

## Incision rate of the Oshika-gorge, Tottori-prefecture, estimated from Terrestrial in site Cosmogenic Nuclides dating

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Incision rates of the Oshika-gorge, in Misasa, Tottori-prefecture were estimated from Terrestrial in site Cosmogenic Nuclides (TCN) dating of the strath terraces developed at a bend of the gorge (N35 22'18", E133 58'26"). The bedrock of the gorge consists of granite. At a surveying point, 7 terraces and present streambed were distinguished and we collected 8 samples of each surface site for TCN surface exposure dating. According to Kohl and Nishiizumi(1992), we extracted <sup>10</sup>Be and <sup>26</sup>Al. Measurement of <sup>10</sup>Be/<sup>9</sup>Be and <sup>26</sup>Al/<sup>27</sup>Al ratios by accelerator mass spectrometry was undertaken at the Micro Analysis Laboratory, Tandem accelerator (MALT), the Univ. of Tokyo. Exposure ages of each terrace calculated from <sup>10</sup>Be/<sup>9</sup>Be ratio and <sup>26</sup>Al/<sup>27</sup>Al ratio gave close agreement with each other. Surface exposure ages of two strath terraces were calculated as No.1 strath terrace (relative height, 11.21m): 57.2±3.33 kyr and No.7 strath terrace (relative height, 1.64m): 10.4±0.80kyr. An incision rate of the Oshika-gorge at the surveying site for last 60kyr is 0.2 m/ kyr (0.2 mm/yr).

Keywords: incision rate, Oshika-gorge, strath terrace, TCN ages, dynamic equilibrium, Misasa, Tottori prefecture

## Quantitative determination of erosion rates in humid region using depth profiles of in situ-produced Be-10 and Al-26

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Quantitative determination of erosion rates is important across a diverse range of disciplines in geology, geomorphology, and biogeochemistry (Granger and Riebe, 2007). Yet rates of erosion have until recently been difficult to quantify over long timescale. Measurements of in-situ produced terrestrial cosmogenic nuclides (TCN) allow us to understand earth surface process quantitatively (Goss and Phillips, 2001). It has been successfully used to provide erosion rates of bedrock in arid regions where slow erosion process take place (e.g. Cockburn et al., 1999). On a global scale, environmental parameters such as mean annual precipitation have been used to explain erosion rate variability (Bierman and Caffee, 2002). However, the relationship between erosion rates and precipitation is still under debate due in part to scarcity of data from humid regions. In addition, erosion rates deduced from drainage basins, which is the only method to quantify erosion rates in humid regions, are strongly affected by basin slope (Riebe et al., 2000). Therefore, different approach to determine the erosion rates in humid regions is required to corroborate findings from arid regions. Here we present hilltop depth profiles of in situ-produced <sup>10</sup>Be and <sup>26</sup>Al from Japan. Due to such sampling location, the contribution of basin slope should be minimized, allowing a direct comparison to studies of bedrock erosion rates in arid regions. When applying TCN-based erosion rates in mid latitude humid regions, where granitic saprolite is distributed, density uncertainties play an important role in determining erosion rate. The aims of this study are (1) to develop a model for TCN depth profiles, based on actually measured density in granitic saprolite, and (2) to assess the correlation of erosion rates and precipitation. These data indicate a link between earth surface process and climatic condition.

Keywords: cosmogenic nuclides, erosion rate, climate

## Signatures of ESR signals observed in quartz of Kizu river sediments and of host rocks

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Paramagnetic lattice defects in quartz have recently been used as tracers to study the transportation of sediments on the surface of the earth especially on the origin of aeolian dust (e.g. Toyoda and Naruse, 2002), like isotopes have been used. Studies on aeolian dust utilizes only the  $E_1'$  center while impurity centers were shown to be other useful signatures in the studies of river sediments (Shimada, 2008).

The present research aims to characterize sediments of Kizu river by analyzing ESR signals in quartz including the  $E_1'$  center and the impurity centers.

