Consideration for marine alluvium in Bisan-Seto, Seto Inland Sea. –by re-examination of seismic profiles-

*Ryo Ohira[1], Yoshio Inouchi[2]

1. ocean engineering corporation, 2. Waseda Univ.

Re-examination of stratigraphy of so called alluvium all over Japan has been in progress. Investigations at alluvial plains are mainly based on analysis of drilled samples. On the other hand, so called marine alluvium has not yet been re-examined up to the present. Marine alluvial stratigraphy around Bisan-Seto at the central part of Seto Inland Sea is focused this time. As a result of re-examinations based on seismic profiles acquired by Bubble Pulser (Boomer) system, a new acoustic reflector is identified in marine stratum of upper portion of alluvium. This reflector divides upper sandy layer that forms sand bank in present marine sedimentary condition and lower muddy layer, and it reflects environmental change caused by the formation of strait between eastern Bisan-Seto and western Bisan-Seto (or the formation of straits lying between islands). This is the largest environmental change of Bisan-Seto caused by sea level rise after the end of last glacial period. Bay muds are distributed beneath the reflector, and sandy sediments which deposit under the influence of tidal current are distributed above the reflector.

Keywords: alluvium, Seto Inland Sea, seismic profiles

Geomorphological Evolution of Hashirikotan barrier spit controlled by Seismotectonics along the Southern Kuril Subduction Zone

*Futoshi Nanayama[1], Kiyoyuki Shigeno[2], Kazuaki Watanabe[1], Takeshi Hasegawa[3], Yasuhito Uchida[4], Yasuo Ikeda

1. Geological Survey of Japan, AIST, 2. MEICON, 3. Ibaraki University, 4. Geological Survey of Hokkaido

The Hashirikotan barrier spit is active in the northeastern part of Furenko lagoon facing the Nemuro Strait because five branches of spits (BS1~BS5) are clearly observed and dated by tephrochronology. The Hashirikotan barrier system has been established since 5.5 ka. The youngest BS1 has occurred after the 17th century and BS2 caused by the last seismic up rifting in the 17th century. BS3 rifted in the 12~13th century. BS4 caused by the seismic up rifting in the 9th century. BS5 has occurred at 4 ka. Since 2003, it was clearly that the great earthquakes (Mw8.5~9.1) have been occurred at an interval of 500 years along the southern Kuril subduction zone. Especially coastal area raised almost 1~2m just after the great earthquakes due to the post seismic displacements. But conversely land subsidence has been continuing at a rate 1.0 mm/year since the 17th century until now. We express that geomorphological evolution of the Hashirikotan barrier system has been controlled by the seismotectonics along the Kuril subduction zone.

This research has been supported in part by JSPS KAKENHI Grant Number 23540539, 22340153 and 15K05323.

Keywords: geomorphological evolution, Hashirikotan barrier spit, seismotectonics, southern Kuril trench, eastern Hokkaido

Effects of valley topography on run-up of the 2011 Tohoku tsunami on the Sanriku coast, northeastern Japan

*Takashi OGAMI[1], Toshihiko Sugai[2]

1. Faculty of Science and Engineering, Chuo University, 2. Graduate School of Frontier Sciences, Tokyo University

The 2011 Tohoku earthquake and tsunami caused heavy damage in low-lying valleys of the Sanriku coast, northeastern Japan. The landward extent of inundation by the tsunami varied considerably among the river valleys, indicating that tsunami run-ups were strongly affected by the subaerial fluvial morphology of the valleys. We used detailed tsunami inundation maps to investigate tsunami run-ups along river valleys along the Sanriku coast, considering both the protected areas landward of coastal seawalls and levees (protected zone), and areas riverside of levees (channel zone). We compiled detailed longitudinal river profiles and used them in conjunction with published tsunami inundation maps to determine the distances and heights of tsunami run-ups in 68 valleys along the Sanriku coast. Run-up heights tended to be higher and run-up distances longer in the channel zone than in the protected zone. Comparison among valleys of run-ups with longitudinal valley slopes showed that run-up distances decreased with increasing valley slopes, and that run-up heights increased with increasing slopes. Further studies of the effects of subaerial fluvial morphology and friction on tsunami run-ups, and the influence of tsunami wave height, are needed to improve our interpretation of paleo-tsunami deposits in Quaternary sediments and improve future tsunami-disaster prevention programs.

