Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SSS32-01 Room:A04 Time:May 26 14:15-14:30

Long-term seismic quiescence before the recent great earthquakes along the Kurile Trench

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The 1994 Hokkaido-toho-oki earthquake (Mw8.3) was preceded by a long-term seismic quiescence started 13 years before the main shock. The 2003 Tokachi-oki earthquake (Mw8.3) was preceded by a long-term seismic quiescence started 10 years before the main shock. The 2006 naka-Chishima earthquake (Mw8.3) was preceded by a long-term seismic quiescence started 10 years before the main shock. An earthquake catalog created by International Seismological Center (ISC) is analyzed in the study area, 140E to 160E, 39N to 55N, between January 1964 and June 2012, including 1641 earthquakes shallower than 60 km with the body wave magnitude of $5.0 \leq mb \leq 7.2$. Clustered events such as earthquake swarms and aftershocks are removed from the ISC catalog by using a stochastic declustering method developed by Zhuang et al. (2002). A detailed analysis of the earthquake catalog using a gridding technique (ZMAP) shows that the quiescence areas are located in and around the focal areas of the three great earthquakes. The quiescence area for the 1994 Hokkaido-toho-oki earthquake is a circle centered at (43.5N, 146.9E) with a radius of 32 km. The quiescence area for the 2003 Tokachi-oki earthquake is a circle centered at (42.5N, 143.5E) with a radius of 88 km. The quiescence area for the 2006 naka-Chishima earthquake is a circle centered at (47.2N, 153.1E) with a radius of 68 km. Moreover I find a long-term seismic quiescence in two areas, which has not been followed by a great earthquake yet. One of them is a circular area centered at (39.8N, 144.2E) with a radius of 68 km, which is a southern part of the focal area of the 1968 Tokachi-oki earthquake. The other one is located in and around the focal area of the 1963 Etorofu earthquake.

Keywords: seismicity, seismic quiescence, Kurile trench, great earthquake, body wave magnitude, ISC

Japan Geoscience Union Meeting 2015
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SSS32-02 Room:A04 Time:May 26 14:30-14:45

Triggering process of the M6.4 Eastern Shizuoka earthquake on March 15, 2011

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We investigated the triggering process of the M_{JMA}6.4 Eastern Shizuoka earthquake which occurred near Mt. Fuji at a depth of about 14 km, four days after the Mw9.0 2011 Tohoku-oki earthquake. The Eastern Shizuoka earthquake may have been triggered by the static stress changes from the 2011 Tohoku-oki earthquake and/or the dynamic stress and strain changes due to the passage of surface waves from the M_{JMA}6.2 Fukushima-oki earthquake which occurred about 230 sec earlier and at a site located about 400km away.

Keywords: 2011 Eastern Shizuoka earthquake, 2011 Tohoku-oki earthquake, static stress changes, dynamic stress changes, triggering

SSS32-03 Room:A04 Time:May 26 14:45-15:00

2011 Yamagata-Fukuhsima Border Earthquake Swarm and Tanakura Tectonic Line

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An active earthquake swarm occured in the Yamagata-Fukushima border induced by the 2011 Thohoku-Oki earthquake. Hypocenters were relocated precisely by temporary stations, which clearly showed hypocenter migration (Okada et al., 2014). The migration has been estimated to be related with the flow of fluid which reduced the mechanical strength. This study examined the relation between seismicity and geologic structures.

The focal area locates on the mountainous region with 1000-2000m of altitude in the Yamagata and Fukushima border to the west of Azuma Volcano and to the north of Bandai Volcano. In the geologic view, the focal area is passed through with north-south trend by Tanakura Tectonic Line, which is estimated to be formed by sinistral strike slip fault movement in late Createaceous (100-80 Ma) [?] along the eastern margin of Asian Continent. The Tanakura Tectonic Line is major tectonic line in the Japanese Island Arcs and bounds northeast and southwest Japan. The west of Tanakura Tectonic Line is composed by Ashio Belt of Jurassic accreationary complex with the intrution of Asahi Paleogene granits and the east with Abukuma Creatacous granits. Ashio Belt is eastern extend from Mino and Tamba Belts in southwest Japan.

The epicenters do not fit to the active volanos and subsiding area in Yonezawa Basin of north and Kitakata Basin of southwest.

