Pediment in the Taean Peninsula and the Yeongsan River Basin, Korea

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Yoshihiko AKAGI

I Introduction

Erosion surfaces like steps can be found in the Korean peninsula. The lowest erosion surface extending from near Pyeongyang to Kwangju along the west coast, is the widest. This surface has been considered to be a marginal peneplain. However F. Tada (1942) has pointed out that a pediment-like morphology has developed on this erosion surface. The results of the author's study of pediments in Korea (Akagi, 1965) based on the topographical and geological maps can be summarized as follows:

1) In Korea, pediments are generally found in granitic areas with an overlying hardrock cover, where the local base-level is relatively stable and the relative relief is large. Hence, pediments have developed in Central and more predominantly in South of the Peninsula.

2) The erosion surfaces are classified into three levels: over 800 meters in altitude, about 500 meters and under 200 meters.

3) The pediments are classified into two levels. The upper pediments are correlated with the middle erosion surface while the lower pediments are correlated with the lower erosion surface.

4) The pediments develop either in basins, or at the lower margins of the steep slopes which divide the erosion surfaces, or around the residual mountains above the erosion surfaces. The first belongs to the early stage of pedimentation, the second to the middle stage and the third to the last stage.

5) Pedimentation has ceased and the pediment surfaces have been dissected by streamlets.

6) The landforms and geological setting of the pediments in Korea, resemble those found in the Chugoku Mountains of Southwestern Japan (Akagi, 1961.1962), but they are larger in scale than the latter.

In August 1970, the writer had the opportunity to observe Korean pediments near Namweon and Kwangju. In these areas pediments truncating on granite have been dissected by streamlets. Fossilized blockstreams sweeping from the mountain flanks flow the streamlets which dissect the pediment (Akagi, 1971).

Chai Hoon Chang (1966.1972) surveyed gentle piedmont slopes truncating on granite near Gurye, Techeon, Chungju and Namweon. He supposed that these

slopes are pediments which had been formed under more arid climate than that of the present, because the shapes of these slopes are similar to those pediments which are nowadays developing in arid and semi-arid climates.

Sang Ho Kim (1966) studied gentle piedmont slopes truncating on gneiss near Seoul. By their shape and deposits he, too, supposed that these gentle slopes were pediments and had developed under more arid climate than that of the present. He further studied the erosion surfaces in Central Korea and concluded as follows (Kim, 1973):

1) These erosion surfaces can be classified into three levels. Regarding their distribution, the upper erosion surface can sometimes be seen at the altitude of 500 meters. However it also prevails on the summit areas of the Taebek Mountains which reach the altitude of 900 meters. The middle erosion surface develops on granite area between 300 and 700 meters in altitude and exists as erosional basins surrounded by the upper erosion surface. The lower surface as found in the Taebek Mountains forms a marginal area less than 300 meters in altitude.

2) The middle and lower erosion surfaces are judged to be pediment remnants

Fig. 1 Location map

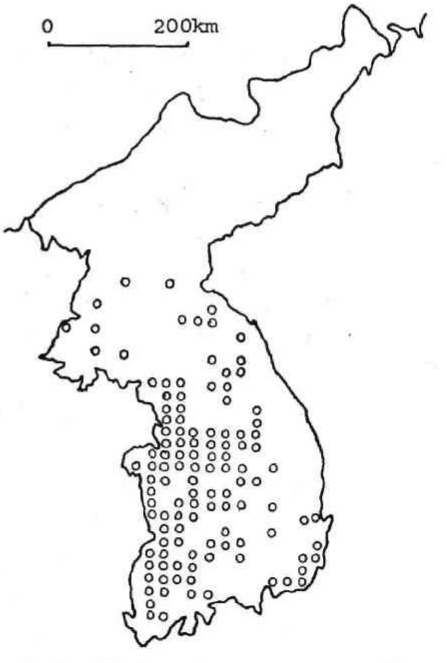

Fig. 2 Distribution of pediment in the Korean Peninsula

connecting the accordant summit levels of the undulating hills and the slope profile from the gentle piedmont slope surface to the mountain front, whereas the upper erosion surface is the endform of the humid erosional cycle.

Pediments are distributed broadly in the Korean Peninsula from Suweon to the Taean Peninsula, from Kunsan to Iri and in the Yeongsan River Basin (Fig. 2). These pediments are classified as lower erosion surfaces. In this paper the writer discusses pediments in the Taean Peninsula and the Yeongsan River Basin as examples of Korean large-scale pediments.

II Description

1 Pediments in the Taean Peninsula

The Taean Peninsula is about 80 km south-south-west of Seoul. The Gaya Mountains, about 30 km long and 10 km wide, is situated in the center of the Peninsula, while the Palbong Mountains which is smaller, is situated in the west. The pediments and pediplains that have developed, surround these two mountain-chains and terminate at the coast.

1) *Pediments in the Seosan Area*

The Seosan area is located between the Gaya and the Palbong Mountains (Fig. 3). Pediments in this area are surrounded by mountains on three sides (Fig. 4, Photo 1). Pediplains are found in the central part of this area.

Geologically, the pediments and the pediplains are composed of coarse crystalized granite and almost all part of the Gaya Mountains are composed of fine crystalized granite that intruded in the late-Cretaceous period. The mountains surrounding these pediments and pediplains are composed of Pre-Cambrian gneiss. Mt. Dobi, composed of green schist, stands in south-west corner of this area (Tokyo Geographical Society 1954–1956: Geological Maps of East-Asia, on a scale of 1: 250,000).

