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MOBILE GEOPHYSICAL LABORATORY: ELECTROMAGNETIC, ELECTRIC AND SEISMO-ACUSTIC ANALYSIS

CONTENTS

ABSTRACT

The mobile geophysical laboratory (MGL), built-in a 4WD car, has been organized in connection with the "Virtual international laboratory of geodynamics" and it was motivated by the results obtained in the framework of the National Program "MENER". The main purpose of the lab is to investigate the electromagnetic, electric and seismo-acustic phenomena induced by the lithospheric processes; especially by the natural and anthropic hazard (seismic active zones, landslides, land collapses in the mining areas with salt dissolution etc.). At present, the lab's activity includes electromagnetic, geomagnetic and geoelectric observations having the following major objectives: (1) to investigate the shallow and deep structures in order to elaborate the adequate geodynamic models, (2) to draw up the EM tomographies at different levels in order to point out the active fault, the geometry of the relic slab in seismic active zones, caverns with salt dissolution in mining areas, landslide's surfaces etc., (3) to establish optimum placement and geoelectric pattern (type of geological structure with its strike direction and the standard deviation of the detectable parameters in non-seismic conditions), so that a regular monitoring of some EM parameters be accomplished, simultaneously with seismic events, with the aim to reveal the earthquakes' precursory phenomena.

KEY WORDS: Geodynamics, geoelectric pattern, electromagnetic tomography, seismic event

1. INTRODUCTION

The modern researches accomplished in the framework of geodynamics revealed the fact that the prediction of the complex systems¢ evolution is possible just in circumstances where local specific information, or those which are interrelated in the nearer vicinity, may be identified. With the other wards, the success related to the implementation of a system which enables us to get geodynamic information concerning the imminence of a natural disaster is strictly determined by its adaptation to the particularities of the zone taken into consideration. Therefore, it may be asserted that the main difficulty in achieving an automatic supervision system for zones characterized by a high natural or anthropic hazard consists both the monitoring ōf representative parameters, during a sufficient long period, and in analyzing their values, what makes possible to identify their changes in conditions of geodynamic activity , on the one hand, and to calibrate the scale according to these changes and to the magnitude of the natural/anthropic event, on the other hand. It is important to point out that only a cumulating of data obtained by means of a more and more complete monitoring of the environment, as well as an adequate soft may lead to the improvement of the prediction of some disasters and, impliedly, to a civilian protection more efficient.

To reach all these objectives, we decided to cover more research stages, in order to achieve a complex mobile geophysical equipment, suitable for multiparameter measurements made on areas placed far away of geodynamic observatories and laboratories, in isolated zones without electrical power and communication systems, to identify proper placements for measurements leading to a correct evaluation of the active geodynamic zones.

The basis geonomical principles which will be used for the projection, execution and implementation of this geophysical measurement system in the geodynamic activity are emphasized below, in the frame of some specific investigation methods (Stanica and Zugravescu, 2002).

2. MEASUREMENT SYSTEMS OF THE MOBILE GEOPHYSICAL LABORATORY

The geophysical measurement system is built-in a 4WD car (Fig. 1) and consists of three separate equipments able to carry out discrete observation and/or continuous monitoring of:

a) ULF and HF electromagnetic field (Geophysical electromagnetic measurement system - GMS 06);

b) Geomagnetic field (MAG 03 DAM);

c) Geoelectric field (Resistivimeter INTEL V3);

All the three measurement equipments include: (i) *Specific sensors*; according to the measured field specified above, the sensors which have been experimented are: a) for geomagnetic field: 3 induction coils, type MFS06 (Metronix-Germany) having a wide frequency range from 4096 sec. to 10 kHz, with two bands: LF (4096sec.-1kHz) and HF (0.5kHz-10 kHz); three axis magnetic field sensor, type MAG-03 MC/MSL, frequency range from DC to 1kHz, measuring range ± 70 m T (Bartington , England); b) for electric field: electric sensors: Pb-$PbCl_2$ and Cu-$CuSO_4$, the both type with solution of kaolin gel, very stabile in time (made by IG-RA, Romania). (ii) *Data acquisition modules (hardware)*: a) ADU-06 (Metronix-Germany) with 5 channel including GPS-clock, frequency range DC to 20 kHz, network capabi-

