Traces of Natural Disasters and Artificial Alteration Recorded in the Bottom Sediments of the Lake Hibara Site

*Wataru Tanikawa[1,2], Yuhji Yamamoto[2], Shintaro Yamasaki[3], Akira Ijiri[5], Takehiro Hirose[1], Jun Kimura[4], Randy Sasaki[8], Hisashi Nakagawa[6], Akihiro Shimada[7], Tetsuya Yamamoto[1]

1. Japan Agency for Marine-Earth Science and Technology, Kochi Instutute for Core Sample Research, 2. Kochi University, 3. Kyoto Univerisity, 4. Tokai University, 5. Kobe Univeristy, 6. Toyohashi City, 7. Izunokuni City, 8. Teikyo University

[Introduction]
Geoscientific and archeological investigations for the submerged village Hibara-juku under the lake Hibara, Fukushima, were carried out to reveal the process of submerging and acute aftermath around the lake. The former village of Hibara-juku was completely submerged following the Mt. Bandai-san eruption in 1888 and its sector collapse. Unlike other submerged underwater sites, the Hibara-juku village before submergence can be estimated to some degree from the literary record. Therefore, geoscientific and archaeological approaches can be used to reconstruct the contents of the written documents. This study shows lake sediment records that have preserved traces of Hibara-juku.
[Survey Sites and Analysis Methods]
Hibara-juku was a prosperous village, developed as key stop on the highway leading from Yonezawa to Aizu during the Edo period. Oyamazumi Shrine, located on the northern shore of Lake Hibara, retains the vestiges of the submerged village. Rows of trees seen today from the shrine leading south into the lake was a passage way from the center of the village. Looking at a historic map of the area before the submergence of Hibara-juku, it can be assumed that the center of the village was located at the intersection of this north-south path and the old Yonezawa Highway. Two torii gates were built near the shrine (Nino-torii) and along the passage 70 meters south of Nino-torii (Ichino-torii). Both torii gates were built in the Showa period. The Ichino-torii, which is 4 to 5 m high, is submerged up to its top when the water level is high.
In this study, core samples of the surface layer of the lake bottom were collected at 30m, 52m, 70m, and 100m south of the Ichino-torii (passage core), and at the confluence of the Aizu River and Lake Hibara along the highway, far from the center of the village. Core samples were collected by divers using polycarbonate pipes and a geo-slicer. Samples were subjected to X-ray CT imaging, density and magnetic susceptibility measurements using a non-destructive multi-sensor core logger (MSCL), density and porosity measurements using the nitrogen gas displacement method, grain size analysis using laser diffraction, and mineral identification using powder X-ray diffraction. In addition, tree species identification and age analysis of the buried forest on the approach to the site were conducted.
[Results and Discussion]
Sediment samples up to 35 cm long were collected using pipes. All passage cores showed indistinct striated fine-grained sediments in the shallow part (Unit I) and silt mixed with angular gravel in the deeper part (Unit II). In the 100-m core, pottery shards were observed within Unit II. The pottery sherds had regular striations engraved on the interior, and their shape suggests that they were fragments of a mortar from the Early Modern period or later. Compared to Unit II, Unit I exhibited lower bulk density, magnetic susceptibility, percentage of grains larger than 1 mm in diameter, and dispersion of grain size distribution. In particular, a clear physical property boundary was observed between Unit I and Unit II in terms of bulk density. In addition, Unit II of the 100-m core, which contained earthenware fragments, was characterized by a higher porosity than the 70-m core. Unit I was characterized by a larger proportion of diatoms and volcanic glass and a smaller proportion of quartz than Unit II. Both units also contained kaolinite, but no

illite or chlorite was found in Unit II. Kaolinite is most likely a clay mineral derived from granitic rocks, while illite and chlorite are from andesitic rocks. Analysis of the buried forest at the approach revealed that the tree species was cedar, which was alive during 1851-1881 and stopped growing in between 1888-1917.

[Summary]

The analysis of lake sediments around Hibara-juku revealed clear physical properties and material boundaries at all core samples, suggesting that Unit II was deposited before the formation of Lake Hibara and Unit I after the formation of Lake Hibara. The reason for the lower density of Unit II in the 100-m core compared to the other cores may be that the site was subjected to artificial modification of the land (such as waste deposit or farmland) prior to the eruption. In the future, we would like to conduct a detailed evaluation of environmental changes from the time when the town was active to the post-formation period of Lake Hibara through chemical analysis (biomarkers, XRF, and isotope analysis) with high spatial resolution.

Keywords: Lake Hibara, Mt. Bandai, Hibara village, Lake Sediment, Physical Property, Underwater Archaeology

