

Exploration Geophysics in India

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Our wonderful earth, on which we live and from which we derive all our resources, is one of the 9 planets circling around the sun. The Sun is one of the 100 billion stars in the Milky Way, which in turn is one of the galaxies out of 500 million assessed so far. Its insignificance in the entire universe is therefore obvious yet its importance to man and the generations to come cannot be underestimated.

Man's association with the Earth Sciences is the oldest in the history of human evolution and it has continued to grow rapidly as the material demands of man have been increasing. The most important minerals today are copper, silver, gold, aluminum, uranium, coal, petroleum and a host of other earth metals to meet the growing energy and mineral demands for industrial growth. Man's earliest requirements were only for flint, quartz and hard quartz rocks to hunt animals for his livelihood.

The early study of the earth developed in a fragmented fashion. Geodesy-the study of the shape of the earth grew from land surveying and measuring techniques of geometry. Geology the study of rocks, minerals, fossils and forces that shape the earth's surface, began as a simple study of land features. Geophysics-the application of the methods of physics to the study of the earth, originated with the precise theories of geomagnetism by William Gilbert and of gravity by Isaac Newton.

Earth Science as now understood, developed in India after the British advent. The first departments to be set up were the Survey of India in 1767; the geological Survey of India in 1851 and India Meteorological Department in 1875. Lambton first started the triangulation survey network in 1799 and the first geomagnetic observatory at Colaba was setup up in 1847 (After Greenwich). Pratt established the theory of Isostasy in 1852; Heaviside and Basevi set up the first 30 gravity pendulum stations from Cape Comorin to Himalaya during the period 1865 to 1873. T. Oldham in 1888 published for the first time, a catalogue of Indian earthquakes from earliest times to the end of 1869 A.D.

Geophysics for oil exploration was used first in 1923 by Burman Oil Corporation (BOC) in the Indus Valley using a Torsion balance. Electrical surveys were first carried out in Nellore District and later in Singhbhum for copper in 1933 by Ms/. Piepmeyer and Kelbof. The credit of first geophysical survey by an Indian goes to late Shri M.B.R. Rao when in 1937 he carried out electrical surveys for sulphide ore deposits in Mysore.

During the war between 1939-45, Mysore Geological Department with Shri. M.B.R. Rao was the only organisation carrying out geophysical work using self-potential

and resistivity surveys.

The initiation of Geophysical exploration activities in Geological Survey of India are largely due to the efforts of G. Dessau in 1945, when attempts were beginning to be made to organise a geophysical wing in GSI. Soon the services of an Italian instrument technician, Delcarlo were enlisted and a workshop for repair and maintenance of geophysical instruments was set up. This wing carried out a number of self-potential, resistivity and magnetic surveys at different places. It was planned that this wing should also carryout surveys for engineering problems, water resources; metalliferous and coal deposits, and petroleum exploration. Oil & Natural Gas Commission (ONGC) established in 1956 has a large number of gravity, magnetic and seismic crews. The petroleum and natural gas reserves established so far as mostly geophysical discoveries. The establishment of National Geophysical Research Institute (NGRI) in 1962 has added another dimension to geophysical exploration with increased R& D activities in the country.

With the increasing demand of minerals and fuels for industrial growth, exploration for minerals, coal, petroleum and natural gas has been acquiring increasing importance. And under the new economic policy and liberalisation the hydrocarbon sector have been opened up to foreign and Indian private companies increasing greater demand of exploration geophysics and competent geophysicists.

Petroleum exploration and exploitation has been perhaps the most rewarding enterprise since the first oil well was drilled by drake in 1869. And petroleum industry has been vital for economic and industrial development throughout the world. The early oil discoveries were primarily based on mapping surface geology and the entrepreneurs achieved fair success in the early years. However, it was soon discovered that in addition to favorable geology, suitable structures for oil entrapment were also necessary to find oil. This gave birth to sue of geophysical methods to survey for petroleum resources. Besides gravity and magnetic methods, seismic refraction method was introduced in 1920s. The success to discover oil was amazing in Europe and Gulf Coast of USA. The surge of discoveries resulting from the initial use of refraction seismograph started fading by the mid 40s and a new wave of successful oil exploration started in about 1950s with the introduction of analogue records through continuous seismic reflection profiling for deeper structures. The method gave better definition of structures and success ratio improved. But it was followed by another slack period in exploration activity until the mid-60s when three technological innovations were introduced digital recording, stacking of data and its processing through

computers. processing through computers. The exploration activities again gained momentum all over the world. But then, another slump followed this till new technological developments were available to the industry in about 1970s. The Bright Spot Theory and Inversion Techniques helped in new discoveries. There was a slack period again and the latest cycle of new oil discoveries have come through 3-D seismic exploration methods and several new innovations in computer processing. The historical perspective thus shows that petroleum discoveries have followed in cycles directly depending upon generation of new ideas and new technological advances over the years.

The most recent major advance, migration, especially 3-D migration, by moving the stacked data to its proper position, greatly clarifies the structural skeleton on which stratigraphy clings, and allows more precise definition of reservoirs.

Other new techniques in addition to 3-D seismic that are being used to extract more detailed structural, stratigraphic, and reservoir information from the seismic data include seismic lithological modeling, reflection amplitudes vs. offset distance, shear-wave exploration to compliment compressional -wave exploration, deconvolution methods that compensate for phase and allow the effective seismic pulse to be non-minimum phase, inverse attenuation filters to remove time variance from seismic data, and vertical seismic profiling.

Seismic exploration is undergoing a rapid evolution, and as it becomes more and more definitive and precise, it will play an ever-increasing role. The recent liberalization of economic policies provides definite advantages by opening up areas for petroleum exploration to both Indian and foreign companies as private or joint ventures. However, it will have to be ensured that companies, which ask for concessions, possess a good trade record and have established reputation in their own fields.

There is also a lurching danger of the national efforts slackening and slowing down which will have to be adequately safeguarded. If the country, is to compete with the western companies in these areas, our institutions mainly ONGC, and OIL will have to continuously upgrade their technologies and enhance their concerted efforts with greater vigor to establish their leadership in the fields of geology and geophysics. The efforts should be to match their operations with any company in the world, so that they can also go out and compete for exploration bids abroad just as the foreign companies would be competing within our country.

I feel confident that with commitment and perseverance Exploration Geophysics in India will successfully meet the present and future challenges.