GLACIATED TOPOGRAPHY IN THE KANBÔ MASSIF, TYÔSEN (KOREA)

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With 2 Plates and 11 Text-figures

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INTRODUCTION

So far as has been hitherto known, traces of past glaciation in the Japanese Islands have been recognised only in the highest mountain districts such as the Central Mountain Range in Taiwan (Formosa), the Japanese Alps in the central part of Honsyû (Main Island of Japan) and the Hidaka Mountain Range in Hokkaidô. Accordingly, the existence of glaciated remains is naturally expected in the northernmost high mountain district in Tyôsen (Korea). It has often been noticed by mountaineers in recent years that glacial topographies do exist in the Hôtaisan Group, and also in the Kanbô Massif, the highest mountain in Tyôsen.

Remarkable landscape resulting from glaciation in the latter massif was first recognised by Prof. K. TAKENAKA of the Tyôsen Sangakukai (Korean Alpine Club) in the summer of 1932. Afterwards the vicinity was visited by a few investigators such as Prof. H. TADA of the Tôkyô Imperial University, Mr. K. KOZIMA of the Kyôto Imperial University and Mr. T. KANO of the Tôkyô Imperial University, but no official report was made available before Mr. T. KANO presented an account of the subject very recently.** The pre-

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** Tadao KANO: Glacial Topography of the Mountains of Northeastern Korea (in Japanese with English Résumé). Geographical Review of Japan. Vol. 13, No. 12, pp. 1124–1143. Dec., 1937.

sent authors, also, had occasion to climb the massif in the summer of 1937 and spent a few days on the ridges, searching for traces of former glaciation. The following is a summary of the present writers' notes on their observations, written by Y. SASA and revised by K. TANAKA, with considerations on some problems.

The authors wish to make grateful acknowledgments to Professors K. TAKENAKA and H. TADA and also to Mr. R. SAITÔ of the Tyôsen Sangakukai for their useful suggestions and criticisms in the course of their study. Hearty thanks are also due to Mr. S. IZUMI of the Tyôsen Sangakukai for the use of his fine illustrations in this paper. They are also indebted to the Nippon Gakuzyutu Sinkôkai (Foundation for the Promotion of the Scientific and Industrial Research of Japan) for financial aid, which enabled them to accomplish their study.

TOPOGRAPHICAL SKETCHES OF THE KANBÔ MASSIF

The Kanbô Massif is situated on the northeastern corner of the so-called Kaima Plateaux in northeastern Tyôsen, about 129°14′ E. longitude and 41°42′ N. latitude. It is built up of gneissose granite masses, accompanied by granitic gneiss, granite porphyry and injection metamorphics, and penetrated by many basaltic extrusives.

Geomorphologically, the massif and the adjacent ranges as a whole represent an upwarped mountain region which has been sculptured almost to full maturity of the erosion cycle, with however, wide areas of small relief erosion surfaces of the former erosion cycle remaining on the ridges (Fig. 1). The back slope of the region gently declines to the west, associated with a few marginal benchlands, while the steeper front faces to the east. The ranges run rather straight from northeastnorth to southwestsouth for as much as 50 kilometers at an altitude of more than 2000 meters, in which the Kanbô Massif itself is nothing but the culminating portion of the whole range.

In describing the massif, it conveniently may be subdivided into two, the eastern and western ranges (Fig. 2). Several peaks are found in each range, namely, enumerated from north to south, Kita-kanbôhô (2334.4 m), Naka-kanbôhô (ca 2440.0 m), Kanbô-syuhô (Main peak, 2540.9 m), Minami-kanbôhô (ca 2360.0 m), Hakubahô

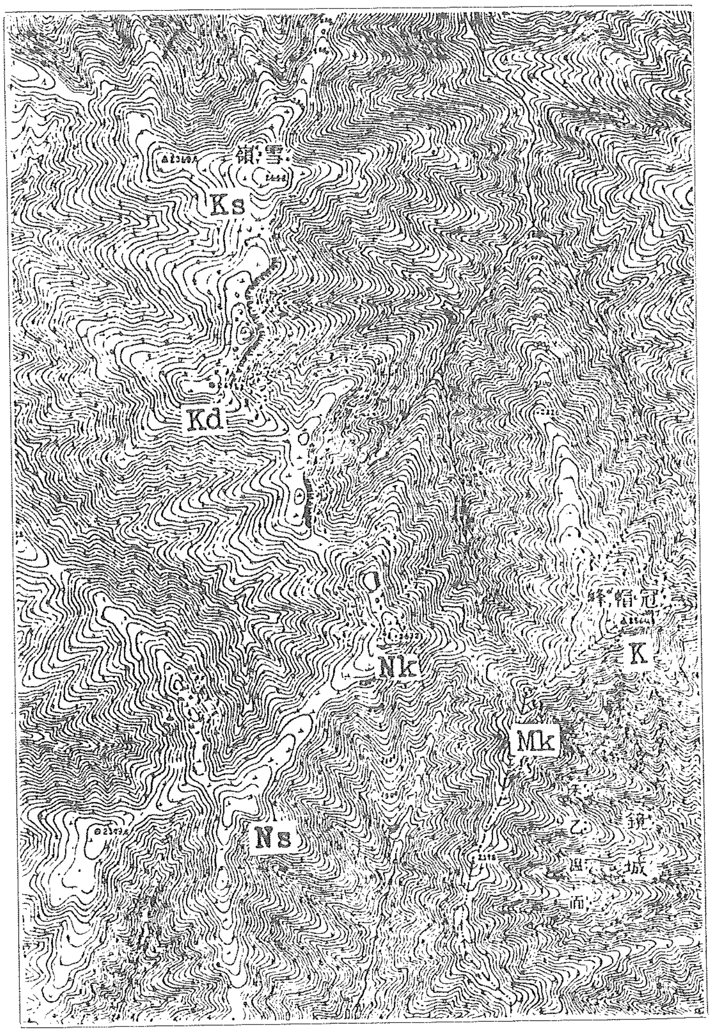

Fig. 1. Topographical map of the main part of the Kanbô Massif. The wide flat-topped ridges are well represented. The cirques are indistinctly drawn. (Scale; 1 : 75000. Contour interval: 20m. Reproduced from sheet Kanbôhô. 1 : 50000, Military Survey Map.)

K.......Kanbô-syuhô.	Mk.......Minami-kanbôhô.
Ks......Kita-seturei.	Kd.......Kôdaihô.
Nk. ....Nisi-kanbôhô.	Ns.......Naka-seturei.

