Strain rate dependency of b-values of oceanic intraplate earthquakes

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Oceanic intraplate earthquakes (OCEQs), which are intraplate earthquakes occurred in the oceanic lithosphere (from oceanic ridge to before outer-rise), provide information regarding stress state in the oceanic lithosphere. We modeled stress evolution in the oceanic lithosphere and revealed that observed focal mechanism of OCEQs could be basically explained by thermal stress [Sasajima and Ito, 2015, SSJ fall meeting]. Also decreasing seismic moment release by OCEQs with age of the oceanic lithosphere could be well explained by age dependent thermal stress generation rate in young age oceanic lithosphere (<30Ma) quantitatively. However, seismic moment release by OCEQs in old age oceanic lithosphere (>45Ma) was only approximately 10% of expected one from model. This gap was significant even if we consider the uncertainties due to shortage of observation period.
In this presentation, we report candidate of explanation of this gap and remarkable results. We revealed that b-values of OCEQs show clear age dependency. OCEQ b-values in young oceanic lithosphere (<15Ma) are around 1.0, those in middle age (15-30Ma) are around 1.4, and those in old age (>30Ma) are around 1.7, which is significantly higher than b-values in the world. If b-value is greater than 1.5, contribution of small earthquakes on total seismic moment release becomes significant. Thus, we suggest that missing seismic moment release in old age oceanic lithosphere is released by unobservable (Mw<5.0) small magnitude earthquakes.
We also found that b-value of intraplate earthquakes in the Ninety East-Sumatra orogen, where oceanic lithosphere has higher strain rate than it of normal oceanic lithosphere, is 0.93, which is significantly smaller than OCEQ b-value (1.7) at the same age. Thus, we conclude that OCEQ b-value age dependency relates to the age dependent slow strain rate of the oceanic lithosphere and is not caused by age dependent thermal structure.

Keywords: Oceanic intraplate earthquakes, b-value, Oceanic lithosphere

Seismic structure of northwest of the Pacific Plate by applying seismic interferometry to airgun-OBS data

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Although it is considered that the seismic structure of the oceanic crust is relatively homogeneous, several previous studies reported the presence of evident deep reflectors in the lower crust or in the uppermost mantle, which can be related to the processes of formation and growth of the oceanic plate. For an example, the reflectors identified at the uppermost mantle of the Pacific Plate off Kuril Trench were interpreted as riedel shears which are formed during the plate motion. In this study, we investigate the crustal structure in the NW Pacific east of the Japan Trench by analyzing an airgun-ocean bottom seismometer (OBS) survey to discuss the development process of the Pacific Plate in this area.Traveltime analyses are popular to obtain seismic structures from wide-angle seismic experiment using OBSs data. Recently several studies have shown that OBS data processes usually applied to reflection-survey data can provide detailed structure images of deep into the crust. Seismic Interferometry (SI) provides waveforms from a virtually arranged receivers dataset denser than the actual OBS spacing, and we expect that seismic profiles from OBS data can be improved by applying the SI to OBS data before they are processed for the reflection processing.In this study, we applied an SI technique to the OBS data collected by the seismic refraction survey made in the northwest of the Pacific Plate in 2010. 23 OBSs were deployed along survey line (239 km, in total) at 6 km spacing. Airgun was fired every 0.2 km. We expect that the SI provides virtual receiver gathers with spacing of 0.2 km, the shot interval.Here, we calculated cross-correlation functions for all the observed trace pairs to obtain seismic traces, virtually recorded at the sea surface with both the shot and receiver intervals are equivalent to the actual shot interval, 0.2 km. By using the obtained virtual traces, we prepared CMP ensembles by arranging the traces according to the order of common midpoints, and we stacked all the traces having common mid points (CMP ensembles). Stacking with using velocity of 1.5 km/sec, the water wave velocity, gave coherent signals at ~7.3 sec in two-way travel time, corresponding to the reflections of the seafloor at depth of ~5,500 m, proofing that seismic reflection image can be obtained by the present data processing scheme. We searched optimum stacking velocity for the sub-seafloor structure in the range of 1.75–3.75 km/sec. We found a continuous reflector, corresponding to the Moho of the oceanic crust, was coherently imaged on the stacked section with RMS velocity of 3.50 km/sec. The S/N ratio of the Moho reflection phase is somewhat low on the present section, and we attempt to improve the quality by applying appropriate filters such as band-pass filter or inner mute to OBS data before applying SI, so that we discuss detailed structure in the crust and uppermost mantle in the Pacific Plate off the Japan Trench.

