Landforms on the Ridge of Mt. Goyo, southern Kitakami Mountains

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雑誌名	The science reports of the Tohoku University. 7th series, Geography
巻	20
号	2
ページ	237-244
発行年	1971-03
URL	http://hdl.handle.net/10097/44938

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In the southern Kitakami Mountains, pre-tertiary granitic rocks are distributed widely. Mt. Goyô is one of these granitic rock areas consisting of granitic rocks called Goyôzan granite mass (Onuki 1969). Mt. Goyô, about 12 km north of Ôfunato city, Iwate prefecture, rises like a monadnock above the surrounding summit surface of uplifted peneplain (about 700–800 m a.s.l.). The top is a relatively broad ridge line ranging about 3 km from northeast to southwest (Fig. 1). There are small hills and peaks on the ridge line, the relative heights of which are small and little varied. The elevation of the highest peak is 1341.3 m above sea level and others are about 1310 m. The relief of the ridge is so small that an individual summit surface is considered about the level. Nine hills and peaks can be distinguished within the area of our investigation. There are such landforms as tors, block streams and block fields around the hills and peaks. It is the purpose of this paper to point out the processes of the denudation of mountain ridges by means of the observation of these landforms.

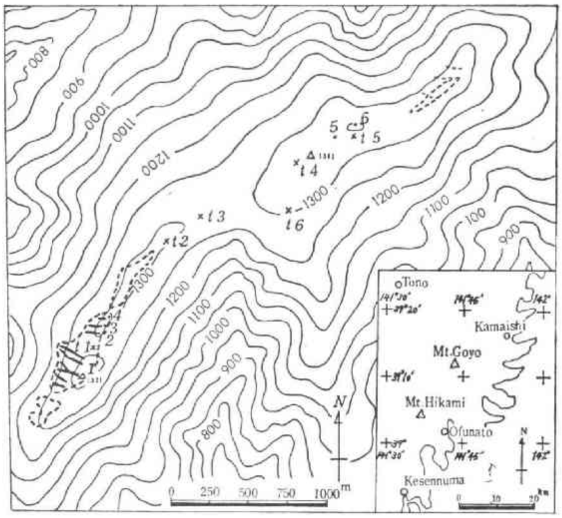

Fig. 1 Location Map Block scattering in closed broken line Bare rock masses and block concentrated belts at heavy lines

The eastern half of the ridge surface is relatively broad and smooth from ENE to WSW, but the western half is narrower and steeper from NE to SW. The slopes of the ridge are asymmetric, NW slope is gentler and SW one is steeper. Block fields and block streams are seen on the gentle part of slopes in general.

The Western Half

At the western-end appears a hill (location 1), but there are no bare rock masses as mentioned below. On all slopes many blocks are scattered forming block fields. Two conspicuous block-concentrated belts are recognized, one stretches N 70°W from the summit of this hill to the NW faced slope and the other is on the E faced mid-slope with similar feature. The former is larger and rather distinct and its long-profile is shown in Fig. 2. The upper part of this has a width of 5–10 m and convex cross section, the lower part shows concave one and broadens gradually downward. It is assumed that the concave cross section indicates the initial stage of valley head formation caused by the washing away of weathered fine materials by run off. Though these block-concentrated belts are similar to the block streams in appearance, it is not likely that they have been transported a long distance or to have been accumulated at present locations. The bare rock masses collapsed in situ, and blocks were produced. That is, the block-concentrated belts are the remains of bare rock masses in the past.

As for the size of blocks, many are 1.5–2 m in diameter and the maximum is over 4.5 m, and the thickness of blocks is not over 1 m depending on the nature of joints in the bare rock mass. Many blocks are angular but some are subangular whose edges cut round. Although the base of piling blocks can not be found, it seems to reach to a considerable depth. A pile of large blocks with many small rock fragments filling the gaps, attains a depth of about 5 m. On the hill of location 1, the land surface beside the block-concentrated belts is wholly covered with shrubs less than 1 m in height. However, soil develops poorly, and only thin humus and regolith are found on the blocks at many places.

