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# Modern glaciers on the south slope of West Kunlun Mountains (in Aksayqin Lake and Guozha Co Lake drainage areas)*

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**Abstract**

In this region, there are 262 glaciers, of total area 1277.17km², which makes up 18.7 per cent of the total inland drainage area on the Qingzang plateau. The snow line is between 5700m and 6120m above sea level. The annual mean air temperature near the snow line is −13.9℃, the annual precipitation is about 300mm. The air temperature is the lowest in the whole Qingzang Plateau. The flat−top glacier is an important glacial type. The Guliya Flat−Top Glacier is the largest of the flat−top glaciers in this region. The area on the south slope is 119.33km² and the mean thickness is 212m. The area of glacier accumulation is large. The AAR value of most glaciers is above 0.7. The glaciers fluctuate within a narrow range, with a slow rate of advance and retreat. The retreat rate of the Chongce Flat−Top Glacier fluctuation is not clear. But the Guoza Glacier and Litian Glacier have been advancing.

## 1. Introduction

The south slope of the West Kunlun Mountains is situated on the northern Qinghai−Xizang Plateau(70° 48'−81°55'E, 34°40'−35°48'N) with very high terrain, bad climate conditions. Almost no data are available on the area, since no people live there. Investigations of glaciers in the region were carried out by a Sino−Japanese Joint Scientific Expedition from July to Aug., 1985. The inventory work was done at LIGG. In this paper, the distribution of glaciers in the region is discussed based on those data.

## 2. Conditions for glacier development

West Kunlun Mountains (about 300km long) are part of the Kunlun range (total length is about 2200km), which runs from west to east. The main range is the boundary between Xinjiang and Tibet. Most of the peaks are 6,500m above sea level. The highest summit, Kunlun Peak, is 7,167m above sea level. Modern glaciers are concentrated above 6,000m. From the main range to the south, elevation reduces gradually and relief becomes gentle. No glaciers develop below 5,200m.

The south slope of the West Kunlun Mountains was the typical shape of a plateau surface. Rivers cut down weakly and the valley is wide and shallow. Lakes spread everywhere. Aksayqin lake and Gozha Co Lake are the biggest lakes in this region.

### *2. 1. Precipitation*

The climate on the south slope of the West Kunlun Mountains is very dry and cold. This district is one of the driest on the Eurasian continent, Characterized by an extreme continental climate, which is presumably caused by the natural fence of the Himalaya. As the warm and damp south−west air current flows into the interior of plateau, the precipitation reduces progressively. Precipitation dumped by westerly and north−westerly air currents play an important role in glacier development. Based on weather data surveyed by Kang Xiwa (3986.4m a.s.l.) meteorological observatory and Tian Wendian (temporary) (5243m a.s.l.), the air currents from Jan. to Apr. and from Oct. to Dec. mainly come from the west and south−west. Maximum wind speed is 20−28m/s. From May to September, the sir current

* Zheng Benxing, Li Shude, Zhang Wenjing and Shen Yongping joined the field work.

mainly comes from the north and north-west, which reflects the direction of the valley wind, corresponding to the summer air currents. The maximum wind speed is 17-19m/s. The annual mean relative humidity is 34 %.

The annual mean precipitation was 37.7mm during 22 years at the Kang Xiwa meteorological observatory (1963-1984) and 64.9mm during 2 years at Tian Wendian(1963-1964). The precipitation gradient is 2.2mm/100m, the precipitation near the snow line is 81.6mm/yr. reckoned by the gradient. However, the annual mean precipitation (1964-1970) was 64.7mm at Tongguziluoke hydrographical station (1650m above sea level) by Yulongkashi River in north slope of the Kunlun Mountain and 170.0mm (1964-1968) at Heishan hydrographical station (2750m above sea level). The precipitation gradient is 9.6mm/100m. Using this figure, the annual precipitation near the snow line (5800m) on the north slope is calculated to be 462.8mm, far more than the south slope. This shows that the mountain ridge obstructs the transportation of moisture. Although a difference of precipitation between the south slope and the north exists to a certain extent, the disparity is not large (described below).

It snowed twice in July 1985 at 5200-5700m above sea level, which provided about 3.5mm of precipitation. The relative humidity in July is 51%. The precipitation on the plateau is mainly concentrated in four months, May to August. Figure 1 shows that the maximum precipitation, humidity and temperature were recorded in june, July and August respectively.

Based on the data observed at kang Xiwa weather station, the depth of snowfall was less than 30cm per year during 19 years (from 1962 to 1981). The days of snowfall in the whole year average 82. Most of them were in May, and the least in July and August because of higher temperature in summer. There were usually 18 to 39 days of snowfall in the remaining months. The days of snowfall in 1979-1980 were the most during the 19 years, up to 32 days, and the least in 1973-1974, only 10 days.

