Bulletin of Glacier Research 6 (1988) 75–80

The preliminary report of Sino-Japanese Joint Glaciological Expedition in West Kunlun Mountains 1987

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(Received December 24, 1987; Revised manuscript received January 24, 1988)

Abstract

The joint observations between China and Japan in West Kunlun Mountains, northwestern part of Xizang (Tibet) Plateau were carried out in summer 1987. Outline and the preliminary results of the field works on glaciology, snow/ice core drillings, meteorology, volcanic geology, Quaternary glaciations, permafrost, periglacial phenomena and others are described.

1. Introduction

West Kunlun Mountains lie in the northwestern part of Xizang (Tibet) Plateau (Fig. 1). There are 4306 glaciers with a total area of 8438 km², which corresponds to about three quarters of the glacier area in the whole Kunlun Mountains, in the range from the Yarkant River gorge to the longitude 83° 30′ E surrounded with arid zone. The greatest ones among them, mostly 20–30 km long, are distributed in the high mountains between Tianshuihai and Keriya Pass, south of the Yurunkax River, and there are 652 glaciers with a total area of 3300 km² in this region (Fig. 2). About 60% of glaciers in number and area are located on the northern slope of this region. The melt water from those glaciers serves as the important water supply for the industry and agriculture of oases in the southern periphery of Taklimakan Desert.

At the beginning of this century, a few European explorers visited that region. During 1960's and 1970's, the mapping department of China surveyed this region and an aerophotogrammetric topographic map in large scale was made. In 1976, the Comprehensive Scientific Expedition of Qinghai-Xizang Plateau, Academia Sinica investigated the southern slope of West Kunlun Mountains briefly. In the meanwhile, a geological survey was carried out by the geology and geography department of Xinjiang Province, but detailed observations on glaciology and geocryology were not conducted due to the difficult field conditions. In July, 1985, the small party consisting of both Chinese and Japanese scientists made a reconnaisance for the present expedition along the southern slope of these mountains (Watanabe and Higuchi, 1987; Watanabe and Zheng, 1987), and investigated the existing glaciers, Quaternary glaciations, permafrost and periglacial phenomena briefly. Their reports were published in this 'Bulletin of Glacier Research' **5** (1987).

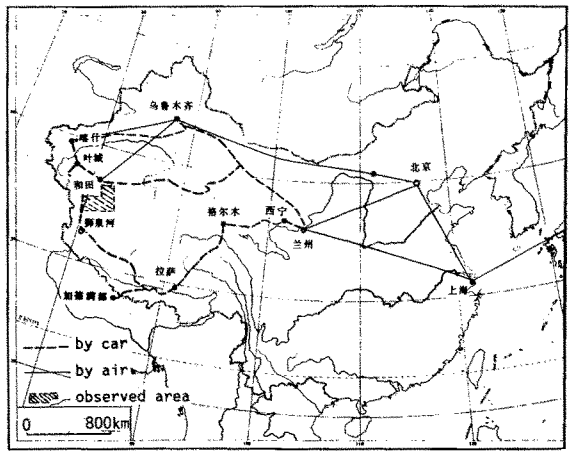

Fig. 1. Routes of Sino-Japanese Joint Glaciological Expedition to West Kunlun Mountains in 1987.

The present expedition was organized as the joint team between China and Japan under the financial support of Academia Sinica, and the Ministry of Education, Science and Culture and other organiza-

