

## Periglacial Processes in the Khentei Mountains (Mongolia)

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### Abstract

The Khentei Mountains were subjected to ancient glaciation in the Pleistocene. There is no sign of contemporary glaciation. At present only the remnants of ancient glaciation can be observed. The average annual air temperature is from  $-2^{\circ}\text{C}$  to  $-4^{\circ}\text{C}$ , and on the high mountains it is lower. The Khentei Mountains are situated near the southern boundary of the permafrost of the Northern Hemisphere. Therefore, the permafrost in Mongolia is dynamic. In this connection it is pointed out that the mountains are characterised by the active development of periglacial processes.

### Introduction

The region of the Khentei Mountains is situated in the north-eastern part of Mongolia. According to Devjatkin (1981), it is characterised by large upwarping and complicated neotectonics with block structures.

These mountains were subjected to glaciation in the past (Tsegmid 1969). There are cirques, glacial troughs, tills, and morainal lakes in the high mountain massifs (Murzaev 1948). Glaciation no longer occurs in the Khentei Mountains.

The Khentei Mountains consist of high mountains, middle mountains, and broad mountain valleys (Murzaev 1948). According to the geocryological map of Mongolia, three types of permafrost – sporadic, discontinuous, and continuous – are present in different altitudinal zones (Nauka 1994).

The Khentei Mountains are situated very near the southern boundary of permafrost of the Northern Hemisphere (Fig. 1). Therefore the effects of seasonal thawing on the temperature of rocks are of the transitional and semi-transitional types. Given the altitudinal climatic zonality, the periglacial processes cannot here be investigated in detail.

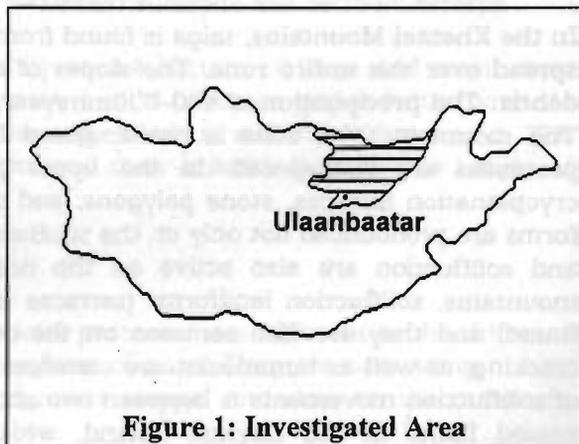


Figure 1: Investigated Area

## Landscape Zonality

The natural conditions, relief, landscape, and altitudinal climatic zonality have been investigated by Murzaev (1948), Tsegmed (1969), Marinov and Popov (1963), and Jigj (1975), etc. As a result of these investigations the following four altitudinal climatic and landscape zones have been identified.

1. Goletz with mountain tundra
2. Mountain taiga
3. Forest steppe
4. Mountain steppe

## The Goletz with Mountain Tundra

According to aforementioned studies, the present Goletz zone is situated between 2,200m and 2,800masl (Asralt Mountain). The remnants of the ancient glaciation are found above 1,750masl in the mountain area (Devjaktin 1981). These are confined mainly to the mountains. On Asralt Mountain, glacial cirques one to two km across, moraine hills, and morainal lakes are found. The contemporary processes of frost weathering are active. Fresh rock talus accumulates along the back wall of cirque-forming rock glaciers.

In the Goletz zone the, permafrost is continuous. Cryoplanation terraces with escarps from two to 15m are common in this zone. The length of cryoplanation is in the range of from three to five km or more, while its width is from one to four km. The height of the escarps is from five to 20m or more (Devjaktin 1981). These escarps of cryoplanation terraces are recessed. Particularly above 2,300masl, fossil cryoplanation terraces can be found, and they are better developed on the northern slopes. On the southern slopes above 1,700masl they are of a relict character. According to K. Pekala and Pekalova (1985) solifluction lobes are formed on all slope expositions. Nivation is active on north-facing and east-facing slopes. The pulling on blocks and sorting of debris islands by frost, cryogenic desertification, etc are frequently observed here.

## Mountain Taiga

In the Khentei Mountains, taiga is found from 1,400 to 2,200masl. Permafrost is spread over this entire zone. The slopes of mountains are covered with clayey debris. The precipitation is 400-600mm/year. Seasonal thawing is insignificant. The mountain taiga zone is characterised by its humidness since periglacial processes are widespread. In the upper part of the mountains there are cryoplanation terraces, stone polygons, and debris islands. The periglacial land forms are pronounced not only on the southern slopes of the mountains; Kurums and solifluction are also active on the northern slopes. At the foot of the mountains, solifluction landforms (terraces and lobes) and sorted polygons are found, and they are also common on the southern slopes. Frost heaving and cracking, as well as hummocks, are common in the valley bottom. The intensity of solifluction movements is between two and 40cm/year. There are some deep-seated faults in the Khentei upland, which abounds in not only physical-geological but also periglacial processes.

### Forest Steppe

The forest steppe is observed in the Kentei Mountains from 1,100masl to the onset of the mountain taiga. The forest steppe zone is situated mainly in the foothills of these mountains.

Here the permafrost is of the sporadic type. The slopes of mountain areas with a southern exposition feature clayey debris covered with forest. The mountain slopes with a southern exposition are covered predominantly by debris and are generally bare.

In the Goletz-zone of Erdene-uul Mountains, cryoplanation terraces are found with few steps from 2,150 to 2,304masl. The escarpments of terraces reach heights of from seven to 12m. On the surface of these cryoplanation terraces are large stone polygons and debris islands. Cryogenic desertification is active on the graded summit of the mountain in spring and autumn. The forest zone is situated at a height of 1,650-2,150masl on the northern slopes. In the upper part of this zone there are mostly cedars and, in the lower part, larches. On slopes above 1,700masl fossil cryoplanation terraces and solifluction terraces are found.

On southern slopes, snow drifts accumulate during the winter, while solifluction lobes of clayey debris form in spring as a result of melting snow at the foot of these slopes higher than the ones taking place at nival niches. The length of such solifluction lobes is 80-100m; their breadth and height 50-60m and 8-10m respectively. The lobes consist of loamy sand and loam with an admixture of partly rounded large boulders and blocks.

### Mountain Steppe

The foothills of these mountainous regions fall within the mountain steppe. According to the aforementioned studies, the mountain steppe starts from 1,100m and continues to the forest-steppe zone. The permafrost is sporadic. The slopes are covered by thin loamy sand and loam with an admixture of boulders. Periglacial processes are of limited extent on the mountain steppe. Physical weathering is active on the rocks of mountain summits and tectonic escarpments.

The periglacial processes occur mainly at the bottom of large and small river valleys (with mire and grove) and at the foot of northern slopes (with mire). At the bottom of river valleys, frost heaving, hillocks, and so on are found. The length of solifluction streams is 100m and their breadth is 80m. The height of frontal escarpments is 1.5-2.0m.

### Conclusion

In the Khentei Mountains the periglacial processes are different in the different landscape zones that reflect the altitudinal climate. They are very active in the Goletz zone, active on the taiga and forest steppe, and slow on the mountain steppe.

In the Goletz zone, the periglacial processes have a tendency to even out the surface. On the slopes of mountains, the periglacial processes are involved in side-cutting with different effects on northern and southern slopes. On the northern slopes, cryopedimentation is more active. At the bottom of valleys, the periglacial processes contribute to the accumulation of material.

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