Keywords: 2011 Tohoku earthquake, Sanriku coast, Tsunami run-up, Narrow valley floor, Longitudinal valley profile, Tsunami inundation map

Holocene sedimentary succession and crustal movement in the Tsugaruishi plain, central Sanriku coast, northeast Japan

*Yuichi Niwa[1], Toshihiko Sugai[2], Yoshiaki Matsushima[3], Shinji Toda[1]

1. International Research Institute of Disaster Science, 2. Graduate School of Frontier Science, The University of Tokyo, 3. Kanagawa Prefectural Museum of Natural History

Along the Sanriku coast, discrepancies in crustal movement (10^5 year scale uplift and 10^1 –10^2 year scale subsidence) have been reported between long (10^4–10^5 years) and short (10^1–10^2 years) timescales. Well-dated Holocene incised valley sediments provide records of millennial-scale vertical crustal movement, which is a key to understand the tectonic history in this area. Recent study of the age and distribution of early Holocene intertidal deposits in the incised valley suggested that the southern Sanriku coast has subsided during the Holocene with an average rate of about 1 mm/yr. Here we studied three sediment cores collected from the Tsugaruishi plain, on the central Sanriku coast.

A typical Holocene deltaic succession was recognized in both three cores; basal gravel of alluvium, flood plain or estuary sand and mud, inner bay mud with subtidal molluscan shells, deltafront sand layer with upward coarsening successions, and modern fluvial sand, mud, and gravel layer, from lower to upper. In the upperstream site, sand and mud layer with finning upward succession is identified just above deltafront sand layer with coarsening upward succession. This sand mud layer contains in situ intetidal molluscan shell, indicating intertidal deposition. Thus, elevation of this intertidal sediments (ca. -12 m relative to present sea-level) approximates paleo-sea level at the timing of deposition (ca. 7500 cal BP). Along the Pacific coast of northeast Japan. RSL at 8000 to 7000 cal BP is estimated to be higher than -5 m relative to the present sea level (Okuno et al., 2014). Thus, middle Holocene intertidal deposits at ca. -12 m relative to the present sea-level indicates Holocene subsidence trend along the Tsugaruishi plain as estimated along the southern Sanriku coast.

Keywords: Holocene, Sanriku coast, crustal movement

Study of shallow subsurface geology based on analysis of sedimentary cores drilled in the Aizu Basin, Northeast Japan

*Takeshi ISHIHARA[1], Takehiko SUZUKI[2], Misao HONGO[3], Youhei UCHIDA[1]

1. AIST, 2. Tokyo Metropolitan University, 3. Alps Technical Research Co., Ltd

1. Introduction

Aizu Basin is one of tectonic basins aligning with north-south direction in the south part of Northeast Japan. Along the west and east margin of the basin, the West Aizu Basin Fault Zone and the East Aizu Basin Fault Zone, active reverse faults, stretches respectively (e.g. AIST, 2007). Quaternary geological structure of the Aizu basin and tectonic histories of both fault zones are still not clear because of lack of chronological studies of underground sediments of the basin, except Suzuki et al (2013, 2016) discussed tephrochronology in the basin and activity of the West Aizu Basin Fault Zone since middle-Pleistocene based on analysis of a sediment core (AB-12-2, 179.1m asl, 99.5m depth) drilled in the western part of the basin.

AIST drilled two sediment cores (GS-SOK-1, 175.99m asl, 130m depth; GS-AZU-1, 208.36m asl, 100m depth) in the eastern part of the Aizu Basin and reported their stratigraphy based on tephra and fossil pollen analysis (Ishihara et al., 2015, 2016). In this report, we discussed a shallow subsurface geology by correlating each stratigraphy of GS-SOK-1, GS-AZU-1, and AB-12-2 cores.

2. Geogical stratigraphy of cores in the Aizu Basin

GS-SOK-1: Sn-SK tephra (220ka, Suzuki et al, 2004) is included in the depth of 81.1-81.7m. Twelve local pollen assemblage zones (SOK-I, -II…, and –XII, in ascending order; added to Ishihara et al., 2016) are divided. Tertiary flora (e.g. *Metasequoia*, *Keteleeria*, *Carya*) are slightly included in SOK-I zone (111.1-126.7m depth; Ishihara et al., 2016). On the basis of tephra, pollen, and 14C analysis, we divided stratigraphy of GS-SOK-1 into the following: Holocene (0.0-6.0m depth), upper Pleistocene (6.0-45.0m), middle Pleistocene (45.0-110.5m), and lower Pleistocene (110.5-130.0m).

