FINAL REPORT CERGPOP-2/ENVIRONMENT WP3: „PERIODIC IMPROVEMENT OF THE REFERENCE FRAME CEGRN"

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Summary: ***The main objective of CERGOP-2/Environment Work Package (WP)-3 was defined in the Project as "Monitoring the CEGRN by regular and systematic GPS measurement, satisfying the strict quality standards set by WP 2". The main task in the course of the Project was the organization of the CEGRN epoch observation campaigns. Therefore the activities focused on the preparation and the careful realization of these measurements. Two CEGRN campaigns were carried out – CEGRN03 and CEGRN05 - in the same part of the year (in June) in order to minimize seasonal effects in the measurements. In both cases the CEGRN campaigns were overlapped with national campaigns (e.g. in Hungary the HGRN epoch campaigns) by which the scope and efficiency of data availability were greatly enhanced. An other task was to monitor the status of CEGRN. Due to the project support 25 new sites became part of CEGRN. Serbia as a new CEGRN Consortium member (not included in the Project) joined the campaigns in 2005 the first time.***

INTRODUCTION

The objective of CERGOP-2/Environment Work Package (WP)-3 was defined in the Project as "Monitoring the CEGRN by regular and systematic GPS measurement, satisfying the strict quality standards set by WP 2". WP 3 has carried out its activities in collaboration with all project partners, more precisely with the CEGRN Consortium partners. The Consortium was established in 2001 ad served as the formal institutional basis for the project. As input for our work we made use of an already established and well maintained network, the CEGRN that had a history and experience of 6 epoch campaigns between 1994- 2001. This final report is a concise summary of 3 earlier yearly reports of WP 3 submitted to the project reviews and published in the Reports on Geodesy series.

THE CEGRN'03 EPOCH CAMPAIGN

The preparation of the CEGRN'03 epoch campaign was the task of the Hungarian group. We have distributed the circulars for the campaign call. Consulted technical details with the Graz Data Centre and the project coordinator. Responded to several inquires of participants.

The CEGRN'03 campaign was successfully carried out from 16 to 21 June 2003 on 58 accepted CEGRN sites in 13 Central European countries and an additional 10 other sites simultaneously. 4 of the other sites were in the close vicinity of accepted sites due to monument displacement or establishment of new permanent stations. The data have been submitted to the CEGRN Data Centre in Graz.

THE CEGRN'05 EPOCH CAMPAIGN

The CEGRN'05 campaign was very successful and high quality, valuable GPS data have been submitted to the CEGRN Data Centre in Graz. The number of participants were the highest ever in CEGRN history.

The GPS measurements were carried out from 20-25 June 2005 on more than 80 sites in 14 Central European countries. Serbia as a new consortium member participated the first time with 3 stations (SUBO, LJIG, LESK). Further new stations were activated in Austria (TRFB), in Bulgaria (ROZH, VARN), in the Czech Republic (SNEZ), in Hungary (SUME), in Italy (ROVI, ASIA), and in Poland (SACZ). In addition several other sites have sent data to the Graz Data Centre without notifying WP 2 or WP 3 about their site characteristics. We do not consider these as CEGRN sites until approved by the CCGB. They are labeled "candidate" in Table 1 where an overview of historical site occupations is shown. The situation of BH sites has been clarified following the final project meeting in Graz: Banja Luka (LUKA)and Mostar (MOST) were nominated as new CEGRN permanent stations and Kudic Brdo (KUDB), Turic (TURI) and Leotar (LEOT) were nominated for new CEGRN epoch sites. WP 2 will make the necessary assessment and recommendations in due time.

THE CEGRN SITE OCCUPATION HISTORY

Figure 1 gives a site occupation statistics since 1994. The number of sites significantly increased in the CERGOP-2 project period (1999-2005) as compared with CERGOP-1 (1994 – 98). Particularly, the sharp increase following 2001 was due to the EU project support in CEGRN extension/densification activities. We note that 18 sites have fully participated in each (8) epoch campaign since 1994. This gives a very valuable 11 years monitoring time base for these stations that is a significant subset of present day CEGRN.

