THE CO_2 RECORD IN ICE CORES: A RECONSTRUCTION OF THE ATMOSPHERIC EVOLUTION BETWEEN 18 ka BP AND 1850 AD

(Abstract)

by

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Air bubbles trapped in glacial ice at the time of its formation provide a unique record of variations in past worldwide atmospheric CO_2 content. Published records, covering approximately the last 30 to 40 ka, indicate a minimum in the CO_2 concentrations during the latter part of the last ice age, around 18 ka BP, with values of the order of 200 ppmv (see, in particular, Delmas and others 1980, Neftel and others 1982). The ice records indicate also that during approximately the last 2 ka, before any significant anthropogenic influence on the atmospheric CO_2 content, the concentrations were of the order of 260 to 270 ppmv (Neftel and others 1982, Barnola and others 1983). By comparison the present mean annual concentration in the atmosphere is about 340 ppmv.

We present new results obtained on the Dome C and D 57 cores taken in East Antarctica, which will be published in detail elsewhere. The D 57 results indicate that before 1850 AD the CO_2 concentration was as low as 258 ppmv, with a significant fluctuation between 258 and 272 ppmv in the interval between approximately 1500 and 1850 AD. The D 57 record also indicates the initiation of a marked increase in the CO_2 concentration near the second part of the last century and the first part of the present one. The new Dome C results provide a detailed CO_2 record for the last 25 ka which is in general agreement with the previously published Dome C record (Delmas and others 1980). This new record confirms, in particular, the occurrence of a low CO_2 level of the order of 200 ppmv during the last glacial maximum, around 18 ka BP. It indicates, also, that (1) the increase in CO_2 concentration associated with the end of the last ice age began before or simultaneously with the important climatic change indicated by the large shift observed in the isotopic composition of the ice, (2) this CO_2 increase may have occurred in two steps, and (3) there is a large scatter in the CO_2 concentration near the end of the ice age-Holocene transition, with most of the values as high as about the present-day atmospheric concentration of 340 ppmv.

Our new results permit the following preliminary conclusions to be made. (i). The atmospheric CO_2 level during pre-industrial times may have been as low as about 260 ppmv, in contrast with the value of 290 ppmv which has been frequently quoted (see, for instance, World Meteorological Organization in press). This particularly low level strongly suggests that there was an important biospheric source of CO_2 induced by mankind before the use of fossil fuel. This should be taken into account when modelling the evolution of atmospheric CO_2 and the corresponding climatic change for the time period during which anthropogenic CO_2 sources are important. In addition, natural fluctuations of the order of 10 ppmv or more may have occurred during the few centuries before 1800-1850 AD, which may reflect changes in the biospheric and oceanic CO_2 reservoirs. (ii). The low atmospheric CO_2 concentration (about 200 ppmv) inferred for the last glacial maximum should be taken into account when modelling the climatic conditions for 18 ka BP. (iii). The interpretation of the comparative timing between CO_2 and climate changes at the end of the ice age could be complicated because of the discontinuous nature of the corresponding CO_2 increase.

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