ROMANIA CONTINUES THE PARTNERSHIP IN THE NEW STAGE OF EPOS-ERIC PROJECT (SUSTAINBILITY PHASE)

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ABSTRACT

The EPOS Research Infrastructure (EPOS RI) has completed its Implementation Phase (2015-2019), the phase in which INCDFP remained with 23 other European countries, achieving a cornerstone in its lifecycle and it is currently facing the transition from the Implementation to the Operational Phase.

To ensure the long-term sustainability of the EPOS research infrastructure, this year a new phase of the project was started, EPOS Sustainability Phase, in which Romania is a partner. The overall objective of the EPOS Sustainability Phase (EPOS SP) project is to provide the long-term sustainability of the operational services (Integrated Core Services and Thematic Core Services). This requires government support and efficient financial mechanisms to support the activities of the service, but also the attractiveness of using these services in scientific research, as well as in their applications for society, in all these activities NIEP being involved and having significant contributions.

Main objectives of the EPOS SP dissemination and communication for ABD (Adriatic-Balkans-Dinarides) region, where Romania is involved are: 1) to consolidate existing contacts with stakeholders already engaged in EPOS; 2) to engage new stakeholders (users, new scientific communities, private sector, society) to tackle the sustainability challenge; 3) to foster an effective collaboration framework with solid Earth science community projects and initiatives in Europe and at the global level.

Keywords: EPOS-ERIC, NIEP, Romanian Research Infrastructures, Earth Science

INTRODUCTION

The Romanian National Institute for Research and Development for Earth Physics (NIEP), is an active member of the European Plate Observing System (EPOS) project. EPOS is one of three ESFRI (European Strategy Forum on Research Infrastructures) priority projects mentioned in ESFRI Roadmap 2016 as an active project and become an ERIC (European Research Infrastructure Consortium) at the end of 2018. EPOS aims at creating a pan-European infrastructure for solid Earth science to support a safe and sustainable society.

In line with this scientific vision, EPOS's mission is to integrate European research infrastructures (IRs) for sound Earth science, building on new e-science opportunities to monitor and learn about the Earth's dynamic and complex system. In accordance with this scientific vision, the mission of EPOS is to integrate the diverse and advanced European Research Infrastructures for solid Earth science. It relies on

new opportunities for electronic science to monitor and learn the Earth's dynamic and complex system. The final goal of EPOS is to enable the innovative multidisciplinary research to better understand the physical processes of the Earth controlling earthquakes, volcanic eruptions, instability of slopes, tsunamis, as well as, those driving tectonics and Earth surface dynamics.

NIEP is involved in EPOS project, representing Romania as part of the EPOS initiative and participating in all phases of the project (Preparation Phase, Implementation Phase and Sustainability Phase) along with other Universities and European research institutions. NIEP contributes to the implementation of services for seismology, GNSS data and Near Fault Observatory (NFO), in cooperation with other institutions and universities from Romania aims to implement other thematic services (e.g. anthropogenic hazards, multi-scale laboratories). NIEP along with other Romanian infrastructures declared in Research Infrastructure Database for EPOS (RIDE) already offers services through EPOS (e.g. NIEP is one of 10 EIDA - European Integrated Data Archive - nodes of the European Seismic Network).

To accomplish and develop a distributed infrastructure in the field of Earth sciences at the national level, a Romanian consortium has been established (National Institute for Earth Physics, Romanian National Institute of Marine Geology and Geoecology - GeoEcoMar, Romanian Geological Institute – IGR, University of Bucharest, Faculty of Geology and Geophysics / Faculty of Physics; INCD in Construction, Urbanism and Sustainable Territorial Development - URBAN INCERC, Technical University of Construction Bucharest, Romanian Academy, Institute of Geodynamics "Sabba S. Ştefănescu").

At the national level, NIEP's actions consist of maintaining on the national roadmap of the EPOS project and strengthening the national consortium EPOS-RO, aiming to plan and coordinate the activities at the national level.

METHODS AND RESULT

The EPOS architecture is composed of three connected technical and organizational elements (Figure 1): *National Research Infrastructures* (**NRI**); *Thematic Core Services* (**TCS**); *Integrated Core Services* (**ICS**).

