日本のジオパークにおけるジオサイトの保全状況
Conservation state of geosites in Japanese geoparks

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現在日本には，ユネスコ世界ジオパークが8箇所，日本国内で認定された国内ジオパークが35箇所ある．それぞれのジオパークには，複数のジオサイトがある．その中には，管理方法が十分検討されていないジオサイトがある．本発表では，日本列島の自然環境の中での地球科学的遺産の劣化について定義した上で，風化や破壊が進んでいる日本のジオパークのジオサイトについて整理をする．日本のジオサイト適切な管理のためには，その場所の自然環境を正しく理解することが必要である．

キーワード：日本のジオパーク、ジオサイトの管理、地球科学遺産、ジオ多様性、保全地球科学
Keywords: Japanese Geoparks, management of geosites, geoheritage, geodiversity, conservation earth science

Evaluating deterioration of stone-built Cultural Heritage and rock-formed Natural Heritage by means of Non-Destructive Techniques

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Natural and Cultural Heritage conservation is regarded as a priority for humankind, as the UNESCO recognised in the Convention Concerning the Protection of the World Cultural and Natural Heritage in 1972. This convention encouraged to adopt joint policies aiming to give the cultural and natural heritage a function in the life of the community. From the material point of view, both stone-built Cultural Heritage and rock-formed Natural Heritage undergo similar weathering processes and in both cases the use non-destructive techniques to evaluate the effects of weathering is particularly relevant. Non-destructive evaluation techniques do not only allow to respect the integrity of the studied elements, but also allow to make successive repeated measurements in particular points. Repeatability is crucial to understand the evolution of weathering processes and plan preventive conservation strategies. Even more so as changing climate in necessarily affecting the type and extent of weathering processes. This presentation explores a series of existing non-destructive techniques used for the evaluation of weathering/decay, stressing the parallelism between the evaluation of stone decay in built heritage and the assessment of weathering in rock-formed natural heritage. These techniques include morphological evaluation through 3-D digital models, Ultrasound Pulse Velocity determination and Infrared Thermography among others. This presentation will give an overview of how these tools have been used in specific case studies and discuss their advantages and disadvantages for evaluating weathering.

Keywords: Stone decay, Rock weathering , Non-destructive testing

Dynamic Geoconservation and Tourism as a Geoconservation Tool: Comparative Analysis of Europe and Japan

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This paper analyzes the concept of dynamic geoconservation, particularly focusing on two concepts: Despite identification of ‘geosites’ and creating appropriate protection measures in geoparks, many sites continue to be ‘fragmented’ because of insufficient attention to the ‘integrity’ of the natural processes operating at large spatial scales and over long time.
How properly informed tourism could be used as a ‘tool’ for monitoring such environments and promote non-obtrusive geoconservaion.
Through key case studies from Europe (especially the UK) and comparative cases in Japan, the paper analyzes the problems of mismatch between geoconservation objectives and praxis. The paper introduces Gray(2013)’s contention that the abiotic diversity of the planet should be recognized for its ‘intrinsic’ value, and Mathews’ (2014) contention that geodiversity and biodiversity components should be integrated to promote a strong feedback loop for conservation of geosites. The paper argues that geomorphic and ecological processes operating over large spatial units (and over long temporal scale) offer important insights for geoconservation. Based on the case studies, we also put forward the idea of ‘dynamic geoconservation’ whereby the integrity of natural processes rather than scenic or tourism capital values of a specific site or landmark is considered the conservation goal. Lack of monitoring data on geosites and heritage landmarks is a major challenge for dynamic conservation, and the paper argues that properly informed multi-stakeholder tourism can act as a ‘stewardship’ tool for geoparks (or similar heritage management schemes) by providing monitoring bby guides and tourists and elevating the awareness for dynamic conservation at the same time.

キーワード：動的ジオコンサベション、自然的プロセス、イギリス、日本
Keywords: Dynamic Geoconservation , Natural Processes, UK, Japan

Three dimensional documentation and surface erosion of andesitic building stones in Yokosuka Arsenal Dry Dock No.1, Japan