In addition, it is necessary to explain that the two weather station in the south slope are far (about 150km) from the region where the field work was carried out in 1985. Much more precipitation was observed in the field in 1985 than at the two stations. The rainfall in the region depends on the lakes near the glaciers to a great extent. The precipitation

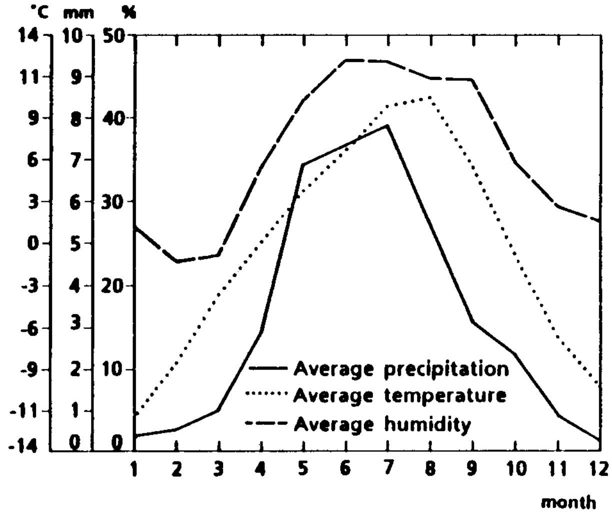


Fig. 1. Monthly variations of temperature, humidity and precipitation.

caused by the local circulation supplements the precipitation caused by the large-scale weather, which is an important condition for glaciers to develop on the driest part of the plateau. The annual precipitation in the glacier areas was estimated at over 300mm. Xiao Shu (1981) pointed out that, although the precipitation in the West Kunlun Mountains is only about 300mm, it is more than that in Taklamagan Desert in the north and also that on the northern Xizang Plateau. This is of great advantage for forming glaciers in the area.

*2. 2. Temperature*

In this region, the annual mean temperature is below -5°C. With increasing elevation, the temperature decreased. The annual mean temperature was - 0.6°C in average for 22 years at kang Xiwa weather station. The highest temperature, 10.3°C, appeared in August and the lowest, - 11.3°C, in November. The annual mean temperature recorded at the weather station at Tian Wendian (5243m above sea level was -9.4°C. The highest temperature, 11.3°C, appeared in August, and the lowest, -26.6°C, in January. The annual mean temperature near the snow line (5900m) may be - 13.9°C reckoned by the lapse rate (0.69°C/100m). Figure 2 shows that the precipitation is large in July when the temperature is low, and *vice versa* (Fig. 2) This was very clear in 1967,1971, 1972, 1973, 1975 and 1983. This trend is of great advantage for developping glaciers.

The annual mean temperature is 11.7°C observed

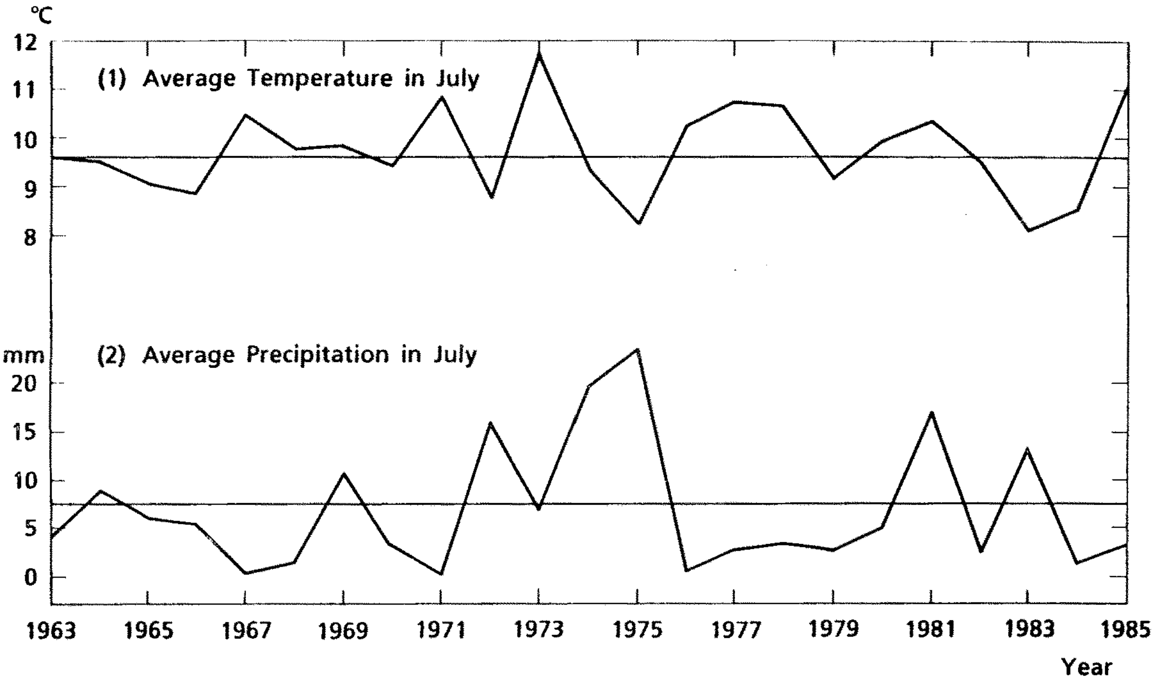


Fig. 2. Average temperature (1) and precipitation (2) in July at Kang Xiwa meteorological station (63–85 years).

