MAGNETIC PROSPECTING METHOD

The Magnetic method is very similar to the gravity method as it is used to detect lateral variations in the properties of rocks. Magnetic susceptibility is the property of a material which determines how much magnetization will be present due to external magnetic field. The intensity of magnetization in a material is proportional to the strength of the external magnetic field.

$$J = kH$$

Where J is the magnetization, H is the external magnetic field and K is the magnetic susceptibility.

Mineral are classified as either diamagnetic or paramagnetic. Diamagnetic minerals have negative and very low susceptibilities. Most paramagnetic minerals have positive susceptibilities but also with very low values, so they are not of interest in geophysical surveys. Some paramagnetic are ferromagnetic minerals which have alignments of magnetic moments in small areas called magnetic domains. These materials are not naturally occuring on earth, so again they are not of interest in exploration.

Ferrimagnetic minerals, on the other hand, are common and naturally occuring. These minerals (e.g. magnetite, pyrrhotite) have a net magnetic moment and thus relatively high susceptibilities. In general, igneous and metamorphic rocks have higher susceptibilities than sedimentary rocks.

The magnetic methods are among the cheapest geophysical methods and from the operational point of view, also among the easiest and fastest. The applicability of magnetic methods is so wide that it is generally a sound policy to incude a magnetic survey in every comprehensive Geophysical campaign i.e. it is used for reconnaissance survey. magnetic susceptibility is a physical property that changes significantly from one rock type to another. Another such property is natural magnetisation. A Knowledge of the distribution of any of these properties within the ground would convey information about the subsurface Geology. J = KH, H = Applied field (in the lab).

H = Magnetic field intensity (Earth's field).
J = Induced magnetization
K = Magnetic susceptibility.

Each of the properties mentioned above is the source of a potential field which is intrinsic to the body possessing that property and which acts at a distance from it.

J & KH = KH

Thus the means exist at least in principle of studying the distribution of magnetization under the ground from the magnetic field at the surface. magnetic exploration is based earth to a bar magnet.

J = KH…….. (i)

H = Applied field magnetic intensity.

J = Induced magnetization

K = Magnetic susceptibility.

The line of force in a bar magnet is from N - S but for that of the earth is from S - N.

The direction of the magnetic field at the surface of the earth depends on location. With respect to the magnetic poles. How close a location is to the magnetic field is measured by inclination of the earth' field or the magnetic latitude i.e. tan I = 2 tan^…… (2)

I = inclination

^ = magnetic latitude

This equation can be used during our mapping.

NOTE: (1) The field or lines of force of the earth exhibit the usual pattern common to a small magnet (ii) The direction of the field is vertical at the N - S magnetic poles i.e. I = 90 and horizontal at the magnetic equator T = 0.

Rock types vary in magnetic susceptibility J = KH, so that when placed in a magnetic field such as the earth, they assume an appreciable magnetization of their own. These induced effects will show up in the main magnetic field as anomalies, which may be used to outline the zones of high susceptibility within the ground.

Some rocks have a permanent magnetization known as a Natural Remanent magnetization (NRM). This is independent of the earth's magnetic field and it may be in a quite different direction. rocks possessing this create their own magnetic fields and in sufficient volume their NRM produce magnetic anomalies.

Magnetic Instruments

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Introduction

Magnetic measurements in one prospecting are carried out most conveniently by means of magnetometers. The value of an effect of the magnetic field at any point is then expressed as a difference from its value at a suitably chosen based station.

The quantity most commonly used for the purpose is the vertical intensity the anomalies which are denoted by Z This is because this as a rule is the easiest to interprete.

Magnetic Susceptibility Meter

The most significant magnetic property of rocks is their susceptibility. Susceptibility is a measure of the degree of which a substance is attracted to a magnet.

J = KH.

J = Intensity of magnetization

H = Magnetic field intensity

Folami (1980) further defined magnetic susceptibility as a measure of magnetic mineral content in a rock.

In the laboratory, a no. of instrument are employed to measure the susceptibility/viscosity magnetometer, susceptibility Bridge etc.

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Operating principle

Introduction

The fundamental of the instrument is an LC oscillator of 10kg, the inductivity of which is embodied by a flat measuring coil situated at the active face of the instrument. The instrument is powered by one - 9V battering type 6F 22, IEC standard. If a standard dry battery is used e.g. varta type 3022, the operating time exceeds 100 ohms.

Power on/off

The instrument can be switched on or off by means of a slide switch on the real side of the case. A red dot marks the on position of the switch. When the instrument is turned on, the buzzer beeps and the display shows the standby status e.g. 8.8.8

Measurement

Immediately after switching on, the instrument is ready to measure. The measurement is carried out in two steps by pressing the switch c/m on the side of the instrument for the 1st time, the instrument is cleared, or (zeroed); by pressing this switch for the second time, the susceptibility of the specimen is measured. To be cleared properly, the instrument must be removed from the measured rock and from other magnetic or conductive objects to a distance of at least 30cm. The clearing cycle takes about 0.5 second. At the end of the cycle, the display shows C000. The character "C" indicates that the instrument is clear.

During the measuring interval, the active, face of the micro kappa must be pressed lightly against the surface of the rock. When the C/M is pressed for the second time, the measuring cycle is started. It takes about 0.5" and is accoustically indicated. At the end of cycle, the susceptibility of the rock (in 10-3) S:I units) is displayed. e.g.

