

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

キーワード: volcanic impact, river, lake, Late Holocene

Keywords: volcanic impact, river, lake, Late Holocene

北海道，大沼湖沼堆積物の物理量から推測される水文環境変動 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.

キーワード: 湖沼堆積物, 湖沼 - 流域系, 降雨強度

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

マルチビーム測深地形図の解像度と礁地形の規模

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

円筒水路を用いた孤立砂丘の形成プロセスのモデル実験 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.

キーワード: 水路実験, プロトデューン, サンドパッチ, サンドリボン

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

オーバル修道院における人工石材の物性と塩類風化に関する研究

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 μm for SL, a few tenths of μm for BL and 0.01-1 μm 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

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.

キーワード: Distribution coefficient, Cesium, Strontium, Redox zone, Pumice tuff

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

立体地形解析図を用いた福島第1原子力発電所事故による放射性セシウムの沈着状況の解析

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.

キーワード: 立体斜度図, 航空機モニタリング, 福島第1原子力発電所事故, 放射性セシウム

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

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.

キーワード: tsunami flood, river flood, 2011 Tohoku Earthquake, unprotected floodplain, micro-landform, River Natori

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

史跡・吉見百穴の地下軍需工場坑道壁の崩落可能性の検討

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

凍結破砕に与える礫の寸法効果に関する研究 Laboratory experiment of scale effect for frost shattering

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1. はじめに

岩石の凍結破砕に関して、既往の実験には、岩石の種類と物性の関係に着目したものが多く、しかしながら、野外には様々な環境（礫種、礫径、温度等）があり、凍結破砕が活発に進行する条件は明らかにされていない。野外での凍結融解プロセスによる礫の移動に関する観測も多く行われてきたが、礫の移動を十分に説明するためには凍結破砕の影響を考慮する必要もあると考えられる。同じ環境下においても礫の寸法によって凍結破砕の速度が異なり、周氷河環境下における物質移動速度に大きな影響を与えていると思われる。しかしながら寸法の違いが凍結破砕にどのように影響するのかを試みた実験は少ない。そこで本研究では凍結破砕に与える礫の寸法効果を室内実験で検証した。

2. 実験方法

試料には5種類の岩石を異なるサイズの立方体に成形したサンプルを用いる。サンプルはA. 溶結凝灰岩（芦野石）、B. 石灰岩（サブオニエール石灰岩）、C. 凝灰岩（大谷石）、D. 凝灰質砂岩（福島県達瀬町）、E. 砂岩（白浜砂岩）である。凍結破砕作用への抵抗性について、その寸法効果を検証するため、これらの岩石を大きさを変えて成形した。溶結凝灰岩、石灰岩、大谷石の3種類についてはそれぞれ一辺が5, 4, 3, 2, 1の5つの供試体を用意し、凝灰質砂岩、砂岩の2種類についてはそれぞれ一辺が2, 1の2つの供試体を用意した。有効内容積が130^{cc}、器内温度設定範囲が-15 ~ +50℃、運転モードとして定値運転とプログラム運転が可能なインキュベータに試料を容器ごとに入れ、最高+15度、最低-15度、周期6時間（1日4サイクル）の温度変化を繰り返し試料に与え、破砕速度や割れ方を観察した。

3. 実験結果

いずれのサンプルも大きさが小さい方が破砕速度が速い傾向にあることが分かった。特にB石灰岩、C大谷石、D凝灰質砂岩でその傾向は顕著であった。A溶結凝灰岩はサイズが1cmのサンプルのみ破砕した。またE砂岩を除く4種類の岩石ではいずれも、一辺が1cmの最も小さなサンプル（A1, B1, C1, D1）だけが400サイクル以内に2mm以上（サンプル本体+破片）の乾燥質量がほぼ0となり完全に破砕した。

E砂岩を除いた4種類の岩種については、破砕しにくい岩石の順番がA溶結凝灰岩、D凝灰質砂岩、B石灰岩、C大谷石であり、密度が大きい順番がA溶結凝灰岩、D凝灰質砂岩、B石灰岩、C大谷石なので、破砕しにくい岩種ほど密度は大きいことが分かった。

また空隙率は小さい順にA溶結凝灰岩、D凝灰質砂岩、C大谷石、B石灰岩であり、破砕しにくい岩種ほど空隙率は小さい傾向にある。E砂岩については密度・空隙率の値がA凝灰岩と近いにもかかわらず、破砕速度が速かった。

4. 考察

全ての岩質で寸法が小さい方が破砕速度が大きい。特に1辺1cmのサンプルは全ての岩型が400サイクル以内ですべて2mm以下粒子となる。この理由として、凍結破砕は岩石の表面から中心部に時間をかけて進行し、岩石が完全に破砕するためには岩石の中心部まで凍結が及ぶ必要があるためと考えられる。空隙率が大きく、密度が小さい岩型ほど破砕速度が大きい傾向にあるが、砂岩のみについては異なった。これは、岩石の空隙率が大きく密度が小さいほど岩石の中心部まで水が浸透する時間が短いためと考えられる。

以上のことから、自然状態において岩石が破砕する理想的な条件として、岩石が多孔質で径が小さく（厚さが1~3cm程度）、-10 ~ +10℃くらいまで気温変化し、6時間以上の凍結があることなどが挙げられる。

キーワード: 凍結風化, 凍結破砕作用, 寸法効果, 室内実験

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