# LONGWALL VENTILATION PRACTICES- A CASE STUDY OF GLOBAL EXPERIENCE

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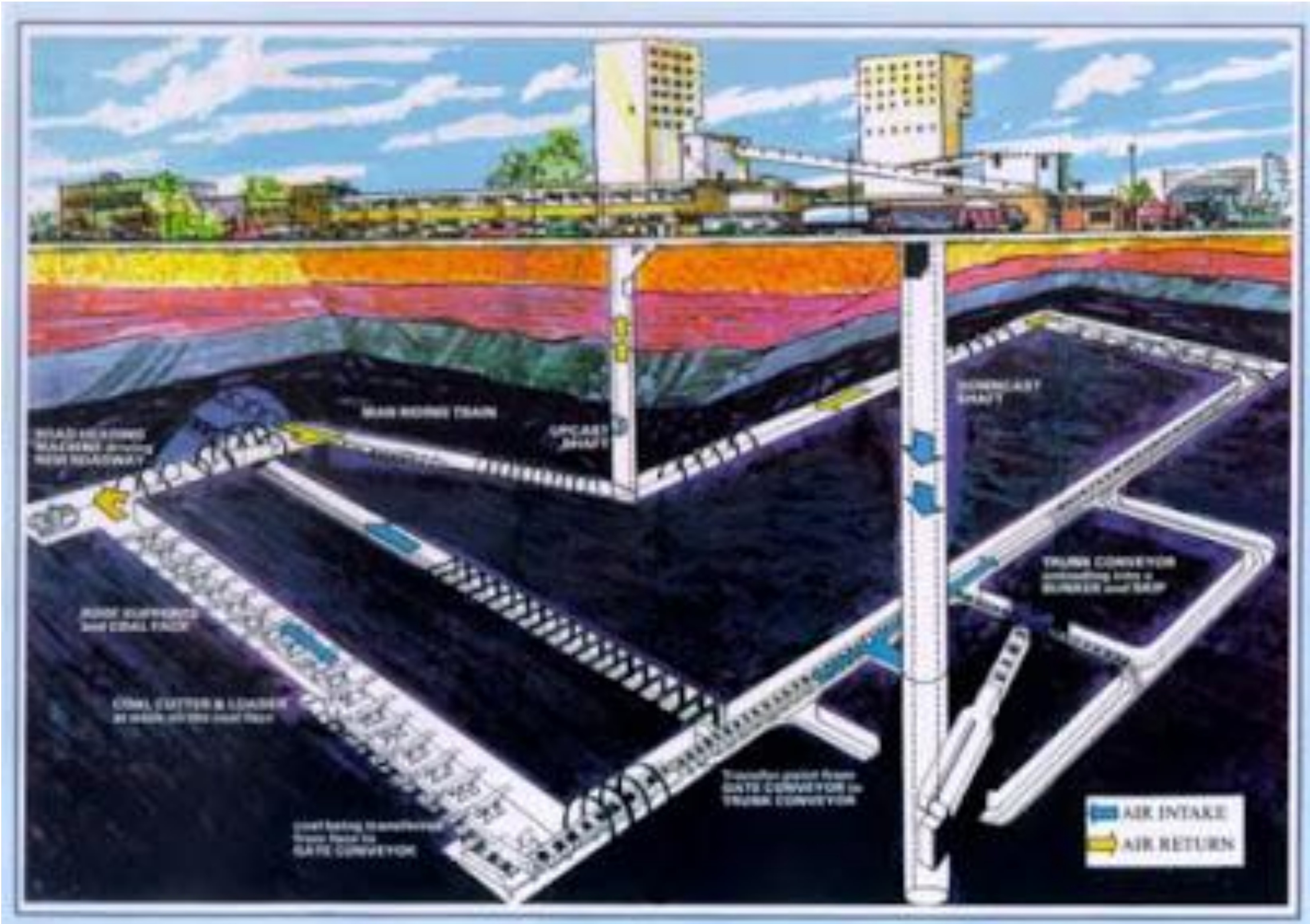
