Geohazard identification and early reconnaissance for hydrocarbon potential using Marine Electromagnetic and High Frequency Acoustic methods

X. Garcia (1) Xavier Monteys(2), Rob Evans(3), Brian Kelleher(4)

(1) Dublin Institute for Advanced Studies (2) Geological Survey of Ireland (3) Woods Hole Oceanographic Institution (4) Dublin City College

xavi@cp.dias.ie

EM data and core samples collected in the Malin shelf (Ireland) area have been integrated with existing acoustic data from the Irish National Seabed Survey. The objective of this project is to use a combined acoustic and electromagnetic geophysical approach to study the near-seabed composition in a recently discovered shallow gas bearing area, involving core sample analysis, multibeam and single-beam backscatter classification, and a marine controlled-source electromagnetic method. This combined method enables us to map in an unprecedented way the upper 20m of the seabed and correlate the main geophysical parameters with the geological properties of the seabed, thus providing a unique tool for geohazard identification, seabed classification, fluid flow migration paths and sediment porosity. Here, we present preliminary results.

The airwave in marine CSEM

Peter Weidelt

Insitute of Geophysics and Extraterrestial Physics Technical University of Braunschweig D-38106 Braunschweig Germany

p.weidelt@tu-bs.de

The airwave with its slow $1/r^3$ decay (guided at the air-earth interface) dominates the electric field at long offsets in marine CSEM measurements, in particular in a shallow ocean and thus conceals the interesting substructure information. We give a simple general formula for the airwave in a layered conductor with arbitrary position of transmitter and receiver and identify the contributions to the airwave in the complex wavenumber plane.

A newly developed three-dimensional forward program for the Magnetometric Resistivity method

N. Tada (1) M. Kido (2),N. Seama (1)

(1)Kobe University, (2)Tohoku University

noriko@kobe-u.ac.jp

Our three-dimensional (3-D) numerical forward program for the Magnetometric Resistivity method calculates three components of magnetic field, which is generated by a vertical bipole electrical current source with the existence of arbitrary resistive anomalous bodies in the upper oceanic crust. We focused on anomalous magnetic field, which is the differential between magnetic field generated in the condition with a reference structure composed of two horizontal layers (seawater and the oceanic crust) and one with an arbitrary 3-D resistivity structure. This technique minimizes effects of the singular point and the boundary condition to improve accuracy in calculations. We estimate sensitivity of depth and thickness of anomalous body to the magnetic field. This technique also allows us to obtain a relation between anomalous magnetic field and anomalous body.

Electric fields due to ocean tidal flow. Model studies and comparison with observations

A. Kuvshinov (1,2) A. Junge(3), H. Utada (4)

(1) Danish National Space Center, Juliane Maries Vej 30, DK-2100 Copenhagen, Denmark, (2) Institute of Terrestrial Magnetism, Ionosphere and Radiowave Propagation, Russian Academy of Sciences, 142190, Troitsk, Moscow region, Russia, (3) University of Frankfurt am Main, Feldberstrasse 47, D-60323 Frankfurt am Main, Germany, (4) Ocean Hemisphere Research Center, Earthquake Research Institute, University of Tokyo, Yayoi 1-1-1, Bunkyo-ku, Tokyo 113-0032, Japan

alexei@spacecenter.dk

The tidal motion of the ocean water through the ambient magnetic field, generates secondary electric field. This motionally induced electric field can be detected in the sea or inland and has a potential for electrical soundings of the Earth. A first goal of the paper is to gain an understanding of the global distribution of the electric signal due to tidal ocean flow. We simulate the electric signals for two tidal constituents - lunar semidiurnal (M2) and diurnal (O1) tides. We assume a realistic Earthś conductivity model with a surface thin shell and 1-D mantle underneath. Simulations demonstrate that in some coastal regions the amplitudes of the electric field can reach 100 mV/km and 10 mV/km for M2 and O1 tides respectively. Simulations clearly demonstrate the significant feature of motionally induced electric field - its dependency on lithosphere resistance. On average two order change in resistance leads to one order change in the coastal electric signal. The predictions as a whole are in a good agreement with experimental tidal electric signals from the northern Germany sites and tidal voltage signals from the northern Pacific Ocean cables. An agreement is especially encouraging for the cable data and suggests lithosphere resistance in the range of 10**8 Ω m**2 and 10**8 Ω m**2 .