At locations 2,3 and 4, the bare rock mass lying on the lower gentle slope has collapsed already and a block-concentrated belt as those of location 1 is formed (Fig. 2). The bare rock mass with the width 4–4.5 m at the top rises distinctly 5.5–6 m in height above the surrounding land surface and its length is measured

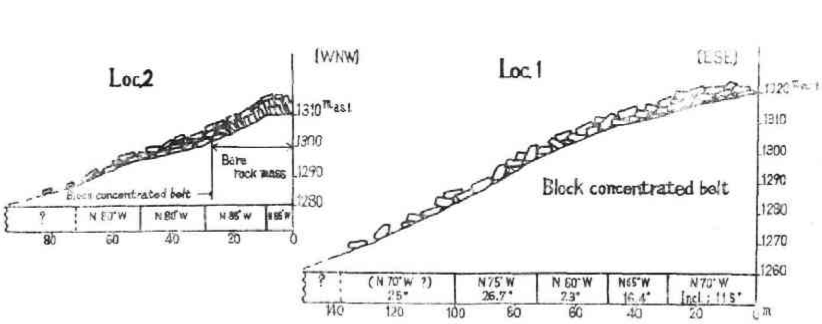

Fig. 2 Long profiles at locations 1 and 2

about 30 m. The rock mass is cut vertically (about 80°) at the joints as round slice, horizontal joints are found at the upper part. The thickness of the slice is limited 30–70 cm in size. In a ward, the rock mass has started to collapse and to produce the blocks, while the cracks along the joints are considerably widened. The top is especially loose and some blocks are stripped off.

At location 3 the bare rock mass is similar to those above-mentioned but there is no distinct block-concentrated belt. The rock mass protrudes about 5 m high and its top is 4–7 m and 40 m in width and length respectively.

At location 4, there is a little protruding rock mass which seems to be in an early stage of exhumation process from the sub-surface, and the bare head of the rock mass 3×30 m in dimension appears only at the top. Its NW slope is covered with dence vegetation and separate blocks are not apparent. At the opposite side vertical fresh rock wall is exposed 3 m high and with E-W orientation, being the upper part of the rock mass. This exposed rock is cut by joint systems as mentioned above. However, it is remarkable that the cracks along the joints are not developed yet and the exposed rock surface appears relatively fresh.

The Eastern Half

There is no distinct bare rock mass protrusion on the eastern half of the ridge which is relatively broad and gentle, but blocks are scattered here and there. They are rather small and round, and are more sparse than those of the western half. A small head of rock mass extends E-W in direction to the east of the top summit of Mt. Goyô (location 5), where bare rock surface with width of about 3 m and the length of about 10 m is exposed but the exhumation of rock mass does not occur. At location 6, there is a rather small rock mass protrusion about 3–4 m high standing on the shoulder between the gentle ridge slope and the steep mountain flank like a stack or a tower. According to air-photos, there are no conspicuous rock masses or block fields such as those of the western half beyond this location, but there are some stack-like bare rock mass protrusions, covered with the forest dominated by *Tsuga diversifolia Max.*, while, the vegetation to the west of the location is consisted of shurbs or grasses.

Surface Materials

Soil formation is very poor in block-concentrated belts and in areas of rock masses, where a little fine weathered granitic and humic materials are sticked upon the bare block surfaces with the plant root system. On the contrary, soil develops well on the cols among peaks of the western half and on the broad ridge slope. Six trenches are digged for soil profile observation at the col between small peaks or on the gentle slope. These trench sites are not so inclined (2°–8°) and covered with shrubs and grasses except the trench 5. Profiles of surface materials are shown in Fig. 3. All the lowest horizons consist of weathered granitic sandy materials including many rock fragments and mica flakes. At trench 4 and 5 in the eastern half, weathered core stones like boulder are excavated from the same

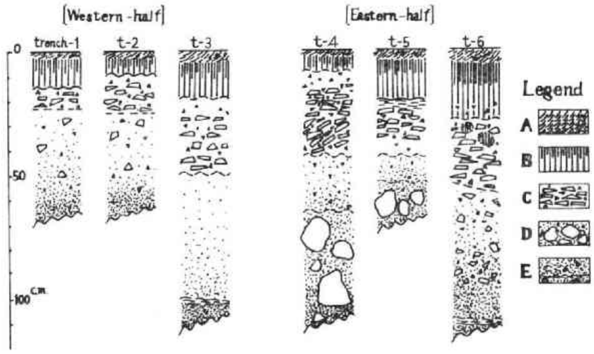

Fig. 3 Columnar profiles of surface materials
A: Litter B: Surface soil C: Fresh rock fragments D: Core stone E: Sandy materials

horizons. It is uncertain whether such core stones are originated from the weathered bedrock or from the separate blocks, for the trenches were not large enough to decide the origin. It is noticeable that relatively fresh rock fragments originated from blocks or core stones in lower horizons are accumulated closely under the surface humus horizon in all profiles. They are fresh and platy (5–10 cm in diameter), and are deposited horizontally. This peculiar depositional facies is distinct at trenches 4,5 and 6. Thus, there are two materials which indicate different weathering processes, one is core stone which suggests the advance of sub-surface weathering, and the other is fresh rock fragments. The horizontal arrangement of rock fragments is probably caused by the movement of materials near the surface. But, it is not obvious whether this movement is directly related to the process of rock mass exhumation during the latest time or not.