Bending-related topographic structures of the subducting Pacific plate in the Northwestern Pacific Ocean

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Prolonged topographic structures associated with bending of the subducting Pacific plate along the trenches of the western margin were investigated using multibeam bathymetric data, accompanying reidentification of magnetic anomaly lineations on the Pacific plate to reveal controlling factors for strikes of bending-related topographic structures. The newly compiled bathymetric map demonstrates that most of bending-related topographic structures exist in the oceanward trench slopes within 100 km from trench axes. The bending-related topographic structures are developed parallel to the trench axis or inherited seafloor spreading fabric. Seafloor spreading fabric were reactivated instead of forming new trench parallel structures in the area where it strikes at an angle less than 30 to a trench axis. The topographic expression of bending-related structures is classified into two types according to whether new structures develop parallel to the trench axis or inherited seafloor spreading fabric reactivates. That of reactivated structures is characterized by half-graben or narrow ridge topography. That of newly formed structures is characterized by a horst and graben topography.

Keywords: bending-related topographic structures, seafloor spreading fabric, Pacific Plate

Marine magnetic anomaly and magnetization of the subducting Pacific Plate seaward of the Japan Trench

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We studied marine magnetic anomaly and magnetization of the subducting Pacific Plate seaward of the Japan Trench. Magnetization is one of the indicators to understand physical and chemical conditions of the oceanic plate, and also tectonic processes the plate has experienced. The Pacific Plate on the seaward slope of the Japan Trench is characterized by a series of parallel magnetic anomalies (Japanese Lineation) during M14-M7 (140-132 Ma). Half spreading rates when the plate was formed were estimated to be 4-6 cm/yr which is categorized as fast-spreading. It was considered that the plate was situated at low latitudes in the southern hemisphere, and was drifted to the present place. We made the magnetic anomaly dataset by compiling our JAMSTEC data, as well as data from Japan Oceanographic Data Center (JODC), National Geophysical Data Center (NGDC), and Geological Survey of Japan (GSJ). The magnetic anomalies are well lineated and have high-amplitudes. Meanwhile, the Pacific Plate is being subducted beneath the Tohoku Arc at the Japan Trench. The amplitudes of the anomalies gradually decrease toward the land from the trench axis. The decrease of amplitudes is mainly caused by increasing depth of the oceanic plate associated with subduction. In order to correct the effects caused by increasing depth of the subducting plate, we calculated magnetization from the magnetic anomaly. We used a three-dimensional inversion method for the calculation of magnetization. Upper surface of the magnetic layer was assumed to be the surface of oceanic crust. In the seaward slope, the surface was defined by subtracting 500 m as the thickness of sedimentary layer from the bathymetry. The surface of the subducting oceanic crust in the landward of the trench was determined using seismic refraction and reflection profiles. Densely distributed profiles of seismic survey in the study area enabled us to constrain the depth of the plate. The declination and inclination of magnetization were set to be several directions around -30° to +30°, -20° to +20°, respectively, in reference to ocean drilling rock magnetic measurements, skewness of the magnetic anomaly, and seamount's magnetization. On the seaward slope of the Japan Trench, fracture zones, which are originated from transform faults and are large offsets in the oceanic plate, are not identified. However, the existence of non-transform discontinuities (NTD) is probable. The NTDs are important to better understand the physical conditions of the oceanic plate, because they may act as some kind of weak zones. However, the NTDs are difficult to be identified, because sedimentary layers cover the old seafloor and conceal the abyssal hill fabrics. In this situation, the magnetization is useful for identifying the NTDs. Magnetic lineations located in 37°-39°N adjacent to the trench show highly oblique and largely discontinuous. This disorganized structure was implicated in the past ridge propagation. In other places, higher magnetization or small dislocation linearly aligned sub-perpendicular to the strike of magnetic lineations could suggest small offset NTDs. Low magnetization appears on the seaward slope near the trench, and the magnetization intensity gradually decreased as the plate subduction proceeded. On the seaward slope, horst-graben structure has been developed and large steps have grown associated with plate bending and normal faulting. Tectonic phenomena such as formation of the horst-graben structure and subsequent plate subduction would cause destruction and disorganization of the magnetic layer by faulting, which implies mechanical demagnetization. Possible cause of chemical demagnetization in the oceanic crust is low-temperature oxidation due to

