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

HCG35-01 Room:105 Time:May 27 09:15-09:30

Separating silicate weathering effect from grain size and source rock effects on sediment composition of Yangtze River

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Silicate chemical weathering plays a critical role on the long-term carbon cycle and stabilizing atmospheric pCO_2 by so-called Walker feedback (a negative feedback) through neutralizing carbonic acid by dissolving Ca and Mg silicate minerals and re-precipitated as carbonates and chert (SiO_2). Consequently, it is important to quantitatively evaluate past intensity of silicate weathering. There are several proxies proposed for silicate weathering intensity based on chemical and/or mineral composition of bulk sediments. However, it becomes increasingly apparent that chemical and mineral composition of bulk sediments is significantly influenced by the difference in grain size as well as the difference in source rocks. However, none of previously proposed proxies takes into account of both the grain size effect and source rock effect simultaneously.

We selected Yangtze River because it is one of the largest river in the world with over 250 gauge stations, the large variation in bed rock geology among branches, and large ranges in topographic relief and climate. Thus we expect large ranges in chemical weathering intensity and source rock types.

In this study, we used 21 river bed sediment samples and 42 suspended particulate matter (SPM) samples collected from major branches and throughout the main stream of the Yangtze River. We conducted grain size separation of bulk river bed sediment samples into 3 fractions ($<4\mu$m, 4-16μm, 16-63μm). As to SPM samples, we did not conduct grain size separation because their median diameters range from 3.5 to 10.6 μm and more than 98% of SPM is less than 100μm. We analyzed major element composition and mineral composition of these samples by XRF and/or ICP-AES and XRD, respectively. We compare chemical and mineral compositions of the 3 size fractions of the same samples to evaluate the grain size effect on chemistry and mineralogy. We found sediments and SPM are basically composed of 3 components; one is Si, Na, Ti, Mn (quartz)-rich component representing coarser grains, another is Al, K, and Fe (clay minerals)-rich component representing finer grains, and the other is Ca and Mg (carbonate)-rich component representing dolostone and limestone fragments. Sediments from the uppermost reaches and their branches where chemical weathering is minimal, K/Al and Fe/Al of the 3 different size fractions tend to show similar values suggesting Al, Fe, and K are contained in the same component with the same composition that are diluted by the coarser fraction that are dominantly composed of quartz. However, K/Al of fine fraction relative to K/Al of coarse fraction decreases downstream with the increase in temperature and precipitation, suggesting the ration $(K/Al)_f/(K/Al)_c$ ratio may reflect the intensity of chemical weathering.

We will discuss the possibility of $(K/Al)_f/(K/Al)_c$ ratio as a quantitative indicator of silicate weathering.

Keywords: chemical weathering, sediments, chemical composition, grain size effect, source rock effect, Yangtze River

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HCG35-02 Room:105 Time:May 27 09:30-09:45

ESR and TL signals in quartz in the present river sediments along with the Kurove river

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The variations in the number of oxygen vacancies, measured as the ESR (electron spin resonance) intensity of the E_1' center in quartz, and in the TL (thermoluminescence) colors in quartz of quartz of the sediments are investigated along with the Kurobe river together with those in the bedrocks in the river reaches. The number of oxygen vacancy in quartz indicates the age of the host rocks from which the sediments have been generated by weathering while the red TL color corresponds to volcanic origin and blue to plutonic origin. The quantitative TL color measurements were made possible with the time-resolved 2 dimensional TL spectroscopy system.

The number of oxygen vacancies, higher in the upper reach, gets lower in the middle, and further higher in the lower reaches due to the inflow of the sediments originated from the younger and from the older bedrocks, respectively. The high temperature red to low temperature blue TL ratios, higher in the upper reach, gets lower in the middle and lower reaches due to the sediments having lower values. The change in the values along with the river flow is found to be explained by the inflow of the sediments originated from the bedrocks around the river.

Keywords: river sediment, provenance, ESR, TL

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HCG35-03 Room:105 Time:May 27 09:45-10:00

Lead isotopic variations of fine particles discharged from rivers of Tokai area, Central Japan

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We report lead isotopic variations of fine fraction of river sediments of the Tonankai area in order to provide the reference data in resolving the provenance of hemipelagic sediment distributed in the Shikoku Basin. We targeted smaller particles than 10 μm. This grain size is important because they constitute the majority of hemipelagic sediments distributed on seafloor of the Shikoku Basin (Saitoh, 2014).