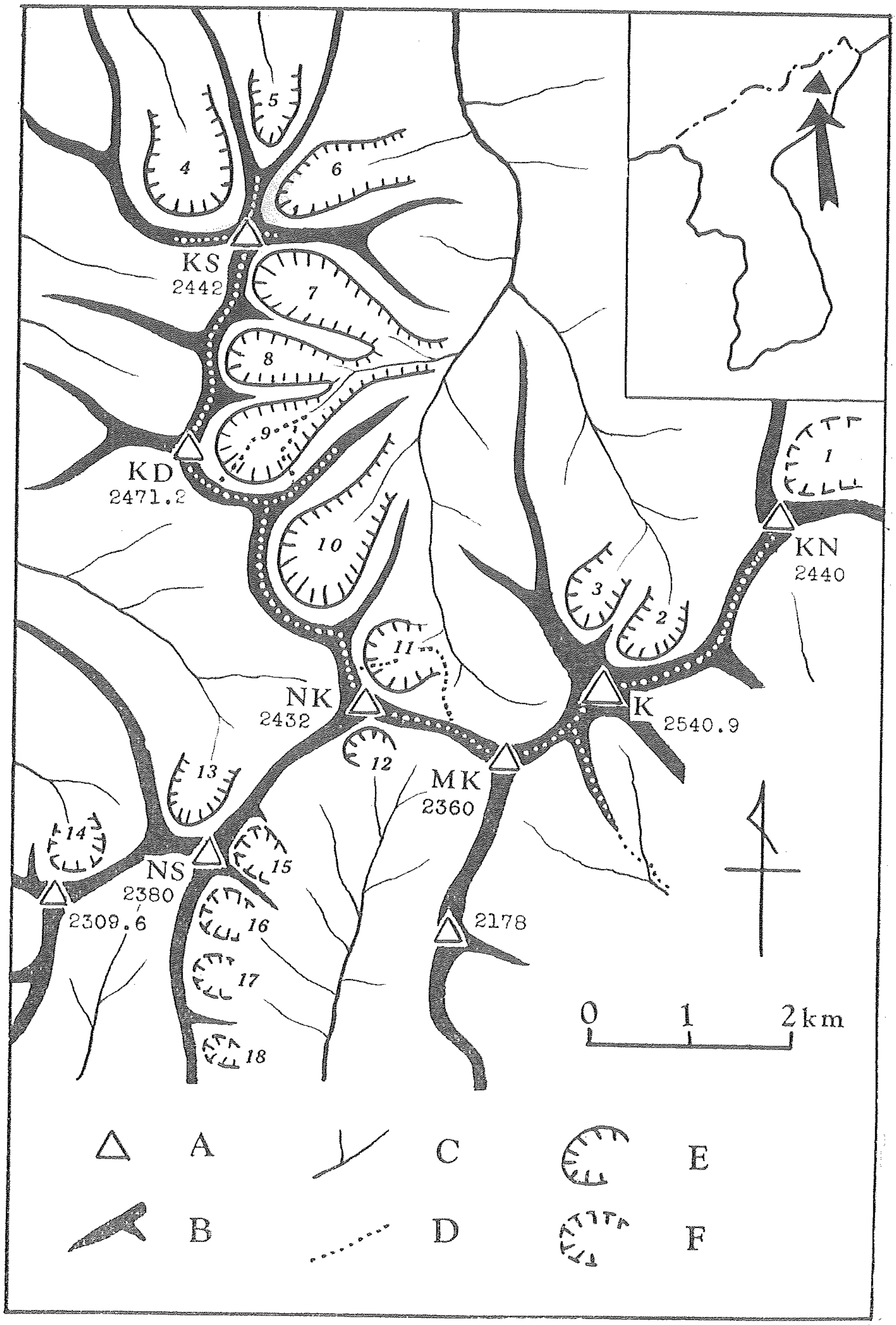

Fig. 2. Map showing the distribution of the glacial topography in the Kanbô Massif.

KN....Naka-kanbôhô. K......Kanbô-syuhô. MK....Minami-kanbôhô.
KS. ...Kita-seturei. KD....Kôdaihô. NK....Naka-kanbôhô.
NS. ...Naka-seturei

A......Summit. B.....Ridge. C.....River. D.....Survey route by the authors. E.....Glaciated area. F.....Ditto. (uncertain ones).

(2339.6 m) and Kizanpô (2277.0 m) on the eastern or Kanbô Range. In the western or Seturei Range are found Kita-seturei (2442.0 m), Kodaihô (2471.2 m), Nisi-Kanbôhô (2432.0 m) and Naka-seturei (ca 2380.0 m). The two ranges stretch nearly parallel to each other in a trend from north to south. They are connected at their center between Minami-kanbôhô and Nisi-kanbôhô by a saddle of about 2150 m altitude. There is a contrast between the ranges as the Kanbô Range exhibits round-topped peaks and is deeply incised by valley patterns on the eastern face while the Seturei Range bears rather wide flat-topped areas as above mentioned, the remains of the past peneplains, with gently ascending river beds (Fig. 1, Pl. XVIII (I); Figs. 1 and 2). It is a striking scene, as one approaches the ranges from a considerable distance, to see the series of amphitheatre-like picturesque cirques deeply carved in the mountain sides of the ranges, and it reminds one of the landscape exhibiting a similar kind of sculpturing, at the Snowden District in Wales.

DISTRIBUTION OF THE GLACIAL TOPOGRAPHY

The glacial sculpture of the massif is chiefly represented by the cirques around the ridges, eighteen in number including a few uncertain cirques, and by a very shallow trough (Fig. 2). The cirques are seen almost entirely on the Seturei Range while being very few, only three, on the Kanbô Range. It is also a noticeable fact that nearly all of the cirques are found on the eastern side of the main ridges, with their outlets to the east. Even in the few exceptions that opened northward on the northern mountain sides, projected subordinate ridges or spurs are observable on the western side of the cirques.

The cirques on the Kanbô Range are three in number in which two cirques, No. 2 and No. 3 are situated on the north side of Kanbô-syuhô with northward opened outlets and the remaining No. 1 cirque lies on the north side of Naka-kanbôhô, facing the northeast.

The cirques on the Seturei Range are found mostly to the north of Nisi-kanbôhô. The three cirques No. 4, No. 5, and No. 6 invaded the northern slope of Kita-seturei. The former two open toward the north while the latter one to the northeast. The three cirques No. 7, No. 8 and No. 9 are arranged side by side on the eastern flank of the ridge between Kita-seturei and Kôdaihô, the former two facing eastward and the last northeastward. The two cirques No. 10 and No. 11 face northeast on the eastern side of the ridge between Kôdaihô and Nisi-kanbôhô. One cirque, No. 12 is seen on the eastern face of Nisi-kanbôhô, with a southeastward opening. The remaining six cirques* are scattered around Naka-seturei, of which the two cirques No. 13 and No. 14 are situated on the northern slope with northward outlets and the other four are on the east face of the ridge, facing to the east.

