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

SSS29-P01 Room:Poster Time:April 28 18:15-19:30

Determination of the coefficients of Mhdd by a grid search approach

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Hara (2007) developed an empirical magnitude formula using durations of high frequency energy radiation and maximum displacement amplitudes using tele-seismic P waves. Recently, Hara (2013), who referred to this magnitude as M_{hdd}, tried to re-determine the coefficients of the formula using a larger dataset by a linear inversion. The M_{hdd} calculated by the proposed coefficients better agree with the moment magnitudes from the Global CMT catalog. However, there is slight epicentral distance dependence for their differences. In this study, in order to reduce this epicentral distance dependence, we performed a grid search to determine the coefficients of M_{hdd} by minimizing both the differences between M_{hdd} and moment magnitudes and the dependence of their differences on the epicentral distance. The dataset is the same as that of Hara (2013). The search ranges for each coefficient can be set reasonably based on the studies of Hara (2007) and Hara (2013). The preliminary result suggests that it is possible to reduce the epicentral distance dependence using the coefficients obtained by the grid search method.

Keywords: magnitude, high frequency energy radiation, Grid search method

SSS29-P02 Room:Poster Time:April 28 18:15-19:30

Wavelet domain inversion for examination of the frequency-dependent characteristics of the seismic wave radiation

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Frequency-dependent characteristics of the seismic wave radiation from earthquake sources are important subject for advancing the source physics and the strong-motion prediction. The 2011 Tohoku-Oki earthquake has exhibited particularly distinctive characteristics. The large slip is estimated in the shallow part of the fault from the low-frequency waveforms or geodetic data, whereas the source models derived from the analysis of the higher-frequency seismic data, such as the empirical Green's function modeling or backprojection method, suggest that the high-frequency waves were intensely radiated from the deeper portion. Our previous study (Suzuki et al., 2011) examined the contribution of the significant slip events to the waveform synthesis from the low-frequency waveform inversion results. We found that the sources of the very-low-frequency waves (<0.02 Hz) and higher-frequency waves seem different in the location even in the frequency band used in the waveform inversion. The examination on the frequency dependence in this previous study is somewhat indirect. We have therefore developed the source inversion method that utilizes the wavelet coefficients as the target to fit. This new method is based on the multi-time-window scheme and is linear inversion. The moment rate is directly related to the waveform in each octave band. We have first applied the developed method to 0.01-0.125 Hz strong-motion data of the largest aftershock of the Tohoku-Oki event that occurred in the off Ibaraki prefecture. The preliminary analysis does not suggest the clear frequency dependence for this Mw7.9 event in the analyzed frequency band. As future work, we will extend the analyzed frequency range and also apply to the Tohoku-Oki mainshock.

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SSS29-P03 Room:Poster Time:April 28 18:15-19:30

Tracing Rupture Process of the 2011 Tohoku M 9.0 Earthquake Using Small Seismic Arrays in China

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Back projection(BP) can trace rupture front of large earthquakes. It has been widely applied for better understanding rupture processes of recent large earthquakes. An important result/ouput from BP is rupture length, which roughly corresponds to the final size of earthquakes given geological environment. Thus it can be used for fast estimate of the size of large earthquakes for the purpose of tsunami warning and disaster evacuation.

Most studies were focused on using data recorded at distances of 30 to 85 degrees to epicenter, in which distance range the first coming wave is direct P wave which ensures a good resolution for the results from BP.

Here we applied several sub China array data to trace the rupture propagation of the Tohoku earthquake to investigate the effect of the other regional phases such as Pn. We tested the effects with seismograms recorded in sub arrays of China seismic array. The results suggest that the overall rupture length can be recovered, though there is some visible disconvergence, especially for those results derived from distant sub arrays.

