

4.7.5. RECENT GEODETIC INVESTIGATIONS PERFORMED IN THE FRAME OF CERGOP2/PROJECT

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4.7.5.1. Introduction

Romania, represented by National Centre for Geodesy, Cartography, Photogrammetry and Remote Sensing (NCGCPRS), former Institute for Cadastre, Geodesy, Photogrammetry and Cartography (ICGPC) under the authority of National Agency for Cadastre and Land Registration (NACLRL), former National Office for Cadastre, Geodesy and Cartography (NOCGC) performed the main activities mentioned in the contract EVK2-CT-2002-00140 CERGOP-2/Environment. This project continued the similar activities performed in the CERGOP(1) project with the same main objective – geodynamic investigations in the Central and East European area. CERGOP Workpackage WP.10 „Geodynamics of Central Europe“ was established to concentrate all geodynamic research conducted by several groups in the region of Central Europe covering the area of CEI¹ countries. Among the 7 groups acting on WP.10, Romania was responsible for WP.10.2 „*Three dimensional plate kinematics in Romania*“.

The WP.10.2 action plan was discussed at the Working Conference of the chairmen of the WP.10 held in Prague on 14-15 May 2003. According to First Circular Letter of WP.10 (Prof. J.Sledzinski and Prof. P.Vyskocil), Prof. D.Ghitau (former Romania National Investigator) answered to the proposed Questionnaire defining the main activity directions on WP.10.2 (studies on Vrancea zone, publications, one monography to be published). The main institutions involved in CERGOP-2 activities were named ICGPC and IG (Institute of Geodynamics of the Romanian Academy).

4.7.5.2. General main characteristics of the region

Vrancea active seismic region is located in the bending area of Romanian East Carpathians, at about 180 km NE from Bucharest, the capital of Romania (Fig. 4.7.5.1). Due to their location in the upper mantle, Vrancea strong earthquakes (3-4 events by century with magnitude higher than 7.0) create an usual seismic risk area that overpasses the state borders of Romania (Beşutiu et.al., 2005).

As it can be seen from the picture (Fig. 4.7.5.1.), epicentral area covers both the SE slope of East Carpathians, and part of their foredeep (Focşani basin).

¹ Central European Initiative

4.7.5.3. Status of geodetic activities performed within the CERGOP-2 Project

- **First year project activities**

For the first year of CERGOP-2 project, Romania represented by ICGPC and above mentioned partners, performed the activities derived from „*Concise plan of immediate planned action in the frame of WP.10.2*“. The main objective of WP.10.2 is to monitor the recent crust movements, detecting the borders of the tectonic plates and quantifying their three dimensional rates. The objective is achieved especially by the use of GPS technology and other significant data sources (levelling, gravity, seismic data et al.).

The main activity performed in 2003 was the CEGRN² campaign with GPS observations from 16 June 12:00 UTC to 21 June 2003 12:00 UTC including:

- epoch stations: Măcin (MAC2), Vrâncioaia (VRN1), Tismana (TIS3), Măgurele (BUCA), Fundata (FUN3);
- permanent stations: București (BUCU), Timișoara (TIMI), Suceava (SUCE), Sibiu (SIBI), Cluj (CLUJ), Brăila (BRAI).

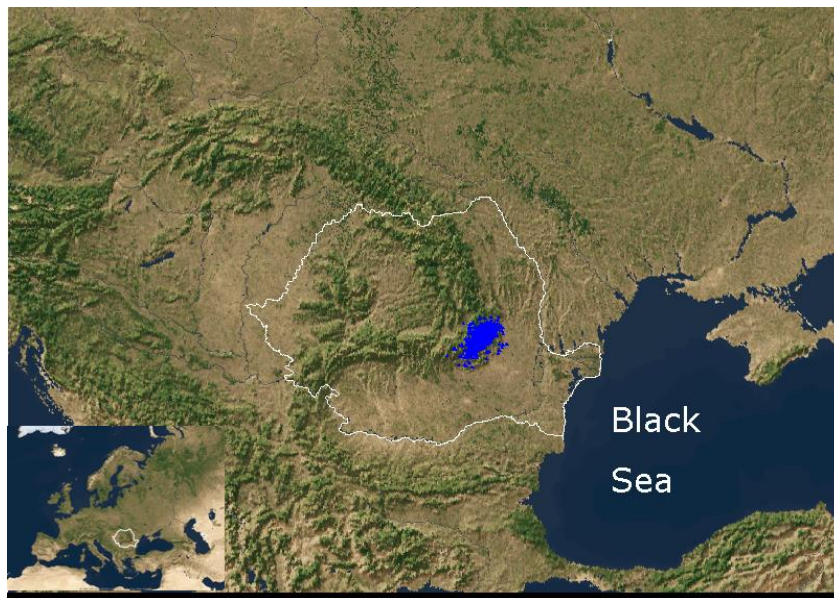


Fig. 4.7.5.1. Satellite view of the location of the Vrancea active seismic zone (Besutiu, 2005)

