Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

SSS24-01 Room:315 Time:May 1 15:15-15:30

Structural analysis of seismogenic fault of the 2013 Mw 5.8 Awaji Island earthquake, NW Japan

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The 2013 Mw 5.8 (Mj 6.3) Awaji Island earthquake occurred in the southwest Awaji Island, at 5:33, 13 April, 2013, ca.25 km southwest of the epicenter of the 1995 Mw 6.8 (Mj 7.2) Kobe earthquake, southwest Japan. Pre-existing geologic data and focal mechanism show that this earthquake was triggered by an unknown active fault with a thrusting-dominated mechanism at high-dip angle of >70 degree. Interpretations of aerial photographs and 3D perspective images, field investigations and structural analysis of fault rocks, reveal that: i) a new fault, called Yamada Fault here, striking NNW and dipping WSW at a high-angle of 86 degree was found along a topographic lineament developed along the geological boundary between the Mesozoic granitic rocks and the Late-Tertiary-Quaternary Osaka Group composed of interbeded sandstone and mudstone; ii) a main shear zone of the Yamada Fault consists of a fault core that includes a narrow fault gouge zone of <10 cm in width (generally 1˜5 cm), a fault breccia zone of <100 cm in width, and a damage zone of 10˜50 m in width that is composed of cataclastic rocks and fractures; iii) the foliations characterized by S-C fabrics developed in the shear zone indicate a dominantly thrusting sense, consistent with that revealed by the focal mechanism; and iv) co-seismic surface ruptures occurred locally along the Yamada Fault, which are composed of numerous short fissures ranging from centimeters to several meters in length and concentrated in a zone <5 m. Our findings show that the newly found Yamada Fault is a active fault that probably triggered the 2013 Mw 5.8 (Mj 6.3) Awaji Island earthquake. Therefore, it is necessary to reconstruct the fault model for studying the tectonic activity and paleoseismicity and to reassess the seismic hazard of the active faults for densely populated Awaji Island, northwest Japan.

Keywords: 2013 M 6.3 Awaji Island earthquake, seismogenic fault, active fault, Yamada Fault, S-C fabrics of fault rocks, fault damage zone

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SSS24-02 Room:315 Time:May 1 15:30-15:45

Quasi-cylindrical seismic waveform modeling considering surface topography

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An accurate and efficient modeling of regional seismic wave propagation can be achieved by the axisymmetric modeling using the cylindrical coordinates. It assumes the structural model as rotationally symmetric along the vertical axis including a seismic source, and then solves the 3-D wave equation in cylindrical coordinates only on a 2-D structural cross section (i.e., 2.5-D modeling). Therefore, this method can correctly model 3-D geometrical spreading effects and the pulse shape, with computation time and memory comparable to 2-D modeling.

On the other hand, application of the conventional purely axisymmetric approximation is difficult in practice because the structure along the measurement line of the seismic survey is rarely symmetric with respect to the source location. To overcome this difficulty, Takenaka et al. (2003) proposed a ”quasi-cylindrical approach”. They developed a numerical scheme for seismic exploration using the finite-difference method (FDM). The FDM scheme had then been improved to include an arbitrary moment-tensor point source and the anelastic attenuation for further realistic modeling (Toyokuni et al., 2013, AGU Fall meeting).

In this work, we extended the scheme to treat land and ocean-bottom topographies. We adopted the cell-based staggered-grid FDM, which places the normal-stress components at the center of a unit cell, and applies the 2nd-order FD approximation around the free surface or fluid-solid boundary (Okamoto & Takenaka, 2005; Takenaka et al., 2009; Nakamura et al., 2012). In the presentation, we will show an application of the scheme to the waveform modeling for the volcanic areas in Japan.

