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MEASUREMENT OF THE DISSOLUTION VOLUME AND THE DIFFUSION COEFFICIENT OF CARBON DIOXIDE IN AN ICE SINGLE CRYSTAL (ABSTRACT)

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Recently, a strong correlation between the concentration profile of carbon dioxide and climatic change was found by the chemical analysis of deep ice cores recovered from Vostok, Antarctica (J. JOUZEL *et al.*, Nature, **329**, 403, 1987). For further analysis of the CO_2 profile, however, atomic processes of the CO_2 molecules in the ice sheet have to be taken into account, because CO_2 content in air bubbles may differ from its initial value owing to molecular diffusion in ice during the densification process in the ice sheet. In order to clarify the process quantitatively, the dissolution volume and the diffusion coefficient of CO_2 molecules in ice crystal were measured in the present study.

A single crystal of ice sample was annealed under high CO_2 gas presssure at about 270 K. The gas pressure in the chamber decreased with time and reached a stable value when the ice crystal was saturated with the gas. The equilibrium dissolution volume and the diffusion coefficient of CO_2 into ice crystal were calculated from this measurement. Subsequently, the outer diffusion of CO_2 molecules from the gas saturated sample was also studied. The quantities of CO_2 dissolved in ice at about 270 K and 1 MPa (which correspond to the conditions at about 100 m of depth in temperate glacier) are below 5×10^{-4} (mole cm^{-3} of ice), which is smaller than that in water at 293 K. The diffusion coefficient of CO_2 in ice is of the order of 10^{-7} ($cm^2\ s^{-1}$) at about 270 K, which is two orders in magnitude smaller than that of water molecules moving through ice lattice. The influence of the quantity dissolved and the diffusion rate of carbon dioxide in the ice on the CO_2 profile obtained from ice cores is discussed.

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