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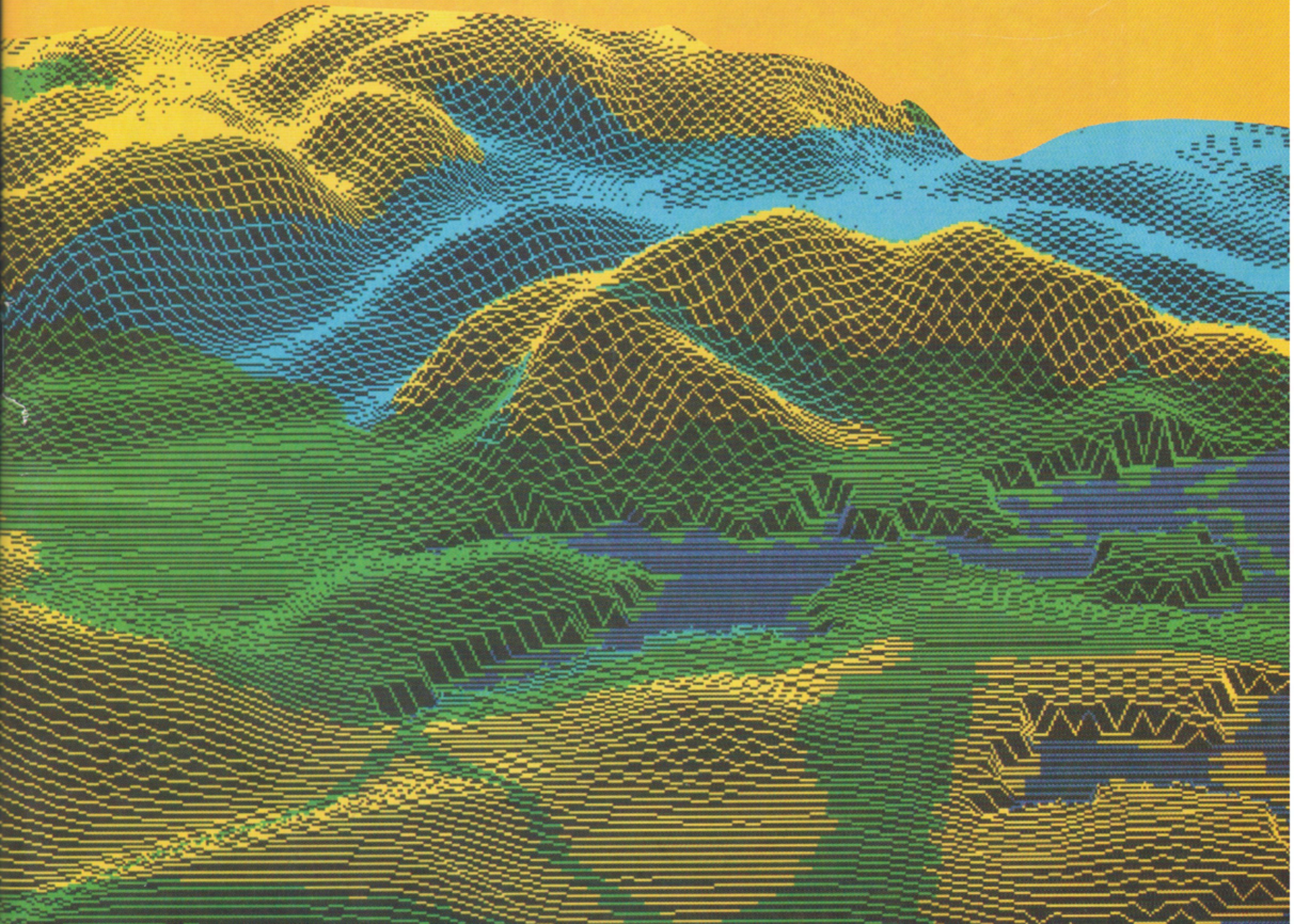

Waterfall on the Malá Morava River.

Photo J. Demek, 1995.

Illustration to the paper on of J. Demek - J. Kopecký

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ENVIRONMENTAL SYSTEMS STUDIES - A NEW APPROACH TOWARDS THE ENVIRONMENTAL EDUCATION IN AUSTRIA

Walter ZSILINCSAR

Abstract

The increasing concern about local, national, and global environmental conditions in the late sixties, which had affected especially young people in the USA, in Western and Central Europe, most of them students and the "intelligency", had its consequences - after a certain time - lag - also at the universities.

The first initiatives towards environmental education were made at institutes of technology, where a 4-semester postgraduate course "Technical Protection of the Environment" had been installed. The study concentrates upon two optional fields of interest: 1) air and noise protection and 2) water pollution and waste control. Great emphasis is laid on practical experience.

At the traditional university level the internal discussion had prevented the institutionalisation of special environmental education as long as winter 1990 when an irregulare study of "Environmental Systems Studies" with a duration of 10 semesters started. Although it was planned at the beginning that the access to this new study should be opened to all disciplines of the faculty of natural sciences it was finally reduced to students in the fields of geography, physics, chemistry, political economy and business studies.

The "studium irregulare" is going to be completely restructured, although no definite concepts have been presented so far.

Shrnutí

Vzrůstající zájem o lokální, národní a globální podmínky životního prostředí na konci šedesátých let, které ovlivnily zejména mladé lidi v USA, západní a střední Evropě, nejčastěji studenty a inteligenci, se s určitým časovým odstupem projevil také na univerzitách.

První iniciativy k environmentálnímu vzdělávání byly podniknuty na technologických institutech, kde byly zavedeny čtyř-semestrální postgraduální kurzy "Technická ochrana životního prostředí". Studium se zaměřuje na dvě volitelné zájmové oblasti: 1) ochrana ovzduší a hlučnosti, 2) ochrana vod a kontrola odpadů. Velký důraz je kladen na praktické zkušenosti.

Interní diskuse na tradiční univerzitní úrovni zachovala institucionalizaci speciálního environmentálního vzdělávání až do zimy 1990, kdy začalo mimořádné deseti-semestrové studium "Environmental System Studies" (Systém environmentálního vzdělávání). Na začátku bylo záměrem, aby k tomuto studiu mohly přistupovat všechny obory z přírodovědecké fakulty, ale nakonec bylo omezeno jen na studenty oborů geografie, fyziky, chemie, politické ekonomie a obchodních oborů.

Přestože nebyl dosud zveřejněn konečný návrh, bude toto mimořádné studium zcela restrukturalizováno.

Key words: Interdisciplinarity, environmental training, environmental system studies, studium irregulare

1. Introduction

In 1983, for the first time, a commission for the foundation of an interdisciplinary institution on behalf of ecology and environmental protection has been installed by the faculty of natural sciences of the University of Graz. The motive for this decision was the students' demand for a separate chair and study of ecology. Since the realization of such a project seemed unrealistic considering the scientific width of such a "hyper-institute", the organizational difficulties and high costs of its installation alternatives were being discussed.

One such alternative was a special ecological branch of study integrated into the field of biology. The biggest disadvantage of this proposal was the renunciation to utmost interdisciplinarity and interdisciplinarity was strongly demanded by the students' council of the University of Graz and given reasons as follows:

"The main goal of an ecologist is to properly react to present and future environmental challenges and to understand their mechanisms and consequences. Thus it is inevitable to the ecologist to dispose of a sound knowledge of all the processes changing the face of the earth and to develop methods which may reconcile the scientist a better understanding for the environment.Todays natural scientists are highly specialized. That kind of specialisation is not to be aimed at by the ecologist, although he should be willing to cooperate with the specialists and inform them about those environmental parameters which, by no means, must be changed" (cf. Umweltsystemwissenschaften, ed. by Arbeitsgruppe "Ökosystemstudien", Öst. Hochschülerschaft, 1994).

Ecological studies should focus on environmental problems.

The strict biological comprehension of bioms is the task of biology. Though it contributes with important parameters, it is not a key to the solution of environmental problems.

Another option towards environmental studies was seen in a post graduate study similarly structured like the one at the Technical Universities of Graz and Vienna. Although favoured by the members of the faculty of natural sciences, this idea was finally rejected because no competition with the existing post-graduate study "Technical Protection of the Environment" was intended .

Apart from that, problems arising from a short programme of only four semestres as to a well founded interdisciplinary environmental education were clearly seen.

Thus from very pragmatic reasons one renounced the all in all positive combination between a major in natural sciences and a post graduate specialization in environmental studies not denying the fact of better chances for jobs. Moreover it had to be considered that the idea of interdisciplinarity could not be restricted to technology and natural sciences but had to include also social sciences, law, economics, medicine and even theological approaches.

2. Environmental Systems Studies

Following an intense discussion at the faculty of natural sciences in 1985 the installation of an independent branch of study ("environmental systems studies") was proposed at the Austrian Ministry of Sciences. It was intended to open this branch to almost all students of the above faculty. Yet, only in winter 1990/91 the academic senate at the University of Graz decided to start the project of "environmental systems studies".

The basic ideas for this new and forward-looking field of study were described by the students council as follows:

"Environmental problems are inextricably linked with people's actions. That is why a scientific and/or technological analysis is not sufficient. Rather, one has to look at the issue from an interdisciplinary perspective, taking social, economic, legal and philosophical aspects into consideration, in accordance with the systemic, nonlinear nature of ecosystems.

Apart from the sound technical training (at the moment students can focus on one of the following five subjects: chemistry, physics, geography, economics and business studies) "Umweltsystemwissenschaften" (environmental systems studies) aims at conveying the fundamental principles of a few other disciplines and putting them in relation to one another.

"Umweltsystemwissenschaften" involves not only the analysis of a global system's individual components but also studies of systems dynamics and of the ways in which individual components are linked up. That is why systems analytic and mathematical methods are an essential part of the environmental systems studies.

Working in an interdisciplinary team, graduates of "Umweltsystemwissenschaften" should be able to use both their technical competence and the ability of linking up different scientific fields.

Interdisciplinary studies require the sound technical training in natural, biological, artic, formal, and legal sciences. Apart from reinforcing the technical training, the "environmental systems studies" focus on the comprehension of ecosystems from the perspectives of different scientific fields. Multidisciplinary lectures and seminars on specific ecosystems will allow students to look at the issue from the perspectives of different scientific fields. The systems analytical and cybernetic aspects, for instance control mechanisms in ecosystems, will also be taken into account. The practical training will focus not only on repairing the ecological damage but also on planning strategies. In project studies ecologically successful or unsuccessful strategies (e.g. the construction of power stations, road and urban planning, eco-friendly products and ways of production, tests determining the extent to which a product is environmentally tolerable, etc.) will be analyzed.

In the interdisciplinary courses students will look at the interactions between human beings-nature-culture-technology. In optional courses students will be able to get both the interdisciplinary training and the opportunity to focus upon a particular subject".

The structure of the new study was based on a sound basic training in one of the fields of natural, social or arts subjects including economics, supplemented with a combination of subjects focusing ecology and systems analysis (Tab. 1).

At the moment students can concentrate on either business studies, economics, physics, chemistry, or geography. The subject focused upon constitutes 60 % of the time-table.

In each perid of study students have to choose combinations of subjects from the fields of science other than the subject focused upon in order to gain knowledge in other ecologically relevant fields. Normally the combinations consist of courses conveying the basic knowledge and of extensive courses reinforcing what the students already know. In the first period of study, the students are advised to attend the basic courses since they lack any previous knowledge; in the second period of study there are several possibilities to choose from:

- they can choose combinations of subjects not attended in the first period of study and thereby get a broad training in environmental science, which is limited to the acquisition of basic knowledge in particular fields;
- they can choose combinations of subjects already attended in the first period of study, thereby gaining more profound but not very extensive knowledge in the environmental sciences;
- a combination of those two options entails the acquisition of a certain amount of basic knowledge and extended technical knowledge in other fields.

Because it is essential for the comprehension of ecosystems the subject "Systemwissenschaften" (systems sciences) is compulsory.

Students focusing on different subjects collaborate on specific environmental issues.

In optional courses, the students can extend their knowledge in the subject focused upon in the combination of subjects or in the systems sciences.

Within the framework of existing curricula of relevant scientific fields subjects which could be renounced should be eliminated to guarantee a basic and special training in the main field of interest of about 100 to 115 hrs. per semestre.

An additional compulsory bundle of subjects comprising ecology and systems analysis should include between 6 and 10 scientific fields e.g. mathematics, biology, zoology, chemistry, physics, geology, geophysics, medicine, philosophy, social and economic sciences, law, foreign languages, etc. being taught 9 hrs each per semestre at the maximum, yet not exceeding a total of 54 hrs. per semestre.

"Environmental systems studies" were finally introduced at the university level in winter 1991/92 in the form of a "studium irregulare". It comprised two main fields of interest:

- economic sciences for students of political economy and business studies;
- natural sciences for students of geography, physics and chemistry.

This meant, however, to make considerable cuts as to the initial plans of opening this new form of the environmental education to a wide range of students of various fields of natural sciences. So, unfortunately, no admission to the irregular studies programme was being granted to students of ecologically important fields such as biology or geology.

Nevertheless, the curriculum for the studium irregulare "Environmental Systems Studies" proves the attempt to combine the advantages of a regular study programme in the natural sciences with a special interdisciplinary training in ecology and systems analysis.

3. The Study Programme

As an example the study programme for students focusing on geography as a basic field shall be presented very briefly.

Tab. 1 Curriculum of Environmental Systems Studies

The first period of a study of all together 10 semestres covers 4 semestres and comprises the following subjects (in brackets their number of weekly hours to be attended throughout four semestres):

- General physical geography (10-20)
- General human geography (10-12)
- Cartography (7)
- Statistical methods (6)
- Compulsory subjects and systems sciences (i.e. mathematics, earth sciences, botany, zoology, chemistry, physics, meteorology, geophysics, environmental hygiene, psychology, systems analysis, political economy, business studies, environmental law) (18)
- Practical training in environmental systems analysis (4)
- Optional subjects (e.g. languages) (8)

The second period of the study covers six semestres and includes subjects such as:

- Comparative physical geography (10-15)
- Comparative human geography (8-13)
- Thematical cartography (3)
- Regional geography (4)
- An optional field of geography (19)
- Compulsory subjects and systems sciences (see above) (36)
- Optional subjects (12)
- Theory of the sciences, philosophy, sociology, etc. (4)

The students are required to write a master's thesis in one special field of an ecosystem with the special regard to available informations. The thesis should be worked out as an interdisciplinary team project and it is graded by an interdisciplinary team of advisors.

Graduates of environmental systems studies should be capable of giving an overall global judgement of interdisciplinary knowledge including the subject they focus upon. In a team they should develop strategies for the solution and prevention of environmental problems.

Graduates should be able to work in all fields that take technical knowledge (that is as chemists, geographers, management experts, ...).

In addition they will be able to collaborate in the following fields:

- research and teaching in environmental fields of science;
- looking after environmental institutions within communities, districts, provinces, states and the Federal Government and giving them advice;
- management of and work on research projects and tests determining the extent to which a product is environmentally tolerable;
- involvement in the design, construction, operation, evaluation, and interpretation/analysis of environmental observation systems;
- involvement in the planning and development of eco-friendly products and ways of production;
- media work and teaching at schools and institutions for further education;
- involvement in all other areas demanding expert knowledge coupled with ecological understanding.

According to the short time which has passed since the installation of "Environmental Systems Studies" no practical job-experiences of graduates can be presented at this early stage.

4. Critical Evaluation

No doubt the idea of an environmental education at the university level being founded on either natural sciences or economics offers many advantages. First of all it takes into account that the ecologist as a kind of "supra-genius" does not really exist simply because too many single scientific disciplines are involved in this topic.

Thus it seems legitimate already at the beginning of the "studium irregulare" to combine the necessary fundamental training of the students in one of the optional basic fields of natural sciences or economics with special environmental subjects.

Another positive aspect of the study may be seen in the various options the students have in selecting their own fields of interest to an optimum extent. Especially the second period of study dedicated to a deepening and advanced education provides the students with the further insight into typical problems of ecology and gives the single student the chance of choosing those environmental solutions which according to his own scientific background seem to meet his demands best.

The interdisciplinary educational programme is intended to make the student capable of evaluating and judgeing special environmental problems and ecological situations from a point of view reflecting the principle of entirety.

In practical life, however, this goal can hardly be achieved, which shall be demonstrated for the field of geography:

The present study programme of geography at the university takes only little care of the needs of "Environmental Systems Studies". There is hardly any qualitative difference between the basic programmes of "Environmental Systems Studies", the geography teachers programme and the master's programme of geography. An intensified ecological training has been achieved only in a very limited way so far. This is also true for the presentation of the dynamic aspect and the interactive structure of a global environmental system.

There is unfortunately hardly any information exchange among the single lecturers which is to a certain extent counterproductive to the demand of interdisciplinarity.

The students' interest in environmental education is generally great. They regret, however, the uncertain legal position of the "studium irregulare" and underlined their demand for an institutionalization of the study.

Critics argued that the realization of the original goals as to "Environmental Systems Studies" suffered now and then from personal disputes, lacking interest of some of the lecturers, personal vanities or egoisms and competition among single subjects. Moreover, too little exchange of experience between the "Environmental System Studies" and the postgraduate programme "Technical Protection of the Environment" is deplored as well as the insufficient information transfer between lecturers and students. The students, on the other hand, are not always willing to make use of interdisciplinary and special offers of environmental courses. This might be a consequence of the great number of optional subjects. On the contrary, within some of the natural sciences like geography the number of special ecologically oriented lectures is probably too small.

In comparison to the branch of environmental systems studies focusing on natural sciences the situation of the economic sciences branch is different. In 1997 of a total of 412 students of environmental systems studies 205 were enrolled in business studies and 47 in political economy (Tab. 2).

The students of business studies generally rated the quality of their education positive. They especially welcomed the possibilities of project-studies and interactivity, although special offers of environmental courses are rare.

Tab. 2 Students of "Environmental Systems Studies" as to major field of study, number of foreign students, sex and beginners in the summer-semester 1997

major field	Immatriculated students			students in the 1st sem.		
	male	female	total	male	female	total
Geography						
Austrians	56	55	111	8	11	19
Foreigners	1	0	1	0	0	0
Total	57	55	112	8	11	19
Chemistry						
Austrians	14	9	23	2	1	3
Foreigners	0	1	1	0	0	0
Total	14	10	24	2	1	3
Physics						
Austrians	17	6	23	2	0	2
Foreigners	1	0	1	0	0	0
Total	18	6	24	2	0	2
Business Studies						
Austrians	117	86	203	10	12	22
Foreigners	1	1	2	0	0	0
Total	118	87	205	10	12	22
Political Economy						
Austrians	20	27	47	2	5	7
Foreigners	0	0	0	0	0	0
Total	20	27	47	2	5	7

As to the importance of various disciplines for the solution of environmental problems personnel managers of all big Austrian enterprises employing more than 400 people have been asked to give their personal ranking of those disciplines (Tab. 3). Quite surprisingly they ranked environmental law highest. Great importance was also attributed to ecology and process engineering. On the other hand geology and geography were ranked lowest. The relatively bad image of geography among Austrian industrial mangers may result from the still rather low willingness of many university teachers to pay more attention to problems of applied geography.

Therefore closeness to practical needs should be achieved from the offers of political economy courses during environmental systems studies. Interdisciplinarity and practical project studies are being encouraged. The number of special environmentally oriented courses is respectable within the field of political economy.

The possibility of attending lectures of other disciplines is not being accepted sufficiently by the majority of the students. All in all the students are quite content with the quality and structure of the study programme. The generally high requirements bring about a certain quality selection among the students.

Tab. 3 Ranking of disciplines according to their importance for the solution of environmental problems as seen by personnel managers of great Austrian industrial enterprises

Science	Mean	Science	Mean
environmental law	2.86	psychology	1.40
ecology	2.53	English	1.39
process engineering	2.48	systems theory	1.32
public law	2.22	mathematics	1.21
plant economy	2.20	marketing	1.17
costs calculation	2.00	sociology	1.12
production economy	1.97	political economy	1.04
biology	1.75	geology	0.95
physics	1.61	geography	0.61
controlling	1.45	French	0.29
statistics	1.44	other languages	0.21
private law	1.41	Spanish	0.20

Source: A. Wittmann, 1996

As a positive result of the Environmental Systems Studies programme it should be mentioned that the population gets increasingly aware of interrelations between economics and environmental policy.

Therefore little understanding can be shown for the fact that the Austrian educational policy does not take very much into account the above development since the future of both environmental programmes having been discussed in this paper is insecure.

5. Conclusion

The importance of environmental studies has been recently steadily increasing. Geography in Austria as a science, however, has much too long neglected these new trends in environmental research as well as in environmental training. Only in 1991 "Environmental Systems Studies" have been established at Graz University in Austria as an interdisciplinary study programme comprising 10 semesters. The role of geography within the Environmental Systems Studies still is a mixed one: On the one hand there is a high demand for a stronger integration of environmental investigations into geographic research whereas on the other hand teaching the environment in the field of university geography still lags behind the demand of those (namely policy makers, economists, teachers, etc.) who search for adequate solutions of their environmental problems.

References

Arbeitsgruppe "Ökosystemstudien". Akad. Senat. Österr. Hochschülerschaft, FV-NAWI. (1994). Umweltsystemwissenschaften an der Universität Graz.

Technische Universität Graz. Studienkommission Aufbaustudium "Technischer Umweltschutz".(1984). Das Aufbaustudium Technischer Umweltschutz.

Universitätsdirektion d. Universität Graz. o. J. Studienprogramm für das Studium irregulare "Umweltsystemwissenschaften", Fachschwerpunkt Betriebswirtschaftslehre.

WITTMANN, A. (1996): Umweltorientierte Personalplanung und -entwicklung im Industriebetrieb. Dipl. Arb. an der sozial. und wirtschaftswiss. Fakultät d. Universität Graz, 59 pp.

WITTMANN, A. (1996): Anforderungsprofile für Mitarbeiter im betrieblichen Umweltschutz. Ergebnisse einer Industiebefragung. Inst. f. Innovations-management, Univ. Graz, 29 pp.

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Reviewer

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THE REGIONALLY GEOGRAPHICAL VIEW OF LABOUR MARKET IN THE CZECH REPUBLIC

Josef KUNC

Abstract

At the beginning of the 90s, the Czech Republic once again met with the phenomenon of unemployment and with the term of labour market since they did not exist in this country in the form conforming to market economy more than forty years. The article starts with a brief commentary to the course of years of transformation, to the most significant changes and oscillations occurring on the Czech labour market. Attention is also paid to some aspects resulting as a rule in labour market imbalance, whose impacts and spread are to a greater or lesser extent influenced by regional differentiations. The author wished to reveal and study these aspects, to point out the related problems and to attempt at a deduction of possible future consequences.

Shrnutí

Česká republika se na počátku 90-tých let opět setkala s fenoménem nezaměstnanosti a s pojmem trhu práce vůbec, který zde v podobě odpovídající tržní ekonomice po více než čtyřicet let neexistoval. Článek nejprve stručně komentuje průběh transformačních let, nejdůležitější změny a výkyvy, které se na českém trhu práce staly. Pozornost je také věnována vybraným aspektům způsobujícím zákonitě na trhu práce nerovnováhu a jejichž vliv a působnost ve větší či menší míře ovlivňují regionální diferenciace. Snahou bylo tyto aspekty odkrýt, poukázat na problémy které s sebou přináší a pokusit se vyvodit možné důsledky do budoucna.

Key words: labour market, unemployment, Czech Republic, regional differentiation

1. The labour market development until the 1st quarter of 1998

Similarly as in other post-communist countries, unemployment and coming into existence of labour market, in other words a relation between the labour offer and vacant labour power demanded have become an accompanying phenomenon of the transition from the planned to the market economy in the Czech Republic (CR). A certain activity on the newly forming labour market could be seen as early as in the first months of the transformation process. The increase of unemployment was gradual and reflected (in the comparison with other countries under transformation - to a lesser extent) mainly radical changes that occurred at the turn of the 80s and 90s. These included the disintegration of the COMECON group of countries and Soviet Union, the rapid drop in production and investment activities, the attempt to cure the existing over-employment, internal sales problems of Czech economy, the distorted economic structure characterized by oversized and technologically backward industries and extensive agriculture, low labour productivity, the starting process of privatization, etc. The labour market was only getting its vague contours.

In the connexion with the great amnesty at the beginning of 1990, the number of unemployed persons marked a pronounced increase (the files of the former labour departments at local national committees indicate that there were 324 jobless persons towards the end of 1989). The unemployment rate (number of persons seeking jobs) further increased in 1990, which was - to a certain extent - contributed to by the adopted legislation measures enabling to persons that had never worked to register as applicants for jobs just to get access to the allowance before employment, not the employment itself.

The number of jobs available (JA) that employers were by law obliged to report to the Labour Offices was decreasing along with the increasing numbers of applicants for jobs. In spite of this, the preponderant demand for labour power persisted on the labour market in the comparison with the available labour power as long as until the end of 1990 (in December 1990, the number of available jobs exceeded the number of unemployed persons by 18 000). The structure of available jobs (the majority of them for skilled workers), however, did not correspond with the offer of the applicants who were mostly unskilled workers and amnestied persons side by side with secondary school-leavers and university graduates. The turn of 1990 and 1991 saw a marked growth of unemployment rate between individual months. The number of applicants for job raised towards the end of January by nearly 50 % as compared with December 1990 the figure being the so far highest inter-monthly increase. A typical situation on the labour

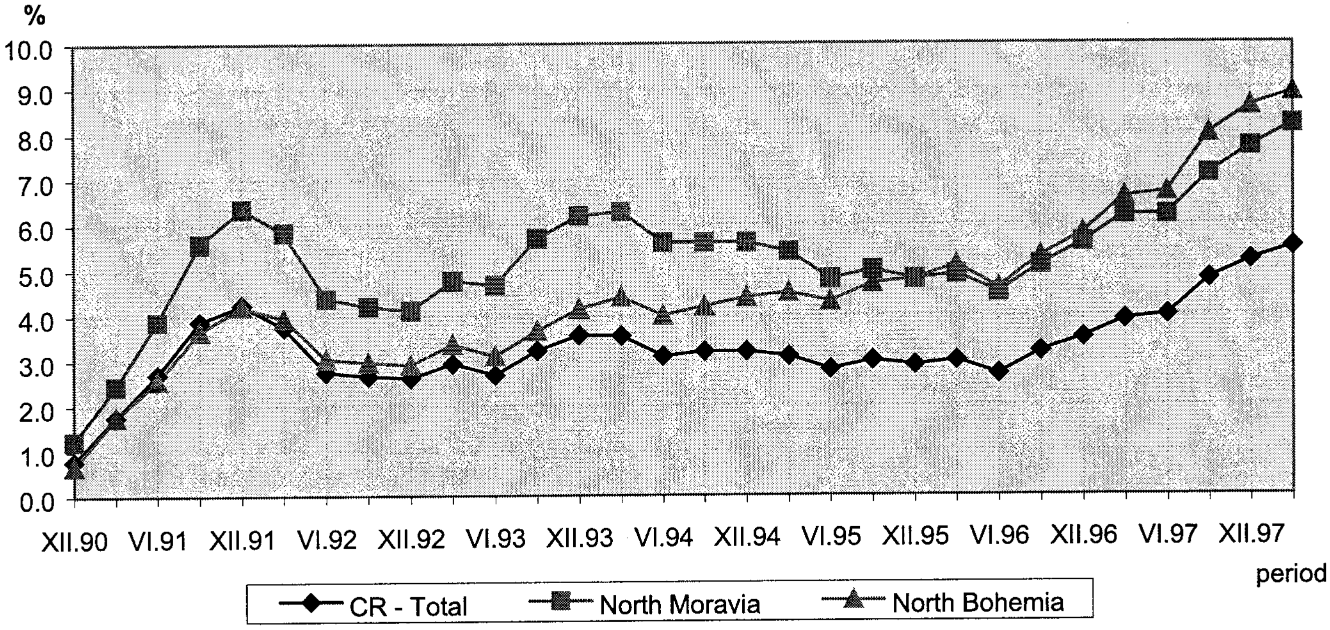


Fig. 1 The development of registered unemployment in the Czech Republic and some regions for the period from December 1990 to March 1998

Source: Monthly reports, Employment Service Administration, CR Ministry of Labour and Social Affairs "Applicants for work and vacant jobs", Prague, 1990-1998.

Tab. 1 The order of some districts by their unemployment rate at the end of 1991, 1996, and the 1st quarter of 1998

District	Max. UR in % to 31 Dec. 1991	District	Max. UR in % to 31 Dec. 1996	District	Max. UR in % to 31 March 1998
1. Třebíč	8.8	1. Most	9.4	1. Most	12.4
2. Šumperk	8.6	2. Louny	8.2	2. Chomutov	12.1
3. Bruntál	8.6	3. Chomutov	7.7	3. Louny	11.0
4. Vsetín	7.9	4. Karviná	7.7	4. Karviná	10.8
5. Příbram	7.7	5. Děčín	7.6	5. Teplice	10.5
6. Jihlava	7.6	6. Teplice	7.1	6. Znojmo	10.3
7. Znojmo	7.0	7. Šumperk	6.6	7. Děčín	9.8
District	Min. UR in % to 31 Dec. 1991	District	Min. UR in % to 31 Dec. 1996	District	Min. UR in % to 31 March 1998
1. Karlovy Vary	0.8	1. Praha	0.4	1. Praha-East	0.8
2. Praha	1.3	2. Praha-East	0.5	2. Praha	1.2
3. Praha-East	1.4	3. Praha-West	0.6	3. Praha-West	1.3
4.České Budějovi	1.5	4. Domažlice	1.2	4. Mladá Boleslav	2.1
5. Plzeň-South	1.5	5. Jablonec nad	1.2	5. Benešov	2.6
6. Plzeň-North	2.1	6. Plzeň-South	1.3	6. Plzeň-South	2.7
7. Mladá Boleslav	2.1	7. Mladá Bolesla	1.4	7. Jindřichův Hrad	2.9

Source: Monthly reports, Employment Service Administration, CR Ministry of Labour and Social Affairs "Applicants for work and vacant jobs", Prague, 1990-1998.

market in 1991 could be characterized by decreasing employment, decreasing available jobs and rapidly increasing unemployment (to the date of 31 December, 1991 the registered number of unemployed persons was 221.7 thousand as compared to 39.4 thousand to the same date of previous year). This means that towards the end of the year the total increase of applicants for job was 182.4 thousand in this year. The increase was seen to continue until January 1992 when the number of applicants with no job (231.2 thous.) as well as the unemployment rate (4.4 %) reached the so far maximum. The labour offices had 55.5 thous. available jobs, i.e. there were 4.4 applicants per a job.

To the date of 1 January, 1992 a new amendment to the employment law came into force, which imposed much stricter conditions for unemployment compensation contribution. The new regulations included a reduced time length for the unemployment benefit (6 months), a maximum unemployment compensation contribution as well as a condition that the government would settle a citizen's social and health insurance provided that he or she is officially registered at the labour exchange.

The number of unemployed persons began to gradually drop in the course of 1992. The greatest improvement was reported to occur in the Spring with the cummulation of several favourable factors: development of small and medium-sized businesses, extensive activities of labour offices to implement the active employment policy, growing seasonal jobs in trading, travel industry, building and agriculture. This favourable development was somewhat slowed down in the Autumn when school-leaver and university graduates flooded the labour market together with persons coming back for the registration after having ended seasonal or utility works. Yet, the November of 1992 was a month with the absolutely lowest unemployment since 30 June 1991 with 128.9 thous. unemployed persons, the total unemployment rate of 2.5 %, and 1.6 unplaced applicant per an available job. However, starting from December the labour market situation began to worsen again.

In 1993, the number of applicants for a job was growing (with the exception of seasonal drop in Spring) and the number of available jobs offered decreasing. The unemployment rate to 31 December 1993 increased up to 3.3 % (the number of registered unemployed persons was approaching 200 thous.) and there were 3.4 applicants per an available job. The period from the Spring of 1994 to the end of the year can be characterized as relatively stabilized with fluctuations on the labour market occurring mainly due to seasonal effects (the increased demand in the Spring and Summer, the Autumn with the unemployment rate increasing due to newly registered school-leavers and university graduates, the Winter with the lack of available jobs for seasonal workers). The year 1995 can also be assessed as relatively balanced from the viewpoint of the labour market with the unemployment rate ranging around 3 % (rather slightly below this level) and reaching 2.9 % at the end of the year. At a low oscillation of applicants for a job (about 150 thous.), the number of available jobs was more than 100 thousand. Towards the end of the year, the official records spoke of 1.7 applicant per an available job, the data that could only be compared with the somewhat special year 1992 when the Czech labour market was temporarily influenced by the above mentioned favourable factors. The development of year 1995 reflected better dynamics of economy after the first transformation "years of crisis" and the trend continued until the end of the first half of 1996. In June 1996, the offer of available jobs doubled in the comparison with the beginning of 1994 in order to once again get over 100 thousand (109 774). At the same time, there were only 144 065 unemployed persons registered in the Czech Republic, which means that there was only 1.3 applicant per an available job. Such a "close tuning" between the labour market offer and demand was last achieved in June 1991.

Unfavourable factors began to impact the labour market situation in the second half of 1996. Sales problems of many industrial companies, the lower labour productivity in the comparison with economically advanced countries and the ever more severe competition forced the companies to make a great number of their employees redundant in attempt to improve labour productivity. This reflected in the increasing number of registered applicants for a job that reached more than 180 thousand at the end of the year. To the date of 31 December 1996 there were 2.2 applicants per an available job and the unemployment rate raised to 3.5 % with the still steadily declining offer of available jobs. The trend continued at the beginning of 1997: in January, the number of registered applicants for a job again overstepped the boundary of 200 000 (205.2 thous.), similarly as at the turn of 1991 and 1992 and the available jobs dropped to 81.5 thousand. In February the unemployment rate amounted to already 4.1 %. With seasonal works started the number of available jobs slightly increased in the Spring with the number of unemployed persons exhibiting also a mild decrease and the unemployment rate dropping by 2 tens of per cent, ie. below 4 %. Nevertheless, the positive seasonal oscillation was very vague in the comparison with the preceding years.

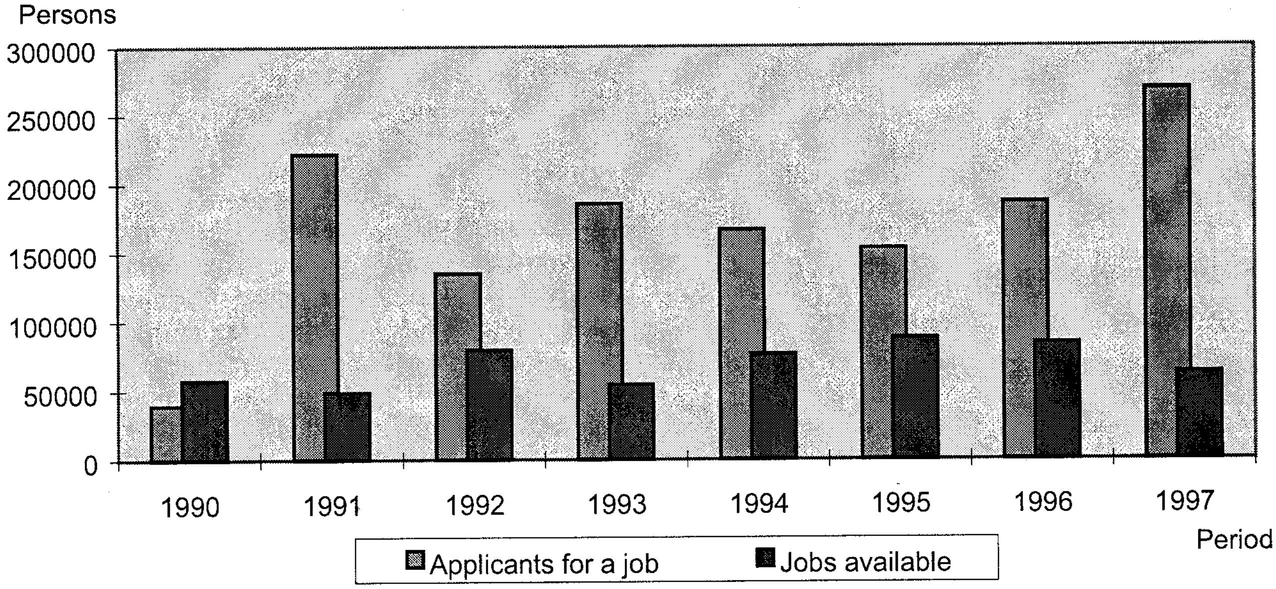
However, the ever increasing pressure of labour offer on the Czech labour market was obvious as early as in June 1997. Savings measure announced by the Czech government, disastrous floods which afflicted Moravian and Silesian territories in July as well as other already mentioned factors resulted in an extremely rapidly growing unemployment in the holiday months together with the relatively slower decrease of available jobs offered. As early as in August the unemployment rate amounted to 4.5 % - the level that was by 0.1 %

Tab. 2 The order of some districts by their index "Applicants for a job per 1 job available" (X) at the end of 1991, 1996 and the 1st quarter of 1998

District	X max. to 31 Dec. 1991	District	X max. to 31 Dec. 1996	District	X max. to 31 March 1998
1. Třebíč	66.1	1. Louny	33.4	1. Louny	26.9
2. Žďár nad Sázavou	60.2	2. Teplice	7.2	2. Znojmo	22.1
3. Znojmo	27.9	3. Olomouc	7.1	3. Teplice	18.8
4. Brno-province	26.9	4. Bruntál	7.0	4. Chomutov	15.6
5. Jihlava	24.1	5. Vyškov	6.0	5. Most	13.6
6. Kroměříž	20.0	6. Ústí nad Labem	5.7	6. Karviná	12.9
7. Břeclav	18.8	7. Chomutov	5.7	7. Frýdek-Místek	12.3
District	X min. to 31 Dec. 1991	District	X min. to 31 Dec. 1996	District	X min. to 31 March 1998
1. Karlovy Vary	0.6	1. Praha	0.2	1. Praha-East	0.6
2. Praha	0.7	2. Praha-East	0.3	2. Mladá Boleslav	0.9
3. Cheb	1.0	3. Praha-West	0.3	3. Praha	1.1
4. Praha-East	1.1	4. Mladá Boleslav	0.4	4. Praha-West	1.4
5. České Budějovice	1.7	5. Jindřichův Hradec	0.5	5. Semily	1.5
6. Ústí nad Labem	1.7	6. Domažlice	0.6	6. Náchod	1.5
7. Most	2.0	7. Semily	0.6	7. Benešov	1.7

Source: Monthly reports, Employment Service Administration, CR Ministry of Labour and Social Affairs "Applicants for work and vacant jobs", Prague, 1990-1998.

