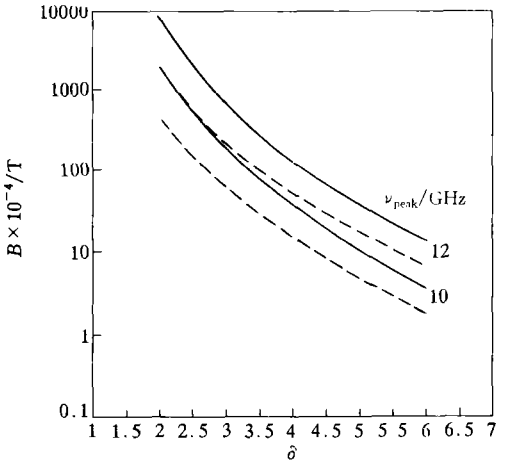

Fig. 1. Variation of B with ν_{peak}, $T_{b\nu}$ and δ, where $T_{b\nu}(\nu = 30\ \mathrm{GHz}) = 5\times10^{7}$ (solid line) and 10^{8} (dashed line), $\nu_{peak} = 12$ GHz and 10 GHz, respectively.

trum, $\triangle\delta$ is $\pm4.6\times10^{-3}$. Finally, the observational error of B is ±0.50 if we use data of OVRO. For theoretical errors, because the accuracy of η_ν/BN and $\kappa_\nu B/N$ of ref. [1] is not so good, this error is ±0.35. However, this error for B could be decreased to ±0.18 in eq. (4). Therefore the diagnostic accuracy of the magnetic field, especially one of the energetic electron information, could be improved further.

In addition, it must be noticed that in ref. [1] the precision of the formulas η_ν/BN and $\kappa_\nu B/N$ decreases greatly at the two ends of the valid range of δ and the harmonic number s ($2\leqslant\delta\leqslant7$, $10\leqslant s\leqslant100$). So it influences greatly the diagnostic precision of B and other information for great or small burst. But there is no problem in the case of equation (4).

It must be pointed out that eq. (4) is valid only in the range of $2\leqslant\delta\leqslant7$, $10\leqslant\nu/\nu_B\leqslant100$, with θ being not an extreme angle and in the case of quasilongitudinal propagation.

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Effects of ion elution on formation of ice core record

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Keywords: ion elution, ice core record, chemical distribution.

PREVIOUS studies have shown that 50%—80% of the pollutant load in the snowpacks can be

released with the first 30% of the meltwater[1]. 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[2]. In order to reconstruct the paleoclimate 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.

1 Methods

An ice core, 13 m long, was obtained from the Kangwure Glacier (6 150 m a.s.l) during the Chinese-US-former Soviet Union joint expedition to the Xixiabangma Peak in 1991. The ice core was equally split in the field and was separately brought to low temperature laboratories in China and the United States in its frozen state. The retrieved core was cut into disks (10 cm thick) with machine auger. Before analysis, about 1 cm outer annulus was removed. The ice disc was kept in plastic bag and was allowed to melt at 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, Lanzhou Institute of Glaciology and Geocryology 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 chromatograph by the United States cooperators. The accuracy was about 10 mg/L.

2 Results and discussion

2.1 Ion elution of the Kangwure Glacier

In 1991, the measured temperature at 5 830 m of the Kangwure Glacier was 0— −2℃ between 0 and 2 m deep and −9℃ at 6 m deep. The relatively high glacier ice temperature, with strong solar radiation at the glacier surface, causes the snowpacks to melt easily, which provides a predominant condition for ion elution process. The ion concentrations of the upper 4 m of the 13-m ice core is shown in fig. 1. It is clear that the ion concentrations in the snowpacks 0—1.4 m deep were very low. However, the concentrations increased rapidly below 1.4 m, and the peak and valley are also obvious in this part of the ice core. In the Kangwure Glacier the snowpacks can become ice within one year, the ion elution mainly occurs during summer season, and the leached ions are enriched 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 weaker 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 components deposited in the ice do 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 moves to the ice layer or runs off the glacier system with the meltwater, and the uneven distribution of the chemical component forms in the ice layer because of the different degrees 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.

