

Impact of volcanic activity on Late Holocene sedimentation pattern of a river-lake system in Hokkaido

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Sediment production and sediment transfer through fluvial systems into oceans is very high on the Japanese Islands compared to other regions of the world, as most rivers in Japan are relatively short, show high gradients and are disturbed by human activity. In this study we reconstruct the sedimentation history of the floodplain of Bibi River and Lake Utonai to analyse the impact of volcanic activity on this river-lake system located in Southern Hokkaido. Bibi River is 17 km long and its catchment of 88 km² consists of the Eastern slopes of the active volcanic complex Shikotsu-Tarumae. The flat, 4.1 km²-large floodplain formed 3000 years ago after the regression of the Pacific Ocean. Bibi River drains into the North-Eastern section of Lake Utonai, which has a total area of 2.3km² with a maximum depth of 1m. During the last 3,000 years the catchment has been continually used for agriculture and was systematically developed since the beginning of the last century.

To analyze the volcanic impact 6 cores on the floodplain and 7 cores in the lake were taken. To distinguish between air-fall sediment and fluvially transported sediment the cores were sliced into 3cm or 5cm thick samples. For the 620 samples the parameters dry density and ignition loss mean grain size, sorting, skewness and kurtosis were determined.

Three air-fall deposits were identified as Ta-a (1736 A.D.), Ta-b (1667 A.D.), and Ta-c (3000 yBP) which each deposited 1.4 Mio t to 1.8 Mio t sediment on the floodplain and in the lake. Layer thickness on the floodplain depended on eruption direction. For the lake deposits, lake currents seem to focus of the air-fall tephra during flotation. About 0.6 Mio t of fluvial sediment was deposited on the floodplain during the last 3,000 years. During the period 1667 A.D. ? 3,000 yBP an average of 0.070t/ha/y were deposited with an increasing sedimentation rates downstream. During 1736 A.D. and 1667 A.D. an average of 1.5t/ha/y accumulated on the floodplain with highest rates in the middle reach. Sedimentation rates decreased to 0.69t/ha/y during the recent period (2006 A.D. - 1736 A.D.), but showed very high values near road construction sites of the last century. Lake deposition reached 0.05t/ha/y (present - 1736 A.D.), 0.47t/ha/y (1736 A.D. to 1667 A.D) and 0.04t/ha/y (1667 A.D. to 3,000 yBP) with highest sedimentation rates in the northern section due to sediment focusing.

Results suggest that the sediment stored on the floodplain and in the lake is dominated by air-fall tephra (4.6 Mio t out of 5.2 Mio t). Even though the catchment was disturbed by human activity only very little fluvial sediment was deposited on the floodplain or in the lake after the Ta-a eruption. This indicates that mid-Holocene coastal plains can significantly reduce sediment transfer through fluvial systems into oceans by buffering sediment on floodplains and lakes. This finding might not only apply to the study area, but also to other volcanically disturbed catchments with mid-Holocene coastal plains. In such systems the impact of volcanic activity may dominate over human and climate impact.

Keywords: volcanic impact, river, lake, Late Holocene

Hydro-environmental fluctuations inferred from physical properties of lacustrine sediments in Lake Onuma, Hokkaido

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Lacustrine sediments have high-resolution regional environmental information on lake and its surrounding catchments. Therefore they are of great use for reconstructing past hydro-environmental fluctuations, understanding lake-catchment processes, land-use changes and etc.

Here we discuss about hydro-environmental fluctuation during the past 100 years including the instrumental observation period and historical period on the basis of physical properties of Lake Onuma sediments. Lake Onuma, located in Hokkaido, is a dammed one. It is reported that the lake was formed by debris-avalanche deposit in the eruption of Mt. Komagatake in AD 1640.

Several surface sediment core samples were obtained with a gravity core sampler (1-m) in September, 2011. Some long core samples were obtained using a piston core sampler (4-m) in June, 2012. The analytical items discussed here include the following: water content, mineral content, grain density, grain size (whole and mineral) and radioactive concentrations of Cs-137, Pb-210ex and C-14.

Physical properties of sediment are compared with meteorological data for reconstructing hydrological condition. Meteorological data were observed in Mori local meteorological station and Hakodate Marine Observatory near Lake Onuma. Annual rainfall without snow cover period is used for discussion.

