Arc-parallel extension of forearc region vs. 3-D bending-buckling mode of oceanic lithosphere at subduction zones

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In this study, we consider the fundamental physical origin(s) of arc-parallel horizontal extension tectonics, being dominant at some island-arc systems with the currently active back-arc opening. Next, by taking account of both the trench-parallel and trench-normal configuration of the bending-buckling oceanic lithosphere, we discuss the evolutionary process of island-arc systems.
We use the expression of 3-D principal stress axes (the maximum, intermediate, and minimum are S1, S2 and S3, respectively). At the island-arc systems with active back-arc extension such as the Okinawa Trough, Bismarck Sea etc., most of the S3 being approximately inferred from the low-angle T-axes of normal fault or strike-slip type earthquakes within the forearc overriding lithosphere, strike in the arc-parallel direction.
For the arc systems with the active back-arc extension, it seems that the forearc intra-plate shallow seismicity is lower than that of the back-arc.
When the dynamic process associated with the deflection and buckling of oceanic lithosphere at a trench-parallel zonal area from trench to outer-rise permits the horizontal migration of trench axis geometry towards ocean-side, we can expect some trench-ward retreat of the gradually lengthening forearc segment. The seafloor age of PH (Philippine sea plate) tends to become younger in the southwestward direction at least along the southern half of the Ryukyu trench. Recent geodetic GPS data by the GSI (Geographical Survey Institute, Japan) for the Ryukyu-Okinawa island arc system do not contradict the southward (or SSE) retreat of the arc from the back-arc continental area. This geodetic information implies the inevitable relative trench-ward migration of the axis of the Ryukyu Trench from the back-arc continental side. Thus, at least for the Ryukyu-Okinawa island arc system, the arc-parallel extension of forearc region is a passive phenomenon due to the active regime of back-arc extensional opening.
By considering the activity of regional shallower earthquakes within the overriding lithosphere accompanying the back-arc extensional tectonics, we conclude that the primary governing tectonic origin of arc-parallel extension at the forearc region is the back-arc extensional rifting or opening. In other words, the arc-parallel extension of forearc region is a secondary or passive phenomenon due to the active regime of back-arc extensional rifting or opening.

Keywords: arc-parallel horizontal extension, bending-buckling of oceanic lithosphere, subduction zones, back-arc extension

Seismically Active Region and Asperity in the mid-western Shizuoka

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Long-term slow slip events (LSSEs) have been repeatedly observed beneath the Lake Hamana (GSI), whereas the seismicity in the crust of the central western Shizuoka becomes low simultaneously with the LSSEs (JMA, 2014). The authors have pointed out that a temporal correlation exists between LSSE and seismic activity in the same region for the past LSSEs and have showed the effectiveness of monitoring the seismic activity in the region to confirm LSSE activity. Here we have tried to elucidate details of a space-time structure of seismic activation and quiescence in and around the asperity for the anticipated Tokai earthquake found by Matsumura (2007), which may give us important clues about the relationship between LSSEs and seismic activity in the crust of central western Shizuoka. Matsumura used a method to display the occurrence rate of earthquakes for a reference period within a certain area as a spatial quantitative analysis of seismic activity (Matsumura (2002)). On the other hand, the authors have been using the method of showing the statistically significant areas of activation and quiescence based on the Poisson probability less than 1% in all the spheres of the earthquake actually occurred (Aketagawa and Ito, 2008; and Hayashimoto and Aketagawa, 2010). The latter does not require defining the study area for each analysis and make it easier to make three dimensional map of the sources of activation and quiescence using ordinary mapping tools.As a conclusion the activated areas evaluated by the authors is not the same as that corresponding to the asperities found by Matsumura (2007), which may due to the differences in reference- and evaluation- periods, as well as the data sets they have used. In spite of this, it may be certain that there are activation parts in special regions in the crust of the central western Shizuoka and some parts in the boundary regions. It is easy to compare the activation parts and the asperities near the plate boundary. The problem is whether the activation parts act as the asperities, even in the low seismic activity in the period of LSSE.

