THE PHOENIX

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Phoenix AMT Survey Maps Deep VMS Ore Body

Phoenix carried out an AMT test survey last March at the Lalor deposit owned by Hudbay (Hudbay Minerals Inc.) near Flin Flon, Manitoba, Canada.

Rich in gold, zinc and copper, the Lalor deposit was discovered in 2007 by drilling a large-loop TDEM anomaly. (*See The Phoenix 49, March 2010*). Subsequently, dozens of deep drill holes outlined the deposits.

Lalor is a Volcanogenic Massive Sulfide (VMS) deposit. Such deposits are formed in groups on the ocean floor near hot, mineral-rich fluid outflows called "black smokers". The smokers are associated with the spreading of tectonic plates; see page 4 to learn more about them.

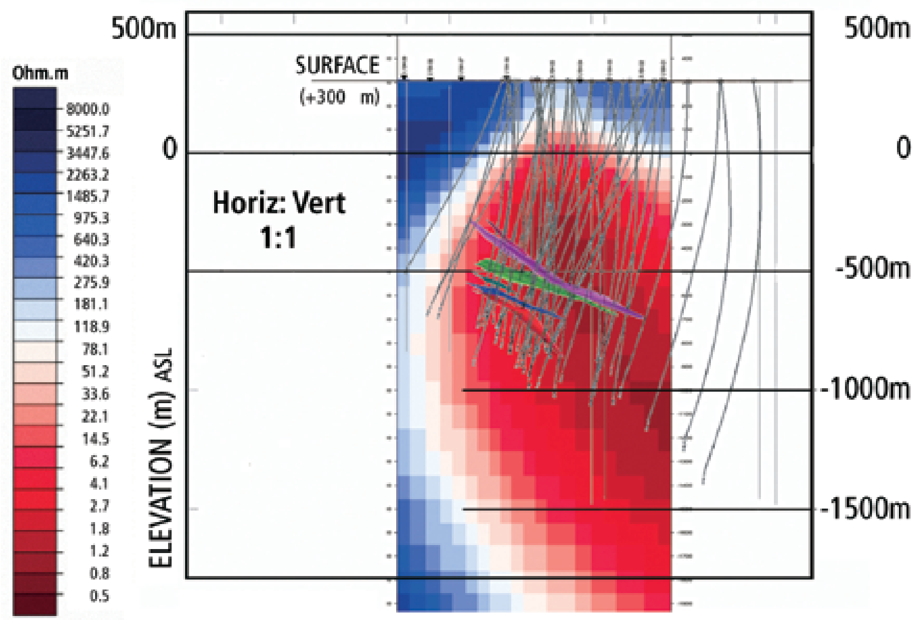
There are more than 800 known VMS deposits worldwide, and over 300 in Canada. The numerous VMS deposits in the Flin Flon area – now several hundred meters below surface and in the center of a continent or "craton" – were once on the sea floor.

HudBay recently established a project for multiple test surveys over the Lalor deposit, with a goal of publicly presenting all the findings. The resulting Lalor Symposium was held in Vancouver, Oct.16–17, 2014, under the auspices of the British Columbia Geophysical Society. Phoenix geophysicist Caroline Finateu presented the results of the Phoenix survey.

The unconstrained 2-D inversion shown above, as is typical, has greater spatial extent than the actual 3-D orebody. But the core of the 2-D inversion (inside the 2.7 ohm-m contour) shows reasonable agreement with the known boundary (left hand side), plunge, depth, and resistivity of the orebody. Other surveys and 3-D inversions reported at the symposium also indicated possible deeper conductive zones, which according to Hudbay cannot be ruled out.

The Lalor deposit, which is now in production, generates considerable 24/7 EM noise. However, Phoenix MT processing techniques were able to mitigate the high levels of ambient noise and provide a satisfactory data set for inversions. The 2D MT inversion along one of the lines (line 184) is shown above. ■

2D Inversion Profile L184
with Drill Section (approx.)



AMT survey succeeds in brownfield noise conditions

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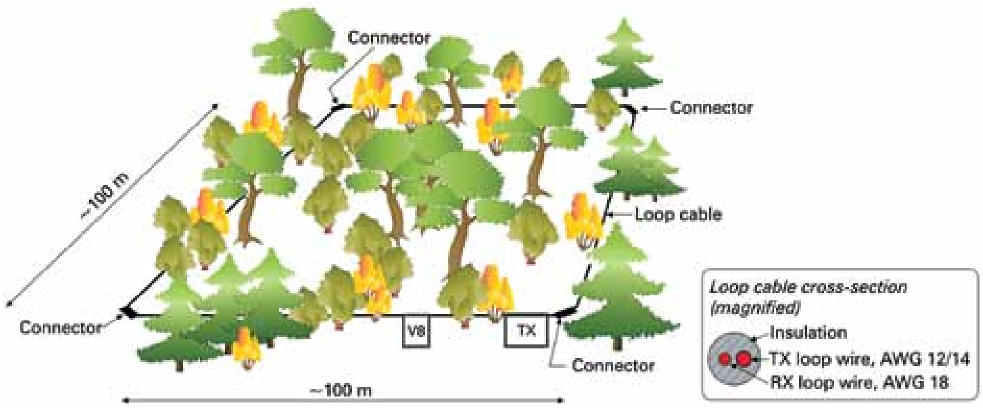
40 YEARS 1975-2015 PHOENIX GEOPHYSICS

