uppermost mantle beneath the Japanese Islands by using receiver function analyses, and compared them with existing results of seismic velocity structures estimated from travel time tomography.

We first searched for the best-correlated velocity structure model between an observed receiver function at each station and synthetic ones by using a grid search method. Synthetic receiver functions were calculated from many assumed one-dimensional velocity structures that consist of four layers with positive velocity steps. Observed receiver functions were stacked without considering backazimuth or epicentral distance. We further constructed the vertical cross-sections of depth-converted receiver function images transformed the lapse time of time series to depth by using the estimated structure models. Receiver function amplitudes were projected and stacked at each cross-section. Telemetric seismographic network data covered on the Japanese Islands and several temporal dense seismographic stations are used. We selected events with magnitudes greater or equal to 5.0 and epicentral distances between 30 and 90 degrees based on USGS catalogues.

As a result, we clarify spatial distributions of the crustal S-wave velocities. Average S-wave velocities from the ground surface to 5 km deep indicate thick low-velocity layers in several plain and basin areas. Although the velocities are slower than those of tomography models, the spatial patterns are corresponding with basement depth models. The velocity perturbations in the crust are consistent with tomography models. There are low-velocity zones corresponding to volcanoes in the upper crust and around the crust-mantle boundary. In the lower crust, our results show low-velocity structures in the Niigata-Kobe Tectonic Zone. From depth-converted cross-sections, we can detect the upper boundary and the oceanic Moho of the subducting plates that dipped toward northwest. High velocities near the southern coastline of the Japanese Islands correspond to the oceanic Moho of the subducting Philippine Sea plate. We also estimated the tops of the mantle depths in the overriding plate from the velocity discontinuities of layered structures and depth-converted cross-sections of receiver function images. It is deep beneath the mountain region of the land area and becomes shallow toward the surrounding seas in most part of the Japanese Islands. The tendency of depth changes is consistent to the patterns of the Moho discontinuity proposed previously, but the depths are deeper than those results in several regions. We will be able to resolve detailed whole structures by considering difference of both images.

Keywords: Receiver function analysis, Crustal structure, the Japanese Islands

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

SSS034-07 Room:105 Time:May 23 10:00-10:15

Crustal Vp, Vs, and thickness estimations via vertical and radial receiver functions

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Receiver function analysis is one of the effective tools to investigate crustal seismological structure. Here, we present a grid search technique using three seismic phases, Ps, PpPs, and PpPp, observed at teleseismic P coda portion in radial and vertical components, in order to simultaneously determine crustal properties, such as vertically-averaged P and S wave velocities (Vp and Vs), and Moho depth. Using a nonlinear waveform analysis, called simulated annealing, source wavelet of teleseismic P wave can be estimated by using records in vertical component observed at an array of seismometers. Deconvolving individual vertical component by the resulting source wavelet, PpPp phases recorded in vertical component can be extracted. Ps and PpPs phases can be extracted by calculating conventional radial receiver function. The frequency bands are 0.2-1.0 Hz for Ps converted phase, and 0.1-0.5 Hz for PpPs and PpPp reflected phases. The time-to-depth conversion of receiver function is performed by using 1D JMA velocity model. As a result, in addition to seismic images produced by using Ps and PpPs phases, seismic images with PpPp phase also successfully display the continental Moho, the oceanic Moho and the top slab surface of the Philippine Sea slab. This allows us to obtain reliable crustal properties by a grid search over three parameters, Vp, Vs, and thickness. Moreover, we demonstrate that seismic images could be improved by applying the estimated crustal properties, representing crustal lateral variations, to the conversion of time-to-depth domain receiver function.

Keywords: receiver function, Moho, seismic wave speed, Vp/Vs

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

SSS034-08 Room:105 Time:May 23 10:15-10:30

Crustal structure of the central part of East Antarctica from broadband seismic deployments and gravity surveys

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The Antarctica's GAmburtsev Province / GAmburtsev Mountain SEISmic experiment (AGAP / GAMSEIS) was an internationally coordinated broadband seismic deployment in the middle part of East Antarctic continent during the International Polar Year (IPY 2007-2008). More than 50 broadband seismographs were deployed over huge highland on the ice sheet from the crest of the Gambursev Subglacial Mountains (GSM; including Chinese station Dome-A (79.6S, 77.4E)) to the region around Japanese station of Dome-F (77.4S, 39.6E). The broadband seismic studies from the recorded teleseismic events provide new information of fine crustal structure and constrain on the origin of GSM, and more broadly on the structure and evolution of the East Antarctic craton and the subglacial environment. The GSM has the most enigmatic tectonic features as one of the Earth frontiers. Buried beneath the thick ice sheet, the mountains are characterized by peak elevations reaching 3000 m above sea level. Until recently, only limited constraints were available on the crustal structure of the GSM and surrounding region but new data from GAMSEIS allows more detailed investigation. The gravity measurements with land-type gravity meters were conducted by the Japanese Antarctic Research Expedition (1992; JARE-33, 1997; JARE-38, and 1998; JARE-39) over the inland traverse routes from Syowa Station (69.0S, 39.6E) to Dome-F. Free-air and Bouguer anomalies based on gravity disturbance along the routes were obtained by use of both surface elevation and bedrock elevation from radio-echo sounding. A density model of crustal structure between Syowa and inland plateau was derived based on the P-wave velocity model from active source refraction surveys and of the P-wave receiver function inversions. A crustal structure of the southern part of the inland plateau was derived from only gravity data. The Bouguer gravity anomalies were calculated by assuming the layered density model of the crustal structure to fit the observed Bouguer anomalies. Decrease in Bouguer anomalies about -200 mgal from Syowa toward Dome-F indicated crustal thickness about 45km beneath the Dome region. Analyses on S-wave receiver functions and Rayleigh wave phase velocities for GAMSEIS data provided estimates on crustal thickness beneath the GSM and surrounding region. The cratonic crust surrounding the GSM was 40-45 km thickness, which agrees with the crustal thickness from gravity surveys by JAREs and was consistent with average Pre-Cambrian crustal thickness found globally. Beneath the GSM, in contrast, the crust thickness was determined almost 55-58 km and provides isostatic support for the high mountain elevations. It is considered that the thicker crust beneath the GSM may reflect the old continental feature associated with Proterozoic and/or Paleozoic orogenic events in East Antarctica. Accordingly, the whole crustal model from the Luzow-Holm Bay (around Syowa) to Dome-F and GSM were obtained for the first time by combining the results of both broadband seismic studies by GAMSEIS and gravity surveys by JAREs. The cross section over 3,000 km length in the middle part of Antarctic continent was achieved to provide predominant information on tectonic evolution of Gondwana super-continent in Earth history.

