Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

SCG063-01 Room:201B Time:May 26 14:15-14:30

Reanalysis of motion of forearc sliver along the southern Kuril arc using the F3 solution of site coordinates of GEONET

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Previously, we investigated the motion of forearc sliver along the southern Kuril trench, using the F2 solution of GPS site coordinates of GEONET in Hokkaido. Thereafter, newly determined site coordinates called F3 solution have been provided by GSI. Since the errors of F3 solution are considered to be smaller than those of F2 solution, we reanalyze the motion of forearc sliver using the F3 solution.

We employ a kinematic model which is basically similar to the previous one. It assumes that the observed site velocities in Hokkaido are affected by the motion of forearc sliver as well as by the slip deficit on the interface of the subducted Pacific plate. Thus the model parameters are the slip deficits on the megathrust plate boundary, the rate of rigid motion of the forearc sliver, and the slip deficits on the boundary of forearc sliver. The slip direction on the megathrust plate boundary at the base of forearc sliver is assumed to be different from that in the surrounding region. In contrast to the previous case in which we dealt with the site velocities relative to Sarufutsu (950101), a site located at the northern tip of Hokkaido, we deal with the velocities in the reference frame of ITRF2005. Presuming that the GPS sites are placed on an unknown microplate, perhaps Okhotsk plate, we determine the Euler vector of the microplate such that the GPS site velocities represented in the reference frame of the miroplate can best be fit by the slip deficit on the megathrust plate boundary between the microplate and Pacific plate. This is done simultaneously with the inversion for the other model parameters. Thus we can deal with the problem without assuming the plate on which the GPS sites are placed. Moreover, a correction is made for the effect of the slip deficit on the convergent plate boundary along the eastern margin of the Japan Sea before the inversion, since it became clear in the previous study that the effect is significant. As a result, the standard deviation of residuals reduced greatly in comparison with the previous case.

As in the previous study, the results show that it is difficult to determine the motion of forearc sliver and the slip direction of the subducted Pacific plate relative to the forearc sliver independently, though the standard deviation of residuals is reduced appreciably by allowing for the discrepancy between the slip direction of the subducted Pacific plate relative to the forearc sliver and slip direction on the megathrust plate boundary in the surrounding region. The model of partitioning of oblique plate convergence cannot explain the inverted correlation between the motion of forearc sliver and slip direction of the subducted Pacific plate relative to the forearc sliver. It is suggested that the slip direction on a severely deformed megathrust boundary may not simply be represented by the rigid rotation of horizontal plate convergence vector about the local strike of subducted slab.

Keywords: motion of forearc sliver along the southern Kuril arc, F3 solution of GPS site coordinates of GEONET, plate tectonics in far-east Asia region, oblique plate convergence boundary, crustal deformation in Hokkaido, slip deficit on the subducted Pacific plate

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SCG063-02 Room:201B Time:May 26 14:30-14:45

Precise seismic velocity structure beneath the Hokkaido corner: Arc-arc collision and the 1982 Urakawa-oki earthquake

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Using data both from the nationwide Kiban seismic network and from a dense temporary seismic network covering the area of the Hokkaido corner [Katsumata et al., 2002], we precisely determined three-dimensional seismic velocity structure beneath this area to understand the collision process between the Kuril and NE Japan forearcs. Tomographic inversions were performed with smaller grid spacing than our previous study [Kita et al., 2010]. Inhomogeneous seismic velocity structure was more clearly imaged in the Hokkaido corner at depths of 0-120 km than the previousresult. A northeastward-dipping high-velocity zone with a volume of 20 km x 90 km x 35km was detected at depths of 0-35 km. This high-velocity zone reaches near the surface at the Hidaka metamorphic belt. The highest velocity value in the high-V zone corresponds to those of the upper mantle material. The southern edge of the high-V zone is located just beneath the Horoman-peridotite. On the other hand, a broad low-velocity zone of P- and S- waves with a total volume of 80 km x 100 km x 50 km is distributed to the west of the Hidaka metamorphic belt at depths of 30-90km, having velocities of crust materials. This low-V zone consists of several layers of high and low velocities forming alternate layers, and is inclined toward the northeast at an angle of 40-60 degrees. One of the layer boundaries within the low-V zone corresponds to the main fault plane of the 1982 M7.1 Urakawa-oki earthquake. The hanging wall of the fault plane has anomalously high velocities, while the foot wall low velocities. A considerable number of earthquakes, including aftershocks of the 1982 Urakawa-oki earthquake, occur in theis low-V zone at depths of 0-80 km (even at depths of the mantle wedge), whereas seismicity is very low in other areas. The present observation provides important information to deepen our understanding of the ongoing arc-arc collision process and earthquake generation mechanism in the Hokkaido corner.

Keywords: Hidaka collision zone (the arc-arc type collision zone), Seismic velocity structure, Seismicity, the 1982 Mj 7.1 Urakawa-Oki earthquake, Horiman Peridotite

Japan Geoscience Union Meeting 2011
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SCG063-03 Room:201B Time:May 26 14:45-15:00

Seismic Deformation at the Northern Tip of the Subducting African Plate in SW Turkey

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We investigate the seismotectonic features resulting directly and indirectly from the interaction between the northeast moving African plate and the westward moving Anatolian block focusing mainly offshore and onshore of the region between the Fethiye Bay and the Gulf of Antalya. Our data is the broadband waveforms recorded at the seismic stations run by Kandilli Observatory and Earthquake Research Institute. In addition to these stations we deployed three broadband stations along the Mediterranean seaside to improve the network coverage so as to constrain better the source parameters of the smaller events taking place offshore. The recorded 3-componet waveforms of the small to moderate size earthquakes were analyzed to determine a seismic moment tensor for each event. The tectonic implications of the spatial distribution of the events and their focal mechanism solutions shed light onto the present geodynamic processes taking place along the Anatolia-Africa boundary zone.

These results points out three distinct patterns of deformation undergoing in the western, central and eastern part of the project region. The tectonics in the western part is mainly influenced from the interaction of the motion along the eastern flank of the Hellenic arc and the southwestward extrusion of Anatolia. The intermediate depth seismic activity along the eastern flank of the Hellenic arc where predominantly left-lateral strike-slip faulting occurs extends well below the Fethiye Bay and even further northeast. The piece of knowledge that gives sign for the propagation of the left-lateral motion further beneath the mainland is based on quite recent data acquired from the Cameli Basin which comes both from the field and seismology. The analysis of the data reveals conjugate extensional directions from NW-SE in Mio-Pliocene and NE-SW to N-S in Quaternary up to present. In the western part although the intermediate depth seismic activity exhibits strike-slip faulting the shallow seismicity shows predominantly normal faulting mechanisms. The central part of the project area undergoes different pattern of deformation where most of the seismic activity is confined within the crust and the dominant focal mechanisms are strike-slip and reverse faulting resulting from north to northeast compression and south- to southeast extension. No normal faulting mechanism events are inferred from the seismological data in the central part though the field data points out several recent normal faulting events. The tectonics of the eastern part of the project area is influenced mainly from the subduction process along the western flank of the Cyprus arc. The intermediate depth seismic activity beneath the Gulf of Antalya exhibits mostly reverse and strike slip faulting resulting from NE compression while the shallow seismic activity show predominantly normal faulting.