Marine CSEM in Cascadia: The Electromagnetic Signature of Gas Hydrates and Seismic Blanking

Katrin Schwalenberg (1) Katrin Schwalenberg (1), Carsten Scholl (2), Ele Willoughby (3), and Nigel Edwards (2)

(1) Federal Institute for Geosciences and Natural Resources (BGR), Germany; (2) University of Toronto, Canada; (3) Geological Survey of Canada, Pacific Geoscience Centre

k.schwalenberg@bgr.de

In the summers of 2004 and 2005 we collected important CSEM data over a cold vent field on the Cascadia Margin, which has been the focus area of intensive gas hydrate studies for more than a decade. We observe highly anomalous resistivities over a series of seismic blank zones visible in various seismic data sets. We used the Toronto inline electric dipole-dipole system and have thus far collected data along 4 profiles across and adjacent to the vents. All profiles intersect at Bullseye, the largest of the vents and one of the drill sites of the recent IODP Leg 311. The blank zones have been diversely interpreted as fault-related features of enhanced methane flux and gas hydrate filled cracks and fissures which scatter seismic energy, but the true nature of the blank zones remained unclear from seismic data alone. The 1D inverted resistivity models show consistently uniform background resistivities along all profiles and resistivities which are more than 5 times higher over the vents. However, true modeling of the data at Bullseye requires a 3D approach which is currently underway. We conclude the resistivity anomalies are caused by a locally enhanced gas hydrate concentration probably accompanied by free gas. Pressure coring at Bullseye revealed massive hydrate layers in the upper 40 mbsf providing evidence for the presence of hydrate.

Marine MT Experiment on Subduction Zones

T. Worzewski (1) M. Jegen (2)

(1)and(2): IFM-Geomar, SFB574 of the Christian-Albrechts-University Kiel, Wischofstr.1-3, 24148 Kiel, Germany

tworzewski@ifm-geomar.de

The water content and its distribution play an important role in the subduction process. The amount of water carried into the subduction zone and its distribution are not well constrained by existing data and are subject of vigorous current research. At IFM-Geomar and University of Kiel we are building up a marine EM group and are constructing marine MT Stations as well as a Controlled Source EM instrument, which will be used 2007 in Central America to conduct an onshore-offshore marine MT experiment together with the Free University of Berlin. In this poster we present numerical modeling studies aimed to determine the resolution and sensitivity of the MT response to fluids in the crust and subducting slab.

Statistical and spectral properties of electromagnetic wind waves signals as result of measurements in a coastal zone of the sea.

L. Abramova (1) L. Abramova (1), D. Abramova (2)

(1) Geoelectromagnetic Research Centre of Shmidt Inst. of Physics of the Earth, Russian Academy of Science (2) Institute of Terrestrial Magnetism, Ionosphere and Radiowave Propagation, Russian Academy of Science

abramova@igemi.troitsk.ru

Results of unique experiments of electric, magnetic and hydrodynamic fields studies are examined. Measurements were carried out at coast of the White Sea, in a place where rise of tide reaches of 7-8 m. Connections of motional induced electromagnetic field with hydrodynamical parameters are investigated. Synchronous records a component of electric, magnetic and hydrodynamical fields are made at different meteorological conditions and the various depths of the sea caused by the tide. For each parameter statistical characteristics of processes: average value, dispersion and standart errors, etc. are designed. For comparative research of statistical properties of distribution of amplitudes and the periods of examined processes histograms, distribution functions and integrated utility of elements are designed and constructed. Comparison of the measured parameters power spectra and cospectrum have shown, that spectral characteristics of the wave velocity and height are consistent close with the electrical and magnetic signals, being coordinated with the theory. The considered results of the statistical and spectral analysis of hydrodynamical parameters, and electric and magnetic signals caused by the motional induction of sea water moving in the steady main magnetic field of Earth show, that between there is a precise and steady connection.

