Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

SCG73-01 Room:202 Time:May 21 13:45-14:00

Is dissolved salt necessary for the formation of continental shelves?

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Nearly all continents and large islands such as Papua New Guinea are surrounded by continental margins, each composed of a shelf, slope and rise. Here we consider siliciclastic margins constructed by fluvial input of terrigenous sediment, rather than carbonate platforms. Continental shelves tend be wider along passive margins and narrower along active margins, and in some cases bulge seaward in the vicinity of deltas. Shelves are nevertheless bench-like morphologies which continue from delta to delta without break. At stratigraphic time scale, this gigantic morphology has been interpreted as coastal plain that was exposed at low stand, but subsequently drowned during transgression. But even though near-stillstand has prevailed for the last 6000 years, there are many locations where shelves or protoshelves are being actively constructed by subaqueous morphodynamic processes, as manifested by offshore-migrating clinoforms. In the case of large freshwater lakes such as Lake Malawi or Lake Baikal, however,deltas appear as isolated protrusions with no connecting bench-like clinoforms. Here it is hypothesized that the difference between the two cases is mediated by dissolved salt. In so far as freshwater lakes present no density barrier associated with dissolved salt, rivers carrying suspended load show a strong hyperpycnal tendency, according to which they deposit their gravel and sand at deltas, and then plunge to form turbidity currents that carry mud directly into deep water. In the case of the ocean, however, the suspended sediment concentration required for river water to be heavier than standard seawater is 43,000 mg/l, a value that is only rarely exceeded in nature. As a result, nearly all river flows into the ocean are hypopycnal, forming surface plumes rather than plunging. As mud rains out in relatively shallow nearshore water, it can deposit a platform of terrigenous sediment to a height that is modestly in excess of wave base. This mud can then be mobilized by combined wave-current flows, delivered seaward and then deposited to form an offshore-migrating clinoform. This same sediment can be redistributed by alongshelf processes, so forming benches connecting deltas. It is thus hypothesized that continental shelves possess an aspect that is unique to seawater.

Keywords: continental shelves, deltas, turbidity currents, seawater, fresh water, siliciclastic margins

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SCG73-02 Room:202 Time:May 21 14:00-14:15

Autostratigraphy of delta-feeding continental shelves: A strategy to explore

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Autostratigraphy is the stratigraphy that takes full account of large-scale, deterministic non-equilibrium response of the depositional systems to steady dynamic forcing of basins. The primary target of autostratigraphy so far has been river deltas which are built during a single sea level rise or a single sea level fall. However, it is desired, and perhaps possible, to extend the autostratigraphy framework to a delta-feeding continental shelf system that grows under the intense influence of multiple sea level cycles. A preliminary view to explore such a new scheme of autostratigraphy is addressed. A key issue is to test by model experiments the hypothesis that (1) non-equilibrium stratigraphic responses *proper to* a delta-shelf system can change drastically as the shelf progressively expands seaward (i.e. as the sea level cycles proceed), and (2) this can account for a particular stratigraphic pattern of Quaternary shelf systems.

Keywords: autostratigraphy, continental shelf, river deltas, sea level changes, model experiment, non-equilibrium response

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SCG73-03 Room:202 Time:May 21 14:15-14:30

Characteristics of 2011 Kumano River flood deposits on off Kumano submarine slope

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Submarine flood deposits were obtained from off Kumano submarine slope. The flood deposits are characterized by homogeneous brown clay with sharp basal contact and higher bulk density than the hemipelagic mud. Comparison of sediment sequence with the previous report from the same slope indicates the brown clay is the 2011 Kumano River flood origin. There are some differences between the 2011 flood deposits and the 1889 Totsugawa flood deposits at the same site. The Totsugawa flood deposits was composed of thick sand beds with abundant plant debris, but the 2011 flood deposits had no or only a thin (less than a few mm) sand bed. Collapse of natural dams and rive mouth bars might be influenced to make such differences.

Keywords: marine sediments, flood, sea bottom environment, hyperpycnal flow

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SCG73-04 Room:202 Time:May 21 14:30-14:45

Stratigraphic patterns of turbidites in ponded submarine minibasins: Implications from flume experiments

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Minibasins are an important geomorphological feature on continental slopes. Minibasins are formed by various processes such as thrust movements or salt diapirs, and filled by hemipelagic mudstone and turbidites. Thus, morphodynamics of minibasins are significantly affected by the dynamics and depositional processes of turbidity currents. The behavior of turbidity currents can be classified into two types: surge and sustained types. Surge-type turbidity currents are reflected by the downstream lip of the minibasin, and the sustained turbidity current causes ponding of the minibasin. Ponded minibasins have clear interface of ambient water and turbid water, and this interface strongly affect the dynamics of inflowing turbidity currents. The resulting turbidite stratigraphic patterns are also supposed to be influenced by the ponding of the minibasins. This study aims to reveal the morphodynamics of the sustained turbidity currents and the resulting turbidite stratigraphic patterns in the minibasin.

