Absolute ages for huge eruptions of Towada Caldera and Baitoushan volcano in the 10th century as seen from dendrochronological studies and historical documents

*Masataka Hakozaki[1], Fusa Miyake[2], Masaki Sano[3], Katsuhiko Kimura[4], Toshio Nakamura[2], Mitsuru Okuno[5], Minoru Sakamoto[1], Takeshi Nakatsuka[6,2]

1. National Museum of Japanese History, 2. Nagoya University, 3. Waseda University, 4. Fukushima University, 5. Fukuoka University, 6. Research Institute for Humanity and Nature

The Towada Caldera (Aomori Prefecture / Akita Prefecture) and Baitoushan volcano (China / North Korea) each caused a huge eruption in the 10th century, respectively. These traces are clearly left behind in the stratum of the northern Japan as To-a tephra and B-Tm tephra. These two eruptions are estimated to be one of the largest in Japan and the world in the past 2000 years, respectively (Hayakawa & Koyama 1998). However, direct document records of these eruptions have not been found from any countries around the volcano. For that reason, these absolute ages had long been unknown. Also, due to uncertain age, the impact on human society and the global environment of these eruptions has not been evaluated.

Recently, the absolute age of the 10th century eruption of Baitoushan volcano was decided in AD946(Oppenheimer et al. 2017, Hakozaki et al. 2018). It was achieved by "^{14}C-spike matching" which is applied a rapidly carbon-14 increase event in AD775 discovered from tree-rings of Japanese trees (Miyake et al. 2012). And this age was also verified by the result of the oxygen isotopic dendrochronology (Kimura et al. 2017). Hayakawa and Koyama (1998) picked up this age (AD946) from descriptions suggesting distant eruptions written in a few old documents of Japan and Korea (ex. "Kofukuji-nendaiki", "Goryeosa") .

On the other hand, due to fixed in AD946 the absolute age of B-Tm, doubts occurred in the age of 10th century eruption of the Towada caldera. The 10th century eruption of Towada caldera had been estimated to be AD915 according to the description on the "Fuso Ryakuki" suggesting the eruption, and the dates of archaeological timbers buried in the lahar at Akita prefecture. Based on this age, the varves at lakes in Akita prefecture counted between To-a and B-Tm to be 14 layers, Kamite et al(2010) estimated the eruption age of Baitoushan volcano to be AD929. However, since the absolute age of B-Tm was AD946, as described above, it became clear that there was a gap of 17 years from Kamite et al's estimates. In other words, there is a possibility that the 10th century eruption of Towada caldera may be AD932. If this is correct, there is a possibility that the description of AD 915 in the "Fuso Ryakuki" indicates the eruption that occurred in volcanoes other than Towada caldera.

Recently, the oxygen isotopic dendrochronology was applied to the timbers of the fence of Tagajo site of Miyagi prefecture, and the absolute age was decided to be AD917 (Saito et al. 2018). In the archaeological survey, this fence has been thought to be built before the ash fall of To-a tephra (AD915) (Miyagi prefectural research institute of the Tagajo site 2018). The fact that the tree-ring of the AD917 was recognized in the timbers of the fence largely contradicts the estimated age (AD915) of To-a tephra. Furthermore, neither bark nor sapwood remained in these timbers, and it is clear that the logging year is later than AD917.

In this presentation, we show how the ages of timbers of Baitoushan volcano and Tagajo site determined

by two new dendrochronological methods, and what is necessary to determine the absolute age of the 10th century eruption of Towada Caldera.

Keywords: dendrochronology, 14C-spike, Baitoushan volcano, oxygen isotope, Towada Caldera, huge eruption

