

3.1. GEODYNAMICS OF THE BALKAN PENINSULA WITHIN THE FRAMEWORK OF CERGOP-2

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3.1.1. Introduction

Brief information about the project CERGOP-2 (Central European Regional Geodynamic Project) is given. The characteristics of the Balkan Peninsula in geodynamic respect are briefly outlined. The necessity, aims, prerequisites, concepts, methodology and stages of geodynamic investigations are presented. The results are formulated. The activities performed so far and the obtained results are discussed. A generalized program for investigations is presented (Milev et al., 2004).

3.1.2. CERGOP-2, a multipurpose and interdisciplinary sensor array for environmental research in Central Europe

3.1.2.1. Problems to be solved

The project CERGOP-2, a Multipurpose and Interdisciplinary Sensor Array for Environmental Research in Central Europe (Acronym CERGOP-2/Environment, Programme: Energy, Environment and Sustainable Development) primarily addresses the monitoring of crust movements in the central part of Europe, covering an area of 15 % of the continent, with the aim to determine the velocities of selected points in seismic active areas over decades (Fig. 3.1.1.). Investigation of the change of velocities (accelerations) leads the description of the underlying driving forces and of energy transfers leading to earthquakes. As these movements are very slow an utmost accuracy of the determined coordinates down to the millimetre level is required if expressive results during a time span of say a decade should be achieved. The existing network CEGRN, in operation now for 8 years, will be updated and intensified to an operable multipurpose station array for permanent, automated monitoring using GNSS methods. Moreover, this network will support the monitoring of fast dynamic processes like weather changes and positioning of moving objects in near-real and real time. The operation will be continued after the end of the project as only permanent monitoring over decades can deliver a correct picture of our permanently changing environment.

3.1.2.2. Scientific objectives and approach

The project will define a yearly set of coordinates for the complete network CEGRN (about 100 stations) using the GPS/GLONASS system (later also GALILEO) with an accuracy of better than 5 millimetres. Together with the existing realisations of CEGRN (since 1994) 12 yearly sets of coordinates are at disposal which are the basis for extensive scientific investigations leading to velocity fields changing with time, and describing the geodynamic behaviour of the selected area. In addition a subset of stations will observe permanently, time series of daily computed coordinates will give, after filtering, accuracies down to the millimetre level, giving the opportunity to

compute yearly velocities with an accuracy of better than 1 mm/year. In order to get this accuracy the project will also investigate the influence of the troposphere which heavily deteriorates the precision of GPS height determination.

