ACTA MONTANA IGt AS CR (1993)
Series A, No. 4(90), 3—6

ENGINEERING GEODYNAMICS: A THEME OF RECENT BULGARIAN-CZECHOSLOVAK COOPERATION

(Introductory Note)

[a]Jan Rybář and [b]Iliya Iliev

[a]*Institute of Geotechnics, Academy of Sciences of the Czech Republic, V Holešovičkách 41, 182 09 Prague, Czech Republic*

[b]*Laboratory of Geotechnics, Bulgarian Academy of Sciences, Acad. G. Bonchev Str., bl. 24, 1113 Sofia, Bulgaria*

In the mid-sixties, contacts between the research teams of the Laboratory of Engineering Geology of the Bulgarian Academy of Sciences and the Department of Engineering Geology of the Czechoslovak Academy of Sciences were established. This cooperation has been marked by the dominating activities of E. Avramova-Tačeva and B. Košťák, with the coordinating efforts of both authors. This brief review of the history of these contacts is aimed to introduce a series of contributions dealing with main results of the joint research and explain its concepts and methods.

A basis for the systematic cooperation was formed in 1970. First, the regional surveying of selected important landslide regions in Bulgaria and Czechoslovakia was effectuated. It concerned regions of Tertiary brown-coal basins and regions with deep creeping movements of the block type. The first joint publication (Kamenov *et al.*, 1973) dealt with such block-type movements.

The collaboration was intensified in 1976, when new instrumentation, developed in the Czechoslovak Academy of Sciences, was introduced and the in-situ and laboratory model research of the recent activities of dangerous landsliding processes started. After 1980, the joint activities were concentrated mainly on the seismotectonically active areas and regions with complex geologic conditions for brown coal mining in SW Bulgaria and at the foot of the Krušné hory Mts. in Bohemia.

Thanks to this cooperation, many new pieces of knowledge have been acquired and published both in separated and joint contributions. Information concerning the detection of deep block-type slope displacements (Košťák and Avramova-Tačeva, 1977) has been completed. The dilatometer TM 71 has been developed and applied to joint measurements with very high precision and stability required for the observation of these very slow movements (Czechoslovak patent No. 131631, author Košťák). The regularities of the cyclic course of deep slope deformations were studied at the Taukliman locality in Bulgaria, with perfectly developed block-type

movements. The effects of earthquakes on the failure mechanism were studied and the prognosis of slope deformations given, enabling an effective utilization of an important recreational potential (Košťák and Avramova-Tačeva, 1981) of the area. Theoretical information acquired at this model locality was applied to the solution of the mechanism and dynamics of slope developments in other economically important areas of Czechoslovakia (e.g. neovolcanites of central Slovakia, sandstones of the Bohemian Cretaceous Table, etc.) and Bulgaria.

The results of the block-type movements research have, in addition to their scientific and important economic significance, also a social impact. On the Black Sea coast in Bulgaria, where suitable grounds for recreational structures have become scarce, the research results enable the sections affected by deep creeping deformation to be utilized more effectively. The results of in-situ research near Banská Bystrica contributed to the decision of modifying the mining schedule of a cinnabar deposit.

Theoretical and experimental principles of photoplastic modelling of geodynamic phenomena were elaborated with the aim to measure the mechanism of block-type slope movements. The comparison of model results on the Taukliman locality with the particularly well documented course of sliding phenomena on a real slope proved wide possibilities of photoplastic modelling of geodynamic processes (Košťák and Avramova-Tačeva, 1981).

The methodology of direct measurements of recent movements on tectonic fault structures (Košťák and Avramova-Tačeva, 1988) has been developed and checked. Measurements by means of devices developed in the Czechoslovak Academy of Sciences were concentrated on the high-seismicity areas in SW Bulgaria, which are characterized, by the UNESCO-index, among the sites with the highest seismic risk in the world. The measurements are a part of relatively extensive research works on the geodynamic polygon. Information on the relation between the movements on tectonic faults and the seismicity and gravitational motions was evaluated (Avramova-Tačeva and Košťák, 1986). The Czechoslovak partners obtained here, by joint research, comparative data, applied to the determination of critical slope angles in the crystalline rock mass of the Krušné hory Mts. in the forefield of large brown-coal open-pit mines (Rybář *et al.*, 1986).

The geologically young territory of Bulgaria, with a high proliferation of forms in relief, offers a better opportunity for studying the recent geodynamic processes than in Czechoslovakia (Avramova-Tačeva *et al.*, 1984). Therefore, the possibility of in-situ studies of the Quaternary earth-crust dynamics in Bulgarian regions with high seismotectonic activity brought valuable comparative information for analogous investigations within the Bohemian Massif (e.g. Kalvoda and Zvelebil, 1983; Kalvoda *et al.*, 1990) and the West Carpathians.

The investigation of unusual landslides in size and character in the brown-coal Maritsa-Iztok basin contributed also to the evaluation of the effects of recent tectonic processes on the stability of slopes (Rybář, 1971). The obtained comparative information was used for the analysis of the genesis of fossil deformations of sedimentary fill of brown-coal basins in Bohemia and Germany. Further, information concerning the effect of exogenic phenomena on the deformation of water reservoir

banks in Bulgaria and Czechoslovakia (Horský *et al.,* 1984; Spanilá and Simeonova, 1989) could be generalized. The process of landsliding and of the abrasive activity on water reservoir banks in clayey rocks has been analyzed in detail.