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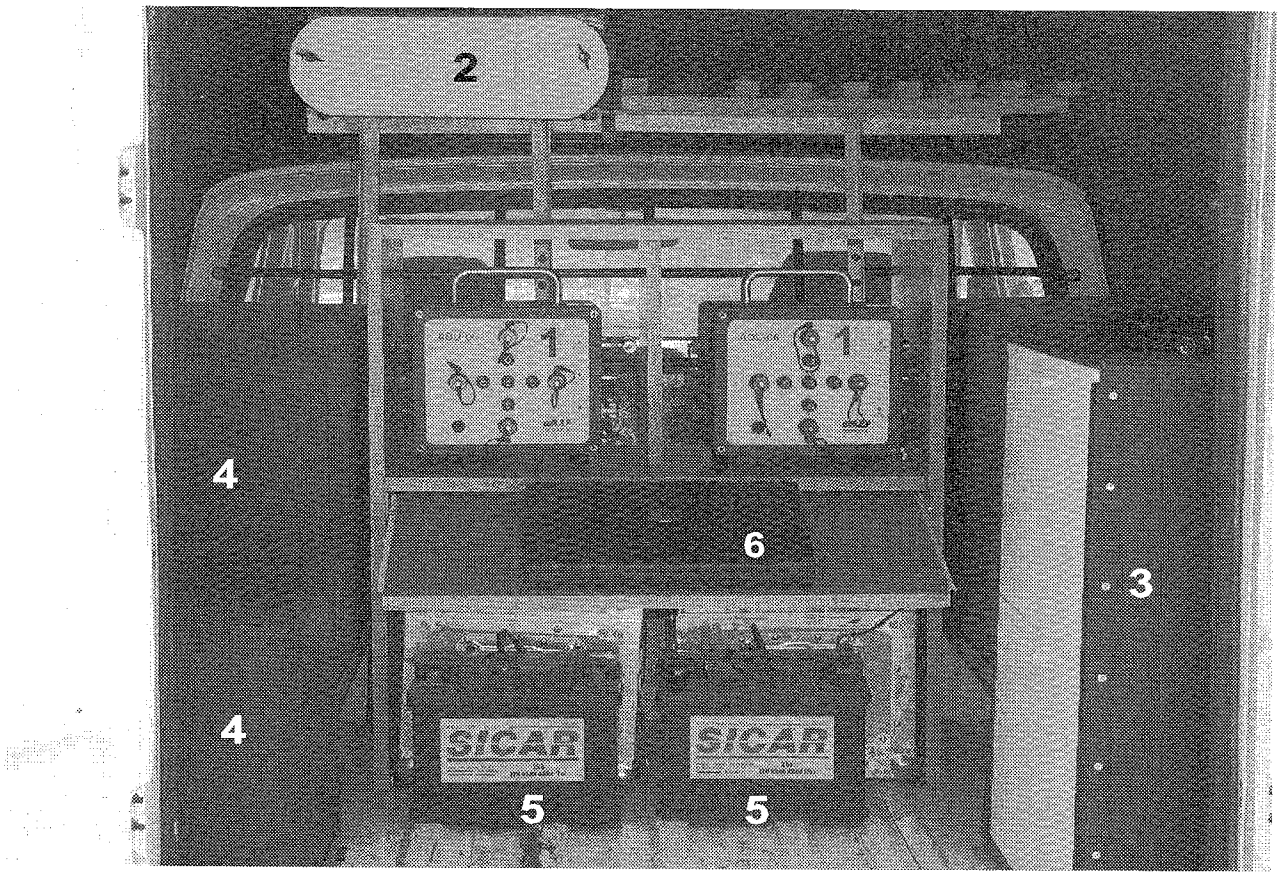

Fig. 1 - Geophysical electromagnetic measurement system (GMS 06). 1. ADU 06–Analog/digital unit with 5 channels; 2. Box for the magnetic sensors; 3. Box for the electric sensors; 4. Boxes with the connection cables between ADU-06 and electric, magnetic sensors; 5. Two battery of 12 V/45Ah; 6. Laptop computer.

