GEOPHYSICAL METHODS OF EXPLORATION

CORE DRILLING

Core drilling can be considered both a geological and geophysical exploration method and forms the foundation for the positive confirmation of targets, the delineation and proving of ore bodies, and the expansion of reserves. Core drilling also provides the backbone of detailed mine planning activities. Core drills are used frequently in mineral exploration where the coring may be several hundred to several thousand feet in length. The core samples are recovered and examined by geologists and geophysicists for mineral percentages, lithology, petrology, and stratigraphic contact points. Drilling represents one of the most significant and costly methods employed throughout exploration programs for virtually every mineral.

SEISMIC

Seismic techniques have recently had relatively limited utilization, due primarily to their relatively high cost and the difficulty of acquiring and interpreting seismic data in strongly faulted and altered igneous terrain. However, shallow seismic surveys employ less expensive sources and smaller surveys than are typical of regional surveys, and the cost of studying mineral deposits hosted in the near subsurface may not be prohibitive. Reflection seismic methods provide fine structural detail and refraction methods provide precise estimates of depth to lithologies of differing acoustic impedance. The refraction method has been used in mineral investigations to map low-velocity alluvial deposits such as those that may contain gold, tin, or sand and gravel.

MAGNETIC TECHNIQUES

The magnetic method of mineral exploration exploits small variations in magnetic mineralogy (magnetic iron and iron-titanium oxide minerals, including magnetite, titanomagnetite, titanomaghemite, and titanohematite, and some iron sulfide minerals, including pyrrhotite and greigite) among rocks. Measurements are made using fluxgate, proton-precession, Overhauser, and optical absorption magnetometers. In most cases, total-magnetic field data are acquired; vector measurements are made in some instances. Magnetic rocks contain various combinations of induced and remnant magnetization that perturb the Earth's primary field. The magnitudes of both induced and remnant magnetization depend on the quantity, composition, and size of magnetic-mineral grains.

ELECTRICAL TECHNIQUES

Electrical methods of exploration comprise a multiplicity of separate techniques that employ differing instruments and procedures, have variable exploration depth and lateral resolution, and are known by several names and acronyms describing techniques and their variants. Electrical methods can be described in five classes: **(1)** direct current resistivity, **(2)** electromagnetic, **(3)** mise-a-la-masse, **(4)** induced polarization, and **(5)** self-potential. In spite of all the variants, measurements fundamentally are of the Earth's electrical impedance or relate to changes in impedance. Electrical methods have broad application to mineral exploration. These techniques may be used to identify sulfide minerals, are directly applicable to hydrologic investigations, and can be used to identify structures and lithologies.

REMOTE SENSING

Remote sensing includes methods that utilize images obtained in the ultra-violet, visible, and near infrared bands of the electromagnetic spectrum. Remote sensing data are treated in digital image format so that they can be processed conveniently. By comparison with known spectral responses of minerals or mineral groups, iron hydroxide minerals, silica, clay alteration, etc., can be defined over broad areas. Remote sensing can also be used in geoenvironmental studies to map surface alteration and to identify anomalous vegetation patterns in areas related to abnormal metal content in soil. With the rise in UAV (drone) use, remote sensing on a high-resolution regional or project specific scale has now become more accessible and affordable than ever before.

OTHER METHODS:

GRAVITY METHOD - Gravity measurements define anomalous density within the earth.

GAMMA-RAY METHODS - Gamma-ray methods use scintillometry to identify the presence of the natural radioelements potassium, uranium, and thorium.

THERMAL METHODS – Thermal methods can be used to determine the Earth's surface temperature and thermal inertia of surficial materials or of subsurface materials exposed in a borehole.

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REFERENCES: USGS 1995 GEOPHYSICAL METHODS IN EXPLORATION AND MINERAL ENVIRONMENTAL INVESTIGATIONS by Donald B. Hoover, Douglas P. Klein, and David C. Campbell