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

HDS004-P01 Room:Convention Hall Time:May 27 09:00-10:45

Paleoseismic studies along the Philippine fault zone, eastern Mindanao, Philippines

Jeffrey Perez[1*], Hiroyuki Tsutsumi[1]

[1]Dept. of Geophysics, Kyoto University, [2]PHIVOLCS-DOST

The Philippine fault zone (PFZ) is one of the major strike-slip faults of the world that transects the entire length of the Philippine archipelago for more than 1,200 km from northwestern Luzon Island in the north to eastern Mindanao Island in the south. Consists of several segments, this arc-parallel, NW-SE trending, left-lateral fault zone is related to oblique subduction of the Philippine Sea plate beneath the Philippine island arc. This fault zone has been seismically active for the past 100 years with more than 10 earthquakes greater than M7. The most recent devastating earthquake was the 1990 Mw 7.7 Luzon earthquake that produced more than 120-km-long surface rupture along the Digdig fault with maximum horizontal slip of about 6m.

In Mindanao Island, the PFZ traverses its eastern portion for about 320km. It is characterized by fault parallel ridges, systematic deflection of stream and fluvial terraces, sag ponds and fresh tectonic scarps related to historical surface rupture. Historical documents also show possible surface-rupturing earthquakes such as the 1879 Ms 6.9 Surigao earthquake, 1891 Ms 7.2 Davao earthquake, and 1893 Ms 7.3 Monkayo earthquake. The fault trace in this island contains numerous geometric discontinuities such as en echelon steps and branching that may be used for segmentation of the fault zone. However, the timing of most recent earthquakes and recurrence intervals for these faults were poorly constrained. In order to reveal its paleoseismic activities, we have excavated multiple trenches across the different segments of the PFZ in Mindanao Island for the past two years.

Two sites were excavated across the Surigao fault located in the northern part of the island. Near vertical faults were identified on both sites and revealed evidence for at least two and probably three surface-rupturing earthquakes during the past 1,300 years that includes the 1879 Ms 6.9 Surigao earthquake. Prior analysis of aerial photographs and field observation along this segment also revealed fresh tectonic scarps and offset river terraces related to the surface rupture of the 1879 Surigao earthquake. In central part of eastern Mindanao, trench exposure in Compostela Valley across an east facing scarp that cuts an alluvial plain in an inter-valley mountain, exposed near vertical faults and contained evidence for at least two probably three or more surface-rupturing earthquakes for the 1,700 years that may include the 1893 Ms 7.3 Monkayo earthquake. Near the southern end of PFZ in Mindanao Island, trenching studies conducted north of Mati City showed a longer recurrence interval (> 1,000 years) compared to the other segments in this island. No historical earthquake (>M6) was documented in this area for the past 400 years.

Trench investigation conducted in this island revealed systematic variation of recurrence interval from 500-600 years in the northern part (Surigao segment), 500-1000 years in the central part (Compostela Valley) to > 1000 years along the southern end of the PFZ. This variation may be correlated to the southward decrease on slip rate along PFZ in this island from 24 mm/yr in the northern part (Surigao) to about 10 mm/yr in the south (Davao) derived from campaign type GPS survey (Aurelio, 2000, Island Arc).

Keywords: Philippine fault, paleoseismology, active tectonics, recurrence interval

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

HDS004-P02 Room:Convention Hall Time:May 27 09:00-10:45

Enhancement of Earthquake and Volcano Monitoring and Utilization of Disaster Information in the Philippines: Part 2

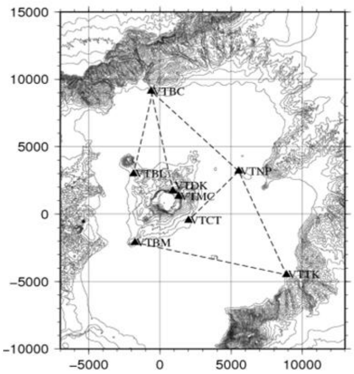
Hiroshi Inoue[1*], Hiroyuki Kumagai[1], Fumiaki Kimata[2], Toshiyasu Nagao[3], Renato Solidum[4], Bart Bautista[4]

