Geomorphic Evolution in the Northern Fringe of the Abukuma Mountains

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Yoshio NAKAMURA*

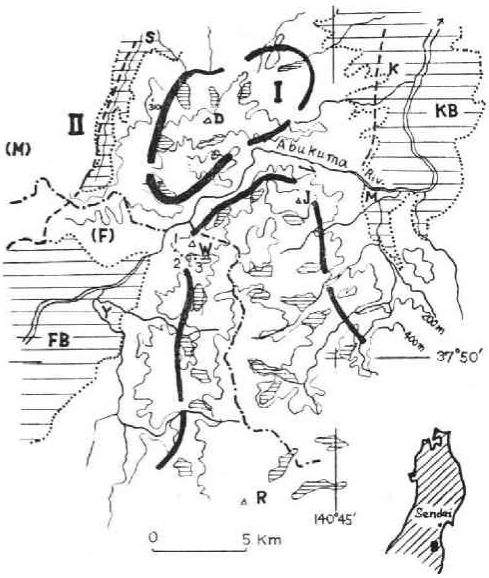
1 General landscapes

The Abukuma river, stretching for 225 km, the third in length in Tohoku, crosses over the northern part of the Abukuma mountains, where the river makes a deep gorge with steep cliffs about 200 m high along the valley, 10 km in distance from Yanagawa, northeastern corner of Fukushima basin, to Marumori, southwestern corner of Kakuda basin, Miyagi Prefecture. Apparently this gorge, so-called "Abukuma-Rhein" in a current sight seeing sense, is regarded as a typical landform of an antecedent valley, for the Abukuma mountains, about 400 m in the average elevation at the northern part, is an uplifted mountain block of former peneplain formed in late Tertiary (Nakamura 1960). Along the upper reach of the Abukuma river, on the other hand, the flat floor of Fukushima basin extends widely, only 80–40 m in elevation, resulting from a remarkable depression of the basin as a part of Morioka-Shirakawa lowland.

Subsequently here arises an interesting evolution of landforms after the incision of the Abukuma river, in other words, after the formation or completion of the Abukuma valley in this section. Any landform in this region is more or less necessarily concerned with the regime that it must evolve itself within the range of relief between the summit level of the Abukuma peneplain and the valley level of the Abukuma river controlling the height of the floor of Fukushima basin. Thus the present landscapes of the northern fringe of the Abukuma mountains here limited for the area adjacent to the Abukuma valley have been settled under erosional operation which basically reduces the initial relief about 400 m by means of several processes of denudation. If the Abukuma river had flowed near the present course before the uplift of the mountains, we can find some evidences like as river terraces. To the present, however, we have not found anything but topographic profiles, which suggest such a geomorphic occurrence.

This large scale upheaval of the mountains presumably preceded the depression of the upper reach of the Abukuma river to form Fukushima basin, resulting in deposition of a large quantity of Pleistocene deposits (Yoshida *et al.* 1969). The landform of this region thus have been settled in the erosional area in longer

* Department of Geography, Faculty of Education, Fukushima University, Fukushima



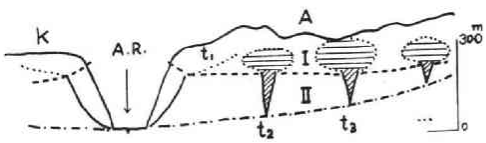


Fig. 2 A schematic profile illustrating the separation of the Kakuda hills (K) from the northern part of the Abukuma mountains (A) by the Abukuma river valley (A.R.), and the geomorphic differentiation to I (undulating area) and II (rugged area) in vertical relation; t_1, t_2.... tributaries to the Abukuma river

Fig. 1 Distribution of the intermontane erosional basins in the northern part of the Abukuma mountains
I: basins (in fine stripe) distribution area=undulating area
II: basins lacking area=rugged area
D Mt. Dôyama, 350 m J Mt. Jirôtarô, 529 m R Mt. Ryôzen, 805 m
W Mt. Wada, 336 m K Kakuda M Marumori S Shiroishi Y Yanagawa
FB Fukushima basin KB Kakuda basin
(F) Fukushima Prefecture (M) Miyagi Prefecture
1–3: location number correlative in Photos 1—4, Contour lines: 200 m and 400 m

time equivalent to whole Pleistocene period, and a landform differentiation has occurred to produce the present appearance of topography in the same duration.

