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Low Frequency Radio-wave System for subsurface investigation

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Low frequency radio-wave methods (RWM) allow subsurface investigations in terms of lithological structure characterization, detection of filtration flows of ground water, anthropogenic and natural cavities.

In this contribution, we present a RWM that exploits two coils working at frequencies of few MHz as transmitting and receiving antennas. The basic principle of this inductive method is as follows. The primary alternating electromagnetic field radiated by the transmitting coil induces eddy currents in the subsurface mainly due to the conductivity anomalies. These eddy currents generate a secondary (scattered) magnetic field which overlaps to the incident magnetic field and is detected by the receiving coil.

Despite the simple operation of the system, the complexity of the electromagnetic scattering phenomenon at hand must be properly modeled to achieve adequate performance. Therefore, an advanced data processing technique, belonging to the class of the inverse scattering approaches, has been developed by the authors in a full 3D geometry. The proposed method allows to deal with data collected on a scanning surface under a dipole inductive profiling (DIP) modality, where the transmitting/receiving coils are moved simultaneously with fixed offset (multi-bistatic configuration).

The hardware, called Dipole Inductive Radio-wave System (DIRS), is composed by an electronic unit and transmitting and receiving loop antennas radiating at frequencies of few MHz (2-4 MHz), which are installed on theodolite supports. The compactness of DIRS and its robustness to external electromagnetic interference offers the possibility to perform geophysical research up to the depth of some tens of meters and under several types of ground and water surfaces, vegetation, and weather conditions. The light weight and small size of system (the single antenna with support weights about 5 kg and has a diameter of 0.5m) allows two operators to perform geophysical research without disturbing the surface integrity of investigated ground massif. The value of base and the value of voltage induced on the digital voltmeter of the receiver are stored in memory on a SD-card for a subsequent visualization and processing.

Realistic cases of application of the DIRS system enhanced by the inverse scattering approach will be presented at the conference with regard to the geological characterization of a mine shaft and an archaeological site.