QUATERNARY GEOLOGY OF HOKKAIDO*

1st Report: On the Ice-ages and Post glacial age of the Hidaka mountain-range

By

Seiji HASHIMOTO and Masao MINATO

(With 10 Figures)

Contribution from the Department of Geology and Mineralogy, Faculty of Science, Hokkaidô University. No. 531.

1. Ice ages of the Hidaka mountain-range

From its south-western extremity in the central volcanic highland area in Hokkaido (Daisetsusan National Park), the Hidaka mountain range extends south-ward with continuity for 140 kms to Cape Erimo. Throughout this course the range stretches as precipitously as walls between the two adjacent districts, Tokachi plain, to the east, and Hidaka low land area extending to the west.

In the northern part of the range, the higher peaks attain altitudes of 1900 to 2000 m, while such peaks in the southern part of the range, show elevations of 1700 to 1500 m.

Evidences of the former existence of glaciers have been discovered at various localities in the range as shown in Fig. 1.

---

* It is planned to publish in this series of papers: 1) The ice-ages and post glacial age of the Hndaka mountain range, 2) Terrace chronology in Hokkaido, 3) Pleistocene and Holocene volcanic activities in Hokkaido, 4) The Lower Pleistocene deposits in Hokkaido, 5) Some biogeographical considerations on faunal and floral aspects of Hokkaido in relation to palaeogeography of the Quaternary age, 6) The Palaeolithic age in Hokkaido, and 7) The underground resources in relation to the Quaternary geology in Hokkaido.

This is the first report in the list of proposed articles above enumerated.

MINATO once gave a preliminary account on the problem of the glacial geology of the Hidaka mountain range, in cooperation with Dr. SEIJI HASHIMOTO. Since then, the latter has studied in more detail the cirque topographies as well as moraine deposits in those mountains, and a large body of new data has also been accumulated by him for the correlation of the ice-ages, inter-ice age and so forth. Accordingly the present writer proposes here to deal with those data in the first report of this series under Dr. HASHIMOTO's kind leadership. (M. MINATO)

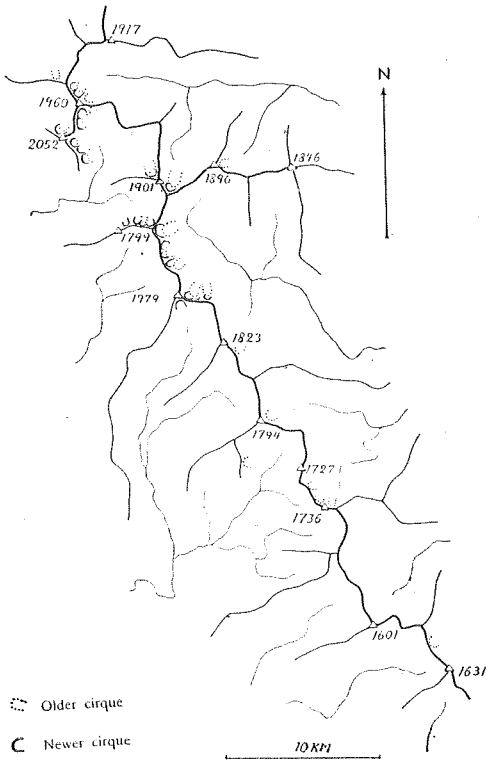

Fig. 1. The map showing the distribution of cirques in the Hidaka mountain range (altitudes in meters)

That most of the cirque topographies occur on the east slope of the range is undoubtedly in a measure due to the effects of the prevailing west to northwest winds in winter.

In regard to the topography of the cirques and the stratigraphy of the moraines, these cirques in the Hidaka range, as has been briefly reported by us[1], should be concluded to be the result not of glaciation in one period only but of double glaciation in two different ice-ages.

In the Hidaka range, especially in its northern part, it is very often found that the cirques, typified into different groups, are situated side by side or one overlapping another.

Most of these cirques exist on the ridges near Mt. Tottabetsu (1960 m), Mt. Poroshiri (2052 m) and Mt. Kamuiekuuchikaushi (1979 m) in the northern Hidaka range.