Keywords: Antarctic continent, broadband seismometer, polar frontier, array deployment, International Polar Year, gravity measurement

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

SSS034-P01 Room:Convention Hall Time:May 23 10:30-13:00

Crustal structure around the focal area of the 1952 Tokachi-oki earthquake by an airgun-OBS seismic survey

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We conducted an airgun-OBS experiment between the Tokachi-oki and the Nemuro-oki seismogenic segments in August 2010. The seismic line is parallel to the Kuril Trench axis and runs ~50 km landward from the trench axis with 240 km length. The experimental area includes the source area of the 1952 Tokachi-oki interplate earthquake (M8.2), where the largest amount of coseismic slip of 7 m took place at the eastern central part of the line. The corresponding area was not ruptured by the 2003 Tokachi-oki earthquake (M8.0), though the hypocenters of these earthquakes are almost the same. This difference can be explained by a physical condition on the plate boundary, such as the topography of the slab surface, the existence of the low velocity layer on the subducting plate. The object of this experiment is to investigate the relation between the seismic structure and the interplate rupture area.

OBSs recorded clear airgun signals, and they imply a structural difference bounded on the central part of the line. At the OBSs deployed westward of the line, observed first arrival was discontinuous at the offset ~40 km, increasing apparent velocity from 5 to 7.2 km/s. Meanwhile the eastern OBSs recorded continuous first arrival. Several later phases were observed within the offset 40 km but not clear enough to be picked at the western OBSs. These along-arc differences imply a structural difference between the 1952 rupture area and surrounding area. We expect that further analyses using travel time data will extract lateral structural variation related to the extent of rupture area.

Keywords: crustal stracture, Kuril Trench, subduction zone

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

SSS034-P02 Room:Convention Hall Time:May 23 10:30-13:00

Group velocity distribution of Rayleigh wave in the central part of the Tohoku rejoin by ambient noise cross-correlation

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Seismic interferometry has been a new seismological method to estimate subsurface structure. Seismic interferometry is based on the fact that cross-correlation function of random wave filed computed between a pair of stations contains Green' s function between the two stations. Recently, seismic interferometry has been applied for ambient noise to reconstruct surface wave propagating between two stations. Shapiro et al. (2005) performed tomographic method to obtain group velocity structure of Rayleigh wave. This method is called ambient noise tomography. In this study, we applied this method for dense seismic network at the central part of Tohoku including the focal area of the 2008 Iwate-Miyagi Nairiku earthquake.

Data are vertical component of continuous record not only of Hi-net short period stations but also of Tohoku Univ., JMA and F-net. First, we calculated daily cross-correlation function for each pairs after correcting instrument response, removing earthquake, whitening, and 1-bit normalizing. Then we averaged daily cross-correlation functions over about 3 month. Averaged cross-correlation functions had obvious peaks which seem Rayleigh wave. We applied multiple filter technique (Dziewonski et al., 1969) for reconstructed Rayleigh wave to determine group velocity dispersion. Using tomographic method, we estimated group velocity map at 1-16 s from dispersion.

Group velocity map at short period, especially at 2 s, shows clear correlation with surface topography. Low velocities were observed at Sendai Plain, Osaki Plain and Kitakami Basin, in contrast, high velocities were observed at Kitakami massif and Ou Backbone Range. It is considered that the propagation velocities estimated in this study depends on subsurface seismic velocity structure such as low-velocity sedimentary layer in plains and basins, and high velocity basement rocks in mountain ranges.

At the longer period from 10 s to 16 s, the low velocity area is distinct near the Mt. Kurikoma. Body wave tomography (e.g. Nakajima et al. (2001); Okada et al. (2010))showed low velocity zone at similar area at a depth of more than 10 km. We interpret that this low velocity area is caused by a part of magma supplying system to Mt. Kurikoma. Considering that Rayleigh wave at about 10 s has high sensitivity at about 10 km, we can observed a shallow part of the magma supplying system. We also found low velocity area at the Matsushima Bay. As well as the low velocity area near the Mt. Kurikoma, this low velocity area is also observed by the body wave tomography. The 2008 Iwate-Miyagi Nairiku earthquake (M7.2) occurred near the Mt. Kurikoma and the 2003 Northern Miyagi earthquake (M6.4) occurred near the Matsushima Bay This suggest these low velocity area may relate these inland earthquakes as hypothesized by Hasegawa et al. (2005).

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

SSS034-P03 Room:Convention Hall Time:May 23 10:30-13:00

Seismic Reflection Survey at Kawajima Saitama

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We conducted seismic reflection survey at Kawajima, Saitama in December 2010. The length of survey line is about 7600m from the Iruma River to the Ichino River by way of a well for subsidence monitoring, and the direction of the survey line is South to North. AIST conducted another survey along the Iruma River in 2007. The purpose of this survey is the revelation of the geologic structure between the previous survey line and the well. We used 10Hz geophones, and deployed them at intervals of 10m. We used distributed seismic recording system DSS-12 produced by Suncoh Consultants Co., Ltd. We recorded traces at intervals of 1ms. We used IVI T-15000 mini-Vibrator. We shot 6times at intervals of 10m with sweep frequency of 15 to 120Hz, sweep length of 16s, and listening length of 3s. Each shot is recorded at 156 geophones. First arrivals can be clearly seen in shot gathers along whole survey line. Reflected events can be seen at around 0.6 to 0.8s of two way time along whole survey line. Strong reflected events can be seen at around 1.6s in the north of the survey line. In the results of the constant velocity stack with $<$2km/s, south dipped event can be seen at 0.2s to 0.4s around the north end, and at 0.4s to 0.7s around the south end of the survey line. In the results of the constant velocity stack with 2.1km/s, south dipped event also can be seen at 0.7s around the north end of the survey line, and at 1.3s around the center of the line. Moreover, in the north of the survey line, clear events can be seen at around 1.4s. These events can be clearly only in the north of the survey line, but can be barely traced to the south of the line.

It is expected that these events become clearly with the detailed processing.

