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Glaciological Studies on Qingzang Plateau, 1989
Part 1. Outline of the Project

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Abstract

The China-Japan Joint Glaciological Expedition to Qingzang Plateau, 1989 was sent to study the characteristics of glaciers in different climates, the evolution history of the cryosphere and the role of the cryosphere in meteorological and hydrological processes on the plateau. Field observations were carried out during the two periods, May-June and September-October, in the East Kunlun Mountains, Tanggula Mountains and Nyainqentanglha Mountains. Intensive observations of glaciology, meteorology and hydrology were carried out in the Tanggula Mountains. An outline of the research work is described.

1. Introduction

The Qingzang Plateau, with an average altitude of about 4,500 m a.s.l., is one of the most glaciated regions and one of the largest regions with existing glaciers in middle and low latitudes. On Qingzang Plateau and in surrounding areas, there are 9.5×10^4 km^2 of glaciers of which 4.7×10^4 km^2 are in China (Li *et al.*, 1986; Table 1). According to Table 1, the Nyainqentanglha range has the largest glacier area on the Qingzang Plateau. The largest glacier on the Qingzang Plateau, Kaqin Glacier, which has a length of 35 km and area of 172 km^2, is located in the Nyainqentanglha. In the main path of the westeries, the West Kunlun is a large center, with 3180 glaciers having a combined area of 4,331 km^2. In the Karakoram, there exists the longest glacier in China, Yinsu Gaiti Glacier, 42 km long. Although the total glacier area in the Himalaya is the largest in Table 1, all the Himalayan glaciers in China are shorter than 20 km. In the inland part of the plateau, glaciers are small and characterized by small ice caps.

There is much difference in snowline altitudes between the south-east part and the inland part of Qingzang Plateau. In the Nyainqentanglha Mountains, snowline is as low as 4,200 m. In the inland part of the plateau, snowline is between 5,500 m and 6,000 m, its altitude varies little over a wide area. Such a difference causes a contrast between 'maritime-type glaciers' with much annual water exchange and 'continental-type glaciers' with less exchange. Comparison of the characteristics of both glacier types is important to understand the water cycle in Asian highland regions.

Recently, the important role of the Qingzang Plateau on the climate in surrounding areas and the northern hemisphere has been pointed out by many scientists. For example, heat conditions over the plateau are related to the interannual fluctuation of the summer monsoon, "Mei Yu" and "ENSO". Snow cover on the Qingzang Plateau controls the heat conditions of the plateau through its effect on albedo and melting-evaporation in the surface layer of permafrost.

It is clear that the cryosphere and the atmosphere over the Qingzang Plateau are highly interrelated through water and heat exchange. To compare the characteristics of glaciers in different climates, to study the evolution history of the cryosphere and to clarify the role of the cryosphere in hydrological and

Table 1 Glacier areas and snowline altitudes on Qingzang Plateau and in surrounding areas. (from Li *et al*., 1986)

Mountains	Glacier area (km²)	Glacier area in China (km²)	Snowline (m)
Himalaya	29685	11055	4300−6200
Gangdisi Shan	2188	2188	5800−6000
Nyainqentanglha	5898	5898	4200−5700
Gangri Gabu	1638	1638	4300−5000
Hengduan Shan	1456	1456	4600−5600
Tanggula	2082	2082	5400−5700
Qiangtanq Plateau	3566	3188	5600−6000
Kunlun Shan	11639	11639	4700−5800
Qilian Shan	2063	1973	4500−5250
Karakoram	17835	3265	5100−5400
Pamir	10304	2258	5500−5700
Hindu Kush	6200	0	4000−5100
Total	94554	46640	4000−6200

meteorological processes in the plateau, the China-Japan Joint Glaciological Expedition to Qingzang Plateau, 1989 was sent following joint expeditions to the West Kunlun in 1985 and 1987. The main subjects of the present expedition related to cryosphere are glaciers, snow cover and permafrost. The studies in a representative area are aimed at obtaining the seasonal cycle of the heat and water flux at the surface of the cryosphere. Emphasis was placed on temporal and spatial variations of these fluxes in relation to surface and atmospheric conditions, and some physical processes which are not well understood.