To understand the depositional processes in minibasins, we conducted a series of flume experiments. The experimental tank used for the present study was Margi 6 (Length 6.5m $*$ Width 0.6m $*$ depth 1.3m) in Muto Laboratory, Faculty of Enviromental Studies, Nagasaki University. Inside Margi 6, a plastic tank (Length 6.5m $*$ Width 0.18m $*$ depth 0.83m) was placed, which kept salt water. During the experiment, both Margi 6 and plastic tank were filled with clear water. Inside plastic tank, an acrylic flume (length 4.0m $*$ width 0.04m $*$ depth 0.5m) was placed with a fixed inclination to simulate a minibasin. Then turbidity current was generated by mixing blue colored salt water (1.18 g/l) and plastic grains (specific density 1.5). Experimental turbidity current flows into the tank, causing the ponding of the minibasin with the interface between salt water and clear water. During the experiments, turbidity currents were supplied at a constant rate, and the interface raise also at a constant rate.

We conducted a series of experiments with different conditions, and the observation of the experiments revealed following six points:

(1) Subaqueous delta was formed in all experiments. The morphology of deltas resembles to the Gilbert-type delta whereas they show gradual transition from topsets to foresets.

(2) Slope of depositional surface changes from gentle to steep at near the saltwater-clear water interface, which corresponds to the location of topset-foreset transition

(3) Antidune and cyclic steps were formed on the topset slope, and plane bed were formed on the foreset slope.

(4) Topset foreset transition initial migrated downstream and then moved upstream when the saltwater-level was raised at a constant rate (autoretreat).

(5) During topset foreset transition was moving upcurrent, sediments did not reach the downstream slope (autobreak)

(6) Turbidite stratigraphic pattern at intersection (interface and acrylic frame tank), downstream part was filled with foreset deposits, middle part was filled with foreset deposits, and upcurrent part was filled with topset sediment. Movement of topset-forset transition depends on water discharge, sediment supply and rising rate of interface. Autobreak at downstream is caused by the limited length of topset.

Topset-foreset transition and the movement can be also observed at seismic section of the natural minibasins. Also the movement of topset foreset transition was reconstructed in numerical models. Comparing with flume experiment, numerical model and fieldwork, a synthetic model of the stratigrafic pattern of minibasin will be established in future studies.

Keywords: Minibasin, Ponding, Turbidite, Flume experiments

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SCG73-05 Room:202 Time:May 21 14:45-15:00

Limit of mountain growth in the rainfall-erosion and uplift experiment

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The experiments with rainfall-erosion and uplift of various rates suggested the existence of two threshold uplift rates, across which experimental landforms show different aspects of development. When the uplift rate is below the lower threshold, a certain characteristic relief determined by mound erodibility and rainfall intensity dominates. When the uplift rate exceeds the lower threshold, the uplift starts to exceed the erosion from the upstream area where fluvial erosion works less. Hills grow until slope failures occur. Slope failures and creep inside the uplifted area do not change average height unless the sediments are carried away from the uplifted area by fluvial processes. When the uplift rate becomes higher, hills grow more and sediment supply from slopes increases, but the resultant increase in gradients helps fluvial processes carry more sediments. Uplift and erosion become balanced to keep average height roughly constant, and similar landscapes exist for a long time. If the uplift rate becomes even higher and crosses the upper threshold, the uplift will overwhelm the erosion and hills will grow into high mountains. Two runs of the experiment (runs 25 and 26) reported here are the runs performed to examine this upper threshold of uplift rate.

A mixture of fine sand and kaolinite compacted in a square-prism-shaped container (c.a., 60 x 60 x 40 cm) was pushed out by a stepping motor and worm gears set beneath the bottom plate. Artificial rainfall of about 40 mm/h was applied on the square sand mound rising from a flat surface. Different from previous experiments, the width of deposition area was reduced to 10 cm, and mist type rainfall was generated from two spray nozzles. The uplift rate was 5 mm/h (run 25) and 0.4 mm/h (run 26). In run 25, average and maximum heights went up with the uplift, but the rise slowed down after 40 h and 56 h, respectively. After the average height went up above 100 mm (56 h), it started to decrease while the mound was still uplifted, and then decreased rapidly after the uplift stopped (72 h). The maximum height reached the peak (240 mm) at 72 h and then decreased rapidly. Both heights decreased only slightly after 150 h to the end (1000 h) with almost no change in topography. In run 26, the increase in average height with uplift started to slow down around 200 h. After it reached 100 mm at around 600 h, relatively rapid decrease and slow increase occurred repeatedly to keep roughly constant height around 80 mm. The maximum height also increased with the uplift until about 680 h (220 mm), but it showed changes similar to the average height after 680 h around the height of 200 mm.