The pediment is 2–3 km in length. The upper part of the pediments are 6°–8° in gradient, while several hundreds meters distant from the upper ends, gradient of 3°–5° are found. In the middle and lower parts gradients are generally less than 1°. The mountain slopes are inclined at an angle of 20°–25° from the pediments. The knickpoints are between 60–80 meters above sea level, while at the coast the height of pediment-end is 20 meters above sea level (Photo 2). The foot of the escarpment forms a straight line bounded with the pediment. These pediplains, on which small inselbergs and knolls can be seen, are distributed from the central part to coast in this area. The pediments have been dissected to a depth of 10–20 meters by rivers and streamlets. Thus, in many cases, original

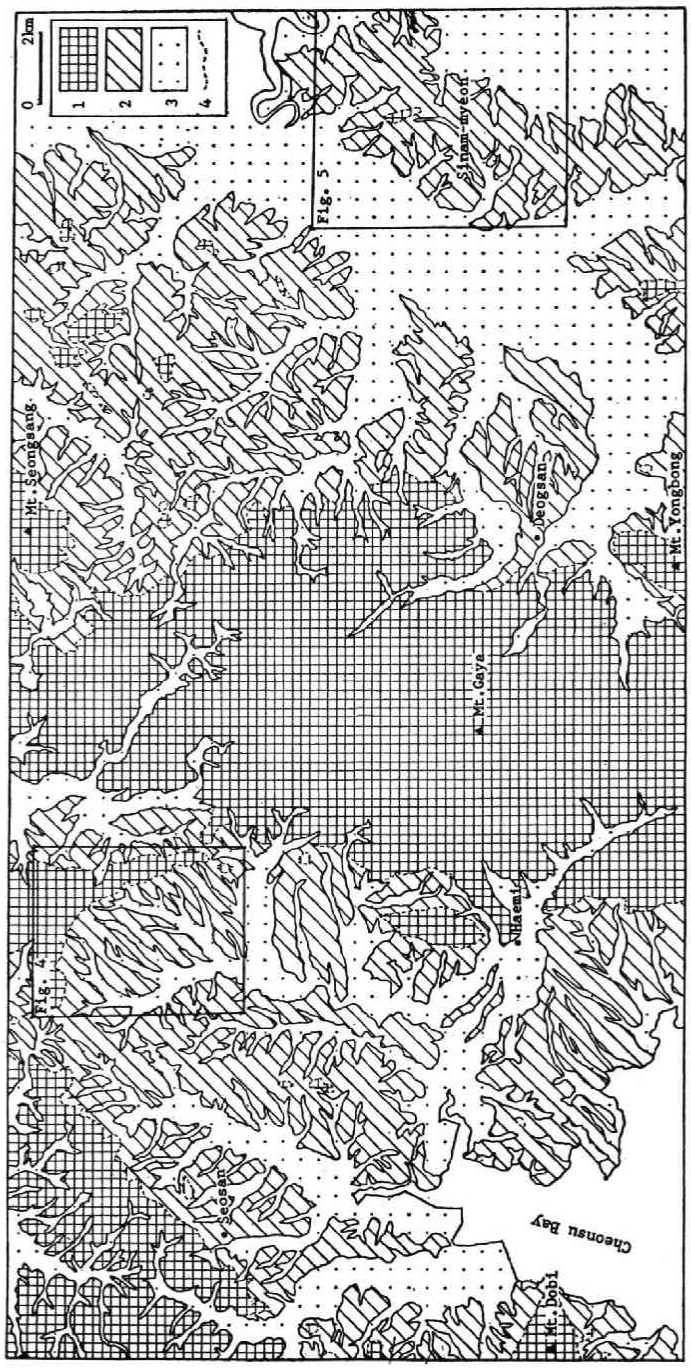

Fig. 3 Geomorphological map of the Taean Peninsula
1: Mountainous area 2: Pediment and pediplain 3: Alluvial plain 4: Inner boundary of pediment

Fig. 4 Topographic map of the northern part of Seosan area

pediment surfaces remain only in the upper and middle parts. The pediments are generally covered with a veneer of boulders, cobbles and coarse sand about 2 meters in depth. The bedding, sorting and roundness of these materials are not remarkable. The soil cover on this veneer is about 1 meter in depth (Photo 3). Basement granite has been weathered to a depth of more than 20 meters, but there is not soil (or A and B horizons of pedology) under the veneer. The upper parts of the basement granite are similar to Zone 1 of the weathering zones as defined by B. Ruxton and L. Berry (1957). The veneer and basement granite have been dyed reddish to the depth of 4–5 meters.

A large-scale block field is on the north-north-east facing slope, of Mt. Dobi which is composed of green schist. It is about 4 km wide, and between 500–600 meters long (from upper end to lower one). This block field originates in the

middle part of the mountain slope, where the gradient is less than 20°, and sweeps down to the upper part of the pediment and/or streamlets dissecting the pediment (Photo 4). On the upper part of this mountain slope many large rocks resembling tors stand up to several meters above the slope. These blocks, composed of green schist, are generally 1–4 meters in diameter and sub-angular in shape. This fossilized block field is covered with bushes and trees. In part of this block field the blocks are concentrated like blockstream (Photo 5). Isolated blocks are also found on a slope facing south-south-west, but not in sufficient concentrations to form block field or block stream.

2) *Pediments in the Deogsan Area*

Pediments in this area extend eastward from the foot of the Gaya Mountains and pediplains are among these pediments at Asan Bay and Muhan River (Fig. 3). This area is composed of granite of the late-Cretaceous period in geology, but the difference in crystal size influences landforms. Slope forms change abruptly at the variation of crystal size in a narrow extent, whereas the change is less pronounced, where the size of the crystal is less marked.

Mt. Yongbong, located in the south-west corner of this area, rises sharply 250–300 meters above the pediment. In longitudinal profile, the pediment has a gradient of 8° in the upper parts and 1° or less in middle and lower parts. From the pediment the mountain flank is inclined at an angle of between 25°–30° (Photo 6). The foot of the mountain has a straight outline. A veneer of boulders, cobbles and coarse sand is found only on the upper part of the pediment.

Mt. Seongsang located in the north-west corner of this area, also rises steeply above the surrounding pediment. The pediment is about 3 km in length and the inclination is almost the same as that of Mt. Yongbong. This pediment is covered with soil to the depth of aproximately 1 meter and underlying veneer 1–2 meters in depth.

