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GEOINFORMATION POTENTIAL OF THE LABE RIVER CANYON IN THE DĚČÍN HIGHLAND, CZECH REPUBLIC

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ABSTRACT. Morphostructure and surface forms of valley slopes of the Labe River Canyon and its vicinity provide a relatively detailed record of the neotectonic and paleographic history of one of the most remarkable regions of the Bohemian Massif. This region, a relatively small one, presents a chance to study most phases of morphological evolution of rock slopes in quadratic sandstones, including all the preparatory phases of catastrophic rockfalls. The high geoinformative potential of the region, valuable scientifically as well as practically, has not been fully utilized, yet. As an example, the analysis of the seismotectonic evolution of this region in the Quaternary, notably during the Holocene, can be given.

KEY WORDS: land forms evolution, geodynamics, neotectonics, rockfalls

1. INTRODUCTION

The Dolní Žleb Project – a dam project of the Labe River in North Bohemia, has frequently been the object of controversial polemics stirred up by environmentalists. The Labe River Canyon between the towns of Děčín and Hřensko, where the dam site is to be located, appears to be very interesting region for natural historians. From the point of view of both the geological and geographical sciences the canyon is more than
quadratic sandstone relief of the Děčín Highland [Balatka and Sládek 1984]. The morphostructure and surface forms of the canyon valley slope provide a relatively detailed record of the neotectonic and paleogeographic history of one of the regions of great importance to the general studies of the geological and the geomorphological evolution of the Bohemian Massif, more closely of the Bohemian Highland. Here, can be found specific information
field in geoscience. According to the authors this quality has not been exploited satisfactorily. It is our intention to show those thematic fields where the theoretical, as well as the practical knowledge of more than local/regional importance, can be enhanced.

2. GEOINFORMATIVE CAPACITY OF THE REGION

The antecedent canyon of the Labe River in the Děčín Highland and in the Elbsandsteingebirge reaches more than 300 m depth at places. It was formed during the Old and Middle Pleistocene by successive deepening of the river into mostly sandy marine Upper Cretaceous sediments, or even to their crystallinic base. Stratigraphically cretaceous sediments range here from the Cenomanian to the Middle Turonian, being represented mainly by quadratic sandstones. Their base is formed from Lužice granite and the metamorphic rocks of its mantle. The successive erosion of the river was stimulated climatically and partially by tectonic movements [Kalvoda and Zvelebil 1983]. The slopes, bottom, and close vicinity of the canyon can serve as a rich source of a wide spectrum of geoinformation. The rock slopes of the canyon borders provide the opportunity for direct structural – geological and lithological studies in a natural continuous cross section for more than 20 km on the Czech, as well as German territories.

From the point of view of historic and dynamic geology, a wider vicinity of the present canyon represents a weakened marginal zone of the Bohemian Massif. It is just this place where transgressions of epicontinental seas encroached repeatedly into the heart of the Bohemian Massif in the Mesozoik. On the contrary the neotectonic stage of its evolution is characteristic of repeated block uplifts. In spite of that, this region forms the erosional base of a major part of the Bohemian Massif. Here, there is an intersection of two first order tectonic zones, important to the entirely of the Bohemian Massif, and permanently active, which has given way to morphostructure of the region. One of the two zones, the Labe lineament, shows a general orientation NW–SE having been repeatedly activated long since the Proterozoic. The second of them is an elongation of the Krušné Hory Mts. fault zone to the NE. Here, it is locally described as the Děčín and Česká Kamenice fault zone. The fault zone turns to WE orientation (Fig. 1) and bears signs of repeated reactivations since the Tertiary [Malkovský, 1979].

Geomorphological analysis of mutations in the dynamics of slope evolution in the Quaternary, performed in the northern section of the canyon [Kalvoda and Zvelebil 1983], has shown the impact of repeated Old and Middle Pleistocene tectonic uplifts upon the valley formation. Besides, indications for the existence of a partial uplift as late as the Holocene (i.e. during last 10 000 years) have been observed. Some morphological indications for very young movements, again the Holocene is most likely, have been found even in the southern section of the valley [Zvelebil 1989]. German professional publications dealing with the valley present even quantitative data for subsidence of the tectonic origin [Präger 1966, 1976; Präger and Lemke 1967; Thurm 1973].