2. Cirques near Mt. Tottabetsu

Cirques of Mt. Tottabetsu (Fig. 2 and Fig. 3) are located at the upper end of the Tottabetsu valley watershed between Mt. Kitatottabetsu and Mt. Tottabetsu, just east of the saddle connecting the two peaks. The characteristics of the cirque wall which embraces a flat floor to the east side of its face falls into two categories whose distinct features serve to emphasize important topographic differences. The cirque wall situated to the south of the floor is composed of biotite gneiss and is considerably modified by erosion. Although now covered by talus deposits, this wall is traceable until it is buried under a large land-slide at the elevation of 1730 m.

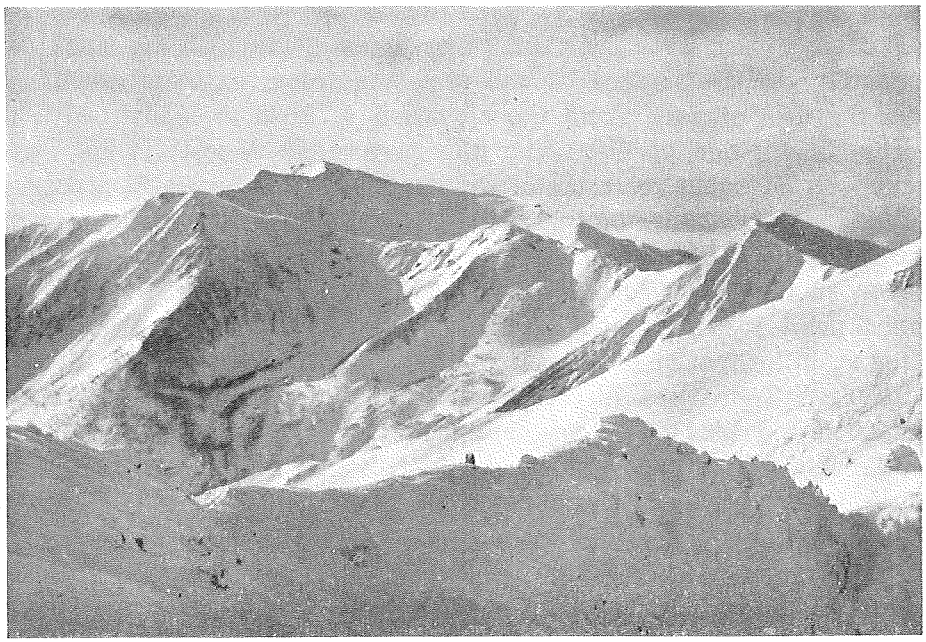

Fig. 2. Mt Poroshiri and Mt. Tottabetsu viewed from north-east

Gigantic, as is the meaning of the name in Ainu, Mt. Poroshiri stands with its shoulders spreading out. Frontal pyramidal peak is Mt. Tottabetsu. The cirque in the left was formed in the older ice stage. The cirques in the center and in the right side show the newer glaciation, too. The well-preserved flat floor surfaces are characteristic. Within the central cirque, the discontinuous two series of walls are clearly visible. The rocky wall extending in to the main ridge is the newer, while the older one is preserved just above the floor.

The west wall of the cirque is a steep cliff on which bare dunite rock is exposed. Since this cliff represents the probable continuation of the destroyed cirque wall to the north-west, it becomes apparent that the trend of the south side wall does not continue to the trend of the west side wall.

The break in the trend of the cirque walls is significant, since it indicates that the western cirque wall was formed by scraping off of a part of the former wall. In other words, the cirque wall on the western side i. e. the dunite wall, is of younger age than the other wall i. e. the southern side of the cirque.

On the other hand, in the slope that descends east-downward from the cirque floor to the valley, there are found to exist upper and lower

groups of glacial moraines respectively, the surfaces of which are also marked by topographic contrast. The upper portion of the slope corresponding to the surface of the upper moraine, extends downward from the floor surface from the elevation of 1630 to 1530 m with an average inclination of 31°. The upper morainic deposit is composed exclusively of subangular till of dunite and its surface still preserves well-defined terminal moraines which, though worn by erosion, can be traced without difficulty. The lower morainic deposit has a somewhat uneven surface that slopes gently with an average inclination of 21° from a point 1530 m in altitude to 1430 m, then falls steeply into the valley at an inclination of 35°. Its lowest part is reached at an altitude of 1380 m. There are ill-preserved terminal moraines at elevations of 1430 m and 1480 m. Those moraines are chiefly composed of subangular cobbles of amphibolite and biotite gneiss, and they are evidently and unconformably overlaid by the upper moraine in their upper part.