Keywords: Seismic activity, Asperity, Mid-western region of Shizuoka Prefecture

Postseismic effects of viscoelastic relaxation and afterslip following the 2011 Tohoku-oki earthquake, Japan, on the 2016 Fukushima-oki and North Ibaraki Earthquakes

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In 2016, two earthquakes of normal fault type occurred: Mw7.0 Fukushima-oki earthquake on November 22th and Mw5.9 North Ibaraki earthquake on December 28th, which appear to be affected by the 2011 Tohoku-oki earthquake. What is the mechanism of these earthquakes to take five years to occur after the Tohoku-oki earthquake? Investigation of the mechanism is also important for the prediction of the future seismic activity. Our previous study on postseismic deformation using finite element model revealed viscosity structure beneath the Japanese islands and 3-year cumulative afterslip distribution, which enable to evaluate regional stress change.
First, we calculated temporal change in stress field due to viscoelastic relaxation in the asthenosphere after the Tohoku-oki earthquake. Results showed area of shear stress increase broaden with time. At the hypocenter of the North Ibaraki earthquake, shear stress increased 0.2 MPa in five years. On the other hand, shear stress did not change at the Fukushima-oki earthquake, which is located closer to the Tohoku earthquake. Elastic response to three-year cumulative afterslip is also calculated. We observed 0.4 MPa increase at the Fukushima-oki earthquake, and 0.2 MPa at the North Ibaraki earthquake.
Next, we calculated Coulomb stress change on each fault plane. Fault parameters (strike, dip, rake) are taken from Hi-net mechanism solutions and selected the nodal plane consistent with aftershock distribution. In the case of Fukushima-oki earthquake, we assumed strike = 52.1˚, dip = 37.6˚, and rake = -86.5˚, and in the case of North Ibaraki earthquake, strike = 317.3˚, dip = 31.4˚, and rake = -118.8˚. Just after the 2011 Tohoku-oki earthquake, Coulomb stress on both fault planes was calculated positive. However, earthquakes did not occur at this time, which implies that more stress was needed. The five-year viscoelastic effects brought about Coulomb stress decrease of 0.16 MPa at the fukushima-oki earthquake and increase of 0.11 MPa at the North Ibaraki earthquake. On the other hand, calculation of elastic response to three-year cumulative afterslip showed the Coulomb stress increase of 0.29 MPa at the Fukushima-oki earthquake, and increase of 0.15 MPa at the North Ibaraki earthquake. In general, afterslip continues with gradual decay. If we assume no significant change in spatial pattern of the afterslip, Coulomb stress will increase a little further at five years.
Sum of the viscoelastic and afterslip effects on Coulomb stress change is 0.13 MPa at the Fukushima-oki earthquake and 0.26 MPa at the North Ibaraki earthquake. These results mean that postseismic stress loading was added to the coseismic stress to contribute to the earthquake generation. However, the driving mechanism is different between the two earthquakes: the primary role was played by the afterslip in the case of Fukushima-oki earthquake, while viscoelastic relaxation and afterslip equally contributed to the North Ibaraki earthquake.

Keywords: 2011 Tohoku earthquake, Finite element modeling, Viscoelasticity, Afterslip, Coulomb stress

Seismogenic Layer within the Crust of Japanese Islands on the Japan Sea side using JUICE catalog

