THE PHOENIX

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PHOENIX MT EQUIPMENT, RUSSIAN EXPERTISE – A WINNING COMBINATION

Russia has a long history of outstanding accomplishments in EM exploration techniques. With the largest land area in the world, highly prospective for metals, oil and gas, Russia has always sought rapid, low-cost geophysical reconnaissance techniques.

Major practical accomplishments of Russian EM and MT include the discovery of the large basement uplift near the little trading post of Urengoi in the Tyumen region of West Siberia. When drilled, this structure was found to host the giant Urengoi gas field, with reserves of 5 trillion cubic metres, which now supplies large amounts of gas to western Europe.

A major Russian theoretical accomplishment was the co-invention of the MT technique in the early 1950s by Tikhonov. (The other co-inventor was Cagniard, in France.) Russian geoscientists soon developed analog MT systems which were easy to use, portable and robust. From the 1950s to the 1970s, more than 100 geoelectric crews mapped large areas of Russian territory. Such widespread application of geoelectrics still has no counterpart in western countries.

Russian scientists also developed a high level of expertise in other EM techniques: Transient Sounding (TS); Frequency Sounding (FS), and Induced Polarization (IP). all of which were used in oil and gas exploration. Little of Russian literature about these techniques has been translated to English.

As relations between east and west improved in the 1970s, western scientists gradually became aware of the high level of development of EM theory in Russia, as well as the wide practical application in exploration of MT, TS and FS. Australian geoscientist Brian Spies visited the USSR in the early 1980s and wrote a well-known review paper, "*Recent Developments in the Use of Surface Electrical Methods for Oil and Gas Exploration in the Soviet Union*", GEOPHYSICS 48, page 1102, 1983. Other western geoscientists such as Keeva Vozoff and George Keller facilitated translations of relevant Russian works. Emigration of Russian EM experts (including Kaufman, Pabarovsky and, later, Zhdanov) also disseminated EM expertise in western countries.

The TS technique (called TDEM, or

Continued page two

Dr. Andrei Yakovlev (in front of Moscow University, MGU) is an adjunct Professor at MGU as well as President of Nord-West Ltd., a geophysical company which is actively using Phoenix System 2000 MT equipment for regional profiles, exploration surveys and academic studies with MGU.

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time domain electromagnetics in western countries) was also invented in Russia. It was rapidly adopted by Australian geoscientists in the early 1980s when they realized that the TDEM technique was ideal for "looking through" the typical tropical-zone weathered, conductive surface layer which covers much of Australia.This prompted development of an Australian TDEM system (called SIROTEM) by Australia's Commonwealth Scientific and Industrial Research Organization (CSIRO). Similar systems were developed by North American geophysical companies.

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MT played key role in discovery of supergiant Urengoi gas field

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The first North American commercial MT systems (based on Russian and French experience) appeared in the early 1970s. These developments were accelerated by the post-1973 increase in oil prices, with consequent increase in frontier oil exploration by multinational oil companies. In such frontier regions, seismic data is often poor or unusable, or very costly to obtain. By contrast, MT or EM techniques cost much less than seismic and often can easily "see" through the same rocks which cause problems for the seismic technique.

In the late 1970s, several factors combined to spur rapid evolution of western MT and EM equipment. High oil prices, advances in electronics and microprocessors and the 1978 theoretical breakthrough in MT called "remote reference", led to much wider application of MT by western oil and gas companies. Then the 1985 crash in oil prices caused western oil and gas exploration with geoelectrics to decline. Staff reductions and consolidations led to the present low level of theoretical and practical knowledge of EM techniques within western oil companies. The present "seismic by default" exploration paradigm inadvertently deprives many oil companies of the benefits of MT and other EM techniques realized elsewhere.

By contrast, since the early 1980s, geoelectrics in China (especially MT) has experienced continued growth in oil and gas exploration, creating a new market for western MT and EM equipment. (Phoenix first entered the China market in 1983.) Political and economic changes in China increased demand for hydrocarbons; high imported oil costs stimulated domestic exploration; academic expertise supported practical application in exploration; and the large area of unexplored sedimentary basins (many of them unsuitable for seismic exploration) emphasized the role of deep-penetrating EM techniques, especially MT. Recent significant large discoveries (*see Issue No. 21*) have accelerated the trend.

