

## 屋久島とイングランド南西部ダートムーアにおける起伏構造と地形の類似性 Similarities in relief structure and landforms between Yakushima Island in Japan and Dartmoor in southwest England

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Relief structure and landforms was examined in two granitic mountains, Yakushima Island in south Japan and Dartmoor in southwest England. This study aims to compare these geomorphological characteristics between two mountains which have different geomorphological and geological settings.

Yakushima Island mainly consists of the Yakushima Granite dated at about 16Ma, which intruded into the Kumage formations of the Palaeogene. The highest peak is 1936 meters a.s.l. The area of the island is about 500 sq. kilometers. Dartmoor is underlain by a major batholith dated at 280 Ma which intruded into the sedimentary rocks of the Devonian and the Carboniferous. The area of Dartmoor is about 1000 sq. kilometers. The highest peak is 621meters a.s.l. Yakushima Island has been uplifted since the middle Pleistocene with high rate, whereas Dartmoor is in the tectonically stable environment.

In this study digital terrain model was used for analysis of the relief structure. The standard deviation of altitude in a 1 sq. kilometer unit is used for expressing relief. Each unit square includes 25 lattice points of a grid system with intervals of 250 meters. It is obtained from 1:50,000 scale topographic maps in Yakushima Island area and from a 50m-DTM made by Ordnance Survey Britain (OS) in Dartmoor area.

Although mean altitude and mean relief in Yakushima Island are higher than that in Dartmoor, shape of cross sections and pattern of altitudinal change in relief within each area is quite similar. The both mountains have a circle-like planform and a domelike profile. Relief increases with altitude in lower part of the both mountains. In the higher altitude area which is located in the central part of the two mountains relief decreases with altitude. This shows that relief structure of the both areas is characterized by the higher relief rims and the lower relief central parts. The cross sections of the dissected rivers show that the valleys with steep side slopes are found near the rims of the mountains and shallow valleys with gentle side slopes are found in the central part of the mountains. Although altitude, relief and inclination of slope are quite different between the two mountains, several similarities are found in relief structure and landforms, which could characterize the granitic mountains.

キーワード: 花崗岩山地, 起伏構造, 地形, 屋久島, ダートムーア

Keywords: granitic mountains, relief structure, landform, Yakushima Island, Dartmoor

## インド洋の環礁におけるファロの形成過程 Development of faro topography in the Indian Ocean atoll

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Faro (little ring-shaped reef, miniature atoll) is a circular reef, usually less than 3 or 4 km in diameter surrounding a shallow secondary lagoon of depths generally less than 20 m which is a characteristic feature in Maldivian coral reef. Because faros rise from the lagoon floor and edges of atolls, their mode of formation must differ from oceanic atolls whose foundations extend to great ocean depths (McLean 2011). However, there has been no substantive study of faros in Maldives.

Holocene reef structure and formation process are observed through an ocean-lagoon transect across the atoll-rim by observations of drilling cores and submarine exposure of reef interior at North Male Atoll, Maldives. We found a distinct faro formation during the Holocene reef development in Male Island which is the first report for substantive study on faro development.

The drilling penetrated 53.5m is conducted at the southeastern part of Male Island where former reef-crest lies under the present reclaimed land. Five reef units are defined from lithofacies of the core. In each reef unit, coral-algal bindstone accumulated on the top of loose reef sediments. The top unit is the post-glacial reef. The other four units are the Pleistocene reefs. The thickness of the post-glacial reef is around 8m where the coral-algal bindstone forms the uppermost 3.3m.

The post-glacial reef structure is also observed at a lagoon slope of the northeastern Male Reef from an exposure of reef interior down to 25m deep where a reef failure happened. The exposure composed of the post-glacial reef. The rigid reef structure is observed at the upper 2m of the lagoon-slope. The antecedent atoll-rim topography of the post-glacial reef is shallower at the rim and deeper beside the lagoon in the North Male Atoll.

AMS datings of the coral/algal samples show the development of the atoll-rim reef after 8,000 cal yBP. The upward reef growth in the early to middle Holocene is the same pace with the sea-level rise at the seaward edge and lagoon-ward edge which reached to the sea-level in the middle Holocene. The typical faro topography formed in this stage. The additional upward reef growth observed from drilling core at the seaward edge indicates the middle Holocene sea-level highstand in Maldives. Faro lagoon is buried by loose reef sediments after the middle Holocene.