The geology of the focal area is summarized as follow;

1) pre-rifting stage: Jurassic accretionary complex, Abukua Createaceous granits (100-85Ma), Asahi Paleogene granits (65-54Ma) along eastern margin of Asian Continent,

2) rifting stage [concentric bent slab started to fall into lower mantle] : overlaid terrestrial sediments on rifting continental margin (20-16 Ma),

3) Japan Sea opening stage [slab falled into lower mantle]: marine sediments with so called green tuff (15-14 Ma),

4) peak of transgressive and sinking stage [collapse of slab]: pelagic sediments (13-12 Ma),

5) regressive stage [break and falling down of slab and subduction of next slab]: terrestrial volcanic efusives of caldera (8-5 Ma),

6) dacitic volcanism.

Jurassic accretionary complex intruded by Asahi Plaeogene granits exposes in the west and Abukuma Createaceous granits in the east of the focal area, which indicates for Tanakura Tectionic Line to pass between them.

The focal area is located at a caldera (5) and dacitic (6) volcanisms. It suggests the magma reservoir of the volcanisms relating to the earthquake swarm. The earthquake swarm initiated from the central part of the dacitic volcanism (6) where thick dyke for the main vent exposes after the uplift and erosion of the volcanic body. It is estimated that decrease of the east-west compressional stress by the Tohoku-Oki earthquake induced uplift of fluid into the upper crust which reduced mechanical strength of the upper crust and induced those earthquakes.

In the early stage, hypocenters migrated up westward along eastward dipping plane in the central part of the focal area. Then, changing the direction, hypocenters migrated eastward along the main westward dipping plane. It is not easy to correlate the westward dipping plane with the surface geology, because the hypocenter depths range 8-10 km. However the westward dipping nodal planes of focal mechanisms trend along this westward dipping plane. Thus we can use the intersection of the nodal planes with the surface for the correlation. Because the intersections are paralleled to the unconformity of overlaid terrestrial sediments (2) on Abukuma Createaceous granits (1) along Tanakura Tectionic Line, the westward dipping plane can be correlated with Takankura Tectonic Line. The migration of hypocenter can be estimated with flow of the fluid along Tanakura Tectonic Line.

In the later stage, hypocenters migrated westward without significant differences of depth, which may relates to fractures on the hanging wall of magma reservoir

Keywords: Yamagata-Fukushima border, Tanakura Tectonic Line, distribution of hypocenters, migration of hypocenter, nodal plane, geologic structure

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SSS32-04 Room:A04 Time:May 26 15:00-15:15

Seismic activity and stress field in and around Tarumae Volcano

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Tarumae Volcano, which is located in the southern part of Shikotsu caldera, is an active volcano that has repeated various volcanic activities since historical records. Although the volcanic activity has recently been inactive in and around the volcano, crustal deformation accompanied with volcanic activity was found in the deeper region in the northwest part near the summit from the end of June, 2013 through the beginning of July and following then the seismic activity has also increased in the western part around the summit at a depth of 3-5km from the beginning of July, 2013 through August. It is considered that these activities have been the most active since the installation of the seismic observation of 1967 in and around the volcano (Report of Coordinating Committee for Prediction of Volcanic Eruption, 2013). Furthermore, the event of M=5.3 occurred in the western part around the summit at 18:05 (JST) on 8 July, 2014 and then many aftershocks were also observed. It is expected that examining the seismic activity and the stress field in and around the magma chamber to understand the magma feeding system in the volcano leads to the improving the prediction of the volcanic eruption in addition to understanding the volcanic activity.

In this study, we especially focused on the seismic activities before and after the 2014 mainshock (Mw=5.3) and determined the hypocenter by using the method of the hypomh (Hirata and Matsu'ura 1987), taking account of the station correction of the observation stations in and around the volcano. The seismic activity after the mainshock is likely distributed to the west side of the volcano, compared to the distribution before the mainshock. On the other hand, the distribution of the seismic activity beneath the volcano did not change before and after the mainshock. We also determined focal mechanisms using S-wave/P-wave amplitude ratios in addition to P-wave first motion polarities, using the method of Hardebeck and Shearer (2003) and then performed the stress tensor inversion using of the code by Martinez et al. (2014). As a result, the stress fields before and after the mainshock did not significantly changed, showing the stress fields of reverse to strike-slip fault type with the maximum horizontal stress in WNW-ESE direction in both term. Furthermore, to clarify whether the seismic activity after the mainshock was affected by the static stress change by the mainshock, we calculated $\triangle$CFS, referring to some focal mechanisms obtained in this study as a receiver fault. It was found that quite a few aftershocks occurred on the area with $\triangle$CFS <0 and all the aftershock did not necessarily occurred only in the area with $\triangle$CFS >0.