hydrothermal circulation along the faults. Serpentinization of the uppermost mantle may modify the magnetization.

Keywords: Magnetic Anomaly, Magnetization, Pacific Plate, Japan Trench, Horst-Graben, Subduction

Crustal resistivity Structure of Pacific Plate just before Subduction using Marine Controlled-Source Electromagnetic Surveys

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In the Japan Trench subduction zone, an old oceanic plate with an age of over 100 m.y., the Pacific plate, is subducting beneath the northeast Japan arc. However, recent heat flow surveys have revealed that the Pacific plate just before subduction may not be uniformly cold contrary to its old age. Localized high heat flow anomalies suggest that thermal structure of the Pacific plate in this area is not a typical one for old oceanic lithosphere, at least at shallow depths. To evaluate the factors controlling the temperature structure (e.g., fractures, fluid etc., together with heat sources), we conducted dense heat flow surveys and electromagnetic soundings on the seaward slope of the Japan Trench. In this presentation, we focus on the preliminary result obtained by the electromagnetic soundings.
The offshore experiment was done on July, 2014 at the KY14-10 cruise (R/V Kaiyo, JAMSTEC). The water depth in the target area (on the Pacific plate, far off Tohoku region, Japan) is about 5300-5600 m. We used a newly-developed controlled-source electromagnetic (CSEM) survey system for this research. It can be applied to exploration of seafloor resistivity, originally designed for AUV but available with a deep-tow system (DT). The power for transmitter is supplied from the DT. Three pressure cases (transmitter, controller and power converter) are mounted on the DT frame, and a long cable with length of 350m is towed behind the DT. Two source electrodes attached at the both end of cable are used for transmitting the artificial electric current into the seawater. The pulse width for artificial current was 2 seconds, and the amplitude of current was approximately 20-30 A. Two CSEM profiles were conducted in this cruise. The altitude of DT (and the source dipole) was about 50-100m with towing speed of about 1 knot or less.
The preliminary results indicate the low resistivity of shallow layers of the oceanic crust of Pacific plate. The amplitude of received electric field recorded by an OBEM was about 0.04 nV/(Am^2) when the source-receiver separation was about 1km. The received signal can be clearly recognized within the source-receiver separations of about 4km. All of the amplitude of electric field is smaller than the predicted ones from a numerical simulation, with assuming the uniform sub-seafloor structure with 1 Ohm-m (and a sea water layer of 0.3 Ohm-m). This implies that the shallow part of oceanic crust (possibly less than 1km) have very low resistivity than 1 Ohm-m. The anomalous feature may be related to the buried fractures in the top of oceanic crust, and could be related to the fluid circulations, a candidate of factors to explain the high heat flow.

