

# **Geomorphological aspects of slope deformations in the Outer Western Carpathians, Eastern Moravia, Czech Republic**

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## **1. Introduction**

Slope movements are a significant modelling agent of the flysch rock relief of the highlands and mountains of the Outer Western Carpathians in the Eastern Moravia. The role of slope deformations in the relief development was underestimated at a number of sites in this territory. The landforms of these sites were usually geomorphologically interpreted as cryogenic. We present geomorphological features of the selected sites with large slope deformations and new geomorphologic interpretation.

## **2. Basic geomorphological features**

The relief of the research area is a part of the geomorphological province – the Outer Western Carpathians (Fig. 1). It is located in Moravskoslezské Beskydy Mts., Hostýnsko-Vsetínská hornatina Mts. (subregions Hostýnské vrchy Mts., Vsetínské vrchy Mts.), Vizovická vrchovina Highland and Javorníky Mts. The research area is drained by typical Carpathian streams Vsetínská Bečva and Rožnovská Bečva. The research area is formed mainly by rugged highland to mountainous erosion-denudational and structure-denudational relief. Typical features are very dynamic geomorphological processes, especially fluvial processes and slope movements. The area is predominantly a part of the Magura Flysch Belt (Rača tectonic unit) in the the Moravskoslezské Beskydy Mts. The other part lies within Outer Flysch Belt (Silesian unit). The flysch complexes are formed by alternating layers of claystones and sandstones of the Mesozoic and Tertiary age.

## **3. Slope deformations**

In favourable geomorphological, geological and hydrogeological conditions the development of slope movements is a very important modelling agent. The triggering mechanisms are extreme precipitation, intensive snow thawing and the human factor (Kirchner, Krejčí, 2002). Selected localities were researched with respect to engineering geological recommendation and detailed geomorphological mapping was performed. Geological and geophysical methods were also used to explain the origin of slope deformations and their relation to fresh and fossil landform changes.

### **Kněhyně – Čertův mlýn site**

The locality (Photo 1) is modelled by bulky block landslides as well as landslides affecting only slope sediments (Photo 2). There are several entrances into pseudokarst caves. The well-known Kněhynská propast chasm (Photo 3) originated at a crossing of

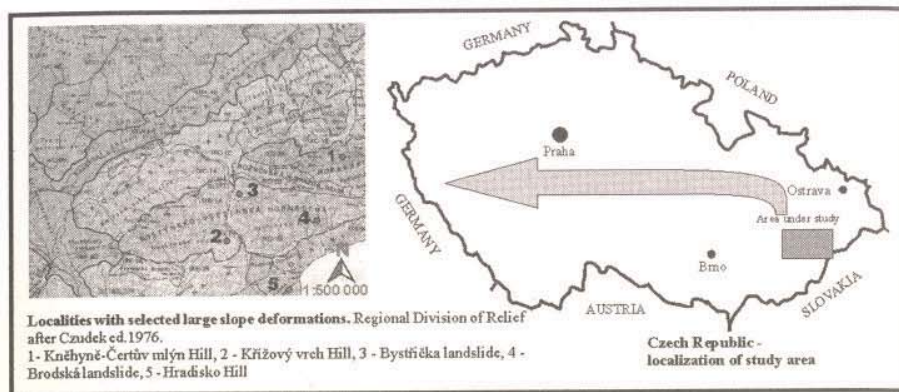


Fig. 1 Localization of the study area and positions of selected large scale deformations

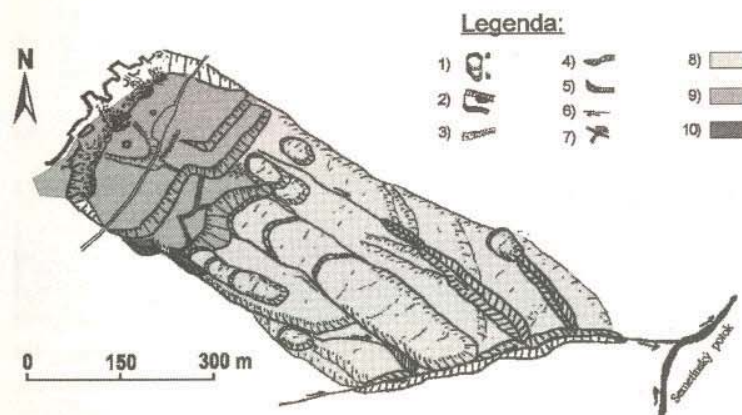


Fig. 2 Fossile slope deformation on the Křížový vrch Hill (after I. Baroň in Krejčí et al., 2002)

the E-W and N-S trending tectonic lines reaching down to the depth of 57.5 m. The character of the slopes in the summit parts is influenced by gravitational movements, which are linked with the N-S tectonic lines.

#### Křížový vrch Hill

Křížový vrch Hill (670 m a.s.l., Photo 4) has a large fossil slope deformation (length 925 m, width 525 m, Fig. 2) which originated as a complex of a block slide, landsliding, earth flows and rock fall. The upper part of the rock wall is 6.5–7 m high and 300 m long (Photo 5). In the past, these landforms were considered to be frost riven cliffs with cryoplanation terraces.