Two runs showed similar limits of average and maximum heights despite their very deferent uplift rates, indicating the existence of a limit of mountain growth. This limit is considered to be determined by the width of deposition area and the mound material. The narrow deposition area probably worked to lower the limit of mountain growth significantly from the previous experiments, which had the deposition area 60 cm wide. The mound seemed to reach the limit before it attained the quasi-steady state height. The decrease in the rate of rise occurred when the sediments produced by large slope failures moved directly out from the deposition area around the mound. Judging from the maximum height, slopes seem to have a limit around 0.6 (30 degree), above which slope failures actively occur. The roughly constant height after 680 h in run 26 probably does not indicate the quasi-steady state but the limit of mountain growth. However, both average and maximum heights are higher than estimated from the previous experiments. The mist type rainfall could generate less surface water flow and therefore fluvial erosion. The decrease in erosion probably causes the decrease of the threshold uplift rate, and the mound could easily reach the limit of mountain growth lowered by the narrow deposition area.

Keywords: rainfall-erosion experiment, threshold uplift rate, limit of mountain growth, deposition area, slope processes, fluvial erosion

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SCG73-06 Room:202 Time:May 21 15:30-15:45

Reconstruction of suspension fluxes from branches of Yangtze River using quartz in river sediments

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In Yangtze River basin, water and sediment discharges are routinely measured at water stations both in the main stream and in branches, and it is possible to reconstruct temporal and spatial variability of sediment discharges by using these data. However, since the observation of sediment discharges starts only in 1950s, the sediment discharge history before observation can't be known directly. To estimate sediment discharge from each branch before 1950s, we plan to utilize the sediment records recovered from the Yangtze delta, and utilize the proxy to distinguish suspended particle from each branches.

In this study, we conducted water and sediment sampling along the main stream of Yangtze River especially at junctions with main branches. We focused on ESR signal intensity and CI (Crystalinity Index) of quartz in suspended particles in order to 1) characterize suspended particles from each branch, 2) reconstruct the ratio of suspended particles derived from main stream and each branch, and compare it with the ratio calculated from observational data, and 3) establish the proxy to distinguish suspended particles from different branches.

First, we reconstructed the ratio of water discharge by using the hydrogen and oxygen isotope ratio of water. The product of water discharge and sediment concentration gives the suspended sediment flux. Second, based on suspended sediment fluxes and ESR signal intensity and CI values of suspended particles of the main stream and of the branch before the junction, we estimated ESR signal intensity and CI values of suspended particles after the junction. If these estimated values agree with the actual values, it means that the reconstruction method works well and we can reversely know the mixing ratio of sediments based on the values of quartz in sediments after the junction.

Keywords: Yangtze River, river sediments, sediment flux, ESR signal intensity, Crystalinity Index

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SCG73-07 Room:202 Time:May 21 15:45-16:00

Numerical simulation of braided channels with aspect ratio larger than 1000

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Rivers all over the world face to a rapid climate change because of the global warming phenomena. Climate change will change the precipitation characteristics, sediment production characteristics and vegetation growth characteristics. As a result, water discharge, sediment transport rate and sediment size of bed material in downstream area will be changed. These spatiotemporal changes of water discharge, sediment transport rate and sediment size will change the geometric characteristics of channels and bed configuration. Braided channels produce diversified physical environment and it is considered that the diversity of the physical environment must affect on the quality of ecosystem in the river. Hence, the temporal changes of the bed configuration and geometric characteristics of bars affects on the quality of ecosystem. In this study, effects of increase and decrease in water and sediment supplies on geometry of braided streams with large aspect ratio (larger than 1000) are discussed by use of results of horizontal two dimensional bed deformation analysis.

The straight rectangular open channel with the constant channel slope is used as the calculation domain. The bed slope is 0.0032. The channel width is 1000m. These values are decided by channel characteristics of the Tagliamento River at the upstream area of Pinzano. The braided width is used for the channel width here. Hence, the channel width includes the potential channel area; the vegetated area along the river is included in the calculation area. The bed materials are treated as both non-uniform sediment and uniform sediment with a particle mean diameter of 2 cm. The distribution is decided by the results of field survey performed in Sep. 2009. Growth and wash away process of vegetation is considered in the model. 1200m3/s, 1800m3/s and 600m3/s are selected as the water discharges in the analysis. All hydraulic conditions are located in the formative conditions of braided stream (Takebayashi H. and Egashira S. (2000)). Water discharge in Case 1 is 1200 m3/s and the aspect ratio is 1204. Vegetation growth is considered and the bed material is treated as uniform sediment. Water discharge in Case 2 is 1.5 times as that in Case 1. Sediment transport rate at upstream boundary is calculated by use of the equilibrium sediment transport formula. As a result, the sediment discharge at upstream boundary in Case 2 is 2.7 times as that in Case 1. Water discharge and sediment discharge at upstream end in Case 3 are 0.5 times and 0.02 times as those in Case 1, respectively. Water and sediment discharges in Case 4 are the same as that in Case 2. However, vegetation growth is neglected in Case 4. Water discharge in Case 5 is the same as that in Case 1. However, bed material is treated as non-uniform sediment in Case 5.