Keywords: seismic waveform, finite-difference method, topography, fluid-solid boundary

Japan Geoscience Union Meeting 2014
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SSS24-03 Room:315 Time:May 1 16:15-16:30

Spatial distribution of aftershock decay property beneath Japan Trench

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We analyzed the aftershock sequences for individual M6-9 class inter-plate earthquakes and intra-plate earthquakes in Japan Trench for the period between October 1997 and March 2013 using JMA hypocenter catalog (final solution). The purpose is to examine a spatial relationship between the slip zone by the M9 earthquake and activity of aftershock series before the M9 and to understand the mechanism of aftershock. We approximated time variation of the number of aftershock sequences for each earthquake by the modified Omori ' s Law. Each aftershock sequence was identified from its spatial and temporal distribution. K and P parameters of Omori ' s Law were obtained by fitting the logarithmic Time-Frequency graphs of the aftershock sequence by linear function. We analyzed aftershock sequences for 44 events and adopted 17 whose K values are larger than 10 as available results because the results with smaller K values than 10 had large uncertainties due to lack of data. The results showed negative correlation between P values and Mj of the mainshocks. Before and after the M9 earthquake, there was no significant change in the aftershock parameters. However, we found a depth-dependent spatial distribution of aftershock decay properly. In the plate boundary, the aftershock sequence lasts for longtime without significant decay in the deeper portion, in contrast that the aftershock decays quickly at the shallower portion. It is known that the deeper part of plate boundary tends to slip aseismically without earthquakes. Taking this slow slipping property into account, our result suggests that the inter-plate frictional property should be responsible to the delay and decay property of the aftershocks.

Keywords: Aftershocks, Modified Ohmori's Law, Tohoku-Oki earthquake, Seismicity

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

SSS24-04 Room:315 Time:May 1 16:30-16:45

Location of early aftershocks of the 2011 Tohoku-oki Earthquake using seismogram envelopes as templates

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The location of early aftershocks is very important to estimate the initial size of mainshock fault, because the aftershock zone generally extends with time. However, the location of early aftershocks is often difficult due to the long-lasting coda wave of mainshock and successive occurrence of aftershocks. To overcome this situation, we developed a location method using seismogram envelopes as templates. During the process of location, we firstly calculate the cross-correlation coefficients between a continuous (target) and template envelopes, and obtain time series of station-averaged cross-correlations for all templates. We then search for templates (initial location) in the descending order of cross-correlations in a time window excluding the dead times around the previously detected events. The third process is the relative event location that accounts for the lag times between actual and template envelopes. We applied the method to the early aftershock sequence of the 2011 Off the Pacific Coast of Tohoku Earthquake (Mw = 9.0). In a time window of 30-minutes just after the mainshock, we could locate 22 events in 8 Hz band by using 96 templates recorded at 33 Hi-net stations. The number of located events by the JMA is 13. Though we should carefully examine the location of detected events, we conclude that the proposed detection method works adequately even just after the mainshock of large earthquake.

Acknowledgement: We thank the NIED for providing waveform data of Hi-net. This work was supported by JSPS KAKENHI Grant Number 23540487.

Keywords: early aftershocks, template, envelope, Off the Pacific Coast of Tohoku Earthquake

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

SSS24-05 Room:315 Time:May 1 16:45-17:00

Aftershock distribution in the northern source region of the 2011 Tohoku earthquake by long-term OBSs

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The 2011 Tohoku earthquake occurred at the plate boundary and many aftershocks followed. To obtain a precise aftershock distribution is important for understanding of mechanism of the earthquake generation. In order to study the aftershock activity, we carried out extensive sea floor aftershock observation using more than 100 ocean bottom seismometers just after the mainshock. Deployment and recovery of the OBS were repeated, and we obtained the data from OBSs just after the mainshock to the middle of September, 2011. A precise aftershock distribution for approximately three months in the whole source area, with an emphasis on depths of events, was obtained from the OBS data. In the southern source region, an aftershock distribution until September, 2011 was also estimated. Totally urgent OBS observations located 1210 aftershocks (Shinohara et al., 2011, 2012). After the urgent aftershock observation using short-term OBSs, we continued the observation using long-term OBSs to monitor seismic activities in the source area. We deployed 40 LT-OBSs in the whole source region in September 2011 and have completed recovery of the LT-OBSs until November, 2012. In this presentation, we concentrate seismic activities in the northern source region using the data from the urgent aftershock observation and long-term seafloor observation.

