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Reminiscences of a Field Geophysicist of Geological Survey of India

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After graduating in Applied Geophysics from Indian School of Mines Dhanbad in the year 1963, I joined GSI in a career spanning nearly 38 years. During this long tenure I was engaged in a wide range of investigations comprising predominantly of search for economic ore deposits and secondarily of shallow seismic refraction surveys to locate suitable sites for steel plants, power supply stations, rail bridges and sea ports. There were also brief excursions into marine geophysics and oil exploration in my initial years. Marine activities off east and west coasts involved systematic measurement of variations in the earth's magnetic field along specified traverses with concurrent determinations of ocean depth. I was also temporarily attached to a crew of the ONGC conducting deep seismic reflection survey for oil in the Indo-Gangetic plains.

My expertise, however, has been almost entirely in the field of Mineral exploration or 'Mining Geophysics', as it is sometimes called, employing the entire range of electrical methods besides EM and magnetics. These projects were spread across Rajasthan, Gujarat, undivided Bihar, Odissa and West Bengal. I intend to share here some of my experiences in ore search in the belief that they would be of some interest to younger geophysicists.

What was once regarded as the Hesatu-Belbathan polymetallic belt in Bihar (Jharkhand) is a notable example of belied hopes. Geological exploration complemented by drilling had gone on for as long as thirty five years. Much money and resources had been expended without producing any significant ore finds. At that stage I took the initiative to suggest a gravity survey to locate a magmatic chamber, if any, at depth whose plumes could then satisfactorily account for the mineral shows that are noticed commonly in the area. The survey did indeed bring out significant residual gravity anomalies bearing remarkable correlation to the surface mineral shows. This correlation bears indirect evidence of a magmatic chamber at depth whose plumes must have been the carriers of mineral bearing fluids. Test drilling was accordingly suggested to confirm the surmised magmatic body but it does not seem to have been implemented so far.

The role of the magnetic method is often underrated in base metal exploration whereas it can be the only savior available to detect sulphide bodies either directly or indirectly in certain geological milieus. Sindesharkalan and Khetri in southern and northern Rajasthan, the Singhbhum copper belt in Jharkhand and Gorubathan area in Darjeeling of North Bengal may be cited as typical examples:

Sindesharkalan in Udaipur district was investigated for over three years by EM, SP, IP and Magnetics. While EM and SP were quite effective in tracing the graphitic horizon hosting sulphides, they were of little help in locating sulphide ore bodies as such. The magnetic picture on the other hand showed low order anomalies distinctly superimposed over a relatively flat background. When drilled these low intensity anomalies were found to correlate with basemetal sulphides carrying pyrrhotite in good measure. This finding went a long way in optimizing further exploration strategies and substantially reducing the cost of exploration.In the Khetri copper belt again drilling of low intensity magnetic anomalies across extensive sand cover have proved copper sulphides with associated pyrrhotite.

In Kharkhola area of Gorubathan rich zinc and lead sulphide ores with associated gold and silver are hosted by a huge magnetite quartzite formation most of which is buried under debris brought down from the upper reaches of the Himalayas. The geophysical problem was essentially to map the concealed extensions under cover of this host formation. This was successfully accomplished by a simple magnetic survey. The resulting geophysical map of the host rock not only explained why some of the boreholes drilled earlier had turned out to be barren of ore but also served the far more important purpose of effectively guiding future drilling operations.

Like the magnetic method, SP too has by and large taken a back seat in basemetal exploration following the emergence of more modern EM and IP techniques. And yet, given favourable conditions, SP can provide clinching evidence of the presence or otherwise of an ore body when indications from other methods turn out to be ambiguous or uncertain. SP has also been remarkably successful in locating graphite bodies. I had the opportunity also of conducting borehole SP measurements that successfully lead to location of targets missed in earlier exploratory drilling. In estimating depths to the source from SP profiles, thumb rules in my experience have worked better than rigorous modeling. Such thumb rules enabled the preparation of the depth section of a graphite body in

Sambalpur district, which matched remarkably well with the actual depth section prepared by the company mining the property.

As disseminated sulphide ores are more the rule than exception, IP has found extensive application particularly in this country. I had the opportunity to carry out IP surveys in Agucha area of Bhilwara district, Rajasthan. Agucha is quite well known for its rich zinc-lead ores with associated silver and minor amounts of iron and copper sulphides. The host rock here is graphitic schist within Banded gneissic complex. The conductive graphitic schist disseminated abundantly with resistive sphalerite offers itself as a good IP target. Time domain IP surveys were carried out over the years 1980-'83 with a three electrode array. The deposit has a well defined SW limit with a clear plunge towards NE. One of the boreholes in the NE gave evidences of possible pinching of the load in a shallow intersection. This drilling evidence was quite misleading as it could have meant termination of mining activity beyond this point. Geophysics saved the day so to say. IP traverses brought out strong chargeability anomalies that persisted with increasing array length actually suggesting richer lodes at depth in the northeast. This is a clear case of geophysics effectively guiding mining operations. It is heartening to learn deep reflection profiling studies by NGRI revealed presence of potential ore deposits extending to deeper horizons.

The few instances recounted here are intended to give some idea of the significant role geophysics has played in effectuating exploration in some of the well known mineral belts in the country. While this ought to be a matter of legitimate pride to any geophysicist, it must also be admitted that borehole geophysics has yet not come into its own in this country. This is an unfortunate lacuna that needs to be filled essentially by the exploiting agencies to guide their day to day drilling and mining activity. Needless to mention that systematic application of multi-method borehole geophysics would make a big difference to efficiency and economy of both exploration and mining.

As I look back over my cherished years in GSI, I am filled with a deep sense of fulfillment, fulfillment perhaps not so much in terms of discoveries made as in terms of having given all of myself and the very best of myself to the task on hand day after day and year after year!

New Director for CSIR-NGRI

Dr. V.M. Tiwari, former Scientist of CSIR-NGRI and also former Director of National Centre for Earth System Studies, Tiruvananthapuram took charge as Director of CSIR-NGRI, Hyderabad on 11th July, 2016.

Editorial Board of JIGU wishes him successful tenure as Director of CSIR-NGRI and solicits his support to JIGU.