The results are summarized as follows:

(1) The numerical model can reproduce the periodical multiple row bars which has 7 rows in the first stage of the bed deformation. The periodical bars are transformed to irregular braided channels.

(2) When water and sediment supplies are increased, the number of channels is decreased. In addition, when water and sediment supplies are increased, two or three large channels which have the nearly same scale are formed. These results show that the size distribution of habitats is changed very well due to the change of water and sediment supply conditions.

(3) When water discharge becomes half, sediment transport rate decreased to 2%, because sediment transport rate decreases rapidly near critical shear stress.

(4) When vegetation growth is neglected, the maximum scale of islands becomes smaller.

(5) When bed material has wide size distribution, the scale of the islands and the submerged bars becomes large. Furthermore, width-depth ratio of each channel becomes large, because armoring phenomena of bed material is developed in channels and bed degradation is suppressed.

Keywords: Braided channel, Numerical analysis, Aspect ratio, Vegetation, Tagliamento River, Multiple row bar

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SCG73-08 Room:202 Time:May 21 16:00-16:15

Channel networks formed on steep slopes due to rainfall

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It is commonly observed that channel networks are formed on slopes subject to erosion due to flowing water. Characteristic morphology of channel networks has been attracting many researchers' interest since long time ago. In the case of mild slopes for flow to be subcritical in the Froude sense, the flow is affected by morphology at the downstream end. Indentations formed at the downstream end of the slope attracts more water than other parts, and the resultant concentration of erosion takes place at the indentations. The interaction between flowing water and morphological changes causes the formation of channel networks. Taking into account of this physical process, the author has performed linear stability analysis to explain the formation of channels on mild slopes. According to their results, channels with spacing equivalent to the critical flow depth divided by the friction coefficient grow faster than those with other spacing. Estimating the friction coefficient to be on the order of 0.01, he concluded that the channel spacing is on the order of one thousand times the critical flow depth. On the other hand, however, his analysis shed no further light on the formation of channels on slopes in the Froude sense. In this study, a series of experiments have been performed to study the formation of channels on steep slopes. According to the experimental results, channels are formed from the downstream end in the case of relatively mild slopes such as 10 degrees, and the channel spacing is relatively large. When the slope angle is 20 degrees, relatively narrow-spaced parallel channels are formed on slopes. When the slope angle is larger than 30 degrees, rhomboid patterns of channels are formed on slopes.

Keywords: Channel network, gully, rainfall, erosion

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SCG73-09 Room:202 Time:May 21 16:15-16:30

Dune morphology changed by multiple flow conditions using a numerical simulation

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Sand dunes are found in many places such as deserts, the sea bottom and the surface of Mars. They are formed through interplay between sand and air flow or water flow. When a strong flow blows, sand grains are dislodged from the sand surface. The entrained sand grains collide with the ground and are sometimes deposited. This process takes place repeatedly, resulting in the formation of a dune. The profile of the wind flow is modified by dune topography. We reproduced some dune morphology in numerical simulations and investigate the dynamics, changing the environmental condition such as the direction of winds..

The motion of sand grains is realized by two processes: saltation and avalanche. Saltation is the transportation process of sand grains by flow. The saltation length and saltation mass are denoted L and q, respectively. Saltation occurs only for cells on the upwind face of dunes. The saltation length L and the amount of transported sand q are modeled by the following rules,L = a+bh(x,y,t)-ch2(x,y,t), where a=1.0, b=1.0, and c=0.01 are phenomenological parameters. The last term is introduced for L not to become too large. Note that L is used only in the range where L increases as a function of h(x,y,t). The saltation mass is fixed at 0.1 for simplicity. In the avalanche process the sand grains slide down along the locally steepest slope until the slope relaxes to be (or be lower than) the angle of repose which is set to be 34 degrees.

The dune pattern is classified by the amount of initial sand and directions of flow. For simulating multidirectional flow, wind direction is changed in a certain period Pch from one direction to the other. When the wind is unidirectional and the sand bed is thin barchans appear. When the wind is unidirectional and the sand bed is deeper, transverse dunes appear. As the amount of sand mass increases, the transverse dunes become wider. Linear dunes appear when the wind direction is two and sand bed is thick. As the amount of sand mass decrease, the linear dunes become drop dunes. When the number of wind direction is four Pch=100, star dunes appear. Also we reproduced network dune and make a catalog of them. We discussed about the formation processes of network dune.

