中 国 煤 与 瓦 斯 共 采 及 其 利 用

Integrated Coal Production and Gas Extraction and Utilization in China

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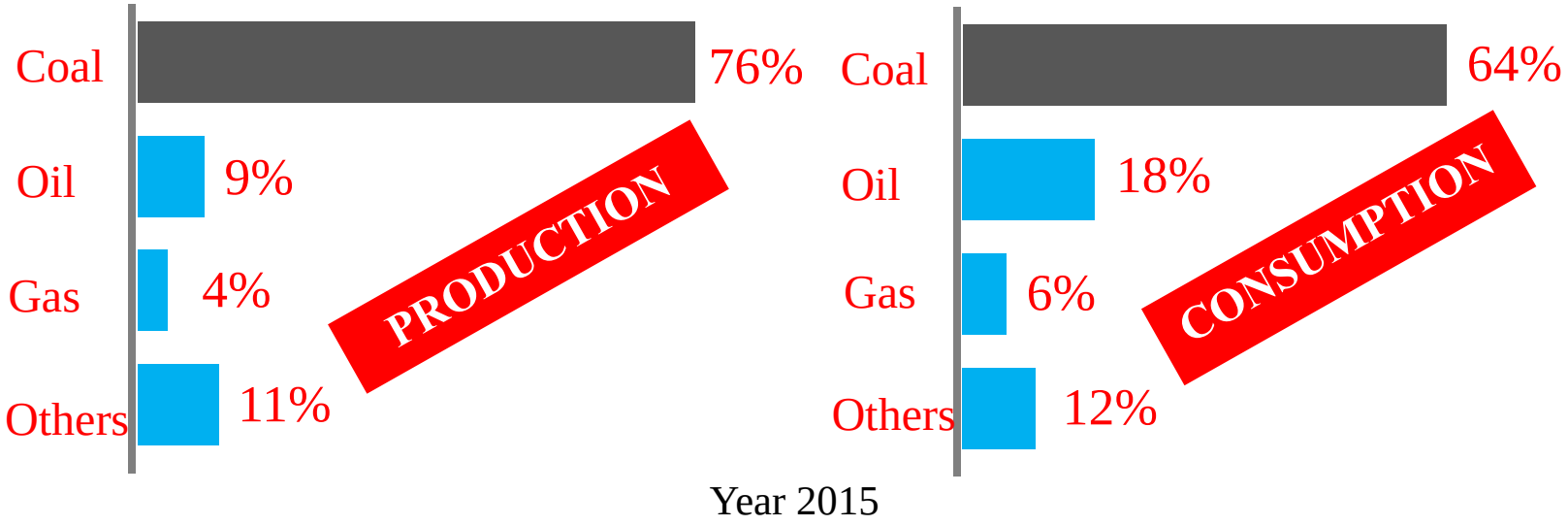
1 中国煤炭开采基本情况

Introduction to coal mining in China

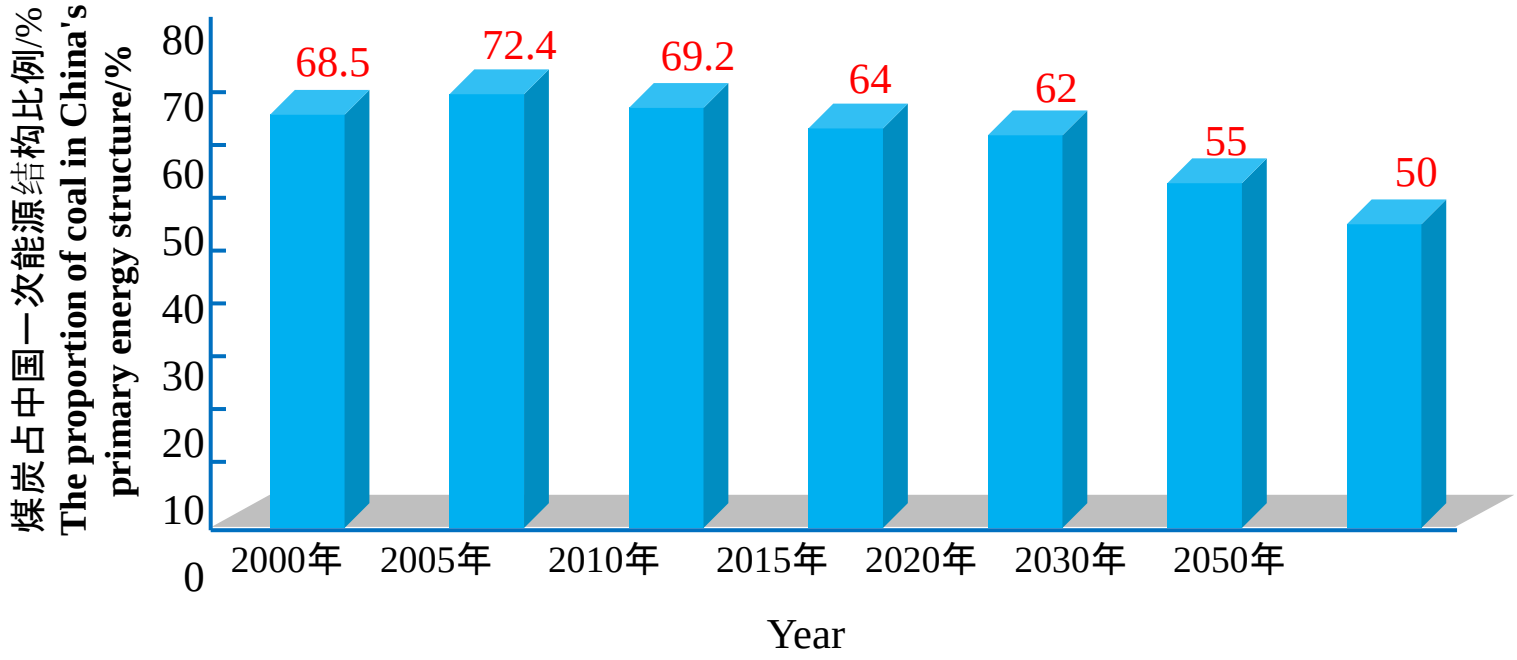
一、中国煤炭开采基本情况

- **中国是世界上最大的煤炭生产国和消费国**
  - 煤炭在一次能源的生产和消费结构中的比重分别占76%和64%
  - 煤炭为中国经济社会发展提供了60%多的能源支撑，远高于30%的世界平均水平
- **China: the largest coal producer and consumer**
  - Production:76% , Consumption:64%
  - China: coal provides 60% energy source; World: coal provides 30% energy source



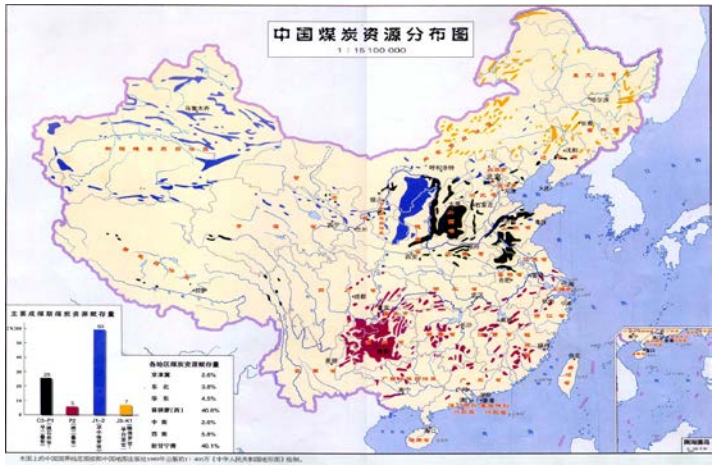
一、中国煤炭开采基本情况

- 到2020年、2030年、2050年煤炭在中国一次能源结构中的比重还将保持在62%、55%、50%以上
- 2050年中国煤炭需求量在25~30亿吨
- In China: coal in energy mix : 62% in 2020, 55% in 2030, 50% in 2050; coal demands in 2050: 2.5~3.0 billion tons



