

CERGOP-2: New Phase of Geodynamic Studies in Central Europe

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Abstract

First phase of the Project CERGOP (Central Europe Regional Geodynamics Project) initiated in 1994 by Hungarian and Polish scientists was concluded in June 1998. The Project is realised under the umbrella of the Central European Initiative (CEI). The concise information on this organisation you can also find in this paper. The following 12 countries joined the first phase of the Project: Austria, Bulgaria, Croatia, the Czech Republic, Germany, Hungary, Italy, Romania, Poland, Slovakia, Slovenia and Ukraine. The main result of the first phase of the realisation of the Project is the establishment and maintenance of the Central European GPS Reference Network (CEGRN) consisting of 31 sites on the territories of 11 countries. The sites satisfy the strict requirements for repeated GPS monitoring on the highest accuracy level; the accuracy of 2-4 mm in horizontal coordinates and 4-8 mm in vertical coordinates has been achieved. The second phase of the Project CERGOP-2, now being realised, includes two new member countries: Albania and Bosnia&Herzegovina, extension of the CEGRN results in accepting in total more than 60 CERGOP (CEGRN) sites. Thus the extension of the geographic area of the project concludes in establishing the Central European Extended GPS Reference Network (CEEGRN). The great role play the existing permanent satellite stations for maintenance of the Central European Terrestrial Reference Frame (CETRF), which is best suited for regional tectonic investigations; it is also envisaged to introduce CEEGRN network as a subnetwork of the EUREF permanent network. The calculation and interpretation of the 3D tectonic velocity field covering the Central European Region will be continued; the geodynamic investigations of interesting regions of Central and Southern Europe will be extended. New thirteen CERGOP-2 Study Groups were established. Since 1994 four epoch monitoring satellite GPS CEGRN campaigns of the first phase of the Project have been carried out in yearly intervals (in 1994, 1995, 1996, 1997). In 1999 the first campaign of the second phase of the Project was organised and successfully performed. The CERGOP Data Centre was established in 1994 and is hosted by the Observatory Lustbühel, Graz, Austria. The processing of the campaigns and data analyses are performed by eight CERGOP Processing Centres.

The discussion of main achievements of the first phase of the CERGOP, some details of the programme of studies of the second phase of the project are given in the paper.

1. Central European Initiative – the Forum of 16 European Countries for the International Cooperation in Scientific, Social and Economic Areas

Central European Initiative (CEI) is the organisation established in 1989 at very high level of Ministers of Foreign Affairs of Central European countries. In November 1989 the Foreign Ministers of Austria, Hungary, Italy and Yugoslavia at the conference in Budapest founded an organisation named QUADRAGONALE. A few months later, in April 1990 (Vienna) former Czechoslovakia joined this organisation forming the PENTAGONALE and in July 1991 at the conference of Prime Ministers in Dubrovnik Poland was admitted creating the HEXAGONALE. In July 1992 the HEXAGONALE was renamed as CENTRAL EUROPEAN INITIATIVE. Violent political development in Europe, break-up and civil war in Yugoslavia, disintegration of Czechoslovakia, formation of new countries in the region of Eastern and Southern Europe, all these events caused considerable changes in organisation and international cooperation within the Central European Initiative. The current (1.06.2000) status of the CEI membership is the following: Albania, Austria, Belarus, Bosnia&Herzegovina, Bulgaria, Croatia, Czech Republic, FYROM (Macedonia), Hungary, Italy, Moldova, Poland, Romania, Slovakia, Slovenia and Ukraine. It is to be mentioned that in the realisation of the geodetic programme participate also two other non-CEI countries; they are Germany and Finland.

The main objectives of the CEI cooperation are to strengthen the stabilisation within the region of Central Europe, to promote all-European integration processes and to help the Central and Eastern European countries in entering the integrated world by adjusting their multi-lateral relations to Western European standards.

It was agreed that a Summit (Heads of Governments and Foreign Ministers) would be held once a year in October or November and a meeting of Foreign Ministers of the member countries would be organised every year in spring (May-June). Working Groups constitute the basic structural component of the CEI. They plan and approve initiatives, agreements and projects that they promote and complete in cases requiring financing, or which they pass to the National Coordinators or Foreign Ministries for approval and financing.

