Characteristics of Yala Glacier on the Viewpoint of Tritium Content

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Abstract

The vertical distributions of tritium content in glacier ice were determined at two different heights of Yala Glacier in the Langtang Region, Nepal Himalayas. In the vertical profile of tritium content at the upper point, ca. 5,400 meters high, there exists a clear peak, which shows the injection of artificial tritium due to nuclear weapon test series. At the lower point, ca. 5,200 meters high, the tritium content is relatively low throughout the core, decreasing with depth. Precipitation nourishes the glacier in the accumulation area and, after a long time, appears in the ablation area with the movement of ice body, causing the different profiles in tritium content between the two points.

The tritium content in the precipitation in Yala Glacier is more similar to that in New Delhi, India, than in Karizimir, Afghanistan. Generally speaking, tritium content in the precipitations is lower in the coastal area than in the continental area. The precipitation in Yala Glacier belongs to the coastal type on the viewpoint of tritium content. There possibly exists a great difference in tritium content between the glaciers nourished by water vapours from the sea and from the continent.

1. Introduction

The climate of the great Himalayas, located at the boundary area between the tropical zone and the temperate zone, is influenced considerably by the monsoon from India in the summer and by the westerlies in the winter. As the high mountains stretch from the east to the west in the Himalaya Region, it is considered that the amount of water vapour, passing through the Himalayas during the monsoon season, is relatively small. Under such a meteorological situation, there exist many large glaciers hanging on the southern slope of the Himalayas, organizing important water resources in the region. In this report, we discuss the origin and the circulation of water in the glacier based on the tritum content obtained in Yala (Dakpatsen) Glacier by the Glaciological Expedition of Nepal in 1981 and in 1982.

2. Methods and Materials

Core borings of the glacier from the surface to the bottom were carried out at Yala Glacier, located in the Langtang Himalaya in Nepal, by the projects in 1981 and in 1982. The boring sites were set up on Yala Glacier, covering up the mountain area from an altitude of 5,500 meters to 5,100 meters, at the heights of 5,180 meters in 1981 and 5,405 meters in 1982. More detailed descriptions on the geographical features of the glacier and on the projects are introduced by Watanabe et al. in this volume. Some of the core samples were subjected to the determination of tritium content.

3. Results and Discussion

3.1. Concentration of tritium in the boring core samples

The concentration of tritium in the core samples is shown in Fig. 1. All of the values are converted into those in November in 1982, because they always decrease due to radioactive decay. Open circles at the surface of the glacier show the concentration of tritium in the snow sample obtained on November, 3 in 1981. The dashed line in the figure shows the range of the depth, where the water in liquid phase was spouting in the boring hole, and the tritium content in the water. Throughout the core at the boring site in 1981, the concentration of tritium was relatively low and seemed to decrease gradually with depth from the surface. On the contrary at the site in 1982, tritium content increased with depth, showing its maximum value at ca. 22.5 meters depth, and then decreased to the lowest value at the bottom of the glacier.

3.2. Structure of Yala Glacier on the view point of tritium content

Miller et al. (1965) reported that the vertical distribution of tritium content in the glacier in Nepal kept records of past fallout on the glacier and had some peaks due to thermonuclear test series. Here we can also conclude that there are some injections of the artificial tritium, resulting from thermonuclear test series, in the ice layers at the site 5,405 meters high, because there exist some layers of high concentration of tritium. On the contrary, we cannot detect such tritium peaks in the core at the site 5,180 meters high. Taking the facts into consideration, we can conclude that the area near 5,400 meters high is an accumulation area and that the area near 5,200 meters high is an ablation area, where the ice body of the glacier flows down from the accumulation area.

