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GPS SUBSIDENCE MONITORING NETWORKS IN THE NORCIA AREA (CENTAL ITALY)

CONTENTS

ABSTRACT

A new processing technique for GPS observations taken in a monitoring network is described. The technique minimizes the effect of multipath and ionospheric delay; under certain conditions we achieve accuracies of fractions of mm. The network configuration has undergone a constant development in order to catch the maximum geodynamic deformations looked for.

In this paper we present the results of a 3-D subsidence network installed in the Norcia seismic zone (Cental Italy). Measurements were performed in May 2001 and May 2002; first we used a wide network and post processed the observations, next we used a line-type network the observations of which were processed in real time.

KEYWORDS: GPS technique, multipath, ionospheric delay, active faults

1. GPS MONITORING EXPERIMENT

Today GPS observables are so accurate that it makes sense to investigate if they can be used for subsidence monitoring at the mm-level. This challenge, of course, asks for using sophisticated filters and data handling. Most systematic errors are eliminated to some extent by using relative positioning techniques. The difficulties in ionospheric and tropospheric modelling set certain limits for the extension of the system: all baselines should be short and the height differences small. The ultimate difficulty is to cope with multipath effects. We exploit the well-known repetition of the satellite constellation every 24 hours. Efficient filters model this error source down to sub-millimeter level.

In order to test a new super-precise GPS measuring system for monitoring of 3-D subsidence networks, a cooperation, under the auspices of the COST (European Cooperation in the Field of Scientific and Technical Research)-Action 625 "3-D Monitoring of Active Tectonic Structures", among researchers from the Universities of Aalborg (Denmark), the CNR-Institute of Geosciences and Earth Resources (Florence) and the University of Camerino (Macerata) was initiated in the Central Italy (Norcia seismic zone; CELLO *et alii*, 1997).

On the base of geological information regarding the main properties of the seismogenic faults (TONDI, 2000; TONDI & CELLO, 2003), we installed in the Norcia seismogenic zone a local network of geodetic stations (benchmark for GPS).

The area selected for this study (Fig. 1) has suffered some of the strongest historical earthquakes recorded in Italy (CPTI, 1999): i.e. that known as the Norcia earthquake, which occurred on the 14^{th} of January 1703 (Imax=XI). From a structural point of view the Norcia area, located in the axial zones of the central Apennines (refer to Fig. 1), is affected by two major NNW-SSE trending normal-transtensional faults border the Norcia basin, a tectonic depression filled with Pleistocene-Holocene fluvio-lacustrine sediments (CELLO *et alii*, 1997; TONDI, 2000; TONDI & CELLO, 2003).

Measurements in the Norcia seismic zone were performed in May 2001 and May 2002; first (May 2001) we used a wide network, including six Sercel receivers (Thales Navigation), and post processed the observations, next (May 2002) we used a line-type network, including five Z-Xtreme receivers (Fig. 2, EIVA Ltd. and Aalborg University), the observations of which were processed in real time (BORRE *et alii*, 2003).

The objective of the project was to test a new super-precise GPS measuring system for monitoring of 3-D subsidence networks in active tectonic zones. We used the DEMON software (BOVA ApS firm) that was especially developed for this kind of experiment (Fig. 3). The software has both an initialization and a monitoring mode. The initialization period takes 24 hours, monitoring takes place in the 24 hour periods following the initialization by comparing the results from these periods with those from the initialization period. Since the orbital repetition is not exactly 24 hours, the software determines the optimal repetition period. Also, it takes care that the same satellite configuration is used when comparing corresponding epochs.

The experience gained during the Norcia project led us to modify the DEMON software in the autumn 2002; it now provides phase-only solutions and improved atmospheric models for longer baselines with larger height differences.

