

Technology Development and the Challenges for Mineral Exploration and Discovery in the 21st Century: A Canadian Perspective

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Summary

Dramatic changes in technology entering the 21st century are impacting mineral exploration in Canada. However, we face challenges of increased cost with insufficient replacement of mineral resources. The record of the mid 20th century in Canada demonstrated that application of new technologies with systematic field strategies resulted in major resource discoveries. Recent discoveries under cover in north central Canada show the way to use a well-integrated, systematic approach that integrates geology and geophysics. Important aspects of future resource development include continued success of Canadian service companies that adapt technological innovation to field application and government-supported public case studies where technical applications are related to the geological framework.

Introduction

The impact of technology on mineral exploration is dramatic in the the 21st century compared to the decades of discoveries in the mid 20th century. We now process terrabytes of data in minutes and days. A variety of GIS software systems integrate layers of a wide range of data types and formats. High resolution (100 to 400 m line spacing) airborne surveys for electro-magnetics, magnetics and gravity mapping guide exploration targeting. Multi-array and multi-channel geophysical setups detect electrical conductors at 1000 m depth and map fault structures and rock alteration to 2 kilometres depth.

Challenges, however, impede the rate of discovery in the 21st century. Detailed geological integration does not keep pace with geophysical surveys. The boom and bust financial cycles restrict funding and capacity to advance exploration and technology development. Drill targeting and discovery at depth and in remote areas is largely unsuccessful or difficult. New remote discoveries are the result of a combination of persistent teamwork of experienced specialists, timing and serendipity.

Application of Technology to Discovery in the Mid 20th Century

Development and application of new technologies to mineral exploration and discovery in the mid 20th century is a great success story. The advent of airborne magnetic and electrical field technology resulted in a string of discoveries that resulted in mineral production on a major scale in New Brunswick, Ontario, Manitoba and Saskatchewan. The development of time domain electromagnetic surveys and borehole electromagnetic probes in pace with new analytical tools to measure sub-ppm levels of elements enabled deeper and more precise drill targeting.

Experienced exploration teams in a variety of companies applied systematic field methods and strategies to integrate geology, geochemistry and geophysics to guide drill targeting. Records of discoveries through the 1950s to the 1970s attest to the impact of new technologies integrated with

systematic exploration strategies. In the 1990s numerous diamond discoveries once again demonstrated how the combination of technologies, till sampling and follow-up mineral chemistry and high resolution magnetic surveys, with systemic field methods resulted in new mines.

21st Century Successes and Challenges

In the new century the industry faces a decrease in the rate of important discoveries of resources paralleled with record costs of exploration. This record reflects a number of factors: (1) rising costs of exploration, (2) technical surveys that are easy to do, but insufficient constraint with geological data, (3) decline of experienced exploration teams and strategies, and (4) brief time to assess new targets.

Recent discoveries in Canada, however, demonstrate successful application of methods and strategies for exploration under cover. Some key case examples include (1) uranium deposits in the Athabasca Basin under 400 to 800 m of cover rock, (2) modification of electromagnetic surveys to detect a large deposit of zinc, copper and gold (the Lalor deposit) in northern Manitoba and (3) discovery of an extensive area of chrome and nickel beneath watery tundra in Northern Ontario.

An important aspect of the advance of technology in Canada is the role of small to medium-sized service companies that develop instruments and carry out geophysical surveys, analytical geochemical laboratories, always testing and developing new methods and instrumentation, and companies that focus on presentation and analysis of GIS data in 3D. In particular, the geophysical service companies develop technologies (borehole EM, borehole gravity, magnetotellurics and new airborne systems) and maintain field crews to run the surveys. From field applications, technological modifications are made to meet the applications and field conditions. Technological development has significantly benefited from government-funded programs: examples, the Federal Targeted Geoscience Initiatives, the Ontario Mineral Exploration Technology Program, Discover Abitibi, Geoscience BC, Strategic Investment in Northern Economic Development (SINAD) and Geomapping for Energy and Minerals in the North (GEM). These opportunities provide publicly available case studies where geology is well integrated with technical surveys.

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