We collected twenty Kizu river sediment samples and granite samples which are possible sources of river sediments. The samples were sieved to 1000-500, 500-250, and 100-250 micrometers. Quartz grains were extracted from each fraction by chemical treatment and density separation. The quartz samples were heated at 400<sup>0</sup>C for 1 h to erase the inherited ESR signals before gamma ray irradiation. ESR measurements were performed at room temperature and at 81 K to observe  $E_1'$  and Ge, and Al and Ti centers, respectively.

The impurity centers were enhanced by gamma ray irradiation. The formation efficiencies of the signals at the origin were obtained, which probably correspond to impurity concentrations in quartz. The  $E_1'$  center was observed after heating the sample irradiated to 2.5kGy at 300<sup>0</sup>C for 15 min. The formation efficiencies of impurity centers and the intensity of the  $E_1'$  center were plotted against the geographical positions to find that there are several positive and negative correlations between those efficiencies and intensity.

If the sediment is a mixture of two sources, we will be able to find the mixture ratio by analyzing the sources and the sediment. We will perform further analysis to discuss the origins of the sediments with this basis.

Keywords: Kizu river, ESR, River sediments, quartz

## Human impact on Bedforms of the Mid-Arakawa, Central Japan

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I carried-out continuing observation of the changes in river-bed landforms in the alluvial-fan reaches of the mid-Arakawa. Destruction and reconstruction of a weir and a stepwork for irrigation induced the instability of sediments which resulted in the development of alternate bars and transverse bars with imbrication structures downstream. It is interpreted as response of fluvial system to human impacts.

Keywords: Human impact, River-bed form, Alluvial fan, Dynamic equilibrium, Fluvial system

## A geomorphological project about the seismic barrier system around Lake Furenko

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There is an active barrier system around Lake Furenko in eastern Hokkaido. In general, the barrier system is a typical depositional system during transgression stage, however, many regions of Japan is a regression stage since 5000-6000 years ago. There are two major reasons about this issue. First, sea level is almost stable since 5500 years ago in this area. Second, this area has been affected by seismic activity of the Kuril subduction zone. The last unusual earthquake caused in the 17th centuries and this area has been subsided at a rate of 8.5mm/year. We want to clarify detail sedimentological and geomorphological process of the Furenko barrier system in the next three years.

Keywords: Lake Furen, seismic barrier system, unusual earthquake, transgressive stage, sea level change, eastern Hokkaido



## Discovery of submerged karst topography in Nagura Bay, Ishigaki Island by broadband multibeam bathymetric survey

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The existence of submerged exo-karst is pointed out by aerial photographs or topographic map of shallow seas (e.g., Hori 1996). However, most of these submerged karst identified by aerial exposure of high portion. There is no report on submarine topography of submerged karst area. The broadband multibeam survey was conducted in the central area of Nagura Bay, Ishigaki Island in the southern Ryukyu Islands. The sounding results are visualized at a lateral grid resolution of 1m. The observed submarine topography shows the development of various types of karst in extensive area.

The survey was carried out in August 2011 using a broadband multibeam sounding system R2Sonic 2022. This system is a shallow-water multibeam echo-sounder with selectable operating frequencies within the 200 to 400 kHz band and variable swath width from 10 to 160 degree. Within the acoustic sector, 256 receiver beams were formed using 1 degree across beamwidth x 1 degree along beamwidth. It may also rotate the swath sector either port or starboard side of the vessel. The main part of the sonar has a vertical resolution of 1.25cm. The system is operated with Hemisphere VS111 GPS Compass and Teledyne TSS Dynamic Motion Sensor DMS-10. The accuracy of VS111 GPS Compass is 0.6m in distance and 0.15 degree in direction when placing A30 and A20 antennas at 1m interval. The accuracy of DMS-10 Motion Sensor is 0.07 degree in roll and pitch, and 5cm in heave. The vertical accuracy of the system is around 5 to 10cm. The survey and data processing are carried out by the hydrographic survey software Hypack 2010. The visualization of the 3D bathymetry model is conducted by IVS 3D Fledermaus. In this research, we confirmed the observed submarine topography and the sedimentary features by SCUBA diving surveys.