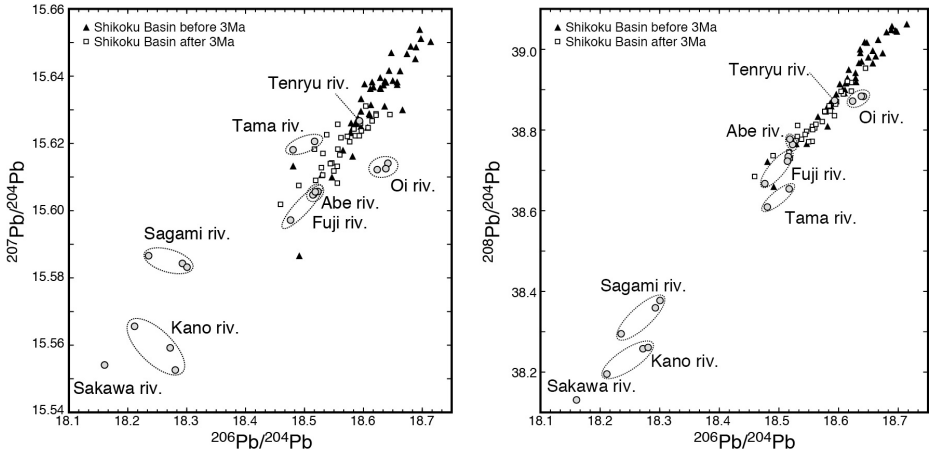
Lead isotope ratios widely differ by rivers. The most prominent contrast is recognized between the rivers draining the Izu-Honshu collision zone and the others. Isotopic ratios of the former, the Sagami, Sakawa, and Kano rivers are low (^{206}Pb/^{204}Pb: 18.15-18.3; ^{207}Pb/^{204}Pb: 15.55-15.59; ^{208}Pb/^{204}Pb: 38.1-38.4), while those of the latter are higher (^{206}Pb/^{204}Pb: 18.46-18.66; ^{207}Pb/^{204}Pb: 15.59-15.63; ^{208}Pb/^{204}Pb: 38.6-38.9) (Figure). The low ratios of the former are supposed to be the results of the contribution from the mafic rocks distributed around the collision zone. Contribution from the sedimentary rocks of accretionary complexes distributed in the watersheds must increase the isotopic ratios of the other rivers. Minor isotopic differences are supposed to be dependent on the age of accretionary comprex and types of other rocks distributed in watershed of each river. Isotopic comparison with these river sediments suggests that the sediments of the Shikou Basin deposited after 3Ma are mainly contributed from the Fuji, Abe, and Tenryu rivers.

Sr-Nd isotope ratios of river sediments will be also shown and discussed.

Reference

Saitoh, Y., 2014. Data report: grain size distribution of the late Cenozoic hemipelagic mud from Site C0011. In Henry, P., Kanamatsu, T., Moe, K., and the Expedition 333 Scientists, Proceedings of the Integrated Ocean Drilling Program 333: Tokyo (Integrated Ocean Drilling Program Management International, Inc.).

Keywords: Pb isotope ratios, Sr-Nd isotope ratios, river sediments, hemipelagic sediments, Shikoku Basin



Japan Geoscience Union Meeting 2015
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HCG35-04 Room:105 Time:May 27 10:00-10:15

Grain and chemical composition of coastal sand in Kanto and adjacent region

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Grain composition and chemical composition of beach sand, over 200 samples collected from Southern Abukuma region, Choshi region, Kujukuri region, Shonan region and West Suruga-Bay region, had analysed.

The composition of sand had wide variety in Kanto and adjacent region, and also show areal differences in each coast, caused by sand supply from river system and coastal current differenciation.

Rock fragment dominates in both Shonan and West Suruga-Bay coast, but Shona sand consist of mainly volcaniclastic fragment, while West Suruga-Bay sand consist of sedimentary rocks origin fragment, which made in accretionary process in subduction zone. Trace element composition shows also differences between two coast in sand grain origin.

We will discuss about the importance of grain and chemical composition analysis of recent coastal sands, not only in the field of coastal engineering, but also in earth science, in the context of tectonic setting analysis of geological time scale.

Keywords: beach sand, grain composition, chemical composition, trace element, tectnic setting, erosion

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HCG35-05 Room:105 Time:May 27 10:15-10:30

Variation of source rock assemblage recorded in the Tokiguchi Porcelain Clay Formation

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The Miocene Tokiguchi Porcelain Clay Formation consists mainly of muddy sediments, which were deposited in the tectonical controlled small inland basin in the southern part of the Gifu Prefecture, central Japan (Nakayama and Todo Collaborative Research Group, 1989). The depositional age of the formation is designated to Middle Miocene (approximately 10 Ma) on the basis of the yielding of *Penus trifolia* (Miki, 1939) and radiometric ages of tuffaceous sediments (Yoshida et al., 1997).

