

## Format for Bio-Data

1. **Name:** Dr. Gautam Banerjee

2. **Date of Birth:** 29/07/1962



3. **Current Position and Address:** Chief Scientist, Longwall Mining Division  
CSIR-Central Institute of Mining and Fuel Research (CSIR-CIMFR),  
Barwa Road, Dhanbad - 826015

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4. **Educational qualifications:** (Graduation and above)

Sl. No.	Degree/ Certificate	Year of Passing	University/ Institute	Subjects
i.	B.Tech (Hons).	1984	I.I.T. Kharagpur	Electrical (First class (69.73% marks))
ii.	M. Tech. (Mining)	1994	I.S.M. Dhanbad	M-Tech Thesis titled : "Selection and Maintenance of Longwall Mining Equipment-Some Considerations"
iii.	Ph.D Mining	2007	I.S.M. Dhanbad	Ph.D Thesis titled "Numerical Modelling Studies For Prediction Of Longwall Roof Behaviour"

5. **Work experience**

Designation	Institution/company	From	To	Nature of work
1	TISCO, Jamadoba, Dhanbad	18-06-84	09-08-85	Graduate trainee
2	TISCO, West Bokaro Collieries, P.O. Ghatotand, Hazaribagh	10-08-85	30-04-87	Asst. Engineer
3	CSIR-Central Institute of Mining & Fuel Research, Barwa Road, Dhanbad	01-05-1987	30-04-1990	Scientist Group – IV (1)
4	CSIR-Central Institute of Mining & Fuel Research, Barwa Road, Dhanbad	01-05-1990	30-04-1995	Scientist Group – IV (2)
5	CSIR-Central Institute of Mining & Fuel Research, Barwa Road, Dhanbad	01-05-1995	30-04-2000	Scientist Group – IV (3)
6	CSIR-Central Institute of Mining & Fuel Research, Barwa Road, Dhanbad	01-05-2000	30-04-2005	Scientist Group – IV (4)
7	CSIR-Central Institute of Mining & Fuel Research, Barwa Road, Dhanbad	01-05-2005	30-04-2010	Scientist Group – IV (5)
8	CSIR-Central Institute of Mining & Fuel Research, Barwa Road, Dhanbad	01-05-2010	Till date	Chief Scientist

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**6. Area of specialization:** Engineering Sciences specialization  
Rock Mechanics and Mining Methods Longwall Mining, Numerical Modelling, Microseismic Signal Analysis, Condition Monitoring

**7. Honors/Awards received:**

- i. Dorabji TATA merit scholarship for 5 years from 1979-1984.
- ii. First Prize from Director CSIR-CIMFR for raising the External Cash Flow (ECF) of CSIR-CIMFR through R&D in the year 2005-2006
- iii. Awarded for raising the ECF of CSIR-CIMFR through Grants-in-aid project entitled "Investigation of Cavability of Overlying Strata and Development of Guidelines for Estimation of Support Capacity for Longwall Faces" Award for application of copyright for "Autonomous Control of Shearer Motor (AUTOCSM)" registered in 2005-06

**8. Fellowships/Scholarships:**

**9. No. of Research Publications:** 49 (forty nine)

- List of best 05 publications:

	<b>Authors</b>	<b>Title of Paper</b>	<b>Journal/International Symposium</b>
1	<b>G. Banerjee</b> , N Ghosh, D. Kumbhakar, K.P. Yadav	A method for simulation of Longwall Goaf	Accepted to be published in 49 <sup>th</sup> US Rock Mech/Geomech Symposium Organised by American Rock Mechanics Association (ARMA), (28 <sup>th</sup> June – 1 <sup>st</sup> July, 2015)
2	<b>G. Banerjee</b> , D. Kumbhakar, & A. Sinha	Study of Caving behaviour in Longwall Working – A Numerical Modelling Approach	Journal of Mines Metals & Fuels, Vol. 56, May-June 2008, pp 77 to 82.
3	<b>G. Banerjee</b> , M.T. Rahaman, Prof. S.B. Srivastava & Dr. P.R. Sheorey	Prediction of main fall span at alongwall panel by numerical modeling – a case study'	First Asian Mining Congress organized by The Mining, Geological & Metallurgical Institute Of India (MGMI) during 16-18 January, 2006 at Kolkata. pp 233-240.
4	<b>G. Banerjee</b> , A. Kushwaha, D. Kumbhakar & A. Sinha	Prediction of strata and support behaviour during shortwall mining off developed bord & pillar working at Balarampur Mine, SECL	The Indian Mining & Engineering Journal, Vol.46, No. 11, November 2007
5	A.K. Ray, G.S.P. Singh & <b>G. Banerjee</b>	Influence of petrographic constituents on softening characteristics of coal measure rocks	International Journal of Rock Mechanics and Mining Sciences 43 (2006) 494-502.