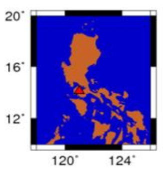
[1]NIED, [2]Cent.Seis.Volc., Nagoya Univ., [3]Res.Cent.Earthq.Predict, Tokai Univ., [4]PHIVOLCS

We started a five year (2010-2014) project of Enhancing Earthquake and Volcano Monitoring Capabilities and Promoting Effective Utilization of the Disaster Information in the Philippines, under SATREPS (Science and Technology Research Partnership for Sustainable Development) program. In this project we (1) install broadband seismometers, seismic intensity meters, and an automated source analysis system to promptly estimate ground shaking and damage, (2) evaluate earthquake generation potential by GPS measurements and geological survey, (3) install broadband seismometers, infrasonic sensors, GPS receivers and electro-magnetic sensors at Taal and Mayon volcanoes, and (4) develop an earthquake-volcano disaster information portal site and promote its effective utilizations.

In the first Japanese fiscal year (JFY 2010), we carried out (A) installation of broadband and strong motion sensors at five VSAT seismic stations (Virac, Lubang, Guimaras, Bataraza, Pagadian) and the source inversion system(SWIFT) to PHIVOLCS in Manila, (B) development of a prototype software of real time seismic intensity measurement and its test operation in PHIVOLCS, (C) GPS campaign observation in Mindanao and analysis of existing data, and GPS continuous observations in Mindanao (Butuan, Tandag). We installed (D) five broadband seismic, two infrasonic, three GPS, and three electro-magnetic sensors and their telemetry at Taal volcano,. We carried out a (E) comparative shaking experiment of non-engineered concrete hollow block (CHB) masonry houses using a large-scale shaking table of NIED, Tsukuba. CHB is most common building material of residential houses in the Philippines. We also invited PHIVOLCS staff members to Japan for learning the current status of earthquake and volcano monitoring in Japan, and we held a project workshop in Manila.

In JFY2011, we will carry out installation of broadband and strong motion sensors at five more VSAT stations, continuous operation of SWIFT inversion system, test installation and operation of the intensity meter network in Metro Manila, campaign and continuous GPS measurements for evaluating earthquake generation potential, and integrated seismic, GPS, and EM monitoring of Taal volcano. We also plan to make survey and experiments for developing simple seismic diagnosis of residential houses and evaluation of vulnerability of towns, and designing a Web portal site of earthquake and volcano disaster information.





station	BB	SP	IF	GPS	EM
VTBC	*	*			
VTNP	*		*		
VTBM	*	*		*	*
VTDK	*		*	*	*
VTCT	*	*		*	
VTMC		*			*
VTTK		*			
VTBL		V			

V: vertical component only

Keywords: Philippines, earthquake, GPS, volcano, monitoring, disaster information

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

HDS004-P03 Room:Convention Hall Time:May 27 09:00-10:45

New multi-parameter observation network at Taal volcano, Philippines

Hiroyuki Kumagai[1*], Tadashi Yamashina[1], Yuta Maeda[1], Rudy Lacson[2], Mel Figueroa[2], Toshiyasu Nagao[3], Akihiro Takeuchi[3], Yoichi Sasai[3], Takeshi Hashimoto[4], Paul Alanis[2], Juan Cordon[2], Fumiaki Kimata[5], Takahiro Ohkura[6], Hirotaka Obata[7], Akira Wada[7], Agnes Aguilar[2], Jaime Sincioco[2]

[1]NIED, [2]PHIVOLCS, [3]Tokai University, [4]Hokkaido University, [5]Nagoya University, [6]Kyoto University, [7]Hitach Zosen

