Principle of CBM Generation & Production and Overall CBM Scenario in India

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LKMT SEMINAR

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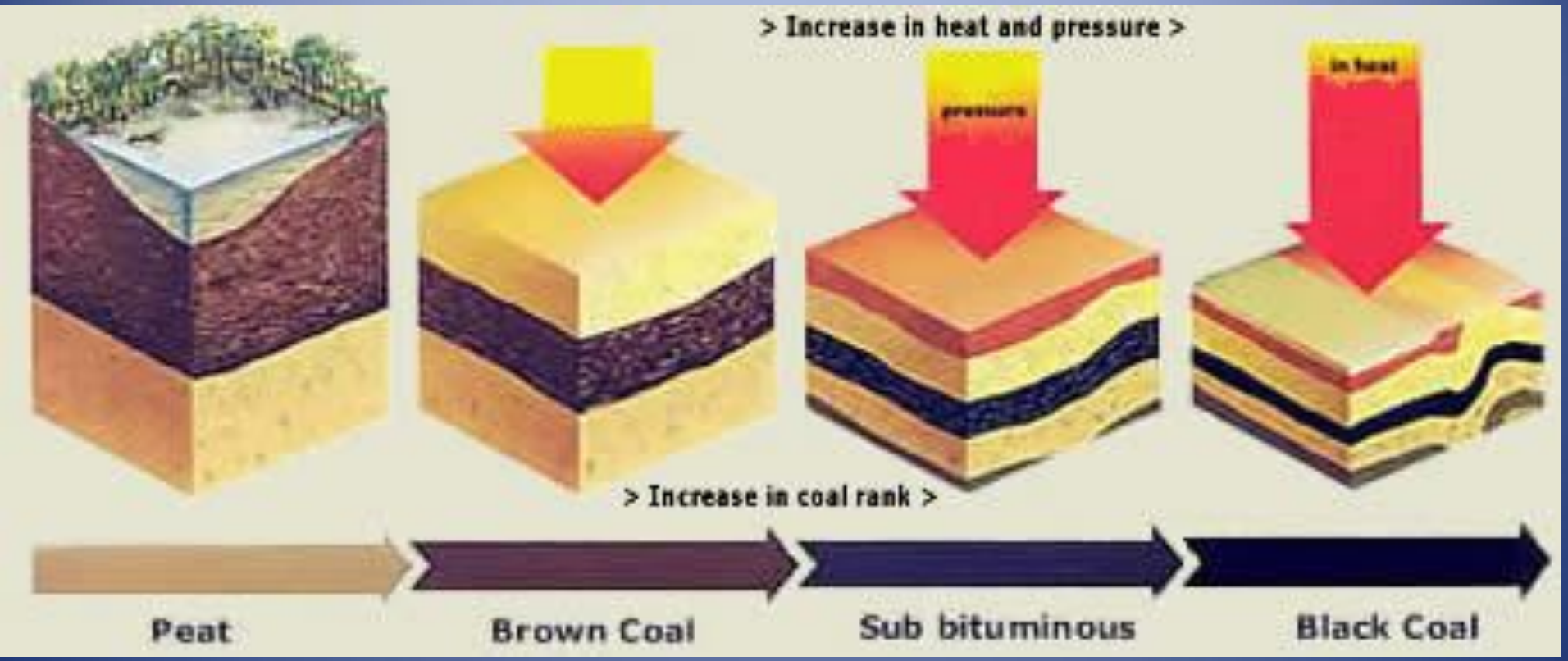
PART-1. Principle of CBM Generation & Production

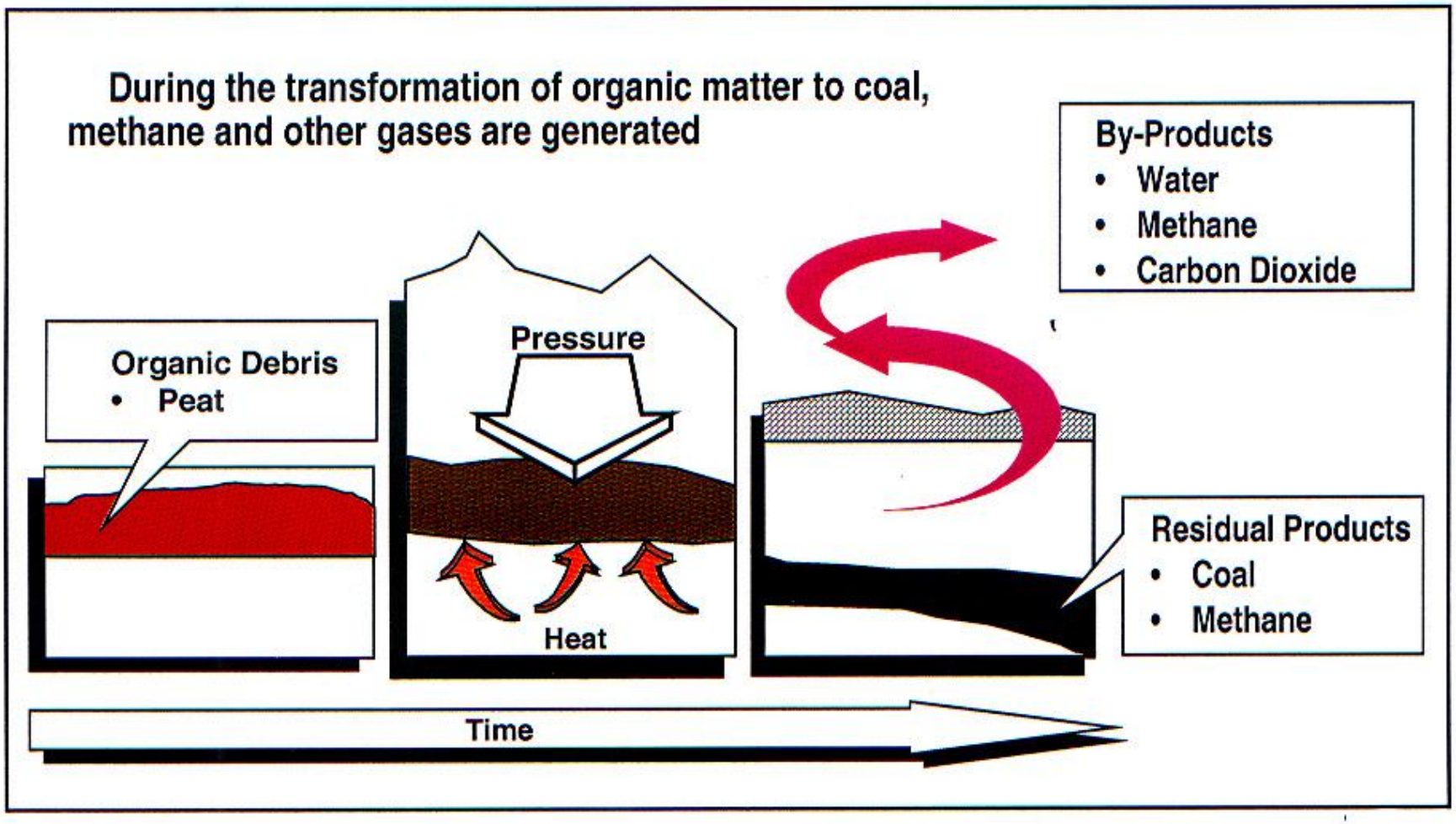
OUTLINE

- Coal formation
- CBM Generation
- Stages of Coalification and Coalbed gases
- Production of conventional vs. CBM
- Gas content and saturation
- Permeability of coal
- Typical CBM well construction
- Steps Followed for Producing CBM Wells
- Artificial lifts for dewatering
- A typical CBM well under production
- A Typical production profile
- Typical surface facilities