The sedimentological studies after 1980's revealed the depositional environments and detail of the sedimentary basin (ex. Nakayama and Todo Collaborative Research Group, 1989). Recently, paleosol horizons are reported from this formation (Hatano and Yoshida, 2014).

This research focuses the U-Pb radiometric ages of detrital zircon grains in the sandy sediments in this formation in order to clarify the provenance variations by radiometric ages. Additionally bulk rock assemblage of the hinterland was estimated by the REE chemical composition of the muddy sediments to search the source rock assemblage. The detrital zircon grains were sampled from Hishiya and Nakayama Mines, which are separated into 1 km distance, in Tajimi and Toki Cities respectively. As a result, the zircon grains sampled from the Hishiya Mine mainly indicate 70- 80 Ma, accompanied with zircons showing 200, 1700, 1900 Ma, while the zircons from the Nakayama Mine concentrate mainly 12-15 Ma with small amount of zircons in 1700, 1800 and 2900 Ma. REE composition of the muddy sediments indicates various source rocks in the hinterland including basic, intermediate and felsic rocks.

The Late Cretaceous-Early Paleogene radiometric ages were reported from the basement igneous rocks, Inagawa Granite (56-86Ma; Shibata et al., 1962; Suzuki and Adachi, 1998), Toki Granite (68-72Ma; Shibata and Ishihara, 1979; Suzuki and Adachi, 1998), Nohi Rhyolite (58-85Ma; Yamada and Koido, 2005), distributed around the sedimentary basin of the Tokiguchi Porcelain Clay Formation. Also the detrital zircons yielding Early-Middle Miocene ages are reported from the Early-Middle Miocene Mizunami Group (Sasao et al., 2006, 2011). Thus, the zircon group showing 70-80 Ma is interpreted to be originate from basement rocks. The group with 11-15 Ma zircons was possibly derived the Mizunami Group sediments. The zircon grains with Archaean - Proterozoic ages imply the derivation from the Jurassic Mino Terrane.

Though the Tokiguchi Porcelain Clay Formation in above two mines were deposited in the same sedimentary basin, the age assemblage of detrital zircons shows significant difference which implies provenance variation. Also REE geochemistry is indicative of various source rock assemblage in the hinterland. These permit an inference that the change of river catchment area and interfingering deposition by the different river discharge made the difference of provenance records.

This study was carried out under a contract with METI (Ministry of Economy, Trade and Industry) as part of its R&D supporting program for developing geological disposal technology.

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Keywords: Miocene, Chemical Weathering

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Geochemistry and Clay mineralogy of Paleosols in the middle Miocene Tokiguchi Porcelain Clay Formation

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The middle Miocene Tokiguchi Porcelain Clay Formation is fluvial deposits distributed in Aichi to south-eastern Gifu Prefecture (Akamine, 1954; Nakayama and Todo Collaborative Research Group, 1989). This formation is mainly composed of clay-silt with lignite and that is known as a high quality resource of ceramics (Fujii, 1967). Most previous studies had focused on the clay mineral composition and the parent materials so as to imply the mechanism and the timing of genesis of clay minerals (ex. Fujii, 1968; Tanemura, 1964). In general, clay mineral composition of sediments, however, is affected by parent materials, sorting of specified minerals during erosion, transportation and deposition and the chemical weathering after the deposition. The Tokiguchi Porcelain Clay Formation includes apparent paleosols that were formed by the physical, biological and chemical modifications of sediments and exposed at the earth surface. The paleosol horizons, thus, provide detailed information related to paleoweathering regimes. In this study, accordingly, we aim to clarify the relation among geochemistry, clay mineral composition, sedimentation and development of the paleosols in the Tokiguchi Porcelain Clay Formation.

The sedimentological measuring was performed in three mines, where were distributed within a radius of 5 km, across Tajimi to Toki Cities in Gifu Prefecture. The formation, besides, exposes as 15 to 30 m thick succession in these mines.

The sedimentary facies associations indicate that depositional environments was mainly in lake, swamp and marsh. Furthermore, approximately 20 paleosol horizons can be recognized in each mine. These paleosol horizons are characterized by various pedogenic features, such as root fossils over 150 cm in length, apparent soil horizons which include A, B and C horizons and microfabric of clay minerals.

