Practise and Technology for Effective Methane Drainage and Utilization

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Pre-Drainage of Deep Coal Seams

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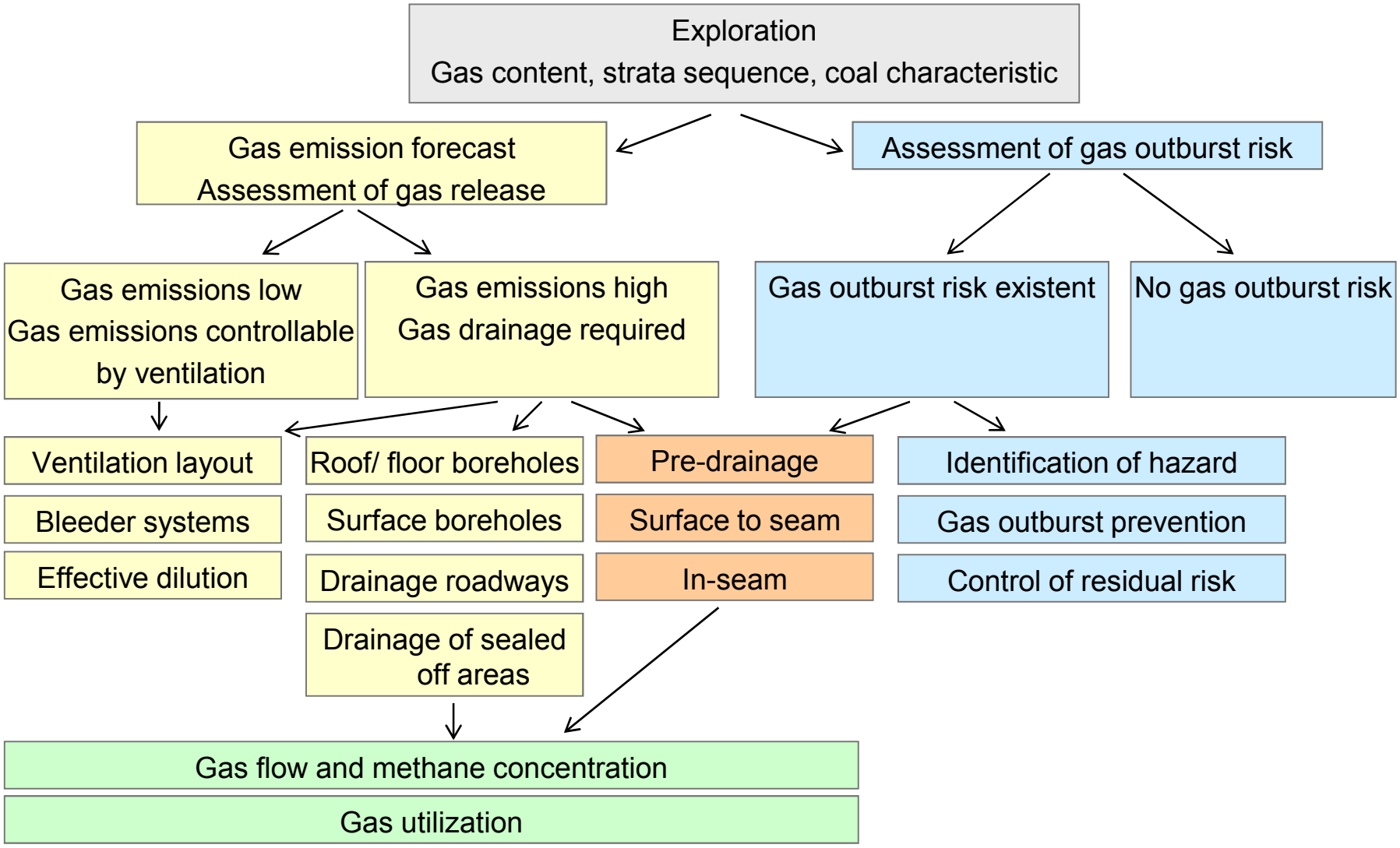
DMT GmbH & Co. KG

- independent technology services in consulting & engineering, testing & certification, measuring, research & development
- fields of activity: mining technology, coke making technology, exploration & geosurvey, infrastructure & civil engineering, building safety, mechanical engineering & plant construction
- annual turnover: 95 mio. € (2008)
- 540 employees
- 16 government approved expert bodies for safety
- 3 accredited testing laboratories
- 75 accredited experts (e.g. underground gas emissions, ventilation, gas outbursts, monitoring systems)
- since 2008 member of TÜV Nord group
- subsidiaries: UK (IMC GCL), Russia (IMC Montan), India (IMC SRG), Canada (AGL)

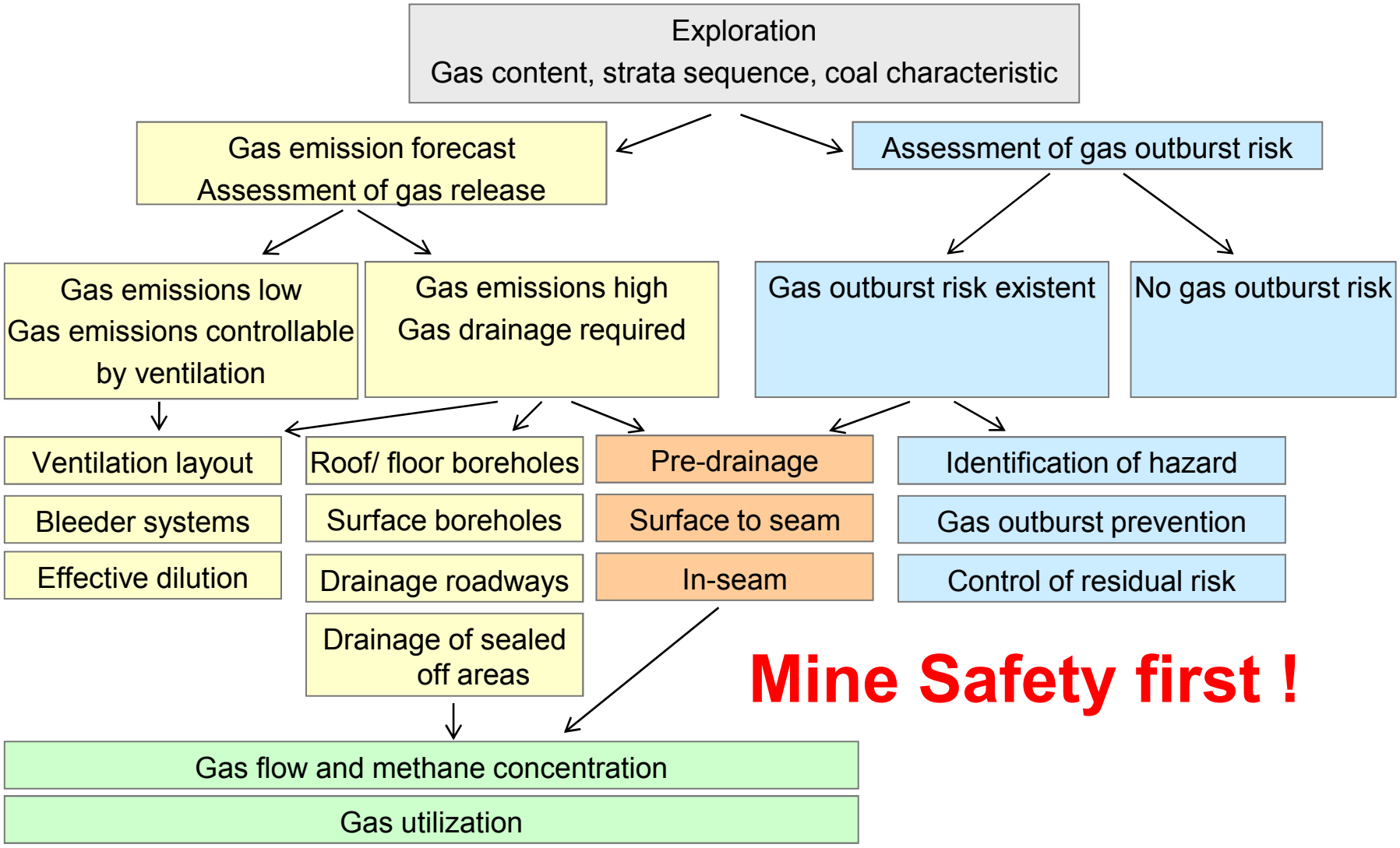
References

- cooperation with German hard coal industry for more than 100 years
- consulting & engineering service related to gas emission control and gas outburst prevention in Europe, CIS, Asia-Pacific and America
- extensive consultancy, engineering and exploration services for 100+ CBM, CMM, VAM and AMM recovery & utilization projects in Europe, CIS, Asia-Pacific, America and Africa
- significant role in building up Germanys AMM and CMM industry with > 220 MW_{el}

Overview on “Gas”

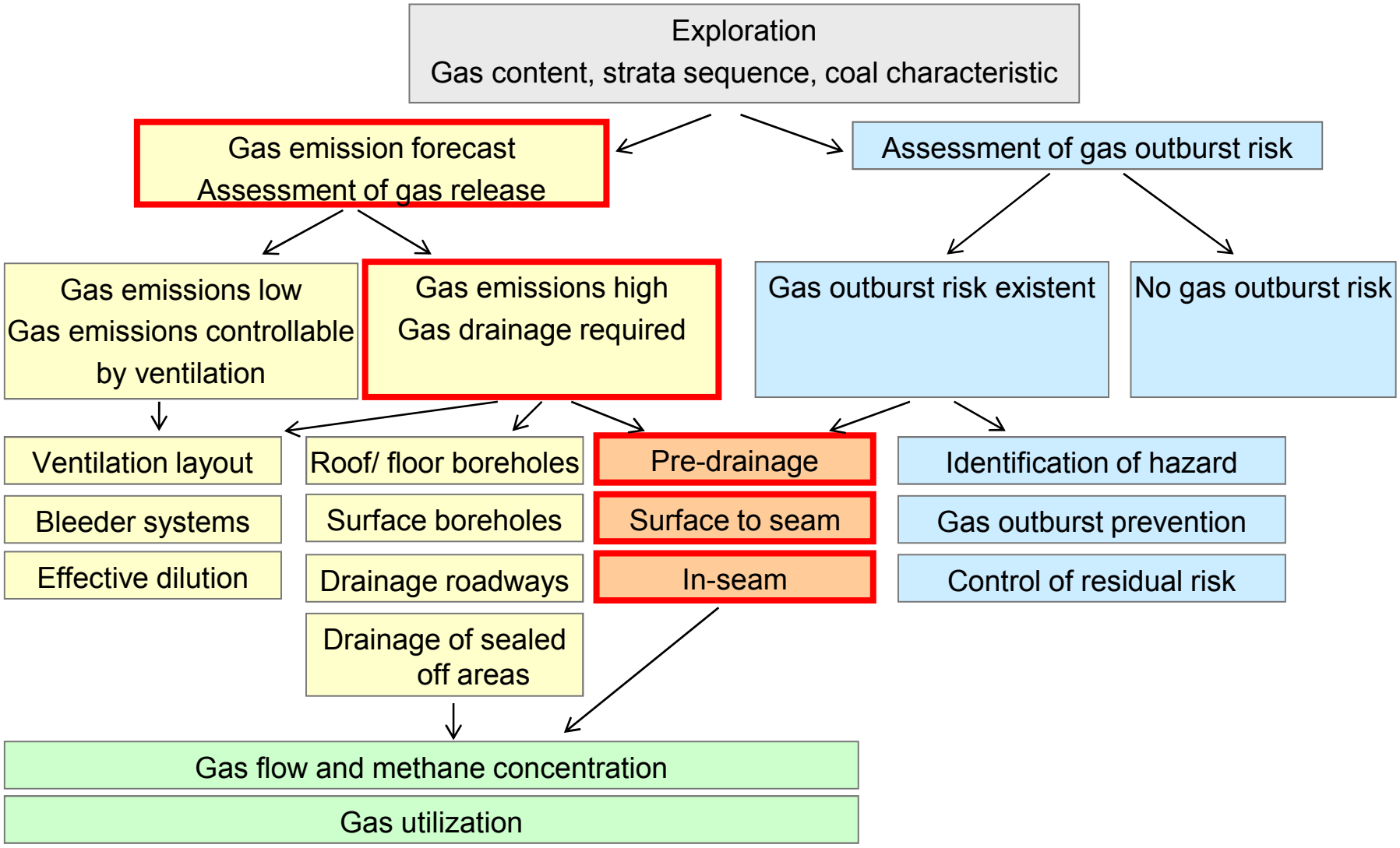


Overview on “Gas”



