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GEODYNAMIC INVESTIGATIONS ALONG THE MECSEK-FAULT IN HUNGARY USING PRECISE GEODETIC DEVICES

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Abstract

During the planning phase of low and medium radioactive waste deposition in Hungary the recent activity of the Mecsek-fault was investigated using precise geodetic devices also. The observations were carried out with Leica NA3003 precise levelling instrument, Leica DI2002 precise EDM instrument and four Trimble SSE GPS receivers. For continuous observations two borehole tilt meters were installed at both sides of the fault.
The measured height differences between the end points of the precise levelling, which are placed in the outcrop of limestone and granite base, show a periodic behaviour with approximately two years of wavelength and 0.5-1.0 mm amplitude. The -0.08 mm/year linear trend may be neglected. The periodic behaviour can be recognized in the case of EDM and GPS derived distances as well. The EDM derived distances are always longer than the GPS derived ones, however the time series of GPS derived distances seems to be more consistent. The linear trends of horizontal changes are not significant at the moment. The tilt meter registrations are in accordance with the traditional observations.

1. Introduction

In the course of preliminary planning phase of low and medium radioactive waste deposition in Hungary the eastern part of the Mecsek Mountain proved to be a suitable place for this engineering object. In the second phase, during the geophysical and geotechnical investigations, the recent activity of the Mecsek-fault was investigated using precise geodetic devices also.
According to our knowledge the Mecsek-fault zone is a complex system with low seismicity (Tóth et al., 2002). The earthquakes of the last fifty years had magnitudes of less then 2.0 and they usually can not be attached to specific faults.
The recent activity of the geologically known fault, nearest to the planned waste deposition, was investigated by precise levelling, GPS observations, EDM distance measurements and continuous bore hole tilt meter registrations. In this paper a relatively long period (five years, eleven epochs) of practical geodetic observations are summarized.

2. Planning of the geodetic networks

The geodetic benchmarks were placed in the sediments above limestone (north of the fault) and above granite base (south of the fault) according to Fig. 1. The levelling benchmarks 1001, 1002, 1003 and 1004 were placed in the outcrop of the bedrocks, while the benchmarks 100 and 200 were placed in boreholes filled with concrete. For horizontal investigations reinforced concrete pillars were built (4366, 4371, 4446 and 2052). The bore hole tilt meter D1 reached the bedrock, while the D2 tilt meter is only near to the bedrock.
The observations were carried out with Leica NA3003 precise levelling instrument, Leica DI2002 precise EDM instrument and four Trimble SSE GPS receivers. Two component Applied Geomechanics Model 722A borehole tilt meters were used for continuous observations.