一、中国煤炭开采基本情况

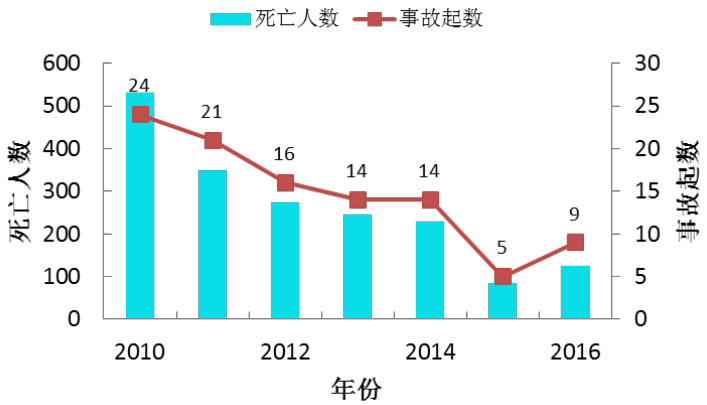
- **中国煤炭资源赋存条件复杂**
  - 煤炭资源分布差异大、地质条件差，薄和极薄煤层、厚与特厚（巨厚）煤层、大倾角与急倾斜煤层广泛分布，特别是瓦斯等灾害威胁严重，开采难度大
- **Coal deposits : complex and serious potential hazards**
  - Difficult mining conditions, various seam thickness (very thin to mega thick) and dip angle (from flat to steeply inclined), highly gassy, difficult to extract



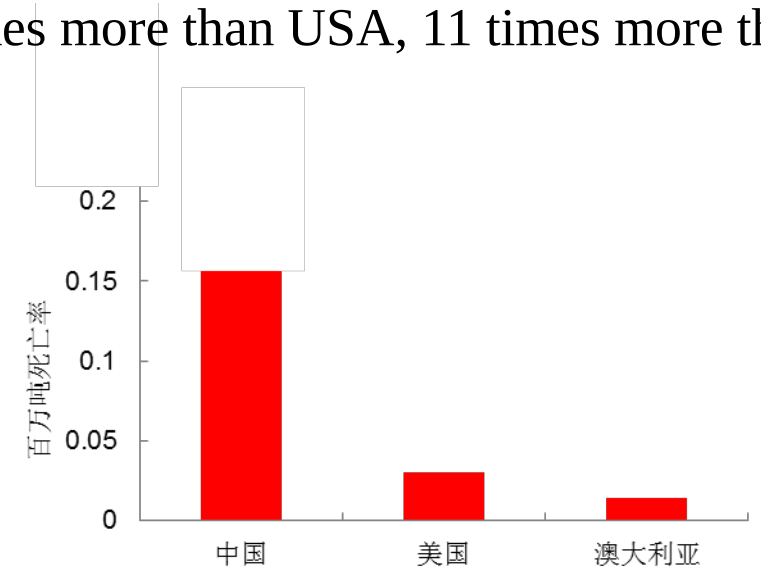
中国煤炭资源分布
Coal deposits in China

一、中国煤炭开采基本情况

- **中国煤炭安全开采形势严峻**
  - 重特大事故事故时有发生，2016年重特大事故不降反升，社会影响恶劣
  - 煤矿百万吨死亡率与世界发达国家相比仍存在较大差距，是美国的5倍，是澳大利亚的11倍
- **Coal mining safety – still challenging**
  - Major disasters still occur, serious social impact
  - Fatality rate is still too high, 5 times more than USA, 11 times more than Australia



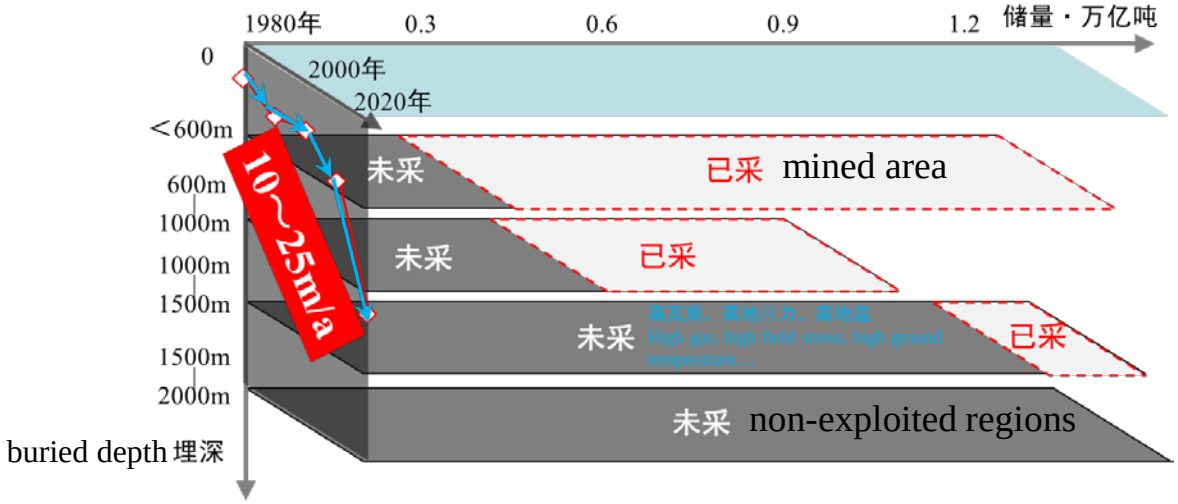
Major disasters



Fatality rates in China, USA and Australia

一、中国煤炭开采基本情况

- 已探明煤炭资源中，埋深在1000m以下资源量占53%
- 现有煤矿采深正以平均每年10～25米的速度增加，我国采深超千米的矿井有47座，山东新汶矿业孙村煤矿采深达1501米
- 千米深井各种灾害相互耦合，成灾机理复杂，防治愈加困难
- 53% of coal deposits are more than 1000 m deep
- Mining depth increases by 10～25 m per year. 47 mines extract coal of >1000 m deep, the deepest mine reaches 1501 m
- In deep mines, co-existence of multiple mining hazards



深部煤炭开采是世界性难题，安全高效开采威胁巨大！

Safe and efficient mining of deep coal seams is a world-wide issue!

