Actually Contribution at Geodynamic Determination in Romania

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Abstract: *Based on the previous geological and geophysical information a special network for geodynamic monitoring of the Romanian territory has been designed and achieved. The network consists of three lines crossing the major lithosphere contacts: the Tornquist-Teisseyre Zone (TTZ) separating the East European Plate from the Intra-Alpine Microplate (IaP), Peceneaga-Camena Fault, as the boundary between EEP and Moesian Microplate (MoP), and the Trans-Getica Fault (TGF) between MoP and IaP. The fourth line is crossing the Vrancea active geodynamic area located in the bending area of East Carpathians. The project INDEGEN (grant CEEX-2 MENER no. 732/2006-2008) started in 2006 with a duration of three years, managed by the Institute of Geodynamics of the Romanian Academy in co-operation with other scientific organizations: Technical University for Civil Engineering – Faculty of Geodesy, University of Bucharest, Geological Institute of Romania, and National Institute for Earth Physics. The main task of geodetic investigation will consist in repeated GPS and leveling observations combined with other observation techniques as gravity. The geodetic network was connected with CEGRN (Central European Geodynamic Network) by GPS and leveling observation campaign performed in July 2007. A new campaign will take place in 2008.*

Keywords: *geological and geophysical information, geodynamic monitoring, network, geodetic investigation.*

1. Introduction

The INDEGEN project research represents an attempt to explain intimate mechanism of the intermediate-depth seismicity within Vrancea zone through the links between the geodynamic activity seismic contribution of the thermo-baric accommodation phenomena (following the penetration of a colder lithosphere into the hotter upper mantle). The idea came from the correlation between the distribution of earthquakes with the depth (with maxima located at 90 km, 130 km and 150 km), and location of the major thermal discontinuity (asthenosphere) of the three lithosphere compartments joining the region (90 km for Intra-Alpine Microplate, 130 km for Moesian Microplate, and 150 km for East European Plate), based on the well known potential for generating seismic energy of temperature-accommodation phenomena (e.g. convective currents, thermal stress, phase transform processes, devolatilization).

2. Objectives and Expected Results

The main aim of research is an attempt to explain the intermediate-depth seismicity within Vrancea zone through the link between the geodynamic environment (that seems to determine the sinking of the seismic source) and seismic contribution of thermo-baric accommodation phenomena (following the sinking). The proposed research should answer several major questions such as:

Are there temperature-accommodation phenomena able to generate the observed seismicity in Vrancea zone?

1. What is the critical mass of lithosphere that should be exposed to higher temperature by sinking into the mantle?
2. What is the speed limit of sinking in order to avoid gradual heating without (or with minor) associated seismic phenomena?
3. Is there any correlation between the sinking of seismic zone and horizontal lithosphere dynamics?
4. Could we monitor in almost real-time geodynamics in the area, and consequently, the induced seismicity?

Measurable objectives to be achieved are:

A new model for the tectonic and geodynamic framework of Vrancea active seismic zone:

1. Geothermal models providing constraints to each scenario of geodynamic evolution;
2. Research on the amount of the seismicity generated by the temperature accommodation phenomena;
3. A model for the lithosphere structure of the seismic zone (geometry, rheology, temperature distribution);
4. Quasi real-time monitoring of the lithosphere dynamics within Vrancea zone in order to build up an integrated seismic-geodynamic model (including relationships between geodynamics-thermodynamics-seismicity);
5. Considerations on seismic hazard evaluation within new circumstances;
6. Providing means for increasing public awareness on the seismic hazard: providing support for policy-makers involved in civil protection for appropriate management to mitigate risk related to the Vrancea seismicity;
7. Developing a pool of highly qualified Romanian scientists in the related field.

Expected results of the research are:

1. improved model for geodynamic evolution of the East Carpathians region;
2. model simulating the lithosphere structure within active seismic zone based on geophysical data interpretation;
3. study on the seismicity generated by temperature accommodation phenomena with qualitative and quantitative evaluations on the volumes of lithosphere and sinking speed able to generate significant earthquakes in Vrancea;
4. a complex seismic-geodynamic model of the intermediate seismicity in Vrancea zone through the integration of geodynamic, thermodynamic and focal mechanism elements.

3. Geodetic Activities within the Indegen Project

Phase II of the project for UTCB (Technical University of Civil Engineering) was dedicated to the *"Design and realization of the geodetic observations in the geodetic monitor network"*. The activities were performed quite well and the main objective of the phase was achieved in good conditions – the realization of the first geodetic observations campaign ("zero" epoch) in the geodetic monitor network (Fig.1).