The shallow glacial trough noted above is traceable on the northeastern foot of Kôdaihô, as a downstream extension or prolongation of cirque No. 9, in which the lower outlets of cirques No. 7 and No. 8 coalesce into one as tributaries.

MORPHOLOGY OF THE GLACIAL TOPOGRAPHY

The topographical features of the glacial cirques on the said massif are certainly well preserved though it has suffered slight modification by the weathering in post-glacial time.

Of all the cirques, the four, No. 7, No. 8, No. 9 and No. 10 around Kôdaihô are most typically representative in their sculpture (Fig. 3, Pl. XVIII (I) ; Fig. 1). They also have the largest dimensions. For example, cirque No. 9, just below the summit of Kôdaihô shows a tadpole-like or spoon-like form in plan, elongated and narrowed to the outlet, with a width** of 850 m at the broadest diameter and about 400 m at the outlet, while nearly 1000 m at the elongation. The cirque wall develops very conspicuously, making a sharp contrast with the flat-topped surrounding ridges (Fig. 4, Pl. XVIII (I) ; Fig. 2). The wall is steeper and higher at the western and southwestern head part, exceeding 250 m in height and having an average inclination of 40° to 50° and often nearly 60° at a part of the highest declivity. The wall

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* The existence and nature of cirques Nos. 14–18 were heard from previous investigators but were not examined by the authors themselves who had no opportunity to do so.

** The width of the cirque is measured at a distance between the two upper rims of the cirque wall of the glaciated area in the broadest transversal profile and the length is estimated from the uppermost border of the cirque head to the lowest end along the longest extention. The altitude of the cirque floor is measured in almost all cases by an aneroid barometer approximately at the lower end of the floor, though it was often rather hard to settle that position because of the undulating surfaces.

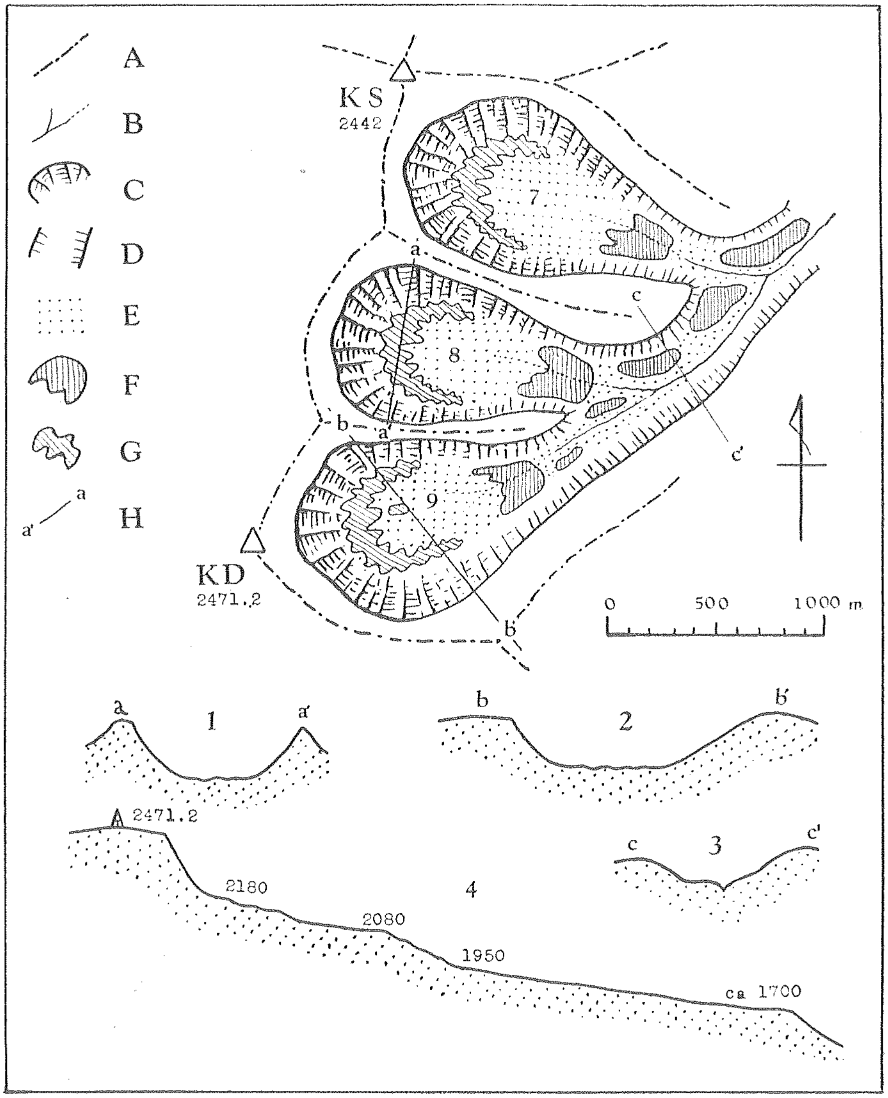

Fig. 3. Sketch map of cirques Nos. 7, 8 and 9.

KS..Kita-seturei. KD..Kôdaihô.

A..Ridge. B..River. C..Cirque wall. D..Glacial trough-like valley.
E..Cirque floor. F..Moraine. G..Talus. H..Profile line.

1. Transversal profile of cirque No. 8 along aa′.
2. Transversal profile of cirque No. 9 along bb′.
3. Transversal profile of trough-like valley along cc′.
4. Longitudinal profile of cirque No. 9 along its elongation.