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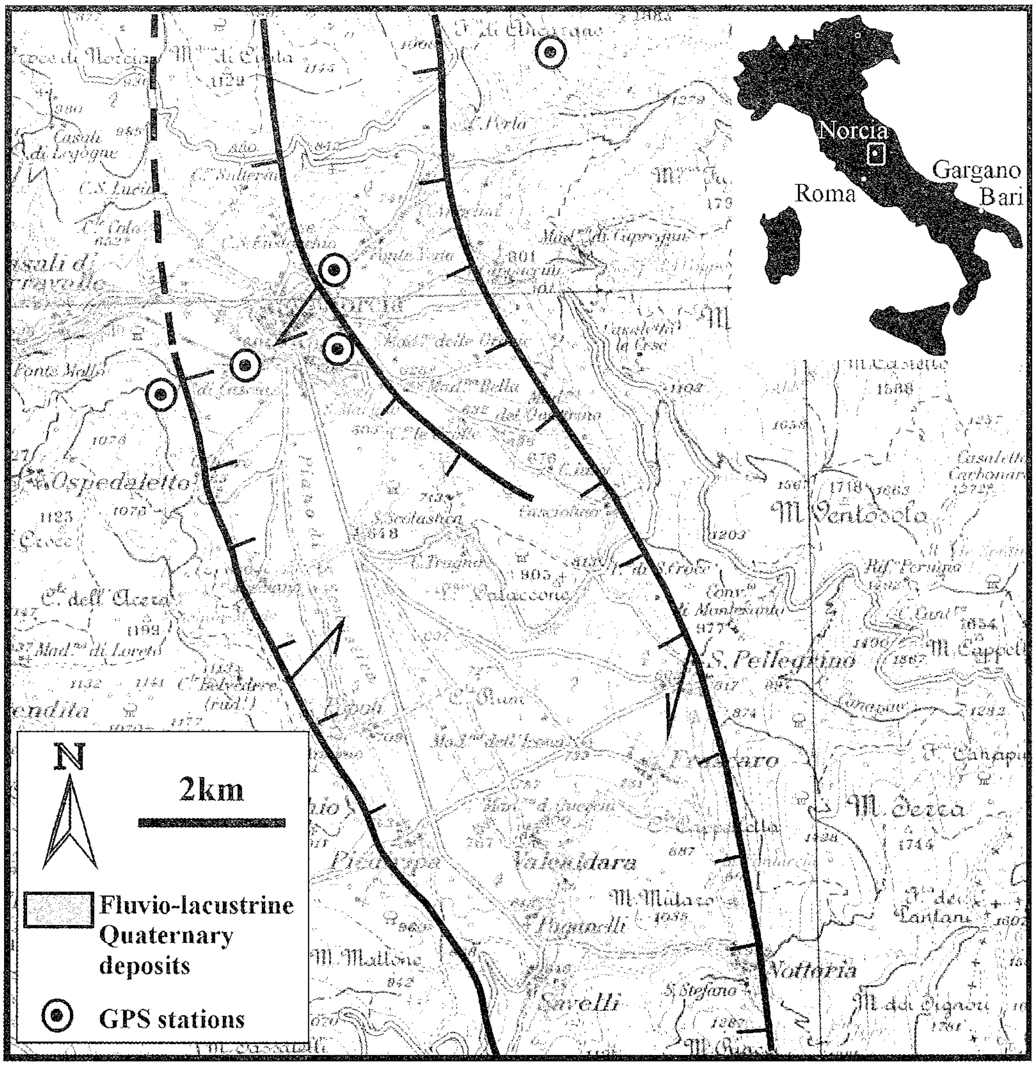

Fig. 1 - Norcia fault system, with location of the monitoring instrumentation.

Fig. 2 - The antenna at Station 2 on the top of a concrete block established more than a century ago.