Formation of Coal



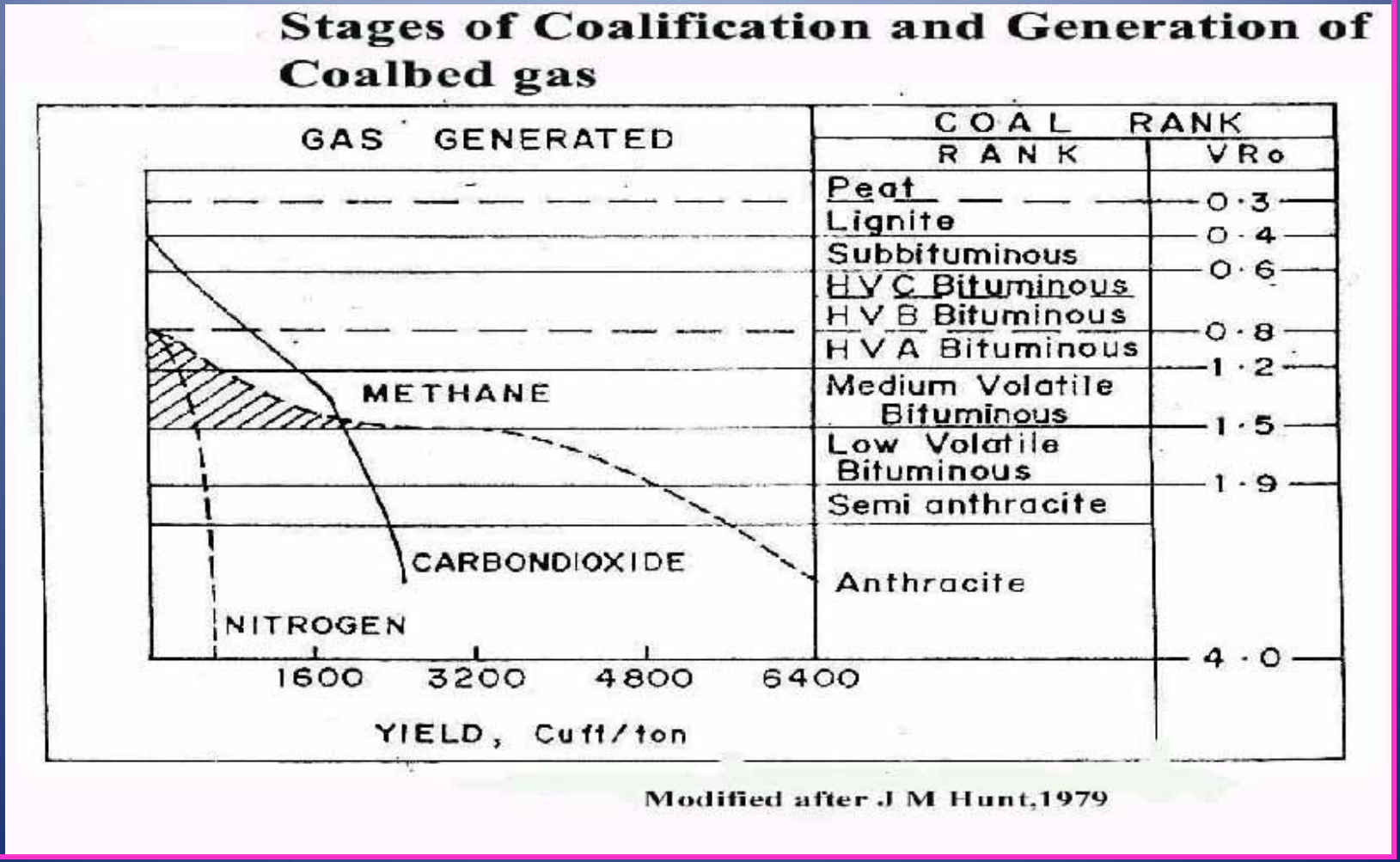
Generation of CBM



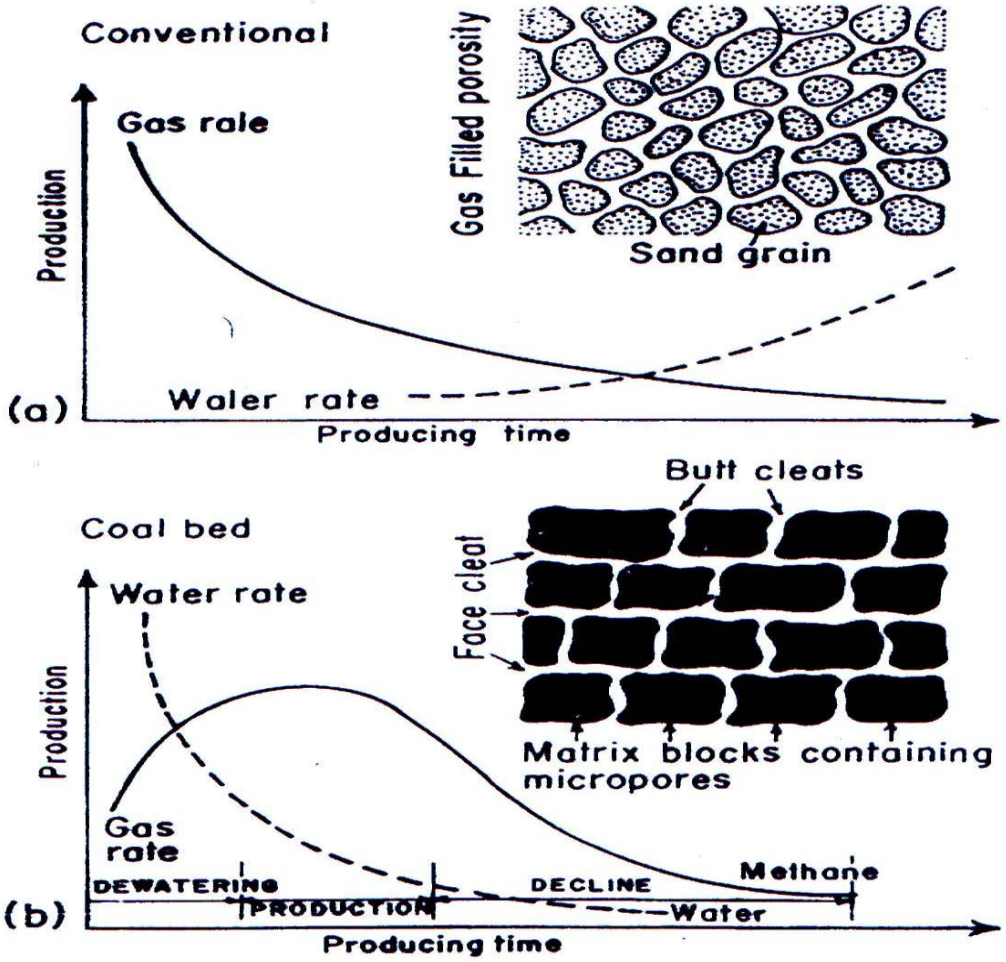
Transformation of Organic Matter to Coal.

PRINCIPLES OF CBM GENERATION

- Large quantities of Methane is generated – within High Volatile Bituminous (VR_0 0.6) to Anthracite(VRo $\geq$1.9)