GS-AZU-1: Five tephra layers are identified as follows (depth: tephra neme and age), 13.35-13.38m: AT (29-30ka, Machida, 2011), 30.25-30.30m : Aso-4 (87ka, Aoki *et al.*, 2008) , 34.10-35.10m: Nm-SB (110ka, Suzuki et al, 2004) , 52.35-52.40m: Sn-MT (180-260ka, Suzuki et al, 2004) , and 70.5-76.3m: Kachikata ignimbrite (one of the Shirakawa ignimbrites; Yoshida and Takahashi. 1991; Kurokawa *et al.*, 2008). On the basis of tephra and 14C analysis, we divided stratigraphy of GS-SOK-1 into Holocene (0.0-5.0m depth), upper Pleistocene (5.0-36.5m), middle Pleistocene (36.5-52.5m), and lower Pleistocene (52.5-100.0m).

AB-12-2: On the basis of Suzuki *et al* (2016), geological stratigraphy of AB-12-2 is divided into Holocene (0.0-ca. 8.5m depth), upper Pleistocene (ca. 8.5-44.5m), and middle Pleistocene (ca. 44.5-99.5m).

3. Shallow subsurface geology in the Aizu Basin

Accumulation rate of the sediments at GS-AZU-1 are 0.45m/kyr between ground surface and AT, and 0.26-0.27m/kyr between AT and Nm-SB, whereas the accumulation rates of AB-12-2 (Suzuki *et al.*, 2016) are 0.46-0.55m/kyr between ground surface and DKP (55-66ka; Suzuki *et al.*, 2016), and 0.19-0.23m/kyr beween DKP and TG (129ka; Aoki *et al.*, 2008). Similarity of accumulation rates between GS-AZU-1 and AB-12-2 indicates that vertical average slip rate of the East Aizu Basin Fault Zone is comparable with rate of the West Aizu Basin Fault Zone if the accumulation in the basin corresponds to the activity of both fault zones. Difference in changing period of accumulation rate implies time lag of each fault activity and/or local variation of sedimentary environment.

Boundaries between lower and middle Pleistocene in the Aizu Basin are, at 50-60m depth in Aizu-Wakamatsu, 110-120m in Shiokawa, 50-60m in Atsushio (Tohoku METI, 1999) from south to north, indicating structure of lower Pleistocene inclining toward central basin from south and north margin. By contrast, in Aizu-Bange, western part of the basin, stratigraphy of AB-12-2 (Suzuki *et al*., 2016) and well columns indicates lower Pleistocene lies below 100-150m depth, showing incline westward of lower Pleistocene. These results are important to clear tectonic histories of both fault zones.

Keywords: Aizu basin, Quaternary, Pleistocene, shallow subsurface geology, tephra, fossil pollen

Crevasse splay evolution and changes in depositional condition of surrounding floodplain inferred from surface deposits of the Kinu River, central Japan

*Atsuto Izumida[1], Toshihiko Sugai[1], Hiroyuki Matsuzaki[2], Toru Tamura[3]

1. Graduate School of Frontier Sciences, The University of Tokyo, 2. The University Museum,The University of Tokyo, 3. Geological Survey of Japan, AIST

Crevasse splays are an important component of floodplains and have been suitable topography for human occupation through the prehistorical and historical times because of rapid, intensive aggradation of the specific area in floodplains which in turn produces relatively elevated place against following inundation events. However, more needs to be known about their morphology, time scales of formation, and relationships with surrounding floodplains to clarify the roles for floodplain evolution and human use of crevasse splays.
A crevasse splay diverted from the Kinu River at Obokawa, Joso City, Ibaraki Prefecture was reconstructed by analysis of several drilling cores (up to a depth of 5 m), coupled with ground penetrating radar (GPR) survey and radiocarbon dating. The study area is located 25 km upstream from the confluence of the Kinu River with the Tone River. The Kinu River in this area has a low sinuosity, single channel and a sandy bed with a gradient of about 1/2500. Sadakata (1971) suggests that overbank vertical accretion is dominant in the floodplain there, which is 4–8 km wide and is bordered on both the west and east by the Kinu and Kokai rivers.
The crevasse splay is about 2 m higher than surrounding flood basins, forming a convex-shaped mound. The splay and the trunk channel of the Kinu River were connected by a narrow crevasse channel. The crevasse splay experienced the development of new rice fields since 17th century, indicating the inactivity of the splay since then.
The facies of the cores were roughly divided into three depositional units composing channels (CH), natural levees (LV), and back swamps (BS). Core OBK-01, located in the crevasse channel, had two CH units at the depths of 1–2.5 m and 3–3.5 m, positioned above and below a BS unit. The radiocarbon age determined at Micro Analysis Laboratory, Tandem accelerator, the University of Tokyo suggests this repetitive channel emergence dated back to later than 1000 BC. Cores adjacent to the crevasse channel showed alternate deposition of BS and LV units in 0.5–2 m thick for each unit, indicating that the LV units were associated with development of the crevasse channel and the distribution of alluvial topography had frequently changed in the past. Detailed facies analysis, GPR profiles, and additional radiocarbon ages will be shown in the presentation.

