Ramblings of a Geophysicist or "35 years chasing the world's greatest anomaly"





Walking down the mountain Andris Kikauka Al Scott **Rob Gordon** Luca Riccio **Trevor Boyd** Greg Crowe



1991From Point Lake to Ekati







Competing scientists began to do some high-tech claim jumping. Since many had only a general knowledge of how to detect kimberlite pipes with geophysics, the airspace over Point Lake suddenly swarmed with planes trying to calibrate their instruments on the pipe's signature. BHP retaliated by looping an electric cable around the cake, when enemy aircrait sweet red in, they switched on a generator, sending out a field that made airborne instruments go crazy. BHP and most of the others fielded small air forces are not with instruments to root out every magnetic or conductivity anomaly in their new domains. Soon they identified dozens of possible targets resembling Point Lake and slung in drills. To prevent the opposition from seeing, crews hung camouflage nets over their rigs.



















7200 Hz Apparent Resistivity









Fugro Arbonne Surveys Ltd. is proud to have made a direct and significant contribution to Canada's first Diamond Mine EKATI

Gordon of the North !



1993Voiseys Bay

Hudson Bay

Passages

Labrador Sea

GUT OF STATE





Inco - Voisey's Bay Nickel Project 900 Hz Apparent Resistivity





TITAN 24 distributed acquisition system layout



line

Deep multi-parameter information



TITAN 24

LINE 12+00E - QCI PLANE-WAVE EVA 2D MT INVERSION



Map Generated by QCI - RReddig (Oct-2002) + JMLegault (Nor-2002)

Exploration

TECHNOLOGY TODAY

Deep success for Quantec

Canadian geophysics specialist Quantec Geoscience Ltd has developed a combined magnetotelluric/induced-polarisation technology which can provide highdefinition resistivity data to depths of up to 2 km. Conventional electrical geophysical systems can typically penetrate to depths of around 300 m.

The Titan 24 system has been developed after four years of research. The system uses an array of sensors to collect inducedpolarisation data during daylight and magneto-telluric data at night. The extremely large datasets are then processed using 14 Pentium IV personal computers running in parallel to produce the resistivity profiles. The company has receiv support from the provincial Ont

Mineral Exploration Technologies (OMET) programme, which together with mining companies has funded the application of the technology. The first prototype has been in use by Barrick Gold Corp., one of Quantec's major shareholders, at its

Goldstrike operations. A second unit has been in use in Canada and has identified a major anomaly on Tribute Minerals Inc.'s Dixie property in the Red Lake area of Ontario (this issue p.169). The tario (this issue pice) been used at

From left: Michael White of IBK Capital; Ian Brodie-Brown, President and CEO of Tribute: Debert Corries of Question: and Deter Brodie-Brown of Tribute

etrate thick overburden, focus deep drilling

From left: Michael White of IBK Capital; Ian Brodie-Brown, President and Tribute; Robert Gordon of Quantec; and, Peter Brodie-Brown of Tribute

BY SAMANTHA D. AMARA



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in 1966 had identified 45 of these targets, and Falconbridge now plans to test the additional five. Other Tribute to Technology that are using the

Geoscience Ltd, 116 Spadina Avenue, Suite 400, Toronto, Ontario, M5V 2K6, Canada. Tel: +1 416 306 1941. Fax: 306 1949. E-mail: rgordon@quantecgeoscience.com

Deep imaging New technology lowers cost of discovery

by Mike White and Rob Gordon

ining and exploration companies wanting to capitalize on the current up-tick in the gold price and potential future improvement in other commodities must overcome the short-term difficulty of raising funds. Companies that can demonstrate timely and cost-effective methods to improve chances for exploration success are more attractive to potential investors. One junior, Tribute Minerals Inc. of Toronto, has demonstrated that new exploration technology can provide a significant edge, for both scientific discovery and fund-raising efforts.

