

Best practices in gas outburst management

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Initial geological conditions and gas content exploration methods (1 of 2)

Country / parameter	Germany	Russia	Australia	Kazakhstan	China	USA
Typical depth of mining	1000 - 1500 m	< 800 m	< 600 m	< 800 m	< 1000 m	< 700 m
Permeability	Low	Low	Medium to high	Low	Low to high	Medium to high
Gassy seams intensity, typical virgin gas content	Mostly gassy, 8-20 m ³ /t gas content	Coking coal seams mostly gassy, up to > 20 m ³ /t	Coking coal seams mostly gassy, up to 15 m ³ /t	Coking coal seams mostly gassy, up to > 20 m ³ /t	Coking coal seams mostly gassy, up to > 20 m ³ /t	Coking coal seams mostly gassy, up to 10 m ³ /t

Initial geological conditions and gas content exploration methods (2 of 2)

Country / parameter	Germany	Russia	Australia	Kazakhstan	China	USA
Fault intensity	High	High	Low to medium	High	High	High
Gas content testing during exploration	Yes core sampling and chip sampling	Yes core sampling	Yes core sampling	Selective, chip sampling	Yes core sampling	Yes core sampling
Gas content measurement during mining	Yes in gas outburst risk zones	No lab testing, recalculation of CH ₄ concentration in ventilation	Yes in gas outburst risk zones before and after gas pre-drainage	Partly, in implementation	Selective or none	Selective or none

Mining methods and gas drainage practices (1 of 2)

Country / parameter	Germany	Russia	Australia	Kazakhstan	China	USA
Typical mining methods	Longwall > 250 m	Longwall 200-400 m, few R&P mines	Longwall and R&P mixed	Longwall 200-250 m	Longwall 250-300 m	Longwall and R&P mixed
Multi-seam mining	Yes, up to 10 seams in one block	Yes up to 4-5 seams	Very rare	Yes, typically 2-3 seams	Yes multiple seams	Rare
Thick seam mining methods	Not	Mostly slicing	If yes, LTCC	Slicing	Mixed slicing and LTCC	Not

Mining methods and gas drainage (2 of 2)

Country / parameter	Germany	Russia	Australia	Kazakhstan	China	USA
Gas pre-drainage methods	UG straight	UG straight or directional (rare)	From surface or UG directional	UG straight	UG straight or directional	From surface or UG directional
Obligation of gas pre-drainage	No	Yes, if gas content > 12 m ³ /t	Yes, if gas content > TLV (usually ~ 9 m ³ /t CH ₄)	No	No	No
GoB drainage	From UG	From surface and UG	From surface and UG	From surface	From surface and UG	From surface

Regulations and mine planning

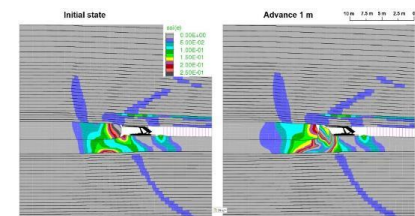
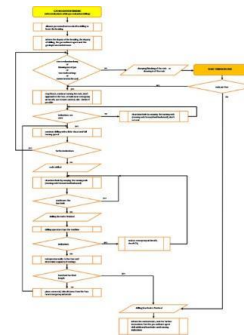
Country / parameter	Germany	Russia	Australia	Kazakhstan	China	USA
Assesment of gas outburst risk	Generally based on gas content, faulting and abutment pressure, subject to individual assesment	Based on general practice and depth of mining, general and subjective	Based on measured gas content and faulting	Based on depthfor entire seams	Based on gas pressure, coal strength, gas emission rate and tectonic structures, strictly regulated	No gas outburst risk recorded
Assesment process	Outburst guideline, final consensus reached by the mine, mining authority and independent expert	Based on regulations and made by prescribed bodies (till 2017)	Definier by operator in outburst management plan agreed with the mine inspectorate	Based on regulations and made by prescribed bodies	Generally prescribed by regulations	None
Assesment tools	Multiple software, gas lab, gas monitoring, drill results	Empirical formulas, geoacustics, drill results	Gas lab	Empirical formulas, gas lab (initial trials)	Empirical formulas, many methods are ried	None

Key features of successful gas outburst management

- Priority in gas outburst management is (1) prediction, (2) prevention and (3) protection.
- **Prediction** covers risk assessments prior to mining. Focus should be on most relevant factors: **gas content, coal structure, abutment pressure**.
- **Prevention** covers the elimination of actual gas outburst hazard and has to consider local geological conditions. Successful **pre-drainage and protection seam mining** eliminates high gas contents as the key factor. **Relaxation drilling** is used where reduction of gas content is not doable (low perm coal) and targets the local reduction of gas pressure. Smart procedures of relaxation drilling allow maximizing safety and advance rates and minimizing operational expenditures.
- **Protection** covers various safety measures being required if protection fails. People are removed from face during any major impact on coal (**remote controlled heading and drilling**) and have **access to breathable air** (O₂ self rescuer and emergency air breath supply). **Explosion protection** is required in zones where the explosive range is possibly crossed.

DMT project references

- **Advise to operators of gas outburst mines in Germany, Mexico, Kazakhstan, Russia, Australia and New Zealand** - with long term involvements. DMT's service covers investigations of gas outbursts, reviews and audits, risk assessments, training, implementation of short and long term strategies of prediction, prevention and protection. DMT holds international and long term experience with respect to high gassy and low permeable coal seams.
- **Gas lab** to measure CH₄ content on a short term basis and in mass – technology proven in **Germany** and implemented in **Turkey, Mexico and Kazakhstan** – very useful in mining environment with rapidly changing gas content (e.g. multi seam mining).
- **Analysis of gas outburst and degassing mechanisms** is done case by case, supported by **state of the art modelling tools** (e.g. GEDRU, FLAC, SimedWin). This allows the selection of most effective measures of prediction and prevention and considers the actual local mining conditions.



The future

- **Geohazmap Coal – 4D geotechnical risks modelling** is currently implemented as pilot project in **Russia**.
- The systems allows effective management of big data, transparent assessment and real time visualization of coal mine related risks, effective mine planning and alerting. Both, data and knowledge driven approaches are possible.
- Information has no value if not being accessible and used. Geohazmap Coal addresses the fact that much data is gathered during exploration and mining without being considered in risk assessments.
- The identification of simple-to-manage areas (pre-drainage or protection seam mining possible) and hard-to-manage areas (local relaxation and/ or remote heading required) is easy. Execution of appropriate measures can be triggered in time.