National RIs (**NRI**) for solid Earth science in Europe generate data and information and are responsible for the operation of instrumentation in each country.

The **Thematic Core Services (TCS)** represent the community-specific integration to ensure the sustainability of the data and services provision (e.g., in seismology, volcanology or geodesy).

The **Integrated Core Services** (**ICS**) represent the novel e-infrastructure consisting of services that will allow access to multidisciplinary data, products (including synthetic data from simulations, processing and visualization tools) to different stakeholders, including but not limited to the scientific community (i.e., users).

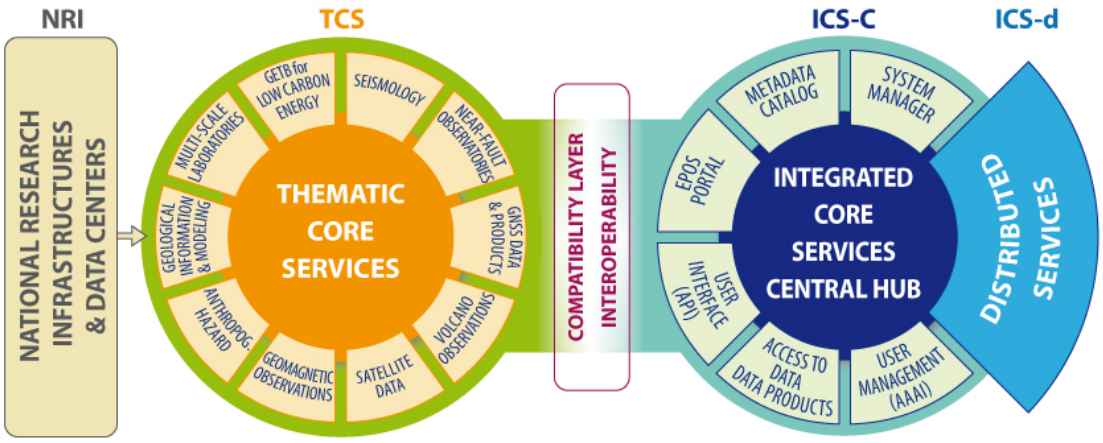

Figure 1- Key elements of the EPOS Functional Architecture.

Since the initiation of EPOS ERIC (European Research Infrastructure Consortium), NIEP has been contributing to facilitate the access to observation data of the national research infrastructures by offering services at both European and global level through:

- The National Seismic Network (RSN INFP, Figure 2) as part of the **EPOS Seismological Thematic Service (TCS Seismology)**;
- The Permanent GPS Station Network – as an integrated part of the **EPOS GNSS Thematic Service (TCS GNSS)**;
- Vrancea Seismological Observatory - being an integrated part of the **EPOS NFO (Near Fault Observatory) Thematic Service;**
- **Surlari National Geomagnetic Observatory** as part of the **EPOS Geomagnetic Observations TCS;**
- **The resonant column** as part of the **Multi-scale laboratories TCS.**
- Anthropogenic induced seismic episodes as part **Hazards Episodes TCS.**

The overall objective of Thematic Core Service **TCS Seismology** is to establish sustainable and harmonized services in Seismology that provide access to - and interaction with - seismological data, products, and tools (services) on a European level.

INFP has been providing data and services through the National Seismic Network (RSN) from the first phase of the project - Preparatory Phase (2010-2014). The real-time digital seismic network consists of 156 seismic stations with three components and 2 arrays: BURAR with 12 elements and PLOR with 7 elements. All data recorded by this network are transmitted in real time at NIEP for automatic data processing, analysis and dissemination. The network has digital seismic stations equipped with different high quality digitizers (Kinemetrics K2, Quanterra Q330, Quanterra Q330HR, PS6-26, Basalt), broadband and short period seismometers (CMG3ESP, CMG40T, KS2000, KS54000, KS2000, CMG3T, STS2, SH-1, S13, Mark l4c, Ranger, gs21, Mark l22) and acceleration sensors Episensor Kinemetrics (Craiu et al., 2017, Marmureanu et al., 2015).