Fig. 2 The development of the number of applicants for a job and jobs available in the Czech Republic in 1990-1997



Source: Monthly reports, Employment Service Administration, CR Ministry of Labour and Social Affairs "Applicants for work and vacant jobs", Prague, 1990-1998.

However, the ever increasing pressure of labour offer on the Czech labour market was obvious as early as in June 1997. Savings measure announced by the Czech government, disastrous floods which afflicted Moravian and Silesian territories in July as well as other already mentioned factors resulted in an extremely rapidly growing unemployment in the holiday months together with the relatively slower decrease of available jobs offered. As early as in August the unemployment rate amounted to 4.5 % - the level that was by 0.1 % higher than the "historical record" of January 1992 (4.4 %). The historical maximum in the number of applicants for a job of the same date was then exceeded in September (247.6 unemployed persons). The situation further worsened with the unemployment rate getting over 5 % in December. In the comparison with the preceding year 1996 the number of unemployed increased by 44.3 % (82.6 thous. persons) and the number of available jobs dropped by 25.8 % (21.7 thous.). The situation culminated at the beginning of 1998 when the unemployment rate reached 5.6 % in the first months of the year, the number of unemployed persons got close to 290 thousand and the number of available jobs fell down to 61.3 thousand. The number of applicants for a job registered by the labour offices per an available job amounted to 4.7.

Should we evaluate the period from July 1996 (the approximate beginning of recession of the Czech economy) to March 1998, i.e. the period as short as one year and nine months, by the most complex labour market indices, we would arrive at the following conclusions:

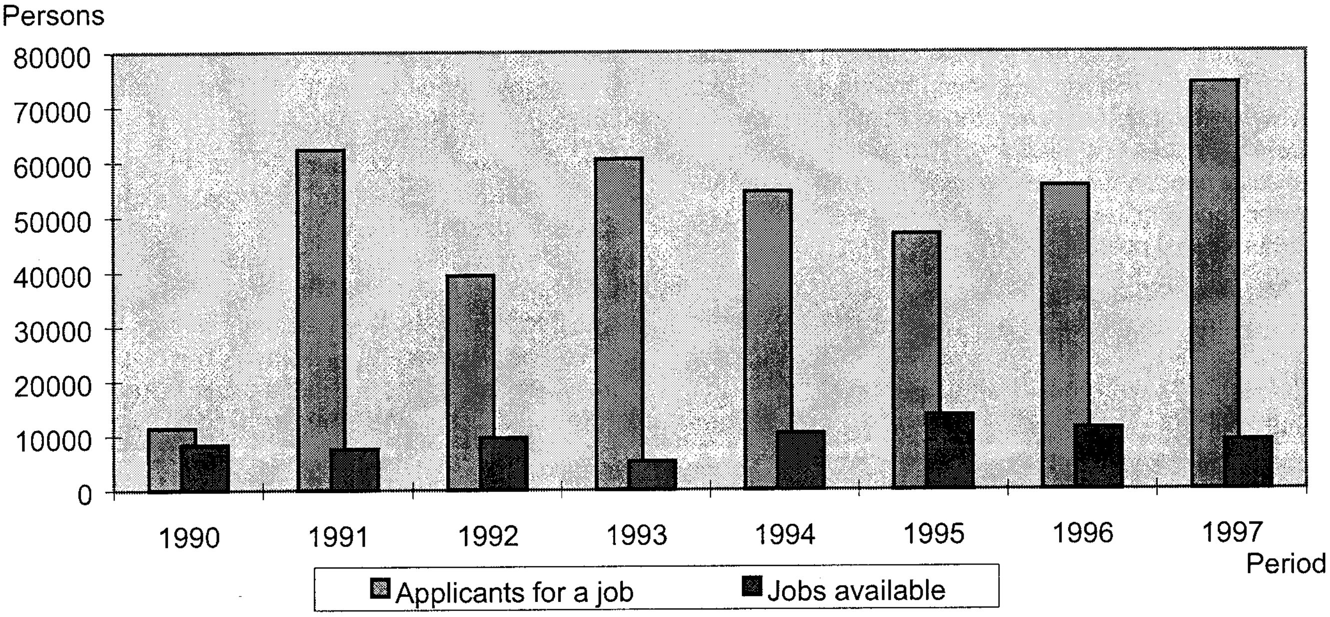
- The unemployment rate raised from 3 % to 5.5 %, i.e. by 2.5 percentual points;
- The number of unemployed persons increased by nearly 126 thousand (from 158.2 thous. to 284.1 thous., i.e. by 80 %);
- The number of available jobs fell by 43.5 thousand (from 107.8 thous. to 64.3 thous., i.e. by more than two fifths);
- Due to the above reasons the number of applicants for a job per an available job increased from 1.5 to 4.4 persons, i.e. approximately 2.9 times.

2. *Some aspects concerning the Czech labour market from the regional point of view*

The labour market as a homogeneous entirety with opened inputs and outputs has not kept its original shape as at the beginning of the transformation period. From the geographical point of view there were relatively frequent displacements of problems gradually into regions with just occurring the inherited low diversification od economic base. The regional development of unemployment often reflected the cummulation of problematic productions issuing from the former one-sided economic specialization of districts and whole regions. At the very beginning of the transformation process it was particularly southern Moravia in terms of agricultural workers, which was replaced by northern Moravia in the 90s and by northern Bohemia in the last three years, where the ceased brown coal mining and metallurgy resulted in a marked increase of unemployment at the existing low diversification of the economic base. The rate of unemployment in these regions has been growing for already several years, reaching 8.2 % and 8.9 % in northern Moravia and northern Bohemia, respectively to the date of 31 December, 1993 (CR average being 5.5 %) . The number of applicants for a job in these regions was 7.8 and 8.4, respectively with the CR average being 4.4. The two regions together had over 130 thousand registered applicants for a job, which was more than 46 % of the total number of unemployed persons in the Czech Republic. In contrast, Prague and several other districts could boast of a negligible unemployment rate (1.2 %) and the ratio of approximately one applicant for a job per an available job. This indicates that the unemployment is of exclusively social character because the one who really wants can easily find a job. On the other hand, this phenomenon imposes some restrictions on firms and entrepreneurs as to their possibilities of choice with some professions being utterly lacking, particularly those of qualified tradesmen.

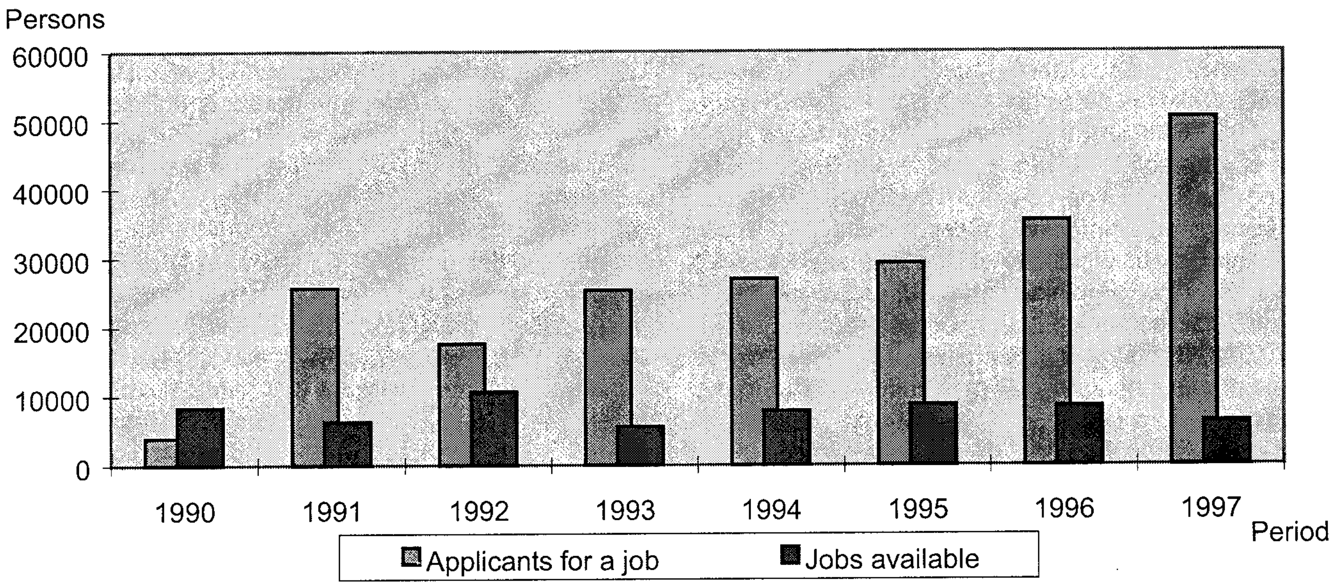
The basic picture of regional differentiations on the newly formed labour market was arising as early as in the course of 1991 and later sharpened and stabilized its contours. The most significant changes were associated with the changed geopolitical situation, location of some regions and namely with the initiated structural changes. A useful indicator to express the regional differentiations is the percentage of district unemployment standard deviation in the average unemployment rate. According to Čihák - Frýdmanová (Hospodářské noviny, March 1998) as well as in accordance with author's calculations it is possible to draw a conclusion that the former mildly increasing up to stagnating unemployment rate of about 3 % resulted in a gradually growing regional differentiation. In contrast, the rapid growth of unemployment in 1997 was accompanied by a marked decrease of this regional differentiation. A cause to the decrease of regional differentiation, well documented also by the decrease of the above mentioned indicator in 1997 in the comparison with previous years, was probably the fact that the unemployment rate was growing much faster in 1997 than in 1996 in the districts with lower unemployment than in the districts with high unemployment. However, this finding cannot be yet generalized into an idea that the high unemployment districts have already reached their maximum and the other ones will "try" to keep pace. It is rather a slowdown of labour power demand, typical for the economic recession in 1997, which could not show in a more significant growth of unemployment in districts with serious structural problems since a number of companies had

Fig. 3 The development of the number of applicants for a job and available jobs in the region of northern Moravia in 1990-1997



Source: Monthly reports, Employment Service Administration, CR Ministry of Labour and Social Affairs "Applicants for work and vacant jobs", Prague, 1990-1998.

Fig. 4 The development of the number of applicants for a job and available jobs in the region of northern Bohemia in 1990-1997



Source: Monthly reports, Employment Service Administration, CR Ministry of Labour and Social Affairs "Applicants for work and vacant jobs", Prague, 1990-1998.

to reduce their employees down to the necessary minimum already some time ago.

The fact that the regional differentiation has been diminishing is of a different importance for individual categories of education. While workers with the basic education have to face ever growing difficulties in getting a job in regions with the higher unemployment rate, the situation of unemployed persons with the secondary and university education is dissimilar. According to the above mentioned authors, the unemployment sensitivity of people with the secondary and university education to the regional development of the labour market is considerably lower than that of the people with the basic education. Nevertheless, the secondary education system has already experienced some negative trends from the past. These mainly concern a great surplus of applicants for a job - leavers of secondary integrated, family, economic and business schools and colleges for whom it becomes very difficult to find a job not only in the region but in general. Problems with finding their place on the labour market are becoming serious also for university graduates, especially those from arts subjects, natural sciences and teaching. This is why the author can see a coordination between the educational system conceptions and the needs of labour market to be an efficient regional policy.

As reported by the Czech Bureau of Statistics (ČSÚ), the average gross monthly earnings in 1997were 10 695 CZK (approx. 325 US $). The regional differences show even here with the highest income in Prague (13 011 CZK) and the lowest earnings in eastern Bohemia (9 406 CZK). The earnings of industrial employees were approximately reaching the national average while persons working in health service institutions, schools, agriculture and particularly those working in textile industries earned considerably less and earnings in finance and insurance industries were twice as high. Thus, in the comparison with previous years it is the ever greater opening of the scissors between the individual industries the greatest differences being seen between the earnings under the national administration and the earnings under the foreign capital.

The comparison of the minimum wage and the subsistence minimum and their influence onto the Czech labour market gives a good reason for an interesting polemic. While the minimum wage in the Czech Republic is 2 650 CZK at the present, the subsistence minimum of a person living alone amounts to 3 430 CZK - the sum that is considered absurd by all political parties with social programmes (e.g. Czech Social Democratic Party and Communist Party of Bohemia and Moravia) as well as by the CR minister of labour and social affairs Mr. S. Volák according to Hospodářské noviny from April 1998. It is said that the present minimum wage makes the less qualified people concerned just in the obtainment of social allowances - not work, which contributes to the building of social unemployment. In many a case, the allowances are just representing a complementory income within the so called grey economy where people are mostly paid cash for their work. Although the percentage of persons working for the minimum wage does not reach 1 % within the whole Czech Republic, the payments in cash facilitate a considerable tax avoidance.

According to J. Kasnar - Director of Employment Service Administration, CR Ministry of Labour and Social Affairs (Hospodářské noviny, November 1997) the requested increase of minimum wage could secondarily impact the competitiveness of Czech products where labour costs would be responsible for the major part of the company's expenditure, particularly in facilities with the technologies of low standard or moderate production extent and the preponderant manual work. Any increase of the minimum wage could mean a pressure on higher earnings which would push up the labour costs and hence the prices. This would most probably lower the competitiveness of many companies that would have to fight for merely maintaining their position in the market.

The minimum wage in European countries is usually ranging between 35 %-40 % of the average wage, which is normally some 10 to 15 % above the subsistence minimum. The Czech Republic is going to ratify the European Social Charter in which the recommended minimum wage is reaching as much as 68 % of the average wage, but its implementation is not realistic in the close future. The Czech Republic is therefore yet not prepared to ratify the Charter article on the minimum wage since the high costs are not affordable at the present difficult economic situation.

Another regional factor that has a great influence on the labour market consists in business activities. It is possible to make a general statement that these activities decline in the West-East direction with the unemployment having an opposite trend and Prague together with Central Bohemia forming an area of entrepreneurial and foreign capital activities of a special significance. The fact has resulted from a new geo-political situation. The western and south-western parts of the country (should we neglect the Capital of Prague) have become the area of interest for the strong German capital after the removal of the iron curtain, which is making use of both the near-by state border and the cheap labour power. The German capital helps to generate a considerable number of new jobs and supports the development of small and medium-sized businesses. After Slovakia became an independent country in 1993, the eastern Moravia is a new periphery of the Czech Republic. To illustrate the dominating position of the Prague agglomeration - at the end of 1996 the northern Moravia had 24 entrepreneurs and tradesmen per a hundred of economically active inhabitants in the comparison with 29 in Prague and Central Bohemia.

A very good evidence capacity on the district level has the index of " private entrepreneurs per capita" although not all entrepreneurs with official seats in one district run their businesses in that particular district. If it is possible and economically profitable, they often displace their activities into neighbouring districts in order to find better conditions such as cheaper labour, greater purchasing power of the local population, etc. Typical can be considered the case of Uherské Hradiště, the town which has in fact become a business background of Zlín. The 1996 top four localities with leading counts of private entrepreneurs per capita were Prague (167), some districts of Central Bohemia (over 140), Zlín and Brno-City. Less than a hundred of private entrepreneurs per capita were registered in eleven districts of which five ranked with the districts of northern Bohemia

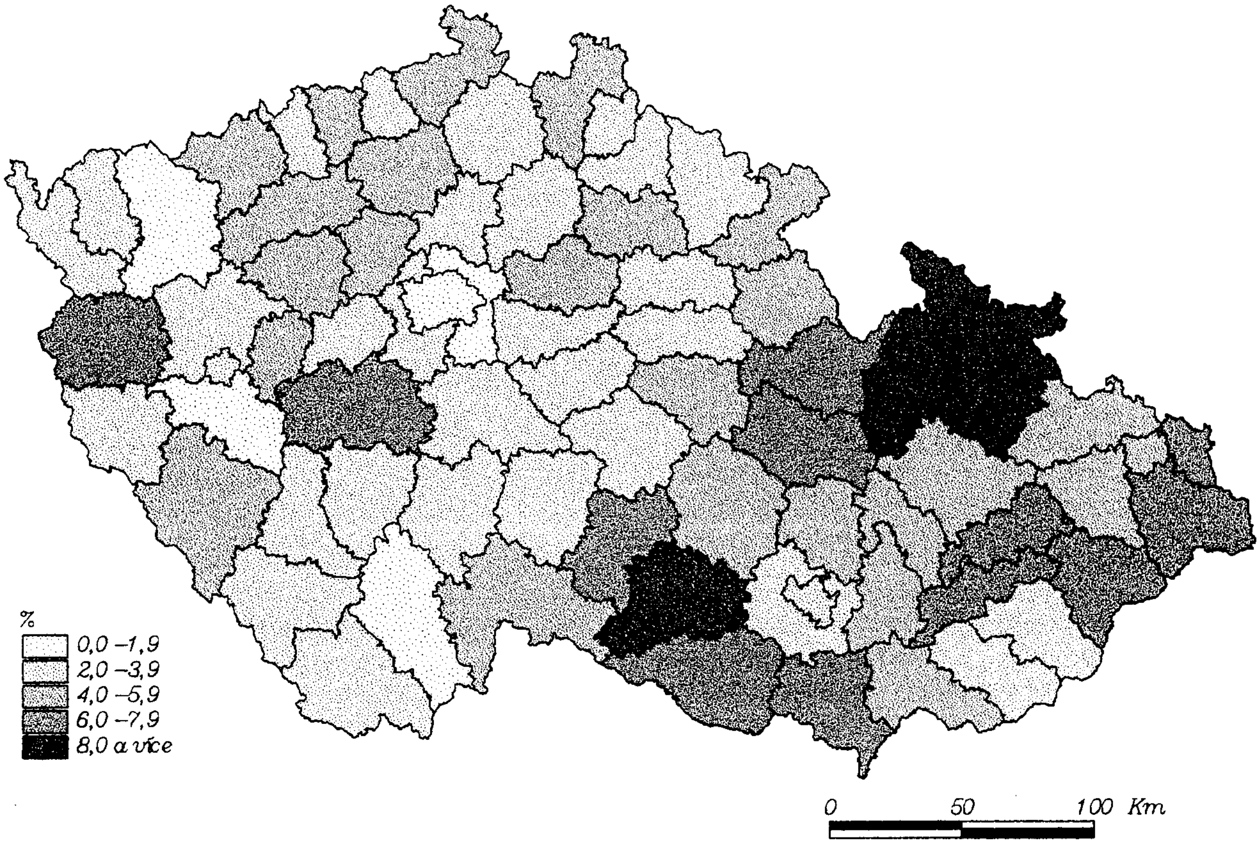


Fig. 5 The rate of unemployment in CR districts to 31 December, 1991

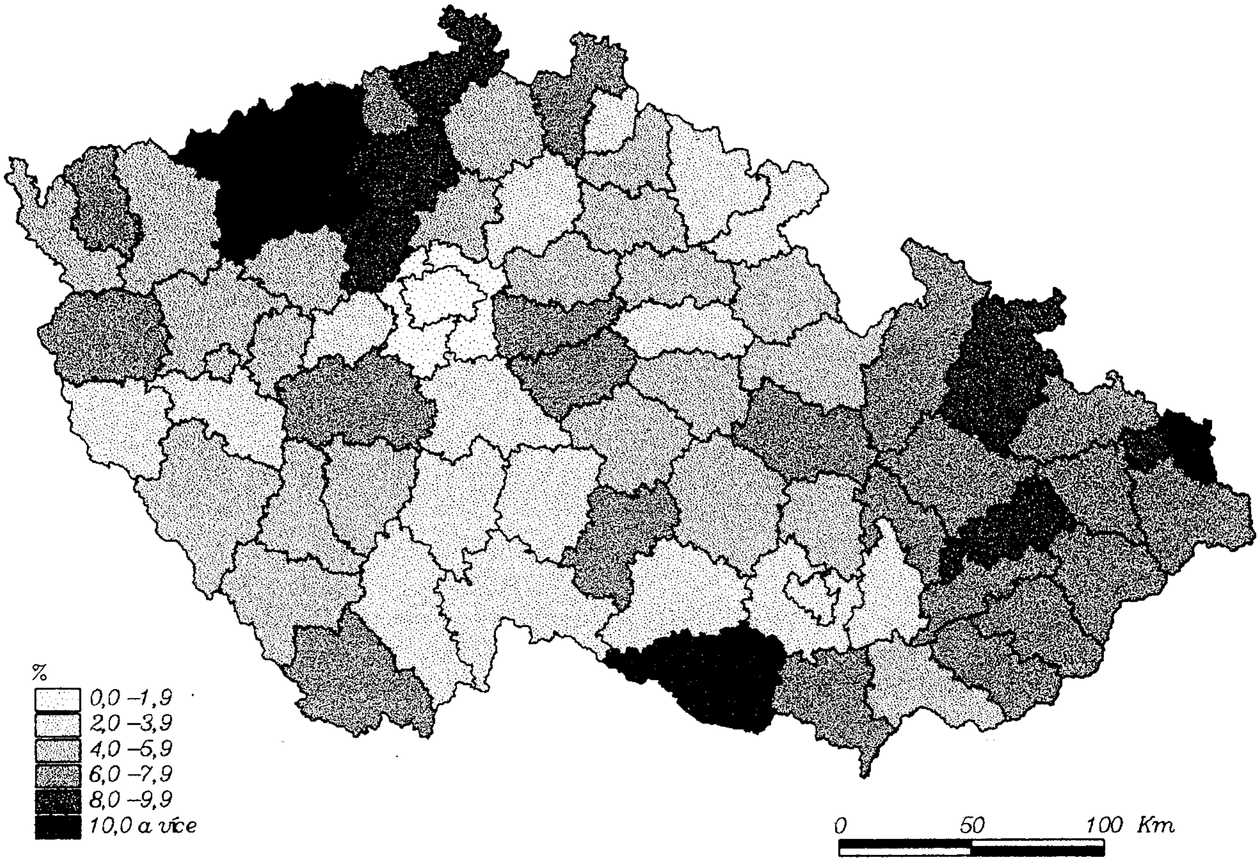


Fig. 6 The rate of unemployment in CR districts to 31 March, 1998

and northern Moravia with the highest unemployment rates.

An important role in reducing the labour market imbalance could play the regional mobility of labour power, particularly in the short-time horizon (see also OECD, 1995). However, the mobility is getting ever more limited by the underdeveloped housing market with the migration into large cities (with a relatively more favourable housing conditions) becoming practically impossible with the regard to the existing shortage of reasonably priced flats. The Czech government will have to find a very radical solution of the housing issue within the earliest time possible. It is necessary to promote the house-building and to focus on cheap small flats that would attract young people and young families into regions with not necesserily insufficient jobs but irrealistic housing.

Under the existing situation, a great number of economically active inhabitants find the solution of their problems with unemployment in commuting - either daily or to a larger distance. Main commuter belts are the largest regional agglomerations, i.e. Prague, Brno, Ostrava-Karviná, Pilsen, and to a lesser extent also Hradec Králové, Pardubice, Ústí nad Labem, Chomutov, Olomouc, České Budějovice and Zlín. The districts situated either close to the state border or at a greater distance from main centres, which can in addition be characterized by a high unemployment rate in the primary sector such as Znojmo, Jindřichův Hradec, Prachatice, Klatovy, Tachov, Bruntál, Pelhřimov, Svitavy, etc. are rather enclosed and provide only a low chance of commuting for work to other districts. Some people in regions situated right on the border of the Czech Republic with Austria and Germany make the use of a possibility to commute over the border. This kind of mobility, however, has not been statistically monitored which means that the commuter fluxes in these regions are underestimated.

Both the Czech and other European labour markets are to a greater or lesser extent affected by certain seasonal fluctuations and influences. In some of them the regional differences are great, in the other the regional differences are suppressed and rather impacting the whole country. As suggested in the first part these seasonal fluctuations and influences include:

- the spring decrease of unemployment due to the start of cleaning and utility works, treatment of public areas, increased activities in forestry production, construction works, etc.; the decrease also relates to the lowest number (culmination in April-May) of applicants for a job, who were excluded from the files during the year in the case of successful attempts to get a job;
- the summer period can be characterized by a gradual increase of leavers from all possible types of schools of whom not all without a job registered at the labour exchange because some of them go for their private activities during the holiday months; on the other hand, this period is a time of intensifying agricultural and harvest works, increasing opportunities of getting a job in the travel industry and seasonal trading, ie. it can also be characterized by an improved and in terms of the structure more diversified offer of available jobs;
- the autumn increase of unemployment is mainly associated with the registration of school-leavers at the labour offices (maximum in September);
- the winter decrease of available jobs that can be readily offered by the labour office is closely connected with the growth of unemployed persons due to the reduction or stoppage of seasonal works outdoors, redundance of employees - "traditionally" before the end of the year, and other negative factors.

3. Conclusion

The Czech Republic finds itself in the period of transition at the present time. After a certain animation of the economy towards the end of the first half of the 90s a heavy fall occurred in 1996 which has not been entirely stopped until today. The right-wing government was unable to respond sufficiently fast upon the striking symptoms of economic recession and piled up erroneous decisions and measures. The situation resulted in the resignation of Prime Minister Václav Klaus and in the nomination of the temporary government under J. Tošovský. The insecurity before the untimely parliamentary elections (19-20 June, 1998) did not do much good to the Czech economy either and European countries look at the Czech Republic with a certain caution and no confidence - waiting.

The unemployment rate which will most probably exceed the boundary of 7 % this year still puts the Czech Republic on a position which is best among all countries under transformation. Our country holds a very flattering place even from the global point of view. However, it should not be forgotten that this is no friction short-term unemployment which is a normal accompanying phenomenon of the market economy and in fact facilitates the desired labour mobility, but a strongly structural unemployment which shows with all its unwanted attributes especially in regions of northern Bohemia and northern Moravia.

It is absolutely and vitally important for the Czech labour market that the economic growth is "started" as soon as possible since it is generally considered a remedy against unemployment. Should the GNP growth keep its present pace, i.e. 1 % per year, the Czech Republic will have to anticipate the unemployment rate of 9.5 % to 10 %, which will bring it closer to the European Union where the present unemployment rate is about 11 % and unemployment is the number one issue in many of its countries.

References

DUŠÁNKOVÁ, O. et al. (1996): The labour market time series in the Czech Republic. CR Ministry of Labour and Social Affairs, Prague, 142 pp. (in Czech)

Hospodářské noviny, Prague, 1997-1998.

CHALUPA, P. (1996): On the low rate of unemployment and its consequences. Moravian Geographical Reports 4, No. 2, p. 35-39.

KOKOTEK, T. et al. (1996): CR Labour Market Annual Report. CR Ministry of Labour and Social Affairs, Prague, 234 pp. (in Czech)

KUNC, J. (1997): A geographical analysis of the labour market in the Czech Republic. (Dissertation), Department of Geography, Masaryk University, Brno, 70 pp. (in Czech)

Monthly reports, Employment Service Administration, CR Ministry of Labour and Social Affairs "Applicants for work and vacant jobs", Prague, 1990-1998.

OECD (1995): The survey of labour market in the Czech Republic. OECD Paris, 143 pp.

Districts of the Czech Republic in 1996. ČSÚ Praha, 1997, 256 pp. (in Czech)

TOMEŠ, J. (1996): In: Hampl, M. et al.: The development of regional differences in unemployment as an indicator of transformation changes. DemoArt Prague, p. 255-301. (in Czech).

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Mgr. Pavel VICHEREK

MT. KRÁLICKÝ SNĚŽNÍK (CZECH REPUBLIC): LANDFORMS AND PROBLEM OF PLEISTOCENE GLACIATION

Jaromír DEMEK - Jiří KOPECKÝ

Abstract

Mt. Králický Sněžník (Polish Snieznik, 1423.7 m a.s.l.) is situated at the frontier between the Czech Republic and Poland. The Czech part of the mountain takes up 76 square km. Up to 1990 the knowledge of denudation chronology of the mountain group was very limited. In the last ten years new data about the geological and geomorphologic situation in the given territory were collected by both - the Czech and Polish parties (Jahn - Kozlowski - Pulina, eds. 1996; Gawlikowska - Opletal eds., 1997; Demek - Kopecký, 1997). Mt. Králický Sněžník was a prominent mountain group already in the Neogene Period. In the Pleistocene Period reached European Continental Glaciers at least twice the northern foot of the mountain group. It is therefore rather surprising, that no glacial erosion forms were found in the mountain group. On the other side, deposits were found in the Czech part, which can be classified as deposits of glacial complex. This is why the authors propose a hypothesis of the presence of cold-based Pleistocene glaciers in the mountain group of Mt. Králický Sněžník.

Shrnutí

Horská skupina Králického Sněžníku (polsky Snieznik, 1423,7 m n. m.) se nachází na hranici mezi Českou republikou a Polskem. Část ležící na území České republiky zabírá plochu 76 km^2. Až do roku 1990 byly geomorfologické znalosti o území velmi omezené. V posledních letech znalosti o geologických a geomorfologických poměrech území se značně rozšířily (Jahn - Kozlowski - Pulina eds., 1996; Gawlikowska - Opletal eds., 1997; Demek - Kopecký, 1997). Králický Sněžník byl již v neogénu výraznou horskou skupinou. V pleistocénu zasáhly pevninské ledovce nejméně dvakrát k severnímu úpatí Králického Sněžníku. Je proto poměrně překvapující, že na rozdíl od jiných pohoří Sudet nebyly na Králickém Sněžníku nalezeny erozní glaciální tvary. Na druhé straně byly na české straně identifikovány sedimenty, které mohou být klasifikovány jako sedimenty glaciální série. Autoři proto v článku předkládají hypotézu o výskytu sněžníků a ledovců s chladnou bází na Králickém Sněžníku v chladných obdobích pleistocénu.

Key words: Bohemian Massif, Mt. Králický Sněžník, pediments, Pleistocene cold-based glaciers

1. Introduction

Mt. Králický Sněžník is a prominent mountain group situated at the border between Czech Republic and Poland (Fig. 1). The Czech part of the mountain group takes up 76 square km and reaches its highest elevation 1423.7 m a.s.l. Value of medium slope inclination is approx. 15˚. The dome - shaped summit of Mt. Králický Sněžník is visible from a long distance. A relative difference in heights between the bottom of the neighboring Klodzko Basin in Poland and top of Mt. Králický Sněžník is greater than 1000 m.

In the past, geomorphologists paid less attention to the study of the Czech part of Mt. Králický Sněžník. It is strange, that up to nineties there was only one complex geomorphologic study of Mt. Králický Sněžník written by German geologist H. Schön in 1928. In the last decades, karst and cryogenic forms were studied in the mapped area by Czech and Polish scientists. In 1996, a representative book Polish and Czech authors was published in Polish language: Masyw Snieznika - changes in natural environment (edited by Jahn - Kozlowski - Pulina). The authors of this paper gemorphologically mapped the Czech part of Mt. Králický Sněžník

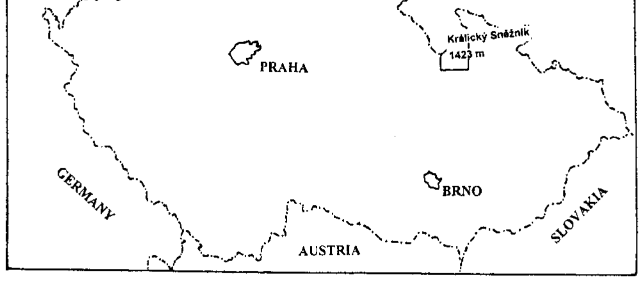


Fig. 1 Situation of Mt. Králický Sněžník in Czech Republic

(on a scale 1:25 000) in the period from 1993 to 1997 (Demek - Kopecký, 1997). The study was subsidized by the Department of Environment of the District Office in the town of Ústí nad Orlicí.

There are 5 mountain ridges running out from the dome - shaped summit of the Mt. Králický Sněžník, of which the Southwestern, Northeastern and Southern Ridge are situated on the territory of Czech Republic. These ridges are rounded and mountain summits divided by shallow cols are rising above their surface.

The border between Czech Republic and Poland is situated on the Southeastern Ridge with Mt. Malý Sněžník (1337.7 m), Mt. Bílý kámen (1184.0 m), Mt. Klepý (Polish Trójmorski Wierch Mt. 1143.6 m). This ridge ends with Mt. Roudný (871.1 m) above the village Prostřední Lipka.

The Northeastern Ridge (also Border Ridge - called in Polish Dziczy Grzbiet) declines from the dome - shaped summit of Mt. Králický Sněžník to Kladské sedlo Col (815.4 m a.s.l.).

The Southern Ridge is called Mokrý hřbet Ridge with its highest point of Mt. Sušina (1321.2 m a.s.l.). To the south from Mt Sušina the ridge is divided by the valley of the Malá Morava River into the Western and the Eastern Mokrý Ridge. The Western Mokrý Ridge begins with Mt. Podbělka (1307.8 m) and runs to the summit of Mt. Sviní hora (1232.4 m) as far as Mt. Chlum (1115.8 m) and ends as the Selské vrchy Ridge. The Eastern Mokrý Ridge runs to Mt. Souš (1224.0 m) and to Mt. Srázná (1073.8 m).

A deep valley of the Morava River, in which the village Velká Morava is situated, divides the Southwestern and Southern Ridge.

Mt.Králický Sněžník is situated on a Main European Divide and is sometimes called "the roof of Europe", because it represents an important area which feeds water into three seas. The state border copies the watershed line. On Mt. Klepý (Polish Trojmórski Wierch - Three Seas Mt. 1143.6 m) lies the divide between the Labe (Elbe) R. and the Odra (Oder) R. on one side and the Odra R. and the Danube R. on the other side. The Nysa Klodzka R. and its tributaries Wilczka, Biala Ladecka, Konradka and Morawka drain into the Baltic Sea. The Tichá Orlice R. and its tributary of Lipkovský potok Brook drain into the North Sea. The Morava R. with its left tributaries of Malá Morava R. and Krupá R. drain the area into the Black Sea. From Mt. Klepý runs the watershed line between the Labe R. (the North Sea) and the Danube R. (the Black Sea) to the south to the village of Červený Potok crossing the low ground of the Basin Červenopotoční kotlina.

Mt. Králický Sněžník has a dense river pattern due to high average annual precipitation ranging from 800 to 1200 mm. Streams are often torrential and locally have small waterfalls and rapids. Many creeks and rivers form deeply incised valleys with steep slopes forested by spruce. The most of the Czech part of Mt. Králický Sněžník is drained into the Morava R. whose spring lies on its southern slope at elevation 1380 m a.s.l. In the village of Malá Morava empties into the Morava River its left tributary - the Malá Morava (Little Morava) River. The eastern part of Mt. Králický Sněžník is drained by right tributaries of the Krupá R., which empties into the Morava R. in the town of Hanušovice. The Polish part of Mt. Králický Sněžník is drained by Nysa Klodzka, which flows from slopes of Mt. Klepý (Mt. Trójmorski Wierch). Deep valleys can be seen to dissect namely marginal parts of the mapped area.

2. Passive Morphostructure

Mt. Králický Sněžník is morphostructurally a horst composed of crystalline complex of the core of the Orlické hory - Klodzko Dome. The crystalline complex is represented by migmatites and orthogneisses of the Gieraltów and Sněžník types. They are forming thick sheets separated by mica-schists and gneisses of the Stronie complex.

The central part of Mount Králický Sněžník is composed of migmatites and orthogneisses of the Gieraltów and Sněžník types. The Gieraltów and partly also Sněžník gneisses originated from the Proterozoic sediments by metasomatic granitization of different grade. In the gneisses, schlieren of amphibolite, quartzite and rocks of mica-schists type can be found. The transitions between the gneisses and metamorphosed rocks of their mantle (Stronie, Staré Město and Zábřeh complexes) are gradual (Svoboda et al., 1966).

The Gieraltów gneisses are very fine-grained, light reddish or light-grey thin- or thick-laminated two-mica rocks of different structure. A typical gneiss of the Gieraltów type occurs on the top of Mt. Králický Sněžník and forms the Southern Ridge (Mt. Sušina 1321.2 m - Zapletal in Demek - Novák eds., 1992). The gneisses of the Sněžník type are connected with the gneisses of the Gieraltów type in space and genesis. The transitions are usually gradual. The light-gray or reddish Sněžník orthogneiss has a mostly lenti-cular structure with lenses of fine-grained feldspar and qu-artz grains, among which several millimeters large microcli-ne porphyroblasts enveloped by mica flakes are often prominent. In Mt. Králický Sněžník these rocks are exposed on the Southwestern Ridge (Mt. Malý Sněžník 1337.7 m, Mt. Klepý 1143.6 m).

The mantle of the orthogneiss bodies in the core of the Orlické hory - Klodzko Dome is built of pararocks named as the Stronie complex. The principal rocks of this lithologically varied unit are mica-schists, frequently garnet-bearing, with intercalated paragneiss. They contain layers of light-colored muscovite quartzite (up to 20 m thick), or graphitic quartzite, crystalline limestone and erlan. In the Morava R. valley between the top of Mt.

Králický Sněžník and the village of Velká Morava there is an outcrop of crystal-line limestone (marble). The best exposure of marble is in the Marble Quarry situated in the village of Velká Morava. Amphibolites form isolated small bodies concordantly empla-ced in mica-schists and paragneiss. Paragneisses of the Stronie complex are represented by two types of rocks. At the base there is a very fine schistose rock. Paragneisses of the second type alternate with mica schists through the whole range of the complex and are frequent in its top layers. They are also fine to medium-grained rocks.