The question of the neotectonic activity during the Holocene as well at the present time is still remaining open. The same is the situation with the problem of present time seismic potential of the region. Regarding the geodynamical type of morphostructure (e.g. see Buben, 1990), present seismic and likely even movement activity of more distant sections of both the fault intersecting zones [Kárník et al. 1957, 1981; Kalvoda et al. 1990], and the presence of morphological indications for

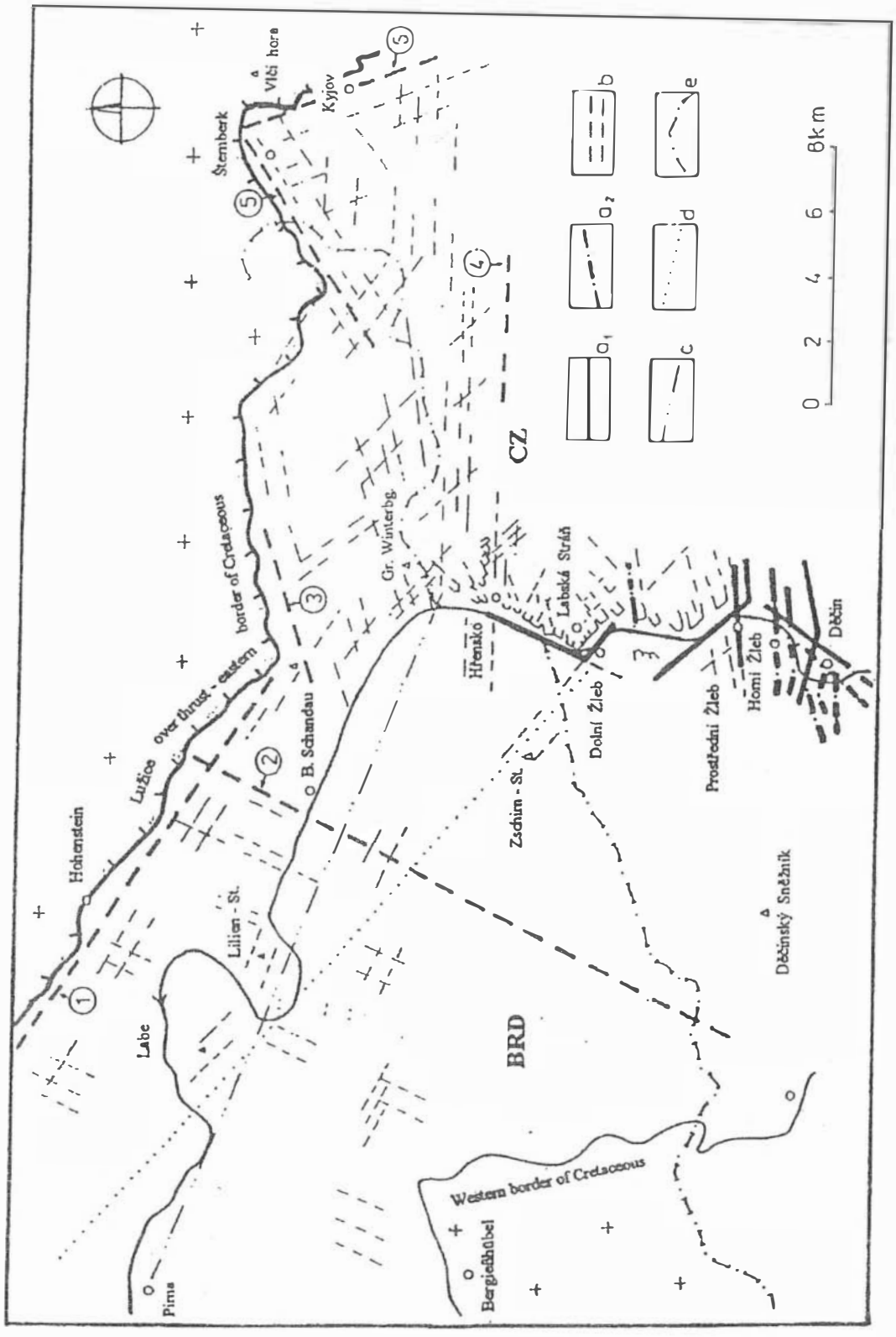

FIG. 1. Tectonic sketch of the Labe River Canyon. Detailed block mozaic in the zone of the Labe lineament and Krušné Hory Mts. fault belt intersection. It can be noted that the course of the Labe Canyon is based on faults.
Explanations: a_1 – faults detected; a_2 – faults anticipated; b – orientation of saxonian fissures in Cretaceous sediments; c – principal orientation of structures in crystalline basement of Cretaceous; d – longitudinal axis of the Děčín Highland horst.

