Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

SSS30-P01 Room:Convention Hall Time:May 24 17:15-18:30

The comparison of hypocenter location and magnitude determined by JMA and USGS.

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[1]MRI

We compared Japan unified earthquake catalog and USGS earthquake catalog from October, 2002 to May, 2011. We compared Japan hypocenter and USGS hypocenter which were judged to be the same earthquake. For the inland earthquake and the coastal earthquake, USGS hypocenter location has tended to be decided a little west side compared with Japan hypocenter location. Although they are almost same longitude for small earthquakes, USGS hypocenter location has tended to be decided more west than Japan hypocenter location for large earthquakes. However, for the earthquake near a trench axis, USGS hypocenter location has the tendency to be located in the east side compared with Japan hypocenter location.

Keywords: Japan unified earthquake catalog, The 2011 off the Pacific coast of Tohoku Earthquake, USGS earthquake catalog

SSS30-P02 Room:Convention Hall Time:May 24 17:15-18:30

The attempt of re-making Japan earthquake catalog based on Japan seismic networks (Part 2)

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Japan Meteorological Agency has been making catalog of earthquake which occurred in and around Japan since August, 1923. Since October 1997, we calculate hypocenter locations and magnitudes based on seismic data of related organizations(JMA, universities, NIED and so on). But, until September 1997, they had been calculated with only JMA seismic data. Therefore, the difference of the detectability of the earthquakes is remarkable on the boundary of October, 1997. Moreover, the detection accuracy of hypocenter location is different every age, because hypocenter determination method is different every age.

Then, we expect improvement of earthquake catalog if we re-calculate location of earthquake which occurred before September 1997, based on seismic data of "Earthquake Database of Japan University Seismic Observatory Networks(Umino et al., 2007)", NIED and JMA.

Last year, we got seismic data of NIED(from January 1979 to September 1997) and Japan University Seismic Observatory Networks(from January 1994 to September 1997). And we recalculated seismic events from January 1994 to September 1997 with JMA and these data.

We introduced our recalculation plan at JpGU Meeting 2011.
In this time, we will introduce a part of the recalculation result.
Finally, we have a plan to publish final result by the Headquarters for Earthquake Research Promotion.

Reference

Umino,N., S.Hirahara, J.Nakajima, K.Katsumata, M.Kosuga, N.Hirata, T.Kanazawa, S.Sakai, F.Yamazaki, K.Matumura, S.Kimura, K.Uehira, K.Goto, R.Matsu'ura and K.Tsumura, 2007, Earthquake Database of Japan University Seismic Observatory Networks, abstract of Japan Geoscience Union Meeting 2007, S144-003.

Keywords: Earthquake Catalog, Database of Japan University Seismic networks

Japan Geoscience Union Meeting 2012
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SSS30-P03 Room:Convention Hall Time:May 24 17:15-18:30

Research on the Aftershock Series for the past 10 years in the Japan Trench

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We analyzed the aftershock series for each individual M6-8 class earthquake in the Japan Trench for the period between October 1997 and November 2010. The purpose is to detect the stress state for the occurrence of the M9 earthquake. We approximated time variation of the number of each of the aftershock series from JMA hypocenter (final solution) data to the modified Omori's law. Furthermore, we compared with P values and existing research results about the stress state.

1. Introduction

On March 11 2011 the M9 earthquake occurred. Prior to that, it was not considered that there had been enough stress storage for the occurrence of a M9 class earthquake in the area from its history and distribution of asperity that inferred from waveforms by past earthquakes and GPS displacement data.

Aftershocks generally occur due to redistribution of stress by the mainshock. We have thought that the stress building up situation that could have caused the M9 earthquake might influence the aftershock activity. In this study, we analyzed each aftershock series spatially and temporally, and sought the relationship between the aftershock and the stress state.

2. Method

First we picked up M6 or larger earthquakes. Then we determined each aftershock series from its spatial and temporal distribution. Next we applied the modified Omori's law (below) to the each aftershock series making the logarithmic graph with the number of aftershock each day and elapsed days since the mainshock.

N(t) = K/(t+C)^P, where:

N(t): Number of aftershock per unit time.
t: Elapsed time since the mainshock
K: Number scale of the aftershock
C: Difficulty of the aftershock to occur immediately after the mainshock, and C=0 in this study.
P: Decay rate of the aftershock

This law means that the aftershock decreases exponentially.

3. Result and Discussion

We found some aftershock series that may not be approximated to the law. Hereafter, we describe the aftershock series of inter plate earthquakes with P and K from 0.4 to 1.5 and from 1 to 300, respectively.