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At the moment (as on 1 June 2000) there are eighteen CEI Working Groups:

1. Agriculture (chaired by Poland);
2. Civil protection (Italy);
3. Combatting organised crime (Italy and Slovakia);
4. Culture and education (Slovakia);
5. Energy (Ukraine);
6. Environment (Austria);
7. Environment and transport (Austria);
8. Human dimension (Austria);
9. Human resource development and training (Czech Republic);
10. Information and media (Austria and Romania);
11. Migration (Hungary);
12. Minorities (Hungary and Romania);
13. Reconstruction and rehabilitation of Bosnia&Herzegovina and Croatia (Bosnia&Herzegovina and Croatia);
14. Science and technology (Italy);
15. Small and medium sized enterprises (Slovenia);
16. Tourism (Croatia);
17. Transport (Italy);
18. Youth affairs (Macedonia).

The Earth sciences and, in particular geodesy, are represented in the Working Group "Science and Technology." The Earth Science Committee of this Working Group consists of three sections: A – "Geology", B – "Geophysics" and C – "Geodesy". The Project CERGOP is realised in the frame of the international cooperation organised by the Section C "Geodesy".

2. Project CERGOP (Central Europe Regional Geodynamics Project)

The main objectives of the project for its first phase were formulated as follows:

- to integrate the geodynamic research in the Central European region based on high accuracy space geodetic measurements,
- to investigate the most profound geotectonic features in the Central European region, the Teisseyre-Tornquist zone, the Carpathians, the Bohemian Massif, the Pannonian Basin and the Alpine-Adria region,
- to provide a stable Central European GPS Reference Network (CEGRN) for sub-regional, local or across the borders investigations and deformation studies.

The first phase of the Project was concluded on 30 June 1998 and now the second phase of the Project is being realised. The following 12 countries joined the first phase of the Project in 1994: Austria, Bulgaria, Croatia, the Czech Republic, Germany, Hungary, Italy, Romania, Poland, Slovakia, Slovenia and Ukraine. The second phase of the Project CERGOP-2 includes two new member countries: Albania and Bosnia&Herzegovina. The main objectives

of the Project remain the same and generally can be shortly summarise as follows:

- to extend and densify the Central European GPS Geodynamic Reference Network (CEGRN) in order to include new, tectonically relevant sites in the area of study,
- to maintain the Central European Terrestrial Reference Frame (CETRF),
- to provide a reliable 3 dimensional tectonic velocity field covering the Central European Region and integrate this into hierarchically higher level (i.e. global) tectonic models,
- to analyse kinematic results and give geophysical interpretations,
- to support local area geodynamic research, environmental studies, seismic hazard assessments, meteorology etc. in the Central European Region based upon the high accuracy space geodetic measurements, carried out on an integrated geodynamic network, the CEGRN.

Since 1994 four epoch monitoring satellite GPS (Global Positioning System) campaigns of the first phase of the Project have been carried out on this network in yearly intervals (in 1994, 1995, 1996, 1997). In 1999 the first campaign of the second phase of the Project was organised and successfully performed. The CERGOP Data Centre was established in 1994 and is hosted by the Observatory Lustbühel, Graz, Austria. The satellite observational data of the CEGRN monitoring campaigns were processed in the CERGOP Processing Centres. Originally three processing groups were formed in Graz, Austria; Penc, Hungary and Warsaw, Poland. In a later stage of the project the number of processing centres increased to 8 by organising further centres in Bratislava, Slovakia; Frankfurt, Germany; Matera, Italy; Pecny, Czech Republic and Zagreb, Croatia. The project participants have met regularly at the semi-annual CERGOP Working Conferences. The proceedings of these conferences were published in REPORTS ON GEODESY by the Warsaw University of Technology, generally within 3 months following the conference. The scientific results of the project were mainly presented at the bi-annual International Seminar on „GPS in Central Europe", organised by the FÖMI Satellite Geodetic Observatory, Penc, in Hungary. The proceedings of these conferences were also published in the REPORTS ON GEODESY series.

Now we remind shortly the main achievements of the first phase of the Project CERGOP-1:

- Establishment and maintenance of the Central European GPS Reference Network consisting of 31 sites on the territories of 11 countries. The sites satisfy the strict requirements for repeated GPS monitoring on the highest accuracy level (the accuracy of 2-4 mm in horizontal coordinates and 4-8 mm in vertical coordinates have been achieved).
- Eleven CEGRN stations were permanent GPS stations providing continuous monitoring capabilities for tectonic studies. The remaining 20 sites are so called „epoch

stations' which give positional information at the measurement epochs.