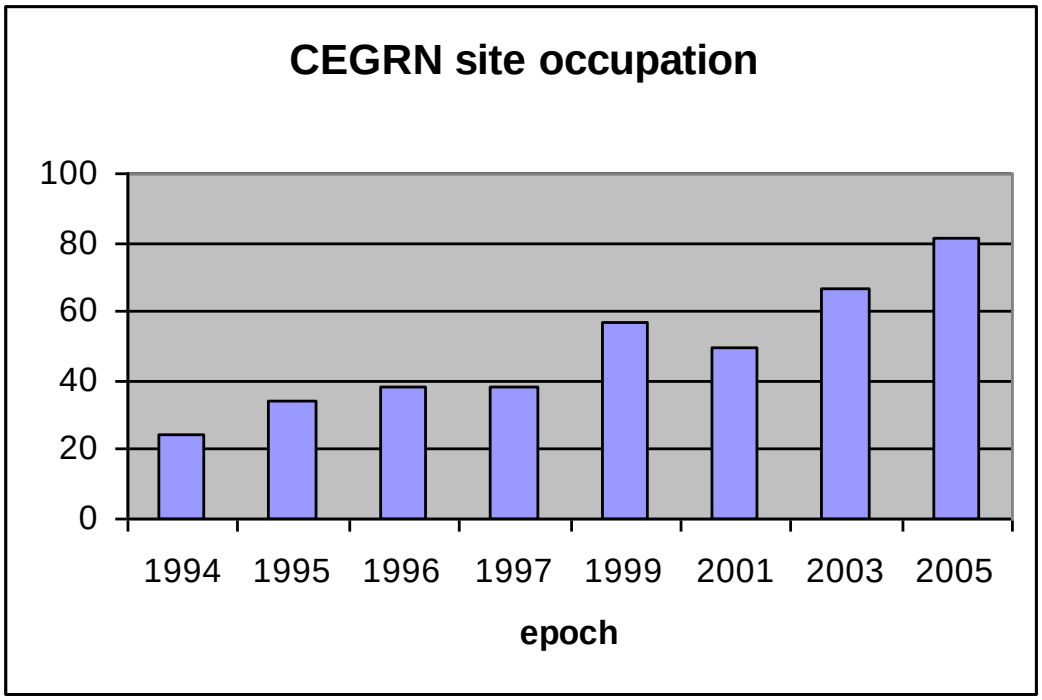

Fig. 1. The number of sites participating in CEGRN epoch campaigns 1994-2005.

Table 1 gives a historical overview of site occupations in more details. Some unavoidable changes in the network can also be tracked which may help in data analysis or to shape future designs. The table contains destroyed, defunct, problematic, inactive and candidate sites as well as twin (very close) sites in order to provide a comprehensive picture.

Table 1. The CEGRN site occupation history (version 2006-08-14)

Country	Marker Name	OCCUPATION								Remark
		1994	1995	1996	1997	1999	2001	2003	2005	
AUT	GRAZ	x	x	x	x	x	x	x	x	
	GRMT	x	x	x	x			x	x	epoch marker
	GRMS					x		x	x	permanent
	HFLK		x	x	x	x	x		x	
	AT01	x	x	x	x	x	x	x	x	=HUTB
	SBGZ					x	x	x	x	
	TRFB								x	
BIH	SRJV					x	x	x	x	
	MOST									candidate
	LUKA									candidate
	KUDB								x	candidate
	LEOT								x	candidate
	TURI								x	candidate
BUL	GABR							x	x	
	HARM			x	x			x	x	
	KAVA							x	x	
	SOFI			x	x	x	x	x	x	
	ROZH								x	
	VARN								x	
CRO	BRSK	x	x	x	x	x	x	x	x	
	CAOP						x	x		problematic
	DUBR						x	x	x	
	HVAR				x	x	x	x	x	
	OSJE					(x)	x	x	x	
CZE	GOPE	x	x	x	x	x	x	x	x	
	LYSA					x	x	x	x	
	POLO	x	x	x						
	POL1					x	x	x	x	
	SNEC							x	x	
	TUBO		x			x	x	x	x	
GER	DRES					x	x	x	x	
	HOHE	x	x	x	x	x		x	x	
	KIRS	x	x	x	x	x				inactive
	POTS		x	x	x	x	x	x	x	
	WTZR			x	x	x	x	x	x	
HUN	CSAN					x	x	x	x	
	CSAR	x	x	x	x	x	x	x	x	
	DISZ	x	x	x	x	x	x	x	x	
	PENC	x	x	x	x	x	x	x	x	
	SUME								x	
	TARP					x	x	x	x	