Evidences available within the cirque lead to the assurance that it was formed in two glacial stages, interrupted by one interglacial stage within this region.

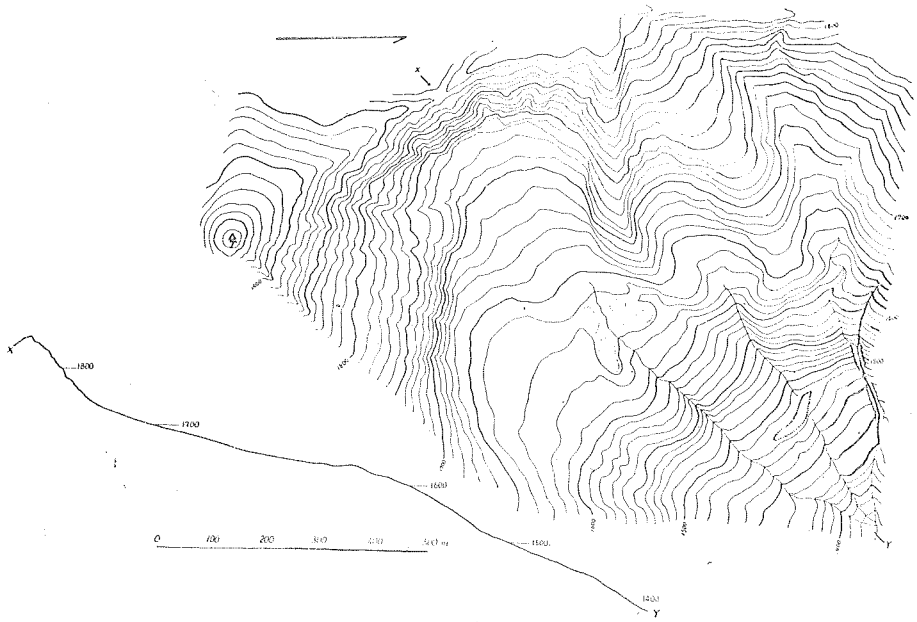

Fig. 3. Topographical map of the cirques just north of Mt. Tottabetsu (cf. Fig. 2)

The sequence of the glaciations within the cirque is as follows: the glaciation of the earlier ice stage left the older (lower) moraine and older (lower) cirque wall. Probably the cirque wall of this stage had once been steep, and the materials of the corresponding moraine accumulated like those of the newer moraine.

It was in the following inter-glacial stage that the former cirque wall was broken down by the attacks of weathering, and the running waters have left evidences of their action on the older morainic surface.

The glaciation of the latter ice stage formed the newer cirque wall and moraine in a somewhat higher area than the older one.

Accordingly, the writers propose to call the two glacial stages and inter-glacial stage in the Hidaka mountain range, under the names "Poroshiri glacial stage" (older), "Poroshiri-Tottabetsu inter-glacial stage", and "Tottabetsu glacial stage" (younger) respectively.

Evidence is recognizable of such double glaciation in the Hidaka mountain range, not only in the cirque above noted but also in many other places, as indicated in Fig. 1.

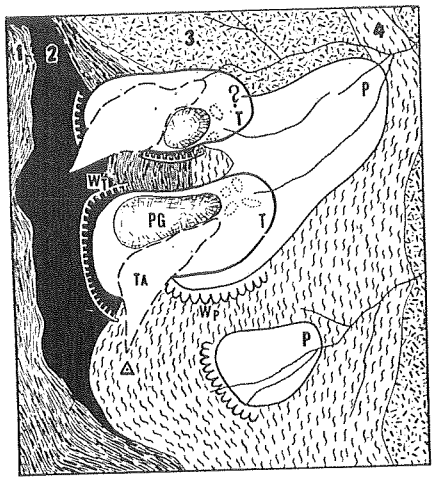

Fig. 4. Reconstructed map, showing the maximum extention of the glacier in each glacial stage in the cirques near Mt. Tottabetsu