Keywords: resistivity, CSEM, Pacific Plate

Lithology and physical property of sediments covering horst-graben structures of the Japan Trench: Preliminary results of KS-15-3 sediment core analysis

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Large coseismic slip along the shallow portion of the plate boundary fault beneath the Japan Trench caused the catastrophic tsunami of the 2011 Tohoku Earthquake (e.g. Fujiwara et al., 2011; Ito et al., 2011; Kodaira et al., 2012). Researches on core samples taken by D/V Chikyu (IODP Expedition 343, JFAST) revealed that the plate boundary fault at the IODP Site C0019 of the Japan Trench is composed of pelagic clay layer which contains large fraction of smectite, and low coseismic friction of smectite would contributed to the coseismic slip propagation along the shallow portion of the plate boundary fault (Ujiie et al., 2013; Kameda et al., 2015; Moore et al., 2015). However, high-resolution seismic profiles indicate heterogeneous distribution of pelagic clay layer, and there are several portions where the thicknesses of the incoming sediments are very thin (less than 50 m). To reconcile the nature of the “thin” incoming sediments, we sampled seven piston cores from horst-graben structures of the Japan Trench during the KS-15-3 cruise (R/V Shinsei Maru, May 3-19, 2015).
Cores were taken from four different settings: PC01 from graben, PC02 and PC07 from graben edge, PC03 and PC04 from horst, PC05 and PC06 from seaward trench slope, respectively. We present preliminary results of core analysis including visual core descriptions, X-ray CT images and successive density and magnetic susceptibility values measured by multi-sensor core logger (MSCL), and discuss sedimentation process of horst-graben structures that causes the diversity of incoming sediments.

Mechanical properties of surface sediments estimated from frictional heating on east slopes in the Japan Trench

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1. Introduction
Marine heat flow measurements have been conducted on the northwest Pacific plate off the Japan Trench since the 1960s, and a large amount of data was accumulated by recent intensive surveys (Yamano et al, 2014). Generally, the heat flow is obtained in the following way. 1) a heat flow probe (hereafter probe) of several meters in length attached with several temperature sensors is penetrated into sediments in order to measure the geothermal gradient, 2) thermal conductivity of the sediments collected at or around the penetration point is measured, 3) the heat flow at the point is calculated from the geothermal gradient and the thermal conductivity. The geothermal gradient can be calculated from the temperature data obtained with the sensors attached along the probe. In general, right after the probe penetration into the seafloor, the sensor temperature increases rapidly by about 1 K due to frictional heating and then gradually approaches the sediment temperature at the sensor depth. But, in the area off the Japan Trench, we found that there are horizons with extraordinarily large frictional heating, where the temperature rise by frictional heating exceed 5 K (hereafter anomalous heating horizon). The anomalous heating horizons might correspond to some hard and/or consolidated layers. The purpose of this study is to understand the relationship between the anomalous heating horizons and the mechanical properties of sediments.
2. Survey area and the research cruises
Heat flow was measured at 69 points using a 3 m long probe during the cruises YK14-21, KS-14-17 and KS-15-16. Sediment samples were obtained at two sites in the survey area (KR09-16 HFPC01 and KR10-12 HFPC01) using a piston corer with temperature sensors attached along the core barrel.
In this study, we used four measurement devices attached to or in combination with the probe in order to obtain information on the penetration process; 1) Temperature sensors (sampling rate: 10 sec, except for eight sites with a rate of 1 sec). 2) Tiltmeter (30 sec). 3) Wire tension meter (1/10 sec). 4) Accelerometer (1/100 sec). Because we cannot directly observe the penetration process, we should indirectly understand the penetration process (e.g., penetration start time and end time) using above four data.
3. Result
The core sediments, KR09-16 HFPC01 (274.5 cm in length) and KR10-12 HFPC01 (181.0 cm in length), are mainly composed of silty clay with diatoms. Tephra layers were observed at 120 - 145 cm and 155 - 180 cm in KR09-16 HFPC01 and at 100 - 102 cm and 140 - 148 cm in KR10-12 HFPC01.
Anomalous heating horizons were detected in a depth range from 150 cm below seafloor (hereafter cm-bsf) to 300 cm-bsf. The frictional heat generated at the horizon tends to be higher at eastern and northern parts in the survey area.
The results of this study indicate that the anomalous heating horizon continuously extends sub-parallel to the seafloor, and there is a regional variation in the amount of heat generation. We suppose that the anomalous heating horizons result from a hard layer with lateral variation of the thickness, corresponding to the tephra layers observed in the core samples. However, the subbottom depths of the anomalous heating horizons, ranging from 150 to 300 cm-bsf, are several tens of centimeters deeper than those of the tephra layers in the samples. We intend to make further investigation on the problem of this depth difference.