Paragneisses are oldest rocks of the dome and are assigned to the Proterozoikum (Svoboda et al., 1966) with the radiometric age 550 to 650 millions years (Mísař et al., 1983). Remnants of small non-specified fossil in rock of the Stronie complex allow - at least partly - to date them into the older Paleozoic Era (Harazim - Pacltová - Pouba, 1981; Zapletal in Demek - Novák eds., 1992).

On the eastern border of Mt. Králický Sněžník a tectonic contact of rocks of the Orlické hory - Klodzko Dome was established to rocks of the Staré Město Unit. The rocks of the Orlické hory - Klodzko Dome are overthrusted over the rocks of the Staré Město Unit (Zapletal in Demek - Novák eds., 1994).

The Cadomian, Caledonian and Variscan orogenic phases caused folding and also faulting. Especially the Variscan orogenesis originated a system of radial faults which had broken the ancient structure into a series of large and small blocks.

3. Active Morphostructure

Old radial faults were for the most part renewed during the neotectonic period. Some of them are of local importance only, whereas others considerably influenced the geomorphologic development of the entire Mt. Králický Sněžník. The oldest system of radial faults is a NE-SW system, represented by the Hedeč dislocation (Kočandrle, 1983) trending from the village of Červená Voda to villages of Dolní Orlice and Červený Potok. Near the village Červený Potok the Hedeč dislocation crosses the E-W running Lipkov Fault. The Hedeč Fault runs farther into the valley of the Upper Morava River. The fault is rep-resented by a system of small dislocations and orthogneis-ses of the same type which are strongly ruptured. The thickness of the tectonically ruptured orthogneisses reaches 41 m of these about 13 m are strongly crushed orthogneisses and mylonites (Kočandrle, 1983; Kočandrle - Opletal, 1985).

Younger faults trend to NW-SE. The youngest faults run to N-S and E-W. These faults control subsided Cretaceous deposits (around 90 million years old) in the Klodzko Basin. The faults have locally the character of reverse fault. The most important faults in the E-W direction in the mapped area are the Lipkov Fault and parallel faults limiting Mt. Králický Sněžník on the south. According J. Kočandrle (1983) movements along the fault system repeated several times during the neotectonic period. The evidence of these movements are remnants of Tertiary deposits in the Červenopotoční kotlina Basin.

The Neotectonic period consisted of two phases older and younger (Soukup - Klein in Svoboda - Chaloupský, 1961). The morphologically striking Králíky Graben, a part of the Klodzko Basin, originated in the younger phase. The Klodzko Basin is situated to the west from Mt. Králický Sněžník (Svoboda et al., 1964). The Basin is filled with Cretaceous deposits (calcareous marlstones, claystones, siltstones, sandstone and conglomerates) limited by faults. They are up to 800 m thick. The Klodzko Basin today separates the Orlické hory Mts. from the crystalline complex of Mt. Králický Sněžník. It originated by the breaking through of the central part of the Orlické hory - Klodzko Dome along the NW-SE and N-S faults in the Neogene Period. All these neotectonic faults imprinted last features on the structure and geomorphology of Mt. Králický Sněžník (Svoboda et al., 1966).

Tertiary fluvial and lacustrine deposits occur in the Červenopotoční kotlina Basin along the Main European Divide. Near the town of Králíky and the village Červený Potok the Neogene gravels and sands are considerably extensive and up to 30 m thick. Remnants of Neogene deposits (about 5 million years old) are situated on the left side of the Upper Morava River valley near the village Velká Morava. Boreholes indicated that they are from 7 to 14 m thick (Kočandrle, 1983).

A scarp between villages of Heřmanice and Prostřední Lipka represents - according to geological maps on a scale of 1:200 000 and 1:50 000, a fault scarp separating the Upper Cretaceous deposits of the Klodzko Basin from the crystalline complex of the Orlické hory - Klodzko Dome.

The authors classify also southern border slopes of Mt. Králický Sněžník as fault scarps controlled by the Lipkov and parallel faults. These are very prominent scarps which cut geological structures. Fault scarp separates Mt. Králický Sněžník from a lower relief of the Červenopotoční kotlina Basin. Pediments developed at the foot of the fault scarps (see further).

The eastern border slope of Mt. Králický Sněžník, which rises above the Staroměstská kotlina Basin, is also controlled by dislocations along the overthrust of rocks of the Orlické hory - Klodzko Dome over rocks of the Staré Město Unit (see Zapletal in Demek - Novák eds., 1992). Pediments developed at the foot of these prominent slopes (see further).

4. Morphosculpture

The relief of Mt. Králický Sněžník developed under conditions of changing climate. Up to the Middle Miocene was the studied area ruled by a tropical climate of the savanah type. Progressive cooling of the climate combined with a decrease of precipitation culminated in the Middle Pliocene. That time was ruled by the semi-arid climate. The climate of Upper Pliocene was of Mediterranean type (warm subtropical climate) which probably lasted up to the Lower Pleistocene. Than came to the change of the Ice Ages (mostly with the cold glacial and periglacial climate) with Interglacial Ages characterized by warmer humid climate. In the Holocene, after the climatic optimum, the contemporary mild humid climate stabilized. The climatic changes resulted in the contemporary polygenetic relief with preserved landforms of warm humid, arid, cold and mild humid climate.

4.1 Planation surfaces

4.1.1 Summit polygenetic planation surfaces

Mountain summits and ridges are often remarkably flat with occasional tors or frost-riven bedrock remnants rising above the summit surface. Folded and faulted basement rocks are planated. J. Vítek (1995) described the summit flat at an eleva-tion of 1420 m a.s.l. around the highest point of Mt. Králický Sněžník. The summit flat has an area of 400 square meters and an inclination up to 5°. On the southern side, the summit flat is limited by a frost-riven scarp. There are periglacial stone polygons on the flat (Chábera, 1956).

The authors found summit flats on Mt. Malý Sněžník (1337.7 m) situated on the Southwestern Ridge, on the Southern (Mokrý) Ridge (e.g. Mt. Stříbrnická 1250.1 m, Sušina 1321.3 m, Podbělka 1307.4 m, Souše 1224.9 m - see also Vítek, 1995).

There are different opinions among Czech geomorphologists about the origin of these summit flats. All geomorphologists agree that they are parts of planation surfaces. Some authors interpreted these summit flats as parts of a peneplaine (Chábera, 1956; Šrobánek et al., 1964). Since there are no thick regolith mantles on the flats, most probably they are remnants of an etchplain or a cryoplain (Vítek, 1995).

The authors have not enough information for the comparison of planation surfaces analysis on the Polish side of the Mt. Králický Sněžník (see for instance Don, 1989). Further research of this problem is needed.

4.1.2 Pediments and glacis at a foot of border slopes

At the foot of the fault scarp between villages Heřmanice and Prostřední Lipka developed a slightly inclined surface in Upper Cretaceous deposits. The surface is inclined from a foot of the fault scarp to the West to the Heřmanický potok valley. Near the foot of the fault scarp has the surface an inclination of 12 to 10°. Downslope the inclination decreases to 4°. The fault scarp developed in more resistant crystalline rocks of the Orlické hory - Klodzko Dome. The fault-scarp has an inclination of more or less 20°. The surface at its foot developed in less resistant Up-per Cretaceous deposits (claystone with intercalation of calcareous sandstone), which are exposed directly on the surface. Only the lower part of the pediment surface is covered by slo-pe deposits. The authors therefore classified this surface as glacis ďerosion.

Glacis ďerosion developed also in Neogene sands at the foot of Mt. Větrný vrch (807.3 m) between the valley of the Lipkovský potok Brook and the Morava River in the Červenopotoční kotlina Basin. Boreholes has shown the thickness of Neogene deposits at least 25 m. The surface is inclined to the South to the Col Červenopotoční sedlo.

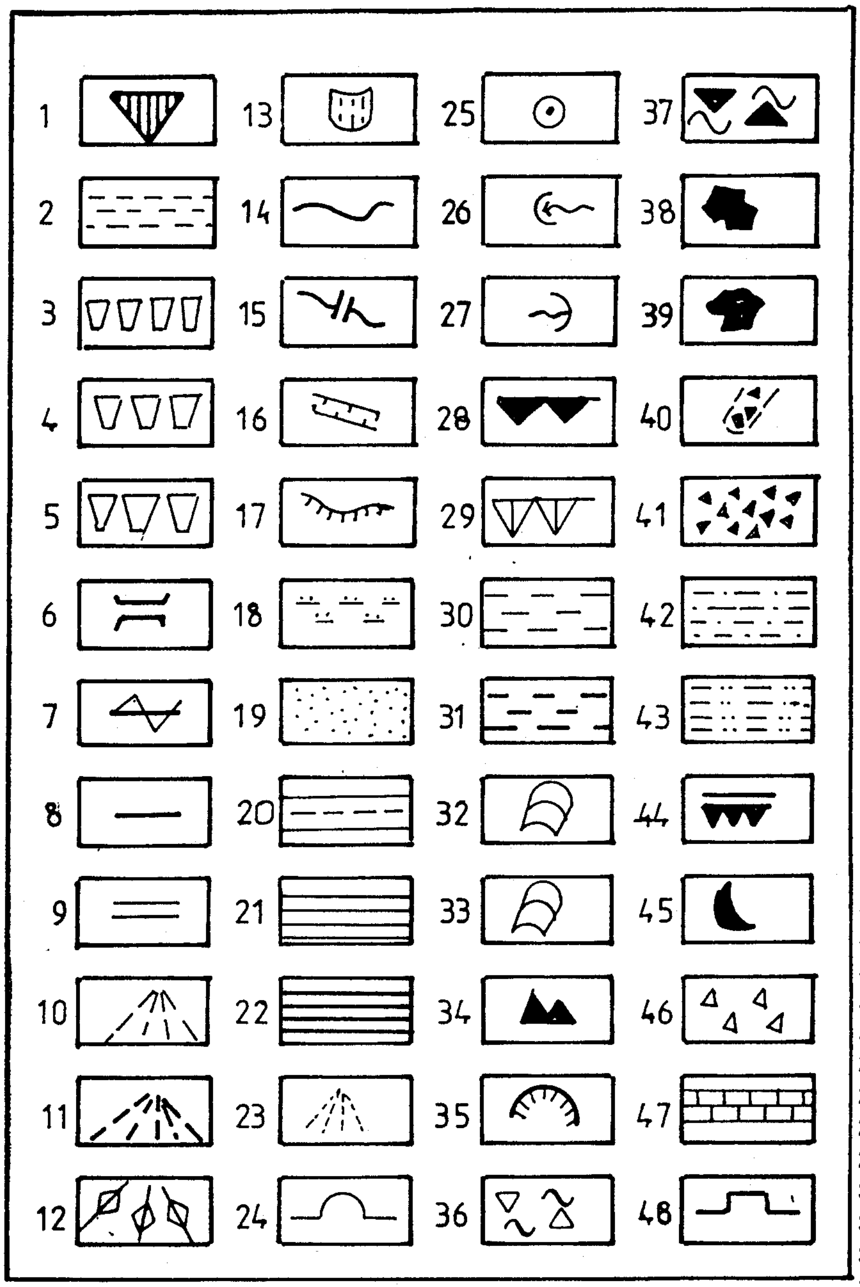
Remnants of pediments on metamorphose rocks were mapped along the foot of the southern fault scarp (Mt. Srázná 1073.8 m) near the village Vojtíškov. The pediments originated in the fine-grained two-mica gneiss of the Orlické hory - Klodzko Dome. Pediments and the fault scarp developed in the same rocks.

There are remnants of three levels of pediments. Remnants of pediments exhibit the form of small flats inclined from the foot of the fault scarp to the Morava River valley. The largest areal extent have remnants of the lower pediment situated immediately above the edge of the incised Morava River valley et elevation 540 to 550 m a.s.l.

Remnants of the middle pediment were mapped at the elevation ranging between 580 and 590 m a.s.l. Remnants of the highest pediment are situated around the village Vojtíškov at the elevation 700 to 710 m a.s.l.

Pediments at the foot of the border slope of Mt. Králický Sněžník between villages Vysoká and Stříbrnice developed in the similar way. In this part also originated the border slope to the Staroměstská kotlina Basin and the pediment in fine-grained two-mica gneiss.

A more complex situation was found in the part situated to the north from the village of Stříbrnice. In this area pediments developed both in two-mica gneiss of the Orlické hory - Klodzko Dome and in mica schists of the Staré Město Unit. The pediments sloped downward to the east and level also tectonic lines of the overthrust of rocks the Orlické hory - Klodzko Dome over the Staré Město Unit. According to the State geological map 1:50 000 (Opletal, ed., 1992), these dislocations are co-vered by slope deposits are between villages Stříbrnice and Nová Seninka. But the leveling of dislocations is clear in the section to the north from the village Seninka. The pediment is leveling both gneisses and mica-schists. The border slope was backwearing and the pediment formed at the same time.



Legend:
1. Fault Scarp
2. Remnant of a polygenetic planation surface (etchplain) inclined 0-2°
3. Remnant of the lowest pediment
4. Remnant of the middle pediment
5. Remnant of the highest pediment
6. Narrow and rocky ridge originated by the intersection of valley sides
7. Narrow rounded ridge originated by the intersection of valley sides
8. Broad rounded ridge
9. Col
10. Glacis ďerosion cutting Upper Cretaceous deposits
11. Glacis ďerosion cutting Neogene Deposits
12. Peripediment
13. Spur
14. River bed
15. Waterfall
16. Gully
17. Scarp originated by lateral river erosion
18. Floodplain
19. Accumulation valley bottom inclined to the valley axis
20. Valley slope inclined 2-5°
21. Valley slope inclined 5-35°
22. Valley slope inclined more than 35°
23. Alluvial cone
24. Cave (entrance)
25. Karst doline
26. Ponor
27. Karst spring
28. Frost-riven cliff
29. Frost scarp
30. Cryoplanation terrace inclined 2-5°
31. Cryoplanation terrace inclined 5-15°
32. Dell inclined 2-5°
33. Dell inclined 5-15°

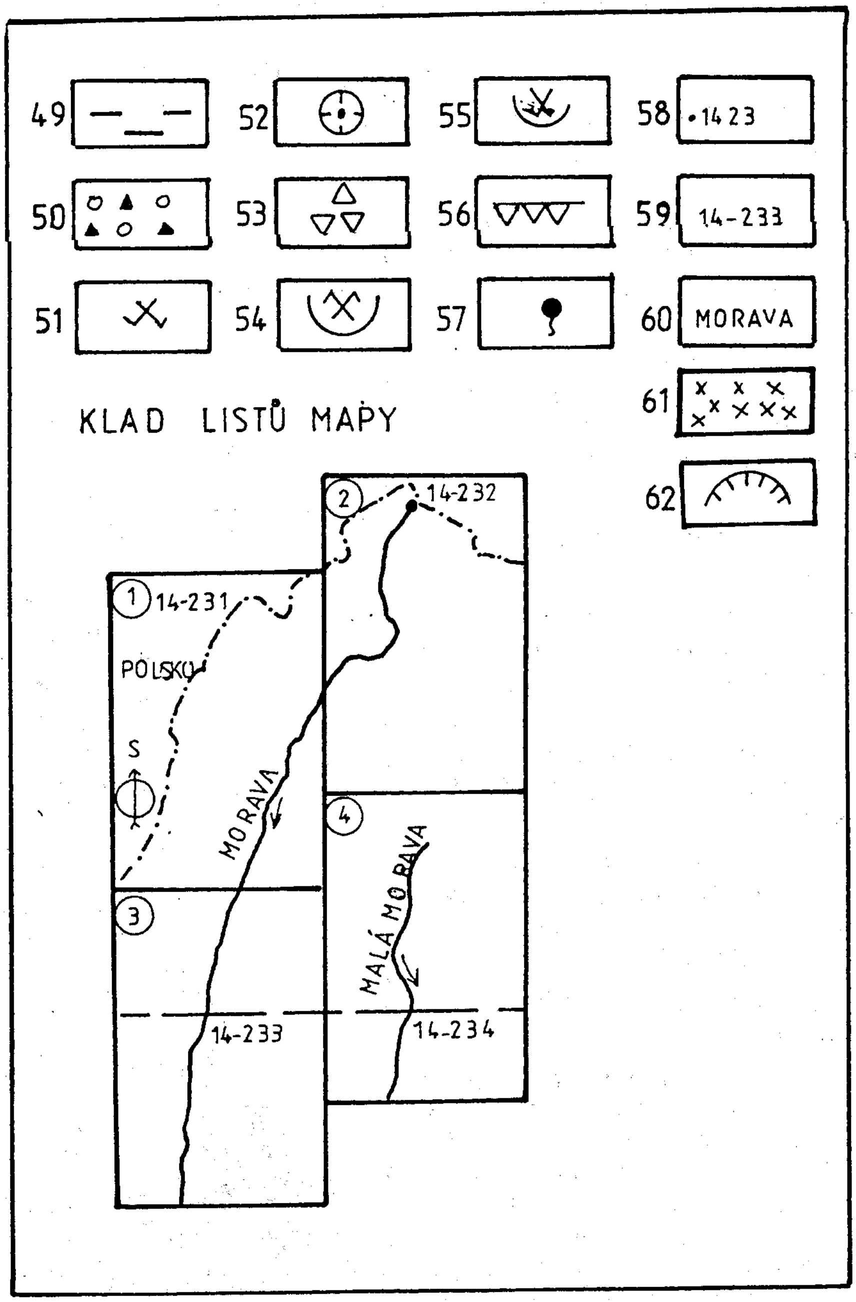
4.1.3 Valley pediments and peripediments

Pediments and glacises ďerosion at the foot of border slopes run out from the Červenopotoční kotlina Basin into valleys both of the Morava R. and the Malá Morava R. as rock platforms at the foot of valley slopes.

In the valley of the Morava R. a prominent rock platform developed at the foot of the left valley side at least in two levels. The lower level is situated directly above the edge of the youngest incision. It runs continuously from the mouth of the non-name left tributary of the Morava R. in the forest tract V koutech up to caves Tvarožné díry and farther up to the valley of the Mlýnský potok Brook. In the forest tract V kolínské (between valleys of the above mentioned non-name left tributary of the Morava R. and the valley of the Mlýnský potok Brook the pediment elevation is 600 to 650 m. According to the State geological map 1:50 000 (Opletal ed., 1992) is the surface of the pediment is covered by Neogene deposits, which are overlapped by Quaternary slope deposits. A debris slope developed at the foot of Mt. Maliník (789 m a.s.l.).

In the section between the Mlýnský potok Brook in the south and the Kamenný potok Brook in the north a pediment developed both in the fine-grained two-mica gneiss of the Orlické hory - Klodzko Dome and in the crystalline limestone of the Stronie complex. Boreholes has shown that the pediment is partly covered by Tertiary (Miocene?) deposits (fluvial and lacustrine gravels and sands). The Tertiary deposits are covered with a Quaternary slope and proluvial deposits The Miocene deposits were not exposed at the time of the geomorphologic mapping. The borehole situated on the pedi-

34. Tor
35. Nivation hollow
36. Debris slope inclined 2-15°
37. Debris slope inclined 15-25°
38. Blockfield inclined 2-5°
39. Blockfield inclined 5-15°
40. Blockstream composed of angular blocks
41. Angular debris
42. Surface of loess loams inclined 2-5°
43. Surface of loess loams inclined 5-15°
44. Root area of rock slide
45. Head of mudflow
46. Surface of mudflow
47. Peat bog
48. Stone - quarry - active
49. Stone quarry - abandoned
50. Fluvioglacial deposits
51. Abandoned mine - entrance
52. Depression of unknown origin
53. Agricultural stone heap
54. Mine heap - active
55. Mine heap - abandoned
56. Agricultural balk
57. Spring, spring niche
58. Spot height
59. Number of map sheet
60. Name of river, name of village
61. Karst area
62. Edge of cirque-like depression



ment in the village of Velká Morava (about 1 km to the south from the church) showed the following profile (Kočandrle, 1983):

0.00-0.20 m loam (Holocene)

0.20-2.20 m debris (orthogneiss) with loam (Pleistocene)

2.20-10.00 m sandy clay with partly rounded fragments of orthogneiss, some fragments of quartzite and mica-schist, chaotic structure

10.00-10.50 m sand with some clay particles (Tertiary)

10.50-11.30 m biotitic orthogneiss (block?)

11.30-12.00 m coarse grained sand with clay intercalations and some fragments partly rounded quartzite (Tertiary?)

12.00-13.70 m grey-brown sandy clay with small fragment of quartz and quartzite to 3 cm (Tertiary deposits or saprolith?)

13.70-14.00 m grey - brown sandy clay with grass - green intercalations and some fragments of quartzite (up to 2 cm) (Tertiary deposits or saprolith?)

14.00-14.70 m biotit - muscovitic orthogneiss (bedrock)

14.70-18.40 m fragments of weathered orthogneiss (bedrock)

18.40-19.00 m quartzitic orthogneiss (bedrock)

19.00-22.00 m weathered rusty grey orthogneiss (bedrock)

22.00-24.00 m muscovitic orthogneiss, weathered (bedrock).

Gneisses are exposed in a long defile below the pediment in the scarp of the youngest incision of the Morava R. The thickness of the colluvium and proluvium on the pediment ranges from 7 to 14 m.

Behind the buffet on the upper parking place in the village of Velká Morava the following profile was found at the edge of the peripediment (June 1998):

0.00-0.20 brown cambisol

0.20-9.30 m brown sandy loam with angular fragments of gneiss, quartz up to block dimensions, some rounded gravels (Pleistocene)

9.30-9.70 m brown loamy sand with medium rounded gravels, some angular fragments of quartz (Pleistocene)

9.70-11.90 m rusty brown fluvial sand with gravels up to block dimensions, at the base large blocks (terrace of Morava R. - Pleistocene)

13.20 m level of the Morava R. floodplain.

In the pediment, the Quarry Mramorový lom (Marble Quarry) is situated, in the village of Velká Morava. In the Marble Quarry, crystalline limestone of the basement lays directly on the surface. Colluvial deposits of the Quaternary age fill a part of the depression of the karstified surface. The colored weathered mantle and deposits in cockpits among karst cones (see further) are evidently of a Tertiary age.

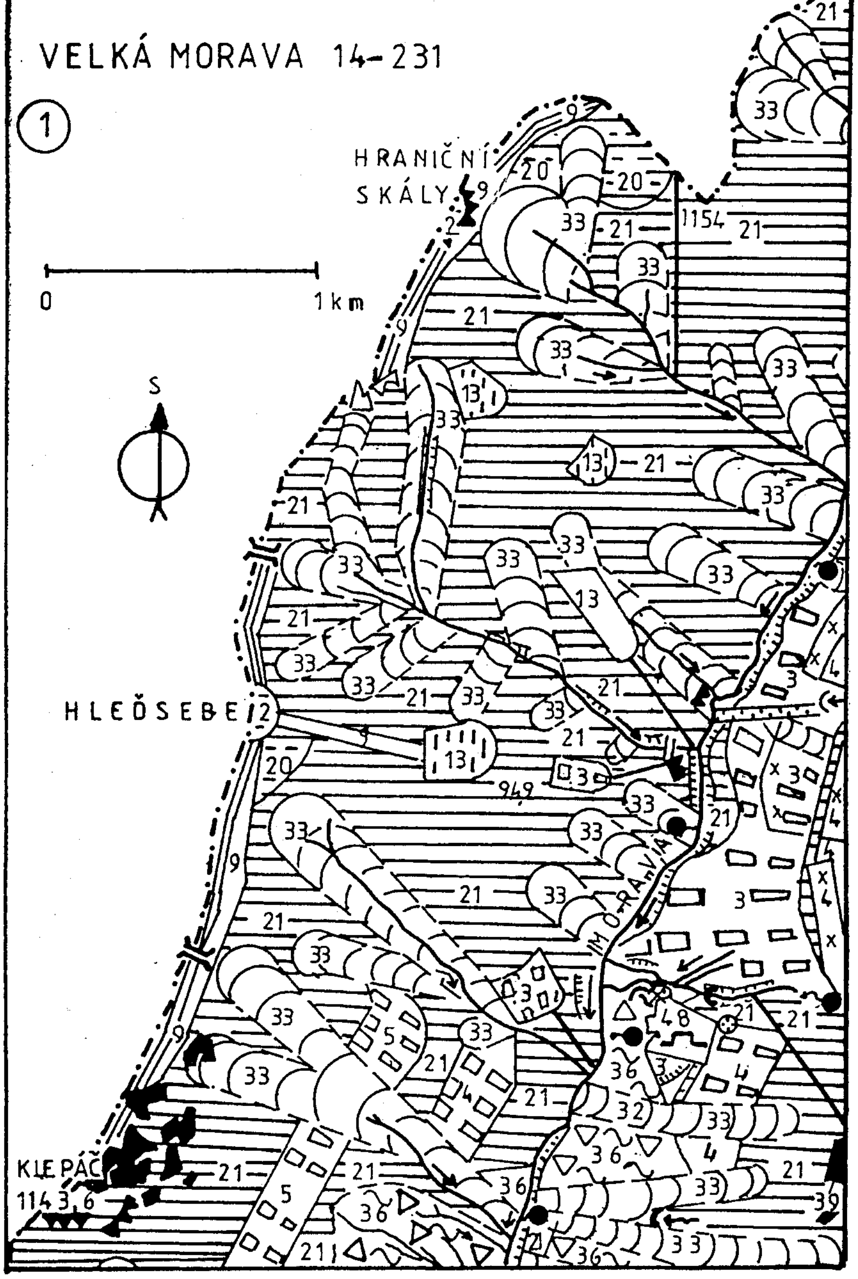


Fig. 2.1 Detailed Geomorphologic Map of the Central Part of Mt. Králický Sněžník (mapped by J. Demek and J. Kopecký 1993-1995, supplements 1997 and 1998, drawn by J. Demek, 1997 and 1998).

In the next sector between the valley of the Kamenný potok Brook and caves Tvarožné díry a piedmont surface developed in both gneiss and crystalline limestone of the Stronie complex. The valley pediment developed in two levels separated with a scarp with frost-riven cliffs (see map). The lower pediment developed immediately above the steep, but low step of the youngest incision of the Morava River. The higher pediment is separated from the lower one by the above mentioned scarp. Karst phenomena (e.g. doline) developed on the lower pediment above the caves Tvarožné díry.

The valley piedmont surface in the Morava River valley can be called a polygenetic pediment, which apparently developed during the Tertiary Period. In the Quaternary period, it was remodeled in periglacial and humid climate. Parts covered by Neogene fluvial and Quaternary slope and proluvial deposits are interpreted by the authors as peripediments (see map).

Similarly, piedmont planation surfaces developed in two levels on the watershed between the Morava R. and the Malá Morava R. in the Basin Červenopotoční kotlina. The higher pediment is situated at a elevation approx. 650 m a.s.l., the lower one above the edge of the Morava R. and the Malá Morava R. valleys at the elevation of 610 to 570 m a.s.l. On the surface of the piedmont gneiss of the Orlické hory - Klodzko Dome is exposed. Similarly as in the Morava R. valley, a continuous piedmont surface developed also in the Malá Morava River valley. Gneiss of the Orlické hory - Klodzko Dome appears near to the surface of the piedmont. The piedmont surface cuts the same rocks as the steep head-scarp. According to the geological maps 1:50 000 (Opletal ed., 1992; Gawlikowska - Opletal, 1997) there are no Quaternary deposits on the piedmont surface. The surface inclines from the foot of the steep head-scarp to the Malá Morava R. valley between villages Sklené and Malá Morava. In the longitudinal profile its elevation rises from 600 m a.s.l. near the village Malá Morava to 770 m a.s.l. near the village Sklené. Therefore, also this piedmont surface can be called pediment, because it cuts the same rocks as the head-scarp.

There are some shallow rocky shelves on valley slopes of the Morava R. and the Malá Morava. These shelves were interpreted as remnants of ancient valley bottoms (Bosák - Hýsek, 1993a).

The analysis of pediments and peripediments indicated, that Mt. Králický Sněžník was a prominent mountain group already in the Tertiary Period (Migon in Jahn - Kozlowski - Pulina, eds. 1966; Demek - Kopecký, 1997). The Quaternary tectonic movements and the incision of water courses into Tertiary pediments were relatively small in the Quaternary Period (20 to 30 m only).

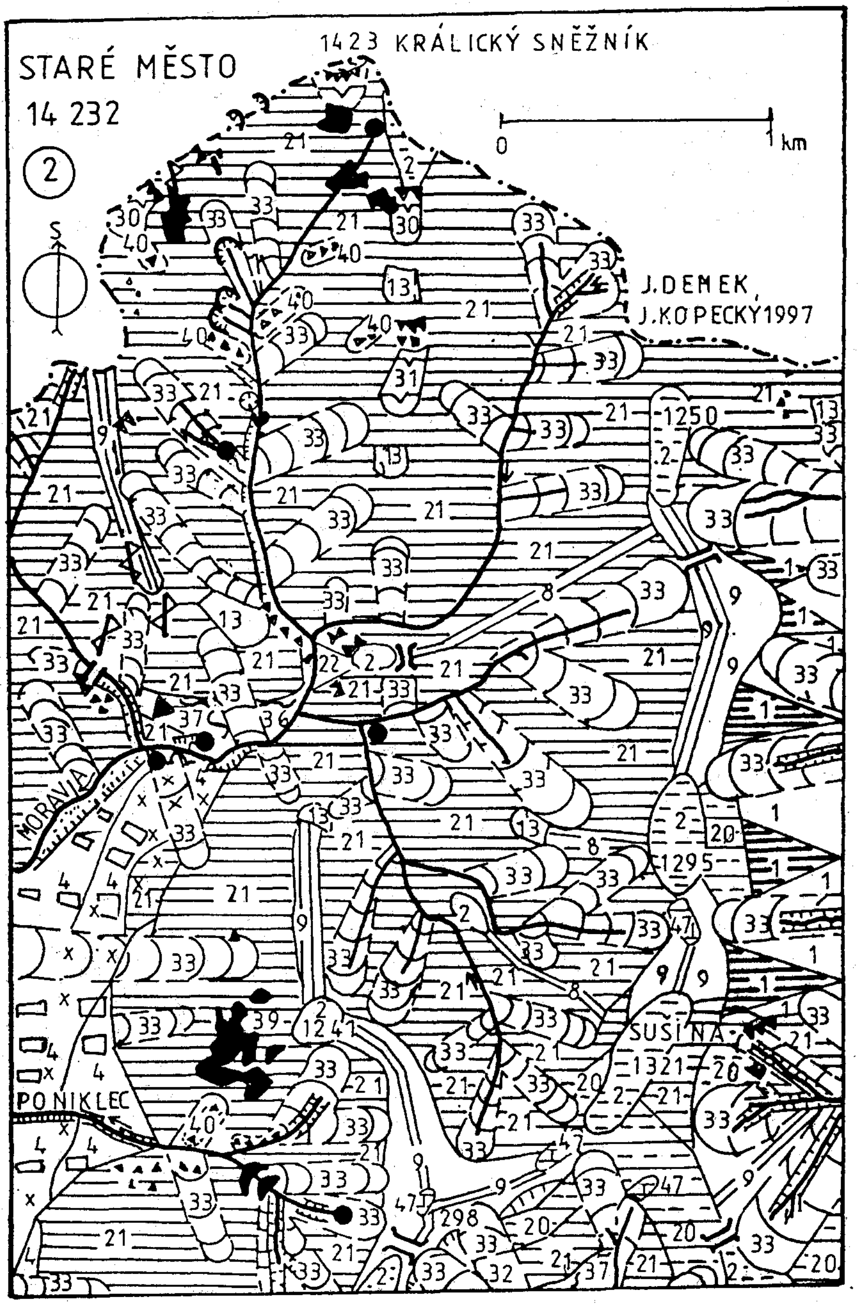


Fig. 2.2 Detailed Geomorphologic Map of the Central Part of Mt. Králický Sněžník (mapped by J. Demek and J. Kopecký 1993-1995, supplements 1997 and 1998, drawn by J. Demek, 1997 and 1998).

4.2 Fluvial Form

4.2.1 Fluvial Erosion Forms

The longitudinal profile of streams in the mapped area is none-graded. There are waterfalls and rapids on several places. To mention some of larger waterfalls (for location see map): the waterfall Pod strašidly on the right tributary of the Morava R., the valley of the tributary is controlled by the fault, the waterfall with surrounding cliffs and tors developed on the quartzite layer of the Stronie complex and consists of 2 steps. The waterfall of the Brook Hluboký potok (right tributary of the Morava R.) near the mouth of valley Hluboký dol into the Morava R. valley. The waterfall developed on a layer of graphitic mica-schists with the intercalation of graphitic quartzite. Further, many waterfalls on the upper reaches of the Prudký potok Brook (up to 6 m high) and the waterfall on the upper reaches of the Malá Morava R. (3 m high).

Many slopes are dissected by gullies. Gullies are mostly incised into Quaternary slope deposits or into deposits on bottoms of dells and dry valleys. Their depth vary.

The most important fluvial erosion forms are river valley slopes. The mapped area is dissected by a dense pattern of river valleys. In the upper reaches, the valleys exhibit in their cross sections the form of a letter V. The slopes are very steep with the gradient of 25° to 35°. There are frost-riven cliffs, block fields and scree on the slopes. Common are amphitheatric heads of valleys.

In middle and lower sectors of the streams, the valleys exhibit the trough-like profile in cross sections. Valley pediments developed in some valleys (e.g. in valleys of the Morava R. and the Malá Morava R.).

The intensity of slope processes on valley sides is high. There are rock slides, mud streams and gullies on the valley slopes. Trees on the valley slopes are drunk due to creep.

4.2.2 Accumulation forms due to river aggradation

Floodplains developed along the Morava R., the Malá Morava R. and the Brook Lipkovský potok. Floodplains are composed of two layers - lower and upper. The lower layer is composed by forms river gravel and sand. According to J. Řehák (1993, p. 4), the lo-wer layer thickness ranges from 3.5 to 4 m. The upper layer consists of loam, clay and sand. Its thickness is about 0.5 m. The floodplains are of Quaternary age (Wurmian and Holocene).

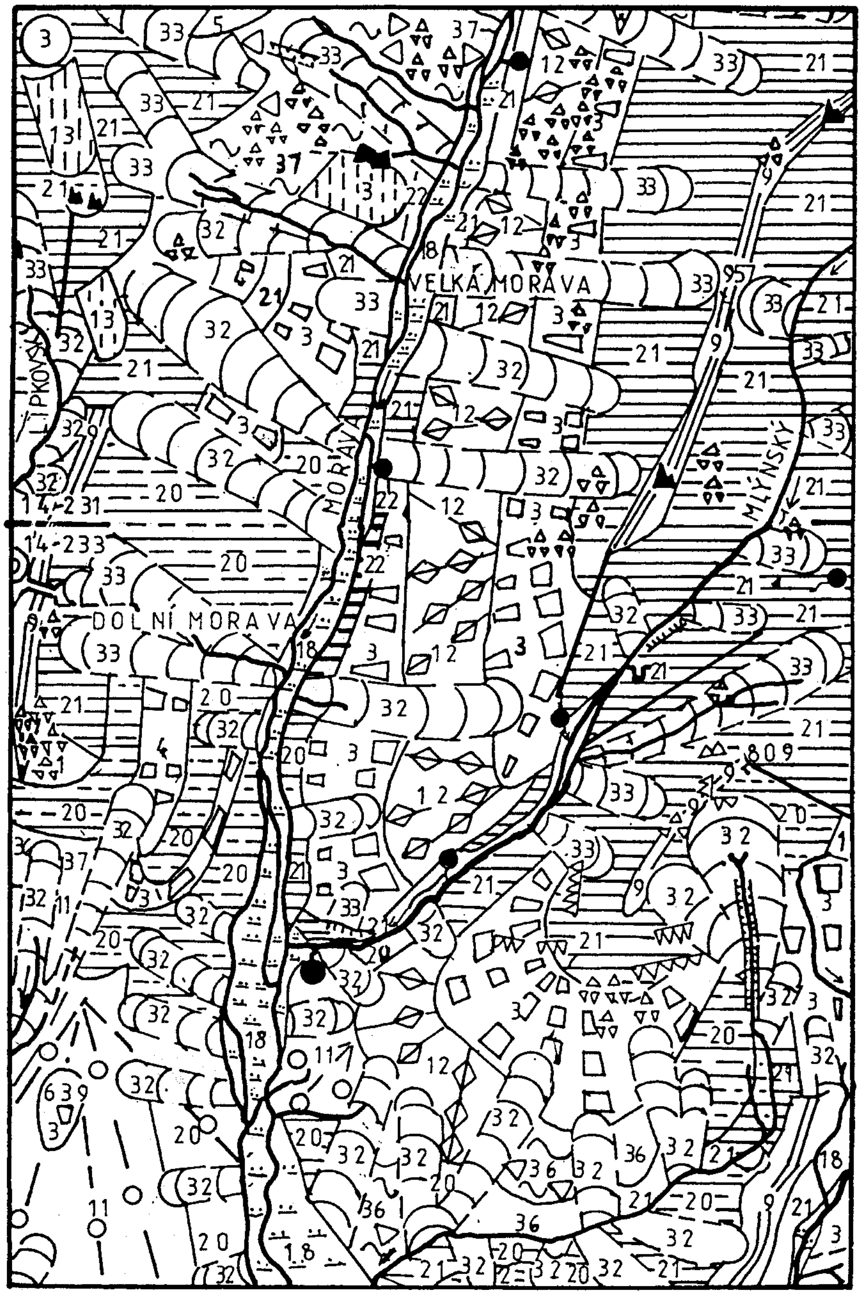


Fig. 2.3 Detailed Geomorphologic Map of the Central Part of Mt. Králický Sněžník (mapped by J. Demek and J. Kopecký 1993-1995, supplements 1997 and 1998, drawn by J. Demek, 1997 and 1998).

