CHANGES OF 14C CONCENTRATION IN MODERN WOOD FROM URBAN AREA

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INDTRDUCTION

Atmospheric CO_2 is increasing due to the emission of gases from burning fossil fuels, such as coal, petroleum and natural gas. Recently the CO_2 concentration has exceeded 370 ppm [1, 2]. This process causes changes in the proportion of carbon isotopes in the atmosphere and subsequently in the biosphere and ocean. Radiocarbon concentration in atmosphere rapidly increased in late 1950s and early 1960s due to nuclear bomb tests, reaching a maximum in 1963, when the level was almost double that of natural ^{14}C concentration [3]. After the test ban treaty was enforced, the ^{14}C concentration in the atmosphere slowly decreased, due to carbon exchange mainly against the oceanic carbon reservoir and the input of "dead" carbon from fossil fuels. In the 1990s, the level was still about 10 % higher than pre-bomb concentrations [4, 5]. Several laboratories around the world are continuously monitoring atmospheric CO_2 levels and ^{14}C concentrations, either directly from the atmosphere [4, 6], or in plants [5, 7, 8]. Results from such studies show that large local emissions of fossil-fuel CO_2 will cause changes in the carbon isotope composition of the atmosphere and local biosphere. This effect is strongest in heavily industrialized areas, but can also be observed in highly urbanized areas, where CO_2 is emitted from industrial facilities, vehicles and other common sources. The magnitude of changes in ^{14}C concentration depends on the distance to sources of CO_2 emissions [9].

SAMPLES AND METHOD

Samples of annual growth rings from Nagoya (Japan) and Krakow (Poland), as a radial section of a diameter of 5mm, in the pine tree were taken using a hollow drill. To obtain sufficient material for AMS analysis, three core samples were collected from each tree and the annual growth rings were separated. A mixture of early wood and late wood was used to represent a single year sample. Samples were washed in distilled water and prepared using the A-A-A method. The treated residues were combined with cupric oxide and sealed into glass tubes evacuated with a rotary pump. The tubes were then placed in an electric furnace for 2 hours at 850°C. Carbon dioxide produced from the samples was purified in a glass cryogenic vacuum line system and then reduced to graphite

using iron powder as a catalyst [10]. The resulting mixture of graphite and iron powder was dried and pressed into a target holder for AMS ^{14}C measurements. The stable carbon isotope ratio was measured using a Finningan MAT 252 isotope-ratio mass spectrometer at the Center for Chronological Research, Nagoya University. Radiocarbon contents are reported as $\Delta^{14}C$ in permil (‰) deviations from the standard sample, 95% activity of NBS oxalic acid (SRM-4990C) [11]. The stable carbon isotope ratio is expressed in $\delta^{13}C_{PDB}$ notation on the PDB scale [12].

RESULTS AND CONCLUSION

Radiocarbon concentrations in the atmosphere over large cities depend on emissions of CO_2 from fossil fuels. Concentrations of CO_2 can be divided into three components: a background component (C_a); a biogenic component (C_b); and a fossil fuel component related to the anthropogenic emission of CO_2 (C_f). Mathematical equations, widely described in [6] and [8], can be used to describe the relationships between each component and carbon isotopic composition, and were used to estimate the fossil fuel component. The fossil fuel component of CO_2 concentration in the atmosphere was calculated using data obtained experimentally, along with additional data that represent yearly average values of $\Delta^{14}C$ and CO_2 concentration in "clear air" at Schauinsland station [2, 4], which include both, background and biogenic components. The yearly average value for analyzed period was 15.2 ppmv for Nagoya, which falls between the approximate seasonal values of 27.5 ppmv (winter) and 10 ppmv (summer), calculated for the period 1983-1994 in the urban area of Kraków [6]. The error of estimation for the anthropogenic emission of CO_2 (C_f) is around +-8 % or less of the total value.

The results show that, with the isotopic information recorded in tree rings, it is possible to reconstruct ^{14}C concentrations for the past. The use of annual rings of trees to obtain the secular variations of ^{14}C concentration of atmospheric CO_2 provides us a valuable environmental monitor.

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