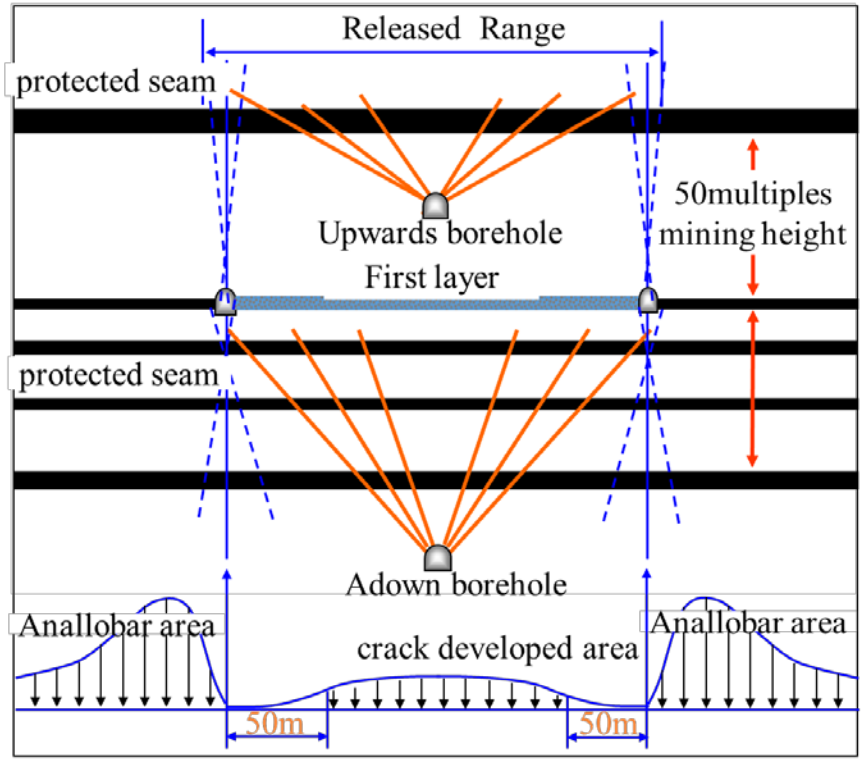
2 煤与瓦斯共采关键技术

Key technology in coal and gas co-extraction

二、煤与瓦斯共采关键技术

- **卸压开采煤与瓦斯共采技术**
  - **技术原理**
    - 在首采保护层工作面形成的应力降低区和裂隙发育区内布置瓦斯抽采工程，待首采层卸压开采后抽采采空区卸压解吸瓦斯的工程技术方法

- **Coal and gas co-extraction by stress-relief mining**
  - **Technical principle**
    - Gas drainage is undertaken in the de-stressed zones of first mining (protection) seam. Desorbed gas in the goaf of first mined seam is drained



二、煤与瓦斯共采关键技术

- **技术体系**
- **Technical system**

➢ 首采层瓦斯抽采消突技术

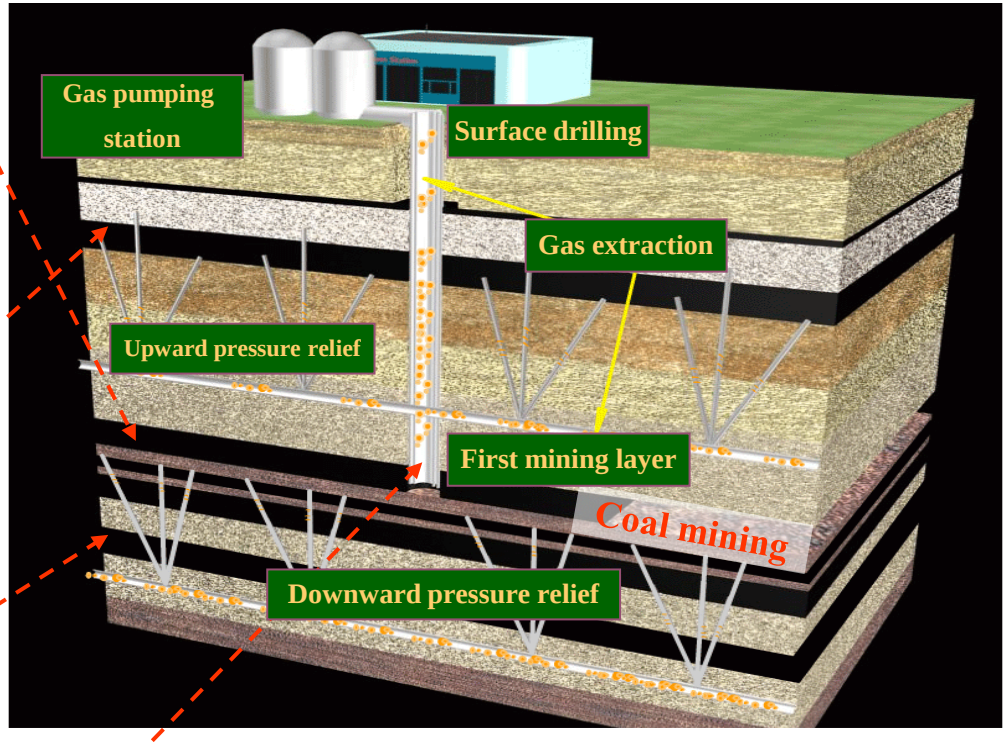
Outburst elimination technology of gas extraction in first mining seam

➢ 大间距上部煤层抽采被卸压煤层解吸瓦斯技术

Desorption gas extraction technology of stress-relieved overlying coal seams with large seam intervals

➢ 多重开采下向卸压增透瓦斯抽采技术

De-stressed & permeability-enhanced gas drainage with multiple mining



➢ 地面布置钻孔抽采被卸压煤层解吸瓦斯技术

Gas drainage in de-stressed coal seam by surface boreholes

二、煤与瓦斯共采关键技术

- **首采层瓦斯抽采消突技术及装备**
  - 研发了煤层瓦斯含量直接测定装置
  - 研发了深井强突煤层安全钻进防护系统
- **Outburst elimination technology & equipment of gas extraction in first mining seam**
  - **Coal seam gas content direct measuring device**
  - **Safe drilling protection system for strong outburst coal seam in deep mine**

煤层瓦斯含量直接测定装置
Coal seam gas content direct measuring device

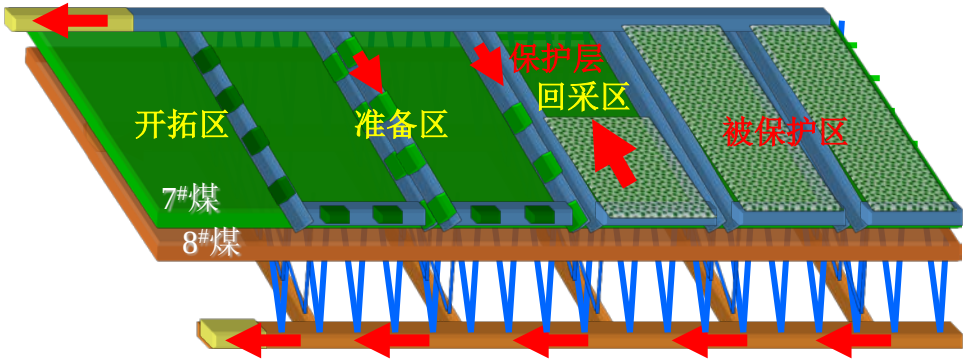
深井强突煤层安全钻进防护系统
Safe drilling protection system for strong outburst coal seam in deep mines

建立了防突预测预报指标体系，测准瓦斯含量和压力是关键

The outburst prediction and prediction index system is established, and the determination of gas content and pressure is the key