It is thus implied that although the seismic activity in and around the volcano has basically occurred under the regional stress field accompanied by the plate subduction, some factors except for the regional stress also contribute to the occurrence of the seismic activity in and around the volcano. In addition, it is thought that there is little influence in the volcanic activity in Tarumae volcano due to the 2014 mainshock since the remarkable change in seismic activity is not seen beneath the volcano.

Keywords: volcanic activity, hypocenter distribution, stress field, static stress change

Japan Geoscience Union Meeting 2015
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SSS32-05 Room:A04 Time:May 26 15:15-15:30

An improvement of JMA's earthquake catalogs

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Based on measures of The Headquarters for Earthquake Research Promotion, Japan Meteorological Agency(JMA) is collecting the data of the high-sensitivity seismographs nationwide, performs the processing of hypocenter determination centrally, etc, and publishes the result as the earthquake catalogs.

In current earthquake catalogs, we post things that meet certain criteria as a result of scrutiny. However, after The 2011 off the Pacific coast of Tohoku Earthquake, in the aftershock area, although aftershock activity has been reduced, seismic activity is located in the lively situation in comparison with the previous, so we are processing by raising the lower limit of the magnitude of the earthquake to be processed. Therefore, some earthquake, like an earthquake that has not enough accuracy or smaller than processing limit, are not listed in the earthquake catalog. In addition, by the deployment of seismic network of sea waters that are planning in future, improvement of earthquake detection level is expected to in the waters, and number of earthquakes to be processed is expected to increase than ever. So it is necessary to conduct more effective and more efficient treatment than ever from now on.

Against the backdrop of these things, under the Earthquake Research Committee, an examine for improvement for the way of earthquake catalogs was performed in 2013 fiscal year, and summarized reports that shows three directions, 1) to maintain the earthquake detection capability, 2) to post all of the earthquakes detected to the earthquake catalogs, 3) to perform the quality management with a stage to accuracy.

Based on this report, Japan Meteorological Agency is planning to improve and change the hypocenter determination process, taking advantage of automatic picking processing, for example.

Here, I will introduce the changes of the earthquake catalogs from present to next.

Keywords: Earthquake Catalog

Japan Geoscience Union Meeting 2015
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SSS32-06 Room:A04 Time:May 26 15:30-15:45

Relationship between half-graben and high-velocities area at depths of 10km 8

OISHI, Yukio[1]*

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Figure indicates four special geological areas at the depths of 10km in Japan after tomography of Nakamura 2008.
1 high velocities and high Poisson's ratio area (HVHP area) indicated in purple or red

Purple indicates HVHP areas. Red also indicates HVHP areas, but where major destructive earthquake occurred since around 1800.It is a noteworthy fact that five of the eight major destructive earthquakes since 1995(Han-Shin Awaji 1995, Western Tottori 2000, Northern Miyagi 2003, Chuetsu 2004, West Off Hukuoka2005) occurred in these areas.

MORB(Mid Ocean Ridge Basalt) in Muroto and Kii peninsula,mantle peridotite in The Central Hokkaido, and Izu Peninsula are in HVHP area. We might say that HVHP area is alike MORB, mantle peridotite, oceanic island. By the way breaking start point of March 11, 2011 Disaster exists on the plate boundary of the surface of subducting Pacific plate that is HVHP area.

2 high velocities and low Poisson's ratio area (VHLP area) indicated in blue

Many of normal fault earthquakes around Idosawa Fault occurred in one of these areas after Mach 11 Disaster.

3 low velocities and high Poisson's ratio area (LVHP areas) indicated in brown

For example oil fields in Niigata and Shizuoka prefecture.

4 low velocities and low Poisson's ratio area (LVLP areas) indicated in yellow

These areas have Unzen, Beppu, (Japanese famous hot spring) Kakutou caldera, Aira caldera and so on.

Given the situation, we can say that these areas may concern with felsic caldera and smectite, volcanic activity, volcanic ash, volcanic gas and so on.