The clay mineral assemblage of fine deposits is composed of almost kaolinite, expandable clay minerals, mica clay mineral and chlorite. There are no significant relationship between the clay mineral assemblage and the soil horizons, but the clay mineral assemblage is correlatable to the grain size of the sediments.

Geochemical approach indicates the variation of the parent materials in each horizon. In some horizons, the chondrite-normalized REE patterns show significant negative Eu anomaly and enrichment of LREE, which mainly suggest the provenance of felsic parent rocks. Whereas, in the other horizons, the REE patterns show slight negative Eu anomaly and gentle slope of LREE. The sediments of these horizons are characterized by the high expandable clay minerals/kaolinite ratio and yielding chlorite. In addition, the chemistry and clay mineral composition suggest the major provenance of mafic parent rocks.

The Chemical Index of Alteration (CIA index; Nesbitt and Young, 1982, 1984) shows high chemical weathering degree as a whole clay-silt samples from 88 to 95. In the surface soil horizons, furthermore, the paleoweathering ratios are higher than that in the sub-surface soil horizons. Thus, the chemical paleoweathering had been progressed in the soils after the deposition.

Though, the geochemistry shows the provenance variety in each horizon of the Tokiguchi Porcelain Clay formation, intense chemical weathering had masked provenance variety. In consequence those results suggest the progression of paleoweathering on the hinterland and after the deposition in the Tokiguchi Porcelain Clay Formation.

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Keywords: paleosol, chemical weathering, Miocene, chemical composition, rare earth element, clay mineral composition

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HCG35-07 Room:105 Time:May 27 11:00-11:15

Cyclostratigraphic analysis of the Middle Triassic bedded chert sequences in Southwest Japan

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Milankovitch cycle recorded in sedimentary rocks provides a high resolution and precision astronomical time scale throughout the Earth history. Bedded chert sequences of the Jurassic accretionary complexes in Southwest Japan have a potential for the template of the early Mesozoic astronomical time scale. Although astronomically paced sedimentary rhythm of the Triassic bedded chert sequence was detected in the Inuyama area of the Mino Belt, central Japan (Ikeda et al., 2010), the validity requires detailed stratigraphic correlations to other Triassic bedded chert sequences in Japan.

In this study, we investigated the sedimentary cycle of the Middle Triassic (Anisian) bedded chert sequence in the Tsukumi area of the Chichibu Belt, Southwest Japan. The study section is located at the Ajiro Island in the Tsukumi area of the Chichibu Belt, Southwest Japan. The depositional age for the bedded chert sequence is Middle Triassic (Anisian) based on radiolarian bio and magnetostratigraphy (Uno et al., 2012).

The average duration of a chert and shale couplet in the Middle Triassic bedded chert of the Tsukumi area is ca. 10 kyr. This duration is inconsistent with the ca. 20 kyr duration of the precession cycle during the Triassic, which was confirmed by estimated average duration of a chert and shale couplet in the Triassic bedded chert of the Inuyama area. The dominant cycles in a bed number series of thickness variations in the Middle Triassic chert beds show approximately 2, 5, 10, 40, 200, 300 and 400 beds cycles. Given that the average duration of one chert and shale couplet is ca. 10 kyr, these cycles correspond to approximately 20, 50, 100, 400, 2000, 3000 and 4000 kyr periodicities. The periodicities of the Tsukumi chert are consistent with those of the Inuyama chert (approximately 40, 60, 100, 140, 240, 400 and 4000 kyr).

Previous palaeomagnetic studies have revealed that the Middle Triassic bedded chert in the Ajiro Island section were deposited in the equatorial region, whereas the deposition of the Inuyama chert occur at relatively higher latitude. If the interpretation that rhythmical alternations of chert and shale beds are paced by precession and eccentricity cycles is valid, the average duration of a chet and shale couplet from the Tsukumi area might reflect the semiprecession cycle (ca. 10 kyr) in the equator area caused by biannual passage of the Sun. However, the phases of the bedded chert thicknesses in a bed number series show no clear relationships between Tsukumi and Inuyma areas despite bio and magnetostratigraphic correlation. Further stratigraphic analyses will be required to estimate the paleolatitudinally dependent patterns in the cyclicities of the Triassic bedded chert sequences in Japan.

