Journal of The Korean Speleological Society, 2005, 69, 9~20

The Landform Developments in Relation with the Geologic Structures

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Abstracts : Geologic Structures are reflected on the landform development. So lots of studies are emphasized on the individual processes and mechanism of the relationship between geologic structures and landforms. In this study, many cases are represented, such as : weathering, stream directions and structures expecially joints, gnamas, meander bending etc. New D-D Diagrams and photos are available to explain the relations of two factors. Landform developments are depend on geologic structures.

Key Word : structure, landform, weathering, stream direction, joint, gnamas, D-D Diagram

Ⅰ. Introduction

Landform developments are close relate to the geologic structures. In this study, the photos and lots of diagrams are employed in theoretically. So it is necessary to discuss about the photogeography and draw a new concept of D-D Diagram. And joint patterns are related to the stream direction and granite weathering.

In this research category, granite weathering, salt weathering and gnammas are belong to the weathering.

The purpose of this paper is to clarify the relationship between geologic structures and landform development especially in weathering, joints, stream directions and some cases of the local area.

Ⅱ. Methods

1) In this study the photos and lots of diagrams are available. First of all it is necessary to provide a basic theory of photogeography. There is a close relationship between photos and fine arts, but lots of differences. For examples photos are arts of cognition, analytic media and time. But the fine arts are arts of creation, synthetic media and space. Geographic photos are photos useful for geography. Geographic-photos are a kinds of academic photos which deals with special meaning of geographic phenomena and cognition of the certain area. According to the nature the photos available for geography, can be grouped into geographic photos and general photos.

Geographical ideas, photographical skills and artistic senses are necessary to the photo-geographers. Geographic photos are useful for research and educational purpose. The aspect of research is related to the systematic geography, for example ; geomorphology, historical geography etc.

Recording of geographic photos are grouped into objective and subjective records. The geographic- photos must represent the photo-geographer's geographical ideas and philosophy. And the geographic photos must be a artistic value. In this case the most important thing

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is originality and individuality. In conclusion, to the photo geographer the geographic idea is more necessary than the skill of photography.[1)]

2) Discussion about photogeography

Photogeography is to effectively utilize the documentary and artistic nature of the photo, as an image medium, in the geographic study. the concept of photogeography, along with the term photogeology, is already known widely in foreign countries, and extensive research has been carried out in the field. However, here in Korea, nobody knows the concept of photogeography. Since photogeography has not been systemized as a science, and interest in photography is being minimal, photography, in reality, has in no way been utilized effectively.

The photographs used in photogeography can be classified, according to character, into two major categories, geographic photographs and general photographs, and according to subject and camera, into still photographs and dynamic photographs. Photographs, such single photographs, slides, air photographs and satellite photographs are in the category of still photographs, while pictures like video and movie pictures are dynamic photographs.

Photogeographers are required to possess an appreciative eye capable of viewing photographs from a geographical point of view; the necessary technology to make their geographic photographs more effective, and the artisticc sense necessary for effective expression, interpretation and delivery of the content. Accordingly, research and development into these subjects are the very matters into which photogeography must delve.

It is hoped, therefore, that "The Association of Korean Photo Geographers" will play a significant role in this respect.[2)]

3) D-D Diagram

To clarify the processes of present tectonics and structural phenomena, the systematic studying is necessary. In tectonic geomorphology, it is very important than the observing field data and it's analysis.

The purpose of this paper is to analyse the general characteristics of joint phenomena and to device a new concept of D-D diagram. Many diagrmatic methods are employed to represent the joint patterns. They are point diagrams, contour diagrams, joint map, diagram, SSO diagram, strike frequency diagrams etc.

Joints are the most commonly developed of all structures, since they are to be found in all competent rocks exposed at the surface. Yet, despite the fact that joints are so common and have been studied widely, they are perhaps the most difficult of all structure to analyse. The analytical difficulty is attendant upon a number of fundamental characteristics of these structures. And another difficulty in joint analysis springs from the facts that, characteristically, joints exhibits little or no displacement along the joint plane. Consequently, except in special instance, it is extremely difficult, even impossible, to establish the age relationshipof joints planes with one orientation to those with a different orientation. As a result, incorrect assumptions regarding the ages of joints may easily be made and this can invalidate the conclusions of the analysis.