The core sample (ON11-2-1) obtained in the deepest point cover the hydro-environmental fluctuation during the past 100 years. It seems that some physical properties of the sediments (the mineral content and grain density) reflect the change in annual rainfall; the fluctuations in physical properties are corresponded to increase in annual rainfall around 1960.

Keywords: lacustrine sediment, lake-catchment system, rainfall intensity

Resolution of multibeam bathymetric mapping and the dimension of coral reef topography

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The complex reef topography such as spurs and grooves are difficult to visualize. This study attempts to observe 3D measuring and mapping of outer reef slope using high-resolution multibeam bathymetric sonar. The survey was carried out off the southern coast of Kume Island in the Ryukyu Islands, southwestern Japan. The minimum/maximum depth in the survey area was 0.2/284.7m in the measured area of 1.15 x 1.35 km. The reef topography was visualized with 2 m mesh-size for whole area, 1 m mesh-size for the area shallower than 60 m deep, and 0.2 m mesh-size at ~10 m deep. The bathymetric result was confirmed by SCUBA above the 40 m depth line.

The reef micro-topography (e.g., spurs and grooves) with the dimension ranges from units to tens of meters was visualized when 1 m mesh-size was adopted. The undulation associating with coral colonies which dimension is around tens of centimeters was not visible at the highest resolution map of 0.2 m mesh-size. The reef micro-topography was obscure when the mesh-size larger than 2 m was adopted. This comparison between the map resolution and the topographic dimension is useful for future bathymetric surveys.

Keywords: multibeam bathymetric survey, submarine topography, mapping, scale, coral reef, Kume Island

Model experiment on the development of isolated dunes using a circular flume

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A model experiment using a circular water flume was conducted to elucidate the formative process of isolated dunes from the condition where there was no available particle on the bottom surface. Such condition often occurs in various environments, e.g., the margin of large dune field, the seafloor affected by tidal flows, and the snow surface having a snowstorm, although the whole process have never been observed yet.

The experimental procedure was as follows. In advance, a given amount of very fine sand was put in the channel, and then a strong water flow was exerted to suspend all sand from the bottom. After that, the flow velocity was reduced to the given velocity, and an experimental run started. During the run, 20 g of the sands were supplied in the flume every 6 minutes. The development of topography was recorded by digital cameras from the top and side of the flume, and the distribution of the flow velocity was measured by the PIV method.

The isolated dunes developed on the solid surface (flume bottom) from sand ribbons through sand patches and protodunes. Sand ribbons, the first feature that appeared in this experiment, were stream-like and low-relief features parallel to the flow direction. The ribbon covered almost the entire bottom of the flume. After that, sand patches were formed on the sand ribbons, and then the patches elongated transverse direction. Protodunes developed from the transverse sand patches. Finally, mature dunes that have a clear slipface appeared.

Keywords: flume experiment, protodune, sand patch, sand ribbon

Salt weathering susceptibility of natural limestone and reconstituted stone used in the Orval Abbey, Belgium

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To understand the weathering of the building stones observed at the Orval Abbey, a major monument of southern Wallonia, Belgium, environmental conditions prevailing there and rock properties were investigated and a weathering experiment was performed. The Abbey was partly destroyed and rebuilt several times since the Middle Ages. The older buildings were constructed with two types of natural stones: (1) the Bajocian limestone (BL) with abundant well-preserved calcite shells and (2) the Sinemurian limestone (SL), rich in quartz grains. The materials of the newer buildings constructed during 1932-1948 were mostly reconstituted stones (RS) agglutinated using cement with crushed two types of limestones. Ironically, the new material RS are much more susceptible to salt and frost weathering than the two natural limestones, BL and SL. A measuring station was set up at the newer building to monitor temperature and relative humidity. The temperature fluctuated between ca. -10 and 30. The RH was between 20 and 100%. Rock properties of the three stones were tested: bulk density, porosity and tensile strength. Bulk density of BL, SL and RS are 1.9, 2.39 and 1.79 g/cm³, respectively, whereas porosity values are 29.0, 12.9 and 32.8%, respectively. The dominant pore size is a few μ m for SL, a few tenths of μ m for BL and 0.01-1 μ m for RS. Tensile strength of BL, SL and RS are 3.05, 4.82 and 1.38 MPa, respectively. A capillary rise experiment was also performed using the three rocks and three solutions; saturated Na₂SO₄ solution at 20, 50 %-saturated Na₂SO₄ solution at 20 and distilled water. The results showed that RS had the fastest rates of capillary rise under saturated Na₂SO₄ solution and nearly the same rates of 50 % saturated Na₂SO₄ solution as BL. After the capillary rise test, RS was completely destroyed but BL was not. Thus, it is considered that RS has less durability for salt weathering, even though it has higher strength than BL and SL.