Keywords: dune, morphology

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SCG73-10 Room:202 Time:May 21 16:30-16:45

Pattern formation of granular avalanches simulated by particle method with hydrodynamics interaction

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Avalanches, generally taken as a class of massive landslide phenomena, cover gravity currents and density currents, for instance, snow avalanches, debris flows, and pyroclastic flows. These flows migrate downward as a mixture of solid and fluid and form common structures, one of which is termed as the head-tail structure. Concretely, at the moving front of avalanche, a large head is formed by gathering the large materials, whereas at the rear end, an elongated tail is formed by leaving behind the smaller materials. As a factor for the formation of head-tail structure, the ratio of the air drag to the gravity is considered most relevant. For example, a granular flow consisting of the light particles like the polystyrene forms the head-tail structure as well as the wavy pattern with many heads at the moving front of avalanche [1]. In contrast, experiments using heavy particles (air drag $<<$ gravity) like the glass beads do not generate the head-tail structure although they form wavy pattern similar to ones using light particles [2]. Additionally, the experiment using light particles shows that the head size increase with the increasing particle radius. To explain these facts, several models have recently been proposed; the fluid flow model assumes an avalanching body as a mass of fluid, the mass center model assumes an avalanche as a huge particle, and so on [3, 4]. However, the materials constituting avalanches are granular materials such as polystyrene or glass beads and are definitely not fluid. Moreover, the interaction between particles may play a nontrivial role, which is out of the scope of fluid model and one particle model. The following our models are proposed to overcome the above shortage of previous models.

This model is roughly based on three basic assumptions; First, the granular consisting of spherical (three-dimensional) particles only moves along two-dimensional surface. Second, only the translational motion of particles is considered, whereas the rotational motion of particles is ignored. Third, as the force acting on the particle, we considered three types; (i) gravity as the dominant driving force of avalanche, (ii) repelling force between particles which causes the excluding volume effect, and (iii) drag force by fluid.

Numerical simulations using this model are conducted on a slope with a constant inclination angle. As initial conditions, we use 2000 particles and two different setup; i) circular and ii) linear. Simulations using i) show the formation of a single head and the vortex convection inside the avalanche independent of the particle radius, whereas an increasing in the particle radius enhances an effect to pull the rear particles forward. On the other hand, simulations using ii) show that the air drag destabilizes the initial straight front of avalanche to deform into a wavy pattern with many heads. In addition, the width of head increases with the number of particles constituting a head and gives a linear relation ship with the particle radius.

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Keywords: avalanche, pattern formation, particle method, numerical simulation

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SCG73-P01 Room:Convention Hall Time:May 21 17:15-18:30

Volume of turbidite body evaluated from 1-D geological information

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To estimate the volume of a sedimentary body composed of turbidite distributing three-dimensionally, using one-dimensional information such as the sedimentary log of outcrops or a borehole, several hypotheses and the experience and knowledge of specialists are required. For determining the sedimentary environments or depositional elements in turbidite successions, we will consider the thickness of individual turbidite beds, the ratio of hemipelagic mudstone to turbidite bed, variability of the turbidite thickness, lateral variation in bed thickness or sedimentary facies, and stratigraphic changes in these characteristics. Because these characteristics are statistical in nature, the consideration of these data of turbidites suggests that one-dimensional information makes it possible to estimate the volume of sedimentary body and lateral variability on the basis of sedimentary environments and depositional elements, even if it is hard to achieve. In this study, we present an evaluating method to estimate the volume of sedimentary body on the basis of bed geometries, bed thickness trends of depositional elements, and statistical data of turbidite successions in several examples.

In turbidite successions, examples of depositional elements that have a good continuity in the lateral direction include deep-sea channel fills, sheet-sand, and lobe deposits. Lobe deposits have a good continuity in the lateral direction and are one of the most important elements of sedimentary body in turbidite successions. Although these data are not independent variables, the following data are necessary for estimating the volume of sedimentary body from a one-dimensional columnar section: (1) lateral continuity and extent of the body, (2) thickness of the body, and (3) observation location of the body. In this study, we focused on lobe deposits, which have a large extent and can satisfy these conditions as compared to other depositional elements. First, we investigated the statistical characters and the method for determining the observation location from the lobe deposits from several turbidite successions, then applied the method, and as a case study, analyzed the turbidite succession of the Awa Group that have detailed three-dimensional information.