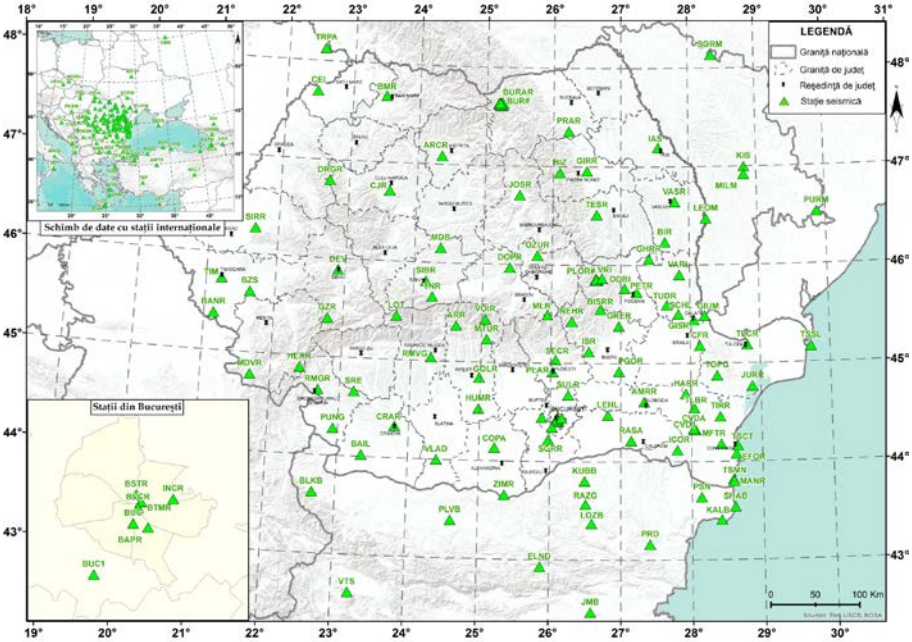

Figure 2 - Romanian Seismic Network – RSN (www.infp.ro).

The EPOS Thematic Core Service (TCS) GNSS Data and Products focuses on developing an open source platform to store and disseminate data and metadata from GNSS station operating in Europe. It provides access to an integrated European network of data providers through an e-infrastructure to disseminate the continuous GNSS data from existing Research Infrastructures.

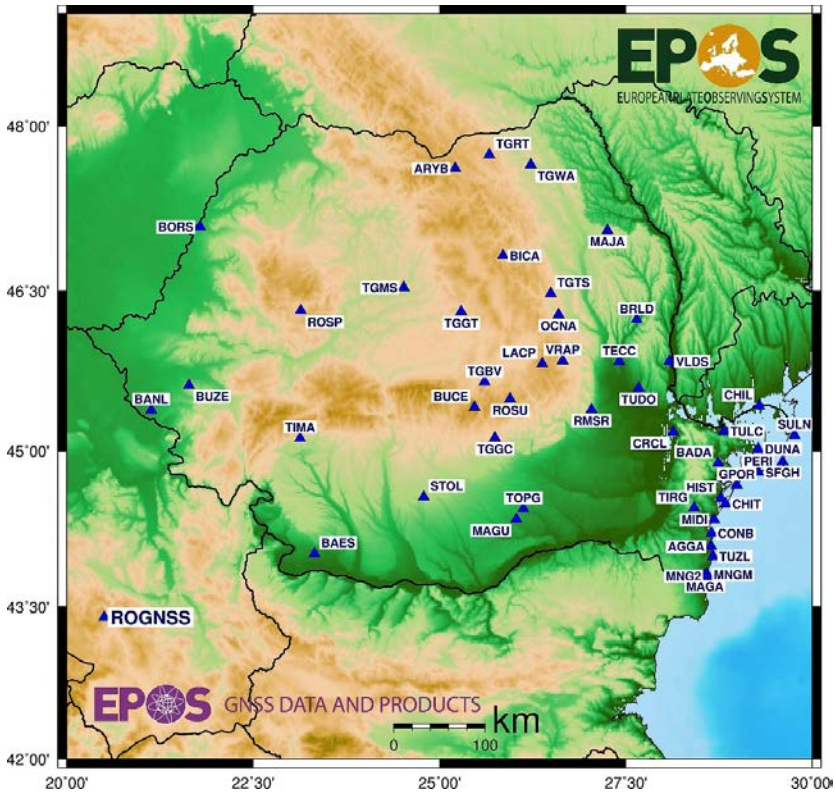

Figure 3 - ROGNSS network, stations submitted in EPOS project.