at Hetian weather station (1500m above sea level) on the north slope. The annual mean temperature near the snowline (5900m) in north slope may be −14.7℃ estimated with the lapse rate of 0.6℃/100m. This is slightly lower than the annual mean temperature, near the snow line (5600m) of No. 5 glacier at the head of Muzitageyingxue River in the Kunlun Mountains(−11.0℃), near the snow line (5700−5800m) of Mayi Glacier (−10.0℃), and near the snow line (5800m) of Naku Glacier (−9℃) on the Qiang Tang Plateau. The south slope of the West Kunlun Mountains is, hence, where the annual mean temperature is lowest on the plateau.

*2. 3. Topographical conditions*

The mean altitude of the mountains in the region is about 6000m above sea level. The height of peaks is about 7000m above sea level. The relief of the mountain tops is gentle. Tarim Basin lies in the north of the area and Qiangtang Plateau in the south. In the area of the north slope, the difference of height between the foot and the top of the mountain are great, and the valleys are deep and long. on the south slope, on the other hand, river development is less because of the uplift of the plateau as a whole and less precipitation. Weak erosion of the river makes the planation surface well preserved. The high altitude and the distinct topography provide good conditions for developing big valley glaciers, broad tail glaciers and flat−top glaciers.

## 3. The distribution of modern glaciers

The area of glaciers on the south slope of the West Kunlun Mountains is 1277.17km$^2$, which makes up 18.7 percent of the total area of the glaciers in the inland drainage on the plateau (Zhang and Jiao, 1986). The glaciers mainly distribute on the mountain ridge except for small scale hanging glaciers.

*3. 1. Glacier distribution in different drainages*

There are 262 glaciers in the region. The area of glaciers is 1277.17km$^2$. The number of the glaciers in Guoza Co drainage (the area is about 3500km$^2$) makes up 23.7 per cent of the total number, and 76.3 percent in Aksayqin lake drainage (the area is about 16000 km$^2$). Though scale of Guoza co drainage is small and the number of glaciers is less, the area of glaciers are up to 42.6 percent, and 57.4 percent in the Aksayqin lake drainage. The average area of individual glaciers is 4.87 km$^2$, and the altitude of the snow line from 5700 to 6120m, maximum and mini-

Table 1. Glaciers of drainage areas on the south slope of West Kunlun Mountains

| Name of river | Coding | Number | | Area | | Reserves | | Average area ($km^2$) | Altitude of Snow line (m) | Altitude end | | Max. Gl. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Num. | % | $km^2$ | % | $km^3$ | % | | | Max. m | Min. m | $km^2$ | km | + m | − m | Number |
| Guozhacobeihe | 5Z431A | 2 | 0.8 | 10.45 | 0.8 | 0.7945 | 0.4 | 5.23 | - | 5590 | 5520 | 5.37 | 4.8 | | | 5Z431A1 |
| Tianshui River | 5Z431B | 15 | 5.8 | 108.40 | 8.5 | 12.0471 | 5.3 | 7.23 | 5820-5920 | 6020 | 5390 | 33.47 | 13.1 | 610 | 530 | 5Z431B14 |
| Chongcebingchuanhe | 5Z431C | 30 | 11.5 | 413.28 | 32.4 | 78.8492 | 34.4 | 13.78 | 5860-6120 | 6090 | 5320 | 163.06 | 28.7 | 783 | 800 | 5Z431C1 |
| Guozhaconan He | 5Z431D | 6 | 2.3 | 2.26 | 0.2 | 0.0541 | 0.0 | 0.38 | | 5640 | 5520 | 0.68 | 1.1 | | | 5Z431D4 |
| Guozhacoxinan He | 5Z431E | 9 | 3.4 | 9.95 | 0.8 | 0.5350 | 0.2 | 1.11 | | 5870 | 5440 | 3.38 | 3.6 | | | 5Z431E8 |
| Aksayqinbei He | 5Z433A | 8 | 3.1 | 17.87 | 1.4 | 1.4821 | 0.6 | 2.23 | 6070-6080 | 6000 | 5540 | 8.97 | 6.5 | 388 | 500 | 5Z433A8 |
| Quanshui River | 5Z433B | 48 | 18.3 | 86.25 | 6.8 | 8.8791 | 3.9 | 1.80 | 5700-5935 | 6080 | 5440 | 30.64 | 10.8 | 526 | 390 | 5Z433B47 |
| Bingshui River | 5Z433C | 38 | 14.5 | 322.74 | 25.3 | 58.3493 | 25.4 | 8.49 | 5875-5960 | 6120 | 5360 | 113.80 | 20.5 | 781 | 580 | 5Z433C27 |
| Litian River | 5Z433D | 22 | 8.4 | 277.40 | 21.7 | 67.4239 | 29.4 | 12.62 | 5910-5965 | 6240 | 5400 | 241.00 | 23.4 | 992 | 565 | 5Z433D8 |
| Xinxing Lake | 5Z433E | 4 | 1.5 | 2.82 | 0.2 | 0.1017 | 0.0 | 0.71 | | 5820 | 5600 | 1.32 | 1.8 | | | 5Z433E4 |
| Wuming River | 5Z433F | 9 | 3.4 | 1.66 | 0.1 | 0.0337 | 0.0 | 0.18 | | 5900 | 5650 | 0.55 | 1.2 | | | 5Z433F9 |
| Qiazhilegudi | 5Z433J | 10 | 3.8 | 1.80 | 0.1 | 0.0326 | 0.0 | 0.18 | | 5820 | 5510 | 0.47 | 1.0 | | | 5Z433J10 |
| Jianshui Lake | 5Z433L | 10 | 3.8 | 8.75 | 0.7 | 0.4006 | 0.2 | 0.88 | | 6100 | 5510 | 2.91 | 2.1 | | | 5Z433L9 |
| Kushui Lake | 5Z433K | 20 | 7.6 | 4.37 | 0.3 | 0.1194 | 0.1 | 0.22 | | 6080 | 5580 | 1.39 | 2.1 | | | 5Z433K10 |
| Quanshui Lake | 5Z433M | 5 | 1.9 | 1.31 | 0.1 | 0.0254 | 0.0 | 0.26 | | 6200 | 5650 | 0.41 | 1.1 | | | 5Z433M1 |
| Hongshan Lake | 5Z433N | 26 | 9.9 | 7.52 | 0.6 | 0.1859 | 0.1 | 0.29 | | 6000 | 5560 | 1.12 | 1.4 | | | 5Z433N9 |
| Total | | 262 | 100 | 1277.17 | 100 | 229.3136 | 100 | 4.87 | 5700-6120 | 6240 | 5320 | 241.00 | 23.4 | 992 | 565 | 5Z433D8 |