is represented by many rocky riblets or narrow buttresses and with many rinnes or gulleys, frequently revealing slab-like smooth rock surfaces at the foot (Fig. 10). On the other hand, the wall at the southern part of the cirque gradually transits, decreasing as to inclination and height compared with the western head part and merging into the form of a normally eroded slope at the eastern wall, with about 30° to 40° average inclination, still showing, however, a rather cliffy, concave slope. Therefore, a diagonal section of this cirque has an assymmetrically U-shaped profile, being steeper at the northwestern lateral wall and gentler at the southwestern side (Fig. 3). The floor of this No. 9 cirque is horse-shoe form in outline surrounded by the steep wall. It has a breadth of nearly 500 m and a length of 700 m, narrowing to 350 m in width at the outlet. The floor, generally speaking, exhibits a wide flat area with a gentle slope of 10° to 20° average inclination downwards, but upon closer view it is found to possess a wavy, rolling surface, covered with many morainic drifts and other rock wastes, among which are scattered many huge erratic blocks. The portion of the wall junctional to the floor, at about 2180 m altitude, seems to have been abrupt at the time of formation, is now rather smoothly transitional, being covered by many talus-cones at the foot of the wall (Figs. 5 and 10). It is usual, at the upper part of the floor, that there occur several morainic heaps, ovate- or tongue-form in outline, with a height of about 10 m and often of 20 m at the downward front. They are evidently in part nivation debris and mainly the product of rock-streams from the surrounding wall, as may be judged from their positions and forms (Fig. 5). The moraines of this cirque are found at the outlet where it transforms into the lower trough. The moraines are round-topped tongue-like hills or ovate mounds of about 10 m to 20 m in height, often exceeding 30 m at the frontal outside (Fig. 6). They present as a whole a wavy or rolling hummocky landscape. The lateral moraines occur as a few rows elongating downstreamward and the terminal moraines have overflown into the trough, overlapping each other in many steps, in which the upper part of the morainic hills are at a height of approximately 2080 m above sea level. Since the ravines have cut through the terminal moraines at several places, as they run down to the trough, it is possible to examine the materials that construct the drifts. They are built up of unsorted piles of angular or subangular blocks, irregular in size and in form, and are filled up with loose, coarse sandy or gritty matrix. The morainic blocks are mostly gneissose granite, the same kind as that forming the surrounding mountains. The blocks of basalt which penetrates the country rocks at several parts of the range, are also found. The striated or polished moraines and boulders are rather hard to see, probably buried under the wastes, while the blocks and boulders on the surface of the floor are almost entirely free from such surface markings. Glacially fluted bed rocks of the floor are also unknown as they are covered by thick deposits.

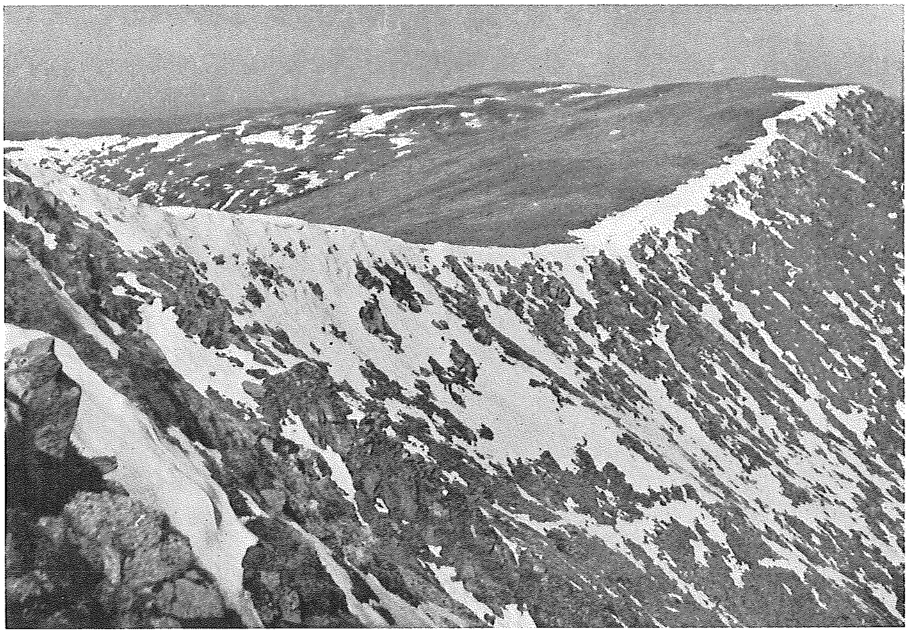

Fig. 4. Upper rim of the cirque wall in cirque No. 8. The small relief surface is sharply invaded by the wall. (Photo. by S. Izumi)

The glacial trough to the north of this cirque is a prolonged portion of the latter and forms a very shallow, wide flat-bottomed valley (Figs. 3 and 7, Pl. XIX (II) ; Fig. 1). It is about 1300 m in length and 300 m in breadth, transiting into a normal fluviatile valley with an abrupt, high nick. The walls on both side of the trough are not so distinct as in the case of the usual glacial trough, for they are not so steep and high, do not show sharply facetted spurs on the sides, but do present a shallow, concave U-shaped profile (Fig. 3). The floor of the trough seems certainly to be well preserved, incised by a few ravines and covered with bushes and trees. Several lateral moraines as well as terminal moraines are also observed on and along the western lower part of the trough, but the present authors had no chance to examine the natures of them. The altitude at the terminal of the trough is probably about 1700 m as measured by eye from the end of the cirque moraines.

The other two cirques No. 7 and No. 8, north of the above described one, have quite the same features as the latter (Fig. 3). Both have outlets to the east. Their dimensions are also rather

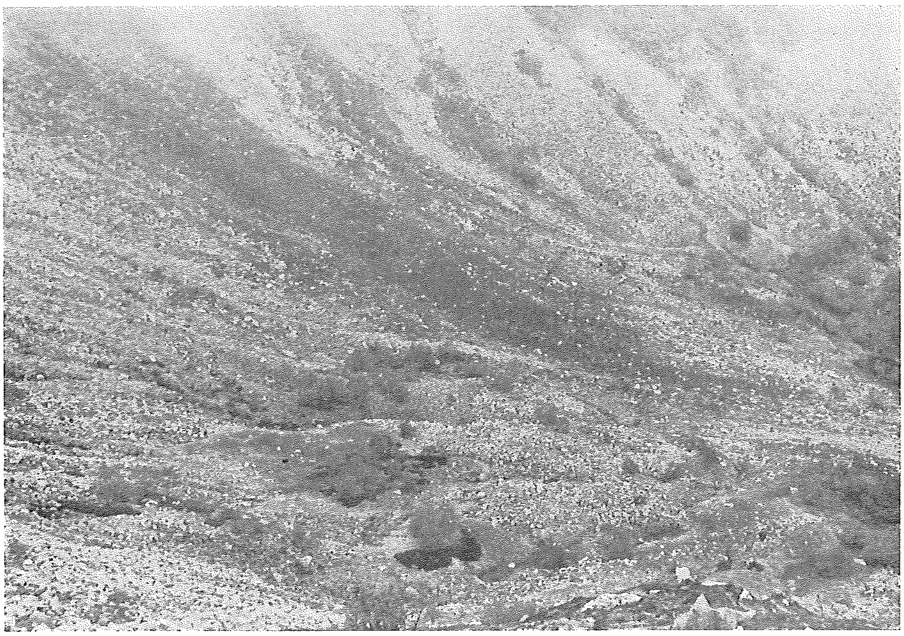

Fig. 5. Talus and rock-stream heaps at the foot of the wall in cirque No. 9. The mounds of debris are covered with bushes in the lower center of the picture. (Photo. by Y. Sasa.)

similar. Cirque No. 7 is slightly larger being 850 m in width and 1200 m in length, while No. 8 is 700 m by 1000 m. The walls incline steeply on all sides: they are high, exceeding 300 m at their heads, and show typical U-shaped profiles in their diagonal sections (Fig. 3). The spurs between these three cirques are sharply formed by the walls at their upper parts and represent rocky arêtes, in which the one between cirques No. 8 and No. 9 is distinctly knife-edged. Their floors are also typically developed with wide flat bottoms, approximately 2050 m in altitude at their end (Pl. XIX (II); Fig. 2). Trough-like valleys continued to their outlets could also be observed in parts buried by the moraines of the cirques, and coalesced into one at their downstreams with the trough from cirque No. 9.