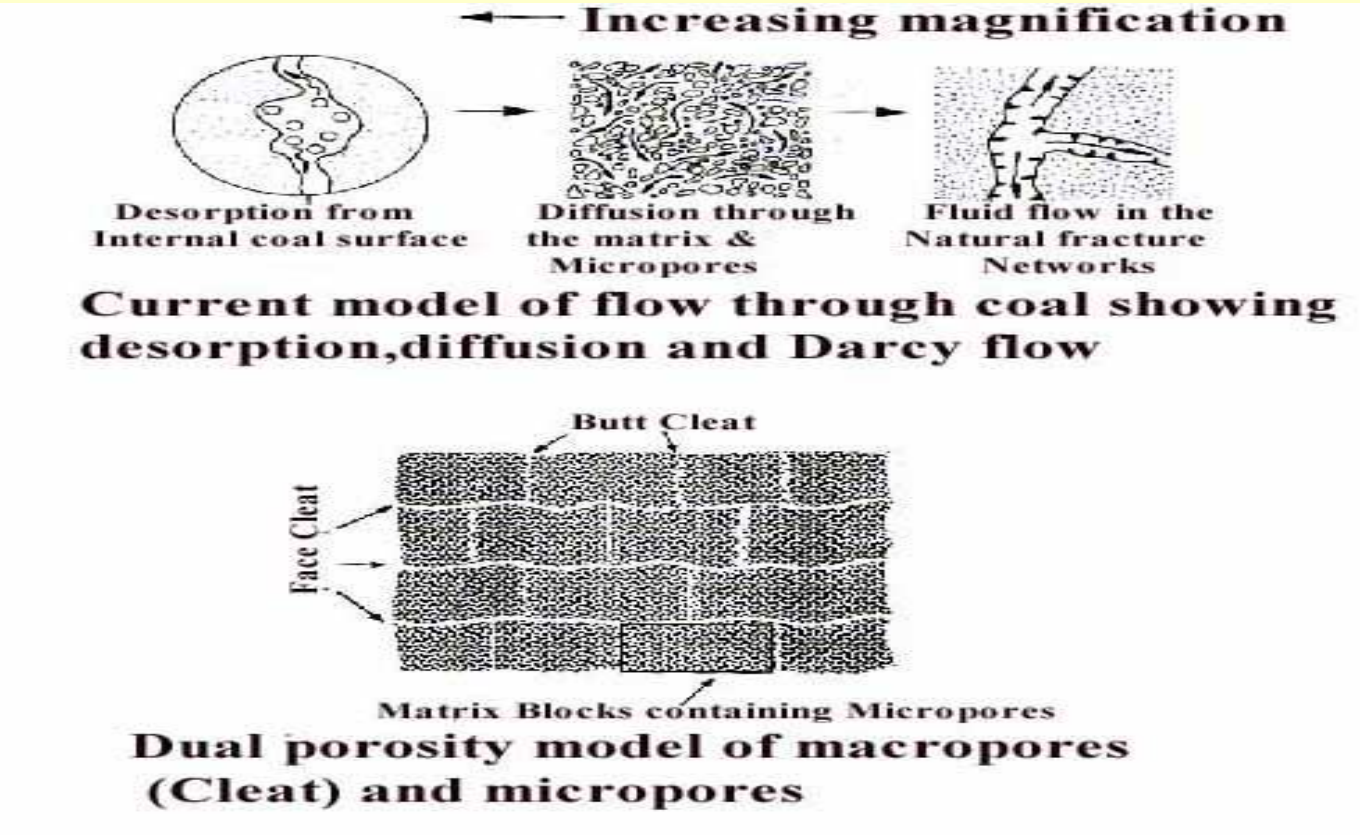


Recovery of Conventional vs Coalbed Gas

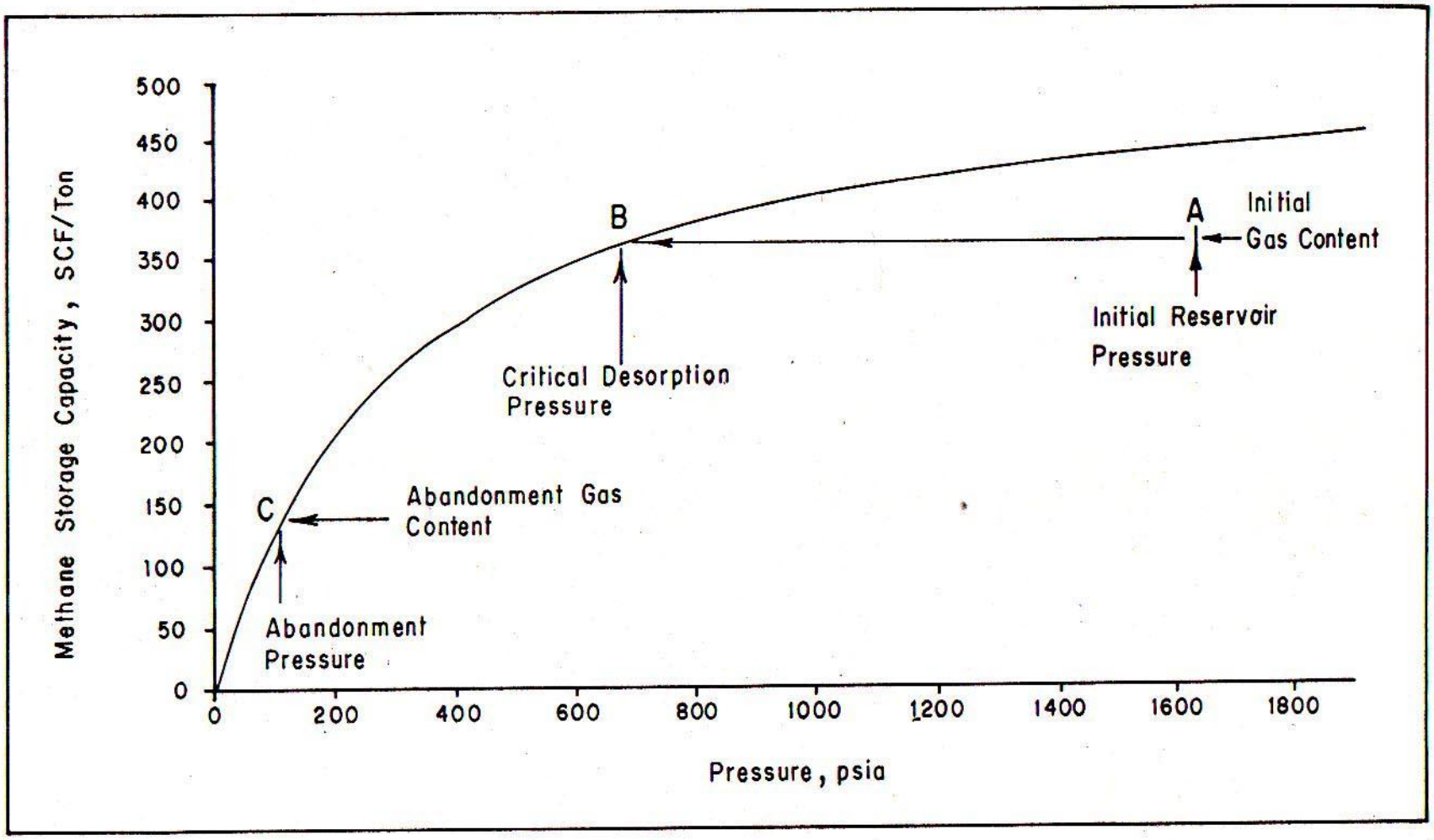


After: B. J. Huges etal 1990.

PRINCIPLES OF CBM STORAGE AND FLOW MECHANISM

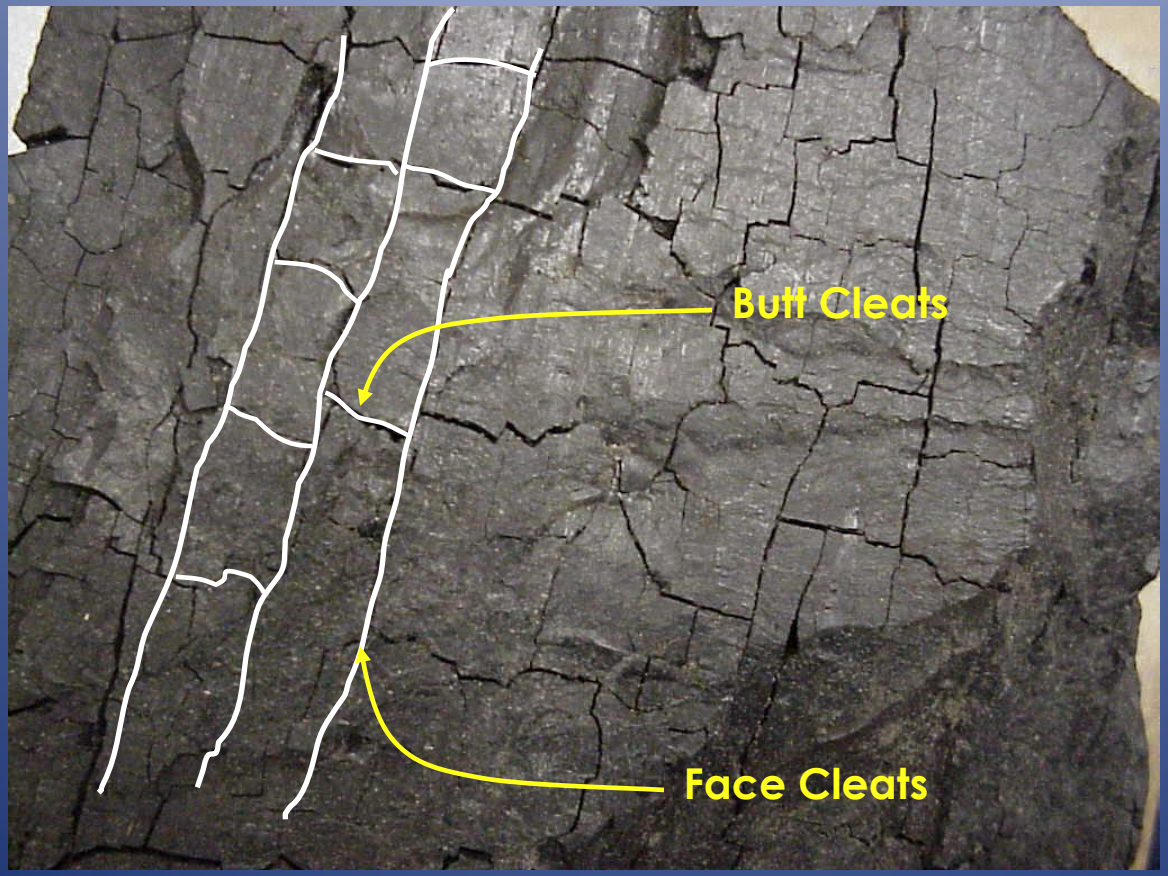


- Production of CBM gas from coal is controlled by a three step process- diffusion of gas from the bulk to the surface, desorption of gas from the surface to the cleat / fracture and flow of gas from cleat/ fractures to the well bore.