Reference

Sadakata, N.: Formation of the Lower Kinu River Floodplain, Geographical Sciences (Chiri Kagaku), 18, 13–22, 1971 (in Japanese with English abstract).

Keywords: crevasse splay, floodplain, the Kinu River, ground penetrating radar

3D geologic modelling in the subsurface of the Tokyo Lowland : methodology and application

*Katsumi Kimura[1], Yuki Hanashima[2]

1. National Research Institute for Earth Science and Disaster Prevention, 2. Smart Solutions Cooperation

This study demonstrates a 3D ground model of the coast plain in the Tokyo Lowland and the adjacent upland, using borehole log data (standard penetration test for engineering works). The borehole data are about 6000, digitized for modelling. The model area ranges from X: 387,000 –407,000m and Y: 3,944,400 –3,956,500m in the UTM 54 zone, and being composed of the coast lowland and the adjacent loam upland geographically. The 3D model is expressed with both the surface model of geologic boundaries and the 3D grid with attributes of N-value, lithology and geologic unit. The grid size is 100m in width, 1m in height. The detailed methodology refers to Eto et al.(2008) and Kimura et al.(2013, 2014).
The surface model consists of a geomorphic surface based on a digital elevation model (5m mesh) and the stratigraphic basal surfaces including the Holocene sediment (Chuseki-so), the fluvial terrace deposits, and the Middle to Upper Pleistocene Shimousa (Sm) Group, in descending order. The basal horizon of the Sm Group is close to the engineering base surface (more than 50 of N-value). The 3D grid model is constructed by horizontal interpolation of borehole data on each altitude with the inverse-distance weighting method and stacking vertically. The borehole data for modelling are subdivided into each geologic unit and the model calculation is performed for every subdivided geologic units.
The distribution pattern of the N-values and lithofacies in the 3D grid model demonstrates inner physical structure and sedimentary facies of ground such as basal gravel of the Chuseki-so, meandering-channel fills, and marine mud of inner bay. In addition, the 3D grid model offers a detailed renewable geologic model to calculate the S-wave velocity structure model for evaluating the seismic amplification properties.

Keywords: 3D geologic model, voxel model, borehole data, Tokyo Lowland, ground model

Environmental History during the last 2,000 years in Lake Hamana, Shizuoka

*Kazuyoshi Yamada[1], Koji Seto[2], Kota Katsuki[2], Takumi Sato[2]

1. Museum of Natural and Environmental history, Shizuoka, 2. Shimane University

Lake Hamana is seventh biggest lakes in Japan, locates on the coastline of the Pacific Ocean. Archaeological data suggests that people lived around the lake from Jomon periods, and brackish environment in the lake that is modern condition might be caused by tsunami event related to huge earthquake along the Nankai Trough in 1498 AD.
In order to reconstruct the variation of the past environment during the last 2,000 years, TOC, TN, TS contents with multiple radiocarbon data are measured with high-resolution.
The bottomed sediments were obtained at northern flat basin which is approximately 11 m in water depth in the lake. Two sediments cores which are 378 and 132 cm length, respectively have continues deposition since the 2,100 cal yr BP on the basis of radiocarbon data.
Our preliminary results of variations of TOC, TN, TS contents indicates brackish to marine environments last for the 2,000 years, and there is no signal against tsunami event in 1498 AD.