Figure 3 shows the stations that are included in the NIEP GLASS node. This node distributes GNSS data from Romania and includes data from stations managed by the National Institute for Earth Physics - NIEP, National Institute for Research and Development on Marine Geology and Geo-ecology – GeoEcoMar and Topgeocart company. This node accepts data from Romanian GNSS Stations that comply with minimum quality levels of operation and in accordance with the representative Node's established standards.

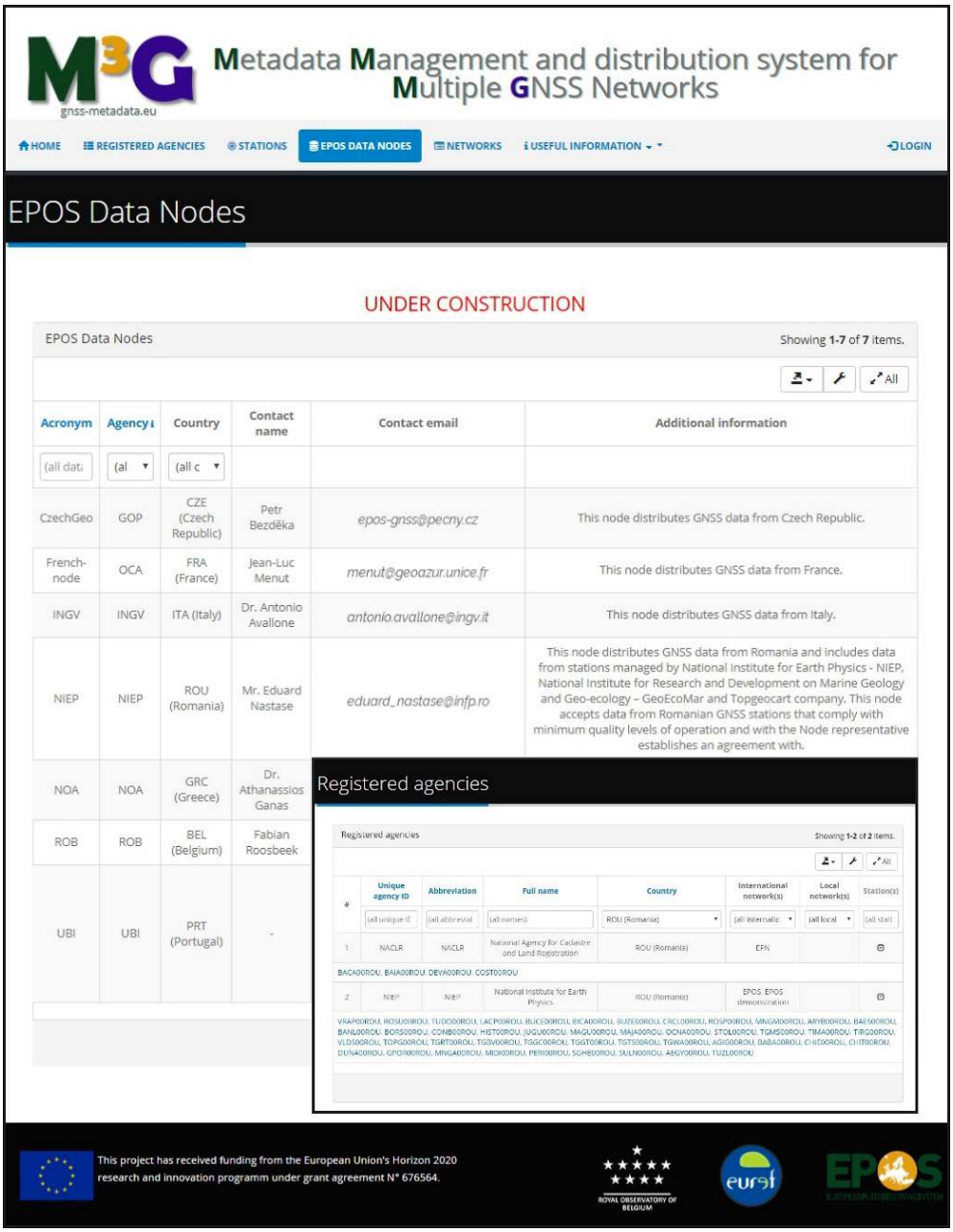

Figure 4 -M3G data portal. EPOS NIEP Data Node and National registered agencies and stations.

