Neotectonic process on Mt. Paektu area and effect to the surroundings

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The great leader Comrade **Kim Jong Il** said as follows.

"Scientists and technicians, basing themselves firmly on reality, must take the problems arising in practical socialist construction as the subjects of their scientific research, and solve the scientific and technological problems appearing in the application of the achievements of their work to production, in a responsible manner."

As the Paektu volcanic structure was greatly acting during Neogene, Pleistocene in Quaternary period and also Holocene, it's interested from my country and neighbor countries.[1, 5] The dynamic stability of Mt. Paektu area is the first problem in the sustainable development and use of this region.

We studied the relief analysis about the neotectonic processes on Mt. Paektu area and the effect to the surrounding areas.

1. Relief formation processes and physiographical condition of Mt. Paektu area

Mt. Paektu was formed through the several tectonic movements since the platform bedrock has formed in Archaeozoic era and the volcanic eruptions during late Neogene and Quaternary period.[1, 5]

By the Cretaceous tectonics, in Hyesan-Riwon depression, the mountainous relief was formed and after that by the continuous erosion and denudation during the static period, the peneplain was formed in late Miocene.

In late Miocene–early Pliocene when the climate was generally hot and humid, the area of my country began to rise rapidly. After the elevation of Kaema Plateau that began to rise from Miocene in Neogene, the graben of Hyesan-Riwon depression and neighbor peneplain areas began to rise, while the basalt lava was erupted in bulk. During the first volcanic period, the emission of basaltic and trachyte magma was repeated about ten times and flew out both sides of graben gap, which resulted in the formation of Paektu Plateau.

During the second volcanic period, the main volcanic cones of Paektu volcanic chains were formed and after that the volcanic activity was comparatively weakened, when the subsidiary volcanoes such as Taeyonjibong, Soyonjibong, Taegakbong, Mudubong etc.

were formed.

Also after then the small eruptions were in the crater of the Lake Chon of Mt. Paektu volcano 7, 8 times and thin layer of volcanic debris including the volcanic ash, bomb, sand and block.

Such a relief formation processes are represented well in the geological conditions in Mt. Paektu area.

The basement of Mt. Paektu area consists of various strata since lower Proterozoic to Cenozoic era. But as the Paektu volcanic zone was formed in Cenozoic era, the former strata was bared at the only places where are deeply eroded by rivers.

Because the Mt. Paektu area is high in elevation, it has typical high mountain climate. This area is the coldest and the climatic change including the precipitation and wind, etc. was the biggest in my country. And the precipitation amounts are comparatively high and rainfall dates are great.

This makes good conditions for the river development in this area where the impermeable weathering layer from the basalt bedrock. Therefore there are the Lake Chon in the crater, many big and small lakes and springs, from which Amnok River, Tuman River and Songhua River in China and their tributaries are flowing.

The singular nature landscape including animals, plants and soils etc. on Mt. Paektu is greatly related to the volcanic activity of Mt. Paektu and the relevant physico-geographical elements such as climate.[1]

2. Study area and method

From the synthesis of the relief formation processes based on the various observations and measurements on Mt. Paektu and Paektu Plateau in my country, the formation of the Paektu volcano effects to the relief and landscape of neighbor country areas. So we established the study area as one from 38 ~ 44°N latitude and 123~132°E longitude, which covers the northern part of my country, the northeast part of China and southeast part of Russia.

In the study we used the DEM data with spatial resolution of 500m in the whole area and the detailed DEM in local area.

The tectonic process in various scales during the various periods is synthetically represented on the relief.[2, 3] Therefore, through the division by period and by scale, we can clarify the sequential tectonic movement processes and this is realized by ordering of river valley.

The valley order is a synthetic index that reflects the relief formation process and material and temporal and spatial characters simultaneously. That is, the valley order reflects the relative age of relief. The higher the valley order is, the older the age of relief is. The age of valleys with the same order is similar.[3]

First of all, we extracted the valleys from DEM and decided the valley order by the Horton-Strahler or Strahler-Filosofov method.[2, 4]

Figure 2 and table 1 show the rivers in this area by the order.

Table 1. Rivers in study area by the basins

Valley order	the Amnok River basin	the Tuman River basin	the Songhwa River basin	the Liaohe River basin
5	1	1	1	1
4	5	3	6	8
3	25	10	21	32
2	128	34	117	245

Then we did the base level analysis, one of morphometric methods to clarify the sequential tectonic processes. The base level of river basin is the plane that passes the channel and possesses the local erosion base level.

From the detailed DEM and terrace measurements of some river basins at the study area, the age of 1 or 2–order valleys is about middle Pleistocene in the Quaternary period. From this, the time of 2- order valleys formation is corresponding to late Tertiary period ~ Pleistocene of Quaternary period. And the time of 1-order valleys formation is from upper Pleistocene to Holocene in Quaternary period.

3. The neotectonic process on the study area and it's effects

In order to clarify the successive neotectonic process on Mt. Paektu area, we analyzed the base level by order and the difference base level which derived from the minus of base levels.

At early time, there were main streams of Amonok River, Tuman River, Songhwa River in China and their tributaries involving the Changjin River, Hochon River, Liuhe River and so on.

It shows that the Changjin area was the highest and surroundings were lowered. The height of base level of 4-order at Changjin and Pujon area was about 1 050m, 560m at Mt. Paektu area, 30m at Liaohe area in China, 190m at Jilin area and 5m at the margin of

Russia.

When the 3-order rivers were formed, the northeast coast area of my country involving Hamhung-Kimchaek area(-910~-700m) and Chongjin area(-240m) was greatly subsided and south part of Yenji in China weakly(-147m).

While the Paekam part was elevated rapidly(450~550m) and the axis of Paektu mountains was shaped, the part of Kim Hyong Gwon county part (340~380m) and the border of Liaoning and Mudan provinces in China also began to rise up (300~400m)

When the 2-order valleys were formed, the intensive elevation was accompanied by the big erosion so as to form the tributaries. There were intensive elevation at Mt. Paektu part(350m) and Myonggan county part(450m) in Korea, Wanjiang part(350m) in China, the border of Russia and China(350m). And, there was transgression at the northeast coast of Korea and the right part of Vladivostok in Russia and there were formed several depressions in Kaema Plateau.

In Holocene, Mt. Paektu area continues to rise in the whole area, so the several mountains were formed in Paektu Plateau and Hamgyong Mountains and Rangnim Mountains had a vivid axis. Also it's seen that the uplift area tends to be extended to the northeast part in China.

At present, all parts are locally rising involving Mt. Paektu part with the amount of 300~800m.

The vertical displacement of topography is shown in Table 2.

Table 2. The vertical displacement of the crust by the relief deformation period

Order of difference base level	Average	standard deviation	maximum
3–4	26	140	638
2–3	33	79	781
1–2	30	71	918
sum	90	178	1 276
Sum after Neogene	63	109	1 089

By the continuous uplift at Mt. Paektu area, there are intensive erosion and

sedimentation at surrounding areas. This effect can be analyzed by the residual topography analysis. From the residual topography, the average value is 127m that is more than the rising amount after Neogene. This shows that the crust material will be continuously eroded and flow out to the surrounding lower plains and to the sea. Nowadays, the erosion and sedimentation of crust materials is the most intensive at Mt. Paektu part, south part of Yenji and downstream part of Tuman River.

Conclusion

The result shows that the elevation in the area of Mt. Paektu began at the coast of Korean East Sea and grew expanding to the internal continent. So it needs for these areas to take a measure according to this.

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