In many instacces it is difficult to ascertain the origin of joints. It is not always possible to distinguish tension joints, which form perpendicularly to forces tending to pull the rock apart, from shear joints, which are due to forces tending to slide one part of the rock past an adjacent part.

Joints developed in size differ from few feet to few kilometers. Joints may be classified in various method according to their development size, frequency, and origin etc. In the geometrical classification, size, frequency, shapes are very significant but in the genetic classification, shear, tension, torsions are important. According to the developed size, joints may be classified to master joint, major joints, minor joints. When the standard of the classification is frequency, it may be classified to primary joints, secondary joints etc.

Joints are indirectly potent influence in geomorphology. It related to the all erosive processes underground water cycle, gradation, weathering etc. Many geologist interested in joint phenomena in abroad but in the interior it is lack of understanding.

To represent the joint data many diagrams are available but lack of outcrop size. D-D diagram means D and Diamond shaped diagram. D shaped semicircle indicate the strikes of joints and diamond shaped show the character of dips of joints. NE, NW, SE, SW means the quadrants. NS is the base line and all angles are zero degree at the line. Strikes and dips are divided into ninety.

Using the D-D diagrams following conclusions can be able to obtain.

1) D-D diagrams can express the strikes, dips and outcrop size.

2) It is very easy to understanding the concentration trends of the strikes and dips in tectonic and structural phenomena.

3) There is no anxiety to misinterpretation of strikes.[3)]

Ⅲ. Joints

1) Joint patterns and stream directions

Fracture analysis is based on the premise that the earth's crust is systematically fractured.

The first purpose of this research is to investigate the development of joint patterns around the Han-Cheon and Cheongdam-cheon area which is a part of the Chugaryong rift valley : the second purpose is to contribute the data for clarifing the geomorphic characteristics by comparing the joint strikeswith stream directions.

The standards established by K.E.LOWE is applied to the joint survey. Joint sets, strikes and dips are measured in the outcrops. Clinometer is used for measuring the strikes, and the data changed 7° to the east. Stream direction is read on the map, and the data illustrated by strike-frequency diagrams and contour-diagrams. To know the relation between joint patterns and stream directions Spearman's γ is adapted.

The joint patterns around the Han-Cheon area are concentrated to the North and the strike from N5W to N25E represents a master joint set, 37.2% of the total frequency of this area. Stream directin frequency distribution of the Han-Cheon area is 54.1% in the above range. Spearman's γ of the Han-Cheon area is 0.65. The ranges of

N46E~N55E (7.4%) and N56W~N65W (6.2%) are two minor joint sets : N15W~N5E (17.8%), N35W~N55W (16.3%) N16E~N25E (12.3%), and the stream direction frequency distribution is concentrated to the N15W~N15E (19.6%) and the Spearman's γ is 0.65.

As a whole the joint patterns in the studying area are three sets, one is concentrated to the North and two are separated by 50~60° in the opposite direction from the North. It may not be asserted confirmedly that the master joint as a fault line exists because of deficiency of data, but it can be possibly agreed that there is a structural line through this studying area judging from the strike concentration. And so this study comes to the conclusion that there is amount of correlation between the joint patterns and the stream directions.[4)]

2) Joint distribution through photography

The purpose of this paper is to analyse the general characteristics of joint phenomena and to device a new concept of join density group. Joints developed in size differ from few feet to few kilometers. To represent the joint data many methods are available but lack of joint densities.

In this field study the following conclusions can be able to obtain.

1) The joint strikes of N x° E are about forty percent and N x° W are about sixty percent. And the highest frequency is in the range of N56°~ 65° E(13.5%) and N76°~85°E (11.4%)

2) The dips of joints are twenty percent in the range of 60°~70° and twenty seven percent is in the range of 70°~80°. So more than ninety percent of the dips are represent as a high angles.

3) There are seven joint patterns in the field, suchas Linear, Cross, T or Y, Cross Check, Curviplanar, Radial and Irrequlars patterns.

4) The concept of the joint density is the total length of joints developed on the outcrops and can be divided into several groups.

