NATURAL ANALOGUE
Working Group

Carbonation of anthropogenic concrete; Evaluation of carbonation process in concrete with analysis of carbon isotopes (^{14}C, $d^{13}C_{PDB}$)

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Abstract

Carbon isotopes including radiocarbon have been applied to concrete in order to estimate progression and the age of carbonation in concrete. Concrete cores from a building constructed in 1965 on the campus of Nagoya University, Japan, were collected in 2008, and were investigated for ^{14}C, $\delta^{13}C$ and CO_2 content. The amount of carbon dioxide was 9 % at the concrete surface where the concrete is highly carbonated, decreasing with depth, and was 1 % at the depth where carbonation is hardly observed. The measured ^{14}C values were 139 to 148 pMC at the carbonated surface and 71 to 86 pMC at the depth of less carbonation, decreasing from the surface down to the depth. These profiles can be interpreted as the following: (1) Comparison of C isotope data including ^{14}C from the concrete with those from cements and fresh concrete reveals that the carbon dioxide at the depth of less carbonation was fixed in the construction time of the building, and that the primary CO_2 originated from cements (marine limestone origin) and direct absorption of atmospheric CO_2 in 1965 throughout the whole of the concrete. (2) After the correction for ^{14}C value of the primary CO_2, the age of carbonation at the concrete surface (1 cm) can be estimated by the ^{14}C dating coupled with the atmospheric ^{14}C curve over the past 50 yr (Hua and Barbetti, 2004). Most part of CO_2 in the surface concrete is estimated to be absorbed and fixed in 2–4 years after the construction. This preliminary analysis of 45 years old concrete suggests that the methodology using radiocarbon can be applied to quantitative analysis of ancient concrete by estimation of the absolute age.