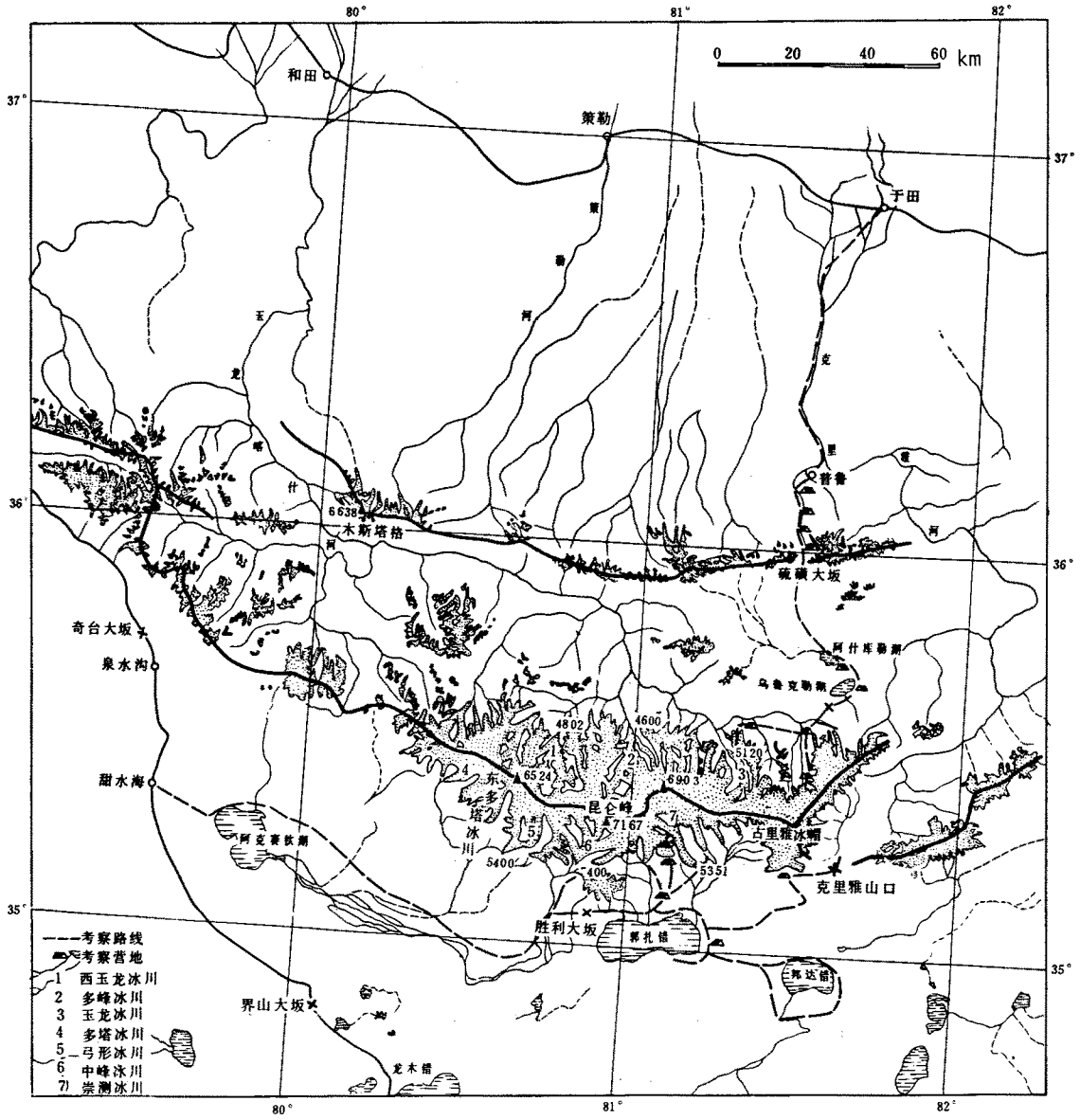

Fig. 2. West Kunlun Mountains, and the camps along the routes of the expedition (dashed line).
1. West Yulong Gl. 2. Duofeng Gl. 3. Yulong Gl. 4. Duota Gl. 5. Gongxing Gl.
6. Zhongfeng Gl. 7. Chongce Gl.

tions in Japan. The leader of the Chinese side was Prof. XIE Zichu (Lanzhou Institute of Glaciology and Geocryology, Academia Sinica) and of the Japanese side Prof. Keiji HIGUCHI (Water Research Institute, Nagoya University). This expedition was composed of 22 Chinese and 11 Japanese scientists including the authors as the acting leaders, 5 video recorders (4 from Japan) and 26 logistic supporters from China.

The expedition aimed at the studies on general feature, process of accumulation, that of ablation and variation of existing glaciers; environment of Quaternary glaciers, and of volcanos, lakes, permafrost; and their relations to the climate changes and water resources, which will provide a scientific reference to the economic development of southern Xinjiang and ra-

tional utilization of northern Xizang. Therefore, scientists from many fields joined to the expedition, such as glaciology, meteorology, hydrology, geomorphology, volcanic geology, geocryology, glacier mapping et al.. The field observations were carried out in summer, 1987. Although the detailed reports of this expedition will be published in near future as mentioned in the last section, preliminary results of the fieldworks will be described in this report.