Coincident Loop TDEM Function for V8 Receiver

MT static shift correction with TDEM typically uses the central-loop configuration. In this configuration, the TX loop is typically about 100 m x 100 m to 200 m x 200 m. Here, the V8 receiver measures a single station at the geometric center of the square TX loop.



However, the central-loop configuration is difficult to implement in areas with significant vegetation, such as fields with tall crops, jungle, or heavy bush. In such areas it is still possible for the operator to install the TX loop by paying out the loop wire behind him while he walks round the loop plan following a compass heading. However, it is often difficult to install the receiver magnetic sensor at the center of such a loop, because there is poor visibility or lack of access.

The solution is to combine the wire for the receiver loop with the wire for the transmitter loop in a single multi-conductor cable. This is called the coincident-loop configuration, since two loops are coincident in space. The loop cable is provided in portable segments typically about 100 to 200 m long and weighing about 10 kg. The segments are joined by rugged connectors.

The new configuration is being used successfully in Japan for a different objective: volcano studies, where the coincident loop is deployed around the rim of a small crater.

The advantages of the coincident loop include insensitivity to minor topographic variations; ease of use, especially in areas with heavy vegetation; greater volume-averaging for the static-shift correction application; and strong RX signal due to the large RX loop area – typically at least 100 times greater than the equivalent area of a small portable receiver loop. ■

PRESIDENT'S MESSAGE

This year, Phoenix is 40 years old. A group of six senior ex-McPhar employees founded Phoenix in May 1975.

The brand new Phoenix promised to adhere to the McPhar key values of continuous improvement and innovation. That promise has been well kept: Phoenix has developed eight generations of geophysical equipment in four decades, equipment that is now used in more than 80 countries. The latest generation has found worldwide market acceptance, and the Phoenix innovation team continues to grow. You can read more about the company's founders and their vision in the first issue of *The Phoenix*, October 1994 (available on our website).

Last July, several Phoenix employees gathered in Las Vegas to celebrate the 25th anniversary of the company's current ownership; it was in 1989 that the present employee group bought Phoenix from the previous shareholders.

It has been an exhilarating quarter century, with innumerable adventures, travels and challenges. The company is now in a solid financial and technical position.

We hope the years to come will be as much fun and as rewarding as the past 40 have been!

~ Leo Fox

Eight of the current Phoenix shareholders gathered with colleagues to mark their quarter century of ownership. Seated are Leo Fox and Mitsuru Yamashita and standing are, left to right, George Elliott, James Kok, Robert Norris, George Balint, Gordon Thompson and Gerald Graham.

Japan

In late 2014, Phoenix engineer Gerald Graham and geophysicists Mitsuru Yamashita and Caroline Finateu replaced sensors and electrodes at two earthquake-monitoring stationary sites in Sawauchi and Kagoshima. **Below:** Gerry and Mits at left, Caro and Gerry at right

Algeria

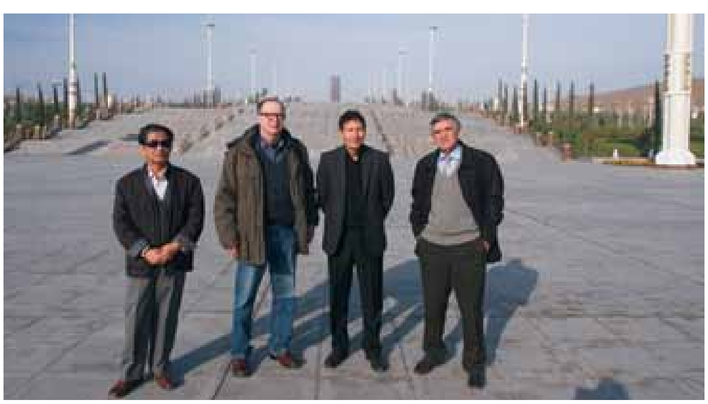
The Université des Sciences et de la Technologie Houari Boumediene (USTHB) recently purchased MT equipment. Phoenix geophysicist Caroline Finateu visited USTHB in January to provide equipment and software training. Caroline also gave presentations to Phoenix customer Centre de Recherche en Astronomie, Astrophysique et Géophysique as well as to other organizations. **Below:** Caroline with USTHB personnel