The investment climate for resource-based companies has significantly improved in the past year, a welcome change after five miserable years. Three factors had all contributed to the decreased



Deep conductive features are shown in red, and chargeability features in purple at Tribute's Dixie gold property.

interest within the sector: the decreased rate of discovery, the high cost of discovery, and the extensive time line to discovery. Today's rejuvenated market has not forgotten the past, and has adopted a new attitude towards exploration. Investors don't want to wait for discoveries, and they want discoveries to come cheap.

New technology such as Quantec Geoscience Ltd.'s new Titan 24 system provides a means to explore from surface to great depths with greater accuracy than ever before. Titan is the most advanced electrical earth imaging technology to date, able to provide accurate images from surface to depths of greater than 1.5

km and in some cases 2 km. (This is well past the 300 m previously possible using most traditional geophysical technology.) The accompanying figures show deep Titan 24 structural information and conductive bodies from recent work on Tribute's Dixie gold property in the Confederation Lake Belt, 40 km southeast of Red Lake, Ont. and Goldcorp's Red Lake property.

In addition to 3D earth modelling, virtual reality laboratories and quantified petrophysics, this technology is slowly being accepted as the new standard for exploration practices. Today, 3D subsurface earth models significantly increase the chances for drill success, and make it easier to show shareholders exactly what their return on investment may be. Quantec and its customers can now take years of historical data and compile them into one up-to-date model that allows for quick and decisive decisions about what to do next.

Advanced explorers such as Barrick Gold Corp., Goldcorp Inc. and FNX Mining Co. Inc. are all making use of 3D visionariums on a regular basis. Mining companies can choose the most prospective areas by integrating all spatial data into one common shared model of the earth, and using advanced hyperspectral methods. Communication of subtle details in all data sets ensures that the decision-making process is optimised and better justified. One of the most significant benefits is the ability to use both historic and new



3D earth model showing projected geology and deep structural information at Goldcorp's Red Lake property.



Titan MT image from Qg220 report on Dixie-Ben lake project for Tribute Minerals Inc. (2002), as part of OMET project 14-2001. Jean M Legault, P.Eng., P.Geo. – October, 2007. See also: A. Jones, and Garcia, X. (2003), Okak Bay AMT data-set case study: Lessons in dimensionality and scale, Geophysics, v68, p70-91. Geophysical Explanation: MT fields do not easily propagate through 3d conductor lying at shallower depth (800m!) – as a result the 2d inversion image artifact gives false sense of exaggerated vertical depth extent below the zone, extending below 1-1.5km



Cuporphyry - Resolution



MT Inversion - Resolution, Arizona - Porphyry Copper









Oyu Tolgoi (Mongolia)

Greg Crowe President Entre Gold







Oyu Tolgoi Forward Model Case History:

Idealized Geologic Section

Porphyry mineralization 1000m below surface forming a halo around a granodioritic porphyry

Forward model IP Chargeability Inversion N= 0.5 - 23.5 A= 200m

The Titan 24 array can be configured to provide IP penetration to depths in excess of 1000m as is shown in the Oyu Tolgoi case.











Notice Improved Lateral Resolution and Depth Penetration using same equipment and manpower. Required time increases.











<u>Unit</u>	<u>Resistivity*</u>	Chargeability*	<u>Unit</u>	<u>Resistivity*</u>	Chargeability*
1. Hazelton	1 000 ohm-m	7 milliradians	1. Hazelton Volcanics (late)	1 000 ohm-m	7 milliradians
2. Takla	300 ohm-m	10 milliradians	2. Takla volcanics (host)	300 ohm-m	10 milliradians
3. Black Lake	5000 ohm-m	1 milliradian	3. Black Lake Intrusive (late)	5000 ohm-m	1 milliradian
Intrusive (late)	200 alima m	0.5 millionaliana	4. Overburden	200 ohm-m	0.5 milliradians
4. Overburden	200 onm-m	0.5 milliradians	5. Pyrite Cap	100 ohm-m	50 milliradians
			6. Cu-Pv Ore	50 ohm-m	30 milliradians



Barren Model

Porphyry Model



Barren Model

Porphyry Model



Beep search technology near Kameus Mina, Nerthern BC, Canada IP data collected in rugged terrain Actual line indicated is 4000m long 2d inversion shows to 700m depth

1800m

700 metres

New Discovery

Kemess North Offset Zone Kemess North Deposit

Almost an award....

