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Reservoir Mapping Success in Brazil

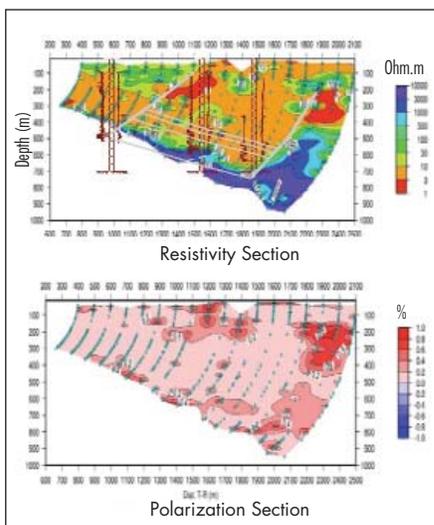
A successful onshore reservoir mapping project for Brazil's national oil company, PETROBRAS, has been completed with Controlled Source EM (CSEM) equipment made by Phoenix.

The project was carried out by the State University of Northern Fluminense (UENF) of Macaé, Brazil; Phoenix built the geophysical system according to the specifications of Prof. Carlos Dias of UENF's Petroleum Engineering Laboratory (LENEP), as described in *Issue 20*.

Prof. Dias and his colleagues studied a well-known producing oil field in north-east Brazil. Knowledge from the many wells, seismic surveys, and geological studies provided constraints and checks for the EM project. Both water and steam injection is underway for secondary recovery. The objectives of the EM study included mapping oil-water contacts and zones of steam invasion.

The sedimentary strata in the oil field dip at an angle of approximately 30 degrees. Hydrocarbons are found between 400m and 700m subsurface, sealed above by thick shales and laterally by faults. The oil-bearing sandstones overlie highly resistive basement rocks.

The figures above show the resistivity and polarization sections along one of the five 1.8 km-long profiles.



The results of the UENF work were first presented at the Brazilian Geophysical Society Meeting in Salvador, Bahia, Sept. 2005; they will be also presented as *Poster EM P1.2* at the SEG Meeting in Houston this month.

The UENF researchers concluded that:

- Lithological interfaces (defined from well log data) and faults were easily correlated with the CSEM data.
- The oil-saturated sandstone is seen as a high resistivity/low polarization zone on all profiles.
- The oil-water contact is electrically distinguished.

The UENF scientists also saw evidence that CSEM detected the zones of steam injection.

More mapping projects are planned, and PETROBRAS plans to significantly increase funding for non-seismic R&D projects in Brazil.

Reference: *Multi-frequency EM Method for Hydrocarbon Detection and for Monitoring Fluid Invasion During Enhanced Oil Recovery*; C. Dias, H. Sato, and O. Lima, Poster EM P1.2, 75th SEG meeting, Houston, Nov. 6-12, 2005

(See more on CSEM, pg 2)

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Leo Fox, Prof. Carlos Dias and Dr. Tad Ulyrch visit in the Phoenix booth in Salvador, Brazil.



Direct Hydrocarbon Detection in China with Phoenix System

A drilling success rate of 73% has been achieved by China National Petroleum Corp. (CNPC) using High-Powered Spectral Induced Polarization (HPSIP) equipment built by Phoenix. The statistics are based on 65 wells drilled in six oil fields in China. The HPSIP technique directly detects hydrocarbons as deep as five kilometres. The equipment developed by Phoenix for CNPC includes the T-200 transmitter (see Issues 22 & 25) and a 20-channel V8 wireless receiver system, introduced in 2004.

The figures below are excerpted from CNPC presentations given this year at the June EAGE in Madrid and the November SEG in Houston.

Figure 1 illustrates the equipment configuration. Maximum separation of transmitter and receiver units is approx. 8 km, permitting investigation as deep as 5 km.

Figure 2 shows an example from the Tarim Basin in northwest China. The reservoir here is a lithologic trap in Tertiary sediments at a depth of approximately 4,000-4,500 m. On this type of plot, high polarization (purple area) corresponds to the presence of hydrocarbons and producing wells.

