Study of the slow deformation observed at the Vyhne tidal station

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A b s t r a c t : The results of the extensometric measurements at the Vyhne tidal station in non-tidal frequency domain are presented in the paper. Obtained results are compared with the slow deformations observed at the Sopron tidal station. We concluded, that only those strainmeters, oriented near to the N-S direction, observed real long-term strain variations of the compressional type. This phenomenon coincides with the main feature of the European recent stress field. The similarity is not yet well established in the extensometric network described in this paper due to the small number of the strainmeters and due to the possible strong and non-accurately enough known local disturbances.

Key words: extensometer, slow deformations of the earth's crust

1. Introduction

In the Carpatho-Pannonian region a network of extensometric stations (see Fig. 1) was built (*Brimich and Latynina, 1988; Varga and Varga, 1991*), which consists of the stations Vyhne (Slovakia), Budapest, Sopron (Hungary) and Beregovo (Ukraine). The Carpatho-Pannonian region belongs to the most active parts of Europe, which is characterized by recent movements of the earth's crust, high activity of the tectonic movements, anomalously high heat flow and high seismicity. The results of extensometric measurements at all above mentioned stations were interpreted in numerous papers (e.g. *Varga, 1984; Varga and Varga, 1994*). For the correct interpretation of the measured data, it is necessary to reduce the instrumental errors. First of all, the uniform calibration of the instruments is very important (*Mentes and Brimich, 1996*). For this purpose the high precision calibration apparatus developed for the calibration of magnetostrictive coils and crapaudines

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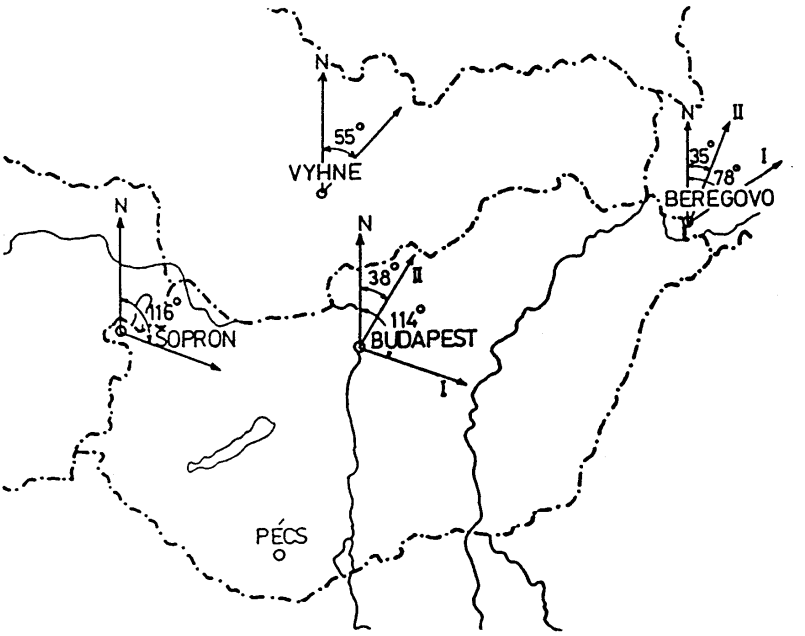

Fig. 1. Network of extensometric station in Carpatho-Pannonian region.

(Mentes, 1986, 1987, 1993) is very suitable due to its portability. The results of the unified calibration of quartz-tube extensometers at the Vyhne tidal station and Sopron station are presented in *Mentes (1991), Brimich and Dudášová (1995).*

2. Analysis of the extensometric measurements in the non-tidal frequency domain

The slow deformations observed at the Vyhne station were studied in *Kohút and Dudášová (1995).* The curve of these deformations is presented in Fig. 2. It is evident, that the drift of slow deformations can be devided into three parts. The first component is periodic with a period of about one year. By comparing this component on the curve of the thermoelastic deformations, due to the annual temperature variation we can deduce the thermoelastic origin of the periodic component *(Hvoždara and Brimich,*

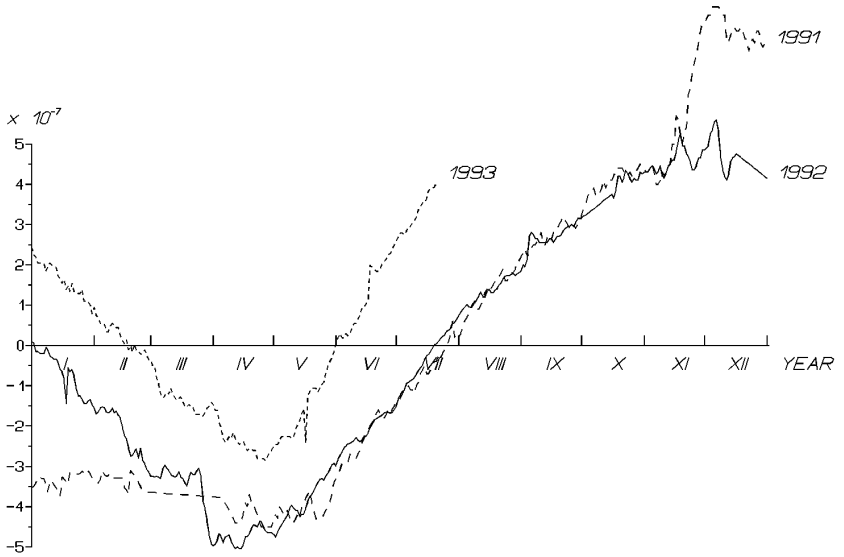

Fig. 2. The curve of slow deformations observed at the Vyhne tidal station.