Convex and concave topography consisted by closed contours is visualized in the surveyed area. The similar topography is not formed by accretion or sedimentation under the submarine environment such as coral reef formation. Because of the closed drainage, it is recognized as karst, the topography formed by groundwater flow. The following five karst types are recognized in the surveyed area. These types may reflect the difference of karstification process and stage. 1) doline karst, 2) compound doline (uvala) or mega-doline, 3) cockpit karst, 4) polygonal karst, 5) fluviokarst. SCUBA diving observations suggest the Holocene reef and reef sediments are accumulated on the submerged karst to form "cover karst" in Nagura Bay. The small-scale karst landform such as karren may buried in this covering process.

According to the aerial photographs, the shallow marginal area of Nagura Bay also consists of the submerged karst. We suggest that the Nagura Bay extent of 6 x 5 km is the largest submerged karst in Japan. The size is equivalent to Minami Daito Island in the Phillipine Sea and Hiraodai Plateau in northern Kyushu Island.

Keywords: submerged karst, coral reef, broadband multibeam echosounder, Ishigaki Island, Ryukyu Islands

## A History of Mass Movement at Gangneung area, Eastern Coast of Korea, Since the Middle Holocene

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This study intends to reconstruct the history of mass-movement occurrence since the Middle Holocene in Gangneung area, east coast of Korea. For this purpose, the Sacheoncheon basin and the Yeongokcheon basin where large-scale landslides occurred particularly due to typhoon Rusa in 2002 were selected. Detailed field observation revealed that inorganic layers of hillslope origin and organic layers of former humic topsoil or swamp origin alternated in the deposits of the river terraces, floodplains and the present river beds along the uppermost stream. The upper surface of the organic layer indicates the date of colluvial event which is recorded by the overlying inorganic layer. Stratigraphic investigation of the deposits assisted by radiocarbon dating of organic layers enabled to point out the following results:

(1) On the uppermost valley bottom at Gireogigol (Loc. 1), mass movement occurred 2 times between 740yrB.P and 260yrB.P. and 2 times after 260yrB.P., while in Seokgugol (Loc. 2), the occurrence during recent 6,700 years was mass movement was about 10~20 times.

(2) On the backslope of river terraces as Loc. 3, mass movement occurred at least 1 time in the period between the formation of river terrace and about 2,000yrB.P. and at least 1 time after about 430yrB.P.

(3) On the backslope of floodplain as Loc. 4, mass movement occurred at least 1 time after around 2,800yrB.P.

(4) On the backslope of the present river bed as Loc. 5, mass movement occurred at least 1 time before A.D. 1869 and at least 3 times after the A.D. 1869.

From the above facts it is concluded that mass movements occurred several to scores of times after the Middle Holocene in the investigated area.

Keywords: Gangneung, Holocene, valley bottom, mass movement, river terrace, floodplain

## Visualization of 3D crustal motions of Japan

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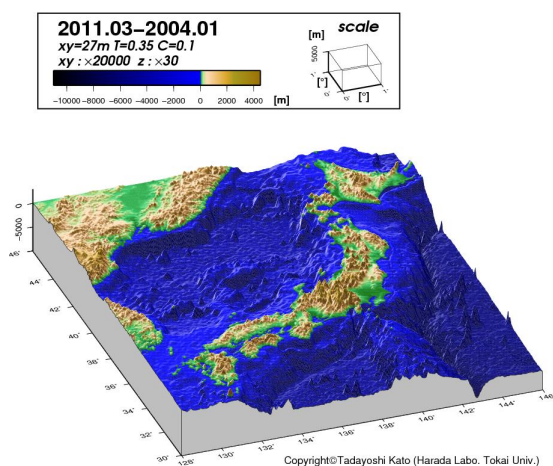
After 3.11 earthquake in Tohoku, Japanese people realize that they do not know much about crustal deformation in Japan continuously occurring and they do not know how to prepare for big earthquakes. One of the reasons of this problem is that crustal deformation is so slow that people can not understand how Japan is continuously deforming. The GPS observation is one method that can detect this kind of slow motions, and the Geographical Survey Institute of Japan(GSI) has about 1400 GPS stations over Japan to observe Japanese crustal deformations. If those deformations are easy to understand, people could prepare much better for big earthquakes in the near future.

