THE ROLE OF MINING HYDROLOGICAL INVESTIGATION WITH EMPHASIS ON GEOPHYSICAL APPROACH TO ASCERTAIN COAL BARRIER THICKNESS IN PART OF RANIGANJ COALFIELD - INDIA.

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ABSTRACT

Underground Mines are the natural non renewable resource base, which sustain the prosperity of region and optimize local resource balance. The conservation and safety of underground mines from minewater inrush point of view, requires concentrated and coordinated efforts toward comprehensive knowledge of mining hydrology. The conceptual mine hydrological modeling is a successful venture and needs to be developed further for minewater flow characterization and minewater prediction rate on regional basis.

The introduction of suitable legislation for coal barrier thickness is mandatory for successful underground coal mining operation in river valley. An attempt has been made to determine the critical coal barrier thickness at shallow depth, along partially approachable and largely unapproachable area using geophysical approach under the overall frame of mining hydrologicaly investigation. The study area belongs to the part of Raniganj coalfield, where the coal mining had been introduced in India since 17th century. The study has delineated the critical coal barrier thickness with accuracy +/- 1m in conjunction with horizontal bore hole drilling with regulatory valve system at approachable area, as well as extended to 2unapproachable area. The study leads for provision of optimum minewater column to control over mine fire encroachment at one end, besides to prevent mine water inrush through old water logged portion at under side. The application of Artificial Neural Network(ANN) as modern powerful tool may find large potential in better understanding of mining hydrological aspects at regional basis as well as its safety, conservation aspects at colliery level along with suitable instrumentation and their data interpretation.

INTRODUCTION

The major elements of conceptual mine hydrological cycle are: Precipitation, Terrain set up, Surface water and Hydrogeologic anomaly. (4) The precipitation is governed by hydrometerology and is responsible for recharge characteristic, evaporation, cloud cover. The terrain of coalfield is influenced by fluviogeomorphology, demography, hydrology and geomining with their

responsibility towards inflow vis - a - vis outflow characterization of water resource. The surface water bodies and temporal behavior influence coal mine drainage. Coal mining practices under the presence of surface water, ground water, mine water needs to hydrogeologic anomaly. The systemic study of all these elements are necessary for preventing the possibility mine inundation under the preview of mining hydrological investigation.

The proper understanding of complex processes pertaining to coal mining hydrology; due to interrelation of their major parameters and associated aspects require sophisticated modern modeling venture. The Artificial Neural Network (ANN) represents idealized mathematical model for understanding the complex process. It is based upon technique, which neither require algorithm nor ruled development and thus reduces the quality and complexity of software. It is not programmed like conventional software, but is presented with examples of parameters, observations, concepts with more learning ability; due to its massive parallel processing architecture. (3) It is also known as *Neuro computing* and is mostly preferred now a days high speed processing of huge data. It is associated with three silent features.

1. Generation of meaningful information even when input data contents errors are incomplete information.

2. Capability of adopting solution for changing circumstances, high degree of error tolerance.

3. Generalization of wide range of varied data.

The potential application of ANN in coal mining hydrological investigation are as follows(5)

* Geophysical log interpretation.

* Aquifer parameter estimation.

* Spatial estimation of aquifer properties.

* Design of pumping strategy.

The coal barrier thickness with adequate dimension along old underground mine, water logged portion fault has unique importance for safety of miner and conservation of minable coal material. There is vast variation among regulation regarding coal barrier thickness in different countries. In India the statutory requirement for adequate dimension as per coal mine regulation No. 137 part (3) is as follows:

No working which has approached within a distance of 60m of any disused or abandoned workings (not being workings which have been examined and found to be free from accumulation of water or other liquid matter) whether in the same mine or in adjoining mine, shall be extended further except with prior permission in writing of

the chief Inspector and subject to such conditions as he may specify there in.