Keywords: seismic reflection survey, Saitama, Kawajima

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

SSS034-P04 Room:Convention Hall Time:May 23 10:30-13:00

Estimation of Vs Using one 3-Component Seismometer with P-wave Reflection Profiling - Application to a Survey in Saitama

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We developed a new method to obtain S-wave velocity in a shallow depth during P-wave reflection profiling (Ohtaki et al., 2011). This method requires only one additional 3-component seismograph, which was installed on the profiling. P-to-SV reflected waves generated by the reflection source will be observed on station gather of radial component of this seismograph. We picked P-to-SV reflected waves on the station gather, and adjusted theoretical travel-time curves to the observed waves at the seismometer. When travel times are calculated, velocities of P-wave and depths of layer boundaries are fixed to the result of P-wave reflection profiling, and variables are the mean ratio of Vp to Vs from the surface to the reflector. The reflected depth is determined from slowness of the wave, and then S-wave velocity from traveltimes. The ratio for well-matched theoretical time is considered as the mean ratio of vertical travel times of S-wave to P-wave from the surface to the reflected layer. Shear-wave velocity for each layer, even if a reflected wave is not observed from the layer, is thus calculated from the ratio.

In the previous paper (Ohtaki et al., 2011), we also assessed a validity of this method with synthetic tests for simple horizontal layer models and dipping layer models. We also applied this method to a previous real seismic reflection survey with 3-component seismometers. This survey was designed for converted-wave reflection profiling and P- and S-wave velocity profiles was obtained to 2-km depth. Another velocity profile near the site was also obtained by using VSP method. S-wave velocity profile that we obtained is consistent with the profiles of these studies to 2-km depth. Our results show that this method provides adequate shear-wave velocity profile with little additional cost to P-wave reflection profiling.

The survey we analyzed in the paper was designed for P-S converted wave processing. Thus its specification may be different from that of P-wave reflection processing. We then examine another on-site testing by using P-wave reflection survey data in this paper. We have installed one 3-component seismometer on several previous P-wave surveys. Among these surveys, we selected a survey at Konosu city, Saitama prefecture on November 2006 (Yokokura et al., 2007).

The survey area is in a gap between the Fukaya Fault and the Ayasegawa Fault. The survey line is a 10 km long from Sekishinden in Konosu city to Yoshimi hill. The source is one large vibrator except near the center of the line. The 10-Hz up-down component seismometers were installed at every 10 m. The total channel number is 192. A 3-component seismometer was installed near recorders. These are the specification for one expansion. Five expansions were totally conducted. Five 3-component record sections were thus obtained. Among them, we selected one station gather that has a largest data set. The station is located in the northeast part of the line. The maximum offset of the records is about 1 km. The record length is 4 s, which is the same as the length of up-down component records. Our preliminary analysis suggests that several P-to-SV reflected waves were observed in the station gather and that S-wave velocity will obtained to about 1 km depth. We will show S-wave velocity structure beneath the site. Note that Vp and depths of reflectors were fixed to the result of the P-wave reflection profiling by Yokokura et al. (2007).

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SSS034-P05 Room:Convention Hall Time:May 23 10:30-13:00

Relationship between half-graben and high-velocities area at depths of 10km in Kanto area 4

Yukio Oishi[1*]

[1]none

The distribution of half-graben (ground-based V shaped Valley structure) (Takahashi 2005)seems to coincide with high-velocities area at depths of 10km in Kanto Area(Matsubara 2005)-(Oishi 2007)

It is possible that the southern part of Ibaraki prefecture and northern part of Chiba prefecture were once pilled under Saitama prefecture, slipped out and moved to about 80 km east the Miocene epoch. (Oishi 2009), after analysis of the shape and the cross section of the high velocities areas and the distribution of the rocks .

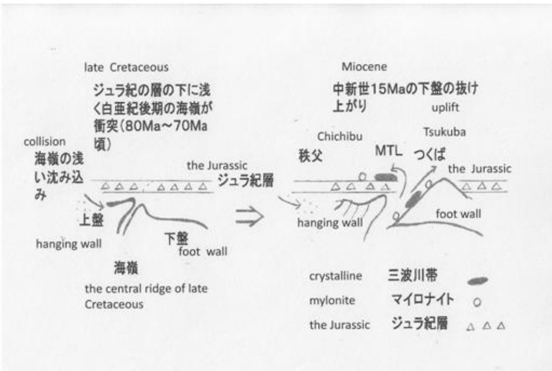
Especially, around Tsukuba , south part of Ibaraki prefecture satisfy the three conditions of metamorphic core complex ,rift flank uplift .

1 Moho is shallow ,only about 25km deep.
2 high gravity anomaly
3 high heat flow

1 after Katsumata 2010 in Kisyoken 2 gravity anomaly after Sansoken AIST 3 after Matsumoto in Bosaiken NIED

The lower illustration shows the collision of the central ridge of late Cretaceous (about 70 Ma) under the Jurassic and the movement of the rift of the Miocene (about 15Ma)

With this picture, we can understand why the two layers of Jurassic go side by side striding MTL.



Japan Geoscience Union Meeting 2011
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SSS034-P06 Room:Convention Hall Time:May 23 10:30-13:00

Seismic structure under the Kanto Plain using receiver functions from deep borehole records

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At the High Sensitivity Seismograph Network (Hi-net, NIED) most stations in the Kanto Plain are located at bottom of the boreholes deeper than 1 km . Since the Kanto Plain is covered with very thick sediment layers, the deep borehole records observed in hard rock layers are useful for imaging the deep seismic structures. Takenaka and Murakoshi (2010, AGU) proposed a "receiver function" which is useful for deep borehole records to image the seismic structures below the stations. This method for deep borehole records is similar to an "S-wavevector receiver function" (SWV-RF) for ground surface records, introduced by Reading et al. (2003, GRL). The SWV-RF removes the free surface reflection phases and the first P-pulse and gives the complete representation of the converted waveform. The standard receiver function from deep borehole records is difficult to extract the P-to-S converted phases from seismic discontinuities because of the contribution of the free surface contaminating the P-to-S converted phases . The SWV-RF is relatively robust to the borehole structure model. The preliminary results of Takenaka and Murakoshi (2010, AGU) show that the SWV-RF from deep borehole records at Atsugi station removes the initial P-pulse and indicate P-to-S converted phases clearly. In this presentation, we will describe the estimated crustal structure by using the SWV-RF to the deep borehole records of the Hi-net in the Kanto Plain.

Keywords: receiver function, deep borehole, Kanto Plain, crustal structure, Philippine Sea slab

SSS034-P07 Room:Convention Hall Time:May 23 10:30-13:00

Crustal structure in the northwestern part of the Izu collision zone

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Since the middle Miocene, The Izu-Bonin arc has been colliding with the Honshu arc in central Japan. This collision process is responsible for an extremely complex crustal structure of the Izu collision zone. The Kanto Mountains is located at the northern side of the Izu collision zone, and mainly composed of the Paleozoic to Mesozoic accretionary prisms represented by the Sambagawa metamorphic belt, the Chichibu belt and the Shimanto belt. In the southwestern part of the Kanto Mountains, the Kofu Granitic Complex (KGC) is exposed at the surface, and a basin structure was formed called the Kofu Basin. Although these areas are bordered to the northwesternmost part of the Izu-Bonin arc and expected to provide important geological/geophysical information in understanding the collision process in an early stage, their crustal structures remained to be clarified.