According to the project objectives, UTCB will support three main research approaches:

(i) *determination of crust deformation of the tectonic and geodynamic framework through regional GPS observations* (observations will be made 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 polygon no. 1 (Tulnici-Valea Sării-Vrâncioaia); (iii) *monitoring of horizontal crust deformations along active faults*: the action is aimed at revealing the eventual relative displacements of the fault flanks in connection with lithosphere sinking.

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

- design of geodetic observations for vertical crustal movements determination in Tulnici geodynamic (no.1) polygon (Fig.2);
- 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 (Fig.3 and Fig.4);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;

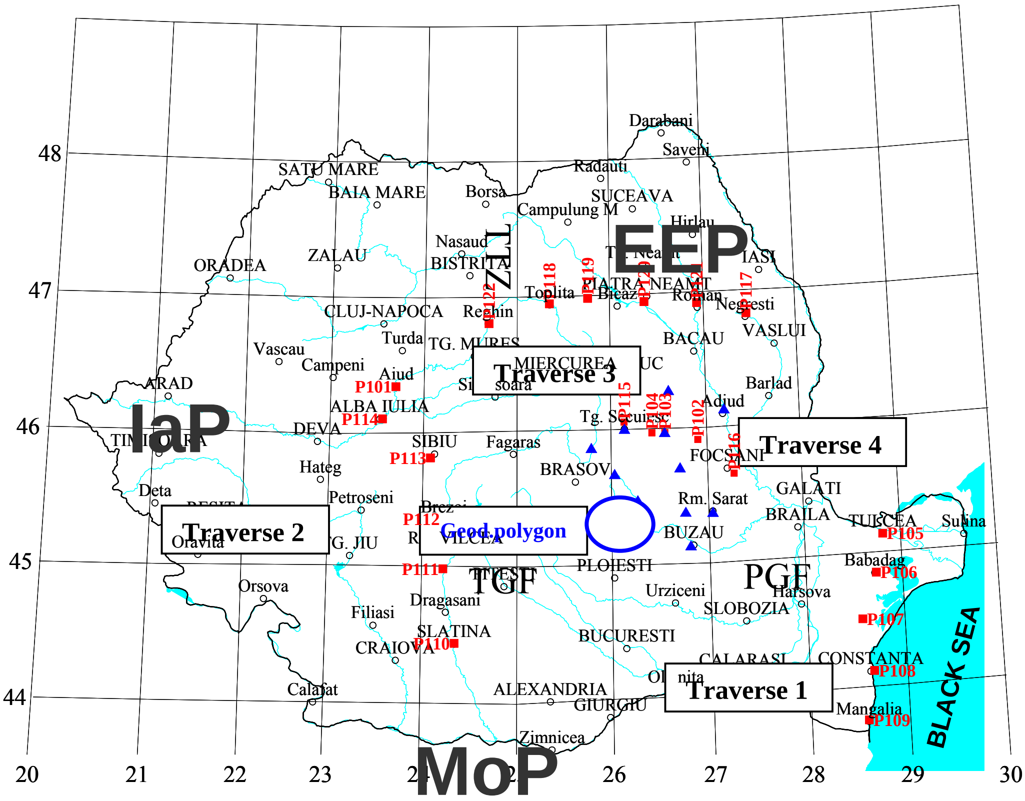

Fig.1 Geodetic monitor network
(four traverses – red squares and geodynamic micropolygon – blue ellipse)

- students of the 2nd study year from Faculty of Geodesy contributed to the realization of the leveling observations, the campaign interval being coincident with students' training time (after summer semester);
- satellite observations from the geodetic network were designed for the 4 traverses (Dobrogea, Oltenia-Transilvania, Transilvania-Moldova, Moldova-Dobrogea) – 22 pillars and micro-traverse Vrancea (geodynamic micropolygon Tulnici) – 4 pillars; 7 field teams were organized for observations and travelled each more than 2000 km during the satellite observation campaign;
- UTCB had at disposal geodetic GPS receivers with 2 frequencies and performant antennas; the centering was realized with devices special designed and made for that purpose before the observation campaign; each pillar was observed continuously for

- 24 hours and data recording interval was 30 s; more than 10 cars were necessary for the field transport of the teams if we take into account the great network area and the necessity for the sincronization of the satellite observation sessions;