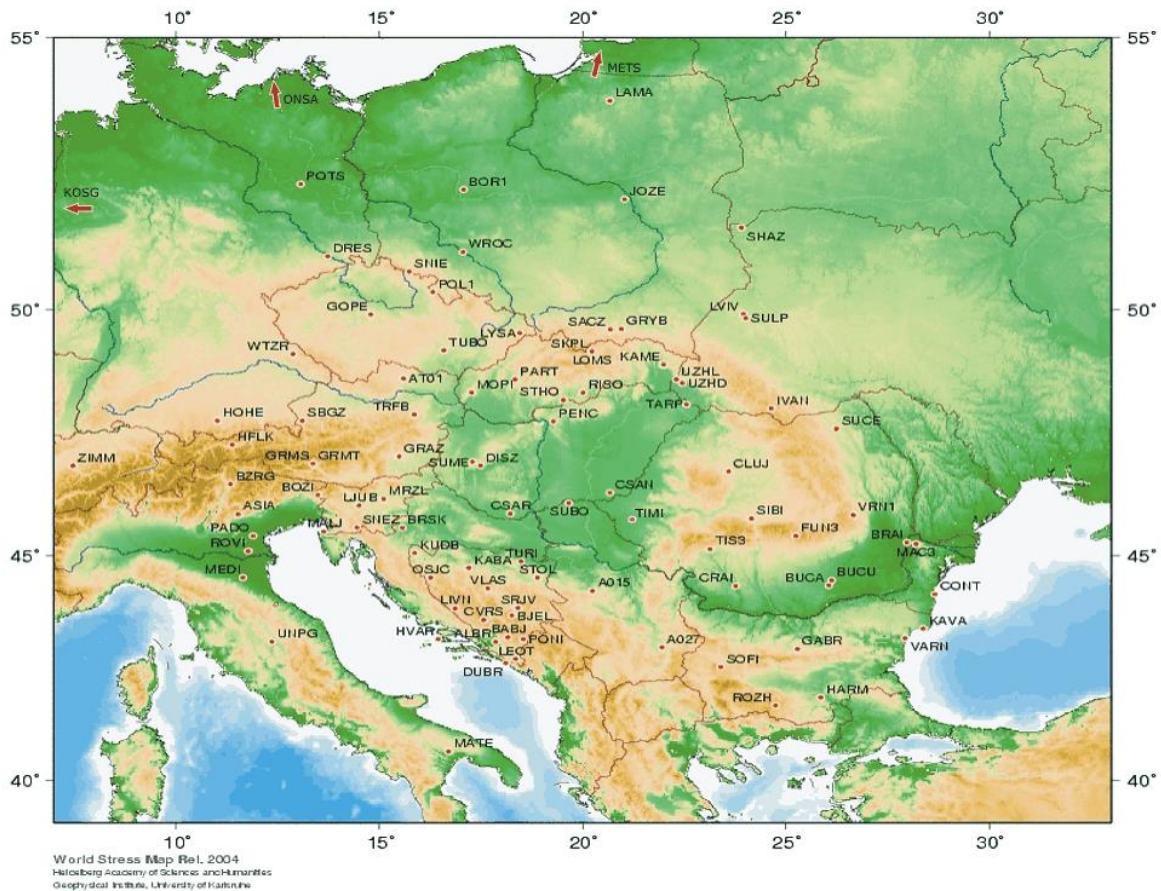


Fig. 3.1.1. CERGOP-2 Area and stations

For moderate (glaciers, landslides, ...) and fast moving (vehicles, ...) objects reference data of up to 1 Hz sample rate will be placed at disposal in real time, a task force will be created which can be brought to action in case of emergency (e.g. after earthquakes) for monitoring sudden changes of our environment. The present network (~ 60 stations) will be intensified to about 100 stations; about 50 % will receive permanent status. For these new stations a prototype GPS-package will be developed in order to save money and standardize the equipments for easier maintenance.

Seven seismic active regions were selected for closer inspection. Local networks will monitor the local behaviour along the respective plate boundaries on a yearly basis. Special monographs will be published for those regions, in cooperation with geophysicists and geologists. They will provide the “historical” background for future earthquake prediction and hazard mitigation.

3.1.2.3. Expected impacts

By the end of the project an operational multipurpose monitoring network will be available covering 15 % of Europe and consisting of about 100 reference stations. This long-term observation facility will continue its work during the following 5 years, hopefully ending up in a regular service for Europe. The periodical establishment of a new reference frame will describe the geo-kinematical history of the selected area starting with the year 1994, which will be an important input for all geodynamical

investigations during the current century. Future analysis with a more and more extended sample period will lead to the physical understanding of the mechanisms of crust movements which is a prerequisite for certified earthquake prediction and hazard mitigation. Likewise the local monitoring of endangered regions like the surroundings of water-dams, nuclear power plants, and regions of large population will give an important contribution to the safety of mankind and property.

The disposal of real-time data for public use will give a great impact especially for the non-EU countries, where it will be the starting point for networks enabling real time navigation, an item to which more and more attention

3.1.3. The characteristics of the Balkan Peninsula in geodynamic respect

The territory of Balkan Peninsula is characterised by active geodynamics (Fig. 3.1.2.) (Monograph, 2000-a, Monograph, 2000-b). It is the most active region in Central and Eastern Europe in geodynamical respect. A number of hazardous geodynamic processes of endogenic (earthquakes, contemporary movements of the Earth's crust, mud volcanoes) and exogenic origin (natural and technogenic), including landslides, abrasion, erosion, subsidence, collapse, rockfalls, mud-stone flows, deformations caused by mine workings, karst, etc., are observed in the area.

The single processes and cases are superposed or interact with each other in many respects. Their combined display, range of manifestation and multilateral, in many cases destructive effect is especially typical for the Balkan Peninsula territory.

