FORM – I

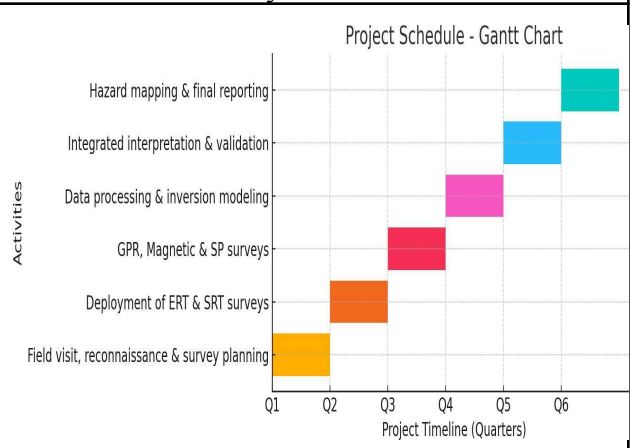
PROJECT PROPOSAL FOR S&T GRANT OF MoC

1	PROJECT TITLE	:	Study of hazards due to mining induced sub-surface cavities and waterlogged areas in inaccessible old workings in underground coal mines using geophysical technique
2	Name and address of principal Implementing Agency(s) Name of Project Leader/Coordinator/Principle Investigator	:	Prof. Sanjit Kumar Pal Associate Professor and Head of Dept. of Applied Geophysics (AGP)
3	Name and address of Sub-Implementing Agency(s) Name of Co-investigator(s)	:	Eastern Coalfields Limited (ECL) and BCCL (Bharat Coking Coal Limited)
4	Definition of the issue (Max. 300 words)	:	Old and abandoned underground coal mine workings in India pose a significant risk to surface infrastructure, mining operations, and human safety due to the presence of uncharted subsurface cavities, fire-affected voids, and waterlogged zones. Over time, the integrity of underground excavations deteriorates due to roof collapses, subsidence, groundwater ingress, and residual coal combustion. These hidden conditions can critically weaken overburden strata, resulting in potholing, land subsidence, sudden ground collapse, or catastrophic inrush of accumulated water into active workings. Such events threaten the lives of mine workers, disrupt mining activities, damage heavy machinery, and contribute to extensive financial losses. A major challenge is that these hazardous regions are often located in **inaccessible areas** of old workings where physical entry for inspection is impossible due to instability, toxic gases, or fire, as observed in the project field visits conducted within ECL and BCCL areas Furthermore, the terrain above these workings is typically complicated by dense vegetation, dumped materials, trenches, and uneven ground, making traditional subsurface mapping impractical. At present, there is a lack of reliable, continuous, and updated subsurface hazard information for abandoned mines in India. Without proper geotechnical knowledge, coal companies struggle to plan safe development, implement preventive measures, or predict zones susceptible to collapse or water inundation.

			Therefore, a scientific and technologically advanced approach is required for **non-invasive detection** and **mapping of hidden mine hazards**. The issue demands an integrated geophysical methodology using Electrical Resistivity Tomography (ERT), Seismic Refraction Tomography (SRT), Ground Penetrating Radar (GPR), Magnetic, and Self-Potential surveys to accurately delineate voids, fire zones, and waterlogged areas beneath inaccessible regions. This mapping is essential for safety management, mine closure planning, environmental protection, and sustainable coal mining operations in India.
5	Objectives (Specific and not more than 2-3)	:	To identify and delineate hazardous subsurface conditions such as cavities, fire-affected voids, and waterlogged zones beneath inaccessible old underground coal mine workings using integrated geophysical technique To analyze geophysical data using advanced processing and inversion tools for accurate characterization of weak strata and zones susceptible to ground collapse or water inrush. To generate hazard maps and provide engineering recommendations to ensure safety of mining operations and surface infrastructure.
6	Justification for subject area (Max. 200 words)	:	Abandoned underground coal mines in India continue to pose long-term geo-hazard risks due to unknown subsurface damage, fire zones, weakened strata, and accumulation of water. Physical entry for inspection is often impossible because of unsafe conditions, dense vegetation, and backfilled mine voids. These limitations prevent coal companies from accurately assessing collapse-prone areas, leading to unexpected ground failures, potholing, or sudden flooding during future mining operations. An integrated non-invasive geophysical approach is essential to detect such hazards remotely and ensure early warning and risk mitigation. Therefore, this project area is critical for sustainable and safe coal resource exploitation in India.

