The Ion Elution Effects on the Ice Core Record in Kangwure Glacier, Xixabangma Peak

(希夏邦马峰抗物热冰川离子淋溶作用对冰芯记录的影响)

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ABSTRACT The ion elution process has a severe effects on the formation of ice core record, which is discussed on the results of ice core record from kangwure Glacier, Xixabangma Peak.

KEYWORDS ion elution, ice core record, formation, Kangwure Glacier

1 INTRODUCTION

Previous studies have shown that 50%～80% of the pollutant load in the snowpacks can be released with the first 30% of the meltwater (Johannessen and Henriksen, 1978). So the ion elution can alter the seasonal-layer distribution of chemical contents deposited in the snowpacks and form a new chemical distribution, which is preserved perpetually as the ice core record. In order to reconstruct the paleo-climate and paleo-environment from the ice core with high accuracy, it is necessary to determine the correlation of the chemical distribution between pre- and post-ion elution processes.

2 METHODS

An ice core, 13 m long, was recovered from the Kangwure Glacier(6 150 m a. s. l.) during the Chinese-US-former Soviet Union joint Expedition to the Xixabangma Peak in 1991. The ice core was equally splitted in the field and was returned to the Chinese and the United States low temperature laboratories in its frozen state, respectively. The retrieved core was cut into disks(～10 cm thick) with machine auger. Before analysis, an outer 1 cm annulus was removed. The ice disc was kept in plastic bag and was allowed to melt under room temperature (～20 ℃). After the ice became water completely, the water was filled into special sample bottles and sent to the Laboratory of Ice Core and Cold Regions Environment, LIGG, CAS for further chemical analysis.

The cation ions were determined on a PE-2380 atomic absorption spectrometer. The standard error for K^+, Na^+, Ca^{2+} and Mg^{2+} was estimated to be less than 5%. The anionic components were determined on an ion chromatography by the United States cooperators. The accuracy was about 10 mg/L.

3 RESULTS AND DISCUSSION

3.1 Ion elution of the Kangwure Glacier, Xixabangma Peak

In 1991, the measured temperature at 5 830 m of the Kangwure Glacier was 0～-2 ℃ between 0～2 m and -9 ℃ at 6 m depth. The relative high glacier ice temperature, with strong solar radiation at the glacier surface, causes the snowpacks melt easily, which provides a predominant conditions for ion elution processes. The ion concentrations of the upper 4 m layer of the 13 m ice core is shown in Fig. 1. It is clear that the ion concentrations in the snowpacks at 0～1.4 m were very low. However, the concentrations increased rapidly below 1.4 m, and the peak and valley rhythm is also obvious in

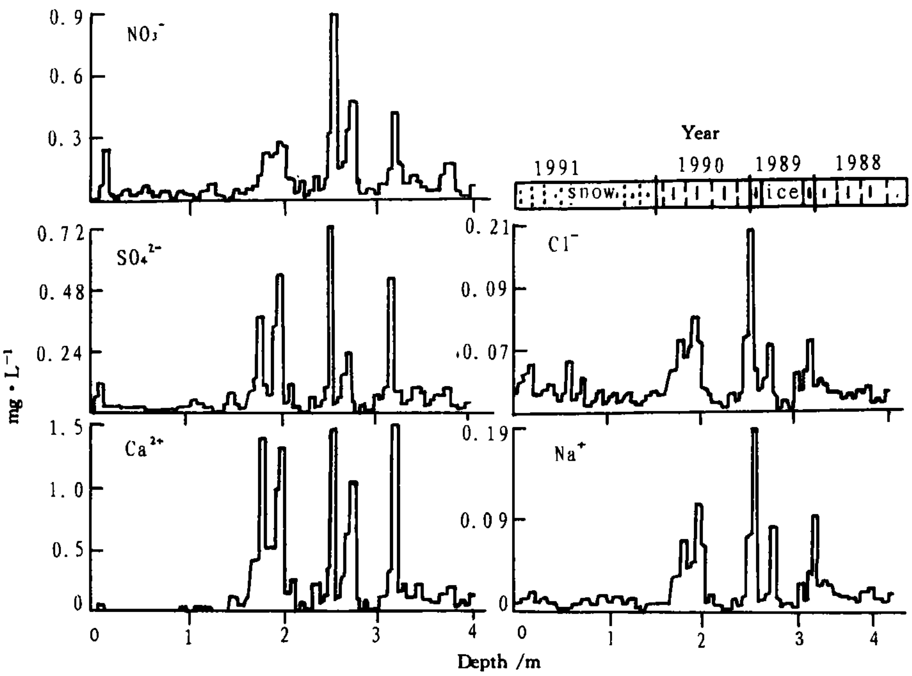

Fig. 1 Ion concentrations of the surface layer of the ice core from the Kangwure Glacier

this part of the ice core. In the Kangwure Glacier the snowpacks can become ice within one year, and the ion elution mainly occurs during summer season, and the leached ions enrich in the dirty layer which forms at the end of summer, therefore, the peak concentrations form in the corresponding dirty layer. During winter time the ion elution is much weak because of the low temperature, weak ablation and quick refreezing, and the ion concentrations give low values. It can be concluded that the ion elution changes the ion distribution in the snowpacks, as a result, the chemical component deposited in the ice does not show the original seasonal variation, but a new ion distribution which is modified by ion elution. In the Kangwure Glacier the ion elution is strong. If there was no ion elution effect, the ion content difference between the snow and ice layer would have not been so great. During the snowpacks melt period, chemical component removes to the ice layer or runoff the glacier system with the meltwater, and the uneven distribution of the chemical component forms in the ice layer because of the different degree of the ion elution effect. However, the ion elution has no great effect on the ion distribution of the other annual ice layer because the snow can become ice within one year in the Kangwure Glacier.