Keywords: Back projection, Rupture Process, The 2011 Tohoku M 9.0 Earthquake, Small Seismic Arrays in China

SSS29-P04 Room:Poster Time:April 28 18:15-19:30

Waveform correlation analysis of small repeating earthquakes using high sampling-rate seismograms

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Repeating earthquake sequence is a series of earthquakes with nearly identical waveforms which occur at the same location repeatedly and they are thought to represent repeated ruptures of small asperities on a fault plane. Since there are many unknown features about asperities such as detailed structures, reproducibility and fluctuation of rupture patterns, it is very important to reveal such features to understand the generation process of interplate earthquakes.

Numerical simulations of the repeating earthquakes with rate- and state-dependent friction laws reveal that stress disturbance caused by postseismic slip of a large earthquake near the repeater can change rupture pattern of the repeater's asperity. Actually, some observations show systematic changes in the magnitudes of small repeating earthquakes immediately after large earthquakes. Such rupture pattern changes will make difference especially in high-frequency components of the waveforms. Therefore, in order to verify the rupture pattern changes of small repeating earthquakes, we have to perform detailed analysis on the differences in high-frequency components of the waveforms.

In this study, we performed 1 kHz sampling-rate seismograph observation at permanent borehole stations along Sanriku coast, Japan for the period from April to November 2011, immediately after the Tohoku-Oki earthquake. We investigate the waveform correlations of small repeating earthquakes using waveform data. We make a pair of earthquakes belonging to the same group of repeating earthquakes and calculate their coherences. The results show that in high-frequency band, there are both high-coherence pairs and low-coherence pairs even in the same repeating earthquake group, although all the pairs show high coherence in low-frequency band. Furthermore, frequency bands in which the coherences are low are nearly the same for all the pairs. These results suggest rupture pattern changes in the asperity.

We also find that earthquakes which show low coherence in high-frequency band for all the counterparts occur immediately after events in the vicinity of the repeater's asperity. This observation implies that rupture pattern changes in the asperity, which make difference in high-frequency components of the waveforms, are caused by stress disturbance due to the nearby earthquakes.

Keywords: repeating earthquake, asperity, high sampling-rate seismogram, waveform correlation analysis, Tohoku-Oki earthquake

SSS29-P05 Room:Poster Time:April 28 18:15-19:30

Study on the source process of the largest aftershock of 1923 Kanto earthquake

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The largest aftershock of M7.5 (Takemura, 1994) occurred at off Boso Peninsula following the 1923 Kanto earthquake. Although the hypocenter have been estimated by previous studies (e.g., Takemura, 1994; Hamada et al, 2001), precise source process have not been estimated yet.

The source region of the largest aftershock is characterized by the region of seismic and aseismic phenomena associated with subduction motion of the Philippine Sea Plate, including slow slip events (SSEs), large backslip events, and repeating earthquakes. Kimura et al. (2009) estimated fault plane of the largest aftershock from geodetic data and they concluded that the fault plane lies within the region of large backslip and the large slip area of the Boso SSE. Estimation of the source process during the largest aftershock is, therefore, important to understand earthquake preparation process around the region.

We set three point sources on the fault plane estimated by Kimura et al. (2009); shallow part (S1), middle part (S2) and deep part (S3). We calculated synthetic seismograms and evaluated the cross correlations between the observed and the synthetic waveforms. We tested the nine hypocenter-asperity combinations using S1, S2 and S3. The combination with the highest value of the average cross correlation is regarded as the best model. We obtained the best score for combination of S2 (hypocenter) and S3 (asperity). This result shows that rupture started from S2 and propagated toward S3.

The observed data used in this study were provided by Kajima Corporation. We are grateful for their kind considerations.