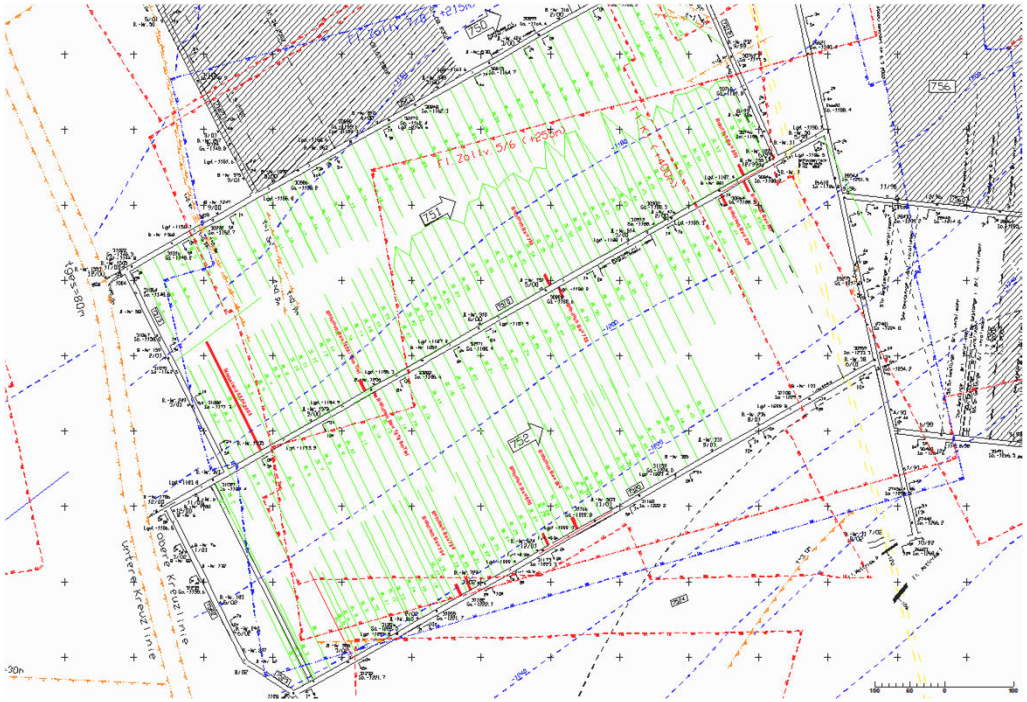
Mine Safety first !

Gas emission control

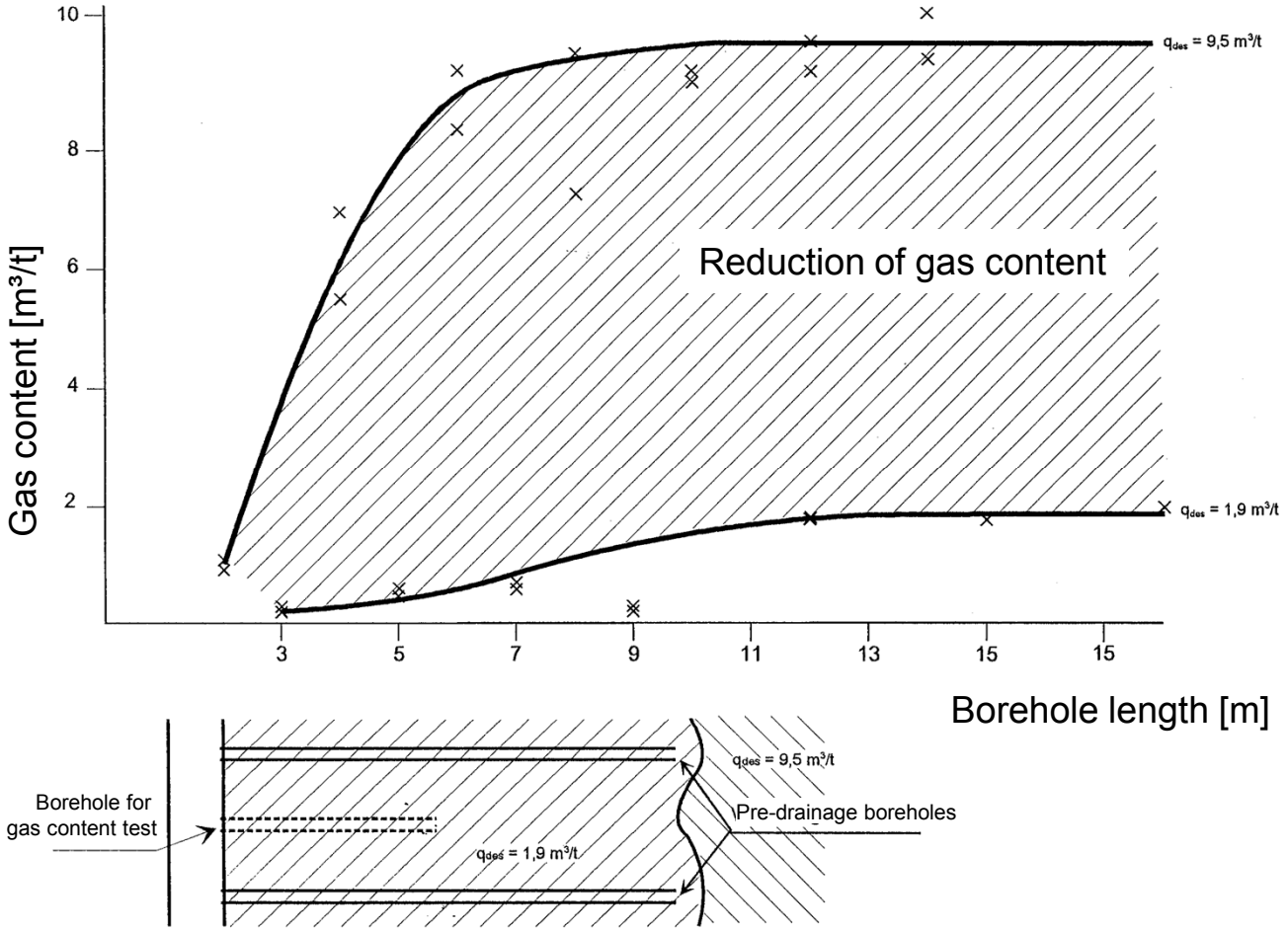


German experience

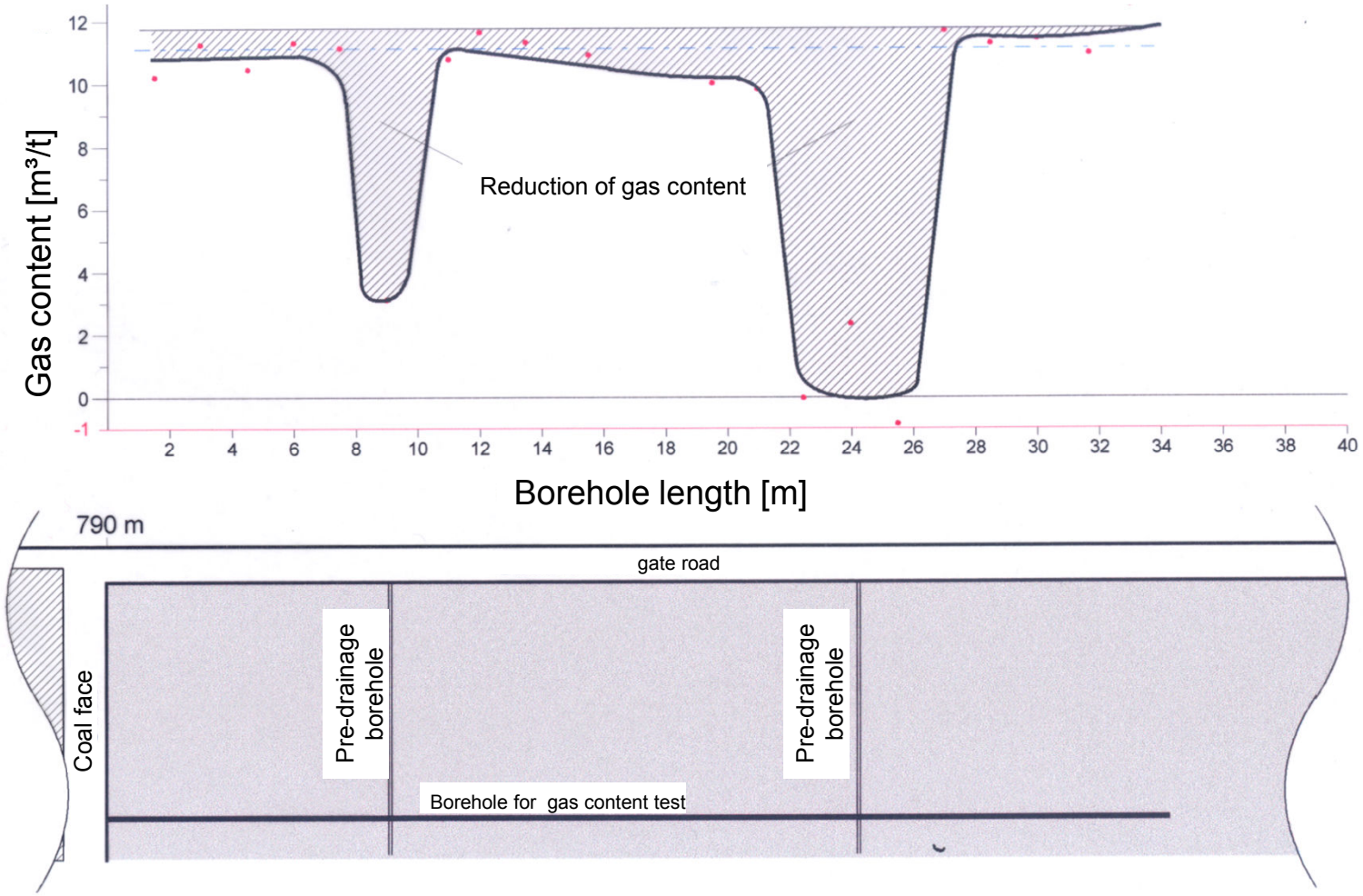
- depth up to 1500 m, permeability usually < 10^{-3} mD
- underground in-seam drilling, surface drilling (tested during 1990ties)
- wide range of drainage efficiency in different seams
- reduction of gas content up to 70 % at 6 - 12 month pre-drainage