Keywords: Sedimentary Environment, Lake Hamana

Tephras from Tarumai volcano in Tonbetsu Plain, Northern Hokkaido,Japan

*Akihiro Yokota[1], Reisuke Kondo[2], Kiyoyuki Shigeno[1], Tatsuo Kanamaru[3], Hiroshi Ushiro[4], Hiroko Fujita[5]

1. Meiji Consultant Co., Ltd, 2. Kogakkan University, 3. Nihon University, 4. Hokkaido Museum, 5. Hokkaido University

Tarumae volcano is an active volcano that performs multiple volcanic activities from the beginning of the Holocene. Tephra of Tarumae volcano are Ta-a, Ta-b, Ta-c 2, Ta-d. They are distributed throughout Hokkaido. However, the Tonbetsu plains have few mention examples of tephra.
In this study, we analyzed it with an outcrop mention in Northern Hokkaido, Hamatonbetsu coastal area and examined tephra.
As a result it was estimated that two tephra layers distributed over the Tonbetsu plains were correlation of the Tarumai volcano.

Keywords: Tephra, Sand dune, Tarumai volcano, Tonbetsu plain, Holocene

MIS 5c key-maker tephras in the upper Pleistocene Joso Formation in the southern Sashima, Tsukuba and northwestern Shimosa Uplands, Kanto plain, Japan

*Daichi Akiyama[1], Toshihiko Sugai[1], Hiroko Okazaki[2], Hiroomi Nakazato[3], Shinzou Ooi[4]

1. Department of Natural Environmental Studies, Institute of Environmental Studies, Graduate School of Frontier Science, The University of Tokyo, 2. Division of Earth Science, Natural History and Institute, Chiba, 3. National Institute for Rural Engineering, 4. Research Institute of Geology and Geoinformation, Geological Survey of Japan

Most of the terraces in the Kanto Plain had been formed in marine oxygen isotope stage (MIS) 5 under the influence of eustatic sea-level lowering after MIS 5e and Kanto basin forming movement characterized by uplift of the marginal part and subsidence of the central part. It remains unknown how upper Pleistocene Joso Formation, Shimosa Group and terraces composed of the Joso Formation had been evolved after MIS 5e at the central Kanto Plain. This study classified terrace surfaces by the integration of geomorphic analysis, sedimentary facies analysis and tephra analysis focusing on the southern Sashima, Tsukuba and northwestern Shimosa Uplands in the central part of the Kanto Plain. Terrace surfaces were classified into 6 levels. The terrace sediments distributed over the 1 to 5 levels from the top in the Sashima Upland and 1 to 3 levels from the top in the Tsukuba Upland were divided into two formations; Kioroshi Formation composed of beach facies, and the Joso Formation composed of flood plain and channel facies. In the Joso Formation, we found two different tephras and correlated them to Nk-Ma (c. 100 ka: Yamamoto, 2012) at Tsukuba Upland and On-Pm1 (c. 96 ka: Aoki et al., 2008) at Sashima upland by element analysis of the volcanic glass and minerals.
Nk-Ma has been identified in the Naka, Kashima, Namekata, Nihari and Inashiki Uplands (Ooi, Ph. D, 2013).We identified Nk-Ma tephra in the Tsukuba upland for the first time. This indicates that the southern limit of Nk-Ma fall range becomes much wider than previous studies. Nk-Ma in the Tsukuba upland has 2 to 8 cm thickness, 12 mm maximum pumice size, light yellow color. It contains orthopyroxene, clinopyroxene, hornblende, brownish bubble-wall and grayish pumice type glass shards. It is expected to trace of Nk-Ma for other regions and to date of Joso formation with tephra including Nk-Ma.

References: Aoki *et al*. (2008) *The Quaternary Research*, **47**, 391-407. Ooi (2013, Ph. D) Doctoral thesis, Graduate school, Ibaraki University, 172p. Yamamoto (2012) *Bulletin of the Geological survey of Japan*, **63**, 35-91.