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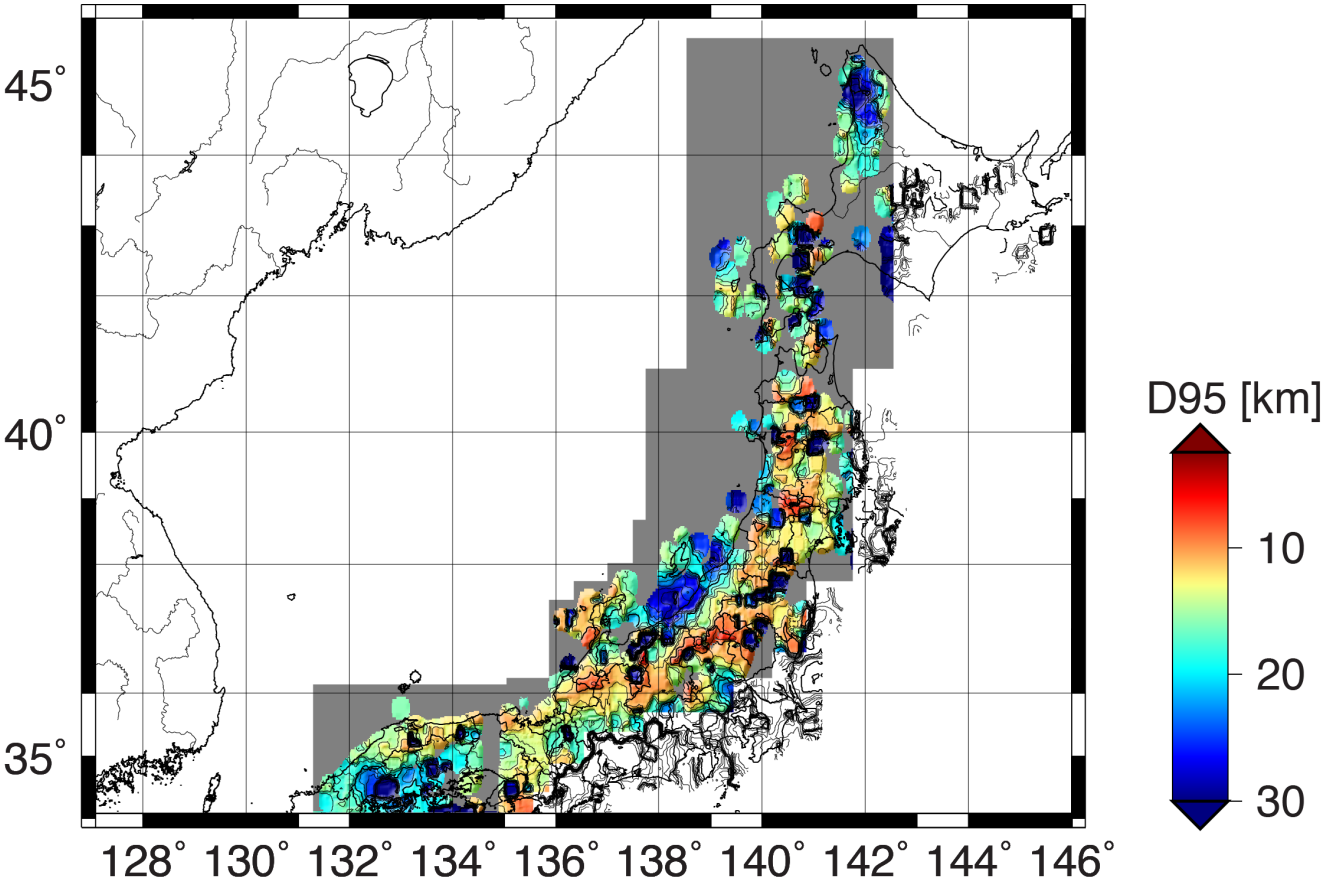
The width of source faults relate to their size of earthquakes. Understanding the high-resolution seismogenic layer is important parameter for the earthquake hazard assessment because it can estimate the seismogenic width of the particular active faults. Heat flow, geothermal gradient, and D90 (the depth above which 90% of earthquakes occur) are known to correlate with each other. The temperatures for D90 range could evaluate to be between 250˚C and 450˚C, which falls within the range for defining the seismogenic zone (e.g., Fagereng and Toy, 2011). In this study, we estimated D95 and D05, the depth above which 95% and 5% of earthquakes occur, because more precise and reliable catalog is now available from the Japan Unified HIgh-Resolution Relocated Catalog for Earthquakes (“JUICE”, Yano et al., 2016).

JUICE catalog contains relocated hypocenters for 12 years between 2001 and 2012 from the NIED Hi-net catalog (Depth 40km, 0.0 M). From the JUICE catalog, we extracted events with magnitude equal to or greater than 1.5 in order to satisfy Gutenberg-Richter magnitude-frequency relation. Then we estimated the D95 and D05 depths using the same method as Matsubara and Sato (2015).

