MARSES: Possibilities of long-term monitoring spatial and temporal variations and changes of subsurface geoelectrical section on the base results of the geophysical survey salt/water interface and groundwater mapping on the Marina Di Ragusa, Sicily and Shalter Island, USA.

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Introduction:

One of the more important challenges facing natural resource managers today is how to identify, measure and monitoring the cumulative impacts of land use decisions across space and time. The secondary task is to measure the soil properties of Martian subsurface, which includes porosity, electrical resistance of the liquid phase, thermal conductivity, temperature dependence. A main task of the MARSES monitoring system is to examine changes in the subsurface properties of local areas regolith on the Martian surface on the base of the database of various soil slices in terrestrial conditions.

Martian Subsurface Model.

Analysis of the ground-based geophysical cryolithozone related to electromagnetic studies, which takes into account characteristics of the preliminary electrodynamics model of martian cryolitozone. This model based on the current geological concepts of the cryolithozone structure, on the estimations of the ice containing material or wet fraction of subsurface horizons at negative temperatures, on physical-chemical transitions in the solutions of KCl , NaCl, $CaCl_2$ with the martian regolith and so on. All of them show the potential possibilities of the Mars electromagnetic sounding in the depth range up to one kilometer both the planetary surface or satellite orbit.[1-4]

The usefulness of different methods of the inductive sounding (frequency modulation or impulsed one) in cryolithozone studies is defined by the following factors:

- cryolithozone is characterized by the relatively low conductivity of permafrost soil of weak contrast of geoelectric section;
- the season variations of phase state of upper and deep layers of martian surface may exit;
- the high and low conductivity screens at the surface and in the depth of permafrost soil may also exit.

These aspects can limit the possibilities of the high frequency sounding (HFS) method for Mars cryolithozone structure studies. The experience in experimental studies of permafrost clay formation in the earth conditions , which are similar to martian permafrost soil, shows that the depth limit of HFS methods is about 50 m.

Martian soils are substantially different according to their properties in comparison with the pure surface ices and gletcher ices on the Earth. The relative magnetic susceptibility of the Earth soils is close to 1, but Martian soils may have much more higher values of magnetic susceptibility. Estimations show that the attenuation in this environment could be several orders of magnetitude higher than in ice [4,5].

The difficulties of the estimation of attenuation (which is in its turn the sounding depth) require the comparative studies in the natural earth conditions close to martian ones.

Theory of meteorite Mars upper crust evaporating.

One of the most probably mechanism of Mars upper crust saturation by stable magnetic materials is mechanism of meteorite evaporating during long-continued geological history of Mars.

As a result of thin atmosphere of Mars martian surface was exposed by the quite intensive meteorite impacting. The very specific upper crust consisting of large percentage of magnetic materials has been composed as a result of such meteorite impacting.

Composing upper Mars layer with magnetic powder fractions of maghemite particles.

Stable maghemite particles was composed as a result of meteorite treatment of Fe_2O_3 under high temperatures and transform in Fe_3O_4 - stable maghemit, that was an additional factor of drying upper layer and Mars water loss in the subsurface which under high temperature transforms to vapor and creation of upper super-paramagnetic layer on the Mars.

As an Earth's analog: Popigai crater (Yakutia), created 35 million years ago, crater's diameter is 130 km.

The main factor that determines remote sounding possibility is presence of Fe_3O_4 layer on the Mars surface that has essential magnetic anisotropy properties that is certainly a serious difficulty for remote sounding results' interpretation (including magneto-telluric sounding) if there is a frequency dispersion of return signal [4],[5].

Comparative investigation of martian and Earth's frozen rocks.

The goals of MARSES Experiment based on MARSES-TDEM (new title of this instrument RESPONSE-TDEM)instrument is comparative investigation of martian and Earth cryolithozone (possible investigation of subsurface relics of martian life) and the interpretation of geophysical data of subsurface soil structure [6], including :

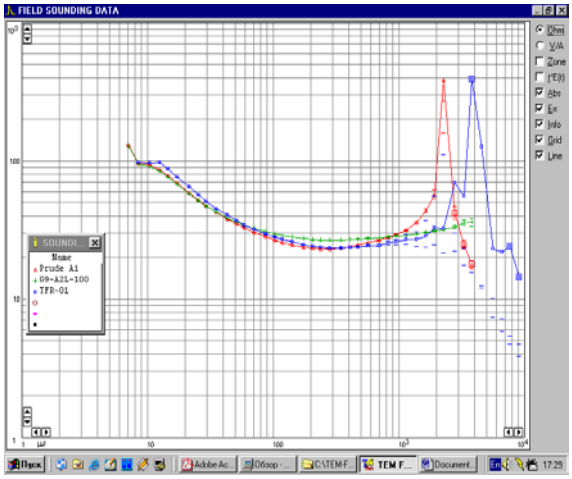
-the theoretical development of comparative models of subsurface frozen structure for typical rocks which formed martian cryolithozone in the mixture of poligonites and montmorillonites;

-the development of the software package for detailed analysis of subsurface martian structure - porosity, electrical resistance of liquid phase, thermal conductivity, temperature dependence, which are in agreement with the interpretation of data obtained in the field testing and laboratory supporting measurements;

-the estimation of maximum depth of sounding and resolution of MARSES instrument in the conditions of rocks close to martian subsurface soil;

- possibility to study subsurface frozen water component using TEM instruments and induced polarization (IP) device in several areas which are close to martian conditions: Antarctic, Iceland, Hawaii (volcanic area);
- - improvements of hardware and software on the base of the field studies in order to use in the earth conditions, including environmental and geophysical application, and future space experiments on the martian surface.

Examples of groundwater mapping subsurface geoelecrical section in winter condition on the Tambov field sites (December,2003):



During of the Shelter Island expedition (May, 2002) first observations of the dynamic parameters (spatial/temporal variations and changes of the salt/water interface in the process of the inland extent and movement of saltwater interface up to sounding depth in order to 100 m) have been obtained on the base new generation non-invasive instrument for subsurface sounding and new methodology [6-7].

The results obtained confirm the importance of such an experiment for studies of the spatial and temporal variation for geophysical survey and monitoring natural ecosystem.

Building of geographical slice using different instruments allows to obtain correct parameters for MARSES TEM in order to employ it in frozen soils for sounding on the surface of Mars and for many applications for long-term monitoring and subsurface studies in the Earth's conditions.

References:

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