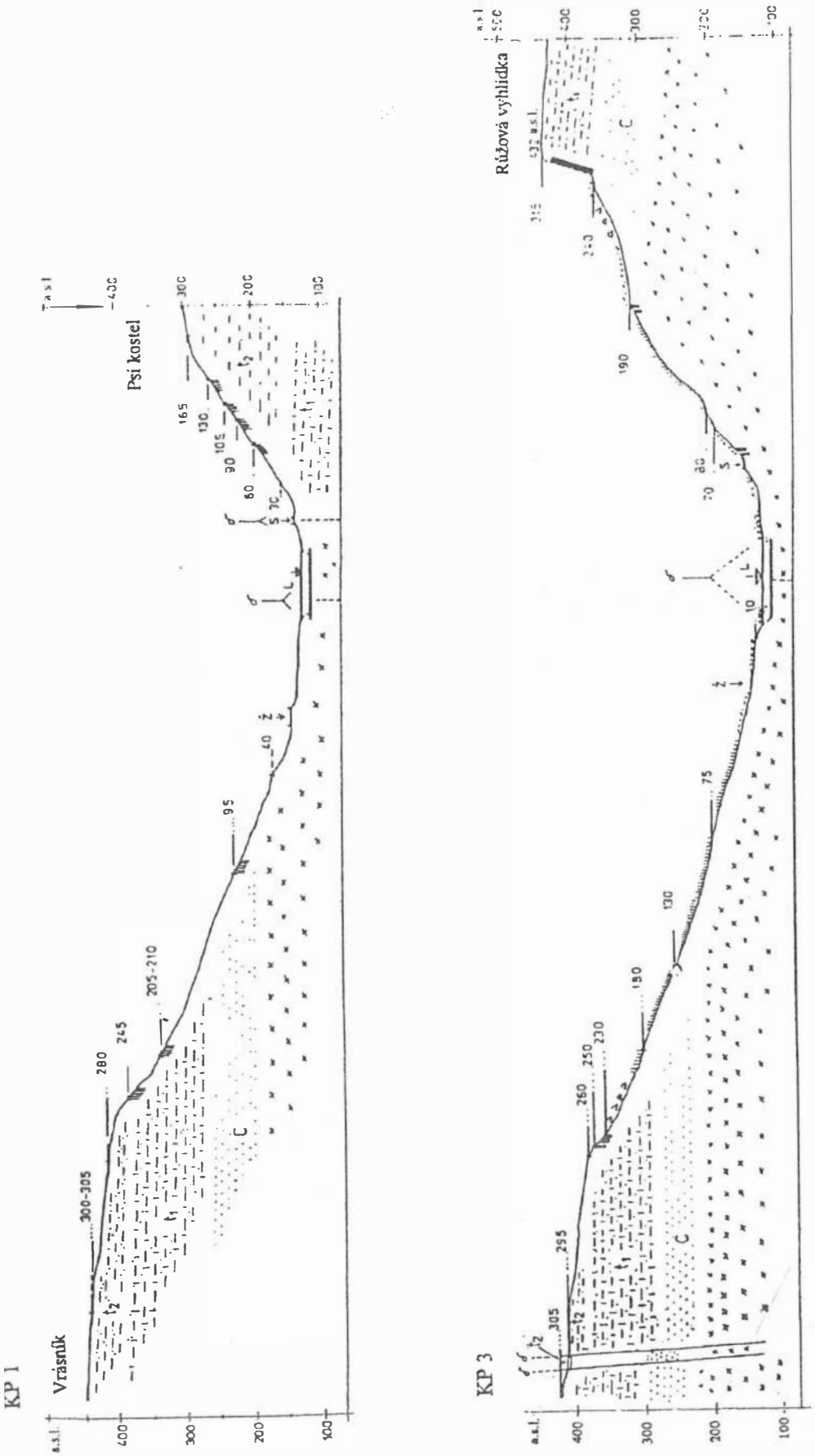

FIG. 2a.

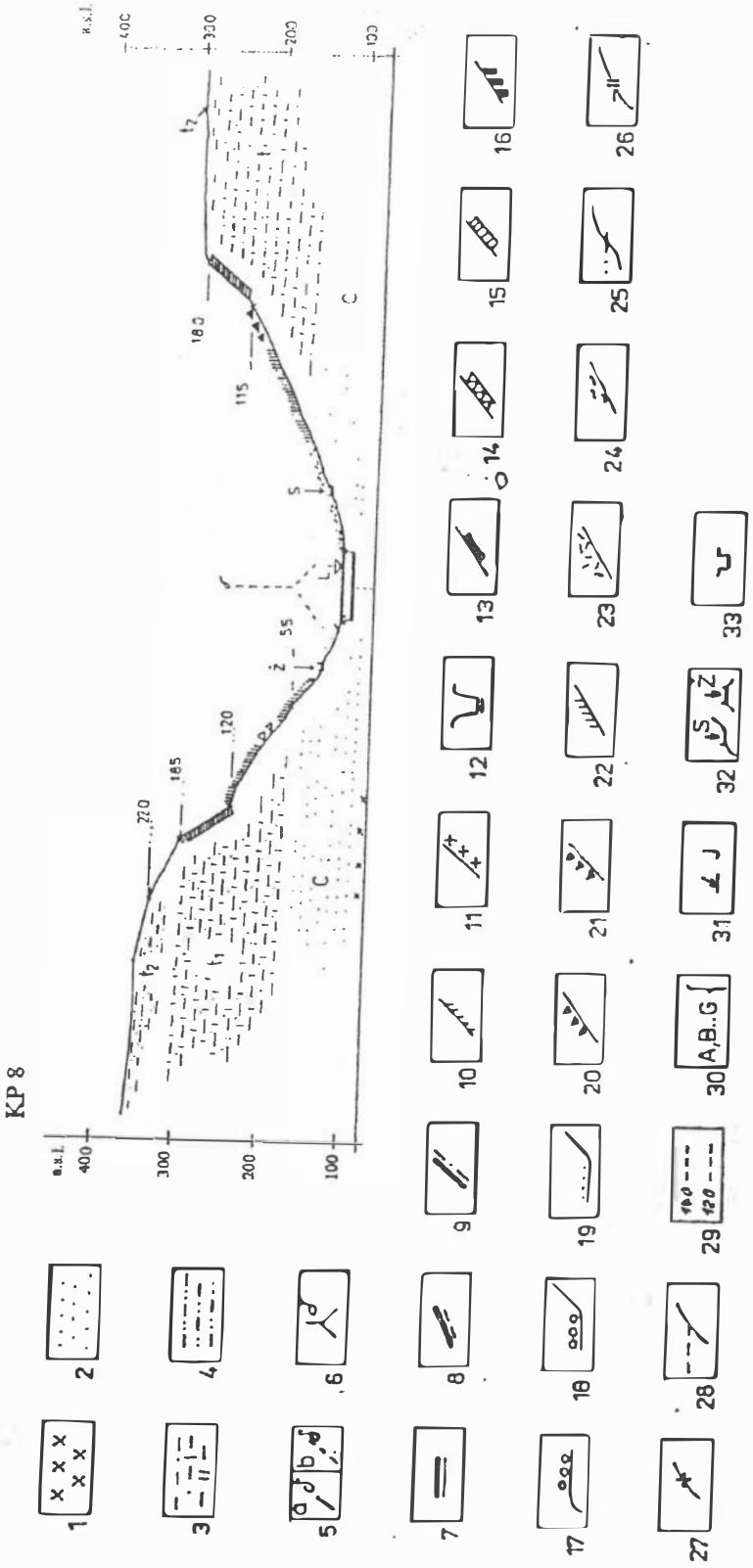
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FIG. 2b.