In 1982, Research group for explosion seismology (RGES) carried out a seismic experiment named Miyota-Shikishima profile in the western flank of the Kanto Mountains and the KGC (RGES, 1986). A 60-km-long profile was extended in NS direction just north of 2005 Odawara-Yamanashi profile (Sato et al., 2006), on which refraction/wide-angle reflection data from 5 dynamite shots were recorded at 61 seismic stations. Although these seismic data are useful for understanding crustal structure in the northwestern part of the collision zone, they were not fully interpreted in terms of collision structure between the Honshu arc crust and the IBA crust further south. We reanalyzed these data paying special attention to the following two points. One is to reveal velocity structure of the pre-middle Miocene accretionary prisms (Shimanto belt). The velocity information is helpful for understanding the origin of crustal material beneath the Kofu Basin which was not fully understood due to the lack of geological evidence. The second is to constrain the subsurface distribution of the KGC. The seismic line was located in the western flank of the granitic complex, which may provide useful structural information for the process of the magma intrusion.

The data quality was so good that P wave first arrivals of every shot were observed in the whole profile. In addition, several P wave reflections and S wave first arrivals were recorded. Using these data sets, we constructed P and S wave velocity models by forward modeling using the ray tracing method (Iwasaki, 1988; Cerveny and Psencik, 1983).

The obtained P wave velocity model showed some interesting crustal features. The first one is a layer with P wave velocity of 5.6-6.0 km/s and S wave of 3.4-3.7 km/s situated in the upper 4 km crust, which corresponds to the Shimanto belt. Although the KGC is exposed at the southern part of the profile, a significant velocity variation was not identified in this layer. Among several clear reflectors found at a depth of 4-20 km beneath this profile, the most important is one at the depth of 4 km in the southern part. From amplitude modeling, P wave velocity beneath the reflector is estimated to be 6.15-6.4 km/s, 0.15-0.2 km/s higher than that further north. This reflector continues further south to a top of the high velocity body of the KGC in 2005 Odawara-Yamanashi profile (Arai et al., 2010). In addition, the location of this reflector almost corresponds to the north-south extension of the KGC at the surface. Thus, the reflector at 4 km depth is interpreted to be the top of the high velocity body of the KGC which is imaged as a higher velocity of 6.15-6.4 km/s in a depth range of 4-10 km. For these reasons, we interpreted that the Shimanto belt extends further south beneath the Kofu Basin and the Misaka block. The whole crustal model suggests a tectonic history including intrusion of the KGC into the Shimanto belt and obduction of the Misaka block onto the Shimanto belt. Probably, a large amount of the KGC magma intruded from just beneath the Kofu Basin.

Keywords: Izu collision zone, Seismic wave velocity structure, Refraction/wide-angle reflection analysis, Kofu granitic complex, Misaka Mountains, Shimanto belt

Japan Geoscience Union Meeting 2011
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SSS034-P08 Room:Convention Hall Time:May 23 10:30-13:00

Shear-wave Splitting Analysis in the Focal Area of Earthquake Swarm at the Hakone Volcano

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Hakone Volcano is one of the active volcanos with fumarolic activity. Many intense earthquake swarms have been reported in the Hakone caldera. The relationship between the occurrence of earthquake swarms and crustal fluid have been discussed in the previous studies. It is considered that hydrothermal activity from deep underground causes the earthquake swarms.

We performed the shear wave splitting analysis for the seismograms recorded at the stations located just above and around the focal area of the earthquake swarms to depict the seismic structure, that is the crack distribution, and discuss the relationship between the structure and the occurrence of the earthquake swarms.

We used the seismograms of the earthquakes recorded at five stations (KZR, T.OSS, KIN, KZY and KOM) located in and around the Hakone volcano for the period between June 2009 and February 2010. We adopted the rotated axis and the lag time as the direction of faster split shear waves polarization (PHI) and the time lag between the two split shear waves (DT) when the cross-correlation coefficient attains the maximum value.

The average values of PHI at two stations located above the focal area correspond to each fault strike of the earthquake swarms. In contrast, the average values of PHI at three stations located around the focal area correspond to the direction of the maximum horizontal compressive stress. The fact suggests that the cracks formed by stress field are distributed widely around the focal area, but the clustered cracks aligned in the same direction as the fault strike are locally distributed near the focal area.

We find that the average values of DT near the focal area are relatively high compared to the values around the focal area. The fact suggests that the cracks near the focal area are distributed with higher density than that of the cracks formed by stress field.

In conclusion, we found that the cracks near the focal area aligned in the different direction on the stress field with relatively high density. The result suggests that the crustal fluid selectively flowed into the planar structure and caused the earthquake swarms in August 2009.

Keywords: Shear-wave splitting, Hakone Volcano, earthquake swarm, crustal fluid, crack

Japan Geoscience Union Meeting 2011
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SSS034-P09 Room:Convention Hall Time:May 23 10:30-13:00

A Pilot Study on Three-dimensional S-wave Anisotropic Tomography

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Seismic anisotropy is a useful indicator for identifying the physical and chemical conditions of the Earth′s interior. To understand the dynamics of the subduction zone, we investigated P- and S-wave seismic anisotropy beneath the Japan islands through travel-time analyses.

Assuming weakly anisotropic media with horizontal symmetry axes, we resolved the three-dimensional P-wave anisotropic structure (with heterogeneity and azimuthal anisotropy described by the fast propagation direction and the strength of anisotropy) beneath the Japan islands. The obtained P-wave anisotropy in the crust is consistent with S-wave polarization anisotropy determined by splitting measurement for S phase, however, there is a discrepancy between P- and S-wave anisotropy in the deeper portion. This is because anisotropy in the uppermost layer has a significant effect on the S phases. This means it is difficult to construct three-dimensional S-wave anisotropic structure through S-wave splitting measurement.

However, to understand the subduction system, consideration of both characteristics of P- and S-anisotropy is required. In particular, mantle anisotropy is an essential factor. Accordingly, to resolve the three-dimensional S-wave anisotropic velocity structure of the Japan islands, we are working on tomographic study using S-wave travel-time under the same conditions as P-wave. In this study, we developed a three-dimensional S-wave anisotropic tomography method and applied it to S-wave travel-time data compiled by JMA to reveal a three-dimensional S-wave anisotropic velocity structure beneath the Chugoku and Shikoku district.

