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GEOPHYSICAL EQUIPMENT MEANT FOR COMPLEX STUDIES IN GEODYNAMIC ACTIVE ZONES

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Abstract. The main purpose of the geophysical equipment is to investigate the electromagnetic (EM) and electric phenomena induced by the crustal and subcrustal processes, especially by the natural and anthropic hazard (seismic active and landslides zones, land collapses in the mining areas with salt dissolution etc.). The equipment's applicability includes electromagnetic (10 kH to 4096sec) and DC 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 to point out the active fault, the geometry of the relic slab in seismo-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 and its strike direction, 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 parameters.
Key words: geophysical equipment, geodynamic model, EM tomography, geoelectric pattern strike direction, precursory parameter.

1. INTRODUCTION

It is well-known the interrelations between the tectonic activity and the anomalous changes of the geophysical, geochemical and geohydrological parameters characterizing the Earth's lithosphere. These changes reflect the certain modifications in the crustal and subcrustal state of stress and may indicate that critical stresses have been reached. As a consequence, different methods of geosciences should be into operation in order to monitor tectonic activity, with the purpose of detecting regions and phases of critical stress on the base of precursory phenomena causally connected with earthquakes, landslides, land collapses, etc.In this respect, the goal of this paper is to describe the experimental studies which have to be made in order to achieve the geophysical equipment, built in a 4DW car (Fig.1), electrically powered by itself and able to carried out the geophysical parameters connected with natural and anthropic phenomena occurred in geodynamic active areas.

For solving this main objective, there are three principal directions extended for about 3 years interval, as follows:

- Experimental studies concerning the adequate choosing of some sensors able to respond to the necessities imposed by a complex approach of the geophysical processes, in order to characterize and to delimit an active geodynamic zone, and, respectively, to obtain a larger number of types of measurements with applicability in predicting and in estimating some natural and anthropic disasters;

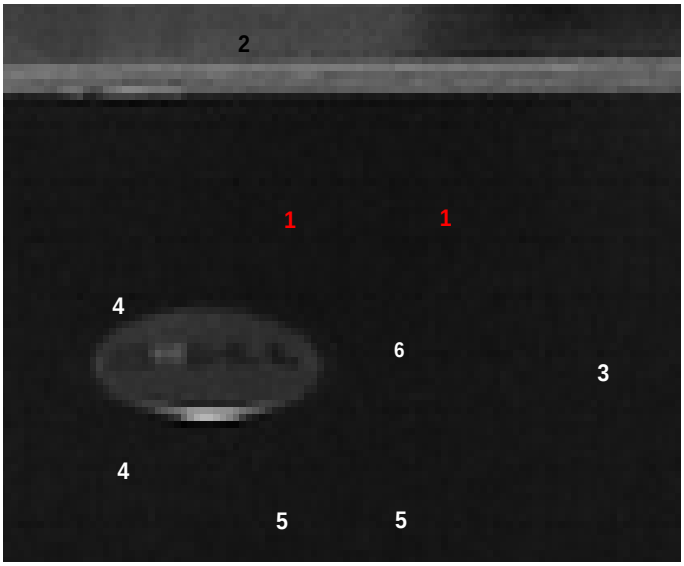

Fig. 1 – Gephysical measuring system instaled in 4WD car.
1-ADU 06–Analog/digital unit with 5 channels; 2-Box for the magnetic sensors; 3-Box for the electric sensors; 4-Boxes with connection cables between ADU-06 and electric, magnetc sensors; 5-12 V battery; 6-Laptop computer.

- The projection and achievement, in a demonstrative phase, of a mobile geophysical equipment, able to make facile the movement of the acquisition apparatus, to assure the power supply autonomy necessary for the working of the acquisition computerized system, for the storage and the complex processing of information supplied by the sensors system;
- The experimental determination of the equipment's performances and definition of the working processes according to the operations possible to be made (monitoring in zones of high anthropic and natural risk, studies in isolated zones, assessment of stability for buildings and dams, etc.).

To reach all these objectives, we decided to cover more research stages, so that we can achieve a complex mobile 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, in order to identify proper placements for measurements leading to a correct evaluation of the active geodynamic zones.

The modern researches accomplished in the frame of the geodynamics revealed 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. To be more specific, the success related to the implementation of a system which enables us to get 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 risk consists both in monitoring the values for representative parameters (thus carrying out a specific scale) , during a

sufficient long period, and in analyzing their values, what makes possible to identify their changes in conditions of seismicity, on the hand, and to calibrate the scale according to these changes and to the magnitude of the seismic events, on the other hands. 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.

The basis geonomical principles which will be used for the projection, execution and implementation of this equipment in the geodynamic activity are emphasized below, in the frame of some specific investigation methods.

2. GEOPHYSICAL MEASUREMENT SYSTEMS OF THE EQUIPMENT

The measurement systems of the geophysical equipment consist of three separate modules for discrete observation and regular monitoring, respectively of:

a) ULF and HF electromagnetic field;

b) DC electric field (Resistivity method - VES);

All the three measurement systems include specific sensors, data acquisition modules and software.

