ASPECTS OF GEODETIC PRACTICE IN THE AREA OF VRANCIOAIA GEODYNAMIC MICROPOLYGON

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Abstract: *This paper presents aspects of the organization and development of geodetic practice organized by the Department of Geodesy and Photogrammetry of the Faculty of Geodesy Bucharest. Since 2006, in the Vrancea area were accomplished the necessary conditions for the good performance of the geodetic practice including geometric levelling, directions and distance measurements, satellite measurements. The existing geodynamic micropolygon in the area was completed with a geodetic network allowing proper development of the mentioned types of measurements already mentioned.*

In parallel with specific educational activities conducted, the observations results contributes to geodynamic phenomena research in the Vrancea area.

Keywords: *student geodetic practice, Vrancea micropolygon, geodynamic research*

1. Introduction

In general the *practice of geodesy* is a professional and organized act of gathering physical data on the surface of the earth with the use of precision instruments. It is also the scientific and methodical processing of these data and presenting them on graphs, plans, maps, charts or documents. It shall embrace, but is not limited to, the following activities:
(1) Professional geodetic services with the use of surveying and mapping equipment such as graduated rods, measuring tapes, levels, theodolites, electronic distance meters, global positioning systems, computers, plotters and all other instruments that are used to determine positions of points on the surface of the earth, ground elevation, gravity, crustal movements and the size and shape of the earth, and other instruments used for construction survey, and those instruments used to guide the installation of large industrial equipment and machineries;
(2) Horizontal and vertical control surveys;
(3) Land surveys to determine their boundaries and prepare the plans thereof for titling and for other purposes;
(4) Subdivision, consolidation and/or consolidation-subdivision of titled properties;
(5) Submission of survey plans of subdivided, consolidated and/or consolidated-subdivision titled properties to the government agencies concerned;
(6) Preparation and making of sketch, lot and location plans;
(7) Conduction of engineering surveys and the technical preparation of engineering survey plans such as topographic, profile, cross-section, construction and boundary surveys;

(8) Parcellary surveys of lands traversed by infrastructure projects; and the preparation of subdivision plans;
(9) Conduction of gravimetric and photogrammetric survey and the technical preparation of such survey plans;
(10) Survey and mapping works such as the preparation of geographic and/or land information system;
(11) Survey to determine and establish line and grade for the construction of buildings and other structures and its attachments;
(12) Construction of as-staked and as-built surveys for infrastructures;
(13) Conduction of mineral and mining surveys;
(14) Installation of machineries requiring the use of precision instruments;
(15) Engagement in the transfer of the knowledge and technology of geodetic engineering in any institution of learning.

2. Geodetic training activities in general

One of the most important part of geodetic discipline learning plan at Technical University of Civil Engineering Bucharest (TUCEB), Faculty of Geodesy, consists in performance of practical training. Along the years this activity has some evolution steps up to the present situation. According to the practice plans of our faculty, geodetic practice it is performed on the 4th semestre after some theoretical and practical backgrounds gathered at disciplines (topography, mathematical geodesy, physical geodesy basics, data adjustment and statistics, EDM basics et al.) and introducing the future disciplines (EDM, geodesy, engineering surveying, space geodesy, physical geodesy, geodetic network design and optimization, deformations, et al.).

The practical themes includes mainly design, observation, preliminary data processing and results evaluation for 1D (leveling) , 2D (triangulation, trilateration) and 3D (spatial) geodetic networks. All the observations are performed on the field with proper equipments available in our faculty (theodolites, levels, total stations, GNSS equipments and accessoirs). The students have now the possibility to chose where to perform the observations: in the area of TUCEB or outside (Vrancea area). In general, half of them preferes to go outside Bucharest. During the 90 hours allocated for geodetic practice in our faculty, the students should solve themes as: triangulation (network design, horizontal observations and data processing, marker excentricity determination), trilateration (network design, EDM observations, zenith observations for trigonometric leveling and data processing), geometric leveling network (network design, precise leveling observations and data processing), spatial network (equipments description, introduction in static and kinematic observations).