The general pattern of our results is consistent with previous studies of D10 and D90 (e.g. Matsubara and Sato, 2015; Tanaka, 2004; Omuralieva et al., 2012). For example, deep D95 lies beneath the northern Hokkaido and northern Honshu and shallow D95 extends along the belt-like volcanic areas. In addition to this general profiles, we can find the local variability of D95 along the active faults. For instance, the northern part of the Kamishiro fault, in the northern Nagano prefecture, has D95 shallower than 15 km while southern part has D95 deeper than15km. Moreover, this study enables us to compare the seismogenic thickness and the actual crustal seismicity along the particular faults such as the 2014 North Nagano and the 2016 Central Tottori earthquakes. In our presentation, we will show the D95 and D05 depths on both general and local profile along the particular faults.

Figure 1: Map of D95 on the Japan Sea Side inferred by the JUICE catalog. Our study region is indicated in colored background. Gray area is where number of events is insufficient in order to estimate D95.

Keywords: Seismicity, Seismogenic layer, Crust, Hypocenter relocation



Nucleation Process of the 2011 Mw6.2 Northern Nagano Earthquake

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Introduction. Previous research.
An Mw6.2 inland earthquake occurred in northern Nagano region, central Japan, about 13 hours after the Mw9.0 Tohoku-oki megathrust earthquake. The regional seismic activity recorded by the Japan Meteorological Agency (JMA) catalog in the first hours following the megathrust event was highly incomplete, thus not allowing a detailed analysis of triggering mechanisms. By applying a Matched Filter Technique (MFT) to the continuous Hi-net (NIED) waveform data, Shimojo et al. (2014) revealed an immediate post-Tohoku seismicity activation in an area located about 10 km south of the Mw6.2 Northern Nagano source region. They also detected a few foreshocks close to the hypocenter of the Mw6.2 mainshock, within one hour before the occurrence of the moderate-size event. However, the physical processes that led to the occurrence of the Mw6.2 earthquake remained unclear. In this study we take advantage of the data recorded by a dense temporary seismic network operated by NIED from 2008 to 2012 to reveal with an unprecedented resolution the nucleation process that culminated with the occurrence of the Northern Nagano earthquake.

Data and Method
We use the waveform data of the NIED “Hizumi” temporary network, with station spacing of about 5 km or less in the study area. The data recorded by the permanent Hi-net stations (spacing of about 20 km) complements that of the dense regional network. We have first picked P- and S-wave arrivals of earthquakes on the continuous seismograms and use the pick data to locate the events. The earthquakes were then relocated using the tomoDD software (Zhang and Thurber, 2003) and a 3D velocity structure in the region (Sekiguchi et al., 2013). The newly located earthquakes were further used as MFT templates to search for new events within the 13-hour time interval, in the hypocentral region of the Mw6.2 earthquake.

Results and Discussion
We have detected a total of 285 earthquakes in the source region of the Mw6.2 event. The earthquakes are relatively small, with magnitudes less than 2.5, and distribute within two spatially distinct clusters: one of these clusters was located close to the hypocenter of the Mw6.2 event (“West” area), the other about 5 km to the east (“East” area).
In the “East” the seismicity starts within one hour after the Tohoku-oki earthquake. The events occur off the Mw6.2 fault and expand with time from shallow towards deep locations. In the “West” the seismicity starts immediately after the passage of surface waves excited by a moderate earthquake in the Tohoku-oki aftershock area, which occurred 21 minutes after the Mw9.0 megathrust; most of these events distribute along the fault line of the Mw6.2 mainshock. Within the “West” seismicity area, a tight sub-cluster that occurred in the immediate vicinity (within about 2 km) of the Mw6.2 hypocenter was strongly activated twice: about 3 hours before and 50 minutes before the mainshock, respectively.
In both “West” and “East” areas some events occurred during or immediately after the passage of surface waves from some M_{JMA}>=6.0 Tohoku-oki aftershocks. In particular, the final activation in the “West” starts during the passage of surface waves from a moderate event occurred off-shore Fukushima and continues until the occurrence of the Mw6.2 Nagano earthquake. Such activations may indicate that

successive dynamic stress changes caused by the remote Tohoku-oki mainshock and its subsequent aftershocks contributed to the weakening of the seismogenic region in northern Nagano, culminating with the Mw6.2 earthquake. Excitation of crustal fluids might have been at least partly involved, as revealed particularly by the migration pattern of activated seismicity in the “East”.