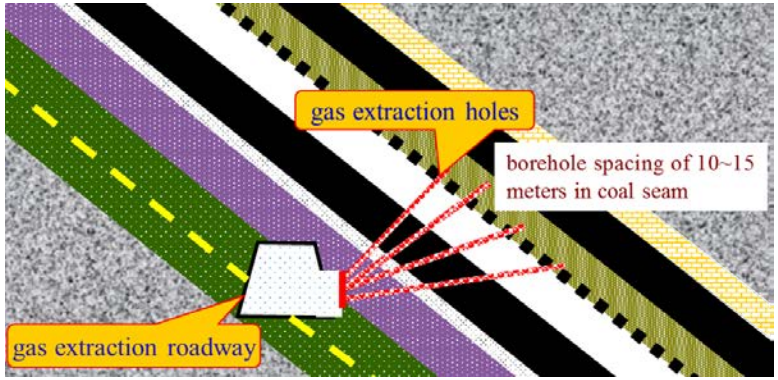
二、煤与瓦斯共采关键技术

- 母巷穿层钻孔抽采瓦斯技术
  - 首采层卸压消突抽采瓦斯是瓦斯治理的重中之重：布置顶、底板瓦斯抽采母巷，开发出成套穿层钻孔卸压增透专门技术，实现有效防突和高效预抽瓦斯
- Gas drainage by cross-measure boreholes in roadway
  - The first mining seam stress-relieve gas extraction is the top priority of gas control: the roof and floor gas extraction tunnels are arranged, the equipment and technology of cross-measure drilling are developed



底板专用瓦斯抽采母巷

Special gas drainage tunnel in floor

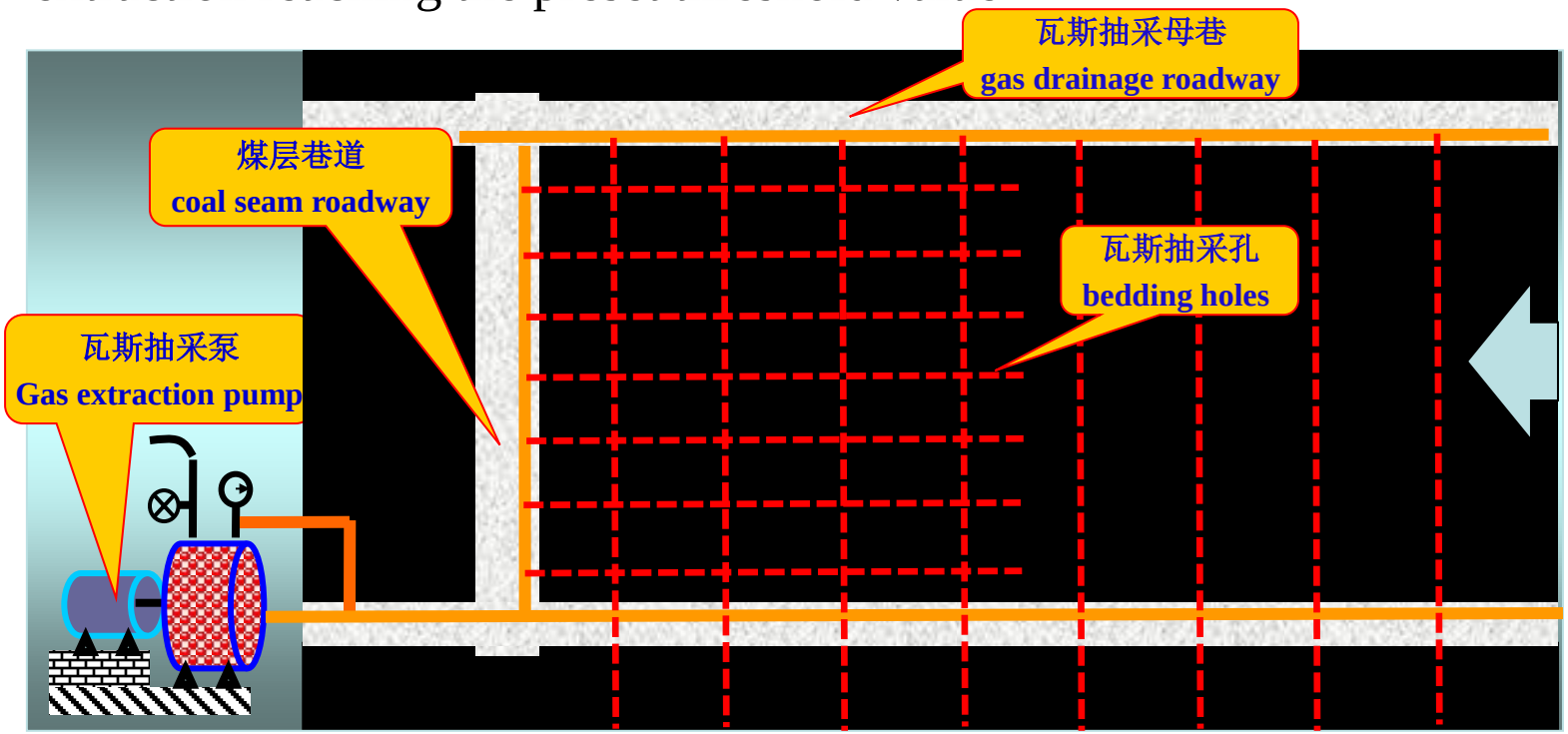


母巷穿层钻孔抽采瓦斯技术

Technology of gas drainage by cross-measure boreholes

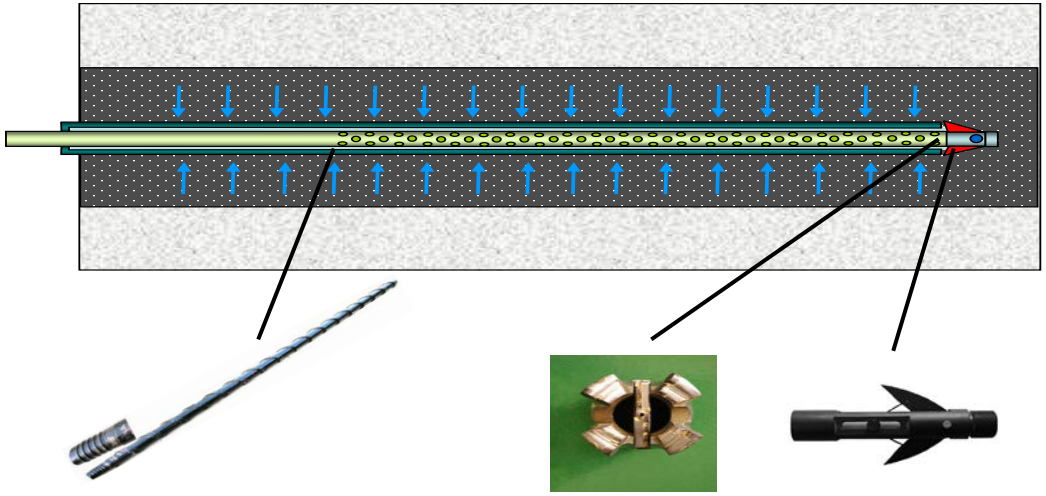
二、煤与瓦斯共采关键技术

- 母巷顺层钻孔抽采瓦斯技术
  - 回采巷道掘出后，利用母巷施工顺层孔，进行多次抽采卸压，瓦斯抽采达标后方能回采
- Technology of gas drainage by inseam boreholes
  - After roadway has been developed, inseam holes are arranged in roadway, seam gas pressure is reduced, coal are mined after gas extraction reaching the preset threshold value