2. Outline of the fieldworks

The fieldworks of the expedition were composed of three parts : First, on the southern slope of the West Kunlun, the systematic observations on glaciology, meteorology, hydrology, glacier mapping and ice core drillings were done on Chongce Ice Cap and in the surrounding area (Fig. 3) by Chen J., Y. Ageta and 20 scientists. Second, around Tianshuihai, geocryological survey and drillings in the lacustrine deposits were carried out by Li S. and 3 scientists. Third, on the northern slope of the West Kunlun, the volcanos in Ashikule Basin, the existing glaciers, periglacial geomorphology and Quaternary glaciation at the upper reaches of the Yurunkax River and at the head of the Keriya River were investigated by Zheng B., H. Fushimi and 5 scientists. Then, on the southern slope of the West Kunlun, lake geomorphology and lacustrine around Tianshuihai, Aksayqin Lake, Gozha Co Lake, Bangda Co Lake and the glacial and periglacial landforms in these areas were also surveyed by this party.

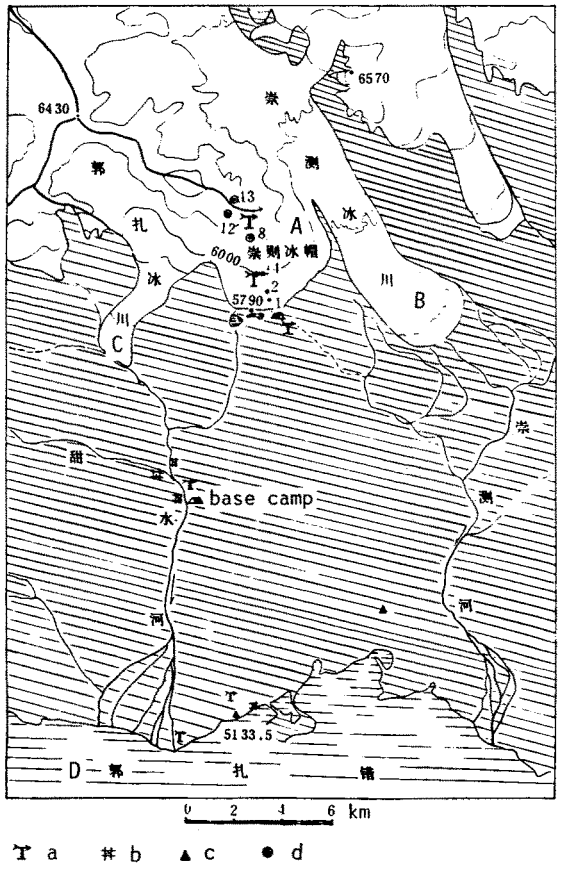

Fig. 3. The main research area and the observational stations on the southern slope of West Kunlun Mountains.
a. meteorological station b. hydrological station c. triangulation point d. core drilling point
A. Chongce Ice Cap (1–13 : Station no.) B. Chongce Glacier
C. Gozha Glacier D. Gozha Co Lake

For the southern slope of the mountains, the Chinese advance party, led by Zhang W., left Lanzhou on May 16 and established a base camp on the bank of the Tianshui River at an altitude of 5260m on June 10. The meteorological station and the hydrological station were set up there in the middle of June.

The Japanese party except 2 members who went to the northern slope, started from Yecheng on July 2 and arrived at the base camp on July 8. The advance base camp was settled at the terminus of Chongce Ice Cap, 5805m in altitude on July 15 for the observations on the ice cap. Motorcars for off-road could be used up to the advance base camp for transport. During the observations on the ice cap, 2 snowmobiles were used effectively for the transportation of instruments and members to the tops of the ice cap (6374m and 6530m a.s.l.). After various observations, the advance base camp was withdrawn on August 28.

The northern slope of the West Kunlun was observed from the beginning of July, then the party moved to the southern slope along the Xinzang Highway in the first half of August. Completing the field observations, all the expedition members withdrew the base camp on September 1.