Considering the three pattern of deformation we suggest that the western part of the study region is influenced from the northeastward propagation of the eastern flank of the Hellenic arc. Subduction process along the western flank of the Cyprean arc is active and effective beneath the Gulf of Antalya. The central part is a transition between the two where no evidence of subduction is observed and this part is probably the most northern tip of the African plate that touch Anatolian block supporting the highly elevated mountains.

Keywords: Small earthquakes, Seismic moment tensors, Subduction, African plate, Seismic deformation, Turkey

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SCG063-04 Room:201B Time:May 26 15:00-15:15

Crustal deformation in the Andaman Islands suggested from paleoseismological data

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The Andaman Islands were located in the northern part of the rupture area of the 2004 Sumatra-Andaman earthquake, and accompanied with coseismic crustal movement which was southeastward tilting based on the height of uplifted corals and tide gauge data. After the 2004 earthquake, we carried out paleoseismological survey all through the islands.

In the Interview Island situated in the 2004 uplifted area, northwestern part of the Andaman Islands, we found older uplifted corals divided into at least four levels. Radiocarbon ages suggest that uplift events have repeatedly occurred at every 250-350 years during 6600-5700 years ago. However, their heights reached to 0.6-1.3 m above present mean sea level are unexpectedly low in spite of repeating uplift. And curiously, no visible evidence of uplift in the period until the 2004 since 5700 years ago was found. This phenomena can be explained by influence of eustatic sea level change, but also it suggests that residual uplift per event is little (0.1-0.5 m).

In the southeastern part, the 2004 subsided area, we found the evidence of past subsidence as well as the 2004 event from the stratigraphy observed by trenching and coring survey. Radiocarbon ages indicate that the timing of event is after 400 years ago which is probably correlated with the historical earthquake of the 1679 in Eastern Bengal. Although this area has repeatedly subsided, we also found in-situ fossil coral of 5000 years ago at almost present sea level, which suggests residual subsidence is very little.

In the Neil Island located at back arc side, further east of the 2004 rupture area, five steps of distinct marine terraces have been developed, though this island was coseismically stable during the 2004 earthquake. Height distributions and radiocarbon ages obtained from each step suggest that coseismic event accompanied with net uplift of 1-2 m have occurred at every 700 years during 6000-3000 years ago.

Summarizing above results, cumulative amount of coseismic crustal movement in the 2004 rupture area of the Andaman Islands is little through Holocene. Recurrence interval revealed by paleoseismology is consistent with geodetical estimations in and around the islands (230-600 years; Subarya et al., 2006, nature. ave. 400 years; Gahalaut et al., 2008, JGR.). This suggests that the most of crustal strain associated with plate subduction has been released by great earthquake such as the 2004 event. On the other hand, back arc side of the islands has been actively uplifted by another type event probably related to intra-plate fault.

Keywords: giant earthquake, crustal deformation, Holocene, uplifted coral, marine terrace, Andaman Islands

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SCG063-05 Room:201B Time:May 26 15:15-15:30

Complementary distribution of various slip events on the plate boundary around Shikoku, southwest Japan

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A wide variety of interplate faulting phenomena have been found in the western Nankai Trough subduction zone around Shikoku, southwest Japan. The Nankai megathrust earthquake occurred in 1946, followed by the significant afterslip. Long-term slow slip events repeated beneath the Bungo Channel in 1997, 2003, and 2009-2010. In addition, short-term slow slip events accompanying deep low frequency tremors occur almost every 6 months. Such a diversity of faulting phenomena may be attributed to the heterogeneous distribution of frictional properties on the plate interface. Then we infer that those different types of faulting behaviors should have complementary distribution one another. There have been several studies demonstrating complementarity of the coseismic slip and the following afterslip. On the other hand, spatial relationship between the afterslip and slow slip events has not been investigated so far. Thus we analyze leveling, tidal, and GPS records to examine complementarity of various faulting phenomena on the plate interface after the 1946 Nankai earthquake.

For this purpose, we conduct inversion analyzes of geodetic data to estimate slip distribution during the coseismic (1929-1947), the postseismic (1947-1964), and the slow-slip periods (1997, 2003, 2009-2010). We apply the same geodetic inversion code with the same three prior constraints: 1) the slip distribution is smooth, 2) the slip direction is in accordance with the plate motion, 3) the low frequency tremor distribution delineates the deeper limit of the fault slip. Relative weights of prior constraints are determined by the ABIC minimum criterion.

As a result, the coseismic slip of the 1946 Nankai earthquake occurred shallower than 20km depth. The afterslip occurred at the deeper extension, in the depth range of 20-30km, beneath the central as well as the eastern Shikoku. On the other hand, the slow slip events occur at the depth of 20-40km to the west, and the slow slip area does not overlap with the afterslip distribution. Based on this analysis, we conclude that the slow slip and the afterslip are spatially separated. Since the 1946 afterslip and the Bungo Channel slow slip events occur in the same depth range, the variability in slip behavior and thus the frictional properties may be ascribed to the dip angle or some other structural features such as the amount of oceanic sediments, rather than the temperature.

Keywords: Shikoku, Nankai Trough, Nankai earthquake, afterslip, slow slip event

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SCG063-06 Room:201B Time:May 26 15:30-15:45

Split Philippine Sea Plate beneath Western Japan

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The shape of the Philippine Sea Plate subducting beneath western Japan is a crucial factor in understanding earthquakes and volcanic activity. We propose that the subducted plate was split along an extinct ridge due to an abrupt change of subduction direction, followed by elastic deformation of the plate and an accumulation of stress near the ridge. This shape is consistent with receiver function images, the distribution of deep tremor sources, the seismicity and focal mechanisms of intraplate earthquakes, and the distribution of anomalous ratios of helium isotopes in ground water. The movement history of the plate can explain active tectonics in western Japan in the last 2?4 Ma. The location history of the volcanic front and the tear control where fluids ascend in the crust, and these fluids are responsible for the generation of large earthquakes and volcanoes.

Keywords: Philippine Sea Plate, Plate motion, Reciever function

Japan Geoscience Union Meeting 2011
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SCG063-07 Room:201B Time:May 26 15:45-16:00

Deformation of the Philippine Sea slab and its implication for tectonics of central and western Japan

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The contraction rate in central and western Japan was estimated from the deformation of the Philippine sea slab. Usually a slab subducts with little deformation as indicated by the slab contour lines which are nearly parallel to the trench. Little deformation of slabs is also reasonable from the point of view of elastic energy.

However, large deformation of the Philippine Sea slab under central Japan has been estimated from hypocenter distributions, receiver function analyses, and tomography. Such large deformation is considered to be caused by east-west contraction, which prevails in the most area of Japan.

Observed characteristics of the deformation in the Philippine Sea slab are as follows: (1) little deformation in the west of the Kii strait; in the east of the Kii strait, (2) little deformation in the region between the Nankai trough and the coast line, (3) progressively accumulated deformation to the north of the coast line. Little deformation in the west of the Kii strait is consistent with less number of active faults and their commonly slow displacement rates.

The deformation rate of the Philippine Sea slab related to the characteristic (3) was estimated to be about 5 - 10 km/Ma. This estimate would give the minimum contraction rate in the crust of the Chubu and Kinki district, Japan.

Keywords: slab, deformation, Philippine Sea Plate, Kinki triangle, central Japan

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SCG063-08 Room:201B Time:May 26 16:00-16:15

Review and new perspectives on Quaternary tectonics from Kanto to southwest Japan

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We show review and new perspectives on Quaternary Tectonics from Kanto to southwest Japan subducted by Philippine Sea and Pacific plates.