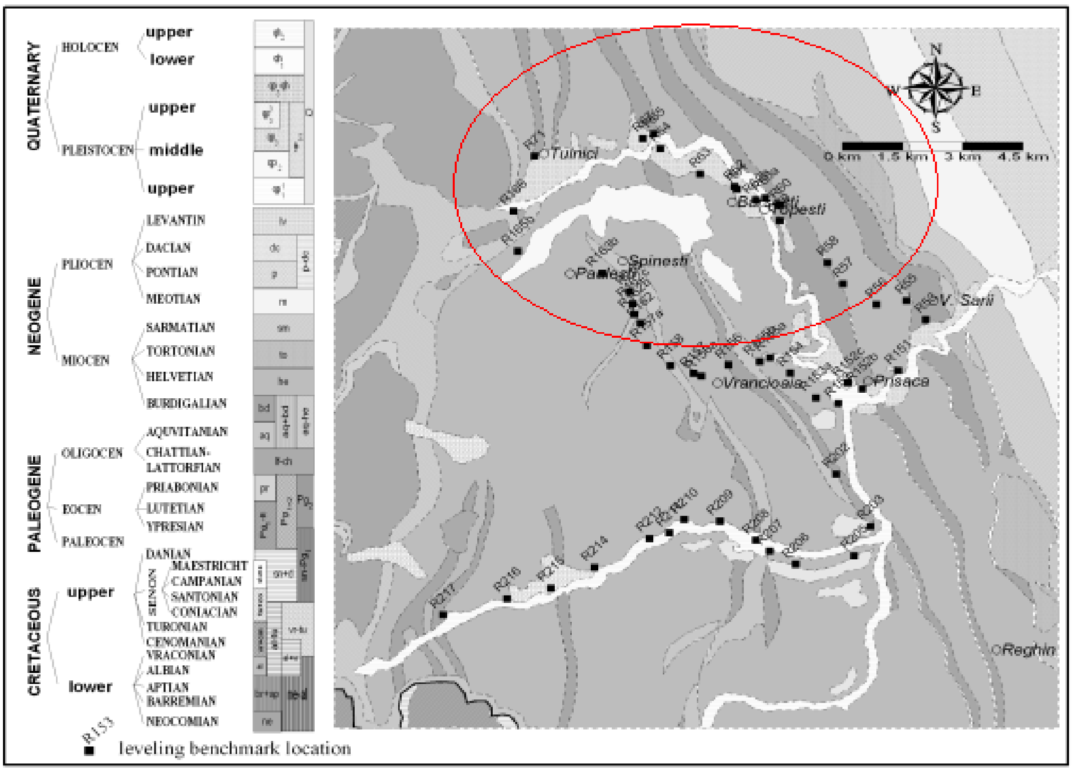

Fig.2 Geodynamic micropolygon Tulnici-Valea Sării-Vrâncioaia


Fig.3 Classical leveling instruments (Ni007) and tripod


Fig.4 Modern electronic leveling instruments (Leica DNA03)

- GPS geodetic network includes one permanent station (Constanta) with the possibility to include more, if we consider that some sites from Romanian GNSS permanent stations are proper for geodynamic investigations;
- All GPS data were collected into the receivers and transferred in digital format to CD/DVD's;

Fig.5 GPS equipments prepared for night observations

Fig.6 Pillar identification mark

Fig. 7 Satellite observation equipments (GPS Trimble 4000 SSE, car and tenth)

Fig.8 GPS receiver front panel view

Fig.9 Site panorama (Băbeni, Vâlcea)

Fig.10 Forced centering system of the antenna

Fig.11 Upper view of the GPS antenna

- A theoretical study was also realized about the height systems available in Romania and in Europe in order to make clear few aspects concerning the proper systems to be used for geodynamic investigations and the practical methods of implementation;
- It was recommended the realization of gravity observations on the levelling markers or the determination of the precise heights of the gravity markers, and the posibillity for data adjustment including the gravity field corrections;
- Site descriptions were checked and corrected when necessary for all the ground markers; it was observed that presently not all vandalism acts can be avoid; together with IG-AR (Insitute of Geodynamics – Romanian Academy) partner, protection actions were established including building of „twin" markers for the special situations (when the existing markers could be destroyed due to motorway modernizations, new buildings closed to the pillars et al.);