Keywords: P-wave anisotropy, S-wave anisotropy, travel-time tomograpy, azimutal anisotropy

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SSS034-P10 Room:Convention Hall Time:May 23 10:30-13:00

Estimation of Polarization Anisotropy in Multilayer Structure by using Ps-converted Wave

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The shear-wave polarization anisotropy data of Ps-converted wave tell us about anisotropic properties in zone between seismic station at which the Ps wave is observed and velocity discontinuity at which the Ps conversion takes place. But it is very difficult to know anisotropic structure as a function of depth from the polarization anisotropy data, because the data are obtained as a quantity integrated on ray path from the station to the velocity discontinuity. To estimate seismic anisotropy in a layer of layer structure by splitting analysis of Ps-converted wave which is generated at upper boundary of the layer, we must strip off the effect of seismic anisotropy existing above the layer. In this study, we contrived a way, stripping method, to correct for polarization anisotropy of Ps-converted wave which takes place at a velocity discontinuity. As a result, we verified that combination of the stripping method and shear-wave splitting analysis is useful to obtain correct estimation of seismic anisotropy in each of layers which a layer structure comprises. In addition, we examine how the stripping method is influenced by stacking method and SVD filter (Singular Value Decomposition filter) to remove background noise on the receiver functions.

Keywords: stripping method, polarization anisotropy, Ps-converted wave, multilayer structure

Japan Geoscience Union Meeting 2011
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SSS034-P11 Room:Convention Hall Time:May 23 10:30-13:00

Anisotrophic medium structures above a deep low-frequency tremor zone in the southern Kii peninsula

Atsushi Saiga[1*], Aitaro Kato[1], Eiji Kurashimo[1], Takashi Iidaka[1], Noriko Tsumura[2], Takaya Iwasaki[1], Shin'ichi Sakai[1], Naoshi Hirata[1]

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A dense seismic observation with a linear array was conducted from December 2009 to May 2010 above a low-frequency earthquakes (LFEs) belt in central Kii peninsula. We studied anisotropic medium structures of the crust and mantle wedge by shear-wave splitting analysis. To determine the azimuths of the fast direction of polarization and the delay times of the split shear waves, we applied the method of Silver and Chan (1991) to band-pass filtered (1-8 Hz) horizontal-component seismograms by a semi-automated grid-search inversion method. We obtained a total of 1934 pairs of optimized splitting parameters.

We obtain the fast direction of polarization parallel to the direction of the maximum horizontal compressive stress in the crust. This suggests that anisotropy originate from regional stress in the crust. Depth variation profiles for the delay time show a increase with the increasing hypocenter depth. The increase in the delay time with depth is remarkable in central Kii Peninsula where there is about 0.05 s increase between depths of 30 and 50 km. This suggests that anisotropy may exist not only in the upper crust but also in the lower crust, the mantle wedge, and/or the subducting slab beneath the Kii Peninsula.

Keywords: shear wave splitting, Kii Peninsula, deep low frequency earthquake, mantle wedge, seismometer array

Japan Geoscience Union Meeting 2011
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SSS034-P12 Room:Convention Hall Time:May 23 10:30-13:00

Estimation of velocity discontinuities in and around the swarm seismicity region beneath the Kii Peninsula

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There is a non-volcanic swarm seismicity beneath the Wakayama region, southwest Japan (Mizoue, 1971; Matsunami and Nakamura, 2004). Mizoue (1971) detected the S wave reflection phase from the Conrad discontinuity at depth of ˜20 km. Recent receiver function analyses (e.g. Yamauchi et al., 2003; Shiomi et al., 2008; Ueno et al., 2008; Shibutani et al, 2009) also detected the velocity discontinuity at depth of ˜20 km in the whole Wakayama region. Kato et al. (2010) conducted the dense seismic observation in the southern region of the swarm activity and detected the low Vp/Vs region at depth of ˜8 km through travel time tomography. Though crustal structure has been studied in this region, the mechanism of the swarm activity is not still completely understood.

In this study, we investigated lateral velocity discontinuity distribution in and around the swarm region, using Sp converted waves from deep events. We used waveforms recorded at Hi-net and university stations in the Wakayama region from ˜20 deep events which occurred in the Pacific Plate at depths of 320-420 km beneath the Kinki district. Converted waves from deep events which contain high frequency (˜5 Hz) components enable us to estimate velocity discontinuities with high resolution and even in the region where no crustal earthquakes occur. First, two horizontal components were rotated into radial and transverse ones and picked S time by eye. Then, updown components recorded at each station are arranged at the picked S time by the order of their azimuths to detect the coherent phases. We applied to the waveforms bandpass filters of 1.2-1.5 Hz and 1.2-3.0 Hz in order to estimate the large-scale (e.g the Moho discontinuity) and crustal velocity discontinuities, respectively. Particle motions were drawn to confirm that the detected phases are the converted waves.

As a result, we found velocity discontinuities at every station at depths of ˜20 and ˜40 km. These discontinuities are thought to correspond to the Conrad and the Moho discontinuities from previous studies. We also detected converted waves at depths of ˜10 km in the swarm region, which was located at the lower limit of the seismicity in the crust. In the future work, we will estimate heterogeneous structure with high resolution and discuss its relation to the generation process of the swarm activity.

Keywords: velocity discontinuity, converted waves, swarm activity, the Conrad discontinuity

Japan Geoscience Union Meeting 2011
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SSS034-P13 Room:Convention Hall Time:May 23 10:30-13:00

Semi-permanent continuous monitoring of a focal region along an interplate boundary by seismic ACROSS & multi-receivers

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We are showing a preliminary result of a trial for detecting a time-variant earthquake focal region along an interplate boundary by means of a new imaging method through a numerical simulation.

Remarkable seismic reflections from the interplate boundaries of a subducting oceanic plate have been observed in Japan Trench (Fujie {¥i}et al{¥i}., 2002; Mochizuki {¥i}et al{¥i}., 2005) and in Nankai Trough (Iidaka {¥i}et al{¥i}., 2002). Those strong seismic reflections existing in the current aseismic zones suggest the existence of fluid along the subduction boundary, and it is considered that they closely relate to a future huge earthquake. Seismic ACROSS is the time-lapse measurement technology to monitor the changes of transfer function along the propagating ray paths, by transmitting an accurately-controlled steady continuous signal and repeatedly receiving the steady continuous signals (Kumazawa {¥i}et al{¥i}., 2000). If physical state in a focal region along the interplate was changed enough in the time and space, for instance, by increasing or decreasing the fluid flow, we could detect some differences of amplitude and/or travel-time of the particular reflection phases from the time-variant target zone.

