

東アジアの乾燥・半乾燥地域における古環境変動史と黄砂変動
PALEO-ENVIRONMENTAL HISTORY AND KOSA (DUST AND SAND STORM)
FLUCTUATION AT ARID - SEMI-ARID REGIONS IN EAST ASIA

鹿島 薫^{1*}
KASHIMA, Kaoru^{1*}

¹九州大学大学院理学研究院地球惑星科学部門

¹Department of Earth and Planetary Sciences, Faculty of Sciences, Kyushu University

There are two methods to monitor environmental changes and desertification at arid and semiarid regions. The first one is the short-term monitoring, and examined the changes during several years or decades by meteorological, hydrological, geophysical and geochemical observations. The second one is the long-term monitoring, and presumed changes of environment during hundreds or thousands years using geologic and geographical methods. Although a lot of expeditions have reported short-term changes, the reports for long-term environmental changes have been limited because it takes a lot of efforts to take efficient samples to presume in detail environmental histories.

Department of Earth and Planetary Sciences, Kyushu University has started international research project to make long-term monitoring of desertification in East Asia to correspond with the East Asian Environmental Problems Project of Kyushu University. In cooperation with Mongolian Academy of Sciences, National University of Mongolia, Xinjiang University in China, the field surveys have been done to obtain samples for long-term monitoring at lakes, ponds and marshes in Mongolia and north western China using geological and geographical methods. Our researches presumed long-range (about hundreds or thousands years) changes of the lowering of lake levels and under ground water levels, the reducing of forest areas and the expanding of deserts in those regions. The desertification has been accelerated in these two hundred years in both regions.

キーワード: 新疆ウイグル, 気候変動, 砂漠化, モンゴル, 地球温暖化, 黄砂

Keywords: Xinjiang Uyghur, Climatic changes, Desertification, Mongolia, The Global Warming, KOSA (Dust and Sand Storm)

地中レーダーを用いた液状化による地層変形探査 Visualization of liquefied layers using GPR in Watarase flood plain, central Kanto

瀬戸 真之^{1*}; 市川 美南海²; 北沢 俊幸²; 中村 洋介¹; 田村 俊和²
SETO, Masayuki^{1*}; ICHIKAWA, Minami²; KITAZAWA, Toshiyuki²; NAKAMURA, Yosuke¹; TAMURA, Toshikazu²

¹ 福島大学, ² 立正大学

¹Fukushima University, ²Rissho University

1. はじめに

2011年3月11日に発生した東北地方太平洋沖地震により、沿岸部を中心に液状化現象が観察された。液状化現象が発生すると地下から砂や水が噴き上げ、地表には亀裂やマウンドが形成される。遺跡の発掘で掘られたトレンチには地表まで到達していない液状化現象による砂の立ち上がりが認められる。このことから、液状化現象が発生したにもかかわらず、地表まで砂や水が到達せず、液状化現象が認識されないケースが多々あることは容易に推定できる。地表で液状化現象が認められなくても、地下で液状化現象が起きていれば、その場所の地盤の支持力は大きく減少する。そこで本発表では地表で確認できなかった液状化現象、すなわち液状化による地下での地層変形を地中レーダーによって捉える試みについて報告する。

2. 調査地の概要と調査方法

2011年の東北地方太平洋沖地震により、関東平野中央部に位置する渡良瀬遊水地の一角では液状化現象が発生した。地下から水と砂が噴き出し、亀裂やマウンドが形成されたのである。運動公園の地層は渡良瀬遊水地が造成される前は赤麻沼という沼沢地であり、泥、シルト、砂など河性の細粒な堆積物から構成されている。

本研究ではこの運動公園を調査地として、堆積物の構成を知るための簡易ボーリングと地中レーダーを用いた地下探査を実施した。さらに簡易ボーリングの結果と地中レーダーの探査結果とを対比するため、地中レーダーの測線にそって簡易ボーリングを実施することも合わせて行った。

3. 調査結果と考察

採取した堆積物を、それぞれ粗粒砂、中粒砂、細粒砂、砂質粘土、粘土の5つに区分して記載した。地点A・B・Cは2013年、地点D・Eは2011年に掘削した。簡易ボーリングによる各地点の地下水位は地点Aでは115cm、地点B・C・D・Eでは200cmであった。