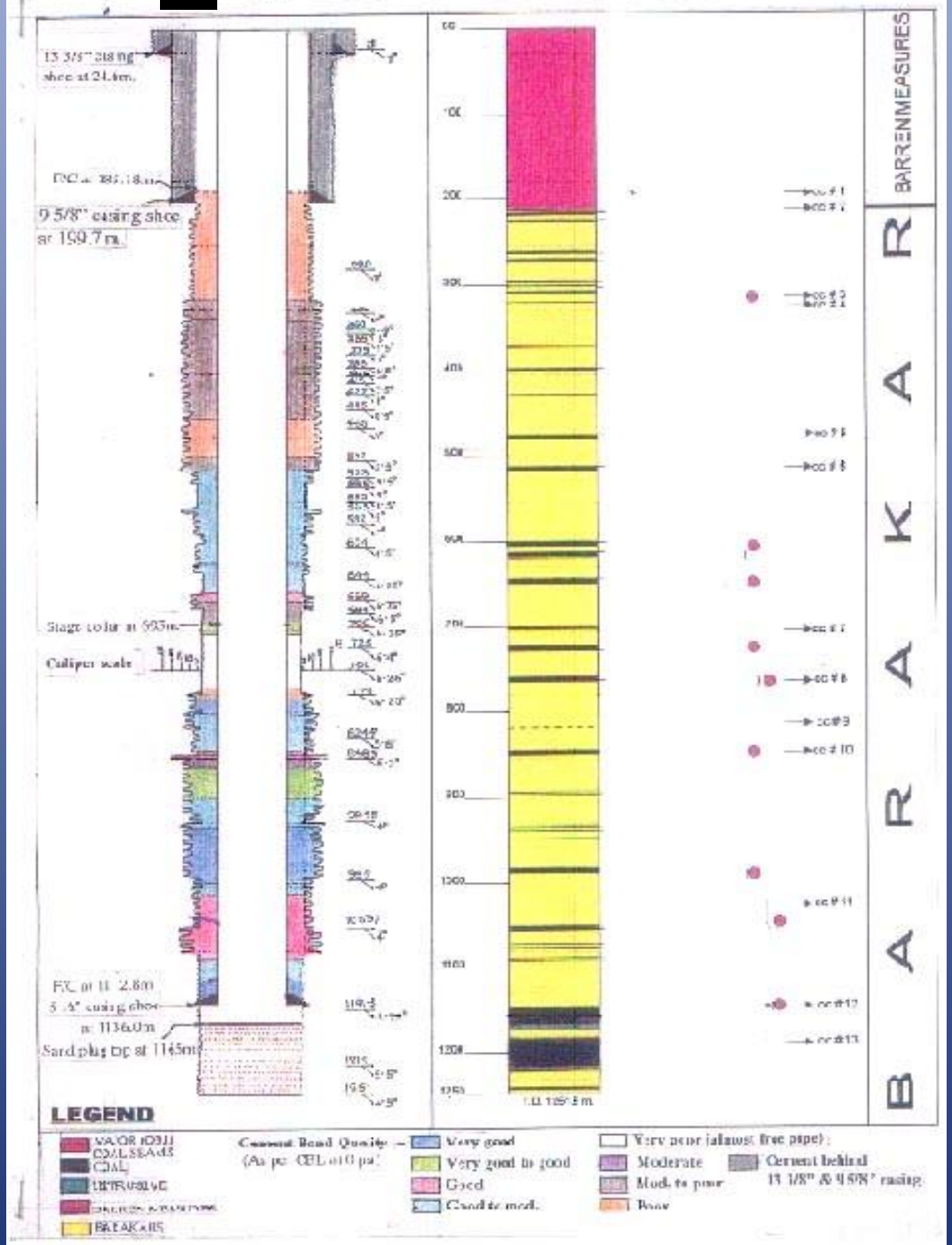


Typical Sorption Isotherm of Coal

Cleats in Coal

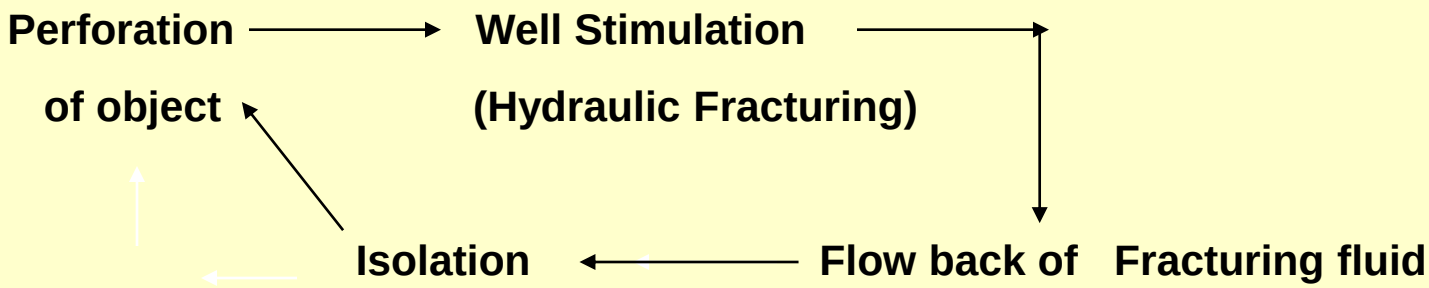


Typical Well Construction



Steps Followed for Producing CBM Wells

The Sequence of operation During HF in Development Phase



Operation repeated for each object

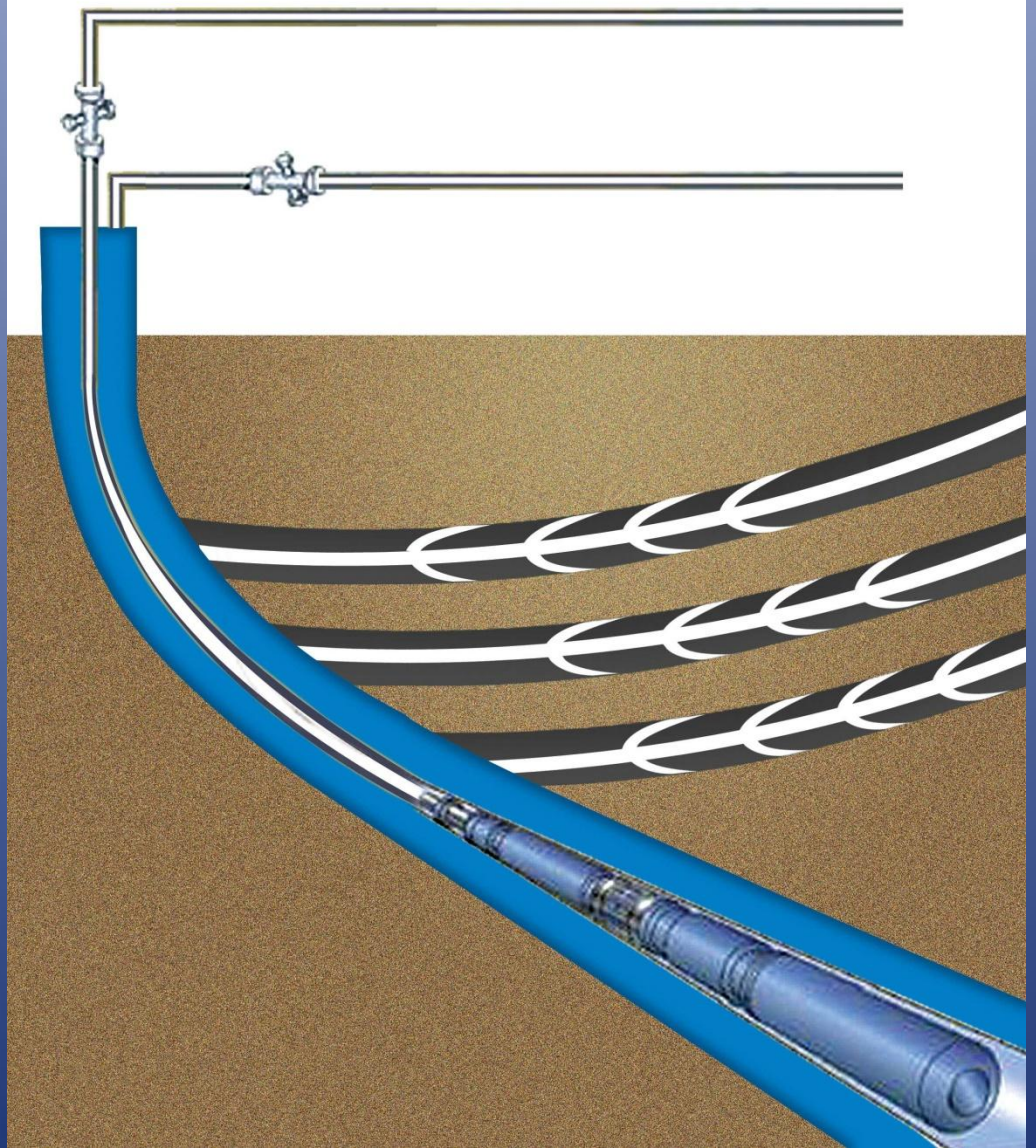
Dewatering and production

* In Development wells reservoir testing may be carried out in selective number of well as per specific requirement
* **No additional time involvement is envisaged for production testing before actual production unlike exploration & Pilot wells**

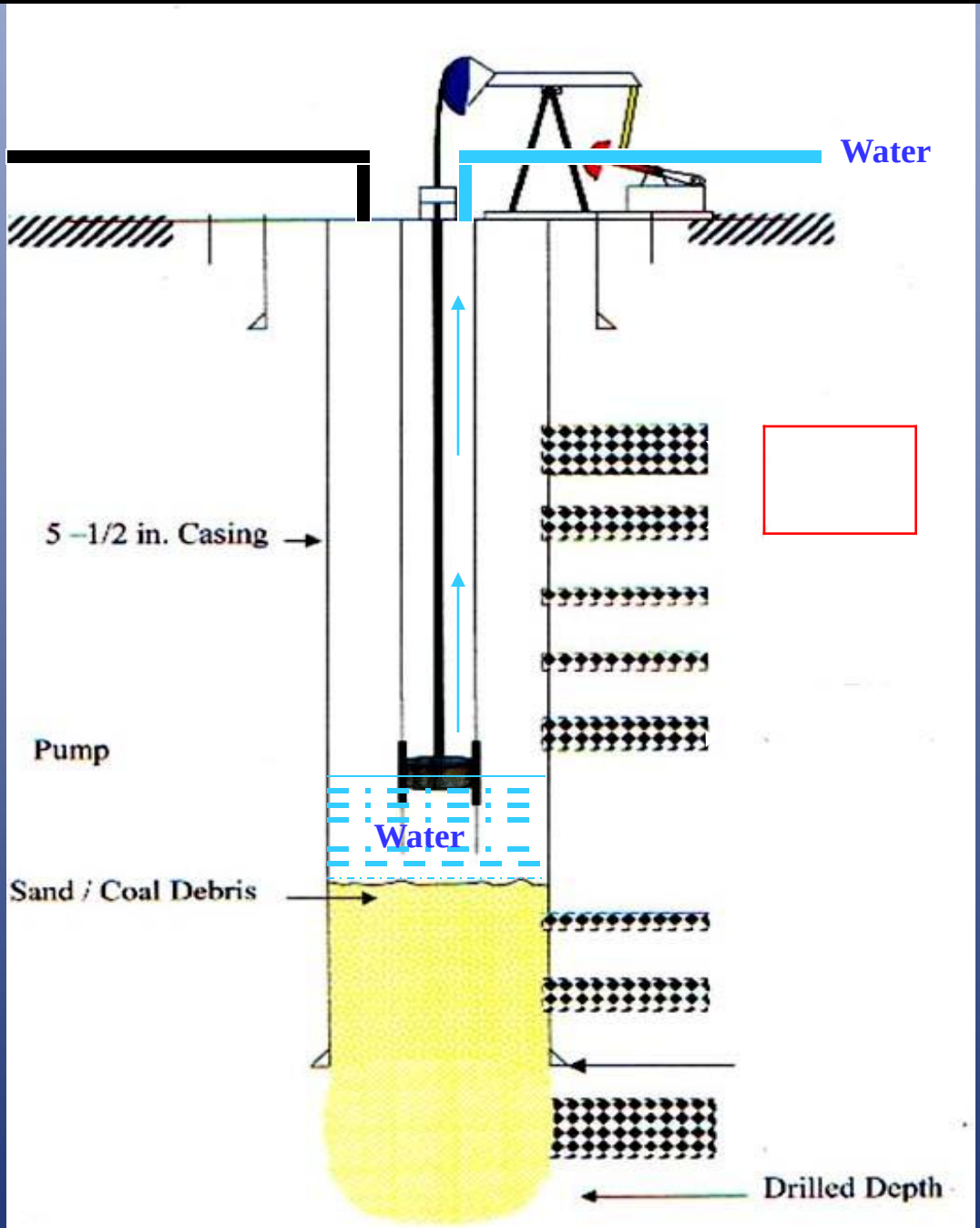
SRP (Conventional)