Keywords: the 2011 Northern Nagano earthquake, dense temporary regional network, Matched-Filter Technique, dynamic stress change

Investigation of the foreshock and aftershock sequence of the 2012 Mw 7.4 Ometepec earthquake using fingerprint and matched filter techniques

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On March 20 2012, the Mw 7.4 Ometepec earthquake ruptured a section of the Middle America Trench. This event triggered an unusually large aftershock sequence (UNAM seismology group 2013), and was widely felt across central and southern Mexico. Four months before the mainshock, an equivalent magnitude Mw 6.9 slow slip event (SSE) began and migrated towards the rupture zone reaching its maximum slip one month before the earthquake (Graham et al. 2014). One day and a half days, a temporary aftershock seismic network, consisting of 6 broadband 100Hz temporary stations, was installed to monitor the resulting increase in seismicity. We process the data, from this deployment and the permanent stations nearby, to track the occurrence of the characteristic repeating earthquake sequence and the evolution of the seismic activity prior to the event and at the onset of the postseismic relaxation. A previous study showed that numerous characteristic repeating sequences appear along the strike of the subduction zone from the shallow section of the trench up to 20km depth (Dominguez et al. 2016. JGR). As a result of strain release, we found a significant number of previously unobserved repeating sources seismicity appeared along the rupture zone, and previously reported sequences shortened their recurrence time intervals. We searched for characteristic repeating earthquakes hidden in the coda of the mainshock, and scanned for unreported events using both fingerprint (Yoon et al., 2015) and matched filter analysis. Our analysis focuses on evaluating the long-term slip rate inferred from the characteristic repeating earthquakes, unreported seismicity, and the evolution of the SSE rupture that led to the Mw 7.4 mainshock.

Keywords: Characteristic repeating earthquakes, 2012 Ometepec earthquake, Matched filter, Fingerprint

Normal-faulting earthquakes in the northern area of Ibaraki Prefecture in 2011 and 2016 - Duplicate events detected by InSAR observations -

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Introduction
Following the 2011 Tohoku earthquake, many inland crustal earthquakes has occurred with a source mechanism of normal fault motion in the Fukushima hamadori and northern Ibaraki areas. 30 seismic events larger than or equal to Mj5.0 (4 events >= Mj6.0) has occurred in this area, but there has been no events more than or equal to Mj5.0 since January, 2014 (for Mj6.0 since May, 2011). Under such a seismological background, an inland earthquake with Mj6.3 occurred in the northern area of Ibaraki Prefecture at 21:38 on Dec. 28, 2016. On the next day, an L-band synthetic aperture radar (SAR) satellite, known as the Advanced Land Observing Satellite 2 (ALOS-2), makes observations with an emergency operation for the purpose of detecting crustal deformation using SAR interferometry (InSAR), and the crustal deformation has been detected. The most interesting point is that the location, spatial distribution, and magnitude of the obtained deformation is almost same as those observed for the inland earthquake that occurred with Mj6.1 on March 19, 2011. In this presentation, I will show the crustal deformation and the fault model for the 2016 event, and discuss the similarity to the 2011 event.

Crustal deformation and fault model
I applied InSAR analysis to ALOS-2 data to obtain the crustal deformation. The most concentrated crustal deformation is located about 10 km west of the city of Kitaibaraki, with a maximum slant range lengthening of about 30 cm. The deformation elongated along the north-south orientation. A displacement discontinuity with a length of about 2 km is recognized in the northeast of the source region, probably suggesting that a rather shallow slip occurred. On the basis of the interferogram data, we constructed a fault model under an assumption of a rectangular fault with a uniform slip in elastic half-space. I assumed two fault planes to account for the widely-distributed deformation and the local deformation with the displacement discontinuity. The two-segment model is able to reconcile the observations well. The fault model shows (1) west-dipping fault planes with dip angles of 50–60 deg, (2) NNW-SSE (NW-SE) strike direction, (3) nearly pure normal fault motions, and (4) a shallow local slip. The widely-distributed deformation can be explained by a fault that has a fault length of 8 km with NNW-SSE strike at about 2km depth (upper edge of fault). The estimated moment magnitude (Mw) is 5.83. On the other hand, a shallow fault slip that produces the displacement discontinuity on the ground is inferred at the northeast of the main fault. The Mw is estimated to be 5.13. The total Mw is 5.85. The aftershocks occurred around the inferred fault, while there are little aftershocks in the proximity of the fault.

