RATE OF SNOW ACCUMULATION DETERMINED FROM OXYGEN ISOTOPE AND STRATIGRAPHIC ANALYSES OF THE CORE FROM MIZUHO STATION, EAST ANTARCTICA (EXTENDED ABSTRACT)

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The ice-core drilling was undertaken at Mizuho Station, East Antarctica, from 1970 to 1975. Two core holes were drilled to the depth of about 150 m, whereby various observations and analyses were made using the holes as well as the cores obtained (KUSUNOKI and SUZUKI, 1978).

In the region around Mizuho Station, frequent occurrences of glazed surface as well as dunes and sastrugi, representing a depositional form and an erosional form respectively, are the most characteristic surface features (WATANABE, 1978a). The glazed surface is occasionally exposed over one year, resulting in hiatus of annual layer(s). The existence of hiatus should be considered in the determination of the annual snow accumulation with the stratigraphic method. Therefore, the rate of snow accumulation was determined from both stratigraphic (NARITA *et al.*, 1978) and oxygen isotope (KATO, 1978) analyses of the core from Mizuho Station (WATANABE *et al.*, 1978).

When a surface condition attains to the equilibrium stage in deposition-erosion processes, a difference between the deposited and eroded amounts corresponds to the net accumulation. This snow accumulation should remain as a unit of snow stratification, which is superimposed upon the previous surface. This unit of stratification is called a unit layer (WATANABE, 1978b). Therefore, an annual layer is composed of unit layer(s).

Unit layers of 1283 were found in the core from the surface to the depth of 106.46 m. The weight of every unit layer was calculated by multiplying its thickness by

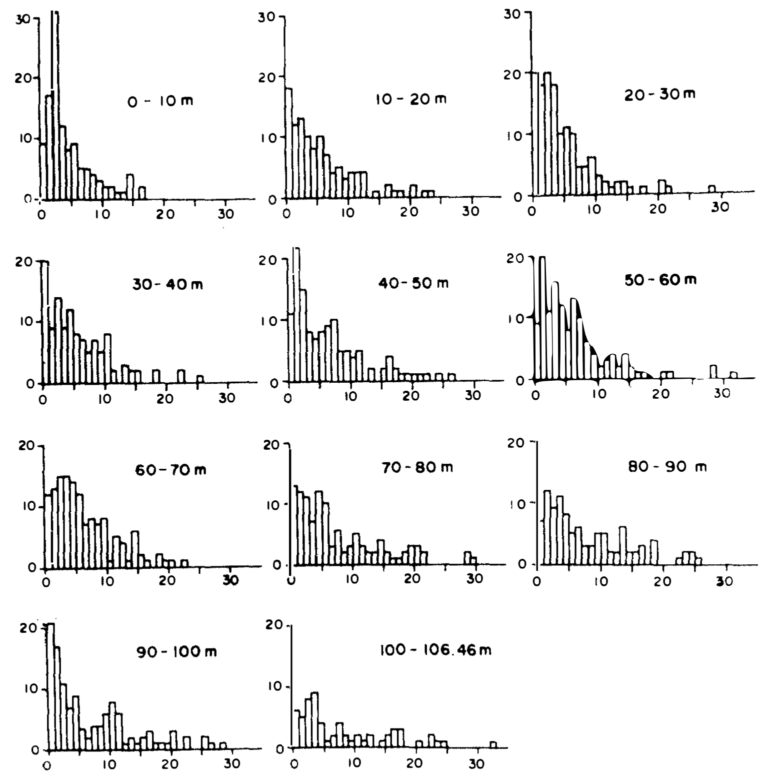

Fig. 1. Histograms of weight of unit layer for every 10 m interval in the core from the surface to the depth of 106.46 m. Vertical axis: number of unit layers. Horizontal axis: weight of unit layer in g/cm^2.

its density. The total load of 1283 unit layers is 8093 g/cm^2. Fig. 1 shows the histograms of weight of unit layer in every 10 m interval from the surface to the depth of 106.46 m of the core. The weight distribution of unit layers shows a Poisson pattern. The weight distribution of unit layers below a depth of 70 m is fairly different from that above 70 m. This fact may be attributed to disappearance of some boundary structures below a depth of 70 m of the core, hence difficulties in identifying unit layers. It is concluded that the visual stratigraphic analyses may be valid only to a depth of 70 m of the core.

Stratigraphic profiles in the four different depth intervals of the core are shown in Fig. 2. The profiles in these intervals were selected among those in all the intervals, considering the existence and good-preservation of all structures observed in the core. These depth intervals are 20.50–23.42, 32.60–35.60, 41.50–44.30 and 62.50–65.50 m. The profiles of depth hoar development are also shown on the right side of stratigraphic diagram.