Keywords: atoll, faro reef, coral reef, drilling core, Holocene, Maldives

## ベトナム北部，紅河デルタの自然堤防形成と遺跡分布

### Natural levees and human settlement in the Song Hong (Red River) delta, Northern Vietnam

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The Song Hong (Red River) delta, northern Vietnam, is characterized by huge natural levees in an area of the delta plain known as the West Floodplain where fluvial sedimentation predominates. The natural levees along the Day River, a major distributary of the Song Hong, are larger than those of the main course of the Song Hong. The Day River levees are 3.8 km wide and rise 3.5 m above the adjacent backswamps and have played an important role in human settlements since the late Metal age. We reconstructed the Holocene evolution of the Day River levees to determine their relationship to Holocene sea-level change, delta progradation, and the distribution of archaeological sites on the delta plain. During the early Holocene, the accumulation of sediment discharged by the Song Hong enhanced both aggradation of the levees and river mouth progradation within the drowned valley of the Song Hong. Radiocarbon dates from cores, trench exposures, and archaeological sites record a dramatic slowing of aggradation when sea level stabilized during 6.4 cal kyr BP (the Holocene sea-level highstand). As sea level fell to the present level during 4.0 cal kyr BP, the river mouth prograded rapidly toward the Gulf of Bac Bo (Gulf of Tonkin) and the river channels extended seaward. In the West Floodplain, lateral accretion overtook vertical accretion to generate the present longitudinal profiles of the Song Hong and Day rivers. During this period, human settlements spread across the backswamp and Holocene terrace area, lagging around 2 kyr behind the shoreline migration.

キーワード: 堆積速度, 考古遺跡, デルタ, 自然堤防, 海水準変動

Keywords: accumulation rate, archaeological sites, delta, natural levees, sea-level change

## モンゴル北部フデル泥炭地における完新世の環境変動 HOLOCENE ENVIRONMENTAL CHANGES IN KHUDER PEATLAND, NORTH- ERN MONGOLIA

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Holocene paleoenvironment in Khuder peat bog, the northern Mongolia was reconstructed by diatom and pollen analyses on peat boring samples. Diatom records of two boring cores showed a general chronology of peat land development from stream environments, marsh and then to the present acidic peat bog established as early as in the mid Holocene. Pollen and diatom records revealed Mid-Holocene drought from 6,000 to 3,000 cal yr BP and its periodic extent was correlative with other studies in Mongolia and the southern Siberia.

Abrupt changes of water environment and vegetation observed are associated with global climatic changes such as the Bond events occurred in North Atlantic Ocean. Cooler period of Little Ice Age and the warmer period of Medieval Warm Period were also remarkably manifested respectively as dry and wetter spells implying a strong connection of climate changes around the Northern hemisphere. However, climate changes contradictive with the results of other studies were also often observed, so the geographical features, pedology and orography should be the key control factors for the moisture balance of the area. We inferred that the observed climatic changes would be reflecting displacement of continental dry region as the study area is located in the transitional vegetation zones between Siberian taiga and Mongolian arid steppe.

キーワード: モンゴル北部, 完新世, 気候変動, 泥炭

Keywords: Northern Mongolia, Holocene, Climate change, Peat sediment

## 琵琶湖周辺における湖沼堆積物に記録された大洪水イベント Disastrous flood events found in lacustrine sediments around Lake Biwa

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Lacustrine sediments have high-resolution regional environmental records on lake and its surrounding catchments in addition to global information. Therefore they are of great use for reconstructing past hydro-environmental fluctuations and understanding lake-catchment processes. Lake-catchment systems with many instrumental stations are of great use for past environmental reconstruction in detail and process-understanding of the systems (e.g. Lake Biwa).

Here we discuss about hydro-environmental fluctuation in the instrumental observation period on the basis of physical properties of sediments. Some sediment core samples were obtained with 1-m sampler in Lake Biwa and Lake Yogo, central Japan.

Analytical results for the core sediments, obtained in Lake Biwa, show that disastrous flood events, Isewan Typhoon (1959) and Meiji heavy rainfall (1896), are clearly recorded in physical properties of sediments; density and mineral content are good proxies of rainfall intensity (100mm excess rainfall); and grain size distribution in lakes may be a function of rainfall intensity in the catchment and transporting distance from the river mouth. Additionally, we compare results of physical properties of sediments in Lake Biwa with those in Lake Yogo during the flood events in detail.