Comparison with the 2011 evetnt
It should be noted that the observed crustal deformation is similar to that for the 2011 event. The crustal deformation for the 2011 event, which is obtained from the InSAR analysis using ALOS data, distributes in almost the same area (Kobayashi et al., 2011). Also for this event, a clear displacement discontinuity was observed, and it is surprising that both the position and the length of the discontinuity are the same between the two events. It strongly suggests that a shallow slip occurred at almost the same location. As is the case in the 2016 event, the aftershocks occurred around the inferred fault, while there are little aftershocks in the proximity of the fault.

Acknowledgements: ALOS-2 data were provided from the Earthquake Working Group under a cooperative research contract with JAXA (Japan Aerospace Exploration Agency). The ownership of ALOS-2 data belongs to JAXA.

Keywords: InSAR, crustal deformation, normal fault earthquakes, Northern Ibaraki

Seismic Activity in the central Tottori prefecture with an M6.6 earthquake on October 21, 2016 detected by the Matched Filter Method

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Seismic activity in the central Tottori prefecture, southwest Japan was analyzed by using the Matched Filter Method (MFM). This swarm activity started with an M6.6 event on October 21, 2016. In this analysis, we implemented MFM as a pseudo-automatic hypocenter determination system that enables to locate earthquakes one by one. Our interest is if the MFM is a useful tool for immediate grasp of an ongoing intense seismic activity.

In the MFM analysis, selection of the template earthquakes is important since the spatial distance and magnitude difference among the template earthquakes affect the detectivity of earthquakes. For this purpose, we separately implemented the conventional event detection algorithm using STA/LTA (short term average of the ground motion / long term average of the ground motion) to detect possible template earthquake in order to configure a set of template earthquakes. We manually inspect the hypocenter of a possible candidate of a template event and then we inspect the succeeding event if it is also suitable for a template. We used the spatial distance and magnitude difference as the criteria to select a succeeding template. In the current analysis, if the spatial distance is greater than 2.5 km and magnitude difference is greater than 1.0 among existing templates, this event is selected as a new template. We repeated this procedure during 17 days from October 21 to November 7 to select a set of templates. When we obtained a new templates, all the continuous record in the test period are scanned by the new template to detect new earthquakes. We finally selected 37 template earthquakes in this manner in this test period.

During the test period of 17 days, about 7,000 earthquakes are detected and located with 37 templates. Comparison with manually inspected catalogue provided by JMA (Japan Meteorological Agency) indicates that the configuration of earthquake clusters well coincide with each other with slight differences and it was useful to understand the outline of the activity in the early stage. Although the manually inspected catalogue data is essential for the precise evaluation of a seismic activity, we suppose MFM is one of the powerful tools for an immediate grasp of the ongoing intense swarm activity.

Keywords: Central Tottori earthquake, Matched Filter Method, pseudo-automatic hypocenter locating system