The criterion for interpretation of annual layers was derived from the stratigraphic study of surface layers in Mizuho Plateau (WATANABE, 1978b). Using this criterion, annual layers of the core were interpreted (WATANABE *et al.*, 1978). The results are shown in Fig. 2 and Table 1. The average weight of annual layers in the four depth intervals ranges between 9.1 and 11.8 g/cm^2, the mean value being 10.6 g/cm^2.

The $\delta^{18}O$ values in the depth of 20.60–23.30 m are also shown in Fig. 2. Water vapor diffuses in snow layers during depth hoar formation under a considerable temperature gradient. Diffusion of water vapor contributes to the mass exchange. Accordingly, depth hoar formation causes some change in $\delta^{18}O$ of accumulated snow. Taking the depth hoar formation into consideration, the whole trend of vertical

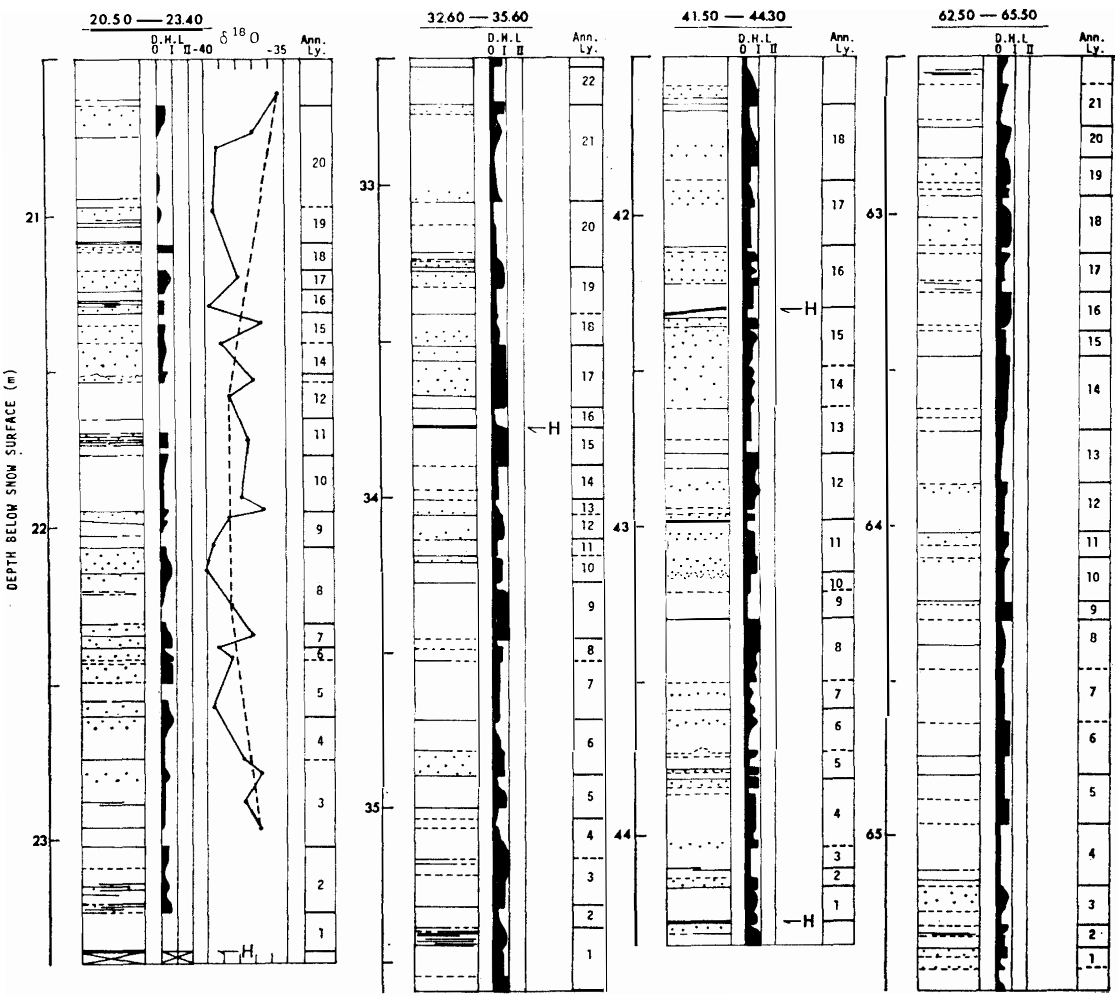

Fig. 2. Stratigraphic diagrams at various depths of the core. D.H.L.: depth hoar level. $\delta^{18}O$: oxygen isotopic composition in ‰. Ann. Ly.: interpreted annual layer in sequence (solid line: probable, broken line: possible). H: hiatus. The definition of the stratigraphic symbols and depth hoar level is found in WATANABE et al. (1978) and NARITA et al. (1978).