Geoelectrics suffered a temporary decline in Russia between 1985-2000 due to the widespread changes brought about by the end of communism. Today, improvement of the Russian economy, increased oil and gas production (and higher prices), greater east-west linkages and availability of modern western equipment have sparked renewed interest in EM in Russia. Phoenix is increasingly active in the Russian market and strongly supports this rebirth of Russian EM under some of the ablest practitioners in the world. ■

The above article is based in part upon a review paper *"Geoelectric Surveys in Russia: Oil and Gas Prospecting"* very kindly prepared under the direction of Prof. Mark Berdichevsky of Moscow State University (MGU). The MGU group, under the direction of Professors Berdichevsky and Leonid Vanyan, has made numerous and outstanding contributions to MT and EM (Electromagnetics).

Prof. Berdichevesky (shown at right) is the leading figure in Russian MT. He has published more than 250 scientific papers and several books and has been a professor at MGU since 1969.

MESSAGE FROM THE PRESIDENT

Phoenix was awarded US Patent No. 6,191,587 B1 for the System 2000 concept, on February 20, 2001.

The patent covers the basic concepts of the System 2000: a distributed MT system, in which most of the data acquisition units measure two components of the electric field, and a smaller number measure three components of the magnetic field; and the use of time signals broadcast by GPS (Global Positioning System) satellites to synchronize all recording units.

A patent confers recognition and intellectual property protection. However, the real test of an invention lies in the benefits arising from its application. By this test, the System 2000 concept is very successful. Our many clients use the System 2000 technology in exploration (for oil and gas, metal deposits, diamonds and geothermal fields), in production (to monitor reservoirs) and in research (to look for earthquake effects, map deep geological structure and to monitor the natural EM fields).

~Leo Fox

NEWS FROM JAPAN

A Phoenix crew field tested the new AMT function for the System 2000 in Japan in early May.

The Geological Survey of Japan worked with colleagues in New Zealand in February this year. The System 2000 technology encountered an unusual noise source – literally hundreds of electric fences. With some careful work by the scientists, the remote reference technique was able to work satisfactorily even in this noisy environment.

National Institute of Polar Research (NIPR) reports success in carrying out MT surveys in Antarctica with the System 2000. ■

Left to right, Phoenix Vice-president Mits Yamashita, Dr. Shigemitsu Nakamura, Manager, R&D, Meiyo Denki Co. Ltd., Phoenix President Leo Fox,and Dr. Ryuji Kioka of the Shibaura Institute of Technology in the Phoenix booth at the PDAC Meeting in Toronto in early March.

NEWS FROM CHINA

China continues to acquire more System 2000 equipment, as MT surveys expand in scope.

A new client, Sinopec 6th Geophysical Exploration Team, in Nanjing, purchased their first System 2000 in March.

Existing clients also expanded their systems to satisfy the demand. Jianghan Oil Field, CNNC 814 Team, CNNC-Tientsin and Zhejiang Petroleum Exploration in Hangzhou, Zhejiang Province, all added data acquisition units and sensors. The Geophysical Exploration Bureau (GEB) in Baoding, Hebei, also acquired more System 2000 equipment.

Travel between Phoenix and China continues: a delegation of five from China National Petroleum Corporation visited Phoenix in April.

Phoenix engineers Lu Yi and James Kok visited China in March and April for equipment service and meetings with clients; geophysicist Mitsuru Yamashita visited a previous client, the Chinese Academy of Science in Beijing, for more training on the V6 system acquired last year. ■

MT R&D PROJECT

University of Toronto, well-known for expertise in electromagnetics, is planning to become more active in applied MT R&D.

U of T's eminence in EM techniques dates back to the late 1940s when the university provided the theoretical and electronic expertise for development of new geophysical equipment and techniques during the post-war economic and mining exploration boom. The powerful three-way combination of university expertise, a bevy of practical-minded spin-off geophysical companies in Toronto (among them, Phoenix predecessor, McPhar) and widespread application of the techniques in mining exploration in the nearby Canadian Shield, provided a solid base for continued development. Besides, university students in geophysics could always find jobs in industry and pay their way through school.