#### Bystřička landslide

Potential fossil area of the landslide had been earlier observed by geologists (Fig. 3). The extreme precipitation in July 1997 activated the mass movements of the Bystřička locality (Photo 6). Two significant slope deformations developed, ran

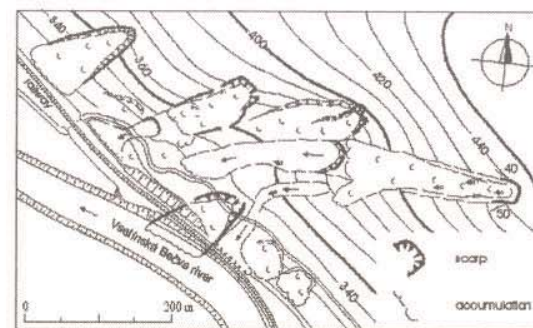


Fig. 3 Schematic map of the Bystřička landslide (after J. Rybář and J. Stemberk, modified by M. Bíl in Kirchner et al., 2000)

down and destroyed a railway tracks. The deformation in the upper part of the slope is conditioned by geological structure (Photos 7 and 8) because of saturation and motion of the rocks of the Rusava layers syncline.

#### Brodská landslide

A large slope deformation of the Brodská site is of earth-flow type (Photo 9) with the total length of 690 m, width of 50–70 m and the relative height of 170 m. The recent landslide movement has a length of over 300 m and the accumulation lobe is 10 m high. The upper part of the landslide is morphostructurally controlled (Photo 10) because it is situated on bedding plane and tectonic failure zone.

#### Hradisko Hill

The Hradisko Hill (773 m a.s.l.) is the largest castellated rocky ridge (Photo 11) in the Outer Western Carpathians in Moravia with many fossil slope deformations, pseudokarst and structural landforms. The bedrock is composed of the Luhačovice Member (Eocene) anticline affected by small faults and joints (Fig. 4). Previously

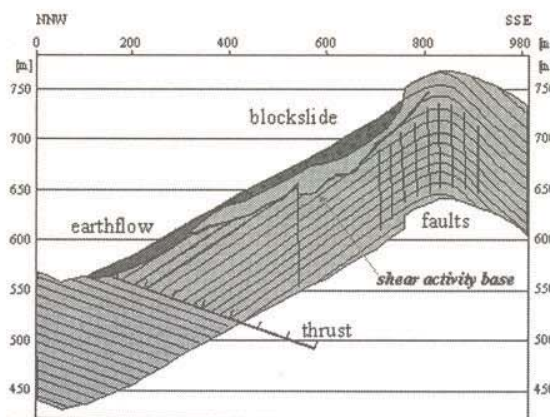


Fig. 4 Cross-profile of the Hradisko Hill built as an anticline of the Luhačovice Member (Eocene) with deep slope deformations (after Krejčí et al., 2002).

shared opinion was that the site was a frost-riven cliff (18 m high rock wall) with cryoplanation terraces. Recent joint geomorphological, geological and geophysical investigations have led to a new view on the origin of the NW slope of the Hradisko Hill. It has been found that the former relief was modified by a large slope deformation with rock scar and block slide (Photos 12 and 13). The length of the landslide is 635 m, its shear plane is in depth cca 20 m and under the shear plane there was identified a weathered and fractured zone to 20 m thick. The total thickness of the slope deformation reached cca 36 m and a potential shear zone is in depth up to 70 m.

#### 4. Conclusion

Slope movements have an important role in the process of originating of highland and mountain ridges in the Outer Western Carpathians. The development and positions of these slope deformations with gravitational origin are also controlled by the properties of bedrock. Modelling of landforms in the scale of meso-forms (e.g. large ridges, slope depressions, rock walls) needs a close cooperation between geomorphologists and geologists.

#### Acknowledgements

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#### References

- KIRCHNER, K., KREJČÍ, O. (2002): Slope deformations and their significance for relief development in the middle part of Outer Western Carpathians in Moravia. – *Moravian Geographical Reports*, 10, 2, 10–9, Brno.
- KIRCHNER, K., KREJČÍ, O., MÁČKA, Z., BÍL, M. (2000): Slope deformations in eastern Moravia, Vsetín District (Outer Western Carpathians). – *Acta Universitatis Carolinae*, 2000, Geographica, XXXV, Supplementum, 133–143, Praha.
- KREJČÍ, O., BAROŇ, I., BÍL, M., HUBATKA, F., JUROVÁ, Z., KIRCHNER, K. (2002): Slope movements in the Flysch Carpathians of Eastern Czech Republic triggered by extreme rainfalls in 1977: a case study. – *Physics and Chemistry of the Earth*, 27, 1567–1576, Elsevier Science Ltd., Amsterdam.



Photo 1 Area of large slope deformations on the Kněhyně ridge in the Moravskoslezské Beskydy Mts.