Keywords: turbidite, depositional body, volume, bed-thickness distribution, bed-by-bed correlation, depositional element

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SCG73-P02 Room:Convention Hall Time:May 21 17:15-18:30

Dynamics and sedimentary processes of the turbidity current generated by the 2011 Tohoku Oki Tsunami

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On the basis of the sea-floor sediment cores, records in ocean bottom seismometer and ocean bottom pressure observation, it was suggested that large-scale tsunamis influence deep-sea floor by generating turbidity currents. Tohoku Oki Earthquake (Mw 9.0) and subsequent large tsunami occurred at March 11 2011. Eastern Japan such as Sanriku Coast was severely damaged by the inundation of the tsunami. Coasts and levees were largely eroded by the tsunami waves. On the other hand, we revealed that the broad region of sea-floor from the shelf to the trench slope was covered by the muddy event deposit. OBP and OBS record suggests that the event deposit was transported by a turbidity current generated from the suspended sediment cloud caused by the tsunami wave. The current reached the OBP site that locates 70 km off Sanriku Coast 3 hours after the earthquake, and it was sustained at least 2.5 hours. The head velocity was approximately 5.5 m/s, and the sediment concentration was tentatively estimated as 0.9 ? 2.6 vol.%. The turbidite ranges from 0.3 cm to 15 cm in thickness, and consists of clay to coarse sands. This study reports on the distribution and the detailed characteristics of the turbidite, and estimates the morphodynamics of the tsunanmi-generated turbidity current.

Keywords: tsunami, turbidite, turbidity current, morphodynamics

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Geomorphological and sedimentological dynamic changes at the coast of Tottori Sand Dunes over a last half-century

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Since 1980's, coastal erosion and vegetation growth were key tasks at the Tottori Sand Dunes, south-west Japan. We surveyed these issues from a view point of basin-scale sediment systems. The Sendai River, which is the main river to supply sediments to the coast, has characteristics of intermittent intensive sand transport. As for offshore bars along the coast, we surveyed them by air photos from 1968 to 2008 in every 5 year intervals. The result indicates that offshore bars had declined in the period from 1968 to 1998, but have enlarged since 2003.These changes were caused by large floods at the Sendai River in 1998 and 2004. Grain size analyses of berm-crest sediments along the Tottori Sand Dunes coast were conducted repeatedly since 1955. The result is shown in the figure below. Median diameters of 2004-5 and 2009 beach sediments were coarser than 1.0 mm but ones at 2011 were decreased dramatically: finer than 0.5 mm, which is a similar value to 1955. These changes were perhaps caused by gravel harvesting activities at the Sendai River during 1960's -1970's, which conducted coastal erosion issues later and beach sediments coarsening at that time. The large flood events of 1998 and 2004, however, supplied huge amounts of fine sediment to the coast and enlarger offshore bars and then recovered the beach sediment to be finer since 2011. According to wind duct experiments, sediment transport rates by wind from beach are influenced effectively by their grain sizes. Vegetation growth issues at Tottori Sand Dunes might be related with beach coarsening and decrease in the amount of blown sand. So we are expecting that vegetation growth at Tottori Sand Dunes will attenuate naturally by the increase of blown sand from the beach in near future.

Keywords: offshore bar, beach sediment, grain size changes, the Sendai-river basin, major flood events, particle-size mixture effects on sediment transport

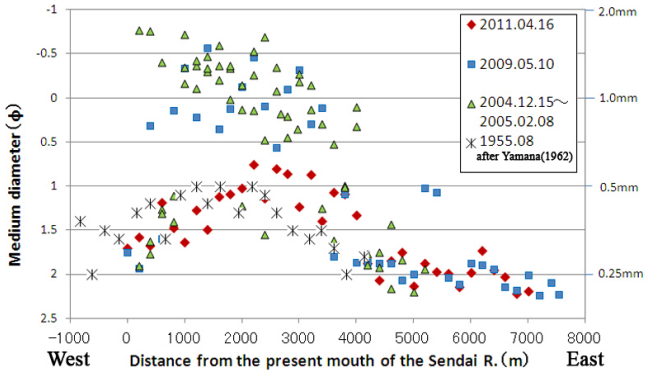

Fig. Medium diameter changes of beach sediments along the Tottori Sand Dunes over 56 years

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(May 20-25 2012 at Makuhari, Chiba, Japan)

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Influence of slow bed aggradation/degradation on river meandering

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It is commonly observed that rivers frequently change their courses under bed aggradation, and they do not shift their courses under degradation. In this study, influence of bed aggradation and degradation on river meandering is clarified with the use of linear stability analysis. In the analysis, we introduce the ratio between the time scales of channel shift and bed aggradation/degradation as a small parameter. Applying the multiple scale method and the WKBJ method with the small parameter to the formulation of river flow described by shallow water flow equation and the time variation of bed elevation by Exner equation, the growth rate of perturbation is derived as a function of the aspect ratio and the wavenumber of meandering. It is found that unstable region increases in the aspect ratio-wavenumber plane in the case of bed aggradation while stable region expand in the case of bed degradation. The implication is that river channels have high tendency to meander when bed aggradation takes place while straight channels tend to be maintained when bed degradation takes place.