地中レーダーは地下に電磁波を放射し、地下構造を画像化する。平滑な地層面は、地中レーダー断面でも平滑な反射面を示すことが多い。地中レーダー探査より6つの探査画像を取得した。地中レーダー画像と簡易ボーリングによる柱状図とを重ね合わせると、粘土層は強い反射、砂層は弱い反射として画像に表されており、「砂質粘土層」と「粘土層」の境界および深さ「粘土層」と「砂層」の境界が読み取れた。

今回の地中レーダーによる探査結果は地下の平滑な地層を示すものではなく、電磁波の反射形に多数の乱れがみられた。地中レーダーによる電磁波の反射形に乱れが起こる要因として、埋設物の存在が考えられる。そのため、反射形の乱れが埋設管などによるものではないかを検討した。地中レーダーによる埋設管およびマンホールの検知例では埋設管は丸く上に凸型の幅20m程度の反射形として、マンホールは筒状の反射形として、それぞれ表示される。地中レーダーの探査結果に見られた反射形は尖った凸型で幅2m程度の反射形であり、埋設管やマンホールのものとは反射形の形態や大きさが明らかに異なった。また地層中の礫により電磁波の反射が乱れたことも考えられるが、調査地が氾濫原であることや、ボーリングの際に地中レーダーに反応するような大きな礫が全くみられなかったことからその可能性は低い。したがって、深さ2mの砂層にみられる尖った凸型の反射形は液状化現象による地層の変形だと判断した。どの地点でも地層の変形は地表面までは達していない。このような液状化現象による地層の変形は地表では目視できないので本研究では潜在的液状化と呼ぶ。地中レーダーに捉えられた潜在的液状化による噴砂の幅は0.5mから2.5mで、立ち上がりの高さは0.2mから0.95mであった。また、測線に見られる潜在的噴砂の間隔は1mから2m程度の部分と20m程度の部分とがあった。1mから2mの間隔は地表で観察された亀裂の間隔と一致する。他方で20m程度の大きな間隔も見られる。これは液状化現象により発生した砂脈の立ち上がりと地中レーダーの測線との位置関係による違いであると思われる。

東北地方太平洋沖地震の起きた2011年3月11日の前は9日間連続で降雨があり、地下水位はここで用いている2011年4月や2013年8月のボーリング調査で判明した値よりも高かった。したがって、液状化現象の発生が疑われる深さ2m付近の砂層は地震発生時には多量の水分を含んでおり液状化の発生条件を満たしていたと判断できる。東北地方太平洋沖地震の際にこの渡良瀬運動公園で液状化したのはこの層であったといえる。

東北地方太平洋沖地震の際に液状化が確認された渡良瀬遊水地内の運動公園で調査を行い、液状化発生層位が特定できること、多数の潜在的液状化が認定できることを明らかにした。さらに地中にある砂脈あるいは砂柱の幅、高さ、間隔のデータを取得することができた。

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Keywords: GPR, Liquefaction, 3.11 Mega quake

Coastal geomorphology as a proxy of large paleothrust earthquakes along the Andaman Trench Coastal geomorphology as a proxy of large paleothrust earthquakes along the Andaman Trench

ANDRADE, Vanessa^{1*} ; RAJENDRAN, Kusala¹ ; RAJENDRAN, C. P.²
ANDRADE, Vanessa^{1*} ; RAJENDRAN, Kusala¹ ; RAJENDRAN, C. P.²

¹Indian Institute of Science, Bangalore., ²JNCASR, Bangalore.

¹Indian Institute of Science, Bangalore., ²JNCASR, Bangalore.

Estimating hazards from earthquakes and tsunamis along subduction zones is of significance to coastal communities. Here, we discuss the coastal geomorphology of selected sites in the Andaman Islands, which lie within the rupture zone of the 2004 Sumatra-Andaman earthquake. As part of the near-source region, these islands witnessed considerable geomorphic changes, both before and after the 2004 earthquake, which may be related to the maturity of a megathrust subduction zone earthquake cycle. Assuming that these geomorphic landforms are properly preserved and attributed to the right sources, it is possible to build the history of large paleothrust earthquakes for the Andaman Islands. Given that these landforms are a result of similar processes through time, our sites are broadly divided as regions that subsided or were uplifted in 2004.