Prior to the campaign a site inspection took place in order to establish the actual station's situation. GPS receivers observing CEGRN stations in Romania were Leica 520 on epoch stations and Leica 530 on permanent stations, except Bucharest (BUCU) permanent station with Ashtech Z-XII receiver. On the same time, other 7 stations were observed on Romanian territory in a parallel EUREF campaign. All data were delivered at CEGRN Data Centre in Graz. Data processing covering CEGRN-Romania was performed in Graz on two stages of Romanian specialists together with Austrian colleagues from Institute for Space Research.

Another activity was the start of close cooperation with IG³ in order to elaborate a monograph of our region under study.

² Central European Geodynamic Regional Network

³ Institute of Geodynamic – Romanian Academy of Sciences

The ICGPC plans in the Geodesy field included the densification of GNSS permanent stations network. On this direction in March 2004 was established a new permanent station in Craiova (SE of Romania), the 7th Romanian permanent station. The ICGPC field equipment including 7 Leica 520 receivers was supplemented with other 13 Trimble SSE (L1, L2) receivers after software upgrade (navig.vs.7.19B) of these receivers. In this conditions, for the 2005 CERGOP-2 campaign, GPS equipment was entirely supported by ICGPC. The 2003 status of CEGRN permanent and epoch stations is presented below (Fig. 4.7.5.2.).

- **Second year project activities**

Activities developed by NCGCPRS (former ICGPC) Bucharest during 2004 followed the objectives mentioned in the contract for WP.10.2. One major activity was dedicated to the „*Monograph of geodynamics research in Romania – Vrancea region*“ jointly prepared by scientists from the Institute of Geodynamics of the Romanian Academy and NCGCPRS. The monograph is dedicated to present sub-regional geodynamic investigations in Romania, mainly derived from CERGOP (1 and 2) projects.

New GPS permanent station in Constanța was installed in August 2004 in close cooperation with Space Research Institute Graz – Austrian Academy of Sciences. Our colleagues kindly provided on bi-lateral agreement under CERGOP-2 umbrella, GPS permanent station equipments and software.