Denudation Process

The landforms such as bare rock masses, scattered block fields and block-concentrated belts seem to correspond to the phases of denudation processes of the mountain ridge.

Partial weathering of granite mass of bedrock proceeds in the first phase, and unweathered rock mass and weathered materials are differentiated. Judging from the almost similar directions of rock masses or the block-concentrated belts and their long extension, the pattern of sub-surface weathering seems to be directly influenced by the structure of bedrock. But actual process in this phase is not clear with the collected field data.

The second phase is a dynamic process, for instance, rock mass exhumation and protrusion, rock mass collapsing and block field formation. The important process in this phase is the removing of weathered materials. Location 4 is in the early stage of the protrusion, location 3 is in the full stage and location 2 has already been in the collapse stage. The block field of location 1 is in the far advanced stage of this phase. The block-concentrated belts are the disintegrated rock masses in origin. While these phases, the land surface is lowered, that is, the denudation process.

The chemical weathering is dominant process in the third phase, when, subaerial weathering and removing of materials in short range are rather dominant than the lowering of land surface. The eastern half of the ridge seems to be in this phase.

Following problems are still unsolved; 1) whether differential weathering actually took place in the past or not. 2) whether each process such as weathered materials elimination or rock mass protrusion, is periodical one or not. 3) whether such landform processes are correlated with the climatic changes during late Pleistocene or not.

The writers would like to acknowledge the continuing guidance of Prof. K. Nishimura and wish to thank Mr. H. Makita Institute of Geography, Tohoku Univ., for his advice in field.

Reference

Onuki, Y. (1969): Geology of the Kitakami Massif, Northeast Japan Tohoku Univ., Inst. Geol. Pal., Contr. **69**, 239 ps.

Photo 1 A view of western half from eastern half

Photo 2 A block-concentrated belt on E faced mid-slope (A) at location 1. Barerock mass (B) and collapsed rock mass (C) at location 2

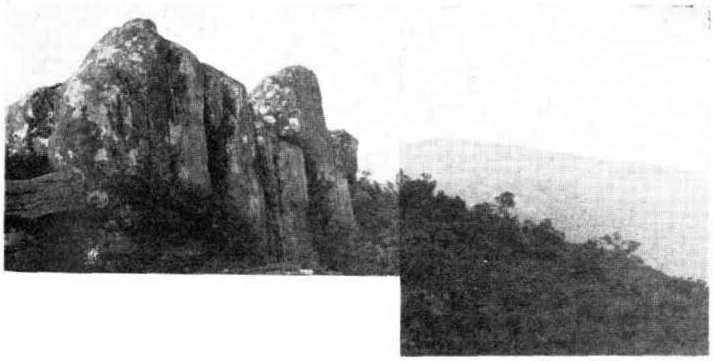

Photo 3 Vertical rock wall of a rock mass at location 4

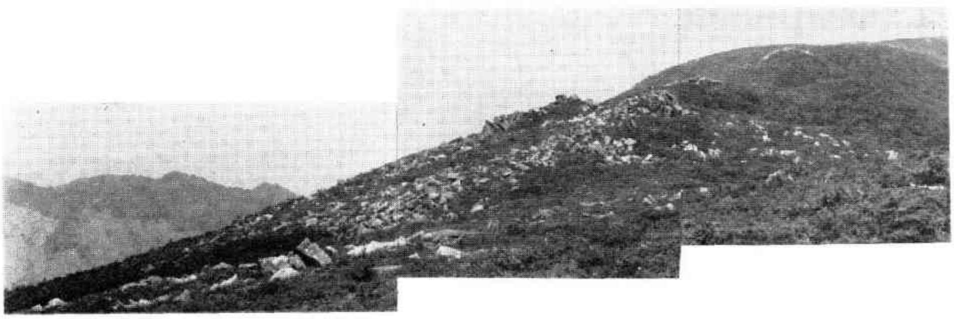

Photo 4 Protrusions and collapses of rock mass