At Hut Bay and Interview Island, uplifted coralline terraces were mapped, as were stream inlets that cut through the newly-formed as well as older terraces. Samples collected from these locations include wood pieces from trees embedded in the stream bank, shells from pebble-rich layers along the exposed bank as well as coral fragments from the terraces themselves. At Port Blair, large stretches of land subsided in 2004. While several farmlands remain inundated beneath the present-day tidal-line, several mangroves trees died in situ, their roots being preserved in the shallow subsurface. Along a stream bank, a similar root horizon was identified 1m below the present day surface which was sampled at multiple locations. Additionally, a shell sample was collected from within the paleo root-zone.

The ages of these samples were estimated using AMS radiocarbon dating, and they cluster at AD 1100, AD 1500, and AD 1900. Though these geomorphic landforms may be the result of other coastal processes, either regional or global, we believe that these ages, with corroborating evidence from several studies in the Andaman Islands and from coastlines in Sri Lanka, mainland India, Sumatra, and Thailand are representative of large earthquakes in recent history, some of which may have been tsunamigenic.

キーワード: 2004 Sumatra-Andaman earthquake, Coastal geomorphology, Andaman Islands, Uplifted terraces, Subsided lowlands, Paleothrust earthquakes

Keywords: 2004 Sumatra-Andaman earthquake, Coastal geomorphology, Andaman Islands, Uplifted terraces, Subsided lowlands, Paleothrust earthquakes

さまざまな岩石の風化時の体積変化とその地質学的意義 Volumetric changes of various rocks during weathering and their geologic significance

千木良 雅弘^{1*}; 中田 英二²; 大山 隆弘²
CHIGIRA, Masahiro^{1*}; NAKATA, Eiji²; OYAMA, Takahiro²

¹ 京都大学防災研究所, ² 財団法人電力中央研究所

¹Disaster Prevention Research Institute, Kyoto University, ²Central Research Institute of Electric Power Industry

A rock volume may change during weathering, which would have various importance in earth surface processes. However, little is known on the volumetric change. We summarize our research results of various rock types and refer to its geomorphological importance. Basic idea is so-called isocon concept, which assumes immobile chemical elements during weathering and calculate a volume change from density and chemistry of rock before and after weathering (Grant, 1986). We assume TiO₂ is the immobile element.

Granitic rocks:

Volumetric change may be different between granite and granodiorite/quartz diorite. White et al. (2002) reported that granodiorite and quartz diorite are isovolumetric during weathering. Chigira (2002) reported that granite expands 50% during weathering, which is consistent with Folk and Patton (1982) who estimated the volume change from the inflection of a pegmatite vein in a weathering zone. These expansions lead to spheroidal weathering or micro-sheeting.

Sandstone:

Matsuzawa (2008) studied the weathering of sandstone of the Cretaceous Izumi Formation in Ehime and estimated 20-30% expansion during weathering, which closed joint openings.

Mudstone:

Calculation from the data of Chigira (1988) for the Quaternary Haizume Formation in Niigata suggested that mudstone expanded 10-30% during weathering in the upper part of the dissolved zone. Such expansion may facilitate downslope soil creep.

Vapor-phase crystallized tuff:

Calculation from the data of Chigira et al. (2002) for vapor-phase crystallized tuff of the Shirakawa ignimbrite in Fukushima suggested its weathering was isovolumetric except for the topmost part, in which fabric collapsed and the rock shrank.

Tuff breccia:

We studied the weathering of tuff breccia of the Miocene Tomari Formation in Aomori, which suggested that it occurred with 20-50% expansion. So-called active faults in the Higashidori nuclear power plant site are apparent active faults made by rock expansion during weathering.