3.2 The ion elution difference between the south and north parts of the Qinghai-Tibet Plateau

The atmospheric environment differs much in the different part of the Qinghai-Tibet Plateau, and the ion elution also differs, such as in the Kangwure Glacier and the Guliya Ice Cap. In 1990 ～1991, the measured ice hole temperature at a height of 6 200 m of the Guliya Ice Cap was -13.3 ℃ at 2 m depth and -15.5 ℃ at 10 m depth. At the elevation of 6 070 m a snowpit, 1.9 m long, was dug with a sample interval 10 cm. Analysis result is shown in Fig. 2. Because of the low atmospheric temperature, low glacier ice temperature and quick refreezing, the ion elution is weak. During dust period (Feb. ～May) a dirty layer can be formed and the ion concentration is also high in the dirty layer. To the contrary, the ice layer that is formed in the summer season is transparent and the ion concentration is low in these corresponding ice layers (Li *et al.*, 1994). So the ion distribution is characteristic with high concentration in the annual bottom layer and low concentration on the upper annual layer. However, the high ion concentration can also be observed in the middle part which is formed under unique atmospheric conditi-

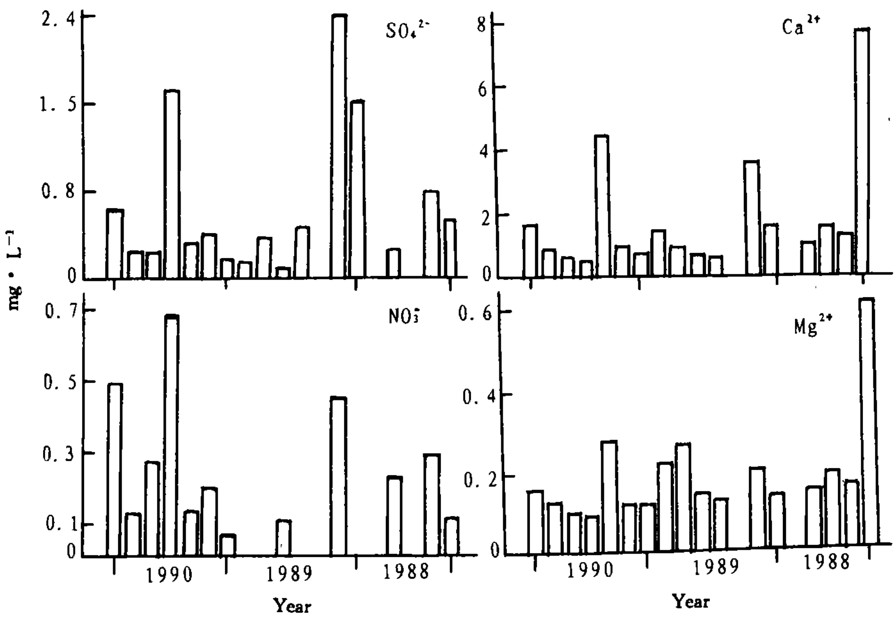

Fig. 2 Ion concentrations of the surface layer of the ice core from the Guliya Ice Cap

ons. But the main ions distribution down the snowpit gave the original chemical record.

4 THE ION ELUTION EFFECT ON THE ICE CORE RECORD

To reconstruct the past climate and environment conditions from the chemical ice core record plays an important role in the global change research. For the glacier that received no or only a little ion elution effect, the ice core record can be used for the reconstruct work. To the contrary, for the glacier that received much ion elution effect, for example, the Kangwure Glacier, the chemical component distribution has changed after deposition, and its seasonal variation is thus disturbed, as a result, this kind of ice core can not be used to reconstruct the paleo-climate and paleo-environment with high accuracy. In case of runoff occurs, the ice core record will strengthen the temperate climate significance. So it is urgent necessary to study the ion features during the snowpacks melt process, to figure out the factors controlling the chemical component movement in the snowpacks, finally, to determine the chemical relationship pre- and post-snowpacks melt. According to Tsiouris *et al.* (1985), the preferential ion elution order is as following: $SO_4^{2-} > NO_3^- > NH_4^+ > K^+ > Ca^{2+} > Mg^{2+} > H^+ > Na^+ > Cl^-$. However, the order can change under different conditions, especially the ion Ca^{2+}, but most research still prove that SO_4^{2-} and NO_3^- can be easily leached than Na^+ and Cl^-, which means that the ion movement not only concerns with its own characters, but also with temperature, matching of the ions and ion concentration, and so on. However under strong ion elution conditions, almost all the chemical component leaves the glacier system with the meltwater runoff, the preferential elution can not show clearly, either.

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