7	How the project is beneficial to coal industry		Prevents loss of life and heavy asset damage by detecting collapse-prone and water-charged voids before mining activities.

			• Enables risk-free planning for expansion into areas above old workings, reducing operational disruptions. • Supports DGMS compliance by improving mine safety assessment practices. • Provides cost-effective, non-invasive alternative to drilling-based exploration.
8	Work Plan (Max. 100 words)	:	The work will begin with reconnaissance surveys and field visits to mark suitable survey profiles. A combination of geophysical techniques including ERT, SRT, GPR, Magnetic, and Self-Potential investigations will be conducted over selected inaccessible mine zones. Data will be processed using advanced inversion and modeling software to generate subsurface hazard maps. Interpretation will be validated through correlation between all techniques, followed by final reporting and recommendation for mitigation
8.1	Methodology (Max. 200 words)	:	The project employs an integrated geophysical investigation to map hazardous subsurface zones. Field reconnaissance will assess terrain conditions and accessibility. Profile layouts will be planned based on structural complexity and safety concerns. Electrical Resistivity Tomography (ERT) will identify voids and water-bearing zones, while Seismic Refraction Tomography (SRT) will delineate fractured strata and weak formations. Ground Penetrating Radar (GPR) will support high-resolution shallow imaging; magnetic and self-potential surveys will help detect fire zones and groundwater-related anomalies. Data acquisition will follow approved standards, and processing will be performed using state-of-the-art software including Res2DINV, SeisImager, WinMASW, Radon-7.0, and Geosoft Oasis Montaj to generate 2D/3D hazard maps. Integrated interpretation will allow accurate identification of vulnerable zones leading to potholing, sinking, collapse, or sudden water inrush risks.

8.2	Organization of work elements (Max. 200 words)	:	**1. Site Selection & Reconnaissance**: Field visits, hazard identification, and profile planning in ECL/BCCL areas. 2. **Geophysical Survey Deployment**: Execution of ERT, SRT, GPR, Magnetic, and SP surveys in inaccessible zones. 3. **Data Processing & Inversion**: Use of industry-standard tools such as Res2DINV, SeisImager, WinMASW, Radon-7.0 and Oasis Montaj for subsurface modeling.
			4. **Integration & Interpretation**: Correlation of anomalies to validate identification of cavities, fire zones, and waterlogged voids. 5. **Hazard Mapping & Reporting**: Development of risk maps and actionable recommendations for safe mining and infrastructure stability
8.3	Time schedule of activities giving Milestones (also include a Bar Chart/PERT Chart)	:	

9	**Details of proposed outlay**		(Rs.in lakhs)			
Sl. No.	Items		Total cost estimated			
			Total project cost	1st Year	2nd Year	3rd Year
	Capital Expenditure					
9.1	Land & Building	:	0.00	0.00	0.00	0.00
9.2	Equipment	:	45.00	30.00	10.00	5.00
9.3	***Total Capital****(9.1+9.2)*	:	**45.00**	**30.00**	**10.00**	**5.00**
	Revenue Expenditure					
9.4	Salaries / allowances	:	90.00	30.00	30.00	30.00
9.5	Consumables	:	18.00	8.00	6.00	4.00
9.6	Travel	:	21.00	7.00	7.00	7.00
9.7	Attending or organizing Workshop/Seminar	:	6.00	2.00	2.00	2.00

9.8	***Total Revenue expenditure****(9.4+9.5+9.6+9.7)*	:	**135.00**	**47.00**	**45.00**	**43.00**
9.9	Contingency	:	9.00	3.00	3.00	3.00
9.10	Institutional Overhead	:	18.00	6.00	6.00	6.00
9.11	Applicable taxes/duties/charges etc.		3.00	1.00	1.00	1.00
9.12	**Grand Total** (9.3+ 9.8+9.9+9.10+9.11)	: :	**210.00**	**87.00**	**65.00**	**58.00**

Foreign Exchange Component:

Name of the Foreign Currency: USD (United States Dollar)

Exchange Rate:1 USD = ₹83.50 Date:05/12/2025

10.0 Phasing of fund requirement (in percentage) with respect to activities/milestone

11.0 Outlay for land & Building:

(Rs. in lakhs)

Building:

Sl. No.	Item	Plinth Area	Type of Bldg.	Estimated Cost
1.	Existing laboratory & office space at IIT(ISM) Dhanbad	Not Applicable	Existing Academic Infrastructure	0.00
2.	Existing facilities at ECL/BCCL mines for field deployment	Not Applicable	Existing Academic Infrastructure	0.00
Total				0.00