3.1. Earthquake with Afterslip

We focused four earthquakes with significant afterslip which were reported by Suito et al. 2011. The P values of their aftershock series tend to be smaller than average, meanings that the decay rate is slow. It suggested the relationship between aftershock and afterslip.

3.2. Significance

It was decided that the results with K values less than 10 are not fairly evaluated. The following are three tendencies on the approximation by smaller K values, meaning that the number of the aftershock is not enough:

- Results greatly depend on the definition of aftershock periods. Thus the reliability is low.
- Number of aftershocks varies significantly, do not show exponential decay.
- Difficult to determine P value

3.3. Correlation

Correlations between P values or K values and M of the main shock are as follows:

- A positive correlation between K values and M
- A negative correlation between P values and M

3.4. Locked Zone

We compared with P values and distribution of locked zone in Tohoku region that were geodetically observed before the M9 earthquake. As a result, it seems that the aftershock series with smaller P values distribute around the locked zone.

4. Conclusion

In this study, we estimated two parameters of the modified Omori's law, P and K, for each aftershock series and then considered the relationship between M and them. The area with small P value is coincident with the inter-plate coupled area before the subsequent megathrust earthquake. Further research based on existing studies such as slip state dependent friction law will help us to understand what this coincidence physically means.

Keywords: the Japan Trench, aftershock, the modified Omori's law, P value, K value, stress state

Japan Geoscience Union Meeting 2012
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SSS30-P04 Room:Convention Hall Time:May 24 17:15-18:30

The statistical analysis of the earthquakes around the Greenland

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Recently, global abnormal weathers are observed at many places on the earth by the influence of global warming. Especially, the snow and ice melt and ice sheets are drained in the Polar region. In conjunction with these, it is reported that the frequency of the glacial earthquakes increases in the Greenland from 2000 (e.g. Ekstrom et al., 2006 and Tasi and Ekstrom, 2007). In addition, we see that the frequency of seismic events also inverse around the Greenland from the earthquake catalog of the International Seismological Center (ISC). To examine this trend of seismicity, we analyze the earthquake catalog of the ISC statistically. For the glacial earthquake, we use the catalog which is reported by Tasi and Ekstrom (2007). From these analyses, we can confirm the activation of seismic events and glacial earthquake in west Greenland, especially.

Keywords: Greenland, seismicity, glacial earthquake

Japan Geoscience Union Meeting 2012
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SSS30-P05 Room:Convention Hall Time:May 24 17:15-18:30

Statistical analysis of seismicity by discretized triggering model

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[Introduction]

To quantify interactions between earthquakes, earthquake triggering, we can regard an earthquake sequence as a point process and analyze seismicity statistically. A probability of an event occurrence at a given time depends on the history of event occurrences up to that time. To quantify the frequency of earthquake occurrences, we can explain it by stationary activities (background term) and triggering effects (triggering term) and the form of the triggering term is not unique.

[Method]

The Epidemic-Type Aftershock Sequence (ETAS) model is a well-known point process model and widely used [Ogata, 1988]. The ETAS model explain the triggering term using a specific form of function following the Omori-Utsu law which is an empirical law on aftershock sequences, so we can consider that the ETAS model is developed for modeling of aftershock sequences. Though the ETAS model explains the triggering term with a continuous function depending on time and magnitude, the discretized triggering model developed by this study explains it discretely which enables us to explain a complex dependencies of the triggering term on time and magnitude and gives us a simple way to model more general earthquake sequences other than aftershock sequences. Moreover, we used a maximum-likelihood estimation (MLE) to estimate model parameters and compared the results of the ETAS models and several discretized triggering models which are different in discretization using AICs.

[Data]

We apply the ETAS model and several discretized triggering models to two types of earthquake catalogs. One is a relocated catalog in southern California by Shearer et al. [2005] as an example of ordinary seismicity (an aftershock sequence), and the other is three low-frequency earthquake (LFE) catalogs in Japan detected by Aso et al. [2012 (this meeting)] as an example of extraordinary seismicity.

[Results and Discussion]

When we apply models to the SHLK catalog and compare results, we get a better AIC value than the ETAS model with a model in which we assume a separation of time and magnitude dependences of the triggering term. The result by this model shows a magnitude dependence of the corner of the triggering term which is corresponding to the c-value of the Omori-Utsu law, and we can say that the discretized triggering models are useful tools to enable us to quantify the c-value and its physical meanings.