2 Small basins, ravines, undulating reliefs, and some features of the northern Abukuma plateau

As well as many summits and ridges in accordant height about 400–500 m, there are a number of small intermontane basins, with floors about 300 m high and only a few hundred meters wide (Fig. 1). They are erosional basins developing along middle and upper reaches of small tributaries. The small tributary valleys transform themselves from shallow-open profile to V-shaped one, and their streams become rapids or ravines at remarkable knickpoints. The accordant height of basin floors and almost completely preserved basin forms suggest so rapid upheaval of the mountains that it did not disturb the process of small-basin forming. Streams of these small valleys, with their feeble ability of downcutting, could not exceed the uplift, while, in the upper reaches the surface

Photo 1 Colluvium at Loc. 1, covering the granite bedrock, gravels are mainly basaltic rocks tumbled down from the upslope.

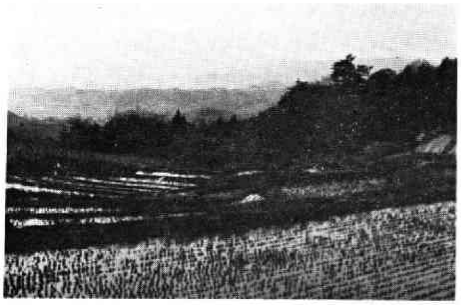


Photo 2 A view of the high-level valley at Loc. 2, rice fields stretching to near the divide; viewed downstreamward

Photo 3 A front of headward erosion of a tributary in attack to the bottom floor of the high-level valley, near Loc. 2

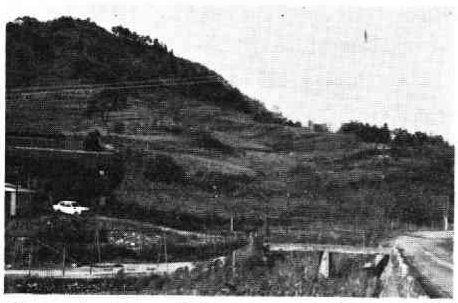


Photo 4 An undulating landscape of the hillslope surrounding the small intermontane basin at Yokeishi, Loc. 3

denudation aided to enlarge the basin floor by active mass wasting in stead of linear erosion (Fig. 2).

Morphologically speaking, if rejuvenation does not reach these small basins retreating knickpoint with violent downcutting, the intermontane basins above the knickpoint of valleys, are continuing their enlargement. Fortunately, the writer supposes, following three conditions play important role in this region for development and conservation of the basins: (1) rapid and large scale uplift compared to the small scale of tributaries, (2) favorable situation that there had been developed a peneplain as an initial surface, and that the Abukuma river was powerful enough to overcome the uplift of bedrock, and (3) in addition to them, most part of the region consists of granite which seems to be resistant to linear erosion, but to be susceptible to weathering and mass wasting. The third condition may be expressed as a result of rock control. The present writer would propose here a concept of differential effect of rocks for each different denudation process, for

example, like as described above (3).

Along the southwestern mid-slopes of Mt. Wada (336 m), a path has recently been constructed for traffic, and we can see there some favorable outcrops suggesting an aspect of landform evolution of this region. At a fresh cutting (Photo 1), it is observed that granite bedrock is covered with gravels in certain thickness. The gravels are composed chiefly of angular fragments of poorly weathered basaltic rocks, and comprise some beds of coarse sand. These non-granitic rocks, or debris, were deposited on this location after tumbling down from the upslope of Mt. Wada whose most part consists of Miocene basaltic agglomerate belonging to Ryôzen group (Suzuki *et al.* 1972). The boundary between gravels and bedrock is strikingly clear, and this means that the gravels deposited after, or at the same time, somewhat vigorous denudation of the weathered crust of bedrocks. Moreover, the gravels deposited not always continuous or in uniform rate, as they imply thin beds of sand. Such deposits are observed at many locations in this region, therefore the writer describes them collectively as colluvium.