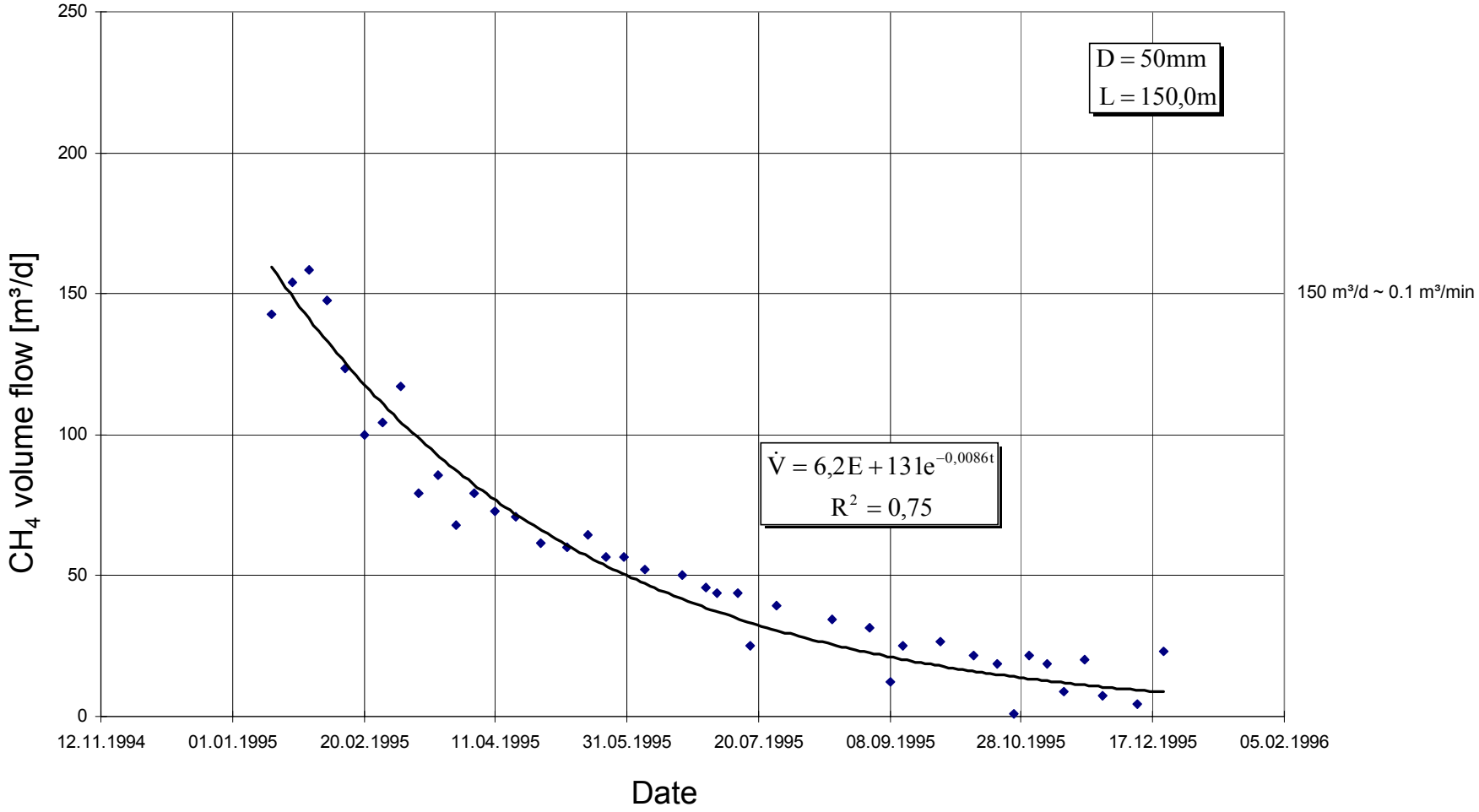
Pre-drainage
Reduction of gas content - 12 month