P: Extent of the glacier in the older ice stage
T: Extent of the glacier in the newer ice stage
PG: Glacial remains in the Post glacial age
WP: Cirque wall in the older glacial stage
WT: Cirque wall in the newer glacial stage
TA: Talus deposit
1: Amphibolite 2: Dunite
3: Gabbro 4: Biotite gneiss

The Hidaka range attains its highest elevation between the peaks of Mt. Poroshiri and Mt. Kamuiekuuchikaushi, reaching heights from 1900 to 2000 m, but the altitudes become gradually lower both to the northward and to the southward; the average altitude of the summits in these areas is 1700 to 1600 m or less.

As before mentioned, the newer cirque walls and floors in the northern Hidaka mountain range are observed to be formed at altitudes between 1800 m to 1700 m above sea level and 1600 m respectively,

while the older walls and floors are at still lower levels (1600 to 1500 m and 1400 m).

Accordingly the snow line** in the Tottabetsu glacial stage must have existed at a still higher elevation than in the Poroshiri glacial stage. The difference in the altitude of the snow line between the two glacial stages may be estimated to reach at least 200 m.

This may be a reason why it is not possible to detect evidences of the glaciation of the Tottabetsu glacial stage in the southern Hidaka mountain range, in spite of the presence of evident proofs for glaciation during the Poroshiri glacial stage.

3. Correlation of the two ice stages

In the Hokkaido, so-called "marine terraces" are widely traceable along almost the entire sea coast. They usually tend to be continuous landwards as so-called "river terraces".

These terraces, either marine or fluvial in origin, are divisible into three major groups such as "lower", "middle", and "higher terrace", not only from their altitudes, their inclinations, the degree of topographical dissections, and the surface properties of the terrace scarps, but also from the manner of the depositions and the fossil contents.

Of them, the "lower terraces" are distributed most widely, usually 20–40 m above sea level in coastal region, where they are generally flat or least inclined at their surface and always surrounded by very steep cliffs. In most places they are covered by gravels, 5–10 m in thickness.

At Ogoshi, near Cape Erimo, at the southern end of the Hidaka mountain range, two molars belonging to *Mammonteus primigenius primigenius* (BLUMENBACH) were recently collected at the very base of this gravel bed[3].

** The altitude of the cirque floors is believed to be not always coincident with the regional snowline around the mountainous area, where the cirques are to be found. G. IMAMURA 2) once held an opinion, that the snowline might be about 2700 to 3000 m above sea level in the Japanese Alps in Honshu, during the ice age, although according to him, the altitudes of the cirque floors are there locally quite various, and most those floors exist far below the imagined snowline.

However in the Hidaka mountains, there are two sets of cirques formed in different ice ages as above stated, and the altitudes of the cirque floors differ; besides this, in each set of cirques respectively, the altitude of the floor is nearly equal.

Accordingly, the writers are now inclined to regard that the levels of the cirque floors correspond to the general altitude of the regional snowline in the ice ages.

The "middle terraces" being 80–100 m above sea level in the coastal regions, also develop fairly widely; their surfaces display much more wearing by erosion than those of the former. Also their surfaces are far more inclined in comparison with the "lower terraces". The surrounding cliffs forming the margins of the "middle terraces" as a rule do not show any steep slopes, but rather exhibit gentle ones coated thickly with debris.

These terraces are also veneered with gravel layers of various thickness, but no fossils directly helpful for chronological correlation, have been discovered from them up to the present day.

On the western side of the Hidaka mountain range especially, these two sorts of terraces above stated, are traced along most of the river sides for a long distance from the coastal regions up into the stream valleys. On the other side of the range, in the eastern footplains, the vast development of fanglomerates which have been built up by the rivers that flow down from the ridges heavily burdened with waste materials, conceal the terraces to a large extent. However, it is possible to classify the fanglomerates into two types. One of them is to be observed to cover the surface of the "middle terraces" but it has been eroded away by flowing water prior to the formation of the lower terrace or to the deposition of gravels on the lower terraces.

This type of fanglomerate has been denominated "Makubetsu fanglomerate" by the writers.