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There are 6 dry docks in Yokosuka Naval Base, Japan. Three of them are made with building stones. The first one, which was called as “Yokosuka Arsenal Dry Dock No. 1” had been constructed about 150 years ago. Mount Hakusen, which was composed of Pleistocene mud sediments, was excavated during the construction of the dock. The building stones are mainly andesite from the quarry in Manazuru Peninsula, far southwestern corner of Kanagawa Prefecture. The stone is called as “Shin-Komatus-Ishi”. Shin means new and ishi is stone. The dock was suffered from 1923 Great Kanto earthquake, however there was no serious damage in the dock. The dock is still in use today. However the surfaces of building stones have been eroded by weathering. And some of them show honeycomb structure.
For the purpose of future preservation, three-dimensional mapping of the dry dock No. 1 was carried out by means of close-range digital photogrammetry. About 100 photographs had been taken as photo-sequence for the total area of the dock. And these multiple 2-D images had been installed into a computer and analyzed by a commercial photogrammetric software. After the photogrammetric manual analysis, the software can match the same position on multiple 2-D images and generate 3-D points in the computer. Finally, three dimensional surface model could be generated.
In addition to three dimensional documentation of the total site of the dock, photogrammetric measurement could be applied to the surface erosion of andesitic building stones in the dock. Generally, surface erosion had been measured by scale, and only the depth of erosion could be clarified. Application of photogrammetry makes it possible to measure the volume of erosion on the surface of building stones. Thirteen building stones have been selected for measurement. Those stone show various depth erosion on the surface. As the results of mean erosion depth calculated from erosion volume and surface are of the building stones, erosion process by weathering is clarified by comparison of erosion rates and erosion structures.
The quarry site of the building stone “Shin-Komatus-Ishi” had been closed many years ago. At present, we can observe the old quarry site in the coast line of Manazuru Peninsula. There are many plug-and-feather holes and traces of the pickax in the quarry site. And some small honeycomb structures can be recognized on the rock surface of the site. However the depth of erosion is not so much compare to the building stones of the dry dock from the view point of weathering structure. In the case of the dry dock, sea water had been carried in and out every time the ship had been repaired. Therefore, it is considered that surface erosion had been advanced inside the dock with seawater fill and dry.

キーワード：写真測量、蜂の巣状風化、海水、石丁場
Keywords: photogrammetry, honeycomb structure, seawater, quarry site

Historic porous limestone quarries in the city of Budapest (Central Europe), their exploitation history and preservation

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Budapest, the capital of Hungary (Central Europe) had a rapid urbanization and transformation at the end of 19th and at the beginning of 20th century. The population of the city grew from 300,000 (in 1880) to nearly 900,000 (in 1920). This process invoked an urgent and continuously growing need of construction material. The closest resource that was available was a porous limestone. The Miocene limestone has appropriate properties for constructional use. It has a high porosity (up to 40%), a low unit weight (light stone) and good workability (easy to cut and carve). Due to the appropriate properties its use already began by the Romans (1st and 2nd century AD) and continued in the medieval period, however major and large-scale exploitation was mostly in the late 18th to early 19th century associated with the population boom. The porous limestone covered smaller elevated hills on both side of river Danube in Buda and in Pest site. The exploitation of the stone first started in open quarries. The first quarries were located outside of the town during the Roman times. The Medieval stone exploitation was also from external quarries, while from the 18th century onward with the city development the suburbs provided stone materials: The stone was used for the construction of public buildings and housing. These monuments, which date back to that period, are now in the city centre (House of Parliament, Opera House, Mathias Church), but at the construction time some of them were in the suburbs (e.g. Central Building of Technical University). The first quarrying operation started where vineyards and orchards were located. Due to the increasing need of stone larger areas were used for quarrying and it caused a conflict with agriculture, and caused the significant loss of fertile areas. Consequently, in the second phase of stone exploitation the quarrying activity were shifted toward subsurface galleries. It reduced the land use and resulted in the excavation of long passages and larger galleries at subsurface. In the late early 20th century the operation of the quarries terminated and galleries became abandoned. These abandoned quarries than were used as wine cellars or occupied by inhabitants and became a dwelling and housing place, an urban habitat. In the 1960’ies the population were pulled out from these unhealthy “cave dwellings” and some of the galleries were used as storage facilities and mushroom cultivation sites. At present these subsurface openings cause high risk of land development (collapse) and limit the land use of the given area. Despite their engineering geological risks the galleries and previous quarries represent historic values and their preservation is crucial. The protection of these galleries and subsurface quarries are now in progress. Coevally with the preservation measures it is necessary to record the condition and preserved values (quarrying activity related tool traces, inscriptions, etc.) of these systems. It is also crucial to make surveys and stability calculations to avoid outbreaks and collapses. This paper points out that urban development, cultural and geological heritage needs to be understood and managed in a sustainable way.

Keywords: limestone, cultural heritage, urban development, subsurface galleries, cellars

Methodology of 3D Measurement - Case Study in the Main Church of Sopocani Monastery, Southern Serbia -

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Aim of study

This paper deals with the methodological challenges of 3D scanning of the main church of Sopocani Monastery (hereafter called Sopocani church)[Fig.1], the world cultural heritage in southern Serbia. Accurate documentation of the heritage is the fundamental basis of scientific analyses as well as its conservation. 3D scanning, with rapid development both in hardware and software during last decades, has been applied in the field of the heritage study with different range of accuracy and scale.
In some cases, however, the requirement of survey and the delicacy of the heritage may cause particular difficulties, even though 3D scanning enables us to reach such part where measurement could not be carried out otherwise. This paper shows challenges of heritage scanning, taking Sopocani church an example of historical structure of stone. The scanning data of this church, threatened of decay, should constitute an effective base for the future conservation project.

Method of study

Two types of 3D measurement were carried out: the laser scanning (Riegl VZ400) and the LED scanning (Artec Spider).