The tectonic on the Balkan Peninsula is determined by the fold structures of the Alpine-Himalayan orogen. The territory of the peninsula had been subjected to older orogeneses too. The Alpine-Himalayan orogen itself, which builds the three big South-European peninsulas and the greater part of Middle Europe, is bilateral. Its northern branch is represented by the Alps, the Carpathians and the Balkanides and is called the Carpathian one. The southern branch, called the Dinarian, comprises the real Dinarides and the Hellanides. Both branches are equally well expressed and are in close contact on the Balkan Peninsula.

At present the space of the Balkan Peninsula falls within the zone of collision between three large plates - Eurasian, African and Arabian, which are themselves divided in smaller ones (Fig. 3.1.3.).

The geostructural situation and the geological evolution of the Balkan Peninsula territory presupposes the established geodynamic development and the display of the hazardous and other phenomena considered in the future monograph.

They represent a substantial element of the general situation of relatively high seismicity in the region. Investigations and publications, including books, studies and papers, have treated general and particular aspects of these phenomena during the elapsed period. Undoubtedly a new complex outlook is necessary using the possibilities of modern science, taking under consideration the fact that the seismic activity is one of the major manifestations of the geodynamic situation on the territory of the region, as well as that the united efforts of the scientists from different branches, and especially from Earth Sciences, will contribute to further understanding of these disastrous and destructive phenomena.



Fig. 3.1.2. Balkan Peninsula

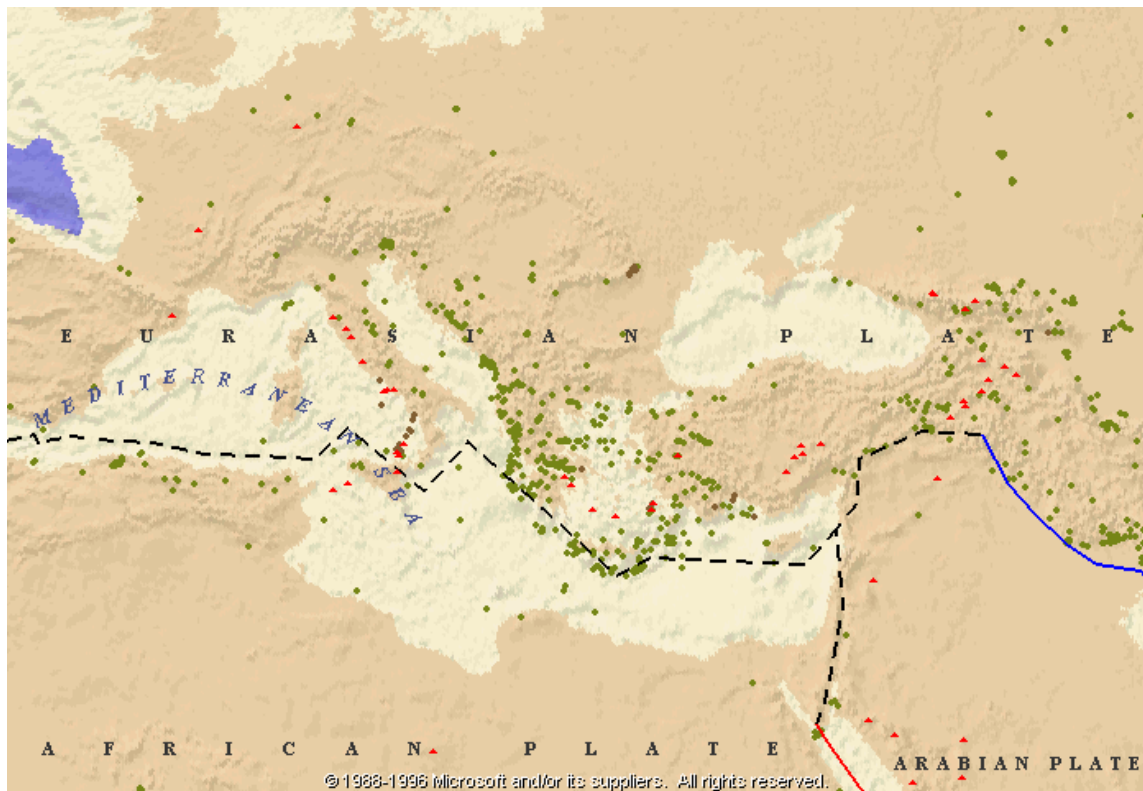


Fig. 3.1.3. Main lithosphere plates and their interaction along the East Mediterranean

The basic problems treated in the monograph are connected with: seismological, seismotectonic, geological and geodetic investigations; complex interpreting; protective measures.