SCG063-09 Room:201B Time:May 26 16:30-16:45

Spatial distribution of random inhomogeneities and intrinsic attenuation in the crust and uppermost mantle

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High frequency seismic waves (>1Hz) that are impulsively radiated from a point source are collapsed and broadened as travel distance increases. This broadening process can be described by the multiple forward scattering due to random velocity inhomogeneities and intrinsic attenuation. Recent progresses of the theoretical studies on the wave propagation in random media clarified mutual relations between the seismic wave envelopes and statistical properties of random velocity inhomogeneities [e.g., Saito et al. 2002 JGR]. On the basis of these studies, inversion approaches have been proposed to estimate the 3D distribution of random inhomogeneities and intrinsic attenuation [Takahashi et al. 2009, GJI; Takahashi et al. 2010, JPGU SCG004-01]. For example, inversion analysis in the northeastern Japan imaged the strongly inhomogeneous regions at small spatial wavelength range (~ a few hundred meters) beneath the Quaternary volcanoes and at the high-seismicity region [Takahashi et al. 2009, GJI]. Random inhomogeneities beneath the Quaternary volcanoes are characterized by weak spectral gradient. Meanwhile, those in the high-seismicity region has steep spectral gradient. Intrinsic attenuation structure in the northeastern Japan shows strong attenuation beneath the Quaternary volcanoes (1/Q~1/300 at 4-8Hz) and high-Vp/Vs region in the fore-arc side of the volcanic front (1/Q~1/500 at 4-8Hz). Dimension reduction for random inhomogeneities, intrinsic attenuation and seismic velocity [Matsubara et al. 2008] shows components that are related to volcano distribution and seismic activity. This reduction result implies that random inhomogeneities and attenuation are important to characterize medium properties in the crust and uppermost mantle.

Keywords: random inhomogeneities, intrinsic attenuation, dimension reduction

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SCG063-10 Room:201B Time:May 26 16:45-17:00

Characteristics of crustal deformation style of inland Japan deduced from dense GPS observation

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We have been investigating detailed crustal deformation around active fault zones in central Japan to understand the tectonic loading and inland deformation processes. Based on these GPS observation data, the short-term geodetic deformation rate is equal to the long-term geologic deformation rate in some cases, but in most cases, a few times as large as the long-term rate. The difference in deformation rates depends on how we obtain those estimates. Geodetic estimates are based on the measurement of crustal movement over a wide area. On the other hand, geologic estimate is usually based on on-site measurement at the fault trace. So we also have to take the earthquake cycle deformation of the surrounding crustal blocks into account. That is, if all the distributed interseismic strain concentrates on the fault at the time of an earthquake, both data should be consistent each other. Contribution of inelastic deformation becomes negligible in this case. The situation around the Gofukuji Fault and plate boundaries where there is distinct strength difference between the fault plane and the surrounding media. On the other hand, it is highly possible that a significant portion of inland deformation is inelastic and earthquakes at active faults release only a part of accumulated strain. It is suggested based on such discussion that contribution of off-fault inelastic deformation to the inland earthquake cycle needs to be quantitatively discussed for evaluating long-term seismic activity in the inland area. Inconsistency between geodetic and geologic deformation rate provides a clue to quantitative estimate for that.

Keywords: crustal deformation, GPS, slip rate, active faults, stress accumulation, inelastic deformation

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SCG063-11 Room:201B Time:May 26 17:00-17:15

Stress fields in inland areas of the Japanese Islands reproduced by plate subduction and compression

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We calculated theoretically the stress accumulation rates generated by the subduction of plates surrounding Japan and by crustal compression, with a view to elucidating the origins of the overall stress distribution patterns in the Japanese Islands.

As in Hashimoto and Matsu'ura (2006), the stress accumulation rates were calculated by superposing analytic solutions for viscoelastic responses to dislocations along plate boundaries (Sato and Matsu'ura, 1991). Rates of relative motion between the Eurasian, North American, Pacific and Philippine Sea plates were derived from the NUVEL-1A model (DeMets et al., 1994). No relative motion was assigned to the Izu collision zone. We adopted the NIED's J-SHIS model for the geometry of the subducting Pacific plate and Nakajima et al.'s (2009) model for the geometry of the subducting Philippine Sea plate. Viscoelastic responses were calculated by using the analytic solution of Fukahata and Matsu'ura (2006) for an assumed elastic/viscoelastic two-layered structure (elastic layer thickness 40 km).

Calculations for individual plate subduction-zone segments produced stresses that tended to be of the normal-fault type inland in front of a subduction zone, of the reverse-fault type on both its sides, and of the strike-slip type diagonally to its front. The normal-fault type stresses in front of a subduction zone were also present in the results of Sato and Matsu'ura (1991), who pointed out the effects of plate bending.

Summing up the effects of all subduction zones resulted in the accumulation of strike-slip type stresses in the Izu area and to its front, whereas accumulation of normal-fault type stresses was seen nearly everywhere else in the Japanese Islands. In reality, by contrast, active fault surveys and seismic source mechanism analyses have revealed the following characteristics in the Japan area:
(i) Compressional stresses, tending roughly E-W, from eastern Hokkaido to northern Kyushu
(ii) Reverse-fault type stresses over broad areas in NE Japan, and strike-slip type stresses over broad areas in SW Japan
(iii) An island of reverse-fault type stresses in the Kinki triangular zone in SW Japan.
The above calculations have therefore not been able to reproduce the real stress fields.

On top of the calculation results described above, we added a homogeneous compressional stress rate of 3 kPa/y oriented N110E, which is the direction of motion of the Pacific plate. This changed the normal-fault type stresses into the strike-slip type. However, the reverse-fault type stresses in the Tohoku district could still not be reproduced.

Finally, we assumed crustal shortening localized in the Tohoku district and, instead of adding homogeneous E-W compression, we imposed normal, compressional stresses along the plate boundary off Tohoku.We then redid the calculations by slicing 25% off the plate subduction rates off Tohoku. This relies on the hypothesis of Takahashi (2006), who argued that the westward motion of the Philippine Sea plate necessitates westward motion of the Izu-Bonin trench, whereby the Japan trench also travels westward at a speed of 2-3 cm/y. The Tohoku district is thereby subject to horizontal compression from the east and, out of the approximately 10 cm/y in the relative plate motion rate, net subduction accounts for only 7-8 cm/y. These recalculations changed the stresses in Tohoku into the reverse-fault type, overall satisfying the characteristics (i)-(iii) . It thus became evident that the overall patterns of the stress fields in Japan can be explained by considering the combination of two factors, namely (1) subduction of the neighboring plates and (2) compression/shortening in the Tohoku district.

Acknowledgment: Viscoelastic responses were calculated using a modification of codes provided by Dr. Yukitoshi Fukahata.

Keywords: Stress field, Stress accumulation, Plate tectonics, Viscosity, Collision, Subduction

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SCG063-12 Room:201B Time:May 26 17:15-17:30

Back-arc rifting favoured by a hot and wet continental lithosphere

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Understand how rifting is initiated promotes a better understanding of the subsequent rifting process. Many quantitative modelling studies have shown how rifting evolves with time for given boundary and other conditions (e.g., Braun & Beaumont, Can. Soc. Petr. Geol., Mem., 12, 241, 1987; Takeshita & Yamaji, Tectonophysics 181, 307, 1990; Buck, JGR, 96, 20,161 1991; Huismans & Beaumont, Geology, 30, 211, 2002; Yamasaki & Stephenson, J.Geod., 47, 47, 2009), but how rifting was initiated has usually been ignored. This is mainly because of poor constraints on the pre-rift structure of the lithosphere and the origin and magnitude of the responsible driving forces.

