2.3.2 Englacial temperatures

Five holes were drilled in Summer 1975 along the centerline from the highest point of the ice cap at 530 m above sea level down to the glacier terminus. The longitudinal (2-dimensional) temperature profile (Fig. 2-17) thus obtained shows the expected cold ice in the upper part of the glacier. At a crevassed area between 300 and 400 m above sea level the ice temperatures rise rapidly. In the lower part, the ice temperature reveals a steep gradient in the upper half of the ice and temperate or near temperate ice with a zero gradient close to the bottom of the glacier.

Shallow depth (10 m) temperatures were also measured from April to September 1975 on the top of the ice cap (Fig. 2-19) together with the air temperatures.

One of the remarkable features of the Laika Glacier temperature distribution is the 10 m temperature as a function of the altitude as shown in Figure 2-18. The 10 m temperature on the top of the glacier is about 4°C higher than the annual mean air temperature. This is a relatively small difference compared with the 6 to 10°C differences in the firn area of the White Glacier. The top part of Laika Glacier is covered with a 1 to 2 m layer snow most of the year. Since there is superimposed ice accumulation, there is no firn but clear ice under the snow layer. The thus smaller thermal insulation effect may explain the relatively low 10 m temperature.

The 10 m temperature in the lower tongue area below 250 m a.s.l. are about 4 to 6°C higher than the annual mean air temperature. The piedmont-type tongue has very few crevasses and is mostly snow-free due to strong winds which blow frequently during the frozen season.

The middle part of the glacier (250 to 400 m a.s.l.) shows a 10 m temperature of as much as 10°C warmer than the annual mean air temperature. This area is crevassed. Most of these crevasses open at the beginning of the melt season and are filled with meltwater. It is likely that part of this water refreezes in the crevasses at the beginning of the winter and releases its latent heat into the ice. A new snow cover, often falling just at the end of the melting season, may help to store the heat better in the ice due to its insulating effect.

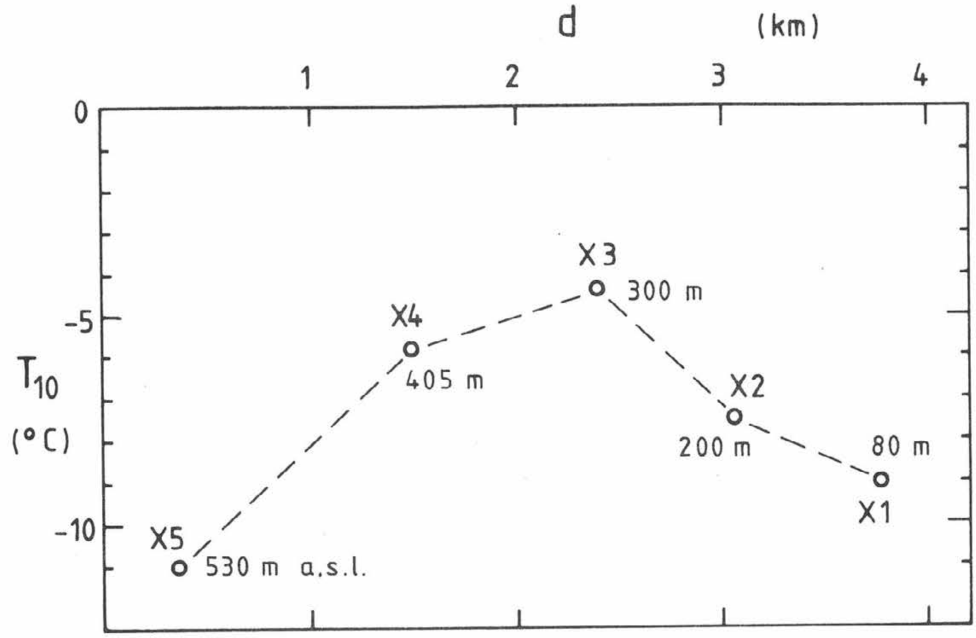

Fig. 2-18 The 10 m temperatures T_{10} of Laika Glacier as a function of the altitude.