5) The joint density can be divided into twelve groups. [Ⅰ(shorter than 0m), Ⅱ(0~1m), Ⅲ(1~2m), Ⅳ(2~3m), Ⅴ(3~4m), Ⅵ(4~5m), Ⅶ(5~6m), Ⅷ(6~7m), Ⅸ(7~8m), Ⅹ(8~9m), Ⅺ(9~10m), Ⅻ(longerthan 10m)].

6) In this area the Ⅳ(4~5m) group is predominant as thirty two percent and the Ⅸ(7~8m) group is the next.[5)]

3) Joint patterns and Granite Weathering

It has often been recorded before that some granite masses give rise to hills of mountains while others are eroded down to lowlands usually bounded by hills formed on the surrounding, more resistant aureole. Many of the lowland granites give rise to the rolling landscape type while highland granties are more likely to give the rugged landscape type.

But some granite landscape of the rolling type are topographic highs. These owe their preservation to their position in relation to old erosion surfaces. In other words they are in such topographic positions that base levelling has not yet affected them very much and so they have comparatively high altitudes despite their comparative ease of erosion.

Joint frequencies beneath a deep regolith are easily measured and the observed jointing on tors and domes will be influenced by the forces acting

on the hill form itself.

It is clear that hierachies or generations of joints exist in a rock mass and that these may influence relief development at different stages. The granite landscapes reflect the deep weathering, weathering intensity, regolith etc.

In this paper, the classification of the joint patterns are as follows;

1. Linear pattern (horizontal, vertical)
2. Cross pattern
3. T or Y pattern
4. curviplanar pattern
5. Radial pattern
6. Irregular pattern

The genetic classification of the joint patterns related to weathering is necessary from now on.[6]

Ⅳ. Weathering

1) Granite Weathering and Salt Weathering

Weathering is the combined action of all processes whereby rock is decomposed and disintegrated because of exposure at or near the earth's surface.

A study on regolith and deep weathering is very important to explain the present landforms.

The fragmenation of rocks by the crystallization of salts, for convenience termed "Salt Weathering" is important in a restricted range of environments and produces distinctive topographic forms, especially in arid regions and along the sea coasts.

Geological and more systematic methods are necessary to interpret the granite weathering and salt weathering.[7]

2) Gnammas

The purpose of this study is to examine the type of gnamma and the processes oftheir formation in AAMDO, Songdo Resort. rock types of the study areas are Gyeonggi Gneiss Complex. More than thirty gnammas(39) are examined during the 6 field surveys from September to October, 1989. To study the relation between gnammas and geologic structures, the author examined the joints and dykes. The results are as follows; First, three major forms are recognised as follows; shallow pan(dish type and plate type), hemispherical pit, armchair-shaped hollow. Second, local structures have a profound influence in gnamma-evolution such as joints and dykes. Third, it supposed that almost gnammas are effected by chemical weathering(solution) and salt crystallization.[8]

Ⅴ. Landforms and Geological Structures

1) Mt. Paekdu

The purpose of this research is to arrange the outline of geology and geomorphology confined to the Mt. Paekdu, and epecially using the photography data as possible and to use the educational materials for geography.

In the area of the Mt. Paekdu, the history of volcanic activities are summarized as follows ; in the Tertiary it erupted seven times, in the Quaternary it erupted six times and they formed basalt plateau, high land and then formed cone of the Mt. Paekdu. The lots of hot springs beneath the Cheonji lake me ns that the hot spots are still

remains under the ground. The pumices located near the peak of the Mt. Paekdu results from the last volcanic activities.

There are varity of landforms in the Mt. Paekdu. For example, there are relics of volcanic activities, glalcial landforms related to structures, and the development of the fluvial landforms.

In this research it is possible to get the following conclusions ;

1. The volcanic activities of the Mt. Paekdu are consists of central and fissure eruptions and the volcanic cone is formed during the late Tertiary and the early Quaternary.

2. The rocksof the Mt. Paekdu is mainly alkalic volcanic rocks.

3. The altitude of the unconformity is about 1,800m.

4. The landforms of the Mt. Paekdu is consists of volcanic and glacial landforms.

5. The erosion surfaces from Yeonbeon to Mt. Paekdu consists five levels and the bottom of the Mt. Paekdu is the third level.