The experts of the Czechoslovak Academy of Sciences provided assistance regarding remedial measures in landslide-prone territories in Bulgaria. The Bulgarian experts introduced then successfully the method of horizontal drainage boreholes and verified its usefulness in dangerous landslide regions of the right Danube riverbank.

The close cooperation between Czechoslovakia and Bulgaria has brought benefit to both partners. The Czechoslovak experts with more sophisticated measuring equipment and also with a longer tradition in the investigation of slope displacements, had an opportunity to study the geodynamic phenomena in substantially younger landforms than in Czechoslovakia. On the other hand, the Bulgarian experts profited from applying ingeniously well tested field methods in their highly seismotectonically active regions.

Thus, the joint results are a contribution to the general development of engineering geology, engineering geomorphology, and experimental mechanics. A practical evidence is contained in the papers presented in this number of the review Acta Montana:

B. Košťák and E. Avramova-Tačeva have proved that it is possible, by long-term measurement of movements in rock mass cracks, to distinguish both the gravitational slope movements, deformations of seismic origin and the manifestations of recent tectonics.

J. Rybář investigated the effect of relieving the abnormal horizontal stress state of seismotectonic origin. Data obtained by the study of translatory landslides in the Bulgarian brown-coal Maritsa-Iztok basin is compared with similar data from Bohemian and German basins.

S. Shanov succeeded, on the example of the tectonic fault zone in SW Bulgaria, to make profitable use of exact extensometric data for a realistic prediction of earthquakes with magnitude $M > 5$. The method offers a chance of successful prediction of stronger earthquakes by 1 to 2 months in advance.

J. Kalvoda and J. Stemberk used the experience from SW Bulgaria, together with information about the geodynamics in Tadzhikistan and High-Asian mountain ranges, to evaluate the Quaternary tectonic activity in selected construction sites of nuclear power plants in Bohemia and Slovakia.

P. Zika, J. Rybář and E. Avramova-Tačeva provide the in-situ evaluation of the stability behaviour of fault slopes in the region of Krupnik in SW Bulgaria and at the foot of the Krušné hory Mts. in Bohemia. The proposed empirical approach enables the analogy to be used for the evaluation of stability of projected open-pit slopes.

T. Spanilá and G. Simeonova investigated water reservoir banks consisting of clayey rocks in Bulgaria and Czechoslovakia. They distinguish genetical bank types with regard to the conditions and deformation factors involved.

B. Vrablyanski and G. Milev discussed the analysis of neotectonic features of geological structure and relief of the Struma fault zone and dealt with the reasons of recent earth-crust motions in SW Bulgaria.

REFERENCES

Avramova-Tačeva, E. and B. Košťák (1986). Direct measurement of recent movements along seismic faults and creep slope deformations, in *Proc. 5th Int. IAEG Congr., Buenos Aires,* Balkema, Rotterdam, Brookfield, 337–346.

Avramova-Tačeva, E., B. Vrabljanski, and B. Košťák (1984). An attempt to detect recent movements along seismogenic faults, *Spis. na Bolgarskoto geol. Druzhestvo* **45**, *3*, 276–287 (in Bulgarian).

Horský, O., G. Simeonova, and T. Spanilá (1984). Remodelling of water reservoir banks by exogenous processes, *Geol. Průzk.* **26**, *6*, 163–166 (in Czech).

Kalvoda, J. and J. Zvelebil (1983). The dynamics and types of slope failures during the development of the Labe valley in the Děčín Highlands, *Acta Montana,* No. 63, 67–74 (in Czech).

Kalvoda, J., J. Stemberk, V. Vilímek, and A. Zeman (1990). Analysis of levelling measurements of the Earth's surface movements on the geodynamic polygon Mikulovice-Jezeří in the Krušné hory Mts. in *Proc. 6th Int. IAEG Congress, Amsterdam,* Balkema, Rotterdam, Brookfield, 1631–1637.

Kamenov, B., J. Pašek, I. Iliev, G. Simeonova, S. Cvetkov, and E. Avramova-Tačeva (1973). Some block-type slope failures in Bulgaria and Czechoslovakia, *Problems of Geomechanics* **6**, 49–61.

Košťák, B. and E. Avramova-Tačeva (1977). Actual dynamics of the block-type landslides, *Čas. Min. Geol.* **22**, 2, 139–149 (in Russian).

Košťák, B. and E. Avramova-Tačeva (1981). Propagation of coastal slope deformations at Taukliman, Bulgaria, *Bull. IAEG* **23**, 67–73.

Košťák, B. and E. Avramova-Tacheva (1988). A method for contemporary displacement measurement on a tectonic fault, *J. Geodyn.* **10**, 115–125.

Rybář, J. (1971). Tektonisch beeinflusste Hangdeformationen in Braunkohlenbecken, *Rock Mech.* **3**, *3*, 139–158.

Rybář, J., P. Zika, and E. Avramova-Tačeva (1986). Application of empirical approaches to the evaluation of high fault slopes in crystalline rocks, *Geol. Průzk.* **28**, 8–9, 252–255 (in Czech).

Spanilá T. and G. Simeonova (1989). Evaluation of the effects of technogenic factors on the conversion of water reservoir banks, *Vod. Hosp.* **39**, 3, 69–78 (in Czech).