Keywords: Kanto Plain, Sashima Upland, Tsukuba Upland, Shimosa Upland, MIS 5c, Tephra

A discovery of Amagi-Kawagodaira tephra(Kg) from core samples taken at the connecting bar in Kushimoto, southern tip of Kii peninsula, Pacific coast of western Japan

Tamaki Kitagawa[1], *Hideaki Maemoku[2], Masanobu Shishikura[3], Tomoo Echigo[4], Yuichi Namegaya[3]

1. Graduate school of Humanities, Hosei University, 2. Department of Geography, Hosei University, 3. Research Institute of Earthquake and Volcano Geology, AIST, 4. Geo-Research Institute

We report a new discovery of Amagi-Kawagodaira tephra(Kg) from two core samples taken at the connecting bar in Kushimoto, southern tip of Kii peninsula, Pacific coast of western Japan. We have taken five core samples at the elevation of 5.7 m a.s.l., in the high school ground located on the connecting bar (tombolo) in order to know the huge tsunami cycles which must have occurred along the Nankai trough subduction zone. We found a very clear tephra layer of Kikai-Akahoya(K-Ah) in one of the core samples, however no other tephra layers could be seen apparently. We divide core samples into every five centimeters and examine them with microscope. We can see many glass particles originated in volcanic ash through microscope in many core samples. Refractive index of every glass particles is measured to identify crypt tephra. Most tephras are identified to Kikai-Akahoya(K-Ah) or Aira-Tn(AT) reworked from surrounding slopes. Only two samples can be identified to Amagi-Kawagodaira tephra(Kg). We examined index of chemical components of volcanic glasses by EPMA. Consequently, we could discover Kg tephra not only at new locality, but also determine the period of a huge tsunami deposit occurred along the Nankai trough.

Keywords: Nankai Trough, crypt tephra, Amagi-Kawagodaira(Kg), tsunami deposit

Postglacial environmental change and prehistoric hunter-fisher-gatherer habitations in the Hokkaido region (northern Japan) inferred from pollen data and archaeological site distribution

*Christian Leipe[1], Chiharu Abe[2], Stefanie Müller [1], Hirofumi Kato[3], Mayke Wagner[4], Andrzej W. Weber[5], Pavel E. Tarasov[1]

1. Paleontology Section, Institute of Geological Sciences, Freie Universität Berlin, Germany, 2. Jomon World Heritage Promotion Office, Hokkaido Government, Japan, 3. Center for Ainu and Indigenous Studies, Hokkaido University, Hokkaido, Japan, 4. Eurasia Department and Beijing Branch Office, German Archaeological Institute, Germany, 5. Department of Anthropology, University of Alberta, Canada

Substantial progress has been made on understanding the evolution of Late Pleistocene/Holocene hunter–fisher–gatherers. A growing body of evidence suggests that most of these groups did not, as was long assumed, remain relatively static and marginal over long periods. One area that has a rich, complex, and dynamic hunter–fisher–gatherer prehistory, which persisted until the middle of the 19th century AD, is the Hokkaido region. While empirical information about the hunter–fisher–gatherer archaeology in this region is increasing, understanding of the specific mechanisms driving the cultural trajectories remains insufficient. What specific mechanisms generated the observed hunter–fisher–gatherer cultural patterns and which role climate change played in these processes are two main research questions of the ongoing Baikal–Hokkaido Archaeology Project (BHAP, http://bhap.artsrn.ualberta.ca). Within this scope, we have (1) examined the spatio-temporal distribution of archaeological excavation sites in the Hokkaido region and (2) have evaluated the findings in view of key palaeoclimate records from the greater study area and the preliminary results of the palaeobotanical analysis of the RK12 sediment core from Lake Kushu (45°25′58″N, 141°02′05″E; Rebun Island). The continuous and well-dated RK12 core covering the last ca. 17,000 years has been identified as a key palaeoenvironmental record for the region of northern Japan.
The spatio-temporal analysis of archaeological sites in the Hokkaido region exhibits hunter–fisher–gatherer population dynamics from the Upper Palaeolithic (>14,000 cal yr BP) to the Ainu period (ca. 700–100 cal yr BP). Most cultural transitions coincide with periods of climate and environmental change. The data support the hypothesis that Palaeolithic subsistence was, at least partly, based on terrestrial hunting. The subsistence strategy shifted towards marine resources and plant exploitation alongside the early phases of the Jomon cultural complex paralleled by lateglacial climate warming, rising sea levels, and a change in regional marine currents. With continuous Holocene climate warming, site numbers increased suggesting a rise in population, which culminated in the Middle Jomon period (5000–4000 cal yr BP). At the same time, Jomon subsistence experienced a process of diversification and intensification in exploitation of natural food resources. These changes in the food economy probably allowed the persistence of the Middle Jomon culture beyond the Holocene temperature optimum (around 5000 cal yr BP). After, the population decreased until the end of the Jomon culture accompanied by a trend towards cooler climate conditions. During the Satsumon/Okhotsk culture periods (1500–700 cal yr BP) population re-increased. While the spread of Satsumon people into Hokkaido appears to have been controlled by human agency, immigration of Okhotsk people may be linked to climate cooling in the regions north of Hokkaido. Sites representing the following cultural period (Ainu, ca. 700–100 cal yr BP) re-decrease and show a concentration in eastern Hokkaido. It remains unclear what brought about the Satsumon–Ainu cultural transition. Thus far, there is no indication for any social or climatic factors having influenced this cultural transformation. Although most parts of the Hokkaido forager trajectory appear to be linked with environmental changes, causal relations need to be verified by future high-resolution and well-dated regional palaeoenvironmental records (e.g. the RK12