The involvement in EPOS (European Plate Observing System) project where we are a national GLASS node (Geodetic Linkage Advanced Software System, an integrated software package to be deployed in a GNSS infrastructure) (Figure 4), helped

us in achieving the objectives we envisaged. GLASS is an integrated software package deployed in a GNSS infrastructure to manage data and metadata.

GLASS is an open source platform, developed by EPOS GNSS Data and Products team, under Creative Commons licensing. GLASS network consists of individual nodes representing a structure for disseminating GNSS data and products. The integration starts from national RIs over national nodes up to EPOS integration service (Muntean et. al., 2019).

The **Near Fault Observatories (NFO)** are long term research infrastructures that strive to provide multidisciplinary and high resolution near fault data and high level scientific products.

The Vrancea Near Fault Observatory is an innovative research infrastructure providing high-quality multidisciplinary data aimed at improving the understanding of multi-scale, physical/chemical processes responsible for earthquakes and faulting. VRANCEA is one of the 7 European Near Fault Observatories (NFO) implemented in seven diverse European countries currently operating in the European Plate Observing System (EPOS) framework. The data generated by VRANCEA is collected, archived and processed in order to enable open science domain and cross domain science, coherently with the long-term vision of EPOS.

The Vrancea Observatory is a multidisciplinary network whose backbone is composed of seismic stations together with infrasound and seismic arrays, a GPS network (10Hz SPS), a Radon monitoring system, meteorological stations, electromagnetic stations and atmospheric ionization monitoring systems (Figure 5) (Toader et al., 2016). The seismic stations are equipped with both short period/broadband and strong motion sensors are located at the surface and within shallow boreholes.

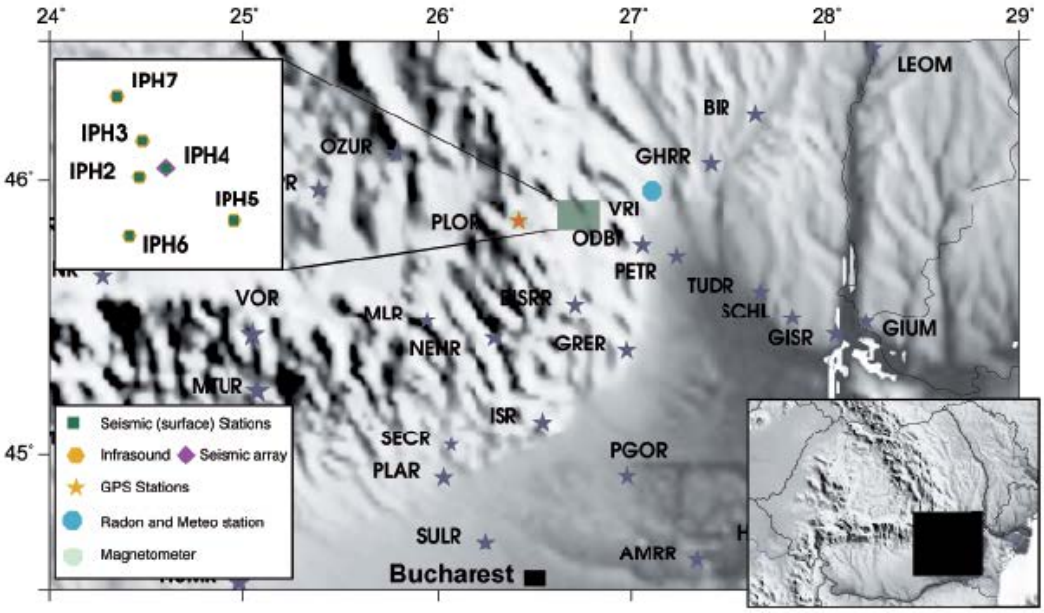

Figure 5 - The map of Vrancea Observatory.