Wells named J1, J2 and J1-2 are indicated by vertical lines. J1 was a known producer, and J2 was a known dry hole. Well J1-2 was being drilled at the time of the HPSIP survey, which predicted that J1-2 would also be a dry hole, and that a favourable zone existed several hundred metres to the east of J1-2.

The prediction was correct; well J1-2 proved to be a dry hole. The well was then re-entered higher up and drilled at an angle to the east to intercept the favourable zone predicted from HPSIP. A 500m section of commercial oil was found in the angled well.

Some of CNPC's conclusions are:

- Many tests and predictions, confirmed by oil companies, show the usefulness of the SIP method
- The SIP method can be used to check known traps for hydrocarbon presence
- The SIP method can also be used to find hydrocarbon traps and guide the drilling of wells

Reference: *Hydrocarbon detection with high-powered spectral induced polarization, two cases;* Z.X. He, et al, Presentation No. EM P1.1, 75th SEG meeting, Houston, Texas, Nov. 6-12, 2005

Marine CSEM and MT Increasing

Use of marine CSEM (MCSEM) and MT (MMT) to determine whether or not offshore structures are charged with hydrocarbons is rapidly increasing. Norway's STATOIL developed and tested the concept in the late 1990s, then spun off an EM surveying company in 2002.

The seismic technique can find sub-sea structures but rarely provides any information about hydrocarbon charge. MCSEM is used to check the structure's resistivity; resistivity higher than background implies hydrocarbon charge. Marine MT provides the background resistivity.

Deepwater offshore drilling is costly (US\$20M to US\$50M per well), so MCSEM/MMT techniques are important risk reduction and cost saving tools.

Oil companies using the techniques include ExxonMobil, STATOIL, TOTAL, Shell, AGIP and a number of others. ExxonMobil alone has studied nearly 150 different offshore oilfields; their results are being reported during the 2005 SEG in Houston where a record high number of EM papers and sessions are being presented.

Onshore CSEM/MT

When onshore oil fields were first formed, they were in marine environments. According to Chinese experts, a high percentage of onshore oil fields have a definitive resistivity signature that, of course, may differ from the offshore situation. Thus, the concept can be "ported" (with adaptations) from offshore to onshore.

Although the multinational major oil companies are primarily focused on deepwater offshore, many national oil companies such as Saudi Aramco, Iran's NIOC, as well as others, have significant onshore interests. Use of onshore CSEM/MT for pre-drill checking of onshore structures is therefore expected to grow.

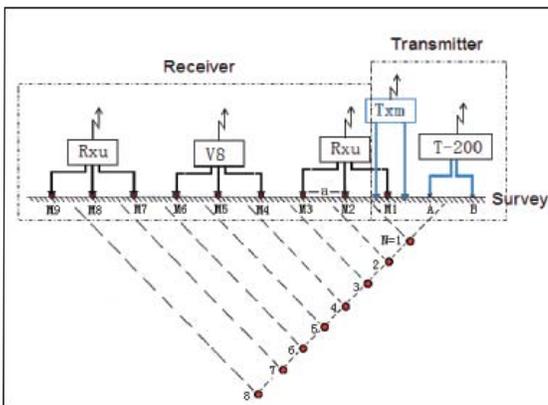


Figure 1
Multi-channel dipole-dipole array of SIP

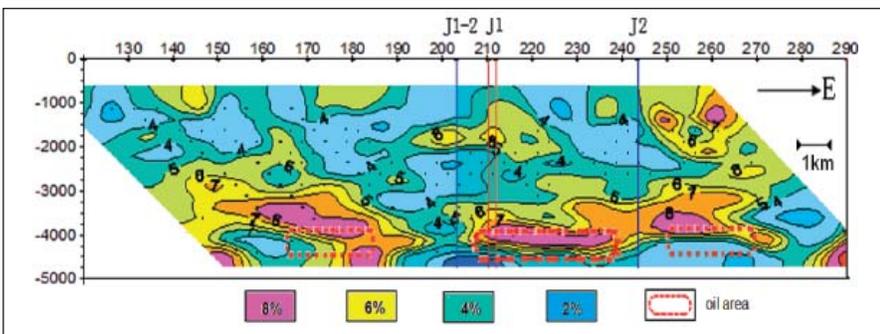


Figure 2: Polarization section of Line L1

NEWS FROM AROUND THE WORLD

Iceland:

Moscow State University (MSU) carried out an MT survey in Iceland using six Phoenix MTU-5A instruments. Pavel Pushkarev of MSU reports good data was collected at 58 sites in an area of 100 square kilometres that included the geothermal zone of Hengill Mountain. The MSU team's fieldwork was supported by Iceland Geosurvey (ISOR), particularly its specialists in MT and TEM methods, Hjalmar Eysteinnsson and Knutur Arnason.

Right: The MSU team on the slope of Hengill mountain; the plume of steam in the background is from the famous Nesjavellir geothermal plant which provides hot water for Iceland's capital, Reykjavik. Left to right: N. Shustov, V. Longinov, E. Aleksanova, V. Kulikov and P. Pushkarev



Alaska:

In August a Phoenix survey crew, headed by geophysicist Caroline Finateu, conducted a 3D MT/AMT survey of 126 sites in an area of approx. one square km for Kennecott Greens Creek Mining Company on Admiralty Island. In 2004 Phoenix surveyed two perpendicular pilot profiles; the 2005 survey was a full 3D grid encompassing the two previous profiles. Andy West, Kennecott Senior Surface Exploration Geologist, oversaw the survey.



The Phoenix survey team kept a wary eye out for grizzly bears roaming the area.

The crew included Kieran Fox, Alex Golyashov, Tes Haile, Yann Avram and Michael Balint. Phoenix president Leo Fox visited the survey during its last two days.

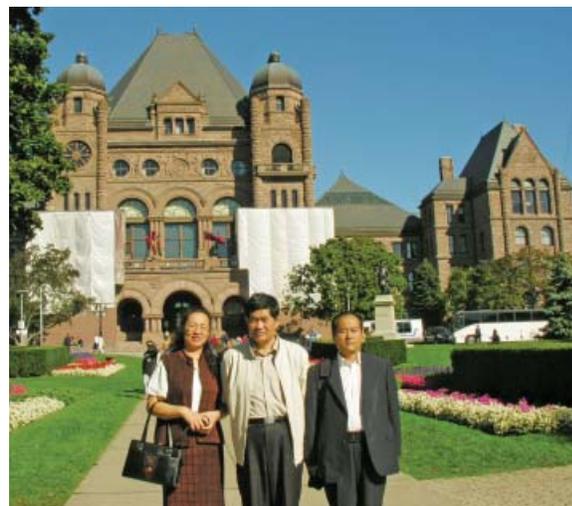
China:

Lu Yi of Phoenix visited China in June for the acceptance by Yangtze University of their new V8 system. Right, Prof. Hu Wenbao of Yangtze University with the Iron Buffalo statue erected in 1957 as a talisman (or charm) to prevent the flooding of the Yangtze River.



Canada:

Phoenix carried out surveys for Manicouagan Minerals Inc. (MMI) in March and April, and again in August and September, in the centre of the Manicouagan Crater. The purpose was to locate Sudbury-type base metal/deep sulfide deposits in the centre of the impact crater. The inner crater, 65km in diameter, is the world's fourth largest meteor impact site. Constantine Salamis, MMI president, confirmed the company is now drilling. See www.manicouaganminerals.com



Inner Mongolia:

The Mineral Research Institute of Inner Mongolia recently took delivery of a multifunction V8 system to be used for various exploration tasks. Acceptance is under way as we go to press.

Left: Representatives from the institute visit Ontario's provincial government buildings in Toronto: Lina An, Changbao Ge and Wang Jian Ming.

