

APPLICATION OF MAGNETICS FOR MINERAL EXPLORATION, OIL AND GAS EXPLORATION, NEAR SURFACE GEOPHYSICS. ETC.

There have been amazing rate of developing in the science and technology of geology and geophysics in the last 40years. Perhaps, one of the most significant has been Magnetic surveying. The purpose of magnetic surveying is to identify and describe regions of the Earth's crust that have anomalous magnetizations.

In the realm of applied geophysics, these anomalous magnetizations might be associated with local mineralization that is potentially of commercial interest, or they could be due to subsurface structures that have a bearing on the location of oil deposits. In global geophysics, magnetic surveying over oceans ridges provided vital clues that led to the theory of plate tectonics and revealed the polarity history of the Earth's magnetic field since the Early Jurassic.

In a magnetic survey, the Earth's magnetic filed and the magnetic responses due to magnetic minerals are measured. Naturally, magnetic minerals such as magnetite (Fe_3O_4), occur in rocks and varying percentages. Other minerals have a magnetic susceptibility resulting in induced fields e.g. Ilmenite, Haemanite. It is both the remnant and induced magnetic responses that are used to map an exploration area and evaluate the susceptibility of rock types.

The surveying of magnetic anomalies can be carried out with a magnetometer on land, at sea and in the air to search for magnetic

rocks and minerals, archaeological artefacts or suspected geological structure. This method is slow but it yields a detailed pattern of the magnetic field anomaly over the structure, because the measurements are made close to the source of the anomaly.

In practice, the surveying of magnetic anomalies is undertaken from an aircraft. Here, the magnetometer must be positioned as far as possible from the magnetic environment of the aircraft. Airborne magnetometers generally have higher sensitivity than those used in ground-based surveying and it is an economical way to reconnoitre a large territory in a short time. The magnetic field, over the oceans may also be surveyed from the air. However, most of the marine magnetic record has been obtained from shipborne surveying.

Magnetics have been employed in diversified ways for mineral exploration, oil and gas exploration, environmental and engineering, education and research, earthquake prediction, geotechnical, and mining related airborne geophysical surveys etc.

Geophysics has formed an integral part in the mineral exploration for kimberlites in the last few decades. The success of magnetics in diamond exploration stems from the ability to quickly define the often circular and characteristic magnetic anomalies related to kimberlite occurrences. On a regional scale, aeromagnetic surveys can be used to identify new kimberlite fields, usually in combination with some form of geochemical or indicator mineral sampling. When the field has been discovered, airborne geophysics, magnetics and frequently electromagnetics can be used to define individual targets.

On a prospect scale, Aeromagnetics and ground magnetics are the premier tools for kimberlite discrimination and delineation (Sumpton and Arnott, 1985). The success of this method relies on the magnetic susceptibility of the kimberlite being different from the surrounding rock. Kimberlite is generally strongly susceptible, which is why the magnetic method is so successful. Airborne magnetics with helicopter surveys is used, but one still have to get on the ground for confirmation owing to the fact that there are always challenges in exactly positioning anomalies and ground work is essential.

Oil and gas fields in many sedimentary basins are distributed along fault-controlled linear trends, and fault identification exploration is often used effectively for target-area selection in hydrocarbon exploration. High Resolution Aeromagnetic (HRAM) surveys, can be used for the deflection and detailed mapping of faults and fracture systems (and every other geological structures like domes, folds, diapirs etc). These are the structures that house the mineral explore which are easily picked during magnetic survey, in addition to the traditional job of defining basement structure and lithology.

The recent improvements in the resolution of aeromagnetic surveys have sparked a renewed interest in single sensor and gradient magnetic surveys for hydrocarbon exploration. Single sensor magnetic surveys have been conducted since just after World War II, when sensors originally developed for submarine were deployed to search for mineral ore bodies and to help define the depth of sedimentary basins.

Magnetics is valued as an integral component of many teaching and academic research programs for students. This reflects the diversity of magnetic application and the relative ease of teaching magnetics. Magnetics also help students develop skills in areas such as computing, data acquisition, analysis and presentation.

Solid understanding of magnetics can help create opportunities; where magnetic methods are viewed as an effective and standard technique for digital geological mapping, surveys where magnetics contributes high volume data for assessment of buried ferrous objects and for integration with other types of geophysical and geological data in assessment and remediation projects. However, they may be affected by cultural noise and near surface debris, whose effects are mitigated by use of a gradiometer.

Furthermore, it is geotechnically applied where the value of magnetics lies in mapping historic structure; locating artifacts, kilns etc. and providing non-invasive sub-surface imaging data that can streamline field work and reduce costs in archaeological investigations, and in observatory, volcanogenic and fault system data that involve acquisition and research for primary understanding of the Earth and its natural hazards.

As part of effort in refining the techniques for detecting basement faults and to assist exploration, the Alberta Energy and Utilities Board / Alberta Geological Survey, and Lyatsky Geoscience Research and Consulting have created a gravity and magnetic atlas of northern Alberta, Canada, with the data processed to highlight subtle lineaments (Lyatsky and Pana, 2003). An atlas intended for a

broad spectrum of geologists, geophysicists, interpreters, processors, instructors and students. The atlas explains the data-processing steps taken to highlight geophysical anomalies, in particular those that may be related to brittle faults.

GEM magnetometer is continuously improving prospects for success by providing data that both major and junior exploration groups rely on for performing reconnaissance exploration and making drilling decisions. It is used for acquiring low noise, high sensitivity results to assist in exploration as well as reduction of surveying times through GPS-based data acquisition of high quality data for input into advanced software processing and modeling packages, and in its ability to offering the highest specifications for reliability and robustness today.

With the resurgence in mineral exploration and continuing demands on time, explorationist re-see tools that will enable them to achieve greater efficiencies in both the field and office. The new V.7.0 release of GEM's magnetometers and gradiometers is designed to enhance efficiency in key areas.e.g Field work; data input and output.

REFERENCES

- a. Henry Lyatsky, Dinu Pana and Reg Olson; Lorraine Godwin: Detection of subtle basement faults with gravity and magnetic data in the Alberta Basin: The leading Edge, June 2005, Vol. 24, No. 12, 1282.
- b. J.D Gilchrist: Extraction metallurgy, 3rd Edition.
- c. Louis Doyle, Barker minerals (Gold and Base Metal Exploration).

- d. Norman H. Foster & Edward A. Beaumont; Oil is first found in the mind: The Philosophy of Exploration.
- e. Philip Kearey, The New Penguin dictionary of Geology, 2ND Edition
- f. Ricahrd S. Smith and David K. Fountain, Geophysics and Diamond Exploration – A review.
- g. William Lowrie, Fundamental of Geophysics.