In this study, we first investigated the seismic characteristics of seismograms and their differences before and after the change of a target zone through a numerical simulation. Then, as one of the trials, we attempted to make an image of such time-variant target zone by applying a finite-difference back-propagation technique in the time and space to the differences of waveforms (Kasahara {¥i}et al{¥i}., 2010).

We here used a 2-D seismic velocity model in the central Japan (Tsuruga {¥i}et al{¥i}., 2005), assuming a time-variant target zone with a 200-m thickness along a subducting Philippine Sea plate at 30 km in depth. Virtual seismic sources were located at the surface assuming the position of the ACROSS sources around Hamana lake, Shizuoka, and at Toki city, Gifu. Vertical and horizontal seismograms were calculated at a 500-m interval in 260-km long by using FDM software (Larsen, 2000). We assumed that P- and S-wave velocities ({¥i}V{¥i}p and {¥i}V{¥i}s) in the target zone decreased about 30 % during the change ({¥i}e.g.{¥i}, {¥i}V{¥i}p=3.5 km/s to 2.5 km/s) by an effect of fluid flow. Remarkable P-to-P reflections from the plate boundary were observed at the epicentral distance around 25- 60 km and at the travel time around 10 - 13 sec from the virtual Toki source. After applying the new imaging method to the differences between both seismograms at each receiver, it is clear that the remarkable signals related with the target change were focused around the target zone during a particular back-propagation time. In case the velocity decreases by a 10 % in the surface layer (from {¥i}V{¥i}p=3.5-4.5 to 3.15-4.05 km/s) possibly due to rain falls and/or seasonal variation, the target waveform-differences were mostly focused near the surface layer but some of them expanded downwards. However, since the target reflection phases from the plate boundary are observed in a limited offset-distance region, it is possible to distinguish between the effects of the change in the surface layer and the effects of the change in the deep target zone by using these limited seismic records.

As a preliminary result, it is still not easy to identify exactly the geometry of the target zone and the velocity change distribution. However, we can conclude that it is almost possible to decide the location of the target zone by means of an optimized receiver array together with the seismic source which can transmit the accurate and steady signals repeatedly like ACROSS even if we use a single source.

Keywords: ACROSS, continuous active monitoring, interplate boundary, time lapse, back-propagation time reversal

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SSS034-P14 Room:Convention Hall Time:May 23 10:30-13:00

Quasi-realtime analysis of seismic ACROSS signal transmitted from Morimachi

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We have analyzed temporal variation of transfer functions using seismic ACROSS signal transmitted from Morimachi station. Morimachi station locates just above the assumed rupture region of Tokai earthquake, and is suitable for monitoring the temporal variation of seismic velocity or reflection coefficient at the plate boundary. We found that the temporal variation of travel time of transfer function is, (1) larger amplitude in later phases compared to the previous ones, (2) well correlated with the precipitation near the transmitted or observed stations, and (3) abrupt change coincident with the strong ground shaking (seismic intensity is greater than 3) by the large earthquake (e.g. 2009/08/11 Suruga Bay earthquake). Seismic experiment using controlled source conducted in this region in revealed the strong reflection phase bouncing at the plate boundary between subducting Philippine Sea plate and overriding Eurasian plate (Iidaka et al., 2003). Frictional strength can be monitored by transmitting coefficient of acoustic waves (Nagata et al., 2008). This suggests the possibility for detecting the change of coupling coefficient before a large earthquake by monitoring reflection coefficient at the plate boundary. For the quick detection of such precursor change, auto-detecting procedure is necessary.

Using telemetered seismograms such as Hi-net, auto-processing program for analyzing temporal variation of travel time and energy ratio for distinct phases in transfer function has been developed. Low frequency type FM signal (carrier frequency: 5.51Hz; bandwidth: 2Hz) from Morimachi seismic ACROSS transmitter is used. The temporal variation is calculated from the reference time (in this case, first term). Nine Hi-net stations with the epicentral distance less than 40km and small noise level are used. Two or three prominent phases, whose travel time is later than direct S wave arrival, are selected and window duration for each phase is set to 1 second. The stacking length for each station is selected considering SN ratio. Since December, last year, we have run auto-processing program once a day and uploaded the figure of the temporal variation for the nine Hi-net seismic stations. The analyzing procedure is almost the same as the previous one. Continuous waveform is segmented into every 400 s. The travel time delay from a reference trace was calculated by means of the phase delay in frequency domain. The variance of noise channels for every four hours is stored to speed-up the weighted stacking process.

S-wave travel time for the reflection phase (SxS) at the upper boundary of the subducted oceanic crust of the Philippine Sea plate is calculated using high-resolution seismic tomography results obtained by the data from the dense linear array of the temporary seismic stations (Kato et al., 2010). We can detect the reflection phase for two stations in Hrt and Htt components: N.TT2H (distance: 21km) and N.TOEH (distance: 34km). These two phases are included in the auto-processing data. The reflection points locate just in the long-term slow slip (2000 ˜ 2005) region and upper extension of the low-frequency earthquake zone along the subducting Philippine Sea plate. During the analyzed period, high activity of low-frequency earthquake occurred in November 2010. The relation between low-frequency earthquake activity and temporal variation of travel time and seismic energy ratio is not clear in this activity. Long-term slow slip event in this region will be expected to occur next 5 to 10 years. This even will give us the chance to verify the temporal variation corresponds to the slow slip at the plate boundary.

Acknowledgement
We used Hi-net seismograms in this analysis.

Keywords: ACROSS, temporal variation, reflection phase from plate boundary

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SSS034-P15 Room:Convention Hall Time:May 23 10:30-13:00

The subsurface structure in northern Mino region, central Japan revealed by reflection method

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The northwest of central Japan is a region on which the deformation is concentrated in Japan, and has a lot of folds and faults. One of those faults is Neodani fault as the earthquake source fault of the Nobi Earthquake in 1891. It is thought that Philippine Sea Plate (PSP) which is subducting under this region is closely related to the formation and the development of such faults, too. The upper surface of PSP under the study area is presumed to form a ridge shape that expands toward the northwestward from the result of the travel time tomography and the hypocentral distribution, but the spatial relationship between upper surface of PSP and the moho in the overriding plate or the mantle wedge are not clarified. In this study, the reflection method is applied to the shot records obtained in the study area and tried to clarify the subsurface structure under the region.