Several embayments have found in the Gaya Mountains between Mt. Yongbong and Mt. Seongsang. Hence the mountain slope is gentler than that of Mt. Yongbong and Mt. Seongsang and thus the angle between the mountain slope and the pediment is not so abrupt. The angle of this slope may be attributed to a change in the crystal size of the basement granite.

The Sinam-myeon pediplain (Temporarily named by the writer) is between the Sabkyo and the Muhan Rivers. An inselberg, about 1500 meters long, and 500 meters wide, projects about 50 meters above this pediplain whose altitude is between 20–40 meters above sea level (Fig. 5. Photo 9). This pediplain surface is slightly undulated due to erosional forces acting on it following pedimentation.

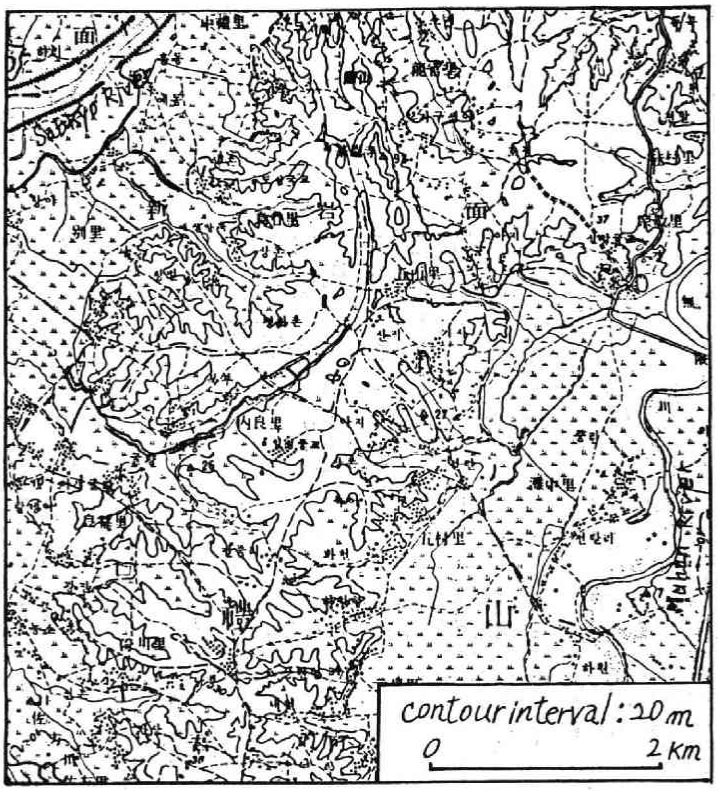

Fig. 5 Topographic map of Sinam-myeon

Except in the north-east part of this pediplain, where the veneer is composed of cobbles and coarse sand 2 meters in thickness, veneers are not found (Photo 7). Bedding and sorting of the material comprising this veneer is not evident. The veneer is covered with soil 1 meter thick.

2 Pediments in the Yeongsan River Basin

The Yeongsan River, located in the south-western part of Korea, is about 80 km long and flows from the north-east to the south-west. There are middle and lower erosion surfaces in this area. Above the middle erosion surface there can be seen mountains, such as Mt. Moodeung, whose summits are correlated with the upper erosion surface. Landforms in this district are influenced by geological structure alternating with gneiss and shistose rock, and granite in direction of north-east to south-west, that is, mountainous areas are composed of gneiss and schistose rock, whereas pediment and pediplain are of granite. The pediment and the pediplain are 10–15 km wide along the main course of the Yeongsan River and

4–6 km wide along its tributaries. Near Damyang the upper end of the pediment is 100 meters above sea level, while the lower end is 50 meters above sea level. And the river floor is 30 meters above sea level. Damyang is located at the upper course of the Yeongsan River. At the mouth of this river the height of the upper end of the pediment is 50 meters, while the height of the lower end is 20 meters

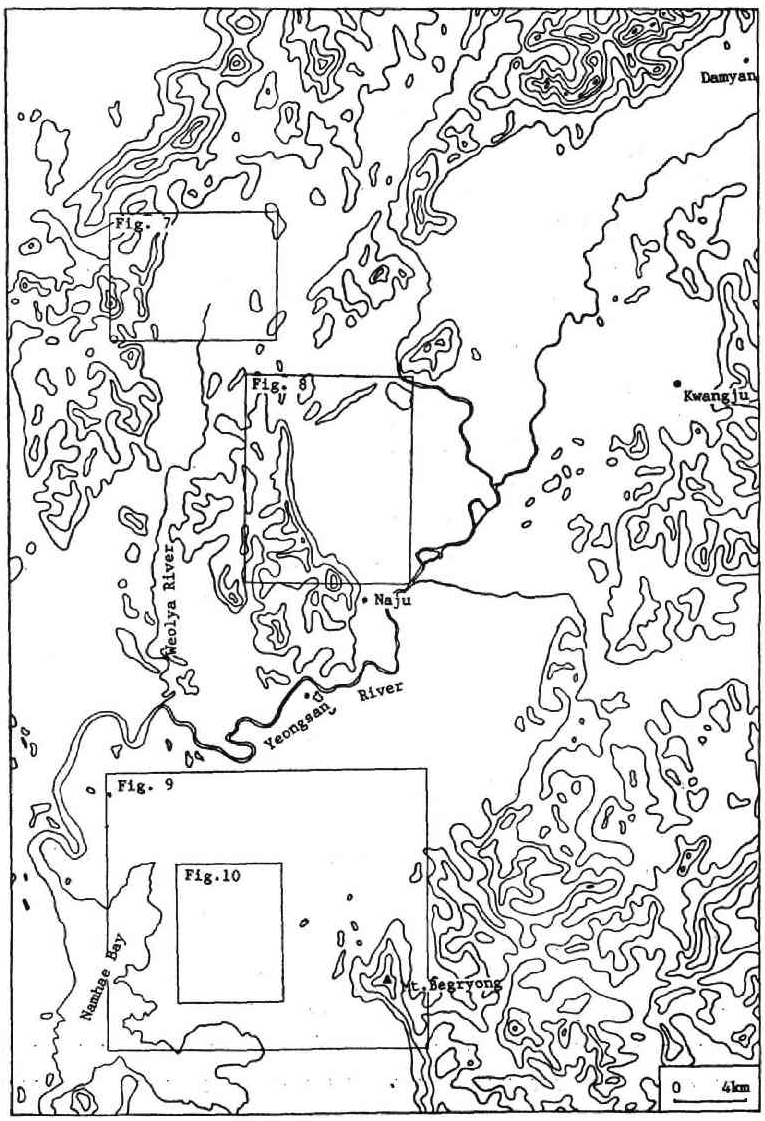

Fig. 6 Summit level in the Yeongsan River Basin, Contour Interval: 100 meters

above sea level. Alluvial plains 1–3 km wide, are found along the Yeongsan River and its tributaries. Pediments and pediplains have been formed on the exposed parts of coarse crystallized granite.