Pre-drainage
Reduction of gas content

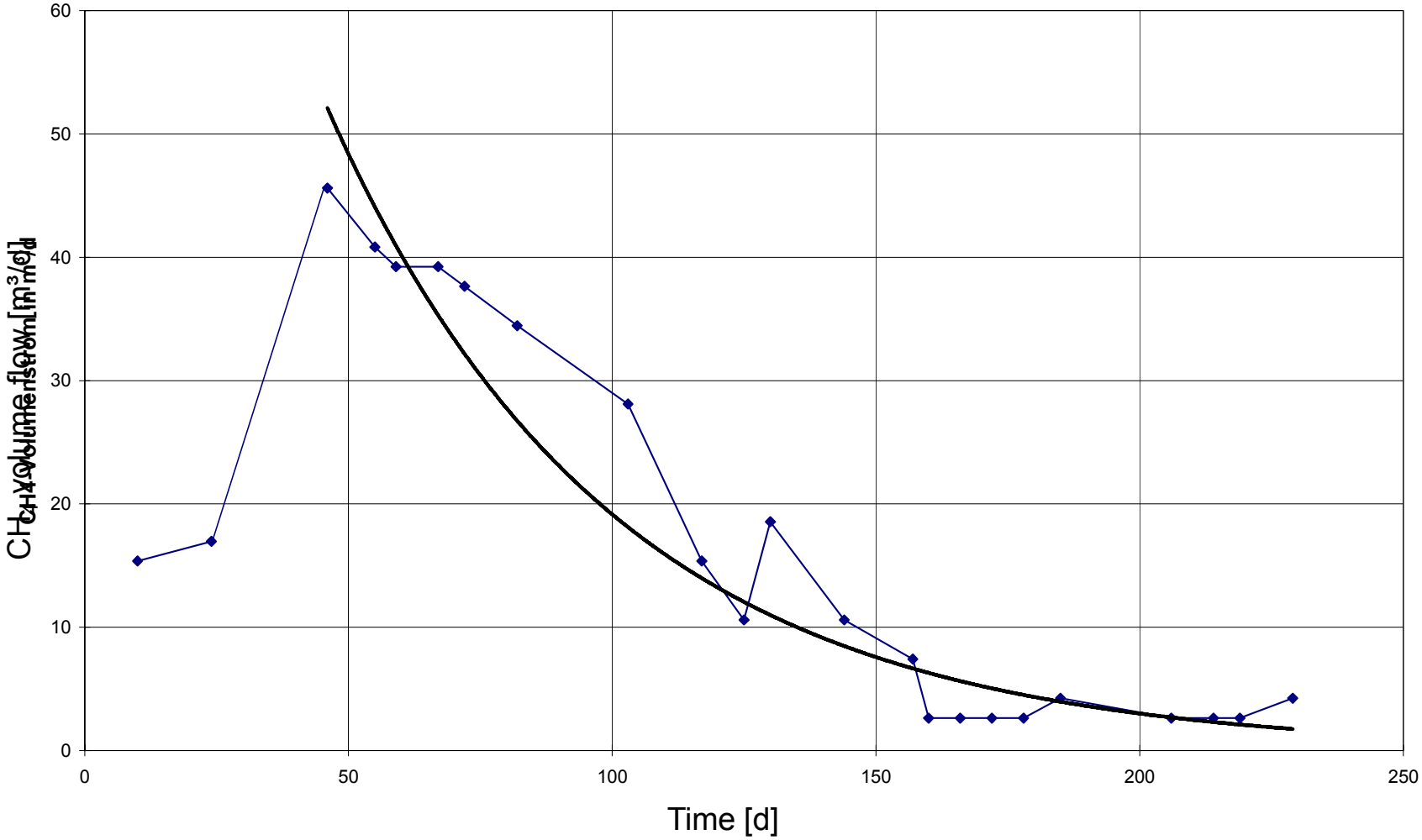


Pre-drainage
Volume flow

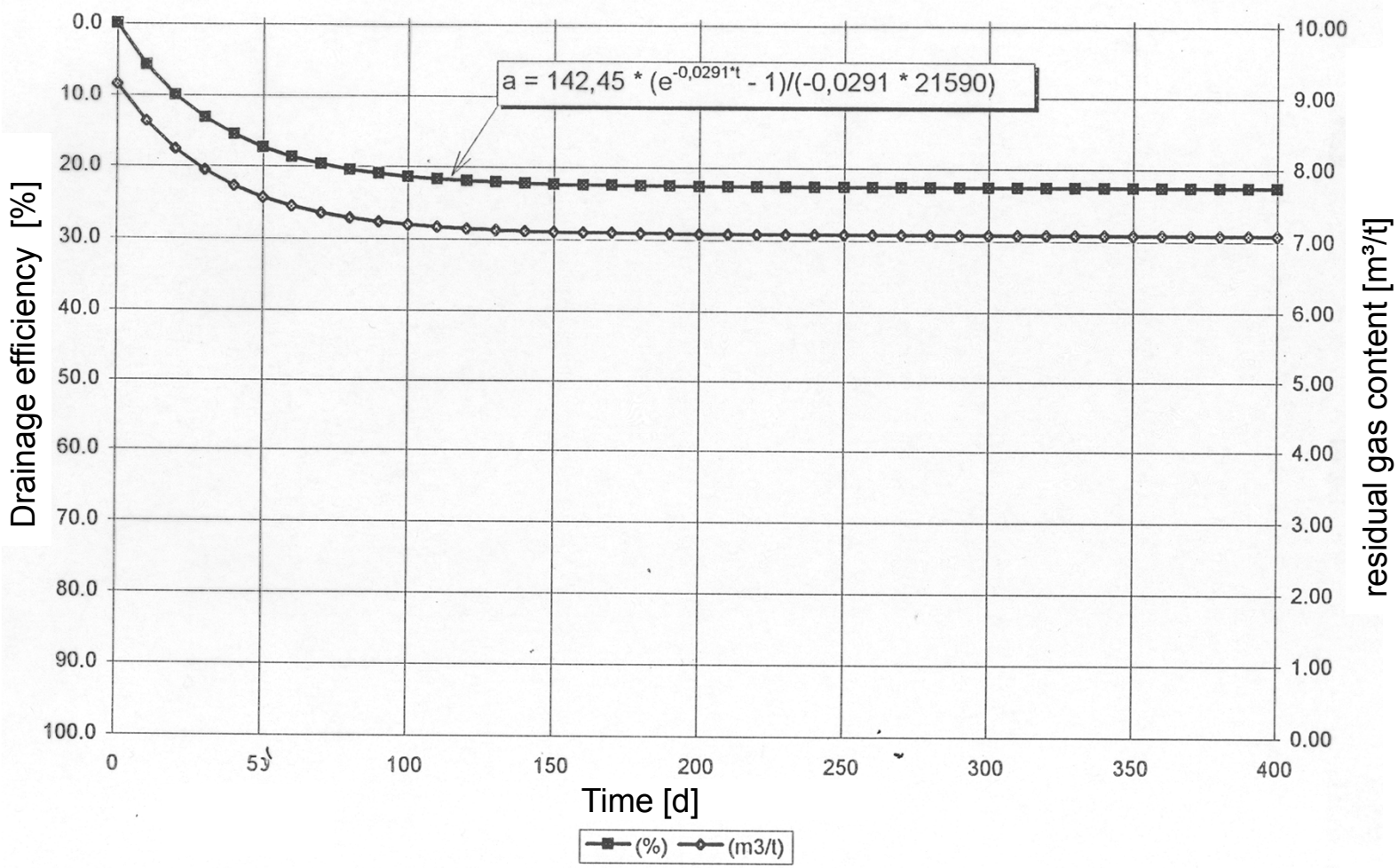


150 m³/d ~ 0.1 m³/min

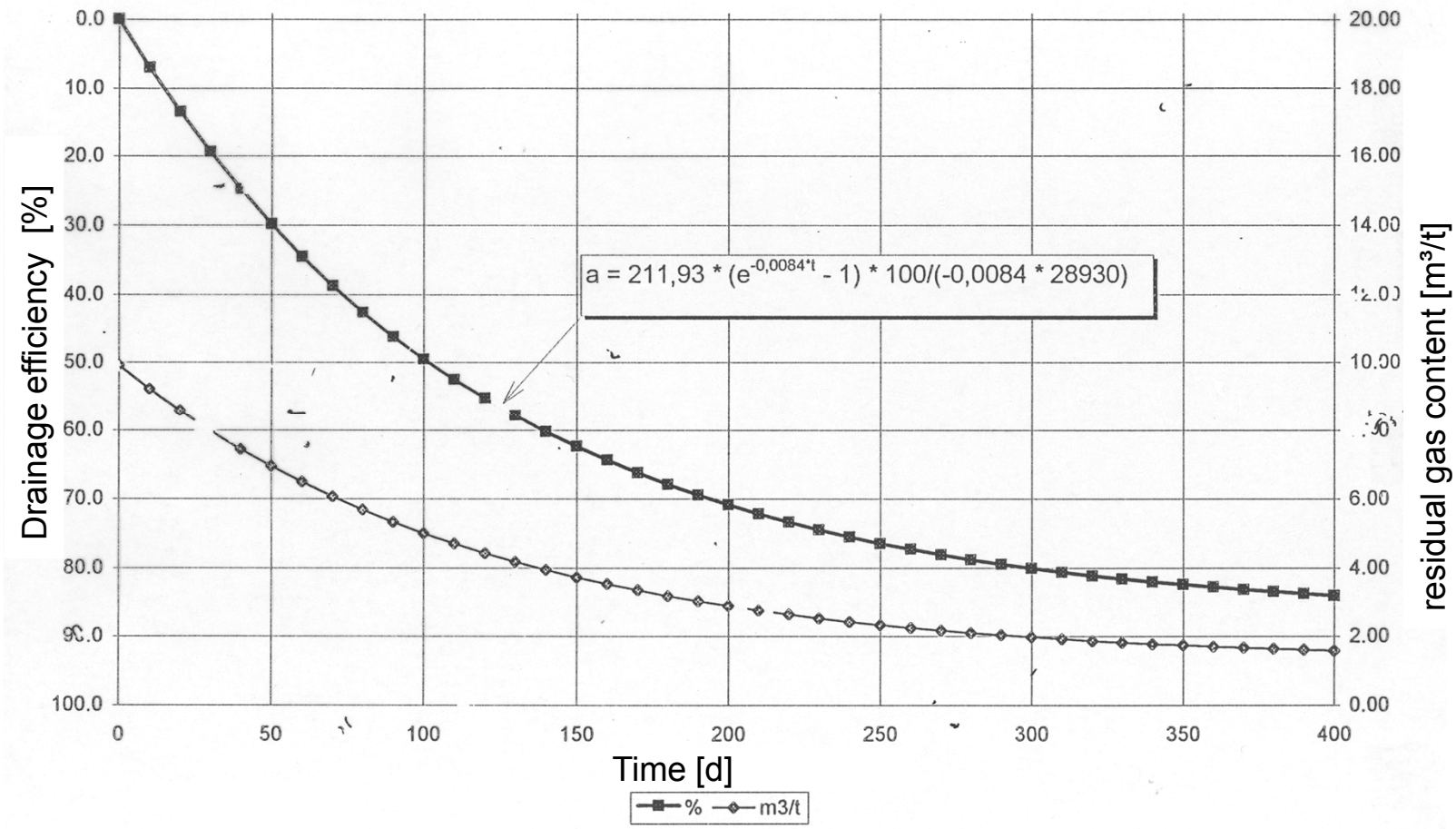
Pre-drainage
Influence of water



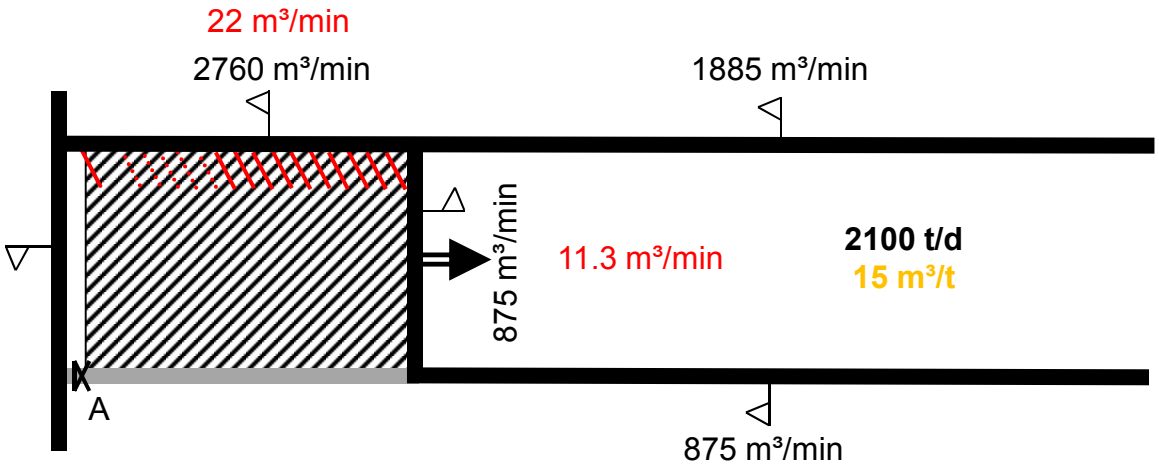
Pre-drainage
Without pressure relief



Pre-drainage
With pressure relief

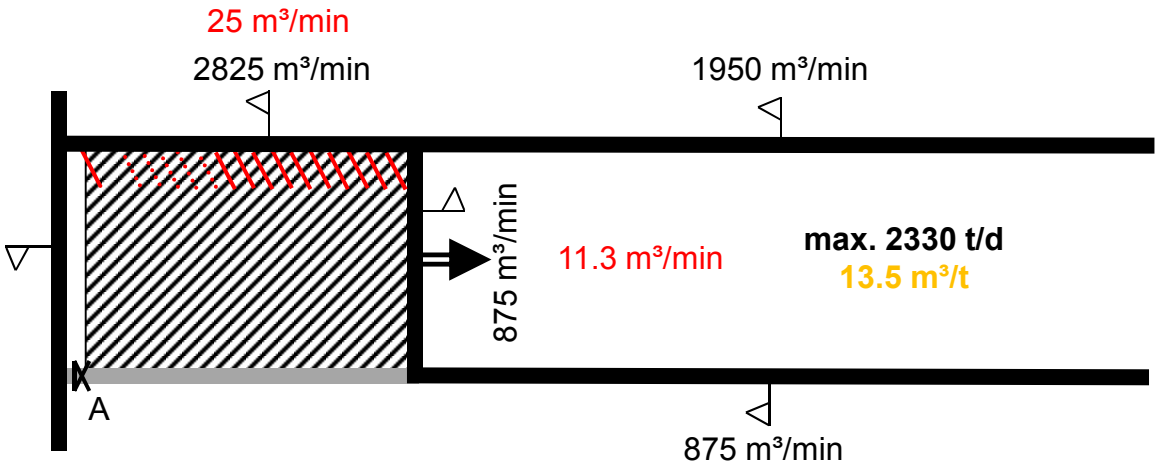


Ukrainian coal mine



- gas content 15 m³/t
- low permeability of coal
- seam thickness < 1 m
- coal production 2100 t/d
- maximum CH_4 concentration 1.3 %
- gas emission coal face max. 11.3 m³/min – limit !
- gas emission gob max. 55 m³/min, 33 m³/min drainable

Ukrainian coal mine - solution



- no success by increasing gob drainage efficiency and ventilation air flow only
- ventilation air flow of coal face limited by cross section
- pre-drainage 1st option
- 10 % reduction of gas content results in +230 t/d

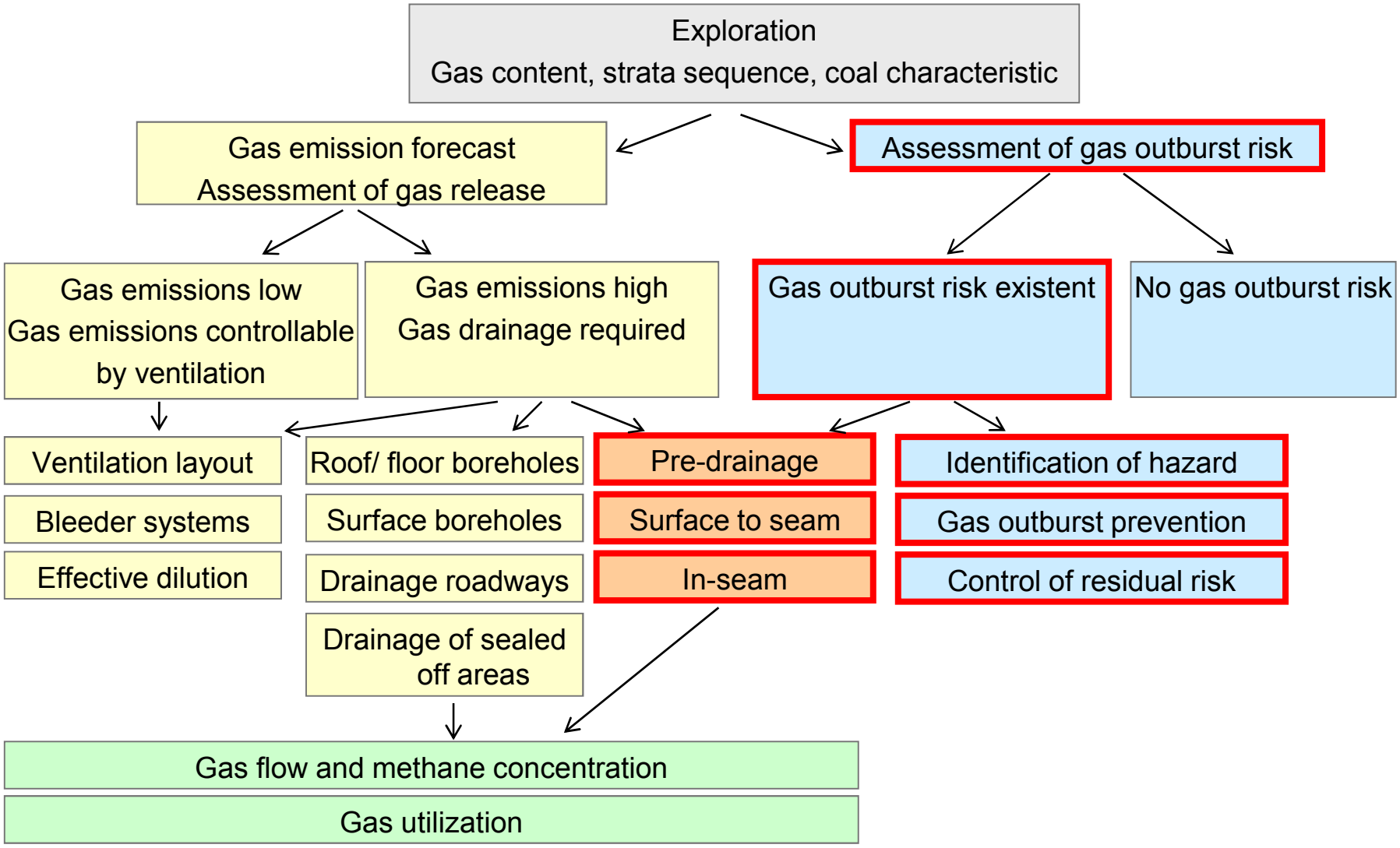
Strategy gas emission control

- Gas source ?
- Possible options (low effort, best result):
  - Increasing ventilation air flow ?
  - Effective dilution of gas ?
  - Adjusting operation of shearer/ plough?
  - Improving gob drainage efficiency ?
  - Pre-drainage ?
- Access to the coal & available pre-drainage time ?