There existed water in liquid phase in the glacier at the upper site, whose tritium content was 39.94±0.20 TU. In December in 1981, we could observe the water flowing from the end of the glacier, whose tritium content was 21.4±2.4 TU. Taking into consideration that the tritium content throughout the core at the lower site was low, it is probably concluded that a part of the glacier in the accumulation area is consumed by flowing down in liquid phase without passing through the ablation area in solid phase. Therefore in order to consider the residence time of water in the glacier, it is probably important that we should treat the glacier as

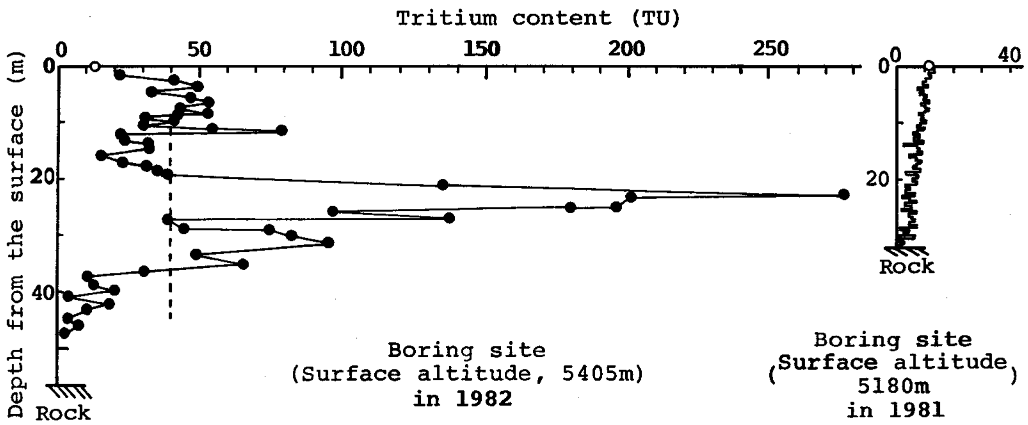

Fig. 1. The vertical distributions of tritium content at two different heights of Yala Glacier. The values are represented as those in November in 1982. The open circles show the value in the snowfall in the glacier on November, 3 in 1981. The dashed line shows the depth where water occurred and its tritium content.

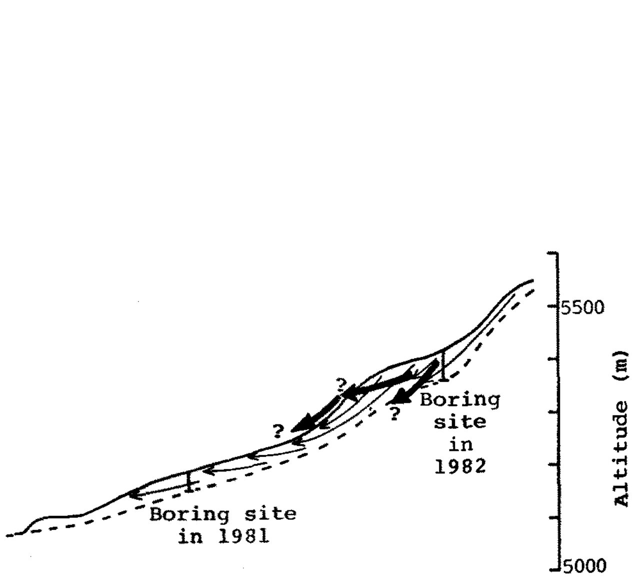

Fig. 2. Schematic diagram of the flow lines of water in Yala Glacier. Thick arrows show the flow lines of water in liquid phase and thin arrows in solid phase.

two parts, an accumulation area and an ablation area. Fig. 2 shows the flow lines of the water in liquid phase (the thick arrows) and those in solid phase (the thin arrows) schematically, estimated in Yala Glacier as mentioned above.

3.3. Origin of water estimated from tritium content

Fist of all, we will introduce the concentration of tritium in the precipitations in the global