1) *Pediments in the Weolya Area*

This area is situated at the upper part of the Weolya River, a tributary of the Yeongsan River (Fig. 6, 7). The landforms in this area have been influenced by geology. The mountainous western part of this area is composed of gneiss, while the eastern part, composed of granite, forms pediment and pediplain (Photo 8,10). The lithological boundary of these rocks lies in the middle part of the escarpment behind the pediment and is about 150 meters above sea level. The upper end of the pediment is 100 meters above sea level and lower end 40 meters above sea level. The pediment has been dissected 10–20 meters in depth by streamlets. The width of this pediment varies from 4 km in the north to 2 km in the south. This difference in length is controlled by the existence of gneiss. A longitudinal profile shows that the escarpment is inclined at angle of 25°–30° with the pediment and that the upper part of the pediment has a gradient of 8°–10° which decreases to 3°–4°. The gradient of the middle and lower pediment is 1°

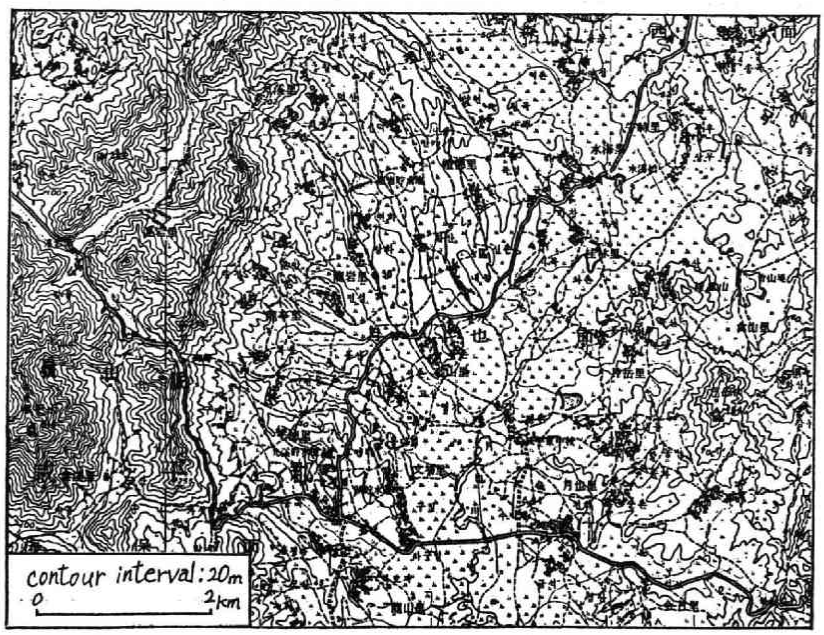

Fig. 7 Topographic map of Weolya-myeon

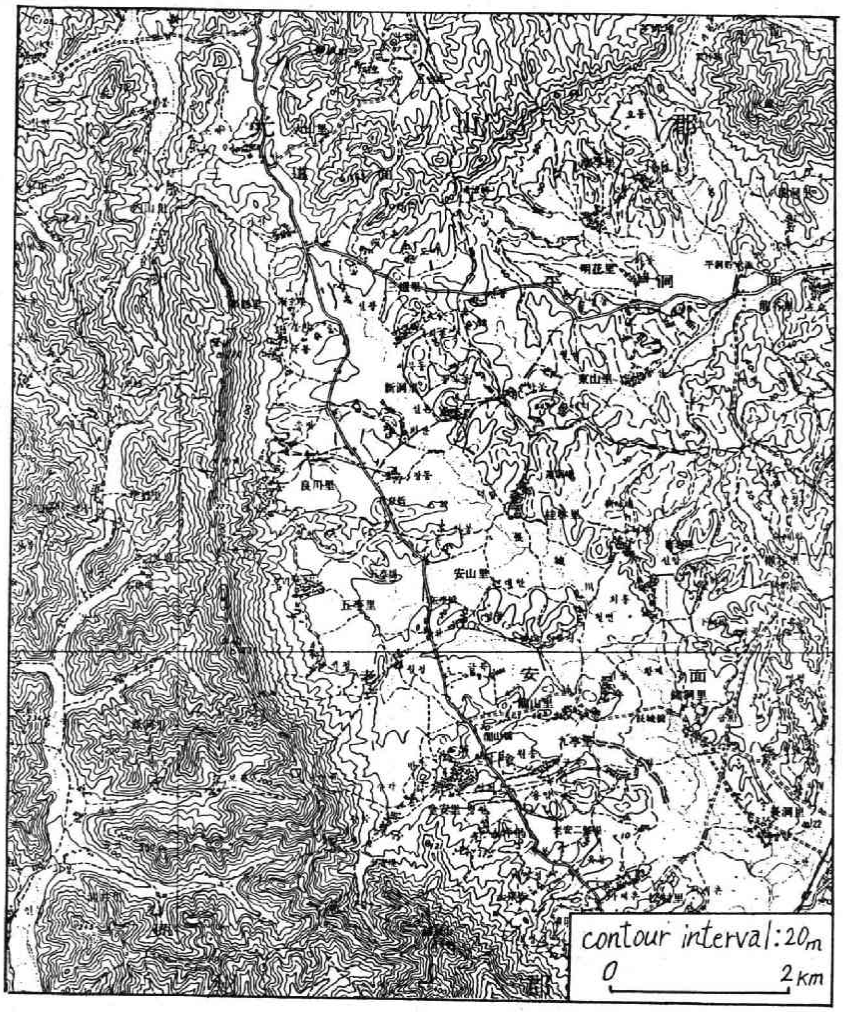

Fig. 8 Topographic map of Naju area

or less. On the greater part of this pediment, the veneer is 1.5–2 meters in thickness. On the upper part of the pediment the debris is 15–20 centimeters in diameter while on the lower part it decreases to 5 centimeters in diameter. The roundness of the debris on this lower slope is remarkable (Photo 11).