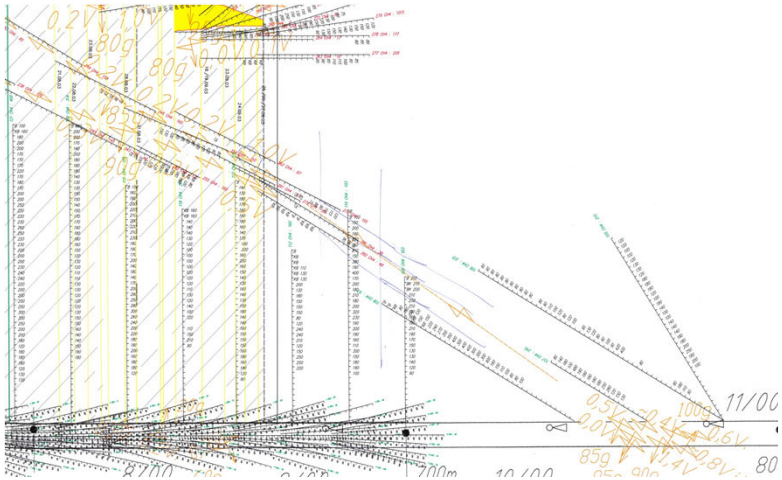
Seam / rock layer	Distance	Thickness	Degree of gas emission	Gas content	Specific gas emission
	[m]	[cm]	[%]	[m³/t]	[m³/t]
sandy shale	181.1	0	0.00	0.11	0.00
sandy shale	178.6	500	7.91	0.12	0.08
sandstone	174.1	400	8.50	0.20	0.12
sandy shale	169.6	500	9.14	0.12	0.10
sandstone	164.6	500	9.90	0.20	0.18
sandy shale	157.6	900	11.07	0.12	0.21
sandstone	151.1	400	12.28	0.20	0.17
shale	147.1	400	13.10	0.04	0.04
sandy shale	141.9	630	14.22	0.12	0.19
sandy shale	136.0	550	15.63	0.12	0.18
sandy shale	132.7	120	16.49	0.12	0.04
sandy shale	128.7	680	17.58	0.12	0.25
shale	123.8	300	19.01	0.04	0.04
sandstone	121.3	200	19.79	0.20	0.14
sandy shale	117.7	520	20.96	0.12	0.23
I6	114.5	115	22.06	13.00	3.00
shale	112.4	300	22.80	0.04	0.05
sandstone	104.9	1200	25.71	0.20	1.09
shale	96.9	400	29.22	0.04	0.08
sandy shale	93.9	200	30.65	0.12	0.13
shale	87.9	1000	33.74	0.04	0.24
sandstone	80.2	550	38.20	0.20	0.74
sandstone	74.9	500	41.54	0.20	0.74
sandstone	69.9	500	45.00	0.20	0.80
sandstone	64.9	500	48.75	0.20	0.86
sandstone	59.9	500	52.81	0.20	0.94
sandstone	54.9	500	57.21	0.20	1.01
I5	52.3	20	59.64	13.00	1.41
sandy shale	46.7	1100	65.23	0.12	1.53
sandstone	39.2	400	73.55	0.20	1.04
sandstone	34.7	500	79.04	0.20	1.40
sandstone	29.7	500	85.62	0.20	1.52
sandstone	24.7	500	92.76	0.20	1.64
sandstone	19.7	500	100.00	0.20	1.77
sandstone	14.7	500	100.00	0.20	1.77
shale	11.6	120	100.00	0.04	0.09
shale	5.5	1100	100.00	0.04	0.78
I4	0.0	110	30.00	13.00	3.90
sandy shale	-1.3	260	100.00	0.12	0.55
I4H	-2.7	20	100.00	13.00	2.36
sandy shale	-6.0	640	100.00	0.12	1.36
sandstone	-12.7	700	95.15	0.20	2.36
sandy shale	-21.0	950	69.61	0.12	1.41
sandy shale	-25.8	20	56.31	0.12	0.02

- Planning of gas drainage scheme

Gas outburst prevention



Gas outburst prevention at RAG anthracite mine – cooperation for 30+ years



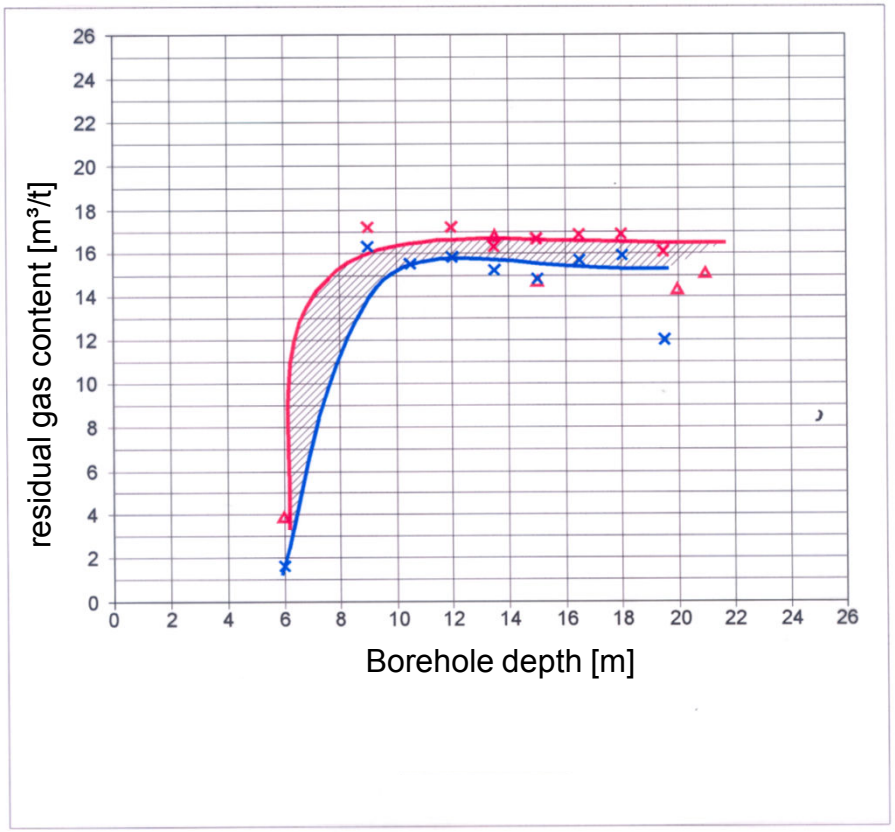
Basic conditions

- multiple seam mining, depth up to 1500 m
- seam thickness around 1 m
- gas contents up to >20 m³/t
- low permeability (~10^{-4} mD)
- gas outburst hazard present

Work performed

- development, planning & inspection of gas outburst prevention
- gas outburst risk assessment
- expert reports, cooperation & coordination with mining authorities
- inspection of gas & ventilation monitoring systems
- training of technical personnel
- research & development

Pre-drainage – 7 month

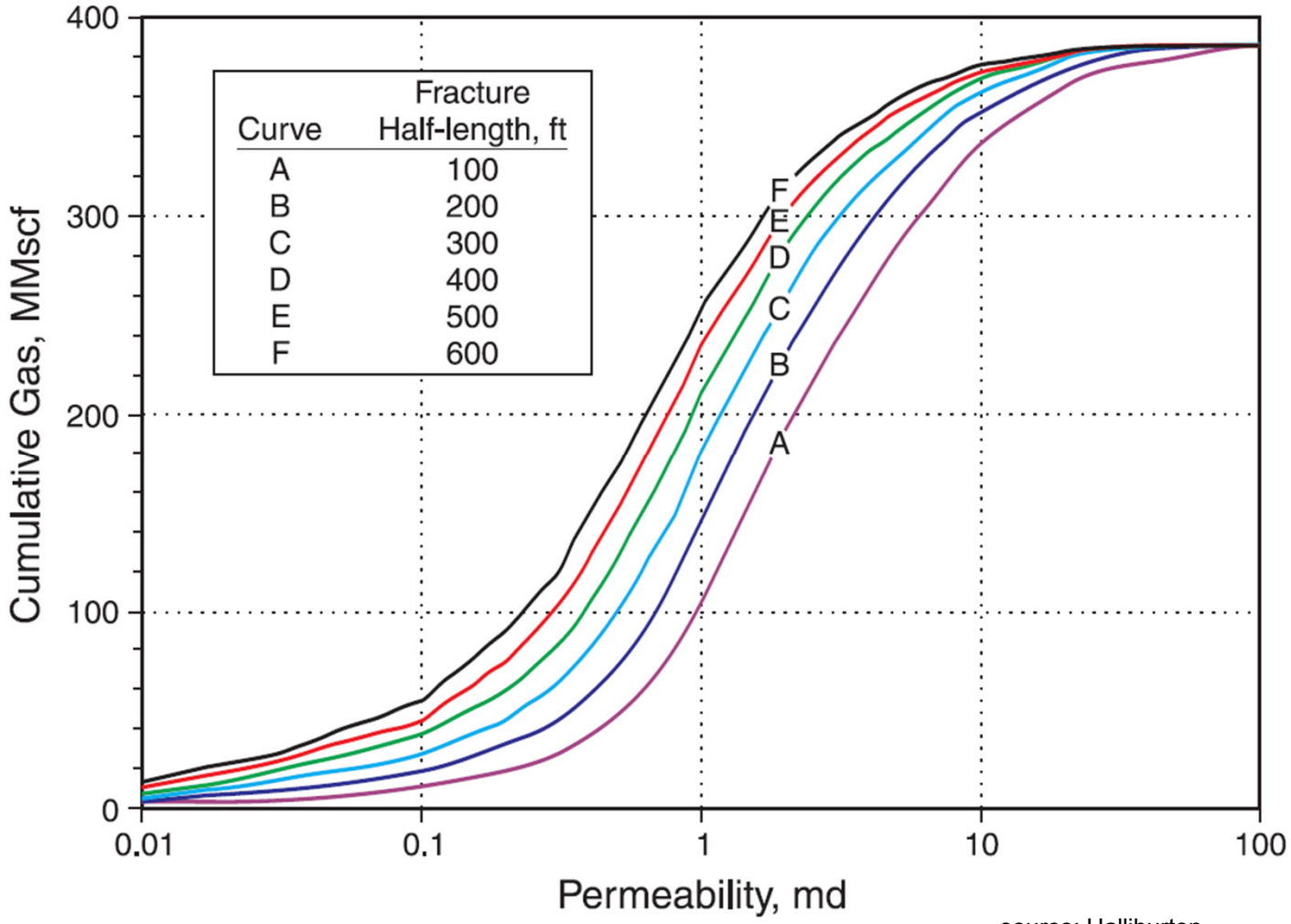


total gas content	20,2 m³/t	19,0 m³/t
gas content at methane pressure 1 bar	3,4 m³/t	3,4 m³/t
desorbable gas content	**16,8 m³/t**	**15,6 m³/t**

