# Structure and fluid penetration at the mid-atlantic ridge from controlled source electromagnetic sounding

**Igor denijs (1) Martin Sinha(1), Fernando Santos(2), Tim Henstock(1)**

**(1)National Oceanography Centre, Southampton (2)University of Lisbon**

**igorgonz@noc.soton.ac.uk**

The aim of this project is to test the hypothesis that exchanges of energy and matter between ocean and crust resulting from hydrothermal circulation are related to the presence of interconnected fracture pathways in the upper lithosphere. Our objective is to study the crustal electrical resistivity around Saldanha massif where clear gas-bearing fluid discharges (7-9 oC) have been observed. These hydrothermal vents are hosted within non-volcanic ultramafic rocks at a non-transform discontinuity of the Mid-Atlantic Ridge located near the Azores. The upper 3km of the lithosphere has been sounded electromagnetically in order to create a mapping of the resistivity. This in turn will give insight into the geological structure as well as the distribution of fluid-filled fractures. Geophysical models will be used to relate the resistivity to the proportion of sea-water filled pore spaces present in the medium, their degree of connection and the conductivity of the pore fluid. The approach will be based on the Joint Effective Medium method of Greer (2000, 2001) which uses the two parameters of porosity and crack aspects ratio to determine the probability of interconnection between adjacent pore spaces.

# **H**ybrid domain measurements of controlled-source electromagnetic data for deep environment studies

**Y. Mitsuhata (1) T. Uchida (1), A. Jyomori (2), N. Jyomori (2) and K. Suguro (3)**

**(1) National Institute of Advanced Industrial Science and Technology (AIST), Japan (2) NeoScience Inc., Japan (3) Three-S Ocean Network Inc. Japan**

**y.mitsuhata@aist.go.jp**

The characterization of relatively deep geological environment is becoming indispensable for the on-going governmental plan of geological disposal of high-level radioactive wastes in Japan. The disposal facilities for the radioactive wastes have been decided to be constructed deeper than 300 m in Japan by the Japanese government. For such relatively-deep investigations, we have been developing a new controlled-source electromagnetic exploration system that measures electromagnetic fields in a frequency domain for high-frequency components and in a time domain for low-frequency components. Therefore, this new system has been named ẗhybrid domainC̈SEM system. We explain the concept of our system and show preliminary results of our field tests.

# Modern long-period magnetotelluric instruments – experience of design and field results

**V. Korepanov (1) Ye. Klymovych (1), O. Kuznetsov (1), A. Prystai (1), V. Tregubenko (2)**

**(1) Lviv Centre of Institute of Space Research, Ukraine, (2) Ukrainian State Geological Survey Institute, Ukraine**

**vakor@isr.lviv.ua**

The magnetotelluric sounding (MTS) remains one of the most efficient geophysical methods for study of the Earth's deep interior. At present, there are two major challenges in the field – to get reliable data in the so called "dead band" (from 5 to 0.1 Hz) and to prolong the apparent resistivity plots till the periods 105 second and more. The ways to complete both these problems and to develop a high-class long-period magnetotelluric instrument (MTI) are discussed in the paper.

First essential problem is how to upgrade the flux-gate magnetometers sensor in order to lower the sensitivity threshold till picotesla level for the frequency band 0.1 – 1 Hz and upper and to reach long-term stability at least 1 nT per week, preferably to get both these advantages simultaneously.

Second problem is proper construction and methodology of use of non-polarized electrodes in order to get as high as possible their own potential stability and low transient resistance.

And last bit not least problem, taking into account that LMTI has to operate during at least a couple of weeks in order to collect necessary amount of long-period data, is LMTI construction allowing to function reliably in the field in every possible weather conditions and even sometimes in the water.

The modern state of the art in all these directions is analyzed and the best achieved results are given. The experimental data of MTS use in different regions of the Globe, including Antarctica, are presented. The best obtained processing results are demonstrated and discussed.

This study was partially supported by STCU grant 3165 and NSAU Contract No 1-02/03 (1274).

# SUFEM-3 a GPS discilined synchronisation unit

**Stefan L. Helwig**

**Institute for Geophysics and Meteorology, University of Cologne, Germany**

**helwig@geo.uni-koeln.de**

In various geophysical applications exact timing between a transmitter and one ore more receivers is of prime importance. I present a new synchronization unit, SUFEM-3, which can be combined with the Zonge series of geophysical transmitters and is primarily constructed for the use in TEM, CSAMT or IP surveys. A hardware-PLL of an internal GPS and a quartz crystal, results in high precision synchronization and practically no drift. Two galvanically insulated control signals are software controlled and can be programmed by the user. This allows the use of pseudo-noise- or other user specific signals. A batch modus offers the possibility to predefine a time schedule and preset all frequencies needed in a CSAMT survey. Scripts to control the SUFEM-3 are written on a PC and are transferred to the unit via USB.

# **A** new receiver for LOTEM measurements

**Stefan L. Helwig R. Bergers, A. Busse**

**Institute for Geophysics and Meteorology, University of Cologne, Germany**

**helwig@geo.uni-koeln.de**

Nowadays LOTEM data can be interpreted in terms of 2D- or 3D-inversions. Therefore transients have to be collected at a large number of locations, resulting in a need for reliable and low cost receivers. While modern MT-receivers in principle are ideal for LOTEM, large arrays become expensive as MT receivers cost 5000-6000 €/channel. However not all features of MT receivers, for example the outstanding long time stability, are needed in LOTEM surveys. In our new design we do not aim to record frequencies of less than 0.1 Hz and save additional costs by working with a fixed data rate. Each receiver comprises of two or three galvanically insulated channels with individual 24 bit ADC and continuous GPS synchronisation saving the data to a standard SD-card.