In this study, using a simple one-dimensional pure shear stretching model, tectonic subsidence data observed in several back-arc basins in the Tethyan belt of Europe and in the western Pacific are examined to infer something about the initiation of rifting and its subsequent evolution in back-arc settings. The origin of the force driving back-arc rifting is relatively better known than for rifting in other tectonic settings: the negative buoyancy force of subducted oceanic lithosphere (e.g., Uyeda & Kanamori, JGR, 84, 1049, 1979; Uyeda, Tectonophysics, 81, 133, 1982), which allows an examination of rifting initiation in relation to the behaviour of the subducting oceanic lithosphere.

The results show that back-arc rifting is initiated only after a certain magnitude of tensional force has been reached. Thus, the timing of back-arc rifting initiation can be explained in terms of the behaviour of the subducting oceanic lithosphere, assuming a balance between continental and oceanic lithospheric deformation. Back-arc rifting is initiated after subduction has already progressed to a point such that the negative buoyancy force of the oceanic lithosphere becomes large enough to deform oceanic lithosphere that has more strength than the overriding continental lithosphere.

The tectonic subsidence data require the magnitude of the tensional tectonic force to abate with time once rifting has started. This indicates that the rifting process is rapid enough that weakening due to an increasing geothermal gradient exceeds strengthening due to crustal thinning and thermal diffusion. This is achieved, given the currently accepted magnitude of slab subduction force, only if the thickness of the thermal lithosphere of the overriding continent is significantly less than 125 km and it has a wet rheology.

Sedimentary basin formation has often been discussed according to tectonic setting, but any aspect of rifting dynamics, such as the magnitude of driving force and the rheology of the lithosphere, has been poorly examined in such discussions. This study describes how the dynamics of back-arc rifting can be characterised in a general way as a first-order approximation. Although the focus was only on back-arc rifting, the results provide a reference for further discussion about the processes controlling rifting in other tectonic settings.

SCG063-13 Room:201B Time:May 26 17:30-17:45

Inelastic Deformation of Island-Arc Crust and Generation of Intraplate Earthquakes: Basic Ideas

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The occurrence of earthquakes is the sudden release of tectonically accumulated stress by faulting. On this point, there is no difference between interplate earthquakes and intraplate earthquakes. However, on the mechanism of stress accumulation in source regions, there is an essential difference between them. In the case of interplate earthquakes, the stress accumulation results from slip deficit at a stronger portion (asperity) of plate interface (Hashimoto & Matsu'ura, PAGEOPH, 2002; Hashimoto, Fukuyama & Matsu'ura, GJI, 2011). The accumulated stress is almost completely released by sudden fault slip that cancels the slip deficit. On the other hand, in the case of intraplate earthquakes, aseismic pre-slip in a weak portion (nucleation zone) of fault causes stress concentration at its margins, and dynamic rupture starts if the stress concentration goes critical (Matsu'ura, Kataoka & Shibazaki, Tectonophysics, 1992). Tectonic stress field in the source region governs the development of dynamic rupture, and so the problem to be solved is how the local tectonic stress field is formed. The essence of this problem is in the inelastic deformation of island-arc crust and the associated stress redistribution process. From the inversion analysis of CMT data of seismic events in and around Japan (Terakawa & Matsu'ura, Tectonics, 2010), we can understand that the regional tectonic stress field of the island-arc crust has been formed as a result of long-term mechanical interaction at plate boundaries and intraplate tectonic boundaries. On the other hand, from the physics-based strain analysis of GPS data, we can estimate continuous inelastic deformation in the crust (Noda & Matsu'ura, GJI, 2010). If the stress change produced by the inelastic deformation is the same as the regional stress field in sense, seismic activity will increase there. If the sense of stress change is opposite to the regional stress field, seismic activity will decrease there. The validity of earthquake generation models based on such ideas can be tested through the statistical analysis of seismic events with a space-time point process model (Ogata, JGR, 2004).

Keywords: island-arc crust, inelastic deformation, stress redistribution, intraplate earthquake, seismicity

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Deformation in Niigataken-Chuestu region by using an InSAR time-series analysis

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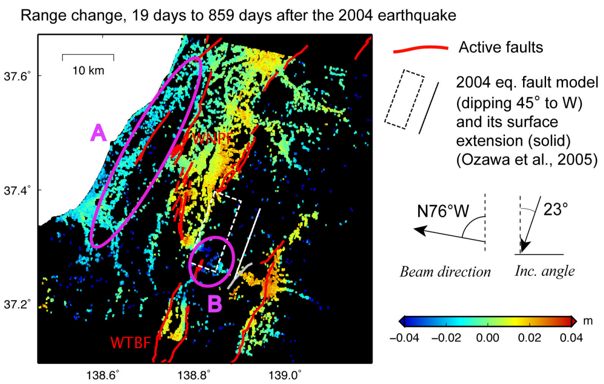
Plate convergence zones exhibit deformation of various scales in both time and space. It is fundamentally important to know the spatio-temporal pattern of such deformation in detail to understand the physics of plate interactions. InSAR time-series analyses, which can track the temporal evolution of detailed deformation patterns, are suitable for such a purpose. In this presentation, we report the result of an InSAR time-series analysis applied on data acquired over Niigataken Chuetsu area, central Japan.

We used 13 ENVISAT SAR images acquired between the occurrences of 2004 Niigataken-Chuestu and 2007 Niigataken-Chuetsuoki earthquakes. We first performed a persistent scatterer SAR interferometry analysis using the StaMPS algorithm (Hooper et al., 2007, JGR). We then corrected for artifacts due to orbit inaccuracies and atmospheric phase delay using GPS displacements. This post-processing revealed that the dominant component of the displacements is a seasonal pattern caused by water extraction during winter. Precise estimation of the tectonic component of the displacements was further obtained by separating out the seasonal component using a principal component analysis.

We identified quasi-steady signals in two different locations. An area close to the coast (A in the figure) moved in the direction toward the satellite (upward and eastward) with an approximate rate of 1 cm/yr. This signal is consistent with the motion of the Amurian plate with respect to the North American plate, supporting the idea that the NKTZ can be considered as the plate boundary. The signal around the southern end of the source fault of the 2004 earthquake (B; west of Suwa-toge flexure (gray curve)) exhibits a higher rate of 2 cm/yr. This signal is consistent with leveling surveys conducted by the Geospatial Authority of Japan, and is best interpreted by an afterslip of the 2004 earthquake.

Acknowledgements: ENVISAT data were provided by the European Space Agency under the research contract CAT-1 #4263. We used the daily solution of GEONET provided by the Geospatial Authority of Japan.