Keywords: 1923 Kanto earthquake, the largest aftershock, source process

SSS29-P06 Room:Poster Time:April 28 18:15-19:30

Earthquake source process of the 2013 Santa Cruz earthquake and the tsunami

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In order to understand the characteristics of large tsunamigenic earthquakes, we analyzed the earthquake source process of the 2013 Santa Cruz earthquake and simulated the tsunami. We first estimated the fault length of about 200 km using 3-day aftershock distribution and the source duration of about 110 sec using the duration of high-frequency energy radiation (Hara, 2007). From these results, we used the initial value of rupture velocity as 1.8 km/s for teleseismic waveform inversions. Teleseismic body wave inversion was carried out using the inversion package by Kikuchi and Kananmori (1991). Teleseismic P waveform data from 28 stations were used and band-pass filter of 0.005 ˜1 Hz was applied. Our best-fit solution indicated that the earthquake occurred on the northwesterly striking (strike = 290) and shallowly dipping (dip = 15) fault plane. Focal depth and rupture velocity were determined to be 23 km and 1.3 km/s, respectively. Moment magnitude of 7.8 was obtained showing somewhat smaller than the result of previous study (Lay et al., 2013). Slip distribution of the event showed roughly two patches of large slip, one around the hypocenter and the other to the southwest.

Using the slip distribution obtained by teleseismic waveform inversion, we calculated the surface deformations using formulas of Okada (1985) which would be assumed as the initial change of sea water by tsunami. Then tsunami simulation was carried out using Cornell Multi-grid Coupled Tsunami Model (COMCOT) code and 1 min-grid topographic data for water depth. Two DART buoy data were used to verify our simulation. In the presentation, we will discuss more details on the results of source process and tsunami simulation and compare them with the previous study.

Keywords: Santa Cruz, source process, tsunami

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Relationship between the source process of the 2013 Sea of Okhotsk deep earthquake and the thermal structure of the slab

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Deep earthquakes occur at depths where, due to the high normal pressures and the prominence of plastic behavior caused by high temperatures, the brittle fracture is difficult to explain. As a consequence, the mechanism of deep earthquakes has been long standing challenge in Earth Science since the early twentieth century. Some mechanisms of deep earthquakes have been suggested and these mechanisms are sensitive to the thermal structure of slabs. Accordingly, the purpose of this study is (1) to infer the source process of the Sea of Okhotsk deep earthquake (Mw 8.3, depth 608.9 km) on 24 May 2013 (UTC) by using the Hybrid Back?projection (HBP) method (Yagi et al., 2012) and waveform inversion (Yagi and Fukahata, 2011) and (2) to elucidate the relationship the source process and the thermal structure in the Kurile slab.

We found that the reactivation of the rupture occurred near the hypocenter. This means that a stress concentration near the hypocenter overcomes the fault strength and reactivates rupture at the hypocenter (Gabriel et al., 2012). We investigated the relationships between our results and the thermal structure of the Kurile slab and found that (1) the main shock started to rupture from the outer portion of the slab (2) the source region of the earthquake extended in a temperature range between 740 ℃ and 990 ℃. This study does not clearly support transformational faulting as a mechanism for occurrence of the Sea of Okhotsk deep earthquake suggested by Zhan et al. (2013) because it is unlikely that metastable olivine exists all over the slab at the depth of the main shock.

Keywords: deep earthquake, HBP method, rupture reactivation

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Focal mechanisms of the triggered tremor beaneath the Hinagu fault zone, southwestern part of Japan

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Non-volcanic tremors induced by large amplitude surface wave have been detected all over the world. Most of them are located on and near the plate boundary (Miyazawa and Mori, 2005; Nadeau and Dolene, 2005) and few of them are near volcanoes (Obara, 2012). Chao and Obara (2012, SSJ) found the triggered tremor that located beneath the Hinagu active fault zone, western part of Kyushu Island, Japan. Miyazaki et al. (2013, SSJ) reported that the tremor occurred beneath the seismogenic zone.

In this study, we attempted to estimate focal mechanisms of the tremors triggered by the surface wave of the 2012 Sumatra earthquake. We use the method developed by Hirasawa (1966) that uses the S wave polarization angles. We eliminated the data with low Signal-to-Noise ratio because the angles of waves of tremors were sensitive to background noise.