Moreover, cirque No. 10 is also a typical one. It has the largest dimensions of all those in the massif and resembles cirque No. 9 in all features. It attains a breadth of about 1000 m and a length of 1400 m, including the trough-like outlet at the end. The tree-covered moraines, terminal and lateral, are seen as hills and benches.

Fig. 6. The morainic drifts in cirque No. 9. The trough is initiated far below these moraines. (Photo. by Y. Sasa)

Cirque No. 11 is also like in form to those mentioned above, however it is smaller in dimensions, 700 m wide by 800 m long and also shallower in depth with walls of about 200 m height (Fig. 8). The floor shows two steps, of which the altitude of the inner one or cirque end is 2050 m and that of the outer one at the trough-like outlet is 1850 m (Figs. 9 and 10).

For the sake of convenience in description, these typical glacial sculptures noted in the foregoing lines are here named the "Kôdaihô type" cirque.

In contrast to this Kôdaihô type cirque, the group seated on the northern slope of the Kita-seturai offer another type* of glacial sculpture. For example, cirque No. 6 on the northeast side of the summit is very shallow in depth with a rather wide floor in comparison with its gentle, low wall. The cirque wall is not so steep as usual, about less than 30° in the average declivity, and shows no precipitous or rugged rocky sides, often descending in narrow ledge-like

Fig. 7. Terminal moraines (left center of the picture) of cirque No. 8, taken from the end of knick point in the terminal moraines of cirque No. 9 to the the trough. The wide, flat-bottomed trough-like valley covered with trees are seen in the foreground of the picture. (Photo. by Y. Sasa)

slopes. The invasion of the cirque into the surrounding mountain side is not so sharp and shows a slight abrupt change of inclination at the upper rim of the cirque. It is also noticed that the rim of the cirque wall lies at nearly equal altitude on the slope. The outline of the cirque is rather irregular, not horseshoe-like as usual and it represents a shallow, upwardly broadened U-shape in diagonal profile. The width is 500 m at the upper part, slightly narrowing to 350 m at its lower part and elongated to as much as 1200 m, including the

* The authors regret that no pictures to show the features of these cirques were taken on account of the misty weather.

lower-half shallow, trough-like part. The undulated topography of probably morainic origin may also be seen from the head at the middle of the floor, where it makes a knick to the lower trough-like part.

Two other cirques No. 4 and No. 5 are also like in form to the "Kita-seturei type" exemplified by No. 6. Cirque No. 4 is about 1000 m by 1200 m in dimension and No. 5, 400 m by 700 m. They are shallower and possess gentler walls than No. 6 cirque.

Fig. 8. Cirque No. 11 on the north face of Nisi-Kanbôhô (left) as seen from the west. The terminal moraines of the cirque is in the middle of the picture and the trough-like outlet is elongated to the left lower corner of the picture. (Photo. by S. Izumi)

Cirque No. 13 on the north side of Naka-seturei is seen from a distance to have the same character as above described.

On the other hand, cirques No. 2 and No. 3 on the north side of Kanbô-syuhô, and cirque No. 1 on the Naka-kanbôhô seem, though not so carefully studied by the authors, to be an intermediate form of the former two types in their glacial sculpture, and more or less akin to the Kôdaihô type, especially resembling cirque No. 11 in size and form.

The cirques on the eastern slope of the ridge between Nisi-kanbôhô and Naka-seturei, though not at all examined by the present writers except cirque No. 12 which was viewed from above Nisikanbôhô, are all known to be much smaller in dimensions and possessed of imperfect glaciation because it has been destroyed by the head erosion of the ravines. They seem not to exceed 400 m in diameters and to have comparatively narrow inclined floors as well as smaller morainic heaps at approximately 2100 m–2150 m altitude, presenting no distinct steps on their floors.

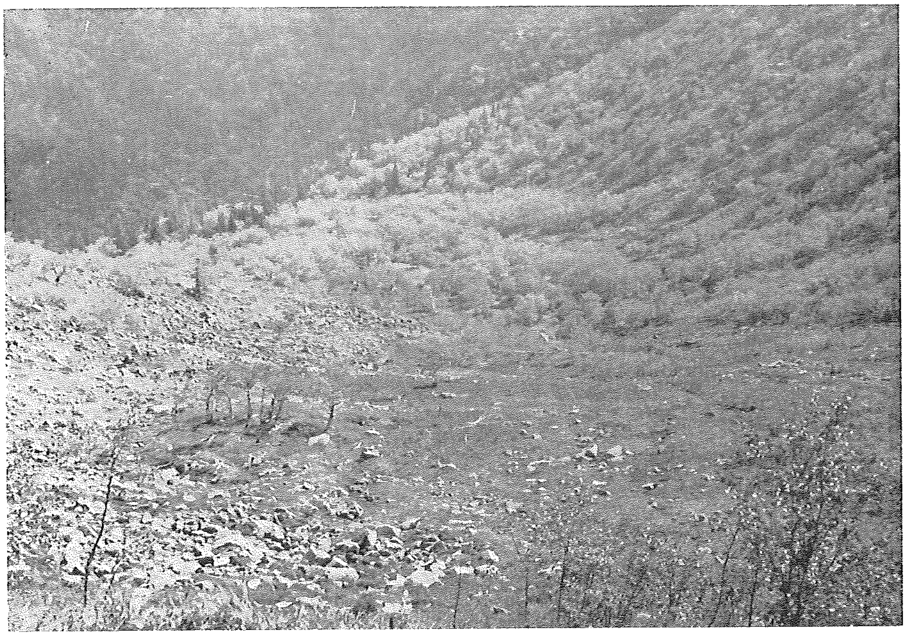

Fig. 9. Floor of cirque No. 11: as looked down from the foot of the wall. The lower trough-like outlet is covered with vegetation. (Photo. by Y. Sasa)

SOME CONSIDERATIONS ON THE GLACIAL TOPOGRAPHY

These facts just above described, concerning the distribution and morphology of the glaciated topography in the Kanbô Massif, lead the present writers to the following considerations and presumptions.