二、煤与瓦斯共采关键技术

- 松软煤层协同式钻进–护孔瓦斯抽采技术
- Gas drainage technology with protected boreholes in soft coal seams



大通孔宽叶片螺旋钻杆

Large diameter spiral drill pipe with wide hole

内芯可脱式PDC钻头

Inner core detachable PDC bit

悬挂装置

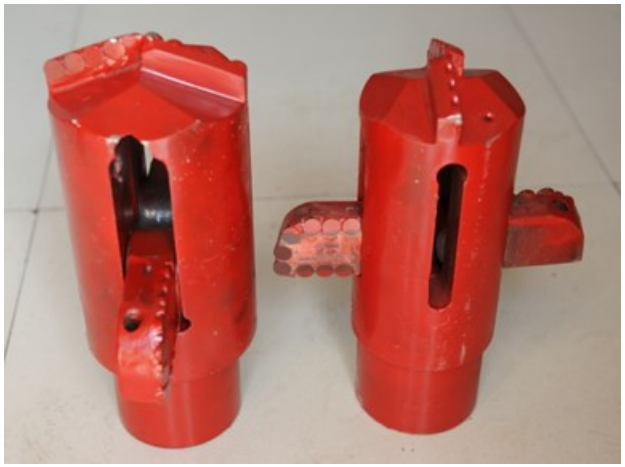
Suspension device

解决了软煤钻后易塌孔的难题

The problem of gas borehole collapse in soft seams has been solved

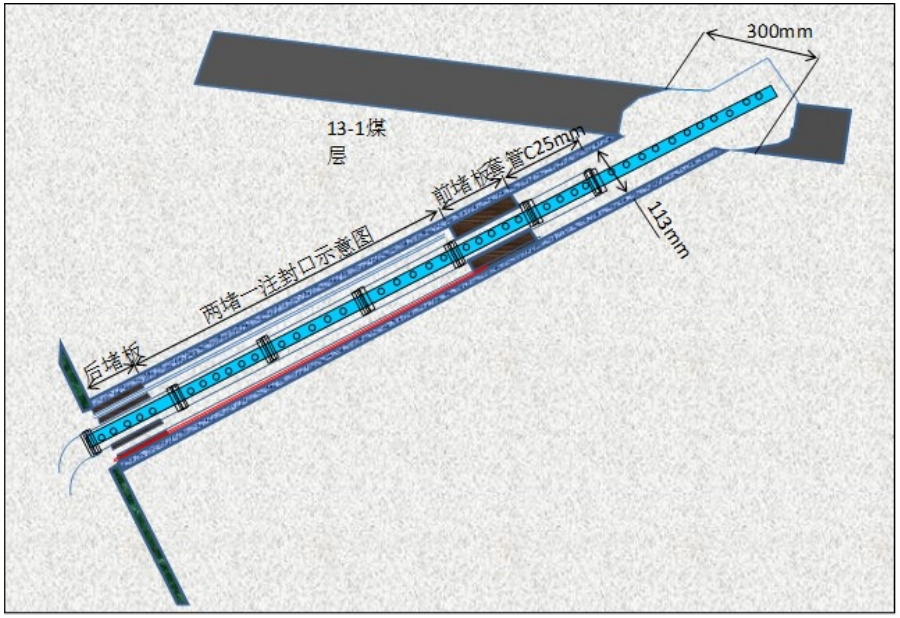
二、煤与瓦斯共采关键技术

- 掏穴钻孔增透技术
  - 研制了扩孔钻头，将见煤段孔径由Φ110mm变为Φ300mm
- Permeability enhancement technology by hole enlargement
  - A enlargeable bit was developed, and the borehole diameter in coal seam can increase from 110mm to 300mm



扩孔钻头

Enlargeablebit



钻孔扩孔强化抽采示意图

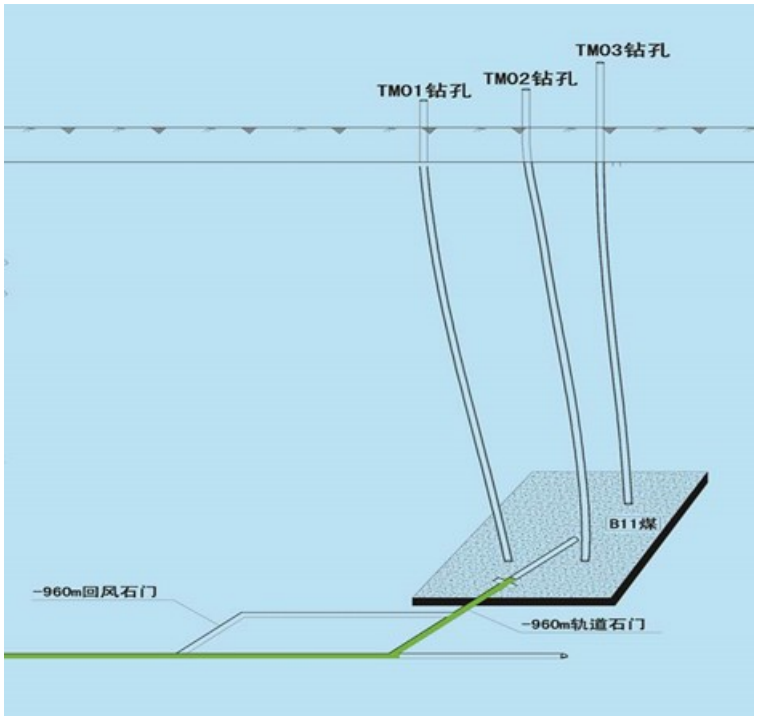
Enhanced gas drainage by enlargeable bit

二、煤与瓦斯共采关键技术

- 地面钻井掏煤预抽辅助消突技术

  背景：谢一矿-960m水平轨道石门煤层瓦斯压力大（> 6MPa）、瓦斯含量高（> 20m^3/t）

  设计：在地面布置三个钻井抽采石门附近煤层瓦斯



- Outburst prevention technology of gas drainage through surface drilling as an auxiliary measure

  Background: the coal seam gas pressure near crosshead is large (> 6MPa), and the gas content is high (> 20m^3/t)

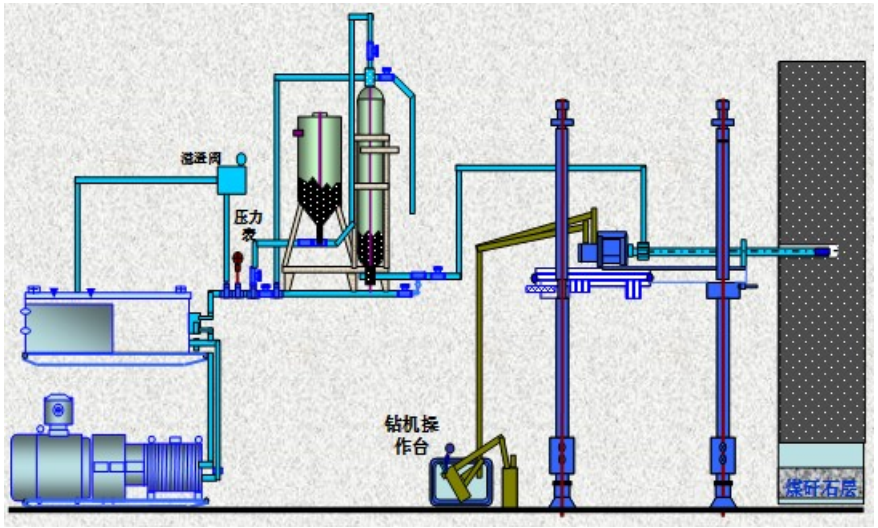
  Design: three surface boreholes are drilled to extract coal seam gas near crosshead