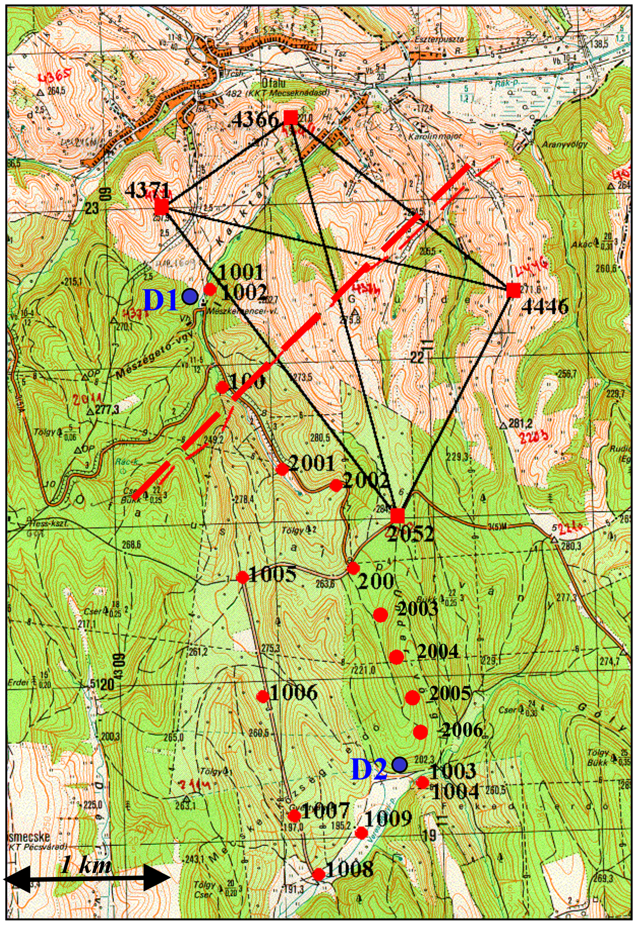

Fig. 1. Geodetic networks of the investigated area

3. Results of precise levelling

The changes of the height differences between the two endpoints (1001 and 1004) measured by NA3003 precise levelling instrument show a periodic behaviour with approximately two years of wavelength and 1 mm amplitude (Fig. 2). The linear trend of -0.08 mm/year may be neglected.

The height changes of the individual levelling benchmarks were determined by the free network approach, where the square sum of the endpoint's changes were minimized (i.e. their mean height was not allowed to change). The endpoints therefore show a very similar behaviour to the height differences, namely the periodic behaviour with a negligible linear trend (Fig. 2). Benchmark 100 near to the bedrock shows similar, but larger changes than benchmark 1001, benchmark 200 in the approximately 25 m thick sediment shows larger changes, which may be connected to the ground water content of the sediment (Fig. 2).

4. Results of GPS observations and EDM measurements

The horizontal network observed for 24 hours simultaneously epoch by epoch using Trimble SSE GPS receivers was partly measured by precise Leica DI2002 EDM instrument to compare the two techniques.

Fig. 2. Graphic interpretation of the measured relative height changes

The GPS derived baselines were determined by the Bernese software using L1 combinations (without ionospheric modelling) and using L3 ionosphere-free combinations together with the estimation of tropospheric effects. The ionospheric scale factors were removed from the combinations of L1/L3 baselines using the GPS-NET software.

For the shorter baselines the GPS and the EDM derived distances show very similar linear trend (Fig. 3), but the GPS distances are typically shorter. The GPS derived distances seems to be more consistent than the EDM derived ones especially at a longer distance (446-4371), where the average refractivity computed from the meteorological values measured at the endpoints is not satisfactory. Those baselines which were determined using only GPS measurements are given in Fig. 4.

Similarly to the precise levelling a periodic behaviour can also be recognized with very low but consistent linear trends.

5. Geodynamic interpretation

The low linear trends determined from precise levelling and horizontal investigations are in good accordance with the tilt observation summarized in Fig. 5 and 6. The tilt meter D1 attached to the bedrock shows very small changes, while the D2 near to the bedrock in the sediment shows larger changes with some periodic character.
The more detailed descriptions of the borehole tilt registrations can be found in Mentes (2000, 2001 and 2003).
In spite of the relatively long observation period and more or less consistent linear trends the parameters of the strain estimations are not significant at the moment. It is in good agreement of the low seismicity of the investigated area.