Pleistocene gravel and sand of the river terraces of the Morava R. were found in several excavations for the house construction at the foot of the left valley side in the village Velká Morava. There are probably more remnants of terraces of the Morava R. buried under colluvial deposits. Proluvial deposits of tributaries of the Morava R. were also found on the lower pediment. Badly sorted deposits of proluvial cones differ from more sorted fluvial (terrace) deposits of Morava R. Well rounded terrace gravels were found in an excavation in a front of Sport Hotel in Velká Morava about 20 m above the Morava R.

Profile (15. 7. 1998):

0.00-0.30 m brown soil (cambisol)

0.30-1.30 m brown loam with angular fragments of gneiss (Quaternary slope deposits)

1.30-1.60 m rusty brown, well rounded fluvial gravel up to 20 cm in longer axis with brown coarse grained sand (Quaternary terrace deposits of Morava R.).

Small alluvial cones developed at mouths of small tributaries into larger streams.

4.2.3 Flood Hazard in July 1997

During four days (July 5th to 8th, 1997) the Meteorological Station in Velká Morava measured of precipitation 550 mm of precipitation (personal communication of Forester Vyskočil). The following flood hazard is known as 1000-year-flood discharge. Linear water erosion prevailed in upper reaches of the Morava R. up to beginning of the village of Velká Morava. The river bed of the Morava River incised into the bedrock became deeper by about 30 cm. Block gravel accumulation took place in some forested sections of the valley bottom. Undercutting of valley slopes caused landslides in lower parts of valley sides (e.g. in some sections of so called Czech Road on left side of the valley).

Side erosion and fluvial accumulation of coarse gravel prevailed in the village of Velká Morava. The side erosion resulted in some landslides (e.g. near to Hotel OREA). An extensive gravel accumulation occurred on the floodplain section at the village of Červený Potok. Thickness of large gravel layer was about 0.7 m.

Bottoms of some gullies on the Morava R. valley slopes became deeper by linear erosion. Outwashed material formed alluvial cones in the Morava R. valley.

In upper reaches of the Malá Morava R. up to the waterfall no distinctive flood erosion forms were observed. Below the waterfall up to the village of Sklené linear erosion took place. Blocks of dimensions 1.5x1.0x0.7 m were moved by water during the flood in the river bed. Landslides formed in lower parts of valley sides. The forest road running parallel upstream of the village of Sklené with the river was destroyed up to the bedrock.

It is interesting, that in the valley of the Brook Prudký potok this flood hazard caused no erosion features.

4.3 Karst forms

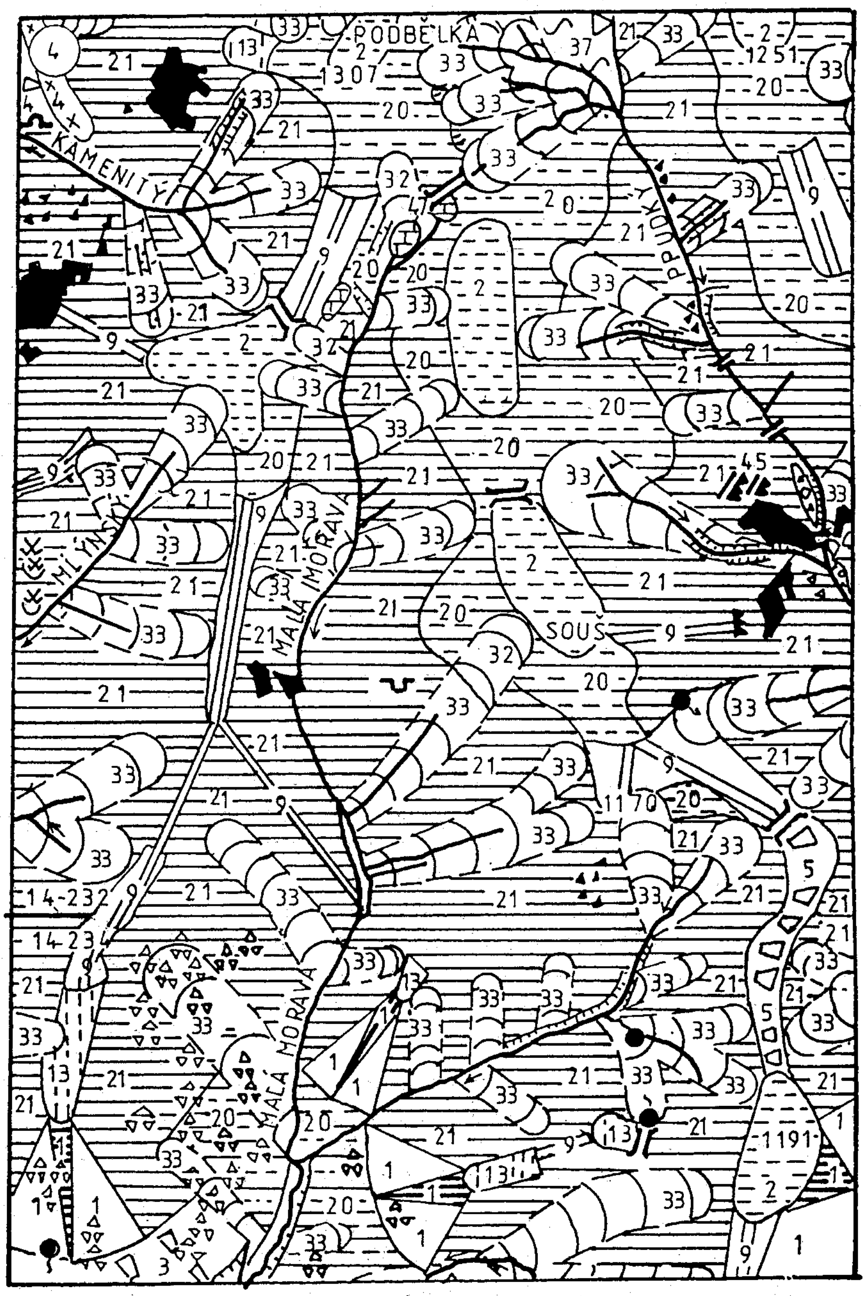


Fig. 2.4 Detailed Geomorphologic Map of the Central Part of Mt. Králický Sněžník (mapped by J. Demek and J. Kopecký 1993-1995, supplements 1997 and 1998, drawn by J. Demek, 1997 and 1998).

Karst forms have been recently studied in recent years by Czech and Polish speleologists and geomorphologists (Bosák, 1993a; 1993b; Bosák - Hýsek, 1993a; 1993b; Ciezkowski - Pulina - Řehák, 1993; Ciezkowski - Maděra, 1985; Demek - Maděra, 1982; Konečná, 1993; Král, 1957; 1958; Krawczyk, 1993; Kučera - Hromas - Skřivánek, 1981; Maděra, 1971; 1974; 1979; 1980; 1982; 1984; 1986; Maděra - Ciezkowski, 1985; Ouhrabka, 1992; Panoš, 1955; 1962; Pulina, 1977; Řehák, 1993; Řehák - Braun - Milka, 1987; Štelcl - Vlček - Panovský, 1976; Vítek, 1970; 1975). Karst features are bound to the crystalline limestone (marble) of the Stronie complex. Crystalline li-mestone thickness ranges between 60 and 150 m. Borings did not reach its base. The following text is based on information contained in the report of J. Řehák (1993).

Marble is divided by longitudinal (older) and radial (younger) faults into several blocks. Development of karst forms is closely connected with the development of the Morava R. valley.

In the geomorphologic map (see Fig. 2) entrances to caves are shown as follows

- one of three entrances to cave Tvarožné díry,
- to cave Propástka (846.7 m a.s.l.),
- to cave Patzeltova jeskyně (874.7 m a.s.l.), the authors use the name given in the Czech Military Map,
- to caves in the Old (Marble) Quarry (see Maděra, 1979, p. 42-43), which in the same time act as ponors.

Due to the scale of the geomorphologic map, the entrance to the cave Kančí díra (840.3 m a.s.l.) situated 26 m to the west from the cave Tvarožné díry is not shown on the map.

There is a total of 11 dolines in the mapped area. According to J. Řehák (1993, p. 8) they are not the classically developed dolines. Their walls and bottoms are covered by rock fragments from the non-karstic rocks transported from the vicinity of dolines. Some dolines were studied with these of excavations (e.g. the doline called Vlčí díra in the pediment above the cave Tvarožné díry). The doline Vlčí díra is a funnel-shaped rounded depression of a diameter 11 m and depth 3 m. The excavation on the bottom of doline was 3 m deep. According to the excavation, the doline bottom is filled with gneiss scree (Maděra, 1979).

Depressions in the Morava R. valley situated above the youngest incision of the river upstream of Chalet Vilemínka are of unknown genesis. There are two real dolines at the bottom of the Morava R. valley upstream from the ponor at the elevation of 900 m a.s.l. (near above the mentioned depressions - see the map).

Many ponors are situated at the contact of marble with non-karstic rocks. J. Řehák (1993) gives the list of 11 ponors in the mapped area. Two ponors are situated directly in the bed of the Morava R. The first of them is above the mentioned ponor situated at the elevation of 990 m a.s.l. and in the summer period takes up all waters of the Morava R. The second one is situated at the elevation of 843 m a.s.l. near the cave Propástka. A part of its water appears in the cave Tvarožné díry (Maděra, 1979).

Another important ponor is situated in the bed of the Poniklec Brook at the elevation of 836 m a.s.l. The hydrological connec-tion with the karst spring Mléčný pramen was proved by color experiments (Maděra, 1979).

Ponors and caves can be also found upslope of the Old (Marble) Quarry are also. Since 1983, a ponor on the Kamenitý potok Brook at the elevation of 775 m a.s.l. is monitored (Řehák, 1993).

There is a number of karst springs in the mapped area. In the geomorphologic map following karst springs are shown:

- the Blom-blom at the foot of the right valley slope of the Mo-rava River near the cave Tvarožné díry;
- the Jeskyně Spring (also Kopřivový, Nesselbrunnen) at the foot of the left Morava R. valley side about 1 km SW downstream from the cave Tvarožné díry;
- the Mléčný Spring (also Lanovka, Milchbrunnen) at the elevation of 750.3 m a.s.l. situated at the northern border of the Marble Quarry, the spring is monitored;
- the spring situated to the south of the Patzeltova jeskyně cave, whose water empties into the Brook Kamenitý potok;
- the spring called Lom situated on the western side of the Marble Quarry;
- the spring at the foot of the left valley side of the Morava R., captured for water supply of the Hotel OREA Sněžník;
- the Louka Spring at the left valley side of the Morava R., captured for supply of drink water;
- the Salaš Spring in the Mlýnická dolina Valley (valley of the Brook Mlýnický potok) at the elevation of 710 m a.s.l. at the foot of the right valley slope.

The karst features are very important for denudation chronology of the Mt. Králický Sněžník. First, the water of several karst springs in the mapped area is coming from the northern slope of Mt. Králický Sněžník in Poland. The underground karst drainage does not respect the main European watershed on the landsurface. Second, the majority speleologists and geomorphologists agree that the karst forms situated on the valley pediment in the Morava R. valley started to develop already in the Tertiary Period (may be even in Paleogene). The pediment cut marble and tropical conical karst developed on the pediment surface. Due to the location of the pediment immediately above the edge of the youngest incision of the Morava R., Mt. Králický Sněžník have been a high mountain massif already in the Tertiary Period.

4.4 Cryogenic forms

4.4.1 Periglacial cryogenic forms

Numerous Pleistocene cryogenic forms were described from Mt. Králický Sněžník (Chábera, 1956; Martini, 1979; Traczyk, 1994; Vítek, 1995; Migon, 1996; Demek - Kopecký, 1997). During the Pleistocene Ice Ages, Mt. Králický Snižník was a part of the periglacial zone in front of the continental glacier. The permafrost was present. Many periglacial forms developed in the mapped area due to a complex of cryogenic processes.

4.4.1.1 Erosional periglacial forms

Frost-riven cliffs are near vertical rock outcrops formed by frost-weathering. They have different lengths and heights and can be found on many places in the mapped area. Nice forms are as follows:

- the castle-koppies Vlaštovčí kameny, bordered by up to 18 m high frost-riven cliffs (Vítek,1995);
- the tor Hraniční skály, frost-riven cliffs up to 6 m high (1995);
- the tor Bílý kámen (1184 m), the largest frost-riven cliff is 5 m high and 20 m long (Vítek, 1995);
- at Mt. Klepý (1143.6 m);
- at the ridge Koňský hřbet (991.1 m);
- the western slope of Mt. Uhlisko (1240.7 m) frost-riven cliffs up to 12 m high and approx. 50 m long (Maděra, 1983);
- the western slope of Mt. Podbělky (1307.4 m) approx. 200 m from the cave Patzeltova jeskyně, a frost-riven cliff in marble, approx. 5 m high and 30 m long (Vítek, 1995);

- the eastern slope of Mt. Chlum (1115.8 m) the right valley slope of the Morava R., a frost-riven cliff about 2 m high;
- on slopes of the Brook Prudký potok valley;
- on the right slope of the valley Hluboký dol;
- on slopes of the amphitheater with springs of the Brook Stříbrný potok to the west from the summit of the Mt. Sušina (1321.2 m).

Frost-riven scarps are rock outcrops which are covered by screes originated via the frost weathering. The frost-riven scarps were found:

- to the south from the top of Mt. Králický Sněžník, the frost-riven scarp is approx. 6 m high and has a arcuate form with nivation hollows;
- about 500 m to SE from the top of Mt. Králický Sněžník, the frost-riven scarp is approx. 20 m high and covered with angular fragments of medium- up to coarse-grained gneiss;
- above the chalet Sněžná chata;
- on the eastern slope of Mt. Klepý (1143.6 m), the frost riven scarp is approx. 10 m high, and
- to the west from the top of Mt. Sušina (1321.2 m).

The cryoplanation terrace is an erosional surface cut into bedrock at the foot of frost-riven cliffs and scarps, or in the surroundings of tors. The majority of geomorphologists agree that cryoplanation terraces are the evidence of occurrence of permafrost at the time of their formation. The cryoplanation terraces occur in the middle and upper sections of slopes, and as mounttop surfaces. Narrow terraces are called nivation benches.

Well developed cryoplanation terraces were mapped in the following places:

- to the south from the top of Mt. Králický Sněžník at the foot of the above mentioned frost-riven cliff,
- some 500 m to SE from the top of Mt. Králický Sněžník at the foot of the above mentioned frost-riven cliff,
- near the chalet Sněžná chata at the foot of the frost-riven scarp;
- at the foot of the tor Kazatelny;
- on the ridge Koňský hřbet (991.1 m);
- on the northern slope of Mt. Klepý (1143.6 m) at the foot of the frost-riven cliff and also on the eastern slope;
- on the Border Ridge, and
- on the northern slope of Mt. Hleďsebe (1119 m).

Very common landforms in the mapped area are dells (see Fig. 2). At some pla-ces, their density is surprisingly high (see geomorphologic map). On topographic maps, the dells give the crenulated appearance to many of the contours. Dells are a typical and important form of the periglacial morphogenetic zone. Today, the dells are main lines of runoff on slopes. There are deposits at their bottoms, often with incised gullies.

Common are also tors and castle-koppies in the mapped area. These features are usually angular, frost shattered rock protuberances bound by two sets of near vertical joints. The tors in the mapped area can be divided into skyline tors of summits and ridges and subskyline tors on slopes. A nice example of the skyline tor can be a rock stack on the ridge Selské vrchy in the turn of a chair lift. The tor is approx. 4 m high. A group of subskyline tors and castle-koppies is situated on the SW slope of Mt. Klepý in a turn of the forest road (see map).

Rocky crests are well developed in the forest tract Kazatelny (two parallel crests), in the forest tract Vlaštovčí kameny and on the Ridge Koňské hřbety (991.1 m a.s.l.).

As an ice age develops, snow patches accumulating at the heads of mountain valleys and in the depressions on slopes began to deepen nivation hollows in the bedrock , first by helping the frequent occurrence of freeze-thaw processes and disintegration of the bedrock, then by turning snow into névé by pressure. The nivation hollows are very common in the studied area. The hollows are filled with blocks and at some places there are block streams running out from the nivation hollows. They are connected with frost-riven cliffs and scarps and with cryoplanation terraces and nivation benches. Even in the present mild humid climate snow accumulates in the nivation hollows, especially above the upper timber line.

4.4.1.2 Accumulation periglacial forms

Talus slopes are the most extensive cryogenic periglacial accumulation form occurring in the mapped area. The talus slopes developed at the foot of high slopes. They are of Quaternary age and the most important process in their formation was congelifluction. Their formation continued in the Holocene. The thickness of scree is up to 30 m. At some places, slope deposits cover pediments forming peripediments.

Frost weathering also produced a surface of broken jagged rocks called the block-field. The block fields consist of angular rock fragments, from about 25 cm to several meters long, with no arrangement. The rock fragments cover more than 50 % of the surface. The block-fields are widespread on slopes of the top of Mt. Králický Sněžník, at the foot of the rocky ridge Vlaštovčí skály, on the slopes of the Morava R. valley, on the western slope of Mt. Uhliska (1240.7 m), on the NW slope of Mt. Slamník, on the slopes of the Prudký potok Brook, on the eastern slope of Mt. Chlum (1115.8 m), on Mt. Klepý (1143.6 m) and on the slopes of the Malá Morava R.

Masses of angular rock rubble streaming down mountainsides form blockstreams on the slopes of the Morava R., on the NW slope of Mt. Slamník, on the slopes of the Malá Morava R. and the Prudký potok Brook. The block streams consist of large, angular blocks and are devoid of vegetation. Their heads are situated mostly in nivation hollows and at the foot of frost-riven cliffs and scarps.

The scree composed of angular rock fragments covers many surfaces of the mapped area. The dimensions of rock fragments vary. Also their thickness differs at different places. At some places scree forms smoothed congelifluction tongues and blockstreams.

Stone polygons are not shown on the map due to its dimensions. St. Chábera (1956) described stone polygons on the summit flat of Mt. Králický Sněžník. While mapping the authors found stone polygons on the summit of Mt. Hleďsebe (1119 m a.s.l.).

4.4.2 The problem of glacial cryogenic forms

During the Pleistocene Ice Ages laid the southern front of the Northeuropean continental glacier in Elster and Saale Glaciation at the northern foot of the Mt. Králický Sněžník. The Pleistocene regional snowline run during this glacials in the Sudety Mts. at the elevation of about 1100 to 1230 m (Králik - Sekyra, 1969). If we accept the hypothesis, that Mt. Králický Sněžník was a high mountain area during the Pleistocene, than the top and main ridges were situated above the regional snowline. An important question is rising than: why erosional glacial forms were not found in the mountain group? Reasons could be as follows:

- there were no mountain glaciers on the top of Mt. Králický Sněžník during the Pleistocene Ice Ages or
- there were cold-based glaciers.

Geomorphologists accepting the first hypothesis mean, that

- the morphological, dome-shaped summit of Mt. Králický Sněžník was not suitable to accumulate the sufficient amount of snow, the area at the altitude above 1200 m representing only 7 square km , basins of cirque-shaped forms in the highest parts of Mt. Králický Sněžník are mostly situated at the elevation from 1000 to 1100 m a.s.l., which means below the regional Pleistocene snowline (Migon in Jahn - Kozlowski - Pulina eds., 1996);
- the ruling cold proglacial climate was very dry.
- Thinking about the hypothese of cold-based Pleistocene glacier or glaciers in Mt. Králický Sněžník, the authors took into the consideration:
- the presence of permafrost in glacial periods of Pleistocene in the studied area;

Fig. 3 Small nivation hollows and blockfield in the top part of Mt. Králický Sněžník. Photo J. Vítek.

- the basal thermal regime being the fundamental control of subglacial erosion, negligible under frozen-bed conditions;
- the finding of deposits in the Prudký potok Brook valley, which can be classified as a glacial complex sediments and/or mudflow sediments;
- the experience of geologists and geomorphologists from Scotland, Sweden and Canada with cold-based glaciers (Dyke, 1993; Ives, 1958; 1974; 1975; Ives et al., 1976; Hall - Melor, 1988; Hall et al., 1989; Kleman, 1994; Kleman - Stroeven, 1997; Lidmar - Bergstrom, 1988; 1998; Lundquist, 1988; 1998; Rea et al., 1996; Sugden - John, 1976; Sugden - Watts, 1977).

4.4.3 Sedimentary sequences in the Prudký potok Valley

The springs of the Prudký potok Brook (called also the Bystřina Bro-ok) are situated in an large amphitheatre among the mountain summits of Mt. Podbělka (1307.4 m a.s.l.), Mt. Milíř (1298.0 m), Mt. Sušina (1321.2 m) and Tetřeví hora (1251.0 m). The Brook empties into the Krupá R. to the south from the village of Staré Město pod Sněžníkem in the Staroměstská kotlina Basin. The upper reaches of the Prudký potok Brook are incised into the fine-grained two-mica gneiss of the Orlické hory - Klodzko Dome. The lower valley part, situated in the Staroměstská kotlina Basin, crosses the strips of mica-schists, amphibolite and gneiss of the Staré Město Serie and the narrow strips of granitoids of Paleozoic age.

The valley of the Brook Prudký potok can be divided into several sectors. As we mentioned above, springs of four collecting channels of the brook are situated on high headwalls of the large amphitheatral basin which is opened downstream to south-east. The arcuate upper edge of the basin runs at the elevation 1200 to 1263 m. The steep headwalls are dissected by gullies. The flat bottom of this amphitheatral basin is situated at elevation 1180 to 1144 m a.s.l. The basin is typically called Mokřina (Wetground). Its bottom is filled with rusty brown loam with numerous angular fragments of gneiss mixed with rounded gravel. The thickness of these deposits is at least 4 m. The flat bottom ends in 4 m high step with a waterfall at the elevation 1144 m a.s.l.

Fig. 4 Frost-riven cliff built of gneiss with talus on Mt. Klepý (Trojmórski Wierch). Photo J. Vítek.

The second sector of the valley is below the step between the altitudes 1144 m and 1090 m a.s.l. The sector is approx. 600 m long. Its cross-section is an open V-shaped valley with the narrow floodplain. This section ends in a waterfall 6 m high.

The third sector is situated between the waterfall at 1090 m a.s.l. and the forest track U srubu (At the blockhouse) at 940 m a.s.l. and is approx. 800 m long. In the longitudinal profile this section is typically non-graded - with a great fall of the stream. The brook flows on the bedrock and there are many waterfalls and rapids on huge blocks. In its cross section the valley shows a narrow V-shaped profile with very steep sides. This sector represents a typical erosion river valley. Floodplain deposits on the valley bottom are drawn by mistake on the geological maps.

The fourth sector of the valley begins at the elevation of 940 m a.s.l. at the forest track U srubu (At the blockhouse) and is approx. 2.6 km long (up to the elevation of 660 m at the Chalet Bystřice). The valley has steep sides (gradient over 35°). The relative height of the right valley side below the Hubert Chalet amounts to 325 m. The left valley slope in the same cross section is 250 m high. In this sector the valley bottom is filled with badly graded deposits often consisting of large angular blocks mixed with loam. The deposits form conspicuous longitudinal convex ridges parallel with the course of the Prudký potok Brook. The longitudinal ridges are rimmed by beds of the Prudký potok Brook and its tributaries. The brook is braided, divides into branches.

In the forest tract U srubu (At the blockhouse), the authors found a large fossil rock slide of two-mica gneiss. In its cross-section the valley exhibits the form of a letter V. The left valley side is about 130 m high and its gradient is approx. 30°. There are block fields without any vegetation on the slope. The right valley slope is approx. 200 m high. There are frost-riven cliffs on the right slope. The valley bottom in the length of about 250 m (from the blockhouse to the bridge) is covered by the chaotic accumulation of blocks of gneiss. Dimensions of blocks are up to 6x5x4 m. The surface of block accumulation is very rough and inclines from the foot of the right valley slope to the left side. The contemporary brook channel dissects the block accumulation. At the foot of the right valley side is dry brook bed (flood channel?). In the chan-nel incision is exposed the thickness of block mixed with rusty brown loam approx. 15 m. The Prudký potok Brook flows over blocks in its bed. On the rough surface of block accumulation there are depressions of about 1.5 m in depth. The voids among the blocks are opened and not filled with loam.

On the left side of the valley the thickness of block field accu-mulation reaches approx. 4 m. The surface of the blockfield is inclined up to 35°.

According to the authors opinion, the headwall of the rockslide is marked by cliffs on the right valley side. The material of the rockslide blocked the valley.

The valley bottom in the sector between the bridge at the end of the rock slide and the chalet Bystřina (approx. 2.4 km long) is covered with badly sorted and/ non-sorted sediments - a mixture of angular blocks, gravel and loam. The thickness of these deposits reaches up to 6 m. The deposits forms longitudinal convex ridges parallel with the course of the Prudký potok Brook. The ridges are rimmed by beds of the Prudký potok Brook and its tributaries. The Brook is braided and divided into branches. The highest ridge situated at the center of the valley bottom was used for a local forest road. The main bed of the Prudký potok Brook changes its course from the foot of the left to the foot of the right valley slope. In some sections, the main bed of the brook crosses the central longitudinal ridge. On the geological maps are drawn alluvial gravels, sands and clays (floodplain deposits) by mistake.

The last, fifths sector is situated in the Staroměstská kotlina Basin. The relative height of valley sides is 50 to 75 m. A floodplain developed at the valley bottom.

4.4.4 Hypothesis of Pleistocene cold-base glacierization of Mt. Králický Sněžník

Authors propose a model, that the Pleistocene cold-based firn fields and glacier or glaciers could have covered the top parts of Mt. Králický Sněžník in some glacials with ice being non-erosive at the ice/bed interface. Especially suitable for snow accumulation were amphitheatrical basins with bottoms situated above the regional Pleistocene snowline (called karoid Lucerna, 1939). In some parts the glacier could have been wet-based flushing out the material, while in other parts cold be cold based and protective to preserve the preglacial surface. The pre-glacial valley of the Prudký potok Brook likely provided a drainage line for melting water.

The proposed hypothesis is backed by the following facts:

i) The springs of the Prudký potok Brook are situated in an amphitheatral basin with steep sides. The bottom of this basin was situated above the regional snowline during Pleistocene glacials. There could be a permanent firn field or a cold based glacier in the glacial/glacials due to the presence of permafrost in cold phases of the Pleistocene in studied area. Also, the top of Mt. Králický Sněžník and the Mokrý hřbet Ridge could have been covered with firn fields and/or cold based glacier/glaciers with ice being non-erosive at the ice/bed interface. It is known from literature (e.g. Rea et al, 1996) that even blockfields and stone polygons were protected by cold-based ice during the periods of glacial coverage.

ii) As early as in 1961, Jeník called attention to the importance of north-western winds for snow accumulation. The fact, that the southeast facing slopes are leeside slopes in areas of prevailing northwestern winds explains why the cirque-shaped glacier and firn fields could have developed in the amphitheatral basin opened towards the southeast. Local wind circulation described by Jeník caused the origin of snow cornices at the edge of amphitheatric basins, avalanches and snow accumulation. It is striking, that the glacial cirques and cirque-shaped basins exhibit the eastern (south-eastern, eastern, north-eastern) exposition (Jeník, 1961). The Prudký potok Brook amphitheatral basin has the exposition to southeast. Local wind streams are directed over the top part of ridges to the upper edge of cirque-shaped hollows. Jeník (1961) observed that the air stream flows into hollows at an extreme speed, at the edge looses from terrain and causes complex turbulent features on the leeside. In winter this phenomenon causes snow accumulation. Snow cornices caused by this effect can be observed in winter in the Sudety Mts. even in the present climate. The snow accumulation in the cirque - like hollows is accelerated by snow avalanches (see Rathsburg, 1932 in the Morava R. Basin).

iii) There is a huge amount of badly sorted and/or non-sorted material in the fourth sector of the valley of the Prudký potok Brook. The material generates conspicuous forms of ridges parallel to the valley axis. These ridge forms and type of material are typical of mud-flows. The experience of huge flood hazard with the 1000-year-flood discharge in 1997 showed, that even so intensive fluvial processes were not able to provoke or change such forms. It would have to be an event of much greater impact in order to generate such a mass of deposits. Therefore, the authors propose to connect the origin of these material and forms with glacierization of Mt. Králický Sněžník, especially with the melting periods of cold-based firn fields and glacier/glaciers in Mt. Králický Sněžník.

4.5 Eolian forms

Eolian forms are less common in the mapped area. Loess-loam deposits were found at the bottom of the Červenopotoční kotlina Basin (loamy slope deposits mixed with eolian dust).

4.6 Gravitational forms

Creep is most common mass-wasting process on steep slopes. Creep manifest itself in a drunken forest. Tree trunk are concave uphill. Creep is also observed on deep and steep cuts of forest roads in colluvium on steep valley sides of the Morava River.

Rock slides occurred on steep and high valley slopes of the Prudký potok Brook. Extensive head walls of root zones of these rock slides are situated on the right valley side.

Slope materials in the mapped area with a high proportion of fine particles are prone to movement by flow. Mud flows were a common feature during the Pleistocene and occur also in the present time. They occur most commonly on steep and high valley slopes covered by scree. Mudflows are reported on valley slopes of the Morava R., the Malá Morava R., the Mlýnský potok Brook, the Prudký potok Brook and also on valley slopes of their short tributaries.

A clearly marked toe of the mudflow was found above the chalet in the valley of the Mlýnský potok Brook. Toes of mudflows which occurred recently were mapped in the spring amphitheater of the Poniklec Brook (left tributary of the Morava R.).

Mudflows on valley bottoms often form prominent ramparts. The water courses then divides into branches which flow either on one side or on both sides of the ramparts at the slope foot, because the valley bottom is domed. This phenomenon can be clearly observed on the bottom of the Prudký potok Brook. The ramparts are composed of non-sorted material - by loam containing huge blocks (many blocks are several meters long).

4.7 Biogenic forms

Small peat bogs developed on rounded ridges and in cols developed e.g. on Mokrý hřbet Ridge, near the Chalet Babuša, etc.).

4.8 Anthropogenic forms

There are many quarries in mapped area. Most of them are abandoned. The largest active quarry is the Mramorový lom Quarry in the village Velká Morava. Many abandoned marble quarries are on the Ridge Na vyhlídce (753.4 m) and on Mt. Roudný (877.1 m).

There are also many sunken roads on fields and in forests.

Above a spoil heap in the valley of the Mlýnský potok Brook is the entrance into the abandoned mine of company Uranium Mines.

Two funnel shaped depressions of unknown origin were found in the valley of the Morava R. above the chalet Vilemínka. The large one has dimensions 10x8 m and is 8 m deep. The small one has a diameter of 2 m. It is not clear, if they are karst dolines or features of old mining.

Numerous agricultural heaps are concentrated in the vicinity of villages Vojtíškov and Sklené. This area has probably the largest density of agricultural heaps in the whole Czech Republic (Gába, 1991). Some agricultural heaps are very noticeable anthropogenic forms in the landscape and contain a large amount of stones collected from fields and meadows. They also appears on contemporary forested slopes.

Miners spoil heaps were found in the valley of the Mlýnský potok Brook (see above) and on Mt. Roudný (877.12 m). A spoil heap is also around the Mramorový lom Quarry.

Hedges between fields are also common antropogenic form. Many of them are composed of rock fragments. They were found among fields, but also in forests. The size of agriculture land was greater in the past.

Modern anthropogenic forms are skiers pistes causing soil erosion and formation of gullies. They often combine with ski lifts.

5. Conclusions

Mt. Králický Sněžník is recently one of the highest mountain groups of the Bohemian Highlands. Its summit rises above the contemporary upper timber line. Detailed geomorphologic mapping indicated that the mountain group shows a complex polygenetic relief. Valley pediments developed along the Morava River and Malá Morava River during late Tertiary. The edge of the lower pediment runs only 20 to 30 m above the floodplain. It means, at first that the incision of both rivers during the Quaternary was only 20 to 30 m and at second that Mt. Králický Sněžník rose as a prominent mountain group above the surrounding lower relief as early as in the Tertiary Period. This fact provoked questions such as like why Mt. Králický Sněžník was not glaciated during the Pleistocene Ice Ages when the front of the continental glacier was situated at the northern foot of Mt. at least during two Glaciations Králický Sněžník. The authors propose a hypothesis of Pleistocene cold-base glacierization of Mt. Králický Sněžník.

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References

BOSÁK, P. (1993a): Nový pohled na vznik krasových jevů Horní Moravy. (New view on origin of karst phenomena in the village Horní Morava.) In Czech. In: J. Řehák ed.: Kras Sudet. Knihovna České speleologické společnosti 24, Praha, p. 55-59.

BOSÁK, P. (1993b): Několik poznámek k vývoji tvarů chodeb ve Tvarožných dírách. (Some Remarks to Development of Forms of Corridors in Cave Tvarožné díry.) In Czech. Kras Sudet. Knihovna České speleologické společnosti 24, Praha, p. 65-66.

BOSÁK, P. et al., eds. (1989): Paleokarst. A Systematic and Regional Review, Elsevier - Academia, Praha - Amsterdam, 725 pp.

BOSÁK, P. - HÝSEK, J. (1993a): Přikrytý kras v Mramorovém lomu: model vývoje. (Covered Karst in Marble Quarry: a model of development.) In Czech. In: Řehák, J. ed.: Kras Sudet. Knihovna České speleologické společnosti 24, Praha, p. 59-64.

BOSÁK, P. - HÝSEK, J. (1993b): Petrologie sedimentů Mramorového lomu a Tvarožných děr. (Petrology of Deposits in Marble Quarry and in Caves Tvarožné díry.) In Czech. In: Řehák, J. ed.: Kras Sudet. Knihovna České speleologické společnosti 24, Praha, p. 67-76.

CIEZKOWSKI, W. - PULINA, M. - ŘEHÁK, J. (1993): Poslední výsled-ky polsko-českých výzkumů v oblasti Králického Sněžníku. (The Newest Results of Polish-Czech Research on the Territory of Mt. Králický Sněžník.) In Czech. In: Řehák, J. ed.: Kras Sudet. Knihovna České speleologické společnosti 24, Praha, p. 34-42.

CIEZKOWSKI, M. - MADĚRA, E. (1985): Wyniki badan znacznikowych nad podziemnymi przeplywami wód krasowych Masywu Snieznika. (Results of Color Experiments of Karst Ground Waters on Mt. Králický Sněžník.) In Polish. Przeglad geologiczny 10, Warszawa.

DEMEK, J. et al. (1965): Geomorfologie Českých zemí. (Geomorphology of Bohemian Lands.) In Czech. NČSAV, Praha, 335 pp.

DEMEK, J. et al. (1987): Zeměpisný lexikon ČSR. Hory a nížiny. (Geographical Lexicon of Czech Republic. Mountains and Lowlands.) In Czech. Academia, Praha, 584 pp.

DEMEK, J. - KOPECKÝ, J. (1997): Geomorfologické poměry Králického Sněžníku (Česká republika). (Geomorphology of Mt. Králický Sněžník, Czech Republic.) In Czech. In: Mečiar, J. - Pavlů, R. eds. Geografie VIII. Katedra geografie Pedagogické fakulty Masarykovy University v Brně, Brno, p. 7-30.

DEMEK, J. - MADĚRA, E. (1982): Symposium o krasu Sudetské soustavy v Králíkách 1981. (Symposium on karst of the Sudetic System in the town of Králíky 1981.) In Czech. Sborník České geografické společnosti 87(1), Praha, p. 72-73.

DEMEK, J. - NOVÁK, V. eds. (1992): Vlastivěda Moravská, Země a lid, nová řada, Sv. 1, Neživá příroda, (Home study of Moravia. Land and People. New Row, Vol. 1, Abiotic Nature). In Czech. Muzejní a vlastivědná společnost v Brně, Brno, 242 pp.

DON, J. (1989): Jaskinia Niedzwiedza na tle ewolucji geologicznej Masywu Snieznika. In: Jaskinia Niedzwiedzia w Kletnie. Badania i udostepnienie. (Bear Cave on the Base of Geological Development of Mt. Králický Sněžník. Research and opening of a show cave). In Polish. Ossolineum. Wroclaw, p. 58-79.

DON, J. - DUMICZ, M. - WOJCIECHOWSKA, J. - ZELAZNIEWICZ, A. (1990): Lithology and tectonics of the Orlice - Sneznik Dome, Sudetes - Recent State of Knowledge. Studies in Geology of the Sudetes. - Neues Jahrbuch für Geologie und Paläontologie., Abhandlungen 179 (2-3), p. 159-188.

DYKE, A. S. (1993): Landscapes of cold - centered Late Wisconsin ice caps, Arctic Canada. Progress in Physical Geography 17, p. 223-247.

GÁBA, Zd. et al. (1991): Jeseníky. (Jeseníky Mts.) In Czech. Turistický průvodce Československé Socialistické Federativní Republiky (ČSFR), 39, 1, Olympia, Praha, 348 pp.

GÁBA, Zd. - GÁBA, Zd. jun. (1997): Povodeň z července 1997 jako přírodní jev. (Flood in July 1997 as a natural phenomenon). In Czech. Vlastivědný sborník Severní Morava 74, Okresní vlastivědné muzeum v Šumperku, Šumperk, p. 3-30.

GAWLIKOWSKA, E. - OPLETAL, M. eds. (1997): Králický Sněžník. Geologická mapa pro turisty. (Snieznik Area. Geological Map for Tourists.) Panstwowy Instytut Geologiczny - Český geologický ústav, Warszawa - Praha.

HARAZIM, S. - PACLTOVÁ, B. - POUBA, Z. (1981): Organické zbytky v krystaliniku silezika a východního lugika. (Organic Remnants in the Crystalline of Silesicum and Eastern Lugicum.) In Czech. Sborník konference. Korelace proterozoických a paleozoických stratiformních lo-žisek. Přírodovědecká fakulta Univerzity Karlovy Praha, p. 224-247.

HOLLUTA, J. (1929): Über radioaktive Quellen in den Sude-ten. (About Radioactive Springs in the Sudety Mts.) In German. Wissenschaft und Wirtschaft 1929, Praha, p. 105-159.