The other fanglomerates show quite even surfaces which develop to cover the lower terrace gravels, and these have been called "Kamisatsunai fanglomerate" by the present writers, in respect to the type locality. That these deposits were formed prior to the Holocene is indubitable.

The fact that these fanglomerates, both old and new, are found only in the eastern foot hills of the Hidaka mountain range, but are not observable in the west, is quite attributable to the fact that formation of the cirques was limited to only the eastern slope of the range.

In order to grasp the stratigraphical relations above noted, one of the writers (S. H.) recently tried to trace these two groups of fanglomerates as well as their corresponding terraces, lower and middle, into the high mountainous upstream area, where the glacial moraines lie. The survey was carried out by means of "levelling" along the course of the Tottabetsu River.

In that valley, there exist two distinct terraces, "lower" and "mid-

dle". In the foot plain, these terraces were buried beneath the gravel beds of fanglomerates, older and newer, respectively.

Toward the upper course of the river, "middle terrace" continues to the upstream valley just below the cirque along the Esaomantottabetsu, a tributary of the Tottabetsu. On the other hand, the lower terrace ceases to exist halfway up where the tributary joins to the main stream as a hanging valley.

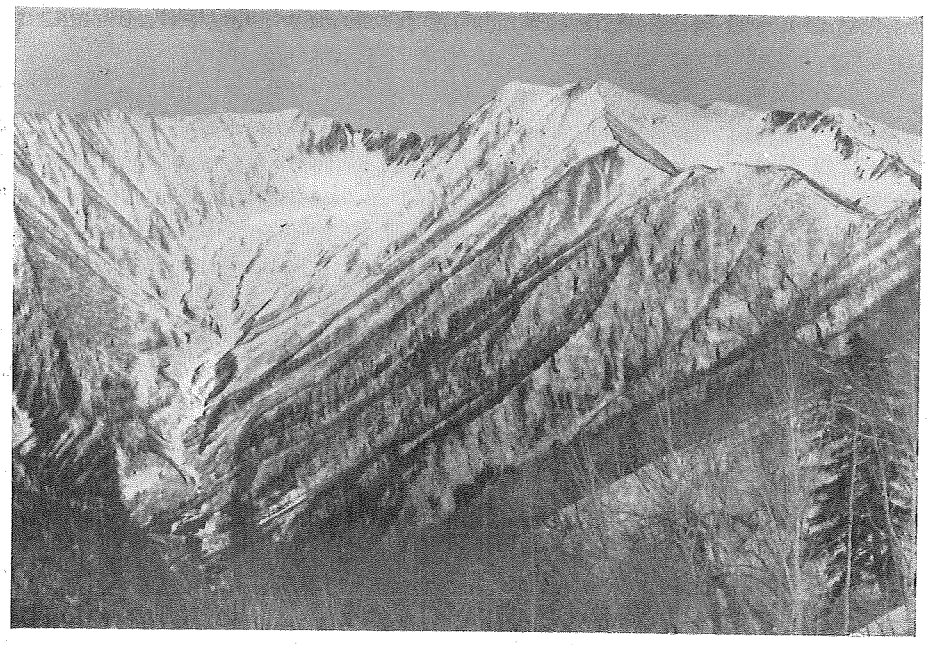

Fig. 5. Eastern face of Mt. Esaomantottabetsu viewed from the north

Two cirques may be seen on the two sides of the ridge connecting to the summit. Two sets of cirques are well developed within the cirque to the left. The lower moraine, although truncated by the running water, hangs down into the valley still retaining its flat surface, and grades into the morainic terrace.

Apart from the terraced upstream valley, within the cirque of Mt. Esaomantottabetsu, two glacial stages, older and younger, are represented by separate groups of moraines. The moraine belonging to the Poroshiri glacial stage, is situated in a lower site (aprox. 1400 m); its surface, although much dissected by streams, grades down to the valley for a distance and forms "the higher morainic terrace".