2) *Pediments in the Naju Area*

This area is 15 km south-west-west of the city of Kwanju. Its western part is mountainous similar to that found in the Weolya area. Pediment and pediplain

have developed between this mountainous area and the Yeongsan River (Fig. 6. 8). The mountainous area is composed of rhyolite and the pediment and pediplain area of coarse crystalized granite. The longitudinal profile can be divided into three sections: Firstly, the upper slopes of the mountain with a slope angle of more than 30°; secondly, the mid-slope, where the angle is between 23°–24°; and thirdly gently sloping pediment. The upper part of the pediment has a slope of 12° but in short distance this slope decreases to 5°, however the greater part of the slope has a gradient of between 1°–3° (Photo 14). Dissection of the pediment is so intense that little veneer is evident.

A block field is located on the mid-slope behind the pediment. This block field, although not as large as that found on Mt. Dobi, is similar in form. The rhyolite blocks are 2–3 meters in diameter, and the field is covered with vegetation (Photo 12).

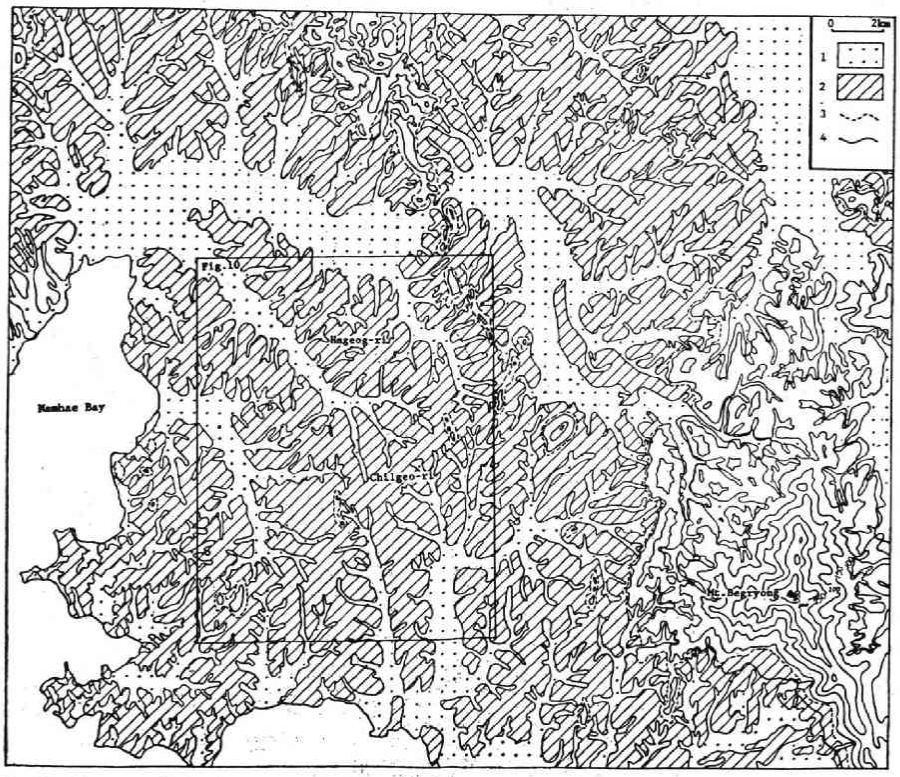

Fig. 9 Geomorphological map of Yeongsan area
1: Alluvial plain 2: Pediment and pediplain 3: Inner boundary of pediment 4: Contour Line (Contour Interval: 50 meters)

3) *Pediplain in the Yeongsan Area*

Typical pediplains are found between the Yeongsan River and a line that would links the city of Kwangju with Mt. Begryong (Fig. 6·9). To the east of this

Fig. 10 Topographic map of Yeongsan area

line lie mountains composed of Mesozoic formations. To the west of the line is the pediment composed of coarse crystalized granite, and inselbergs composed of rhyolite and diabase. These inselbergs rising above the pediplain are small with the exception of Mt. Begryong which is located in the south-east corner of the area. As shown in Fig. 9, most of the Yeongsan area is pediplain and alluvial plain. The height of the lower end of pediplains is 20 meters above sea level, and their inclination is less than 1°. Near Hngdeog-ri and Chilgeo-ri original surfaces of the pediplain remain (Fig. 10, Photo 13·15). On this surface veneers are not evident.

III Conclusion

As above described, pediments and pediplains in the Taean Peninsula and the Yeongsan River Basin are almost the same in shape, geological setting and other features. In general, pediment are 3–4 km in length, with gradient of between 8°–10° on the upper part occasionally 12° within 500–600 meters of the knickpoint to 4°–5°. The lower parts become less slope, generally 1° or less than 1°. The longitudinal profiles of the pediments are slightly concave. Inclination of the escarpments behind the pediments are 20°–25°, becoming 25°–30° on the upper slope and occasionally 35°. The majority of pediments are covered with a veneer of boulders, cobbles, coarse sand, whose bedding and sorting are not evident. This veneer is, in general, about 2 meters in depth. The surface of the granitic bedrock is almost parallel with those of the pediments. In general, no deposits remain on the pediplains. The pediment and pediplains are dissected by rivers and streamlets to a depth of 10–20 meters.

