METHODS OF COAL PROSPECTING

The fundamental objective of coal prospecting is to discover coal resources through a search. In areas where coal mining has not been previously practiced, the search process should result in obtaining coal samples that give reasonable evidence of the existence of a coal seam. The term coal exploration is used to describe these activities. Coal exploration includes activities and evaluations necessary to gather data for making decisions on such issues as the desirability of further exploration, the technical feasibility of mining (including favourable and unfavourable factors), and economic feasibility (including size of mine, coal quality assessment, marketability, and preparation of mined coal for market requirements).

Surface Geophysics

The technique used in the exploration programme are normally those that give broad scale information on a large area at relatively low cost.

These include airborne magnetometer investigation, regional gravity surveys and broad scale seismic studies, used to delineate the sedimentary and structural framework of the area involved.

Together with the result of fields mapping, the data from these techniques can be used to draw up the most appropriate drilling programme to further test the value of the deposits.

1. **Gravity Methods**

The irregular distribution of rock masses of different densities in the crust gives rise to local and regional variation in the earth's gravitational field.

Areas with an anomalously high gravitational field generally have large masses of relatively dense material close to the ground surface. A low gravitational field, on the other hand is commonly associated with an accumulation of less dense material, such as a thick succession of sedimentary strata. The magnitude and form of the anomaly in each case is a function of the shape, orientation and depth of the feature concerned, together with contrast in density between the different materials involved.

2. **Magnetic Methods:**

The strength of magnetic polarization depends principally on the magnetic

susceptibility of the material concerned, which in turn largely related to the abundance of specific components such as magnetite or ilmenite, among the mineral present. Most sedimentary rocks have low magnetic susceptibilities. The susceptibility of crystalline basement rocks tends to be somewhat higher, while mafic and ultramafic igneous bodies usually exhibit particularly high susceptibility values.

Magnetic methods are based on mapping out these anomalies, using ground-based, shipboard or aerial equipment to measure either the total intensity or the vertical component of the field at point across the study area.

3. **Electrical resistivity :**
   The resistance of the rock strata to electric currents depends partly on the minerals involved and partly on the fluids present in the rock's pore spaces. Under laboratory conditions, sub-bituminous and bituminous coals are highly resistive. Shales, limestones and sandstones generally have lower resisitivities, and such contrasts form the basis for the application of electrical resistivity techniques to coal exploration.
4. **Electromagnetic methods :**
   Electromagnetic methods of geophysical exploration are based on

the production of a time varying electromagnetic fields by an alternating or pulsed electric current in a suitably laid out the conductor at the ground surface or in the air above. Magnetic bodies existing below the surface of the earth contribute to the magnetic field of the earth. This contribution is directly proportional to the same power of the depth of its occurrence. The magnetic suspectibility is the controlling physical property in this method. By the study of magnetic anomalies with magnetometers, the anomalus objectives are located.

5. **Seismic reflection :**
   Seismic reflection studies involve the input of shock wave energy into the

ground, reflection of that energy from an appropriate interface and recording of the reflected waves on suitably located receiver called Geophones.

High Resolution seismic Survey (HRSS) is very useful in detailed coal exploration specially for mapping of underground geological features like faults, fold, wash-outs, rolls, steep dips, channel sands, layer of coal seams and others. This is the only method capable of indicating a subsurface fault throw of the order of a few centimeters at depth of a few hundred meters.

Surface Resistivity and seismic refraction survey are useful for coal seam incrop delineation, overburden estimation and locating ground water region at a shallow depth. These inexpensive surveys help in reducing the number of exploratory borehole to be drilled in virgin areas.

Geophysical Logging of Core Bores

The technique of geophysical logging were developed to interpret lithology in non-cored well. The geophysical logging usually less costly per meters than fully cored holes, a greater number of them can be drilled for an equivalent total cost.

Gamma – Ray Logging :

The most abundant elements with radioactive isotope are potassium, which is found in mica, feldspar and some clay minerals.

Strata with major proportions of these minerals, such as shales and felsic volcanic rocks, have significantly higher levels of natural radioactivity than potassium poor strata, such as quartz sandstone and coal.

In Gamma ray logging, a sonde containing a sensitive scintillation counter is passed slowly up the hole, recording the natural radioactivity of the surrounding beds. The apparatus is calibrated against a standard source prior to use, and is adjusted to take readings integrated over a suitable 'Time Constant' interval. If this time constant is too high, the resulting curve is smoothed out too much to detect small-scale fluctuation, but if it is too low, in relation to the speed of passage of the sonde, rapid fluctuation in background tend to mask any more meaningful trends.

Coal seams are distinguished by having very low gamma values. Shaley coals give a somewhat high level of activity, however , and may be indistinguishable on the gamma log alone, from sandstone or other strata.

Mafic igneous rocks also give low gamma ray values, but potassium rich felsic rocks give a much stronger.

Black, partly marine shale commonly exhibit very high level of gamma ray activity if small amount of uranium or thorium are present.

Density Logs:

Density logging is based on the response of the strata around the hole to incident gamma rays, derived from a well shielded source, such as Caesium 137, incorporated in the Sonde.

Depending on the energy level used, this radiation can have one or more of the following effects as it encounters the nuclei of the atoms in beds concerned.

a. Photoelectric effect:
   At relatively low energy levels, the gamma ray photons are completely absorbed, causing electrons (beta particles) to be ejected in the process.
b. Compton recoil effect:
   At higher energy levels, the gamma rays may be partly back scattered and processed in a different direction at lower energy. An electron is also ejected in the process.
c. Pair production effect :
   At still higher energy levels, the incident gamma ray is annihilated and an electron position pair is produced.

Neutron Logging:

Neutron passing through a rock body are slowed or even captured by the atomic nuclei in their path.

Neutron logging is based on measuring the reduction in energy of these particles in different rock types, or the gamma radiation emitted from the strata as a result of neutron capture.

The sonde consists of a neutron source, coupled with either a neutron counter (for neutron-neutron logging) or a gamma ray detector (neutron –gamma logging).

Atomic nuclei of low mass, such as those of hydrogen, produced the greatest energy loss in bombarding neutron. In slowing them down they also provide more opportunity for neutron capture by other elements. Most of the hydrogen in sedimentary sequences occurs as water in pores or as part of the clay minerals and the neutron log is commonly used to identify rock types on the basis of their porosity.

Resistivity logging:

Focused resistivity logs are designed to direct most of their energy through the mud cake and as far into the surrounding rocks as possible. They are less affected by the mud cake or bore fluid, they give more accurate representation of the resistivity of the strata than the conventional resistivity techniques.