For three LFE catalogs, estimated p-values of the Omori-Utsu law by the ETAS model are 1.2-2.2 which are larger than ordinary seismicity. Moreover, results by the discretized triggering models show a mountain of the triggering term in a time range shorter than 100-1000 seconds, and we can quantify a characteristic time scale and successive properties of LFEs. The difference between forms of the triggering terms of ordinary seismicity and LFE activities can imply the difference of physical processes.

Keywords: Discretized Triggering Model, ETAS model, forecast of seismicity, low-frequency earthquake

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SSS30-P06 Room:Convention Hall Time:May 24 17:15-18:30

Early aftershock activity of the 2011 off the Pacific Coast of Tohoku earthquake and the 2004 Chuetsu earthquake

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[1]Graduate School of Sci. & Tech., Hirosaki Univ

The early aftershock activity provides information about the mainshock rupture process that affects the whole aftershock sequence. Most aftershock studies utilize earthquake catalogs. However, the catalogs are incomplete, in particular, for the early stage of aftershock activity due to overlapping of codas of preceding earthquakes on P-wave first motion. We have investigated the early aftershock activity of recent large earthquakes by manually picking events from continuous seismograms. Our aim is to clarify the rate of expansion of aftershock zone, which is important to assess the true size of mainshock fault and to know the factors to control the expansion. The one event is the 2011 off the pacific coast of Tohoku (Tohoku-oki) Earthquake. We found that aftershock activity of Tohoku-oki Earthquake migrated to the north with a velocity proportional to the logarithm of elapsed time from the mainshock. The other target is the 2004 Chuetsu earthquake. We determined much more events than the JMA catalog. However, we need to improve location accuracy by, for example, using template events.

Japan Geoscience Union Meeting 2012
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SSS30-P07 Room:Convention Hall Time:May 24 17:15-18:30

Hypocenter of the 1911 great earthquake occurred around Kikai-jima, Japan

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The hypocenter of the 1911 great earthquake occurred around Kikai-jima, Japan is 28.0N, 130.0E and 100km depth in a general opinion. However, it is not known what kind of seismic data were used to determine the epicenter and the depth of hypocenter is known to be estimated qualitatively. In the present study, we determine hypocenter by using selected data of S-P time with care. The hypocenter is revealed to be 28.90N, 130.25E and 15km depth, where is about 60km NNE off Kikai-jima. We consider the depth of hypocenter, however, is about 30km by referring the latest distribution of hypocenters because of the reliability of estimated one being low. The 1911 great earthquake locates at the deeper rim of low seismic active area on the plate boundary, which extends about 80km length parallel to trench axis. If the low seismic activity is the result of strong coupling on plate boundary, this area may be the focal region of the 1911 great earthquake. Tsunami heights accompanied with this event are reported recently to be more than 5m at Kikai-jima and Amami-oshima, which may support the depth of hypocenter being shallower than 100km.

Keywords: great earthquake, Kikai-jima, Nansei-shoto, plate boundary

Japan Geoscience Union Meeting 2012
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SSS30-P08 Room:Convention Hall Time:May 24 17:15-18:30

True feature of seisimicity in Palau region

ISHIHARA, Yasushi[1*], Azusa Shito[1], Takashi Tonegawa[1], Satoru Tanaka[1], Daisuke Suetsugu[1]

[1]JAMSTEC

Palau islands locate at about 3,000km, south of Japan, in the western Pacific region. The islands locate at edge of Kyushu-Palau ridge and Palau trench develop in the near east of islands. However seismic activity is very low according to earthquake catalogue, which is much different from Mariana trench. Plate motion model also shows very low subducting velocity. The development process of this topography is attractive topic.

OHP network operates broadband seismic network in the western Pacific islands. Koror island, Palau, (station code: PALU) is one station of the network and is operated from 1990's. The continuous seismic data records small local earthquakes frequently. Our team deploys temporal stations in Palau to focus local earthquake monitoring from September, 2011. The other purpose of campaign measurement is evaluation of new site for PALU station to record low ambient noise.

Fortunately there was a major earthquake on October, 2011 at northern region of the island. The earthquake is catalogued by global network monitoring and good index to evaluate performance of our temporal array. The local array succeeds to record frequent small earthquakes, including its aftershocks and other swarm-like activity.

We tried to locate hypocenters of these seismic events using P and S wave arrival time. Hypocenters locate at two swarms and sparse events. One swarm is major events and its aftershocks. The other swarm locates in the east of islands, which is near trench axis. The depth of all earthquakes is 20 to 30 km, which means that these events locate under part converse plates. Our observation suggests that high seismic activity and more present active sunduction process.