VIEW OF PC PUMP

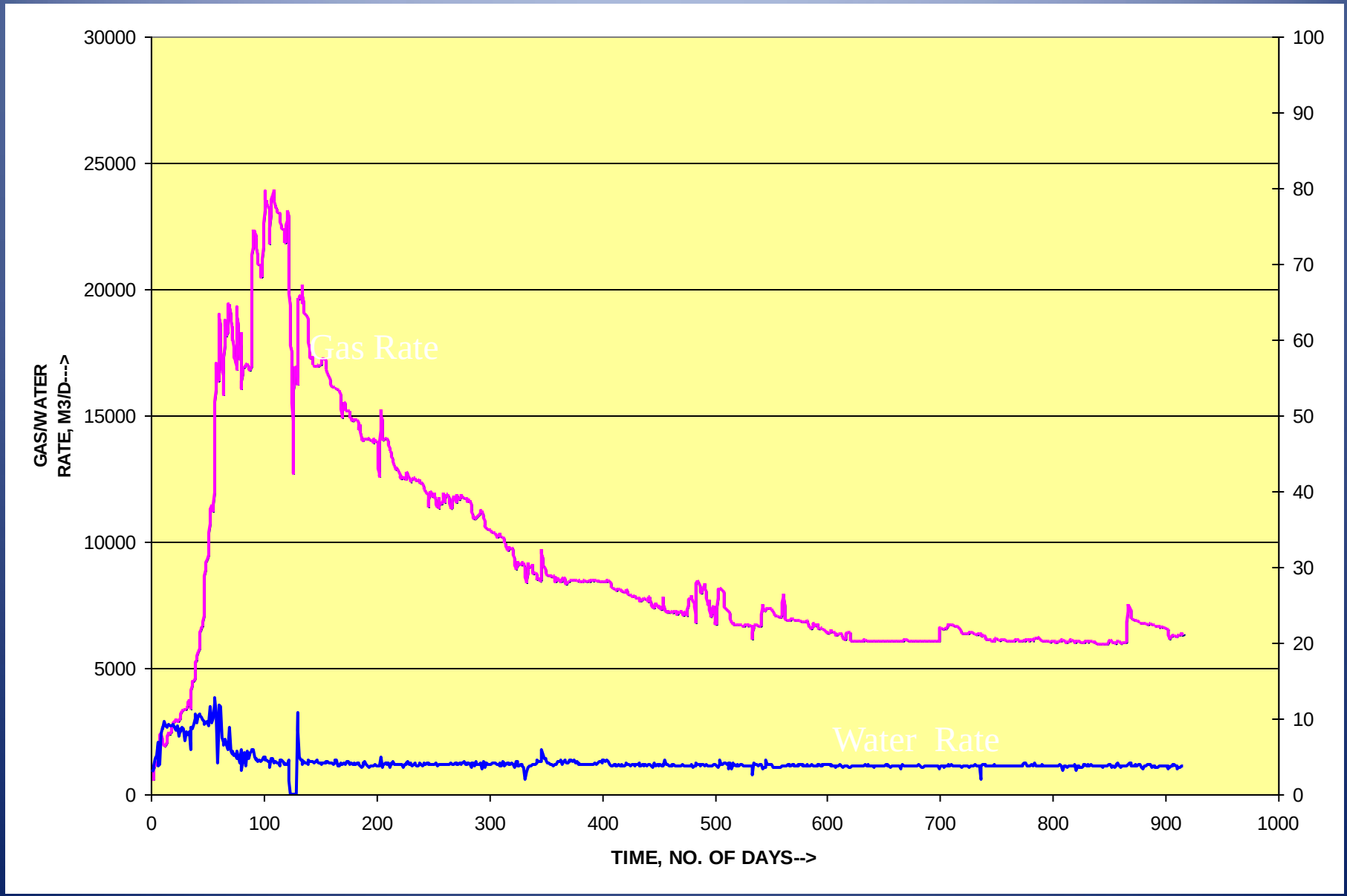
Schematic diagram of a horizontal well completed with ESP

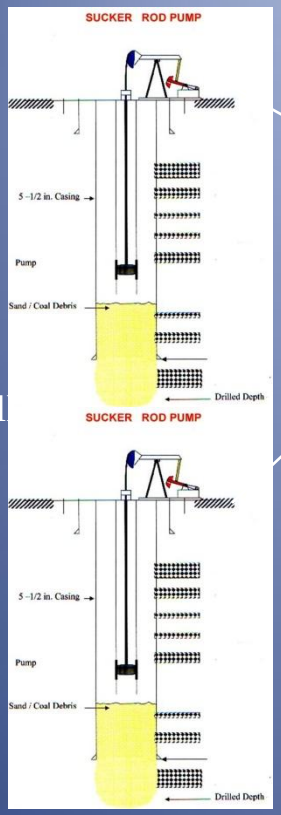


Schematic Of a Producing CBM well- Jharia



Typical Production profile





Wel

Separators

Compressors

Dehydrators

Meter

Treating ponds

River Disposal

Inje on Well

Pipeline Compressor Stations

Main Pipeline

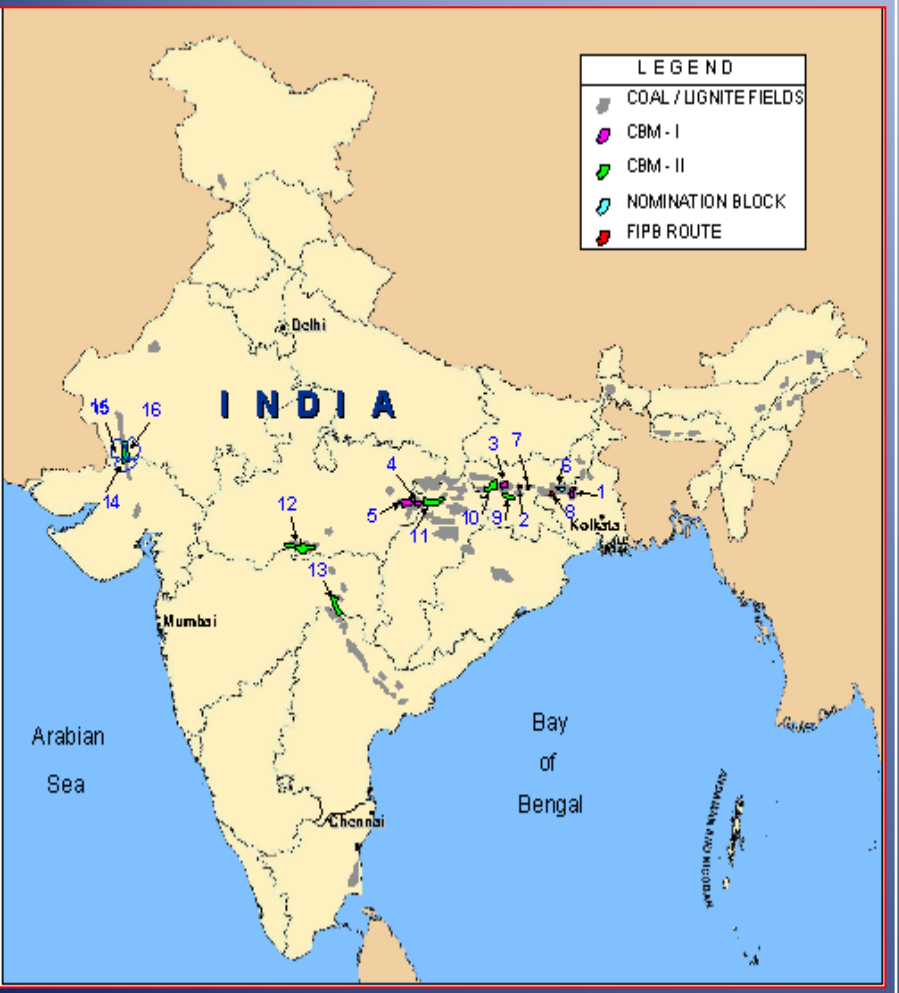
PART-2. CBM Scenario - India

- CBM Initiatives of Govt. of India
- CBM Blocks Awarded Under different Rounds
- Results – Critical Analysis
- Progress in last one and half decade
- Operator-wise and Block-wise Status
- Area , undiscovered Resources and In-place
- Area , undiscovered Resources and rationalised In-place
- Total producible Gas
- Indicative Financial Implications
- Summary

CBM Initiatives

- VCBM Policy formulated in 1997
- 1st Round of Bidding started in 2001
- Total 26,000 Sq.km. with 2.6 TCM resources estimated
- Up to 2010 in 4 rounds of Bidding a total of 33 Blocks awarded
- Total area of the awarded Blocks17,327 Sq.km
- Resources of the awarded blocks 1.8 TCM
- Initially VCBM production potential projected as 38 MMSCMD

CBM Blocks Awarded



1st Round of Bidding(2001)

	Area,Sq KM	BCM	Block	Awardee
1	500 sq km	42	Raniganj East	Essar
2	95	45	Bokaro	ONGC-IOC
3	340	62	N. Karanpura	ONGC-IOC
4	495	49	Sohagpur East	RIL
5	500	37	Sohagpur West	RIL
	1930	235		

Blocks on Nomination Basis/FIPB(2001)

6	350	43	Raniganj,North	ONGC-CIL
7	210	30	Raniganj,South	GEECL
8.	85	85	Jharia	ONGC-CIL
	645	158		

2nd Round of Bidding(2003)

9	70	30	S. Karanpura	ONGC
10	267	43	N. Karanpura(W)	ONGC
11	825	34	Sonhat	RIL
12	714	29	Satpura	ONGC
13	503	20	Wardha	ONGC
14	790	87	Barmer(BS-3)	ONGC-GSPC
15	1045	95	Barmer	RIL
16	1020	88	Barmer	RIL
	5234	426		

Gross 7809 819


BLOCKS ON OFFER CBM-III
SINGRAULI COALFIELD
SR-CBM-2005/III
TATAPANI-RAMKOLA COALFIELD
TR-CBM-2005/III
BARMER SANCHOR
BS(4)-CBM-2005/III
BS(5)-CBM-2005/III
BIRBHUM & RAJMAHAL COALFIELD
BB-CBM-2005/III &
RM-CBM-2005/III
MAND-RAIGARH COALFIELD
MR-CBM-2005/III
SOHAGPUR COALFIELD
SP (N)-CBM-2005/III
KOTHAGUDEM & GODAVARI VALLEY COALFIELDS
KG(E)-CBM-2005/III &
GV(N)-CBM-2005/III

Blocks Awarded Under CBM-III

Sl NO.	COAL-FIELD	BLOCK NAME	AREA (SQ.KM)	STATE
1	Raj Mahal	RM-CBM-2005/III	469	Jharkhand
2	Birbhum	BB-CBM-2005/III	248	West Bengal
3	Tatapani-Ramkola	TR-CBM-2005/III	458	Chattisgarh
4	Mand-Raigarh	MR-CBM-2005/III	634	Chattisgarh
5	Sohagpur	SP(North)-CBM-2005/III	609	Madhya Pradesh
6	Singrauli	SR-CBM-2005/III	330	Madhya Pradesh
7	Kothagudem	KG(East)-CBM-2005/III	750	Andhra Pradesh
8	Barmer	BS(4)-CBM-2005/III	1168	Rajasthan
9	Barmer	BS(5)-CBM-2005/III	739	Rajasthan
10	Godavari-Valley	GV(N)-2005/III	386	Andhra Pradesh

Critical Analysis-Trend of Results

CBM Round	No of Blocks	Total Area (Sq km)	Resources (BCM)	Resources Density (BCM/sq km) *100	In-place (BCM)	In place density (BCM/sq km) *100	No of Block relinquished/ Proposed for relinquishment	Prospect established		Remarks
								No of Block	Area	
I + Nomination	8	2575	393	15.3	280.2	13.5	Nil	8	2075	71% in-place established
II	8	5234	426	8.13	Nil	-Nil	8	Nil	Nil	No in-place / reserves established
III	10	5791	636	10.98	~50	0.275	5	1	600	Only in SP(N) In-Place established. 5 blocks Relinquished. Though 4 Blocks still under assessment it is envisaged that no in-place /reserves conversion is likely from any of the blocks.
IV	7	3727	330	8.85	Nil	Nil	Nil	Nil I	Nil	Under relinquishment/assessment, however no encouraging results are known and as such unlikely to add any in-place/ reserves.