- The Central European Terrestrial Reference Frame (CETRF) has been established, which suits best for geophysical, geotectonic studies of the region. The yearly monitoring of CETRF provided already significant kinematic results about intraplate tectonic motions in Central Europe. Twenty-two stations from CEI countries (eleven CEGRN stations) are used for permanent monitoring of the European Reference Frame (EUREF).
- The scientific outputs of CERGOP Study Groups presented at different international conferences should also be mentioned. Perhaps the most notables among them are the five monographs of five particular regions in Central Europe produced by CSG.8 „Geotectonic analysis of the region of Central Europe". The following volumes of geotectonic monographs were published in REPORTS ON GEODESY series: The Pannonian Basin (edited by G. GRENERCZY), The Bohemian Massif (edited by P. VYSKOCIL), The Teisseyre-Tornquist Zone (edited by J. LISZKOWSKI), The Northern Carpathians (edited by F. ZABLOTSKI), and The Southern Carpathians (edited by D. IOANE). The monographs summarise the latest geoscience results, available on these regions, with particular emphasis on the project's objectives. There is also a sixth volume by Vyskocil and Sledzinski which contains general characteristics of all regions, list of performed studies and a summary, indicating some proposals for future investigations.

The new CEGRN-2 consists of 63 sites of which 22 are permanent GPS stations presently, the rest are epoch stations. An updated map and table of CEGRN-2 sites are shown in Fig 1, and in Table 1 respectively. Thus the extension of the geographic area of the project concludes in establishing the Central European Extended GPS Reference Network (CEEGRN). The great role play the existing permanent satellite stations for maintenance of the Central European Terrestrial Reference Frame (CETRF), which is best suited for regional tectonic investigations; it is also envisaged to introduce CEEGRN network as a subnetwork of the EUREF permanent network. The calculation and interpretation of the 3D tectonic velocity field covering the Central European Region will be continued; the geodynamic investigations of interesting regions of Central and Southern Europe will be extended.

A major development of the project was the establishment of CERGOP Study Groups (CSGs). The groups were formed by the collaboration of scientists from two or more member countries to carry out research in a particular field. Nine CERGOP Study Groups remained active during the whole project period. The CERGOP Study Groups established for the second phase of the Project are listed below.

CERGOP-2 Study Groups

CSG.1 CERGOP stations and site quality monitoring chaired by G. VIRAG (Hungary);

CSG.2 Coordination of CERGOP analysis centres – G. STANGL (Austria);

CSG.3 CERGOP Reference Frame and geokinematic modelling – J. HEFTY (Slovakia);

CSG.4 Height determination and atmospheric effects – J. SIMEK (Czech Republic);

CSG.5 Geotectonic analysis of the region of Central Europe – J. SLEDZINSKI (Poland) and P. VYSKOCIL (Czech Republic);

Groups for regional investigations

CSG5/1 Monitoring of recent crustal movements in Eastern Alps and the North and Eastern Adriatic with GPS – C. MARCHESINI (Italy);

CSG.5/2 Three-dimensional plate kinematics in Romania – D. GHITAU (Romania);

CSG.5/3 Integration of present geodynamic investigations in the Pannonian Basin – G. GRENERCZY (Hungary);

CSG.5/4 International geodynamic test area Plitvice Lakes – chairman to be nominated;

CSG.5/5 Geodynamics of the Tatra Mountains – K. CZARNECKI (Poland) and M. MOJZES (Slovakia);

CSG.5/6 Geodynamics of Northern Carpathians – F. ZABLOTSKI (Ukraine);

CSG.6 Real time monitoring by GPS – A. NARDI (Italy);

CSG.7 Maintenance and update of the permanent sensor array – M. BECKER (Germany) and P. PESEC (Austria).