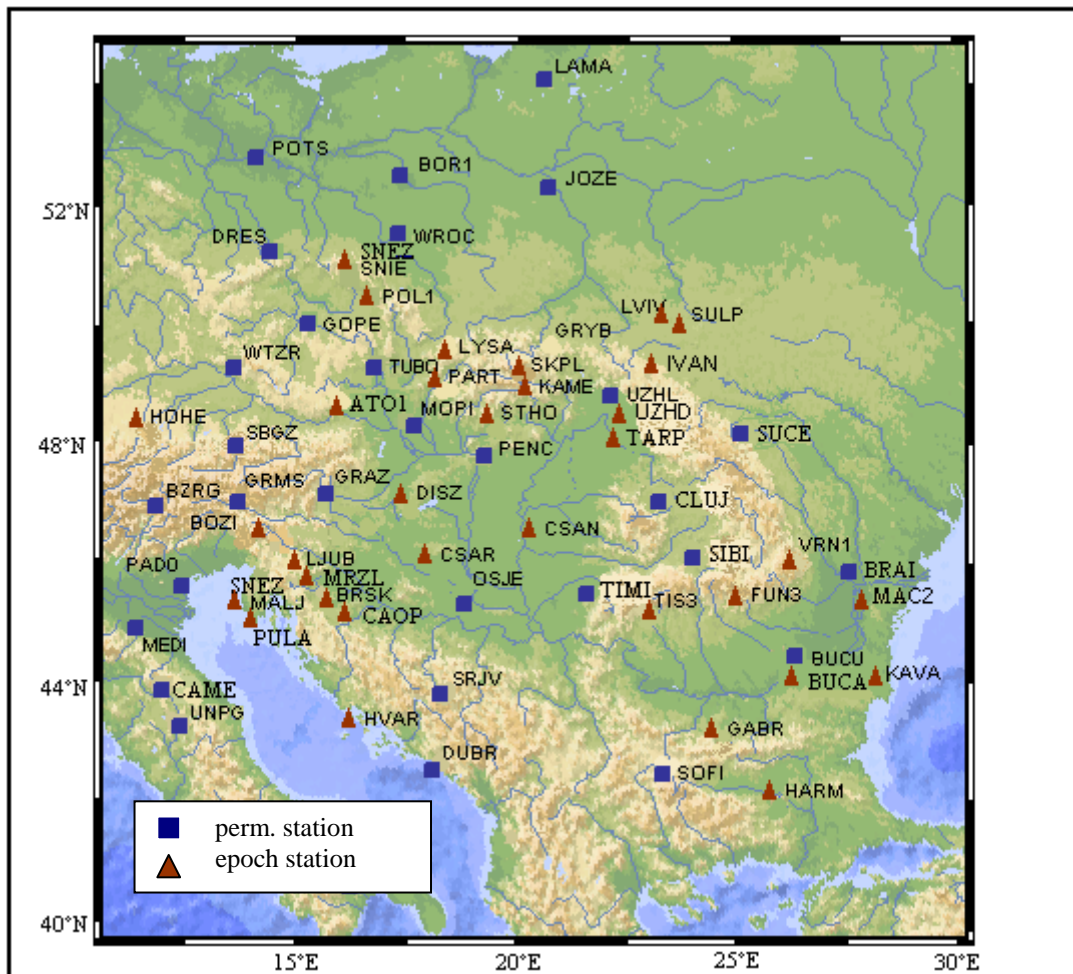


Fig. 4.7.5.2. Map of CEGRN permanent and epoch stations (2003)

The importance of permanent station installed in Constanța comes from two facts: the station it is significant for geodynamic investigations and in the same time the station it is situated in collocation with one Black Sea tide-gauge. On November 2004 the GPS antenna was connected by precise levelling with the existing tide gauges including EUVN⁴ marker in Constanța (Fig. 4.7.5.3). It is intended to start a research activity together with Romanian Marine Research Institute in Constanta - the administrator of the tide gauges on Romanian Black Sea coast, for common investigations : geodetic studies on Black Sea Datum, sea level investigations, hazards et al.



Fig. 4.7.5.3. Precise leveling determination by NCGCPRS (2004)

In order to improve CEGRN on Romanian territory, GPS permanent stations were included in this network. At the end of 2nd year project four permanent stations contributed with GPS data (hourly and daily files) for the project (Sibiu, Suceava, Braila, Cluj). Craiova and Constanta stations were also prepared for sending hourly and daily data to CERGOP-2 Data Centre Graz.

Site quality monitoring started in this CERGOP-2 phase by establishment of one monitor network around each CEGRN permanent station in Romania. The goal of this activity it is to investigate antenna stability in time by repeated GPS observations. Each monitor network includes 3 markers on the ground. As station adapter it is installed one forced centering system on every marker. First („zero epoch“) observations was already performed in November 2004.

- **Third year project activities**

The main activity performed was the preparation and observation for the CEGRN2005 campaign (20-26 June 2005) on the Romanian territory. Prior to GPS campaign a site reconaissance was performed by NCGCPRS personnel in order to establish the epoch site marker's situation and to observe some site eccentricities for these stations.

This year in Romania (Fig. 4.7.5.4.) were observed 5 epoch stations: Buca, Fun3, Mac3, Vrn1, Tis3 and 8 permanent stations: Bucu (IGS), Brai, Cost, Crai, Cluj, Sibi, Suce,

⁴ European Unified Vertical Network

Timi according with CEGRN general rules. All data was transmitted to CEGRN Data centre in Graz (Tab.4.7.5.1).



Fig. 4.7.5.4. Map of CEGRN permanent and epoch stations (October, 2005)

Table 4.7.5.1. GPS Data Files Availability CEGRN 2005 – Romania

No.	Station Name	Station code	DAY NUMBER						Receiver	Antenna	Obs.
			17 1	17 2	17 3	17 4	17 5	17 6			
1	Braila	BRAI	x	x	x	x	x	x	Leica 530	AT504	<i>perm. station</i>
2	Bucharest – (Magurele)	BUCA	x	x	x	x	x	x	Trimble 4000 SSE	Compact L1/L2 GP	<i>epoch station</i>
3	Bucharest	BUCU	x	x	x	x	x	x	Ashtech Z-12	700936 DM	<i>perm. station</i>
4	Cluj	CLUJ	x	x	x	x	x	x	Leica 530	AT504	<i>perm. station</i>
5	Constanta	COST	x	*	**	x	x	x	Z-Xtreme	701945B_M	<i>perm. station</i>
6	Craiova	CRAI	x	x	x	x	x	x	iCGRS (UZ-12)	701945B_M SNOW	<i>perm. station</i>