**10. Number of Books authored/edited:** Nil

**11. (a) No. of Patents granted/applied for:** Patents: 4(four), copyrights 5 (five)

SI No.	Title	Country	Filed on (Date)	Patent No.	Names of other inventors
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1.	A device for sealing inside an upward drilled borehole for water injection under high pressure in underground mines	India	"0855/DEL/2001 dated 16-8-2001'	Patent No. IN220660	<b>G. Banerjee</b> , A. K. Ray, K.P.Yadava, G.S.P. Singh , R. Prasad
2.	An improved caving longwall method for winning of coal from thick seam in underground mines "	India	212/DEL/2002 dated 11-3-2002	Patent No. IN219305	<b>G. Banerjee</b> , A. K. Ray, K.P.Yadava, G.S.P. Singh , R. Prasad
3.	An Autonomous Control System for Shearer Loader in underground Longwall Coal Mines	India	NFNO 0075NF2004/I N & AN No 1025DEL2004		L. K. Bandyopadhyay, <b>G. Banerjee</b> & S. K. Chaulya
4.	Continuous Roof Convergence Monitor For Underground Openings.	India	Sept. 2011	In Process	D. Kumbhakar, <b>G.Banerjee</b> , K.P. Yadava, A.K. Ghosh

**Copyrights filed**

SI No.	Title	Country	Filed on (Date)	Granted on(Date)	Names of other inventors
1.	Autonomous Control of Shearer Motor (AUTOCSM)	India	2005-06		L.K. Bandyopadhyay, <b>G. Banerjee</b> & S. K. Chaulya
2.	Dynamic simulation of healthy squirrel cage induction motors	State Regn. 3498 Ulaanbaatar, Mongolia	2009	Certificate Registration 2009/141	A. Purvee, <b>G.Banerjee</b> , Dorj Gunchin Rakesh Kumar
3.	Dynamic simulation for eccentricities (dynamic, static) of squirrel cage induction motors	State Regn. 3538, Ulaanbaatar, Mongolia	2009	Certificate Registration 2009/182	A. Purvee, <b>G.Banerjee</b> , Dorj Gunchin Rakesh Kumar
4.	Dynamic simulation for squirrel cage induction motors with rotor faults	State Regn. 3539, Ulaanbaatar, Mongolia	2009	Certificate Registration 2009/183	A. Purvee, <b>G.Banerjee</b> , Dorj Gunchin Rakesh Kumar
5.	Dynamic simulation for squirrel cage induction motors with bearing faults	State Regn. 3540, Ulaanbaatar, Mongolia	2009	Certificate Registration 2009/184	A. Purvee, <b>G.Banerjee</b> , Dorj Gunchin Rakesh Kumar

(b) **Technologies developed, Licensed and/or commercialized:**

12. **Foreign visits:**

13. **Details of Professional memberships:**

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- i. Member, ISRM International Society for Rock Mechanics (India)
- ii. Member, National Institute of Small Mines, India (NISM)
- iii. Member, Computer Society of India.