We selected events whose epicenter is located below the OBS network form the JMA earthquake catalog, and P and S-wave arrival times were picked from the OBS data. Hypocenters were estimated by a maximum-likelihood estimation technique with one dimensional velocity structures. Thickness of sedimentary layer changes at each OBS site was evaluated and the estimated travel times by the location program were adjusted. We will report precise seismic activities in the northern source region with spatial and temporal variation. From preliminary analysis, seismic activity in off-Miyagi region was still low until the end of the long-term observation.

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SSS24-06 Room:315 Time:May 1 17:00-17:15

A boundary of stress-field orientation in northwestern area of the Kanto plain

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Kanto-Tokai area is particularly important in terms of seismic hazard and mitigating disaster since this area is having high potential to economic and social impacts. Despite the fact, the Kanto region is one of the most seismic active areas due to its complicated tectonics and has an active fault zone, containing Fukaya fault, in northwestern area of the Kanto plain, which has potential to the M8 class earthquake. Many studies and research projects have attempted to understand the seismic activity and stress field. However, reliable and high-resolution catalog is required for the detailed discussion.

We have launched Japan Unified High-resolution Relocated Catalog for Earthquakes (JUICE) project since 2013. Events were relocated using the Double-Difference method for high-resolution hypocenter location to estimate seismogenic layer thickness, to evaluate active faults, and to understand the tectonic processes in Japan. We have completed for the first version of Catalog in the region of Kanto-Tokai area for the shallow (>40 km) earthquakes between M0 and M6.5 from 2001 to 2012. Here, in this presentation, we introduce the result from JUICE focusing on the northwestern area of the Kanto plain that contains a sharp boundary in which pressure and tension axis dramatically change by 90 degrees.

The JUICE catalog clearly shows a band of seismicity from Izu peninsula to the north. This seismic band has a nearly constant width of about 50 km. The focal mechanisms show that strike and thrust type dominate throughout this seismic band continuously, though there exists a area where pressure and tension axis dramatically change within this seismic band. While this " area " has been already recognized (e.g. Suzuki, 1989), JUICE helps to draw a precise " line " as a stress-field orientation boundary where happened to be close to Fukaya fault.

Bouguer gravity anomaly and seismic exploration data imply structural changes at the stress-field orientation boundary. According to the Bouguer gravity anomaly (Komazawa, 2004), the boundary appears to be associated with the gravity-low zone. The gravity anomalies show a lineation that trends NW-SE, the same direction of the boundary. Seismic profile (Sato et al., 2003) displays changes in basement character showing the pattern of depression beneath Fukaya fault. The shape of depression corresponds to the pattern of seismicity beneath this area, and also the boundary sites beneath the lowest point of the depression.

It appears to split into different regimes at the stress-field orientation boundary. We conclude that it is possible to have major tectonic boundary underneath this northwestern area of the Kanto plain. Moreover, we suggest that Median tectonic line (MTL) is a major candidate underneath this area. MTL runs parallel to the island arc through southwest Japan and divides different geological structures into outer (the forearc side) and inner arc (the backarc side). The trace of MTL disappears on the eastern side of Itoigawa-Shizuoka tectonic line, but Takagi et al. (2006) found an evidence of inner arc materials in the core sample obtained around this area. Therefore we assume that MTL is buried underneath the boundary. This finding may eventually impact on the research relates to hazard of Kanto area.

Keywords: Seismicity and tectonics

Japan Geoscience Union Meeting 2014
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SSS24-07 Room:315 Time:May 1 17:15-17:30

Estimating earthquake swarms in volcanic regions

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In the eastern Izu region, earthquake swarms have occurred repeatedly since 1978. These events are known to be triggered by magma intrusions, and the amount of magma intrusion is correlated with volumetric strain of the crust. We show the background seismicity rate is highly correlated with the volumetric strain in this region, with a short time delay. We then discuss the possibility to forecast the seismicity in volcanic regions.