As a result, we found that focal mechanisms of the triggered tremors were roughly consistent with regional stress field. They could provide constraint for investigating dynamic triggering process of the tremor.

Acknowledgement
We used the seismic data from Kyushu University, the Japan Meteorological Agency, the National Research Institute for Earth Science and Disaster Prevention and Kagoshima University.

Keywords: triggered tremor, focal mechanisms, Hinagu fault zone

SSS29-P09 Room:Poster Time:April 28 18:15-19:30

Spatio-Temporal Variation of Stress Drop Observed at Carthage Cotton Valley Gas Field, Texas

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Understanding source characteristics of hydraulic fracturing induced microearthquakes is expected to provide a better understanding of the fracturing process and the influence of pre-existing structures controlling the distribution of events. Especially it is still controversial whether the events are associated with volumetric change or not. To address this question, we estimated the source parameters using the empirical Greens function analysis.

Keywords: Stress Drop, Hydraulic Fracturing, Induced Seismicity, Pore Pressure

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SSS29-P10 Room:Poster Time:April 28 18:15-19:30

Collapse of intraplate earthquake, Separation of accretionary wedge, and Rotation of plate by lateral-fault type

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[1]none

(Refer to the chart)

”Nankai Slab” that subduct from Nankai Trough forms the slope that turned to the northwest and is soaked to the thing that heads eastward. That edge shapes to receive resistance. And, ”Nankai Slab” receives the right turning force and weak places collapse. The part that is deeper than that place crawls up and the whole might rotate right. (A),intraplate earthquake of ”Nankai Slab”, and (B), lateral-fault type earthquake that the boundary with ”Tokai Slab” causes, are the Nankai Earthquake(EQ) and the To-Nankai EQ and the Tokai EQ.(this paragraph (1)(2))

Two huge cracks that seem that they relate to the right rotation exist if seafloor topography chart(3) is seen.

Crack(a):This crack starts from the place of about 10km to the east in Cape Daio and lengthens to the south. And, this crack gets to the trough. The trough projects to the south on the west side on the boundary of this place. I think that this crack slips when the upper plate(land side plate, accretionary wedge)

greatly moves on the lower plate ”Nankai Slab”.

Crack(b):This crack is shape of the character of Y off Lake Hamana and reach the trough. ”Nankai Slab” and ”Tokai Slab” are completely separate in the north from Lake Hamana(7). And, I think in the south this crack leads to the trough while touched. This crack is the one that this plasmotomy reached bottom of the sea and that slips when the whole of lower plate moves with the upper plate put.

Earthquake(B) is the one that Crack(b) slips. It can be said that that Crack(a) slips is intermediate of earthquake(A) and (B).

Dr. Yamanaka proposed in 2004 large and clear source model of the 1944 To-Nankai EQ that eastern edge within the range gets to Omaezaki(4).

That large area of slip is equal to the area of Crack(a) and (b). The 1944 EQ was not only earthquake(A) and everything might have happened. I composed the source process by earthquake(A),(B) and Crack(a),(b) referring to Dr. Yamanaka’s (interplate earthquake) source process.

1.Earthquake(A) occurred, and it spread in the direction of northeast along the slab-contour. 2.Separation of the accretionary wedge spread to the southeast and it reached the trough. 3.The separation spread along the trough first and spread along Crack(a) next. 4.(Rotation of upper plate) Crack(a) slipped because the separation was large-scale. 5.(Rotation of lower plate) Crack(b) slipped and earthquake(B) occurred because the environment was in order. The stress occurred in the vicinity of the trough. 6.The Mikawa EQ occurred because of the influence of 4,5. 7.The 2004 EQ occurred and the stress of 5 was absorbed.

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SSS29-P10　　Room:Poster　　Time:April 28 18:15-19:30