*E. AVRAMOVA-TACHEVA, G. FRANGOV

ABOUT THE RELATION BETWEEN ACTIVE TECTONICS AND GRAVITATIONAL PHENOMENA IN THE TERRITORY OF BULGARIA

CONTENTS

ABSTRACT

The high tectonic activity and seismicity determine a great variety of gravitational phenomena on the territory of Bulgaria. They cause considerable destructions, economic damages and human losses. The slope processes provoked by active tectonics could be divided into two groups first group caused directly by earthquakes and second group occurred as a result of indirect impact and slow tectonic movements. Some examples are given.

KEYWORDS: Tectonic Movements, earthquakes, landslides.

1. INTRODUCTION

The territory of Bulgaria is characterized by a medium to relatively high tectonic activity and seismicity. The country had been subjected to strong historic and contemporary earthquakes causing great human losses and destructions. A number of secondary seismo-tectonic gravitational phenomena and surface deformations are known which cause additional destruction (ILIEV, 1973; FRANGOV *et alii*, 1998). In many cases it is very difficult to distinguish landslide slip surface from active faults. The slope processes occurred as a result of active tectonics could be divided in two groups: the first group is caused by earthquakes and the second one by slow tectonic movements.

2. SLOPE PROCESSES DIRECTLY INDUCED BY EARTHQUAKES

During the Shabla earthquake (1901), the Balchik landslide was activated. Large stones from the high localities above the town fell down. A part of the coast to the southwest of Balchik (Momchilov rid) with an approximate area of 200 10^3 m^2 slid down. Sliding of the coast near Kaliakra Cape was observed too. Horizontal cracks appeared at the high places (WATZOF, 1903).

As a result of two catastrophic earthquakes in the Simitli region (1904) large slope deformation with a volume of 4,5 10^6 m^3 of a complex type occurred SE of the village of Kroupnik (Fig. 1). Other landslide with area of 330.000 m^2 was activated in the eastern part of the same village (DOBREV, 1997).

The Gorna Oryahovitsa earthquake (1913) was accompanied by rock falls on the Arbanassi-Veliko Turnovo road, the Tsarevets Hill, the gorge near the Samovodene village, near the Preobragenski Monastery, etc. (STAIKOV, 1917).

The Vrancea earthquake (1940) was felt on the whole territory of Bulgaria. Some landslides along the bank of the Danube (Toutrakan, the Gorni Tsibar village, etc.) were activated.

Another strong earthquake with an epicenter in Vrancea occurred in 1977. Many landslides were triggered (Oryahovo, Gorni and Dolni Vadin, Nicopol, Toutrakan). Rock falls were observed on steep slopes made of limestones and sandstones (the village of Shirokovo, Rousse and Balchik districts, Taukliman).

Considerable damages and destruction were caused by the Strazhitsa earthquake in 1986. Most of the damages occurred on the steep terrains of the settlements and were related to the activation of slope deformations.

3. SLOPE PROCESSES CAUSED BY INDIRECT IMPACT AND SLOW TECTONIC MOVEMENTS

A typical example of an intermediate influence of an active tectonic process is the impact of Vrancea earthquakes (1977) on Taukliman block type deformations (North Bulgarian Black sea coast). The relation is proved by 3-D monitoring with TM-71 extensometer (KOSTAK & AVRAMOVA-TACHEVA, 1981). The dynamical impact in this case induced structural changes in the lower clay layer of the slope massif, leading to changes in its rheological parameters and increasing of the creep rate (fig. 2). Such influence, but with a different occurrence, has been established in the region of Aladja Monastery, north of the town of Varna (AVRAMOVA-TACHEVA *et alii*, 1998.).