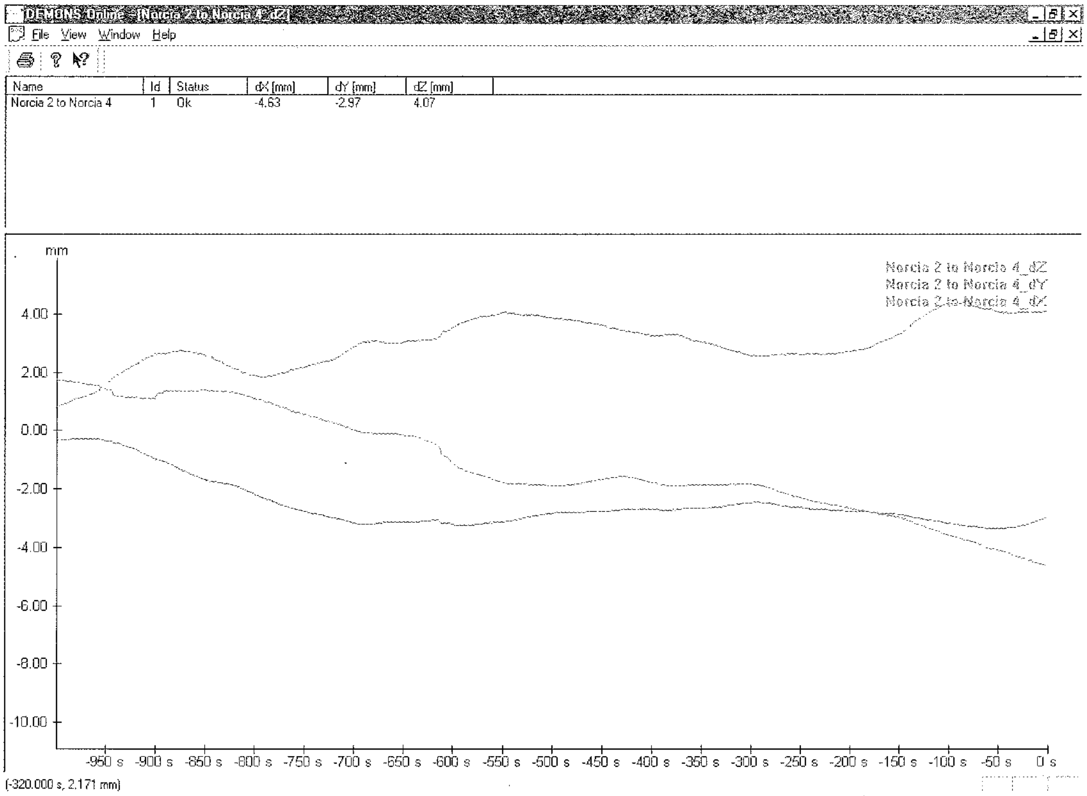

Fig. 3 - Typical DEMON output; the corrections of the components of the baseline vector between Stations 2 and 4 vary between +4 and -4 mm over 16 minutes.

REFERENCES

BORRE K., CACON S., CELLO G., KONTNY B., KOSTAK B., LYKKE-ANDERSEN H., MORATTI G., PICCARDI L., STEMBERK J., TONDI E., VILIMEK V. (2003) - *The COST project in Italy: analysis and monitoring of seimogenic faults in the Gargano and Norcia areas (central-southern Apennines, Italy)*. Journal of Geodynamics, **36**, 3-18.

CELLO G., MAZZOLI S., TONDI E., TURCO E. (1997) - *Active tectonics in the Central Apennines and possible implications for seismic hazard analysis in peninsular Italy.* Tectonophysics, **272**, 43-68.

C.P.T.I. GRUPPO DI LAVORO (1999) - *Catalogo Parametrico dei Terremoti Italiani*. ING, GNDT, SGA, SSN, Bologna, 92 pp.

TONDI E., (2000) - *Geological analysis and seismic hazard in the Central Apennines*. In: Cello, G.& Tondi, E. (Eds.), The resolution of geological analysis and models for earthquake faulting studies. Journal of Geodynamics, **29 (3-5)**, 517-534.

TONDI E. & CELLO G. (2003) - *Spatiotemporal Evolution of the Central Apennines Fault System (Italy)*. In: Cello, G. & Kostak, B. (Eds.), Active faults: analysis, processes and monitoring. Journal of Geodynamics, **36**, 113-128.