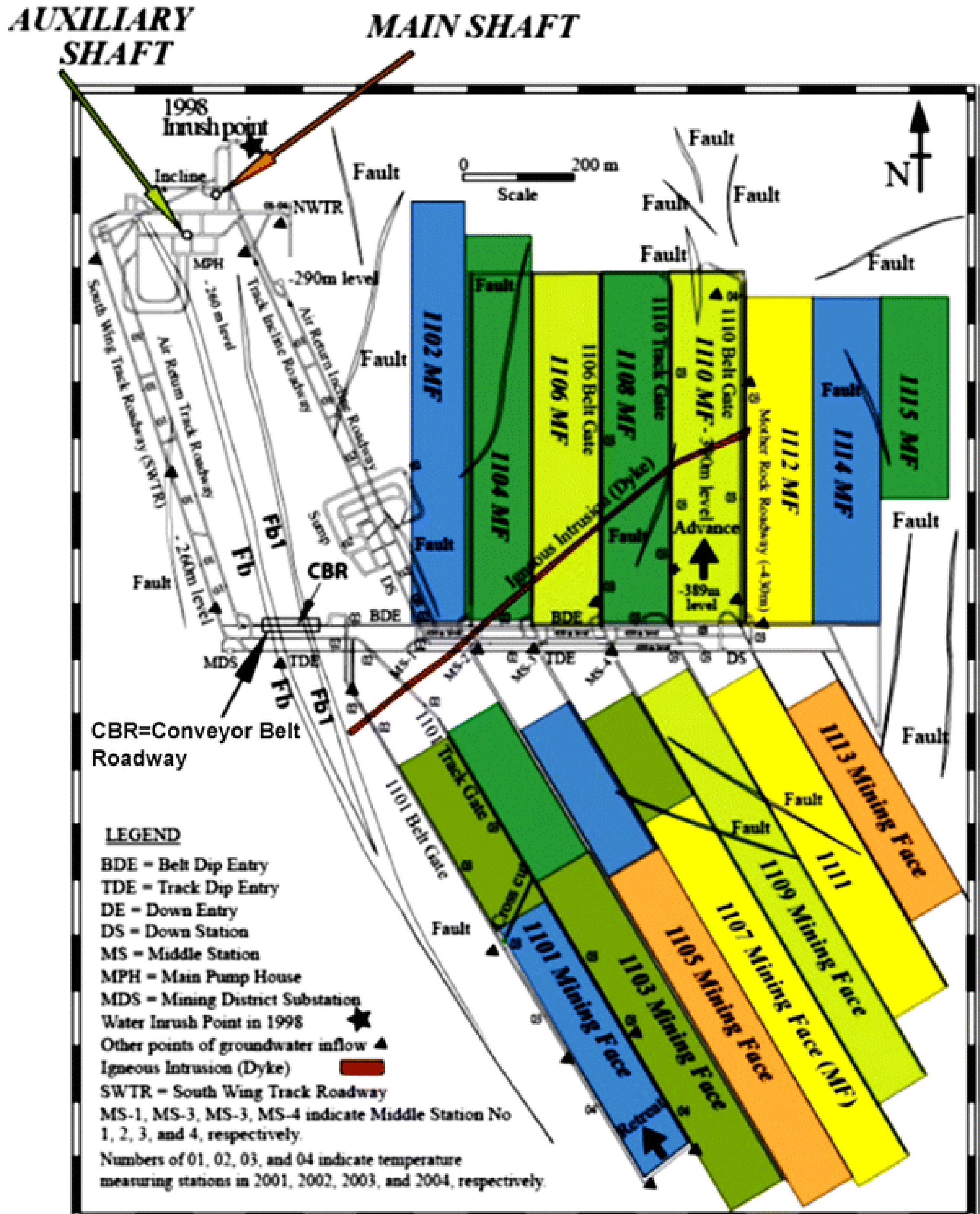
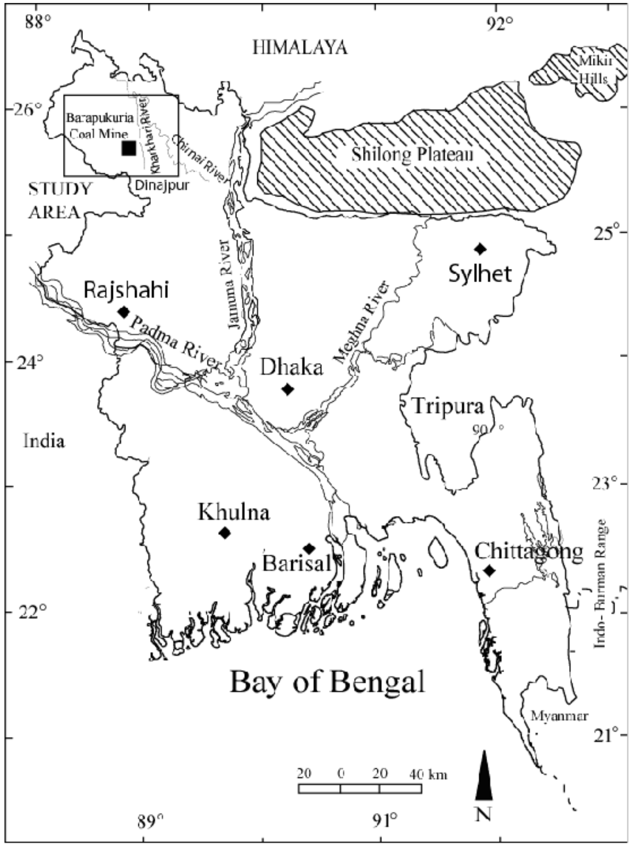
# Barapukuria Coal Mine, Bangladesh