Progress in last one and half decade

- In last 15 years resources to In-place conversion in awarded blocks is only ~22% i.e. 1800 BCM : 400 BCM
- This in-place established in 6 Blocks of 4 Damodar River Valley coal fields(Raniganj, Jharia, Bokaro and North Karanpura) and in 3 Blocks of Son River valley coal fields(Sohagpur-East, West and North)
- Out of the above 7 Blocks 6 Blocks awarded in 1st Round of Bidding in 2002 and SP(N) under Round-III in 2007
- 6 Blocks are in Development Phase, 1 Block[SP(N) to enter Pilot Phase
- The Operators involved in Development Phase are:

- RIL in Sohagpur East & West Blocks

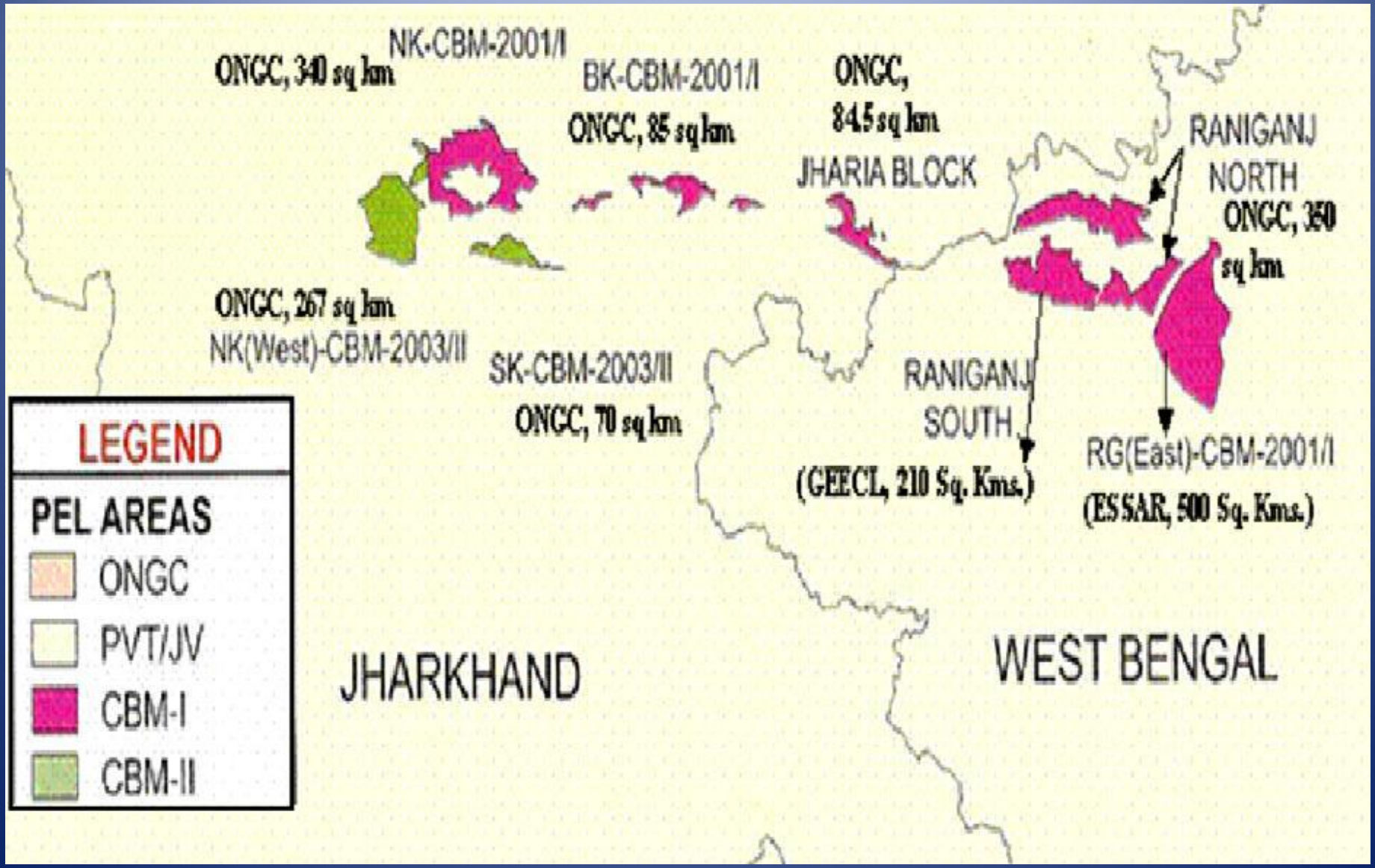
- ESSAR in Raniganj East

- GEECL in Raniganj South

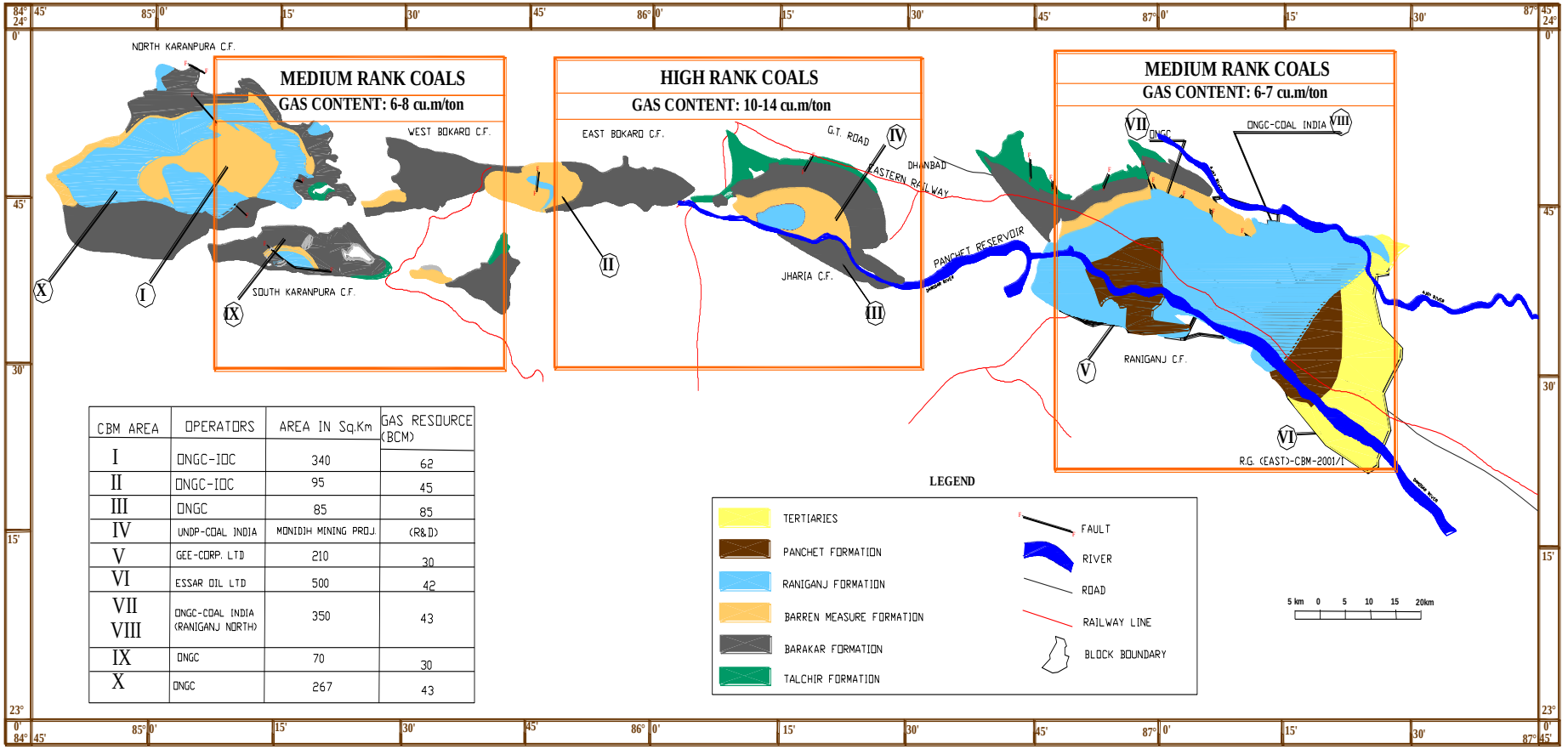
- ONGC-CIL in Raniganj North & Jharia

- ONGC-IOC in Bokaro & North- Karanpura

CBM Blocks in Damodar River Valley

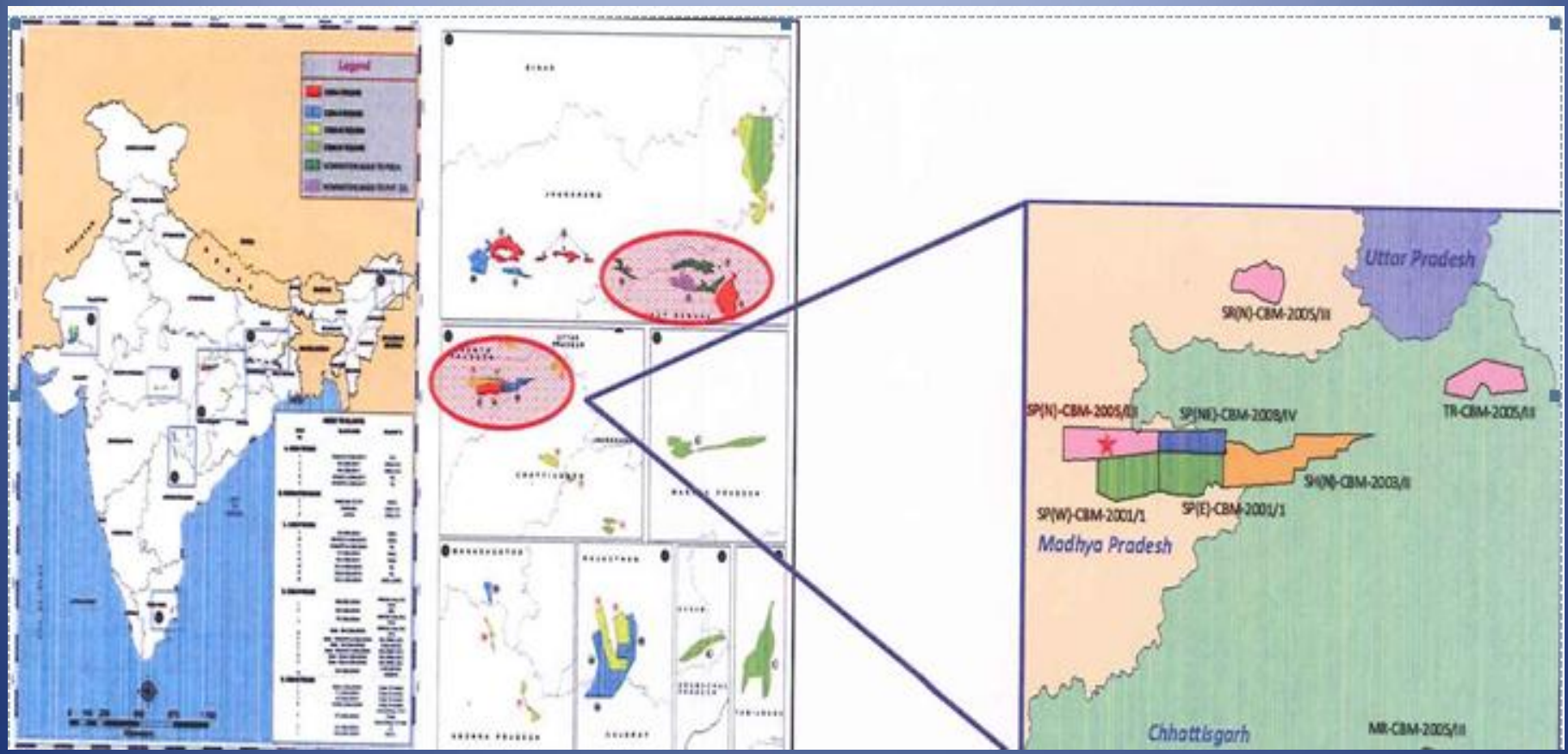


Geological Map of Damodar Valley Coalfields



CBM AREA	OPERATORS	AREA IN Sq.Km	GAS RESOURCE (BCM)
I	ONGC-IOC	340	62
II	ONGC-IOC	95	45
III	ONGC	85	85
IV	UNDP-COAL INDIA	MONIDIH MINING PROJ.	(R&D)
V	GEE-CORP. LTD	210	30
VI	ESSAR OIL LTD	500	42
VII VIII	ONGC-COAL INDIA (RANIGANJ NORTH)	350	43
IX	ONGC	70	30
X	ONGC	267	43

CBM Blocks in Son River Valley



Operator-wise and Block-wise Status

- RIL: Sohagpur East & West
- Total Area-995 Sq. Km. (86BCM- DGH)
- Established in-place volume - 130 BCM
- Currently in Development Phase ; planned to drill 500-600 wells
- Average well production 5000-8000 Cu.m
- Expected Production on full field deliverability -2.5 – 4.5 MMSCMD
- Drilled about 230 wells
- Present Production-0.8 MMSCMD
- Problem of gas pricing and acquisition of land in tribal areas

Operator-wise and Block-wise Status

- ESSAR: Raniganj East
- Total Area-500 Sq. Km. (42 BCM- DGH)
- Established in-place volume - 120 BCM
- Currently in Development Phase ; Identified Fair Way area of around 200 sq. km. planned to drill 550 wells
- Average well production 3000-5000 Cu.m
- Expected Production on full field deliverability -2.5 – 3.0 MMSCMD
- Drilled about 348 wells ; ~150 wells on production
- Present Production-0.6 MMSCMD
- Problem of gas pricing and problems in supply end – reason for less production

Operator-wise and Block-wise Status

- GEECL: Raniganj South
- Total Area-210 Sq. Km. (30 BCM; DGH)
- Established in-place vol. – initially 38 BCM- revised to 69 BCM
- Currently in Development Phase ; planned to drill 300-400 wells
- Average well production 4000-6000 Cu.m
- Expected Production on full field deliverability ~2.5 MMSCMD