Variations in Adsorption Coefficient of ^{133}Cs and ^{87}Sr Caused by Oxidation of Pumice Tuff

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Long term weathering processes in the geosphere surrounding the repository by contacting the surface/subsurface water can lead to the formation of redox front zone. This zone might have significant effect on the adsorption of certain nuclides that could be released from the radioactive wastes. Cesium (Cs) and strontium (Sr), which are common non-redox-sensitive elements released from such wastes, are strategically very important for the performance assessment of a radioactive waste repository. Thousands of radionuclide adsorption data are available in literature where different types of rocks/minerals are used for measuring adsorption quantity in terms of distribution coefficient values of many radionuclides in variety of experimental conditions. In recent years, adsorption characteristics of radionuclides in the oxidizing or reducing conditions have gained interest because of frequent presence of such environment in the subsurface where ground water-rock interaction occurs.

In the present study, an attempt has been carried out to investigate the effect of such redox phenomena on the adsorption coefficient of Cs and Sr on pumice tuff, which is already been selected for hosting low and intermediate level radioactive wastes in Japan. Powder of 150-300 micrometer size pumice tuff was used as solid phases of rock. Specific surface area of the fresh and oxidized pumice tuff were determined by mercury intrusion porosimetry. Mineralogical composition of pumice tuff was done by X-ray diffraction spectrometry and optical microscopy. Batch sorption study was carried at wide range of pH 4-12, varying nuclide concentration from 10^{-4} to 10^{-7} M and high ionic strength of 1.0 and 3.0. Solid-solution contact was made for 12 weeks with pH adjustment at every 2 weeks as necessary. Redox potential of the solutions was monitored to check the tendency of being oxidized. The Cs and Sr concentration in the aqueous phase was determined by ICP-MS and finally adsorption data-set were simulated by the surface complexation model with the help of IgorPro 6 software. Higher adsorption coefficient values were obtained in the oxidized part than fresh pumice tuff for both cesium and strontium. This is indicative to increase of available adsorption sites on the surfaces of tuffs due to oxidizing phenomena.

Keywords: Distribution coefficient, Cesium, Strontium, Redox zone, Pumice tuff

An analysis of radiocesium distribution map due to accident of the Fukushima Dai-ichi nuclear power plant by using stere

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The Great East Japan Earthquake on March 11, 2011 generated a series of large tsunami waves that resulted serious damage to the Fukushima Daiichi nuclear power plant (NPP) and radioactive materials were discharged to the environment. After this accident, various types of measurements were performed to obtain the affected range and concentration of radioactive material depositions. In particular, the aerial radiation monitoring (here after ARM) has measured the ambient dose-rate and radiocesium deposition in large areas including those above the forest and the high mountain which people couldn't enter easily on foot or by vehicles, it is useful for grasping the distribution of contamination. It is thought that understanding the feature of the place where the radiocesium has deposited leads to solving the behavior in the atmosphere of the radiocesium discharged by the accident. In recent years, a stereoscopic slope mapping method has developed by the progress in analysis using digital elevation model (DEM) and being used widely. Since the geographical feature can be visualized to 3D-images by this technology, it is used for understanding the geographical features in various fields. In this research, we tried to analyze in visible clearly about the distribution of the radiocesium deposition by lapping the ARM results over the stereoscopic slope map.