mum altitudes of glacier ends 6240m and 5320m respectively in this region (Table 1).

### *3. 2. Snow line elevation*

The snow line elevation is influenced not only by precipitation and temperature, but also by topography. The snow line is very high in this region, generally 5700−6120m a.s.l., higher in the east and west than in the middle (Fig. 3). The lowest point was found at Quanshui Gou Glacier (5700m a.s.l.), and the highest at Aksayqin No.2 Glacier (6080m a.s.l.) and chongce Glacier (6120m a.s.l.). Chongce Glacier is a valley glacier. It flows from the west in part, which influences the snow line elevation: 5900m a.s.l. at some locations. The snow line elevation is higher on the south slope than on the north slope.

### *3. 3. The scale of the glaciers*

The length range with the largest number of glaciers is less than 0.5km (Table 2). The longer the glacier length, the more the number of the glaciers in that range and the more the area (except for 25.1−30.0 km). The longest glacier in the region is 5Z431C1 (Chongce Glacier) in Guozaco Basin, which is 28.7 km long and 163.06 $km^2$ in area.

The number of glacier (5Z433D8) in Aksayqin Lake basin, its area is 241.00 $km^2$ and length 23.4 km.

### *3. 4. Orientation of the glaciers*

The glacial orientation is the direction of slopes

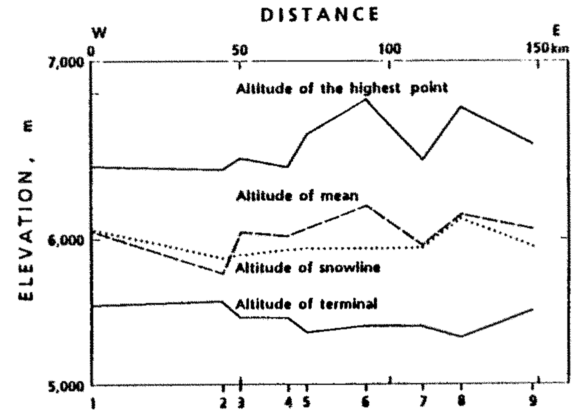


Fig. 3. Highest points, mean heights, snow line and termini of glaciers on the south slope of West Kunlun Mountains.

where glacier is located. Table 3 shows that 49.6 percent of all the glaciers lie on northwest, north and northeast−facing slopes, although their area is only 8.8 percent, and the reserves are 3.7 percent. 32.8 percent of the glaciers face, southwest, south and southeast, and their area and ice reserves are 87.3 percent and 94.5 on south facing slopes in this area.