1988). Short considerable changes in the rate of the slow deformations amount to the second component of the drift. This component is the immediate reaction of a rock massif containing the tidal station Vyhne to the air pressure induced deformations *(Brimich, 1992).* The third component is non-periodical and in this paper an attempt to explain the causes of this non-periodical part of the slow deformations is presented. The slow deformations observed at the Sopron station were studied in *Mentes (1993).* The curve of these deformations is presented in Fig. 3. The drift of slow deformations has a similar character as the slow deformations observed at the Vyhne tidal station. The interpretation of the long-period, non-tidal extensometric data in this case is a complicated problem due to the reduced scale of the variations. Nevertheless, we found some qualitative features of the records obtained at four observatories located in different geological conditions and relatively far from each other. We can conclude, that only those strainmeters, oriented near to the N-S direction, observed the real long-term strain variations of the compressional type. This phenomenon coincides with the main feature of the European recent stress field (*Zoback, 1992*). The similarity is not yet well established in the extensometric net-

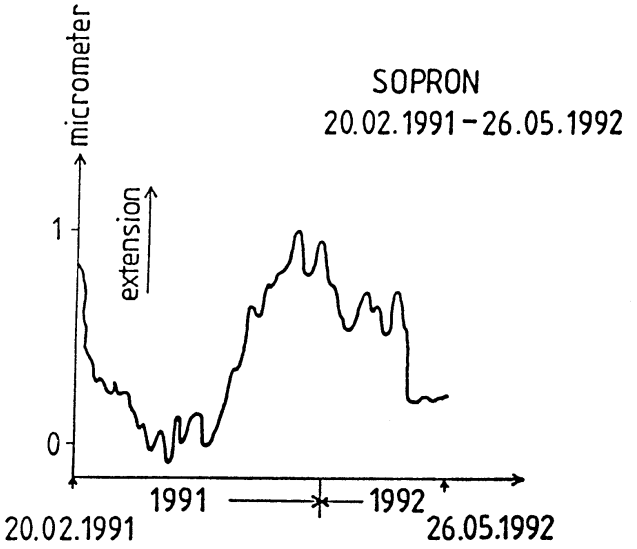

Fig. 3. Long-period variations registered at the observatory in Sopron.

work described in this paper due to the small number of the strainmeters and due to the possible strong and non-accurately enough known local disturbances. In other than nearly N-S direction the long period changes are characterized by much smaller displacements. The annual wave (possibly of thermoelastic origin) has much smaller amplitude at the margin of the Pannonian basin (Vyhne, Sopron) than at its deeper parts (Beregovo, Budapest). The nature and the regionality of this comparison is still, however, doubtful and needs further investigations.

3. Monitoring of the regional and local geodynamic effects

Monitoring of the recent geokinematical processes is a major objective in geosciences. Within this context the determination of local kinematical parameters of faults as well as the detection of so far unknown faults is of particular interest. For the application to dams with hydro power-station or to nuclear power-station the physical object of investigation is the edifice and the close geophysical environment. Consequently one is concerned with

the reconnaissance of potential critical location and its environment and the continuous monitoring of ongoing kinematical processes with the goal to get information about the development of anomalous kinematical patterns in adequate time, having then hopefully sufficient time to react technically.

Active faults generate local or regional deformations. The distinction between active and non-active faults may be just a matter of the signal detection threshold. In general the direct observation of deformation processes by geodetic measurements is confined by the limits of attainable accuracy or resolution. The observations can be mostly performed in a discrete mode. The application of special sensors for high resolution monitoring of distance variations (extensometers - strainmeters) however, require certain environmental conditions. Since the knowledge of the recent trend of ongoing changes in the local geometry of a site (time depending pattern of relative movements) contributes essentially to insights in the underlying geodynamical processes, the alternative to the direct observation of deformations is the continuous measurement of deformation induced geophysical quantities. The basic condition for this concept is stationarity of the regression function or a reliable model concerning its potential time dependence. These indirect deformation measurements can potentially overcome the problem of the limited quantity of observation points. Experiments [1, 2] and experiences [3, 4] have approved that tilt data are powerful means for the indirect monitoring of kinematical processes. An instrumental resolution up to 0.00001 is principally possible. Of course, the higher the accuracy the greater difficulties concerning the instrumental installation and concerning the interpretation of the observed signals.

4. Conclusions

Earth's tides are the only type of global deformation of the Earth, for which we are capable to determine the forces responsible for them with sufficient accuracy. That is why their study is important in geophysics. If the relation between the actually observed tidal variations and the values calculated theoretically are known, it is possible to determine the elastic parameters of the Earth as a whole or of some of its parts. To calculate these elastic parameters it is necessary to eliminate all disturbing effects

from the results of the analysis of tidal observations, thus providing them with the required accuracy.

The measurement of inclinometric processes in arrays or profiles of observation point with free options concerning individual observation modes and resolutions is regarded to be a powerful and flexible method for monitoring tectonical processes, especially in locations where active or "non-active" faults shall be investigated. Also surveying for the detection of unknown faults can be performed.

The interpretation of the long-period, non-tidal extensometric data in this case is an complicated problem due to the reduced scale of the variations. Nevertheless, we found some qualitative features of the records obtained at four observatories located in different geological conditions and relatively far from each other. We can conclude, that only those strainmeters, oriented near to the N-S direction, observed real long-term strain variations of the compressional type. This phenomenon coincides with the main feature of the European recent stress field (*Zoback, 1992*). The similarity is not yet well established in the extensometric network described in this paper due to the small number of the strainmeters and due to the possible strong and non-accurately enough known local disturbances. In other than nearly N-S direction the long period changes are characterized by much smaller displacements. The annual wave (possibly of thermoelastic origin) has small amplitude at the margin of the Pannonian basin (Vyhne, Sopron). The nature and the regionality of this comparison is still, however, doubtful and needs further investigations.

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