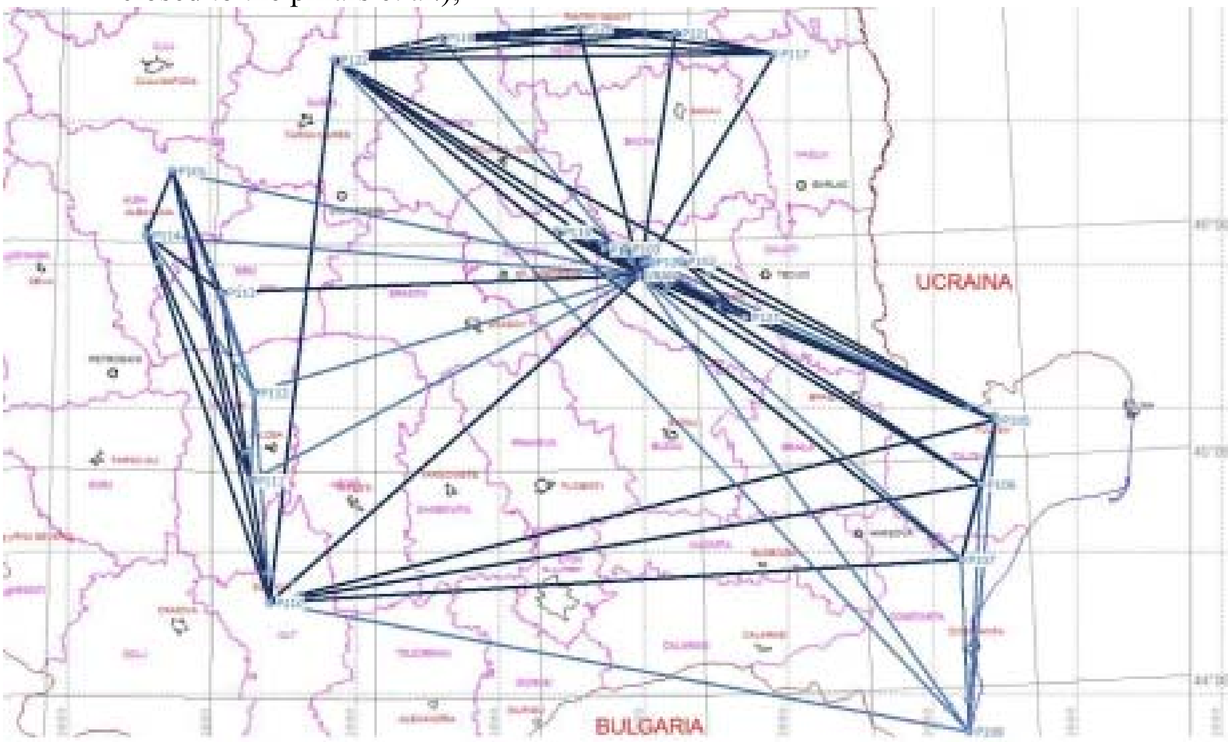

Fig.12 GPS network vectors after observations campaign 2007

4. Preliminary Results of GPS Campaign

After first INEDEGEN observation campaign 2007, data collected started to be processed and presently still going on. GPS data processed in preliminary phase indicated good accuracies. Data collected at 30s for 24 hours sessions will be processed with scientific processing software and specific processing options as: elevation mask 10(5)o, IGS precise orbits, fixed ambiguities, no a priori troposphere model, elevation dependent weighting + dry Niell mapping function, ITRF2000 datum etc. The centering error (planimetry and height) less than 1mm it is possible with the special antenna adapters for forced centering.

Preliminary results were obtained and the rms for coordinates are horizontal less than 5mm and vertical around 10mm (Figs.13,14). Baselines lengths are from about 10km (Vrancea traverse) up to 350 km. Permanent stations suitable for geodynamic investigations from the Romanian GNSS permanent network (i.e. Bucharest, Constanta, Focsani et al.) will be included in the network and the baseline maximum length will decrease. We can mention that all the GPS equipments are of the same type (receivers and antennas) and this could be helpful for a reliable data processing and results.

Leveling data from the geodynamic poligon are still under processing. The leveling instruments used in the campaign have the accuracies of 0.4-0.7 mm/km and are suitable for geodynamic height movements.