NEWS FROM AROUND THE WORLD

Indonesia:

Right: The Research Centre for Geotechnology (RCG), Indonesian Institute of Sciences, purchased two MTU-5A systems in August 2005 to carry out oil and geothermal prospecting and crustal tectonic studies. Dr. Djedi S. Widarto, project leader of Geo-ElectroMagnetics Research Group, has more than 10 years experience in both natural and controlled-source MT exploration. A number of research proposals using these systems for oil and geothermal exploration in Indonesia are being submitted.

At right, Dr. Widarto, Dr. Hendra Grandis and an RCG crew inspect calibration results from a survey conducted in the pine forest on the southern flank of the Tangkubanparahu volcano, Bandung, Indonesia; the survey was carried out at an elevation of more than 1,378 metres.



Left: PT Elnusa Geosains bought several Phoenix MT/AMT systems for geothermal and hydrocarbon exploration. Elnusa is a subsidiary of Pertamina, the national oil and gas company of Indonesia. Pertamina also produces electricity from geothermal fields. Trainees from four organizations, Elnusa, Pertamina, and two research centres, give the thumbs-up sign for Yann Avram's training.

Japan:

Right: Vice-President Mitsuru Yamashita visited Japan in September for the V8 acceptance test by Kyushu University. In the photo, Prof. K. Ushijima, Dr. T. Tanaka, Prof. H. Mizunaga and K. Matsuo (NMC), pose with Phoenix's Wang Fei and Mitsuru.

Italy:

We welcome the return of Geosystem SRL of Milan, Italy as a Phoenix client. Geosystem purchased several V5-16 MT systems in the 1980s and 1990s. Recently, Geosystem acquired a 35-channel MT/AMT system from Phoenix. Geosystem is a geophysical contractor offering MT, CSEM and other services worldwide, as well as the WinGLink® MT interpretation software package. See www.geosystem.net





Prof. Martyn Unsworth stands with the headmen of a village close to the East Anatolian Fault near Elazig; the MTU is placed in the wooden box for temperature control.

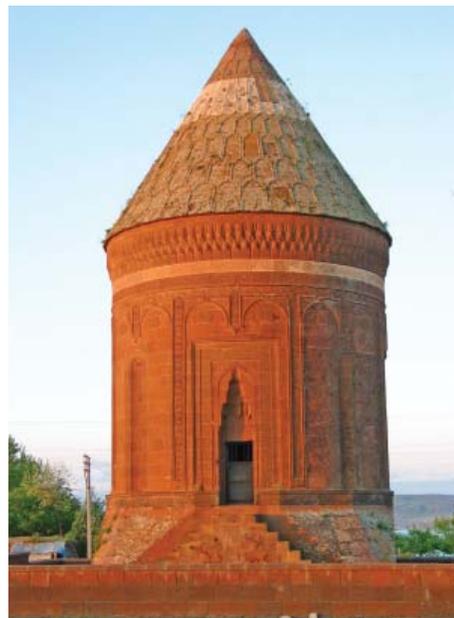
Earthquake Hazards Studied with Phoenix System

Turkey is tectonically very active. The collision of the Arabian Plate with Eurasia forces most of central and western Turkey to move westward along the North and East Anatolian Faults, causing earthquakes such as the large Izmit quake of 1999 in which thousands of people lost their lives.

In a joint research project, the University of Alberta (U of A) and Istanbul Technical University (ITU) are using MT to study the tectonics and earthquake hazards of Eastern Anatolia. The fieldwork is directed by Prof. Martyn Unsworth (U of A) and Prof. Ilyas Caglar (ITU). U of A's Phoenix System 2000 is being used in detailed studies of the East and North Anatolian Faults. Dr. Unsworth reports that the MT system functioned very well, even during the high daytime temperatures of the Anatolian summer.



Volkan Tuncer digging a vertical coil hole



A twelfth-century tomb at Ahlat, Turkey

President's Message

Our "Phoenix family" has experienced many changes lately. Because we are not a large company, life-altering events that happen to any employee affect us all.

