Japan Geoscience Union Meeting 2012
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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.

References
[1] Y. Nohguchi and H. Ozawa: Phys. D **238** (2009) 20.
[2] O. Pouliquen, J. Delour and S. B. Savage: Nature **386** (1997) 816.
[3] C. Hartel, E. Meiburg and F. Necker: J. Fluid Mecha. **418** (2000) 213.
[4] Y. Nohguchi: Ann. Glaciol **13** (1989) 215.

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