At first, with regard to the peculiar distribution of the cirques, that the greater number of them is found on the eastern face of the main ridge, as is the usual case of distribution of cirques in the

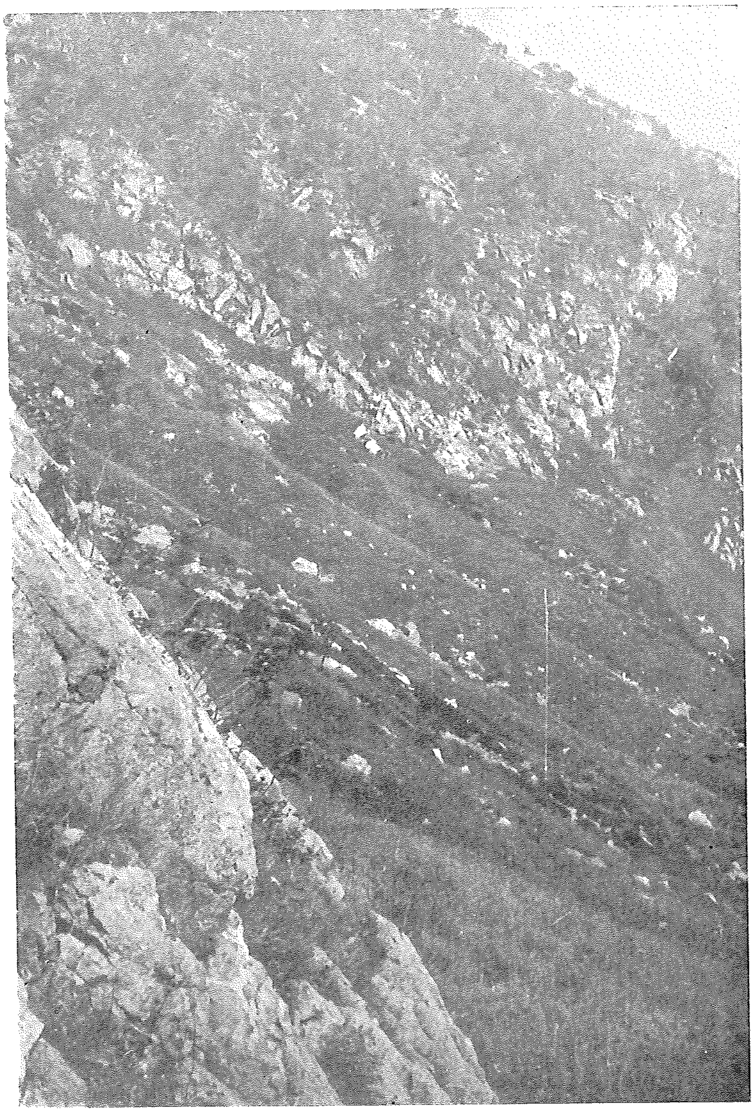

Fig. 10. Slabs at the foot of cirque wall in cirque No. 11.
The foot of the wall is thickly buried under talus-cones.
(Photo. by Y. Sasa)

northern hemisphere, the theory may naturally comes to mind that the cirque glacier favourably occurs in the leeside of the winter prevailing winds. In fact, at present, the eastern side of the ridge is always the leeside of the prevailing westerly or northwesterly winter monsoons,* since the ridge runs in a north-south trend in this district. Therefore, it may be assumed that these climatic conditions must have obtained during the Ice Age in the district, seeing that at present most of the cirques face to the east which is the present leeside. Even the cirques faced toward north owe their existence to the subordinate ridges which played the rôle to form the leeside, projected to the west side of themselves.

The poor development of the cirques on the Kanbô Range is supposed to be due mainly to the difference of amount of snowfall, as almost the whole of the moisture brought by the winter monsoon from the west condenses on the Seturei Range so that little snow is carried to deposit on the Kanbô Range over the wall of the former one. More cirques would have been formed if there had been more distance between these two ranges or if the Kanbô Range had been higher in altitude. The differences in pre-glacial topographical features between the two ranges in that the Seturei Range was gentler in slope and wider in the valley heads affording favourable conditions to bear the great amount of snowdrifts while the Kanbô Range had steeper mountain sides and was severer in head erosion because of the incising valleys, would present another important feature to cause the difference in the density of the distribution of cirques. The remarkable development of the cirques in the eastern face of the ridge between Kita-seturei and Kôdaihô might have been due largely to the coincidence of all the favourable conditions to cause just that.

The glaciers which produced the glacial sculptures in the present massif may have been mostly cirque or corrie glaciers, and their glacial tongues would have overflowed and been elongated down for some distance from the cirques at the time of their largest advancement, i.e. in the first stage of glaciation (Fig. 11, A). The glacier in cirque No. 9 would have transformed into a valley glacier at its downstream, but it was not thick or large enough to excavate a deep glacial trough as usually seen, as is judged from the shallow floor and gentle walls of the trough. The two glaciers in cirques No. 7 and No. 8 would have joined as tributaries at their terminals with the valley glacier from cirque No. 9.

The glaciers would have often been found as small hanging glaciers on the mountain side as in the case seen on the eastern slope around Naka-seturei.

* These statistical data on the direction of the prevailing winds throughout the years are available at several meteorological stations in northern Tyôsen.

In the second stage of glaciation in the Ice Age, the glaciers had retreated to a little higher altitude into their own cirques and is pre-