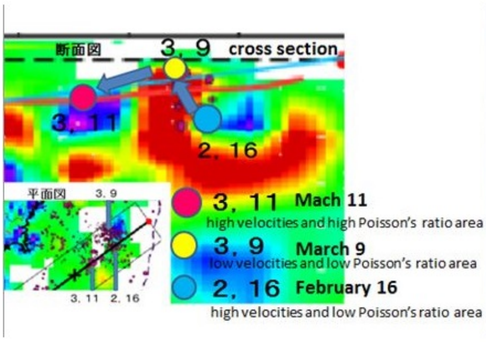
Northern Nagano earthquake 2014 (Hakuba, northern part of Itoigawa-Shizuoka Tectonic Line) also occurred in LVLP area. By the way Azumino and Matsukawa are LVLP areas on the same Tectonic Line. I want to watch this area closely.

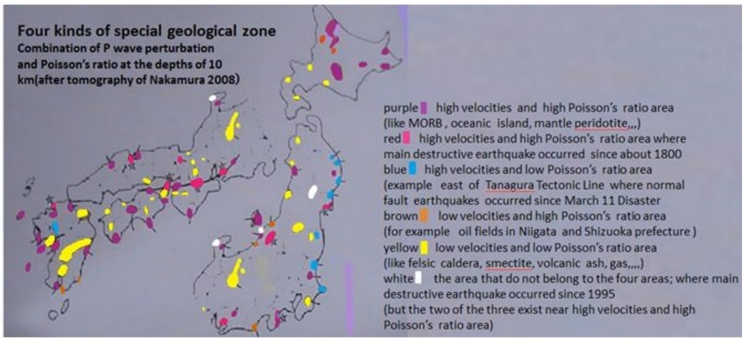
M7 class earthquake on March 9 and Slow quakes since January 27 in 2011 around on the plate boundary of subducting Pacific plate that is LVLP area lying east from the epicenter of March 11 Disaster. The existence of smectite on the plate boundary of the shallow part of the fault on March 11 Disaster, C0019 (Ujiie 2014) is congruent with this finding.

It may be a clue to the mystery of interlocking movement of Mach 11, 2011 Disaster to study smectite (especially whose fluidity and conduction property) and to study electric outbreak by particle of smectite bombardment and electrolysis of the water by the electrogeness. And more, casifications such as oxygen and hydrogen gas by the electrolysis of the water, outbreak of the water by the explosion of the gas, and movement of the smectite between the plates. It is thought that a complex study is necessary.

Keywords: high velocities and high Poisson's area(HVHParea), MORB, low velocities and low Poisson's ratio area (LVLP area), smectite, caldera

SSS32-06 Room:A04 Time:May 26 15:30-15:45





Japan Geoscience Union Meeting 2015
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SSS32-07 Room:A04 Time:May 26 16:15-16:30

Focal mechanism determinations along the North Anatolian fault, below the Sea of Marmara and the Aegean Sea

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Rapid determinations of centroid moment tensor (CMT) of earthquakes, namely the source centroid location, focal mechanism, and magnitude is important for early disaster responses and issuing Tsunami warnings. Using the SWIFT system (Source parameter determinations based on Waveform Inversion of Fourier Transformed seismograms) developed by Nakano et al. (2008), we are developing earthquake monitoring system in Turkey. Also determinations of CMT solutions for background seismicity would reveal the tectonics in the target region, which contribute to develop scenarios for future disastrous earthquakes.

The North Anatolian fault (NAF) is one of most active fault in Turkey, which is a right-lateral fault system running in the East-West direction. NAF can be separated into a number of segments of which ruptures have propagated from east to west in the 20th century. The 1999 Izmit (Kocaeli) earthquake (Mw 7.4) is the westernmost activity along NAF in recent years, and next activity below the Sea of Marmara is anticipated. On 24 May 2014, an Mw 6.9 (USGS) earthquake occurred beneath the northern Aegean Sea, western extension of NAF. A seismic gap between these events still exists beneath the Sea of Marmara.

Using data from broad-band seismometers (Guralp CMG-3T, CMG-3ESP, or CMG-3ESPC) of the regional network in Turkey, we determined CMT solutions of earthquakes along the NAF beneath the Sea of Marmara and Aegean Sea. Seismic events are selected from the USGS ANSS Comprehensive Catalog (ComCat) with magnitude larger than 4 in the target area. We analyzed earthquakes that occurred between 2008 and 2014. We selected seismograms with good data quality. The seismograms are corrected for the seismometer response, band-pass filtered between 20-50 s, and integrated in time to obtain displacement seismograms. The Green functions are synthesized assuming the standard Earth model ak135. Assuming a double-couple source, waveforms are inverted in the frequency domain to obtain best-fit source location and mechanism.

