Press Release

October 5, 2018
Akita University
The University of Tokyo
National Institute of Advanced Industrial Science and Technology
Yamagata University

Investigating Mt. Fuji Eruption History with Lake-Floor Sediments

－Undetected eruptions preserved in Lake Motosu－

Akita University Graduate School of International Resource Science Associate Professor Stephen Obrochta and The University of Tokyo Atmosphere and Ocean Research Institute Professor Yusuke Yokoyama's research group analyzed a four-meter long, continuous subsurface column of sediment obtained from Lake Motosu (one of the Fuji Five Lakes) during the international research project "QuakeRecNankai" (A cooperative study between Ghent University, The University of Tokyo and the National Institute of Advanced Industrial Science and Technology). The result is a reconstruction of the eruptive history of Mt. Fuji based on the ash layers deposited in Lake Motosu over the past 8,000 years that reveals the possible existence of previously unknown eruptions, provides better estimates of the timing of eruptions, and indicates that a wider area was affected by eruptions that previously thought. The societal impacts of a Mt. Fuji eruption are feared to be quite severe. The results of this study have implications for prediction of future eruptions and disaster mitigation.

This research is published in Quaternary Science Reviews (Elsevier B.V.) for release on October 10, 2018.

Research Background. Mt. Fuji is an active volcano and a UNESCO World Heritage site with over 47 million annual visitors to the region. Evaluating the potential of a future eruption and the scope of the affected area requires information about past eruptive activity. To date, this information was available only through land-based studies, which may neither provide a continuous record nor the best material for determination of the age of past eruptions. To overcome these issues, we studied continuously-accumulating sedimentary layers retrieved by sediment coring from below the floor of Lake Motosu, one of the Fuji Five Lakes, obtaining a much clearer picture of the timing of eruptions and the extent of the affected area.

Research Results. At 121.6 m, Lake Motosu is the deepest of the Fuji Five Lakes and preserves a continuous record of environmental change over at least the past 10,000 years. Lake Motosu also contains a history of Mt. Fuji eruptions. In particular, Lake Motsou clarifies which eruptions distributed ash on the western side of the volcano because it is located on the northwestern flank, upstream of the prevailing wind.

Layers of volcanic ash (known as scoria) in the sediment core samples from Lake Motosu were identified through detailed visual observation and X-Ray fluorescence. Over 30 radiocarbon measurements were performed and, along with the ages of two other known eruptions (of different volcanos, not Mt. Fuji), an extremely precise age-depth model was created to determine the age of the sampled material (see figure). This shows that Lake Motosu has recorded the past 8,000+ years. Comparing to results from land-based trench studies, three of the scoria layers in Lake Motosu can be correlated to the Osawa eruption, the Omuro eruption, and the Kengamine eruption (most recent summit eruption). Previous research suggested that the Osawa occurred at around 3400 years ago (3214-3401 cal BP), the Omuro around 3200 years ago (3072-3272 cal BP), and the Kengamine around 2300 years ago. Based on the more accurate age model obtained from this research, these estimates are revised to median ages of around 3042, 2930, and 2309 cal BP, respectively. This is the first time that these eruptions have been discovered on the upwind, western flank of the volcano, indicating ash from these three eruptions is more widely dispersed than previously believed. There are also two additional eruption layers with geologic characteristics indicating a Mt. Fuji origin that cannot be correlated to any previously known eruptions, leading us to believe that these are two newly-discovered, western flank eruptions of the Mt. Fuji volcano. By precisely studying the age of lake sediments, we were able to provide important information regarding the scale and frequency of Mt. Fuji eruptions, which is relevant to prediction of future eruptions and disaster mitigation.

Manuscript Information:

Title: Mt. Fuji Holocene eruption history reconstructed from proximal lake sediments and high-density radiocarbon dating

Authors: Obrochta, S.P., Yokoyama, Y., Yoshimoto, M., Yamamoto, S., Miyairi, Y., Nagano, G., Nakamura, A., Tsunematsu, K., Lamair, L., Hubert-Ferrari, A., Lougheed, Hokanishi, A, Yasuda, A., Heyvaert, V.M.A., i, De Batist, M., Fujiwara, O., the QuakeRecNankai Team