Table 1. (cont.) **The CEGRN site occupation history** **(version 2006-08-14)**

Country	Marker Name	OCCUPATION								Remark
		1994	1995	1996	1997	1999	2001	2003	2005	
ITA	ASIA								x	
	BASO	x	x	x	x					inactive
	BZRG					x	x	x	x	
	CAME							x	x	
	MATE	x	x	x	x	x	x	x	x	
	MEDI					x	x	x	x	
	UPAD	(x)	x	x	x	x	x			inactive
	PADO							x	x	
	ROVI								x	
	UNPG						x	x	x	
POL	BOR1	x	x	x	x	x	x	x	x	
	GRYB	x	x	x	x	x	x	x	x	
	JOZE	x	x	x	x	x	x	x	x	
	LAMA	x	x	x	x	x	x	x	x	
	SACZ								x	
	SNIE	x	x	x	x	x	x	x	x	
	WROC					x	x	x	x	
ROM	BRAI							x	x	
	BUCA		x	x	x	x		x	x	
	BUCU					x	x	x	x	
	CLUJ							x	x	
	CONT								x	
	CRAI								x	
	FUND		x	x						damaged
	FUN3					x	x	x	x	
	GILA		x	x						damaged
	GIL2				x	x				damaged
	IAS3			x	x	x				damaged
	MACI		x	x	x	x				damaged
	MAC2							x		
	MAC3								x	
	MAC5					x				
	ORAD								x	
	SIBI							x	x	
	SUCE							x	x	
	TIMI							x	x	
	TIS3			x	x	x		x	x	
	VATR		x	x						damaged
	VAT1				x	x				damaged
	VRAN		x	x						damaged
	VRN1				x	x	x	x	x	

Table 1. (cont.) **The CEGRN site occupation history (version 2006-08-14)**

Country	Marker Name	OCCUPATION								Remark
		1994	1995	1996	1997	1999	2001	2003	2005	
SER	LJIG								x	A015
	LESK								x	A027
	SUBO								x	
	LOZN									
	PRIJ									
SLO	BOZI					x	x	x	x	
	LEND					x	x			inactive
	LJUB	x	x	x	x	x	x	x	x	
	MALJ					x	x	x	x	
	MRZL							x	x	candidate
	SNEK							x	x	candidate
SVK	KAME					x	x	x	x	
	LOMS								x	
	MOPI	x	x	x	x	x	x	x	x	
	PART					x	x	x	x	
	RISO								x	
	SKPL	x	x	x	x	x	x	x	x	
	STHO	x	x	x	x	x	x	x	x	
UKR	IVAN							x	x	candidate
	LVIV		x	x	x	x	x	x	x	
	SHAZ					x			x	
	SULP				x	x	x	x	x	
	UZHD	x	x	x	x	x	x	x	x	
	UZHL						x	x	x	

Beside the total number of CEGRN sites, the relation of permanent end epoch sites may also be interesting as function of time (Fig. 2). Here we note again, that in many cases the newly established permanent sites are close by to epoch sites which are still active. As the longer time scale concerned, measurements on these epoch sites will tend to be discontinued.