Permeability

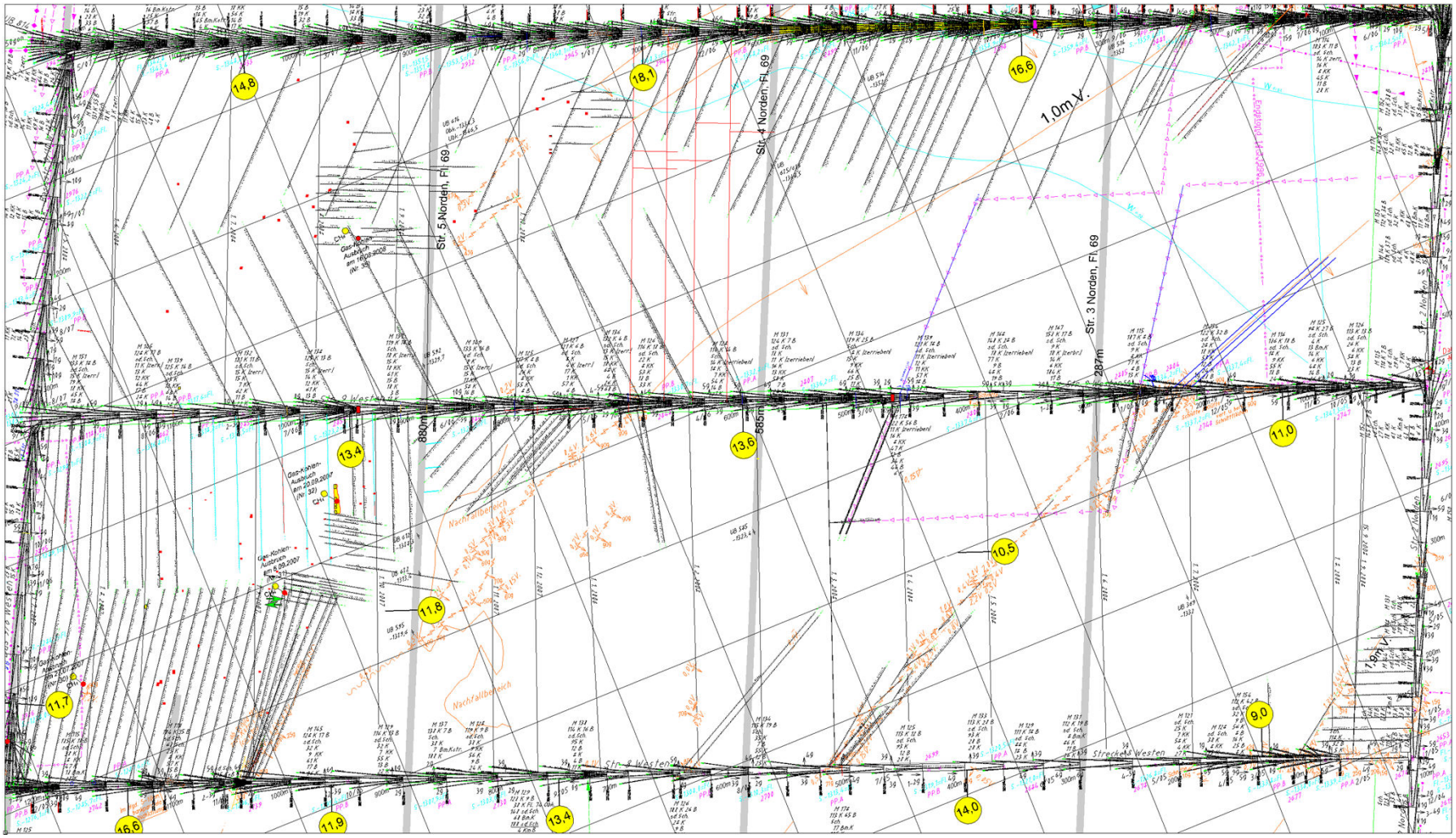
Coal field	Permeability [mD]	Pre-drainage / CBM
San Juan, USA	1.5- 50	successfull
Black Warrior, USA	0.5 – 25	successfull
Karaganda, Kasakhstan	10^{-4}	difficult
Ibbenbüren, Germany	7×10^{-3}-10^{-4}	not successful
n°54 seam (virgin pressure) n°54 seam (over mined at +22 m)	2.9×10^{-4} 3	
n°57 seam (virgin pressure) n°57 seam (over mined at +26 m)	3×10^{-3} 1.6×10^{-1}	

Hydro frac



source: Halliburton

Exploration and pressure relief drilling



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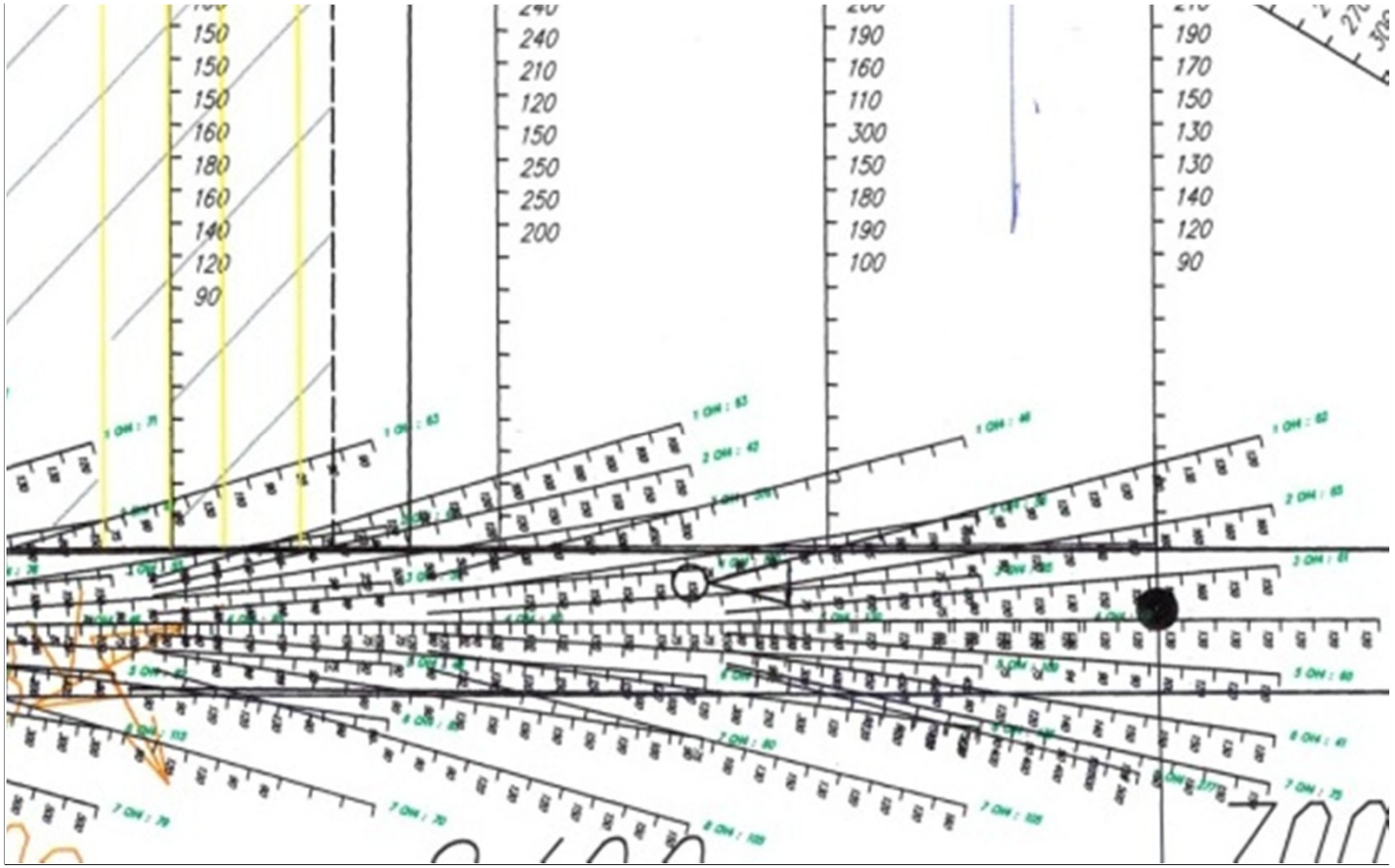

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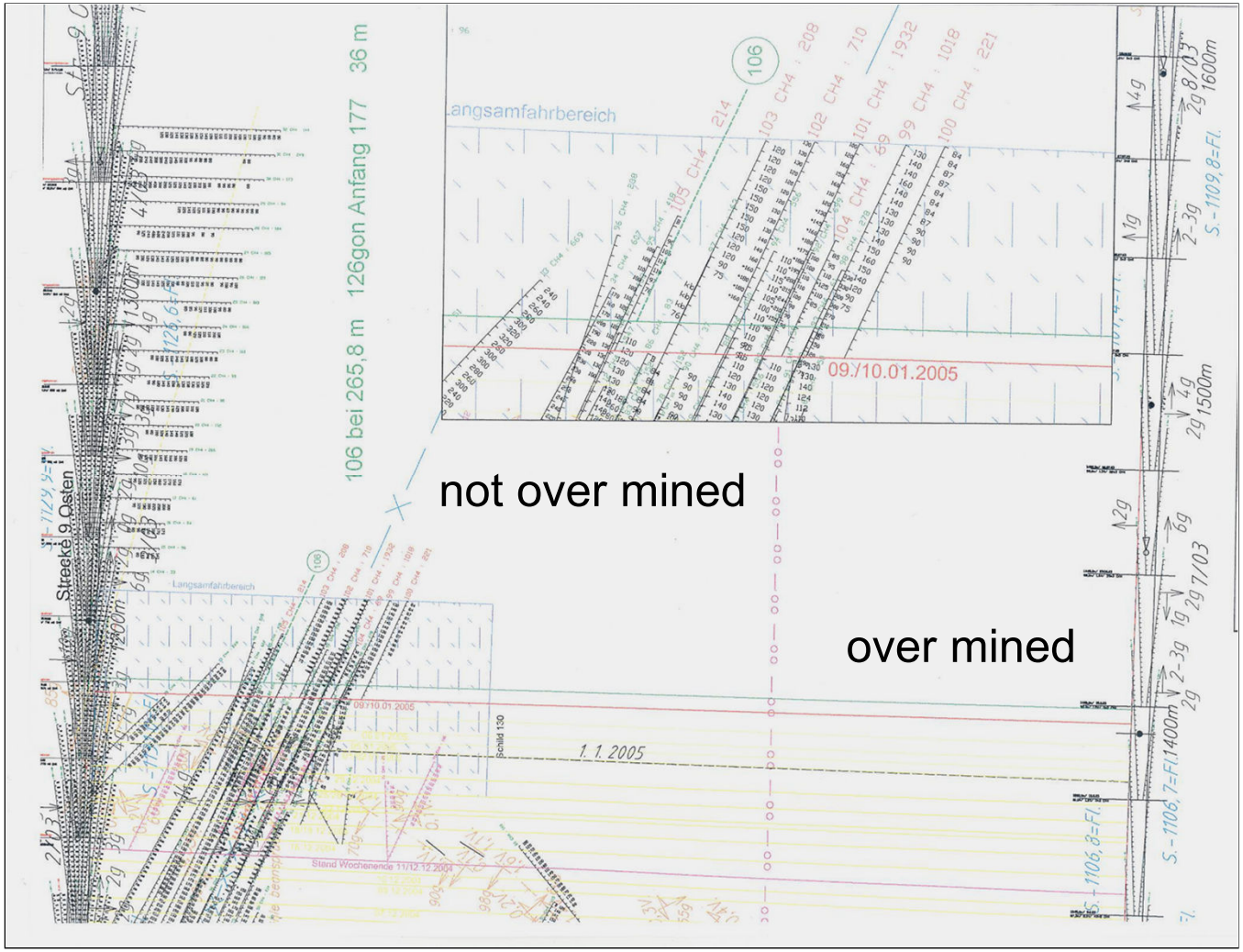