CHÁBERA, S. (1956): Kamenné moře na jižní straně vrcholové části Králického Sněžníku. (Stone Field on the Southern Top Side of Mt. Králický Sněžník). In Czech. Přírodovědný sborník Ostravského kraje, 17, Opava, p. 412-415.

IVES, I. D. (1974): Biological Refugees and the Nunatak Hypothesis. In: Ives, I. D. - Barry, R. G. eds.: Arctic and Alpine Environments. Methuen, London, p. 604-636.

IVES, I. D. (1975): Delimitation of surface weathering zones in eastern Baffin Island, Northern Labrador and Arctic Norway: A discussion. Geol. Society of America Bulletin 86, p. 1096-1100.

JAHN, A. - KOZLOWSKI, S. - PULINA, M. eds. (1996): Masyw Snieznika, zmiany w srodowisku przyrodniczym. (Masyw Snieznika - changes in natural environment.) In Polish. Polska Agencja Ekologiczna S. A. Wydawnictwa PAE, Warszawa, 320 pp.

JENÍK, J. (1961): Alpinská vegetace Krkonoš, Králického Sněžníku a Hrubého Jeseníku. (Alpine Vegetation of the Krkonoše Mts., Mt. Králický Sněžník and the Hrubý Jeseník Mts.) In Czech. Nakladatelství Československé akademie věd, Praha, 409 pp.

KLEMAN, J. - STROEVEN, A. P. (1997): Preglacial surface remnants and Quaternary glacial regimes in Northwestern Sweden. Geomorphology 19 (1-2), Amsterdam, p. 35-54.

KLEMENT, P. (1928): Morphologische Untersuchungen im Altvatergebirge. (Morphological Research in the Hrubý Jeseník Mts.) In German. Firgenwald 1, Liberec, p. 25-51.

KLIMASZEWSKI, M. ed. (1972): Geomorfologia Polski. Tom 1 Polska Poludniowa Góry i Wyzyny. (Geomorphology of Poland. Vol. 1, Southern Poland Mts. and Highlands.) In Polish. PWN, Warszawa, 385 pp.

KOČANDRLE, J. (1983): Vysvětlivky ke geologickým mapám 1:25 000, 14-231 Horní Morava, 14-232 Staré Město, 14-233 Králíky, 14-234 Hanušovice. (Explanation to Geological Maps 1:25 000.) In Czech. Manuskript. Archiv Ústředního ústavu geologického, Praha, 81 pp.

KOČANDRLE, J. - OPLETAL, M. (1985): Srovnání jaderných jednotek východního a západního křídla orlicko-kladské klenby. (Comparison of Core Units of Eastern and Western Part of Orlice-Klodzko Dome). In Czech. Sborník geologických věd, geologie, 40, Ústřední ústav geologický, Praha, p. 63-99.

KONEČNÁ, J. (1993): Předběžné zhodnocení hydrochemického průzkumu v krasu Králického Sněžníku. (Preliminary Evaluation of Hydrochemical Research in the Karst of Mt. Králický Sněžník.) In Czech. Kras Sudet. Knihovna České speleologické společnosti 24, Praha, p. 42-46.

KRÁL, V. (1957): Krasové jevy ve východosudetské oblasti. (Karst Phenomena in the Eastern Sudety Mts.) In Czech. Československý kras 10, Praha, p. 84-86.

KRÁL, V. (1958): Kras a jeskyně východních Sudet. (Karst and Caves of Eastern Sudety Mts.) In Czech. Acta Universitatis Carolinae. Geologica 2, Praha, p. 105-159.

KRAWCZYK, W. E. (1993): Wlasnosci fizykochemiczne wód doliny Klesnicy i Moravy. Kras Sudet. (Physico-chemical Properties of Water in the Klesnice and Morava River Valleys). In Polish. Knihovna České speleologické společnosti 24, Praha, p. 46-55.

KRUTSKÝ, N. (1980): Ložiska mramoru v oblasti Králického Sněžníku. (Marble Deposits in area of Mt. Králický Sněžník.) In Czech. Časopis pro mineralogii a geologii. 25 (3), Praha, p. 329-330,

KŘÍŽ, H. (1976): Hydrologické a klimatologické hodnocení podzemních vod ČSR. (Hydrological and Climatological Evaluation of Ground Waters in Czech Socialist Republic.) In Czech. Studie ČSAV 1, Praha, 107 pp.

KUČERA, B. - HROMAS, J. - SKŘIVÁNEK, Fr. (1981): Jeskyně a propasti v Československu. (Caves and Abysses in Czechoslovakia.) In Czech. Academia, Praha, 252 pp.

LIDMAR - BERGSTRÖM, K. (1988): Preglacial weathering and landform evolution in Fennoscandia. Geografiska. Annaler 70A, Stockholm, p. 273-276.

LUCERNA, R. (1939): Kar am Keilberg. Firgenwald, 12, Liberec, p. 30-43.

LUNDQVIST, J. (1988): The Revsund area, Central Jämtland - an example of preglacial weathering and landscape formation. Geografiska. Annaler 70A, Stockholm, p. 291-298.

MADĚRA, E. (1971): Dosavadní stav výzkumu krasových útvarů v masívu Králického Sněžníku. (Present State of Karst Research of Mt. Králický Sněžník.) In Czech. Krasový sborník 4, Tis, Svaz pro ochranu přírody, Krasová sekce, Praha, p. 31-40.

MADĚRA, E. (1974): Kras a jeskyně pod Králickým Sněžníkem. (Karst and Caves under Mt. Králický Sněžník.) In Czech. Vlastivědný sborník 27, Okresní muzeum v Šumperku, Šumperk.

MADĚRA, E. (1979): Krasové jevy Králického Sněžníku. (Karst Phenomena of Mt. Králický Sněžník.) In Czech. Práce a studie, Ochrana přírody a krajiny, 11, Krajské středisko státní památkové péče a ochrany přírody (KSSPPOP), Pardubice, p. 29-52.

MADĚRA, E. (1980): Zpráva o výzkumu krasových jevů v masívu Králického Sněžníku v roce 1970. (Report about Research of Karst Phenomena of Mt. Králický Sněžník in the year 1970). In Czech. Zpravodaj jeskyňářského od-dílu OT TJ Zbrojovka Brno, 1979, 4, Brno, p. 5-13.

MADĚRA, E. (1982): Nové poznatky o krasu masívu Králického Sněžníku. (New Data about Karst of Mt. Králický Sněžník.) In Czech. Práce a studie - Ochrana přírody a krajiny, 13-14, Krajské středisko státní památkové péče a ochrany přírody (KSSPPOP), Par-dubice, p. 15-30.

MADĚRA, E. (1984): Výsledky hydrologických a klimatologic-kých pozorování v krasu Králického Sněžníku. (Results of Hydrological and Climatological Observations in the Karst of Mt. Králický Sněžník.) In Czech. Československý kras 35, Praha, p. 37-45.

MADĚRA, E. (1986): Výzkum krasu Králického Sněžníku v letech 1981-1983. (Research of the Karst of Mt. Králický Sněžník in years 1981-1983.) In Czech. Československý kras 37, Praha, p. 33-43.

MADĚRA, E. - CIEZKOWSKI, W. (1985): Nové poznatky o cirku-laci krasových vod v masívu Králického Sněžníku. (New Data about Circulation of Karst Water in Mt. Králický Sněžník.) In Czech. Geologický průzkum, 27 (4), Praha, p. 116-117.

MARTINI, A. (1979): Peryglacjalny charakter wierzchowiny masywu Snieznika Klodzkiego. Problemy. (Periglacial Character of the Top Part of Mt. Králický Sněžník. Problems.) In Polish. Zagospodarowania Ziem Górskich 20, Warszawa, p. 203-217.

MELZER, M. - SCHULZ, J. (1993): Vlastivěda Šumperského okresu. (Home study of Šumperk District). Okresní úřad a Okresní vlastivědné muzeum Šumperk, Šumperk, 585 pp.

MIGON, P. (1996): Zarys rozwoju geomorfologicznego Masywu Snieznika. (Draft of Geomorphologic Development of Mt. Králický Sněžník.) In Polish. In: Jahn, A. - Kozlowski, S. - Pulina, M. eds. (1996): Masyw Snieznika, zmiany w srodowisku przyrodniczym. Polska Agencja Ekologiczna S. A. Wydawnictwa PAE, Warszawa, p. 37-45.

MÍSAŘ, Z. et al. (1983): Geologie ČSSR I. Český masív. (Geology of Czechoslovak Socialist Republic I. Bohemian Massif.) In Czech. SPN Praha, 333 pp.

OPLETAL, M. ed. (1992): Geologická mapa ČR 1:50 000, list Králíky 14-23. (State Geological Map of Czech Republic 1:50 000, sheet Králíky 14-23.) Český geologický ústav, Praha.

OUHRABKA, V. (1992): Hydrogeologie krystalických vápenců v horním povodí Moravy pod Králickým Sněžníkem. (Hydrogeology of Marbles in Upper Reaches of the Morava River on the territory of Králický Sněžník.) In Czech. Přírodovědecká fakulta Univerzity Karlovy, katedra hydrogeologie a inženýrské geologie, diplomová práce, Praha, 82 pp.

PANOŠ, Vl. (1955): Jeskyně Severomoravského krasu. (Caves of Northern Moravian Karst.) In Czech. Státní technické nakladatelství (STN), Praha, 150 pp.

PANOŠ, Vl. (1962): Krasová hydrografie malých vápencových oblastí na severní Moravě a ve Slezsku. (Karst Hydrography of small Limestone Areas of Northern Moravia and Silesia.) In Czech. Československý kras 13, Nakladatelství ČSAV, Praha, p. 67-88.

PAUK, F. (1948): Zpráva o mapování krystalinika v Orlických horách a na Králickém Sněžníku. (list generální mapy Vysoké Mýto). (Report on Mapping of Crystalline Rocks in the Orlické hory Mts. and Mt. Králický Sněžník.) In Czech. Věstník Státního geologického ústavu, 23, Praha, p. 155-160.

PAUK, F. (1949): Zpráva o přehledném mapování krystalinika v Orlických horách a na Králickém Sněžníku (list gen. mapy Vysoké Mýto 4050). (Report on General Mapping of Crystalline Rocks in the Orlické hory Mts. and Mt. Králický Sněžník.) In Czech. Věstník Státního geologického ústavu, 24 (2-3), Praha, p. 138-141.

PAUK, F. (1953): Poznámky ke geologii Orlických hor a Králického Sněžníku. (Remarks to Geology of the Orlické hory Mts. and Mt. Králický Sněžník.) In Czech. Věstník Ústředního ústavu geologického 28/1953, Praha, p. 193-212.

PAUK, F. (1959): Zpráva o geologickém mapování v Orlických horách a ve skupině Králického Sněžníku. (Report on Geological Mapping in the Orlické hory Mts. and in the Mountain Group Králický Sněžník.) Zprávy o geologických výzkumech v roce 1957, Ústřední ústav geologický, Praha, p. 177-179.

PAUK, F. (1979): Stavba krystalinika orlicko-kladské klenby. (Composition of crystalline rocks of the Orlice-Kladsko Dome.) Časopis pro mineralogii a geologii 24 (4), Praha, p. 363-370.

PAX, F. - MASCHKE, K. (1935): Die Höhlenfauna des Glatzer Schneeberges. In German. Beiträge zur. Biologie des Glatzer Schneeberges 1935 (1), Breslau, p. 4-135.

PROSOVÁ, M. (1954): Studie o periglaciálních zjevech v Hrubém Jeseníku. (Study of Periglacial Phenomena in the Hrubý Jeseník Mts.) In Czech. Přírodovědecký sborník Ostravského kraje XV (1), Opava, p. 1-15.

PROSOVÁ, M. (1961): Recentní regelace v horských oblastech Českého masívu. (Present-day Regelation in Mountain Areas of the Bohemian Massif.) In Czech. Přírodovědný časopis slezský, 22, Opava, p. 217-222.

PROSOVÁ, M. (1963): Periglacial Modeling of the Sudetes Mts. Sborník geologických věd, Série A (Antropozoikum), 1, Praha, p. 51-62.

PROSOVÁ, M. (1973): Zalednění Hrubého Jeseníku. (Glaciation of the Hrubý Jeseník Mts.) In Czech. Campanula 1973, Ostrava, p. 115-123.

PROSOVÁ, M. (1981-published 1983): Oscilační zóna kontinentálního ledovce. Jesenická oblast. (Oscillation Zone of theContinental Glacier. The Jeseníky Mts. Area.) In Czech. Acta Universitatis Carolinae, Geologica, 3, Praha, p. 265-294.

PULINA, M. (1977): Zjawiska krasowe v Sudetach polskich. (Karst Phenomena in the Polish Sudety Mts.) In Polish. Dokumentacja geograficzna 2-3, Warszawa.

RATHSBURG, A. (1932-1935): Die Gletscher der Eiszeit in den höheren deutschen Mittelgebirgen. In German. Firgenwald, Liberec, 5, p. 5-29, p. 65-77, p. 103-113; 6, p. 96-112, p. 126-27; 7, p. 39-42, p. 77-107, p. 148-158; 8, p. 67-83.

REA, B. R. et al. (1996): Blockfields, old or new? Evidence and implications from some plateaus in northern Norway. Geomorphology 15 (2), Amsterdam, p. 109-121.

ŘEHÁK, J. - BRAUN, J. - MILKA, D. (1987): Výzkum krasu Králického Sněžníku. (Research of the Karst of Mt. Králický Sněžník.) In Czech. III. symposium o krasu krkonošsko-jesenické soustavy. Sborník referátů. Česká speleologická společnost, Praha, p. 66-71.

ŘEHÁK, J. (1993): Kras v údolí řek Moravy pod Králickým Sněžníkem. (Karst in the Valley of the Morava R. in Mt. Králický Sněžník.) In Czech. Manuskript. 21 pp.

SCHÖN, H. (1928): Über die morphologischen Verhältnisse in der Gruppe des Hohen Schneeberges. (About Morphological Conditions in the Mountain Group Králický Sněžník). In German. Firgenwald 1, Liberec, p. 93-104.

SKALICKÝ, J. (1987): Geochemická charakteristika řečištních sedimentů ve skupině Králického Sněžníku. (Geochemical Characteristics of River Bed Sediments in the Mountain Group Králický Sněžník). In Czech. Geologický průzkum, 29 (6), Praha, p. 179-182.

SUGDEN, D. E. - JOHN, B. S. (1976): Glaciers and Landscape. Edward Arnold, London, 376 pp.

SUGDEN, D. E. - WATTS, S. H. (1977): Tors, felsenmeer, and glaciations in Northern Cumberland Peninsula, Baffin Island. Canadian Journal of Earth Sciences 14, Ottawa, p. 2817-2823.

SVOBODA, J. et al. (1966): Regional Geology of Czechoslovakia. Part I. The Bohemian Massif. The Geological Survey of Czechoslovakia. Nakladatelství ČSAV, Prague, 668 pp.

SVOBODA, J - CHALOUPSKÝ, J. et al. (1961): Vysvětlivky k přehledné geologické mapě ČSSR 1:200 000, M-33-XVII Náchod. (Explanations to General Geological Map of Czechoslovak Socialist Republic 1:200 000, sheet M-33-XVII Náchod). In Czech. Ústřední ústav geologický v Nakladatelství ČSAV, Praha, 185 pp.

ŠROBÁNEK, Fr. et al. (1964): Hrubý Jeseník. (The Hrubý Jeseník Mts.) In Czech. Turistický průvodce Československé socialistické republiky (ČSSR), 27, Sportovní a turistické nakladatelství, Praha, p. 1-222.

ŠTELCL, O. - VLČEK, Vl. - PANOVSKÝ, K. (1976): Intenzita koroze různých typů karbonátových hornin v ČSR. (Intensity of Corrosion of Different Types of Carbonate Rocks in Czech Socialist Republic.) Československý kras 28, Praha, p. 29-48.

TILLER, V. (1977): Zkušenosti z hlubinného vrtání ložiska grafitu v oblasti Králického Sněžníku. (Experience of deep-borings of Graphite in the Mountain Group Králický Sněžník). In Czech. Geologický průzkum, 19 (2), p. 51-52.

TRACZYK, A. (1994): Formy i osady peryglacjalne w Masywie Snieznika Klodzkiego. (Periglacial Deposits and Forms in Mt. Králický Sněžník). In Polish. Acta Uniw Wratislav. Práce Geograficzne, Seria A, Wroclaw.

Turistická mapa Klubu Českých turistů 53 Králický Sněžník 1:50 000, Klub Českých turistů - Vojenský kartografický ústav š.p., Harmanec, Praha, vydání 1994-97.

VÍTEK, J. (1970): Krasové dutiny v Mramorovém lomu u Horní Moravy. (Karst Hollows in the Marble Quarry near the village of Horní Morava). In Czech. Listy Orlického Muzea 5 (1), Choceň, p. 70-74.

VÍTEK, J. (1975a): Patzeltova jeskyně pod Králickým Sněžníkem. (Patzelt Cave in Mt. Králický Sněžník). In Czech. Ochranářský Průzkum. Příloha Časopisu. Ochrana Přírody. Praha, 30 (4), p. 16.

VÍTEK, J. (1975b): Kryogenní tvary v Orlických horách. (Cryogenic Forms in the Orlické hory Mts.) In Czech. Sborník České geografické společnosti, 80, Praha, p. 184-192.

VÍTEK, J. (1995): Kryogenní tvary na Králickém Sněžníku. (Cryogenic Forms on Mt. Králický Sněžník .) In Czech. Věstník Českého geologického ústavu, 70 (1), p. 49-56.

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CHANGES IN THE LONGITUDINAL AND TRANSVERSAL SECTIONS OF THE LOESS COVER AT MODŘICE NEAR BRNO

Rudolf MUSIL

Dedicated to the memory of the first specialist dealing systematically with the study of loess deposits and their stratigraphy in Czechoslovakia, Prof. RNDr. Ing. Josef Pelíšek, DrSc. (1909-1993), from whose birth ninety years will elapse in 1999.

Abstract

In studying the loess deposits stratigraphic conclusions are drawn from the present beds of loesses and fossil soils so as if the described section expressed all climatic oscillations of the given time. It is often forgotten that the described section need not at all be complete, that in the longitudinal and the transversal directions of the loess drift considerably great changes can occur, not to speak of sedimentation hiatuses and that the inclusion of beds present at that time into the employed stratigraphic scheme can be erroneous. A document thereof is the exposition of the brickworks at Modřice, several km south of Brno (Moravia, Czech Republic). The brickworks at Modřice is one of the few loess expositions, if not the only one in this country, at which it is possible to document changes both in the fossil soil horizons and in the loess beds, and in their number, as they were recorded by J. Pelíšek in the years 1941-1967. The brickworks is founded in the loess wreath and the respective changes were documented on the one hand in the face haulage wall, i.e. in the direction into the slope (transversal sections through the loess cover), on the other hand perpendicular to this direction (the northern and the southern walls of the brickworks in W-E direction, i.e. the longitudinal sections through the cover). This paper is above all based on the rich documentation of the late Prof. J. Pelíšek which is now kept in the archives of the Mendel University of Agriculture and Forestry in Brno. The long-term documentation of the loess exposition at Modřice shows how deceitful the stratigraphic evaluation can be for only a short space of time. The number and a different development of beds of soil horizon as well as the imperceptible coalescence of time different layers of loesses into one bed need not be any exception also at other expositions.

Shrnutí

Při studiu sprašových profilů jsou z přítomnosti vrstev spraší a fosilních půd vyvozovány stratigrafické závěry, tak jakoby popisovaný profil zachycoval všechny klimatické oscilace. Zapomíná se na to, že popisovaný profil nemusí být vůbec úplný, že v podélném a příčném směru sprašové závěje se mohou vyskytovat poměrně velké změny, nemluvě o sedimentačních hiátech, a že tedy zařazování v té době přítomných vrstev do používaného stratigrafického schématu může být proto mylné. Příkladem je odkryv cihelny v Modřicích, několik km jižně od Brna (Morava, Česká republika). Cihelna v Modřicích je jedním z mála sprašových odkryvů, ne-li u nás pouze jediný, na kterém můžeme dokumentovat jak změny ve fosilních půdních horizontech a ve sprašových vrstvách, tak i v jejich počtu, tak jak byly zaznamenány J. Pelíškem v letech 1941-1967. Cihelna je založena ve sprašové závěji a dotyčné změny byly dokumentovány jednak v čelní těžební stěně, tj. směrem do svahu (příčné profily sprašovou závějí), jednak kolmo na tento směr (severní a jižní stěny cihelny směru Z-V, tedy podélné profily závějí). Tato práce vychází především z bohaté dokumentace zemřelého prof. J. Pelíška, která je dnes uložena jako osobní pozůstalost v archivu Mendelovy zemědělské a lesnické univerzity v Brně. Dlouhodobá dokumentace sprašového odkryvu v Modřicích ukazuje, jak může být ošidné stratigrafické hodnocení pouze z krátkého časového úseku. Počet a různý vývoj vrstev půdních horizontů a rovněž tak i neznatelné splývání časově různých poloh spraší do jedné vrstvy nemusí být i na jiných odkryvech žádnou výjimkou.

Key words: Brickworks Modřice, Upper Pleistocene, changes in stratigraphy in the loess cover in the longitudinal and transversal directions of sedimentation.

1. Introduction

The brickworks at Modřice is one of the typical loess expositions, probably the only one in this country, at which it is possible, thanks to the preserved drawings and notes of Prof. Josef Pelíšek, to document changes in the development of beds in the course of the last 60 years. The employed documentation consists on the one hand of original drawings of sections and of the description of the individual beds carried out in the field,

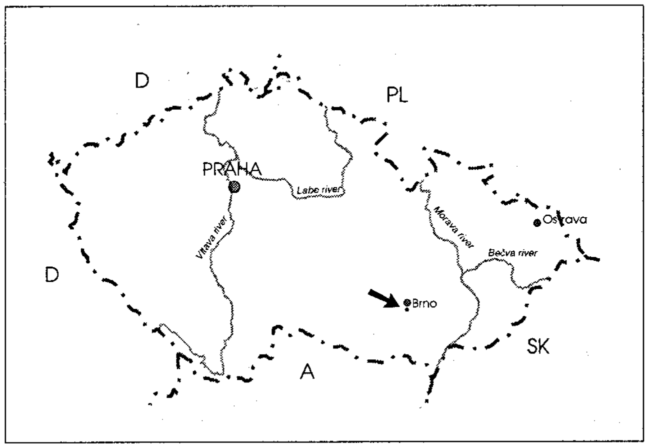

Fig. 1 Topographic position of the locality

and those are the most important from our point of view, and on the other hand of the generalising sections made after a long period of field work, which generalise all information gained in the field for a long time. In some sections made in the field the description of beds is missing and in that case it is possible to deduce from them only the course and number of soil horizons and their colour intensity, colourless horizons being evidently loess beds. The value of the employed base material is thus rather different.

The long-term documentation of the loess exposition at Modřice shows how deceitful can the definitive stratigraphic evaluation be for only a short space of time. The number and development of the individual loess horizons of fossil soils as well as the coalescence of the individual time different beds need not be an exception also at other localities.

In the present paper I tried to utilise above all markedly developed and always repeated horizons, using them for mutual correlation in the whole period of time as leading. I mark the loess layers and the basal bed of gravels by capital letters of the alphabet (A-H, from the bottom to the top, the same letters marking the same bed in time). Fossil soils are then marked by Arabic numbers (1-10) in the same way as the loess beds. Besides the sections of individual years I add a summary profile based on the whole long-term documentation which unlike the individual years, shows all beds on the given exposition. It is, of course, a reconstruction, the section in that completeness never existed, and it indicates the insufficiency of the short-time stratigraphic study of loess localities.

I thank warmly the head of the Archives of Mendel University of Agriculture and Forestry, PhDr. Alena Mikovcová, for a possibility to enter all documentary materials and also for a possibility of using some documentation from the personal inheritance after Prof. Pelíšek.

2. Documentation of the group of loess beds

2.1 The year 1940

The ever earliest and documented expressed paper is that of 1940 (Pelíšek, 1940). It expresses a relatively simple section and gives a brief description evidently affected by the state of the knowledge of that time.

10 Holocene (50 cm).
H, G Loess (410 cm).
6? Brownish soil of loess character, considerably sandy. It is probable that it is a bed that later always overlap the upper soil complex and later was denoted as sandy loam (40 cm).
? The soil horizon of chocolate brown colour (chernozem) (30 cm).
? Horizon of rustyish colour. Pelíšek describes it as a degradation horizon of superposed chernozem (50 cm).
? Loess of ochre yellow colour (520 cm).
? Chernozem of dark chocolate brown colour, according to Pelíšek with long humus infiltrations into the underlying bed. From the descriptions of other years it follows that they were frost wedges (120 cm).

It is probable that we have here two soil complexes later developed in a complicated way and divided by loess. At that time, the upper soil complex was still separated from Holocene soils by a single mighty loess bed, later horizons of brown soil had not been developed. The loess between the two soil complexes was immensely thick and the more it proceeded into the slope, the more it thickness diminished (from five to one metre).

A bed of loess of brownish colour (40 cm).
A Fluvial gravels and sands.

The development of the loess section of that year is different from further years and thus it is difficult to correlate the individual beds with future sections.

2.2 The year 1949

A further description of the loess series at Modřice dates back to the year 1949 (11 Aug. 1949). Available is on the one hand Pelíšek's publication (1949), on the other hand the original description of the northern wall, i.e. the section W-E. Our record comes from the original description of the field confronted with the original drawn section.

10 Holocene.
H Ochre yellow loess (330 cm).
9 Brown loess loam with a slow transition into the underlying stratum (30 cm). The graded transition shows that it is an indigenous and/or para-indigenous bed.
G Ochre yellow loess weakly-bedded (100 cm).

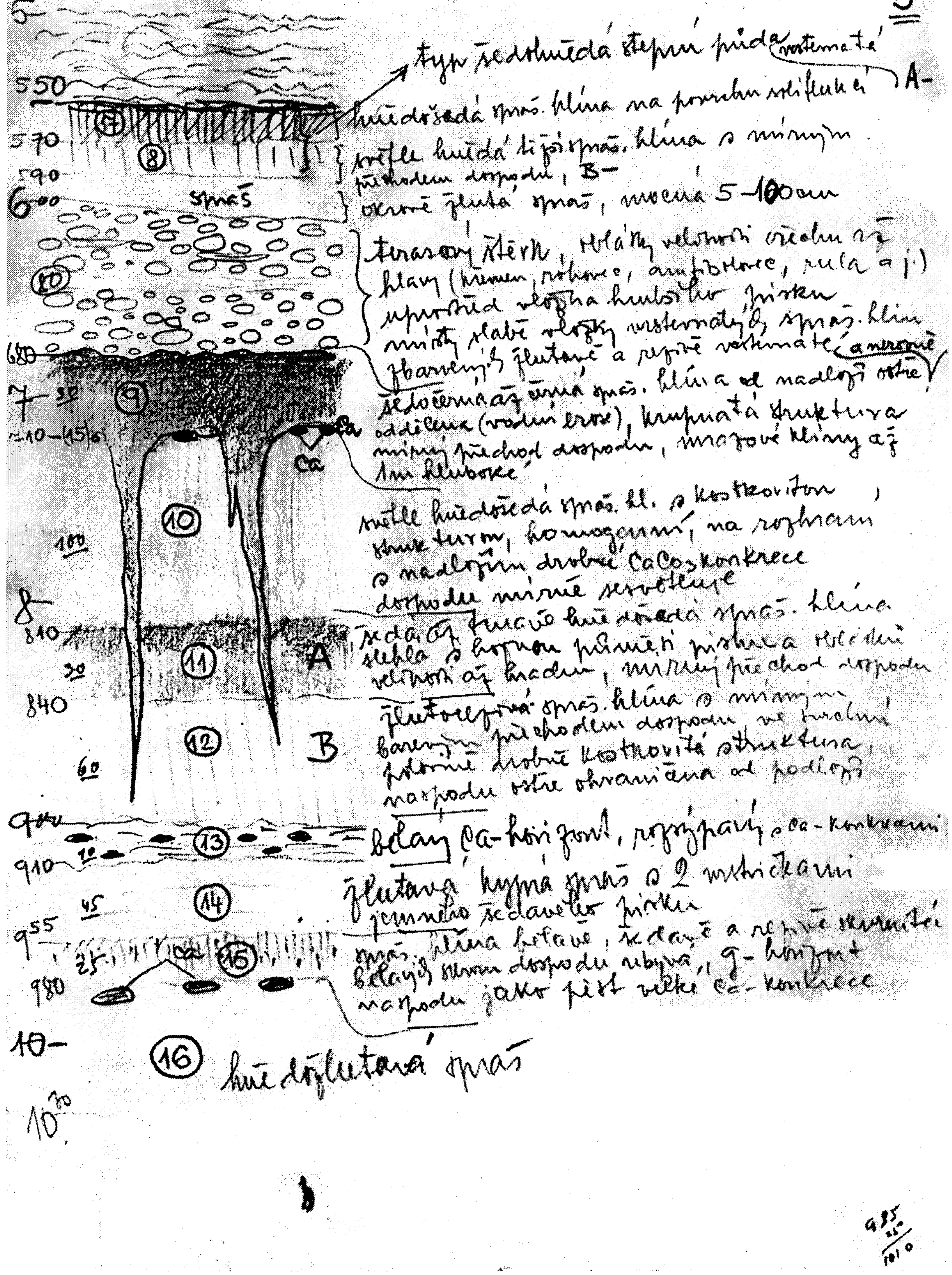

Fig. 2 The exposure of the brickworks at Modřice.. Original drawing by J. Pelíšek illustrating the method of his work (only depths 5-10.30 m, without roof and bottom) evidently made on the basis of a sketch from the field at the institute. This was evidently a summary of information from several sketches. Very well perceptible in it are long frost wedges penetrating from the bed of dark soil into the basement (according to the drawing length of about 180 cm). On the top of the dark soil there is a thick bed of gravels shifted by solifluction from the higher situated Tuřany terrace.

?+8 Yellow loess strongly bedded, yellow and brown coloured lamina alternating. Into the loess bed a layer of brown soil is evidently displaced by solifluction (70 cm).

7? Browngrey loess loam, upper part bedded (solifluction). The lower part is homogeneous (20 cm) with a graded junction into the substrate (into light brown loess loam).

F?, E? Loess of ochre yellow colour, of different thickness (100 cm). At the base there are fluvial gravels (80 cm), the pebbles are of walnut to head size (quartz, chert, hornblendite, gneiss, etc.). There are sporadic intercalations of bedded loess loams in the gravels and roughly in the centre there is a layer of rough sand. These are sediments displaced along the slope by solifluction from the upper part of the hill where, as it is known today, there are gravels of the Tuřany terrace.

5b Black loess loam sharply separated by erosion from the overlying bed (30 cm). It passes gradually to the substrate. Ca-horizon in the subsoil. Frost wedges up to 1 m long.

? Loess of browngrey colour (100 cm).

6? Browngrey loess loam with ample admixture of sand and pebbles of the size of pea, a graded junction to the substrate (later labelling as sandy loam?). Frost wedges penetrate through the bed from the overlaying black loess loam bed.

1 Yellowrusty loess loam of cubic structure with a graded junction into the bottom (60 cm), below it there is a Ca-horizon. Later the bed was labelled by No. 1 as para-brownearth. The above succession of the individual strata does not at all correspond to the later and in more detail developed complexes. It is most probable that there was a shift there by solifluction of the individual layers, so that the succession of strata need not fully correspond to reality. Such displacements due to solifluction are nothing extraordinary at that exposure.

C Yellowish loess with two lamina of fine grey sand (45 cm).

B Loess loam greyish and rusty spotted, at the base there are Ca-nodules of the size of a human fist (25 cm). From the drawn section inside the bed a layer of fluvial gravels and sands is perceptible.
Brownyellow loess (50 cm). This sediment is mentioned only once, only in the present description. In all further descriptions gleyified loess constitutes a basal position.

Thick fluvial gravels (4-5 m) lie under the gleyified loess and they continue the underlying calcareous clay (tegl); Pelíšek describes them as the Svratka fill terrace, later they were denoted as the Modřice terrace. As for the boulder bed overlying the layer B, he believes that it arose by the gradual lifting of the river channel. Now we know, and Pelíšek also came to the conclusion later, that all Pleistocene sediments lie on a relatively steep slope constituted by calcareous clay and therefore extensive solifluctions took place there as well as slides of whole blocks. Due to the fact that at the given locality there are also higher situated gravels of the Tuřany terrace, their secondary presence at the base of the exposure cannot be excluded. Big and thick lenticles of gravels of the Tuřany terrace could also be found in the loess exposition overlying the above Modřice terrace. Today it is thus certain that it also concerns the gravel layer in bed B and some overlying beds and a similar process cannot be excluded in basal gravels overlying the calcareous clay. A section thus developed was found only in the northern wall of the brickworks. The southern wall, only a few tens of meters apart from the northern one, developed in a quite differential. After the sedimentation of the soil horizon with frost wedges there is a great denudation of all beds in the part nearer to the valley. In the filling of the denudation area there appear a great number of lenticles of fluvial gravels of different thickness originating from the higher situated Tuřany terrace.

In the original description Pelíšek notes that "the intercalations of terrace gravels are either of fluvial origin or they are sheet erosions of river terraces. In the former case it would always mean a downcast of loesses below the level of the river (11 Aug. 1949). The surface of the brickworks has the height of 211 m, the base 201 m, the thickness of gravels is 4 m, so that their base is at the height of 197 m. The base of the terrace is thus 2-3 m below the surface of today's alluvial flat (the height 195 m, the thickness of alluvium 4 m). The gravels were also found above the soil with long frost wedges. From the gleyified bedded loess (B) below the black coloured soil there also came a stone artefact. (11 Aug. 1949, a pencil drawing from the field). From the conception it seems as if the existence of the river terrace were not quite clear to Pelíšek at that time.

Apparently of that year (the year is, unfortunately, not indicated) is the following section (Pelíšek, MS).

10 Holocene.

H Loess.

9 Soilforming process, immature brown steppe soil.

8 Solifluction position in the left part of the section, in the right one the layer of gravels ("a solifluctional stream of pebbles from the adjacent slope").

7 Brown steppe soil.
Grey steppe soil.

E Loess, on the base gravels ("solifluction stream from higher altitudes. It is not a river terrace, because the underlying soils are not gleyified").

? Chernozem with long frost wedges (findings of elephant, mammoth?).

D? Humic horizon (loess loam?, loess?).

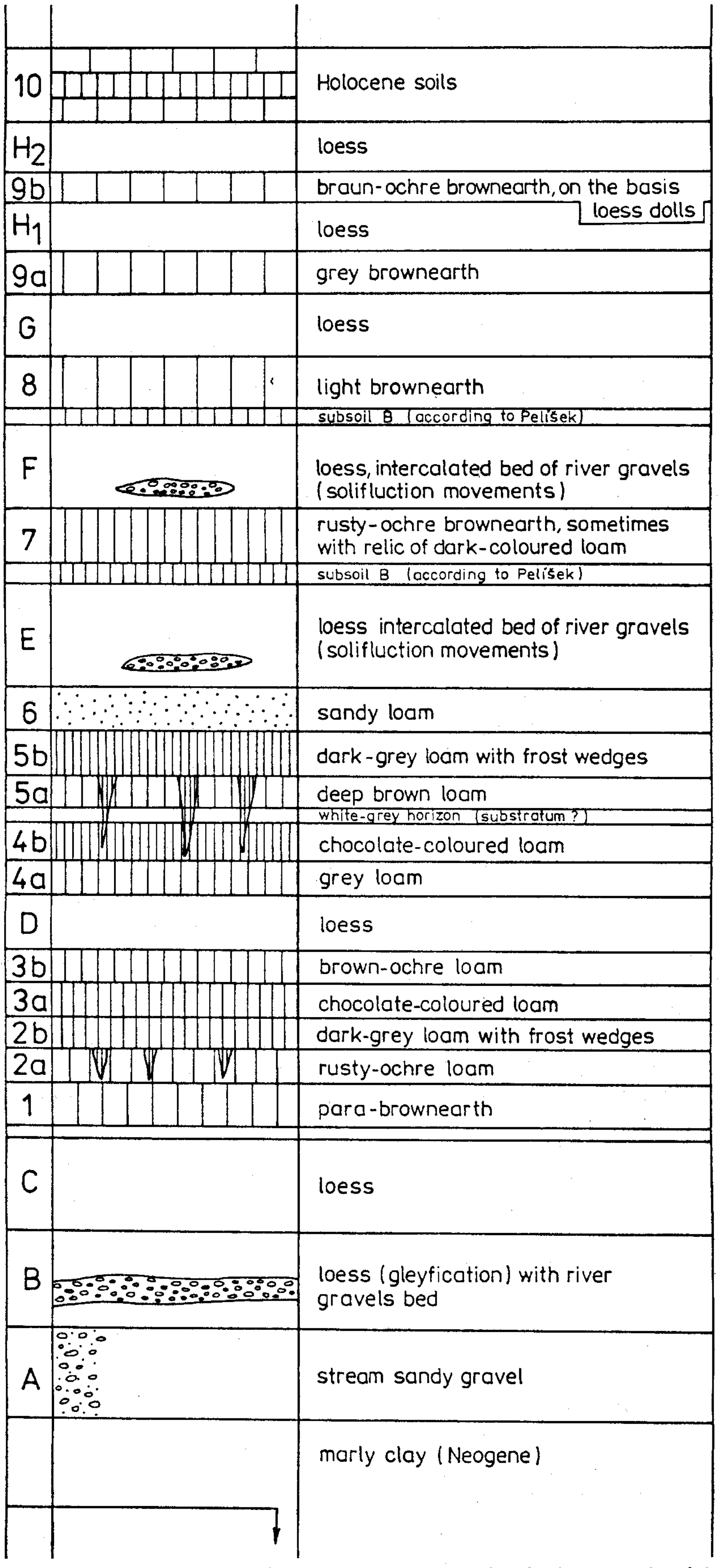

Fig. 3 An ideal section of the brickworks at Modřice made on the basis of a long study of the exposure, expressing all beds of both loesses and fossil soils in mutual relations. Compare this drawing with the description of sections in the individual years.