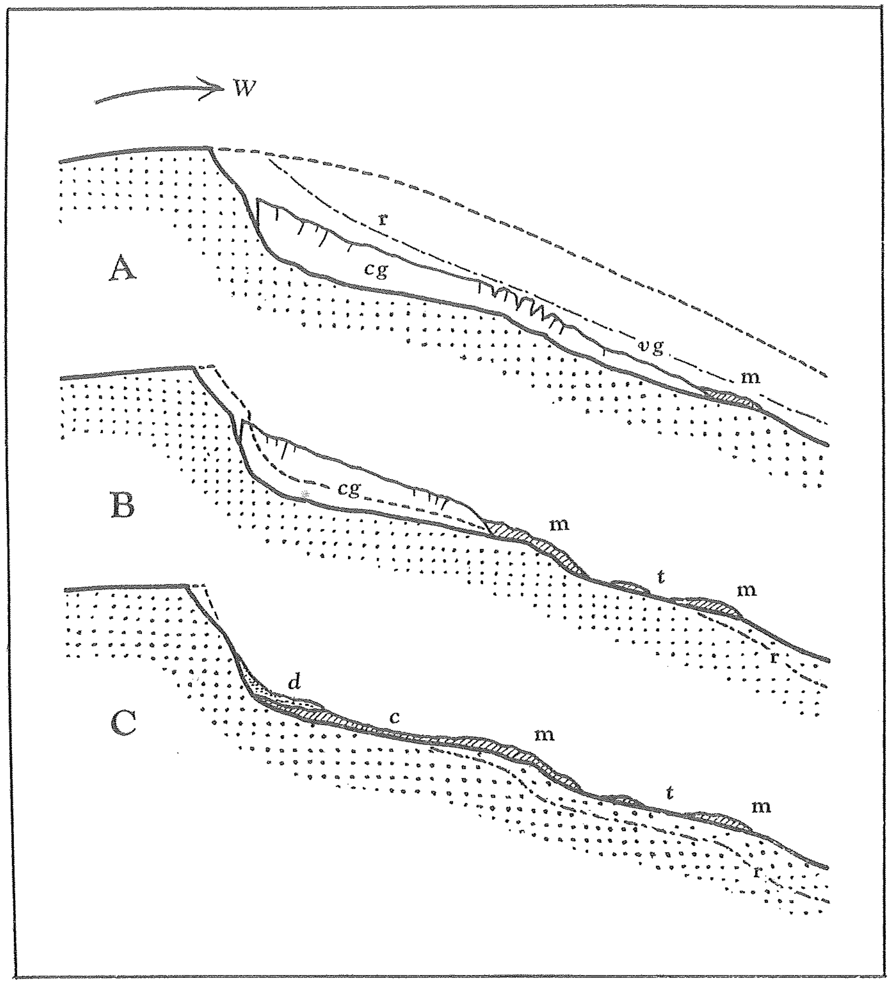

Fig. 11. Diagrammatic explanation to illustrate the stages of development of glacial sculpture on the Kanbô Massif.

A. The first stage.
r . . . river bed of pre-glacial time.
cg. . cirque glacier. vg . . valley glacier. m . . moraine.
w. . . direction of winter monsoon.

B. The second stage.
t . . . trough-like valley. r . . river bed.

C. The present state.
c. . . cirque. d . . . talus.

served slight knicks at their terminals to the trough-like outlets of the former glaciation (Fig. 11, B). The end moraines of the present cirques, it seems, had remained over and around these knicks showing several steps and rows as the glaciers disappeared. The uppermost step by the block heaps at the foot of the wall frequently seen are undoubtedly the products of weathering and washing-out in the post-glacial time (Fig. 11, C). The denudation of the glacial topography in the post-glacial time is fairly intense, destroying the cirque walls and filling the floors with considerable wastes, but it could not so strongly modify the original outlines of the cirques.

The assymmetrical profile of the cirque wall in diagonal section as is seen in cirques Nos. 9, 10 and 11 may be explained due to the difference of severity of sapping or plucking at the margin of the glacier, as it would have been thicker at the western margin from the deeper accumulation of snowdrift than at the eastern side.

The peculiar sculpturing as is seen in the Kita-seturei type cirques Nos. 4, 5 and 6 is thought to depend in part upon the mode of snow accumulation and in part upon the pre-glacial topography. That is to say, the snowdrifts in these northward opening cirques would not be so thick as in the cirques facing eastward and also would not be so heavy at the head part of the cirque as usual, because they situated on the northern mountain side which is not the favourable leeside of the western and northwestern winter monsoons. Consequently the glaciation occurred with rather weak intensity toward the head of the cirque and was impotent at the marginal incising, producing a shallower trough with gentler wall. The almost equal height of the upper rim of the wall, therefore, seems to be owing to the less severe headward sapping of the glacier as compared with the lateral excavation.

The intermediate type cirques such as those on Kanbô-syuhô were perhaps formed under conditions transitional between those under which the Kôdaihô type and the Kita-seturei type were formed, in respect to the quantity of snowfall and topographical situation.

The small incomplete cirques to the south of Nisi-kanbôhô may have resulted from the invasion of hanging glaciers, whose growth had been restricted and prevented because the mountain sides were too steep and narrow to permit the formation of larger ice masses. Whether the poor development of the cirque in this ridge was due to the amount of snowfall or not seems to be out of the question, for there exist no reasons to assume that the amount of snowfall at the south of Nisi-kanbôhô was not heavy as compared with that of at the northern ridge of the same summit where the glaciers were so predominant.

The altitude of the cirque floor seems closely related to the dimensions of the cirques; the smaller cirques are seated higher than the larger ones, and those facing northward are somewhat higher than those opening toward the east or northeast. The altitude of the terminals of the trough-like parts where the glacier tongues overflowed, too, accords with this tendency. The causes for such features are controlled by the circumstances as stated above; that is to say, in greater part these characters resulted from the degree of deepening by excavation and partly from the altitude of the original sites where the glaciers were nourished.

In regard to the snowline in the Ice Age, the authors are of the opinion that it lay approximately at 1900 m–2000 m* in the first stage with the largest extention and retreated in the second stage to 2000 m–2100 m altitude. However, the absolute altitude of the snowline above the sea level in the Ice Age is yet uncertain, because the amount of epeirogenetic dislocation of the post-glacial time, which is not yet available, must be eliminated.

Lastly, as to the geological age of the Ice Age of these glaciations, to make an estimate is difficult because of the scant evidences at hand, but it is supposed to be probably in the later Pleistocene, in accordance with the case in the Japanese Islands when the freshness of the cirque topography of the district is compared with the glaciated remains such as those in the Hidaka Range, Hokkaidô.

RÉSUMÉ

In the present paper, descriptions are offered of the glacial sculptures on the Kanbô Massif in northeastern Tyôsen. Discussions are also presented in regard to the distribution and morphology of the glacial topography. The results of personal observations may be summarised as follows.

1. The Kanbô Massif once suffered from glaciation, probably in the later Pleistocene.

* The estimation of the snowline in these cases will be discussed on an another occasion in near future.

2. The glaciers, eighteen in number, occupied small areas of the valley heads, being influenced by the pre-glacial landforms.

3. Tow stages are recognised in the course of the glaciation.

4. Most glaciers in the first stage were cirque glaciers and with their tongues overflowing as small valley glaciers, forming shallow trough-like outlets. The lowest extention of them was at about 1700 m altitude.

5. A few glaciers joined together at their downstreams and formed a long shallow glacial trough.

6. The glaciers retreated into their own cirque areas in the second stage, attaining an average altitude of 2000 m–2100 m.

7. The snowline in the first stage is assumed to have been at 1900 m–2000 m and at 2000 m–2100 m in the second stage.

8. The glacial cirques are found almost entirely on the Seturei Range, mainly due to the high precipitation on that range, because it stands as a wall against the winter monsoons.

9. Almost all of the cirques are seen, as is commonly the case throughout the northern hemisphere, on the east side of the ridges, the leeside of the winter monsoons.

10. The cirques facing to the east or northeast are well glaciated, while those on the north side of the mountains are shallowly excavated.

11. The cirques develop poorly on the steep slopes and show that the growth of the glaciers depends much upon the pre-glacial topographies.