The relation between earthquakes and gravitational deformations is usually indirect. Active tectonic movements induce slow changes in the primary stress-strain state of a slope massif, hence its equilibrium is disturbed and slope deformations arise, or some already existing gravitational phenomena are activated. These dependences are proved by regional and local tectonic and engineering-geological investigations, as well as by various local 3-D monitoring on the contemporary activity of tectonic faults in the slope or in its close proximity. Such evidences have been established by 3-D measurements in the Simitli graben

* Department of Engineering Geodinamics, Geological Institute, Bulgarian Academy of Sciences, Sofia, Bulgaria. E-mail: frangov@geology.bas.bg

(AVRAMOVA-TACHEVA *et alii*, 1984; DOBREV & AVRAMOVA-TACHEVA, 1999; DOBREV & KOSTAK, 2000).

Gravitational deformations determined by neotectonic vertical movements with high amplitudes are very imposing. Such deformations are observed in Mesta and Strouma valleys, within the Pirin Fault, along the steep slopes in the higher part of Stara planina, on the north Rhodope's slopes, etc.

Ancient and contemporary tectonic movements cause fracturing, breaking, grinding of rocks, perceptible structural changes in cohesive soils, thus modifying their strength and deformation properties. In combination with the impact of the additional factors the slope stability is disturbed and a corresponding type of a slope deformation can arise. Secondary tectonic disturbances parallel to large faults often divide the rock massif into separate lamellas, which

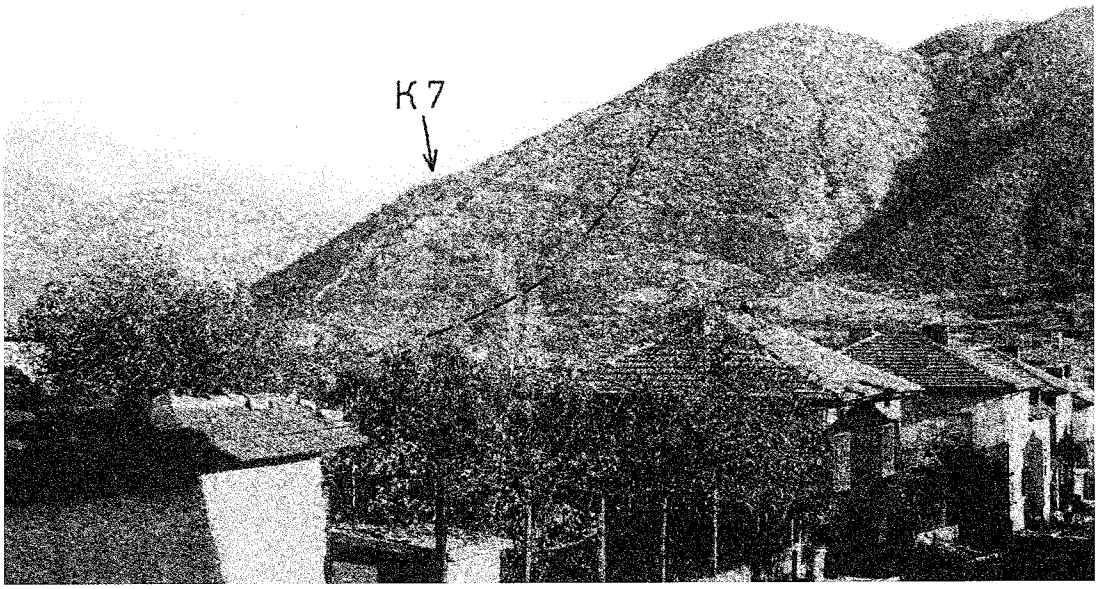

Fig. 1 - Slope deformation SE of the Kroupnik village occurred during catastrophic earthquakes in 1904.