Taal volcano is one of the most active volcanoes in the Philippines. After an exceptionally long dormant period since the last eruption in 1977, renewed volcanic activity began in April, 2010. We deployed a new multi-parameter observation network at Taal volcano in November, 2010. The network consists of seismic, electromagnetic, GPS, and infrasonic stations, and their real-time data are transmitted to the head office of the Philippine Institute for Volcanology and Seismology (PHIVOLCS) in Metro Manila. We installed broadband seismic sensors (Guralp CMG-40T: 0.02-60 s) and short-period seismic sensors (Kinemetrics SS-1: 1 s), and created a network of seven seismic stations (5 broadband and 2 short-period stations) at the volcano. Seismic data are digitized by either Kinemetrics K2 or Basalt 24-bit data logger with a sampling frequency of 50 Hz. We installed three Overhauser magnetometers with one fluxgate magnetometer on Volcano Island. Data from Overhauser and fluxgate magnetometers were digitized with sampling intervals of 10 and 0.1 s, respectively. Three GPS receivers (Trimble NetR5) with a sampling rate of 10 s were also installed on Volcano Island. We further installed two low-frequency infrasonic sensors (ACO TYPE7144/4144: 0.01-10 s). All these data are first telemetered to Taal Volcano Observatory by a local digital telemetry system using 2.4 GHz wireless LAN, and then transmitted to the PHIVOLCS head office through a satellite telemetry system in real-time. Seismic, magnetic, GPS, and infrasonic data are received and processed by four PCs and two cluster machines installed in the head office of PHIVOLCS. These real-time multi-parameter observation data are automatically processed to visualize their temporal variations through web systems. We are currently developing a seismic waveform inversion technique suitable for Taal volcano that holds lakes: Effects of water on Green's functions are investigated to properly estimate seismic source mechanisms using a waveform inversion approach. Systematic uses of quantitative analysis techniques to analyze the data from the network will be useful to detect possible precursors of eruptions and contribute to improved monitoring of Taal volcano.

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

HDS004-P04 Room:Convention Hall Time:May 27 09:00-10:45

Ground deformation of Guntur, Sinabung and Merapi volcanoes, in Indonesia by continuous GPS observation

Takahiro Ohkura[1*], Masato Iguchi[2], Muhamad HENDRASTO[3], Umar ROSADI[3]

[1]AVL, Faculty of Science, Kyoto Univ., [2]SVO,DPRI,Kyoto Univ., [3]CVGHM, ESDM,Indonesia

Indonesia is the greatest volcano-country in the world, with 129 active volcanoes. Prediction of volcanic eruption and mitigation of volcanic hazards are urgently required. However, many active volcanoes are equipped with only one seismic station. For the mid- and long- term prediction and evaluation of post-eruptive activity, continuous observations of ground deformations are necessary. Therefore, we have recently installed GPS stations in Guntur , Sinabung and Merapi volcanoes.

Guntur volcano complex is located 35 km SE of Bandung city, West Java, Indonesia. Although Guntur volcano has been dormant in eruptive activity since 1847, seismicity of volcanic earthquakes is active and mid- and long-term prediction of volcanic eruption is required for reduction of volcanic hazards. On the other hand, ground deformation monitoring is important to evaluate post-deformation of eruption and/or transition of eruptive style.

Sinabung volcano in North Sumatra erupted on August 2010 after >400 years dormancy. The eruptive activity began with phreatic eruption and declined in September, however seismicity on and around the volcano was still high even after the eruptions. An explosive eruption occurred on October 26, 2010 at Merapi volcano in Central Java and the eruptive activity was followed by continuous occurrence of pyroclastic flow from the summit crater during the period from November 3- 5.

In October 2009, 3 stations were installed in the area surrounding Masigit-Parukuyan-Kabuyutan-Guntur craters of the Gntur volcano. Each station is equipped with a dual-frequency GPS receiver (Leica GRX1200+GNSS). A battery and a solar panel were used for power supply for the receiver. Similar observation systems were installed at Merapi volcano in December 2010 and at Sinabung volcano in February 2011. Receivers (Leica GR10) are installed at the flanks of these volcanoes. Continuous observation with a sampling rate of 1second is performed at all stations and GPS data are saved as RINEX file. At the Guntur volcano, observed data is retrieved via the WLAN installed between each station and the Guntur Volcano observatory (POST). We applied a PPP (precise point positioning) using GPS analysis software, GIPSY-OASIS II Ver.5.0. In the analysis, JPL precise ephemeris is used, and dairy coordinates are calculated in the frame of ITRF2005. From the obtained coordinates, we can calculate baseline among stations.