The moraines of the Tottabetsu glacial stage are limited in extent to the area of the highest portion of the cirque floor (1630 m). But a morainic terrace corresponding to the Tottabetsu glaciation occasionaly occurs along the river side as the "lower bench" which lies approximately 10 to 15 m below the higher ones. These morainic terraces, old and new, presumably were formed by the out-washings of the two glaciations. The drifted materials of each out-washing must have been accumlated in the terraced valley, until it was filled up. This assumption may be supported by the fact that the inclination of the river bed of the upper course along the Esaomantottabetsu, increases abruptly at a point where the terrace disappears under the present river bed. The topographical relations of each surface are schematically represented in Fig. 6.

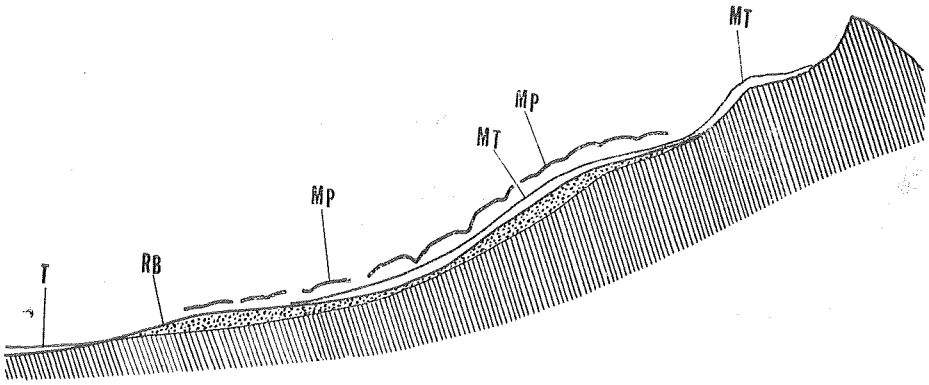

Fig. 6. Schematic representation of the moraines, morainic terraces and river terrace on the east slope of Mt. Esaomantottabetsu.

MP : Deposition surface of the older moraine or surface of the older morainic terrace
MT : Surface of the newer moraine, or the lower morainic terrace
RB : Present river bed
T : Surface of the river terrace, probably corresponding to the surface of the older fanglomerate

Accordingly, the higher morainic terrace, at least, is formed posterior to the river terrace, whose continuation appears as "middle rock terrace" in the midstream area.

These relations between the morainic terrace as well as the fanglomerate and the rock terrace indicate that the accumulation of gravel beds had taken place in the same stage, presumably cor-

responding to the diminishing stage of the glacier.

Yet, the writers are now inclined, in rough estimation, to regard the Tottabetsu glacial stage as probably comparable with the stage of the formation the "lower terrace". The assignment of the lower terracing to later glacial stage is supported by the relative positions, and the degree of erosion.

Such being the case it may be assumed that the Tottabetsu glacial stage can possibly be correlated with the Würm ice age, in respect of the fossil evidence above noted.

Accordingly, the writers were and are now of opinion that the Poroshiri glacial stage may have corresponded to the stage of "middle terracing" or the Riss ice-age in Europe.

Fig. 7. Looking south-eastward from the side-slope of the Numa cirque.

On the floor surface below, the lakes appear under the half melted snow. Crescentic disposition of the moraine hills indicates the sequences of retreat of the former glacier at its fullest extention in the Tottabetsu glacial stage. The central peak is Mt. Esaomantottabetsu, on its frontal face and in the ridge that continues to the right, typical cirque topographies are seen.

4. Post-glacial age

On the floors of newer cirques of the Northern Hidaka range, well preserved moraine hills are left.

Especially in the Numa cirque, which lies just on the south side of Mt. Tottabetsu facing eastward between the highest two peaks in the range, Mt. Poroshiri and Mt. Tottabetsu, the best developed moraine loops are observed (Fig. 7, Fig. 8).

