Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

MIS30-09 Room:501 Time:April 28 11:30-12:00

A new high resolution dating method using tree-ring cellulose oxygen isotope ratio

NAKATSUKA, Takeshi[1*] ; SANO, Masaki[1] ; XU, Chenxi[1] ; KIMURA, Katsuhiko[2]

[1]Research Institute for Humanity and Nature, [2]Fukushima University

Introduction

Dendrochoronology is the most accurate dating method by comparing of inter-annual variations in tree-ring width of wood samples from sedimentary layers, archaeological remains or old architectures against the predated standard ring width variations. Master chronologies of tree-ring width, necessary to be built for each region and species, have been established all over world. Some of them based on many living and buried trees cover the whole Holocene in Northern Europe and New Zealand. Tree rings contain other parameters than ring width, applicable for dendrochronological dating. Oxygen isotope ratio (d18O) of cellulose is one of them. Here, we demonstrate merits, methods and problems of the tree-ring d18O chronology in details.

Merits of tree-ring cellulose d18O chronology

Because tree-ring cellulose d18O is controlled solely by two meteorological factors, precipitation d18O and relative humidity, its inter-annual variation is usually independent from ecophysiological conditions of each tree. As the result, highly correlated tree-ring cellulose d18O variations between different trees ensure high success rate of dating. Moreover, the master chronology of tree-ring cellulose d18O built on cedar and cypress trees can be applied to date wood samples from all other tree species living in the same region and period. Therefore, many tree-ring d18O chronologies are now being created very rapidly all over Japan during the late Holocene, and the established tree-ring cellulose d18O chronologies have been applied for dating of various natural and artificial wood samples to promote new inter-disciplinary studies in both natural and human sciences.

Methods in tree-ring cellulose d18O chronology

There are two important progresses in analytical method behind the emergence of tree-ring d18O chronology. One is the combined instrument of a pyrolysis-type elemental analyzer and an isotope ratio mass spectrometer. The other is ”plate method for cellulose extraction” from tree ring samples. Before 2000AD, it was extremely difficult to measure d18O of organic matter because combustion of samples to gases inevitably causes terrible oxygen contamination. The development of an instrument, which converts organic oxygen to CO without any oxidant at 1400 degree C and transfer the CO to mass spectrometer directly, solved the question how to measure d18O in huge numbers of tree ring cellulose. So far, cellulose extraction from many tree ring samples has been too time-consuming and labor-intensive to meet the huge number of samples in dendrochronological purposes. In 2010, we have developed a new method to extract cellulose directly from thin wood plates with hundreds of rings, which enabled us to start the tree-ring cellulose d18O chronology at last.

Perspectives of tree-ring cellulose d18O chronology

Although it is much more time-consuming to analyze tree-ring cellulose d18O than to measure tree ring width, we have accumulated many tree-ring d18O data from various kinds of samples and obtained many essential knowledge. While some data have successfully dated important archaeological remains, new problems have also emerged. Here, we show those problems and discuss future perspective of the tree-ring d18O chronology. <Tree Species>There are usually high correlations in tree-ring d18O time series between conifer and deciduous hardwood. But, evergreen hardwood may be somewhat different due to the longer photosynthetic season. <Spatial Correlation>Tree-ring d18O chronology in central Japan is coincident with those in western Japan, reflecting inter-annual changes of stationary rain band (Baiu front) activity in early summer. However, tree-ring d18O time series on Japan Sea side sometimes becomes complicated due to effect of heavy snow cover. <Analytical Method>”Plate method” sometimes destroys ring boundary of buried wood, so that it is necessary to further improve cellulose extraction procedure.

Keywords: tree ring, cellulose, oxygen isotope ratio, dendrochronology