# Control source magnetotellurics (CSMT) with industrial power lines.

**A. Zhamaletdinov A. Shevtsov**

**(1) Saint Petersburg Branch of IZMIRAN (2) Geological Institute of the Kola Science Center of RAS**

**abd.zham@mail.ru**

The technique of the deep frequency sounding on the Baltic shield with the use of two mutually-orthogonal industrial power lines (PL) of 109 and 120 km length is described. Frequency band is of 0.1-20 Hz. The generator is of 100 kW power. Most recordings has been carried out at distances up to 510 km from the source. Simultaneously with the PL signals recording the magnetotelluric soundings (MTS) were executed with the use of the same stations. PL and MT signals were separated between themselves by a digital filtration. The influence from a near-field zone, ionosphere and displacement currents is modeled and analyzed. The observed data were used for to study the Earth crust and Upper Mantle conductivity with the special attention to the depth range of 20-50 km.
The work is done under support from Russian Fund of Basic Research, grant No 06-05-64429.

# MHD-experiment "Khibiny" on the superdeep EM sounding – 30 years anniversary.

**A. Zhamaletdinov Ye. Velikhov**

**(1) Saint Petersburg Branch of IZMIRAN, (2) Russian Academy of Sciences**

**abd.zham@mail.ru**

At September 28-th, 1976 the unique experiment with the 80 MW power magneto-hydro-dynamic (MHD) generator "Khibiny" has been put into practice on the Baltic shield. The current in the sea-grounded circuit has reached up to 22 thousand Amperes. The MHD-soundings lasted nearly 15 years (up to 1991)and was performed in complex with the Kola super-deep borehole drilling. Most results of the MHD-experiment "Khibiny" are actual till now and find out application at the recent researches – at the development of the "normal" model of the continental lithosphere electrical conductivity up to the depth of 100-150 km, at study of the nature and structure of crustal anomalies of electrical conductivity, at analysis of a phenomenon of current conductive channels in the earth crust and their use in monitoring of the earthquakes precursors, at temperature extrapolations of the super deep borehole data to the Moho depth while geodynamical reconstructions etc.

# Mapping resistive structures in the marine environment with controlled-source methods: Modeling and Analysis in 3D

**Chester J. Weiss Steven Constable Scripps Institution of Oceanography**
**Sandia National Laboratories Deparment of Geophysics**

**cjweiss@sandia.gov**

The electromagnetic fields surrounding a thin, sub-seabed resistive disk in response to a deep-towed, time-harmonic electric dipole antenna are investigated using a newly developed, 3D Cartesian, staggered grid modeling algorithm. Equivalence is demonstrated between the finite difference and finite volume methods for the coefficient matrix of the resulting system of linear equations. However, the finite volume approach naturally admits quadrature methods for constuction of the system source vector as a measure to minimize grid artifacts. A low induction number preconditioner is developed, resulting in a decrease of 2 orders of magnitude in the number of quasi-minimial-residual iterations used to solve the linear system. Numerical experiments demonstrate the potential usefulness of phase speed anomalies as a diagnostic for disk shape and depth.

# Adaptive power line frequency filter for MT time series in special cases

**G.Virupakshi (1) G.virupakshi (1),T.Harinaryana (2)**

**(1,2)National Geophysical Research Institute**

**g_virupakshi@hotmail.com**

Magnetotelluric signals in most of the cases are contaminated by the power line frequencies (50 or 60Hz). Old versions of the equipment invariably used power line frequency notch filters. These instruments used several notch filters to remove not only fundamental power line frequency but also its harmonics. In the present day versions of instruments, 24 bit Analog to Digital converters are being used to overcome some of the difficulties connected with large dynamic range of the amplitudes of Magnetotelluric signals. Some of the instrument vendors have removed power line notch filters from their instrument hoping that 24 Bit A/D converters will take care of the power line noise interference. It may work when power line interference is minor but may not be effective in the case of large amplitudes. Especially in some of the developing countries (for example- India), power line frequency itself change by as much as 10 to 12

# Second generation lead-lead chloride MT electrodes revisited

**John Booker Aurora Burd**

**Dept. of Earth and Space Sciences University of Washington, Seattle WA 98195 USA**

**booker@ess.washington.edu**

Petiau (2000) described a greatly improved design for long period MT electrodes. However, we had difficulty with actual construction for several reasons: (1) the mechanical design proved insufficiently rugged and prone to leak where the wire entered the top; (2) the very small hole between the inner and outer chambers and the consequent high resistance resulted in non-linear behavior; (3) the chemical recipes given in the paper proved inaccurate; (4) important assembly details were missing. To construct electrodes for the Earthscope backbone sites that are to be deployed for about a decade and for the EMSOC portable array, we have devised new realizations of the Petiau electrodes that addresses these issues. Electrode pairs in a production run of 64 typically differ by 0.2 mv or less. In this process we learned many practical lessons that we wish to pass on to the community. A Powerpoint presentation detailing all the construction steps will be made available.

Ref: Petiau, G., 2000. Second Generation of Lead-lead Chloride Electrodes for Geophysical Applications, Pure & Appl. Geophys, v157, 357-382.