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An evaluation of the effect on 14C dating (AMS) by alkaline treatment of the ABA method on charcoal sample

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Charcoal treatment by means of the Acid-Base-Acid (ABA) method (or Acid-Alkali-Acid; AAA method) has been widely used for radiocarbon (^{14}C) dating in the Earth Science and Archaeological field. Although the ABA method is a basic charcoal pretreatment method for ^{14}C dating, the evaluation of processing conditions of the ABA method based on any chemical indicator does exist few until today. This study aims to clarify the error of ^{14}C dating caused by the alkaline pretreatment which is not studied hitherto. The author performed 3 types of experiments for the purpose. The first experiment was performed for confirmation of the reproducibility of ges. The second experiment was performed for confirmation of optimal treatment time of an alkaline solution. The third experiment was performed for confirmation of the optimal concentration of alkaline solution for the ABA pretreatment.

The first experiment: X^2 test of the results shows T=0.45(df=3;5% risk rate T $>$12.59)for the treated samples which means high convergent validity, while T=10.74(df=4;5% risk rate T $>$9.49)for the untreated samples which means large scattering and significant variability.

The second experiment: even after the visual judgment of the completion of alkaline extraction, 3-DF detected humic acid in the retrieved NaOH solution, and Atsumi et. al. (2009) showed that radiocarbon (14C) dating was influenced the existence of humic acid. These results suggest that visual observation is inadequate for the judgment of the completion of alkaline extraction, and that 3-DF is more effective for monitoring the presence of dissolved organic contamination.

The third experiment: three charcoal samples from a single archaeological context were split into 8 aliquots respectively, and treated with 8 different concentrations of NaOH solutions ranging from 0.001 to 2.0 mol/l. Dating results and X^2 tests showed minimum convergence at 1.2 mol/l. This is supported by 3-dimensional fluorescent (3-DF) analysis, which clearly shows different leaching characteristics between 2.0-1.0 and 0.5-0.001 mol/l. 0.5-0.001 mol/l NaOH solutions were too weak in humic leaching capacity at low excitation ranges, which is thought to be the phenomenon that generates the scattering of dates. We recommend using from 1.0 to 1.5 mol/l NaOH for radiocarbon pretreatment.

These results show that the ^{14}C age is affected by difference of the residual of humic acid caused by the difference of chemical conditions of the pretreatment .

Keywords: 14C dating, ABA pretreatment, 3-D fluorescent spectroscopy, Humic acid, Charcoal sample