A "high-level valley" was found at Loc. 2 near Yokeishi (Photos 2 and 3), where hillslopes gradually continue to the valley floor, and the valley floor is so gentle and flat as to be used for rice field. As well as in other cases of high-level valleys (Nakamura 1969), the valley floor is abruptly cut by *Kerbtal* where a stream channel emerges on the shallow bottom of *Muldental*. The uppermost reach of this high-level valley stretches about 100 m to the foot slope of surrounding hills.

There is a question whether such a valley is relict of former cycle of erosion or not. Surely, supposed base level was higher than of the present, but notwithstanding, the valleys rising on the higher location must take a form of "high-level valley" even if they are formed at present. Accordingly the writer proposed that valley (or slope) feature depends upon the locational situation where it is initially formed (Nakamura 1973).

3 Morphology of hillslopes as an element of undulating feature

It is supported by detailed observation at some cuttings that the present gentle form of hillslopes in this region is a result of weathering and mass movement of weathered materials. The slopes are, as shown in Photo 1 and described above, covered with colluvium in various thickness. Although their feature looks like a kind of block stream, the deposits on slopes are different from the materials of block stream in regard to facies and component. Rock fragments composing the colluvium are very small as much as 3–5 cm in diameter, sometimes interbedded with lenses of sand, but, on the other hand, block streams bring more gigant blocks (Matsumoto 1963, 1964 and 1971). To the writer's presumption, these

small fragments are surely product of severe weathering under somewhat drier, of course much colder climate, where bared hillslopes or crest slopes suffered with violent mechanical weathering. Even under the present climate, such weathering process and resulting geomorphic change are often observed at some mountain regions, for example, near the crest of Mt. Monomi (Taneyama), and on the upslope of Mt. Kabutomyôjin in the Kitakami mountains (Nakamura 1963). As the writer reported on the Kitakami mountains, tor-like knolls exposing on the tops of the mountains are producing rather fine fragments of weathered rock which are easily removed downslopeward without fluvial action. Subsequently a thin veneer of rock fragments is covering the hill side slopes just observed here at present.

The hillslopes spreading in the northern Abukuma mountains are one of important elements of the undulating feature, in regard that they are covered with colluvium and that, therefore, they are included in the area of surface denudation rather than of linear erosion.

4 Kakuda hills as a part of the Abukuma mountains

Kakuda hills are subdivided into two sections after the relief pattern (Nakamura 1964 and Nishimura *et al.* 1972). The southern half, 300–250 m high and descending northward, mostly consists of granite, and partly of Miocene volcanic rocks, hence this section belongs to the Abukuma mountains. This is separated by the incised stream of the Abukuma river from the core area of the Abukuma mountains. The northern half, about 200 m high, however, consists of sedimentary rocks of Neogene, and is densely dissected to a rugged topography with moderate relief. The dissection landscape of this section is common to the Tertiary hills developing in Miyagi and Iwate Prefectures along the eastern piedmont of the Ôu backbone range, and in many other areas of Tertiary rocks in Tohoku.

Now, similar to the Abukuma mountains proper, the southern section of the Kakuda hills also contain many intermontane erosional basins, with the floor about 200 m high. The distribution area of small basins is free from rejuvenation of erosion through ravines branching from the present Abukuma river, and the basins belong to undulating area together with the surrounding hillslopes.

5 Geomorphic evolution and differentiation — Conclusion

Before the uplift of the Abukuma mountains and the following incision of the Abukuma river, this region was supposedly low relief area with undulating feature. The rapid uplift about 200 m in relative height and the resulting incision of the river divided this initially uniform region into two subregions. The one is the undulating area of low relief and surface denudation preserved, where many

erosional basins have developed here and there, under process of enlargement even at the present. Another is the rugged area with steep escarpments of the Abukuma valley wall, V-shaped tributary valleys and many ravines. As a distinctive indicator for the boundary between them, knickpoints on valley floor and a series of gorges at the middle reach of valleys are pointed out.

Especially this section of the northern part of the Abukuma mountains is much favorable to recognize such morphological differentiation after the writer's concern, owing to the fact that the relationship of geomorphic evolution to geology and tectonics could be understood in rather simple terms for this region.

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