We compare the result in the Guntur volcano with a past leveling result. By precise leveling surveys during the period from August 1996 to November 1997, the uplift around the summit area was detected (Hendrasto et al., 1998). Using grid search assuming a Mogi source as the deformation source, location of the source and volume change were determined. The obtained source is located at a depth of 5 km beneath Mt. Masigit (Sadikin, 2008). With this position fixed, volume change between each leveling survey was calculated. Total volume of the pressure source increased by 1.5*10^6 m^3 during the period from August 1996 to December 2002 and volume increase rate is estimated to be 2.5*10^5 m^3/year(Sadikin, 2008). If we apply this average rate to the GPS observation period, we expect a inflation with a volume change of 2.75*10^5 m^3 which cases 0.5cm baselines change among GPS sites. Any significant changes can not be recognized in our GPS measurement. This means deformation rate at the Mogi source beneath Mt. Masigit was smaller than the average rate obtained by leveling data during the period from August 1996 to December 2002 when the seismicity of volcanic earthquakes of Guntur volcano was high.

Keywords: volcano monitoring, GPS, indonesia

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

HDS004-P05 Room:Convention Hall Time:May 27 09:00-10:45

Long-term distribution of volcanic activity around calderas in Bali and East Java, Indonesia, determined by K-Ar dating

Kiyoshi Toshida[1*], Shingo Takeuchi[1], Ryuta Furukawa[2], Akira Takada[2], Supriyati Andreastuti[3], Nugraha Kartadinata[3], Anjar Heriwaseso[3], Oktory Prambada[3]

[1]CRIEPI, [2]AIST, GSJ, [3]CVGHM

Long-term history of active calderas in Indonesia have not been well constrained due to the lack of chronological data. The ages of pre-caldera activities are mostly unknown. We therefore conduct comprehensive sample collection, K-Ar dating and topography analysis of volcanic rocks in Bali and East Java.

We have found three periods of volcanic activity in Bali. They are 1.6 m.y. BP, 0.7-0.5 m.y. BP, and 0.2 m.y. to present. The number of new volcanoes formed increased with successive active periods. Somma of both Batur and Bratan caldera volcanoes consist of multiple volcanoes that were formed at 0.5 Ma and 0.2-0.1 Ma. The calderas have been formed between the edifices.

(a) The ages of lavas from both the bottom and the upper part of Penulisan agree each other at 0.5 Ma. Penulisan is therefore formed at 0.5 m.y. BP.
(b) The age of lava from Tapis is also 0.5 Ma, and agrees with ages of Penulisan lavas.
(c) The ages of lavas at the base of Abang and the northern apron of Batur somma in Les waterfall area are 0.15-0.2 Ma. They are significantly younger than Penulisan.
(d) The age of lava from the small 706 m peak volcano between Batur and Bratan is also 0.2 Ma, and agrees with the age of lava from northern apron of Batur somma.
(e) The ages of lavas consisting the dissected ridges in the northern apron of Bratan are 0.5 Ma.
(f) The age of aphyric lava that forms plateau in the north apron of Bratan (Old Buyan Bratan) is 0.2 Ma.
(g) The age of lava in SW apron of Batukau volcano is also 0.2 Ma.
(h) The age of lava near Asah is 1.6 Ma. The unit belongs to Tertiary Djembrana volcanics, but the age is found to be Quaternary.

At Tengger caldera, East Java, the age of the two caldera-forming eruptions are found to be older than 0.3 Ma., based on dating and stratigraphy of the different parts of somma edifice. The ages are found to be much older than previous studies.

(i) Caldera-forming eruption deposit of Tengger caldera at NW part of the caldera wall consists of alternating layers of pyroclastic fall and pyroclastic surge deposits as well as lava flow layer. The age of the lava is 0.3 Ma. Therefore, Tengger caldera was formed at 0.3 m.y. BP, which is much older than in previous study.
(j) At the NW wall of Tengger caldera, ages of lavas at the caldera rim and the bottom of the caldera wall agree at 0.45 Ma. The age of lava at the bottom of the SE wall and the age of lava from NW apron agree at 0.3 Ma. They are younger than age of NW wall lavas. It seems that Old Tengger (sensu stricto) consists of multiple stratovolcanoes.
(k) Based on the ages from (i)(j), we can estimate that Ngadisari caldera and the intra-caldera units were formed between 0.3-0.45 m.y. BP, which is 2-3 times older than in previous study.
(l) The age of lava from the dissected Kukusan volcano is 1.7 Ma. Kukusan is much older than Tengger. The volcanic activity in the Tengger-Bromo region has started by 1.7 m.y. BP.
(m) The age of lava that fill the depression of the Kukusan is 0.08 Ma. Parasite vent in the northwestern apron has therefore formed during post-caldera stage.
(n) The age of pyroclastic bomb from G. Garu is 0.25 Ma and is younger than Tengger caldera.
(o) The ages from Ayekayek-Ranu Pane area are 0.02-0.04 Ma, which are consistent with previous 14C age.
(p) The age of lowermost unit of Semeru in the southern apron is 0.5 Ma. Activity of Semeru dates back to 0.5 m.y. BP.