In order to solve the themes mentioned, there are available classical and modern geodetic equipments including: theodolites (Zeiss Theo010, Theo010A), classic levels (Zeiss Ni007), electronic levels (Leica DNA03, Topcon DL101C), total stations (Leica TC407), GNSS equipments (Leica System 900, Topcon Hyper Pro GGD), accessoirs (invar rods, barcode rods, poles, foot plates, reflectors, baterries and chargers, tripods et al.).

3. Geodynamic and geodetic infrastructure. Geodetic activities.

3.1 Geodynamic micropolygon

Constrained on technical and economical aspects, geodetic practice in our faculty we can say it is organized and performed in a professional manner.

Since more than five years, Faculty of Geodesy from TUCEB organize yearly geodetic practice in the Vrancea area where the geodynamic micropolygon of IGAR - Institute of Geodynamic - Romanian Academy it is situated and two of the seisimc stations of NIEP – National Institute for Earth Phisics (Fig.1).

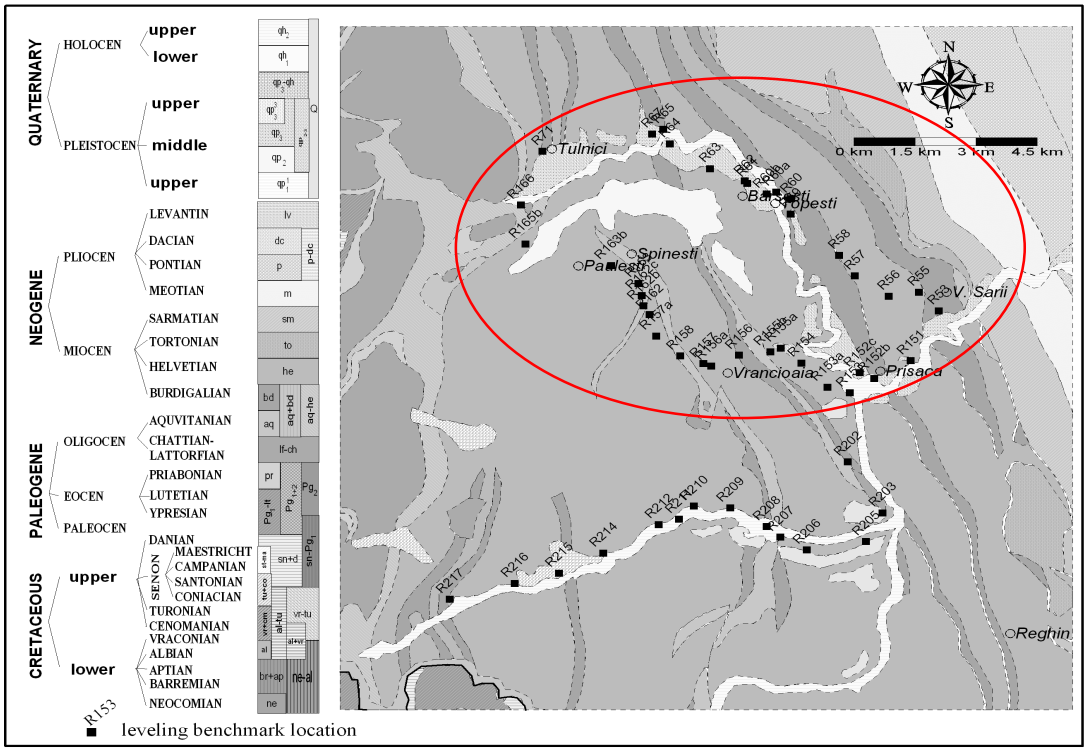


Fig.1 Geodynamic micropolygon Tulnici-Valea Sării-Vrâncioaia

In the area of this micropolygon there are performed geodetic observations (leveling, GNSS, gravity) as other geological and geophysic observations. The micropolygon includes leveling deep ground markers (Fig.2), geodynamic pillars (Fig.3) prepared for leveling, gravity and GNSS observations.