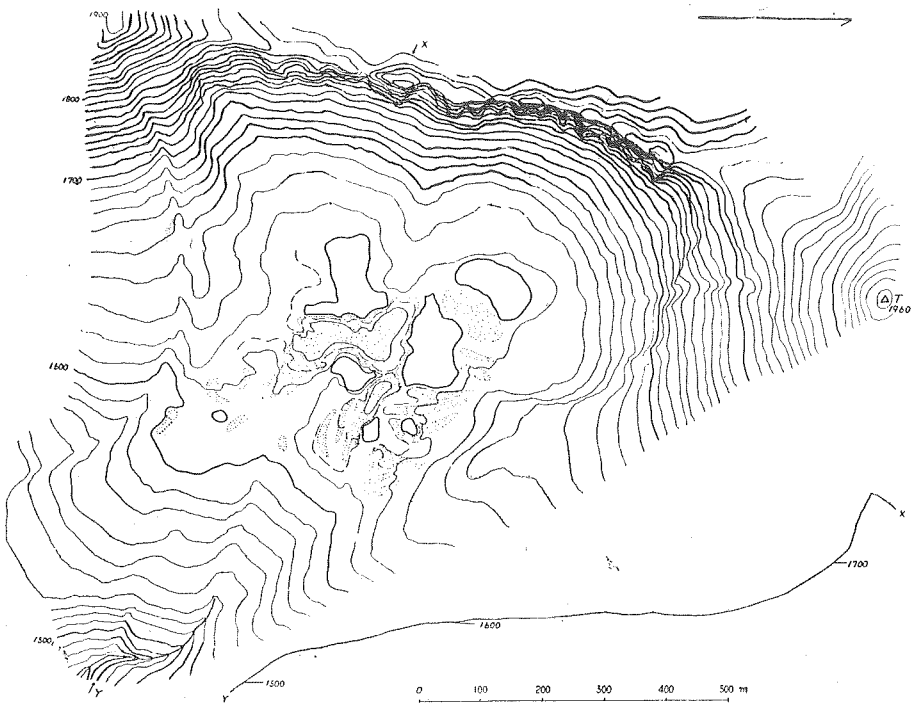

Fig. 8. Topographical map of the Numa cirque

On the floor of the Nume cirque, situated in an altitude of 1620 m above sea level, there lie seven small lakes encircled by moraine hills. The extent of the floor attains 0.7 km both in width and in length. The alignment of the moraine loops which formerly extended around the terminal of the glacier, is shown in Fig. 8. The moraines are 5 to 15 m high on either side and they are elongated, quite narrow, but continuous for 200 m or less. Their topographical freshness illustrates without doubt that these moraines belong to the Tottabetsu glacial

stage. The distribution of the crescentic moraine hills clearly shows the fullest extent of that glaciation. Within an area, encircled by the outermost crescent of the moraines, loops of moraines are disposed in such a manner as to reflect the sequence of retreat of the glacier in that place. The cirque glacier retreated not continuously; it might have readvanced, at least in one period. In this regard, the senior writer proposed very recently to divide the Tottabetsu glacial stage into two substages, Tottabetsu glacial stages I and II.

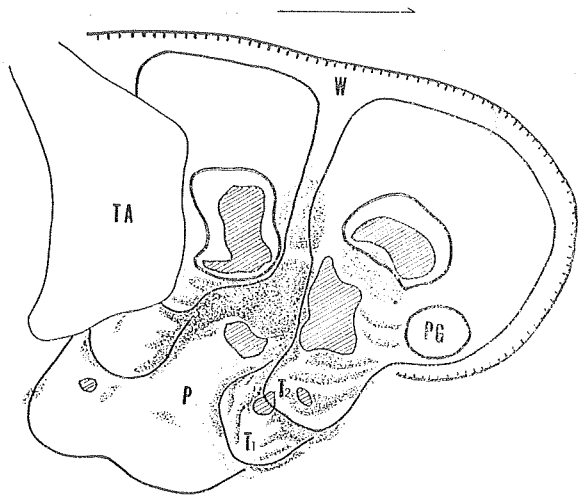

Fig. 9. Reconstructed map of the glaciers in the Numa cirque. Dotted area means the distribution of moraines

T_1 : Extent of glaciers in the Tottabetsu glacial stage I
T_2 : Maximum expansion of glaciers in the Tottabetsu glacial stage II
P : Approximate extent of the glaciated area in the Poroshiri glacial stage
PG : Glaciers remained in the Post-glacial age
TA : Talus
W : Cirque wall

The proposed "Tottabetsu glacial stage" in that definition corresponds to substage I while the following period of the small readvancement of the glacier would be called substage II, respectively.