### 14 . **Major contributions:** ( Max. 150 words)

#### ➤ **NUMERICAL MODELLING OF LONGWALL CAVING BEHAVIOUR.**

Developed a very simple method with logical and mathematical relations to identify the immediate and main roof influencing the local fall, main fall and periodic falls. Further, a realistic simulation of the main fall and periodic falls was done by numerical modeling with sequential advance and progressive failure. A methodology has been developed for estimation of appropriate face length for safe operation of a longwall panel

#### ➤ **LONGWALL GOAF SIMULATION**

Goaf is an unapproachable zone and the understanding of its behaviour is difficult. The goaf was modeled having a non-linear stress strain characteristic, with the tangent modulus of the goaf element varying with the induced vertical stress. Further, he developed equations to estimate the goaf parameters of the Salamon's Goaf Model and this provided a realistic simulation of the stress distribution over the goaf and the abutment ahead of the face in the numerical model.

#### ➤ **STANDARDIZATION OF METHODOLOGY FOR ASSESSMENT OF CAVABILITY, CATEGORIZATION OF ROOF ROCK AND ESTIMATION OF SUPPORT RESISTANCE,**

The outcome of the study are:

- Developed a mathematical procedure with logical parameters for identification of immediate and main roof in the overlying rock beds from bore hole study
- Development of roof-rock categorization by *Equivalent Main Fall Span* ( $a_{eq}$ ) and development of empirical, mathematical (by two-dimensional beam theory) and numerical modelling approach for determination of  $a_{eq}$
- Developed an empirical model for determining the main fall and periodic fall span in longwall panels.
- Development of a standard methodology for assessment of cavability of roof rock by *Parting Plane (PP) approach*, a mathematical approach in MATLAB platform for automatic processing of borehole litholog and its physico-mechanical .

#### ➤ **STANDARDIZATION OF MONITORING TECHNIQUES FOR STRATA AND SUPPORTS IN AND AROUND CAVING LONGWALL FACES.**

Based on the experience gained from monitoring a number of longwall panels, a comprehensive instrumentation scheme has been identified as essential for strata and support behaviour monitoring in a longwall panel. Under the scheme, load and convergence variations ahead of the face were recorded in the main gate and tail gate using load cells and convergence recorders. Movements of the overlying beds were monitored by using surface borehole extensometers and tell-tale extensometers. The stresses in the rib pillars and advance pillars were monitored using stress capsules. The loading pattern of the strata on the face supports were also monitored using pressure gauges and leg closure recorders. Data loggers were also used for continuous monitoring of a few pre-identified chocks. Efforts were also made by using micro-seismic monitoring technique to correlate caving phenomenon with the micro-seismic events. A computer program has been developed for storing and computerized data analysis of condition monitoring observations Some of the instruments fabricated in the laboratory and used for field observations are:

- Fabrication of online strata monitoring instrument for continuous monitoring of support pressure and closure at a longwall face
- Fabrication of Continuous Roof Convergence Monitor Instrument For Underground Openings

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- Designed and fabricated a very cheap and simple device for accurate measurement of strain with the help of slide calipers was made at the colliery workshop of PVK of 5 Incline, Kothagudem Area of SCCL. Mine management is using several numbers of this set in longwall panel to measure strain in coal pillar as well as barrier pillar. This was also used in longwall panels at GDK10A, SCCL, and at Balrampur SECL.

### ➤ **INDUCED CAVING OF DIFFICULT-TO-CAVE ROCK BEDS BY DEEP-HOLE SURFACE BLASTING OVER GOAF OF LONGWALLS AT SHALLOW DEPTH**

Design, implementation and monitoring of induced caving of difficult to cave rock-beds by blasting in deepholes from surface over goaf of longwalls at Balrampur, New Kumda and Rajendra mines. Design of concentric elliptical pattern of deep blast holes from surface for inducing main fall in longwall at shallow depth, number of holes in a row for inducing periodic falls, charge quantity, charging horizon were studied and optimized to reduce the severity of the falls.