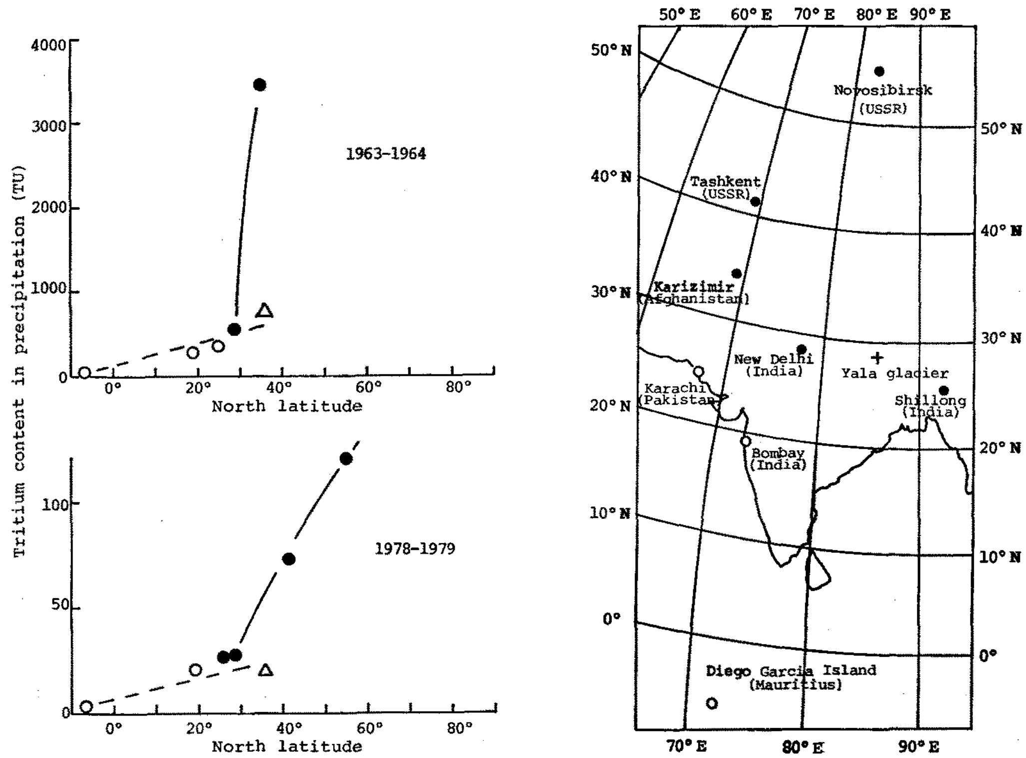

Fig. 3. Map of the distribution of stations of IAEA surrounding the Nepal Himalayas and meridional distributions of tritium content in precipitations averaged during the periods from 1963 to 1964 and from 1978 to 1979. The inland stations are represented as ● and the coastal stations ○. The values in Tokyo are represented as △.

scale. Eriksson (1967) and Stewart et al. (1968) reported that, in the geographical distribution of tritium content in the precipitations in the North American continent, high concentration level occurred in the northern and in the inland parts. Kigoshi et al. (1970) reported from their observation in Japan that the tritium content in the atmospheric moisture from the continental air mass was higher than the one from the maritime air mass. A similar result was also obtained in the rainfall (Shimada, 1978). Ehhalt (1971) described that the higher concentration of tritium was observed in the water vapour of stratosphere than in that of troposphere. Worldwide measurements of tritium content in precipitations were published by the International Atomic Energy Agency (IAEA) (1969, 1970, 1971, 1973, 1975, 1979, 1983). The distribution of stations of tritium measurements surrounding the Nepal Himalayas is shown in Fig. 3, where the coastal and the inland stations are shown, respectively, as open circles and closed circles. In the figure, the meridional distributions of tritium content in the precipitations averaged during the periods from 1963 to 1964 and from 1978 to 1979 in the stations are shown along with the values in Tokyo (the triangles). It is clearly observed that the tritium content in the precipitation in the northern inland stations was higher than that in the southern coastal stations as was reported in the North American continent. Among the stations, New Delhi is the critical point which divides the meridional distribution of tritium content. It is considered that the precipitation in New Delhi is effected by the water vapour from the sea. Fig. 4 shows the annual variations of tritium content in the precipitations in New Delhi

