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# Mesoforms of the relief in the northern part of the Novohradské Hory Mts.

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**Abstract**
The article deals with the most interesting geomorphological locations of the Novohradské Hory Mts. and their mesoforms of relief and describes the geomorphological mapping of the Novohradské Hory Mts. The mounts of Vysoká, Kraví Hora, and Kuní Hora are ranked among the most interesting geomorphological locations of the Novohradské Hory Mts. Geomorphologically, these locations are bornhardts, separated by the Stropnická Upland, a 300 metres high tectonic slope. Ruwaries also occur on the slopes. Frost disintegration during the cool periods of the Pleistocene played an important role in the formation of the mesoforms of relief. The individual periglacial relief formations (e.g. the Napoleon´s Head) are ranked among the most interesting and the most important mesoforms in this part of the Novohradské Hory Mts.

*Key words:* frost disintegration, bornhardts, ruwaries, the Novohradské hory Mts.

## Introduction

The Novohradské Hory Mts. have become a centre of interest for the public, investors and environmentalists as a result of the process of European integration. Their unique qualities and position along the border with Austria are of particular importance. The Novohradské Hory Mts. are a unique area, which has been almost untouched by the influence of human, industrial and agricultural activities till present. As a result many rare plant species and natural formations can still be found in this area.

The Novohradské hory Mts. form a geomorphological unit which is a part of the Šumava Subprovince. Their bigger part is placed on the Austrian side and called "Waldviertel". The altitudes of the Novohradské hory Mts reach more then 1000 m. The highest mount, Viehberg, 1111 m a.s.l., is placed on the Austrian side, on the Czech side the highest mount is Kamenec (1072 m).

## Methods

Contemporary geomorphological research began in the Novohradské Hory Mts. five years ago. The aims of this geomorphological research are the geomorphological mapping of the Novohradské Hory Mts. and the creation of a general geomorphological map with a special focus on periglacial relief. The research until now has focused on traditional geomorphological mapping (Demek 1972a, Bezvodová et al.1985). The terminology of Demek (1987) was utilized for classifying the forms of relief. Nowadays, the traditional geomorphological mapping is no longer conducted, however, its results can be found on working maps in the scale

of 1 : 25 000 for the whole the Novohradské Hory Mts. Some interesting locations have been mapped in greater detail with the help of GPS. For these locations maps have been constructed in a larger scale on the basis of ZABAGED and with the help of GIS tools. The legend for these maps is based on the work of Létal (1998). Among the locations mapped with the help of GPS are the Vysoká, Kraví Hora, and Kuní Hora mounts in the Novohradské Hory Mts.

## Geographical conditions

The Novohradské hory Mts. are characterized by a specific geological structure. They are built predominantly by the weinsberg type of granite which is middle granular and porphyric. The geological structure is completed by cordiritic gneiss, the Mrákotín type and the Číměř type of granite (Staník 1991).

The Novohradské Hory Mts. belong to a cold climatic area. The average precipitation is 950 mm at 1000 m and the average temperatures are from 4.5°C to 7.5°C depending on the altitude (Rypl 2002). The Novohradské Hory Mts. are a source area for the Lužnice, Malše, and Stropnice Rivers and their tributaries (Černá and Svinenský Potok streams). Most of the Czech portion of the Novohradské Hory Mts. belongs to the Malše catchment; only the small southern part of the Novohradské Hory Mts. belongs to the Lužnice catchment. The mountain slopes are covered with cryptopodzols (Šefrna 2004) and we can find two zones of vegetation here: fir-beech and a spruce-beech-fir. Monocultures of spruce are dominant.

## Results

### Vysoká Mt. (1034 m)

The Vysoká Mt., with the altitude of 1034 m a.s.l., is the third highest mountain on the Czech side of the Novohradské Hory Mts. after the Kamenec (1072 m) and Myslivna mounts (1040 m). The geological structure of the Vysoká Mt. is determined by the Weinsberg granite, which is middle granular and porphyric (Staník 1991).