Girlie Diljohn died suddenly on October 10. Girlie joined Phoenix in 1997 and considered our work force to be her second family. Our condolences go out to all her family, especially to her six children. Girlie was a beloved member of the Phoenix family; she will be missed by all of us.

We will soon say farewell to Keith Levere, our longtime Vice-President Finance. After more than 50 years in accounting, Keith is taking a well-deserved retirement. At Phoenix since 1980, Keith has shepherded the company through good times and bad; luckily he's leaving on a high note!

Longtime employees of Phoenix see one another's children grow up – and such is the case with George Elliott's daughter Nicole, born after George joined Phoenix. As a child, Nicole sometimes accompanied her Dad to the field; in 2004/2005, she worked at Phoenix as a manufacturing technician. On October 1, Nicole married Trevor Brook-Allred in an elegant ceremony. Best wishes to the couple from everyone at Phoenix.

We congratulate our Electronics Technician Ashley Fernandes and his wife Audrey on the recent birth of their first child, son Damian. Damian was christened on Oct. 2.



The photos and information sent to us by our clients add a great deal of interest to our newsletter. Special thanks to Prof. Martyn Unsworth, Dr. Djedi Widarto and Moscow University for their submissions to this issue.



Our employees' children are often given summer work experience at Phoenix. Below are a few of this year's workers, Takato Koguchi, Daniel Balint, Adrienne Norris and Nicole Elliott

~ Leo Fox



ON THE ROAD

Spain

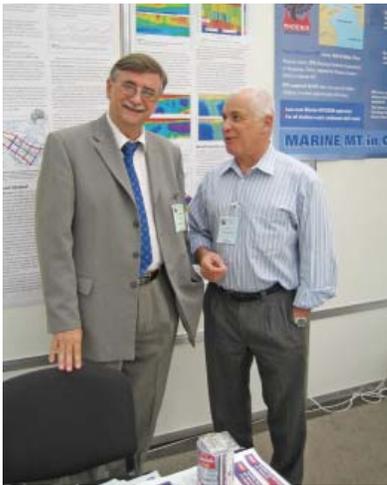
Many visitors came to the Phoenix booth at the 67th EAGE held in Madrid in mid-June. We congratulate the organizers for planning a spectacular gala evening featuring wonderful Spanish food and entertainment; the gala was held at Soto-Viñuelas Castle outside Madrid.

Right, a server entertains gala visitors, pouring sherry with a flourish; the wine is named for the area from which it comes, Jerez de la Frontera in southern Spain.



Romania:

President Leo Fox attended the Balkan Geophysical Society meeting held in Bucharest, Oct. 9-12. Right, he chats with organizer Dr. Constantin Sava. Below, Marius Milea of Prospecțiuni, Bucharest, with Leo Fox in our booth.



Dr. Ion Moroșanu, a geologist with Prospecțiuni, accepts his maple syrup win from Leo Fox.

Brazil

Leo Fox and Carlos Guerrero attended the Brazilian Geophysical Society conference and expo in Salvador, Bahia; after the show, they visited UENF at Macaé. Below, head of LENEP, Prof. Abel Carrasquilla, Prof. Carlos Dias and Leo Fox



COMING UP

- Nov. 6-9, the 7th biennial EM Conference in Chengdu, China: VPs James Kok and Mitsuru Yamashita will attend. Mitsuru will present two papers, one describing the V8 wireless system and the second describing MT monitoring stations installed by Phoenix in various locations since 1996.
- Nov. 14-17, China Mining 2005 in Beijing: Phoenix agent Laurel will have a booth, and James Kok will attend.
- March 5-9, 2006, the 74th Prospectors and Developers Convention, Toronto: Phoenix will have a booth at this event where last year's attendance reached an all-time high of 12,000 participants from 99 countries.
- March 2-5, 2006, immediately preceding the PDAC, the World Mines Ministries Forum will hold its biennial meeting in Toronto. Go to www.wmmf.org for more information.



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