3. Research works and the preliminary results

3. 1. Glaciological observations

Glaciological studies were made on characteristics of mass balance, thermal and physical structures of snow and ice, ice flow and variation of the terminal

position at Chongce Ice Cap which belongs to 'the continental type glacier'. Survey for the glacier mapping on this area of about 450 km^2 and measurements of ice thickness at 1300 points by the use of a ice radar were also carried out. The area of Chongce Ice Cap is 16.38 km^2, and the thickness of the ice cap is in a range from 120 m to 140 m near the equilibrium line.

For the study on mass balance, stakes were set and measured on Chongce Ice Cap at 13 stations along the central axis of the ice cap, 5 stations along the western slope of that and other 8 points, in the altitude range between 5800 m and 6370 m. The stakes along the western slope were set in July, 1985 and the changes of surface lovels for 2 years measured from the stake heights were −17 cm at the lowest station and +88 cm at the highest station.

Stratigraphic studies of snow pits and shallow core samples on mass balance and structure of surface layers were made at the main stations of the ice cap. Snow/ice samples to obtain the vertical profiles of oxygen isotopes, gross β activities et al. were taken from the pit walls at 5 stations. The stratigraphic observation of snow and ice indicates that the ice formation of the ice cap is dominated by the infiltration and congelation.

The snow/ice temperature was mainly measured at the top, 6300 m a.s.l. and at the tongue, 5800 m a.s.l. on Chongce Ice Cap, and also on Gozha Glacier at altitudes of 5740 m and 6000 m close to the equilibrium line. The lowest glacier temperature, −16.4°C appeared at the depth of 8 m−10 m at the top of the ice cap.

Flow velocities of the ice cap were measured on the stations along the central axis and the western slope of that. The movements of the stakes along the western slope were in the range of 4 m−8 m for 2 years from 1985. Strain grids were set at Stations nos. 12 and 4, and measured the deformation in an interval of 1 month.

Terminal positions of the ice cap were measured in August at 8 points in comparison with those in July, 1985. The terminus retreated at a few points and kept stable at most of them, while the tongue of the western part flowing towards a big moraine lake advanced obviously.

3. 2. Snow/ice core drillings

Snow/ice cores were obtained by the use of a mechanical drill system at 3 stations on Chongce Ice Cap in August. The length of the cores obtained were 23.07 m, 10.58 m and 32.49 m at altitudes of 6312 m (Station no. 12), 6374 m (Station no. 13) and 6106 m (Station no. 8), respectively.

The drilling was initiated at Station no. 12 on August 1 by a six-men team. With the 8 days' work, the drill reached down to a depth of 23 m, where a cavity was found. This cavity seemed to have a vertical structure like a crevasse, whose vertical size was more than 0.8 m. The drill site was hence abandoned and decided to move to Station no. 13.

The drilling at Station no. 13 started on 11 th and ended on August 15 at a depth of about 11 m, where the drill hit a big cavity with an approximate size of 1.4 m. The drill was not designed to penetrate through such a big cavity. The drilling site was, therefore, again moved to Station no. 8. At a depth of 10 m at Station no. 8, the drill hit again a cavity with a size of about 0.7 m. After improvement of the parts, the drill could pass through the cavity with this size, and reached a depth of 32.5 m on August 23. Consuming the allocated period for the drillings, the coring activities were ended on this day.

Vertical half of most of those cores were cut at every depth of 5 cm, and they were melted at the advance base camp. The water samples were brought to Japan for further analyses, such as oxygen isotope, gross β activity, electric conductivity, microparticles et al.. The rest of the cores were packed in a freezer, and sent to Lanzhou, mainly for structural analyses.

3. 3. Meteorological observations

On the southern slope of West Kunlun Mountains, observations were planned to clear mainly the following subjects; 1) difference of various surface meteorological elements along the slope from the lake to accumulation area of glaciers; 2) synoptic atmospheric conditions favourable for precipitation in this region; 3) heat balance and water balance at surfaces of glaciers, ground slopes (with and without vegitation) and lakes; 4) conditions of water and water movement within the active layer of permafrost.

In order to investigate these subjects, meteorological observations were made from end of June to August 31 at the base camp. Meteorological observations in shorter periods were made at the shore site of Gozha Co (5125 m a.s.l.), the advance base camp, and at stations beside the Stations no. 1 (5840 m a.s.l.), no. 4 (5971 m a.s.l.) and no. 12 on Chongce Ice Cap. Furthermore, heat balance measurements in short

term were made on Chongce Glacier also.