Keywords: aggradation, degradation, meandering, linear stability analysis

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Re-evaluation of erosion rate in the uppermost reach of Yangtze River based on topographic classification using GIS

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Erosion and deposition in a river system in a tectonically active area plays a role in forming topographic features that keep balance with tectonic activity, and affect atmospheric circulation. Erosion also controls the rate of chemical weathering through interaction with physical weathering by increasing the surface area of rock. Supply of sediments due to erosion also accelerates the burial of organic matters in basins. These processes also affect climate through the changes in atmospheric composition. Therefore, it is important to know how erosion rate changes with changes in relief, uplift rate, bedrock geology, temperature, and precipitation in order to understand tectonics-climate linkage through landform evolution and global geochemical cycles. To discuss this issue, The Tibetan Plateau and surrounding river drainage basins are ideal because of their highly active tectonics.

Measurement of cosmogenic ^{10}Be concentration in quartz grains in river sediments is useful to estimate spatial distribution of relatively long-term erosion rate because river sediment samples are easily obtainable and quartz is common in these sediments. Indeed, there are several studies estimating erosion rates in the Tibetan Plateau and the Jinshajiang River, the uppermost reach of the Yangtze River in south China.

Two common assumptions of this method are 1) erosion rate is uniform within a drainage basin, and 2) eroded sediments do not stay long within a river system but discharge out of the system within a short period. However, such assumptions are not necessarily correct considering topographic variations in a basin and occasional occurrence of depositional landforms that may trap sediments for a long period. We call such landforms 'trapping features'. Previous studies in the Jinshajiang basin using ^{10}Be basically ignored the trapping features although they often occur in the basin. We extracted such features using DEMs(digital elevation models) and GIS and evaluated their depositional effect on erosion rate, re-estimated the sediment flux through the drainage basin, and examined the relationship of erosion rate with local landforms and geology.

Along the lower reaches of the Jinshajiang River, pull-apart-basins and their buried landforms (we call such landforms 're-claimed features') often occurs, whereas there are many small lakes along the uppermost reaches on the Tibetan Plateau. We regarded the reclaimed features and lakes as trapping features. We surveyed some local reclaimed features in the field and described their forms. Then, we used DEMs and ArcGIS to extract the reclaimed features and their source areas. Similarly, we identified the lakes and their source areas. We regarded the rest of the river basin as 'sediment supply area'. Then we re-calculated average erosion rates in the sediment supply areas using 10Be data from previous studies and compared the result with pervious calculations that did not take into account of the effect of trapping features.

The effect of trapping features reduced the estimated sediment flux in the Jinshajiang River basin to about 70% of the previous estimation. We plan to estimate the effect of the trapping features in the drainage area corresponding to each ^{10}Be sample, and discuss the distribution of re-estimated erosion rates in relation to topography, bedrock, geology, and climate.

Keywords: erosion rate, cosmogenic nuclides, GIS, Yangtze River, Tibetan Plateau

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Experimental study of liquefaction and fluid transport: effects of the low-permeability layer

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We report the results of laboratory experiments exploring how the water in a saturated granular medium (glass beads) migrates upwards when it is liquefied by an impulsive vibration. We conduct experiments in a two-layered medium where the upper layer has a lower-permeability and study how it affects the fluid migration. The permeability is controlled by the particle size. In a two-layered medium, we find that the pore water which has originated from the bottom layer temporary accumulates at the interface of the two boundaries, and then ascend through the upper layer in the form of a horizontal sheet or vertical channels. We find that these two different discharge styles are controlled by the permeability ratio of the two layers. We study the temporal change of thickness of the two layers and find that there are three stages; 1: the slope of the upper surface is levelled by the impulse, 2: the pore water is discharged from the bottom layer and accumulates at the interface, after which it migrates upwards, 3: water discharge ends, and the particles settle down. We measured the relaxation time needed for the discharge and compaction to end. Because low-permeability layer inhibits pore water from rising, longer time is needed for a two-layer case compared to the one-layer case. When the particle size of the upper layer is about 1/3 or less of that of the lower layer, relaxation time becomes independent of the bottom particle size. We modelled the relaxation time by introducing the effective permeability of two-layered medium, and find that it explains the measurements well.

Keywords: permeability, Darcy’s law, packing fraction, low-permeability layer

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Slumping of a granular mass on an unconfined slope

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Dense granular flows generated by slumping of granular mass are often encountered in industrial processes where the transport and deposition of granular material such as seeds, cereals, and tablets are involved. They are also observed in geophysical systems, such as pyroclastic flows caused by collapse of a lava dome or volcanic explosions, snow avalanches, and landslides.