increased seismicity on the slopes of the southern section of the canyon [Zvelebil 1989, 1992], the seismic significance of the investigated region seem to have been undervalued.

The Labe River canyon is significant in many ways to the paleogeography, the geomorphology, and the Quaternary. Since the Old Miocene, the river system of Bohemia has been dewatered through this mouth to the N [Kunský 1968]. The Labe canyon represents the historical and the present erosional base of a major part of the Czech Highland. Therefore, it is the place of fundamental importance regarding their regional chronostratigraphical system of river terraces. At the same time, it is a point where this system can be directly and physically attached to the chronostratigraphical system of North Europe's continental glaciation.

As said before, modern studies into both the chronology and the dynamic conditions of individual stages of the valley deepening, have covered only the northern part of the Bohemian section of the Labe River canyon (c.f. Kalvoda, 1980). This type of study is rather complicated in the canyon because the morphology allows for the observation of a complex of forms. There are forms which have been conditioned lithologically and structurally, combined with forms due to the later, exogenous and endogenous effects of the morphological evolution of the valley slopes (c.f. Lamprecht, 1935; Balatka and Sládek, 1984; Zvelebil, 1989). From the point of view of geomorphological and engineering geological theory of slope evolution, the forms of the Labe canyon rock slopes represent more than specific forms of relief evolution in an intersection of two exposed, neotectonically active fault zones. Present continuation of tectonic activity is also possible.

However, more than that, the canyon slopes can be seen as an example of the intensive Quaternary evolution of slopes in marginal hill ranges of the Bohemian Highland. Here, morphostructural and hydrogeological conditions for slope evolution have cumulated into a single, relatively narrow region, where the lithology of sandstones is relatively compact. Absolute timing of main rock walls, bound to Lower Turonian sandstones (Fig. 2)[2], show a different age for individual canyon sections. This can be explained by the consequential process of the Labe River

[2]Caption of FIG. 2: Transversal morphostructural profiles of the Labe Canyon from S to N. Locally uneven morphostructural conditions in individual sections of the canyon, cutting transversally through the assymetrical horst of Děčín Highlands, are documented. Data about individual levels in the profiles respond to individual structural – denudational belts in the slope.
Explanations: 1 – Paleozoic crystalline; 2 – Cenomanian; 3 – Lower Turonian; 4 – Middle Turonian; 5 – Fault: a – detected, b – anticipated; 6 – Fault zone; 7 – Young Tertiary and Quaternary planar surface in a form of denudational platforms sloping by 0 to 2°; 8 – sloping by 2 to 5°; 9 – steeply sloping more than 5°; 10 – erosional platforms sloping by 5 to 8°; 11 – steep erosional sloping more than 8°; 12 – Labe riverbed, deepened; 13 – continuous rock relief, barrier type; 14 – dtto, step–like; 15 – dtto, transitory; 16 – dtto, dissected, degraded; 17 – Upper Pliocene to Old Pliocene terrace; 18 – Würm terrace; 19 – flood terrace; 20 – blocky material; 21 – accumulations, subrecent to recent rockfalls; 22 – stony material; 23 – rough grained material; 24 – washed off sediments; 25 – boundaries of single modelation levels; 26 – upper boundary formed by technogene activity in the remodeled denudational or erosional slope; 28 – anticipated course of single modelation level boundaries; 29 – relative altitude above the Labe River level; 30 – outer boundaries of single erosional–denudational belts; 31 – base of the crack and fissure system of caves; 32 – state road and railway; 33 – quarry wall.