### ➤ **HYDROFRACTURING TECHNOLOGY FOR HARD ROOF MANAGEMENT**

On the work on S&T project "Control of Hard & Massive Roof Rocks by Water Injection under High Pressure" an empirical equation has been developed to quantify the softening of the rock mass and its dependence on grain size and clay content. Further, The flow characteristics of water under high pressure in hard and massive sandstone roof rock was studied and developed empirical relations to understand the stabilisation pressure ( $P_s$ ), the initial injection pressure ( $P_i$ ) and stabilisation time ( $T_s$ ). A hydraulic and one mechanical sealing arrangement were designed and fabricated for field trial of water injection. Further a methodology has been developed for estimation of in-situ rock mass permeability to be used for determining critical injection parameters for hydrofracturing. Hydrofracturing experimentation was conducted at Depillaring panel of Porascole colliery of ECL, two panels in Churcha Colliery of SECL and one Blasting Gallery panel GDK 10 mine of SCCL. The study of the influence of petrographic constituents on softening characteristics of coal measure rocks would help us to plan hard roof management for difficult-to-cave roofs.

### ➤ **APPLICATION OF MICROSEISMIC MONITORING IN MINES**

Micro-Seismic Monitoring was carried over B-6 Longwall Panel of Balrampur Mine of SECL during the month of June and July 2003. The longwall face progressed from 540m to 705m. The system was operated round the clock for a period of 42days. The P-wave velocity was determined as 2852m/s. Event magnitude, location of events, seismic moment and seismic energy were calculated and analyzed. The event count was correlated with the periodic falls as observed in the face.

In an S&T project titled "Development of a micro-seismic monitoring system for stability analysis of underground mine workings under difficult-to-cave roof conditions" microseismic events were studied over underground panels of Ratibati, Jhanjra, Porascole, two sites of Chora collieries in ECL and GDK10A of SECL. A "specific instability criterion" involving event rate count, seismic energies and seismic moment, has been developed to quantify the degree of instability over worked out panels and previously extracted unknown workings in coal mines by micro-seismic monitoring from surface

### ➤ **SHORTWALL TECHNOLOGY FOR DEPILLARING OF DEVELOPED BORD & PILLAR AREA- NUMERICAL MODELLING APPROACH**

A bulk of superior quality of coal is locked in standing pillars. This method for faster depillaring these standing pillars was designed and experimented for the first time in India at Balrampur colliery of SECL. An extensive numerical modelling was done to study the following:

- Influence of depth, face length and hard cover & alluvium thickness on caving behaviour (main fall span) for shallow depth cover,
- Effect of obliquity of the face,
- Safety factor and stability of the triangular rib as the oblique face approaches the advance gallery.
- Support resistance required at the face and in advance gallery.
- Variation of the tension on the cable bolts of different length and configuration along the length of the cable as the shortwall face approaches the advance gallery.

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- Variation of the load on powered supports with different gallery support density as the shortwall face approaches the advance gallery.
- Variation in the expected maximum convergence in the advance gallery and at the edge powered support.
- Variation in the expected abutment stress at the rib pillar and pillar ahead of the gallery.
- Extraction was successfully completed in 10 shortwall panels of Balarampur mine, SECL, 4 shortwall panels in RK-NT mine, Srirampur Area, SCCL with this technology..

### ➤ **SELECTION OF PROPER CAPACITY OF SHEARER VIS-À-VIS ITS POWER RATING**

Developed an empirical- cum – statistical model relating cutting power of a shearer and production rate. A computer program has been developed for selection of shearer and its power rating for a particular Indian geo-mining conditions. This programme also optimizes the operational system variables such as web depth, haulage speed and drum rotational speed for a particular shearer capacity and minimum power requirement.

### ➤ **COMPUTERIZED DATA ANALYSIS OF CONDITION MONITORING OF LONGWALL FACE MACHINERY**

An interactive computer program in 'C' language has been developed by the him for storing and easy analysis of the results of condition monitoring of longwall face machinery and identification of parameters and indices for assessing the reliability of the machines.

### ➤ **STUDY OF RELIABILITY OF LONGWALL EQUIPMENT IN A LONGWALL FACE IN INDIA FROM BREAKDOWN ANALYSIS.**

Two parameters have been identified as an index of reliability of machine (Shearer, AFC, Stage loader, Gate belt, Powered support and Hydraulics and other miscellaneous faults) and the Longwall panel as a whole.

The probability that the machine or the system will run with zero number of breakdowns in the first working week in a particular month.