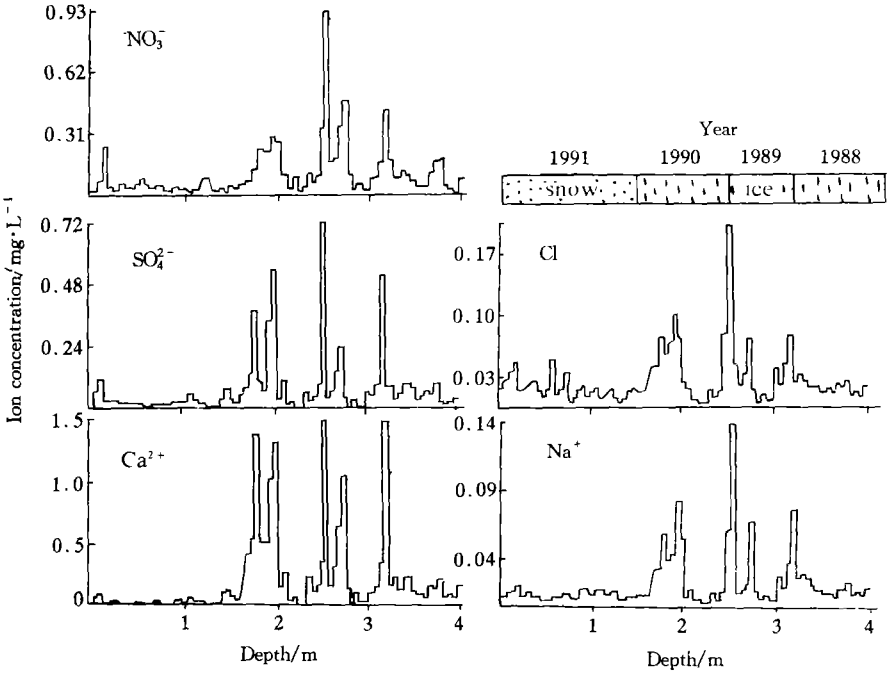

Fig. 1. Ion concentrations of the surface layer of the ice core from the Kangwure Glacier.

2.2 Ion elution difference between south and north parts of the Qinghai-Xizang Plateau

The atmospheric environment greatly changes in different parts of the Qinghai-Xizang Plateau, and the ion elution also changes, e.g. 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 of 10 cm. Analytical results are 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 (February—May) a dirty ice layer can be formed and the ion concentration is also high. To the contrary, the ice layer formed in summer is transparent and the ion concentration is low in these corresponding ice layers[3]. So the ion distribution is characterized by high concentration in bottom of an annual layer and low concentration in the upper part of an annual layer. However, the high ion concentration can also be observed in the middle part formed under unique atmospheric conditions. But the main ions distribution below the snowpit gave the original chemical record.

2.3 Effect of ion elution on 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 chemical component still remained in the original conditions, and the ice core record can be used for the reconstructing 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 has been thus disturbed. As a result, this kind of ice core cannot be used to reconstruct the paleo-climate and paleo-environment with high accuracy. If runoff occurs, the ice core record will strengthen the temperate climate significance. So it is necessary to study the ion features during the snow-

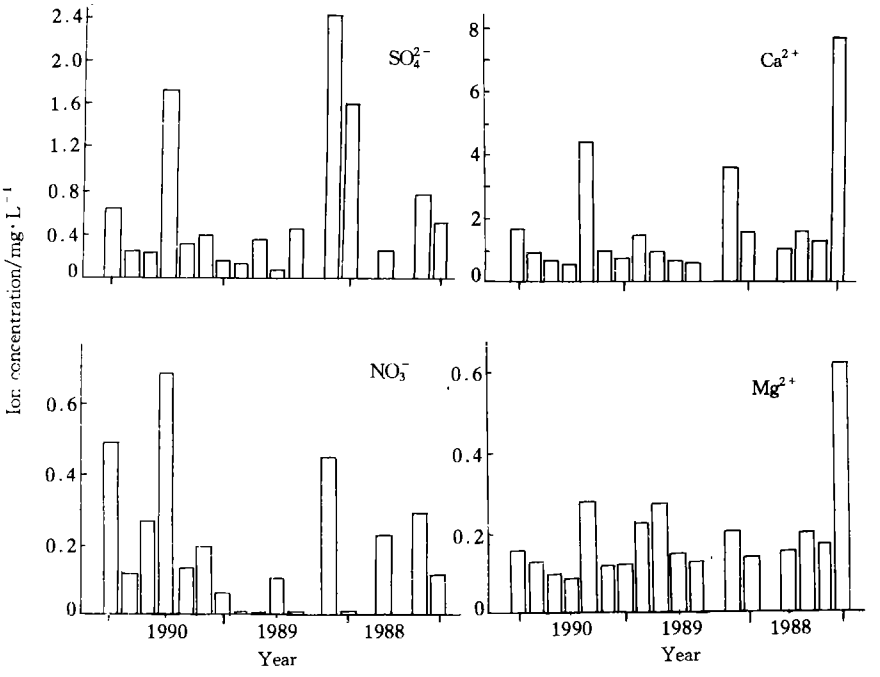

Fig. 2 Ion concentrations of the surface layer of the ice core from the Guliya Ice Cap.

packs melt process, to figure out the factors controlling the chemical component movement in the snowpacks, and finally, to determine the chemical relationship between pre- and post-snowpacks melts.

From analysis of atom radius, the outside electrical construction and the electric number, the main anionic and cationic order by activity can be expressed as $Cl^- > NO_3^- > SO_4^{2-} > K^+ > Na^+ > Ca^{2+} > Mg^{2+}$. But according to Tsiouris *et al.*[4] the ion elution order is $SO_4^{2-} > NO_3^- > NH_4^+ > K^+ > Ca^{2+} > Mg^{2+} > H^+ > Na^+ > Cl^-$. Although these orders can change under different conditions, especially the ion Ca^{2+}, most researches prove that SO_4^{2-} and NO_3^- can be more easily leached than Na^+ and Cl^-, which means that the ion movement is concerned not only with its own character, but also with temperature, matching of the ions and ion concentration. However, under strong ion elution conditions, almost all the chemical components leaves the glacier system with the meltwater runoff, the preferential elution cannot show clearly.

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