

New Phoenix Marine MT Concept – Precision H_z

Phoenix has applied for a patent^(1, 2) for a new Marine MT (MMT) concept that is expected to provide results similar to those of the successful MCSEM (Marine Controlled Source ElectroMagnetics) technique⁽³⁾, but at significantly reduced cost.

MCSEM, developed at STATOIL (Norway's State Oil Company) in the late 1990s, is used to reduce the number of offshore dry holes (costing up to US\$50M per well), by detecting the electrical resistivity of offshore, sub-bottom seismic structures (possible hydrocarbon traps). A hydrocarbon-charged structure has higher resistivity than the surrounding rocks.

The typical offshore hydrocarbon deposit is a thin, sub-horizontal resistive body. (See model of the North Sea's Troll Oil and Gas Field on page 2.)

MCSEM was developed because experts considered that MMT could not

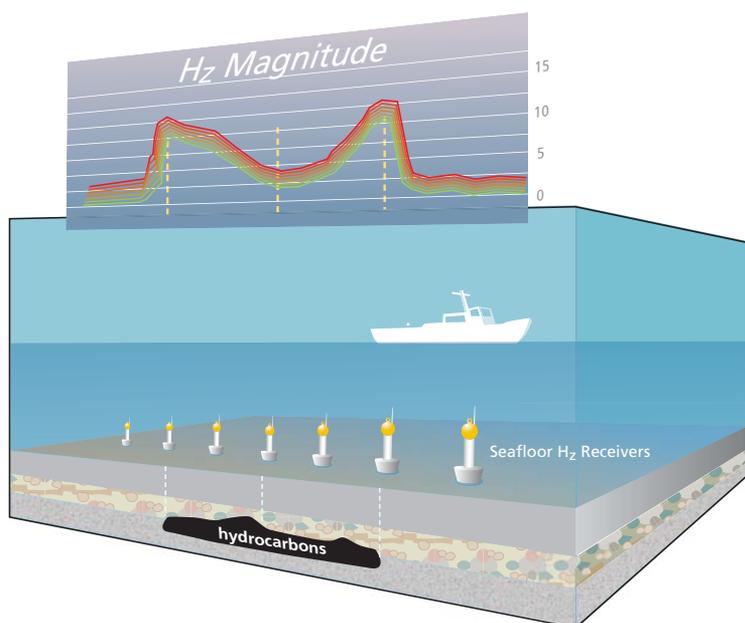
be used to detect the resistivity of this type of target. The fields generated and measured by MCSEM are sensitive to this type of target, whereas the horizontal electric and magnetic fields measured in 4-component MMT are not. MMT does not usually measure H_z (the vertical magnetic field) because it has been thought that the H_z anomalies are too small. Also, reliable measurement of H_z requires precise vertical orientation of the H_z sensor; until now, no means has existed to achieve this, since the MMT apparatus normally rests at an unpredictable angle on the seafloor.

The typical form of H_z anomaly over a sub-bottom hydrocarbon reservoir is shown in the figure below and the contoured diagram on page 2. The vertical magnetic field (H_z) is theoretically zero everywhere except above or near a vertical resistivity contrast. The H_z

magnitude anomalies from such targets are small, but the fields are comparable to those measured by MCSEM. One advantage of the H_z approach is that the anomalies (though small) stand out against a near-zero background.

The new Phoenix MMT- H_z concept overcomes the barriers mentioned above by automatically and precisely orienting the vertical magnetic sensor, as well as implementing greater precision in other aspects. These improvements permit reliable detection of small-magnitude, but information-rich, H_z anomalies. The MMT- H_z concept will cost less than MCSEM for several reasons. For example, MMT- H_z uses the natural EM field instead of the more costly controlled source; as well, it can utilize smaller vessels engaged on short-term lease, rather than the large specialized ships used for

continued on page 2



Left: An array of precision MMT- H_z receivers is deployed across an offshore seismic structure (suspected hydrocarbon trap) by a small, inexpensive "vessel of opportunity". The upper plot illustrates the expected variation of H_z magnitude over a structure charged with resistive hydrocarbons: near-zero background, maxima above the extrema of the object, and a central minimum.