According to the measured field, the sensors which have been experimented are:

a) for geomagnetic field :

- 3 induction coils, type MFS05 (Metronix-Germany) having a wide frequency range from DC to 24 kHz, with two bands: LF (DC-1kHz) and HF (0.5kHz-24 kHz);
- three axial magnetic sensor, type MAG-03 MSL, frequency range from DC to 1kHz, measuring range ± 70 μ T (Bartington , England);

b) for electric field :

- electric sensors: Pb-$PbCl_2$ and Cu-$CuSO_4$ (Fig.2), the both type with gel of kaolin and 0.2 μV sensitivity, very stabile in time (made by IG-SSS-RA, Romania);

Fig. 2 – Electric sensor

Types of data acquisition modules (hardware):

- ADU-06 with 5 channel (Fig.3), 24 bit A/D conversion and data storage (Metronix-Germany);

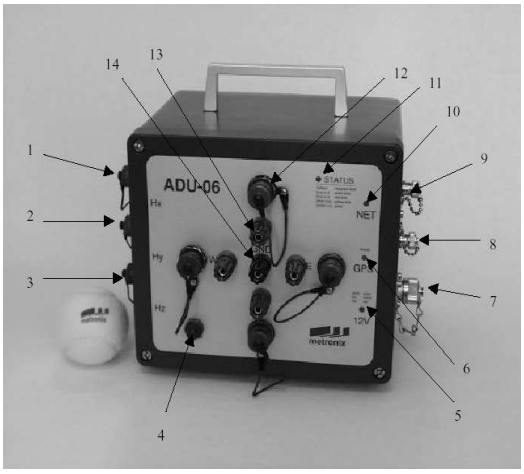

Fig. 3 – Acquisition module ADU-06

1, 2, 3. - Connectors for magnetic sensors (Hx, Hy, Hz); 4-Selftest button; 5-Battery status LED; 6-GPS status led; 7- Connector for battery input (2x); 8-Connector for GPS antenna; 9-Connector for network cable; 10-Network status LED; 11-System status LED; 12-Connector for E-field buffer cables (4x) North, South, East, West; 13- Connector for E-field standard cables (4x) North, South, East, West; 14-GND socket.

- MAG-03 DAM with 6 channel (Fig.4), 24 bit A/D conversion (Bartington, England);

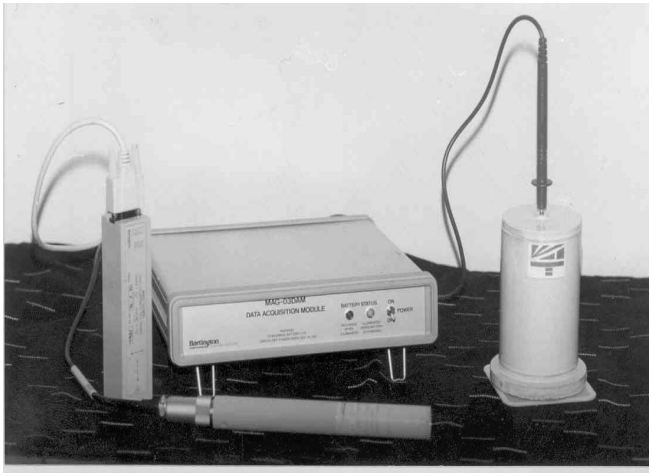

Fig.4 – Acquisition module MAG-03 DAM

- Resistivimeter (INTEL 92, Romania);

- Very precise GPS satellite-controlled time base and location;
- Note Book computer .

Software:

- GMS-06 software packages - MAPROS (real time acquisition and processing, robust estimation of transfer functions);
- 1D and 2D inversion and modeling.

The MAPROS software packages used for the GMS-06 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, is 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:

- Semi automatic definition of sensor field setup;
- System self-test includes ADU and all sensors;
- In-field system calibration and automatic offset compensation;
- Real time data acquisition and processing;
- Robust estimation of transfer functions;
- Display of time series and all important EM-parameters;
- Integrated data base for data storage and retrieval.

3. APPLICABILITY RANGES OF THE EQUIPMENT

The objectives which have to be solved are:

1. Deep structure investigation in order to elaborate the adequate geodynamic models and electromagnetic tomographies [1],[7], (Fig. 5);

Fig.5 – Electromagnetic tomography in the Vrancea zone.
The circles are the earthquakes hypocenters, EP is European Platform, diamonds represents Trans-European Suture Zone, the rectangles are the two horizontal cross-sections through the relic slab

2. Detection of the active faults, geotectonic sutures [2],[3], geometry of the gaps, landslides, land collapses, etc.
3. Identification of the best measuring site for installing specific sensors and evaluation of electromagnetic EM pattern [4],[5], [6],[8],[9] of the proposed site (type of geological structure:1D, 2D or 3D; strike direction and standard deviation of the EM parameters for non seismic conditions), with the aim of making the continuous monitoring of EM field and to reveal the short time precursory phenomena [10],[11]of the seismic events (Fig. 6).

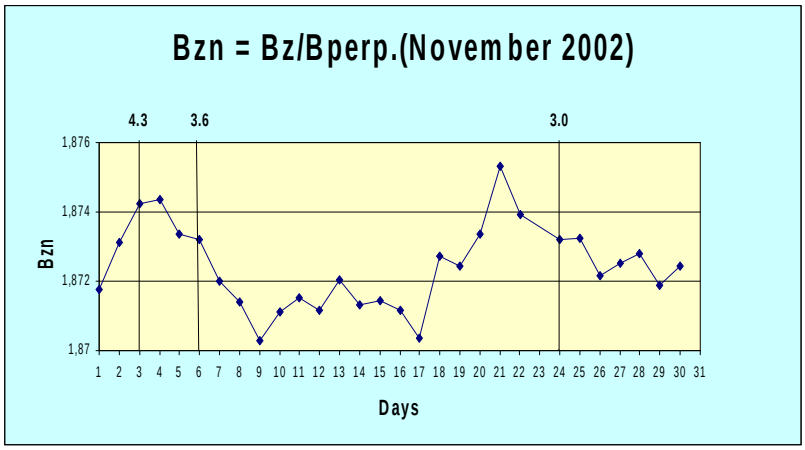

Fig. 6 The normalized function Bzn reprezented simultaneously with seismic events.

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