HCG37-P01 Room:Poster Time:April 30 18:15-19:30

Comparison between the Tidal Zone Deposits and the Terrace Deposits Emerged in the 1703 and 1923 Kanto Earthquakes

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Recurrent giant earthquakes at the plate boundary along the Sagami Trough have been considered as one of the greatest thread of the Tokyo Metropolitan area. At the southwestern tip of the Miura Peninsula, in south of Tokyo, the tide gauge station records the coseismic uplift amount of 1.4 m and the interseismic subsidence amount of 0.3 m in and after 1923 earthquake, respectively. It is effective to reveal evidences of the past coseismic uplift to know the future earthquake.

Wave-cut benches which emerged in 1923 are widely distributed along the rocky coast. Higher wave-cut benches, good indicators of coseismic uplift prior to 1923, are also recognizable. It is, however, often difficult to spatially compare one another due to the erosion.

We investigated the distribution of the tidal-flat deposits and the 1923 wave-cut benches at two small bays in the southwestern and southern parts of the Peninsula. The aggradation of the coastline associated with the 1923 uplift was identified by the comparison between the 1:25,000 topographic maps before and after the 1923 earthquake. Observations of outcrops and drilling cores at the 1923-formed marine terrace showed that the tidal-flat deposits consist of shelly sand and gravels. The elevation of tidal-flat deposits indicates the coseismic uplift in 1923 and the interseismic subsidence after 1923. The uplift amount was estimated approximately 0.9 m and 2.1 m at the southwestern and southern parts of the Miura Peninsula, respectively. The uplift amount inferred from the tidal-flat deposits is concordant with that inferred by the wave-cut benches.

Keywords: Kanto Earthquake, Paleo-earthquake Record, Terrace Deposits, Tidal-flat Deposits

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

HCG37-P02 Room:Poster Time:April 30 18:15-19:30

The paleosols and topography of sedimentary basin relationships in the upper Miocene Clay deposit, central Japan

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The Tokiguchi Porcelain Clay Formation is fluvial deposit distributed in central Japan in middle to late Miocene period. The sedimentary facies analysises were carried out in this formation. Those studies, however, were insufficient to reconstruct fluvial environment, because the fluvial deposit essentially have been bounded by short hiatuses due to sub-aerial erosion and paleo-surface formation. In this study, therefore, we focused on paleosols so as to reconstruct the weathering environment during the hiatuses. In general, paleosol formation in the fluvial sediments also depends on the supply of detritus and drainage conditions. Consequently it is very useful to research paleosol features for reconstruction of the topography in the small sedimentary basin where Tokiguchi Porcelain Clay Formation was deposited.

The clay-dominated sediments, which are interpreted to have been deposited in small sedimentary basin within a radius of 2 kilometers, were examined in two mines, Hishiya and Nakayama mines, across Toki and Tajimi Cities in Gifu Prefecture. The sediments in Hishiya mine shows the deposition in proximal area of the sedimentary basin, whereas those in Nakayama mine displays the facies formed in marginal area of the basin. On the sedimentary facies analysis, 13 facies are recognized in the formation. The sedimentary facies associations indicate the deposition mainly in backswamp environment with minor channel incision. Furthermore the coarse-grained sediments which were deposited as channel-bar and levee deposits intercalating debris flow deposits, with high accumulation rate, were particularly deposited in the marginal area of the basin. In contrast, the fine-grained sediments which were deposited with low accumulation rate in lakes and swamps, were particularly distributed in the proximal area of the basin. For this result, the fluvial system with lakes and swamps was developed near mountain slope side. In the whole are of the basin, approximately 20 paleosol horizons were founded in the lake and swamp deposits within a thickness of approximately 30 meters. In the proximal of the basin, these paleosol horizons range sparser. These paleosol horizons, with various pedogenic features, such as root with approximately 150 centimeters length and trunk traces with approximately 50 centimeters wide, pedogenic concretions, ped structures and microfabric of clay minerals, are formed thickly and developed clearly. In addition to, abundant siderite nodules covered with bright clay are present in lake deposit in the proximal area of the basin.

As a result the characteristics of the sedimentary facies could depend on the sedimentation rate depending on variation of the distance from the rim of the sedimentary basin. Besides the characteristics of the paleosol features could be affected by the drainage conditions due to morphological variation related to the location in the sedimentary basin. The characteristics of the sedimentary facies and paleosol features, however, suggest the large change of water level in the whole sedimentary basin. Concretely the redox condition had shifted from reductive condition in lakes or swamps to oxic condition in bushy grounds. The plausible cause for this change of redox condition in the sedimentary basin could be responsible for water-level change which was frequently occurred by damming of rivers formed from debris flow deposition.