In the Taean Peninsula and the Yeongsan River Basin pediments are found only on granite, as the southern part of the Korean Peninsula (Akagi, 1965·1971, Chang, 1966.1972) and Japan (Akagi, 1972). This fact indicates that the factor controlling pedimentation in these areas is lithology. In general, the granitic bedrocks underlying the pediments are weathered to the depth of more than 20 meters, however some areas the bedrock is not weathered. Quarries are located on these solid bedrocks. Differences in the degree of bedrock weathering are not reflected in the shape of the pediment. The lacking of soil of the bedrocks covered with deposits, and the weathered upper parts of bedrocks like Zone I defined by B. Ruxton and L. Berry (1957), instruct that the chemical weathering into granitic bedrocks started after the ceace of pedimentation truncating solid bedrocks. The facies of the deposits on these pediments resemble those found on pediments developing in arid and semi-arid regions nowadays.

It is well recognized that arid and semi-arid climates are favourable for

pedimentation. And there are two kind of rocks favourable and unfavourable for pedimentation. Granitic rocks belong to the former as indicated by A. Lawson (1915), W.M. Davis (1933), Y. Tuan (1959), Mammerichx (1964) and others.

From the above mentioned facts, the writer has proposed that in the relationship between the genesis of the pediment and the climatic lithologic effect, climate is the most important factor for pedimentation. Then, 1) under arid and semi-arid climates, the lithological factor is inactive. 2) As the climate becomes more humid, lithology becomes important and pediments develop only on favourable rocks such as granite. 3) As the humidity increases the pediment cannot be found at all. In the southern part of the Korean Peninsula and Japan pediment were formed when the climate was in condition 2). Today condition 3) persists.

It can be seen that the gradients of the escarpments behind the pediments have been constant during the early and late stages of pedimentation. From the fact it may come to a conclusion that the pediments have been formed by the parallel retreat of the escarpments.

Judging from the relationship between pediments and terraces, and volcanic deposits (Akagi, 1972), the writer proposes that in Japan pedimentation stopped not later than the beginning of the Würm Glacial Age. It is difficult to determine the period of pedimentation in the Taean Peninsula and the Yeongsan River Basin, because there are no terraces or volcanic deposits available for pediment correlation. However the writer proposes that the period of pedimentation in Korea is the same as that in Japan because of the following facts: 1) At the coast the pediments are 20 meters above sea level. 2) Kimpo erosion surface cutting the pediments stretchs to the sea floor of the western coast (Kim, 1973). 3) Block fields formed during the Würm Glacial Age, originated in the escarpments behind the pediments and sweeped downslope to streamlets joining the Kimpo erosion surface. 4) The facies of deposits on these pediments are similar to those found in Japan. 5) According to B. Frenzel (1968), the Korean Peninsula became drier during the Riss-Würm Interglacial Age.

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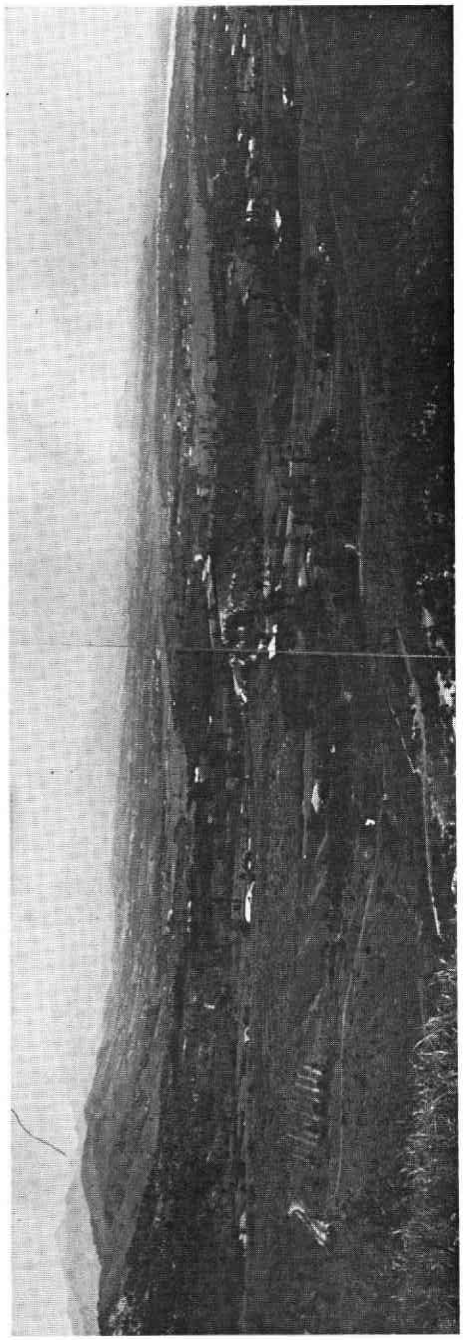