6. In the vicinity of the Mt. Paekdu, there are lots of faults developed in radial directions and the talus slopes are well developed.

7. Three or four craters are collapsed and formed lake Cheonji.

8. The relics of the glacial landforms represented in the wall of the lake Cheonji.

9. According to the instabilities of the slopes, hot spring water, seismic activities and the other evidences, it is possible to conclusion that the volcanic activities in the area of the Mt. Paekdu are now still under going.

To get a lots of geological and geomorphotogical informations about Korean penninsula including Mt. Paekdu, it is hopeful to investigate about geology and geomorphology with unified Korea.[9)]

2) Bulan Mt. Area

The purpose of this paper is to prepare the geomorphic information from the Bulam Mt. Area through the photography.

Bulam Mt. Area belong to granite mass and highest point is 420m and the general characteristics of the features looks like low and undulating monadnock. In this area two kinds of outcrops are represented. One is fresh and the other is somewhat weathered. Structural geomorphologically, the Area has a significant tectinic phenomena such as joint, weathered bedrock, tafoni, physical weatheing, xenolith, dyke and small sized fault, etc.

The conclusions are as follows

1) Sheeting joint are predominant and joints control the stream directions.

2) Bedrocks are well weathered and structures like joint play a significant role to disintegrate the bed rocks.

3) Lots of tafoni developed the granite mass.

4) In physical weathring the roots of plants accelated the weathering of rocks.

5) Various kinds of xenolith represent the index of situations that generated the grannie masses of the study area.

6) Dykes can explain the relation between the bed and the time of formmation.

7) It is clear that the existence of small scale fault means the tectonic aspect of the area.[10)]

3) Southeastern Part of Korea

The purpose of this study is to examine the landform developments in relation with the geological structures in the Yangsan-Yongil area where the NNE-SSW trending Yangsan fault and subsiduary faults are wel developed. The lineament trends of studied area are grouped into N5°E(A), N35°E(B), N55°(C), N80°E(D), N85°W(E), N45°W(F) and N5°W(G), among which the trends A, B and C appear to be predominant. The joint systems observed are dominated by two types, (1) conjugation of N6°~15°E and N76°~85W, and (2) conjugation of N16°~25°E and N66°~75°W.

Prevailing stream directions of the major rivers - the Hyungsan, Taehwa, and Yongsan - are represented by NNE-SSW and NW-SE directions which are parallel to the dominant lineament trends mentioned above. The drainage patterns of the area are well developed into mostly dendritic on the sedimentary and granitic rocks although trellis and rectangular patterns occur in places. And also the Hyungsan river is longer in lengh and gentler in channel gradient than the Taehwa and Yangsan rivers. The trunk streams on the alluvial plains are generally graded. The stream order of the Hyungsan river has up to the 7th order whereas the Taehwa, the 6th order and the Yangsan, the 5th order.

The bifurcation ratio is 3.59 in the Hyungsan river, 4.05 in the Taehwa and 3.72 in the Yangsan, which indicates that the Taehwa is most highly developed in tributaries. The ratio of thestream length(RL) is 0.71 in the Hyungsan, 0.52 in the Taehwa, and 0.78 in the Yangsan, which suggestes that the Yangsan is most developed tributaries in its upstreams. The drainage density in the Taehwa river basin is 2.03, which is higher compared with those of the Hyungsan, 1.79 and the Yangsan, 1.28. This difference in drainage density is due to the fact that the Taehwa basin is largely overlaid by softer sedimentary rocks whereas the Yangsan basin is mainly composed of harder volcanic and granitic rocks and the Hyungsan basin is in between in rock distribution.

The mean slope angle in the Yangsan river basin is 15.50° and steeper than those of the Hyungsan, 12.23°, and the Taehwa, 12.18°. The mean slope are higher in the volcanic and metamorphic terrain thanin the area of granitic and sedimentary rocks. In view of a slope angle, the area can be divided into four categories, that is, low plains(0~5°), hilly gentle slope(5~15°), moderate steep mountain slope(15~25°), and steep mountain slope(over 25°).