Keywords: paleosols, Miocene, terrestrial environment, Tokiguchi Porcelain Clay Formation, sedimentary facies analysis

HCG37-P03 Room:Poster Time:April 30 18:15-19:30

Applications of a method to detect varved sediments

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Studies of lacustrine deposits, especially on varved sediments, have further clarified the high-resolution record of paleoenvironments. Varved sediments are very useful for these studies because they are expected to contain annual records of depositional environments. In order to obtain annual records such as annual thickness, color tones, and chemical compositions, at the very least, it is necessary to detect the boundaries of annual bands. In addition, the detection and measurements should be reproducible.

Methods to measure boundaries of varved sediments are divided into two main categories: (1) measurment by visual judgment and (2) measurment by image analyses. The latter method uses photographs of the sediment, soft-X ray images, element maps, and so on. In order to detect boundaries, a threshold value, wavelet analysis, and wave analyses of the gray value of images have been previously used. While the visual judgment method has the disadvantages of human error and criteria, the image analysis method also has limitations as follows: one threshold value cannot be used for all locations in successive images; this method is dependent on the resolution of images, and it is affected by noise in the image-values.

In this study, we used a new method to detect the boundaries of banded deposits using the following procedure: (1) smooth the images, (2) calculate the inclination of "gray-value map" of the images, (3) calculate a mid-value in one wavelength of the "gray-value wave" in the map, and (4) detect a boundary as a point of the maximum inclination around the mid-value. The result obtained using this a method shows well-defined "boundary map" of the bounded deposits, similar to the result obtained by visual judgment. Using this method, internal information, such as the transmittance value of soft-X ray in a lamina, can also digitized like a lamina thickness. Since a time-series of lamina thickness and internal information of the lamina can be calculated based on this method, lamina-by-lamina facies analysis, such as that performed for detection of flood deposits, can be employed in studying varved deposits automatically and quickly.

Keywords: varved sediments, image analysis, time-series, soft-X ray, diatomite

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

HCG37-P04 Room:Poster Time:April 30 18:15-19:30

Depositional cycle and flood and slope-failure events in an 8,000-yr varve of Pleistocene Hiruzenbara Formation, Japan

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Paleoenvironmental changes can be reconsructed from varve deposits. The Middle Pleistocene Hiruzenbara Formation, which is distributed in the Hiruzen Highland, Maniwa city, Okayama Prefecture in Japan, is composed of mostly pure lacustrine diatomite that contains finely-laminated varves. From these varves, researchers have found decadal-scale depositional cycles that are thought to correspond to solar activities (Ishihara and Miyata, 1999), and intercalated flood- and slope-failure events have been detected. However, the relationship between the solar cycles and hydrogeological events remains unclear. In the present study, we sampled the finely laminated varves in the Hiruzenbara Formation, and obtained an 8,000-yr time-series of varve-thickness, gray-values for each lamina, variance of the gray-values, and deposits of flood- and slope-failure events using image analysis methods. Wavelet analysis and a fast Fourier transform (FFT) were applied to these time-series data to evaluate event-cyclicities.

In the time-series of varve-thickness, a long-term cyclicity of 1,000 - 2,000 yr was recognized. The upper parts of varves were light-green in color, and these were likely deposited during the winter season. Clear increases in thicknesses of the light-green parts were observed from the lower to upper parts of the analyzed section. Results from frequency analyses using the FFT and wavelet analysis of the time-series of varve-thickness data suggest that periods of 8 to 12 yr, 20 yr, and 30 to 35 yr dominate in this region. These periods were also found by Ishihara and Miyata (1999) and Masuda et al. (2004) in other sections of the formation. The periods in varves of 8 - 12 yr and around 20 yr correspond to solar activity, and a 35-yr periodicity of lake environmental change has been reported previously. In this study, however, these periods were not stable in the analyzed section, which is similar to the results obtained by Ishihara and Miyata (1999) and Masuda et al.(2004) who measured varve-thickness using a microscope.

One hundred-forty seven flood deposits were identified in the 8,000-yr record. Portions of the high-frequency parts and low-frequency parts were repeated in the analyzed section. Mean thickness of the flood beds was around 2 mm. Thirty-three deposits from slope failures were found in the section. These deposits were rare in the upper and lower most parts of the section, but were dominant in the lower part. There was no repetition of domination for the deposits that were observed during the flood events. Mean thickness of the slope-failure deposits was around 5.5 mm.