The Project is headed by Hungary (ISTVAN FEJES) and Poland (JANUSZ SLEDZINSKI). The first phase of the Project CERGOP was supported financially from the Programme COPERNICUS of the European Commission. As the Coordinator served Institut für Angewandte Geodäsie, now Bundesamt für Kartografie und Geodäsie (Prof. E. REINHART), Frankfurt/Main/Germany. Following a series of preparatory meetings a new project coordinator (PETER PESEC, Austrian Academy of Sciences, Graz, Austria) has submitted a EU 5th Framework Proposal in June 1999 with the title "CERGOP-2, a Multipurpose and Interdisciplinary Sensor Array for Environmental Research in Central Europe". It was proposed to extend and upgrade the existing hardware and software facilities in countries of the Central Europe Initiative and provide not only data for monitoring low dynamic systems, but apply the GPS Sensor Array data in near real time tropospheric studies, meteorology and other highly dynamic systems as well. Unfortunately, the proposal was rejected by the referees. A new version of the proposal will be worked out hopefully avoiding the pitfalls of the first one.

The CERGOP-2 Steering Committee held a meeting on 27 April 2000 in Nice. The members discussed the EU proposal

and possible alternative funding strategies. The next CERGOP-2 Working Conference will be organised in October 2000 in Graz, Austria. Despite the present problems with international funding, CERGOP-2 should continue its activities according to the objectives outlined above. A minimum level can be defined which preserves the very valuable assets accumulated in the last 6 years. These are: maintenance of the CEGRN-2 sites, organisation of epoch campaigns in every second year, operation of the CERGOP Data Centre and one or two processing centres, ensure some basic study group activities. To our opinion this minimum level can be maintained even within the present situation. Maintenance of CEGRN-2 and epoch GPS campaigns in

every second year could be supported by national means in most of the countries. In those cases where there are difficulties with the minimum program, bilateral agreements with more affluent countries may help find the solution. For exploiting the full potential of the CERGOP collaboration and further development of the project we certainly need to find proper founding. We plan to resubmit our proposal within the EU 5th FP in early 2001. Alternative or supplemental sources should also be explored, such as the COST Actions and the European Science Foundation. Participants should seek for national support of CERGOP within the programs of the Central European Initiative or other national science founding agencies.



Fig. 1. The Central European GPS Geodynamic Reference Network (CEGRN-2)

Table 1. The Central European GPS Geodynamic Reference Network (CEGRN-2)

Country	Site	Code	P/E	Lat.	Long.	Tectonic area
ALB	Tirana	(TIRA)	(P)	(41° 19')	(19° 46')	Dinarides
AUT	Graz	GRAZ	P	47° 04'	15° 30'	Tertiary Basin
	Hutbiegl	HUTB	E	48° 39'	15° 36'	Bohemian Massif
	Innsbruck	HFLK	P	47° 19'	11° 23'	Upper East-Alpine Nappe
	Reisseck	GRMS	E	46° 55'	13° 22'	Central East-Alps
	Salzburg	SBGZ	P	47° 48'	13° 07'	Upper East-Alpine Nappe
BIH	Sarajevo	SARA	P	43° 52'	18° 24'	Dinarides
BUL	Harmanli	HARM	E	41° 53'	25° 51'	Rhodope Massif
	Sofia	SOFI	P	42° 33'	23° 24'	Sredna Gora
	Gabrovo	GABR	E	42° 58'	25° 16'	Fore Balkan
	Kavarna	KAVA	E	43° 25'	28° 22'	Moesian Platform
CRO	Brusnik	BRSK	E	45° 35'	15° 34'	Julian Alps, Savic Folds
	Hvar	HVAR	E	43° 11'	16° 27'	Adriaticum
	Osijek	OSIJ	(P)	45° 34'	18° 41'	Tisza-Unit
	Dubrovnik	DUBR	(P)	42° 38'	18° 07'	Dinarides
CZE	Pecny	GOPE	P	49° 55'	14° 47'	Bohemian Massif
	Polom	POL2	E	50° 21'	16° 19'	Bohemian Massif, Variscan Folds
	Lysa Hora	(LYSA)	E	49° 33'	18° 27'	Outer West Carpathians, Silesian Unit
	Brno	(BRNO)	(P)	49° 12'	16° 36'	Bohemian Massif
GER	Hohenpeissenberg	HOHE	E	47° 48'	11° 01'	Upper East-Alpine Nappe
	Kirschberg	KIRS	E	51° 13'	14° 17'	Variscan Complex, Lausitz Folds
	Potsdam	POTS	P	52° 23'	13° 04'	Precambrian-Platform, German-Polish Depression
	Wettzell	WTZR	P	49° 09'	12° 53'	Moldanibikum, Variscan – Komplex
	Dresden	DRES	P	51° 02'	13° 44'	Variscan Complex
HUN	Csarnóta	CSAR	E	45° 53'	18° 13'	Tisza-Unit
	Diszel	DISZ	E	46° 53'	17° 29'	Alpine-North Pannonian Unit
	Penc	PENC	P	47° 47'	19° 17'	Alpine-North-Pannonian Unit
	Tarpa	TARP	E	48° 08'	22° 33'	Alpine-North-Pannonian Unit
	Csanádalberti	CSAN	E	46° 19'	20° 40'	Tisza-Unit
ITA	Padova	UPAD	P	45° 24'	11° 53'	Adriatic Microplate
	Trieste	BASO	P	45° 39'	13° 53'	Adriatic Microplate
	Medicina	MEDI	P	44° 31'	11° 39'	North Appenines Foreland
	Matera	MATE	P	40° 39'	16° 42'	Adriatic Microplate
	Perugia	PERU	P	43° 07'	12° 21'	Central Appenines
	Bolzano	BZRG	P	46° 29'	11° 22'	Southern Alps
POL	Borowiec	BOR1	P	52° 17'	17° 04'	Paleozoic Platform, German-Polish Depression
	Grybow	GRYB	E	49° 38'	20° 57'	Outer- or Flysh-Carpathians
	Jozefoslaw	JOZE	P	52° 06'	21° 02'	Precambrian Platform, German-Polish Depression
	Lamkowko	LAMA	P	53° 54'	20° 40'	Precambrian Platform, German-Polish Depression
	Sniezka	SNIE	E	50° 44'	15° 44'	Variscan Mountains
	Wroclaw	WROC	P	51° 07'	17° 04'	German-Polish Depression