### *3. 5. Type of glaciers*

Several types of glaciers can be seen in the region such as hanging glacier, cirque−hanging glacier, cirque glacier, cirque−valley glacier, valley glacier, slope−surface glacier and flat−top glacier (Table 4). The hanging glacier reserves form 75.2 percent of the total, which is larger than Altai (64.9%) (Liu Chaohai *et al.*, 1982), Qilian Shan (50%) (Wang Zongtai *et*

Table 2. Grades of length, areas of glacier on the south slope of West Kunlun Mountains

| Length | Number | | Area | | Reserves | | Average Area | Area | Number | | Area | | Reserves | | Average Area |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| km | Num. | % | km² | % | km³ | % | km² | km² | Num. | % | km² | % | km³ | % | km² |
| - 0.5 | 87 | 33.2 | 8.69 | 0.7 | 0.1273 | 0.1 | 0.1 | 0.01- 0.5 | 167 | 63.7 | 35.05 | 2.7 | 0.5779 | 0.3 | 0.2 |
| 0.6- 1.0 | 79 | 30.2 | 24.62 | 1.9 | 0.5554 | 0.3 | 0.3 | 0.51- 1.0 | 27 | 10.3 | 18.56 | 1.5 | 0.5550 | 0.2 | 0.7 |
| 1.1- 2.0 | 43 | 16.4 | 35.78 | 2.8 | 1.2493 | 0.6 | 0.8 | 1.01- 2.0 | 22 | 8.3 | 29.11 | 2.3 | 1.2429 | 0.5 | 1.3 |
| 2.1- 5.0 | 33 | 12.6 | 128.08 | 10 | 9.6684 | 4.2 | 3.9 | 2.01- 5.0 | 16 | 6.1 | 46.88 | 3.7 | 2.9126 | 1.3 | 2.9 |
| 5.1-10.0 | 11 | 4.2 | 163.25 | 12.8 | 18.1852 | 7.9 | 14.8 | 5.01-10.0 | 12 | 4.6 | 81.97 | 6.4 | 6.9157 | 3.0 | 6.8 |
| 10.1-15.0 | 3 | 1.1 | 183.44 | 14.3 | 34.2150 | 14.9 | 61.1 | 10.01-15.0 | 3 | 1.1 | 36.68 | 2.8 | 3.7321 | 1.6 | 12.2 |
| 15.1-20.0 | 3 | 1.1 | 215.45 | 16.9 | 39.5078 | 17.2 | 71.8 | 15.01-20.0 | 4 | 1.5 | 73.38 | 5.7 | 8.5236 | 3.7 | 18.3 |
| 20.1-25.0 | 2 | 0.8 | 354.80 | 27.8 | 87.6492 | 38.2 | 177.4 | 20.01-30.0 | 2 | 0.8 | 43.29 | 3.4 | 5.3258 | 2.3 | 21.6 |
| 25.1-30.0 | 1 | 0.4 | 163.06 | 12.8 | 38.1560 | 16.6 | 163.1 | 30.01-40.0 | 2 | 0.8 | 64.11 | 5.0 | 8.9170 | 3.9 | 32.0 |
| | | | | | | | | 40.01-50.0 | 1 | 0.4 | 46.05 | 3.6 | 7.2299 | 3.2 | 46.1 |
| | | | | | | | | 80.01-90.0 | 2 | 0.8 | 169.4 | 13.2 | 32.278 | 14 | 84.7 |
| | | | | | | | | 100.01-150 | 2 | 0.8 | 233.13 | 18.2 | 49.082 | 21 | 116.6 |
| | | | | | | | | 150.01-200 | 1 | 0.4 | 163.06 | 12.7 | 38.156 | 17 | 163.1 |
| | | | | | | | | 200.01-300 | 1 | 0.4 | 241.0 | 18.8 | 63.865 | 28 | 241.0 |
| Total | 262 | 100 | 1277.17 | 100 | 229.3136 | 100 | 4.9 | Total | 262 | 100 | 1277.17 | 100 | 229.3136 | 100 | 4.87 |

Table 3. Orientations of glacier on the south slope of West Kunlun Mountains.

| Orientation | Gl. Number | | Gl. Area | | Gl. Reserves | | Glaeier Seale | | | | | | Altitude of end (m) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | mean area | Max. Gl. | | | | | | |
| | Num. | % | km² | % | k m³ | % | km² | km² | km | + | − | Num. | Max. | Min. |
| NW | 47 | 17.9 | 53.85 | 4.2 | 4,2789 | 1.9 | 0.87 | 21.09 | 8.3 | 408 | 495 | 5Z433B33 | 6000 | 5440 |
| N | 60 | 22.9 | 47.67 | 3.7 | 3.4303 | 1.5 | 0.79 | 18.47 | 6.0 | | | 5Z431B8 | 6000 | 5460 |
| NE | 23 | 8.8 | 12.15 | 0.9 | 0.5449 | 0.3 | 0.52 | 3.80 | 3.3 | | | 5Z431B4 | 5900 | 5440 |
| E | 27 | 10.3 | 27.61 | 2.2 | 2.5003 | 1.1 | 1.02 | 19.29 | 8.7 | 647 | 400 | 5Z431C15 | 6000 | 5500 |
| SE | 26 | 9.9 | 312.82 | 24.5 | 55.5422 | 24.2 | 12.03 | 163.06 | 28.7 | 783 | 800 | 5Z431C1 | 6100 | 5320 |
| S | 40 | 15.3 | 560.83 | 43.9 | 116.7991 | 50.9 | 14.02 | 241.00 | 23.4 | 992 | 565 | 5Z433D8 | 6200 | 5360 |
| SW | 20 | 7.6 | 240.88 | 18.9 | 44.5719 | 19.4 | 12.04 | 119.33 | 12.4 | | | 5Z431C22 | 6240 | 5450 |
| W | 19 | 7.3 | 21.36 | 1.7 | 1.6460 | 0.7 | 1.12 | 9.75 | 6.1 | 412 | 360 | 5Z431C27 | 6120 | 5520 |
| Total | 262 | 100 | 1277.17 | 100 | 229.3136 | 100 | 4.87 | 241.0 | 23.4 | 992 | 565 | 5Z433D8 | 6240 | 5320 |