In the sections where flood deposits dominated, the mean varve-thickness tended to thinner without exception. In the upper part of the analyzed section, which lacked flood event signatures, the mean varve-thickness was generally greater. These trends suggest that climate conditions and the frequency of flood events might have affected the productivity of diatoms (thickness of the lamina). In addition, the periods detected by frequency analyses were not clear in the flood-deposit dominated sections. Results showing that dominations of slope-failure deposits were not related to the varve-thickness and the gray-values suggest that the slope-failure events were influenced by local phenomena related to lake development.

Keywords: Banded diatomite, Varve, Image analysis, flood deposit, slope-failure deposit, Solor activity

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

HCG37-P05 Room:Poster Time:April 30 18:15-19:30

Subsidence and a change of depositional environment by the 1662 Hyuganada earthquake in southern Miyazaki Plain

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The Miyazaki Plain, southern Kyushu Island, have been damaged repeatedly by a number of great earthquakes (measured or estimated to be >M7-8) occurred in not only the Nankai trough but also the Hyuganada coastal region. A total of six great earthquakes happened in the Hyuganada coastal region in the range of AD1909 to 1984. Historical documents indicate such great earthquakes had also occurred in AD1662, 1769 and 1899. Furthermore, the great earthquakes in the Nankai trough, such as the 1707 Hoei Nankai earthquake and the 1946 Showa-Nankai earthquake, had also attacked the plain with terrible tsunamis (Usami *et al*., 2013).

Recently, the Nankai trough has received extensive attention as hypocenter of great earthquake attacking the Miyazaki Plain, because the Central Disaster Management Council (2012) proposed a new source model of the earthquakes including the Hyuganada coastal region. On the other hand, previous geological and seismological studies about past Hyuganada earthquakes are much less than the Nankai trough despite of their high seismic activity indicated by historical documents.

For example, historical documents shows that the 1662 Hyuganada earthquake brought about serious social and natural damages to the plain (Hatori, 1985). Especially, around the estuaries of the Oyodo-gawa River and the Kaeda-gawa River in southern area of the plain, the tsunami with about 4-5 m height and ~1 m subsidence occurred. This coseismic subsidence made a coastal lagoon around the estuarine area of the Kaeda-gawa River (Shimayama region). After buried by riverine debris, this lagoon was reclaimed and became paddy fields (Miyazaki-city, 1978).

The purpose of our study is to clarify depositional changes around the Shimayama region including coseismic geomorphological change. A multiple geological borings were carried out in the study area. Depositional environments were reconstructed inferred from paleontological, geochemical analyses. Depositional ages of core sediments were estimated by radiocarbon ages. The surface geology was divided into four layers mainly (layer A, B, C and D) in ascending order. The layer A was composed of alternate layers of grayish sand and silt with many angular pumices and organic materials. The layer B consisted of alternate layers of gray or grayish brown mud and sand including numerous well-preserved molluscan fossils. The bottom of the layer B, which covered the layer A above ~-1.5 m T.P. with 10 to 40 cm thick, was black or dark gray muddy fine sand with bioturbation including rip-up clasts, shell fragments and volcanic rocks with >1 mm diameter. The layer C was composed of gray silt with several thin layers of fine to medium sand and plant fragments. The layer D consisted of silt to fine sand layers and surface cultivated sediments with ~20 cm thick overlying them.

Result of some analyses showed their quantitative differences corresponding to depositional facies. The main diatom components of the lower part of the layer A was fresh water benthic species such as *Cymbella turgidula* and *Gomphonema parvulum*, and the upper was few diatom fossil. On the other hand, the layer B showed abundance of brackish to marine water species such as *Cocconeis scutellum* and *Thalasionema nitzschioides*. In addition, absorbed water analysis of the core sediments showed that K, Ca, Na, Mg and SO_4^{2-} concentration, which are rich in sea water, were few in the layer A but increased drastically at the bottom of the layer B. And grain size and molluscan fossils species were also different between the layer A and B.

These results indicate that depositional environment changed drastically from fresh water marsh or shallow pond to tidal or inner bay. Depositional ages of the layer A, B and C were estimated from radiocarbon ages to be AD1445 to 1595, AD1549 to 1771 and AD1651 to 1771 respectively and suggest that the depositional environment between the layer A and B correlate to crustal deformation by the 1662 Hyuganada earthquake.

Keywords: Hyuganada earthquake, Miyazaki Plain, depositional environment