11.9 = 11.9 x 10-3
3.69 = 3.69 x 10-3
23.1 = 23.1 x 10-3

If the susceptibility is higher than 999 x 10-3 S.I unit the instrument will display the error conditions as follows E000

DATA ACQUISITION AND REDUCTION

(a) Introduction:- The only ordinary property of matter that can conceivably be utilized in magnetic exploration is the magnetic field intensity (magnetic susceptibility) J = KH and this property has been used to deduce method for the study of the earth' and in particular for locating structures such as ore bodies.

(b) Collection of preliminary information (Planning):- One of the first steps in lanning magnetic survey is to collect the avilable topographnical, geologicazl and mineralogical information about the area concerned to find out what rocks and minerals we are likely to encounter within and how they are likely to be into elated. The results of such preliminary investigations should decide which steps to be taken.

(c) Staking an area (Profiles, lines or Traverses):- When the area of investigation has been selected, it must be staked by staking the magnetic measurement. Staking enables us to identify the position of eventual indications so that the follow up can be directed to the proper place, especially when one wants to re-occupy the base station for a close up

A well - defined convenient point of the area is chosen and a straight base line is laid out from it in a direction approximately to the known or assumed geological strikes. The line should be clearly marked by staking drilling firmly into the ground at suitable intervals. The base line having been laid out, a set of parallel lines usually called profiles or traverses are staked at right angles to it. These stakes steel tape should be used to measure distances and care must be taken to hold it horizontally between two point.

(d) Field Measurements:- A series of points at which the magnetic measurements are to be made are marked off or staked along each profiles at some suitable intervals. The interval must be chosen with regard to the anticipated depth of the ore bodies and the detail of anomalies required. Example, if the expected depth is small, the interval should be reduced because the anomalies of shallow ores fall off very quickly with the distance so that in using a large point seperation, one runs the risk of missing a significant anomaly. Profiles are normally marks line 1, line 2, etc. They should be sufficiently cover the area of expected anomalies and not extend well outside it into the less disturbed peripheral region so that the flanks of the anomalies are lengthen some or all profiles during a survey.

It is conveient to record the observation in field note books on the top of every page, adequate space should be indicated for general informations, such as cates, name of area, method, instrument and observers name. In

addition, one column should be reserved for remarks. These column can be for noting special information about the topography e.g. rock exposure, at a point, along a stream e.g. methods: Instrument - observers, name; line no; area Date.

(e) Precautions:- Certain precautions must also be taken while carrying out all magnetic field work.

(i) The observer must remove from his wearing apparel iron and steel objects like wristwatch, keys, penknife etc. Some less obvious object which can vitiate the readings are steel wire in spectacle frames, zip fasteners, buckles in belt, Nails in field shoes.

Corrections:- (Variations with time)

The earth magnetic field is always changing with time. The variations may be considered to consist of

(i) Secular variations (ii) Diurnal variation (iii) Magnetic storms.

The cause in this variation may be attributed mostly to the phenomenon of the earth i.e. mechanical change of the earth, conventional current and change of distribution of heat. The magnetic storms is caused by sudden and violent variations in the geomagnetic field.

Magnetic Interpretation

Objectives:- (1) To prospect for structural changes within and between different rock types e.g. (a) Fractured Zone or Fault Zone within a rock type (b) Fractured zone, contact zone or fault zone between 2 rock types.

(2) To deduce the geometry of magnetic bodies causing a giving set of anomlies e.g. minerals or ore bodies.

(a) Depth of burial, (b) Lateral extent, (c) breadth.

Magnetic measurements made close to magnetic bodies would see sharp anomalies, whereas the anomalies may be smaller, broad and smoother. If the magnetic bodies were distant, we can determine the distance to magnetic profiles. Sharp magnetic anomalies indicate basement rocks not far beneath the surface but where magnetic features are broad, magnetic basement may be deep and we infer that the difference between the basement rocks and the surface is filled with sediments.

An anomaly represents a local disturbance in the earth magnetic field which arises from a local change in magnetization or magnetization contrast.

Depth Estimate

(1) Since the magnetization is primarily a tool for subsurface mapping and detection it follows that determination of the depth as well as edges of bodies is important in its application of geological exploration and search.

The basis for depth determination together with the foregoing background on anomaly behaviour should allow one to at least appreciate how a variation in depth affects anomaly.

Knowledge of the depth of a particular formation or source may have considerable geological significance as it determines the nature or configuration of a formation, the depth to various points on the surface of crystalline rock or magnetic basement allows one to map that surface and its topography and to infer thickness of sediments or conformable sedimentary ores placer deposit or ground water. Placer deposits are gold, diamond etc. Areas underlain by sediments or other sedimentary deposits may be ruled economic or uneconomic according to depth. The depth to ore deposit associated with pyrhotite, magnetite or Illemonite may be estimated as an aid to a given program or even for estimation of total tonnage of magnetic Iron ore deposit, Black sand deposits of ruhces zircon, monazite, diamond, Gold, Platinum etc. (these minerals are non-magnetic) are often associated with other high density, very resistant, yet magnetic minerals namely, magnetite or Illemonite.

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