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HCG35-08 Room:105 Time:May 27 11:15-11:30

Seismic geomorphology of Miocene shelf-to-slope depositional system in the southeastern part of the Tsushima Basin

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We report three-dimensional (3-D) seismic geomorphologic features of a shelf-to-slope depositional system in the southeastern part of the Tsushima Basin, offshore Southwest Japan, by using the 3-D seismic survey dataset of Shimane-Yamaguchi-oki. The studied Miocene succession presents seismic facies characterized by incised valleys/channels and subsequent multiple stacked slope channels from shelf to slope, with well-developed clinoform reflections. Such seismic aspects strongly suggest the development of a prograding delta system during Miocene time similar to offshore South Korea.

Keywords: Seismic geomorphology, 3-D seismic survey, Tsushima Basin, Shelf-to-slope depositional system, Miocene

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HCG35-09 Room:105 Time:May 27 11:30-11:45

Developing process-oriented studies of tsunami-induced erosion and deposition, and morphological changes: A brief review

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Tsunamis are capable of eroding huge amount of sediments, depositing them everywhere in the impacted areas and modifying the coastal morphology. Decrypting geological records of tsunamis as well as modeling their sedimentary processes is crucial for providing information for improved hazard assessment. In addition, geological and sedimentological researches may lead us to comprehensive understanding of the linkage of sedimentary process between land and sea (Goto et al., 2014), and clarifying long-term changes in coastal morphology and environments regarding the effects from infrequent large-scale tsunamis.

What information of the tsunami is reflected to its deposits depends on the local settings and dynamics of the tsunami waves. For example, eyewitness accounts suggested that the second wave of the 2011 Tohoku tsunami brought the massive marine sediments onto the head of Samenoura Bay, southern Sanriku Coast. The first wave, which had an equivalent height to the second wave, did not contributed to the formation of the tsunami deposit (Sugawara et al., 2014a). In this case, no information for the first wave can be extracted from the tsunami deposit.

Understandings (and sometimes insights as well) on the processes of the tsunami wave, flow and sediment transport are indispensable to derive interpretations of the deposits that is consistent with the tsunami behavior. Numerical modeling is capable of capturing part of the dynamics of tsunami sedimentation. Along with perspectives of local morphology and sedimentary environment, the modeling may provide aids to interpret the tsunami deposits and tsunami-induced morphological changes.

Our increasing knowledge on tsunami deposits is founded on the various kinds of massive datasets since the beginning of the research field, in particular after the 2004 Indian Ocean and the 2011 Tohoku Tsunamis. Numerical studies of tsunami sediment transport are also founded on the dataset, and these studies brought improved understandings on the tsunami sedimentation. In the case of the 2011 Tohoku Tsunami in Sendai Plain, geological data for the lack of marine signature from the onshore tsunami deposit and the characteristic deposition patterns were explained by the numerical modeling of tsunami transport of sandy sediments (Sugawara et al., 2014b). Tsunami deposits sometimes share their sedimentological characteristics with turbidites. Similarities in terms of a coupled hydrodynamic-transport process between onshore tsunami flooding and submarine self-accelerating turbidity current are found recently and they have been investigated using numerical approaches (Naruse et al., 2014).

Collaboration of observation and modeling are the key for integrated understanding of tsunami erosion, deposition and morphological change. Process-oriented researches may contribute to depict the dynamics of tsunami sedimentation and to make improved criteria to interpret tsunami deposits.

Keywords: Tsunami deposit, sediment transport, numerical modeling

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HCG35-10 Room:105 Time:May 27 11:45-12:00

Palaeoseismic signals in coastal dune ridge systems

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Palaeoseismic research in regions adjacent to active fault zones has traditionally been concerned with identifying geological or geomorphological features associated with the immediate effects of past earthquakes, such as tsunamis, uplift or subsidence, with the aim of estimating earthquake magnitude and/or frequency. In a palaeoseismic context, coastal dune ridge systems are invariably used to infer relative sea level change, be it by uplift or subsidence. However, on a catchment-wide basis, research has linked a sequence of environmental changes such as forest disturbance, landslides, river aggradation and rapid coastal dune building as geomorphological after-effects of large earthquakes (Figure 1). In this model large pulses of sediment created by co-seismic landsliding in the upper catchment are moved rapidly to the coast where they leave a clear signature in the landscape. Coarser sediments form an aggradation surfaces and finer sediments form a new coastal dune or beach ridge. Coastal dune ridge systems are not exclusively associated with seismically active areas, but where they do occur in such places their potential use as palaeoseismic indicators is often ignored. Data are presented from sites in both New Zealand and Japan to illustrate the concept.