Fig.2 Leveling deep ground marker

Fig.3 Geodynamic pillar (IGAR)

Micropolygon leveling network includes a loop of about 40 Km (Vrancioaia-Spinesti-Tulnici-Valea Sarii-Prisaca-Vrancioaia) and geodynamic pillars (P123, P124, P125, P126). During practice, all the geodynamic pillars and the leveling network close to Vrancioaia are observed yearly, and when enough funds are available, all the 40 km loop it is observed. Students accommodates on this geodetic campaings with real field conditions (hot or rainy weather, busy or rare traffic, bad cell phone communication, extended working programme if necessary, living and working in a team et al.). Leveling (Fig.4) and GNSS (Fig.5) observations on the micropolygon network helps students to learn an to have some experience on design and performance of observations with classical (optic) and modern (electrono-optic) instruments.

Fig. 4 Leveling observations

Fig.5 GNSS observations

3.2 Geodetic micropolygon (TUCEB)

In parallel with the geodynamic polygon of IGAR, TUCEB designed and realized in the area of Vrancioaia seismic station, a geodetic (didactic) micropolygon (Fig.6).

Fig.6 Geodetic micropolygon in the area of Vrancioaia seismic station (Google Earth)

It was designed as a multifunctional geodetic network including leveling deep ground markers and geodetic (concrete) benchmarks. It includes plane areas (on the village and on the

top of a hill) as slope areas. There are possible leveling, triangulation, trilateration and GNSS observations (Fig.7) .

Fig.7 Classic and modern geodetic observations (triangulation, trilateration and GNSS)

Students are organized on teams (about 5-10 persons) with a chief and at least two different equipments (i.e. leveling instrument and total station). Before starting the real work, students should accommodate with each kind of equipment in one day training on the sport field of the Vrancioaia school. They need also to discover all the ground markers with the help of previous sketches prepared by other students in the previous practice in this area. The working programme (observations and data processing) includes time intervals for each kind of instrument, each observation method and each student. When the time spent with proper equipments ends, the teams changes the equipments each other, as each student should use all available instruments. A typical daily programme starts with breakfast (7:30-8:30), morning working time (8:30-13:30), lunch (13:30-15:00), afternoon working time (15:00-18:00). The students needs to have a good health (proved by a medical statement) in order to be able to participate at this practice. In the same time they should be well prepared for heavy weather conditions, living in a school building and eating in the school cantine.

After practice period spent in Vrancea, the students are coming back to Bucharest where they finalize the practice by examination and checking the equipments and accesoirs.

4. Scientific activities

TUCEB have a good cooperation with IGAR and NIEP, interested in geodetic research in Vrancea area, due to enormous interest on seismic hazards with origin in this area.