Keywords: Palau, seismicity, Ocean Hemisphere Network

Japan Geoscience Union Meeting 2012
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SSS30-P09 Room:Convention Hall Time:May 24 17:15-18:30

Relation between Temporal Variation of b-value and Recurring Slow Slips off Boso Peninsula

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1. Introduction

Slow slip events with Mw6.3-6.5 have occurred repeatedly in every several years (1983, 1990, 1996, 2002, 2007, and 2011) on the plate boundary between the land and Philippine Sea plates off Boso peninsula (National Research Institute for Earth Science and Disaster Prevention, 2011). Duration times of those slow slips are from a week to ten days. In addition, it is known that the seismicity at northern margin is synchronized with the slow slips. In this study, we investigated a relation between temporal variation of b-value and recurring slow slips, and interpreted it as a manifestation of stress change associated with the slow slips by considering the inverse correlation between b-value of the G-R law (Gutenberg and Richter, 1944, BSSA) and stress obtained in laboratory experiments (Scholz, 1968, BSSA).

2. Data and Method

We used the JMA catalogue in the period from January 1, 1990 to December 31, 2011 (M ? 1.5, Depth ? 40 km). We estimated the temporal variation of b-value by using REASA (Aketagawa et al., 2007). We set 200 events as the calculation unit in order to estimate the temporal variation of b-value and shifted them at every 50 events.

3. Result and Discussion

The following results are obtained.

1) b-value increases before slow-slip event.
2) b-value decreases during and just after slow-slip event.
3) b-value increases little by little until next slow-slip event. And it returns to 1) again.

The above procedure is repeated. By considering the inverse correlation between b-value and stress obtained in laboratory experiments (Scholz, 1968, BSSA), we can interpret these results as follows. A b-value in Boso peninsula is high because stress applied to the region is low due to low plate coupling rate (Sagiya, 2004, Pageoph). This corresponds to 1). Stress increases around the slow slip source by the occurrence of a slow slip. Seismicity in the northern margin of the source is activated due to stress increase. A b-value for this region decreases because the margin is under high stress in this period. This corresponds to 2). Since the slow slip terminates with duration time from a week to ten days, the overall stresses applied to the marginal area begin to fall down (b-value begin to increase). These correspond to 3) and 1). And then, next slow-slip event occurs and stress increases again around the source.

By the way, seismicity at the shallower southern margin of the slow slips is less active than that at the deeper northern margin although it increased slightly in sync with the 1990 and 2011 slow slips. Judging from the magnitude-frequency diagram, we can detect the earthquakes more than M1.6 enough. Therefore, it is true that seismicity is inactive at the shallower southern margin. Sagiya (2004, Pageoph) estimated the slip deficit distribution on the Sagami Trough subduction zone by basing on the GPS velocity data. The result delineates a strongly coupled region on the plate interface, northern part of which corresponds to the 1923 Kanto earthquake. The strongly coupled region is also located at shallower region of the slow slips off Boso peninsula. From this evidence, we suppose that seismicity at south shallow margin is inactive even stress there increases somewhat because adherence of the plate boundary is considered strong at that region.

Keywords: Boso peninsula, Slow slip, b value, Stress, Temporal variation

SSS30-P10 Room:Convention Hall Time:May 24 17:15-18:30

Seismicity and crustal movement in Hokuriku region

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[1]DPRI, Kyoto Univ., [2]DPRI, Kyoto Univ. (retired), [3]Fukui NCT

We show the epicenter maps for microearthquake distribution in the Hokuriku region, and there temporal changes, regional changes of b values, for 1976-2011. Also three extensometer data in the tunnel of the Hokuriku observatory from 2006 to 2011 will be shown.

Two data sets were used. One is THANKS data made from 4 observatories of Kyoto Univ. for 1976 - 1998, and the other is JMA catalogue for 1999 - 2011. Earthquakes often happen as aftershocks in the region, however, some swarm-like earthquakes occur where no earthquakes had happened before. We found 3 regions, in each of them, the temporary change of b value were similar, mamely Tanba, Fukui, Yoro-Nobi.

We set 3 extensometers from 2006 in the tunnel near the Hokuriku Observatory. All of these extensometers show big changes in 2008. And most clearly, 5.0E-6 change through 1 year almost in EW direction. The GPS SABAE-FUKUIIKEDA also shows a big change pattern in the same year.