Keywords: Pacific plate, Heat flow, Tephra layer

Modeling the observed heat flow variation along the Nankai Trough between the Muroto and Kumano transects

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Gradual decrease in heat flow with a spatial scale of several tens of kilometers is observed between the Muroto and Kumano transects of the Nankai Trough, which are located 150 km apart [Yamano et al., 2013, JpGU]. The average heat flow on the trough floor is twice as that of model predicted value around the Muroto transect, whereas that is comparable to model predicted value around the Kumano transect. In this study, we construct a series of numerical models including hydrothermal heat transport within the oceanic crust in order to explain the observed gradually decreasing heat flow.

The first model considers a three-dimensional domain using enhanced thermal conduction within the aquifer [Spinelli and Wang, 2008, Geology], which mimics hydrothermal heat transport by a simplest manner. With a gradual decrease of basal heat flow along the trench axis corresponding to the age difference between the Muroto and Kumano transects, the resulting heat flow gradually varies along the trench axis but is too gradual to account for the observation. With a sharp contrast of the aquifer permeability, i.e., high permeability at the Muroto transect and low permeability at the Kumano transect, hydrothermal heat transport at the Muroto transect does not affect the Kumano transect, and this is also inconsistent with the observation. We expect that the difference in the aquifer permeability as well as the difference in the basal heat input is required to account for the observed heat flow contrast between the Muroto and Kumano transects.

The second model considers the effect of trench-parallel heat and fluid transport, using a two-dimensional computational domain parallel to the trench axis covering the area between the trough floor of the Muroto and Kumano transects. Referring to the result of the first model, in which hydrothermal heat transport occurs along the trench axis, we include an internal heating in a half of the aquifer corresponding to the Muroto transect. In cases of no or weak hydrothermal circulation, for example the permeability is of the order of 10-12 m2, square-sized convection cells are formed within a 500 m thick aquifer, which transport heat vertically through the aquifer and result in a sinusoidal heat flow pattern. The increase in the aquifer permeability results in an elongated convection cell across the heating and non-heating areas. Heat flow above the elongated cell gradually decreases with the spatial scale of the cell. The spatial scale is several tens of kilometers using the permeability of the order of 10-10 m2. This high permeability is consistent with the condition for along-aquifer hydrothermal heat transport to occur.

We construct two end-member models that can qualitatively explain the observed heat flow: (1) three-dimensional heat upwelling involving in the Muroto and Kumano transects and (2) two-dimensional heat upwelling along the Muroto transect and along-trench heat transport of the upwelled heat below the trough floor from the Muroto to Kumano areas. The first model assumes that heat transport pervasively occurs throughout the aquifer between the two transects. The second model, in contrast, assumes that the heat is mined below the Muroto transect, and a part of which is transported along-trench direction below the trough floor. The area involved and the intensity of heat upwelling are different between these models. More heat flow observations, especially on the landward crust between the Muroto and Kumano transects, are required to distinguish these two end-member models.