AIR INTAKE
AIR RETURN


AUXILIARY SHAFT
MAIN SHAFT
1998 Inrush point
Incline
NWTR
MPH
-290m level
-260 m level
Track Incline Roadway
Air Return Incline Roadway
South Wing Track Roadway (SWTR)
Air Return Track Roadway
-260m level
Fault
Scale
0
200 m
N
1102 MF
1104 MF
1106 MF
1106 Belt Gate
1108 MF
1110 Track Gate
1110 MF -390m level
1110 Belt Gate
1112 MF
Mother Rock Roadway (-430m)
1114 MF
1115 MF
Igneous Intrusion (Dyke)
Advance
-389m level
Fb1
Fb
Sump
DS
CBR
BDE
MDS
TDE
MS-1
MS-2
MS-3
MS-4
CBR=Conveyor Belt Roadway
1101 Track Gate
1101 Belt Gate
Cross cut
1101 Mining Face
Retreat
1103 Mining Face
1105 Mining Face
1107 Mining Face (MF)
1109 Mining Face
1111
1113 Mining Face
LEGEND
BDE = Belt Dip Entry
TDE = Track Dip Entry
DE = Down Entry
DS = Down Station
MS = Middle Station
MPH = Main Pump House
MDS = Mining District Substation
Water Inrush Point in 1998
Other points of groundwater inflow
Igneous Intrusion (Dyke)
SWTR = South Wing Track Roadway
MS-1, MS-3, MS-3, MS-4 indicate Middle Station No 1, 2, 3, and 4, respectively.
Numbers of 01, 02, 03, and 04 indicate temperature measuring stations in 2001, 2002, 2003, and 2004, respectively.




ure 1: Generalized map showing location of the study are

- The Barapukuria Coal Deposit is located in the north-western part of Bangladesh, between 25° 21’ N & 25° 34’ N and 88° 57’ E & 88° 59’ E, about 50 km east of the district headquarters of Dinajpur and about 20 km east of the border with India.

- Commercial production of coal commenced on September 10, 2005.

- The Barapukuria coal deposit is presently being worked by underground mining method for a rated production of 1 Mtpa by **Barapukuria Coal Mining Company Ltd.**, a subsidiary of Petrobangla.

- The mine is being operated by **China National Machinery Import & Export Corporation (CMC)** on contract basis.

- Presently only the thick VI seam is being worked in the mine by mechanized longwall technology with top coal caving (LTCC).

Table 1: Characteristics of Coal Seam VI

| **Coal Series** | **Thickness of coal seam (m)** | | | **Lithology of roof and floor** | | **Dip angle** | **Apparent specific gravity** |
|---|---|---|---|---|---|---|---|
| | Min. | Max. | Avg. | Roof | Floor | | |
| Gondwana Group | 29.40 | 40.52 | 36.14 | Medium to coarse grained sandstone | Fine grained sandstone interbedded with siltstone and mudstone | 6-40˚<br><br>Average: 13˚ | 1.43 |

# *Major challenges being faced in Barapukuria Coal Mine*

Underground environmental problems experienced/ faced :

- Heat and humidity problems affecting the workplace environment
- Ventilation problem of the mine
- Spontaneous combustion and fire problems
- Other underground environmental problems

## Underground mine environment and ventilation of Barapukuria Coal Mine

- The underground environment of Barapukuria Coal Mine is adverse due to high temperature, humidity and water inflow.