Keywords: Hokuriku region, hypocenter, b value, extensometer, GPS

Japan Geoscience Union Meeting 2012
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A fluid-filled crack propagation model to explain migration of earthquake swarm activities

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We investigate a migration of epicenters of an earthquake swarm activity in and around Shari-dake volcano in the eastern Hokkaido. The earthquake swarm activity started on April 27, 2004 (Ichiyanagi et al., 2009), and the epicenters migrated 2 km for 2 months toward two direction: southeast and southwest. The migration speed is the same for the two directions, fast for the first 10 days, and gradually decreases. We apply a fluid-filled crack propagation model (Spence and Turcotte, 1985) to the earthquake migration data. As a result we find that the migration distance as a function of time is well-explained by the model, which predicts that the crack length is proportional to the 2/3rd power of time with assumption of the viscosity of water. We also find that if the viscosity of magma is assumed, the crack will open 6 to 20 m, which is not consistent with the observation that no crustal deformation was observed by a GPS network around the Shari-dake volcano. Therefore the fluid in the crack is possibly not magma but water.

Ichiyanagi et al., Seismic activity of the 2004 Syari-dake Earthquake swarm by dense temporary seismic observation network in the eastern part of Hokkaido, Japan, Geophysical bulletin of Hokkaido University, 72, 299-314, 2009.
Spence, D. A., and D. L. Turcotte, Magma-Driven Propagation of Cracks, J. Geophys. Res., 1985.

Keywords: earthquake swarm, Shari-dake, earthquake migration, fluid, crack propagation model

Japan Geoscience Union Meeting 2012
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SSS30-P12 Room:Convention Hall Time:May 24 17:15-18:30

Study of Shape of Mountain (Normal Distribution)of Fourier Spectrum of Earthquake Motion

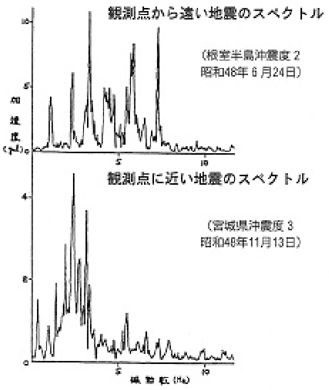
NISHIZAWA, Masaru[1]*

[1]None

Abstract
1.Fourier Spectrum of Earthquake Motion near the Hypocenter forms nearly
Normal Distribution.
2.I compared this Normal Distribution of Fourier Spectrum to a Solitary
Wave. (Science of Form)
3.Soliton is recognized in GPS wave gage of 2011.the Tohoku District Pacific
Ocean Earthquake Motion.
4.In the near future I think that Fourier Spectrum of Eeathquake Motio
will handle same as Solitary Wave and Soliton.

Keywords: Earthquake Motion, Fourier Spectrum, Normal Distribution, Science of Form, Solitary Wave, Solton

図－1



(土木学会東北支部, 1975年 2 月)

Japan Geoscience Union Meeting 2012
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SSS30-P13 Room:Convention Hall Time:May 24 17:15-18:30

M8 earthquakes in Kanto likely triggered by large events off eastern Japan between Sanriku and the Boso Peninsula

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[1]NIED

Only the 1923 and 1703 earthquakes in the Kanto region, central Japan, are widely accepted as M8-class earthquakes that were caused by the relative motion between the Philippine Sea Plate (PH) and the North American Plate (NA) along the Sagami trough. These two events followed M8 earthquakes along the Japan Trench ? where the Pacific Plate (PA) is subducting beneath NA ? in 1896 and 1677, respectively. Assuming a Brownian passage time model based on historical earthquake data, we have simulated earthquake sequences to determine whether these Kanto events were observed just by chance following the Japan Trench megathrust earthquakes. It is not conclusive but probable, at a significance level of 95%, that this historical evidence was not observed by chance. Thus, we assume that a large earthquake along the Japan Trench can trigger an M8 earthquake along the Sagami trough. This triggering could be interpreted as follows. First, we assume that the stress regimes in the Kanto area and along the Japan Trench are mainly governed by the relative motion between NA and PA. Beneath the Kanto area, the relative motion between NA and PA is decomposed into two components along the directions of relative motion between NA and PH, and PH and PA, respectively. If motion between PH and PA could take place, the accumulated stress may be partially released and at the same time the orientation of the resultant stress may be rotated toward a direction compatible with the relative motion direction between NA and PH. Therefore, an M8 Kanto earthquake becomes more probable than before. This interpretation could be confirmed by a Coulomb failure stress analysis, where the resultant stresses are examined based on the fault geometry of the 1923 Kanto earthquake, after a large presumed relative movement between PH and PA beneath the Kanto area due to the 2011 Tohoku earthquake (M9.0) along the Japan Trench.

Keywords: M8 earthquakes in Kanto, 2011 Tohoku earthquake, Triggering, Brownian passage time model, Monte Carlo method, Coulomb failure stress analysis