On the other hand, it is generally observed that landslides have occurred on a large scale on the walls of the newer cirques of the Northern Hidaka range. These debris now in concern, cover the moraine hills, which were deposited by the glaciers in Tottabetsu glacial stage II. However, the extent of distribution of the debris is in some parts, especially in the inner cirque floor, not controlled by the former relief. Moreover the lower marginal part of the accumulations is affected by glacial erosion to some extent. Such being the case, it is highly probable that the cirque glaciers might have still existed in the cirque floors when these accumulations of debris were formed. Accordingly the age in which the formation of such debris occurred

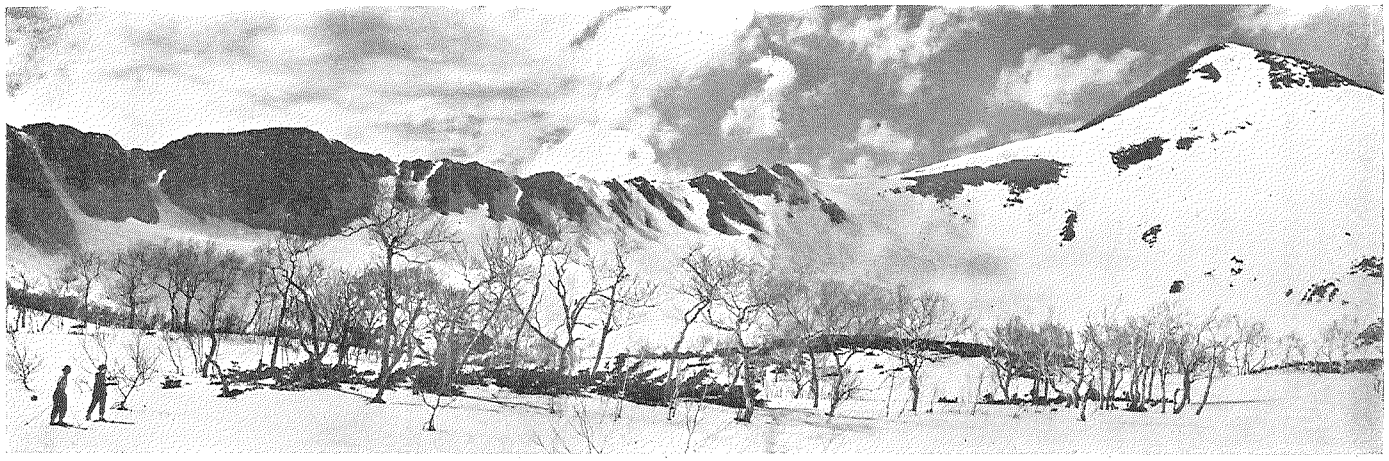

Fig. 10. On the cirque floor of the Numa cirque.

The rows of white birches, in the foreground, indicate the dispositions of the older moraines. Gently inclined hills, in the middleground, having the creeping pines are the hills of the newer moraines.

on a large scale might be Pre-Holocene.

Naturally in most cirques newer debris, developing on a small scale at the foot of the cirque walls, is quite different from those above described.

There is not available at present data to correlate the age of Tottabetsu glacial stage II and the accumulation of the debris lying widely below the cirque walls, however, it is beyond doubt that these accumulations should be regarded as belonging to the Post-glacial age, not as being Holocene in age.

The Tottabetsu glacial stage II, however, may be in the future correlated to such terraces as are found at still lower altitudes than the so-called "lower terrace". The stage of the formation of these still lower terraces presumably belongs to the Tottabetsu glacial stage II which may be correlated to the stage of the first readvancement of ice floors in the glaciated region of north-western Europe during the Post-glacial age.

Acknowledgement

The writers are much indebted to Messrs Sumio KUMANO, Yuichirô MIURA and Susumu HONJÔ for their great assistance during the field survey. Photographs have been provided by S. KUMANO.

References

1) M. MINATO and S. HASHIMOTO: Zur Karbildung im Hidaka-Gebirge, Hokkaido, Japan. Proc. Jap. Acad., Vol. 30. 1954.
2) G. IMAMURA: The Japanese Alps and its glaciers in ice age. Tokyo. 1940.
3) M. MINATO: Zur Mammonteus Faunen Hokkaidos. Jap. Jour. Geol. Geogr. (In print)