The distribution map of the radiocesium deposition which was obtained by the ARM was lapped over the stereoscopic slope map of the whole of Japan by using 10m-mesh DEM data. The DEM data we used for analyzing the ARM data were employed 1.8-km, 3-km, and 5-km mesh data for the areas around the NPP, East Japan, and West Japan, respectively. The ARM data between each point of measurement were interpolated by using a GIS software. The interpolated data were outputted as a 25-m mesh data of the dose-rate map. Here we have lapped the data over the stereoscopic slope map

As a result, the high dose-rate areas more than 1.0 micro Sv/h spread from the NPP to 80 km northwestward, and it turned out southwest from there that the place more than 0.1 micro Sv/h. As for this distribution, radiocesium seems to pass along the low elevation areas between high mountains. On the other hand, the southern part of Iwate Prefecture and the southern part in Ibaraki Prefecture showed that the place more than 0.1 micro Sv/h is flat places comparatively.

It can become the assistance which solves the radiocesium diffusion and its migration by applying this technology to the detailed measurement result used the other monitoring, such as the radiation surveys by using unmanned helicopters.

Keywords: Stereoscopic slope map, Aerial monitoring, Accident of Fukushima Daiichi nuclear power plant, Radiocesium

Geomorphological influences of the tsunami and river floods on the lower Natori River unprotected floodplain

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The lower reaches of the River Natori were attacked by the tsunami disaster of the 2011 Tohoku Earthquake. The unprotected floodplain along the river is traditionally used for farmlands. This study aims to discuss the geomorphological influences in the unprotected floodplain on the degree and types of damage to the farmlands caused by the tsunami flood and river floods after the tsunami disaster. The tsunami ascended more than 8 kilometers from the river mouth in the present channel. It ascended about 6 kilometers on the unprotected floodplain whose surface is 1 to 4 meters higher elevation than the present river channel. On the floodplain micro-landforms such as shallow ditches of former channels and relatively higher parts of islands are well preserved without artificial change. The tsunami flood ascended selectively through the shallow ditches in the upper part of the tsunami affected reaches. On some islands farmlands survived from the tsunami flood. After the tsunami disaster three times of river floods attacked the floodplain in September 2011 and May and July 2012. The fresh water of the river flood washed away the salinity of the tsunami sediments in the surface soil. It is good for growing vegetables in the floodplain. However, flood water ponded in the shallow ditches every flood event and it continued for a longtime. This severely damaged farmlands.

Keywords: tsunami flood, river flood, 2011 Tohoku Earthquake, unprotected floodplain, micro-landform, River Natori

Investigation of possible collapse of the wall of the underground munitions factory in Yoshimi Hyakuana historical site

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Deterioration due to salt weathering is a small scale phenomenon in general. However, the weathering might cause a serious failure after rock strength reduction as a result of the weathering for a long time. This study attempted to rock stability analyses on both ceiling and side wall rocks of underground munitions factory in the historical site Yoshimi Hyakuana. In order to evaluate the rock strength, Equotip hardness test and point load test, because it could not make core specimens for uniaxial strength test using collected rock samples from the site. Stability of ceiling wall rocks was analyzed using converted values obtained from these field data and it resulted in fairly stable at present. With considering the recession of the wall due to salt weathering, the calculated stability is somehow reduced. During the salt weathering, the strength of outermost surface of the rock wall decreases significantly. Stability of the outermost rock-wall was examined and resulted in adequate threshold strength of pre- and post-exfoliation.

Keywords: salt weathering, tuff, stability analysis, rock strength, Equotip hardness test, Yoshimi Hyaku-Ana

Laboratory experiment of scale effect for frost shattering

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This study investigated the size effects for frost shattering on A) welded tuff B) limestone C) tuff D) tuffaceous sandstone and E) sandstone. These samples are made into 1cm, 2cm, 3cm, 4cm and 5cm cubes. Freeze-thaw experiment were performed under the repeated temperate condition between repeated +15°C and to -15°C. This individual cycle continues 6 hours and up to 400 cycles. Exfoliation patterns are summarized that 1) small samples divided into two pieces with nearly equal sizes, 2) the amount of debris increases with decreasing the specimen sizes, and 3) small samples were rocks having bulk density and high porosity tend to be more damaged by frost shattering.

Keywords: frost weathering, frost shattering, size effect, laboratory experiment