The analysis of summit level exhibits that the mean of the highest points in the Yangsan river basin composed mainly of the volcanic andgranitic rocks is 434m which is higher than those of the Taehwa, 327m, and the Hyungsan, 314m composed of the sedimentary rocks. The local rreliefin the Yangsan river basin is 263m which is also higher than those of the Taehwa, 191m and the Hyungsan, 190m.

Spearman's correlation coefficients are very high in all three basins, which are 0.93 in the Hyungsan, 0.82 in the Taehwa, and 0.83 in the Yangsan. These facts indicate that the lineament trends have played major role in controlling stream directions. The stream directions of the first and second order streams of all rivers mostly follow

along strikes of joints (Spearman's γ 0.79), whereas those of the third and the upper orders along the trends of lineaments (Spearman's γ 0.82). The interrelationship between the slope angles, the highest points, the lowest points and the local relief appears to be rather high having the coefficient values of 0.775 for slope angles versus the highest points, 0.844 for slope angles versus local reliefs, and 0.8823 for the highest points versus the lowest points. These facts indicate a close relationships between the four variables.[11]

4) Hwaeum Temple Area

The purpose of this study is to analyze geology and geomorphology of the particular area where Hwaeum temple is located, in order to find the materials of pieces of the sutra inscription which are thought to be produced in Hwaeum temple area. The analysis of topographic and geologic map was adopted as a method and especially, drainage system, summit level and local relief were analyzed for terrain analysis. The representative landform around Hwaeum temple area is the drainage system of Seumjin river and range system which centers around Giri Mt. The drainage system is closely related to the geologic structure with Giri Mt. as watershed. This area shows the characteristic of having a very high northeast part and low southwest part. further, the altitude distribution of the lowest point that is below 200, occupies 52.6%. In terms of local relief more than 80% is found to be less than 400m. The bedrocks of the area pre-cambrian metamorphic sedimentary rocks gneissic complex and sedimentary rocks with relation to the igneous rocks which intrude the basement as a unconfirmity.[12]

5) Bend of Pyoungchang river

From the analysis on the bend of Pyoungchang river, we came to the conclusions as follows ;

1. On the plane form development of the bend, there are assumed a lot of simple forms and they have a tendency to develop in accordance with the influence of bedrock. The regularity of the plane form tends to be higher in tributary than in main stream.

2. The plane scale of the bend tends to be influenced by the bedrock and the hydrological factors. The regularity of a scale tend to be also higherin tributary than in main stream.

3. The cross-section of the bend has a tendency to reflection the bedrock and the hydrological factors and it is closely related to the plane form of the bend. the relief in concave and convex slope of the bend tends to be also influenced by the bedrock and the hydrological factors.

4. The terrace deposits on concave and convex slope of the bend are divided into upper middle and lower levels in accordance with the altitude of distribution and deposit features.

5. The large scale lineaments can be thought not to be directly influence on the decision of the direction of development of the bend itself but can be thought to help erosion of a riverside.[13]

6) Seoul and it's vicinity

The purpose of this study is to summarized the geology and geomorphological characteristics of Seoul and it's vicinity.

The conclusions ars as follows:

1) The geology of the Han River represents from prt-cambrian to present including various types of rocks.

2) Main part of the Han River belongs to the Kyunggi metamorphic complex and lots of fault system are found in the Area.

3) Granites, Schists and Gneisses are the main rock types in Seoul.

4) The Bukhansan Batholith is located in Seoul and the Namsan is a part of the batholith. The kwanaksan is a stock and the distribution of gneisses are predominant between the Namsan and the kwanaksan.

5) The drainage pattern of the Han River is principally simple dendritic pattern but the some small tributaries are rectangular patterns according to the fault systems and joints.

6) The strike of joints in the study area represents NNE-SSW and influences the direction of the stream channels especially in small streams.

7) The types of the tor in the study area classified into tower or table land types. And joints play a significant role to develope the tors.

8) As a result of the observation and analyses of the tafoni developed on the surface granite, its forms are divided into three patterns : the cavern patterns, the lateral erosion pattern and base-elimination patterns.[14]

7) The Temples constructed in Unified-Silla Period

The purpose of this study is to emphasize the importance of geomorphic and geological location of the temples constructed in Unified-Silla period

The conclusions are as follows:

1) The rock distribution of the location of the temple is mainly in sedimentary rocks area(30.6%), and next granite area(29.7%) and gneiss area(17.1%)

2) The distribution of slopes of the location of the temples os mainly in the range of 15°~25°. And there are few locations of the slope steeper than the 30° . This means that the location of the temple is in the area between the gentle slopes and the knick points.