Industry's approval of the new U of T initiative can be gauged by the commitments of financial support from major mining companies INCO and Falconbridge, and from Phoenix Geophysics. ■

HIGH-POWERED EM UNIT ON WAY TO CHINA

A new generation high-powered transmitter was commissioned by China National Petroleum Corporation. The Phoenix T200 is now on its way to China.

Phoenix capability in controlled source techniques dates back to the founding of McPhar in 1947, the predecessor company of Phoenix. Over the decades, Phoenix developed many different geophysical transmitters, for mining, geothermal and oil and gas exploration.

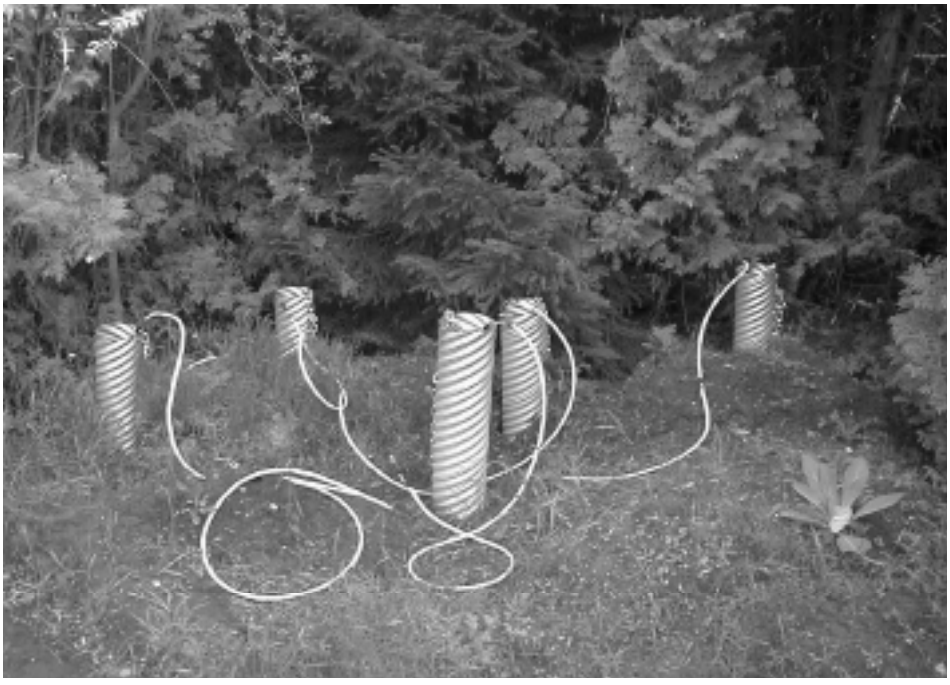
In the early 1980s, Phoenix organized a consortium of 12 major oil companies, including Texaco, Exxon and Chevron, which funded the development of high-powered controlled source technology for the study of the induced polarization properties of oil and gas pools. A number of oil and gas pools were studied in various regions of North America. One of the results from a heavy oil field in Alberta was published as "Spectral Induced Polarization Survey, David Field, Alberta Canada" by Dr. James Klein, 36th Annual Meeting of the Midwest Society of Exploration Geophysicists, Denver March, 1983.

The early 1980s Phoenix project was based on earlier results obtained in the Soviet Union where application of EM techniques in oil and gas exploration were developed to a much higher level than in western countries. (See the front page article about Prof. Berdichevsky and Moscow University.)

The high-powered source developed for the 1980s consortium was called IPT-6 and an IPT-6 system was sold to China's Ministry of Geology in 1983. The MoG group used the IPT-6 system to study many oil fields all over China.

In recent years China National Petroleum Corporation (CNPC) has also carried out surveys with high-powered IP equipment made in Russia. Results of these surveys prompted CNPC to commission the development of a new generation high powered transmitter utilizing the latest technology in power switching, electronic control, etc.