Country	Site	Code	P/E	Lat.	Long.	Tectonic area
ROM	Tismana	TIS3	E	45° 08'	23° 08'	South Carpathian Orogeny
	Gilau	GIL2	E	46° 41'	23° 03'	Muntii Apuseni
	Iasi-Repedea	IAS3	E	47° 05'	27° 39'	East-European Platform
	Macin	MAC5	E	45° 15'	28° 11'	Dobrogea Orogeny
	Bucharest	BUCU	P	44° 21'	26° 03'	Moesian Platform
	Fundata	FUN3	E	45° 25'	25° 15'	Southern Carpathians
	Vrancea	VRN1	E	45° 51'	26° 39'	Vrancea zone
	Vatra Dornei	VAT1	E	47° 27'	25° 21'	East Carpathians
SVK	Strazna Hora	STHO	E	48° 13'	19° 32'	Vepor Unit , Inner-Carpathian Vulcanic Arc
	Modra-Piesky	MOPI	P	48° 22'	17° 16'	Tatran Unit, West-Carpathians
	Skalnate Pleso	SKPL	E	49° 11'	20° 14'	Tatran Unit, West- Carpathians
	Partizánske	PART	E	48° 36'	18° 20'	Vepor Unit
	Kamenica nad Cirochou	KANC	E	48° 56'	22° 01'	Vihorlat-Gutin Chain
SLO	Ljubljana	LJUB	E	46° 03'	14° 30'	In between the Julian Alps and the Dinarides
	Tosko Celo	(TOSK)	P	46° 05'	14° 25'	Northeastern Dinarides
	Maliha	MALI	E	45° 30'	13° 39'	Adriatic Microplate
	Bozica	(BOZI)	E	46° 16'	13° 29'	In between the Adriatic Microplate and the Southern Alps
	Lendavske gor.	(LEND)	E	46° 34'	16° 29'	In the Mid Hungarian Shear Zone between the Tisza-Unit and North Pannonian Unit
UKR	Uzhgorod	UZHD	E	48° 34'	22° 27'	Vihorlat-Gutin Vulcanic Chain, North-East Carp.
	Lviv	LVIV	E	49° 55'	23° 57'	East-European Platform
	Sulp	SULP	(P)	49° 50'	24° 01'	East-European Platform
	Shazk	SHAZ	E	51° 28'	23° 51'	East-European Platform

3. Conclusion

CERGOP-2 is a very powerful co-operation in Central Europe, which should be continued despite funding problems. CERN-2 consisting of 63 sites in 14 countries will be a solid basis for geophysical and environmental research in Central Europe. An upgrade of the stations and communication links could multiply its scope of applications. This multipurpose potential should be more widely exploited. New projects could greatly benefit from CERGOP assets and human potential.

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