Constructing a numerical model to capture the major characteristics of spreading granular materials in the above situations is a significant challenge because the mechanics of the grains and their interactions are incompletely understood at a fundamental level. This study investigated the dynamics of dense granular materials, released from rest and allowed to flow down an unconfined slope, driven by gravitational forces. First laboratory experiments were performed to study granular slumping, in which a measured volume of materials were instantaneously released from a cylindrical tube and spread across an unconfined rigid plane inclined at angles less than the repose angle. On release from the source the particles initially spread radially. However up-slope motion is rapidly arrested and motion down the incline is promoted, leading to an approximately ellipsoidally-shaped deposit once the flow has been fully arrested. Secondly, the flows were modeled under the shallow layer approximation and integrated numerically to capture the motion from initiation to final arrest. In modelling, two types of Coulomb-type friction models were introduced. One has a constant friction coefficient, and another has a friction coefficient that depends upon the dimensionless inertial number of the motion. When the initial aspect ratio of a granular mass and the slope angle is low (< 5 deg), the model with a constant friction coefficient can capture the deposit shape; but when the slope angle is increased, the inertial-number dependent friction model becomes more important. For high aspect ratio granular columns, the shallow water model fails to reproduce some aspects of the experimental observations. Finally an example of model application to geophysical systems is introduced.

Keywords: granular flow, slumping, pyroclastic flow, Coulomb friction law, shallow water theory

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Pore-Scale Simulations of the Diffusion in the Fluid-Saturated Porous Sediments using X-ray Microtomographic Images

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[1]AIST

The material transfer through the microscopic pores in fluid-saturated porous sediments is one of important subjects in sedimentology. We report the results of the application of computer simulations using three-dimensional pore-scale images to the diffusion in porous sediments(Ref.1). Some sets of three-dimensional digital images of sediment samples were obtained by X-ray microtomography. The steady-state diffusion or random-walk simulations were performed on the percolated pores of the images. The results show that (i) it is possible to complete the simulations using a commonplace 64-bit PC in a reasonable time and (ii) the spatial resolution of the CT apparatus is critical. This study was supported by JSPS KAKENHI (No. 23241012).

Ref.1: Nakashima et al. (2011) http://dx.doi.org/10.1007/s11270-010-0473-2

Keywords: sediment, X-ray microtomography, computer simulation, diffusion, porous media

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Cyclic steps formed by a hydrophobic fluid with water dispersed flowing on ice - an analogy with NPLD -

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A variety of characteristic landforms on Mars have been discovered since Mariner 9 spacecraft returned images of Martian surface in 1972 for the first time. Recently, in particular, spiral troughs on Martian north polar ice cap have been focused due to a possibility that characteristic landforms such as spiral troughs can reveal historical variation of climate on Mars. Though they are suspected to have some relation with katabatic wind blowing on the ice cap, it has been unclear how they are formed in detail. It has been observed that spiral troughs are formed perpendicularly to the direction of katabatic wind, so that they should be boundary waves formed between Mars atmosphere and ice rather than troughs excavated by flow. In addition, because internal structures of boundary waves clarified by radar show traces of upstream migration, these steps may possibly be cyclic steps formed by density airflow.

In this study, we have performed a series of analogue model experiments of the formation of cyclic steps on Martian polar ice cap. Experiments were conducted with the use of a low temperature chamber in the Institute of Low Temperature Science (ILTS), Hokkaido University. In order to simulate density airflow including water vapor blowing on Martian polar ice cap, we have used a hydrophobic fluid with water dispersed. We did not include temperature difference among ice, flowing fluid and ambient air, which is important for the formation of cyclic steps on Mars. It is found that cyclic steps were formed on ice even without the influence of temperature. It is suspected that the concentration of water in the hydrophobic fluid changes in space, and non-uniform freezing and melting take place on ice. This causes instability of a flat ice bed. By formulating freezing and melting rates of ice as functions of flow velocity and water concentration respectively, we found that the formation of cyclic steps on ice can be described by the equations similar to that for transportational cyclic steps formed on river beds composed of suspendable fine sand.

Keywords: Cyclic steps, Mars, Polar caps, Ice, Hydrophobic fluid

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An experimental study on cyclic steps formed in bedrock rivers

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A train of steps are often observed to be formed in bedrock rivers. They are thought to be cyclic steps formed due to erosion of bedrock. The erosion of bedrock is assumed to be dominantly driven by abrasion due to bedload sediment transport.

Here we demonstrated a series of flume experiments as an analogue of the formation of cyclic steps on bedrock. The experiments were conducted using the facility of Osaka Institute of Technology. We used a 1.5 m long, 2 cm wide, and 25 cm deep flume made by glass. The flume has 10 cm high weirs at the downstream end and 1.2 m upstream from the downstream end, so that there is an 10 cm deep reservoir. We put sand (0.2 mm in diameter) with cement (150:2) in the reservoir and hardened it so that the flume has an 10 cm 'model bedrock' on its bottom. The flume is tilted by 20 degrees. The water and sand (1.0 mm in diameter) is supplied from a head tank to the upstream end of the flume, flows on 'model bedrock' in the flume, and was dropped from the downstream end into a downstream reservoir, then pumped up to the head tank.

As a result, cyclic steps were formed on the 'model bedrock.' The shapes of the steps were resembled with the shape that predicted by theoretical analysis (Izumi and Yokokawa, 2011).

Keywords: Cyclic steps, Bedrock rivers, Flume experiments