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キーワード: 風化, 体積変化, 活断層

Keywords: weathering, volumetric change, active fault

Use of rock properties in classification of weathering grades: A Sri Lankan case study Use of rock properties in classification of weathering grades: A Sri Lankan case study

Udagedara Dashan T.^{1*} ; OGUCHI Chiaki T.²
UDAGEDARA, Dashan T.^{1*} ; OGUCHI, Chiaki T.²

¹Graduate School of Science and Engineering, Saitama University, ²GRIS, Saitama University

¹Graduate School of Science and Engineering, Saitama University, ²GRIS, Saitama University

Rocks utilised for the Samanalawewa project, have undergone severe weathering after they were excavated late 90's. The rate of weathering is incomparably high with respect to the normal soil formation processes. Different weathering grades of rocks that were used as construction materials, foundation materials and road aggregates are found in the project area. Consequently, they have been threatening to the sustainability of the project. The access adit and rip-rap zone of the dam are vulnerable to damage owing to the rapid weathering. Even though charnockite, marble, biotite and garnet granulitic gneisses were utilized for the project, only pyrite-sillimanite-garnet gneiss has shown extensive weathering. The rapid weathering of this rock is being observed since the commissioning of the project. Rocks were subjected to a petrographic study under the optical microscope. Point load strength, slake durability, loss on ignition and water content tests were employed to distinguish weathering grades. Water-rock interaction was experimented to study the pyrite oxidation. Comparatively to charnockite and marble, pyrite-sillimanite-garnet gneiss is weaker according to point load strength and slake durability indices. Rock strength and chemical properties illustrates that the weathering process takes place at a rapid and a normal stages. It is mainly observed on set of weathering. Corroded grains boundaries and decayed minerals in the rock are consequences of weathering induced by the acidic water generated by pyrite oxidation. The abundance of pyrite in pyrite-sillimanite-garnet gneiss is uneven. Thus, different weathering grades of the rock can be seen over the study area. Extensive fractures, which might be generated during tectonic activities or during excavations, facilitate better interaction with the atmosphere. It also effectively reduces the strength of the rock. It is another reason for differential weathering.

キーワード: Point load strength index, Rapid rock weathering, Loss on ignition, Samanalawewa project, Pyrite oxidation, Pyrite-sillimanite-garnet gneiss

Keywords: Point load strength index, Rapid rock weathering, Loss on ignition, Samanalawewa project, Pyrite oxidation, Pyrite-sillimanite-garnet gneiss

各種煉瓦の劣化現象及び耐久性に関する実験的研究 Experimental Study on Deterioration and Durability of Bricks due to Salts

グエン ティ ハイ デュン¹; 小口 千明^{2*}
NGUYEN, Thi hai duong¹; OGUCHI, Chiaki T.^{2*}

¹Graduate School of Science and Engineering, ²GRIS, Saitama University

¹Graduate School of Science and Engineering, ²GRIS, Saitama University

In Vietnam, heavy construction materials such as bricks are often used because there are many floods. However, the deterioration due to weathering has been found at general houses and historic brick buildings. To investigate deterioration of bricks used in these buildings, the present study performed salt weathering experiments using 6 bricks produced in Vietnam, Japan and China; red brick (RD), beige brick (BG), Vietnam brick (VN), amber brick (AB), brown brick (BR) and refractory brick (RF). These bricks were cut into cylindrical with a size of 3.5 cm in diameter and 7.0 cm in height. After examined rock properties such as physical, mechanical chemical and mineralogical characteristics, two types of salt weathering experiments were performed under 15-35 °C and 20 °C atmosphere. The saline solutions used in this study are 4%-Na₂SO₄, 8%-Na₂SO₄, 10% Na₂CO₃. Results of the experiments show that the deterioration mechanism of bricks is explained that 1) when the salt is absorbed and crystallizes inside brick, micropores of brick are extended by crystal expansion pressure and make cracks, 2) strength of the brick increases slightly by salt crystallization, but decreases gradually by salt deliquescence, and 3) with repeating of 1) and 2), bricks will be damaged. Even chemical and the mineralogical characteristics are almost equal except for BG, physical and mechanical characteristics are different, which controls durabilities of these bricks.

Keywords: salt weathering, brick, Vietnam, experiment, durability factor, salt susceptibility index