掏出煤量400t，抽出瓦斯量5万m^3，揭煤工作面瓦斯压力降至0.2～4.5MPa，瓦斯含量降至12m^3/t

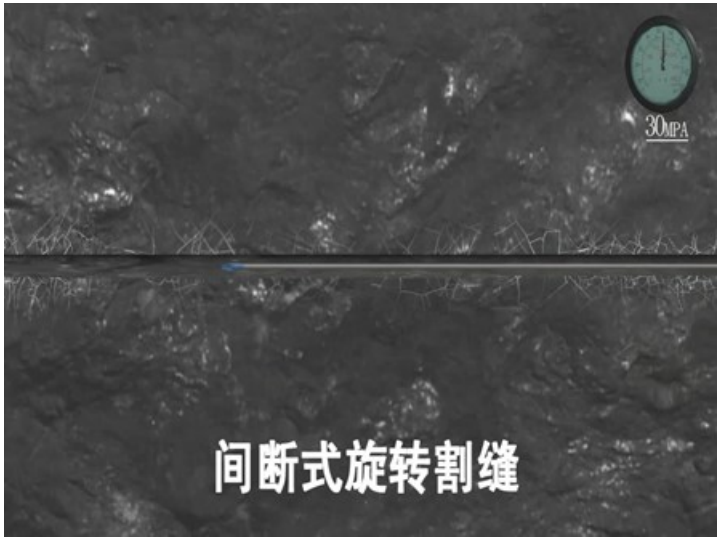
The amount of gas extraction is 50,000 m^3, the gas pressure is reduced to 0.2 ~ 4.5MPa, and the gas content is reduced to 12m^3/t

二、煤与瓦斯共采关键技术

- 高压水射流割缝增透瓦斯抽采技术
  - 建立了一套水力割缝系统，实现了“点”、“线”、“面”、“体”耦合的整体卸压增透抽采
- Gas drainage technology through permeability enhancement by high-pressure water jet fracturing and slotting
  - The hydraulic cutting system was set, the "point", "line" , "surface" and "body" coupling pressure relief gas drainage were achieved



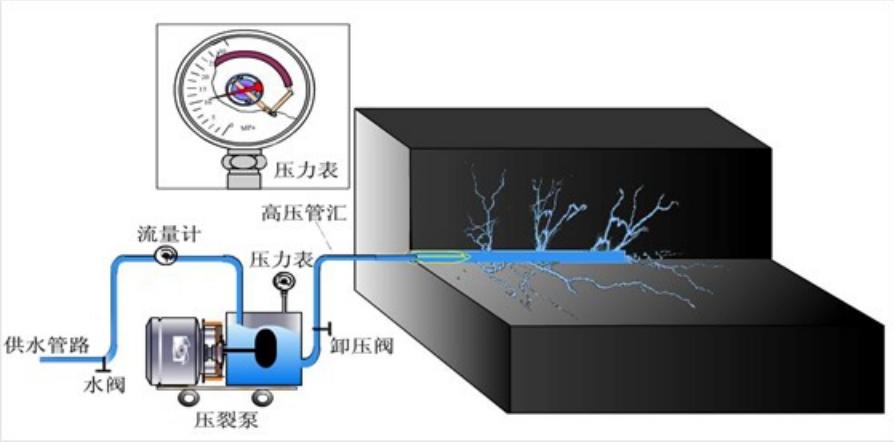
Equipment of high-pressure water jet



Intermittent rotary slotting

二、煤与瓦斯共采关键技术

- 脉动水力压裂增透瓦斯抽采技术
  - 通过高压注水泵和脉冲水锤器提供脉冲压力
  - 钻孔抽采纯量提高10~17倍，抽采浓度为30~86%（普通孔≤29%），有效影响范围提高4倍
- Enhanced gas drainage technology by pulsating hydraulic fracturing
  - Pulse pressure is supplied by high pressure water injection pump and pulse water hammer
  - Gas drainage quantity increases 10~17 times, the gas purity increases to 30~86%, and the effective drainage range increases 4 times