The Vysoká Mt. is a bornhardt which developed from a 500 metre long shelf ridge. The shelf ridge is elongated NE–SW. The northeasterly tectonic slope (Demek 1972b) has an inclination over 20° (Fig. 1). The other slopes around the top of the shelf ridge have a denudational character with slope inclination 10–20° and merge into more gentle slopes. The two most pronounced peaks are found on the top shelf ridge. The main, higher peak rises in the southwest and reaches an altitude of 1034 m. The secondary, lower peak rises in the northeast and reaches an altitude of 1001 m and merges directly into the tectonic slope. At the top of the Vysoká Mt., there are two castle koppies. The first castle koppie is 18×15×6 m (length × width × height) and the second 40×12×15 m. A cryogenetic platform of approximately 150×100 m surrounds them. In the castle koppie, there is a large fissure cave. The cave was formed by the expansion of a fissure due to the frost disintegration and the downslope movement. The cave is 6 m long and has an entrance of 2 m wide (Demek 1964). The tor that dominates the secondary lower peak is about 40×40×60 m.

The castle koppie extends to the northwest from this peak. It was perhaps originally a ruwary. The ruwary was shaped by frost activity during the cold periods of the Pleistocene. It is currently disintegrating and is bipartite over a length of 200 m, with a width of 15 m. The face of the castle koppie in the lower area is relatively high (with a maximum height of 25 m). The mushroom rock in the higher area has dimensions of approximately 6×6×6 m.

The periglacial relief forms are situated on the north and northeasterly tectonic slopes

**Fig. 1.** The tectonic slope of the Vysoká Mt. (1034 m).

**Fig. 2.** Exfoliation processes on the Vysoká Mt.

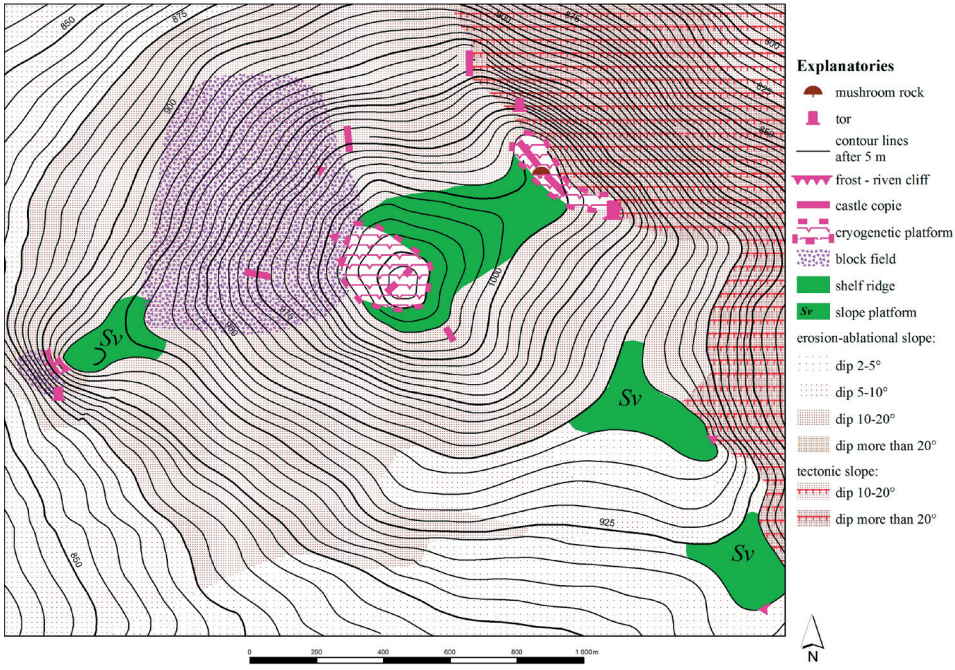


**Fig. 3.** The geomorphological map of the Vysoká Mt.

where the inclination is over 20°. A tor, which is approximately 5×5×10 m, dominates the slope at an altitude of 930 m. A castle koppie is also situated here. It is also disintegrating and bipartite over a total length of 300 m, with a width of 20 m and maximum height of 35 m. We can deduce that the structural fundament of the castle koppie is a result of pronounced exfoliation processes (Fig. 2).