These results enable us to define long-term distribution of volcanoes leading up to caldera-forming activity in the range of 100 thousand to one million-year time scale.

Field surveys were conducted as a part of the project ”Multi-disciplinary Hazard Reduction from Earthquakes and Volcanoes in Indonesia”, supported by SATREPS from JST, JICA, RISTEK and LIPI.

Keywords: caldera, volcano, K-Ar dating, Quaternary, Indonesia

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

HDS004-P06 Room:Convention Hall Time:May 27 09:00-10:45

High-resolution MCS survey during KH-10-5 Leg.1 off northwest Sumatra cruise

Kenji Hirata[1*], Riza Rahardiawan[2], Hisatochi Baba[3], Leonardo Seeber[4], Katsura Kameo[5], Hideki Yamamoto[6], Hiroyuki Hayashi[6], Ayanori Misawa[5], Keita Adachi[5], Hiroshi Sarukawa[3], Takerou Sekimoto[7], Kohki Iyota[7], Toshiya Fujiwara[8], Masataka Kinoshita[8], Hidekazu Tokuyama[5], Yasuyuki Nakamura[8], Kohsak Arai[9], Haryadi Permana[10], Udrekh[11], Yusuf S. Djajadihardja[12]

[1]MRI, [2]MGI, [3]Tokai Univ., [4]LDEO, [5]Univ. of Tokyo, [6]MWJ, [7]Kochi Univ., [8]JAMSTEC, [9]AIST, [10]LIPI, [11]BPPT, [12]BAKOSURTANAL

A huge ocean-wide tsunami, with average heights of more than 20 meters along the west coast of the northern tip of Sumatra followed the 2004 Sumatra-Andaman earthquake (Mw9.2). Several working hypotheses have been proposed, but the generation mechanism for this tsunami remains unresolved. Most of these hypotheses suggest a possible coseismic slip on splay faults in the outer-arc-high off northwest Sumatra. Among these splay faults, the Middle Thrust (or possibly the Lower Thrust), can best account for features of the Indian Ocean tsunamis observed at regional and ocean-wide distances. To map fault traces and other geological structures that may be contributed by splay fault displacements, we conducted the KY09-09 bathymetry survey offshore northern Sumatra in 2009. The aim of that survey was to identify a fault trace that could be considered a candidate for the Middle Thrust (Hirata et al.,2010).

In early November 2010, we have conducted another high-density survey of the likely source region for the tsunami. This survey consists of a MCS (GI-gun, G=45 cuin and I=105 cuin; true GI-gun mode shooting every 10 sec; a 1,200 m-long, 48 channel solid streamer cable) and a 3.5 kHz Sub-Bottom Profiler (automatic ping intervals depending on water depth). A MNBS bathymetry survey using the SEABEAM 2120, shipboard gravity measurement, and 3-component magnetic measurement have also conducted as well. The survey ship speed was set at averagely 4 knots relative to ground. We designed the acoustic survey lines to cross a series of ridges and troughs parallel to the local trench axis and hence to sample fault traces that are candidates of the Main Thrust, the Lower Thrust, the Middle Thrust, the Upper Thrust in the outer-arc high.

The primary objective of the KH-10-5 cruise are to image detailed deformation structure in the uppermost sediment layers, up to 1 second bsfl in TWT, that are plausibly related to deformation occurred along fault traces. Our final goals are (1) to understand the geological structures in the outer-arc high off northwest Sumatra and their deformation history and (2) to resolve the generation mechanism of the Dec 2004 huge tsunami.