SITE CHARACTERISTICS

The understudied mine Nimcha colliery belongs to Raniganj coalfield, where Indian coal mining had been introduced since 30th September, 1774 by M/s Semmar and Hitaly (6). Nimcha colliery has two working unit namely Nimcha and Amkola unit with distance of about 5-6km apart. Nimcha is halt station on main railway line of Asansol - Burdwan section of eastern railway.

Underground working has only one coal seam Nigha at Amkola unit. It has average thickness of 8m with strike direction N 340° - 160° and dip direction S 71° W. It has cover depth of 50m near pit No. 8. The Nigha seam is approachable by pit near rise side while working phase is confined to dip side at about 1.5km distance. Geologicaly Amkola unit has Dolerite dyke cutting across in northern portion. Two parallel dip slip faults with magnitude of 1.6 - 2.5m are running in southern portion close to Nunia Jore a tributary to Damodar river at distance of about 10km.

Raniganj coalfield was extensively worked during 1920 - 1940 in British India period. Most of the workings were abandoned for long period, which later on converted into water logged. Such area is unsafe demographically at present on account of lowering of ground water table, subsidence occurrence.

The Amkola unit of Nimcha colliery has adjacently Damuda unit of Amritnagar colliery along with Nigha seam. There is waterlogged as well as mine fire area along common boundary of both unit pertaining to different colliery. The common boundary as per joint survey shows marginal barrier thickness due to extrapolation of Damuda working at critical sites and may lead to

* Mine inundation in case of higher water column against inadequate barrier thickness.
* Chances of mine fire encroachment if the water column drop sufficiently.

The determination of coal barrier thickness and strength against partially approachable and largely approachable area has been the prime objective of the case study.

GEOPHYSICAL APPROACH

It has indirect application for characterisation of physical properties pertaining to sub surface strata with site specification. It involves seismic, gravity, magnetic, electro magnetic, electrical technique with their varied nature of scope and limitation (2). Electrical method have been proved for its supremacy over other available method pertaining to underground mining activity. The electrical resistivity technique as part of electrical method has been successfully applied

Appalachian coalfield (USA). The delineation of old working over subsided area at shallow depth has been made under the statuary norm of USBM (1)

The electrical resistivity technique works on the principle of Ohms law. It provides apparent resistivity value in Ohms metre for different sub surface material. The employed electrode configuration decides the mode of dimension for different sub surface material. Two conventional electrode configuration Wenner and Schlumberger had been utilised with Geometric factor which provides resistivity value towards specific dimension. The survey had been carried through DC resistivity metre model ASMH of Terra Science, Hyderabad at the onset of monsoon during 19-26 June 1997. The instrumentation had been at six sites from the surface as per requirement of mine management and consideration of field limitation (Fig. 1). There was no rainfall during the investigation period expect heavy cloud and dizling at nights. The four sites namely R2, R3, R5 and R6 had been taken along dip rise orientation over unapproachable area to ascertain critical coal barrier thickness, while R1 site had been at approachable area through underground close to incline borehole and regulatory valve system. The remaining R4 site had been taken along strike direction to cross check the continuity of coal barrier thickness.

INTERPRETATION AND ANALYSIS OF RESISTIVITY DATA

The mine management had drilled three boreholes numbering 1, 2, & 3 through the coal barrier near R1 site to monitor the pressure and temperature of adjoining accumulated water which had indicated the coal barrier thickness of 21.3m, 25.3m and 35.5m respectively. The details resistivity survey pertaining to R1, R2, R3, R5 & R6 have been summarised as follows.

R1 site.

It is north west corner of dry pond. The physical features of site reveals that there was a big water pond with large quantity of water once upon a time; as it is located at outerskirt of established *manjhi basti*. The pond water has been subsided into underground goaf due to subsidence and remittent pond becomes in the form of dry tank .