First, a well dated suite of coastal dune ridge sequences in SW New Zealand are shown to be linked by a series of geomorphological processes to large ruptures of the regionally significant Alpine fault (Wells and Goff, 2006; 2007). These fine resolution chronological sequences were achieved using the ages of trees from the ancient forest still growing there. A time lag of 10-50 years between earthquake and dune ridge formation attests to the short sediment transport distance from the mountains to the coast (˜50 km) coupled with high annual rainfall. Second, these data are contrasted with evidence from SE New Zealand where a longer sediment transport distance from the mountains to the coast (˜150 km) coupled with lower annual rainfall causes a time lag of 150-200 years between earthquake and dune ridge formation (McFadgen and Goff, 2005). Differences in coastal configuration and a lack of native forest chronology complicate event chronologies but additional geomorphological indicators and human responses enhance interpretations. Third, we investigate beach ridges of northern Honshu with a focus on the Sendai Plain where a study carried out following the 2011 Tohoku-oki earthquake and tsunami reveal a regional picture of the seismic driving of beach ridge formation. More work needs to be done but the initial results are both exciting and have significant implications for understand the palaeoseismic and palaeotsunami record for the region.

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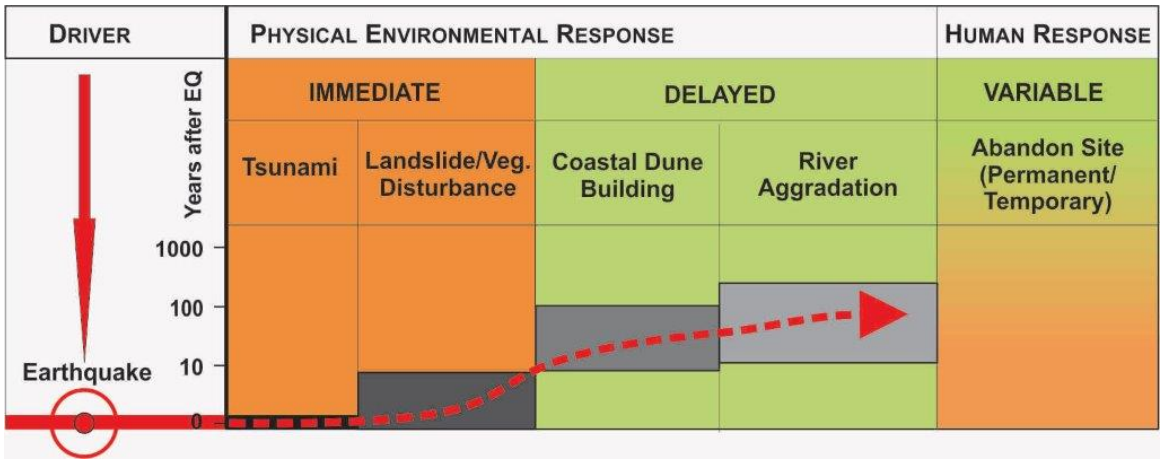
Figure 1: The seismic cascade of physical and human environmental responses to giant earthquakes (after Goff and McFadgen, 2002; Goff and Sugawara, 2014).

HCG35-10 Room:105 Time:May 27 11:45-12:00

Keywords: Earthquakes, Tsunamis, Dune ridges, Landslides, Rivers, Geomorphology



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HCG35-11 Room:105 Time:May 27 12:00-12:15

Equilibrium condition for high-concentration turbidity currents

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This research theoretically explore formative conditions and characteristics of high-concentration turbidity current. Generally, it has been suggested that suspended load even in very high-velocity flows such as tsunamis or turbidity currents cannot exceed 1-5 vol.%. This is because density stratification due to suspended load inhibit turbulence in flows.

However, it was revealed that flow can attain very high concentration (˜30%) of suspension because of hindered settling. When calculation starts from very high-concentration and high turbulent kinetic energy, positive feedback between sediemnt entrainment from a bed and hindered settling occurs, and finally flows reach the equilibrium condition in which suspended load is around 30 vol.%. This equilibrium condition requires (1) small grain-size (<200 micron meter), very high initial concentration (>20 vol.%), (3) high flow velocity (>5 m/s).

The origin of two types of turbidity currents, i.e. low- and high-concentration flows, has been subject to debate for sedimentologists. This research implies that two types of flows are generated from different initial conditions. For example, tsunami-generated turbidity currents are supposed to be low-concentration initally, so that they cannot increase their concentration even if the self-acceleration mechanism works. On the other hand, turbidity currents generated by subaqueous debris-flows are supposed to have very high concentration of suspension, and therefore they may sustain their high-energy and concentration for long distance.