cutting into the longitudinally assymetrical horst of Cretaceous rocks. As a result an atypical rich slope relief developed, characteristic of the transversal, as well as the longitudinal morphological assymetry of the valley. It suggests studies of a majority of geomorphological evolution phases in quadratic sandstones. Until now, the evolution has included stages of catastrophic movements of rockfalls [c.f. Zvelebil, 1989].

Both the destructive and accumulative forms produced by slope movements are obviously related to chronostratigraphically classified depositions of river terraces and to the erosionally denudational belts on slopes (Fig. 3). Besides, there are rich historical records about slope instability events in this area. This provides an exceptional opportunity to step for absolute time calibration of such a model region [Zvelebil 1988, 1989, 1990].

The canyon slopes have been claimed for a systematic research into the complex methodological analysis of catastrophic
rayonization maps, that express levels of rockfall risks. Here, monitoring of slope movements is widely applied with an eye to safety and to look for rockfall prognosis [Zvelebil 1984, 1994].

3. Conclusions

A relatively narrow region of the Labe River canyon in the Děčín Highland and in the Elbsandsteingebirge provides an exceptionally high and rich potential of geoinformation. Its scientific and also practical importance exceeds the frames of this region. Its potential has not been fully used. There is a lack of a complex interdisciplinary synthesis of individual findings. The same goes for the Czech, as well as the German section. We consider that such complex studies in this region may potentially arrive at new and even unpredictable results.

As for the practical impacts of the dam
is a need not only for geodynamical appraisal of the Dolní Žleb site, which should precede the final project, but also to fill in the gaps in knowledge of its geodynamic characteristics. As an
as the recent seismotectonical activity of the region. This is of special importance for a dam planned to be erected at a point of active fault zone intersection – that of the Labe lineament and the Krušné Hory Mts. fault zones.