The underground working is waterlogged upto 45 - 48m depth, and beyond further depth survey has not been conducted. The waterlogged area is under influence of mine fire upto depth of 15m, as evidence low resistivity value of 3 - 5 ohm metre towards Damuda unit. The caving to goaf zone is noticed at depth of 18 - 25 m towards Damuda unit, on the basis of resistivity value of 54 - 62 ohm metre, which is against waterlogged area Damuda unit. The barrier of 42m thickness towards Amkola unit was determined through resistivity value of 56 - 160 ohm meter; with water column of 40m. The site was closed to underground borehole No. 3, which had average mine water mine water pressure of 2.5kg per sq. cm.

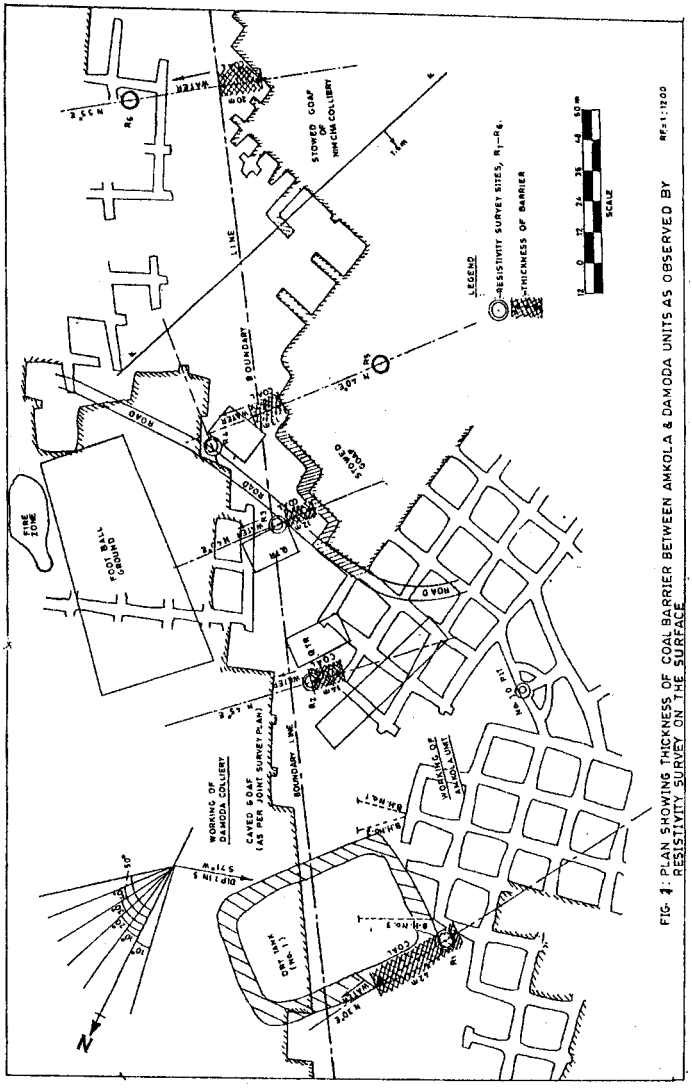

FIG. 4: PLAN SHOWING THICKNESS OF COAL BARRIER BETWEEN AMKOLA & DAMODA UNITS AS OBSERVED BY RESISTIVITY SURVEY ON THE SURFACE

R2 site.

It is close to northern end of boundary wall in between dhora and football ground. Assumed barrier thickness of 6m has been provided by mine management for this site after co-relation of underground inclined bore hole data.

The underground working is waterlogged upto 25m depth. The working in depth range of 25 - 50m have been send stowed for both unit namely Amkola and Damuda in irregular manner, as revealed by resistivity value of 153 - 263 ohm metre. Damuda unit has caving at depth of 20 m, as per characteristic resistivity value of 35 ohm metre. The barrier thickness of 14 m towards Amkola unit is determined through resistivity value of 176 - 200 ohm metre with ground water column of 28 m.

R 3 sites.

It is behind sports club established 1972. Assumed barrier thickness for this site as per co-relation of shifted workings of Damuda unit. The underground working is unapproachable due to stowing.