More periglacial relief forms are situated on the western slope of the Vysoká Mt. The frost-riven cliff is situated on the edge of the shelf ridge at an altitude of 1015 m. It is 30 m long and 15 m high. A group of frost-riven cliffs is situated at an altitude of 975 m. The dimensions of this group vary between 5–10 m in length and 3–10 m in height. Below these cliffs, there is a block field (600×350 m). Two castle koppies of about 50×8×15 m and 15×3×4 m can be found on the northern part of the western slope at an altitude of 975 m. The castle koppie on the south part of the west slope, at an altitude of 945 m, is also disintegrating and bipartite over a length of 100 m, with a width of 10 m and maximum height of 20 m. Once again we can deduce from the pronounced exfoliation processes that it is a ruwary shaped by the frost activities during the cold periods of the Pleistocene.

A pronounced slope platform at the end of periglacial disintegration can be found on the west part of the slope at an altitude of 928 m. It ends with a group of frost-riven cliffs in the two levels. A tor on the slope, which is about 2×4×6 m, is surrounded by the frost-riven cliffs and a block field (300×120 m).

Periglacial relief forms are a rare sight on the south and southeasterly slopes of the Vysoká Mt. The castle koppie is once again situated on the south slope at an altitude of 1005 m. It is also disintegrating and bipartite over a length of 100 m, with a width of 8 m and height between 10–15 m. Two slope platforms at the end of periglacial disintegration, 300×170 m and 250×220 m, can be found on the southeasterly part of the slope at an altitude of 950 m

and 925 m, respectively. Slope platforms always end with frost-riven cliffs. These are respectively 4 m and 8 m long and 3 m and 8 m high with cryogenetic platforms of about 10×25 m and 30×50 m. The block field is approximately 270×270 m and is found to the east of the slope platform at an altitude of 925 m.

The geomorphological map of the Vysoká Mt. is shown in Fig. 3.

**Kraví Hora Mt. (953 m)**

The geological structures of the Kraví Hora Mt., as in the case of the Vysoká Mt., are also determined by the Weinsberg granite (Staník 1991).

On the top of the Kraví Hora Mt. is a castle koppie, which is about 100 m long, 2 m wide and 12 m high. This top castle koppie is demarcated by a snow depression to the west and sharply drops to the tectonic slope to the east at an incline of over 20°. Two smaller castle koppies of about 30×4×4 m can be found on the upper slope in the vicinity of the peak. The Napoleon's Head, a mushroom rock of about 4×4×10 m (Fig. 4), is located at the south end close to the top castle koppie. The next castle koppie is connected with the mushroom rock

**Fig. 4.** The mushroom rock – the Napoleon's Head on the Kraví Hora Mt. (953 m).

and measures 100×2×15 m. The cryogenetic platform below this castle koppie merges into the block field on the west denudational slope which has an inclination between 10°–20°. This platform is demarcated on the northeasterly side by three frost-riven cliffs of about 8–10 m long and 6–8 m high. It is approximately 370×100 m and is connected to the snow depression. We can assume that both the castle koppies and the mushroom rock were formed as one complex during the Pleistocene.

On the west denudational slope, at an altitude of 880 m, there are two smaller frost-riven cliffs of about 8 m long and 4 m high. The two dominant block fields on the east tectonic slope are respectively about 200 and 100 m long, and 100 and 30 m wide. The castle koppie (approximately 35×10×15 m) with the cryogenetic platform (70×60 m) rises to an altitude of 880 m, close to the southern cap stone of both slopes. The cryogenetic platform is demarcated by discontinuous frost-riven cliffs of about 150 m long and between 1.5–3.5 m high. At the base of the frost-riven cliffs there is also a relatively large block field (250×80 m).

The north and the northwestern slopes of the Kraví Hora Mt. are relatively complicated. At first sight it seems that several frost-riven cliffs can be found here. Further comprehensive research allows to suspect that they are structural outcrops. These structural outcrops were created along former ruwaries which were shaped by frost activities during the Pleistocene. These structural outcrops are situated at an altitude of 600 m on the northern slope and the original ruwaries could have been about 150 m long. One of the ruwaries runs to the northeast and two others to the northwest. These structural outcrops are completed by frost--riven cliffs that are 18 and 15 m long and 8 and 6 m high. A well established ruwary is situated at the top of the Kraví Hora Mt. where it drops down from the peak to the northeast. The ruwary is disintegrating and bipartite over a length of 150 m, with a maximum height of 8 m. Both parts of the ruwary are well established.