lity, 24 bit resolution and data storage on the internal 440 MB flash disk, 2 A/D converters per channel, GPS antenna, two battery of 12 V; b) MAG-03 DAM (Bartington, England) with 6 channel, 24 bit resolution, sampling rate programmable, internal and external battery of 12 V , data storage on laptop HD; c) resistivimeter (INTEL V3, Romania) is compact and self-contained thanks to an integrated receiver and transmitter, with internal memory of 64 K, sampling rate of 0.2s, output power up to 200mA, communication trough serial interface enhanced by utility software for Windows. (iii) *software*: a) GMS-06 software packages - MAPROS (real time acquisition and processing of the electromagnetic data, robust estimation of transfer functions); b) program packages for 1D and 2D inversion and modeling of the data.

The MAPROS software packages (Metronix-Germany) used for the electromagnetic system runs under Windows 95 or Windows NT operating systems. An integrated on-line help system assists the operator. The channel configuration and assignment, necessary in a multi-channel system, are simplified by MAPROS. The computer (laptop) on which MAPROS is running is connected to a single ADU or an ADU network. The following basic tasks are performed by MAPROS:

— In-field system calibration and automatic offset compensation;

— Real time data acquisition and processing;

— Robust estimation of transfer functions;

— Real time display of time series and all important EM-parameters;

3. APPLICATION DOMAINS OF THE MOBILE GEOPHYSICAL LABORATORY

The main objectives which have to be solved by using MGL are: (i) shallow and deep structure investigation in order to elaborate the adequate geodynamic models and electromagnetic tomographies (STANICA *et alii*, 1999, STANICA & STANICA 2002) - Fig.2; (ii) Detection of the active faults, geotectonic sutures and transition zones in the lower crust (Fig. 3; STANICA *et alii*, 2000, STANICA & STANICA, 2001, 2002); (iii) evaluation of the electromagnetic pattern (geological structure of 2D type, its strike direction and normal behavior of the EM parameters for non seismic conditions) with the aim of identifying the best place for installing the adequate equipment for making the continuous monitoring of EM field and to reveal the short-term precursory phenomena of the seismic events (Fig. 4; ZUGRAVESCU *et alii*, 2000, STANICA, 2001, STANICA *et alii*, 2002).