3) The summit points distributions are distinguished in the range of 300~400m(15.6%) and 400~500(15.0%). This means that the location of the temple os in the undulating hills and neat the low mountainous areas.

4) The distribution of the local relief is concentrated mainly in the range of 500~ 600m (14.8%) and the next is in the range of 400~ 500m(14.3%)

5) The correlation coefficient between slopes(A), summit(S), Lowest(L) points and local relief(R) is close relation to each other.[15]

8) Kyungju and its vicinities

The purpose of this paper is to prepare the geologic and geomorphic information from the Kyungju and its vicinities including Mt Namsan. In this area the NNE-SSW trending Yangsan fault and subsiduary faults are well developed. Mt Namsan area belong to the granite mass and highest point is 468m and the general characteristics of the features looks like low and undulating monadnock. The summary and conclusions of the study are as follows;

1) The geology of the area consists of Cretaceous,

Tertiary, Quaternary systems.

2) The lineament trends of studied area are grouped into N5° E(A), N35° E(B), N55° E(C), N80° E(D), N85° W(E), N45° W(F) and N5° W(G), among which the trends A, B and C appear to be predominant.

3) The joint systems observed are dominated by two types,(1) conjugation of N6°~15° E and N76°~85° W, and (2) conjugation of N16°~25° E and N66°~75° W.

4) Prevailing stream directions of the Hyungsan, is represented by NNE-SSW and NW-SE directions which are paralled to the dominant lineament trends mentioned above. The drainage patterns of the area are well developed into mostly dendritic on the sedimentary and granitic rocks although trellis and rectangular patterns occur in places. The trunk streams on the alluvial plains are generally graded. The stream order of the Hyungsan river has up to the 7th order. The bifurcation ratio is 3.59 in the Hyungsan river and the ratio of the stream length(RL)is 0.71.

5) The mean slope angle in the Hyungsan river basin is 12.23. The mean slope are higher in the volcanic and metamorphic terrain than in the area of granitic and sedimentary rocks. In view of a slope angle, the area can be divided into four categories, that is, low plains (0~5°), hilly gentle slope(5~15°), moderate steep mountain slope (15~25°), and steep mountain slope(over25°).

6) Speanman,s correlation coefficients is 0.93 in the Hyungsan and this fact indicate the lineament trends have played major role in contrlooing stream directions.

7) Joints are predominant and joints control the stream directions

8) Lots of tafoni and tors are developed in the Namsan.[16]

9) Hyungsan River Basin

The purpose of this study is to analyze the Slope Angles and Summit Levels in the relation with the geological structures in the Hyungsan River Basin where the NNE-SSW trending Yangsan fault and subsiduary fault are well developed.

The mean slope angle in the Hyungsan River Basin is 12.23°. The mean slope is higher in the volcanic and metamorphic terrain than in the area of granitic and sedimentary recks. In view of a slope angle, the area can be divided into four categories, that is, low plains(0~5°), hilly gentle slopes(5~15°), moderate steep mountain slope (15~25°), and steep mountain slope (over25°). The analysis of summit level exhibits that the mean of the highest points in the Hyungsan River Basin composed mainly of the volcanic and metamorphic rocks is 314m

The Hyungsan River Basin can be divide into three categories; Western mountains, central low lands, eastern hill lands.[17]

Ⅵ. Conclusion

It is clear that the relationship between landform development and geological structures, especially in using the lots of photos, theoretical diagrams including D-D diagrams.

In the study of joints and stream directions,

there is amount of correlation between the joint patterns and the stream directions.

The concept of joint density is the total length of joints developed on the outcrops and can be divided into several groups.

In the study of joint patterns and gramite weathering, the granite landscapes reflect the deep weathering, weathering intensity, regolith etc.

The genetic classification of the joint patterns related to weathering is necessary from now on. Geological and more systematic methods are necessary to interprete the landforms and geological structures.

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