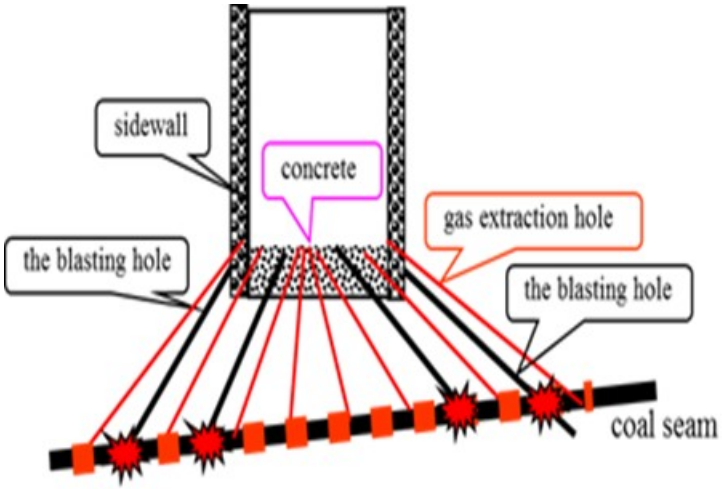


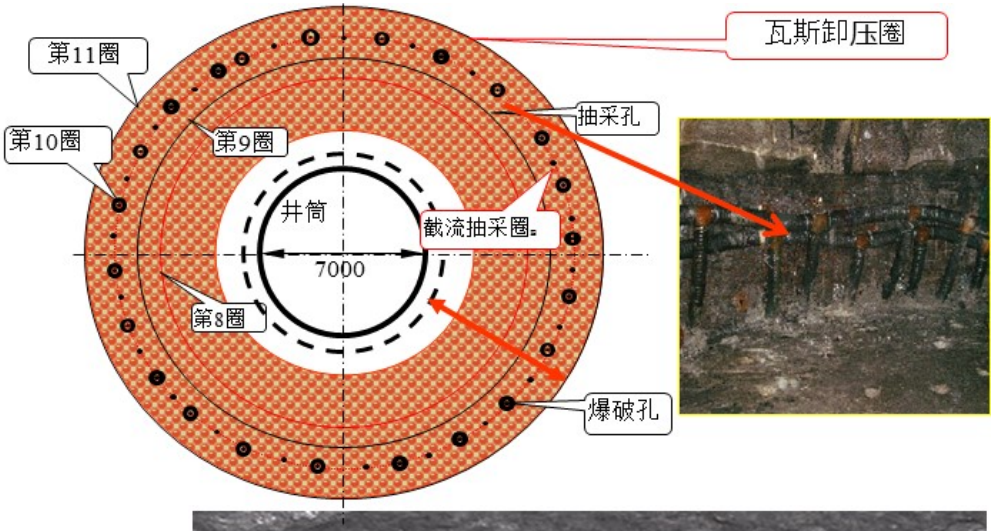
High pressure water injection pump

Pulsed power water hammer

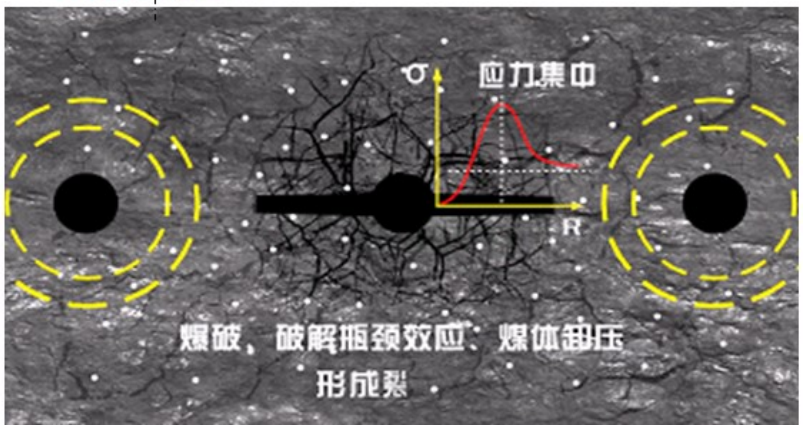
二、煤与瓦斯共采关键技术

- 深孔预裂爆破增透瓦斯抽采技术
  - 单孔瓦斯浓度增大3~4倍，单孔抽采纯量增大4~6倍



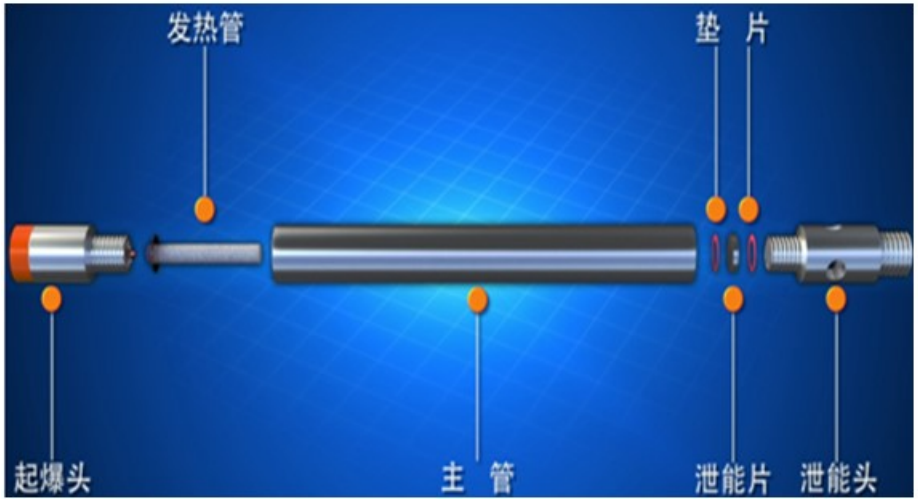


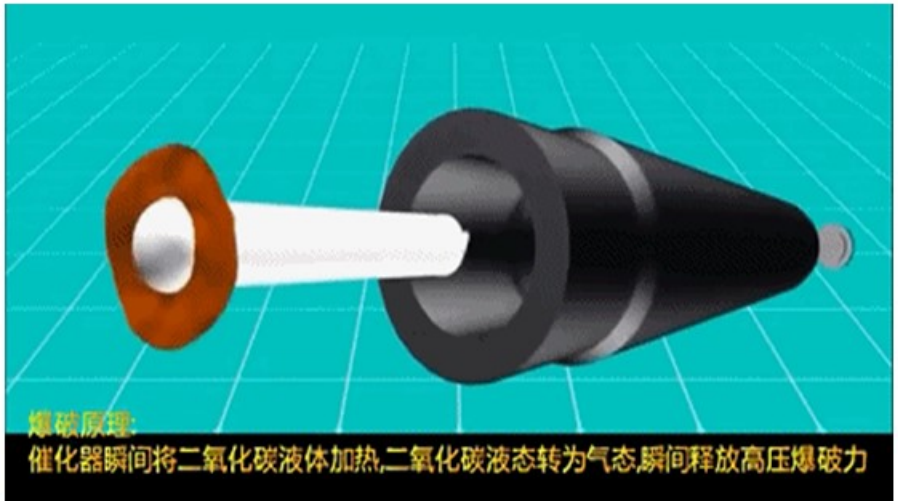
- deep hole pre-splitting blasting
  - The average gas concentration is increased by 3~4 times, and the average extraction amount is increased by 4~6 times



二、煤与瓦斯共采关键技术

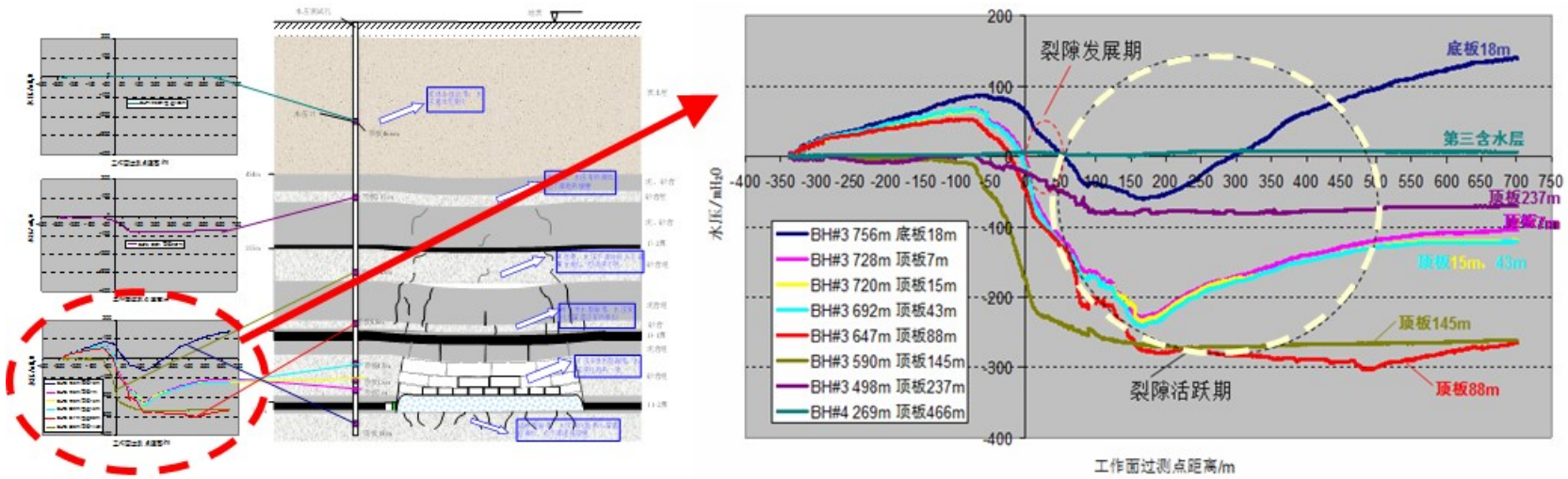
- 二氧化碳致裂增透瓦斯抽采技术
  - 二氧化碳变相致裂后煤层透气性提高5~8倍，抽采影响半径增大3~5倍，钻孔瓦斯流量提高6~10倍
- Enhanced gas drainage technology by CO_2 blasting
  - After the CO_2 blasting, the permeability of the coal seam is increased by 5~8 times, the drainage radius is increased by 3~5 times, and the gas flow is increased by 6~10 times