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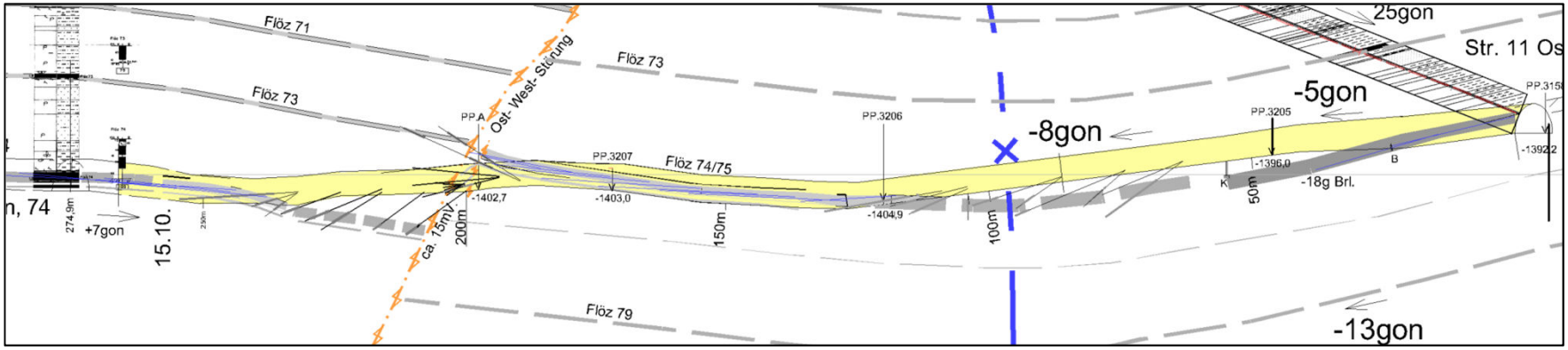
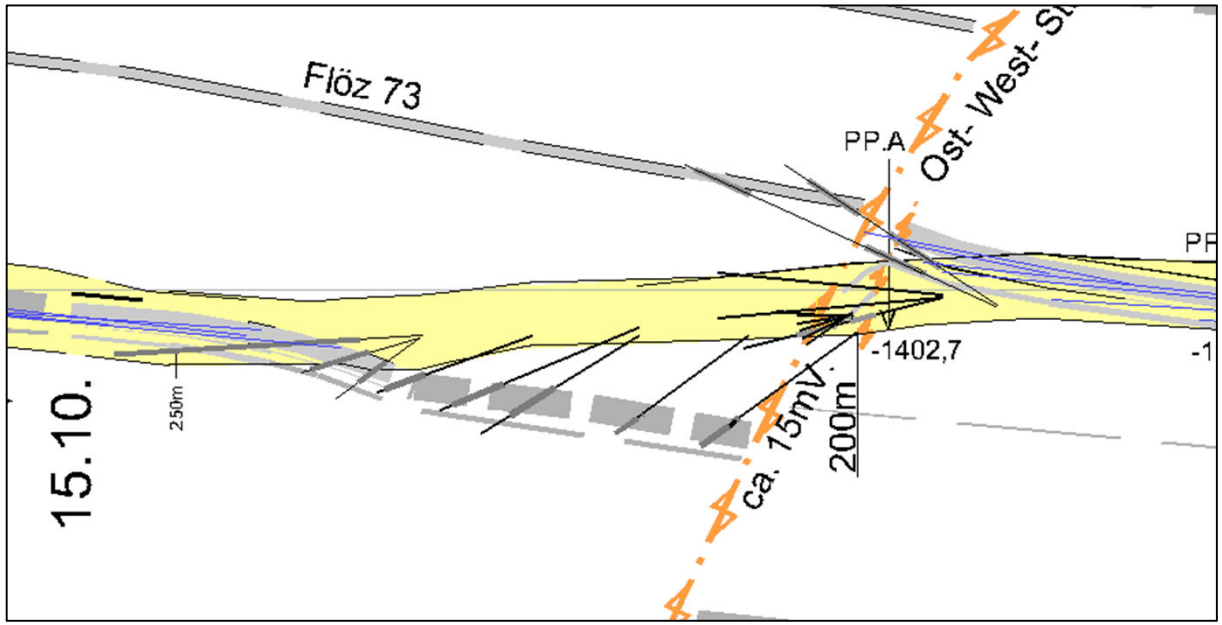
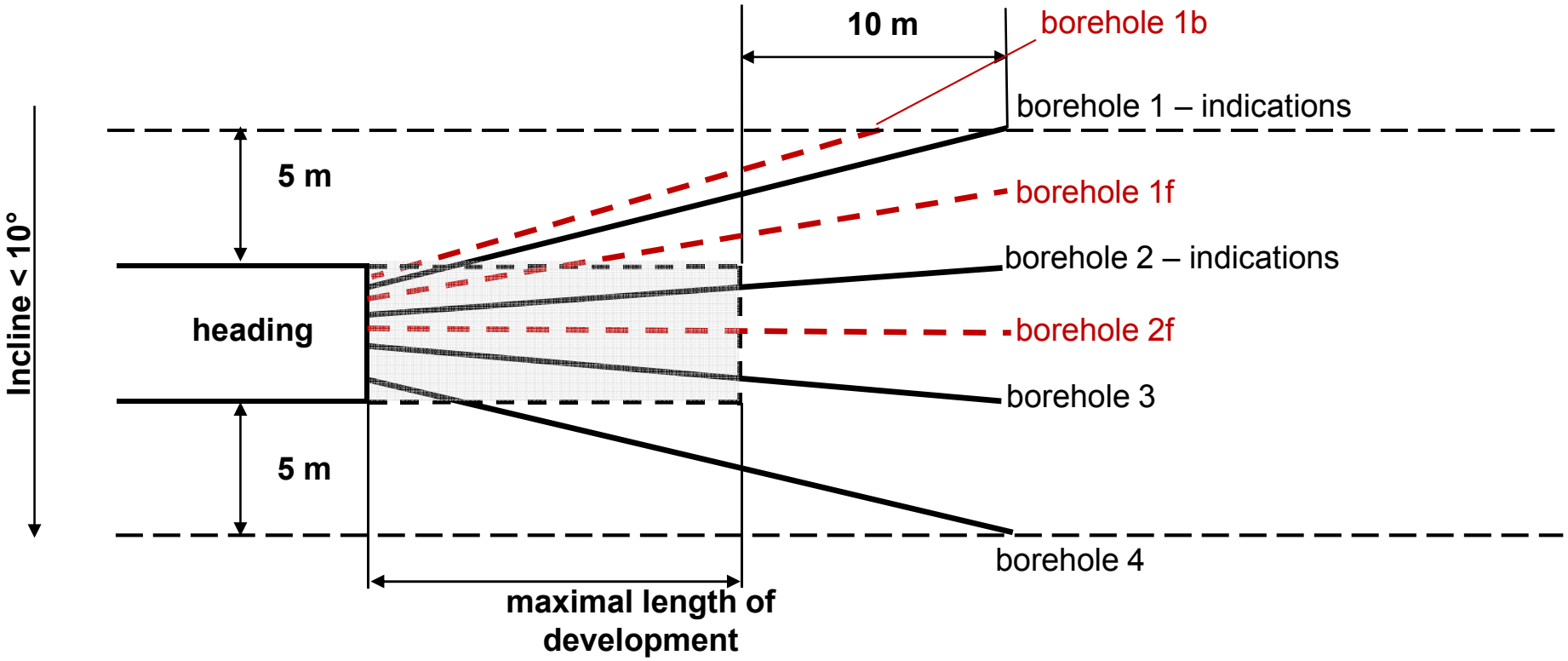