2. Outline of the expedition and its field work

This expedition was organized as a joint China-Japan team under the financial support of Academia Sinica, and the Ministry of Education, Science and Culture (Monbusho) of Japanese Government and other organizations in Japan. The Chinese director was Prof. XIE Zichu (Director, Lanzhou Institute of Glaciology and Geocryology, Academia Sinica —LIGG), and the Japanese, Prof. Keiji HIGUCHI (Water Research Institute, Nagoya University—WRI). This expedition was composed of the following 8 Chinese and 7 Japanese scientists including the authors as co-leaders in the field.

Scientists of the field parties

Chinese side:

YAO Tandong	(Associate Professor, LIGG)
JIAO Keqing	(Assistant Researcher, LIGG)
SHAO Wenzhang	(Assistant Researcher, LIGG)
DING Liangfu	(Engineer, LIGG)
PU Jianchen	(Assistant Researcher, LIGG)
CAO Zhentang	(Training Researcher, LIGG)
SONG Guoping	(Engineer, LIGG)
ZHANG Yinsheng	(Research Assistant, LIGG)

Japanese side:

Yutaka AGETA	(Associate Professor, WRI)
Testuo OHATA	(Assistant Professor, WRI)
Shuji IWATA	(Associate Professor, Faculty of Humanities and Social Sciences, Mie Univ.)
Tetsuzo YASUNARI	(Assistant Professor, Institute of Geoscience, Univ. of Tsukuba)
Takeshi OHTA	(Assistant Professor, Faculty of Agriculture, Iwate Univ.)
Hiroyuki OHNO	(Graduate student, WRI)
Teruo FURUKAWA	(Graduate student, WRI)

The route of the expedition is shown in Fig. 1. The expedition was separated into 2 parts; 4 Japanese belonged to the 1st and the other 3 to the 2nd. The first party (all Chinese members, and Ohata, Yasunari, Ohta, Ohno) started from Golmud on May 3. After brief observations on Meikuang Glacier in the East Kunlun Mountains, they established 'Dongkemadi Base Camp' (5170 m a.s.l.) on May 11 in Dongkemadi Valley as a representative study area in the Tanggula Mountains. Intensive observations of glaciology, meteorology and hydrology were made in this area until June 12, then the party returned to Golmud on

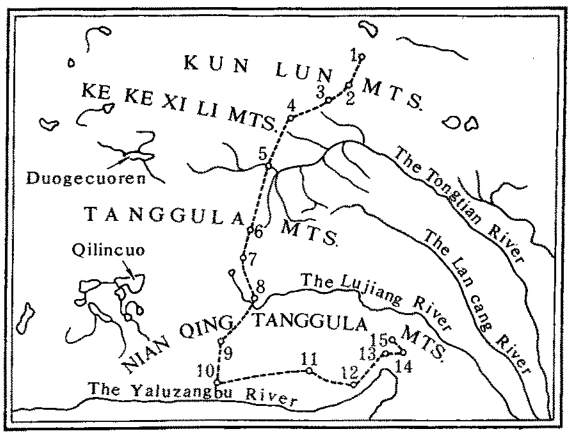

Fig. 1. Route of China-Japan Joint Glaciological Expedition to Qingzang Plateau, 1989.
(1: Golmud, 2: Nachitai, 3: Kunlun Pass, 4: Wudaoliang, 5: Tuotuo He, 6: Tanggula Pass, 7: Anduo, 8: Nagqu, 9: Dangxiong, 10: Lhasa, 11: Gongbu Jiangda, 12: Nyingchi, 13: Tongmei, 14: Guxiang, 15: Zepu Glacier)

June 14.