core) and dedicated archaeological research including conventional methods and more recent techniques like the "life history approach".

Keywords: Human–environment interactions, Hunter-fisher-gatherer cultures, Postglacial climate change, Neolithic, Palaeolithic, Hokkaido

Results of a preliminary study on the obsidian outcrops and Pre-Hispanic sites in Tenerife, Canary Islands

*Yuichi Nakazawa[1], Cristina Vega Maeso[2], Eduardo Carmona Ballestero[3], John Risseto[4], Alberto Berzosa Ordaz[3], Yasuo Naoe[5], Kensho Dohi[5], Mina Araya[5], Mercedes del Arco-Aguilar[6]

1. Graduate School of Medicine / Hokkaido University, 2. University of Cantabria, 3. University of Burgos, 4. Nebraska State Historical Society, 5. Hokkaido Archaeological Operations Center, 6. Tenerife Archaeological Museum

The Canary Islands are an east trending volcanic archipelago located off the western Atlantic coast of North Africa. Tenerife Island, the largest in the seven island chain, was an active volcanic island formed in an active rift zone punctuated by repeated mountain formation and collapse. Volcanic activity on the island started 11.9 Ma, with 90% of the island's volume created by 3.5 Ma during three distinct formation stages (Carracedo and Perez-Torrado, 2013). The latest formation created the Las Cañadas Caldera located in the middle of the island. This area includes the island's tallest volcanoes Teide and Pico Viejo. Los Guanches were the indigenous population who inhabited the island from the late Holocene until Spanish colonization in the 15th century. This Pre-Hispanic society is characterized by life-ways focusing on hunting, gathering, and domestic plant use (e.g., barley). Although there is no evidence of metallurgy, technology focused on stone and osseous tools, ceramic pottery, and wood. Among tool resources, obsidian generated by the volcanic activities on Tenerife was a widely used raw material for making stone tools. The goal of this preliminary study is to collect basic data that helps evaluate Pre-Hispanic lifeways on Tenerife in terms of long-term use of island resources and to elucidate human-volcanic relationships on this geologically and biogeographically unique island. To do this, we focus specifically on the Pre-Hispanic exploitation of obsidian. Since the available data regarding obsidian use in Pre-Hispanic sites are limited, we conducted a field study focused on both (1) obsidian outcrops made by volcanic activities in the Las Cañadas Volcano, and (2) a systematic survey on the alluvial fans and gullies in the southern dry area of Tenerife. With permission from the Teide National Park, two known obsidian outcrops (Tabonal Negro and Tabonal los Guanches) in the central area of Las Cañadas Volcano (Hernández Gómez and Galván Santos, 2008) and a single outcrop along the northern coastal zone (Charco de Viento) were surveyed. Tabonal Negro is located on a phonolitic lava dome originated from Montaña Blanca and contains extensively distributed obsidian boulders dated to ca. 2000 BP (Ablay et al., 1995). The Pre-Hispanic artifacts samples (obsidian debitage and ceramic sherds) represent surface finds located on the alluvial fans deposited in between lava domes. These surface scatters are located in 2270 - 2300 m asl. Tabonal Guanches is an extensive lava flow located on the northern slope of Mt. Teide. Numerous obsidian workshops are identified in between the obsidian boulders that make up the Lavas Negras phonolitic lava flow. This flow dates to 1150 ±140 cal. BP based on charcoal samples obtained from just beneath the Lavas Negras. This suggests that the Guanches' exploitation of Tabonal los Guanches was at least initiated after this period. The northern coastal region (Charco de Viento) where natural obsidian was outcropped is on the distal end of the lava dome (called as Abejara Alta) originated from the slope in 2500 m asl. The AMS radiocarbon date for the charcoal beneath the Abejara Alto is 5911 ±264 cal. BP (Carracedo et al., 2007, 2013), suggests that obsidian of Charco de Viento was generated no earlier than 6000 BP. During the survey campaign, no obsidian artifacts were identified on this part of the lava dome. In southern Tenerife, the archaeological survey took place in the Granadilla area among the extensive alluvial slopes at the outskirts of the Teide volcano. Because of the dry climate, alluvial slopes created numerous now-dry gullies, known as "barrancos". Our three-day survey along the barrancos recorded a total of 32 scatters of artifacts attributable to Pre-Hispanic period. Among them, 29 scatters contained obsidian debitage. The surveyed region of Granadilla is covered with ignimbrite and