- Barapukuria Coal Mine is a high temperature mine, characterised by:
  1. low gas
  2. liable to spontaneous combustion
  3. liable to dust explosion hazard
  4. high geothermal gradient

- **The geothermal gradient of roof strata above Seam VI ranges from 2.92°C/100m to 4.97°C/100m with an average value of 3.83°C/100m.**

- **The geothermal gradient within the Seam VI ranges from 5.96°C/100m to 22.44°C/100m, and 10.46°C/100m on average**.

- The original rock temperature of the main mine district at the lower part of seam VI is about 40°C.

- Since the geothermal gradient of the mine is quite high, the mine belongs to the high geothermal mine.

## *Ventilation problem of the mine*

- More than 27 km of roadways have been developed in underground, which causes high pressure loss in the roadways.

- Air quantity reaching at the longwall face in the range of 20 $m^3/s$, is not sufficient for ventilating longwall panel having high heat and humidity problems.

- The total pressure developed by the fan for handling an air quantity of 120 $m^3/s$ is in the range of 2000 Pa. This pressure is considered very high for a mine having fire problems.

- The high pressure developed by the fan results in increased power consumption by the fan.

## *Recommendations*

For improving ventilation system of the mine, following measures should be adopted:

- Ventilation system should be reorganized in such a way that the ventilation pressure requirement of the system is minimised so as to reduce occurrence of new fires.
- A detailed ventilation survey (pressure-quantity and temperature survey) should be carried out.
- Ventilation network model of the mine should be developed and an exhaustive computer simulation exercise should be carried out.
- Simulation may be carried out for construction of a ventilation shaft which will reduce the air travel distance, minimize air pressure loss and improve the ventilation of the mine. It is expected that in this condition, the pressure requirement for ventilating the mine may reduce to a significant extent which will reduce the total power consumption of the system, and save a large amount of energy cost for the company.
- A well equipped ventilation section may be set up by BCMCL.

**Water inflow and its temperature**

- The high water inflow is one of the major problems of the mine.

- The normal water inflow of the mine is 368 $m^3/h$ and the maximum inflow is 1160 $m^3/h$, which is three times of the normal inflow.

**Underground mine environment**

- The adverse underground mine environment is due to high temperature, humidity and water inflow.

- **Another peculiarity of Barapukuria Coal Mine is high temperature of the water oozing out from the strata, which is in the order of 40-45°C.**

- **The main reasons for abnormal underground temperature of Barapukuria Coal Mine are due to thick overburen (about 500 m depth) and lower heat conductivity of aquifers which result in accumulation of heat.**

- **In addition, the high surface temperature, high geothermal gradient and high water temperature contributes towards the increasing heat load of the underground mine environment of Barapukuria mine.**

**Heat and humidity**

- Barapukuria Coal Mine has got a typical underground mine environment with high temperature and humidity.

- Depending on location, the roadway temperature varies from 28-37°C with 100% humidity and the miners experience difficulties while working in that adverse mine environment hampering the development and production from longwall faces.

- Longwall panel 1116 possesses high temperature and humid atmosphere with DBT and WBT of around 35°C and close to 100% relative humidity.

- In longwall face 1109, the DBT/WBT were recorded highest of 41°C. In the development headings, the underground atmosphere is comparatively more hot and humid due to high water temperature.