The geomorphological map of the Kraví Hora Mt. is shown in Fig. 5.

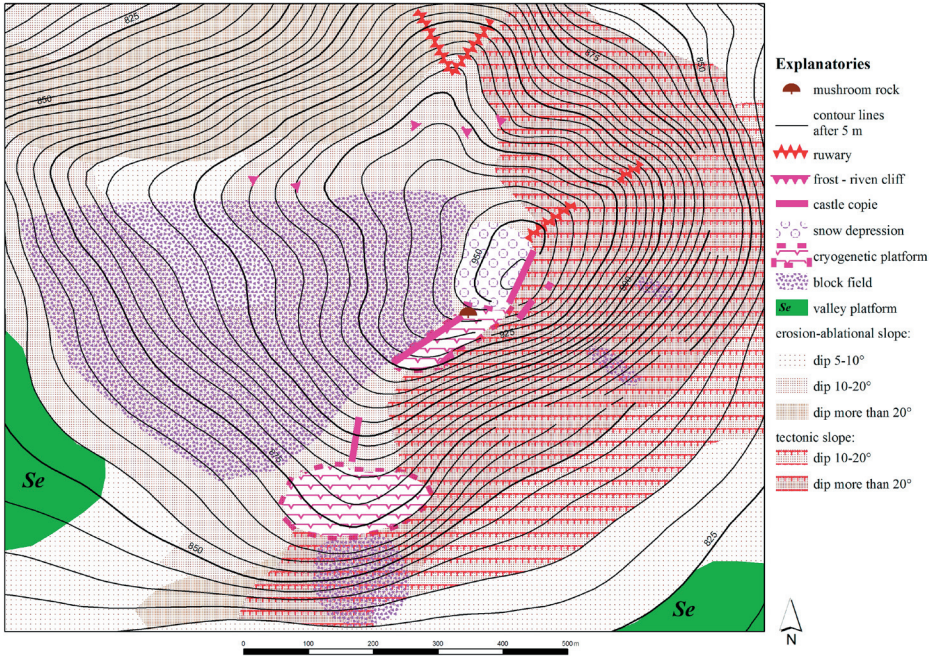


**Fig. 5.** The geomorphological map of the Kraví Hora Mt.

**Kuní Hora Mt. (925 m)**

The geological structures of the Kuní Hora Mt. are also (like the former mounts) determined by the Weinsberg granite.

The top of the Kuní Hora Mt. is a shelf ridge similar to the Vysoká Mt., which runs in a north to south direction and is approximately 370 m long. We can also find two peaks here. The lower peak in the north has an altitude of 900 m, the higher peak in the south has an altitude of 925 m.

The most interesting relief forms are concentrated on the top part of the Kuní Hora Mt. At the north peak there is a castle koppie and three small tors between 2–5 m long, 2–5 m wide and 2–4 m high. The castle koppie is 60×20×10 m. The peak stands on a cryogenetic platform of approximately 120×100 m. To the west the cryogenetic platform is demarcated by three small frost-riven cliffs (4–6 m long and 3–4 m high) and to the east by a higher frost--riven cliff (15 m long and 15 m high).

Two tors (respectively 10 m and 15 m long, 4 m and 7 m wide, and 3 m and 6 m high) and a castle koppie of about 80×20×12 m can be found on the southern peak. A ruwary drops down from the peak to the southwest for about 100 m, its width and height being 4 m. This peak also stands on a cryogenetic platform of about 120×140 m, which is demarcated to the south by a group of frost-riven cliffs between 3–20 m long and 2–10 m high. Both peaks are connected by a castle koppie which is about 60×10×20 m.