The T200 ready to go to the Phoenix test site near Toronto.



Electrode farm at the test site. Multiple electrodes reduce the contact resistance.

The CNPC unit is called the T200. It has maximum ratings as follows: frequency, 256 Hz; current, 160 amperes; voltage, over 1000 volts; power, 160 Kw. The T200 is powered by an industrial diesel engine, and utilizes a specially designed 400Hz alternator.

The T200 is en route to China as we go to press. Watch for more news in future issues.■

T200 Waveforms

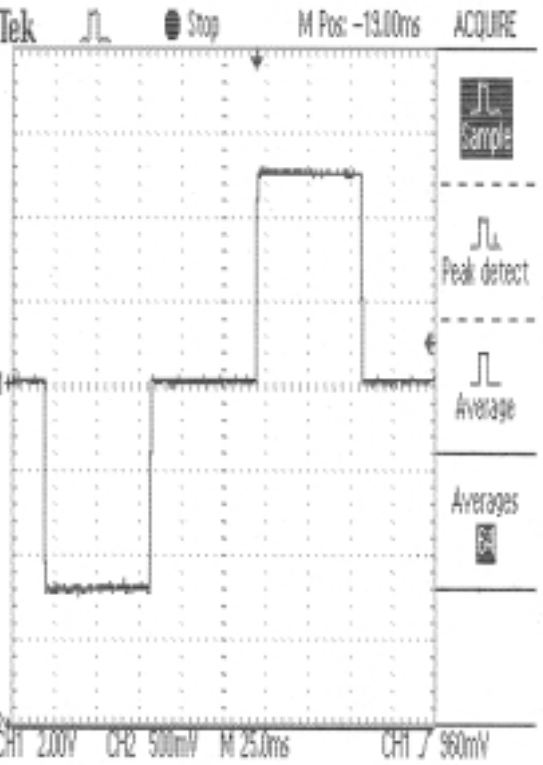


Chart I: Time Domain (50% duty cycle) 4Hz, 100 amperes, approximately 1000 volts.

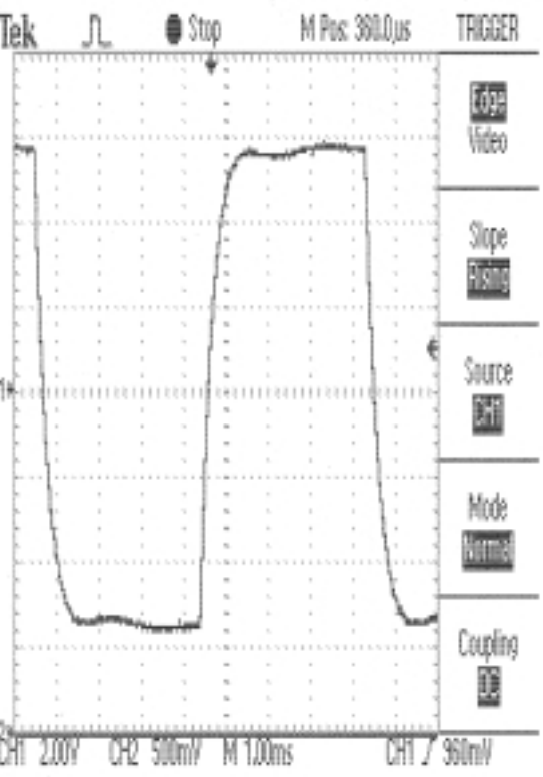


Chart II: Frequency Domain (100% duty cycle), 128 Hz , 100 amperes, approximately 1000 volts.

OIL AND GAS EXPLORATION WITH MT IN ROMANIA

Prospectiuni S.A., a geophysical exploration company in Bucharest, Romania, recently purchased its first System 2000. Prospectiuni provides exploration services (mainly for oil and gas) using both seismic and non-seismic techniques. The company has considerable expertise in MT.