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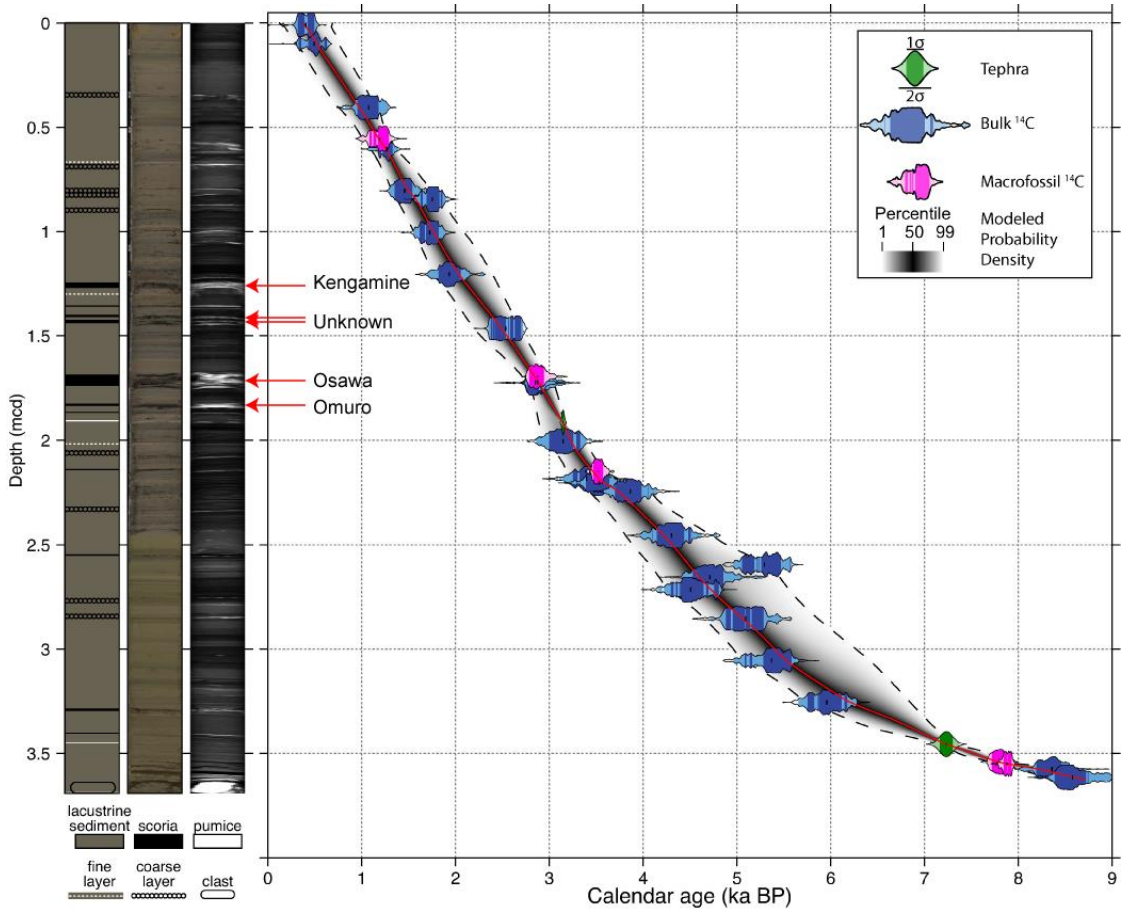

Figure: From left to right, overview of sediment core stratigraphy, core image, and CT scan with age-depth model. Arrows indicate (from bottom to top) the position and age of the Osawa, Omuro, two newly discovered, and Kengamine eruptions.

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Press Release Details

Investigating Mt. Fuji Eruption History with Lake-Floor Sediments

－Undetected eruptions preserved in Lake Motosu－

Presenters

Stephen Obrochta	Akita University Graduate School of International Resource Science
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Yosuke Miyairi	Tokyo University Atmosphere and Ocean Research Institute
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Research Overview

Akita University Graduate School of International Resource Science Associate Professor Stephen Obrochta and The University of Tokyo Atmosphere and Ocean Research Institute Professor Yusuke Yokoyama's research group, as part of the international collaborative QuakeRecNankai project (Note 1) that is funded by the Belgian Science Policy Office (BELSPO), performed detailed analysis and age determinations of a continuous, four-meter long column of sediment obtained by core sampling of Lake Motosu, one of the Fuji Five Lakes at this UNESCO World Heritage site. This is the first time that such a continuous sample has been obtained from Lake Motosu, and the result is a reconstruction of the eruptive history of Mt. Fuji based on the ash layers deposited in the lake over the past 8,000 years. This work reveals the possible existence of previously unknown eruptions, provides better estimates of the timing of eruptions, and indicates that a wider area was affected by eruptions that previously thought. The societal impacts of a Mt. Fuji eruption are feared to be quite severe. The results of this study have implications for prediction of future eruptions and disaster mitigation.