Canada

Phoenix geophysicists Murat Urakov and Caroline Finateu carried out a second phase of a geothermal survey in the Ross River area of the Yukon Territory in Canada's far north. The survey was started in the fall of 2013 with sites along a profile; in 2014, the same number of sites were spread over a larger area. **Right:** Murat and Caroline

Turkmenistan

Murat Urakov, Olex Ingerov and Lu Yi, travelled to Turkmenistan in November 2014 for acceptance of two sets of V8 + RXU-TMR + T-3 + TXU-30 purchased by the Institute of Physics and Atmosphere of Earth of the Academy of Science of Turkmenistan. **Right:** Testing the equipment and training staff in the vicinity of Ashgabat, the capital of Turkmenistan



Left: Lu Yi, Olex Ingerov, field crew chief Agadzhan Altynazarov and Alexandr Kurbanov, chief of the production and survey department, stand in front of the national memorial symbolizing Turkmenistan's recovery after a 1948 earthquake that killed almost 90% of Ashgabat's population.

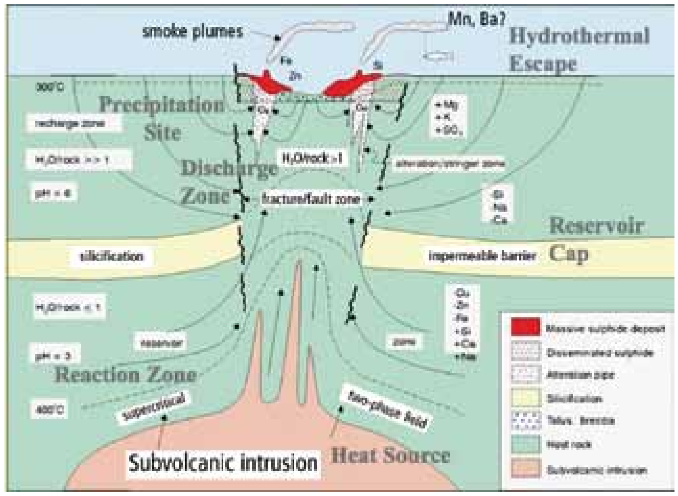
VMS Deposits and "Black Smokers"

Volcanogenic massive sulfide (VMS) deposits are formed at the sea floor near spreading centers – the areas where tectonic plates are pulling apart or rifting. In these zones, very hot molten rock (magma) rises and exits not too far from the sea floor. The elevated temperature above the magma and the conduit provided by the rifted zone create a convection cell.

Cold seawater penetrates through the ocean floor rocks, is heated by the magma and then dissolves minerals and metals from these rocks. Because the heated water is less dense than the cold seawater, it rises, causing more cold water to be drawn in. This convection cycle continues as long as the source of heat exists.

The water is heated to a temperature of 350°C or more, far above the normal boiling point of water on the earth's surface. But, due to the immense pressure at the sea floor, it cannot turn into steam; it remains a fluid. This hot fluid dissolves metals (including zinc, lead, copper, gold and silver) and other minerals (such as sulfur) from the seafloor sediments as it passes through. The minerals turn the hot fluid black. The hydrothermal plume of dark fluid emanating from the seafloor is called a "black smoker". The metal-rich heated water is rapidly cooled by cold seawater (approximately 2°C), and the dissolved minerals precipitate. Over time, the precipitate builds up into a metal-rich seafloor mound.

The process continues in today's oceans. Although most such zones disappear because they are subducted beneath the continents,



some of the ancient VMS deposits were not subducted; rather, they have been shifted by tectonic movements over hundreds of millions of years to where we find them today. For example, the Lalor deposit (*see front page story*) is situated in the center of a continent, several hundred meters below the surface. For detailed accounts of the formation of VMS deposits, see the Woods Hole Oceanographic Institution website or **http://public.byethost8.com/home/Docs/Ressources_Naturelles/Naze/VMS.pdf**, the source of the illustration above.

PHOENIX AROUND THE WORLD

Colombia

Gerald Graham and Carlos Guerrero visited the Geothermal Department of the Geological Survey of Colombia (SGC) in January for acceptance of, and training on, the two SSMT-2000 systems recently purchased by SGC. We especially thank Hugo Gravini, Phoenix sales representative in Colombia, for the photograph and his valuable help during the training. **Right:** Gerry Graham, Hugo Gravini, geologist Edwin Vallejo, SGC Supervisor, Carlos Guerrero and Gilbert Rodriguez. Absent, Miguel Beltran, who also participated.

COMING UP

- **April 19–24:** Phoenix will participate in the World Geothermal Congress in Melbourne, Australia.
- **June 1– 5:** Phoenix will have a booth at the 77th EAGE in Madrid, Spain.

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