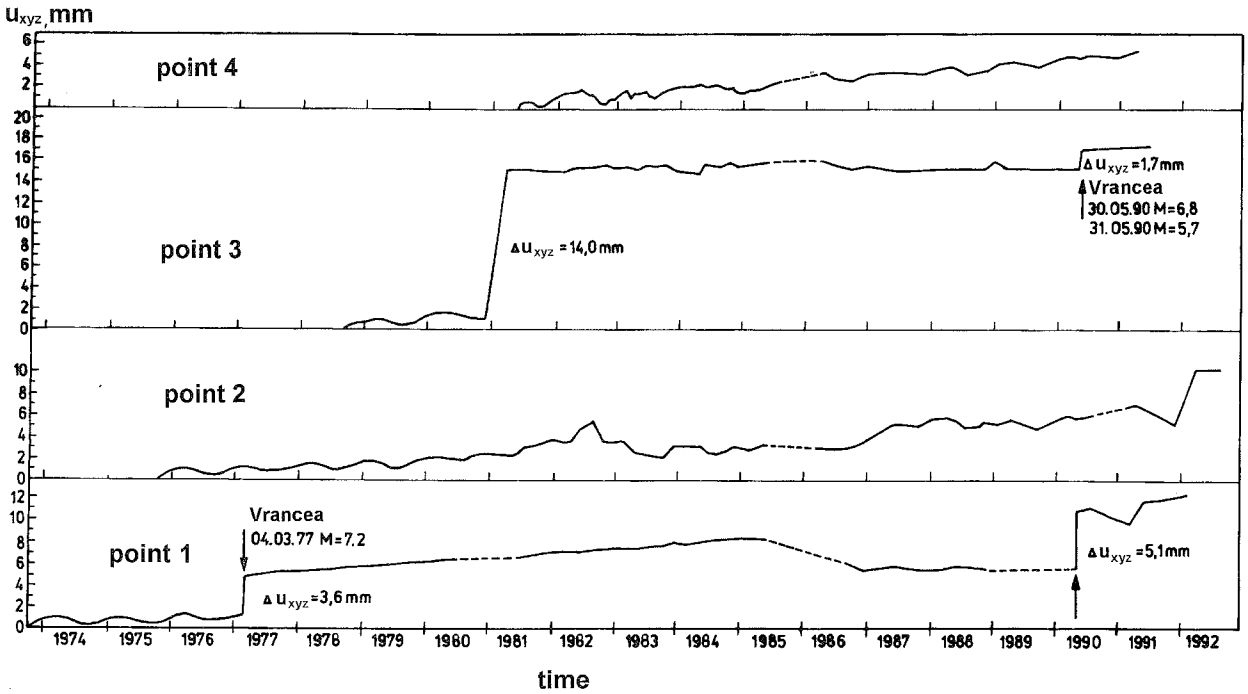

Fig. 2 - Diagram of displacements measured in Taukliman, North Bulgarian Black sea coast (after Kostak & Avramova-Tacheva, 1993).

predetermine the range and type of slope deformations. The intensity of the tectonic activity influences their dynamics.

The latest case of close correlation between landslide activation and recent tectonic movements is the unique landslide phenomena occurred in eastern part of the Rhodopes in the period 1999-2001. These gravitational processes, whose volume exceed 500 10^6. m^3, are closely connected with an active fault zone SW-NE oriented.

4. CONCLUSION

The relation between earthquakes and gravitational deformations is more often direct and clearly expressed, being simultaneous or delayed. The spatial distribution of the gravitational seismically induced phenomena and deformations follows the peculiarities of the morphotectonic structures: in the area of the Danubian plain they have strip-like distribution on the right slopes of the rivers and along the periphery of the plateaux; in the mountains these phenomena have a mosaic distribution with greater frequency in gorge valleys, on steep and high slopes.

The frequency of occurrence of the seismically induced deformations is correlated with the seismic intensity. Earthquakes of higher degree provoke deformations more different in type and greater in amount.

The largest landslide areas in Bulgaria are closely connected with the local seismic sources, or the movements along active fault zones. Monitoring of slope processes in such regions could be used as an indicator for recent tectonic activity in addition to measurements of displacements along the fault structure.

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