The probability that the machine or the system will run with zero number of breakdown in the first working day in a particular month.

The breakdown and downtime data were collected for 3 (three) longwall panels and the above two parameters were calculated for each machine and longwall panel as a whole.

### ➤ **QUALITY OF POWER SUPPLY IN A LONGWALL FACE**

A study was conducted on the problems faced due to voltage drop at the coal face equipment. To assess the quality of power supply the following parameters viz. the power supply regulation and the regulation affecting the motor start performance were monitored for different longwall equipment in use in the longwall faces in India.

### ➤ **COMPUTER AIDED DESIGN OF SHEARER DRUM**

A computer program has been developed for design of the shearer drum based on both loading and cutting efficiency. Study has been conducted to identify the design aspects of various drum parameters such as drum diameter, web depth and width over vanes, pick width and height, number of vane starts, warp and vane angle, line spacing of picks, number of vane and gage picks and others.

### ➤ **A COMPUTER MODEL FOR ARMoured FLEXIBLE CONVEYOR**

Field investigation were carried out towards selection of AFC and determination of the parameters for AFC at a particular geo-mining situation such as Conveyor capacity, pan width, maximum chain tension, chain size and speed, power requirement and optimum chain pretension. A computer model has been developed to optimize and calculate the above parameters for selection of AFC for a particular geomining situation.

### ➤ **DESIGN AND DEVELOPMENT OF MICROPROCESSOR BASED SYSTEM TO CONTROL THE HAULAGE SPEED OF SHEARER**

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Complete control system for the haulage motor of the shearer has been developed to control the torque of the shearer cutter motor with the increase and decrease of the cutting resistance. Experimental setup was designed and fabricated in the laboratory in which the 8085 8-bit Intel microprocessor is connected to a series of sensors and electronic circuitry and experimented with a variable speed drive of a AC 15 hp motor and a variable speed 15hp DC motor . Software development is the major activity of this project. The control software for shearer speed has been developed in modular form in assembly language

### **15. Technologies and Products/ Services**

- a. Shortwall technology for depillaring of developed bord & pillar area
- b. Hydrofracturing technology for hard roof management
- c. Development of a micro-seismic monitoring system for stability analysis of underground mine workings under difficult-to-cave roof conditions
- d. Induced caving of difficult-to-cave rock beds by deep-hole surface blasting over goaf of longwalls at shallow depth
- e. Numerical model for longwall caving behaviour

### **16. Designs and Prototype Developed:**

- i. Design and development of microprocessor based system to control the haulage speed of shearer.
- ii. Design and fabrication of “a device for sealing inside an upward drilled borehole for water injection under high pressure in underground mines’
- iii. Fabrication of online strata monitoring instrument for continuous monitoring of support pressure and closure at a longwall face
- iv. Fabrication of Continuous Roof Convergence Monitor Instrument For Underground Openings
- v. Designed artificial supports for parallel galleries to be crossed by longwalling consisting of two rows of pillars made of a mixture of coal sand and cement with timber cogs on the top to provide a support resistance of 55 T/m<sup>2</sup>.
- vi. Designed and fabricated a very cheap and simple device for accurate measurement of strain with the help of slide calipers was made at the colliery workshop of PVK of 5 Incline, Kothagudem Area of SCCL. Mine management is using several numbers of this set in longwall panel to measure strain in coal pillar as well as barrier pillar. This was also used in longwall panels at GDK10A, SCCL, and at Balrampur SECL.

### **17. Honours and awards won for technological contributions or sociological impact of R&D:**

- i) Award received from Director CSIR-CIMFR for filing a patent “A device for sealing inside an upward drilled borehole for water injection under high pressure in underground mines” in the year 2002.
- ii) Award received from Director CSIR-CIMFR for filing a patent “An improved caving longwall method for winning of coal from thick seam in underground mines” in the year 2003.
- iii) Award received from Director CSIR-CIMFR for filing a patent “An Autonomous Control System for Shearer Loader in underground Longwall Coal Mines” in the year 2006.
- iv) Award for application of copyright for “Autonomous Control of Shearer Motor (AUTOCSM)” registered in 2005-06

Signature