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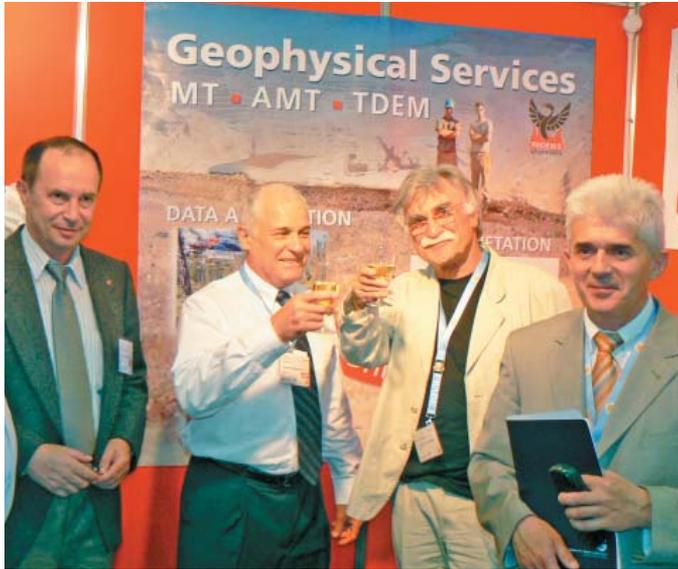
Turkey

The Turkish Mineral Research Directorate (MTA) conducted an MT survey in northwest Turkey with their Phoenix equipment.

Right: MTA geophysical engineer Sultan Bostan checks data on his laptop computer.



Poland



Above: Left to right, Olex Ingerov and Leo Fox of Phoenix, and Dr. Andrzej Gajewski, PBG President, and Tomasz Czerwinski (PBG) toast the signing of a contract during the EAGE meeting in London in June. Leo and Andrzej have been friends since 1978.

PBG (Przedsiębiorstwo Badan Geofizycznych, formerly the Polish state geophysical company) is now an international geophysical contractor. PBG will initially use the multifunctional geophysical system (based on Phoenix V8 receivers and TXU-30 transmitter) for large-scale MT/AMT surveys in Poland. Marek Wojdyla of PBG visited for training in August. (See his photo on page 6.) www.pbg.com.pl/

Russia

New client SaratovNefteGeofizika of Saratov ordered a 15-channel MT system; another new client, SNIIGIMS (Siberian Institute of Geology and Geophysics) in Novosibirsk acquired a five-receiver system. Existing clients Alrosa, Norilsk Nickel and Nordwest have all upgraded their systems.

Kyrgyzstan

The Research Laboratory of the Russian Academy of Sciences in Bishkek upgraded their system.

Uzbekistan

Uzbekneftegaz received five CSEM V8 receivers.

Ukraine

DniproGeofizika of Dnipropetrovsk upgraded their system.

Canada

Right: Using a fisheye (a type of wide-angle) lens, Phoenix employee André Collin captured northern lights over the campsite during a recent Phoenix MT/AMT survey for uranium in Saskatchewan. High hydrocarbon prices are causing a renewed interest in nuclear power; in turn, this has led to an exploration boom in the province's Athabaska Basin, an area of many high-grade uranium deposits.



China

■ The Ministry of Land and Resources (MLR) has signed a \$1.5M contract for five multifunction V8/TXU-30 systems. China is increasing domestic mineral exploration, attempting to reduce metal imports. MLR also purchased a multi-station, satellite-synchronized array MT system – the Phoenix System 2000.

■ **Below right:** Personnel of Heilongjiang Geophysical Survey Institute of Harbin (northeast China) wear mosquito nets and protective clothing during acceptance of their multifunction V8/TXU-30 system.



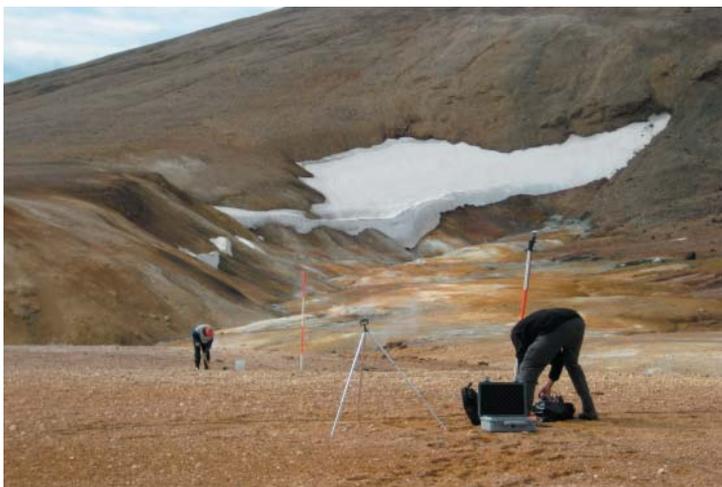
■ **Above:** Szechuan Geophysical Exploration Institute of Chengdu accepted a Phoenix V8 system in June 2007.



■ **Above:** The Bureau of Geological and Mineral Resources, Jiang Xi province accepted a V8 system in September.