Having in mind the enhanced recent seismic activity and the catastrophic earthquakes in West Turkey and Greece, the problems related to the earthquakes acquire special significance for this part of Europe and Asia. In this context each contribution of a scientific or other character related to the earthquakes is of great importance under the existing conditions with high possibility of occurring of strong earthquakes. The great importance of the considered problems is confirmed by the above mentioned considerations.

- Specificity of the study within the framework of the CERGOP-2 consists of (Milev et al. 2004):
 - Only a part of the territory is covered by countries participated in the project
 - Need of integration of the rest of the countries from the Balkan Peninsula
 - Scale, terrain diversity, variety and intensity of the geodynamical processes, overlapping with many state structures and others of the region of interest
 - Lack of information related to the complete interdisciplinary geodynamic investigations of the region. Such investigations exist for separate regions (Monograph, 2000-b, Monograph, 2000-a) and they have been carried out by different methods.

3.1.4. Preconditions, concepts, methodology and development

3.1.4.1. Preconditions and aims

- The main aims are:
 - Establishment of regional interdisciplinary collaboration.
 - Establishment of a representative picture of the Balkan geodynamics.
 - Assessment of the unfavorable influences of the hazardous geodynamic processes in the region.
 - endogenic – seismic risk, recent crust movements,
 - exogenic – local and engineering geodynamics.
- The preconditions for the investigations are related to (Milev et al., 2004):
 - Available studies on different projects –WEGENER-MEDLAS, specific studies, monographs.
 - National projects and investigations: finished and current in different fields of the science, interdisciplinary.
 - Available infrastructure:
 - permanent GPS stations,
 - geodynamic GPS networks,
 - seismic stations and networks.
 - Existing collaboration in the field of geophysics between Balkan.

3.1.4.2. Methodology, description of the work and organisation

They consist of:

- Systematisation and analysis of the existing investigations for the region

- **Accomplishment of complex measurements, investigations and generalizations concerning:**
 - **seismological conditions and processes,**
 - **geophysical fields interpretations related to the geodynamical processes,**
 - **see bottom geology and processes,**
 - **seismotectonic,**
 - **geology and geomorphology,**
 - **geodesy,**
 - **complex analysis and interpretation.**
- **Establishment of contacts with:**
 - **scientific coordinators of the participating countries in the CERGOP-2 project and integration of institutions and leading scientists of their countries in the field of geodynamic investigations,**
 - **institutions and scientists from the Balkan countries not participated in the CERGOP-2 project (Turkey, Greece, Macedonia, Serbia-Monte Negro, Albania.**
- **Cooperation and coordination with other Work Packages of CERGOP-2 concerning the region of study, leading scientists from the Balkan countries in the field of geosciences accomplishing regional geodynamic studies of the Balkan Peninsula and the region of Mediterranean.**
- **Preparation of a generalized monograph.**

3.1.4.3. Main stages in the project implementation and results

They are related to:

- **Integration of the efforts of specialists in the Balkans from the Earth sciences for complex study of the region and carrying out of respective measurements, and investigations applying a common methodology and criteria .**
- **Establishment of permanent and epoch GPS stations on the territory of the individual Balkans countries and their integration in common system.**
- **Carrying out of GPS campaigns in the individual countries, subregions, regions and within the entire CERGOP-2 project, their processing, analysis and interpretation.**
- **To promote innovation transfer in the field of the recent geodynamics, focusing the Balkan Peninsula.**
- **To contribute towards minimizing of the difference of research potential between the participating countries.**
- **Generalization of new knowledges about the geodynamics of the region.**
- **Creation of a recent picture of the Balkan geodynamics.**
- **Preparation and agreement on the generalized monograph.**
- **Preparation, considerations and editing of a generalized study.**

3.1.5. Conclusion

The works accomplished within the framework of the CERGOP-2 project and within the part related to the implementation of the Work Package for the Balkan Peninsula outline their scale, interest and importance. Along with that the successful implementation of the project contributes to the obtaining of important results in several aspects: Establishment of a system of permanent stations, unified coordinate

system, complementation and generalization of the geodynamic investigations of the region, and publishing of a generalized study about the Balkan Peninsula geodynamics.

3.1.6. References

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