Keywords: heat flow, numerical modeling, pore fluid flow, Nankai Trough, Muroto transect, Kumano transect

Structural variation of the incoming Philippine Sea plate along the Nankai Trough off Shikoku

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The next large-thrust earthquake along the Nankai Trough, southwest Japan is concerned to occur within this century. Nonvolcanic deep low-frequency tremors and very low-frequency (VLF) earthquakes considered as one of indicators of the future large-thrust earthquakes are observed around the down-dip limit of the coseismic rupture zone of the last Tonankai and Nankai earthquakes [Obara, 2002]. However the activity of the nonvolcanic deep low-frequency tremors and VLF earthquakes is not homogeneous, and the belt-like tremor zone is divided into several segments bounded by gaps [Obara, 2010]. One of the causes of these low-frequency seismic phenomena is considered to be fluid generated by dehydration processes from the subducting slab. To investigate the relation between the formation process of the Philippine Sea plate and the occurrence of the low-frequency seismic phenomena as well as large-thrust earthquakes, it is important to investigate structural variation in the incoming Philippine Sea plate, including its fluid content.
In 2014, we conducted the seismic refraction and reflection survey in the northern margin of the Shikoku Basin, where the Philippine Sea plate is subducting beneath the Eurasia plate at the Nankai Trough. We conducted a 360km long seismic profile about 50-60km seaward of the deformation front along the Nankai Trough. 35 OBSs were deployed along the profile with the interval of 10km. A tuned airgun array shot with a total volume of 7800 cu. in. every 200m. Moreover, high-resolution multichannel seismic reflection survey is conducted along the same profile by using a 192-channel, 1.2km-long hydrophone streamer and an airgun array of 380 cu. in. volume shot by every 37.5m.
In the time-migrated reflection section, variation in the configuration of the basement reflection can be recognized as the structural boundary off the cape Muroto. The result of first-arrival tomography based on the wide-angle OBS data shows dramatic change in P-wave velocity just beneath the basement corresponding with the structural boundary observed along the reflection section as mentioned above. The structural boundary may be related to the boundary of the plate age proposed by magnetic lineation [Okino, 2015]. From the northeast of the structural boundary, it seems that the undulation cycle of the basement configuration is remarkably similar to the cycle pattern of frequency distribution of tremor along the tremor belt-like zone beneath the Shikoku Island shown by Obara [2010]. Similar undulation cycle of the basement configuration is also recognized in the reflection section previously acquired along trough axis just landward of the seismic profile of this study. Such incoming Philippine Sea plate with the dramatic structural variation is subducting beneath the southwestern Japan, and may have the possibility of any effects on the occurrence of the low-frequency seismic phenomena.
We will show the structural variation in the Vp/Vs ratio that is a sensitive to the presence of fluid by using PS converted wave observed by OBSs.
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Subduction of oceanic plate irregularities in Mexico and Japan and the influence on large megathrust earthquakes

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It is known that oceanic plates morphology is not a simple one, but rather complicated by a series of irregularitiles as seamounts, fracture zones and mid-ocean ridges. These features present on the oceanic floor form part of the fabric of oceanic crust, and once formed they move together with the oceanic plates until eventually enter a subduction zone. Some improvements have been done in the last decades in understanding the influence of seamont subduction on the forearc morphology and also on occurrence of large subduction earthquakes. Although the Cocos plate offshore Mexico present a series of multiple small height seamount chains that enter into subductionas well as large fracture zones (i.e. Tehuantepec fracture zone), the undertanding of the influence of these oceanic features that might play in geohazards (i.e the generation of large earthquakes) in Mexico is not yet well studied. Previoues studies along the Mexican trench reveal that only a lillte protion of the oceanic sedimentary blanket is accreted and this margin seems to be marked by errosional processes. In the particular case of seamounts, it is not well understood for example whether the Cocos plate seamount chains are accreted to the forearc or carried down into the subduction zone, and how the forearc mophology is affected. Whereas offshore Mexico the Cocos plate seafloor is littered with small but numerous seamounts and seamount chains, the Pacific plate offshore Japan is marked by relatively few but large iregularities (i.e. seamounts). However, both subduction zones are very active and prone to produce large and devastating earthquakes.
In this study we use for the ocean bottom topography SRTM30+ datasets which provide global topography and bathymetry at 30″ per-cell resolution (~ 1 km). In order to better indetify shallow feature as seamonts, we use a median-depth grid (using a median filtering tehnique) which is applied to the original bathymetric data. Here we present some preliminary results where we investigate in a comparative manner the shape and structure of medium-size to large seamounts and fracture zones in the vicinity of the trench in Mexico and Japan, and examine the possible links that might exist between these features and the rupture history of large subduction zone earthquakes.