Iceland



Iceland Geosurvey (ÍSOR) carried out a survey for geothermal resources in August using their 18-channel Phoenix MT system.

Japan

Phoenix has signed a contract with WestJEC (West Japan Engineering Consultants, Inc.) of Fukuoka, Japan, for geothermal MT surveys in Peru.

Nevis



West Indies Power Holdings B.V. of Charlestown, Nevis, has acquired several Phoenix MTU-5A systems for on-shore geothermal exploration. A volcanic island, Nevis has considerable geothermal potential; discovery of enough steam to justify a power plant could significantly improve the economy of the island. Nevis now relies on relatively costly imported diesel fuel to generate electricity.

Above: Reed Malin of Duke University (USA) and Kerry McDonald, CEO of West Indies Power, check a Phoenix MT sensor at a site near the Bush Hill Fault on the dry south side of Nevis.

MT Survey in Taiwan Evaluates the Possibility of CO₂ Sequestration

Industrial Technology Research Institute (ITRI) of Taiwan recently carried out a 100-site MT survey with Phoenix MT equipment. Two hundred additional stations will be acquired in 2008/09.

The three-year project will evaluate the distribution of potential reservoir and seal (cap) rocks to see if underground CO₂ disposal (sequestration) is feasible in Taiwan. If it is, there is the potential to reduce greenhouse gas emissions that contribute to global warming.

MT surveys use a remote reference station (ideally in a quiet area) to reduce the effects of noise. Because strong EM noise is everywhere in Taiwan, a good remote reference location is hard to find. For this survey, a remote site was selected on Penghu Island (60km offshore west of Taiwan, and 210km from the survey area). This considerably improved the data quality.

Above right: In seismic survey jargon, the equipment cabin is called the “doghouse”. ITRI cleverly used a real doghouse to protect their equipment at the remote reference site. A solar cell and car batteries supplied stable power. The 2GB flash memory card is large enough that data has to be retrieved only every 30 days.

Below right: Team members of ITRI with Phoenix engineer Gerald Graham at centre



ITRI is a non-profit applied R&D and service organization. It was founded in 1973 by the Ministry of Economic Affairs to attend to the technological needs of Taiwan's industrial development. ITRI has played a vital role in the transformation of the economy from an agriculture-based model to an industrial one.

www.itri.org.tw/eng/index.jsp

AUSTRALIA – Geoforce Buys TXU-30 Transmitter

Geoforce is a Western Australian geophysical contracting and consulting company active in Australia, Africa and Asia.

Geoforce specializes in high-definition geophysical surveying, where rapid characterization of the subsurface is required. The company focuses on problem solving, offering capability in EM, GPR, resistivity imaging (surface and cross borehole), magnetics, surface radiometrics, and seismic (crosshole, refraction and surface wave).

www.geoforce.com.au/about.html

Right: Justin Anning and Syd Greenham of Geoforce, a geophysical contractor in Perth, Western Australia. Geoforce recently acquired a Phoenix TXU-30 transmitter. The TXU-30 can be used with any suitable locally-sourced MG unit – here with an Atlas Copco QAS38.



ON THE ROAD

England: At right, a crowd gathers in our booth for a wine and cheese tasting during the well-attended EAGE in London in June.



Russia : Olex and Tamara Ingerov staffed the Phoenix booth during the 9th Moscow International Oil and Gas Exhibition in late June.

Below: Andrei Elbakidze, software engineer, and Tamara are shown in our booth.



Canada: Exploration '07 was held in Toronto September 9-13.

Left: Mits Yamashita, Paolo Berardelli of Geotech and Leo Fox are pictured with one of our new Phoenix-logo carpets that were hand-woven in Darjeeling, India.



VISITORS



Left to Right: Tes Haile and Gerry Graham of Phoenix working with Berhe Goitom of Eritrea and Marek Wojdyła of Poland at a training site near Toronto.

COMING UP

September 27-30: 4th International Symposium on Three-Dimensional Electromagnetics, Freiberg, Germany. Phoenix is a sponsor.

October 10-13: Phoenix president Leo Fox will present a paper, *Precision Measurement of Hz in Marine MT* at the 8th China International Geoelectromagnetic Workshop in Jingzhou City, Hubei, China.

November 19-23: Phoenix will participate in the Rio 2007 Conference and Exhibition, the Tenth International Congress of the Brazilian Geophysical Society, Rio de Janeiro, Brazil. Carlos Guerrero will attend.

November 20-22: James Kok will staff a Phoenix booth at China Geo-tech 2007 – Shanghai International Exhibition and Forum on Geological Technology, Machinery and Instruments. www.chinageotech.org



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