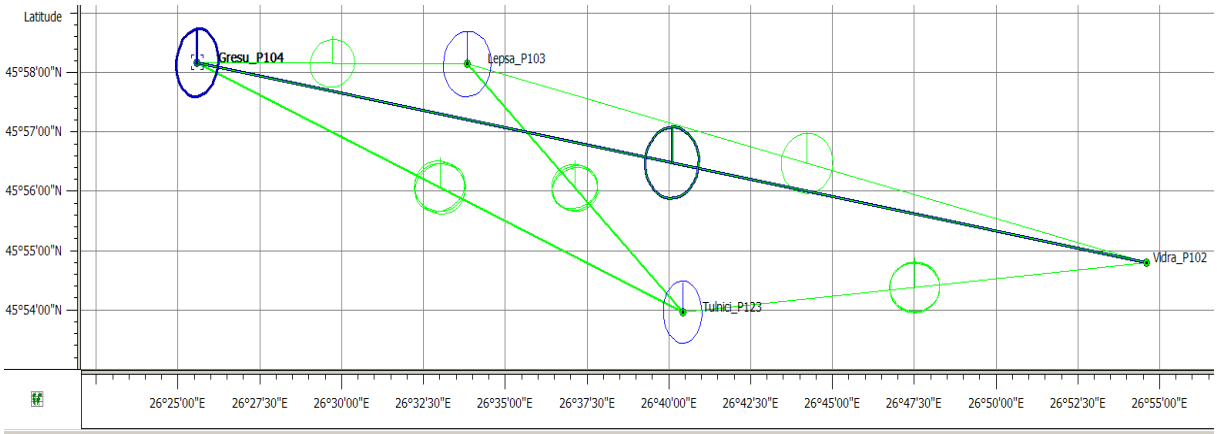
As we mentioned in the previous chapter, the geodetic infrastructure existing in the area creates the possibility to perform good observations in order to be processed and correlated with other data (geodynamic, geological, physical et al.). Between 2006-2008, TUCEB participated by Department of Geodesy and Photogrammetry to the project INDEGEN (grant CEEX-2 MENER no. 732/2006-2008) managed by IGAR in co-operation with other scientific organizations: University of Bucharest, Geological Institute of Romania, and National Institute for Earth Physics. According to the project objectives, TUCEB supported three main research approaches:

(i) *determination of crust deformation of the tectonic and geodynamic framework through regional GPS observations* (observations were done yearly in 2007 and 2008) on the pillars of the network for geodynamic monitoring; (ii) *determination of the crust deformations, as*

precursory/post-seismic factor through the high accuracy repeated geometric leveling on the infrastructure of the geodynamic micropolygon (Tulnici-Valea Sării-Vrâncioaia); (iii) *monitor of horizontal crust deformations along active faults*: the action aimed at revealing the eventual relative displacements of the fault flanks in connection with lithosphere sinking.

The activities were performed by scientists from TUCEB and students from the 4th semester of the Faculty of Geodesy. The following activities included:

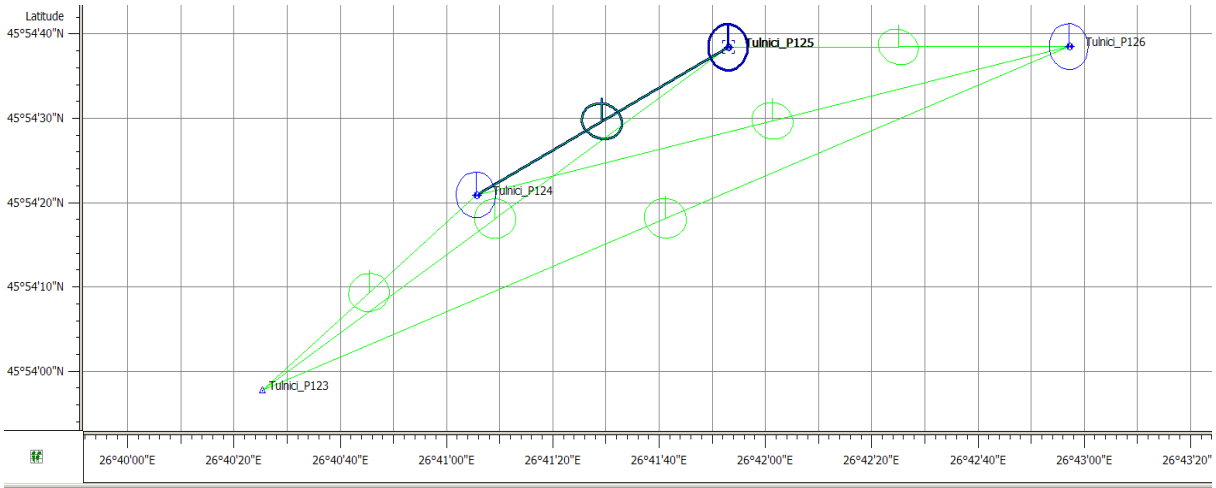
- design of geodetic observations (leveling and GNSS) for crustal movements determination in geodynamic micropolygon (Fig.1, Fig.8a, Fig.8b);
- design of leveling observations for the closed leveling network including more than 40 km of double leveling; observations were performed with high accurate leveling instruments (Karl Zeiss Ni007 and Leica DNA03) and accessories; each leveling line was observed forward and backward by invar stafs and barcode stafs;
- the time interval for leveling observations was at the same epoch with the satellite observations; all data were archived both in analogue (field sheets) and digital format;