キーワード: 洪水イベント, 湖沼堆積物, 湖沼 流域プロセス

Keywords: flood event, lacustrine sediment, lake-catchment process

## 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 km<sup>2</sup> consists of the Eastern slopes of the active volcanic complex Shikotsu-Tarumae. The flat, 4.1 km<sup>2</sup>-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 2.3km<sup>2</sup> 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

## セメント系材料の混入による土壌中自然含有重金属類の溶出可能性に関する研究 Leachability of heavy metals and arsenic in soils due to contamination of disposal cement building materials

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日本の国土は多様な地質からなり、火山や温泉が多数分布している。そのため多くの地層、岩石がしばしば重金属を含んでいる。埼玉県荒川低地においても、堆積物中に砒素や重金属が多く含まれる層が存在することが指摘されている。これらは海成層であることが多く、微小の貝殻などを含むことから、他の層準よりもpHが高くなることが多い。このことから、pHの高低と、砒素などの重金属の溶出量の間には何らかの関係があることが推測される。また今日では、コンクリートは、ビルや住宅、橋梁、ダムなど多くの構造物に用いられており、我々の生活に欠かせない材料である。しかし一方で日々多くのコンクリート構造物が老朽化、もしくは用途がなくなった等の理由で撤去されている。その際に微量ではあるが、構造物撤去後の跡地にコンクリートが残留してしまう。その結果として跡地周辺のpHが上昇し、土壌に含まれていた重金属が溶出し、土壌汚染を招く可能性がある。そこで、pHの上昇と、重金属の溶出の関係性を明らかにすることを目的に実験を行った。

本研究では骨材の影響を排除するため、コンクリートではなくモルタルを使用することで簡潔化した。土壌試料に粉碎したモルタルを、土壌：モルタル比を変えて混入することで抽出溶媒のpHを調節しながら溶出試験を行い、溶出した重金属等の種類と濃度を測定した。用いたモルタルは早強ポルトランドセメントモルタルである。このモルタルを粉碎してふるいにかけ、4.75φ1.18 mm, 1.18φ0.5 mm, 0.5φ0.3 mm, 0.3 mm未満の4段階の粒径にわけた。また、土壌サンプルは埼玉県環境科学国際センター敷地内で掘削されたボーリング試料を風乾後に粉碎し、2 mmのふるいを通過したものを使用した。溶出試験は簡略化のためにサンプル3 g、純水30 mlで行い、土壌へのモルタルの混入率は0%, 1%, 10%, 20%, 50%, 100%の5段階とした。

重金属等の溶出量と、pHの関係を調べたところ、アルミニウムは中性付近ではAlはあまり溶出しておらず、液性が酸性側、アルカリ性側に変化すると溶出量は増加している。Feの溶出にはpHの影響はあまり見られない。グラフ左側に分布している数点では比較的多くのFeが検出されていることから、液性が酸性側になるとFeの溶出量が増加する可能性もある。Mnの溶出量は、Feのものとは比較的近い形の分布となった。Mnにおいても、液性が酸性側となった時に溶出量が増加する可能性が高い。Seについては、pHが6.5を超えた辺りからアルカリ性側に行くに従って、溶出量が増加している。pHが11.22のサンプルから最も多くのSeが溶出している。それよりもpHが高いサンプルでは溶出量が若干少ない。このことからpH11辺りで溶出量はピークを迎え、それ以上のpHだと溶出量は減少する可能性がある。砒素については、pH7の辺りを最小値とし、下に凸の2次曲線のような分布となった。Asに関してもpHが11を超えた辺りから溶出量が減少している。対象としたほとんどの金属において、pHと溶出量の間に関係があることが確認された。また、多くの金属は液性が中性であれば比較的溶出量は少ない。したがって、土壌のpHを中性付近に中和することで、モルタル、コンクリートが混入しても土壌中の金属の溶出を抑えることが可能であると考えられる。土壌汚染対策法で溶出量に基準が定められている重金属(Se, As: 0.01 mg/l)に関しては、基準値を超える溶出は見られなかった。しかし、溶出量は、土壌の金属含有量に依存するため、これらの物質を豊富に含む土壌の場合はモルタル、コンクリートの混入により基準値を超えて溶出する可能性がある。