To reveal a subsurface structure, seismic array observation was conducted by Joint Observation group in the Nobi Earthquake source region. The seismic array consists of three lines which intersected at high angle with Neodani fault; hereafter we call these as line1, line2, line3 from the north. In each line, about 30 seismic stations were settled ever 1km interval from the southwest to the northeast. We analyzed 8 dynamite shots which were carried out by Chiba University, NIED and other universities on mid night of 9th and 10th October 2009. Applying a conventional reflection processing to the shot record obtained at each seismic line, we made zero offset gathers for all shots. From the careful check of the seismic profiles, we were able to find that distinctive reflections exist around two way travel time (TWT) 10s. These reflections were seen in most of the zero offset gathers and seem to form a reflective zone with 2-3diration. Furthermore the upper boundary of the distinctive reflective zone gradually inclined to the northeast in all seismic line. These were another clear and coherent reflections at around TWT 14s of seismic line1 profile, while the similar reflections were not seen in line2 and line3 profiles.

Some previous seismic profiles revealed a crustal structure in the Kinki district, central Japan. Dense reflective zones at TWT 8-10s were found in the seismic profiles and those were interpreted as a lower crustal lamination owing to their depths and reflection patterns. In this study we can confirm that the distinct reflective zone in our profile continues to the western part, because the western end of our line2 was overlapped on the eastern end of a seismic profile (1989 Fujihashi-Kamigori line). Thus the reflective zone of our seismic line also shows the lower crustal lamination. Reflectors of the event around TWT 14s is not clear, but a possible candidate is the upper surface of PSP because of its depth. If these events were reflected at the upper surface of PSP, the upper surface of PSP has a flat shape beneath the seismic array stations although the distinct reflective zone is dipping toward the northeast. It means that thickness of bounded layer between of PSP might affect the deformation such as folding and faulting of the crust in the study area.

Keywords: northern Mino region, lower crust, Neodani fault, reflection method, Philippine Sea Plate

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

SSS034-P16 Room:Convention Hall Time:May 23 10:30-13:00

Second report on the Deep Seismic Profiling "Northern MinoTransect(NORM)2009" in the NW part of Central Japan

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Beneath the northern Mino district, north-western part of central Japan , configuration of the subducting Philippine Sea Plate (PHS), concentration of active faults and the biggest hinge in the mega kink structure of the Mino belt are considered to be strongly related. In order to reveal the whole crustal structure and the geometry of the upper surface of the Philippine Sea Plate (PHS) , the Deep Seismic Profiling, "Northern Mino Transect 2009" (NORM) was carried out there from September 30 to October 20 in 2009.

We set a 90km-long survey line which was divided into two segments, western part having E-W trend and eastern part having SW-NE trend. The seismic line intersected at high angle with the two major active faults, i. e. Yanagase and Neodani faults. Receivers were arranged with an approximately 50m intervals. 8 dynamite shots and 2 Vibroseis shots were used as powerful sources.

After applying a conventional reflection method, a distinctive deep reflective zone was recognized from the western to the eastern ends of the seismic line. As it occurs at two way travel time (TWT) 8 - 11s in the west segment, and at TWT 9 - 12s in the east segment. Further, intermittent reflections can be seen at 2s later than the reflective zone.

To clarify the cause of these reflections, we compared the feature of the NORM profile with those of the other profiles which were obtained in the Kinki district, central Japan; one is the 1989 Fujihashi-Kamigori(FK) profile and another is Shingu-Maizuru(SM) profile.

FK seismic line was located in the northern part of Lake Biwa with E-W trend. Total length of survey line was about 210km and its receiver interval was approximately 1.6km. It had four dynamite shots. In FK profile, we found a reflective zone around approximately TWT 9-11s and the reflective zone continued toward the west. Since the western end of our NORM line was overlapped with the eastern end of FK line, this reflective zone is considered to be the western extension of our distinctive reflective zone. The reflective zone seen in FK profile can be also traced in SM profile which intersects with FK profile. In the previous study, this reflective zone was interpreted as lower crustal lamination because its depths and reflection pattern. Thus distinctive reflections were interpreted as lower crustal lamination which was widely found in areas of Inner Zone because of the continuity.

Intermittent reflections were seen beneath the distinctive reflection zone, but the amplitudes of these phases were quite small. The candidate reflectors of these reflections are the top boundary of the PHS plate or the plate Moho. Although we have no information to judge which candidate is valid to explain the reflections, if these reflections were waves in association with the PHS plate, it means that the very thin mantle wedge is sandwiched between the Moho of the land plate and the top boundary of the PHS plate.

Keywords: Philippine Sea Plate, Neodani fault, seismic reflection survey, lower crust, Mino belt

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

SSS034-P17 Room:Convention Hall Time:May 23 10:30-13:00

Seismic survey using artificial sources at Nobi fault system, central Japan - advanced analysis

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The structure of active fault in deep region has important information for investigating generation mechanism of inland earthquakes and forecasting strong ground motion by the earthquake. In the last fiscal year, we conducted seismic reflection survey using artificial sources (Vibroseis) at Nobi fault system, central Japan in order to investigate the seismic structure beneath the fault system. The strike-slip Nobi fault system, about 80 km long, activated at the 1891 Nobi earthquake (M 8.0). Seismic data were processed, then, using CMP method and the depth converted seismic reflection profiles were obtained. We found some reflection planes around the fault down to the depth of about 10km. The results were reported at 2010 joint meeting in the last year. In this presentation, we applied advanced analysis methods, CRS-MDRS (Common Reflection Surface - Multi-Dip Reflection Surfaces) method and 'Fresnel-volume' migration, in order to make clearer the distribution of reflection planes in and around the fault.

The outlines of the seismic survey were as follows. We set two survey lines; the one was an NE-SW line of about 30 km length crossing the central part of the Nobi fault system (northern line), the other was an E-W line of about 22 km length, beside the southern part of the fault system (southern line). Four large size vibrator trucks vibrate the ground along the survey lines and we tried to image subsurface seismic structures down to the depth of about 20 km. Total vibrating sites were 105 in the northern survey line and 93 in the southern survey line. The sweep signals of 6 - 40 Hz were recorded by geophones and digital telemetry systems (JGI GDAPS4) arranged along the survey lines at about 50 m interval. Geophones and off-line recorders (JGI MS2000) were also used in a small part of the survey line. Total seismic receiving sites were 684 and 453 in the northern and southern survey lines, respectively.

Distribution of reflection planes became to be clear due to the advanced analysis. In the northern survey line, wavy reflection planes are recognized in the depth of about 2 - 3 km which should be correspond to the anticline and syncline structures we confirm on the ground surface. There are reflection planes in the depth of 8 - 11 km in the southwest and northeast region, respectively. The planes seem to be disconnected in the region under the surface fault. In addition, the reflection plane was found in the depth of 14km in the southwest region, which was obscure before applying the advanced analysis. Whereas, in the region of the depth of 3 - 8 km, reflection planes are hardly found. In the southern survey line, reflection plane descending to the west was detected clearly down to the depth of 10km. It is indicated that the reflection plane extends to a buried thrust fault plane where the seismicity is active and the hypocenters are distributed in planar shape. In addition, we found the reflection plane descending to the east in the west part of the survey line, which seems to correspond to the syncline structure confirmed in the northern area of the survey line.