- Drilled about 150 wells ;
- Present Production- 0.5 MMSCMD
- 1st Operator to declare commercial production with 0.15 MMSCMD in 2008
- Reason for gas production of only 0.5-0.6 MMSCMD in 10 years is not known.

Operator-wise and Block-wise Status

- ONGC-CIL(74:26): Raniganj North
- Total Area-350 Sq. Km. (43 BCM - DGH)
- Established in-place vol. – 7.5 BCM (Only in 110 Sq. Km. area)
- Envisaged 28BCM in whole 350 Sq.km.
- EOI Published for starting Development work (1st Phase) through Integrated contract for drilling of 77wells in 110 Sq.km
- Average well production 4000-6000 Cu.m
- Expected Production from this area ~0.3 MMSCMD
- Development drilling to be initiated
- Work delayed due to overlapping issue and extreme difficulties in land acquisition
- No production

Operator-wise and Block-wise Status

- ONGC-CIL(90:10): Jharia
- Total Area-85 Sq. Km. (85 BCM- DGH)
- Established in-place vol. – 22.7 BCM
- 72 fresh development wells and 14 carried forward wells
- Development drilling yet to start
- Average well production 7000-8000 Cu.m
- Expected Production from this area ~0.6 MMSCMD
- No information regarding initiation of Development drilling
- Present Production- 15000m 3/day (i.e.0.015MMSCMD)
- Issue of overlapping of coal mining block and difficulties in land acquisition delayed the progress

Operator-wise and Block-wise Status

- ONGC- IOC(80:20): Bokaro
- Total Area-95 Sq. Km. (45 BCM- DGH)
- Established in-place vol. – 28 BCM
- 146 fresh development wells and 9 carried forward wells
- Development drilling started
- Average well production 6000-8000 Cu.m
- Expected Production from this area ~0.8 MMSCMD
- Regular production from the development wells yet to start
- Delayed progress due to difficulties in land acquisition.

Operator-wise and Block-wise Status

- ONGC- IOC(80:20): North Karanpura
- Total Area-340 Sq. Km. (62 BCM- DGH)
- Established in-place vol. – 23 BCM
- 68 fresh development wells and 6 carried forward wells
- ONGC roped in Prabha Energy (Deep Industries) by off- loading 25% of its PI for initiating development drilling .
- Average well production 4000-5000Cu.m
- Expected Production from this area ~0.3 MMSCMD
- Regular production from the development wells yet to start
- Delayed progress due to difficulties in land acquisition.

Area , undiscovered Resources, In-place

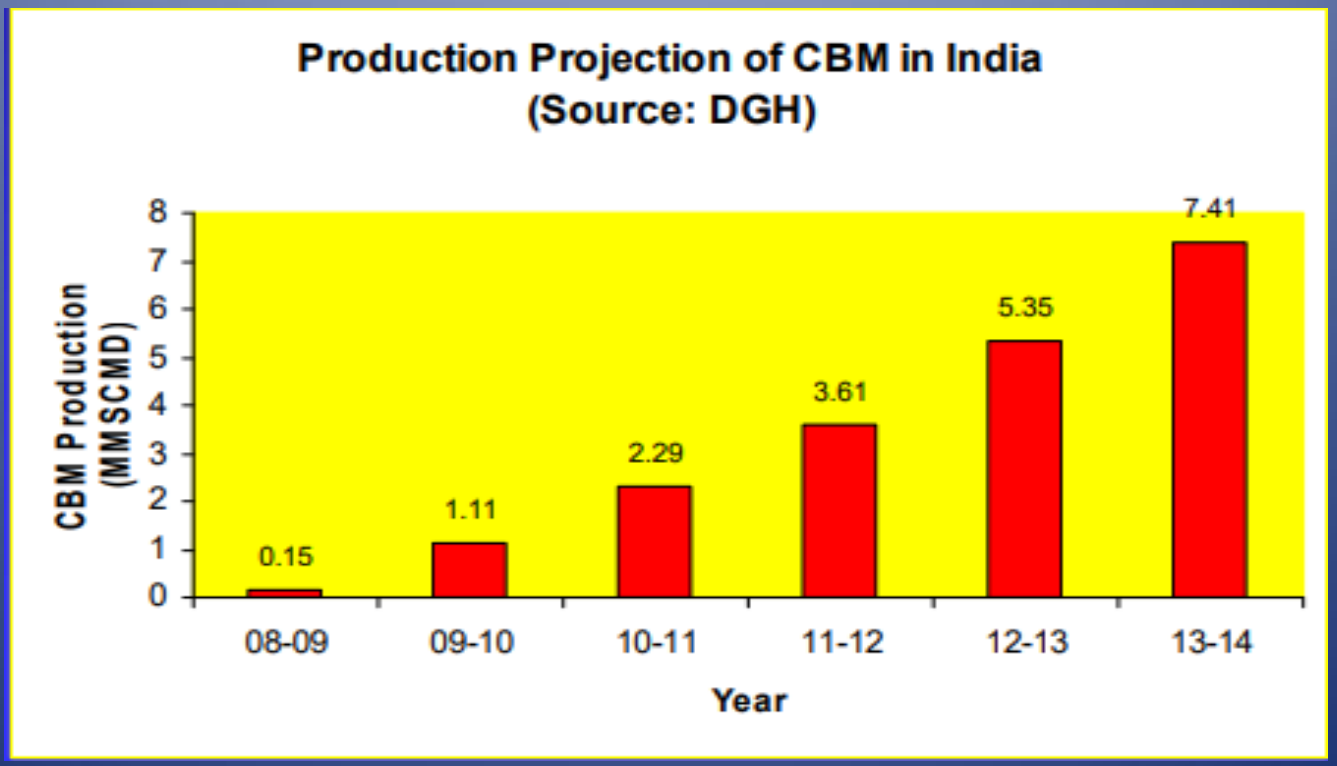
	AREA in Sq. km	Undiscovered Resources (DGH) in BCM	In-place In BCM	Rationalised in –Place in BCM
ONGC	870	235	82	60
RIL	995	86	130	80
GEECL	210	30	69	20
ESSAR	500	42	120	40
Total	2575	393	401	200