Most events are outside the observation network and the azimuthal gap is larger than 180 and 270 degree for events beneath the Sea of Marmara and the Aegean Sea, respectively. However, for most events the obtained source location in our analysis were almost identical to, or different at most 0.1 degree from, the initial source location from the ANSS catalogue. Because of the large azimuthal gap, we also carefully checked the stability of the obtained focal mechanism.

For the 2014 event beneath the northern Aegean Sea, we obtained a right-lateral strike-slip focal mechanism (Mw=7.2), of which one of nodal planes was directing in ENE-WSW consistent with the slip on NAF. Most of other events represented similar focal mechanisms. Some normal faulting events were also observed several tens of kilometers east of the 2014 earthquake and beneath of the Sea of Marmara.

The Sea of Marmara is a pull-apart basin developed at a segment boundary of NAF, where the crust opens and extensional stress develops. The normal-fault earthquakes may represent such tectonic settings. Detailed descriptions of fault segments would help to estimate future earthquake magnitudes. Normal faulting earthquakes beneath the sea would cause tsunamis if large enough. Historical studies of earthquakes beneath the Sea of Marmara revealed that damaging tsunamis had been triggered due to large earthquakes. Therefore, mapping normal faults and evaluation of their seismic potential are important for disaster mitigation from tsunami in this region.

In the research project of SATREPS-Earthquake and tsunami disaster mitigation in the Marmara region and disaster education in Turkey, we will develop a CMT determination system and a CMT catalogue in Turkey.

Keywords: North Anatolian fault, pull-apart basin, centroid moment tensor

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SSS32-08 Room:A04 Time:May 26 16:30-16:45

Offshore seismicity in the western Marmara Sea, Turkey, revealed by ocean bottom observation

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The North Anatolian Fault (NAF) extends 1600 km westward from a junction with the East Anatolian Fault at the Karliova Triple Junction in eastern Turkey, across northern Turkey and into the Aegean Sea, accommodating about 25 mm/yr of right-lateral motion between Anatolia and the Eurasian plate. Since 1939, devastating earthquakes with magnitude greater than seven ruptured NAF westward, starting from 1939 Erzincan (Ms=7.9) at the eastern Turkey and including the latest 1999 Izmit-Golcuk (Ms=7.7) and the Duzce (Ms=7.4) earthquakes in the Marmara region. Considering the fault segments ruptured by the May 24th, 2014 Northern Aegean earthquake (Mw=6.9), the only un-ruptured segments left behind the 1600 km long NAF locate beneath the Marmara Sea and those segments keep their mystery due to their underwater location.

To obtain the detailed information about fault geometry and its stick-slip behavior beneath the western Marmara Sea, we started to operate a series of ocean bottom seismographic (OBS) observations. As a first step, we deployed 3 pop-up type OBSs on 20th of Mar. 2014 as a trial observation, and recovered them on 18th of Jun. 2014. Although one of the OBSs worked only 6 days from the start of the observation, other two OBSs functioned properly during the whole 3-month observation period.

We first searched for the microearthquakes missing by the land seismic network and estimated their precious location by using the initial 6 days data, i.e., using all the temporary OBS stations. Although there are only 3 earthquakes listed on the Kandilli Observatory and Earthquake Research Institute (KOERI) catalogue, we could identify 41 earthquakes with more than 5 picking data of P and S first arrivals, and two-third of them located within the OBS network. We found the earthquake cluster (cluster-A) along the main NAF and whose depth interval is 12-20 km, and some event pair within cluster-A has similar waveform. The location of cluster-A indicates that the dip angle of the main NAF is almost vertical.

Then, we relocated the KOERI-catalogued earthquakes in 3 months periods by combining the land and OBS data. The results indicated that some earthquakes occurred 5-10 km away from the main NAF, and the upper limit of seismicity along NAF seems to dip eastward. Besides, we calculated the correlation coefficient between the waveform data of cluster-A earthquakes and continuous 3-month OBS records to estimate the temporal change of cluster-A activity. The result indicates that the cluster-A became inactive on the end of March. Since the KOERI catalogue reported the active seismicity from 13th to 18th of Mar. near the cluster-A, there is a possibility that the duration of the cluster-A activity was about 2-3 weeks.