2b Chernozem.
1 B-horizon of chernozem. Evidently para-brownearth.
C Loess, in the upper half there is a gleyified layer.
B Loess gleyified loam, an overlying position of gravels which in the figure gradually nips.
A Terrace gravels

From the description of 1949 several interesting facts follow. In one original description from the field basal fluvial gravels are missing which, however, appear in the publication. An interesting change also occurred in soil complexes. The bed of sandy loames in completely preserved sections of later time occurs only in the overlying beds of the upper soil complex, where the para-brownearth always forms only the basal part of the lower complex. The other beds of the complex described in further years are missing here.

2.3 The year 1950

From the year 1950 a manuscript written in pencil comes (Pelíšek, MS) which was evidently the basis of the typewritten manuscript (6 Mar. 1950). It is stated in it that according to boreholes a greenish calcareous clay is found under the Quaternary sediments on which a gravel terrace is deposited. It is not quite clear to what extent this text relates to the earlier described terrace gravels on the base of the brickworks, but it cannot be completely excluded that in the first paper the described gravels may have been only a displaced bed of higher deposited gravels which were always quite thick and which might not be identical with the later proclaimed Modřice terrace. This can be deduced from the fact that only now does Pelíšek mention boreholes as if only now he verified the correctness of his earlier deductions. Pelíšek already realised the exceptionally complicated situation at that locality as for the slide of the whole blocks. He writes: "In the exposures at other walls of the brickworks at places solifluction streams can be seen from higher river terraces constituting differently thick and irregular positions in loesses." He was thus aware of the fact that the layers of gravels could have their origin in some higher terrace. It is therefore not excluded that only in basal gravels he still believed they were indigenous, he defended his first pronounced view, and every others in overlying beds could be displaced (besides the bed of gravels in loess in the roof of basal gravels which he still considers to be fluvial in situ). He does not mention basal fluvial gravels in the description.

Only by the text without a drawing does he describe this section of the front haulage wall.

10 Holocene.
H Ochre yellow loess (according to Pelíšek W 3).
9 Soil of brownochre colour (brownearth), in the lower part there are light mole-chambers, in the bottom lime nodules the size of a nut - weekly formed carbonate horizon (W 2/3).
G Loess.
8, 7 Doubled brownearth soil complex with B-horizons. The upper bed has ochre brown colour, the lower one chocolate brown. On the surface of the upper bed there is through solifluction bedded position, weekly visible solifluction being also on the surface of the lower chocolate brown bed (brownearth). In the lower storey of the brickwork this bed is strongly impaired by solifluction and the individual lamina are sickle-like bent.
E Ochre coloured loess.
6 Solifluction bed (according to the description evidently sandy loam).
5b? 4b? Greybrown horizon (chernozem).
5a? 4a? Light brown horizon.
D Ochre yellow loess.
3a Chocolate brown soil (brownearth).
? Chernozem.
2b Greyblack soil.
1 Brown rusty to brown ochre coloured soil (para-brownearth). From the overlying beds humic wedges (frost wedges?) penetrate into it according to Pelíšek.
Carbonate horizon.
C Loess of flaxen colour.

2.4 The year 1955

After a long time a publication by Musil, Valoch, Nečesaný (1955) appears that describes the section at Modřice in the following way:

10 Holocene.
H Loess (100 cm).
Humic horizon of dark black colour (70 cm).
Loess (100 cm).
Sandy clay with plant remains (reed) (20 cm).
Fine clayey sand (30 cm).
Coarse gravel with sand, its surface not straight (380 cm).
Calcareous clay (bored into the depth of 3 m).

The described section does not at all correspond with the earlier described sections and it is thus difficult to do a correlation of the individual beds. The publication states fluvial gravels situated on calcareous clay described before by Pelíšek and their relatively large thickness. It is not excluded that the fine clayey sand with plant remains in the overlier might represent flood loams of the river terrace, thus confirming Pelíšek's original belief that it was an indigenous river terrace.

2.5 The year 1961

In the archives there is a text of 1961 (Pelíšek, MS) concerning the lower positions of gravels. Pelíšek again holds the opinion in it that the position of gravels in the loess loams in the overlying beds of basal fluvial gravels (the Modřice terrace) originated at the time of the uplift of the alluvial flood plain and the meandering of the river bed. A large number of layers of different colours in the soil complex was to document in R/W Interglacial a large number of climatic oscillations. According to present viewpoints of the sea isotope stratigraphy this might be all substages of stage 5. He also takes his standpoint to sandy loam, unlike Kukla who at that time considers them to be a hydrogenetic process, he believes them to be typical niveo-eolian deposits.

2.6 The year 1963

And again the interest in that locality ceases for some time. In the archives there exists only a field sketch of 1963 (Pelíšek, MS) from which a very detailed composition of the soil complex can be seen which Pelíšek dates to the Last Interglacial. Further, the fact is interesting that in the overlying beds of that complex two layers of soils denoted by Pelíšek as W 1/2 and W 2/3 gradually nip out along the slope until they get lost altogether, so that two original loess beds separating them coalesce macroscopically completely into one. The described section looks like this:

10 Holocene.

H Loess which gradually down the slope cuts all underlying beds up to the bed marked D.

Position of $CaCO_3$. Probably a relic of bed 8 or 9.

F Loess gradually nipping out, so that the position of CaCO3 from the top sets directly on the underlying bed.

7 Nipping out bed of brown coloured soil sediment.

E Loess

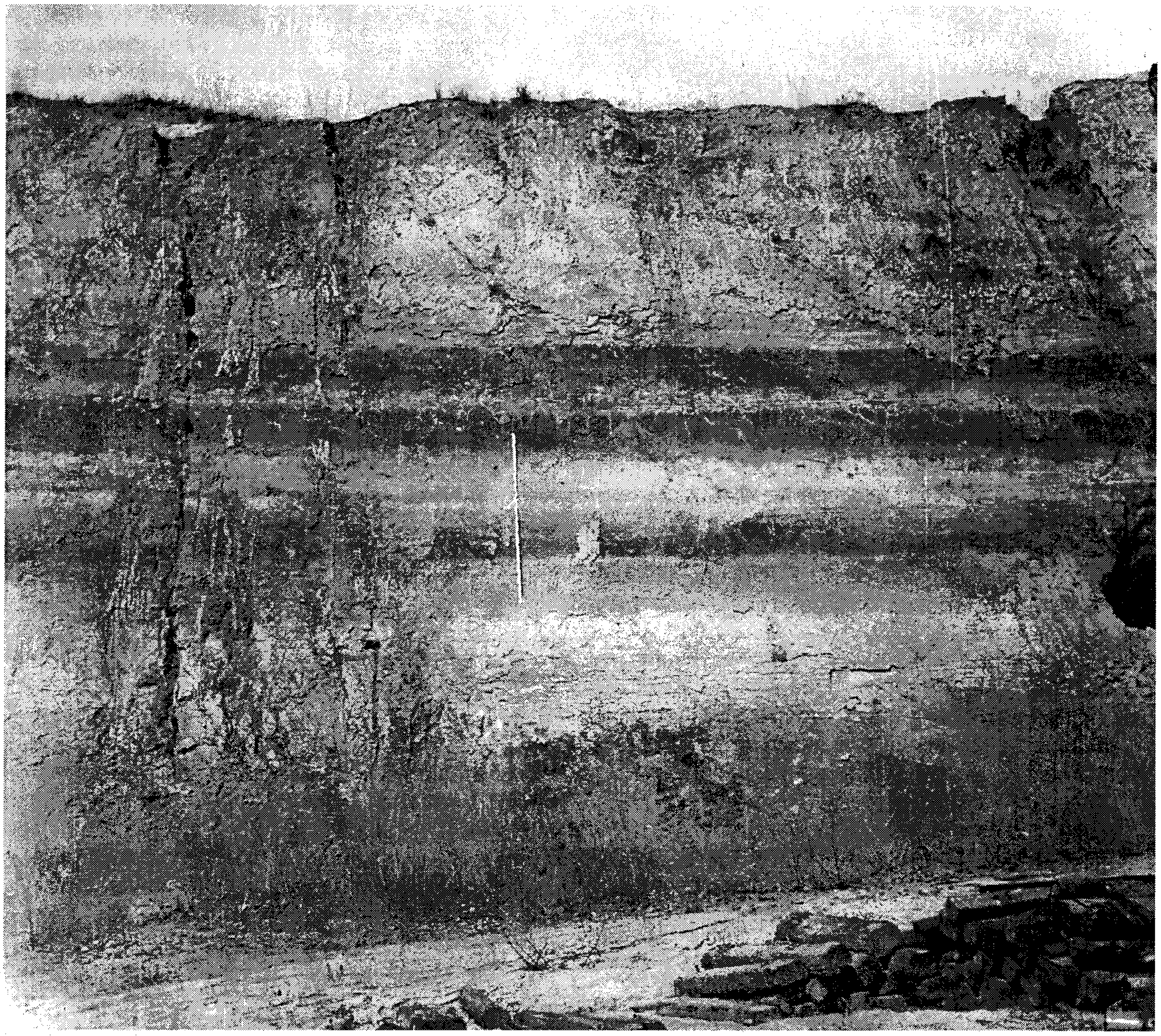

Fig. 4a Exposures of the brickworks at Modřice. Original photograph by J. Pelíšek representing the section at the time of its most detailed development of both fossil soil complexes and their bottoms. A detailed description of beds in the texts of the individual year.

All above beds were described according to the sketch. Pelíšek's description is missing, it is only given at further beds.

6 Solifluction layer of light grey colour. By this term Pelíšek denoted sandy loams, as followed from records of further years.
5b A bed of blackgrey soil.
5a A bed of grey soil.
4b A bed of blackgrey soil.
A bed of chocolate brown soil.
4a A bed of grey soil.
D Loess of ochre colour with lime nodules.
A layer of chocolate brown soil.
3b? 3a? A layer of grey soil.
2b A layer of blackgrey soil with frost wedges.
1 A layer of brownrusty soil. Evidently para-brownearth.
A layer of brown ochre soil.
C Loess of yellow colour.

In that haulage year, for the first time since 1940 a sequence of the large number of beds of the two soil complexes appears, which is clearly separated by typical loess. Up to that time it had never been like that. Thus a large number of beds developed of different colours of soils of the two complexes and remained preserved for a long time. At present it does not occur in the brickworks any more. It is an example of how not only individual beds, but whole complicated soil complexes can change from place to place and how the study of exposures for a long time is important.

Of the same year there are also explanations to the geological map sheet Brno (1:200 000) (Kalášek et al.,

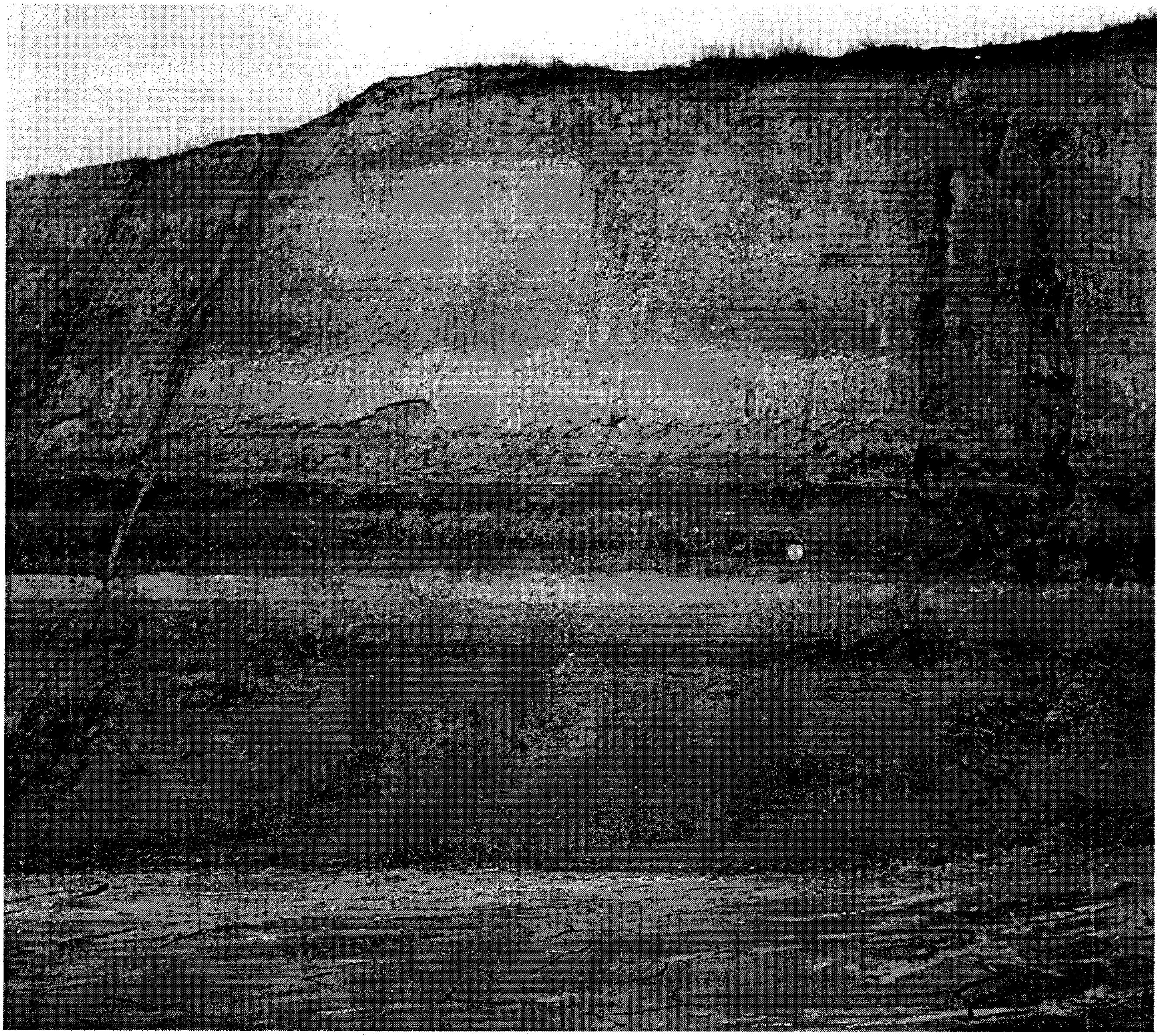

Fig. 4b Exposures of the brickworks at Modřice. Original photograph by J. Pelíšek representing the section at the time of its most detailed development of both fossil soil complexes and their bottoms. A detailed description of beds in the texts of the individual year.

1963). From the front wall of the brickworks the authors publish the following photograph:

H, G Loess.
7 Relatively thick brown soil horizon.
E Loess.
5a Layer of black coloured soil.
4b A bed of light soil.
4a Chernozem.
D A bed of light soil. Probably it was a bed of loess.
3+2 Layer of black coloured soil.
1 Layer lighter than the overlying bed, presumably para-brownearth.
C Loess.

This section corresponds in essence with the description by Pelíšek. At the same time it shows that Pelíšek's description came from the front haulage wall of the locality.

2.7 The year 1967

Of 5 June comes the following description devoted only to the two soil complexes (Pelíšek, MS). He does not mention their overlying beds.

6 Solifluction layer. Again it is a bed of sandy loams.
5b A bed of black soil.
5a A bed of dark greybrown soil.
4b A bed of blackgrey soil.
4a A bed of light brown soil.
D Loess.
3b A bed of rusty dark brown soil.
3a A bed of dark grey soil.
2a A bed of rusty ochre soil.
1 A bed of deep brownish rusty soil. It is para-brownearth. It is not excluded that bed 2a and bed 1 represent one genetic horizon.
Deep ochre soil.
C Loess.

From 1963 to 1967 there was evidently no change in the composition of beds of the lower and the upper soil complexes. At that time in the loess cover the most in detail developed beds of the two fossil soil complexes were discovered. Probably of 1967 a schematic drawing in pencil comes, without an accompanying text which would evidently correspond to the above section. In the very same year Pelíšek makes a generalized section of the brickworks at Modřice in which he sums all information from all his previous explorations (1948-1967). That original was later published in the Časopis Moravského muzea as a summary of information of the period 1971-1972 (Pelíšek, 1972), in essence it is the same in the earlier original which I now present.

10 Holocene.
H Loess (240 cm).
9 Brownearth (50 cm).
G Loess (65 cm).
8 Brownearth (60 cm).
F Loess.
7 Brown soil, relic dispersed by solifluction. At the base there are mole-chambers filled with dark brown loam (40 cm).
E Loess (490 cm).
6 Sandy loams, a bed consisting of sand and fine gravels, gradual transition into the basement. For the first time this term is used by Pelíšek, earlier he denoted this position as a solifluction layer (90 cm).
5b Dark grey coloured soil, frost wedges, chernozem (40 cm).
5a Greybrown coloured soil, frost wedges from the overlying bed (70 cm).
4b Blackgrey coloured soil, chernozem, frost wedges from the overlying bed (50 cm).
4a Chocolate brown coloured soil, gradual transition into the bottom (15 cm).
D Loess (100 cm).
3b Ochre coloured soil, brownearth (40 cm).
3a Chocolate brown coloured soil, brownearth (25 cm).
2b Blackgrey coloured soil, chernozem (50 cm).
2a Brown ochre coloured soil (15 cm).
1 Ochre coloured clayey soil of block structure, brownish clayey infiltrations, evidently para-brownearth (80 cm).
Brown ochre coloured soil (25 cm).
C Loess (160 cm).
B Greyish loess soil, brown ochre spots, semigleyey horizon (60 cm).
Loess soil, Fe-spots, terrace gravels in the form of lenticles. Thickness 100 cm.
Gleyfied loess (110 cm).
Ochre grey loamy soil, Fe-spots, semigley (70 cm).
Ochre soil, rusty spots, gleyfied loess (70 cm).
Greyish to bluishgrey gley horizon (35 cm).

The whole thickness of all horizons of bed C is 345 cm. This position can well be studied up to the present. Terrace gravels in loess loam (B) have been displaced there by solifluction.

A Fluvial sand gravel terrace , large pebbles, in the upper part numerous rusty spots and small limonitic nests.

This description is interesting from several viewpoints. On the one hand the term sandy loams s appears in it, not only the solifluction layer. As important I also see the description of the basal gravel layer from which it follows that these gravels were not verified only by boreholes. It is, of course, interesting that I have never found in the archives a detailed description of the upper part of the gravel layer, it exists only in this description of the section. In this generalized section which gathers the information from a long space of time frost wedges appear only in chernozem situated in the upper soil complex. From earlier drawings it follows, however (1950, 1963) that they were sometimes also found in the chernozem over the bed of para-brownearth, i.e. in the lower soil complex. From even a small space great deviation in their presence can be noticed.

The section shows an overall and almost complete overview of the loess series at Modřice. Two complexes of fossil soils are separated by a bed of typical loess and in their overlier there is further intensely developed soil (7), separated from the upper soil complex by thick loess (E = 490 cm). In the top of this soil there exist two soil horizons of lighter brown colour (8 and 9). It is difficult to decide to what extent they were autochtonous (para-autochthonous), but we know that their transition into the basement was gradual, which would rather support the former case. In any case they mean an interruption of the loess drift and evidently also a warmer climatic oscillation of the Interstadial character.

Probably of the same year 1967 also comes the sketch of the reconstructed overall section (Pelíšek, MS), evidently along the wall of the exposure in the W-E direction, as explicitly stated. In bed F there occur gravels at the base, the same as in bed E, but only in the eastern part of the wall, i.e. nearer the valley. In both cases the two soil complexes displaced by solifluction are again separated by loess (D). From the sketch the coalescence of beds in the eastern direction is evident.

10 Holocene.
H Loess.
9+8+G Brown coloured weak layer dividing in the western direction into two brown beds separated by a bed of typical loess (G). It is an instructive example of different preservation of beds in the direction from the top of the hill to the valley, when the two beds coalesce into one along the slope and the loess bed between them disappears and macroscopically a completely uniform loess layer is formed.
F Loess on whose base there are fluvial gravels.
7 A weak layer of dark soil.
E Loess in its eastern part (i.e. in the direction to the valley) with fluvial gravels.
5b, 5a, 4b A thick black layer, in the western part of the exposure with frost wedges, in the eastern part, like the overlying beds 9 and 8, is divided into two independent beds of black soil (5b, 4b), between which there is brown soil (5a).
4a A layer of brown soil.
D Loess.
3a A thick layer of black soil.
2a A layer of brown soil.
C Thick loess with a bed of fluvial gravels.
B A layer of bedded loess loam.
A A thick layer of gravels.

All the above beds lie, according to the sketch, at the steep slope of the Brno massif. This is not perceptible today, one cannot say where Pelíšek obtained that information. Today, as the front wall is concerned, all Pleistocene sediment are on calcareous clay which has the character of a ridge extending transversally into the valley. It is thus possible that it was only Pelíšek's assumption.

Of that year 1967 there come a number of original descriptions and drawings (Pelíšek, MS), but on the whole, excepting some minor deviations, they correspond to each other. Maybe in a further drawing it is possible to state that bed 6, earlier always denoted as solifluctional layer, is in this sketch denoted as solifluction - sandy loam (100 cm). Further it is necessary to state that bed 7 on the top of the upper soil complex is of dark brown colour (40 cm), it is thus a more intensely developed layer than all further overlying beds. The individual solifluction lamina are sickle-like bent (solifluction dispersion is always typical of this bed, see also the year 1950) and at the base there are dark brown mole-chambers (original of 25 July 1967).

From a very detailed original drawing made in pencil processed in that year in the field the separation of the originally uniform layer 9 into two soil beds separated by loess is clearly evident. Thus, the number of overlying weakly developed soil horizons above the upper soil complex increases by another one.

10 Holocene (three differently coloured beds, 80, 45 and 30 cm thick).
H2 Loess.
9b Soil of brown ochre colour, at the base lime nodules (20 cm).
H1 Loess.
9a Greyish ochre soil (20 cm).

It is the only case when formerly always uniform layer denoted as 9 was divided into two beds separated by typical loess.

G Loess (55 cm).
8 Light brown soil with gradual transition into the bottom (60 cm). This gradual transition means that it originated gradually from underlying loess, i.e. it is autochthonous.
F Loess with brown mole chambers.
7 Rusty brown soil dispersed by solifluction, at whose base there are dark brown mole chambers (40 cm). Solifluction dispersion and, at the same time, a more intense colour are, unlike the overlying layers consisting of lighter brown soil, always developed. The darker colour of the underlying bed and the brown coloration of the overlying ones are characteristic of these beds.
E Loess (200 cm).
6 Solifluction bedded layer consisting of grey sandy lamina with fine gravel. There is a gradual transition into the roof (90-100 cm). It is evidently a bed of sandy loams.
5b Dark grey soil with frost wedges reaching as far as the underlying beds. Gradual transition into the basement (40 cm).
5a Deep greybrown soil (70 cm).

Whitegray lamina (6-8 cm). Appearing for the first time in the section.

4 Chocolate brown soil with dark grey mole chambers (15 cm).

D A loess bed with horizons:
Loess.
Greyish ochre loess.
Loess.
Greyish ochre loess, at the base lime nodules.

The loess bed D is in this case separated by two horizons somewhat different in colour, the lower one having, besides, lime nodules at the base. It is hard to say how they originated and what they represent genetically.

3b Brown ochre soil, with gradual transition into the bottom (40 cm).

3a Chocolate brown soil (25 cm).

2b Dark grey to blackgrey soil (50 cm).

2a Light brown soil (15 cm).

1 Ochre brown fine block soil with dark clayey ochre brown infiltrations (80 cm). It is evidently para-brownearth.
Brown ochre soil (25 cm).

C Loess (220 cm).

B Gleyified loess loam.
A spotty rusty position of loess loam, semigley.
Grey soil with irregular coloured stripes, semigley.
A spotty rusty layer.
A gravel lenticle.
A brown ochre layer.
An ochre grey layer.
A grey layer.
A grey ochre layer, Fe-spots.

The overall maximum thickness of bed B is 3 m. Different coloration can be, in my opinion, quite local and it can change from place to place. This gleyified loess loam can be studied even now at the present base of the brickworks.

Grey loamy to bluishgrey gley (50 cm). This bed either belongs to the overlying bed B or it might be meadow loams of the underlying terrace. But terrace gravels cannot be seen today (1998) any more. Pelíšek, however, states their presence in this year (1967) and their thickness of 5 m and he writes explicitly "terrace with limonite".

This original record is also important from the viewpoint that above the two soil complexes, besides the earlier described soil horizons there was one more which originated by the splitting of the original one bed 9. That means that above the upper soil complex there were four more soil horizons, the lowermost of them (7) has intensely developed soil of darker colour, always dispersed by solifluction.

To that period date not only pencil sketches with a descriptive text, made evidently straight in the field, but also large coloured pictures made evidently according to the original sketches at home. They express relatively well the colour deviations of the individual beds.

If we neglect several pencil drawn sections with the description of the beds in which there is no date of their making, one more section made by Pelíšek exists, published in the proceedings "Kvartér Brněnské kotliny" (Quaternary of the Brno basin) (1982). However, it does not bring anything new and it was evidently made according to earlier investigations. Thus, Pelíšek's long-term study of the locality ends also by publications. His work in the field, however, finished earlier, most probably in 1967. Since that time no new original material has been found.

Since Pelíšek's last studies a number of years have passed and new papers have appeared which I will not discuss in this more or less historically conceived paper. The fact is that at present the section of the brickworks exposure is by far not so complete as it was in earlier years (it was evidently such still in 1968, as documented by the paper by Smolíková). The position of calcareous clay now rises relatively high and the face wall gets into places of strong solifluction displacements and/or block slides of whole ploughing blocks which must have strongly affected the preservation of Pleistocene sediments. It seems that Pelíšek's original descriptions of sections will not have any parallel in the future, as far as the completeness of Upper Pleistocene is concerned, and the more they are, of course, valuable. They are the best and in most detail described fact of the development of the Last Glacial of that region, of course tributary to the level of knowledge of that time.

3. Conclusion

Original field drawings with descriptions of beds with the preserved analyses of sediments, which I do not mention, as well as further notes represent a material which, although it does not correspond completely with the present requirements, is indispensable for all further investigations of this locality and, on the general level, also for all papers concerning the stratigraphy of loess exposures of Upper Pleistocene.

It appears that the local development of the individual soil horizons, but also whole soil complexes is strongly dependent not only on the slope of the then surface, but also on the location on that slope and, of course, also on the basement and its relief. Factors affecting the course and degree of preservation are thus relatively numerous, but never occurring simultaneously in one place. In its consequences this results in the fact that not in a single place is preserved the stratigraphic sequence of all beds, but it is necessary to complement it from several places of a long space of time. That, of course, diminishes the importance of static exposures in which no haulage occurs. It is not even excluded that the same bed can be autochthonous in one place and allochthonous elsewhere.

Today it is impossible to decide whether basal fluvial gravels in the overlier of calcareous clay constituted the river terrace or whether they got there in a secondary manner by the slide of the whole block. Some circumstantial evidence witnesses for the former variant, another, like very numerous slides of whole blocks, for the possibility of the latter variant.

The upper and the lower soil complexes are separated by typical loess. The development of soils of the lower complex is different from that of the upper complex.

On the top of the upper complex there are a major number of soil horizons. Only the bottommost of them is formed as intensive dark soil. It was always dispersed by solifluction, so that the way of its preservation was always changing, in some places it tapered and then it was missing completely.

Above that soil another three soil horizons existed. From their description it cannot be decided whether they were autochtonous or allochthonous, but allochthony cannot be eliminated. Their gradual transition into the basement would even confirm it.

Modřice is the only locality situated on the eastern slope of the Bohemian Massif at which it is possible to follow for 60 years the course of the loess drift and fossil soils and changes in their preservation, both in the transversal and in the longitudinal direction. It is a locality which at the same time shows that for the correct understanding of the whole development of the period of bed sedimentation a long time of study of the exposure in the longitudinal and transversal direction of the then slope is necessary, of course under the assumption of the haulage, and not only a few individual visits. The stratigraphic interpretation of the loess sections where there is no haulage can thus be erroneous.

References

KALÁŠEK, J. a kol. (1963): Vysvětlivky k přehledné geologické mapě ČSSR 1:200 000, M-33-XXIX, Brno. ČSAV, Praha, p. 5-256.

MUSIL, R. - VALOCH, K. - NEČESANÝ, Vl. (1955): Pleistocenní sedimenty okolí Brna. - Anthropozoikum, Praha (1954), 4, p. 107-168.

PELÍŠEK, J. (1940): Studie fluviálních půd (ve spraších) a diluviální podnebí v oblasti svrateckého úvalu na Moravě. - Práce Mor. přírod. spolku, Brno, 12, sp. 1, 15 pp.

PELÍŠEK, J. (1949): Příspěvek ke stratigrafii spraší svrateckého úvalu. - Práce Moravskoslezské Akad. věd přír., Brno, 21, sp. 11, 19 pp.

PELÍŠEK, J. (1972): Pedogenetische Charakteristik der Fossilböden in der Lößschichtenfolge bei Modřice südlich Brno (Tschechoslowakei). - Čas. Mor. muzea, Brno, 56/57, p. 111-126.

PELÍŠEK, J. (1982): Spraše a fosilní půdy Brněnské kotliny. - In Musil R. (ed.) Stránská skála IV, Studia geographica, Brno, p. 80, 85-106.

PELÍŠEK, J.: Písemná a grafická dokumentace cihelny v Modřicích (MS). - Archiv Mendelovy zemědělské a lesnické univerzity, Brno.

SMOLÍKOVÁ, L. (1968): Geneze mladopleistocenních půd v Modřicích u Brna na základě půdní mikromorfologie. - Čas. min. geol., Praha, 13, No. 2, p. 199-209.

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HISTORICAL FLOODS IN BOHEMIA AND MORAVIA ON THE EXAMPLE OF THE YEAR 1598

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Abstract

It became quite evident after the disastrous floods in Moravia, Silesia and eastern Bohemia in July 1997 that there is no relevant information available for the territory of Moravia (unlike for Bohemia) that would facilitate a comparison with historical cases occurring before the year 1900. Therefore, the extent and number of floods in the whole territory of the Czech Republic is assessed on the example of the year 1598. The year was characterized by two flood periods in both Bohemia and Moravia: the spring period resulting from the rapid snow thaw (12th-3th March) and the summer period resulting from August rainstorms.

However, there were additional floods in Moravia in the autumn 1598, during the rainy period that started before 21st September and lasted until 28th October with minor breaks in between. Chronicles in Brno mention drownings in the overflowing Svratka River on 1st November. And there is a total of 5 floods registered in the Brno surroundings from January to 5th November, 1598, the annual balance in the catchment of the Dyje (Thaya) River being 6 floods for this year.

Causes, course and consequences of these floods that occurred 400 years ago are discussed as related to newly discovered sources and their regional occurrence is being compared with analogical data from Poland, Germany and Austria.

Shrnutí

Po katastrofálních povodních na Moravě, ve Slezsku a ve východních Čechách v červenci 1997 se ukázalo, že zatím pro území Moravy nejsou - na rozdíl od Čech - k dispozici informace, které by umožňovaly srovnání s historickými případy před rokem 1900. Na příkladu roku 1598 je proto hodnocen rozsah a četnost povodní pro celé území České republiky. Tehdy byla společně v Čechách i na Moravě dvě povodňová období: jarní z prudkého tání sněhu kolem 12.-13. března a letní z přívalových dešťů v srpnu.

Na Moravě se však vyskytly navíc četné povodně na podzim 1598, a to během deštivého období, které začalo před 21. září a trvalo s malými přestávkami do 28. října. V brněnských kronikách se ještě zmiňují případy utonutí v rozvodněné řece Svratce 1. listopadu. V okolí Brna je pak od ledna do 5. listopadu 1598 evidováno celkem 5 povodní, v povodí řeky Dyje byla roční bilance 6 povodní.

Jsou rozebírány příčiny, průběh, popř. důsledky povodní před 400 lety se zřetelem k nově objeveným pramenům a porovnáván jejich regionální výskyt s analogickými údaji z Polska, Německa a Rakouska.

Key words: floods, weather, 16th century, Czech Republic

1. Introduction

The disastrous floods in Moravia, Silesia and eastern Bohemia in July 1997 (Munzar - Ondráček - Táborská, 1997) are a clear example of the fact that the natural disasters occurring on our planet do not pass by the Czech Republic and that their taking into account is a wise thing to do.

When seeking analogies shortly after these floods it appeared that unlike in Bohemia there is not enough information available in Moravia, which would facilitate a comparison with historical cases before 1900 (Czech Hydrometeorological Institute, 1997; Kakos, 1997) although the 19th century in Moravia was apparently as rich in terms of floods as in Bohemia. This contribution is a follow-up to the paper of Munzar (1992) and at the same time the very first attempt to eliminate the disproportion.

2. Advise of historical floods

There is no doubt that a chronological survey of historical floods in the given region - reaching as back into the history as possible - is useful in order to make a serious assessment of long-term interactions between the floods on the one hand and the man, his seats and landscape on the other. This is why preventive measures are carried out in the countries of European Union after contemporaneous disasters, which take into account the knowledge gained in through the historico-geographical research.

To mention some examples: the project for alleviation of flood losses caused by the Arno River in Florence took into consideration also the impacts of losses caused by the river in 1177-1966 (Siccardi - Adom, 1993). After an unexpected flood in Switzerland in August 1987, Ch. Pfister and S. Hächler (1991) worked out a survey of flood disasters in the territory of the Swiss Alps on the basis of historical sources from the late Middle Ages for government institutions. In Germany, too, the issue of hydrological extremes before 1850 attracted a considerable attention (Weikinn, 1960). Recently, there are some attempts at reconstructions of historical flood disasters from a viewpoint of their weather causes and consequences (Glaser - Hagedorn, 1990; Militzer - Glaser, 1994). Historical floods on the Elbe River in Saxony are the subject of study by D. Fügner (1995). M. Deutsch (1997) set up a detailed list of signs for historical floods on the Unstrut River. A survey of hydrological extremes up to 1600 is available so far for the territory of Poland (Rojecki et al., 1965).

As to the Czech Republic, the historical floods are relatively very well documented for Bohemia (e.g. Brázdil, 1996; Kakos, 1990; 1997; Kotyza et al., 1995; Kynčil, 1992; Kynčil - Lůžek, 1979). However, their list appears far from being complete. For example, on the basis of the original historical sources the list of floods on the lower reach of the Ohře (Eger) River, left tributary of Labe (Elbe), from the 14th century (Kotyza et al., 1995) could be supplemented with a number of cases of great waters which caused losses (Munzar - Pařez, 1997). Over 10 "new" floods are documented for the rivers of Vltava (Moldau) and the lower Elbe in 1565-1581 on the basis of discovered diary entries by J. Strialius (Munzar, 1996b; 1997; 1998b).

There are no similar surveys available for Moravia and Silesia. There is an interesting study by Vermouzek (1985) in which a number of examples from the 13th to 15th centuries are mentioned on the basis of studying extinct villages in floodplains of southern Moravia where their dilapidation was greatly contributed to by floods; yet, the concrete years of flood occurrence are not known.

The intention of this paper consists in an attempt to document one "flood" year for the whole territory of the Czech Republic as far back into the past as possible on the basis of a great number of independent written sources as the regional extent of the flood often appears to be a stumbling stone. For example, for the flood in Prague on the Vltava River on 20th July, 1515 that resulted from rainfalls lasting over several days and which caused damage also in other parts of Bohemia, a chonicler adds a following remark: "And how sad were the news arriving from Silesia, from Moravia and from other lands!" (Porák - Kašpar, 1980) - yet, any independent record from Moravia of this year is missing so far. Was it really such a large region that was afflicted by floods or it is only one of frequent cases when the chroniclers exaggerate the event?

In contrast, a flood occurred on the Morava River near Uherské Hradiště towards the end of November in 1543 that was recorded by Jan of Kunovice in a following way: "A severe cold stroke on Tuesday after St. Martin [13 November] but only until Saturday [17 November] and since that time the warm weather started again with heavy and frequent rains and snowing and there were large waters. The warm weather together with dense fogs lasts up to this day, 10 December [1543]." (Stoefler, 1531; Munzar, 1994). However, no flood is known to occur in this year in Bohemia or Poland although the above mentioned weather character towards the end of Autumn is well documented in western Europe. A passage of ice is reported from Antwerp on the Schelde River on 20th November. The Chronicle of the town of Jena mentions a severe cold on 21st November with heavy snowing so that it was impossible to drive; on 23rd November, 1543 the mild weather is reported again (Weikinn, 1960; Glaser - Militzer, 1993).

The required criteria are fulfilled by for example the year 1598 which was described by A. Strnad (1790) as follows: "This year is specific with more frequent floods and plague which lasted as long as until 1599". Floods in this year are a.o. documented by four poems of the time and prints from Bohemia (Campanus, 1600; Carolides, 1598; Kavan, 1599; Melisseus Krtský, 1598). For Moravia, interesting information was discovered to concern this topic in the correspondence of Karel Senior of Žerotín. This was the reason why the year 1598 (400 years ago) was chosen as a "flood year" study case.

The further text will use the calendar expressions of holidays during the year mostly converted into our present pattern by Friedrich (1997); dates are according to the Gregorian calendar.

3. Floods in 1598 - their causes and impact

There are two flood periods documented in the territory of Bohemia - in water catchments of Vltava and Elbe Rivers: the spring one resulting from the rapid thawing of a considerably thick snow cover (about 12th March), and summer one resulting from permanent rains lasting over several days before 18th August, 1598.