Operator-wise and Block-wise Status

- Reliance Infra: Sohagpur North
- Total Area-609Sq. Km. (19 BCM- DGH)
- Established in-place vol. – 54 BCM
- Exploration Phase completed
- Pilot Phase work yet to start
- Short time Exploratory Test well produced ~3500m3/day
- No projection of production can be made

CBM production projected in 2010

- Commercial production started during 2008-09;it was 0.15 MMSCMD
- In 2010 projected production was 3.61 &7.41MMSCMD by 2011-12 and 2013-14 respectively
- But now in 2018 it stands around 2 MMSCMD only



Area , undiscovered Resources, In-place

	AREA in Sq. km	Undiscovered Resources (DGH) in BCM	In-place (In BCM)	Rationalised in –Place* (in BCM)
ONGC	870	235	81	60
RIL	995	86	130	80
GEECL	210	30	69	20
ESSAR	500	42	120	40
Total	2575	393	400	200

Implications(with 50% recovery and 25 years of Production life)

Operator	Rationalised In –place (BCM)	Producible Reserves (BCM) ; RF= 50%	Production Rate (MMSCMD	Annual Production Rate(BCM)	Total Production in 25 yrs. (BCM)
GEECL	20	10	1.1	0.4	10
ONGC	60	30	3.3	1.2	30
RIL	80	40	4.4	1.6	40
ESSAR	40	20	2.2	0.8	20
	200	100	11	4	100

Indicative Financial Implications

- With the assumption of Average gas price of $ 8 /MMBTU the price of 100BCM gas= $25 billion
- The total approximate investment is of the order of $ 12.5 billion is envisaged
- For producing 10, 20, 30 and 40 BCM of gas, it is envisaged GEECL, ESSAR, ONGC and RIL have to invest $1.25, $2.50, $3.75 and $5billion respectively

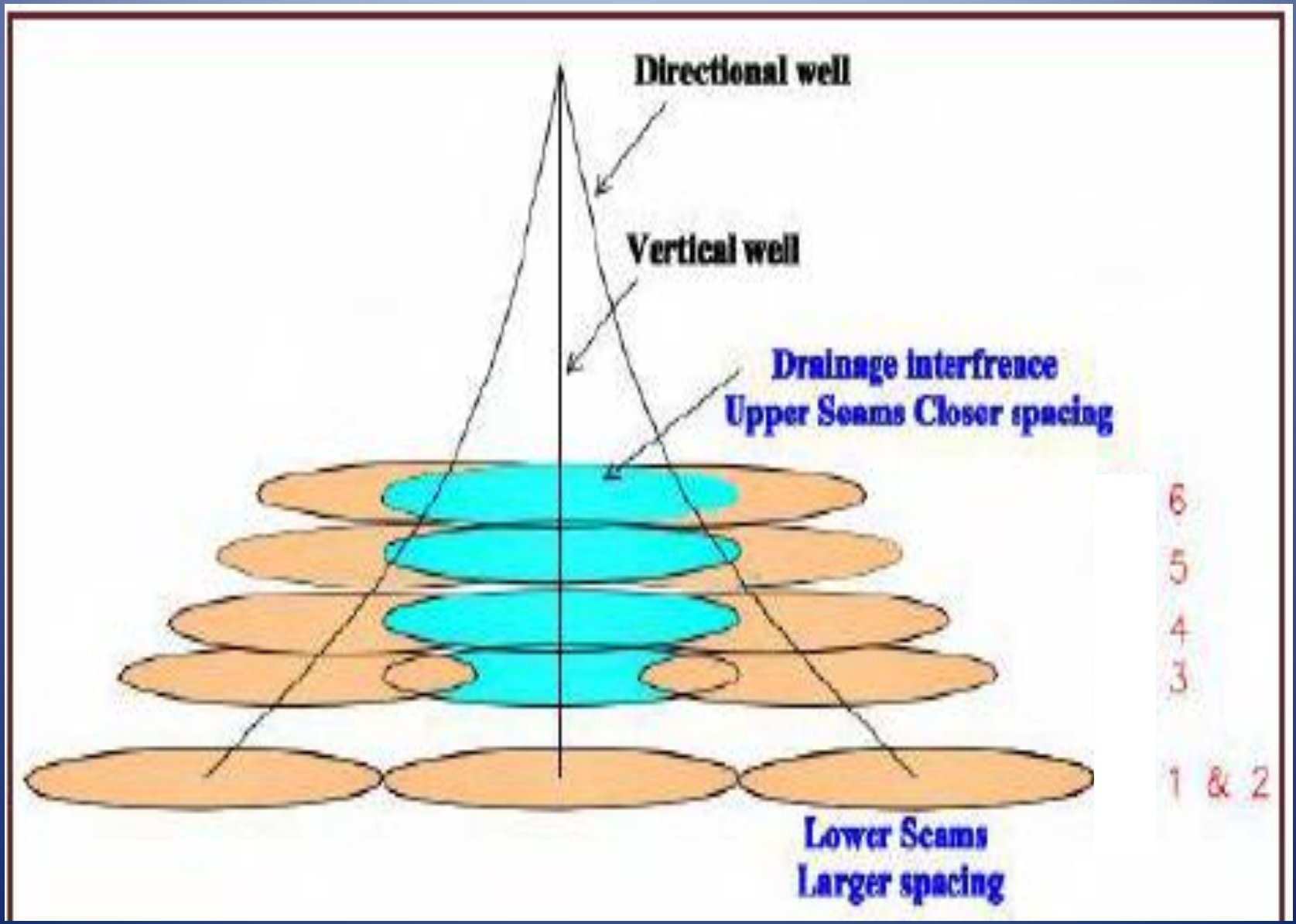
Reasons for slow progress

- Delay in PEL grant by the State Govts.
- Availability of land
- Overlapping of coal mining blocks with awarded CBM Blocks
- Gas price
- Pipe line for transportation
- CBM specific equipment & technology optimisation
- High hiring cost of specialised services viz. logging, hydraulic fracturing etc.
- Most of the Blocks have poor prospect due to poor rank and quality (consequently poor gas content & saturation) with doubtful permeability

Measures for surmounting problems

- State Govts. often delays in granting PEL to CBM Operator – there are cases where PEL grant is pending for 6/7 years-probably no solution
- The problems of land acquisition : acquiring land in tribal areas, forest land where there is no forest but encroached by local people, multiple ownership of small pieces of land
- However, with experience gained by the Operators in last 10 years they have learnt to tackle these problems and it has considerably smoothened now.
- Some Operators are using novel methods of reducing land use through application of technology in drilling and installing modular surface facilities.

Multiple deviated wells from a single well plinth



Measures for surmounting problems

- Overlapping of coal mining blocks and infrastructure projects with awarded CBM Blocks has considerably thwarted the progress of work in Raniganj, Jharia and Bokaro Blocks of ONGC.
- With mutual discussions and understandings this problem seems to have reached a stage wherein ONGC is readying itself to initiate development work in different Blocks.

Measures for surmounting problems

- CBM Pricing: GoI has declared CBM price will be based on RasGas LNG pricing formula linked to preceding three months Brent crude. Accordingly, CBM price is currently US$ 8+.
- The GAIL Jagdishpur – Haldia National Natural Gas Pipeline Grid(Urja Ganga) will pass through all the CBM producing areas from Sohagpur to Raniganj.
- Unified transportation tariff, if approved in future, may provide trans India market for the gas.
- GoI has given the rights to CIL for extraction of CBM from its command areas as VCBM, CMM, AMM and VAM.
- The target Areas in this regard again will be Damodar Valley coal fields having huge potential.

Summary of Outcome of Work in CBM Blocks

- **Only 7 Blocks, 4 in Damodar Valley and 3 in Son Valley are prospective**
- **It is unlikely that CBM prospect may extend in any other coal fields or Basin in India**
- **Initially estimated high resources of 1.8 TCM in 17,327 Sq. Km. awarded area now seems to be restricted only in ~3000 Sq. Km. in above two river valleys with only ~400 BCM of Resources**
- **Now it appears that producible CBM in these Blocks may be in the order of 100BCM.**
- **To produce this gas it is estimated roughly around $12.5billion investment. The total price of the gas is estimated as $25billion ($8/MMBTU average gas price)**

Summary of Outcome of Work in CBM Blocks

- **Initial very high projection of production potential of 38 MMSCMD, after critical examination of all projections it is felt that India's maximum VCBM production potential in coal mining free areas (covered under CBM policy) may be around 10 /11 MMSCMD**
- **Favourable gas pricing mechanism and gas transportation pipeline by GAIL may boost the few active Operators to realise early production**
- **Rights to CIL for CBM extraction as VCBM, CMM, AMM and VAM will boost the CBM production mainly in Damodar Valley**

THANK YOU