

Value of Gravity and Magnetic Data in a Diversifying Resource Industry



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Abstract

Gravity and magnetic methods are essential components of mineral and hydrocarbon exploration. Although low-resolution compared with seismic, they enable fast and low-cost geophysical coverage of even large areas.

These methods are passive, without a man-made source. Instead, they detect lateral variations in the natural geomagnetic and gravity fields. These geophysical variations are then related to the lateral changes in the relevant physical properties of rocks. Field surveys can be conducted on the ground, by boat on the water, or by air. Environmental and logistical disruptions to local communities and habitats are minimal.

Interpretation of potential-field data is not straightforward, and the anomaly-lithology relationship can be convoluted. Whereas seismic methods mostly reveal sub-horizontal discontinuities in the rocks mass, gravity and magnetic data reveal discontinuities that are high-angle. The physical property that links gravity anomalies to variations in rock composition is density; for magnetic anomalies, it is total rock magnetization. These physical properties are a function of the rocks' entire history and their current state. Density is scalar, but the total magnetization of a rock sample is a vector sum of a bewildering variety of magnetizations that can be both induced and remanent. As well, magnetization is carried by specific minerals, whose presence and concentration might not be related to the overall lithology.

Biography

Dr. Henry Lyatsky is a Calgary-based geophysical and geological consultant who has worked across Canada, in northern and western U.S., as well as internationally in oil and mineral exploration. He has conducted many regional and local studies using gravity and magnetic data, and he has designed and implemented numerous airborne and ground field surveys

Henry holds a B.Sc. in geology and geophysics (1985, University of Calgary), an M.Sc. in geophysics (1988, University of Calgary) and a Ph.D. in geology (1992, University of British Columbia). He is the first or sole author of three books (Springer-Verlag) on the regional geology and geophysics of western Canada, as well as of two gravity and magnetic atlases of the Alberta Basin (Alberta Geological Survey) and many papers.

Henry is a past president of the Mineral Exploration Group, a mining-industry association in Alberta. He can be reached through LinkedIn.

The gravity field is unipolar and essentially vertical. The magnetic field is, by contrast, dipolar or higher, and it is almost always non-vertical. For all these reasons, interpretation of gravity data tends to be simpler. In all circumstances, no serious interpretation is possible without geological calibration that requires advance knowledge.

Because magnetic and gravity maps reflect lateral variations in the physical properties of rocks, they are commonly used in the mining industry to help delineate the geology and to locate mineral deposits.

In oil exploration, potential-field methods are commonly used as reconnaissance tools in conjunction with seismic to identify igneous rocks in the basin and to delineate fault-bounded blocks and networks of faults and fractures. Such enhanced knowledge of a basin's geology strengthens exploration programs and improves de-risking in frontier and mature basins.