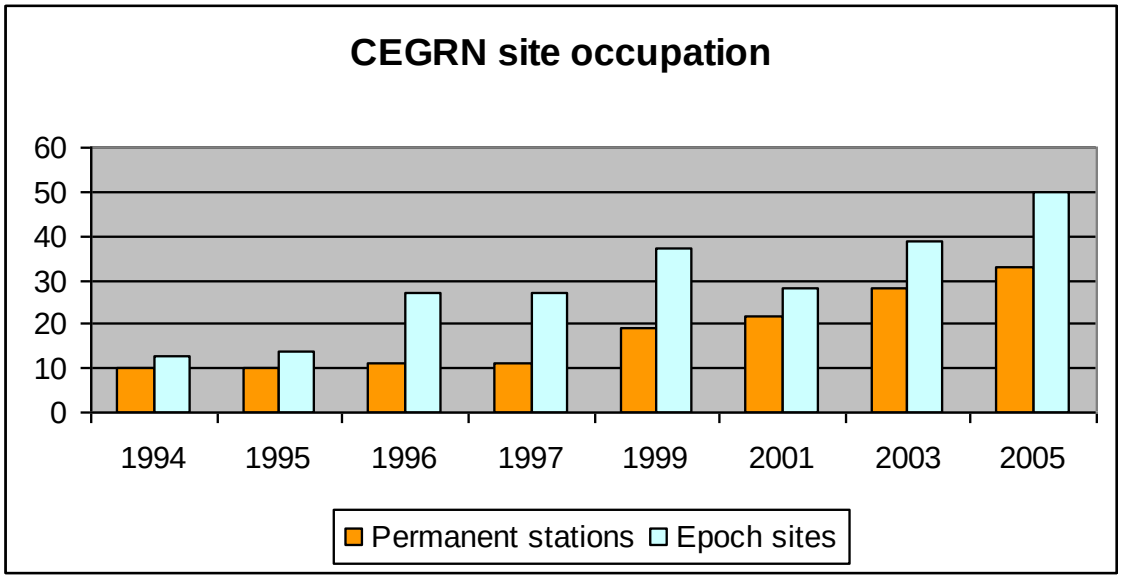

Fig. 2. The number of permanent/epoch sites participating in CEGRN epoch campaigns 1994-2005.

THE HGRN CAMPAIGNS IN HUNGARY

High precision national geodynamic GPS reference networks were established in parallel with CEGRN in several countries in the region. An overview is given by Grenerczy and Kenyeres (2005)). Data from these networks can significantly contribute to analysis and interpretation of tectonic processes in Central Europe consequently to the goal of the CERGOP 2/Environment project. As an example the Hungarian case is described in some details in this section.

The Hungarian Geodynamic GPS Reference Network (HGRN) was established in 1991 originally consisting of 13 sites (Fejes et al. 1993). Historically this was the model for the CEGRN design in 1994. Since 1991 regular 2 years monitoring was carried out on the HGRN. Since 1995 HGRN campaigns were synchronized with the CEGRN epoch campaigns, although with 3X24 hours durations. HGRN can be considered as one of the most regularly measured national networks in Central Europe, providing highly homogenous, long time base data. With the support of the project a new permanent high quality site SUME in Western Hungary has started permanent operation in May 2005 as part of both HGRN and CEGRN.

HGRN presently have 15 sites of which 6 sites are overlapping with CEGRN in accordance with the GRL hierarchy principle (Fejes 1993). Table 2 gives the site occupation history.

Table II. The HGRN site occupation 1991-2005

			OCCUPATION							
Site	**LAT**	**LON**	**1991**	**1993**	**1995**	**1997**	**1999**	**2001**	**2003**	**2005**
AGGT	(48-28-04	20-31-13)	x	x	x	x	x	x	x	x
BUDA	(47-28-56	19-01-02)	x	x	x	x	x	x	x	x
CSAN	**(46-19-10**	**20-40-15)**	**x**				**x**	**x**	**x**	**x**
CSAR	**(45-53-01**	**18-13-02)**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**
CSER	(46-04-20	18-08-08)	x	x	x	x	x	x	x	x
DISZ	**(46-53-02**	**17-29-29)**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**
HOLL	(47-59-49	19-35-02)	x	x	x	x	x	x	x	x
KOSZ	(47-23-07	16-28-59)	x	x	x	x	x	x	x	x
MISK	(48-04-37	20-29-52)	x	x	x	x	x	x	x	x
NADA	(47-15-20	18-37-09)	x	x	x	x	x	x	x	x
PENC*	**(47-47-23**	**19-16-53)**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**
SATO	(48-22-37	21-37-56)	x	x	x	x	x	x	x	x
SOPR	(47-38-44	16-36-15)	x	x	x	x	x	x	x	x
SUME*	**(46-57-51**	**17-17-30)**								**x**
TARP	**(48-07-46**	**22-32-57)**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**

***** Permanent GPS station

In table II the common CEGRN/HGRN sites are indicated with bold characters.