In Moravian region - in the catchment of the Svratka River - both floods can be documented: the spring flood (before 17th March) and the summer flood (after the harvest). However, the catchment of the Odra River reported two floods in August (17th and after 24th August). In addition, there were other floods during the long rainy period at the end of September and in Octo-

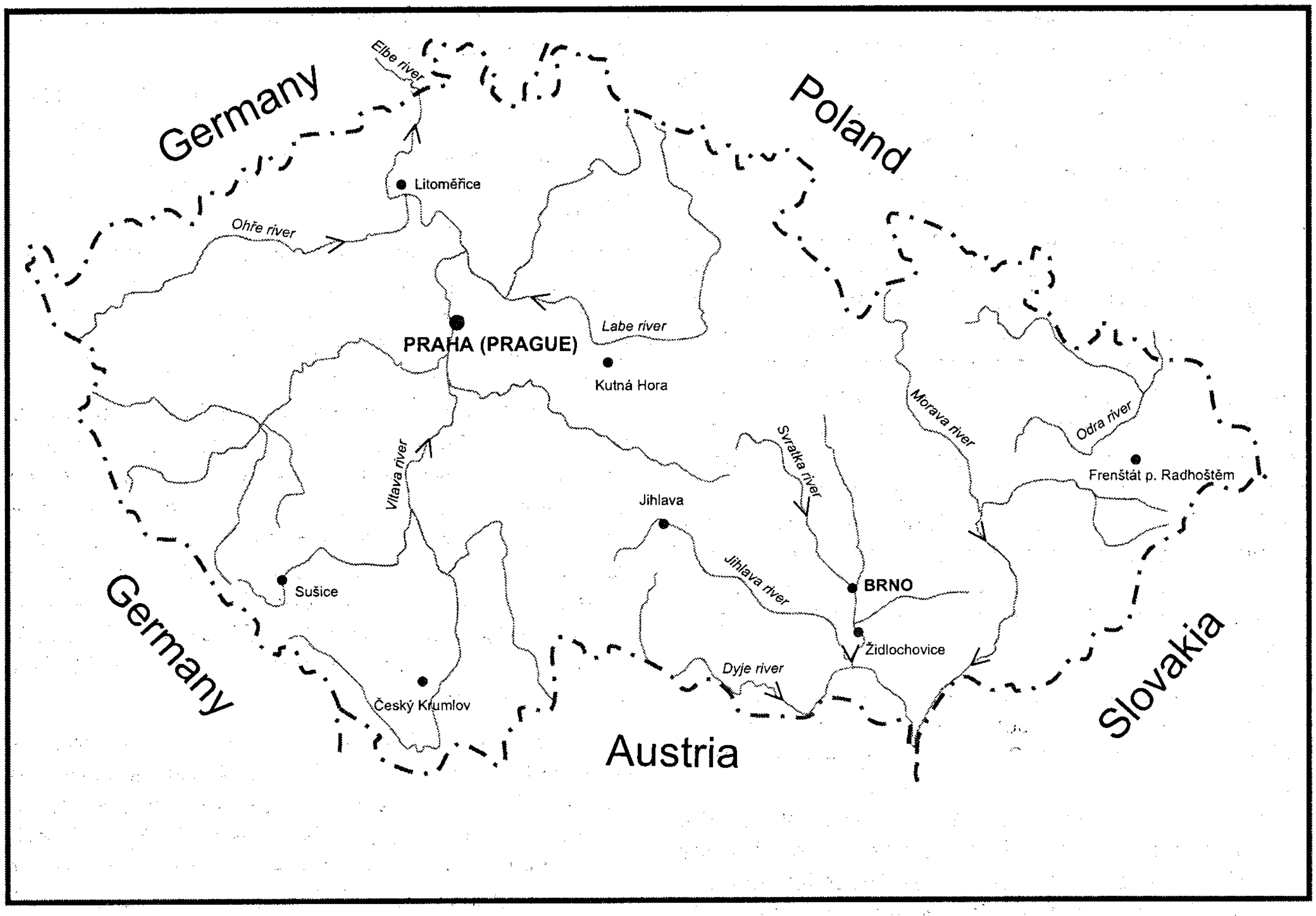


Fig. 1 Principal rivers in the Czech Republic with greater settlements which are mentioned in the paper

ber/beginning of November 1598. The Brno surroundings (the Svratka River catchment) registered as many as 5 floods in this year to the date of 5th November, the annual balance of floods in the Dyje (Thaya) River catchment amounting to as many as 6 floods (Fig. 1).

The files of the time mostly concentrate on the description of losses while the remarks on causes of the floods that are the matter of our concern are rare.

3.1 Floods in March 1598

Several sources confirm the flood of 12th March on the Vltava River in Prague when the first flood wave was observed in Louny on the Ohře River. The flood culminated on the Elbe River in Litoměřice on 13th March, 1598 when the second wave was recorded on the Ohře River and a flood on the River Teplá in Karlovy Vary (e.g. Carolides, 1598; Kotyza et al., 1995; Kovář, 1903; Kynčil - Lůžek, 1979).

In Moravia, exceptionally heavy floods occurred in the Svratka River catchment between 9th and 16th March (according to data from Židlochovice after 8th March and from Rosice before 17th March). The Moravian nobleman Karel Senior of Žerotín mentioned in his letter from Rosice, written in Latin to Václav Budovec on 17th March: "Although we live at a relatively mild place, in these days we experienced bad floods, unusual and unheard-of so far. Due to snow thawing and broken ponds under the attack of water the rivers flooded fields and even houses. Many were deprived of their farms together with the equipment and animals." (Dvorský, 1904; Matuška of Topolčany, 1601; Munzar, 1996a).

As to the causes, the Bohemian and Moravian sources agree that the winter of 1597/98 was unusually long, the snow cover unusually thick and long-lasting, and the thawing in the second week of March unusually rapid.

The Elbe River in Litoměřice was covered with ice from 21st November 1597 till 7th March 1598. In the catchment of the Svratka River at Židlochovice the snow cover held until 8th March after the abundant snow after the Christmas of 1597, which was unusually long (it is said that the frosts and snows in mountain areas lasted until 21st April). On 11th March, a dramatic thaw occurred due to the invasion of warm air from southern directions; the accompanying impact wind caused much damage in Bohemia in the period between 11th-12th March (Katzerowsky, 1886; Kovář, 1903; etc.).

Fig. 2 Historical illustration of flood consequences. By I. Franci (1607)

However, a more detailed analysis revealed that the snow in lowlands began to slowly thaw as early as 2 to 4 weeks before the mentioned thawing. It follows from the Latin diary of M. Borbonius of Borbenheim that permanent frosts in central Moravia in Napajedla lasted only up to 12th-13th February, 1598 when morning frosts were still on but the snow started to melt in the midday hours. On 18th February, there was some more snow and the weather became colder again. There was some rain on 1st March and warm "spring" days in the period from 2nd to 6th March. The period between 7th and 18th March was characteristic of humid and rainy days, which is indirectly confirmed by the flood period before 17th March (Dvořák, 1896; Pejml - Munzar, 1968a, b).

In Bohemia, the gradual thawing can be documented by a letter written in Latin by Mister Vavřinec Sarkander to the Rector of Charles' University mailed from Chrudim on 28th February, 1598. In this letter, Vavřinec apologizes for not having turned up at the Academic Senate when called to Prague on 27th February because the letter was delivered to him bypassed through Kutná Hora as late as on the given date and adds: "However, now when the snow is thawing I can hardly set out on this long journey, not saying that it could be made with no dangers - even if I wanted as much as I could." (Martínková, 1975).

The culminating flood water in Prague on the Vltava River on 12th March is recorded in such a way that the water surface raised one and a half ell above the water gauge of the time in a shape of human head near the Charles' Bridge, called Hlaváč (Heady) or Bradáč (Beardy) (1 ell = 59 cm, i.e. ca. 88 cm above). Water entered Platnéřská street and the house At Golden Sheep (Svobodová, 1990). Kotyza et al. (1995) ranks the flood at the 10th place in the history according to the highest water stages reached whose estimated height was 470 cm.

On the Elbe River in Litoměřice the chronicler mentioned that on 13th March the water table exceeded by 3/4 ell the 1595 culmination point when "the highest case occurred where the human memory can reach" (Katzerowsky, 1886). Notes made by Jan Nožíř (1601) from the same town indicate that ..." The people said the water was by an ell lower than the "St. Mary's" ninety seven years ago [i.e. in August 1501]." The water took down a bridge and Kotyza et al. (1995) rank it at the 18th place in the list of 62 great floods on the Elbe River with no more details. Let us mention for a comparison that in the same list the great water from 13th-18th August, 1501 occupies the 5th place with the estimated culmination point of 1100 cm (reports from Meissen on the Elbe River speak of 702 cm).

In Germany, the increase of the Elbe River water level was recorded in Dresden as early as from 10th March and the culmination is reported in Wittenberg on 15th March, 1598 (Weikinn, 1960). Territories of today's Poland and Austria do not report any floods in March.

3.2 Floods in August 1598

Floods and rainy weather in August 1598 are documented in Bohemia in the catchment of Vltava at Sušice (18 August), in Český Krumlov (17 August rising water level in the pond, 18 August flood on the Vltava River), Protivín (barley in fields began to emerge under the wet weather and workers had to be hired in order to rescue it from rottening), in Prague (15 August /?/ - 18 August) and in Slaný (it was raining on and on for three weeks and the wet weather was so bad that it was impossible to harvest grain and high prices broke in) - see Campanus (1600), Carolides (1598), Kavan (1599), Kotyza et al. (1995), Pánek (1985), Petera (1898), Teplý (1937).

In the Elbe River catchment above the Vltava River the harmful floods occurred in Kutná Hora (at night from 16 to 17 August); below the Vltava River they are decribed in Litoměřice (18 August with another source mentioning "after 10 August"). Whether the flood occurred also on the Ohře River, the left tributary of Elbe, is unclear since the annalist from Louny, on the lower reach of the river, made an entry to the date of 17 August that mentions just floods in Prague - not "at home". On the other hand, we can read in the chronicle of Karlovy Vary - on the upper reach of the Ohře River, on the confluence with the Teplá River - that "in 1598, the continuous rain caused great floods and infectious diseases", which undoubtedly relates to that year's summer. Similarly as in Louny, the Trutnov chronicler does not mention any flood "at home", i.e. in NE Bohemia on the Úpa River, but only the flood in Prague; the spring flood of March 1598 is not recorded at all (Katzerowsky, 1886; Kovář, 1903; Lenhart, 1860; Petrů - Pražák, 1955; Schlesinger, 1881).

The rainy weather and floods in Moravia in the Svratka River catchment in August can be documented in the town of Jihlava on the Jihlava River (6 August? great water broke 11 ponds), in Brno (after harvest flood) and at Židlochovice: "There were enormously great rainstorms and floods across the whole Bohemian, Moravian and Hungarian land." Two floods occurred in the Moravian section of the Odra River in Frenštát pod Radhoštěm (17 August and after 24 August). This well corresponds with entries about the August weather in central Moravia in Napajedla: "There were numerous rains this month, particularly everyday downpours from 21 to 30 August." - see Dvořák (1896), d'Elvert (1850), v. Chlumecky (1859), Matuška of Topolčany (1601), Strnadel (1950), Trautenberger (1895).

The flood in Prague on 17th-18th August 1598 was depicted in Latin poems by humanists Georgius Carolides (1598) and Iohannes Campanus (1600). In his "Elegy on the memorable flood on the Vltava River and on other Bohemian rivers in 1598, twice mourned over", Carolides (Fig. 3) also mentioned the flood of 12th March and ascribes the one of August to "infinite rainstorms". In addition to a general description of dam-

Fig. 3 Georgius Carolides of Carlsperg (1569-1612), the author of the poem describing two floods in Bohemia from 1598.

age he also points out that breaking down of ponds contributed to the floods and voices a moral and environmental criticism of fish-pond cultivation whose motivation is a dainty tooth of lords together with economic greed; the areas that are flooded for ponds would better serve to grow grains is his opinion.

A more realistic description of the flood and losses originated from Kutná Hora. Here the observations were captured both in memories of the Dačický family and in the independent press issued by local priest Jakub Melisseus. According to the memoirs from Kutná Hora the sudden flood occurred at night from 16th to 17th August as a result of "heavy and dense rainstorms" that lasted two days and two nights; the culmination stage was affected by breakage of a pond on the Pách Brook (Petrů - Pražák, 1955). Of three sermons presented by J. Melisseus (1598) on 18th August and 20th August before and at the funeral of victims we learn among other that 15 persons drowned during the flood. From the meteorological point of view it is interesting that immediately before the deadly flood "rain waters kept falling from 23 o'clock until an hour after midnight" of the then time determination, i.e. from about 19.15 to 21.30. Then the water table on the Pách Brook began to fall and people walked out. At that moment everything was sweeped off by a culmination wave caused by broken ponds (reservoirs) on the water stream; this is why their construction is denounced similarly as in Carolides.

Apart from Prague and Kutná Hora, concrete losses in Bohemia are further reported from Kouřim, Český Brod and villages near Elbe. According to memoirs from Litoměřice "they said that the Elbe River itself caused such a damage up to the town of Hamburg where it opens into the sea, which would make a kingdom." (Nožíř, 1601).

Losses in Moravia can be characterized for example by using the chronicle of the town of Frenštát pod Radhoštěm: "In 1598 ... on Monday after the Assumption of Virgin Mary [17 August] and second time after St. Bartholomew [after 24 August] great floods arrived unexpectedly [on the Lubina River with tributaries in the Odra R. catchment] not remembered by anyone, which caused great damage here near the town on fields, meadows, gardens and spring and autumn grains, taking away hay and grass. These waters were nearly around the whole world, even in Bohemia and especially in Prague ..." (Strnadel, 1950).

The Chronicle of Litoměřice dates the period of rainstorms from 25th July to 24 August, 1598 (Kotyza et al., 1995), which is rectified by an information from Slaný in which the personal observer claims that it was raining 3 weeks from the beginning of a new month of "September" (Petera, 1898); this entry was made additionally before the August flood in Prague.

The wet August is also confirmed from Austria from 14th-25th August (Linz) with a subsequent flood on the Danube and great losses. Two floods are mentioned to have occurred in August on the Ybbs River, the right tributary of Danube: the first one in Steyer is dated from mid August after heavy rains, the second one followed after eight days and destroyed bridges in the town (Wacha, 1959).

In Poland, two days of permanent rains resulted in a flood on the Klodzká Nysa, Biala and Bystrzyca Rivers on 16th August, 1598 at about midnight, which is approximately the same time as the flood occurred in Kutná Hora. Great waters were also observed in the surroundings of Klodzko and Wroclaw on 24th August (Rojecki et al., 1965), which is a nearly identical date as that from Frenštát pod Radhoštěm in the same catchment of the Odra River.

As to Germany, data about the wet August are missing; nevertheless, according to Weikinn (1960) a flood occurring on 18th August in Dresden and a summer flood in Wittenberg are well documented.

What was the culmination water stage? Kotyza et al. (1995) inform that water of the Vltava River in Prague raised again 1 1/2 ells above the Beardy - the above mentioned useful water gauge by which this summer flood is said to reach the same water stage as the spring one, i.e. 470 cm and takes up the 11th place in all greatest floods in this town. However, can the chronicler's information be taken for trustworthy? It was just taken over from the Chronicle of the town of Louny (see above) which means that the chronicler used a second-hand information.

Thus it appears that rather than the same culminations in the spring and summer floods in Prague the information in question related to spring and was ascribed to summer by the chronicler by a mistake; as to the March flood, the Chronicle of Louny does not have any quantitative data.

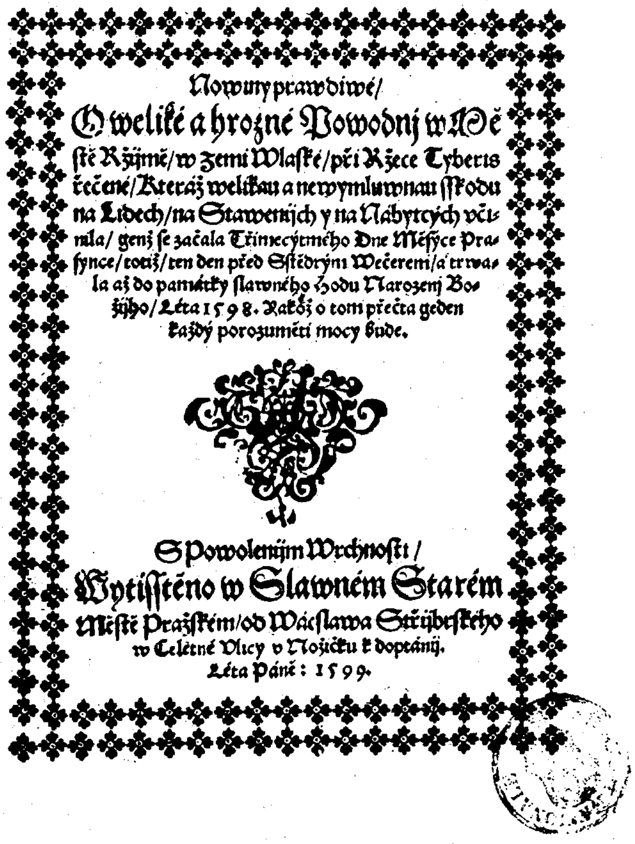
The Memoirs of Nožíř from Litoměřice mention that "...water was by a quarter ell lesser than in spring", which agrees well with another source, and add: "Near Prague, it was by 3/4 ell higher than the spring one" (Nožíř, 1601). Flooded was again a part of the Old Prague Town, with water rising up to the Church of St. Giles.

A bridge was destroyed by flood in Litoměřice. In the list of greatest floods on the Elbe River in Děčín the August flood takes up the 19th place since water was by 1/2 ell above the swelling of the spring flood from 1595 for which the water stage of 920 cm is reported and the flood takes up the 28th place in the list (Kotyza et al., 1995).

3.3 Floods in the autumn of 1598

No floods are documented in the territory of Bohemia in the autumn of this year. A brief reference exists from Litoměřice to the wet autumn weather (Nožíř, 1601). M. Borbonius who stayed in Bohemia in the Autumn, also in Litoměřice and later in Prague, recorded in his diary 16 days with rain and 2 days with snow in the period from 22nd September to 30th October (Dvořák, 1896; Pejml - Munzar, 1968a).

Moravian records speak of a rainy weather lasting for six weeks (Brno). In memoirs from Židlochovice the weather is described as follows: "And then it began to rain again the week before St. Matthew [before 21 September] and the rains went on with small breaks until St. Simeon and Judah [28 October]. And again the rains caused great waters lasting for several weeks, taking away hays and aftergrass from meadows, and where these cannot be taken away, they went rotten on meadows and fields due to wet ... Vintage was very poor with grapes mostly rotten of the wetness and falling away from the stem unripe. And because the roads were bad, wine growers could not take home the crop from the vineyards... Very bad roads which nobody remembered lasted until the evening of Epiphany [6 January 1599]



Nowiny prawdiwé/
O weliké a hrozné Powodnj w Mě
ſtě Ržijmě/ w zemi Wlaſſké/ při Řžece Tyberis
řečené/ Kteráž welikau a newymluwnau ſſkodu
na Lidech/ na Stawenijch y na Nábytcých včinila/ genž ſe začala Třinectýmého Dne Měſyce Praſynce/ totiž/ ten den před Sſtědrým Wečerem/ a trwala až do památky ſlawného Hodu Narozenj Božijho/ Léta 1598. Kakž o tom přečta geden každý porozuměti mocy bude.

S Powolenijm Wrchnoſti/
Wytiſſtěno w Slawném Starém
Městě Pražſkém/ od Wácſlawa Stříbrſkého
w Celetné Vlicy v Nožičku k doptánij.
Léta Páně: 1599.

Fig. 4 Title page of the Czech print from the year 1599, which informed about flood in Rome on Christmas 1598

when frosts eventually arrived." (Matuška of Topolčany, 1601).

The bad i.e. heavily mudded roads about 24th October, 1598 are also confirmed by Karel Senior of Žerotín in one of his letters mailed from Rosice near Brno (Brandl, 1871).

There are entries in Brno chronicles about a carrier's carriage drowned with horses and 7 persons including the load of wine in the flooded Svratka River on 1st November, 1598 (v. Chlumecky, 1859; Trautenberger, 1895).

In general, the same sources from Brno speak of the year 1598 as being memorable for floods that appeared "several times". According to Karel Senior of Žerotín there were altogether 5 floods in the surroundings of Brno from the beginning of the year to 5th November. In his letter to Mr. Adam Slavata of Chlum and Košumberk mailed from Rosice on the same day he mentions:

"...There are many places with plague, and especially here where we had a healthy air last year [1597]. This was most probably greatly assisted by the wet and unstable weather of this autumn, which caused such great waters that even with us having had floods four times before in that year [1598], none of them can be compared to the existing flooding. This is the reason why we can know nothing of what is going on in Hungary because the messangers cannot come and bring news due to the great waters". (Brandl, 1871). It follows out of the context that at least the last flood also afflicted the Morava River that had to be crossed on the way to Hungary.

The Dyje River catchment has the annual balance of 6 floods: "In 1598, ... the Dyje River here [in Šakvice] and in the whole surroundings six times flooded meadows and low [low situated] fields and spoiled the harvest. Then the fall of cattle arrived and lasted until 1599." (Nosek, 1908). Any more concrete dating of the floods is unfortunately missing.

The rainy autumn with floods is confirmed also from the territory of today's Poland where the Odra River culminated in Wroclaw first on 23rd September and then on 31st October, 1598 (Rojecki et al., 1965). In the second case the cause was snow thawing combined with rain. There were altogether several floods in this year spoken of in Wroclaw. The "Polish" weather from the end of October is in a good agreement with the diary of M. Borbonius who recorded during his stay in Prague the first snow on 27th October, rain on 29th October and snow with rain on 30th October, 1598 (Dvořák, 1896).

In Lower Austria, the autumn of 1598 is characterized in the Chronicle of the wine-growing village of Retz as wet and cold ("nasskalt") so that the grapes got rotten (Lauscher, 1985); this corresponds well with the above evaluation from the wine-growing area of southern Moravia.

4. Conclusion

Clark (1980) claims that the summer periods between 1594-1598 were so wet in Europe (western) that the weather caused the poor harvest and famines. As to central Europe, the floods occurred in Austria every year in 1597-1599 and are being compared to floods in 1572 which occurred due to July downspour (Lahnsteiner, 1956). In the Czech Republic, the wet summer and autumn of 1598 can be confirmed, particularly in Moravia.

The presented paper is an introduction study to a prepared collected documentation of historical floods from the 16th century to 1900 within the grant project "Floods, landscape and people in the catchment of the Morava River" (Vaishar, 1998). Results of this work will presumably contribute to the general knowledge of floods in the whole territory of the Czech Republic and will also provide a comparison material for neighbouring countries of central Europe.

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References

BRANDL, V. ed. (1871): Dopisy Karla st. ze Žerotína, psané jazykem českým. In: Spisy Karla st. ze Žerotína, II/2, Brno.

BRÁZDIL, R. et al. (1996): Floods events in selected parts of Europe in the 16th century - 1st version, 26 pp. In: Pfister, Ch. et al.: Climatic Change in 16th Century Europe and its Human Dimensions.

CAMPANUS, I. (1600): Ad Pragam de exundatione Vultavae an. 1598, 17. et 18. Aug. In: Centuriae duae charitum, etc. Pragae.

CAROLIDES, G. (1598): Elegia de memorabili exundatione Wltawae aliorumque Bohemiae fluviorum anno 1598 bis deplorata. Pragae.

v. CHLUMECKY, P. ed. (1859): Des Rathsherrn und Apothekers Georg Ludwig Chronik von Brünn, p. 45.

CLARK, R. (1980): Some late Tudor weather records from West Yorkshire. Weather, Vol. 135, No. 7, p. 208-209.

Czech Hydrometeorological Institute (1997): Povodeň v červenci 1997. Příspěvek na konferenci Vodní toky 1997, Olomouc 30. 9.-2. 10. 1997, 11 pp.

DEUTSCH, M. (1997): Einige Bemerkungen zu historischen Hochwassermarkem - eine Bestandsaufnahme an der Unstrut. Archäologie in Sachsen-Anhalt, 7, p. 25-31.

DVORSKÝ, F. (1904): Dopisy Karla st. ze Žerotína 1591-1610. Archiv český, sv. 27, p. 69-70.

DVOŘÁK, M. ed. (1896): Dva denníky dr. Matiáše Borbonia z Borbenheimu. Historický archiv, sv. 9, 166 pp.

ďELVERT, Ch. (1850): Geschichte und Beschreibung der königlichen Kreis- und Bergstadt Iglau in Mähren. Brünn, p. 148.

FRIEDRICH, G. (1997): Rukověť křesťanské chronologie. Paseka, Praha-Litomyšl (reprint), 340 pp.

FÜGNER, D. (1995): Hochwasserkatastrophen in Sachsen. Taucha, Tachauer Verlag, 78 pp.

GLASER, R. - HAGEDORN, H. (1990): Die Überschwemmungskatastrophe von 1784 im Maintal. Eine Chronologie ihrer witterungsklimatischen Voraussetzungen und Auswirkungen. Die Erde, 121, p. 1-14.

KAKOS, V. (1990): Fluctuations in the frequency of floods on the Vltava river in Prague in relation to meteorological observations at Prague-Klementinum (1771-1988). In: Brázdil, R. (ed.): Climatic change in the historical and the instrumental periods, Masaryk University Brno, p. 319-322.

KAKOS, V. (1997): Hydrometeorological analysis of the 1897 historical flood in relation to disastrous floods in Bohemia in September 1890 and in Moravia in July 1897. (in Czech - English summary), Meteorologické zprávy, 50, No. 6, p. 191-196.

KATZEROWSKY, W. ed. (1896): Die meteorologischen Aufzeichnungen des Leitmeritzer Stadtschreiber aus den Jahren 1564 bis 1607. Prag, p. 23-25.

KAVAN, T. (1599): Descriptio quorundam eventuum anni 1598 etc. Pragae.

KOTYZA, O. - CVRK, F. - PAŽOUREK, V. (1995): Historické povodně na dolním Labi a Vltavě. Děčín, Okresní muzeum, 169 pp.

KOVÁŘ, M. ed. (1903): Pavel Mikšovic a jeho kronika Lounská. Sborník Historického kroužku, Vol. 3.

KYNČIL, J. (1992): Floods in the Ore Mountains (Krušné hory) and their foothills between 1784-1981. In: Frenzel, B. et al., ed.: European climate reconstructed from documentary data: methods and results, p. 57-64. Stuttgart, G. Fischer Verlag.

KYNČIL, J. - LŮŽEK, B. (1979): Historické povodně v povodí Bíliny a Ohře. Chomutov, Povodí Ohře, p. 10.

LAHNSTEINER, J. (1956): Oberpinzgau vom Krimml bis Kaprun. Hollersbach - Salzburg, 691 pp.

LAUSCHER, F. (1985): Beiträge zur Wetterchronik seit dem Mittelalter. Wien, Sitzungsberichte d. Österreichische Akademie der Wiss., Abt. II, Math., Phys. und Techn. Wiss., Bd. 194, H. 1-3, p. 101.

LAUSCHER, F. (1992): Streifzüge durch die Wetterchronik Europas. Wien, 18 pp.

LENHART, J. J. (1860): Fortsetzung der Memorabilien Karlsbads ... mit einem kurzer Darstellung der merkwürdiger Ereignisse vom 1325 bis 1839. Prag, p. 139.

MARTÍNKOVÁ, D. (1975): Poselství ducha. Praha, Odeon, p. 256.

MATUŠKA z Topolčan (1601): Paměti z let 1586-1601. Brno, Moravský zemský archiv, MS. G. 10, No. 656, fol. 6a-7a.

MELISSEUS KRTSKÝ, J. (1598): O povodni škodlivé, v neděli třináctou po sv. Trojici v noci na pondělí léta tohoto 1598, na rozličných místech stalé, kázání troje. Staré Město pražské, 80 pp.

MILITZER, S. - GLASER, R. (1994): Die Thüringische Sintflut von 1613. Zeitschrift d. Vereines für Thüringische Geschichte, Vol. 48, p. 69-92.

MUNZAR, J. (1992): Weather patterns in Czechoslovakia during the years 1588-1598. In: Frenzel, B. et al., ed.: European climate reconstructed from documentary data: methods and results, Stuttgart, G. Fischer Verlag, p. 51-56.

MUNZAR, J. (1994): The discovery of daily weather observation records in Moravia from 1533-1545. An attempt of their authorization and localisation. In: Brázdil, R. - Kolář, M. eds.: Contemporary climatology. Brno, Masaryk University, p. 409-413.

MUNZAR, J. (1996a): A contribution to the reconstruction of weather and environment in Central Europe in the 16th century. Moravian Geographical Reports, Vol. 4, No. 1, p. 40-46.

MUNZAR, J. (1996b): Some notes to the daily weather observations in Bohemia in the 16th century. Communication on international workshop Historical Climatology, 27-29 September 1996, Halle/Saale, Martin Luther University.

MUNZAR, J. (1997): Jan Strialius (1535/6-1582). In: Pfister, Ch. et al., ed.: Climatic Change in 16th Century Europe and its Human Dimensions.

MUNZAR, J. (1998a): Floods in the Czech Lands in 1598 and the human response. Poster on the 2nd International Climate and History Conference, 7-11 September 1998, Norwich, UK, 10 pp.

MUNZAR, J. (1998b): Jan Strialius and his meteorological observations from Bohemia and Germany from the years 1558-1582. (in Czech - English summary), Meteorologické zprávy, Vol. 51, No. 5, p. 149-153.

MUNZAR, J. - ONDRÁČEK, S. - TÁBORSKÁ, J. (1997): Disastrous floods in Moravia and Silesia in July 1997. Moravian Geographical Reports, Vol. 5, No. 2, p. 44-59.

MUNZAR, J. - PAŘEZ, J. (1997): Historical floods on the Ohře (Eger) river and their impact on the landscape and settlements in the Ohře lowe flow area. (in Czech - English summary), Historická geografie, 29, p. 211-237.

NOSEK, F. (1908): Živelní pohromy v Šakvicích. Selský archiv, Vol. 7, p. 126.

NOŽÍŘ, J. jr. (1601): Letopisné a rodové zápisky. Strahovská knihovna, MS, Sign. DA IV 1.

PÁNEK, J. ed. (1985): Václav Břežan - Životy posledních Rožmberků I, II. Praha, Svoboda, 641 pp.

PEJML, K. - MUNZAR, J. (1968a): Mathias Borbonius von Borbenheim und seine Wetterbeobachtungen 1596-1598, 1622. (in Czech - German summary), Meteorologické zprávy, Vol. 21, No. 3, p. 93-95.

PEJML, K. - MUNZAR, J. (1968b): Das Wetter in Basel in den Jahren 1596-1597 nach dem Tagebuch des Matthias Borbonius von Borbenheim. Vierteljahresschrift der Naturforschenden Gesellschaft in Zürich, Vol. 113, No. 4, p. 407-416.

PETERA, J. ed. (1898): Václav Kněžoveský a jeho paměti. Slanský obzor, Vol. 6, p. 53, Národní knihovna v Praze, MS, Sign. 54 A 61.

PETRŮ, E. - PRAŽÁK. E. ed. (1955): Mikuláš Dačický z Heslova - Prostopravda. Paměti. Praha, SNKLHU, p. 476.

PFISTER, CH. - HÄCHLER, S. (1991): Überschwemmungskatastrophen im Schweizer Alpenraum seit dem Spätmittelalter. In: Glaser, R. - Walsh, R. ed.:Historical Climatology in Different Climatic Zones. Würzburger Geographischer Arbeiten, 80, p. 127-148.

PORÁK, J. - KAŠPAR, J. eds. (1980): Ze starých letopisů českých. Praha, Svoboda, p. 392-393.

ROJECKI, A. - GIRGUŚ, R. - STRUPCZEWSKI, W. (1965): Wyjątki ze zródel historycznych o nadzwyczajnych zjawiskach hydrologiczno-meteorologicznych na ziemiach polskich w wiekach od X. do XVI. Warszawa, PIHM-WKL, p. 192-195.

SICCARDI, F. - ADOM, D. N. (1993): A non-structuraral policy for the mitigation of flood effects: the Arno project. In: Nemec, J. ed.: Prediction and perception of natural hazards. Dordrecht, p. 3-12.

STOEFLER, J. (1531): Ephemeridum opus Ioannis Stoefleri Iustingensis, Tubingae. University Library Wroclaw, sign. 4 M 620.

STRNADEL, B. (1950): Nejstarší kronika města Frenštátu pod Radhoštěm. Ostrava, 52 pp.

STRNADT, A. (1790): Chronologisches Verzeichniss der Naturbegebenheiten in Königreiche Böhmen vom Jahre Christi 633 bis 1700. Prag, p. 88.

SVOBODOVÁ, M. (1990): Memories of the inhabitants of the Prague Lesser Town from the years 1581-1628 in Veleslavín's Historical calendar. (in Czech - English summary), Miscellanea oddělení rukopisů a starých tisků, Národní knihovna Praha, Vol. 7, Pt. 1, p. 75-105.

TEPLÝ, F. (1937): Hospodářské poměry statku Protivína v konci 16. století. Věstník čs. zeměděl. muzea, 10, p. 87.

TRAUTENBERGER, G. (1895): Die Chronik des Landeshauptstadt Brünn von der ältesten Zeit bis zum Jahre 1848. Brünn, Bd. III, p. 90.

VAISHAR, A. et al. (1998): Floods, landscape and people in the Morava river basin. A proposal of the project for the Grant Agency of the ASCR 1999-2002. Brno, Institute of Geonics ASCR.

VERMOUZEK, R. (1985): Durch Hochwasser vernichtete Dörfer in der Gegend von Tišnov und in Südmähren. (in Czech - German summary), Vlastivědný věstník moravský, 37, No. 1, p. 68-75.

WACHA, G. (1959): Zur Wetterchronik des Linzer Raumes. In: Lauscher, F. et al.: Witterung und Klima von Linz. Wien, p. 16-20.

WEIKINN, C. (1960): Quellentexte zur Witterungsgeschichte Europas von der Zeitwende bis zum Jahre 1850; Hydrographie - Teil 2 (1501-1600). Berlin, Akademie Verlag, 486 pp.

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Reviewer

RNDr. Vilibald KAKOS

GIS BRNO 1998

Petr MATUŠKA - Andrea PETROVÁ

Another of the series of GIS Brno international conferences named "Geographic Information Systems: Information Infrastructures and Interoperability for the 21st Century Information Society" was held in Brno at the turn of June and July 1998 (27 June-1 July, 1998). The Conference was traditionally organized by the Laboratory of Geoinformatic Science and Cartography, Department of Geography, Faculty of Sciences, Masaryk University in Brno, under the leadership of Milan Konečný. The Conference was held under the auspices of Eduard Schmidt - President of Masaryk University. This time the Laboratory of Geoinformatic Science called for cooperation the EU Information Society Forum, DG III and DG XIII, and its usual partner - International Cartographic Association (ICA); CAGI, EUROG.

As suggested by its name, the Conference wanted to point out the problems and their possible solutions by the future society in which the main capital will be the available information. A marked change has been recently seen in approaching geographical data, which means that the field of activity of modern technologies processing these data has been considerably extended. The geographical data have become to be used for nearly all fields of human activities, which brings about a number of both theoretical and concrete problems. One of them seems to be the publication of geographical data in the environment of Internet/Intranet, the issue of metadata (data about data), standards at the generation and distribution of geographical data - be it for state administration or commercial sphere. The three topics were fused during the Conference meetings.

The Conference was opened on Saturday, 27 June 1998 by an ICA meeting. The ICA Chairman, Mr. James R. Carter was presiding the programme of the meeting that was focused on possibilities of how to use maps and GIS perspective. The ceremonial opening of the Conference on Sunday 28 June, 1998 was preceded by workshops (GIS ON INTERNET, OPEN GIS AND GIS STANDARDIZATION ACTIVITIES IN GI FIELD - EUROPEAN ASPECTS, A CONCRETE EXPERIENCE OF GIS METHODOLOGY FOR DEVELOPING COUNTRIES).

The Conference was officially opened by Joel Morrison and his paper "GI Infrastructure: Keys to Mapping in the 21st Century". The ceremonial opening was attended by representatives from government institutions of the Czech Republic, EU bodies and sponsors (Autodesk, Intergraph, SPT Telecom). On this occasion, a technological exhibition was ceremonially opened, which introduced the most significant firms and organizations dealing with GIS, digital cartography and remote sensing of the Earth.

The Conference was divided into several sections as follows:

- Digital Cartography - Methods
- GIS Practice
- Panel GI WORKSHOP
- GIS Interoperability
- GPS and Photogrammetry
- Digital Cartography - Geodatabases
- General GIS
- EUROPEAN INFORMATION SOCIETY FORUM
- Environmental GIS
- AM/FM - (Automated Mapping/Facilities Management)
- GIS Theory
- GIS Methods
- ABDS Generalisation Session.

The individual contributions dealing with the given issues were then presented in the above sections. The Conference agenda included two "round table" discussions with the first one being focused on the object-oriented GIS and the second one reserved to a discussion concerning GIS in the Czech Republic, attended by representatives from the CR Departments of Agriculture and Environment, universities and Bureau for National Information System. One of the major problems of how to use GIS in the Czech Republic appeared to be the standardization of used data and technologies and the possibility of data being shared by individual fields of state administration. A low standard of knowledge on the part of the state administration about possibilities of using GIS on the level of districts and regions appeared to be one of the most serious problems according to the individual participants of this meeting.

The Conference sheltered a meeting of the Czech and Slovak Graphic Users Group (CSGUG) which is a part of IGUG (Intergraph Graphic Users Group).

An integral part of Brno GIS Conferences is an exhibition at which the renowned domestic and foreign companies introduce their novelties and innovations in geoinformation technologies. The exhibition was attended by 14 companies and organizations (ARCDATA PRAHA, ARGUS GEO SYSTÉM, AUTODESK, BENTLEY SYSTEMS CR, CONDATA, CSMAP, GEODIS BRNO, HELP SERVICE GROUP, HSI, INTERGRAPH CR, INTERMAP CR, LABORATORY ON GEOINFORMATICS AND CARTOGRAPHY, RESEARCH INSTITUTE OF GEODESY, TOPOGRAPHY AND CARTOGRAPHY, SITEWELL, T-MAPY). The high rate of participants provided the representation of greatest world producers and competitors in the field of geoinformation technologies and software. It made possible to compare the latest news in progressive GIS areas and provided an opportunity to Czech companies to prove they can be competitive under severe conditions.