Prospectiuni will use its System 2000 for oil and gas exploration in Romania, initially in the overthrust zones of the eastern flank of the Carpathian Mountains. Here tectonic forces have pushed older, denser rocks above deeper sections of oil and gas- bearing sedimentary rocks. The overlying dense layers degrade or even destroy the seismic image of the deeper rocks. However, careful work with MT has helped Prospectiuni to decipher the complicated horst and graben block structure and to explain some earlier seismic-based dry holes. Recent MT work provided the justification for a 3500 metre-deep well which discovered commercial quantities of gas. This success has prompted larger scale MT surveys.

The System 2000's light weight and portability are ideally suited to the mountainous and remote field survey areas of the Carpathians where there are few roads. ■

Above: Geophysicists Gabriel Ioan, Cornel David, and Aleandru Crupa of Prospectiuni visited Phoenix for training in early April. Phoenix President Leo Fox took the men on a one-day tourist trip which included a Canadian pancake and maple syrup breakfast served by Boy Scouts and a helicopter tour over Niagara Falls. Below, Leo with Aleandru and Gabriel at the Falls.

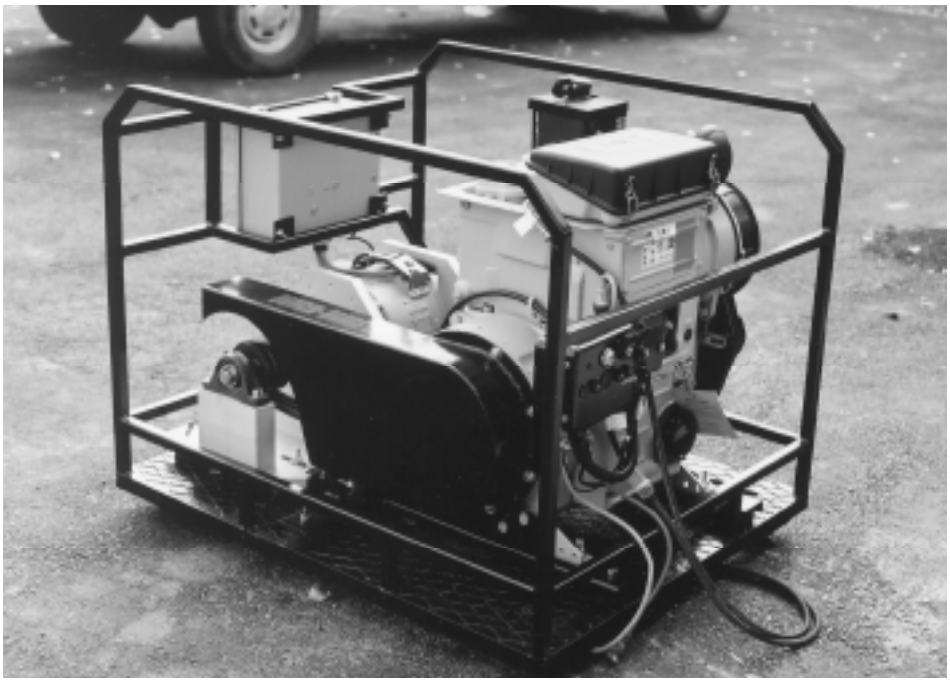
■■

NEW EQUIPMENT NOW AVAILABLE

New Motor Generator Unit

Phoenix now offers a new motor generator unit called the MG-20. Developed for Phoenix by Walcer Geophysics, the MG-20 is powered by a 38-hp air-cooled diesel.

The compact 325 kg MG-20 is the ideal solution for medium powered IP, CSAMT and TEM applications. Air cooling means fluid coolants are not required. Diesel fuel is economical and widely available, and the diesel engine is more robust than a gasoline engine. The 38-hp engine is operated at only approximately 65% of full power which promotes long engine life. ■



The Model MG 20 motor generator

Replaceable Memory Chip Saves Time and Money

Previously, System 2000 boxes used a fixed, 32Mb internal memory. After data acquisition, data was transferred to a ruggedized field notebook computer via a parallel interface. The field data was later dumped to desktops in the office for further processing.

Each of the two data transfer operations took about 15 minutes, required the relatively costly field computer (which could not operate in the same wide range of environmental conditions as the System 2000 boxes) and introduced the possibility of errors.