Photos 1–13 by K. Kirchner



Photo 2 Block landslides on structural-denudational slopes in the Kněhyně – Čertův mlýn area



Photo 3 Large pseudokarst cave in the Kněhyňská propast chasm site

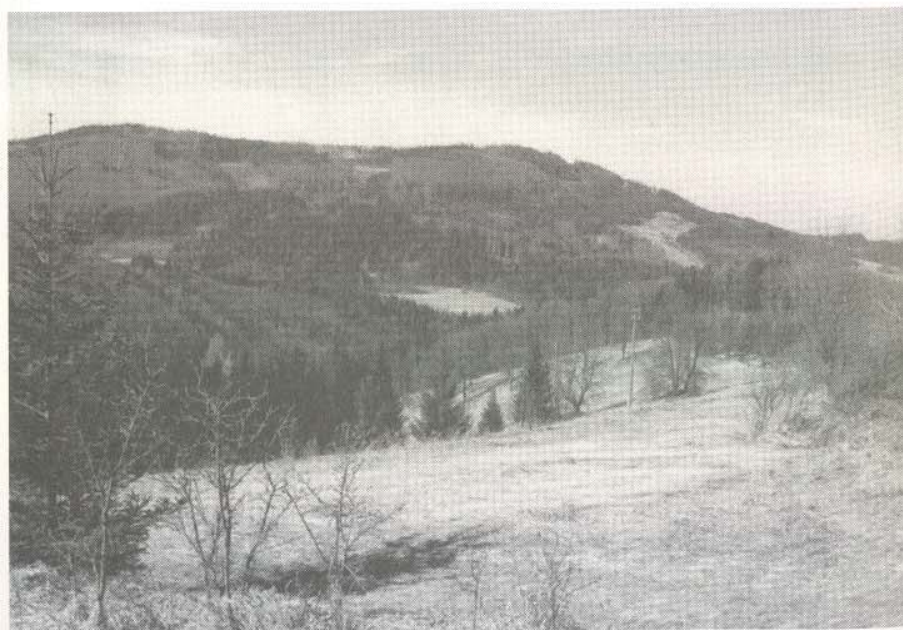
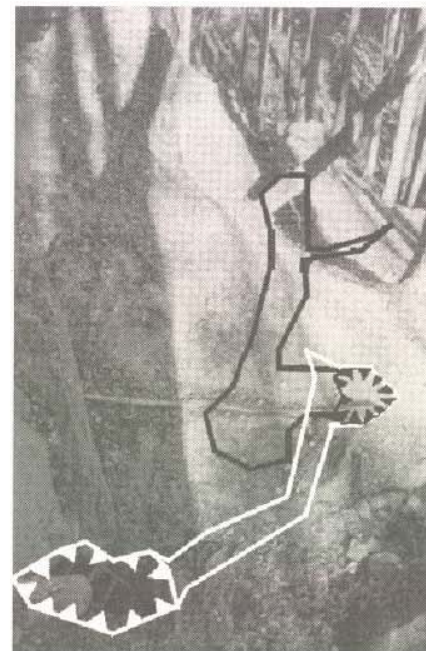


Photo 4 Position of large slope deformations in sandstones of the Křížový vrch Hill

Photo 5 Present-day pattern of the landslide area on the Křížový vrch Hill



► Photo 6 Active slope deformations in the Bystřička area



▼ Photo 7 Upper part of a structurally controlled shape of the Bystřička landslide





*Photo 8* Sandstone blocks in the accumulation zone of the Bystřička landslide



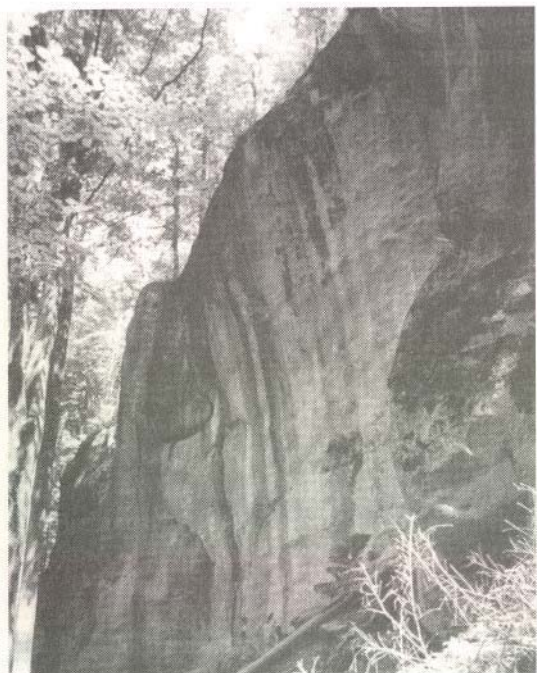
*Photo 9* Large slope deformation of an earth-flow type in the Brodská landslide area



*Photo 10* Trough-like depression in the upper part of the Brodská landslide has a similar shape as the slope dell but it is of the structural origin



*Photo 11* Upper part of the Hradisko Hill with castellated rocks



*Photo 12* Rock scar of block slide on the Hradisko Hill



*Photo 13* Pseudokarst crevasse-type cave on the Hradisko Hill