Keywords: turbidity current, hindered settling, turbulence, suspension, turbidite

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HCG35-12 Room:105 Time:May 27 12:15-12:30

Modeling runout and deposition of dense granular flows and its application to pyroclastic density currents in nature

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Constraining physical parameters of pyroclastic density currents generated by collapsing of lava domes or eruption columns is important to assess volcanic processes and hazards, but is a significant challenge because the mechanics of pyroclastic grains and their interactions are incompletely understood. One approach has been to exploit the thinness of the flows relative to their length by employing a depth-averaged description. A key issue is the granular friction law that is introduced into the models. Recent laboratory studies on granular flows suggest that rheology can be described by friction coefficients. Variation of the friction coefficients related to physical parameters such as shear rate and pressure is captured through dimensionless numbers (e.g., Maeno et al., 2013). Under the shallow water assumption how well the friction models work remains unclear when applied to pyroclastic density currents in nature. In this presentation, I will introduce the shallow water model of granular flows with different types of granular friction laws, and discuss their application to natural system and related issues, taking a case study for Soufriere Hills volcano, Montserrat, Caribbean.

Recent dome collapse events at Soufriere Hills volcano provide good examples to study the dynamics of pyroclastic density currents and to examine granular flow models, because of abundant geological and geophysical data. Here the 20 May 2006 lava dome collapse and resultant deposit are focused. The total collapse volume of the 2006 event was 97 Mm^3, of which about half was dense granular components (Trovimovs et al., 2012). The seismograms showed a prolonged buildup of increasingly large block and ash flows lasting ˜90 min. The most intense phase that produced the main deposit occurred in 35 min with two marked peaks. Based on the collapsed volume and the duration of seismicity, an average collapse rate can be estimated to be $4.7*10^4$ m^3/s. On the other hand, the submarine deposit is characterized by an elongated shape in flow direction and by levee-like facies. The deposit shape was very different from that produced in the 2003 event where collapsed materials 170 M m^3 was released in 2.6 hours with an average collapse rate $1.8*10^4$ m^3/s, and the shape of proximal submarine deposit was characterized by semicylindrical, steep-sided lobes.

To investigate the factors controlling the shape of the deposit in 2006, the 2D shallow water model of granular flows with different types of Coulomb-type friction models is applied to the terrain of the Soufriere Hills. One had a constant friction coefficient, and another had a friction coefficient that depends upon the dimensionless inertial number (I) of the motion. For source condition, a constant mass or a line source with a flux function were used. Parameter studies were carried out within possible ranges of parameters such as volume, grain-size, and friction angles. When the I-dependent friction model was applied with a flux function and specific values of the parameters were used, the characteristics of deposit shape can be reproduced. The I-dependent friction model works better after the flow passing a slope break point where slope angle is equal to the friction angle at zero shear rate. Our results suggest that coupling effects of discharge rates, slope and granular friction properties may explain the different shapes of the deposits produced by dome collapse events at Soufriere Hills volcano.

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Keywords: pyroclastic density currents, granular flow, modeling, shallow water theory

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Distribution and its sedimentary process of river terrace deposits along the middle Kaligandaki, central Nepal

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”Kali Gandaki”is the river runs through the Himalayas from Tibetan plateau to Indian plain. A number of river terraces are distributed along the middle part of the Kali Gandaki. Recent researches reported that catastrophic events such as glacial lake outburst flood (GLOF) and large-scale slope failure have strongly affected developments of river terraces in the Himalayas (Takada,1992. Schwanghart et al,2014). The river terraces along the middle Kali Gandaki have also been thought to be composed of GLOF deposits (Yoshida & Upreti, 2014). Sharma (1980), Yamanaka (1982) originally classified the river terraces based on aerial photo interpretation. Although these pioneering studies have contributed greatly to our understanding of the geomorphological development of the terraces, the classification needed to be examined by using modern highly-accurate altitude measurements, such as GPS. In addition, lithofacies of the river terrace deposits have not been described, which hampers understanding of the depositional processes of the terraces and its origin. Therefore, we carried out re-classification of the terraces and sedimentological description of the terrace deposits along the middle Kali Gandaki (Beni ˜Phalebas) to understand their depositional process and origin. Here we report three achievements as follows.

1)Based on detailing geomorphological analysis by using GIS software coupled with absolute altitude measurements (GPS), the river terraces along the middle Kali Gandaki are re-classified.

2)Lithofacies of the terrace deposits, which were originally described as a single gravel bed, are subdivided into six different types. They often include high-density flow deposits such as debris flow or mud flow.