Points | GPS Occupations | GPS Obs

Icon	Name	Latitude	Longitude	Ell.Height (m)	Code	Control	N...	P...	Layer	Source	Std Dev n (m)	Std Dev e (m)	Std Dev u (m)	Color	Std Dev Hz (m)	Point Symbol
	Gresu_P104	45°58'09.93792"N	26°25'35.29330"E	1217.953		None			0	C:\GPS_2011...	0.008	0.006	0.016	BYLAYER	0.010	BYLAYER
	Vidra_P102	45°54'47.70464"N	26°54'36.44417"E	299.402		None			0	C:\GPS_2011...				BYLAYER		BYLAYER
	Tulnici_P123	45°53'57.73882"N	26°40'25.23715"E	614.901		None			0	C:\GPS_2011...	0.005	0.004	0.011	BYLAYER	0.007	BYLAYER
	Lepsa_P103	45°58'08.63017"N	26°33'50.49511"E	664.745		None			0	C:\GPS_2011...	0.006	0.006	0.016	BYLAYER	0.009	BYLAYER

Fig.8a GNSS network in the area of geodynamic micropolygon (P102, P103, P104, P123)



Points | GPS Occupations | GPS Obs

Icon	Name	Latitude	Longitude	Ell.Height (m)	Code	Control	N...	P...	Layer	Source	Std Dev n (m)	Std Dev e (m)	Std Dev u (m)	Color	Std Dev Hz (m)	Point Symbol
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	Tulnici_P124	45°54'20.90239"N	26°41'05.54302"E	610.973		None			0	C:\GPS_2011...	0.001	0.001	0.002	BYLAYER	0.001	BYLAYER
	Tulnici_P126	45°54'38.50776"N	26°42'57.09136"E	607.945		None			0	C:\GPS_2011...	0.001	0.001	0.002	BYLAYER	0.001	BYLAYER
	Tulnici_P123	45°53'57.75349"N	26°40'25.25832"E	618.319		Both			0	C:\GPS_2011...	0.000	0.000	0.000	BYLAYER	0.000	BYLAYER

Fig.8b GNSS network in the area of geodynamic micropolygon (P123, P124, P125, P126)

- design and performance of GNSS observations for crustal movements determination in the extended (INDEGEN) network including four GNSS traverses (Fig.9).