Keywords: Nobi fault system, Seismic survey, Seismic reflection method, Vibroseis, Common Reflection Surface method, 'Fresnel-volume' migration

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

SSS034-P18 Room:Convention Hall Time:May 23 10:30-13:00

A Gravity Survey in the Southern Area of Uemachi Fault Zone

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1. Introduction

There is an active fault zone called Uemachi Fault Zone. It is about 44 km in length through the center part in Osaka Plain and it has a north-south strike (Osaka Pref. 1999). The fault zone is composed of some faults. Butsunenjiyama Fault at Toyonaka City lies the most northern part of the fault zone, and Kumedaike Fault at Kishiwada City lies the most southern part. Characteristics of Kumedaike Fault is confirmed in detail by Osaka Pref. (1997), Osaka Pref. (1998), and Osaka Pref. (1999). In these studies, the reflection survey and the boring exploration were enforced mainly. A vertical displacement and its average velocity were discussed there.

In general, neither shape nor properties of the edge of the fault zone are clarified. The shape or properties of the edge of the fault zone arouse our interest in the forming process or the behavior of the fault. To obtain the finding of this shape, gravity measurement was executed around Kumedaike Fault which lay the southernmost part of Uemachi Fault Zone (Ryoki and Nishitani, 2010). Continuously, gravity measurement was executed across sakamoto Fault which lay north of Kumedaika Fault in this time.

2. Investigation area

Some survey lines were set along the roads from the vicinity of Fucyocho where is the center part of Izumi City, Osaka Pref. to the vicinity of Murodocho. These roads almost perpendicular to Kumedaike fault. Each survey line almost lay on a position of the active fault shown by Geographical Survey Institute (1996) a center. The length of each survey line was about 1-4.5 km. Moreover, the station interval was about 50 m.

3. Measuring method

The gravimeter Type-G, which was made by the LaCoste & Romberg company, was in use to measure the gravity. The provisional reference point of the gravity was set in Kinki Polytechnic College in Inabacho, Kishiwada. Closed-loop was drawn with measuring the gravity in this point before and after the investigation during a day. The gravity value in this provisional reference point was given to approval by relative measurement with the gravity value on the first order gravity station at Wakayama Local Meteorological Observatories.

4. Result and consideration

The result shows distribution that the northwest side as seaward is lower and the hilly ward is higher along a survey line which crosses the position assumed to be a lying behind part of the Sakamoto Fault (Geographical Survey Institute, 1998). A few rises appear on the geographical features in the northern part from the north-most survey line. If the profile of these observations and the theoretical gravity sections of the fault structure are compared, rising ratio of the gravity value in the northwest side of the presumed fault position is a little larger than another side. The above investigation result suggests that this fault be a reversed fault.

5. Conclusion

It was distinctly in detail decently that the gravity profiles along some survey lines were laid across Sakamoto Fault. These distributions suggest the fault structure. It is essential to execute that the three-dimensional structure is analyzed based on these profiles in the future.

REFERENCES

Geographical survey Institute (1996): Kishiwqada, 1:25,000 Activee Fault Map in Urban Area.
Osaka Prefecture Governmrnt (1997): Report on the Study of the Uemachi Fault Zone, pp. 188 (in Japanese).
Osaka Prefecture Governmrnt (1998): Report on the Study of the Uemachi Fault Zone, pp. 121 (in Japanese).
Osaka Prefecture Governmrnt (1999): Report on the Study of the Uemachi Fault Zone (excerpts), pp. 39 (in Japanese).
RYOKI, K. and NISHITANI, T. (2010); A Gravity Survey in the Southernmost Area of Uemachi Fault Zone, Abstracts, Japan Geoscience Union Meeting 2010, SSS015-P16.

Keywords: gravity anomaly, reverse fault, basement structure, Sakamoto Fault, D structure analysis, high dense gravity measurement

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

SSS034-P19 Room:Convention Hall Time:May 23 10:30-13:00

Terrestrial heat flow and thermal structure in Southwest Japan

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Introduction

We measured thermal gradients and heat flow all over Japanese Islands by using the National Research Institute for Earth Science and Disaster Prevention's (NIED) high-sensitivity seismograph network (Hi-net) boreholes. NIED Hi-net is composed of about 800 borehole stations installed almost homogeneously over the Japanese Islands with an average spacing of 20km. Because these Hi-net boreholes are designed for a long-term observation, these are structurally stable with using casing pipe. Although majority of the Hi-net stations have the boreholes of 100- 200m in depth, deep observation wells were made at some specific sites if necessary. In South West Japan Area, we constructed about 200 boreholes, the deepest borehole station is N.KNHH at the depth of 2000m.

Estimation Method for thermal structure

We researched a thermal structure of the lithosphere in the South West Japan area based on NIED Hi-net borehole heat flow data. In this analysis, we used one-dimensional heat conduction model on steady state.
Geological and crustal model for thermal structure estimation As follows;
Layer 1: sediment (0km?4km)
Layer 2: Pre-Neogene Layer (metamorphic rock, etc., - 10km)
Layer 3: Grants (10km?30km)
We adopted a typical thermal conductivity on various rock respectively, with a temperature dependency. In this study, we considered an exponential model of radioactive heat production in lithosphere as follows,

A(z) = A(0)exp(-z/D): D = 25km, A(0) = 3.0 x 10ˆ-6

A(z) is vertical distribution of heat production, where z = 0 represents the present surface and A(0) is the measured heat generation.

Summary

We estimated thermal structure by using one-dimensional heat conduction equation, with the variables based on published or measured values for our heat flow data, heat generation, and thermal conductivity. Estimated thermal structure in this study is as follows: The evaluated temperature of seismogenic zone in the upper crust range between 200 degree and 400 degree.
Geographical distributions of terrestrial heat flow show that high heat flow stations are observed along the region where non-volcanic long-period tremors occur about 30km deep.Mantle helium has been observed in Shikoku area (Notsu et al., 2006) and the Kii Peninsula region (Matsumoto et al.,2003). In SW Japan, the slab-derived fluids, which cause fracturing within the crust, result in easier transfer of fluids, mixed with mantle helium, to the surface (Notsu et al., 2006). This movement of the slab-derived fluids also transports the heat of mantle wedge, which cause the terrestrial high heat flow anomaly.

Keywords: heat flow, thermal structure, Hi-net