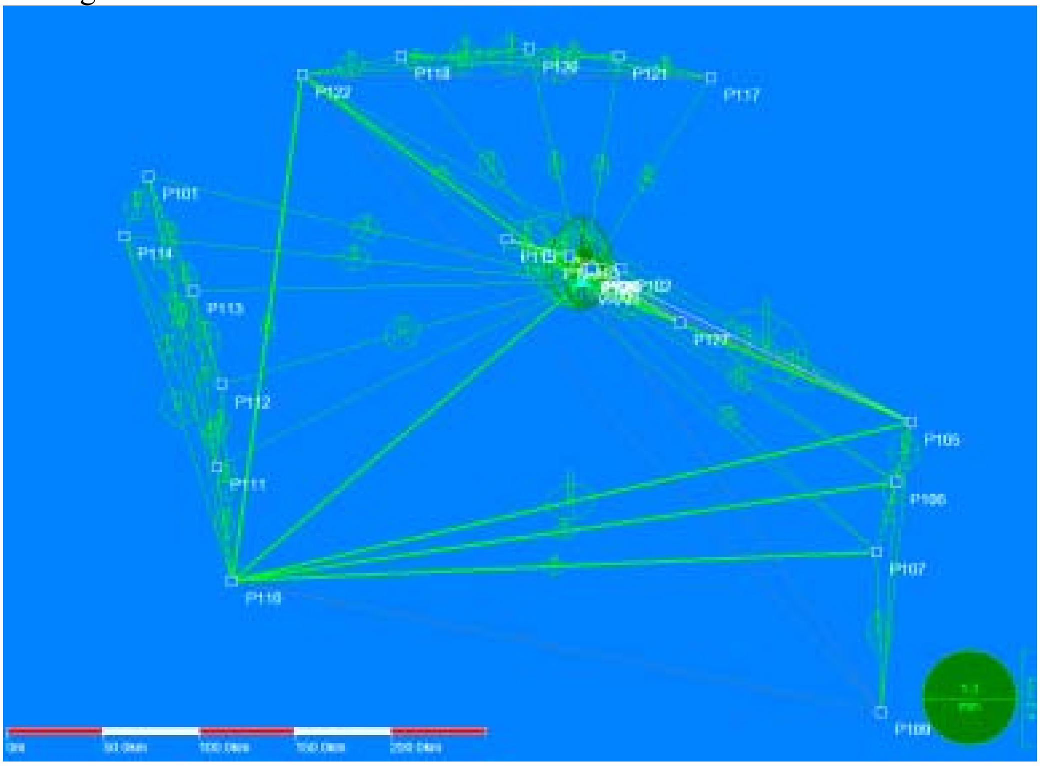

Fig.13 GPS geodynamic network and baseline errors (ellipses and bars)

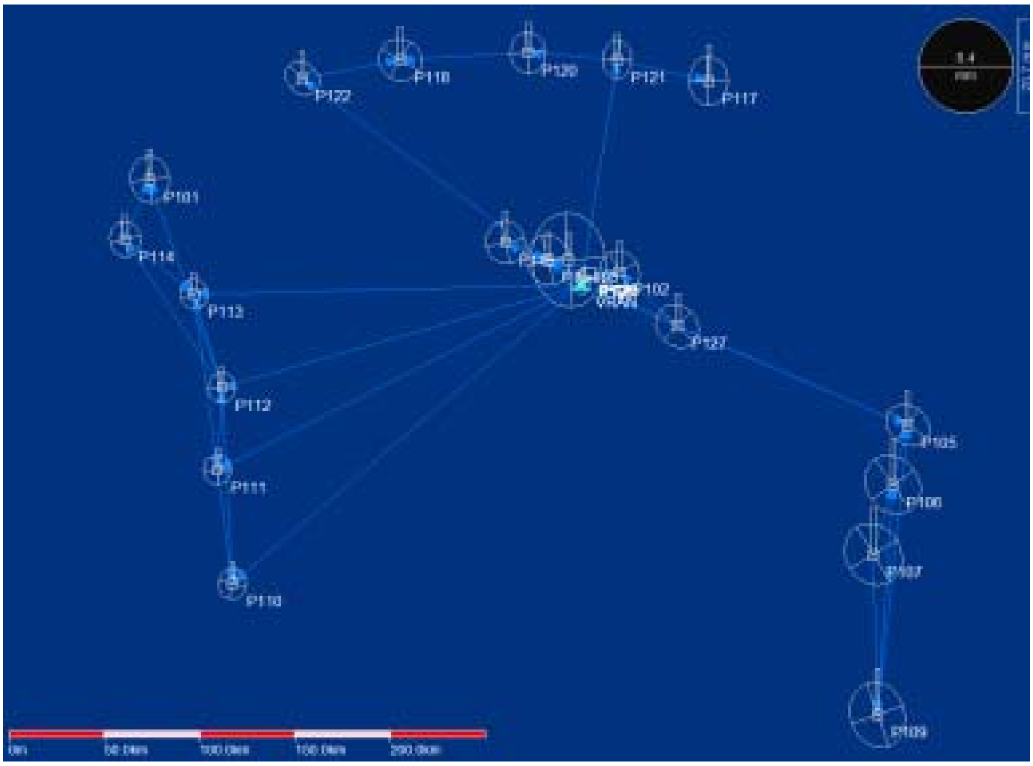

Fig.14 GPS geodynamic network and coordinates errors (ellipses and bars)

5. Acknoledgements

The INDEGEN project it is supported by National Authority for Scientific Research under grant CEEX no.732/24.07.2006, Modul I – C2, P-CD.

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