The underground working is waterlogged upto 33 m for both units. Amkola unit caved upto 40 m as per obtained resistivity 53 ohm metre. The situation caving versus waterlogged is common for both unit in depth range 10 - 30 m. The barrier thickness of 12 m towards Amkola unit has been determined as per resistivity value of 100 ohm metre with water column of 33 m. The is influence of mine fire in waterlogged area of Amkola unit upto 12 m depth as per obtained resistivity 5 - 8 ohm metre.

R 5 site.

The R5 site was oriented in N 40° E along west of fault having a through of 1.6m and was located over stowed goaf of Amkola unit. The formation associated with water was identified upto depth of 30m over Damuda goaf. The barrier thickness of 13m was determined through resistivity value of 145 ohm meter. There was influence of fire in water logged area of Damuda unit upto depth of 6 to 9m as per resistivity value of 0.42 ohm meter.

R 6 site.

It is closed to dip slip fault of 2.5 m and parallel to Nunia Jore. The underground working is waterlogged upto 50 m for both units, and further no investigation was carried out for more depth there are remnants of stowed area towards Damuda unit at depth of 30 m. There is noticed an influence of fire in Amkola unit at depth of 6 m as per resistivity value of 3 ohm metre. It was confirmed in field itself immediately as affect of burning of cow dung *puwal* and cattle waste on the ground surface as a local garbage. The barrier thickness of

20m has been determined towards Amkola unit through resistivity value 98 ohm metre

The barrier thickness has been ascertained through resistivity profiling upto accuracy of 1 m. The strength of barrier thickness pertaining to each site has been estimated on the basis of empirical formula as valid to R1 site i. e. 10 m water column is suitable for tolerance of 1 m barrier thickness. The strength of barrier as per water column varied in range of 2-4kg/sq.cm. This strength value of barrier was very low due to ongoing geochemical reaction in between hot water and coal barrier of compressive strength 98-126kg/sq.cm. A perspective view showing disposition of ascertain barrier thickness is envisaged in Fig. 2.

RECOMMENDATION

The underground working of Amkola unit, Nimcha colliery and its adjoining Damuda unit of Amrit nagar colliery have non renewable coal resource. It sustains the prosperity of local area, habitat and under consistence danger of mine fire vis -a- vis mine inundation; depending upon optimum level of renewable water resource. The past experiences pertaining problem of adequate thickness and strength of coal barrier along waterlogged area as well as presently conducted investigations reveal the following silent aspects :

* The HFL of Nun Jore during monsoon period with reference to deepest mine water occurrence should be monitored for having knowledge of hydraulic head, water column etc.
* The optimum water level as + 3 m of absorbed water column along approachable barrier thickness namely sites R 1 & R 2 should be kept as a safety limit with due consideration of water temperature and water pressure along B 1, B 2, & B 3 bore holes.
* The observed barrier thickness by inclined bore hole drilling along sites R 2 & R 3 as 6 & 4 m respectively has been confirmed as well as modified through resistivity study as + 1 and + 7 corresponding to same sites.
* The delineated barrier thickness along unapproachable area closed two faults along sites R 5 & R 6 are 13 & 9 m. These are surrounded by loosed stowing and caving upto 35 - 40 m depth. It may be considered as maximum limit for hydraulic head.
* The influence of mine fire has been deciphered at depth at depth of 15 and 12 m along sites R 1 & R 3 respectively on the basis of observed low resistivity value 3 - 8 ohm metre. It may be visualised as minimum limit for hydraulic head.
* The barrier thickness along approachable area should be marked on each pillar.