A method of calculation for interpolating englacial temperatures by using only the measured boundary conditions is discussed in Chapter 3.3.2 for the data obtained on Laika Glacier. The calculation can only be used for the higher part of the glacier; melting processes as occurring in the bottom ice of the ablation zone cannot be handled yet.

Figure 2-19 shows the development of the temperatures in the top 10 m of the ice in the highest part of the Laika Ice Cap. A 10 m hole was drilled by hand with the aid of a SIRPE core drill in early April 1975. A cable with thermistors was inserted and the hole was filled with snow and water. The temperatures stabilized some 2 weeks later and the temperature measurement was continued until September.

The 10 m long ice core revealed 30 dirt layers which were interpreted as summer horizons. In the summers, dust and sand are carried onto the glaciers by the strong wind often occurring over Coburg Island. The analysis indicated an accumulation rate of around 30 cm superimposed ice per year since the 1940-ies. It is not clear whether a layer accumulated every year.

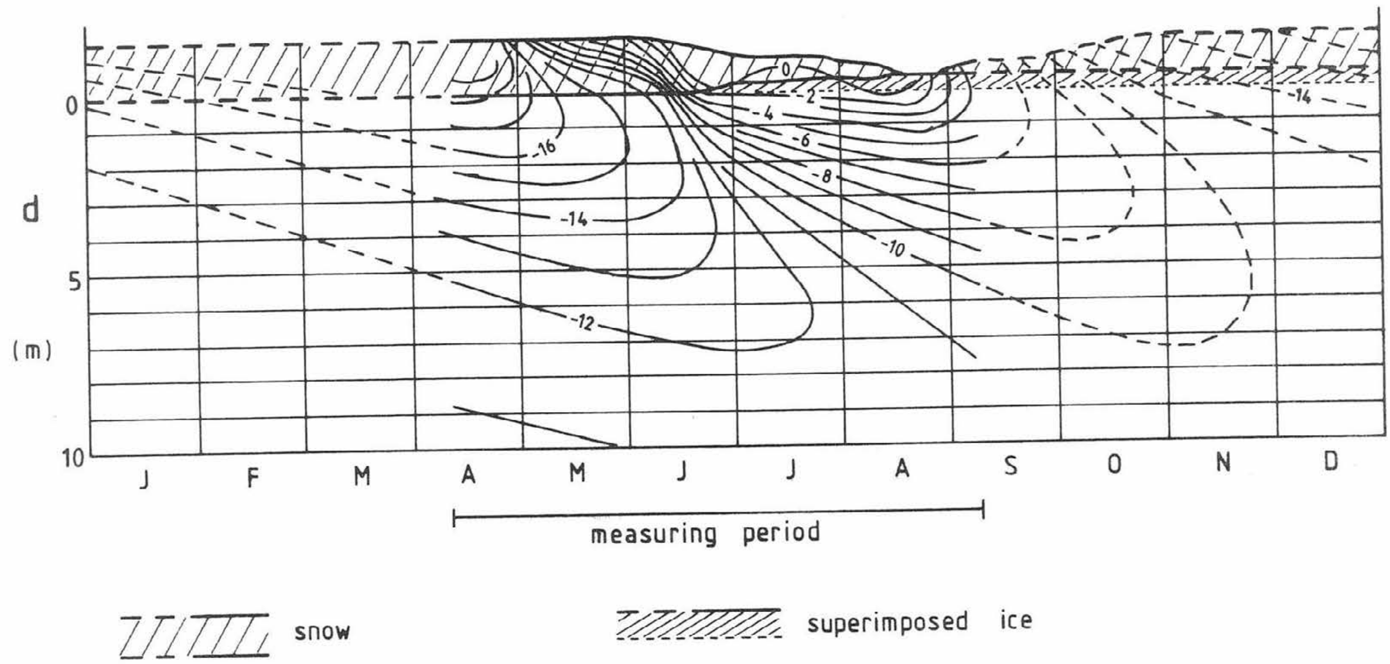

Fig. 2-19 Ice temperatures in the top 10 m at the highest point of the Laika Ice Cap during the summer 1975.

The temperature profile shows the expected penetration of the winter cold wave with a time lag proportional to the depth (about 5 months per 10 m). The detailed data of the ice and air temperature measurements are given in the Tables A-11 and A-10 in the Appendix.