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Research Background

The Mt. Fuji region is a UNESCO World Heritage Site with 47 million annual visitors. However, Mt. Fuji is also an active volcano, causing concern regarding the societal effects of an eruption. Evaluating the potential of a future eruption and the scope of the affected area requires information about past eruptive activity. To date, this information was available only through land-based studies, which may neither provide a continuous record nor the best material for determination of the age of past eruptions. To overcome these issues, we studied continuously-accumulating sedimentary layers retrieved by sediment

coring from below the floor of Lake Motosu, one of the Fuji Five Lakes, obtaining a much clearer picture of the timing of eruptions and the extent of the affected area.

Research Results

At 121.6 m, Lake Motosu (Figs. 1 and 3) is the deepest of the Fuji Five Lakes. Due to it's depth, the lake has not completed dried out in recent geological history and thus preserves a continuous record of environmental change over at least the past 10,000 years. Lake Motosu also contains a history of Mt. Fuji eruptions. In particular, Lake Motsou provides geographic constraints on which eruptions widely distributed ash on the western side of the volcano because it's located on the northwestern flank of the volcano, upstream of the prevailing wind.

This research used a coring platform to perform hammer-piston coring (Note 2) in order to obtain samples below the lake floor (Fig. 1). A total of approximately 2 m length (depth) of sediment can be obtained during a single round of sampling. Sampling is performed multiple times to recover material from progressively deeper below the lake floor. In order to assemble a complete series without breaks, the upper 2 meters is sampled inititally, followed by sampling between 1 and 3 meters and then 2 to 4 meters below the lake floor. The 1-meter overlap between cores ensures that the obtained material is continuous and that there is nothing missing. In this way a single sample approximately 4 m in length was obtained (Fig. 2).

After the field sampling was complete, the sediment cores were described in detail and the depth of volcanic ash-fall layers recorded. The visual description was also aided by X-Ray fluorescence analysis which determines they type of inorganic chemical elements present in the sediment. Next, the age of the sediment was determined by performing over 30 radiocarbon measurements and identifying ash from eruptions of known age of two volcanos in Kyushu and the Izu Peninsula (Note 3). The age information was combined to produce an "age-depth model" that shows the number of years before present at any depth in the core (Fig. 2). Recent advances in radiocarbon dating allow for rapid analyses to be performed, which is how such a high density of age determinations were obtained. The radiocarbon dating was performed at The University of Tokyo Atmosphere and Ocean Research Institute using a single stage accelerator mass spectrometer, and the age model used was developed by Associate Professor Obrochta and known as "Undatable" (Note 4).

The results indicate that the record obtained from Lake Motosu continuously covers approximately the past 8000 years. Comparing to results from land-based trench studies, three of the scoria layers (Note 5) in Lake Motosu can be correlated to the Osawa eruption, the Omuro eruption, and the Kengamine eruption (most recent summit eruption). Previous research suggested that the Osawa occurred at around 3400 years ago (3214–3401 cal BP; Note 6), the Omuro around 3200 years ago (3072–3272 cal BP), and the last summit eruption around 2300 years ago. Based on the more accurate age model obtained from this research, these estimates are revised to median ages of around 3042, 2930, and 2309 cal BP, respectively (Fig. 2). This is the first time that these eruptions have been discovered on the upwind, western flank of the volcano, indicating ash from these three eruptions is more widely dispersed than previously believed (Fig. 3).

There are also two additional eruption layers with geologic characteristics indicating a Mt. Fuji origin that cannot be correlated to any previously known eruptions, leading us to believe that these are two newly discovered western-flank eruptions of the Mt. Fuji volcano (Fig. 2). These two eruptions occurred rapidly with only approximately 20 years between the first and second one (approximately 2458 cal BP and 2438 cal BP). On land, this would likely be too short for soil development, and these could appear to be only a single, larger eruption, leading to misestimation of eruption frequency and magnitude.

By applying the latest techniques to determining the age of lake sediments, these results improve our knowledge of the frequency and magnitude of past Mt. Fuji eruptions, which is the basis for future predictions.