However, time series plotting or vector arrow figures of the GPS data are sometimes not easy to understand the three dimensional deformation with time. In this study, we created 3D animation for Japanese crustal deformation using GPS data obtained by GSI, and make it easier for people to understand the Japanese crustal motions. The GSI already had created 3D animation of Japan for horizontal motion of only limited time and area, whereas we can make animations for three dimensional deformation of any given time and area if the GPS data are available. The newly created animations helped to understand the detailed crustal deformation in Japan.

We compared our results to a 100 years leveling data of Japan and the geological data for about two million years. In spite of time differences, a lot of similarities can be seen on the pattern of deformation of Japan, and amount of crustal motions were comparable between GPS data and leveling data.

By watching these animation, we hope people to understand how earth's crust is moving, and how Japan is deforming with earthquakes.

Keywords: GPS, Crustal motion, Visualization





## Stereoscopic Topographic Map Synthesized from Digital Elevation Model

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A new method for visualizing topographic maps in a 3-dimensional mode, called digital stereoscopic topographic map (DSTM), was developed. By referring to digital elevation model, parallax difference at each pixel of DSTM is adjusted to a specified scale and E-H ratio (ratio between elevation and horizontal distance). One of the advantages of DSTM includes the distribution of thematic characteristics versus elevation in one image. For example, by a stereoscopic slope map, to which the DSTM is applied to a slope map of ground surface, we can interpret ground surface distribution versus elevation simultaneously. DSTM can be printed as anaglyph images to look conveniently, but also directly adopted to regular electronic 3D display devices. The other advantages and applications of DSTM will be introduced by our colleagues in the succeeding oral and poster sessions.

Keywords: Digital elevation model, Topographical feature, Digital stereoscopic topographic map

## Applying digital stereoscopic topographic maps to geomorphological and geological interpretation

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Thematic topographic maps have developed by the progress in analysis using digital elevation model (DEM) and have made clear representation possible. Such situation is supported by the supply of 250 m, 50 m and 10 m mesh DEM arranged by Geospatial Information Authority of Japan (GSI) and higher resolution 5 m, 2m and 0.5 m mesh DEM gained by laser profiler (LP) by private aerial survey companies. DEM-based analyses for topographic representation are various and product contour colored contour map, shaded map, relief map and their 3D map. Our digital stereoscopic topographic map (DSTM) is mainly composed of slope map and openness map, and they are three dimensionally represented by anaglyph image according to the analytical and display method by Yokoyama et al. (2012). These are characterized as follows.

(1) Digital stereoscopic slope map directly shows reliefs and geologic structures. Scarps, such as terrace scarps and fault scarps, are distinguished using high resolution DEM. Thus, we can classify topographic units and fault interpretation, putting results on maps and discussing or crosschecking results on screens by plural persons.

(2) Surfaces controlled by lithology and geologic structures are reflected by slopes more than reliefs. We can easily interpret structural topography among large scale geologic structure, just as if we view it in non-vegetated arid region.

(3) Digital stereoscopic openness map emphasizing valley and ridge lines clearly shows displacement reference topography, especially strike-slip fault topography compared to ordinal toposheets. High resolution LP-based openness map help us to interpret strike-slip offset streams. Besides, the openness map is effective to identify dissection, drainage pattern and catchments in hilly lands.

Keywords: Digital elevation model, Digital stereoscopic topographic map, Digital stereoscopic slope map, Digital stereoscopic openness map, Interpretation of geomorphology and geology