To obtain more information of the fault geometry beneath the Marmara Sea, we started a second step observation by using 10 OBSs from Sep. 2014 to Jun. 2015. In addition, we are planning to add 5 OBSs to this observation in Mar. 2015. All OBS observations are conducted as a part of the “Earthquake and Tsunami Disaster Mitigation in the Marmara Region and Disaster Education in Turkey” project, financially supported by Japan International Cooperation Agency (JICA), Japan Science and Technology Agency (JST), and the Ministry of Development in Turkey.

Keywords: The Marmara Sea, The North Anatolian Fault, Seismicity, Ocean bottom seismograph

SSS32-09 Room:A04 Time:May 26 16:45-17:00

Relocation and fault planes of the 1945 Mikawa earthquake

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We relocated the mainshock, and its foreshocks and aftershocks of the 1945 Mikawa earthquake (M 6.8) using the modified joint hypocenter determination (MJHD) method in order to obtain their accurate hypocenters and to identify fault planes of the mainshock. We used both P- and S-wave initial arrival times at stations reported by the Japan Meteorological Agency (JMA). We confirmed by relocated hypocenters that the mainshock and aftershocks had occurred along the two fault planes proposed by Takano and Kimata (2009) based on triangulation surveys and surface trace of the earthquake faults.

SSS32-10 Room:A04 Time:May 26 17:00-17:15

Landslides triggered by the 1596 Keicho Bungo earthquake in Kitsuki, Beppu, and Yufuin, Oita Prefecture, Kyushu, Japan

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Most studies on the 1596 Keicho Bungo earthquake concern only tsunamis in surrounding coastal areas of Beppu Bay. Both data collection and calculation of tsunami height based on fault models are limited to the inside and mouth of the bay. It is well known that this earthquake generated not only tsunamis but also strong ground motion in the land areas of Bungo, old name of Oita Prefecture. Collection of historical documents on this earthquake conducted by the Earthquake Research Institute, The University of Tokyo shows landslide of slope of Mt. Takasaki and collapse of Yuzuhara-Hachiman Hai-den, which means worshipers' hall.

The aim of this study is to collect data on the earthquake in the documents of the lord family "daimyo-ke" that ruled Bungo in the period right after the occurrence of the earthquake and to estimate earthquake size and source location, and associated natural phenomena. These families are Hosokawa, Matsui, Nakagawa, Kinoshita, Saeki-Mouri, Kurushima, and Inaba. Nakagawa entered Bungo in 1594, Hosokawa, Matsui, and Inaba in 1600, Kinoshita, Saeki-Mouri, and Kurushima in 1601. Matsui was a vassal of Hosokawa and not "daimyo-ke". However, both sho-gun and Hosokawa gave Matsui "daimyo-ke" status and Matsui was the lord of the castle Yatsushiro, Kumamoto.

We have found two records in the documents of Matsui (Yatsushiro Municipal Museum). Here we report on one of the records, a letter sent from Hosokawa Tadaoki to Matsui Yasuyuki on April 22, Keicho 6 (Japanese Calendar) (1601) (Toritsu, personal communication, 2014), about five years later the earthquake. According to Tadaoki, the fief of Hayami-gun, present Kitsuki, Beppu, and Yufuin, yield 60,000 koku. He ordered Yasuyuki to consider damage of about 5,500 koku due to earthquake and reduce land tax in the fief. In the letter no mention was made about earthquake date. We assume the earthquake in the letter is the 1596 Keicho Bungo earthquake.

Using a list of annual rice production of every village in Hayami-gun including Yufuin (1601) (documents of Matsui), we have tried to identify the villages which suffered from destructive landslides. These are Takasu (Kitsuki-City Katano), Yashiro (Hiji-Town Manai Yashiro), Tsujima (Hiji-Town Toyooka), Hamawaki, Tateishi, Tsurumi, Butsusanji, Baba, Yatsukawa, Wakamiya-Hachimansha, and Kozennin, where abbreviation of "old name (present name)" is adopted. The landslides near coasts may enter Beppu Bay, and generate tsunamis.

Acknowledgements: We are supported by Kyoto University Library of Graduate School of Law, Yatsushiro Municipal Museum, Kumamoto University Library, Kumamoto Prefecture Library, Kitsuki City Library, Hiji Town Banri Library, and Oita Prefecture Library.

Keywords: 1596 Keicho-Bungo earthquake, strong ground motion, landslide, tsunami, documents of Matsui, letter written by Hosokawa Tadaoki