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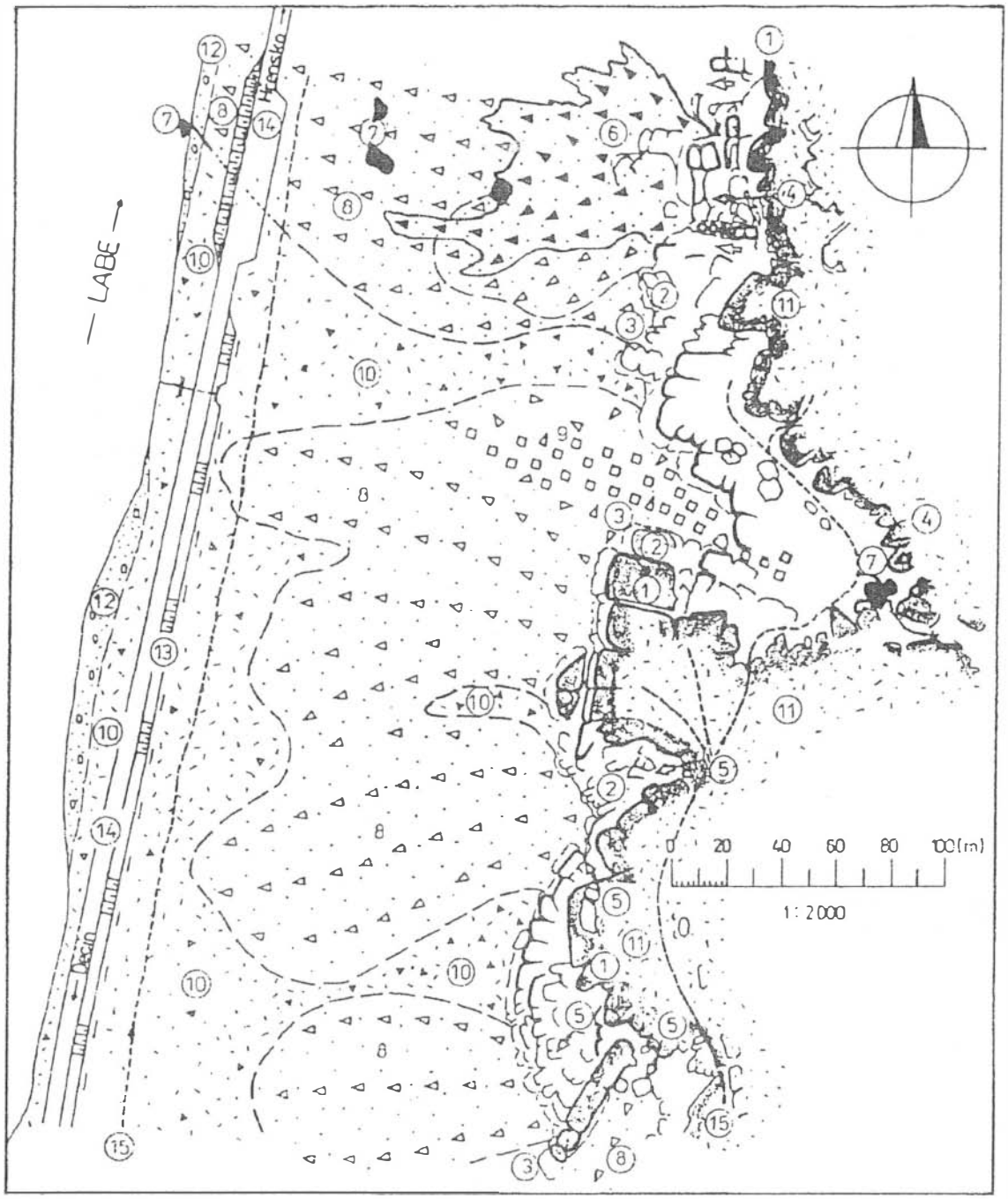

FIG. 3. Detailed map of valley slopes. The map presents the opportunity to find correlations between the youngest river and slope sediments, and in such a way to calibrate evolutionary models of large rockfalls, e.g. to find a number of repeated rockfalls at one single locality during the approximately last 10 000 years.
Explanations: 1 – upper edges of sandstone walls and towers, more than 10 m high; 2 – dtto, less than 10 m; 3 – toe of walls and towers; 4 – scarp area of recent rockfalls; 5 – dtto, subrecent rockfalls; 6 – accumulation pile of a recent rockfall; 7 – the biggest fallen blocks, in scale; 8 – accumulation pile of a subrecent rockfall; 9 – a place of secondary increased concentration of debris blocks on the slope surface after fine grain fractions have been washed off; 10 – stony–sandy slope debris with blocks at places; 11 – sandy–loamy polygenetic accumulations, few blocks; 12 – sandy gravels of Labe terraces; 13 - supporting walls; 13 – state road; 14 – foot–paths.

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GEOINFORMAČNÍ POTENCIÁL KAŇONU LABE V DĚČÍNSKÉ VRCHOVINĚ, ČESKÁ REPUBLIKA

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Morfostruktura a povrchové tvary údolních svahů labského kaňonu a jeho nejbližšího okolí skýtají relativně detailní záznam neotektonické a paleogeografické historie jedné z klíčových oblastí Českého masívu. V rámci jediného, relativně nevelkého území, je zde rovněž možno studovat většinu fází geomorfologického vývoje skalních svahů v kvádrových pískovcích, včetně všech fází přípravy katastrofických skalních řícení. Vysoký geoinformační potenciál území, cenný jak z hlediska badatelského, tak i praktického, však dosud není plně využíván. Příkladem je v tomto ohledu hodnocení seismotektonického vývoje tohoto regionu během kvartéru, zvláště pak během holocénu.