Keywords: InSAR time-series analysis, Niigataken Chuetsu region, Niigata-Kobe Tectonic Zone, Crustal Deformation

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

SCG063-15 Room:201B Time:May 26 18:00-18:15

Crustal structure and active tectonics in the southestern border of Chubu, Central Japan

Tanio Ito[1*], Ken-ichi Kano[2], Satoru Kojima[3], Satoshi Yamakita[13], Takaya Iwasaki[4], Yasutaka Ikeda[4], Hiroshi Sato[4], Yannis Panayotopoulos[4], Tetsuya Takeda[8], Yukitoshi Fukahata[5], Shigeharu Mizohata[10], Susumu Abe[10], Shinsuke Kikuchi[10], Akira Fujiwara[11], Takeshi Muramatsu[6], Nobuyuki Matsushima[6], Kazurou Kawamoto[7], Kazunori Murata[12], Noriko Tsumura[1], Makoto Hayakawa[1], Hiroshi Furuya[1], Toshinori Sato[1], Heitaro Kaneda[1], Yasuharu Shuri[1], Taku Kawanaka[10], Akinori Hashima[1], Takahiro Miyauchi[1], Akihisa Takahashi[10]

[1]chiba University, [2]Shizuoka University, [3]Gifu University, [4]University of Tokyo, [5]Kyoto University, [6]Iida City Museum, [7]Oshika Median Tectonic Line Museum, [8]NIED, [9]ADEP, [10]JGI, [11]GEOSYS, [12]Suncoh Consultants, [13]Miyazaki University

New powerful technique, MDRS (Multi-Dip Reflection Surface) Method (Aoki et al., 2010), has improved successfully seismic imaging of SCAT (2008 Southern and Central Alps Transect). This makes it possible to reveal the crustal framework in the southeastern border of structurally active Chubu region adjoining the Izu collision zone, as follows.

1.The frontal active fault group of the Itoigawa-Shizuoka Tectonic Line and its deeper extension (Active ISTL) is traceable down to 20 km deep at about 20 degrees. It cuts the deeper parts of both the Itoigawa-Shizuoka Tectonic Line (ISTL) and the Outer zone. Beneath it, the subducting Izu arc materials extends in 40 km thick. A-ISTL has been keeping its original form at the beginning of the subduction of the Philippine Sea plate, and still active associated with the present subduction at depth.

2.The present Median Tectonic Line (MTL) running along the western margin of the Southern Alps is not the original one, but corresponds to the northern extension of the vertical Akaishi Tectonic Line (ATL)(Kano,1990). The ATL played the important role on the Middle Miocene bending of the Japanese Island Arc as a huge left-lateral fault, together with the ISTL. Although both the ATL and the MTL do not show superficially the manner of an active fault, their deeper parts are surely active at depth with left-lateral-type-dominant microseismicities.

Keywords: Itoigawa-Shizuoka Tectonic Line, seismic reflection survey, Izu collision zone, bending of the Japanese island arc, Median Tectonic Line, Akaishi Tectonic Line

Japan Geoscience Union Meeting 2011
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SCG063-16 Room:201B Time:May 26 18:15-18:30

Significance of the Tanna Fault in the convergence tectonics around the northeastern Izu Peninsula

Akio Yoshida[1*], Masatake Harada[1], Kei Odawara[1]

[1]Hot Springs Research Institute

The Tanna fault is one of the most active faults in Japan with a left-lateral slip of 2m/1000 year over 500 hundred thousand years (Kuno, 1936). On the other side of the Ashigara plain, parallel to the Tanna fault, there exists the Kozu-Matsuda fault whose vertical slip rate is 2-3m/1000 year. In this report, we present new evidence that shows the Tanna fault has a dip slip component where the eastern side subsides against the western side, and propose an idea that the area enclosed by the Tanna and Kozu-Matsuda faults has been undergoing buoyant subduction.

Having shown that the inclination angle of the eastern flank of Hakone Volcano is steeper than the western flank, Suzuki (1971) suggested it indicates an inclining of the edifice of Hakone Volcano to the east. Using 50m-mesh digital altitude data around Hakone volcano, we calculated average inclination angle at each of the mesh and found that the difference in the inclination angle between the eastern and western parts is seen not only in Hakone volcano, but in the regions to the north and south of the volcano, and the boundary in the difference corresponds to the Tanna fault.

It was already pointed out by Kuno (1936) that motions of the Tanna fault had dip slip components besides left lateral components, but no one has ever noted significance of the fact. We suggest that the vertical slip on the Tanna fault as well as the thrust movement of the Kozu-Matsuda fault can be understood by supposing that the area between the two faults has been subsiding (we call the area the Manaduru block here), and consider that the subsidence manifests buoyant subduction of the Manaduru block associated with the motion of the Philippine Sea plate. Tsuboi (1932), who analyzed crustal deformation caused by the 1930 Northern Izu Earthquake, estimated that the land on the western side of the Tanna Fault displaced at the earthquake. This estimate is concordant with the idea that the Manaduru block constituting the eastern side of the fault has been moving stationary towards north and the western block that has been usually dragged by the motion rebounds at the occurrence of the earthquake. However, since the slip rates on the Tanna and Kozu-Matsuda faults are about one tenth of the relative plate velocity of the Philippine Sea plate, it cannot be considered that the Manduru block moves with the Philippine Sea plate riding on the plate. We speculate that the difference in the motions may provide a clue to elucidate fault model of the so-alled Odawara earthquake.

Keywords: Izu Peninsula, Tanna fault, Kozu-Matsuda fault, Hakone volcano, Inclination, Buoyant subduction

Japan Geoscience Union Meeting 2011
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SCG063-P01 Room:Convention Hall Time:May 26 10:30-13:00

Mechanical buckling of oceanic lithosphere and subduction zone morphology

Takao Eguchi[1*]

[1]NDA, Japan

We present a new concept of the physical background of the global-scale distribution of plate subduction zones, especially around the Pacific ocean, using structural mechanics theory such as those presented by Huang (1964) etc.

According to the compilation by Watts (2001), the elastic layer thickness of oceanic lithosphere is approximately 25km for the 30Ma lithosphere, and is approximately 60km for the 130 - 140Ma.

Assuming the earth' s radius of 6.371 x 10^3 km, and the Poisson ratio of 1/3, etc., in the case of great-circle shape of the global subduction zones with the uniform slab age of 130-140Ma, the result of Huang (1964) suggests that the preferable wave number, parallel to the circumferential direction, of global spherical buckling becomes approximately 12. In other words, the classical result of Huang (1964) suggests the preferable spherical buckling wavelength of the great-circle subduction zone with the 130-140Ma slab is approximately 3.3×10^3km. For the spherical buckling of younger slab than 130-140Ma for the great-circle subduction zone, the preferable spherical buckling wavelength is smaller than approximately 3.3×10^3km.

Whereas, referring to a recent numerical simulation study on the spherical buckling by Mahadevan et al. (2010), we can suggest that the preferable spherical buckling wavelength of the great-circle subduction zone for the 130-140Ma and 30Ma slab are approximately 1.7×10^3km and 9×10^2km, respectively.

However, the above estimation might not be conclusive, because these models don't incorporate dynamic influence originated from the vertical slab extent (especially, whether stagnated at 660km depth, or not), and the ambient mantle flow regime, etc.

In addition, if a certain local portion along the subduction zone segment, during the bucking mode change of subducting lithosphere, has been mechanically fixed to the mantle frame, the forthcoming morphological transforming process of the trench - arc - back-arc system will be constrained by the non-moving site.

In general, the geometrical change of subduction zone due to the spherical shell deformation would provide the instantaneous and long-term responses on various fields of geodesy, geophysics, geology and mineral physics, etc.

We also suggest that the above dynamics is applicable on the other terrestrial planets with plate tectonics.