Table 4. Glaciers types on the south slope of West Kunlun Mountains

| Type | Number of Glaciers | | | | | | | | | | Glacial Area | | Glacial Reserve | | Glacial Scale | | Altitude of end | | mean altitude of snwline |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | NE | E | SE | S | SW | W | NW | Total | % | km² | % | km³ | % | Average km² | Max. km² | Max. m | Min. m | m |
| Han.Gl. | 52 | 20 | 25 | 12 | 25 | 11 | 16 | 36 | 197 | 75.2 | 56.79 | 4.5 | 1.3930 | 0.6 | 0.29 | 2.07 | 6240 | 5510 | |
| Cir.-Han.Gl. | 1 | | | | 2 | 1 | | 1 | 5 | 1.9 | 4.12 | 0.3 | 0.1676 | 0.1 | 0.82 | 1.26 | 6000 | 5580 | |
| Cirque Gl. | 5 | 3 | | 3 | 7 | 1 | 2 | 9 | 30 | 11.5 | 92.70 | 7.3 | 6.9948 | 3.0 | 3.09 | 19.24 | 5800 | 5440 | 5700-5960 |
| Cir.-Val.Gl. | | | | 3 | | | | | 3 | 1.1 | 22.52 | 1.8 | 2.0136 | 0.9 | 7.51 | 12.07 | 5590 | 5520 | |
| Valley Gl. | 1 | | 2 | 6 | 6 | 5 | 1 | 1 | 22 | 8.4 | 932.48 | 73.0 | 188.0712 | 82.0 | 42.39 | 241.00 | 5730 | 5320 | 5800-6120 |
| Slope Gl. | | | | | | 1 | | | 1 | 0.4 | 1.39 | 0.1 | 0.0473 | 0.0 | 1.39 | 1.39 | 5800 | 5800 | |
| Flat-Top Gl. | 1 | | | 2 | | 1 | | | 4 | 1.5 | 167.17 | 13.0 | 30.6261 | 13.4 | 41.79 | 119.33 | 5720 | 5500 | 5900 · |
| Total | 60 | 23 | 27 | 26 | 40 | 20 | 19 | 47 | 262 | 100 | 1277.17 | 100 | 229.3136 | 100 | 4.87 | 241.00 | 6240 | 5320 | 5700-6120 |

*al.*, 1981), or Swiss Alps (42.0%) (Müller, *et al.* 1976). The areas of the glaciers and their reserves, however, are only 4.5 percent and 0.6 percent respectively, since the hanging glacier is the smallest in mean area (0.29 km²). The valley glaciers are the largest (42.39 km²), but their number is only 8.4 percent, the glacial area and reserves are 73.0 percent and 82.0 percent respectively. Thus it can be seen, the hanging glaciers are characteristic of glaciation in the region, but valley glaciers have most of the area and ice reserves (Fig. 4).

The distribution of glacier types is not the same in every drainage basin. Hanging glaciers in Aksayqin lake drainage (82%) are more than in Guoza co Lake drainage (18%). The number of hanging glaciers decreases from west to east, except for the main

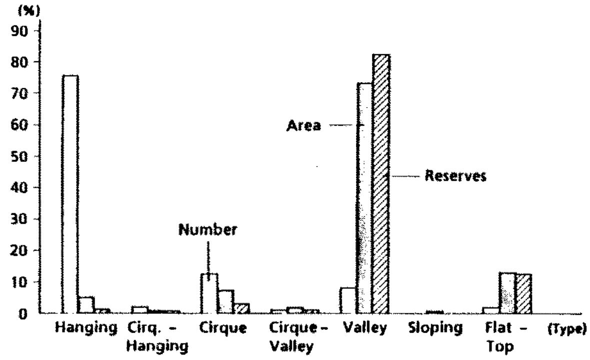


Fig. 4. Number, area and reserves of different types of glacier.

mountain ranges north of Aksayqin Lake and Guoza Co lake, all the glaciers west and south of the lakes are hanging and cirque—hanging glaciers. Valley glaciers, cirque—valley glaciers and flat—top glaciers are distributed mainly in the high peak regions of Aksayqin lake and Guoza Co lake. Cirque glacier are 11.5% of the total and their area 7.3%. Many valley glaciers and flat—top glaciers are developed in this area. Zhongfeng Glacier in the Litian River—Aksayqin Lake drainage is the largest in the region. The biggest glacier in China can be seen in the area, its area is 119.33 km$^2$ on south slope only, and its area is 376.00 km$^2$ (Zheng Benxing, 1986) when all the slopes are taken into account. This glacier, called Guliya flat—top glacier, forms in Chongce Glacial River (No. 5Z431C22) of Guoza Co lake drainage on the south slope of the main range.