7	Fundata	FUN3	x	x	X	x	x	x	Trimble 4000 SSE	Compact L1/L2 GP	<i>epoch station</i>
8	Macin	MAC3	x	x	X	x	x	x	Trimble 4000 SSE	Compact L1/L2 GP	<i>epoch station</i>
9	Sibiu	SIBI	x	x	X	x	x	x	Leica 530	AT504	<i>perm. station</i>
10	Suceava	SUCE	x	x	X	x	x	x	Leica 530	AT504	<i>perm. station</i>
11	Tismana	TIS3	x	x	X	x	x	x	Trimble 4000 SSE	Compact L1/L2 GP	<i>epoch station</i>
12	Vrancea	VRN1	x	x	X	x	x	x	Trimble 4000 SSE	Compact L1/L2 GP	<i>epoch station</i>
13	Timisoara	TIMI	x	x	X	x	x	x	Leica 530	AT504	<i>perm. station</i>

* - missing last 4 hours due to power failure ** - data missing due to power failure

In August 2005 the CERGOP2/Environment partners from WP.2 (CERGOP Station quality assessment and upgrade – SGO⁵ Penc, Hungary) performed a site inspection in Romania including epoch and permanent stations. With this occasion NCGCPRS organized the trip, prepared the site descriptions according to CEGRN standards and supported local frequency scanning for GPS and Galileo interference check (Fig. 4.7.5.5.).



Fig. 4.7.5.5. Frequency interference measurements on Romanian CEGRN sites

In October 2005 on the same CERGOP-2 umbrella a new prototype CEGRN permanent station was installed in cooperation with WP.4 (IPG⁶ Darmstadt, Germany). This station is located in Oradea (Technical University), West of Romania on the Carpathian Orogen unit. Data are transmitted (starting with October 21) hourly and

⁵ SGO – Satellite Geodetic Observatory

⁶ IPG – Institute for Physical Geodesy

daily to the CEGRN Data Centre in Graz (Austria). At this time 8 Romanian permanent stations deliver good quality data for geodynamic investigations on CERGOP-2/Environment project.

Site quality monitoring for Romanian CEGRN permanent stations will continue by the 2nd local deformation campaign (2006) including the monitor network around each permanent station. The goal of this activity it is to investigate antenna stability in time by repeated GPS observations.

4.7.5.4. Conclusions and future plans

CERGOP-2 activities in Romania performed in Workpackage 10.2 followed the planned directions of action. The main tasks were realized and a contribution to the systematic investigations in the geodynamics of this area was obtained. A summary of Romanian contribution to the complex geodynamic investigations includes:

- Maximum extension of CEGRN in Romania up to 14 permanent and epoch stations with good coverage of major tectonic plates; Six CEGRN GPS permanent stations are from Romanian GPS National Network and in cooperation with partners from WP.1 and WP.4 three new CEGRN permanent stations was installed in Craiova, Constanta and Oradea; The tendency was in this time for transition from epoch stations to the permanent stations;
- Participation at the CEGRN GPS observation campaigns in 2003 and 2005 with epoch and permanent stations;
- Establishment of local deformation networks for GPS permanent stations;
- Site quality investigations in cooperation with partners from WP.2 (CERGOP Station quality assessment and upgrade, Hungary) including a site inspection in Romania in August 2005;
- Data processing in cooperation with colleagues from Space Research Institute Graz;
- The „*Monograph of geodynamics research in Romania – Vrancea region*“ was elaborated by scientists from Geodynamic Institute of Romanian Academy and NCGCPRS. IG contribution will be also published by Romanian Academy of Sciences;
- Dissemination of project results from WP.10.2 (Romania) was done mainly by „Reports on Geodesy“ series of Warsaw University of Technology – Institute of Geodesy and Geodetic Astronomy (Prof. Janusz Sledzinski) and CERGOP-2 web pages; Participation at international symposia and workshops was important for dissemination of project results: EGU symposium in Nice(2004) and Vienna (2005), semiannual CERGOP meetings in Sofia (2004), Sarajevo(2005); In October 2005, from WP10.2 was presented the paper „CERGOP2 /Environment Project - Three Dimensional Plate Kinematics in Romania “ at the *4th Congress of the Balkan Geophysical Society, Bucharest (9-12 October, 2005)*.
- As future plans for geodetic investigation in Romania, NCGCPRS planned to continue the CERGOP-2 activities at least by GPS permanent station observations and contribution with gravity data from IG. IG realized a new array of geodynamic pillars available for (GPS) geodetic observations for the next time and by cooperation with NCGCPRS a more dense velocity field could be obtained.

4.7.5.5. References

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