Establishment of Highly Accurate Age Model Using Radiocarbon Dating of Fossil Pollen Automatically Extracted from Lake Motosu Sediments

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Lacustrine sediments record continuous paleoenvironmental changes, and depending on the location, may also record instantaneous event such as volcanic eruptions. Lakes are also often well-suited to provide highly accurate geochronological information, making them key archives for paleoclimate research. In the absence of annually laminated sediments, terrestrial macrofossils, such as leaves and plant fragments, are often relied upon for radiocarbon dating because they are deposited quickly after fixing atmospheric carbon dioxide. Therefore, unlike bulk sediments, no corrections of the carbon reservoir effect are necessary. However, deposition is sporadic, and leaves may be sparse. In addition, in oxidative benthic environments, leaves and plant fragments may decompose quickly after deposition. Pollen, on the other hand, offer a unique solution because they are composed of sporopollenin, a persistent molecule that is typically universally present in lacustrine sediments. The drawback is that the number of needed grains (~50,000) for radiocarbon dating in prohibitively high for manual extraction. Here we present a novel solution to this problem by using a cell sorter with a newly designed pretreatment method and an improved extraction method to extract pollen fossils. This enables us to extract large pollen fossils (~150 μm) than what was previously possible. These are then measured using a single-stage accelerator mass spectrometer (AMS) at the Atmosphere and Ocean Research Institute, University of Tokyo.
We then apply this method to sediments recovered from Lake Motosu, which already has a very robust chronology, to evaluate the new method. Results indicate that the method is both successful and increases the accuracy of the Lake Motosu chronology by a factor between 1.5 and 3.5. Results also better clarify variations in the reservoir age of the lake, which were previously estimated from the ages of known widespread tephra deposited in the lake.

Keywords: Radiocarbon, Lake sediments, Pollen