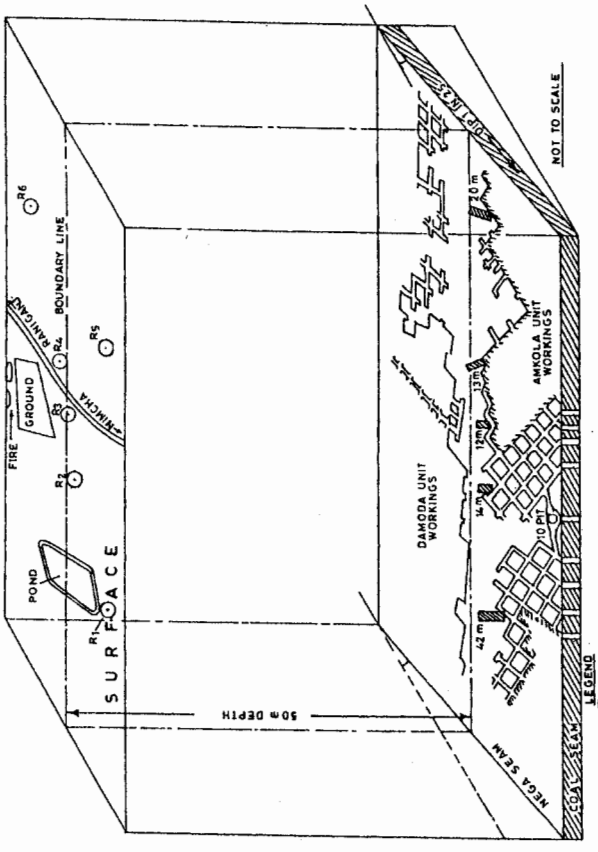

FIG. 9: PERSPECTIVE VIEW SHOWING DISPOSITION OF ASCERTAINED BARRIER THICKNESS BY RESISTIVITY SURVEY FOR AMKOLA UNIT, NIMCHA COLLIERY

* There should not be construction of any structure similar structure to dam along boundary line with notification pertaining to plan and design for DGMS at least 10 days before the commencement of such construction.
* There should be no robbing of coal along boundary line of coal barrier.
* There should be no night working pertaining to development of gallery, face extraction during heavy rainy rainy days.

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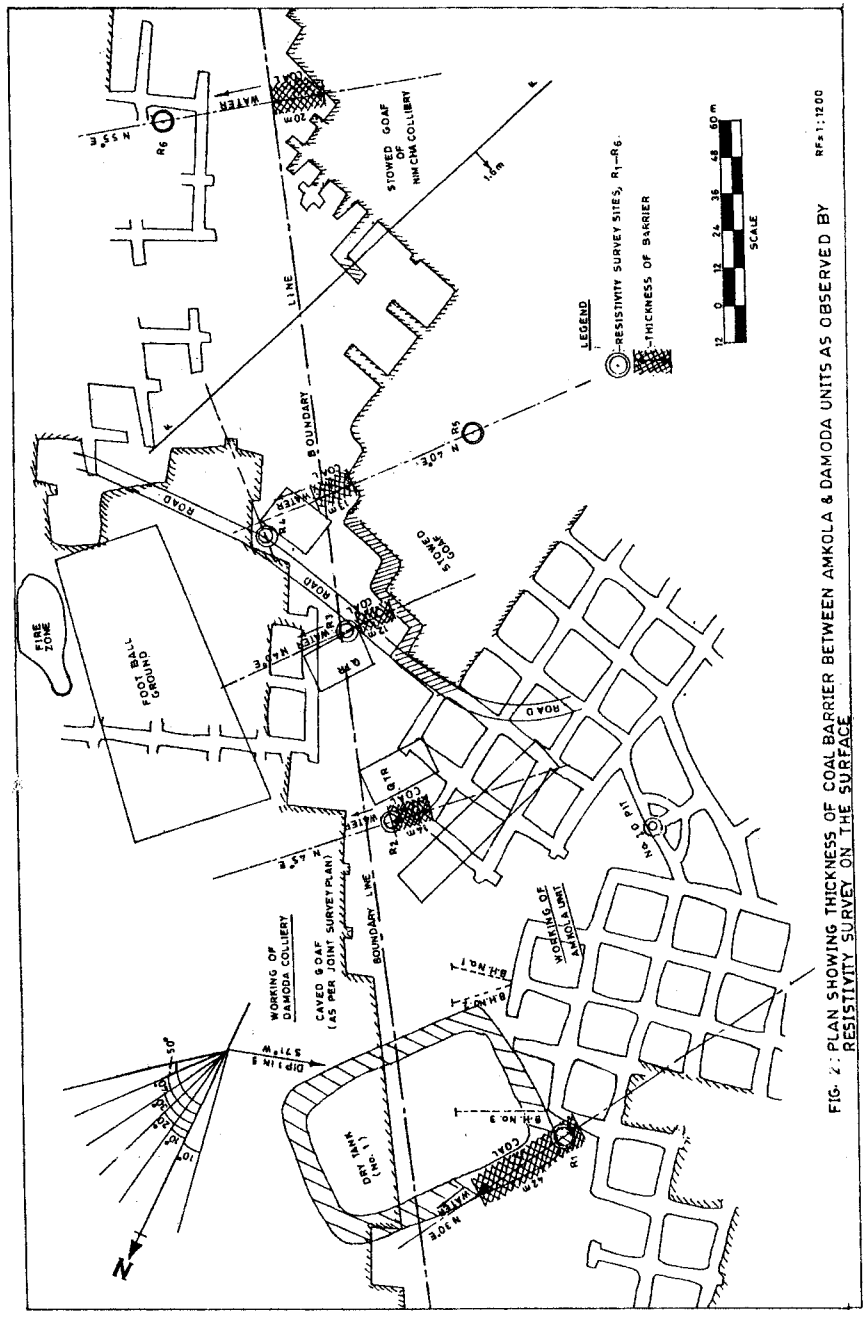