Data is disseminated either by NFO specific frameworks and via existing/developing frameworks where they already exist. In practice, this means for 1) seismic waveforms, infrasound data and station meta-information, the EIDA framework developed and validated in EPOS WP08 Seismology community is used; and 2) for

GNSS data and products, the GLASS network developed and validated in EPOS WP10 GNSS community will be used.

The Thematic Core Service on "Geomagnetic Observations" set a series of objectives to contribute to the EPOS multidisciplinary platform through easier access to geological information and modeling, as well as, its sustainability.

The Geological Institute of Romania (IGR) has been generated maps with a different type of information (geological, hydrological, metallogenesis, etc.) at different scales, this infrastructure contributing from the beginning to the EPOS geological database.

As a member of the widest (/most relevant) program in geomagnetism, INTERMAGNET, the largest geomagnetic and gravimetric database for Romania was developed by the Geological Institute of Romania and the Surlari National Geomagnetic Observatory - a planetary observatory. Over six decades of geomagnetic data were gathered, which contributed to mark out local perturbations linked from electromagnetic induction phenomena to the geological structure of our country, which is also an integrated part of the **Geological Data and Modelling Thematic Core Service.**

TCS Multi-scale laboratories major aim is to create a coherent and collaborative network of European solid Earth science laboratories.

The resonant column apparatus is designed for laboratory determination of the dynamic response of the soils/rocks employing propagating steady-sinusoidal shear or compression waves in a cylindrical soil/rock sample (columns) under resonant frequency conditions. This infrastructure, belonging to the National Institute of Earth Physics (NIEP) is part of **Multi-scale laboratories TCS.** Also the Paleomagnetism Laboratory of the University of Bucharest as part of the **Multi-scale Laboratories (TCS)** and includes: high temperature and pressure experimental facilities, electron microscopy, micro-beam analysis, analogue modeling and paleomagnetic laboratories**.**

The National Institute for Earth Physics participates in **Anthropogenic Hazards TCS** with the following objectives: (i) integration of Anthropogenic Hazards Episodes related to conventional hydrocarbon extraction, reservoir treatment, underground mining and geothermal energy production; (ii) the analysis of the properties of anthropogenic induced seismic series and their dependencies on time and time-varying operational parameters of the inducing technology using new and advance detection and signal processing techniques.

CONCLUSIONS

The European Plate Observing System (EPOS) has been designed with the vision of creating a pan-European infrastructure for solid Earth science relying on novel e-science concepts to provide virtual access to data and services as well as physical access to facilities for a broad community of users, including, but not limited to, scientists. EPOS builds on existing and new Research Infrastructures (RIs) located all over Europe to develop a comprehensive, sustainable Solid Earth Science Research Infrastructure.

The overall objective of the **EPOS Sustainability Phase** (**EPOS SP**) project is to perform activities aimed at **ensuring the long-term sustainability of the EPOS Research Infrastructure**. EPOS SP project aims at performing actions for attaining the

long-term sustainability of the EPOS Research Infrastructure by strengthening financial viability by enlarging the EPOS ERIC membership.

Romania's participation in EPOS ERIC has become crucial due to the fact that it is located in a very active seismic zone, where earthquakes cause a lot of material damage having a strong economic and social impact. EPOS ERIC provides access to data flow that forms the basis for generating different scenarios for the protection of the population in case of natural disasters, such as earthquakes. Additionally, through its training and education component, EPOS ERIC shall provide an appropriate level of knowledge for the analysis of earthquakes and their effects on human habitats, by sharing the information and specialized scientific data between the participating countries.

Following the request of the NIEP for Romania to become a member of the Consortium for a European Research Infrastructure for the European Tectonic Plate Observation System (EPOS ERIC), The Ministry of Education and Research, on behalf of Romania, fully support the joining to EPOS ERIC in accordance with Article 5.1 of the Statues EPOS_ERIC.

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