12.0 Justification for land & building:

13.0 Outlay for Equipment:

Generic Name of equipment and accessories with major specifications		Number	Imported/ Indigenous	Estimated Cost (Rs.in lakhs)	Foreign Exchange Component
1.	Electrical Resistivity Tomography (ERT) Equipment (with multi-electrode cables & switches) – **Hiring/Usage**	1 set	Imported	20.00	10.00
2.	Seismic Refraction Tomography (SRT) System (Geophones & Strike source) – **Hiring**	1 set	Indigenous + Imported Sensors	15.00	5.00
3.	Ground Penetrating Radar (GPR) Antennas & Control Unit – **Hiring/Software Access**	1 set	Imported	10.00	5.00
Total				**45.00 Lakhs**	**20.00 Lakhs**

Note:-

(i) Include GST, installation charges, inland transport, insurance etc.

(ii) For the imported equipment, import duty concessions available for research/S&T/ Environment / Protection
/ Ecology protection projectors will be availed of, wherever applicable.

(iii) A Certificate to the effect that imported equipment is essential to the project and in the

long run will save/not save foreign exchange.

(iv) Please elaborate whether the imported equipment will help/not help in indigenization of technology.

14.0 Justification for Equipment: The project requires advanced geophysical systems including ERT, SRT, GPR, Magnetic, and Self-Potential survey equipment to detect subsurface anomalies such as cavities, fire zones, fractured strata and waterlogged voids in inaccessible abandoned mine workings. These hazards cannot be assessed through conventional surface mapping or drilling alone due to safety limitations and unpredictable terrain conditions. The selected instruments provide high-resolution non-invasive subsurface imaging, improving detection accuracy and reducing operational risk. Some components of ERT and GPR systems are imported due to unavailability of equivalent indigenous technology with the required depth penetration and sensitivity. Hiring the equipment instead of purchasing reduces cost and enables access to state-of-the-art tools necessary for successful project execution.

15.0 Outlay for consumable materials:

Head	Particular	Outlay			
		1st Yr.	2nd Yr.	3rd Yr.	Total
	Q				
	B	8.00	8.00	4.00	18.00
	F				
	E				

	Q				
	B				
	F				
	E				

Q - Quantity/Number

B - Outlay in Rs.

Lakhs F -

FE Components

E - Exchange rate adopted

16.0 Principal Investigator (PI) – Prof. Sanjit Kumar Pal.

- M.Tech., Ph.D. (Geophysics)
- Over 15 years of experience in subsurface geophysical investigations, geotechnical hazard assessment, underground mine safety studies, and implementing geophysical techniques in coal mines across India.
- Methods developed in earlier projects have been applied by Coal India subsidiaries for early detection of hazardous mining zones, reducing risks of ground collapse and water inrush incidents.

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- Published in reputed national and international journals and conferences in the fields of applied geophysics, mining safety, and subsurface imaging.

17.0 Past experience

- ❖ IIT(ISM) Dhanbad has extensive experience in applied geophysics, underground mine safety investigations, subsurface imaging, and hazard detection using integrated geophysical techniques including ERT, SRT, GPR, Magnetic and SP surveys. The institution regularly collaborates with Coal India subsidiaries on field-based safety studies..
- ❖ The Applied Geophysics Department is equipped with advanced data-processing laboratories, licensed geophysical software, and field deployment support systems. ECL and BCCL provide required mine infrastructure for on-site surveys and validation.
- ❖ The PIs and supporting agencies have previously executed similar S&T projects successfully within the approved time schedule. Their technology outputs have been used by coal industry teams for improving operational safety and mine planning.
- ❖ Research projects undertaken earlier by the investigators have been implemented effectively without major time or cost overruns. Their results have contributed to measurable improvements in safety monitoring and risk mitigation strategies across Indian underground coal mines.

18.0 Others

- ❖ Necessary coordination will be carried out with DGMS for obtaining permissions related to underground hazard survey areas and ensuring strict adherence to mine safety standards.
- ❖ Review of recent Indian and international developments indicates that integrated geophysical approaches greatly enhance the detection of subsurface cavities, fire zones and waterlogged areas in abandoned mines. However, Indian field case studies remain limited, requiring further research for optimization in local geology.
- ❖ The project includes development of a combined interpretation workflow and hazard mapping methodology tailored to Indian mining conditions. The proposed outcome will support future risk prediction and decision-making in coal mine safety management systems.