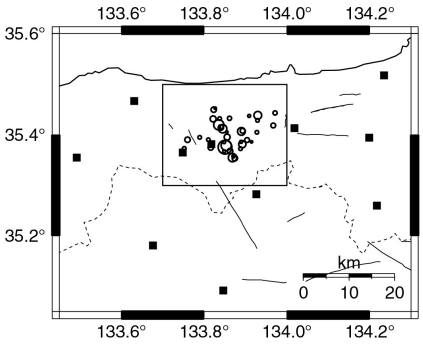

Fig.1

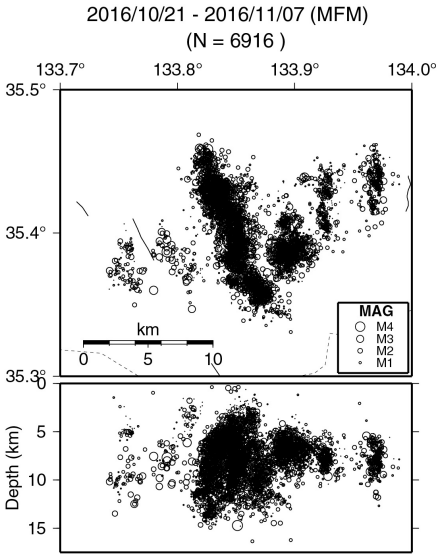

Fig.2

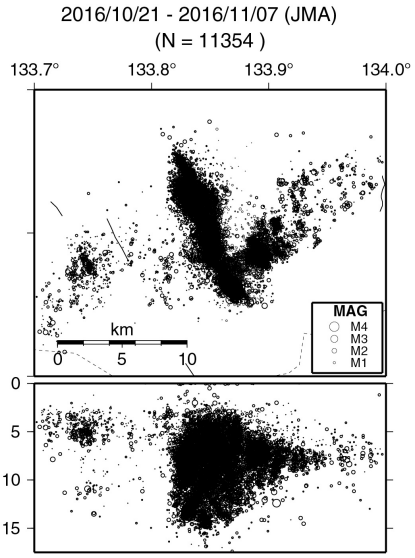

Fig.3

Characteristics of the foreshocks and aftershocks activity inferred from the JMA seismic catalog improved by automatic processing

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In research of seismic activity, it is important to lower a completeness magnitude (Mc) of the G-R law. If we have a sufficient number of earthquakes, we can evaluate seismic activity with high spatiotemporal resolution, such as ETAS analysis, detection of background seismicity rate change, and stress state estimation by b value analysis. Also, a catalog including smaller earthquakes is useful to understand characteristics of foreshocks activity which is generally low seismicity. After April 2016, the JMA unified seismic catalog was improved by a new automatic processing system (Tamaribuchi et al., 2016, in Japanese), which led to the almost twice identifications of earthquakes compared with the conventional catalog. In the 2016 Kumamoto Earthquake, however, all of detected earthquakes could not be cataloged in real time due to a delay of visual inspection for the numerous aftershocks. Therefore, we created a catalog data merged a JMA unified seismic catalog and an automatic processed catalog. In this research, we extracted features of foreshocks and aftershocks activities inferred from this merged catalog. Many clustering methods have been proposed for analysis of big data. We therefore used the Nearest-Neighbor Distance method, which is an objective and systematic clustering method proposed by Zaliapin and Ben-Zion (2013, JGR), and used the efficient program devised by Kasahara (2016). In this method, it is possible to cluster seismic activity objectively and automatically by defining “distance between hypocenters” using epicentral distance, time difference, and magnitude. We confirmed that the histogram of the NND distance is bimodal, and that the seismic activity can be automatically clustered with the same NND threshold value of the conventional research. Therefore, we could categorized events into the foreshocks, mainshocks and aftershocks from these clusters, and analyzed statistics such as b value. In particular, we calculated the b value for 5 clusters with more than 50 foreshocks. The b value of the foreshocks is significantly lower than that of the aftershocks in 2 cases, the 2016 Kumamoto Earthquake and the activity in central Tottori prefecture in October. This low b value may correspond to the increased local stress before the mainshock. On the other hand, it was also found that there are many clusters in which the b value of the foreshocks and aftershocks were almost the same. In the future, we expect that the features of the foreshock and aftershock activities will become clearer with this improved catalog obtained by automatic processing.