Explanatory Notes

Note 1: This research used competitive funding from the Belgian Science Policy Office (BELSPO) as part of a project to conduct geological research in coastal and lake settings in order to better understand past occurrences of earthquakes and Tsunamis along the Nankai Trough.
Participating domestic institutions are The Univesity of Tokyo and the National Institute of Advanced Industrial Science and Technology (AIST). Akita and Yamagata Universities participated as collaborating institutions.
Project duration is 2014 – 2018.
Official project name:
Paleotsunami and earthquake records of ruptures along the Nankai Trough, offshore South-Central Japan
Lead institution: Ghent University (Belgium)
Participating institutions: Geological Survey of Belgium (Royal Belgian Institute of Natural Sciences) (Belgium), University of Liège (Belgium), the National Institute of Advanced Industrial Science and Technology Geological Survey of Japan (Japan), The University of Tokyo (Japan), and the University of Cologne (Germany).

Note 2: A cylindrical sampler is lowed by wire from the platform to the just above the lake floor where it is released and dropped into the sediment for sampling. An Uwitec piston corer was used.

Note 3: The southern Kyushu Kikai Caldera dispersed ash during the Kikai Akahoya eruption between 7165–7303 cal BP. Ash from the Izu Peninsula was produced by the 3149±12 cal BP Amagi-Kawagodaira eruption. These two ash layers are important for determining the ages during the Jomon Period and are commonly used in archeological and geological research.

Note 4: After determining the age at many positions between the top and bottom of the sediment core material, the age model considers the uncertainty in the age measurement, the sub-sampling depth, and the sediment accumulation rate to determine the highest median age probability at any given depth.

Note 5: One type of erupted material that is characterized by vesicles and dark color. It is typically created from andesitic or basaltic magma.

Note 6: BP / Cal BP is used for expressing the ages obtained by radiocarbon dating as the number of years prior to CE 1950. There is uncertainty due to variations in the atmospheric concentration of radiocarbon, which requires that radiocarbon years be converted to calendar years through a calibration curve. cal BP is used to indicate that radiocarbon ages have been calibrated to calendar years.

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Authors: Obrochta, S.P.[a], Yokoyama, Y.[b], Yoshimoto, M.[c], Yamamoto, S.[c], Miyairi, Y.[b], Nagano, G.[b*1], Nakamura, A.[d], Tsunematsu, K.[c, *2], Lamair, L.[e], Hubert-Ferrari, A.[e], Lougheed, B.C.[f], Hokanishi, A[g], Yasuda, A.[g], Heyvaert, V.M.A.[h, i], De Batist, M.[i], Fujiwara, O.[d], the QuakeRecNankai Team

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Figure 1: Coring platform in Lake Motosu. The core sampler is lowered from the triangular derrick.