Approach

The laser scanner is effective for architectural space, while the LED scanner is suitable for details of the surface, though the view-field of the latter is limited to 180×140mm. The combination of these two apparatus of different scale is indispensable for measuring the historical structure, the value of which exists both in architecture and in surface. In Sopocani church, 23 laser scans were carried out in measuring inside/outside of the structure, and 477 LED scans were carried out in measuring west wall of naos. The mural painting of Sopocani church is uniquely characterized by the golden background made of numerous gold leaves. As the gold has turned almost invisible because of degradation, the art-historical research of its iconography would be possible only through the accurate detection of the minute thickness change of paint layers by LED scanner.

Outcome

The laser scanning data indicate relatively small variation of the thickness of the wall of the church, 0.957-1.001m, which may prove the quality of the original construction[Fig.2]. Regarding the porch, added later, there is a difference of 0.784m in width. Columns of the porch show outward inclinations, being 7 degree at the most[Fig.3]. If such inclinations, already confirmed by the author in old photographs as well, should be monitored together with the deformation of the arches, the scanning data are of fundamental importance. The data clearly indicate the difference of building quality between the original and later extension.
LED scanning data have shown certain hidden painting technique and characteristic depiction of the west wall of naos (12.811×6.323m), where saints and angels are painted[Fig.4]. Analysis of scan data has revealed that position of the aureoles of saints is different in lower and upper part of the painting. In lower part, centers of aureoles are placed around the temple, while they are placed around the forehead in higher part. The faces are slightly longer in upper part. We may presume that painters adopted this

technical device as they were conscious of the figures to be looked up by people standing on the ground floor. LED scanning also clarified unique depiction in Sopocani church: fine grid pattern is obvious on the golden background of the alter, which is supposed to be mosaic-imitation. The same pattern is also found in the west wall of naos.

Conclusion

3D measurement is an effective method for the documentation of the architectural heritage. In Sopocani church the scanning measurement clarified the quality of the original construction. The LED scanning has shown particular technique and devices of painters. 3D measurement will be useful for the monitoring of the heritage structure as well.

キーワード：三次元計測、文化遺産、セルビア
Keywords: 3D measurement, Cultural Heritage, Serbia


Fig.1 Sopocani church

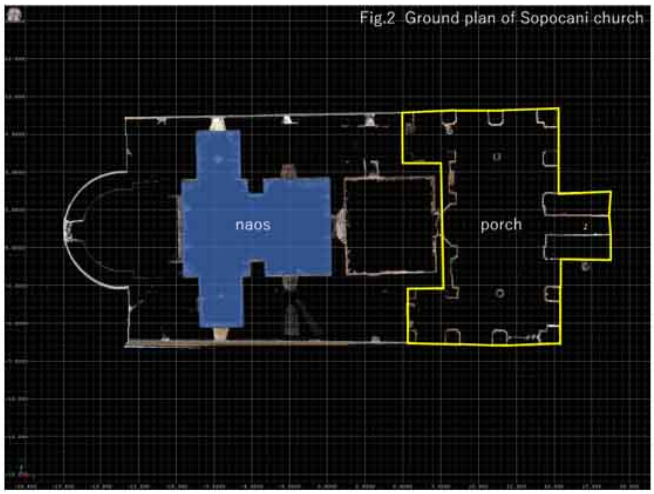

Fig.2 Ground plan of Sopocani church

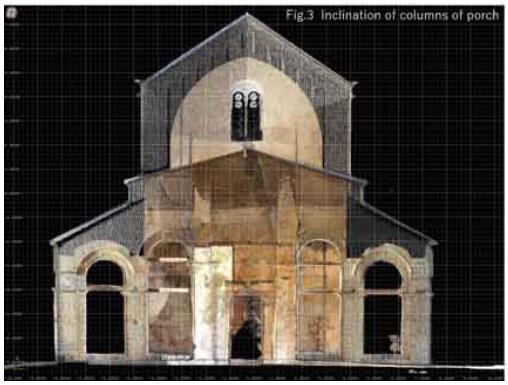
Fig.3 Inclination of columns of porch

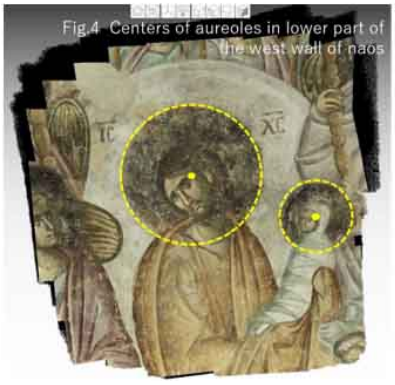
Fig.4 Centers of aureoles in lower part of the west wall of naos

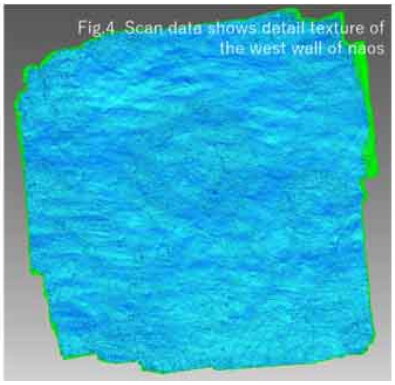
Fig.4 Scan data shows detail texture of the west wall of naos

