Quality control for radiocarbon dating of charcoal: Assessment of decontamination by chemical pre-treatment

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Charcoal is widely used for radiocarbon (^{14}C) dating in archaeological and palaeoenvironmental studies because it can remain well preserved for long periods in geological deposits. Plant-derived charcoal is formed by exposure of lignocellulosic biomassto high temperatures under restricted oxygen conditions. As the pyrolysis temperature increases, aromatic rings are polymerized and chemically stabilized to become resistant to post-depositional chemical alternation and diagenesis. However, the aromaticity and reactivity of charcoal depend on the combustion temperature. At lower temperatures, insufficient pyrolysis of lignocellulosic biomassproduces charcoal with various components, including aromatic components, reaction-intermediate components with low molecular weight, and aliphatic components such as degraded cellulose and lignin. Among the various components of environmental charcoal, the highly aromatic components are the most chemically stable endogenous components of the original material due to pyrolysis, and are likely influenced little by exogenous materials of mostly carbonates and humic substances (fulvic acid and humic acid) from the surrounding soil. The contaminants often have a different ^{14}C age from that of the charred material, and this can adversely affect ^{14}C dating. Therefore, removing all exogenous components other than the chemically stable aromatic components is very important in the pre-treatment of charcoal for ^{14}C analysis.

The chemical method generally used to remove organic contaminants from charcoal samples is acid–base–acid (ABA) treatment. An alternative chemical method proposed by Bird *et al.*(1999) involves acid–base–oxidation with stepped combustion (ABOx-SC). The ABOx-SC method is considered to remove contaminants from charcoal samples more efficiently than ABA treatment. However, the effectiveness of the method has been provedby the ^{14}C results, almost not by a rigorous chemical assessment of the processes during decontamination. Therefore, Tomiyama *et al.* (2016) examined the changes in chemical structure and elemental composition of the charred material during ABA and ABOx decontamination processes using three types of charcoal samples: laboratory-produced charcoal and two samples from a geological site exposed to environmental conditions. The chemical changes in the charcoal were measured using FTIR and elemental analysis (C/H/O) at each stage of the chemical treatments. The results show that the ABOx-SC treatment of the charcoal samples can lead to a more reliable ^{14}C dates than can ABA treatment, and that O/C and H/C ratios together with C content of chemical-treated charcoal samples can become potential indicators for assessment of diagenesis and decontamination in the samples to obtain reliable ^{14}C dates. I will show another examples of quality control for radiocarbon dating of archealogical remains in this presentation.

Keywords: charcoal, radiocarbon dating, chemical pre-treatment, ABOx-SC, ABA

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