Photo 1 Pediment in the northern part of Seosan area

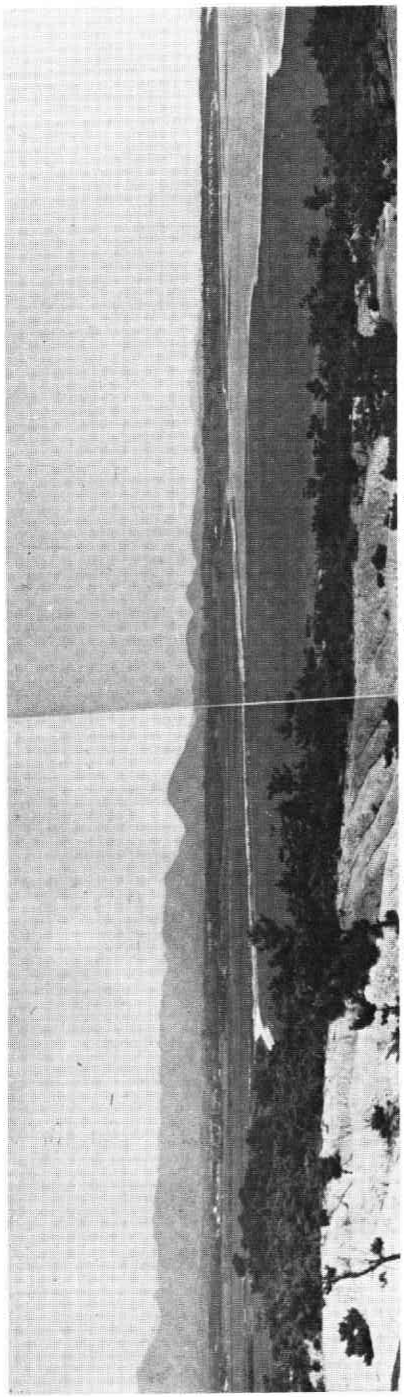

Photo 2 Pediment in the southern part of Seosan area

Photo 3 Veneer on the pediment in Seosan area

Photo 4 Block field on the north-north-east facing slope of the Mt. Dobi

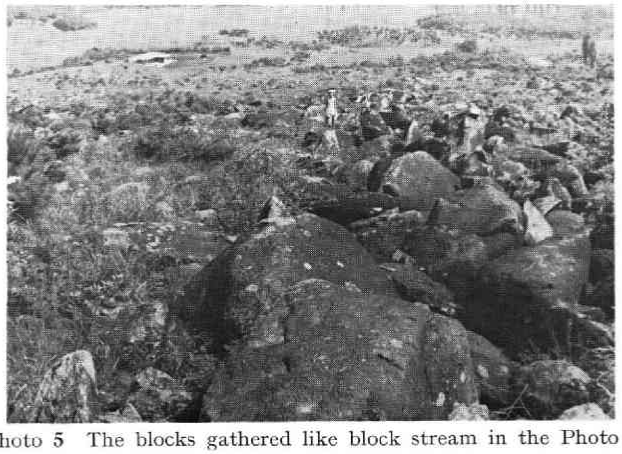

Photo 5 The blocks gathered like block stream in the Photo 4.