キーワード: 溶出, 重金属, ヒ素, 土壌, セメント

Keywords: leaching, heavy metals, arsenic, soil, cement

## ナノライムや樹脂を用いた岩石の強化実験 -大谷石、琉球石灰岩、安山岩を中心に- Experimental study of rock strengthening tuff, limestone, and andesite by using nanolime and other consolidants

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This study is focussing to the efficiency and evaluation of up-to-date consolidants (a non-aqueous colloidal nanolime ( $\text{Ca}(\text{OH})_2$ ) suspension, a well-known oligomeric tetraethoxysilane product (Wacker SILRESR BS OH 100), an extremely low viscous epoxy resin (Araldite 2020) and for cultural heritage the most frequently used thermoplastic acrylic resin (Paraloid<sup>TM</sup> B-72 or also called Acryloid<sup>TM</sup> B-72) which is known from its good durability, high transparency and non-yellowing film-properties for the consolidation of Oya-tuff. The consolidation effect of nanolime particles were also studied on Ryukyu-limestone and Indonesian basaltic andesite.

The actuality of this study is given by the fact, that degradation (corrosion) of the rocks is incredible speeded up in the last decades by the increased air-pollution e.g. acid rain etc. This makes the stone buildings, objects and sites much more vulnerable. The stone material weakens and loses its original binder to a considerable depth. Consecutively many stone historical constructions require consolidation, conservation and restoration in recent days.

The consolidants were tested by the measurement of tensile strength, Equotip surface hardness, p-wave velocity.

キーワード: 岩石強化, ナノライム, 樹脂, 凝灰岩, 石灰岩, 安山岩

Keywords: Rock strengthening, nanolime, resin, tuff, limestone, andesite



## 地表被覆状態の違いによる低標高山地斜面における冬季の斜面物質移動量の違い Difference in surface-stone dislocation by ground cover on wind-beaten slopes in temperate low mountains in winter

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森林限界以下の低標高山地斜面では周氷河性物質移動が十分に起こりうるポテンシャルを持ちつつも、植生によって地表が覆われているために通常は周氷河性物質移動プロセスが活発に起こることは少ない。しかし、強風や人為の影響により植生が破壊されると季節的凍土が出現したり、周氷河性のマスムーブメントが卓越したりするようになり、いわゆる高山環境と良く似た景観を呈するようになる。福島県御霊櫃峠は猪苗代湖の東に位置し、峠に近い標高約1000mの斜面は風衝砂礫地となっている。ここでの年平均気温は7.3℃で、冬季には-10℃付近まで気温が低下する。この砂礫地は表面を扁平な角礫がオープンワークに覆い（C層）、その下位には暗褐色砂壤土が堆積している（B層）。その下位にはぶい黄橙色～暗褐色砂壤土（A層）があって、凝灰質砂岩を覆っている。砂礫地縁辺の植生があるところではC層を欠き、B層の直上に有機物に富む腐植質砂壤土が残っている（F層）。本研究ではこの調査地で気温、地温、地表温度およびペンキライン法による地表物質移動の観測を2006年冬から2009年冬までの4期間実施した。2007年冬は地表物質移動観測後に地表面を観察し、C層が厚い（すなわち礫が地表にある）CタイプとC層を欠き、B層の細粒土層が露出しているFタイプとに区分した。以上の観測の結果、凍結融解が生じているのは地表面下数cmのごく浅い部分（F層）であり、年によっては季節的凍結も見られた。また、2007年におけるCタイプとFタイプの斜面物質の移動距離は平均値でそれぞれ0.35m、0.52mであり、0.2mの差が見られた。このようにCタイプよりもFタイプの方が冬季の物質移動距離が大きい傾向が見られた。この傾向と地温の観測結果から、季節的凍結や日周期の凍結融解サイクルが生じる。B層が地表に露出しているFタイプの方が物質移動が活発であると考えた。CタイプはC層（扁平礫）が地表を覆っているのに対してFタイプはB層の細粒物が地表に露出し、直接温度変化にさらされる。したがって、CタイプとFタイプの両タイプを比較するとFタイプの方がCタイプよりも凍結融解サイクルが生じ易いと言える。以上から御霊櫃峠では地表面付近の凍結融解が冬季における物質移動の駆動源となっており、これにはC層の厚さ、すなわち地表被覆状態の違いが強く影響していると考えた。このように地表被覆状態や地表付近での凍結融解が冬季の物質移動に支配的役割を持つことは、凍結融解サイクルがごく浅い部分でのみ起こる低標高山地斜面の特徴であると言える。