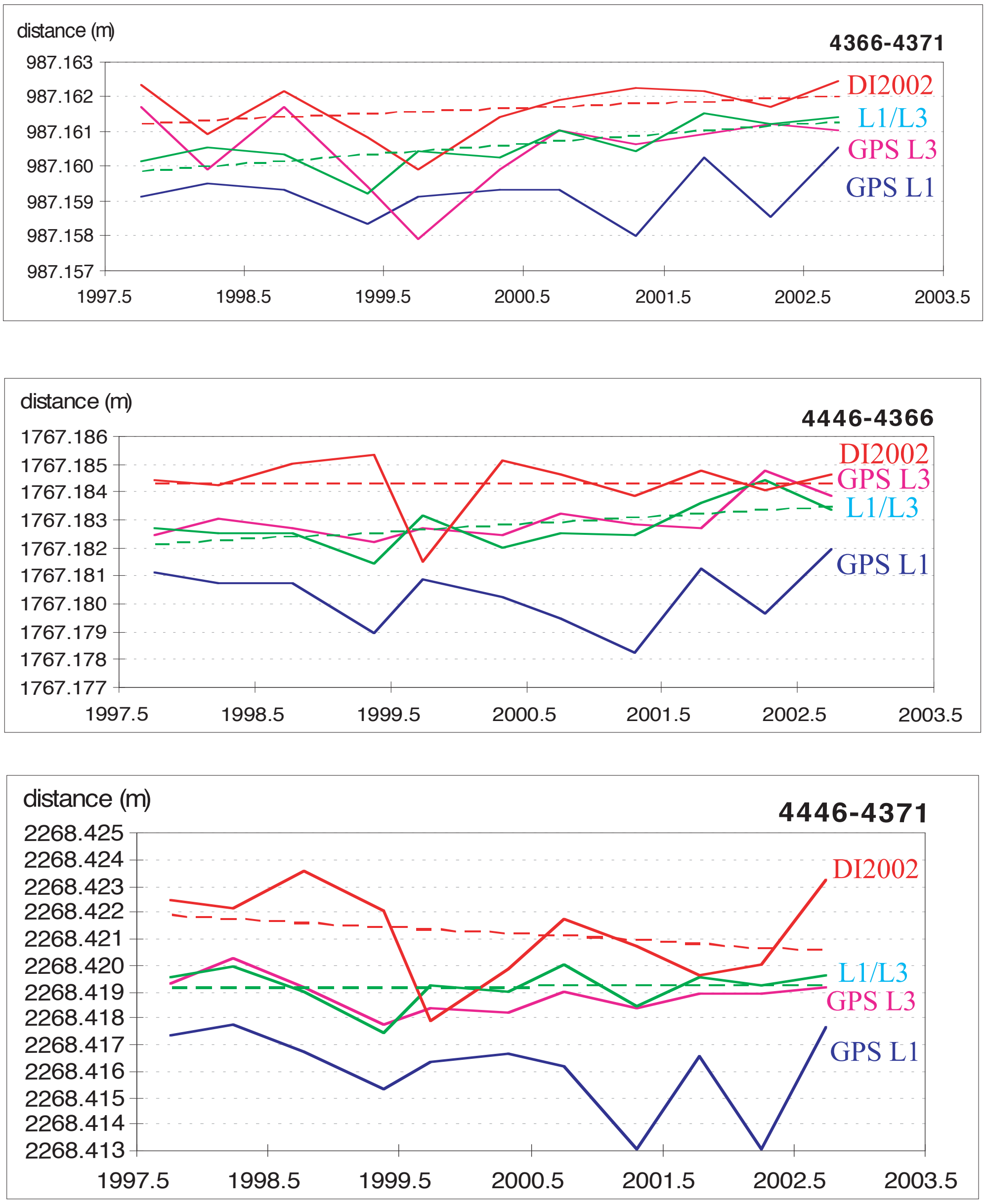

Fig. 3. Comparison GPS and EDM derived distances

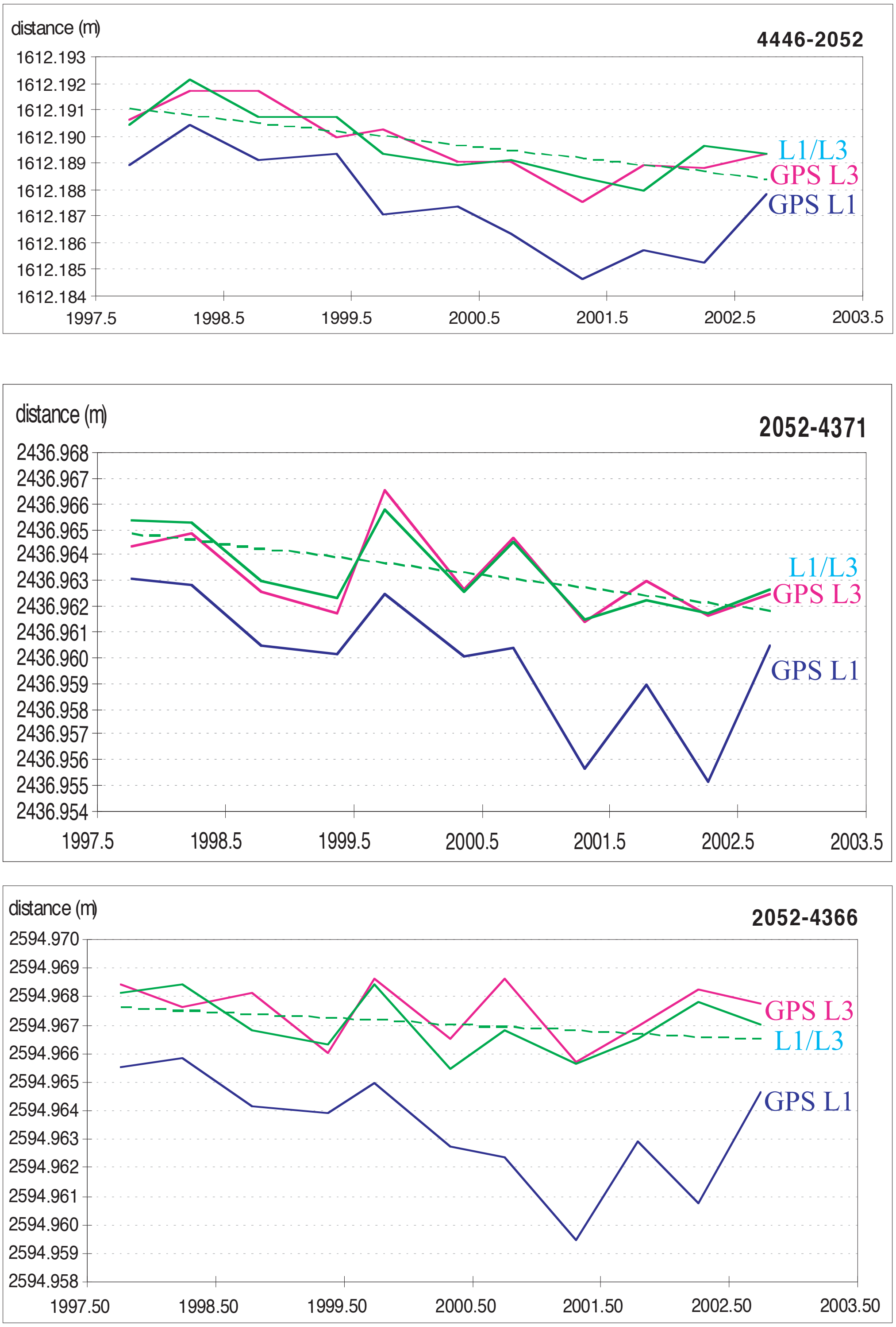

Fig. 4. Only GPS derived distances

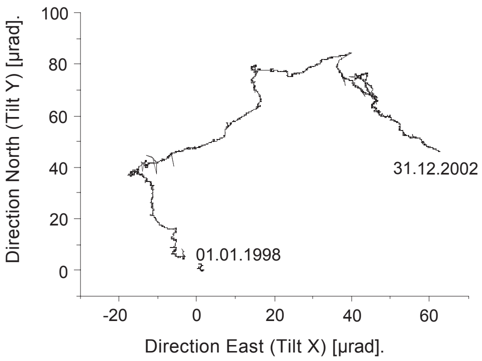

Fig. 5. Tilt measurements at D1

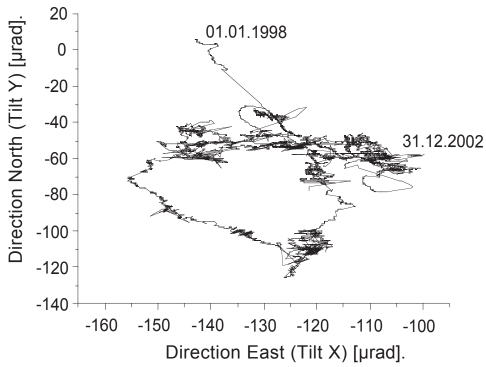

Fig. 6. Tilt measurements at D2

6. Summary

The precise levelling and the GPS observations proved to be preferable techniques in the case of local geodynamic application as well. The GPS technique provided similar trends as the precise EDM instrument, but they have a characteristic difference as a consequence of different scale errors. Because in the case of EDM measurements the average refractivity can not be determined accurately along longer distances the GPS can provide more consistent time series, if the tropospheric and ionospheric effects are properly removed from the observations. The tilt observation can be used to fill the data gap between the traditional measurements epochs.
The proper interpretation of the time series however needs much more longer data set. The separation of the processes caused by the bedrocks and by the sediments is a crucial point of the geodynamic interpretations.

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