Keywords: subduction zone, oceanic lithosphere, buckling, spherical shell

Japan Geoscience Union Meeting 2011
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SCG063-P02 Room:Convention Hall Time:May 26 10:30-13:00

Numerical simulation of incipient plate subduction on intra-oceanic plate boundaries with Distinct Element Method

Kazuya Naito[1*], Yasuhiro Yamada[2], Yasuyuki Nakamura[3], Hidekazu Tokuyama[1]

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Plate convergent margins bring the main driving forces to activate the plate tectonics on the earth. However, the initial formation process of new plate convergent margins has not yet to be adequately described. We constructed numerical models imitating intra-oceanic plate convergent margin, and examined numerical experiments. These convergent margins were constructed by the Distinct Element Method (DEM) that was extended to incorporate ductile deformation by a newly developed 'balloon method'. One plate convergent margin was constructed as one pair of adjacent two plates, and four different pairs of plate thicknesses were set as initial conditions. The two of four experiments showed initial plate subduction, and the results shows that plate subduction starts with a well grown slab head and the flow of asthenospheric mantle beneath lithospheric plate strongly affects to formation of plate convergent margins.

Keywords: plate tectonics, convergent margin, plate subduction, numerical computing

Japan Geoscience Union Meeting 2011
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SCG063-P03 Room:Convention Hall Time:May 26 10:30-13:00

Afterslip and viscoelastic relaxation due to the 2004 Sumatra earthquake seen from GRACE gravity field

Yoshiyuki Tanaka[1*], Takashi Hasegawa[2]

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Geodetic observations have revealed that a large earthquake can cause post-seismic crustal deformation that continues for more than a decade. Investigating mechanisms of post-seismic deformation gives a clue to infer the stress change in space and time on a plate boundary. To elucidate the stress history is important to identify if we are already in the preparation stage for the next event or still in the post-seismic stage of the previous event in the context of earthquake cycle. The diagnosis becomes complicated because various mechanisms displaying different stress behaviors have been proposed, such as afterslip, poroelastic rebound, and viscoelastic relaxation. Surface crustal deformation data have frequently indicated that contributions from different mechanisms are superimposed. The combination of short-term afterslip and long-term viscoelastic relaxation is considered as a representative mechanism for a thrust-type large earthquake in a plate subduction zone. However, when the epicenter is surrounded by the ocean, as often seen in island arc, a clear separation is prevented because a sufficient spatial coverage cannot be obtained by terrestrial observation to distinguish surface deformations expected from those mechanisms. Recently, GRACE satellites have detected post-seismic gravity variations due to the 2004 Sumatra-Andaman earthquake. Satellite gravity data can be obtained over the ocean. In addition, measuring the density redistribution which reflects deformation in a deeper portion of the earth emphasizes the difference between afterslip and viscoelastic relaxation. In the presentation, we use GRACE data for 2003-2010 and show that afterslip and viscoelastic relaxation by the 2004 event can be effectively separated. To accurately model a long-wavelength gravity variation caused by those mechanisms, we develop a spectral finite-element method based on FEM and analytic expression by spherical harmonic tensors. This allows us to consider effects of compressibility of crust and mantle, a strong lateral heterogeneity in the viscosity due to the presence of a slab, and self gravitation in a spherical earth that have not been simultaneously considered in most previous models. GRACE data are corrected for using ECCO Ocean model and GLDAS hydrological models. Most of the remaining signal can be explained by viscoelastic relaxation for a mantle viscosity of 3 x 10ˆ18 Pas. The spatial pattern in the observed gravity field obtained by subtracting the estimated viscoelastic relaxation agrees with that predicted by afterslip. In particular, the trend expected from afterslip and that expected from viscoelastic relaxation is reverse in a region over the ocean. This indicates that the both mechanisms are needed to explain the observed data. The superposition of short-term afterslip and viscoelastic relaxation is consistent also with a result by GPS observation. Our result indicates a validity of satellite gravity observation data for studying mechanisms of post-seismic deformation.

Keywords: crustal deformation, gravity, postseismic deformation, viscoelasticity, satellite gravity mission, geodesy

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SCG063-P04 Room:Convention Hall Time:May 26 10:30-13:00

Structure and evolution of active faults with strike-slip in a forearc basin: An example of Enshu fault system in the ea

Takanori Ojima[1*], Juichiro Ashi[1], Yasuyuki Nakamura[2]

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1. Introduction

Accretionary prisms and forearc basins are developed in the Nankai Trough, SW Japan. Many active faults are recognized and classified into five fault systems in the eastern Nankai Trough. The most landward Enshu Faults System runs over 200 km along the northern margins of the Tokai and Kumano forearc basins. Swath bathymetry and side-scan sonar surveys indicate a general fault trend of ENE-WSW and dextral displacement of submarine canyons. However, there is no report about the history of the active faults. Fault activities have been recorded in sedimentary sequences, because sedimentation in a forearc basin is very active in this area. Therefore, fault activity histories can be restored by seismic reflection records. Structural investigation of this area is important for earthquake disaster mitigation as well as understanding of oblique subduction tectonics because this area is closed to densely populated cities.

2. Data source

This study is based on data from seismic reflection survey "Tokai-Kumano Nada" in 2001 and MITI well 'Nankai Trough' in 1999 conducted by Japan Oil, Gas and Metal National Corporation (JOGMEC) (Fig. 1). 3.5 kHz sub-bottom profiles and chirp sub-bottom profiles obtined during KH-10-3 cruise in 2010 and IZANAGI side-scan sonar images are also used in this study.

3. Results and Discussion

3-1. Seismic stratigraphy

This study picked continuous reflectors and divided the formation into five units. Moreover, these units were correlated with core data from MITI Well "Nankai Trough" and got to correspond to Ogasa Group, Upper Kakegawa Group, Mid Kakegawa Group, Lower Kakegawa Group and Basement (Saigo/Kurami Group), respectively (Fig. 2).

3-2. Terrace structure and Lineament

IZANAGI side-scan sonar image showed the NEN-SWS trending three lineaments parallel to each other on a seafloor (from north to south, L-1, L-2, L-3). Seismic reflection profiles indicate that faults are developed beneath each lineament. It is thought that displacements of active faults formed basin structures and terrace morphologies on a seafloor.

3-3. Flower structure and Strike-slip fault

Seismic reflection profiles indicate that most reverse faults developed beneath lineaments seem to have strike-slip component judging from existences of flower structures. Riedel shear deformations were observed on the Shima Spur, and horizontal shift was recognized at an axis of Anoriguchi submarine canyon. These observations are consistent with strikes-slip deformation. Moreover, shallow extension of fault planes on seismic reflection profiles and cold seeps observed by submersibles, strongly suggest that most faults are active in this area.

3-4. Restoration of activity in strike-slip fault

An isopach map of each unit was made on the basis of seismic stratigraphy. Seismic profiles in E-W direction show discontinuous reflectors suggesting paleo-submarine canyons (Takano et al., 2010) in Units 3 and 4. Unit 3 exhibits horizontal stepwise displacement of a region with uniform sediment thickness. It seems that dextral strike-slip fault displaced a paleo-submarine canyon. Above Unit 2, there is no deformation structure suggesting strike-slip displacement. In summary, fault activity of the lower units (Units 3 and 4) seems to be higher than that of the upper units (Units 1 and 2).