A successful conference would not do without a good social programme which can contribute to establish closer contacts and relationships among participants and provides a number of opportunities to establish to business contacts for exhibiting companies. This year's excursion in a wine cellar was indeed a social climax of the whole programme of this international conference where the participants readily forgot the demanding daily conference programme with songs being played by the live Moravian-Slovakian band.

The success of the Conference can be measured by the number of its participants of 248 (176 from the Czech Republic) who represented 24 countries. Taken from another angle of view, however, the most important index of the Conference success will be the introduction of some new ideas into practice and at least a part of the discussed problems into the awareness of responsible authorities.

Czech-Italian Geomorphological and Geological Workshop in 1998

Karel KIRCHNER

In 1997, M. Hrádek and K. Kirchner from the Institute of Geonics, Academy of Sciences of the Czech Republic (ASCR) attended the 4th International Conference on Geomorphology in Bologna to present results of their grant research projects in sections of applied and tectonic geomorphology (more details see Hrádek - Kirchner, 1997). An agreement was made on the basis of discussions and interest of Italian geomorphologists and geologists in the given issue to invite the Italian experts to the Czech Republic and hold a joint workshop.

The Czech-Italian workshop was organized by the Institute of Geonics ASCR - Branch Brno together with the Czech Geological Survey - Branch Brno and geomorphologists from the Geomorphological Commission at the Czech Geographical Society. The organizers' intention was to present results of geomorphological research projects supported by Grant Agency ASCR (No. A3086601/1996) and Grant Agency of the Czech Republic (No. 103/95/1536), which dealt with the issue of developing relief of the eastern margin of Mohemian Massif, research into slope processes activated by massive rainfalls in northern Moravia in July 1997, and to inform the Italian experts about the present situation in the solution of geomorphological and geological issues at organizers' workplaces.

The Workshop was held from 22nd-26th June, 1998 and from the Italian party it was attended by prof. C. Elmi (geologist) University of Bologna, prof. D. Savelli (geomorphologist) University of Urbino, and Dr. E. Moretti (geologist) University of Urbino. The Seminar was opened in Brno where the Italian experts were informed about the present results of geomorphological, physico-geographical and geological research projects at organizers' workplaces. In the afternoon of the first day a guided excursion around Brno was organized for them with detailed comments not concerning only geomorphology and geology, but also the history and the present of Brno.

23rd June was reserved for an excursion in southern Moravia to the Podyjí National Park and the valley of Jihlava River (near Ivančice). The excursion was attended by 16 experts from geographical and geological institutions in Brno as well as from nature protection organizations. Localities visited in the Podyjí National Park were as follows: Ice caves (account by Dr. Hanžl, Czech Geological Institute, Branch Brno - geology; Dr. Kirchner, Dr. Ivan, Institute of Geonics ASCR, Branch Brno - geomorphology) and Hamerské vrásy (Folds) (account by Dr. Hanžl) near Vranov nad Dyjí. In the locality of Ice caves the account was given about the present stage of exploration. The locality of Ice caves (Ledové sluje) is situated in the northern slope of incised meander of the Dyje River with its parent rock being built up by Bíteš orthogneisses. In the given area, rock slope deformations originated together with the rise of deep rock fissures, extensive block fields, block streams and pseudokarst caves. This area was geologically mapped up to the scale of 1:5 000. Basic geophysical measurements made use of geoelectrical methods. Three independent blocks with fissure zones were determined on the basis of these measurements. Repeated measurements are being made of rock block movements and the mapping of pseudokarst caves continues. Up to now, there are 20 caves, the longest cave system having length over 400 m. The rise of pseudokarst caves and large block fields in the locality of Ledové sluje is connected with backwearing and block slides of orthogneiss parent rock which was disturbed by the fissures. A lively discussion of experts participating at the excursion resulted in a recommendation to focus the further research works on the disclosure of trigger mechanism of the whole process, on the temporal classification of the Ledové sluje locality, and on the continuation of multidisciplinary research.

In the locality of Hamerské vrásy (Folds) an upper part of the Bíteš orthogneiss body is uncovered in the sizeable rock profile, alternating with amphibolites. The alternation of bedrocks of different competence facilitated intensive folding with developing overturned asymmetric folds. Due to the intensive deformation and bedrock plasticity massive non-cylindrical folds developed at some places.

In the relief of Jihlava River valley near Ivančice (account given by Dr. Hrádek, Institute of Geonics ASCR, Branch Brno) pronounced tectonic influences are obvious as well as the fact that the relief is of block faulting. The parent rock is built up by bedrocks of Brno Massif with Miocene sediments, gravel sands of river terraces and loess covers occurring in the valley floor. The new Ivančice viaduct (erected in 1978) is situated on the crossing of conspicuous tectonic systems. The viaduct stability (namely that of the so called Hrušovany pier) is impacted by hydrodynamic changes in the disturbed and aquiferred parent rock. The suffusion of fine particles and compression of parent rock impair the bridge stability. In this locality, the account of the sedimentation status in Miocene sediments and Miocene marine transgressions was provided by Dr. Nehyba (Department of Geology and Paleontology, Faculty of Sciences, Masaryk University Brno).

From 24th-26th June, the Workshop continued with an excursion to northern Moravia. It was attended by 12 experts who were accommodated on the field station of Czech Geological Institute in Hutisko-Solanec (district of Vsetín, Protected Landscape Area of the Beskids Mts.). While on the road, a quarry was visited in Tlumačov (Zlín district) with the demonstration of geological status of Jurassic and Cretaceous limestones and marls on the margin of the Magura flysh cover overthrust. The first excursion day then continued with a visit of new erosion formations in the Rožnovská Bečva River bed, which came into existence during the flood in July 1997, and interesting geological phenomena on river banks (account by Dr. Krejčí, Czech Geological Institute, Branch Brno). In Rožnov pod Radhoštěm the river erosion exposed a rock outcrop with the tectonic contact of Soláň and Zlín Formation of Rača Unit of the Magura group of nappes. Silesian and Subsilesian Unit layers were denudated in the Bečva River bed near Choryně. Abundant karrens were found in dolomitic limestones (Šitbořice Member of Menilite Formation of Subsilesian Unit), giving evidence of fossil karsting. An extensive slide of 250x400 m in size was activated on the left valley slope of Rožnovská Bečva between Rožnov pod Radhoštěm and Zubří with its displacement towards the river bed being min. 20 m.

Further days of the excursion were devoted to visits of important landslide localities (Brodská, Růžďka, Bystřička) and the hill top of Hradisko near Pulčín (Dr. Krejčí - geology, Dr. Kirchner - geomorphology), Prof. Dr. Demek - geomorphology of Hradisko locality, Department of Geography, Faculty of Education, Masaryk University Brno). The landslides were activated after the extreme rainfalls in July 1997. There were more than 250 localities with activated slope movements in the district of Vsetín. The excursion centred its attention only onto the most extensive slope deformations which are conditioned by the geological structure. The landslide area in Růžďka is up to 800 m and 200 m in length and width, respectively. The landslide is considerably active with its depth being great since a plate of heavily aquiferred sandstones some 20 m in thickness is pushing up sub-soil layers with preponderant claystones. The undisturbed flysh parent rock is situated as deep as in 30 m. The accumulation part of the landslide reaches as far as the housing zone (5 buildings damaged), threatens the road and there is a risk that the streambed of Růžďka Brook will be blocked. Two sizeable landslides disturbed the railway Valašské Meziříčí - Vsetín near the village of Bystřička with the accumulation part of the smaller one reaching as far as the railway track embankment. The second landslide is structurally conditioned. In its upper part, the oversaturation occurred with the consequent displacement of sub-soil layer syncline core. The bulky matter shifted the sandstone ridge towards the railway and deformed the rails. Sanative works were lengthy and costly. Another streamslide originated in the valley of Brodská in Nový Hrozenkov, whose length is about 450 m and width 80 m. The pronounced separable area is from 6 to 15 m high and conditioned by geological structure. The movement of flysh layers occurred along the layer surfaces and fissure to the distance of at least 100 m. The slide damaged a large forest area. Sanative measures in the locality would be too costly and practically unfeasible due to the large size and technical demands.

The locality of Hradisko (773 m) northwards of Pulčín can be called a rock-city thanks to its size and diversity of forms. There are high rock walls of frost-riven cliffs as well as of structural slopes (up to 30 m high), mushroom-shaped rock spires, pseudo-sinkholes. Rock surfaces are covered with numerous weathering products such as rock niches, lapies, rock pits. A bulky rock slide originated in the NW part of Hradisko, with a separable rock wall in the upper part (height up to 18 m) which was re-modelled by frost weathering into a shape of frost-riven cliff. There are three fissure caves of which the largest one has a passable system of corridors nearly 50 long.

In addition to the basic geological and geomorphological information the foreign experts as well as other participants of the excursion were given a survey of results from the geophysical research in the above localities so that their idea about the character of the territory and methods of research is complete.

On 25th June, the excursion was informed of natural values in the Protected Landscape Area of the Beskids Mts. by Ing. F. Šulgan from the Headquarters. Prof. C. Elmi presented a lecture about three types of slope deformations, research methods and sanative measures on landslide localities in central and northern Italy (the Apennines and Dolomites). Particularly interesting was the comparison of extent, disastrous consequences and technological procedures of sanative measures in our localities and in Italy.

In addition to the presentation of our works in concrete localities, mutual discussions and exchange of experience with the Italian experts the Workshop brought also a preliminary agreement to organize a similar workshop in Italy in 1999.

References

HRÁDEK, M. (1995): Introduction into the Project "Stability Relation of Supporting Systems of Bridges and Tunnels in Stress Fields of Zones of Gravitational Spreading". Studia geographica 98, ÚGN AV ČR Brno, p.138-161.

HRÁDEK, M. (1995): Valleys of the eastern margin of the Bohemian Massif: brief outline of their origin, age and natural hazards. Acta Montana IRSM AS CR, Series A, No. 8 (97), Praha, p. 29-41.

HRÁDEK, M. - KIRCHNER, K. (1997): Two important geomorphological conferences in Europe in 1996-1997. Moravian Geographical Reports, Vol. 5, No. 2, Brno, p. 60-64.

IVAN, A. - KIRCHNER, K. (1996): Zvětrávací a gravitační tvary kaňonu Dyje (Národní park Podyjí). In: Gruna, B. - Reitter, A. eds.: Výzkum lokality Ledové sluje u Vranova nad Dyjí (NP Podyjí). Příroda - sborník prací z oboru ochrany přírody, Sv. 3, AOPK ČR a Správa NPP, Praha, Znojmo, p. 27-39.

KIRCHNER, K. - KREJČÍ, O. (1998): Charakteristika jevů způsobených extrémními srážkami v roce 1997 na Vsetínsku: návrhy řešení způsobených škod. Geologické výzkumy na Moravě a ve Slezsku v roce 1997, V. ročník, ČGÚ - pobočka Brno, katedry geol. věd PřF MU Brno, ČGS - pobočka Brno, p. 103-108.

KIRCHNER, K. - KREJČÍ, O. (1998): Slope movements in the flysch Carpathians of eastern Moravia (Vsetín district) triggered by extreme rainfalls in 1997. Moravian Geographical Reports, Vol. 6, No. 1, Brno, p. 43-52.

150 years of gas manufacture in southern Moravia

Vítězslav NOVÁČEK

The history of gas manufacture in southern Moravia dates back to the end of the 1st half of the last century. In 1846, several businessmen with a good enterprising spirit made a decision to build a gas plant in Brno and established the "Brno Association for Gas Lighting" which was authorized to light the city of Brno and in the same year received a construction permit to build the gasworks. The first gas plant was situated near the Svitava River in the locality Na špitálce and was put into pilot operation towards the end of 1847. However, the historical date was 22nd January, 1848 when the streets of Brno were first time lighted with town gas. Up to that time the town of Brno used oil lamps that were gradually replaced by gas lamps.

It is exactly 150 years that the gas manufacture in Brno and the whole region of southern Moravia celebrates its anniversary of those pioneer times. It passed a complex technical, technological and social development which reflected the historical, political and social character of its individual stages. Let us mention at least some of important historical milestones in order to better understand the significance of the present position held by Jihomoravská plynárenská a.s. (South Moravian Gas Corporation) in the distribution of gas. The gas consumption was increasingly higher towards the end of the last century and it became vitally important to accommodate resources. As early as at the turn of centuries a project was considered of the construction of new gasworks but the lacking funds prevented its implementation. This is why it was only minor refurbishings and extension of production sources that took place while the essential reconstruction of the whole gas plant and the switch of technological procedure at generating town gas took place as late

Fig. 1 The chairman of the board and general director of Jihomoravská plynárenská a.s. Ing. Libor Martínek during his speech at the international conference, held in Brno on the occasion of the 150th aniversary of gas industry in the South Moravia.
Photo: Vítězslav NOVÁČEK

as in 1928-1929. In these years the gasworks rationally turned away from just a mere town lighting and began to investigate other kinds of gas sales, particularly for cooking, heating, warm water and for technological purposes in various businesses and industries.

A historical reversal of the South-Moravian gas manufacture industry occurred in the 50s when the extraction of natural gas in southern Moravia was markedly extended and construction works started on long-distance conveying systems to bring natural gas to Brno. Although the plans were generous, the transfer from town gas to natural gas started as late as in 1969 with the town gas era in Brno ended for ever in 1976 when all supplies were converted to natural gas. In 1979-1980, the Brno Gasworks closed down three gas holders and the Brno silhouette was thus deprived of "expressive dominants" which used to be a part of town panorama for tens of years. Brno entered a new era of the entirely new gas manufacture and distribution industries based on natural gas.

The example of Brno was soon followed by other South-Moravian towns which introduced the gas lighting with a certain time delay. The construction of gasworks in Prostějov (1868-1871), Kroměříž (1869) and Jihlava (1871) was launched after more than twenty years. To complete the information we should also mention other smaller gas plants erected in the region of southern Moravia in Uherské Hradiště (1884) or Vyškov (1905). In terms of their size and the volume of generated gas the gasworks were not exactly too important but at their time they represented the progressive thinking on the part of town councils because at the time at which they came into existence they were bringing light and heat to people and some of much more important and larger towns could only dream of benefits from using gas. The list of historical gasworks in southern Moravia would certainly be incomplete if the Bata's gas plant in Zlín is not mentioned the construction of which was launched in 1931 and the plant put into operation in the same year.

The history of town gas connects to the consequent development of the use and storage of natural gas. Natural gas finds a significant application in southern Moravia and in Bohemian lands after 1931 when a strong spring was discovered at experimental drilling between the villages of Vacenovice and Milotice in the Kyjov district. The compressed natural gas became widely used in southern Moravia to drive automobiles in the course of World War II. In 1946, the natural gas extraction was started near Břeclav and a long-distance natural gas-pipeline between Podivín and Brno was built up in the same year. At the beginning of the 50s the construction works on long-distance gas pipelines conveying natural gas intensified and the existing gas-line from Podivín was connected to a new natural gas pipeline Malacky-Břeclav. A long-distance pipeline conveying natural gas from southern Moravia to Prague was put into operation in 1958.

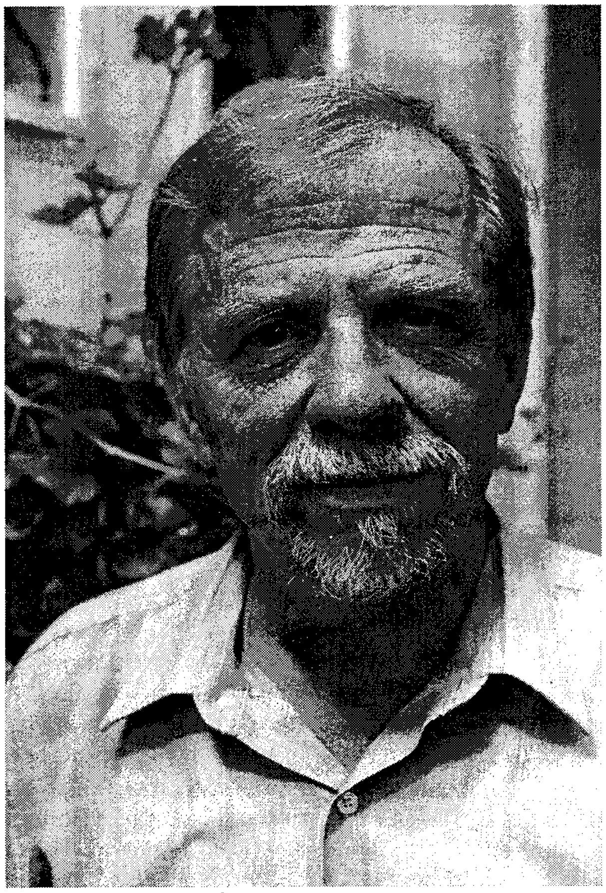
The ever growing consumption of natural gas could not do too long with limited domestic deposits and this was the reason to start building transit long-distance gas pipelines in the second half of the 60s, which were bringing natural gas into our country from abroad. In 1965-1967, a gas pipeline "Brotherhood" was built at the length of 790 km that interconnected gas pipeline systems of the then Soviet Union and Czechoslovakia and the supplies of natural gas from the Soviet Union were started. This was the first international gas pipeline whose construction was decisive for the further development of gas manufacture in our country on the basis of natural gas similarly as in all other countries with advanced gas industry. Underground gas reservoirs had to be constructed in southern Moravia in order to facilitate seasonal peak withdrawals. The first natural gas underground reservoir in the Czech Republic was technologically finished near Hrušky (Břeclav District) in 1972 and was put into pilot operation in 1973. This underground reservoir of natural gas was made of extracted crude oil deposits and its annual storage capacity was 530 mil. m^3. The construction of a natural gas reservoir near Dolní Dunajovice (Břeclav District) whose storage capacity is approx. 700 mil. m^3 was finished in 1989.

In the course of 150 years the gas manufacturing industry in southern Moravia experienced considerable and not always easy transformations. Its major task has always been a good and reliable supply of energy and we are proud to claim that gas supplies have always been the every day's security. Gas industry in southern Moravia justly takes up one of prominent places in the power policy of this country and the statement that natural gas will be a reliable source of ecologically least harmful energy not only for households but also for many industries even in the coming millennium is a deep truth.

The primary concern and goal of Jihomoravská plynárenská a.s. which was established on 1 January, 1994 and which ensures the distribution of natural gas in the whole region of southern Moravia is that the above statement is the deep truth even in the future. Jihomoravská plynárenská a.s. in the largest distributor of natural gas in the Czech Republic. Its share on the Czech gas market exceeds 25 % and its 1997 purchase of natural gas was 2347.2 mil. m^3. At the end of 1997, more than 65 % of households in the region of southern Moravia were introduced with gas. Newly introduced with gas were 145 villages in this year. With its effort to introduce gas into other places Jihomoravská plynárenská a.s. greatly contributes to the improvement of environment in the region since the sources impairing air quality diminish with every coming year.

Natural gas as an ecologically clean fuel will find an ever greater use not only at heating itself, manufacture of heat and electrical energy, but also as a fuel for combustion engines. It is expected that other environmentally friendly procedures using the principle of natural gas combustion as a source of the very clean energy will appear in no time. Jihomoravská plynárenská a.s. is ready to meet all requirements imposed by the modern gas industry and would like to successfully link up with its previously achieved results when a great emphasis is put on dependable and reliable supplies and tradition. Only after having fulfilled its strategic business plans which are focused mainly on the further development of gas introduction within the region of southern Moravia Jihomoravská plynárenská a.s. can hold its ground in the competition with other sources and energy suppliers.

MOJMÍR HRÁDEK (60)



RNDr. Mojmír HRÁDEK, CSc.
born 16 July, 1938 - Bratislava

One of prominent Czech geomorphologists and a long-term worker of the Institute of Geography, Czechoslovak Academy of Sciences - today's workplace of the Institute of Geonics, Academy of Sciences of the Czech Republic, Branch Brno - RNDr. Mojmír Hrádek, CSc. celebrated his 60 years anniversary on 16 July 1998. As a graduate from the Masaryk University in Brno (1962) he dealt in his professional career with a wide range of geomorphological and geological issues which mainly concerned the eastern part of the Bohemian Massif with the Bohemian-Moravian Highlands which have become very dear to his heart. He was the first one to demarcate the reactivated structure of the Jihlava Furrow and to describe its Tertiary and Quaternary sediments. Mojmír Hrádek is one of Czechoslovak and Czech pioneers in morphostructural analysis and morphotectonics and he uses his knowledge in a creative way to study the very complex and controversial issue of block tectonics and development of river valleys on convergent, flexure-deformed eastern edge of the Bohemian Massif. In conjunction with the new trends in geomorphology his enthusiasm and results of research of contemporary relief-forming processes and geomorphological hazards deserve a special reference. In the last few years Dr. Hrádek has also been paying a great attention to applied geomorphology, particularly to issues connected with the deposition of radioactive wastes from nuclear power stations. Dr. Hrádek is an author and editor of more than 100 scientific publications and maps. He has always been opened to new thinking and new research methods and unlike other conservative scientists he has never avoided opinion clashes. We wish him a lot of strength and enthusiasm for his future creative work.

Antonín IVAN

3rd Moravian Geographical Conference CONGEO '99 Regional Prosperity and Sustainability Austerlitz, Czech Republic, September 6-10, 1999

We have the honour of inviting you to the CONGEO '99 conference on REGIONAL PROSPERITY AND SUSTAINABILITY. It is the 3rd of Moravian geographical conferences, which continues in the tradition of biennial international meetings of geographers and other scientists dealing with regional problems. The conference is aimed at accelerating the international collaboration in regional research, in supporting international cooperation in this field and in improving acquaintance of the scientific public with research achievements of prominent geographical workplaces. Program of the CONGEO '99 conference will consist of a block of paper (poster) presentations, bilateral discussions, excursion and social activities.

The conference will be held in the world-known town SLAVKOV near Brno (Austerlitz). The town (population 5 850) is situated about 22 km from Brno in the south-Moravian district of Vyškov. It was established on trade pathways crossings. At the end of the 12th century the Order of German Knights built a fortified residence there which was one of the richest order's estates in the Czech kingdom. At the turn of the 16th and 17th centuries, the original Gothic was replaced by Renaissance. Václav, Duke of Kounic-Rietberg (1711-1794), a representative of the ruling house of Habsburg, made the town more visible in the Central European area. Napoleon Bonaparte's stay in Slavkov Castle and his proclamation after the battle of Austerlitz in 1805 made the town famous all over the world. The conference will be held in hotel Sokolský dům.

The topic of CONGEO '99 conference includes wide issues of regional geography

- Central and Eastern Europe: regions under transition
- restructuring of old industrial regions
- new prosperity for rural regions
- regional sustainable development: prosperity and/or environment
- Europe of regions: regional cooperation in new Europe
- etc.

The conference is to be attended by all scientists dealing with regional problems, both geographers and non-geographers. Organizers are interested in wide contacts in Europe, especially in Central Europe. Working language of the conference is English. Papers in English (after linguistic proof-reading) not longer than 10 pgs. (A4 size) including graphical enclosures are expected before June 15, 1999. Proceedings will be at disposal of participants by the beginning of the conference.

Preliminary registration fee is USD 195. Reduced fee for participants from countries under transition and for persons who will pay before June 30, 1999 is supposed. More information, and 1st Circulars with preliminary registration:

CONGEO '99, Institute of Geonics ASCR
mail: PO Box 23, CZ-613 00 Brno, Czech Republic
(phone) 420 5 45211901, 420 5 576076, 425 573108
(fax) 420 5 578031, (E-mail) ugn@isibrno.cz
URL: http://www.site.cas.cz/UGN/G/congeo.HTM

Professional Preparation of Geographers for the Integrating Europe

Arnošt Wahla

In the school year 1992/93 the Ostrava University launched a professional preparation of future geographers and teachers in geography for the integrating Europe in a response to Article 126 of the Maastricht Treaty, which channels the education of young people towards the European dimension (ED), particularly by means of teaching geography, history, civics and foreign languages. ED has become an integral part of educational programmes in countries of the European Union. The formative objectives of educational institutions newly included following requirements:
- opening to foreign worlds and cultural traditions;
- respect and tolerance to others;
- respect to different cultures;
- tolerance, refusal of prejudices concerning race and nationality;
- explanation of national history, social processes and issues of international context;
- education for multicultural society.

The new educational objectives have also begun to be followed by EU-candidate countries. High activities are shown by geographers at universities and by the Czech Geographic Society. Geography of Europe is a part of general geographical education, which is a direct fulfilment of the intention to teach about Europe and for the integrating Europe.

The Department of Social Geography at the Ostrava University has adopted a programme for the education of future geographers and teachers in geography with a considerably extensive course in geography of Europe and a class in Integration processes in Europe, these courses being complemented with political geography and didactics of geography. The programme has newly included also geography of Czech Republic in lessons about Euroregions. In the course of their study the students gain the information about the European Union, integration processes and regional policies, become familiar with possible organizational forms including the utilization of information means such as multimedia and Internet. Programmes of special events such as The Day of Europe, The Days of European Cultural Heritage, The World's Day of Travelling are often used for educational purposes.

The geographical workplace in Ostrava has been organizing educational events for teachers already for several years and the programme includes the ED issue. It organized a national workshop in 1997 and an international conference of geographers from Poland, Slovakia, Slovenia and Czech Republic in 1998, which assessed conditions and pre-requisites for the implementation of ED in the system of geographical education at primary and secondary schools as well as at universities. Proceedings issued from the two events bring evidence of activities performed by Czech and foreign geographers and at the same time become a mean of information for other teachers in geography, extending and completing the contemporary knowledge of Europe's geography.

References

Proceedings 1997: European dimension in the preparation of teachers in geography and in the teaching subject of geography. University of Ostrava, 87 pp. (Editor A. Wahla)

Proceedings 1998: European dimension in geographical education. University of Ostrava, 286 pp. (Editor A. Wahla)

Review

KOVÁCS, Z. - WIEßNER, R. (ed.): Prozesse und Perspektiven der Stadtentwicklung in Ostmitteleuropa. Münchener Geographische Hefte 76, L.I.S. Verlag Passau 1997, 293 pp.

A scientific symposium Problems and Perspectives of Urban Development in East Central Europe was held under the cooperation of Friedrich Ebert Foundation, Geographical Scientific and Research Institute of Hungarian Academy of Sciences and Geographical Institute of Technical University in Munich in October 1996.The majority of presented papers is a subject of reviewed proceedings. The basic question of the Symposium was whether the common traditions of urban development come into life again in central Europe after the fifty years of different development in the West and East, or whether the acquired disparities remain as permanent as economic differences.

Geographically, the Symposium included Poland, Czech Republic, Slovakia, Hungary and new federal lands of Germany. The centre of attention was focused on the following metropoles: Warsaw, Prague, Budapest, Bratislava and also Leipzig as the second largest city of new federal lands after Berlin. Regarding the Proceedings' name, however, it is necessary to take into account that contemporary processes in other post-socialist countries can be considerably different in some aspects. The editors succeeded in putting together contributions from really renowned geographers, sociologists and urbanists in respective countries, specialized in the given issue. Unfortunately, the Czech Republic was represented only by urbanist Karel Maier from the Faculty of Architecture, ČVUT Prague and urbanist Raymond Rehnicer from Sarajevo, who works in Prague. Czech geography was not represented at all and works of Czech geographers were only referred to by foreign experts.

The papers are listed in several groups by their topics as follows:

- Social changes in the city: Grzegorz Weclawowicz (The changing socio-spatial patterns in Polish cities), János Ladányi (Social and ethnic residential segregation in Budapest), Jens Dangschat (Social change in the city - the case of Eastern Germany);
- Economic changes and development of cities: Stanislaw Misztal (Deindustrialization in Warsaw and redevelopment problems), Pavol Korec (New tendencies of manufacturing development in Bratislava), Robert Pütz (Retail restructuring in Poland: the case of Wroclaw), Ján Buček & Daniel Pitoňák (City- centre information in Bratislava - modernization and financial sector invasion);
- Transformation of housing market: Helga Schmidt (The transformation of the East German housing market - the case of Leipzig), Reinhard Wießner (Socio-spatial polarization in Budapest's inner city), Katalin Berey (Utopia and reality - the example of two housing estates in Budapest), Jozef Mládek (Social transformation and population changes in the housing estate of Petržalka/Bratislava), Karel Maier (Problems of housing estates and the case of Prague), Zoltán Kovács (Transformation of the housing markets in Budapest, Prague and Warsaw);
- Processes of urban periphery: István Berényi (Suburbanization impacts on the urban development in Budapest), Günter Herfert (Suburbanization in Eastern Germany).

A notable and very contributing element is the incorporation into the Proceedings of four papers which came into existence at the end of the Symposium and which attempt at a generalization of its results by experimental identification of general tendencies of urban development in cities of central eastern Europe. It was these four papers which are primarily focused by the reviewer.

Hartmut Häußermann from the Humboldt University in Berlin poses a number of questions of both methodological and material character in his contribution "From the socialist to the capitalist city". He arrives at a conclusion that most suitable for the comparison analysis of cities is the concept of socio-ecological theory which is based upon a postulate that large cities in all industrial societies follow essentially the same pattern of development, which is independent of urban policy. According to him the basic differences between the socialist and capitalist city are forms issuing from the markedly lower social and functional differentiation in socialism. Typical for the socialist city he considers the absence of suburbanization tendencies facilitated in the capitalist society by private ownership of real estates and mass development of motor-car industry. The development of inner city parts was then affected by the price of land that was not constructed by the regular market. On the other hand, the social cities often retained the pre-socialist structure and a whole number of its elements. The author poses another question of whether the post-socialist city represents a new - third type, in addition to the socialist and capitalist city - or what is the inertia of socialist urbanization and how permanent can its tokens be in the period of transformation. Here he suggests to analyze functions of town centres, the form of the town, the traffic system, social segregation and the stage of urbanization. As common features of transformation in the post-socialist cities in spite of all possible differences he considers the rapid deindustrialization, dramatic changes in centres, new forms of socio-spatial segregation and the suburbanization of tertiary sector. In contrast, the so called socialist periphery - large-scale housing quarters of panel blocks of houses located mostly in city outskirts - exhibits a great stability whilst old town quarters - neglected under socialism in terms of house building - experience a completely different development. A great problem of the developing socialist town consists in funding. Old parts of the town similarly as the panel housing quarters and industrial areas call for urgent sanative measures. The city parts that cannot be funded from private sources because they are inhabited by the socially weak population have in fact no chance of being ever revitalized. The transformation processes in the post-socialist countries reproduced to a considerable extent the patterns of communist privileges and constituted new injustices on the start of the market society. However, a decisive fact is whether the political administration is strong enough to set-up a framework for present activities that would result in a meaningful structure of the city, offering attractive opportunities for further development at the same time.

Ulrike Sailer-Fliege from University Marburg discussed the general issue of housing market in more details. The post-socialist countries experience a transformation from the socialist paradigma where flats are considered to be social service to the capitalist paradigma where flats are goods. The difference is of such an essential nature that social problems issuing from the transformation cannot be ignored which results in a conflict with neoliberal approaches of post-socialist governments. The transformation of housing market has brought about a broad array of significant consequences in the cities of which particularly important ones include the increasing shortage of flats, the reduced number of available flats to rent at a low price due to privatization and the problem of available adequate housing facilities for the middle section of population. The segregation processes have lead to a stronger focus on the significance of location rent. The problem of insufficient measures concerning the refurbishing of the old housing resources has become urgent. In Hungary the development leads to the dualistic model of housing while in the Czech Republic, Slovakia and Poland the model of housing is rather unitary. A considerable problem of both models is the high number of flats in large housing quarters due to their construction and social instability.

Heinz Faßmann from the Geographical Institute of Technical University in Munich dealt with the generalization of changes in urban systems. The urban systems develop over a long time and their inertia is considerable. The era of socialism did not take too long to be able to change their groundwork. Attention deserves perhaps only the conception of decentral centralization that endevoured to concentrate the developmental processes not in capital cities, but in the further lower stage of seat hierarchy. Doing this, it prevented the enormous growth of metropoles and contributed to a more even size structure of towns. Dual tendencies appear at the same time after 1990: the return to market economy with variably strong advocation of liberalism combined with general trends of development in the post-industrial society. These tendencies lead to a re-assessment of roles of individual towns in the residential system, to the growing importance of metropoles, diminishing significance of industrial centres, preferrences for residential systems in western borderland regions and to the development of suburbanization. Spatial polarization and regional differences are getting stronger in the course of transformation, bringing a new asymmetry and inequality of residential systems.

Raymond Rehnicer discussed new urban tasks in central eastern Europe with his examples being Prague and the Czech Republic. The first problem is an adverse attitude of the Czech public towards the social role of planning, which issues from the fact that those who believed in idealistic communist dreams have lost their interest in the future while those who anticipated the fall of communism feel to be right in their dreamt-up future. Another problem is the present strategy of elites which try to find a solution of the present complex situation in a simple recipe: all-healing liberalism. This - also - has a negative impact on possibilities of urban planning. In addition, wild capitalism generates an ever-increasing feel of uncertainty in the majority of population, which -in a long-term prospect- can threaten the democratic development. The above facts put the present urbanists in a certain isolation - at the time when a cultural dialogue is urgent not only with politicians, but also with developers and citizens. Instead of attempting at an application of well-proven western experience, the urbanists rely on their past experience. This is the basis of the third problem of contemporary urbanists in the post-socialist countries: how to find a solution for burning issues of the existing development in cities.

It is possible to conclude that the Budapest Symposium opened a range of very topical problems concerning the present development of large cities in central eastern Europe and that the useful exchange of experience in this field should continue. Let us hope that next time it will be with participating Czech geographers who have much to say to these issues.

Antonín VAISHAR

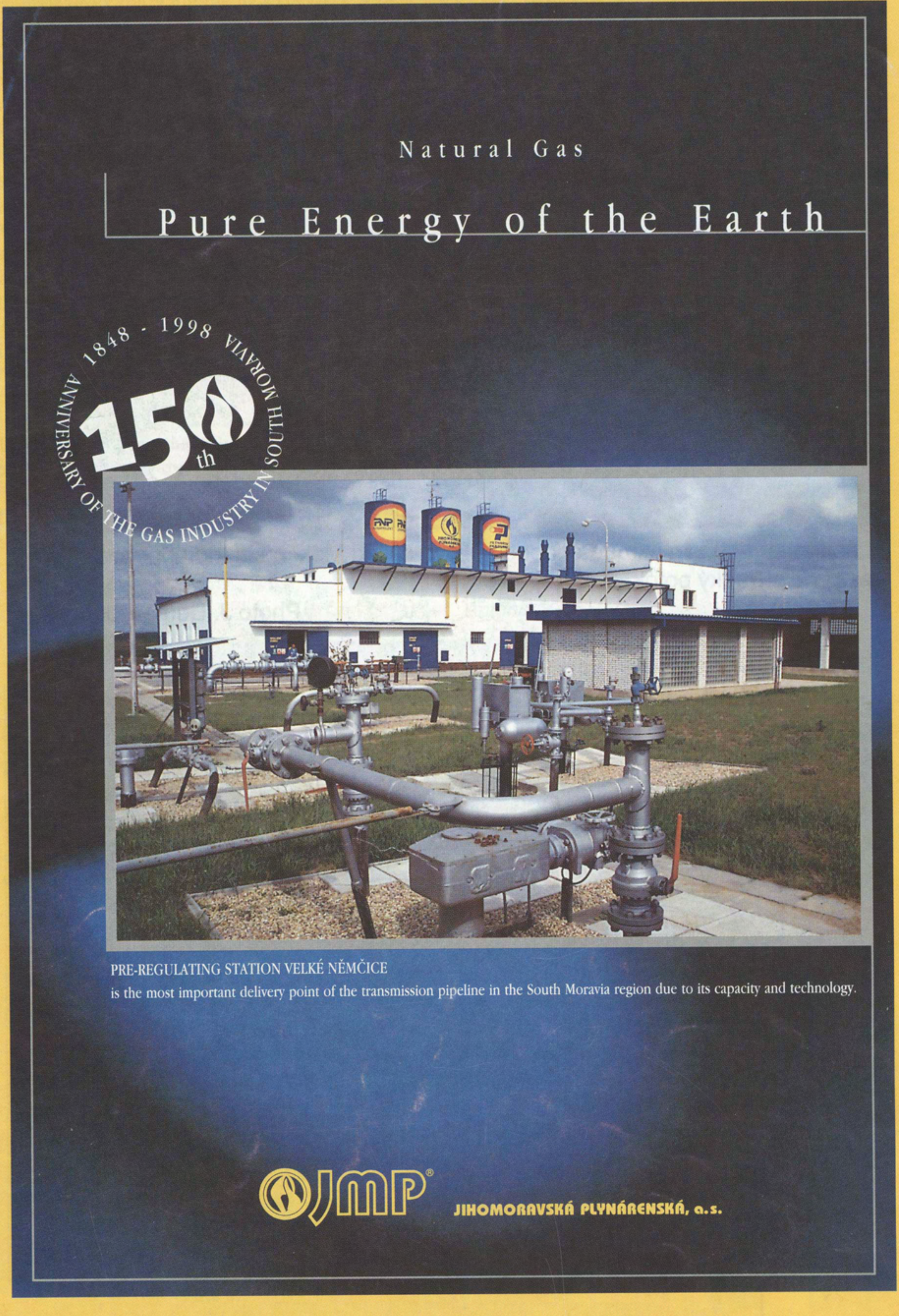
Amphitheatral basin (cirque-shaped hollow) called Mokřina in the upper reaches of the Brook Prudký potok.

Photo J. Demek, July 1998.

Open V-shaped valley section of the Brook Prudký potok below the amphitheatral basin Mokřina.

Photo J. Demek, July 1998.

Illustrations to the paper on of J. Demek - J. Kopecký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