3)At the confluence of rivers, Iithofacies of the river terraces laterally change to be finer from the mainstream to tributaries. It indicates a rapid accumulation of the river terrace deposits along the mainstream of Kali Gandaki. These suggest that the geomorphological development of this area was (partly) affected by the GLOF events. We will focus on high-density flow deposits, and consider their depositional process, origin, and depositional age.

Keywords: Himalayas, Kaligandaki, River terrace

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Late Quaternary river terrace development and estimation of vertical crustal movement along branches of the Tone River

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Introduction

Vertical crustal movement can be estimated by seismologic, geodetic, geomorpholoical and geological approaches in short order. For prehistorical crustal movement, estimation based on geomorphological and geological evidence is valid. While marine terraces have been used in coastal areas (Koike and Machida, 2001), it is necessary to use a different method in inland areas. When similar longitudinal profiles of the river floor are made under similar climate conditions and similar sea levels, relative height between the two terrace levels formed in two successive full-glacial periods may indicates vertical crustal movement occurred in between the two full-glacial periods. This method is called TT (Terrace to Terrace) method (Yoshiyama and Yanagida, 1992). The accuracy of the crustal movement evaluation is considered to be reduced. For these reasons, there is a need for basic study to know the applicable accuracy and limitations of the TT method.

Purpose of study

Tajikara(2000) estimates the crustal movement in Tohoku region based on the TT method. There is also a comprehensively study classified the longitudinal profiles, which is an important element in our study, of the many rivers of Japan as an approximation function form (Honda and Sugai, 2011). By combining these results with this study, it is possible to analogize the tendency of longitudinal profiles change which is not yet fully understood in inland. The purpose of this study is to expand the range to which we can apply TT method in inland.

Method of study

In this study, we conducted a survey in the Kanna river area where fluvial terrace levels have been preserved well. First we made a landform classification by aerial photo interpretation, and we measured relative height of terrace surface using a simple laser surveying instrument. The major elemental composition of the wind stratification such tephra covering the terraces were analyzed using SEM EDS. We measured the relative height of fluvial terraces using 1: 25000 topographic maps of contour interval 10 m and 1: 2500 by the city planning map of contour interval 2 m along with laser meter, and we have created longitudinal profiles of the Kanna River bed and terrace levels.

Results and discussion

In the middle terrace of downstream region, AT tephra with age of 29ka was observed. Although marker tephras from the lower layer was not detected, the middle terrace probably can be correlated with MIS 6 because of such several conditions as gravel weathering below the layer and dissected terrace plain while the lower terrace has developed on wide area and hardly dissected. TT value is 19-29 m between MIS 6 and MIS 2, and average of crustal movement can be estimated to be about 0.14 - 0.22 mm/yr. In upstream region fluvial terraces can be classified into three levels in Sanchu area. The highest terrace possibly was formed in MIS 12. We made series of sampling in the upper terraces outcrop, and tried to determine the age of older (we suppose) than the last glacial age terraces by the tephra analysis.

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Keywords: fluvial terrace, TT method, crustal movement, tephra, longitudinal profile, Kanna River

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A numerical model for predicting alluvial cover in clast-rough and clast-smooth bedrock channel

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The areal fraction of bedrock covered by alluvium is typically modeled as a function of relative sediment flux (sediment supply rate over bedload transport capacity), yet little is known about how the roughness of the underlying bedrock affects the extent of alluvial cover. In this study, we performed flume experiments under varied sediment supply rates and bedrock surface topographies. We then developed a two-dimensional numerical model for predicting the cover fraction in consideration of the relative roughness (bedrock hydraulic-roughness over grain size), and tested the sensitivity of the model to changes in bedrock relative roughness and relative sediment flux.

The numerical results show that: 1) the cover fraction is smaller when the bedrock relative roughness is smaller; 2) when bedrock roughness is larger than alluvial roughness (clast-rough bedrock), the cover fraction gradually increases with sediment supply; 3) in the case of clast-rough bedrock with high sediment supply, mixed alluvial-bedrock alternate bars form, and a meandering thread of alluvial material migrates downstream; 4) when bedrock roughness is smaller than alluvial roughness (clast-smooth bedrock), a fully exposed bedrock channel requires a relatively large sediment supply before any alluvial patch is formed, and as supply increases, rapidly transitions to a fully alluvial channel; 5) in the case of clast-smooth bedrock, the transition between a fully exposed bedrock channel and a fully alluvial channel has hysteresis.

Keywords: Bedrock river, Fluvial geomorphology, Modeling, Sediment transport