3-5. Restoration of activity in reverse fault

In general, reverse faulting is accompanied by thick sedimentary sequence in a footwall side. Such structures are well developed in Unit 4, and partly recognized in Unit 3. In addition, reverse faults were active in the formations lower than Unit 4 by vertical displacements in seismic reflection profiles. In contrast, the faults seem to be inactive above Unit 2. Vertical displacements of Units 1 and 3 show large differences from place by place along lineaments. The cause of this deformation pattern is explained by subduction of a basement high.

Keywords: Nankai Trough, Forearc basin, Reverse fault, Strike-slip fault, Seismic reflection survey

Japan Geoscience Union Meeting 2011
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SCG063-P05 Room:Convention Hall Time:May 26 10:30-13:00

Crustal movement in the past 100,000 years in Ise Bay and Ohmi Basin, based on geomorphology and subsurface geology

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I estimated tectonic movement in the past 100,000 years around the Yoro-Kuwana-Yokkaichi fault zone. I carried out aerial photograph interpretation to classify and correlate terrace surfaces and identify tectonic geomorphology. Additionally, I conducted cryptotephra analysis to constrain the ages of terrace surfaces in the northern part of the Kinki Triangle. Vertical displacement is estimated based on terrace surfaces and subsurface geology. Vertical slip rates are estimated as the Yoro fault: >1.2 mm/yr (only subsidence rate), the Kuwana fault: >1.0-1.1 mm/yr, the Yokkaichi fault: 0.4-0.5 mm/yr.

Keywords: Ise Bay, Ohmi Basin, crustal movement

Japan Geoscience Union Meeting 2011
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SCG063-P06 Room:Convention Hall Time:May 26 10:30-13:00

Denudation history of the Akaishi Range, central Japan, based on low-temperature thermochronology

Shigeru Sueoka[1*], Barry P. Kohn[2], Yasutaka Ikeda[3], Kenichi Kano[4], Hiroyuki Tsutsumi[1], Kunimi Yamada[5], Takahiro Tagami[6], Takafumi Hirata[6], Yoshiki Shirahama[3]

[1]Geophys., Sci., Kyoto Univ., [2]Earth Sci., Melbourne Univ., [3]Earth & Planetary Sci., Tokyo Univ., [4]Geosci., Sci., Shizuoka Univ., [5]JAEA, [6]Geol. & Minr., Sci., Kyoto Univ.

We conducted low-temperature thermochronometric analysis to constrain denudation history of the Akaishi Range. ZHe ages of 20-3.5 Ma were obtained between the MTL (Median Tectonic Line) and ISTL (Itoigawa-Shizuoka Tectonic Line). These data are preliminary interpreted as below: 1) the youngest age, ~3.5 Ma, indicates the upper limit of the onset of the denudation event, which roughly corresponds with the onset of the uplift of the Akaishi Range estimated by previous studies, 2) younger ZHe ages to the east implies westward tilting of the Akaishi Range, 3) assuming geothermal gradient of ~30 deg.C/km and surface temperature of ~20 deg.C, the denudation in the past ~3.5 Ma is calculated at 5-6 km near the ISTL at the eastern margin of the Akaishi Range.

Keywords: fission-track thermochronology, (U-Th)/He thermochronometry, Akaishi Range, denudation

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SCG063-P07 Room:Convention Hall Time:May 26 10:30-13:00

Postseismic deformation due to the 2008 Iwate-Miyagi Nairiku earthquake: follow-up study

Youichiro Takada[1*], Tomokazu Kobayashi[2], Masato Furuya[3], Makoto Murakami[4]

[1]DPRI, Kyoto Univ., [2]GSI, [3]Hokkaido University, [4]ISV, Hokkaido Univ.

At 2009 JPGU meeting, we have presented the post-seismic deformation signals associated with the 2008 Iwate-Miyagi Nairiku Earthquake (2008 June 14 JST, M6.8) detected by interferometric synthetic aperture radar (InSAR) analysis using ALOS/PALSAR data. Due to an orbital change of ALOS, however, only a few InSAR images with small perpendicular base-line were available at that time, which made our conclusion less accurate. Fortunately, ALOS changed its orbit again and much short base-line InSAR pairs became available. By adding those better InSAR images, we have confirmed our previous conclusion and point out more detailed characteristics of the post-seismic deformation.

As we have already presented, the post-seismic deformation signal is characterized by length changes in radar line-of-sight (LOS) to the east of Mt. Kurikoma (KRK), to the south of KRK, around Mt. Amadamori (AMM), and to the east of Mt.Kunimiyama (KNM). Further InSAR analysis illustrated time-dependent nature of the post-seismic deformation. Also, we found a clear correspondence of the coseismic surface deformation derived from pixel offset technique (Takada et al., 2009) to the post-seismic surface deformation, with which we can delineate coseismic fault shape. Through this study, we demonstrated that ALOS/PALSAR has strong ability to detect surface deformation lurking in such a vast mountainous area.

Acknowledgements: PALSAR Level 1.0 data in this study are provided from PIXEL under a cooperative research contract with ERI, Univ. Tokyo and the Earthquake WG established by JAXA. The ownership of ALOS/PALSAR data belongs to METI/JAXA, Japan.

Keywords: 2008 Iwate-Miyagi Nairiku Earthquake, Postseismic deformation, InSAR, Time evolution

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SCG063-P08 Room:Convention Hall Time:May 26 10:30-13:00

Spatiotemporal variation of crustal deformation in northeast Japan estimated from GPS data

Kazuhiro Ozawa[1*], Takeshi Sagiya[1]

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Crustal deformation along the plate subduction zone contains both of the long-term intraplate deformation and the short-term elastic deformation caused by plate interactions on the plate boundary surface. To separate these two contributions and presume both quantitatively are necessary for understanding the deformation physics along the plate subduction zone. It has been clarified that intermittent slip phenomena are generated on the plate boundary surface during interseismic period, for example the slow slip event and the low frequency tremor (e.g. Obara et al., 2002; Ozawa et al., 2002). Thus, it has to be considered for understanding quantitatively how strains are accumulated in seismic cycle to estimate the temporal variation of interplate locking after the separation of two deformation signals mentioned above.

In northeast Japan, the 1993 Hokkaido Nansei-oki (M7.8), 1994 Sanriku-oki (M7.6), and 2003 Tokachi-oki (M8.0) earthquakes have occurred since nineties, when the nationwide continuous GPS observation network was installed. Coseismic and postseismic deformations are observed at these GPS sites (e.g. Nishimura et al., 2004; Ozawa et al., 2007). We focus on time variations of interplate locking, which is like stress accumulation -> coseismic slip -> postseismic slip -> locking recovery -> stress accumulation. On the other hand, Kimura and Kusumoto (1997) suggested that the Chishima forearc region along the Chishima Trench behaves like a block and it migrates to westward with respect to Japan arc. It implied the possibility of intraplate deformation in upper plate along the Chishima Trench.

We analyze the crustal deformation in northeast Japan using block fault model to estimate contributions of the intraplate deformation and plate interaction, quantitatively. We use the dairy coordinate solution (F3) of nationwide continuous GPS network from 1996 to 2010 operated by the Geospatial Information Authority of Japan. We divided whole coordinate data into every two years, and then estimated the average displacement rate at each period. We used the block fault model developed by McCaffrey (2002) in our analysis. Using this model, we simultaneously estimated the rigid rotation of the Chishima forearc and the contributions of the plate interaction along the Chishima-Japan Trench and the eastern margin of the Sea of Japan. In our presentation, we show the temporal variation of interplate locking distribution and discuss how interplate locking is recovered after earthquake occurred.