fallen pumice that included basalt flows. Obsidian was found from the alluvial terraces, although they are generally pebble size and poor in abundance. Conversely, the obsidian from the artifact scatters are larger in size and exhibit various appearances including translucent, opaque, and dark green, indicating that Guanches obtained obsidian from remote regions outside the Granadilla. As research continues, it will be critical to address three main questions: (1) Identifications of the distributions of natural obsidian outcrops, (2) Geochronology of obsidian-related lava flows and terraces/surfaces where archaeological sites are located, and (3) Geochemical sourcing of obsidian and other lithic materials using currently standardized methods. This research was supported by the JSPS KAKENHI Grant No 26350374.

Keywords: Tenerife Island, Obsidian, Lava flow, Pre-Hispanic, Resource exploitation

Subsurface geology beneath downtown Mashiki seriously damaged by the 2016 Kumamoto Earthquake

*Tsutomu Nakazawa[1], Kentaro Sakata[1], Ikuo Cho[1], Yoshiki Sato[1], Atsushi Urabe[2], Hideo Hoshizumi[1], Masayuki Yoshimi[1]

1. Geological Survey of Japan, AIST, 2. Research Institute for Natural Hazards and Disaster Recovery, Niigata University

Mashiki Town, Kumamoto Prefecture, SW Japan was seriously damaged by the 2016 Kumamoto Earthquake. Downtown Mashiki is located on the slope at the margin of an upland formed by the Aso-4 pyroclastic flow deposits. Particularly, building damage was concentrated at the lower part of the slope. The damage concentration was recognized from downtown Mashiki to Higashi-ku of Kumamoto City with a length of 3 km at least along the margin of the upland. We examined sediment cores and SPT samples drilled at three sites in the damage-concentrated zone and its surroundings (Yoshimi et al., 2016), and also carried out micro-tremor array surveys along sections across the zone.
Detailed examination of the sediment cores and the SPT samples reveals that subsurface geology (to the depth of 70 m) beneath downtown Mashiki is composed of a scoria and volcanic ash bed (Aso-3 pyroclastic flow deposits), a tuffaceous mud bed, a pumice and volcanic ash bed (Aso-4 pyroclastic flow deposits), a tuffaceous mud bed, a tephric loess bed, and an artificial fill in ascending order. Among them, the tuffaceous mud bed above the Aso-4 pyroclastic flow deposits exhibits a high water content and a very soft property. It was due probably to a generally shallow water table in the study area. Furthermore, the Aso-4 pyroclastic flow deposits are thicker beneath the lower slope than the upper slope.
Micro-tremor array surveys also reveal that a relatively soft layer with a S-wave velocity lower than approximately 300 m/s, which correspond to the pumice-dominated part of the Aso-4 pyroclastic flow deposits on the basis of the PS logging data (Yoshimi et al., 2016), becomes thicker beneath the lower slope and that the base of the layer decreases the elevation stepwise from the upper to lower slopes. Such distribution pattern of the strata is considered as one of the major factors involved in the maldistribution of the earthquake damage.
On the other hand, building damage was less conspicuous in the lowland south of the margin of the upland. The micro-tremor array surveys indicate that a soft layer with a lower S-wave velocity is distributed beneath the lowland. Further investigation is needed to understand the relation between the geologic properties and the earthquake damage in the lowland.

Reference: Yoshimi et al. (2016) Abstracts, 2016 Fall Meeting, JSAF, P-17.

Keywords: Subsurface geology, downtown Mashiki, 2016 Kumamoto Earthquake