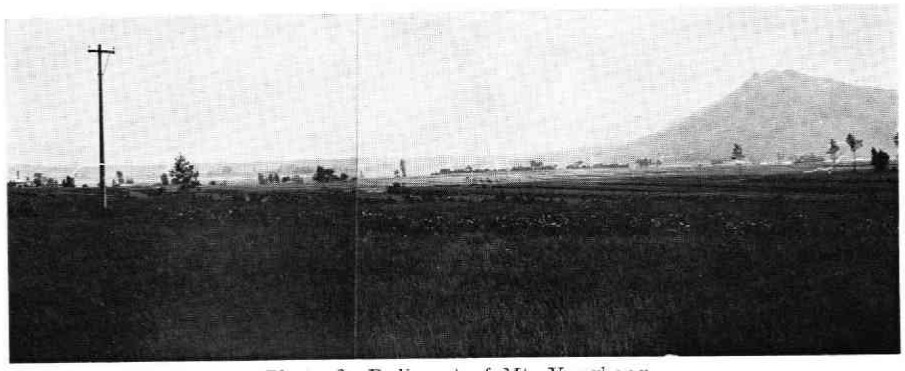

Photo 6 Pediment of Mt. Yongbong

Photo 7 Veneer on Sinam-myeon pediplain

Photo 8 River slopes on gneiss in Weolya area

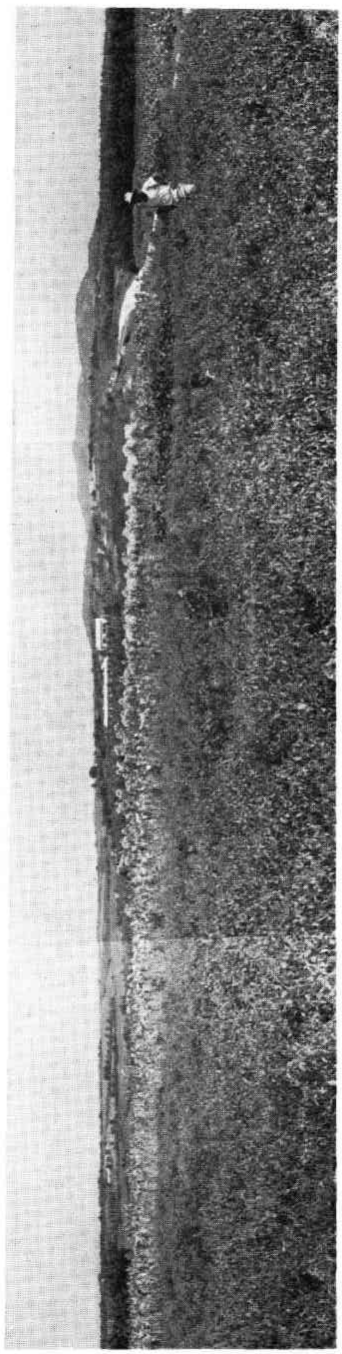

Photo 9 Inselberg on Sinam-myeon pediplain

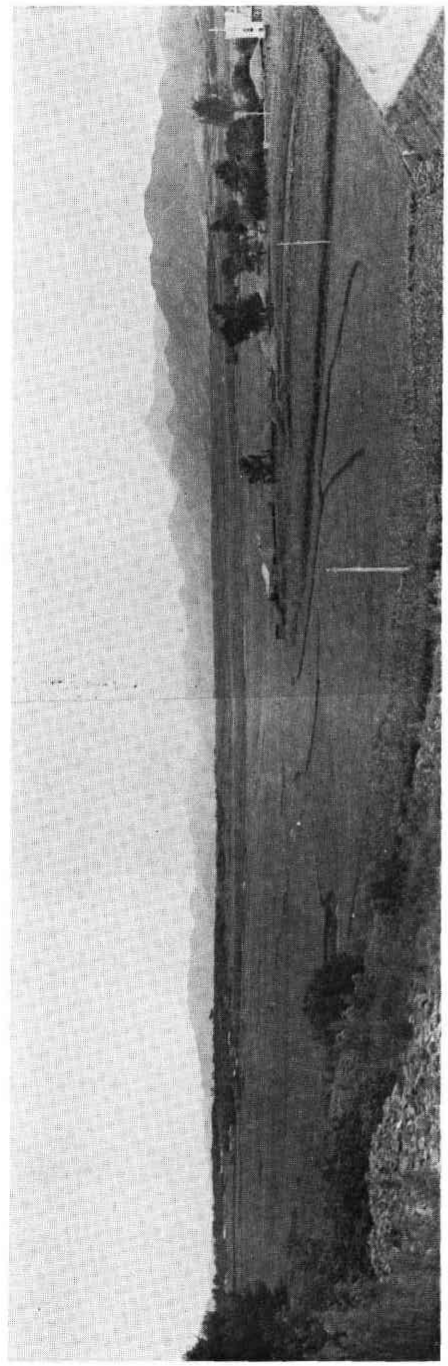

Photo 10 Pediment in Weolya area

Photo 11 Veneer on the lower part of pediment in Weolya

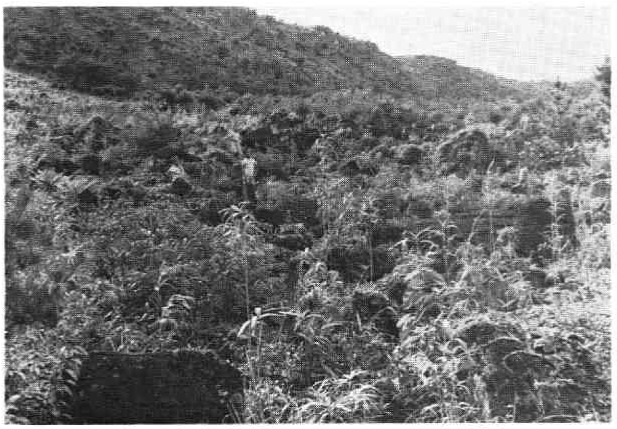

Photo 12 Block field on escarpment in Naju area

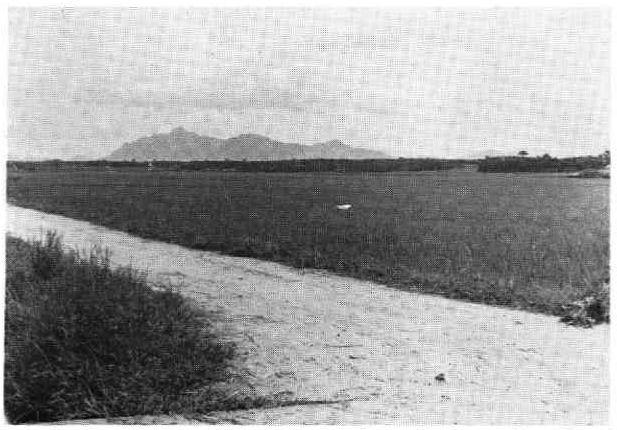

Photo 13 Pediplain in Yeongsan area seen from the opposite side of Photo 15

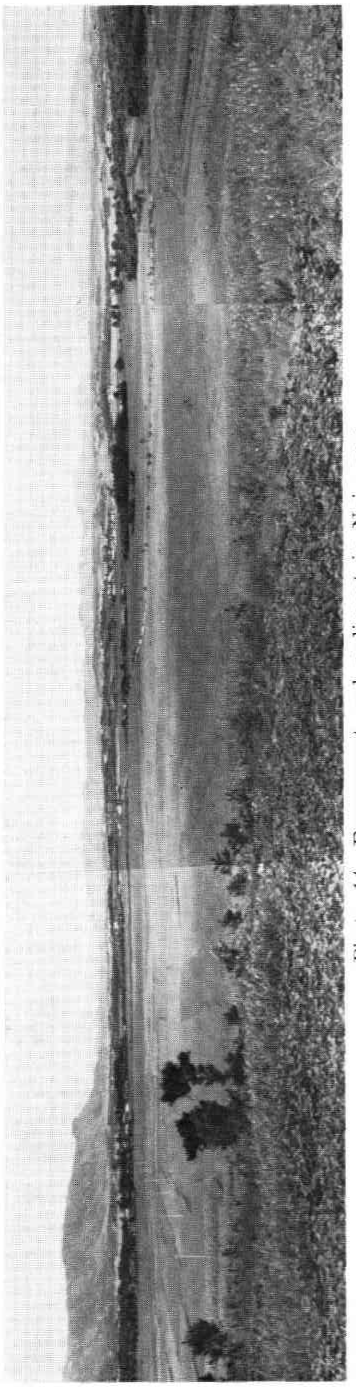

Photo 14 Escarpment and pediment in Naju area

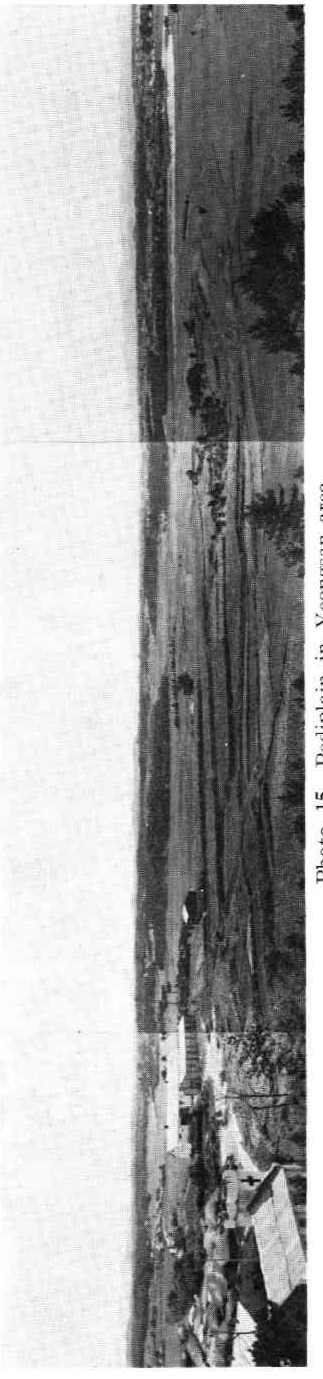

Photo 15 Pediplain in Yeongsan area