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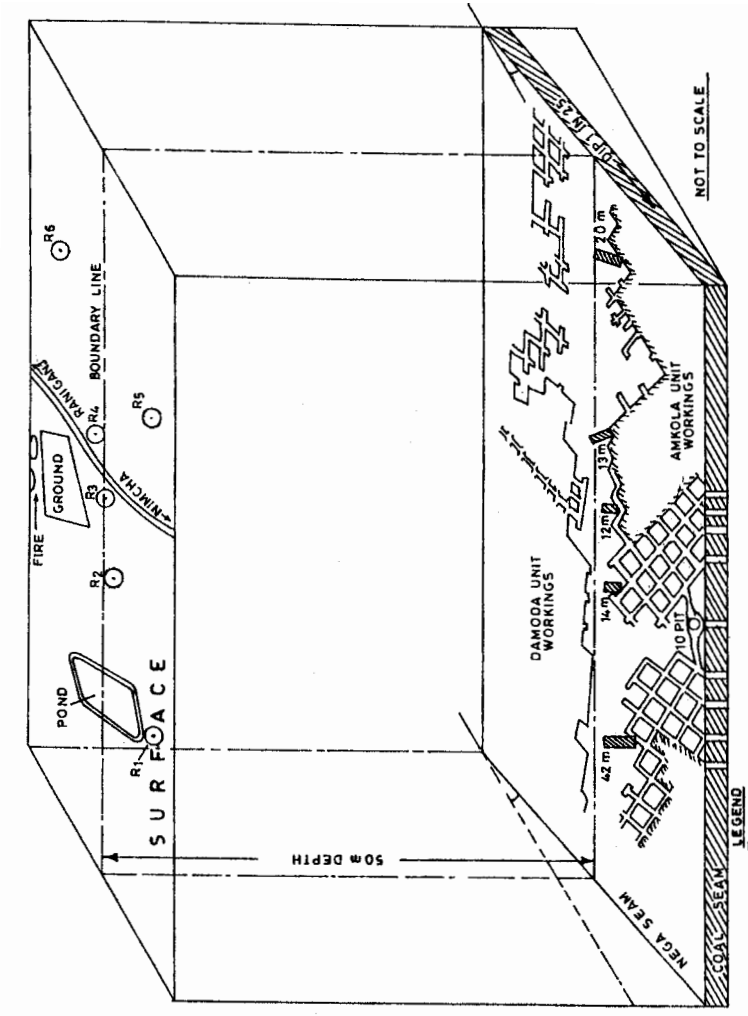

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