Keywords: GPS, block fault model, interplate earthquake, after slip, fault healing, Northeast Japan

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SCG063-P09 Room:Convention Hall Time:May 26 10:30-13:00

Seismic reflection and gravity survey across the Eastern Boundary Fault Zone of Ishikari Lowland, Hokkaido; Line 1

Shinsuke Okada[1*], Kazuo Yamaguchi[1], Tatsuya Sumita[1], Masahiko Makino[1], Takanobu Yokokura[1]

[1]AIST, GSJ

The Eastern Boundary Fault Zone of Ishikari Plain is a zone of North-South trending reverse faults, which border the eastern margin of Ishikari lowland with length of about 65 km length. Active faulting on the Eastern Boundary Fault Zone of Ishikari Lowland shows the latest faulting of Hidaka fold-and-thrust belt that is collision between the Northeast Japan arc and fore-arc sliver of Kuril arc, which is driven by oblique subduction of Pacific plate.

To reveal the subsurface structure of the Eastern Boundary Fault Zone of Ishikari Lowland, we carried out two lines of seismic reflection and gravity survey in November 2010. Seismic line 1 has a length of 19.2 km and started from Hayakita-midorigaoka in Abira town to Kashihara in Tomakomai city along Rout 234. Seismic line 2 has a length of 8.8 km and started from Kashiwadai-minami in Chitose city toward the direction of ENE through the Higashi-chitose Self Defense Force military station. The source used in this seismic survey was a vibrator (Y-2400; IVI Inc.). The receiver was SG-10 (natural frequency, 10 Hz; Sercel Inc.). The source and receiver spacing was 10 m, with 240-ch geophones used for each recording. We selected the DSS-12 (Suncoh Consultants Co., Ltd) for the recording system and its sampling rate is 2 msec. Spacing of each gravity stations along seismic lines and its extension is 250 m standard. We applied D-type gravity meter of LaCoste & Romberg (D-205). To acquire the global position of each gravity station and its altitude, we used Trimble R8 GPS system. 79 gravity stations along Line 1 and its extension and 61 gravity stations along Line2 and its extension were measured in this survey. In this presentation, we focus on the result of seismic and gravity survey along Line 1.

We would like to thank Higashi-chitose Self Defense Force, Abira town office, Tomakomai city office, and Hokkaido Regional Development Bureau for their cooperation.

Keywords: seismic reflection profiling, gravity survey, the Eastern Boundary Fault Zone of Ishikari Lowland, Umaoi Hills, subsurface structure

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SCG063-P10 Room:Convention Hall Time:May 26 10:30-13:00

Seismic reflection and gravity survey across the Eastern Boundary Fault Zone of Ishikari Lowland, Hokkaido; Line 2

Shinsuke Okada[1*], Kazuo Yamaguchi[1], Tatsuya Sumita[1], Masahiko Makino[1], Takanobu Yokokura[1]

[1]AIST, GSJ

The Eastern Boundary Fault Zone of Ishikari Plain is a zone of North-South trending reverse faults, which border the eastern margin of Ishikari lowland with length of about 65 km length. Active faulting on the Eastern Boundary Fault Zone of Ishikari Lowland shows the latest faulting of Hidaka fold-and-thrust belt that is collision between the Northeast Japan arc and fore-arc sliver of Kuril arc, which is driven by oblique subduction of Pacific plate.

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We would like to thank Higashi-chitose Self Defense Force, Abira town office, Tomakomai city office, and Hokkaido Regional Development Bureau for their cooperation.

Keywords: seismic reflection profiling, gravity survey, the Eastern Boundary Fault Zone of Ishikari Lowland, Umaoi Hills, sub-surface structure

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SCG063-P11 Room:Convention Hall Time:May 26 10:30-13:00

Determination of fault plane solutions of small events in Hokkaido associated with the motion of Kuril fore-arc sliver

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In order to find the evidence of transcurrent movement of fore-arc sliver along the southern Kuril trench, we determined the fault plane solutions of smaller events using the method developed by Imanishi et al.(2006). We used P- and SH-wave amplitudes as well as P-wave polarity and determined fault plane solutions with magnitude range from 2.0 to 3.5 and the numbers of P-wave polarity data are 10 or greater. Especially we focused on the fault plane solutions along the estimated boundary of the fore-arc sliver in Hokkaido. We find the fault plane solutions of strike-slip type with the nodal plane of right-lateral slip along the volcanic front. While strike-slip events determined by F-net from 1997 to 2009 concentrate around Teshikaga area, those events determined by this study are distributed along the volcanic front continuously. Around the central Hokkaido where the Hidaka Mountains and volcanic front intersect, strike-slip types with P-axis trending E-W direction were also determined.

In the western side of Hidaka Mountains, we find the fault plane solutions of thrust and strike-slip type with P-axis parallel to the trench. Thrust events are distributed along the Conrad discontinuity or within the lower crust of Northeastern Japan arc inferred from seismic refraction/wide-angle reflection experiments by Iwasaki et al.(2004). On the other hand, Events of strike-slip type are distributed within mantle wedge of Northeastern Japan arc. In the eastern side of Hidaka Mountains, we find the fault plane solutions of reverse type of events with P-axis parallel to the dip direction of descending lower crust due to the delamination of the crust of Kuril arc.

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A geomorphological analysis of the Kumukol Basin at the northeastern edge of the Tibetan plateau using ALOS stereoscopic

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The area of the Tibetan plateau has been expanded laterally after it had attained an equilibrium elevation. The mechanism of lateral growth may be different from region to region. Along the southern edge of the Himalayas, for example, the plate-boundary thrust fault has repeatedly jumped southward, invading stable continental lithosphere on the foreland side. In this area discrete and episodic growth has occurred. In contrast, the lateral growth in Yunnan is continuous growth in space and possibly in time (Clark and Royden, 2000). However, the growth mechanism at the northern edge of Tibetan plateau has not revealed yet.

First, in this study, using global gravity anomaly data, we compared the characteristics of plateau margins in Himalaya and Yunnan with those in the northeastern edge of the plateau. We inferred that a complex and different type of growth occurred at the northeastern edge. So we searched the tectonic relief in Qaidam basin that is located at the northeastern edge of the Tibetan plateau. We found that there is a long-wave anticlinorium in the Kumukol basin (Kumukol Anticlinorium) located in the southern margin of Qaidam basin, and that there are many anticlines, faults and terraces on the surface of this anticlinorium.

Then we analyzed these tectonic features in more detail by the use of GIS software (ArcGIS). Topography data that we mainly used is the SRTM3 DEM with 3-arc second resolution. We also analyzed satellite images with 2.5-meter resolution, which were obtained by the PRISM sensor on the ALOS (Advanced Land Observing Satellite).

It was observed that there are high, middle and low groups of terraces, which were developed across the eastern part of the Kumukol Anticlinorium. Geomorphological analysis revealed that the amounts of vertical displacement with respect to the present river floor are accumulated more in higher terraces than in lower terraces, which terraces are likely to have been developed in response to advances and retreats of alpine glaciers in the surrounding mountains. Moreover by photogeological survey we inferred that Kumukol Anticlinorium is formed by activity of north dipping fault.

Keywords: Tibetan Plateau, Lateral growth, Qaidam Basin, Tectonic landform