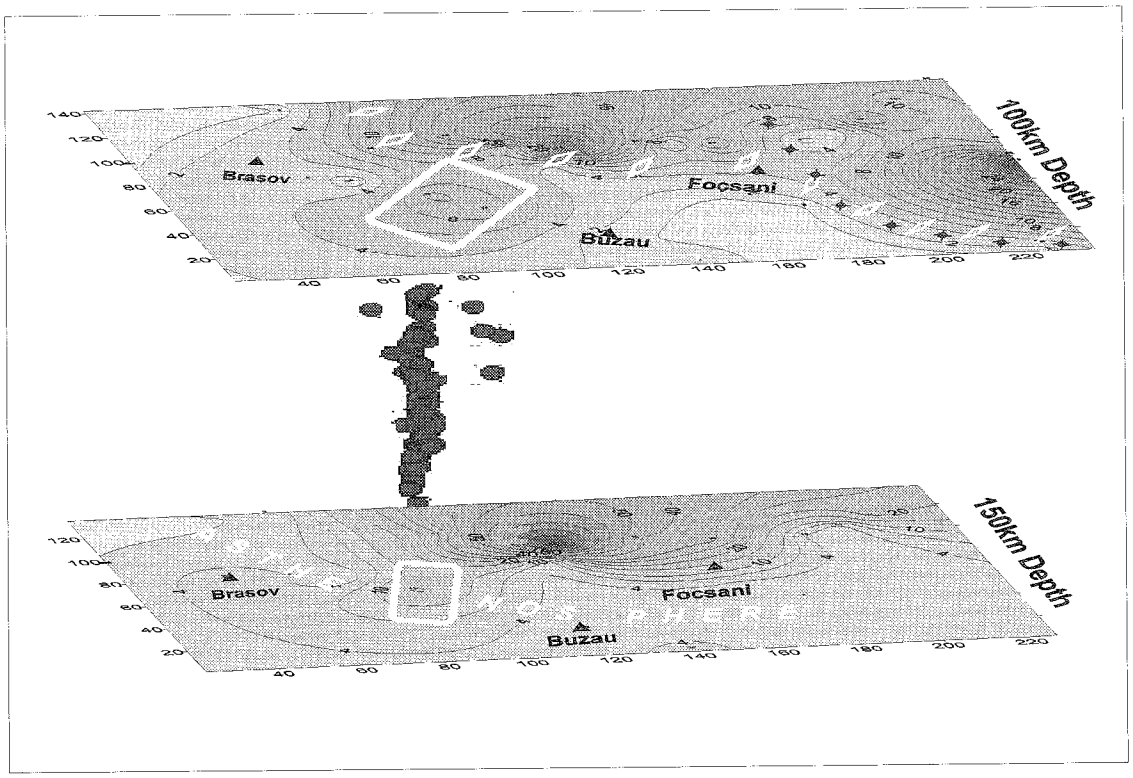

Fig. 2 - Electromagnetic tomography (resistivity distribution) at two depth intervals (100 km and 150 km) in the Vrancea zone. Isolines - resistivity distributions; full circles - earthquake hypocenters; EP - European Platform; diamonds - westwards alignment of the Trans-European Suture Zone; white rectangle - horizontal cross-sections through the Vrancea's relic slab; crosses - alignment of the Peceneaga-Camena fault.

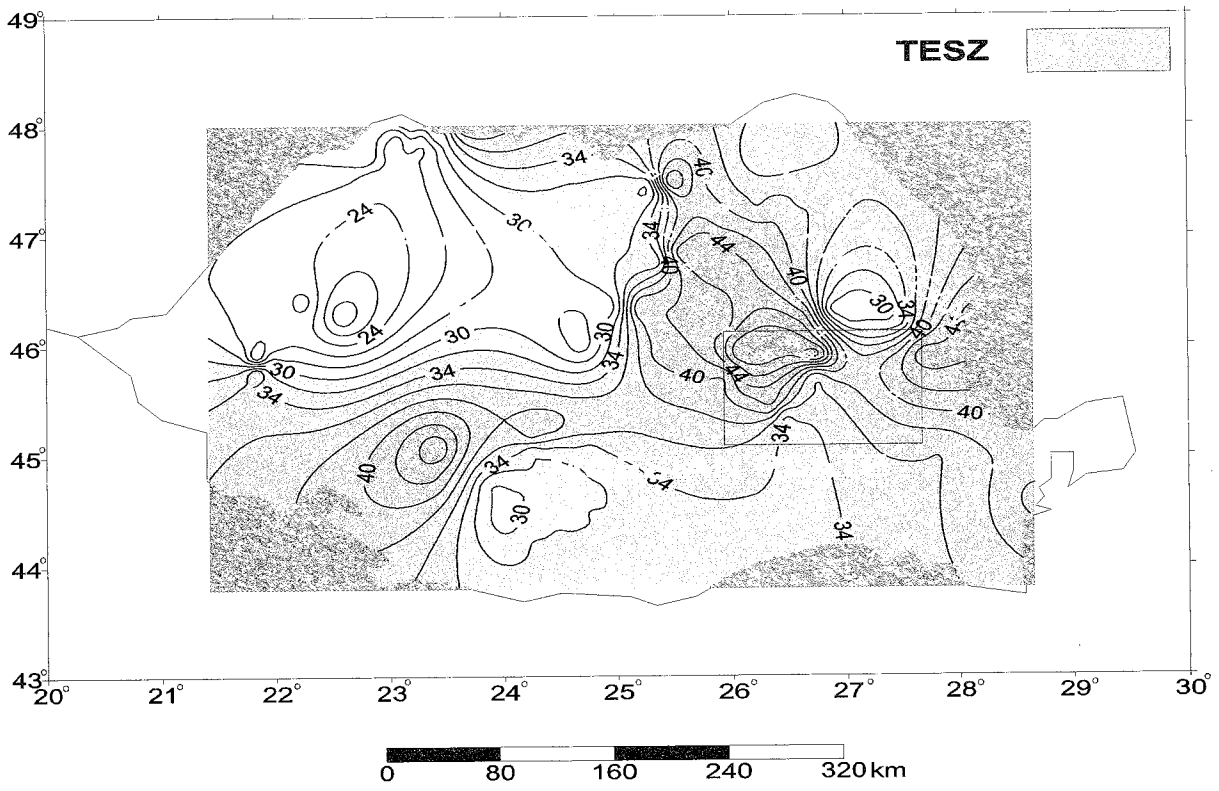

Fig. 3 - Brittle ductile transition zone in the lower crust. TESZ - TransEuropean Suture Zone; 40 - isobaths; rectangle – Vrancea zone