Marine magnetotelluric investigation of the subduction zone offshore Sanriku, Japan

Tada-nori Goto (1) Kerry Key (2) Steven Constable (2) Hitoshi Mikada (3) Kiyoshi Suyehiro (1)

1. Japan Agency for Marine-Earth Science and Technology, Yokosuka, Kanagawa, Japan 2. Scripps Institution of Oceanography, La Jolla, California, USA. 3. Kyoto University, Kyoto, Japan

tgoto@jamstec.go.jp

While seismic experiments have long been used to delineate structures associated with subduction, only a few experiments to date have utilized electromagnetic methods. Subduction zone structures such as the subducting slab, the accretionary prism and nearby volcanic zone can offer a rich environment of heterogeneous electrical conductivity that carries the imprint of tectonic processes. Since subduction starts in the marine environment, broadband marine MT is naturally a good candidate for providing complementary constraints on subduction zone mantle and lithospheric physical properties (porosity, fluid content and mineralogy). We present a case study of a linear array of 10 marine MT sites deployed on the accretionary prism offshore Sanriku Japan at seafloor depths of 1 to 5.5 km. The MT responses are strongly affected by the steep seafloor bathymetry and nearby coastline. However, the magnitude of the bathymetry distortion greatly depends on seafloor conductivity and so 2D modeling that directly includes the seafloor bathymetry can be used to constrain deeper structures. We will present 2D inversions of both TE and TM modes, where bathymetry is directly included in the inversion model. Conductivity models will be synthesized with seismic studies to provide a new interpretation of the seismogenic zone of the Japan Trench.

Motionally induced voltage measurements in near-shore zone of the Black Sea

Nikolay A. Palshin Renat D. Medzhitov, Alexander M. Poray-Koshits and Irina V. Dyakonova

Shirshov Institute of Oceanology, Russian Academy of Sciences

palshin@geo.sio.rssi.ru

The basic scientific goals of these investigations is better understanding of meso-scale variability (eddy structures) and impact of near-shore eddies on the water exchange between the shelf and the deep basin and its role in ventilation of near-shore zone. In 2003-2006 motionally induced voltages (MIV) measurements were carried out in the coastal zone in the northern part of the Black Sea. The results obtained during these short experiments and its interpretation confirmed efficiency of MIV measurements in the coastal zone of the Black Sea. The estimation of the averaged (barotropic) along-coast component of the rim current and its wind-driven variability was obtained as well as spectral characteristic of electric field induced by surface waves in the bay. Long-term measurements of MIV within the coastal zone could be used for studies of quasi-stationary rim current as well as it temporal variability caused by Eckman pumping and associated with anticyclonic eddies.

Electrical conductivity structure of the oceanic mantle beneath the Northwest Pacific

T. Motobayashi (1) H. Toh (2)

(1) & (2) Department of Earth Sciences, University of Toyama

m0540411@ems.u-toyama.ac.jp

Since August, 2001, we have been conducting seafloor electromagnetic observation at a site called NWP on the Northwest Pacific Basin (Toh et al., 2004). One of the objectives of the long-term seafloor observation is to reveal the electrical conductivity structure beneath NWP. The one-dimension conductivity structure estimated by the magnetotelluric method is characterized by two conductors of the order of 0.1S/m centered at approximately 50km and 130km, respectively. The shallow conductor may indicate the source region of the intra-plate volcanism, recently revealed by Hirano et al. (2004). The deeper conductor may correspond to the conductive asthenosphere at the base of the Pacific plate.