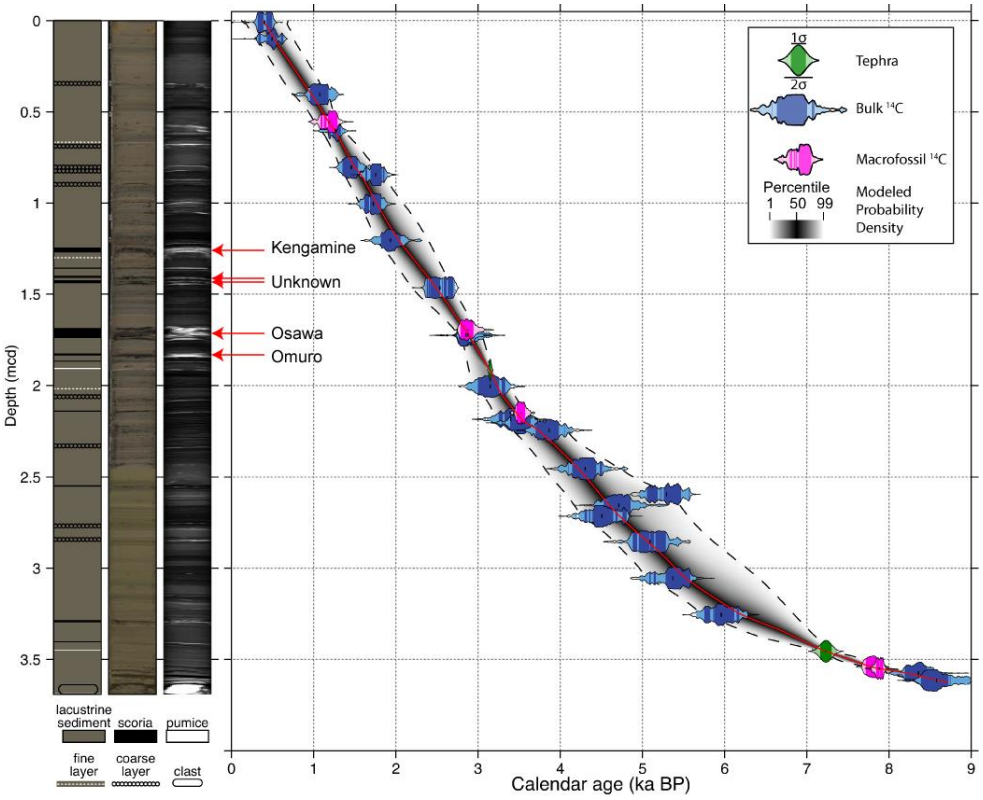

Figure 2: From left to right, overview of sediment core stratigraphy, core image, and CT scan with age-depth model. Arrows indicate (from bottom to top) the position and age of the Osawa, Omuro, two newly discovered, and Kengamine eruptions.

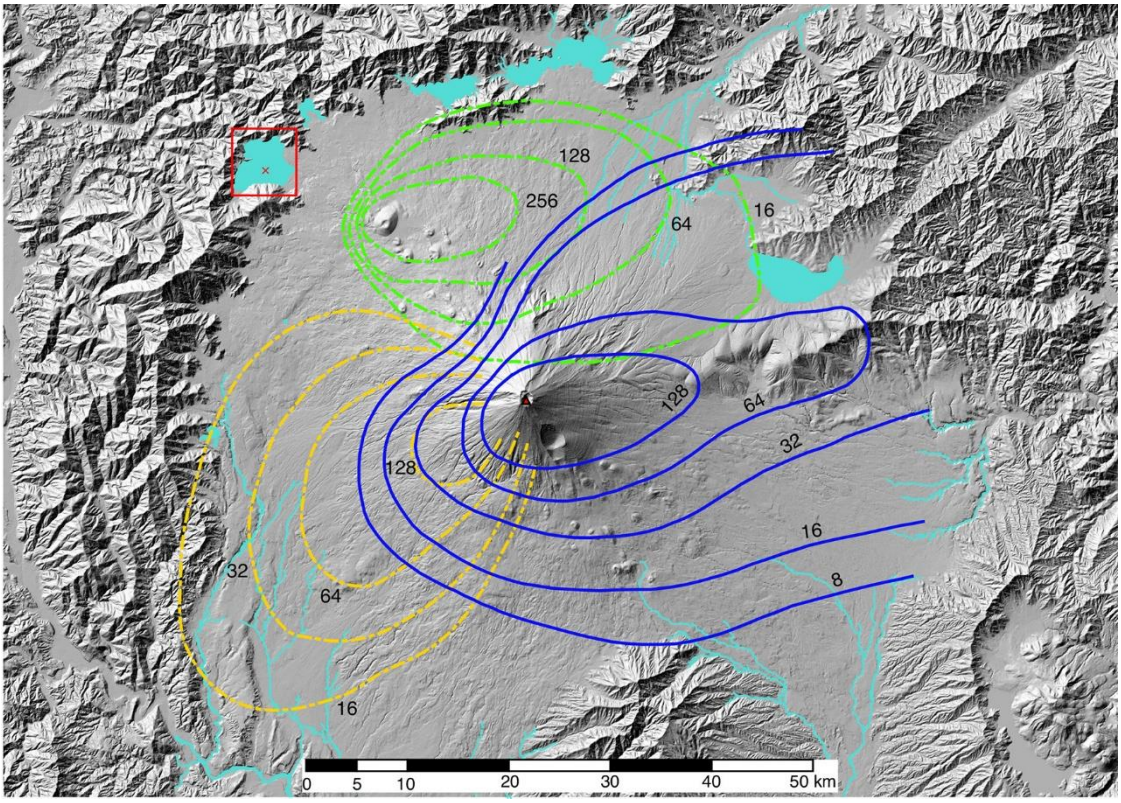

Figure 3: Previous estimates of the distribution and thickness of the Osawa (yellow, lower left), Omuro (green, upper middle), and Kengamine (blue, right) scorias. Thickness is shown in centimeters. None of these have been previously identified in the vicinity of Lake Motosu (red outline, upper left).