The new swappable memory option permits the user to exchange a "full" memory card (now 96 Mb) for an "empty" one in a few seconds. The field computer is no longer needed for this operation and the labor saving is about 15 minutes per box. The larger memory also permits much longer continuous data acquisition runs, for improved data quality in noisy regions.

The transfer operation to the processing computer has also been accelerated – saving another 15 minutes per site. Now the removable memory chip is simply plugged into a special high-speed interface and data is transferred at very high speed.

The benefits are obvious and a number of owners of older System 2000 units (with fixed internal memory) have already opted to upgrade. To upgrade memory size, users will simply use larger memory chips as they become available without any additional hardware changes.■

MTU box with a removeable 96 Mb memory chip.

PHOENIX REPRESENTS TEM-FAST SYSTEM OF AEMR

Phoenix has signed a sales representative agreement with AEMR of the Netherlands.

AEMR's main product is the TEM-FAST Transient EM system for shallow soundings.

Based on a Russian design for a literally interplanetary TEM system (originally intended for a Mars lander), the TEM-FAST system is ultra-lightweight, compact. and affordable. The battery-powered transmitter and receiver are in the same small box, and a single lightweight loop (called "coincident loop") is used as both the transmitter and receiver loop.

TEM-FAST's advanced firmware and software provides a number of advantages compared to other TEM systems.

TEM-FAST's range of applications is very wide and includes problems in exploration, hydrology, foundation planning, pollution mapping, groundwater, civil engineering and detection of UXO (Unexploded Ordnance).

Check out the AEMR web-site to find out more about the advantages and applications of TEM-FAST:

aemr@planet.nl

Tem-Fast Transient EM system: lightweight, compact and affordable.

NEWS FROM TAIWAN

National Chung Cheng University of Taiwan (NCCU) recently acquired a 10-channel System 2000. Standing far left, Prof. Chow-Son Chen of National Central University (NCU) and Prof. Chiou-Fen Shieh, of NCCU oversee their graduate students studying the system at the NCCU campus.

CONFERENCES AND PAPERS

Phoenix participated in the conferences mentioned below. The full text of papers cited is available on request from Phoenix.

- GAC (Geological Association of Canada) Meeting – St. John's, Newfoundland, May 27-30, 2001

  Two diamond exploration papers (see below) were presented at the GAC Meeting. Dr. Olex Ingerov of Phoenix was one of the co-authors for each of the papers. Senior author for both papers is Dr. A.K. Saraev of St. Petersburg State University.

- Possibilities of Magnetotellurics for Kimberlite Exploration at Russian Platform – describes results of a large 4000-point MT / AMT survey carried out in summer of 2000 in the Arkhangelsk region of European Russia, near recent commercial diamond discoveries.

- Magnetotelluric Exploration for Kimberlite Pipes in Yakutian province, Sakha Republic, Russia – describes results of regional MT surveys and also an AMT profile collected during summer 2000 across the Amakinskaya Kimberlite Pipe.The kimberlite pipe swarms usually appear as narrow, linear conductive zones within resistive host rocks.

- EAGE Meeting – Amsterdam, the Netherlands, June 10-14, 2001

- PDAC, Toronto, March 11-15, 2001, "Integrated Exploration at Kidd Property", Fox, L., Patterson, J. and Jagodits, F.

HOPING TO SEE YOU...

…at the 71st SEG (Society for Exploration Geophysicists) Meeting in San Antonio, Texas, USA, September 9 – 14, 2001.

PDAC, TORONTO, MARCH 2001

Above, Kevin Stevens (Falconbridge), Olex Ingerov (Phoenix) and Prof. Michel Chouteau (Ecole Polytechnique) discuss the 3D MT R&D project.

Right: Russian visitors Valeri Arbouzkine (left) and Evgeni Trofimenko (right) discuss MT in the Caucasus with Olex Ingerov (centre).

Below right: Vladimir Longinov (left) and Pavel Pushkarev (right) of Nord-West Ltd., Moscow.

Below: Consultant Frank Jagodits and Leo Fox share a laugh.

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