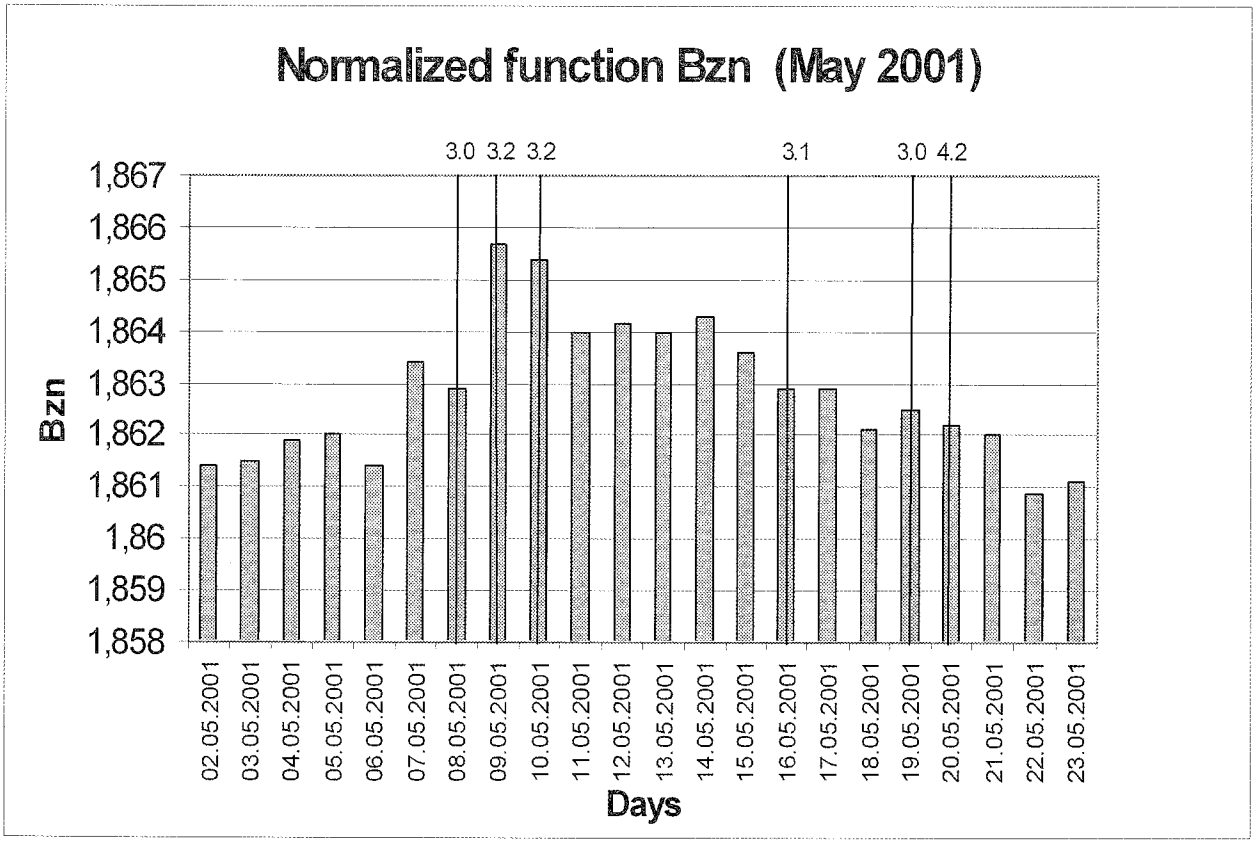

Fig. 4 - The normalized function Bzn (for the month May 2001) represented simultaneously with earthquakes occurred in the same period. Vertical line - seismic event; 3.2 - earthquake magnitude.

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