## Temperature readings at various locations in the longwall panels:

| **Record of ventilation measurements made in panel 1116** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Station Reference | Location | Area of Roadway, $m^2$ | Average Air Velocity, m/sec | Airflow, $m^3/s$ | DB Temp, $^0C$ | WB Temp, $^0C$ | | Relative Humidity, % |
| A | 25m from the first T. Support of B/G | 8.88 | 2.58 | 22.91 | 30.50 | 29.75 | | 95.00 |
| B | 25m from the T. Junction of B/G | 8.71 | 2.50 | 21.78 | 31.75 | 31.00 | | 95.00 |
| C | 25m from the T. Junction of T/G | 9.53 | 2.30 | 21.92 | 34.50 | 34.00 | | 97.00 |
| D | 25m from the first T. Support of T/G | 9.68 | 2.25 | 21.78 | 35.00 | 34.50 | | 98.00 |
| | Longwall face | - | - | - | 33.50 | 33.00 | | 97.00 |

| **Record of ventilation measurements made in panel 1111** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Station Reference | Location | Area of Roadway, m$^2$ | Average Air Velocity, m/sec | Airflow, m$^3$/sec | DB Temp, $^0$C | WB Temp, $^0$C | | Relative Humidity, % |
| A | 30m from the first T. Support of B/G | 9.12 | 2.75 | 25.08 | 27.50 | 26.50 | | 93.00 |
| B | 30m from the T. Junction of B/G | 9.09 | 2.67 | 24.23 | 31.75 | 31.50 | | 98.00 |
| C | 30m from the T. Junction of T/G | 9.12 | 3.42 | 31.16 | 35.00 | 34.50 | | 97.00 |
| D | 490$^{th}$ Trapezoidal Steel Support of T/G | 8.14 | 3.63 | 29.55 | 36.00 | 36.00 | | 100.00 |
| | Open off cut | - | - | - | 31.75 | 31.50 | | 97.00 |

The above temperature measurements reveal that the wet bulb temperature (WBT) and relative humidity at a number of points in the longwall panel is quite high.

Analysis of the information available in Wardell Armstrong, CMC reports and data gathered during the field visit revealed the following important **reasons for such a high underground temperature**:

- **High geothermal gradient:** Considered as one of the main heat sources by heat interchange from rock/coal seam, working/advancing faces and coal/rock caving in the mined out area with the air within the mine.
- **The high virgin rock temperature:** Temperature of the main mining range at the lower part of seam VI is about 40°C which contributes a substantial heat release into the mine environment.
- **Heat liberated from the hot water (40-45°C) oozing out from the mine:** Water transfers its heat to the mine air during evaporation and thereby increasing the latent heat of the air.
- Heat from auto-oxidation of coal, carboniferous and sulphurous surrounding rock and supporting materials.
- Heat from electromechanical equipment operated in the longwall and driving faces.
- Heat due to auto-compression of downcast air and from other sources like heat from explosion, human bodies, coal/rock transportation, lighting, wires and cables etc.
- Heat added from the surface air downcasted underground.
- The high underground temperature along with high volume of water percolation in the mine is responsible for the high relative humidity.

# Suggested measures for heat and humidity

In order to prevent water evaporation and reduce the humidity, it is suggested that water flowing in the longwall panels should be channelized through water drains and drains should be properly covered.

Alternatively, the following arrangements may be done for prevention of water evaporation and reducing humidity in the mine:

- The water percolated in the intake airways should be channelized through the covered drains so that it does not come in contact with the intake air.

- The channelized water through the covered drains should be diverted towards the return circuit, which will reduce the humidity at the working faces.

- Proper planning of draining out of this water should be in the minimum intake air zone of the mine. This can be achieved either by recognizing the ventilation air routes of the mine or by recognizing the water draining out circuit.

## *Heat and humidity problems affecting the workplace environment*

Analysis of ventilation data reveals the following serious heat and humidity problems:

- WBT in some working areas of longwall face reached to 33 °C with 97% humidity.
- In one of the longwall panel, maximum WBT of 36°C with 100% humidity have been encountered.

The reasons for such a high underground temperature are as follows:

- High geothermal gradient.
- Heat liberated from the hot water oozing out from the mine.
- Heat from auto-oxidation of coal and carbonaceous matter.
- Heat from equipment operated in the longwall panels.
- High temperature of surface air in summer.

## *Recommendations*

- Following arrangements should be made for reduction of humidity in the mine:
  - Percolated water in the intake airways should be channelized through the covered drains
  - Channelized water through the covered drains should be diverted towards the return circuit as far as practicable.

- Increasing the quantity of airflow to the working areas to dilute the heat and humidity.

- A detailed study may further be carried out and air cooling system should be installed for solving the heat and humidity problems in the mine.