Keywords: Earthquake Clusters, b value, automatic processing, foreshock

Magnitude-Frequency Characteristics of Seismicity Detected Using Template Correlation: Implications for Geographically and Geometrically Restricted Fault Source Scaling

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The magnitudes of earthquakes detected using matched filters and other correlation-based methods commonly exhibit the power-law scaling relationships characteristic of seismicity in general. In particular, microearthquakes detected by individual templates in a variety of tectonic settings typically have Gutenberg-Richter magnitude-frequency characteristics with exponents of ~1 that are similar to those of conventional seismicity catalogues representing much larger crustal volumes and diverse focal mechanisms. In this presentation, we show examples of Gutenberg-Richter magnitude-frequency distributions for microearthquakes detected using individual templates in tectonically different parts of New Zealand (Taupo Volcanic Zone, central Alpine Fault, Southern Lakes) using magnitudes calculated using singular value decomposition. By design, the earthquakes detected by correlation with a specific template must produce similar waveforms to the template at multiple stations. Consequently, they must have similar hypocenters and focal mechanisms, and this implies that the observed magnitude-frequency scaling of earthquakes detected with individual templates must pertain to a geographically (x, y, z) and, importantly, a geometrically (ϕ, δ, λ) restricted set of sources. By characterizing the magnitude-frequency characteristics of microearthquakes detected by specific templates, controls on earthquake scaling can be studied in increasing detail on individual faults without contamination from adjacent structures.

Keywords: New Zealand, matched-filter, earthquake detection, magnitude-frequency distribution, correlation-detection

Short-term forecast by foreshock discrimination models using magnitude frequency and spatio-temporal features of seismic clusters

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Foreshock activity is a powerful key for short-time prediction of large main shocks. Though many large earthquakes are preceded by their foreshocks, it is very difficult to declare foreshock clusters before occurrence of their main shocks and only probabilistic identification may be available.

Logistic regression is a statistical learning method appropriate to such binary classification problems where a-posteriori probability of class membership given observed features is required. Statistical learning methods can keep learning discreminating features from updating catalog and give probabilistic recognition of forecast in real time. There are some characteristic features of foreshock clusters reported by previous studies, such as law b-values and power-law increase in seismicity. Our approach uses these features to discriminate foreshocks from other seismic clusters by a non-linear logistic regression model. Seismic clusters are constructed from JMA hypocenter catalog by using the single-link clustering method and their magnitude frequencies and spatio-temporal features are extracted for foreshock discrimination. Deviding the catalog into two periods, the model parameters are learned from the earlier period and predictive performance of the learned model is evaluated in the latter period. In addition, probabilities that main shocks larger than certain magnitudes occur are also evaluated by fitting extreme value distribution to the main-shock magnitudes. For the foreshock sequence of the 2016 Kumamoto earthquake of M7.3, the learned model gives relatively high probability forecast.

Keywords: foreshock, short-term forecast, logistic regression, extreme value distribution

Distribution of slab-fluids around the edge of the Philippine Sea Plate in Central to Northeast Japan

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Marginal parts and edges of a plate and subducting slab may play important roles in geodynanmics, because those are the places where the plate interacts with other plates or with the mantle: Thermal, geochemical and mechanical interactions are expected. The Philippine Sea slab (PHS slab) that subducts beneath the Japan arcs has such an edge. To examine the relationship between the arc magmatism and the slab edge in the transition zone from Northeast Japan to Central Japan, we have investigated isotopic systematics of the volcanic rocks in the area, including both the data from literature and the new data for five isotopic ratios of Sr, Nd and Pb. The new data include major element compositions of 22 samples from the back-arc area where a few petrological data were available and five isotopic ratios for the selected 6 samples from Pleistocene to early Quaternary epoch. As a result, a detailed spatial variation of the isotopic ratios can be discussed for Northeast to Central Japan. On the basis of the spatial variation of the isotopic ratios and the estimated amount of slab-derived fluid, we found (1) the amount of fluid derived from the two subducting slabs (i.e., the Pacific slab and the Philippine Sea slab) decreases from a significantly high value (~5 wt.% fluid added to the source mantle) to the north away from the seismically determined edge of the PHS slab, (2) the proportion of the PHS component in the total slab-derived fluid also decays northward, and (3) the PHS component spreads to the north beyond the edge of PHS slab. These observations strongly suggest that the aseismic Philippine Sea slab exists beneath the southernmost Northeast Japan to deliver the PHS component to the arc magmatism. In addition, the double subduction of the two slabs generate enhanced suction force at the corner region near the edge of PHS slab, which may account for the fluid focusing as described (1) above.

Keywords: edge, slab, Philippine Sea Plate, central Japan