Keywords: seamounts, fracture zones, Japan subduction zone, Mexican subduction zone

Extension of Plate Tectonics to subducting Slab

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Understanding of process for subduction of the oceanic plate has remained in the qualitative stage as the oceanfloor spreading theory. Abandon of the central dogma of Plate Tectonics “non-deformational Plate” should be require for subduction along the ocean trench, which can not be realized without deformation.
The seismic activity along the trench should be correlated with the subduction of oceanic plate. The seismic activities represent that Pacific Plate subducts along the Japan Trench with concentric bending and then unbending to continueing with deep seismic plane of Wadati, paticulaly, since the East Japan Mega Earthquake 2011.3.11.
In this study, deformation of the plate is tolerable quantitically to extent Plate Tectonics for subducting slab continueing to oceanic Plate, in following way restrictively.
1) The outline of trench axis bends along small circles as arc. In the case of Japan Trench, the small circles are named as Erimo, Mogami and Kashima.
2) The movement of the point on oceanic plate and slab should be on the parallel of Euler latitude for the Euler rotaion.
3) The distances of the Euler movement are equal on the surface both of oceanic plate and slab. The apperent geocentric movement on slab is slower than on oceanic plate, depend on the inclination of slab.
4) The depth of slab surface is controlled with the distance from the small circle center of trench outline. The depth profile of slab is rotational symmetry alound the small circle center.
5) Oceanic plate subducts along trench with concentric bending and then unbending to continueing with deep seismic plane (Fig). The paramaters of the bending radius and unbending angle and so on is determined to fit with seismic activities for each small circle area.
Under these restrictions, the movement of Pacific slab is calculated in the intervals, ca 10km and 0.125my, and analysed with focal mechanism solusions of initial motion (IM) and centroid of moment tensor (CMT) by Japan Meteorological Agency (JMA). Because Japan Trench area locates outside of seismetric network of JMA, the hypocenters in the area were cross checked with data of ocean bottom seismometry (OBS) by Shinohara el al. (2011, 2012) and Obana et al. (2011, 2012, 2013). The distributions of epicenters are concordant with each other, but the initial motion depths of CMT solutions are larger than initial motion depth of OBS.
The distance between surface and 5km below the surface of oceanic floor is maintained with 5km, but of the slab is changed extreamly large, more than 10%, because the radius of concentric bending is slightly shorter on 5km depth than the surface. The 5% contour is correlated well with the Pacific coast of Japanese Island.
Lateral distance along the parallel of Euler longitude is maintained constant for oceanic plate, but the distance changes upto +/- 1% for slab, because of the difference in the depth. The lateral distance increases for the island arc side position of small circle center, and decreases for oceanic side position. The feature of the changes in the lateral distance is controlled with the position of small circle center and direction of plate motion, and correlated to the distributions of tentional focal mechanisms with the increase, and compressional focal mechanisms with the decrease.
Geocentric 3-dimentional least square method allows us to describe deep seismc plane numerically, and the cross line with slab surface could be calculated along Japan Trench. Compressinal focal

mechanisms distributed along the cross line and the number of foci suddenly decrease on the continental side of the cross line. Distribution of CMT on the deep seismic plane is limited in the narrow zone of the dip direction where the deep seismic plane intersects at higher position of slab surface.

Keywords: Plate Tectonics, subducting slab, Euler rotation, concentric bending, unbending, changs in 3d distance