Table 1. Annual accumulation at various depths of the core.

Depth range (m)	Depth interval (cm)	Numer of layers	Average thickness of an annual layer (cm)	Average density in the depth interval (g/cm^8)	Average accumulation of an annual layer (g/cm^2)
20.50–23.40	270	20	13.5	0.67	9.05
32.60–35.60	297	22	13.5	0.75	10.13
41.50–44.30	263	18	14.6	0.79	11.54
62.50–65.50	277	20	13.9	0.85	11.77
Total average		20	13.9		10.62

variation of $\delta^{18}O$ can be shown by the vertical variation of $\delta^{18}O$ of the thick and fine-grained layers with little developed depth hoar, accumulated during the winter. The vertical variation of $\delta^{18}O$ of such layers is shown as the $\delta^{18}O$ profile in the core from Mizuho Station in Fig. 3, where the profile in the core from Camp Century, Greenland (JOHNSEN *et al.*, 1970, 1972) is also shown.

In the Camp Century core was found the obvious seasonal cycles of $\delta^{18}O$, which

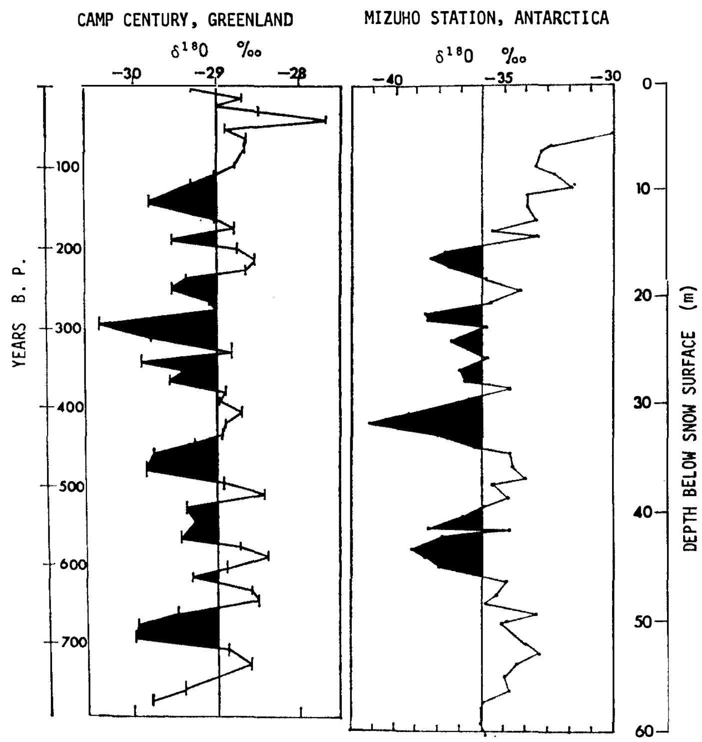

Fig. 3. Oxygen isotope profiles in the cores from Mizuho Station, East Antarctica and Camp Century, Greenland.

are preserved to a depth of 1000 m. Therefore, dating of the core by counting the annual layers determined from seasonal cycles of $\delta^{18}O$ is possible to a depth of 1000 m. Furthermore, counting of annual layers in the core hardly fails, because the annual layers are extremely thick and have many unit layers showing seasonally varying $\delta^{18}O$ values. So, dating shown in the Camp Century core is reliable because of no hiatus of annual layer.

In the Mizuho core was found no obvious seasonal cycles of $\delta^{18}O$, as shown in Fig. 2. However, a general trend is fairly similar in these two profiles shown in Fig. 3. This means that these $\delta^{18}O$ profiles in the both cores reflect the world-wide climatic change; in all likelihood the coldest climate showing the lowest value of $\delta^{18}O$ in Fig. 3 was almost synchronized in Antarctica and Greenland. The lowest value of $\delta^{18}O$ in the Camp Century core is seen at the depth corresponding to some 300 years B. P., while that in the Mizuho core is seen at a depth of 32 m. A cumulative load in the Mizuho core from the surface to a depth of 32 m is about 2100 g/cm^2. Accordingly, the mean annual rate of snow accumulation at Mizuho Station in the past 300 years is about 7.0 g/cm^2, which corresponds to two-thirds of 10.6 g/cm^2 determined from the stratigraphic analyses of the Mizuho core. This means that the periods of hiatus of annual layers are about one-third of the real duration of the core formation.

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(Received January 9, 1979; Revised manuscript received May 2, 1979)