OTHER RELATED ACTIVITIES

Penc footprint monitoring

For monitoring the stability of the PENC reference station placed on the roof of the observatory continuous 24 hours footprint measurements were carried out in September 2004 on the sites Fejhegy, Pokolvölgy, Vashegy, Szendehely and Bér. Processing and analysis of the data proved the stability of the PENC monumentation within the measurement error (<1 mm).

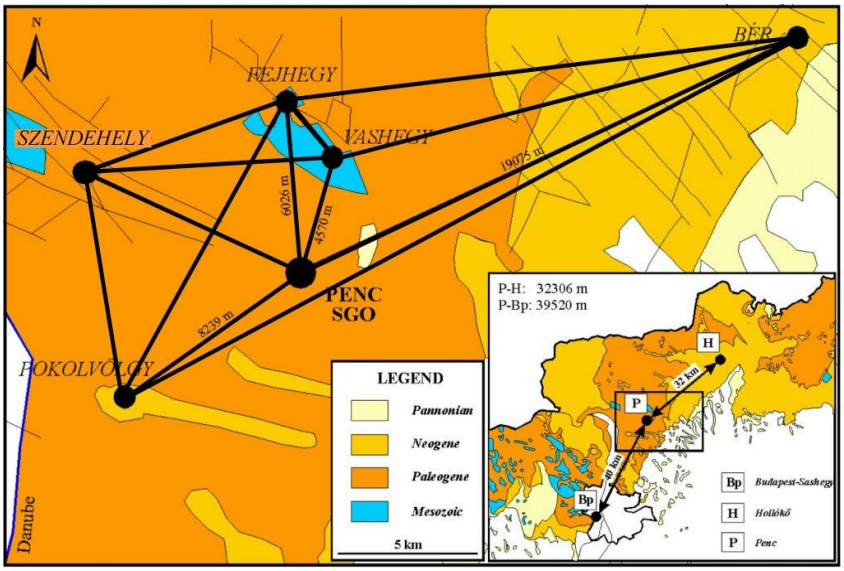

Fig. 2. The locations of the PENC footprint measurements

Receiver selection and purchase

Based on WP 4 recommendations a GPS receiver selection procedure for a new Hungarian permanent station has been carried out in 2004. Ashtech iCGRS, Trimble NetRS and Leica receivers were considered and tested. Finally the decision fell on the Trimble NetRS receiver. Delivery was completed in end August 2004. After arrival of the receiver careful test were conducted in the observatory. Some malfunction of the power supply unit of the receiver was found. Trimble was notified and the receiver replaced on short notice by the manufacturer. The tests were concluded succesfully with the replaced receiver.

The new CEGRN permanent site in Hungary

Search was concluded for a new geodynamic permanent site in Hungary in 2004. At the earlier candidate, Piskéstető serious interference was found on the L1 frequency band, which made the site unsuitable for a permanent GPS station. In collaboration with WP 2. several locations were checked out and seven new sites were investigated in more details in Western Hungary. Tata, Sümeg, Fertőrákos, Győr, Villány and 2 sites in the Mecsek mountains. The sites were checked on geological characteristics, sky coverage, interference occurrence, security aspects and other points of view. Finally Sümeg (SUME)was selected as the best candidate. Negotiations begun in September 2004 with the University of Western Hungary, Faculty of Forestry – the owner of the territory - resulting in a formal agreement for operation of the station. The high quality monumentation (embedded in bedrock) was constructed in October and completed in November 2004 by the FÖMI SGO staff.

Fig. 3. The new Hungarian permanent CEGRN station SUME in Western Hungary

CONCLUSION

WP 3 has achieved its objectives as defined in the Project. The monitoring results led to the definition, practical realization and maintenance of a regional geocentric terrestrial reference frame, providing a reliable intra-plate velocity field of Central Europe.

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