To calculate the background seismicity rate, we used the epidemic-type aftershock sequence (ETAS) model extended for application to nonstationary seismic activity, introduced by Kumazawa & Ogata (2013). The time-dependent rates of both background seismicity and aftershock productivity in the ETAS model are optimally estimated from hypocenter data by Bayesian smoothing method. These rates can provide quantitative evidence for abrupt or gradual changes in shear stress and/or fault strength due to aseismic transient causes such as triggering by remote earthquakes, slow slips, or fluid intrusions within the region.

Keywords: ETAS model, Bayesian smoothing, earthquake swarm, volcanic region, Izu

Japan Geoscience Union Meeting 2014
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SSS24-08 Room:315 Time:May 1 17:30-17:45

Source Characteristics and Coulomb Stress Change of the 19 May 2011 Mw 6.0 Simav-Kutahya Earthquake, Turkey

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Abstract

On 2011 May 19, Simav district of Kutahya province in northwest Anatolia was hit by a moderate size (Mw=6.0) earthquake. Centroid moment tensors for 41 events with moment magnitudes (Mw) between 3.5 and 6.0 are computed by applying a waveform inversion method on data from the Kandilli Observatory and Earthquake Research Institute broadband seismic network. The time span of data covers the period between 2011 May 19 and 2011 August 22. The mainshock is a shallow focus normal event at a depth of 10 km. Focal depths of aftershocks range from 5 to 20 km. The seismic moment (Mo) of the mainshock is calculated $1.15x10^{18}$ Nm. The estimated rupture duration of the Simav mainshock is 30 s. The focal mechanisms of the aftershocks are mainly normal faulting with a variable strike-slip component. The geometry of focal mechanisms reveals a normal faulting regime with NE-SW trending direction of T-axis in the entire activated region. A stress tensor inversion of focal mechanism data is performed to acquire a more accurate picture of the Simav earthquake stress field. The stress tensor inversion results indicate a predominant normal stress regime with a NW-SE oriented maximum principal compressive stress. According to variance of the stress tensor inversion, to first order, the Simav earthquake area is characterized by a homogeneous intraplate stress field. Eventually, Coulomb stress analysis is performed to calculate the stress transfer and correlate it with the activated region. Positive lobes with stress more than 3 bars are obtained, indicating that these values are large enough to increase the Coulomb stress failure towards NW-SE direction.

Keywords: Aftershock, Coulomb Stress Analysis, Focal Mechanism, Simav earthquake, Stress tensor inversion, Western Anatolia

Japan Geoscience Union Meeting 2014
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SSS24-09 Room:315 Time:May 1 17:45-18:00

The Great Kanto Earthquake (of 1923) and YOKOHAMA (1)

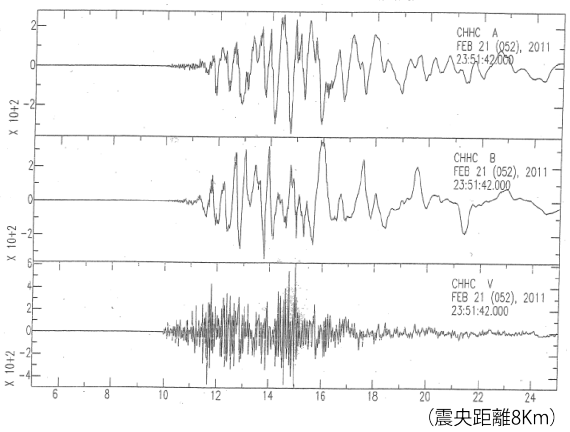
NISHIZAWA, Masaru[1*]

[1]none

1. The reinforced cocrete buildings has been complated the leadership factions after The Great Kanto Earthquake (of 1923).
2. The YOKOHAMA Civilization Colour Print was important mediums of the YOKOHAMA exoticim and cultures.

Keywords: The Great Kanto Earthquake (of 1923), Yokohama, Open a port, YOKOHAMA civilization color print, The reinforced concrete building

クライスチャーチの波形



（震央距離8Km）

東西、南北の波の位相は逆転していることは
他と同じで、水平方向に建物に対して
回転力（又はねじれ）が生じることが判る。

主要動以後の波形は波うっていることは
他と同様。
しかし、上下動も多少は波うってはいるが、
東西、南北に比べると小さい。