Approximately 480 nautical miles of MCS and SBP data were acquired during the KH-10-5 cruise(Figure 1). During the survey, we produced band-pass filtered, single channel profiles as preliminary results for all the survey lines. We could obtain clear images down to about 1.5 sec (TWT) in the trench fill and a maximum of about 1 sec (TWT) in small troughs in the outer-arc high. In Lines 5 and 6, a kink folding and landward vergent backthrusts were identified near the trench. Many of the small basins on the outer-arc high show deformed sediment layer structures, indicating either folding or faulting. Many SBP profiles also show deformation pattern in the uppermost sediment layers that are consistent with deeper deformation imaged by single-channel data. But some of them seem inconsistent, suggesting a difference in deformation pattern between recent (uppermost) and old (substrata) sedimentation periods. In the region where the Middle thrust is postulated, we found abundant evidences of faulting and folding of the sediment within small basins, along lines 4, 5, 6, 8, 10, 11 and 12. But these results are based on onboard processing and are tentative. We are going to process the MCS data and then interpret detailed geological structure in the near future.

Figure 1
The survey lines (heavy black lines) during the KH10-5 cruise. Main structural features (dashed): WAF, West Andaman Fault; UT, Upper Thrust, ; MT, Middle Thrust; LT, Lower Thrust; M'T, Main Thrust. DF, Deformation Front. UT and LT, are depicted according to Sibuet et al. (2007); MT according to Hirata et al. (2010).

Acknowledgement The KH10-5 cruise was conducted by using the R/V Hakuho-maru. We would like to express our gratitude to the Captain Takatoshi Seino and the crew for their cooperation and support during the cruise.

Keywords: sumatra, seafloor, survey, reflection, subbottom, fault

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

HDS004-P07 Room:Convention Hall Time:May 27 09:00-10:45

Tsunami Waveform Inversion of the 2010 Mentawai, Indonesia Earthquake

Yushiro Fujii[1*], Kenji Satake[2]

[1]IISEE, Building Research Institute, [2]ERI, University of Tokyo

We performed a tsunami waveform inversion of the Mentawai, Indonesia earthquake (Mw 7.7, USGS) on October 25, 2010. The tsunami generated by this earthquake was about 4 to 7 m height and killed at least 445 on Mentawai Islands. Seismological analyses (e.g., USGS or NIED) indicate that this earthquake was tsunami earthquake with a long (~ 100 s) duration. The tsunami was recorded at tide gauge and DART stations located in and around the Indian Ocean. We downloaded the tide gauge and DART data from WCATWC's, IOC's and NOAA's web sites and inverted the tsunami waveform data recorded at 9 tide gauges in Indonesia, Cocos, Sri Lanka, Maldives and a DART station located at southeast from the source region.

In order to estimate the slip distribution on the fault, 8 subfaults (4 along strike by 2 downdip) are assumed with the each subfault size of 50 km x 50 km. The focal mechanism is strike of 326 deg, dip of 12 deg and slip of 101 deg for each subfault from the USGS's Wphase moment tensor solution. The top depths of the shallower and deeper subfaults are 3 km and 13.4 km, respectively. Static seafloor deformation (Okada, 1985, BSSA) is calculated for each subfault model as an initial condition for the tsunami numerical computation. We adopted a constant rise time (or slip duration) of 30 s for each subfault. In order to calculate Green's functions from each subfault to the stations, the linear shallow-water equations were numerically solved by using a finite-difference method (Satake, 1995, PAGEOPH). For the far filed stations, we used a basic bathymetry grid of 2 arc-minute with finer grids of 24 arc-second around tide gauges, resampled from GEBCO_08 30 arc-second grid data. For the near field stations (Padang, Enggano, Tanahbalah and Telukdalam in Indonesia), an uniform grid of 12 arc-second was used, which was also resample form GEBCO_08.

The inversion indicates that large slips more than 2 m are located at the shallower subfaults near the trench, a feature similar to other tsunami earthquakes (e.g., Satake and Tanioka, 1999, PAGEOPH; Fujii and Satake, 2006, GRL). The total seismic moment is 4.3 x 10^{20} Nm (Mw 7.7) and the fault length is about 150 km. The synthetic tsunami waveforms generally agree with the observed ones. However, we found that the observed tsunami at Padang is not well reproduced, which is more sensitive to the solution of the slip distribution than the other stations. More detailed tsunami modeling may be required to estimate a reliable tsunami source model, by updating the bathymetry data with nautical charts and adopting a finer grid to express the complicated shorelines.