News in 2007 Drilling of Titan 24 anomalies led to 141 m of 0.39 g/t Au and 0.31% Cu – largest intercept in camp to date. Ken Stowe President of Northgate 2007

2017 - H.H. "SPUD" HUESTIS AWARD - CHRIS ROCKINGHAM, CARL EDMUNDS, WADE BARNES

- Chris Rockingham, Carl Edmunds and Wade Barnes are the recipients of the 2016 H.H. "Spud" Huestis Award for Excellence in Prospecting and Mineral Exploration.
- It is often said that patience and perseverance surmount every difficulty. The discovery of the Kemess East deposit epitomizes this. Under the leadership of Chris Rockingham, the geological insight of Carl Edmunds and execution of Wade Barnes, a blind porphyry gold copper deposit was discovered and delineated. The recognition that the Kemess North deposit was terminated on its northern and eastern edges by faults led the team to search for the offset under deep post-mineral cover. The first indications of a blind mineralized system were encountered in 2002. By the following year, with a large area of phyllic alteration and some low-grade mineralization, Chris, Carl and Wade were confident that they were vectoring towards better mineralization. This was apparent in 2007 when their fourth hole intersected the longest mineralized intercept in the entire Kemess database to that point, but perhaps more importantly, hole 24 intersected 162 m of 0.62 g/t gold and 0.53% copper in potassic altered intrusive. At this point, however, all exploration stopped as the Kemess North open pit proposal was rejected by the federal government. By 2010, commodity price changes made the concept of block caving appear viable, and Kemess North studies were reinitiated. Nonetheless, exploration did not resume again at Kemess East until 2013 and by January 2015, the first resource estimate was released. The most recent drilling has confirmed and upgraded the initial resources estimation, with spectacular drill intercepts such as 628 m of 0.53 g/t gold with 0.41% copper and the deposit remains open in some areas.



• ARGG!!!

Exploration budgets are typically gauged in meters drilled

 Exploration budgets are driven by Geologists for most companies

Globally, several statistics point to roughly only 3 -4% of budgets are used for geophysics

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Geologists
 Geophysicist

The Geologist controls the exploration

Finally.. Copper Mountain BC

A very big anomaly under the old pit

Deep success

CIM 2017

Copper Mtn

- Changed mine plan
- Added mine life
- Saved on condemnation drilling
- "Helped raise 50M dollars"

COPPER MOUNTAIN

Economic Considerations

Titan24 cost: aprox. \$290K (2007)

Savings on Condemnation drilling: ~\$ 140K

Savings on ABA drilling: ~\$ 100K

Savings on permitting time: 2 months

Ability to raise \$50M in the market: Priceless

Discovery of new mineralization: 1) confirmation of depth potential 2) Pit 2 Western extension 3) Pit 2 Eastern Deeps ?? 4) Ingerbelle Extensions ??

World's Fastest Geophysicist

www.quantecgeoscience.com

Drivers for deep innovation

'Proof' of Concept- the Olympic Dam Model

"Fingers of God" – the Scottish Astrologer, 2016

Fingers of God, new edition. Heinson et al., 2018, SciReports

Geophysical Imaging for mineral exploration started to advance significantly in 2000

Top panel: TITAN MT Resistivity
PW 2D inversion;
Typically 1500 metres

MT Resistivity – Regional Transect across the Andes Depth is 40 km !

Generation Mining Regional Survey (NWT 2018)

SPARTAN MT

MT Resistivity/Depth Profile

Generation Mining Limited

Drill Planning – Increase effectiveness

4sq km package imaged from surface to depth

Conventional method

- Geology
- Geochemistry
- Drilling
- Traditional approach

Image before drilling

- Geology
- Geochemistry

ORION 3D

- **Given Structure (faults)**
- Mineralisation (delineation)
- Alteration
- Condemnation
- Discovery
- Drilling

Technology for Discovery

Number of discoveries by size