キーワード: ソリフラクション, 地表物質, 低標高山地斜面

Keywords: Solifluction, Surface materials, Low altitude mountain slopes

## 華嚴滝における崖面のレーザスキャン Terrestrial laser scanning of cliff face at Kegon Falls

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Mechanisms of bedrock erosion at waterfalls have been studied so far for several cases, but there remain some uncertainties in erosional processes with regard to detailed form of rocks composing a waterfall. In this study, detailed form of cliffs around Kegon Falls in Nikko, Japan is examined using a terrestrial laser scanner (TLS). Kegon Falls has a total height of 97 m, with a vertical drop of surface water and outflows of underground water at the lower portion of the cliff. The form of cliffs around the waterfall was measured using a TLS (Topcon GLS-1500) from an observatory facing the waterfall, and the obtained point cloud was georeferenced using a GNSS-based position coordinates of measurement targets. The point cloud was then rotated in order to create a digital elevation model (DEM) on a vertical plane. Longitudinal and transverse profiles were then extracted from the vertical DEM. The stability of the collapsed portion in the cliff indicates that the collapse in 1986 could have likely occurred with crack propagation along joints within the former cliff. The stability analysis also suggests that catastrophic collapse of whole of the waterfall face seems to hardly occur, because the igneous rock composing the cliff is strong enough to keep its current overhanging shape. Actually smaller-scale collapses of the cliff face have occurred in recent years. Whereas, frequent occurrence of freeze-thaw weathering seems to be responsible for the formation of a depression at the bottom of the upper cliff of lava. The load and tractive force by surface water flow (up to 100 t/s when flooding) may support faster removal of rock blocks behind the water drop. Multiple processes are thus responsible for the erosion of the cliff face of Kegon Falls.

キーワード: 滝, 侵食, 岩盤, 崖, 地上レーザスキャン

Keywords: waterfall, erosion, bedrock, cliff, terrestrial laser scanning

## 三浦半島の海岸における1703年元禄地震以前の地震性隆起運動の地形学的証拠 Geomorphic Evidence of Uplifting Associated with Old Kanto Earthquakes Before 1703 in a Coast of Miura Peninsula, Japan

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We need to know the amount of the vertical crustal movement and the occurrence date for the Kanto earthquake prior to 1703, for better understanding the earthquake cycle, and thus to estimate the average recurrence time and the magnitude of earthquake for estimating the future earthquake hazard. So we sought the trace of the crustal movement along the coastal region in the southwestern Miura Peninsula. To identify the uplifts associated with recent great Kanto earthquakes, we made a high-density (50 cm mesh) digital elevations map by aerial measurements of the Light Detection and Ranging (LiDAR) in southwestern coast of the Peninsula. In addition, we analyzed air photos taken in 1946, 1963 and 1966.

As a result, five to six steps of marine terrace surface were observed between the Nobi 3 surface and the present coastline, including the 1923 and 1703 emerged terrace surfaces, in the alluvial valley. These terrace surfaces are edged in a small cliff of the height of 1-2 m. In addition, LiDAR data indicate flights of wave-cut-bench on rocky coast (8 m above MSL) in Jogashima, southernmost tip of Miura. These marine terrace surfaces may indicate additional evidence of the uplift associated with the Kanto earthquakes.

Compared the 1:25,000 of old topographic map made in 1921 by Land Survey Department and in 1966 by Geography Survey Institute, the regradation of the coastline is identified in the coast area of Miura. The coastline was shifted from the land side to the sea side, thus the zone between 1921 and 1966 coastlines was dried from the sea to the land. At the bay head of Koajiro, the sea was dried up approx. 300 m in the length. The lowest level of terrace surface which was identified from LiDAR Data and old topographic map have been formed by 1923.

キーワード: 関東地震, 履歴, 隆起量, 海成段丘面, 海岸線

Keywords: Pre-1703 Kanto Earthquake, Recurrence time, Amount of Uplift, Marine terrace surface, Coastline