Keywords: 2010 Mentawai Earthquake, Tsunami Earthquake, Tide Gauge, DART, Tsunami Source, Tsunami Waveform Inversion

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

HDS004-P08 Room:Convention Hall Time:May 27 09:00-10:45

Source fault and rupture process of the 2006 Yogyakarta earthquake

Yasuyuki Kawazoe[1*], Kazuki Koketsu[1], Yosuke Aoki[1]

[1]ERI, University of Tokyo

The Yogyakarta earthquake with a moment magnitude of 6.3 occurred in the central part of Java, Indonesia on 26 May 2006 at 22:54 UTC, causing severe damage to the densely populated area of the Yogyakarta region. About 6,000 people were killed, and 50,000 were injured. The Opak River fault, located along the damage area, was thought to be a possible source fault of the earthquake, whereas the aftershocks were distributed 10 - 20km east of the Opak River fault (Walter et al., 2007).

Therefore, to clarify the source fault geometry, we first analyzed SAR data. We obtained an InSAR image by comparing the data acquired before and after the earthquake (29 April and 14 June, 2006).

We derived the surface trace of the actual source fault from this InSAR image. We next located three point sources by performing the waveform inversions of Kikuchi and Kanamori [1991] at various positions along the derived fault trace. We chose 29 teleseismic stations at epicentral distances between 30 and 100 degree, and retrieved vertical components of broadband P-wave seismograms for these stations from the Data Management Center of IRIS.

Using the obtained locations and focal mechanisms of point sources together with the aftershock distribution,by Walter et al. (2007) and our InSAR image, we defined the two-segment fault plane and its larger segment was assumed to be bent. We next performed a finite fault inversion of the teleseismic data using the method of Kikuchi et al. [2003]. The Green' s functions were computed with the method of Kikuchi and Kanamori [1991]. In addition to the teleseismic data, we further included strong motion waveform data observed at the NIED stations called BJI and LEM, and performed a joint inversion of the both data using the method by Yoshida et al. [1996] with the revisions by Hikima and Koketsu [2005].

This study identifies the source fault of the 2006 Yogyakarta earthquake and derived its rupture process by the waveform inversions. The inversion results imply that the Yogyakarta earthquake consists of two subevents and the larger one occurred 20 s prior to the smaller one.

Keywords: Yogyakarta earthquake, source process

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

HDS004-P09 Room:Convention Hall Time:May 27 09:00-10:45

Receiver function method for estimation of the shallow structure: example for Tabriz, Iran

Anatoly Petukhin[1*], Masato Tsurugi[1], Fallahi Abdolhossein[2], Miyajima Masakatsu[3]

[1]Geo-Research Institute, Japan, [2]Azerbaijan University of Tarbiat Moallem, [3]Kanazawa University, Japan

Receiver function method is widely used to estimate Earth crust and mantle structure. But to apply it to the estimation of weak low-velocity layers of shallow structure (1-5 km depth), which are important for prediction of earthquake strong ground motions for example, someone need to calculate receiver function at high frequencies, ˜3-8 Hz. High-frequency seismic waves are strongly scattered and calculation of receiver function in many cases become troublesome. To avoid this problem, we can use local small earthquakes. Receiver function approach is helpful to remove effects of source and path by deconvolution of the vertical component from the radial component. In its straightforward application receiver function is used to detect time delay of the Ps converted phases and then depths of the interfaces are estimated using a fixed velocity values in the layers. Instead, we use full waveform inversion of the receiver function into the velocity structure. We applied developed methodology to estimate shallow structures at a few sites in the region around the UNESCO World Heritage site Tabriz Baazar in Iran, constructed on about A.D.1400 or A.D.1500, with the purposes to estimate possible strong ground motions. Velocity of deepest layer was fixed according to the crustal structure. Receiver functions were inverted for velocity structure using Genetic Algorithm; propagator matrix algorithm was used to calculate theoretical receiver functions.

Acknowledgements. This study was supported in part by the Grant-in Aid for Science Research from the Ministry of Education, Culture, Sports, Science and Technology, Japan (No. 21254001).

Keywords: Shallow velocity structure, Receiver function, Strong ground motion