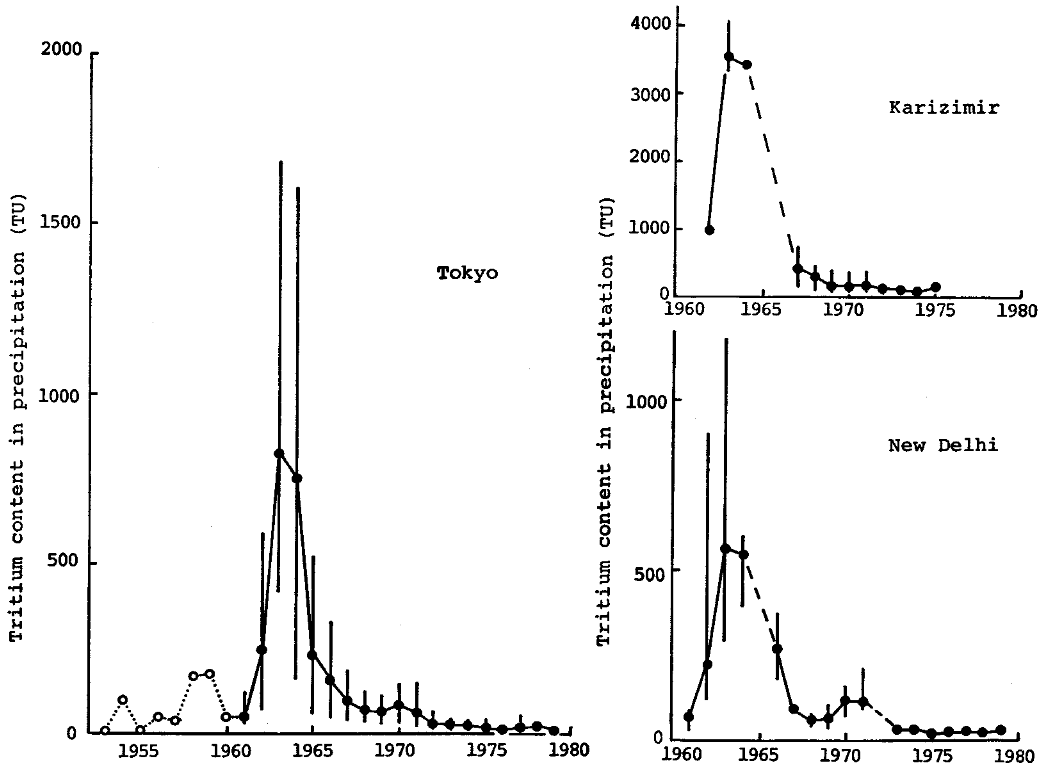

Fig. 4. Annual distributions of tritium content in precipitations in Karizimir, in New Delhi and in Tokyo. The vertical lines show the range between the maximum and the minimum values in the year. The closed circles show the values reported by IAEA and the open circles the ones in Tokyo estimated from the data in Ottawa.

Table 1. Tritium content in precipitations averaged in 1975 after IAEA (1979). *is the value obtained in 1982.

Bombay	Karachi	Shillong	New Delhi	Karizimir	Yala Glacier
19.6	23.3	22.0	20.9	156.5	12.9*

and in Karizimir with the reference values in Tokyo, where the closed circles are the values reported by IAEA and the open circles are the ones in Tokyo estimated from the values in Ottawa, Canada. Tritium content in the precipitations in Karizimir is much higher than that in New Delhi throughout the observed years, which probably shows that the precipitations in New Delhi are influenced by the water vapour from the sea and those in Karizimir by the water vapour from the continent. After 1975, the tritium content did not show a large variation as was estimated from the data in Tokyo. Then, the average concentrations of tritium in the precipitations in 1975 neat the Nepal Himalaya are listed in Table 1 with the data in the snow obtained at Yala Glacier in 1981. It is clearly observed that the tritium content in the precipitation in Yala Glacier is more similar to that in New Delhi in the coastal area than that in Karizimir in the continental area, which shows that Yala Glacier is nourished by the water vapour from the sea. The maximum value of the tritium content obtained in the accumulation area was about 280 TU. If the value was due to the fallout peak in 1963, the tritium content in the precipitation in Yala Glacier in 1963 is estimated to be about 810 TU, taking the radioactive decay into consideration. The value is also similar to the one in New Delhi in 1963. There exists a great difference in tritium content between the precipitations in the continental area and in the coastal area, and the precipitation in Yala Glacier belongs to the coastal type.

4. Conclusion

The vertical distributions of tritium content in the glacier were determined both in the accumulation area and in the ablation area of Yala Glacier in the Langtang Region in Nepal. In the accumulation area, the layer which shows the injection of the artificial tritium was observed clearly. In the ablation area, the injection could not be detected throughout the core. The ice body in the ablation area seems to be relatively old, taking the tritium content into consideration.

The tritium content in the precipitation in Yala Glacier is more similar to that in New Delhi than in Karizimir. Tritium content in the water vapour from the sea is much lower than the one from the continent. It is possibly considered that the tritium contents in the glaciers in China and in USSR are higher than the one in Yala Glacier.

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