*3. 6. Character of glaciers larger than 100 km$^2$*

There are 18 glaciers larger than 10 km$^2$ in the West Kunlun Mountains, but only 4 glaciers have on area larger than 100 km$^2$: 5Z431C1, 5Z431C22, 5Z433C27 and 55Z433D8 (Table 5).

Chongce Glacier (5Z431C1), is a valley glacier 163.06 km$^2$ in area. Its melt water flows into Guoza Co Lake. We found that the glacier has retreated by 200—300 m from a small ice age terminal moraines. The ablation area of this glacier is 24.4 km$^2$. The AAR accumulation area rate, namely AAR= accumulation area/total area) is about 0.85 ; the glacier has a large accumulation area.

Guliya flat—top glacier (5Z431C22), is 119.33 km$^2$ in area, has 25.2980 km$^3$ ice reserves, and its average ice thickness is about 212 m (it is estimated from $H=-11.32+53.21F^{0.3}$ E: mean thickness, F: glacier area, Liu Chachai *et. al*, 1986). The glacier lies in the main range of the West Kunlun Mountains. Its flat—top part is mainly on south slopes, its valley glacier part on northern slopes. Its whole area is 376 km$^2$ ; if valley glaciers and an ice flow tongue in the north slope are excluded, the area is 138.26 km$^2$. It discharges into Guoza Co lake and Wulayingker Lake. The glacier is 12.4 km long and 11.0 km wide ; the ratio (width/length) is 0.9, snow line lies at 5,900m a.s.l. ; the ice tongue is short and wide. Its AAR should be larger than that of valley glaciers

Table 5. Glaciers over 10 km$^2$ on the South Slope of West Kunlun Mountains

| Name of River | Gl. Num. | Glacial Name | Seat | | Area | | Mean Wid. | Len-th | Ac-cu. | Altitude (m) | | | Glacial Type | Snow Line | Thic-kness | Reserves |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | N | E | Total km$^2$ | ablat. km$^2$ | km | km | | Max. | Mean | End | | (m) | (m) | (km$^2$) |
| Tianshui River | 8 | | 35°09.90′ | 80°55.48′ | 18.47 | | 2.9 | 6.0 | N | 6388 | 5950 | 5510 | Flat-Top Gl. | | 116 | 2.1425 |
| Tianshui River | 9 | | 35°13.20′ | 80°55.87′ | 12.99 | | 4.2 | 3.1 | SE | 6164 | 5920 | 5680 | Flat-Top Gl. | | 104 | 1.3510 |
| Tianshui River | 11 | | 35°14.72′ | 80°59.71′ | 12.07 | | 2.5 | 4.2 | SE | 6403 | 6020 | 5590 | Cir.-Val. Gl. | | 101 | 1.2191 |
| Tianshui River | 14 | Guozha Gl. | 35°15.47′ | 81°04.26′ | 33.47 | 9.57 | 2.8 | 13.1 | S | 6530 | 5960 | 5390 | Valley Gl. | 5920 | 141 | 4.7193 |
| Tianshui River | 15 | Chongce Fl. Top | 35°14.39′ | 81°07.10′ | 16.38 | | 3.0 | 5.4 | SE | 6370 | 6050 | 5720 | Flat-Top Gl. | 5900 | 112 | 1.8346 |
| Chongce Gl. Riv. | 1 | Chongce Gl. | 35°16.93′ | 81°12.75′ | 163.06 | 24.40 | 4.8 | 28.7 | SE | 6903 | 6160 | 5320 | Valley Gl. | 6120 | 234 | 38.1560 |
| Chongce Gl. Riv. | 8 | Dongchongce Gl. | 35°19.49′ | 81°10.97′ | 46.05 | 16.46 | 2.8 | 16.2 | SE | 6810 | 6190 | 5460 | Valley Gl. | 6100 | 157 | 7.2299 |
| Chongce Gl. Riv. | 12 | | 35°18.54′ | 81°14.74′ | 11.62 | 3.56 | 1.8 | 6.8 | SE | 6489 | 6040 | 5590 | Valley Gl. | 6000 | 100 | 1.1620 |
| Chongce Gl. Riv. | 15 | | 35°19.46′ | 81°17.93′ | 19.29 | 5.75 | 2.3 | 8.7 | E | 6547 | 6060 | 5500 | Valley Gl. | 5900 | 118 | 2.2785 |
| Chongce Gl. Riv. | 22 | Guliya Fl. Top | 35°16.43′ | 81°27.55′ | 119.33 | | 11.0 | 12.4 | SW | 6667 | 6080 | 5500 | Flat-Top Gl. | | 212 | 25.2980 |
| Chongce Gl. Riv. | 30 | | 35°24.27′ | 81°49.96′ | 19.24 | 3.96 | 3.0 | 6.1 | S | 6287 | 5980 | 5660 | Cirque Gl. | 5860 | 118 | 2.2703 |
| Quanshui River | 33 | | 35°29.71′ | 80°20.96′ | 21.09 | 8.74 | 2.9 | 8.3 | NW | 6343 | 5920 | 5440 | Valley Gl. | 5935 | 122 | 2.5730 |
| Quanshui River | 47 | Quanshuigo Gl. | 35°26.90′ | 80°23.59′ | 30.64 | 6.97 | 3.2 | 10.8 | S | 6386 | 5970 | 5470 | Valley Gl. | 5860 | 137 | 4.1977 |
| Bingshui River | 5 | Duota Gl. | 35°25.19′ | 80°28.68′ | 87.08 | 17.83 | 6.2 | 16.2 | SW | 6546 | 6050 | 5450 | Valley Gl. | 5875 | 192 | 16.7194 |
| Bingshui River | 20 | Duongduota Gl. | 35°22.00′ | 80°35.93′ | 82.32 | 19.97 | 6.6 | 15.6 | S | 6498 | 6020 | 5440 | Valley Gl. | 5927 | 189 | 15.5585 |
| Bingshui River | 27 | Guongxing Gl. | 35°18.38′ | 80°39.19′ | 113.80 | 33.24 | 6.5 | 20.5 | S | 6721 | 6090 | 5360 | Valley Gl. | 5940 | 209 | 23.7842 |
| Litian River | 4 | Litian Gl. | 35°13.35′ | 80°46.25′ | 22.20 | 5.30 | 2.2 | 10.0 | SE | 6433 | 5950 | 5400 | Valley Gl. | 5910 | 124 | 2.7528 |
| Litian River | 8 | Zh ongfeng Gl. | 35°16.94′ | 80°54.32′ | 241.00 | 57.71 | 12.4 | 23.4 | S | 6957 | 6230 | 5400 | Valley Gl. | 5965 | 265 | 63.8650 |