De-stressing by drilling

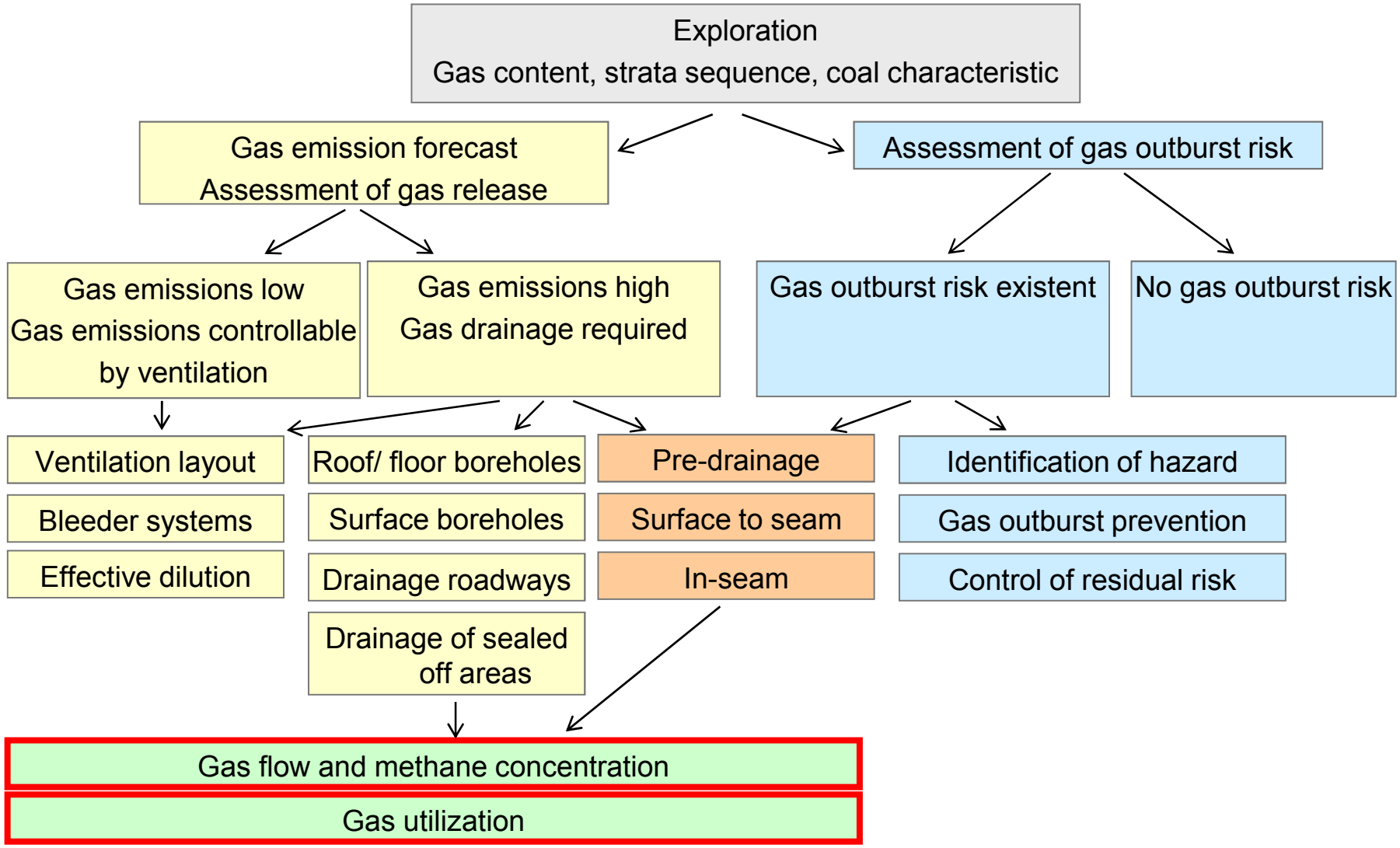


Strategy gas outburst prevention

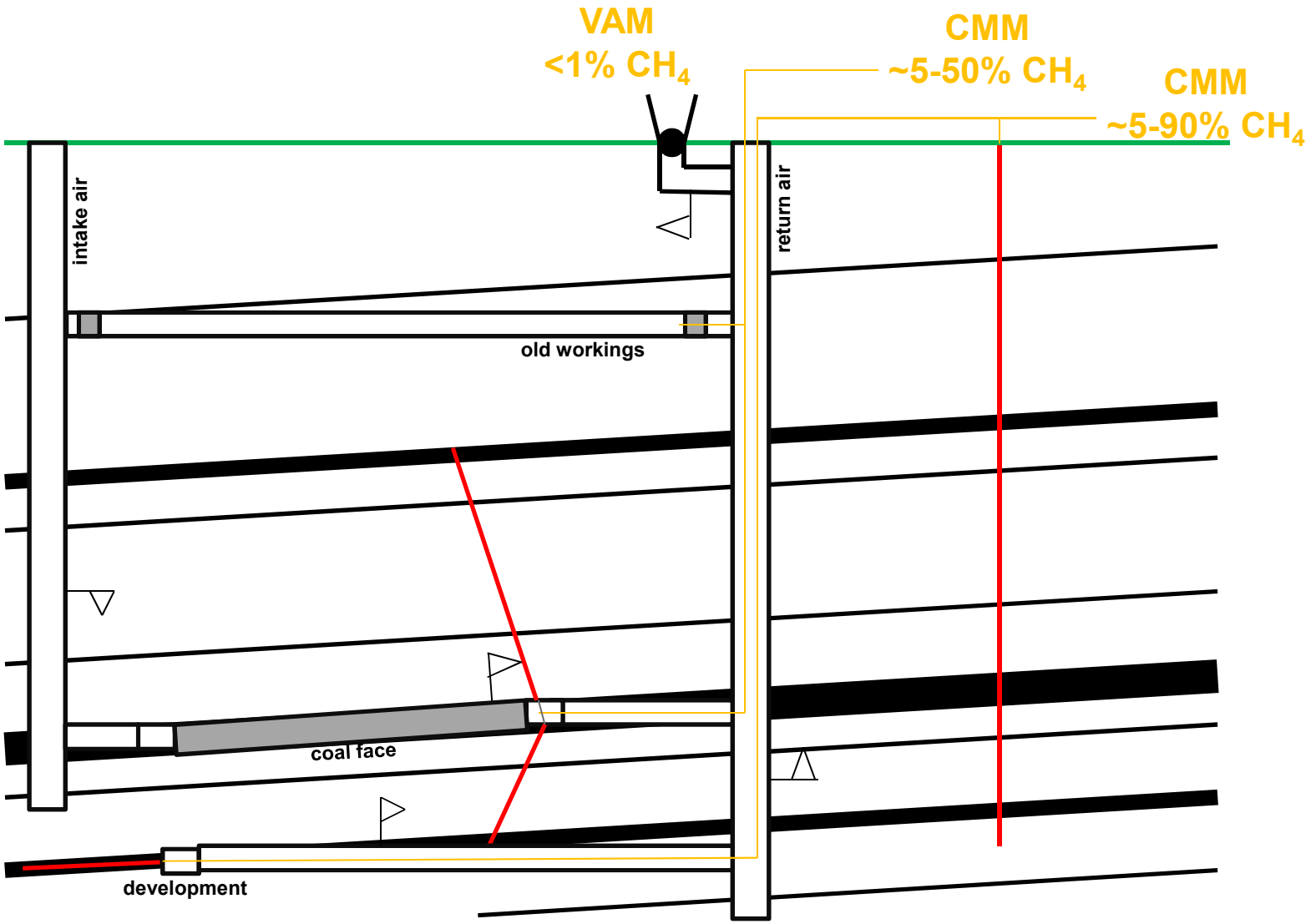
- Origin of gas outburst ?
- Coal properties (permeability, desorption characteristic) ?
- Drillability of coal prone to gas outbursts ?
- Can 100 % safety be achieved by pre-drainage ?

- Research & Development
- Experience, monitoring and ongoing data acquisition & analysis
- Effective flow and use of information
- Combination of different methods

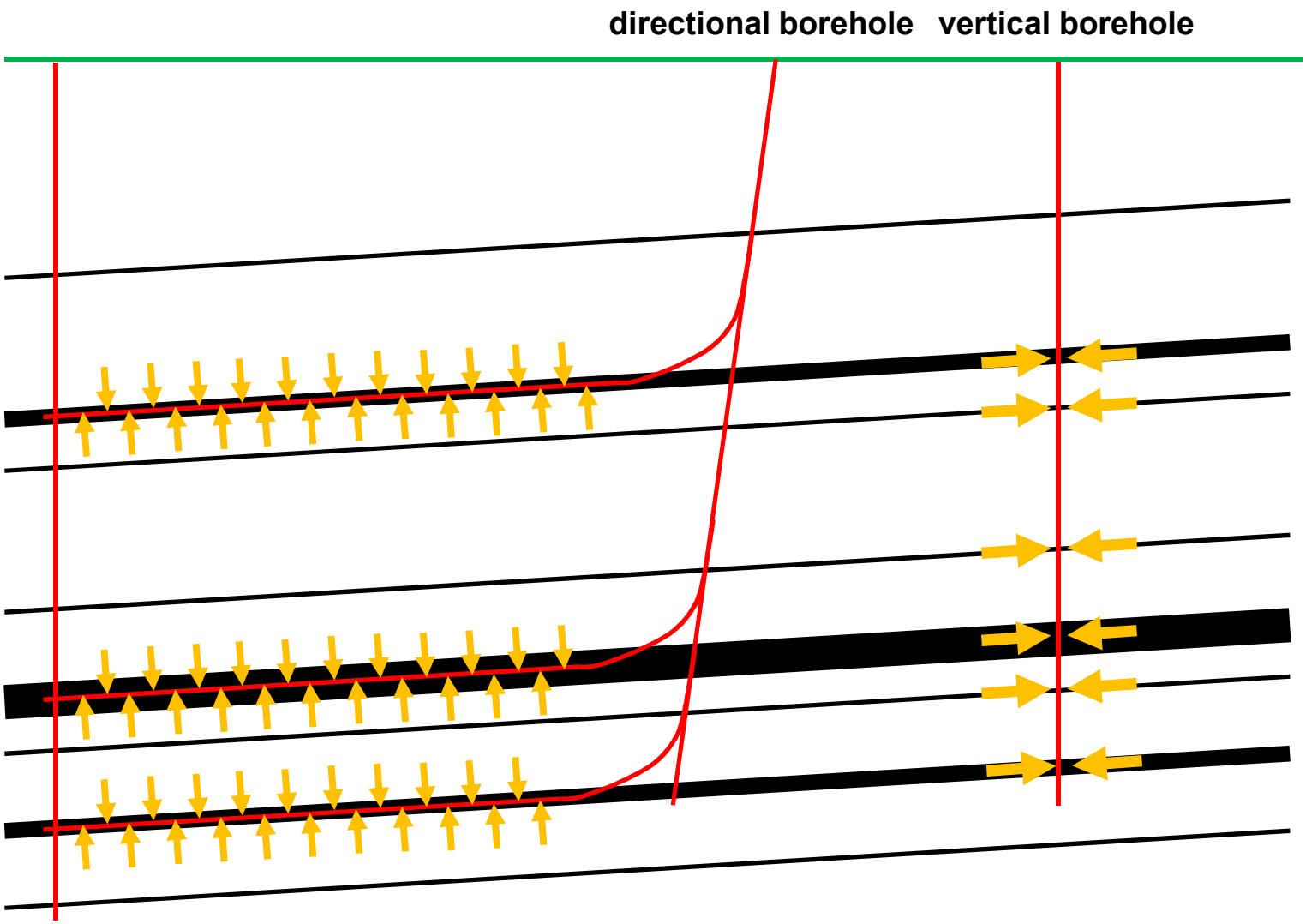
Gas production & utilization



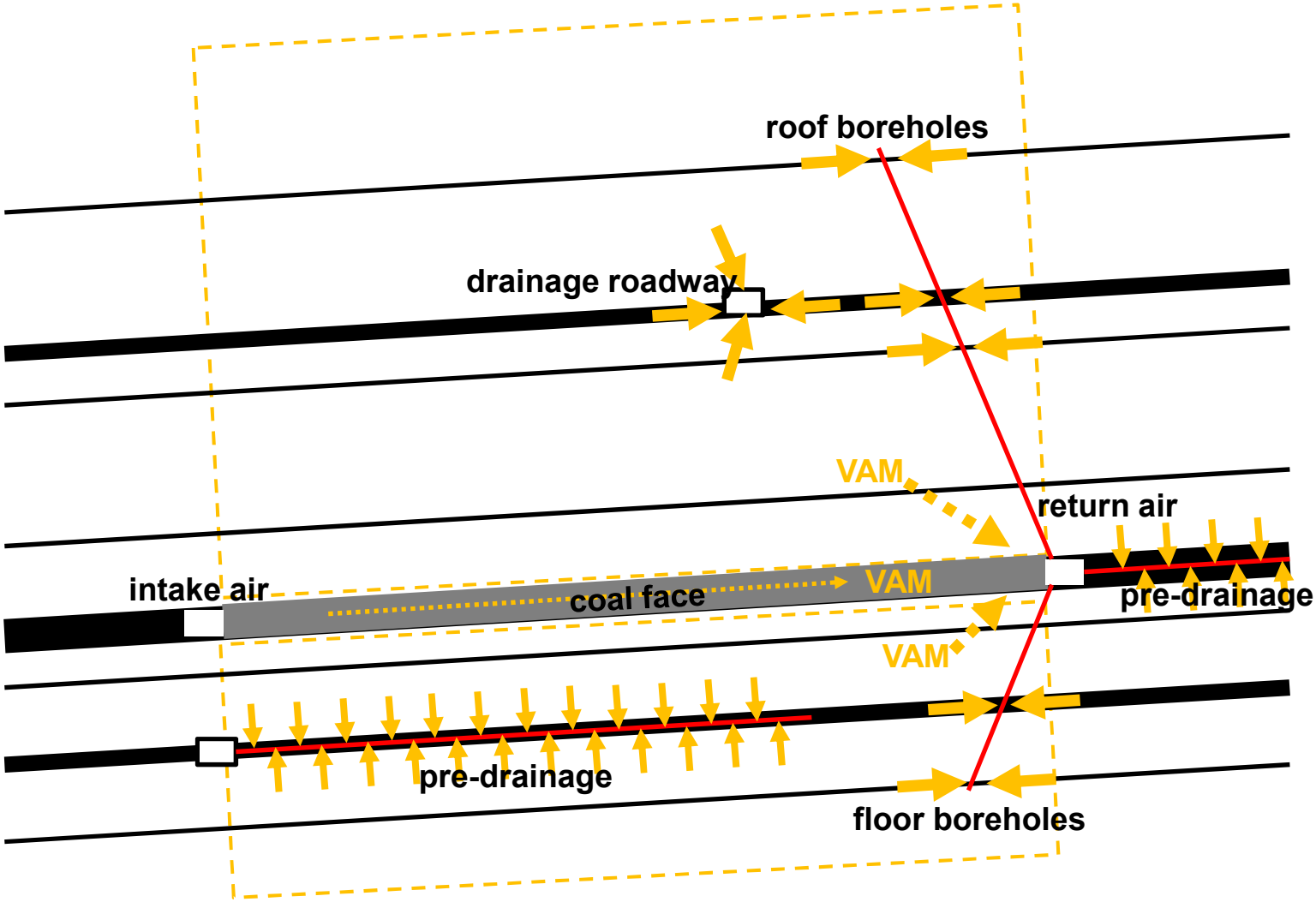
Gas qualities



CBM & CMM pre-drainage



Underground CMM drainage & VAM



Strategy gas utilization

- Gas production only or pre-drainage & gas utilization ?
- Reservoir properties (gas content, gas pressure, permeability, water, cleats ...) ?
- Drillability of coal (seam thickness, tectonic, coal structure ...) ?
- Time gap available for pre-drainage ?
- Targets for mine safety / reduction target for gas content ?
- Market (gas, power, heat, carbon credits) ?

- Proper exploration
- In-depth feasibility assessment
- Combining mine planning and gas production planning in early stage
- Gas management

Thank you !

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