The second party (all Chinese members except Zhang, and Ageta, Iwata, Furukawa) started from Golmud on September 4. After observations in the East Kunlun (6-8 Sep.) and the Tanggula (11-14 Sep.), the party reached Zepu Glacier in the East Nyainqentanglha Mountains on September 23. Glaciological and geomorphological observations were made on Zepu Glacier, Kaqin Glacier and the surrounding area until October 5. The party returned to Golmud on October 12.

3. Research work

3.1 Glaciological research

The glaciological observations in this expedition were made on accumulation, ablation, mass balance, ice temperature, snow pit stratigraphy, glacier flow, fluctuation of glacier terminus and glacier ogive. These studies were mainly carried out on Xiao Dongkemadi Glacier in the Tanggula, Meikuang Glacier on the north slope of the East Kunlun, and Zepu Glacier and Kaqin Glacier in the Nyainqentanglha.

Particular attention was paid to shallow ice core study by the expedition in 1989. The ice cores, 17 m and 14 m long, were obtained at 2 sites on Xiao Dongkemadi Glacier where there is a flat plateau at the head of the glacier. The ice cores were bored by a mechanical drill. The first ice core, 17 m long, was obtained at an altitude of 5800 m a.s.l. Three cavities were found during drilling, at depths of 8-8.5 m, 9.5-10 m and 12-15m. Therefore, we abandoned drilling here. The 14 m long ice core was obtained at an altitude of 5700 m. There was no cavity at this site. Both ice cores were cut into 5-10cm long pieces, then melted and bottled in the field. After being transported back to Lanzhou, analyses were carried out to measure oxygen isotopes, conductivity, PH, anions, cations, dating and net accumulation. The detailed analyses were concentrated on the 14 m long ice core.

3.2 Meteorological and hydrological observations

Observations of meteorology and hydrology were mainly made in the Tanggula. The following items were observed in detail.

1. Variation of snow cover and its effect on heat and water balance
2. Radiative interaction between snow cover and cloud
3. Hydrological characteristics of the permafrost region
4. Evaporation from snow cover and glacier surfaces.

The observations were classified into 3 categories depending on spatial scale:

1) 10^2 km scale: the permafrost region from Nagqu to Wudaoliang along the Qingzang highway. Cars were used for observations once about every 7 days. The main items observed were area of snow cover, amount of precipitation and sampling of precipitation.

2) 10^1 km scale: the main Tanggula Mountain region. Three automatic meteorological stations were established on the south side of Tanggula Pass (D109), the north side of Pass (D105) and at Dongkemadi Base Camp. The observations at the Base Camp and at D109 were stopped on June 12 while the station at D105 continued working.

3) 10^0 km scale: the different altitudes along the Dongkemadi Valley including a glacier. Two temporary stations were set up above the altitude of Base Camp from May to June 1989.

General meteorological observations were made of air temperature, humidity, wind speed, wind direction, solar radiation, ground temperature and precipitation. Hydrological observations in the permafrost area were carried out on river discharge from the glaciers, water level, ground water content, ground water sampling, pressure head, ground water level, evaporation and so on.

3.3 Chemical elements of fresh snow over Qingzang Plateau

To study the spatial and temporal variations of environment and climate parameters, fresh snow samples were collected to analyze isotopes, conductivity, PH, anions and cations. To study spatial distribution, snow samples were collected in a wide range across Qingzang Plateau along the route shown in Fig. 1. Snow samples were also collected at different altitudes. At the Base Camp in the Tanggula, snow samples were collected to study the temporal variations.

3.4 Glacial evolution history on Qingzang Plateau since the Last Ice Age

Geomorphological and sedimentological works related to glacial history were carried out along the expedition route (Fig. 1), mainly in the Xidatan, Tanggula and Nyainqentanglha. Samples were collected for ^{14}C dating, particle size analyses and pollen analyses.

4. Concluding remarks

At present, the analyses of data and samples are in progress. Details of each observation, and preliminary and basic results are described in the following papers in this expedition report. The results of further analyses will be published separately in the near future.

Reference

1. Li J. et al. (1986): Glaciers in Xizang. Science Press, Beijing, 328pp (in Chinese).