in this region because the flat-top glacier lies high and effective accumulation is larger.

Gongxing Glacier (5Z433C27), a valley glacier, is 113.80 $km^2$ in area, 20.5 km in average length and 209m in average ice thickness. Its ice reserves are 23.7842 $km^3$. The glacier flows into Aksayqin Lake through Qiongbingshui River ; the glacier has two main U-shaped ice streams ; its ablation area is 33.24 $km^2$, and AAR is 0.71.

Zhongfeng Glacier (5Z433D8), is a valley glacier ; its area is 241.00 $km^2$, length 23.4 km, average ice thickness 265m, ice reserves 638,650 $km^3$. It lies on the south slope of the main range. It discharges into Aksayqin Lake through the Litian Liver and forms the main part of Aksayqin Lake water. The glacier has 4 ice tongues which are short, but wide. Its average width is 12.4 km. We found many ice-sculptured pyramids on the ice tongues. This glacier has retreated 250-300m during the past 15 years : the retreat rate is 16-20 m/year. The ablation area is 57.71 $km^2$, AAR is approximately 0.76.

These glaciers are larger in area, and their AAR values are bigger than those for normal valley glaciers. The formation of the glaciers is due to the heavy accumulation in this region.

## 4. Variations of glaciers

Whether the flow velocities, ice thickness, and snow line elevations of the glaciers are increasing or decreasing and whether their termini advance or retreat result from the variation of their mass balance, which is caused by temperature and precipitation variations. Such glacier variations are less frequent in this region than for other glaciers in Chine. In other words, these glaciers are relatively stable.

Comparing the topographical map (1 : 100,000) made by aerial photogrammetry with the field observations in 1985, it is considered that two glaciers in this region are retreating, since, the terminal ice-sculptured pyramid of Zhongfeng Glacier have taken away from main part of the glacier. Hot springs in the west part of the ice tongue caused the glacier to retreat faster than that the east part. Another example can be seen in Chongce valley glacier. It has also retreated as ice-sculptured pyramids have taken away from the main part of the glacier, leaving retreating moraines at the terminus of its ice tongue. Also, Zhongce flat-top glacier has been retreating. Its ice tongue becomes thin, forming moraines, which can be seen 14-30m away from the ice tongue terminus, although the variations of this glacier are not clear on an Y aerial photograph taken in 1970.

These are the examples of retreating glaciers found in our expedition. Advancing glaciers, however, were also found, such as Litian Glacier. Its snout advanced by 10m during 1970-1985. Another example is Guoza Co Glacier. Since there is no moraine around the glacier, the ice tongue would have been advancing. Prof. Zheng Benxing (private communication) concluded that Quan Shuigou gust 1976, and that Bing Shuigou Glacier had also advanced 9.6m during the same period at a rate of 1.2m/year.

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