The north slope of the Kuní Hora Mt. is very similar in appearance to that of the north slope of the Kraví Hora Mt. and its structure is similarly complicated. The ruwaries that are situated here are better developed than those on the Kraví Hora Mt. Their length is again approximately 150 m and the height 4 m. A group of frost-riven cliffs (2–15 m long and 3–8 m high) can be found on the top edge of the northwesterly slope. Almost the whole of

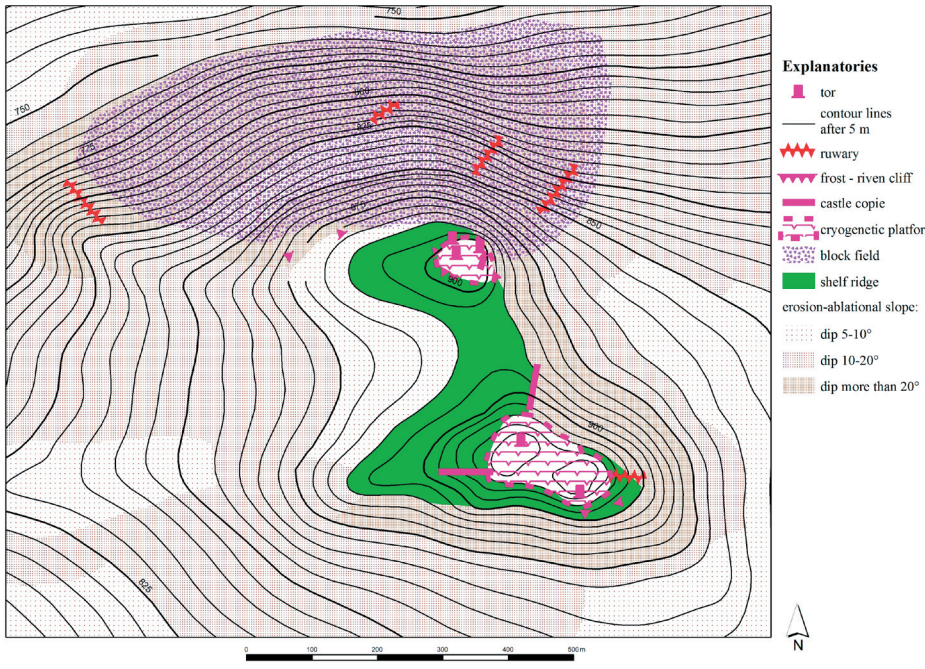


**Fig. 6.** The geomorphological map of the Kuní Hora Mt.

the north slope is covered with a large block field (370×750 m).

The geomorphological map of the Kuní Hora Mt. is shown in Fig. 6.

## Discussion and conclusions

We can expect the presence of periglacial forms in the top part of the Novohradské Hory Mts. and on their slopes, which were created in the cool period of the Pleistocene. We can suppose that this is due to the location of the Novohradské Hory Mts. on the interface between mountain and continental glaciation and also due to their altitude (the top parts at about 1000 m a.s.l.).

The periglacial forms of the relief were actually discovered (Figs. 3, 5, 6) during the geomorphological mapping in the northern part of the Novohradské Hory Mts. on the Vysoká, Kraví Hora, and Kuní Hora mounts. Moreover, ruwaries were also discovered on the slopes of the mountains and they were evidently shaped by frost in the cool periods of the Pleistocene.

We can conclude that the geological structure and altitude were the strongest factors that influenced the development of the periglacial relief forms. More perfect periglacial forms were created in the resistant weinsberg type of granite. The perfect periglacial forms were not created in the less resistant rocks, for example cordieritic gneiss (Rypl 2005). The influence of the altitude is evident in the northern part of the Novohradské Hory Mts. There are the periglacial forms created at an altitude of 800 m (Rypl 2005) and the periglacial forms created at 1000 m. Quantitative and qualitative representative periglacial forms at 800 m are not as important as for example in higher localities of the Novohradské Hory Mts. (Vysoká Mt., Kraví Hora Mt., Kuní Hora Mt.). They are more commonly found than at an altitude above 900 m (Lužnický Vrch hill, 907 m) where the geological structure is created by cordieritic gneiss (Rypl 2005).

The Novohradské Hory Mts. are a geomorphological area of great interest. The individual periglacial relief forms (e.g. the Napoleon's Head – Fig. 4) are ranked among the most interesting and the most important forms in this part of the Novohradské Hory Mts., so reason of the landscape of the Novohradské Hory Mts. creates a high-ranking potential for tourism (Šíp 2006). We think that these periglacial forms should be protected.

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