12. It is an interesting point that the glacial remains on the Kanbô Massif, as they developed rather on a small scale as already stated, suggest that, for the advancement of glaciers, intimate relationships exist among the amount of precipitation by the winter monsoon, the trend and situation of the ridge, the direction of the slope and the surrounding pre-glacial topography.

February, 1937.

Plate XVIII (I)

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Fig. 1. Panoramic view of the Seturei Range taken from the summit of Kanbô-syuhô in the Kanbô Range. The topographical features such as the flat-topped ridges and cirques are well shown. The cirques visible from right to left are Nos. 7, 8 and 9. (Photo. by S. Izumi)

Fig. 2. The small relief topography on the ridge around the Seturei Range, taken from the northern shoulder of Nisi-Kanbôhô. The upper margins of the cirque walls, No. 9. (right) and No. 10 (left) are seen in the center of the picture. (Photo. by S. Izumi)

Fig. 1.

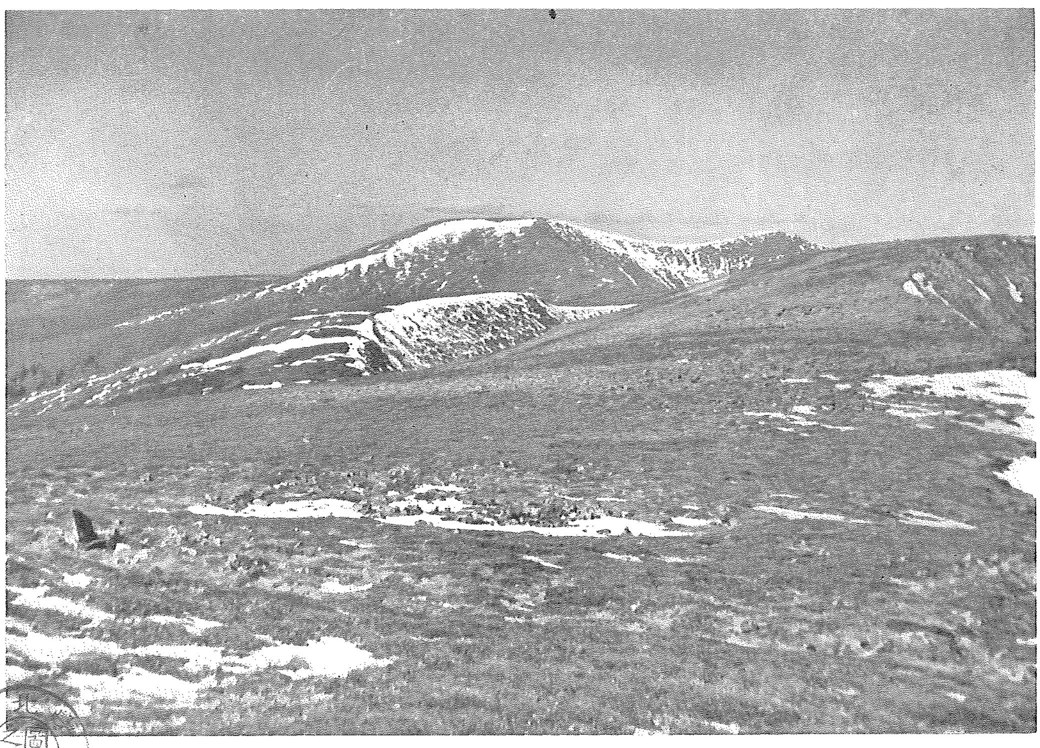

Fig. 2.

Y. Sasa and K. Tanaka: Glaciated Topography in the Kanbô Massif.

Plate XIX (II)

PLATE XIX (II)

Fig. 1. Floor of cirque No. 9 as seen from the southern rim of the cirque wall. The shallow trough-like, wide-bottomed valley is covered with thick vegetation. The terminal moraines of the cirque are in the center of the picture, nearly lying along the margin of the timber-line. (Photo. by Y. Sasa)

Fig. 2. Floor of cirque No. 8 looking down from the head of the wall. The wide, U-shaped profile and rock streams are well shown. The lateral moraines and the overflowed fan-like terminal moraines are also seen in the center of the picture. The trough that runs from cirque No. 9 is traceable in the middle of the picture from right to left. (Photo. by S. Izumi)

Fig. 1.

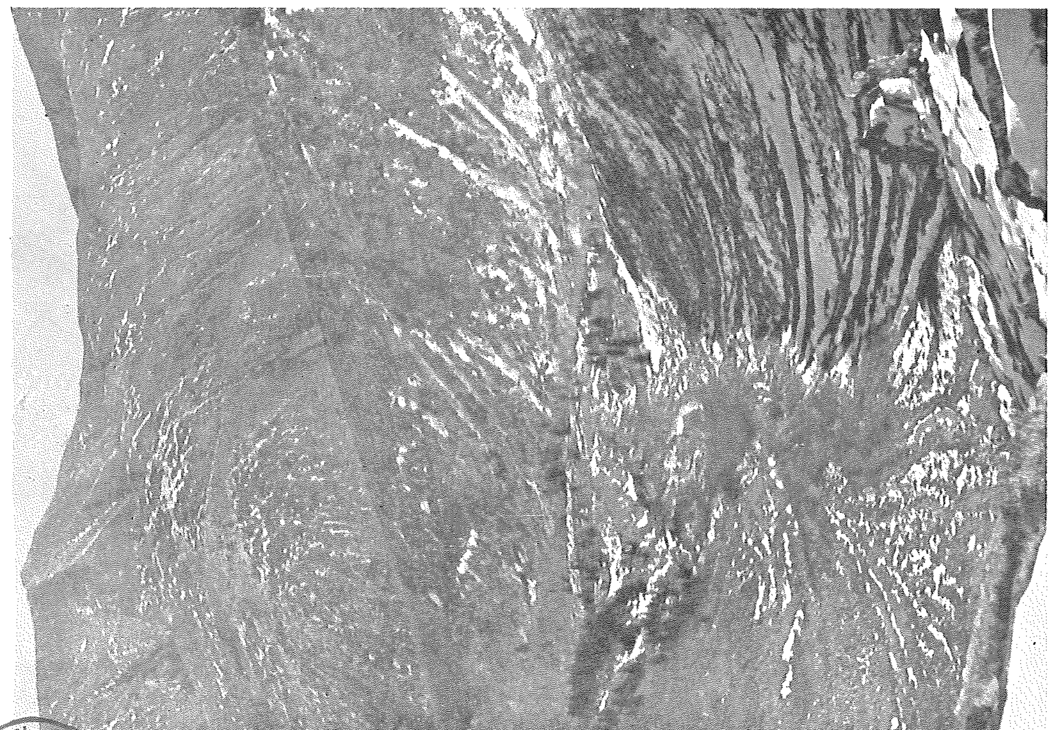

Fig. 2.

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