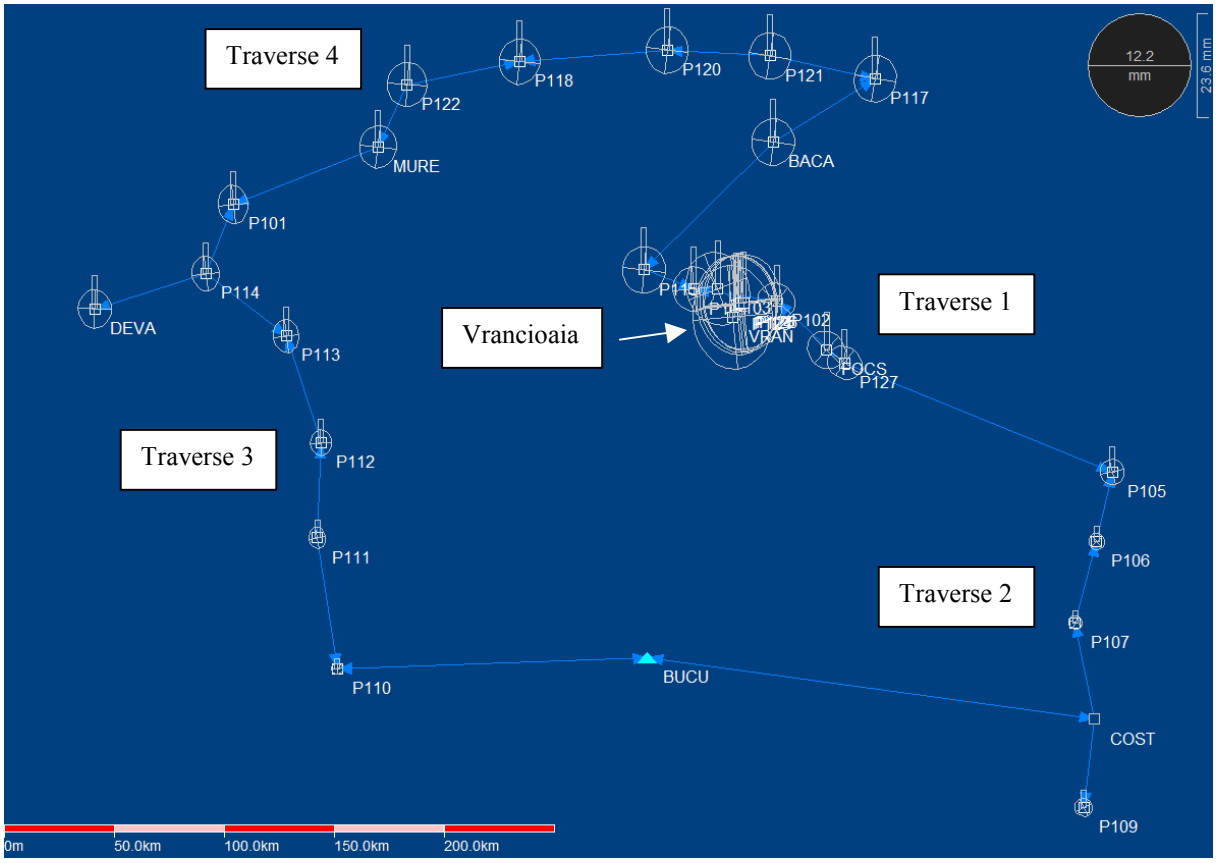

Fig.9 INDEGEN GNSS network

In this manner, geodetic practice performed by students was combined with research activities supported by a grant. Students were very satisfied to participate in such activities and to continue. On that idea at present and in the future we are going to continue geodetic observations in that area (Vrancioaia at least) and scientific investigations by geodetic methods.

5. Conclusions

One of the current activities organized by the technical universities as TUCEB, it is those concerning the geodetic practice. Faculty of Geodesy from TUCEB organize each summer, since more than five years, for about half of the students, practical training in the area of Vrancea (in the vicinity of Vrancioaia seismic station). Student's participation it is based on volunteer participation. Only students who expressed their interest are accepted to perform pratical training in that area. In Vrancea area there are a geodynamic micropolygon realized by IGAR, including geodetic ground markers (proper installed mainly for leveling, but also for GNSS observations) and a geodetic (network) micropolygon realized by TUCEB – Faculty of Geodesy, Department of Geodesy and Photogrammetry. Technical equipments and data processing algorithms, are in general proper for the geodetic student's training. During the practice, students participates at classical (triangulation, trilateration, leveling) and modern (GNSS) geodetic methods and technologies. Practice activities are combined with

research activities as observations are performed in the geodynamic micropolygon and one of the four traverses of the geodynamic network realized by IGAR and TUCEB for crustal movements in Romania. The number of students participating to this activity increased early although most of the expenditure is borne by them. This means that students consider as a very useful activity to particpate on practice campaign, outside Bucharest in Vrancea area, and to learn to work as close as possible to real field conditions.

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