Aerological observations were made at the base camp from July 14 to August 26. Also, samplings of aerosol and water vapour were made to investigate characteristics of atmospheric conditions in this area. Measurements on depth and water condition of the active layer of permafrost from the base camp to the advance base camp were made several times during the whole period.

From these observations, following preliminary results were obtained. 1) The precipitation at the base camp in 70 days was about 100 mm. The amount of precipitation increases from the lake to the ice cap. This is favourable for accumulation of glaciers. 2) In case of weather condition which causes precipitation, there is a strong easterly wind in the lowest 1000 m−2000 m layer above the surface. 3) On the ice cap, evaporation is intense and its amount near the terminus is 1−2 mm water/day. Especially on fine weather days, the evaporation is large and heat used for that occupies quite a large portion in the heat balance. 4) On grass slope, precipitation and evaporation of water show approximately the same amounts, because the precipitation intensity is small, and precipitation takes only the form of snow. Therefore, contribution of precipitation to the river runoff is considered to be small.

After the observation of this time, an automatic meteorological observation system has been left at the base camp and it can be expected to obtain a round-year data.

3. 4. Investigations on volcanic geology and Quaternary glaciations

Along the research route from the northern slope to the southern slope of the West Kunlun, geomorphological and geological studies on paleo-environments were carried out. Samples of the lake deposit were taken from the bottom of Aksayqin Lake and Gozha Co, in thickness of 7 cm and 30 cm, respectively. Some of the preliminary results from those investigations along the routes are as follows.

Volcanic sediment of 250 km^2 in area has been found in the basin of Ashikule Lake on the northern slope. There are 4 large volcanic cones, which are over 100 m in height, 11 moderate ones and 40−50 small ones. Most of them were formed by volcanic activities in various periods of Quaternary. Volcanic ash has been firstly found in the lower layers of the ice tongues in the north and southeast of Guliya Ice Cap.

Three glaciations during Pleistocene have been claimed in the West Kunlun. The largest one happened in the middle Pleistocene, known as the Kunlun Glaciation. Paleo-glaciers were tens km longer than the existing ones. Those on the northern slope had reached the main valley of the Yurunkax, but not extended out of the mountain foot. Paleo-glaciers on the southern slope had reached the plain in front of the mountain foot. For example, Chongce Glacier and Zhongfeng Glacier had extended around 15 km longer in the Kunlun Glaciation than the present position.

After the expedition in the West Kunlun, 3 Chinese and 4 Japanese scientists returned to Lanzhou, traversing Xizang Plateau from Tianshuihai via Shiquanhe-Gerze-Lhasa-Nagqu-Golmud-Xining. Along the route, there is not any geomorphological evidence that the ice sheet covered the whole plateau in the past glaciations.

3. 5. Investigations on permafrost and periglacial phenomena

Observations on distributions and forming conditions of permafrost and periglacial phenomena were carried out around Tianshuihai and along the expedition routes, and the following characters could be known.

In the west part of Qingzang Plateau, sporadic permafrost lies in the high mountain zones above 4500 m a.s.l. Continuous permafrost distributes in the plateau basins and mountainous areas between the south of Qitai Pass and the southern slope, 4400 m a.s.l., of Alikela Kunlun Mountains. The mean annual ground temperature of the permafrost is −3.2°C and the fluctuation of annual temperature occurs to the depth of 13 m−15 m. The thickness of permafrost reaches to 70 m−100 m. The thickness of the seasonal thawing layer is 1.5 m−2 m.

Thick ground ice has grown well in lacustrine deposits of Tianshuihai, and ice wedges have been found there firstly, too. Various periglacial landforms such as bolck fields, stone circles, stone polygons, stone stripes, mountain terraces, snow melt depressions, pingos, icings of rivers, snow-melt debris platforms and large soil polygons are widespread on either southern slope or northern slope.

4. Concluding remarks

At present, the analyses of data and samples are in process. The Sino-Japanese joint symposium for the discussions on the results of the present expedition will be held in November, 1988 in Japan, and the basic results of the expedition will be published as a special edition of this 'Bulletin of Glacier Research' which is planned to be issued in March, 1989. The multi-colour map of Chongce Ice Cap and the neighbouring area in a scale of 1/25,000 will be published at the end of 1990.

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