二、煤与瓦斯共采关键技术

- 首采煤层顶板抽采富集区瓦斯技术
- Technology of gas drainage in methane enrichment area at roof of first mining coal seam



大范围围岩孔隙水压动态变化与采动应力-裂隙关系

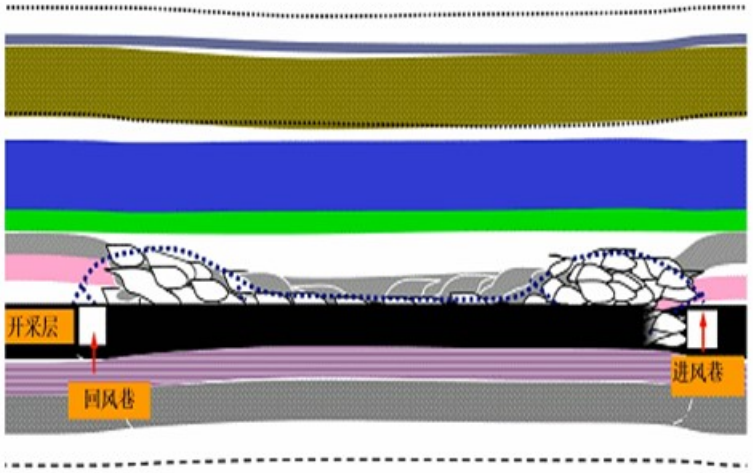
Relationship between dynamic change of pore water pressure and mining stress-fracture in large scale surrounding rock

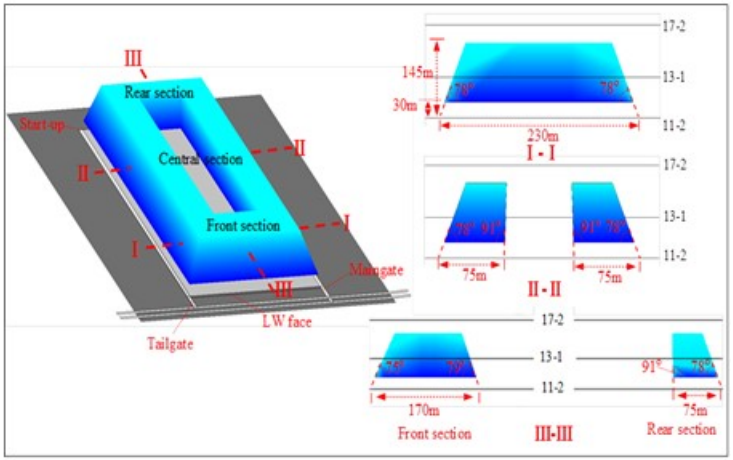
在淮南4对矿井开展了试验，实测揭示了采动覆岩应力场、裂隙场发育及演化规律，裂隙活跃期位于工作面后方50～500m

Tests were carried out in 4 mines in Huainan mining area. The stress field and fracture field evolution of overlying strata were undertood. The fractured area was 50 ~ 500 m behind the working face

二、煤与瓦斯共采关键技术

- 建立了煤与瓦斯共采“高位环形体”理论体系，首次实现了深井采动煤岩体“三场”定量描述
- A theoretical system of "high annular body" for coal and co-extraction has been established, and the quantitative description of "three fields" in deep mining affected coal and rock mass has been given for the first time



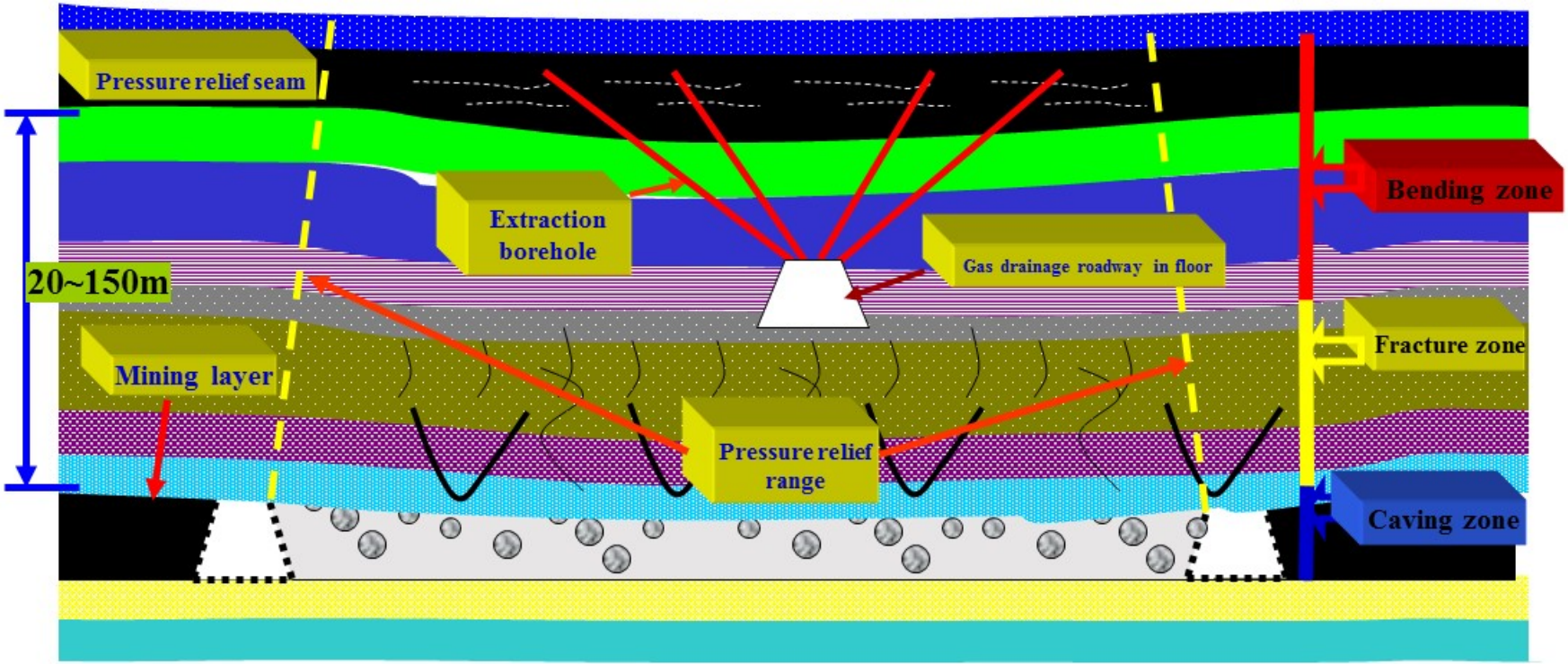


研究成果入选“2013年中国百篇最具影响国内学术论文”、荣获第23届世界采矿大会“最佳论文”奖

The research paper was included in “one hundred most influential Chinese academic papers in 2013", and won the "best paper" award of the 23th world mining conference.

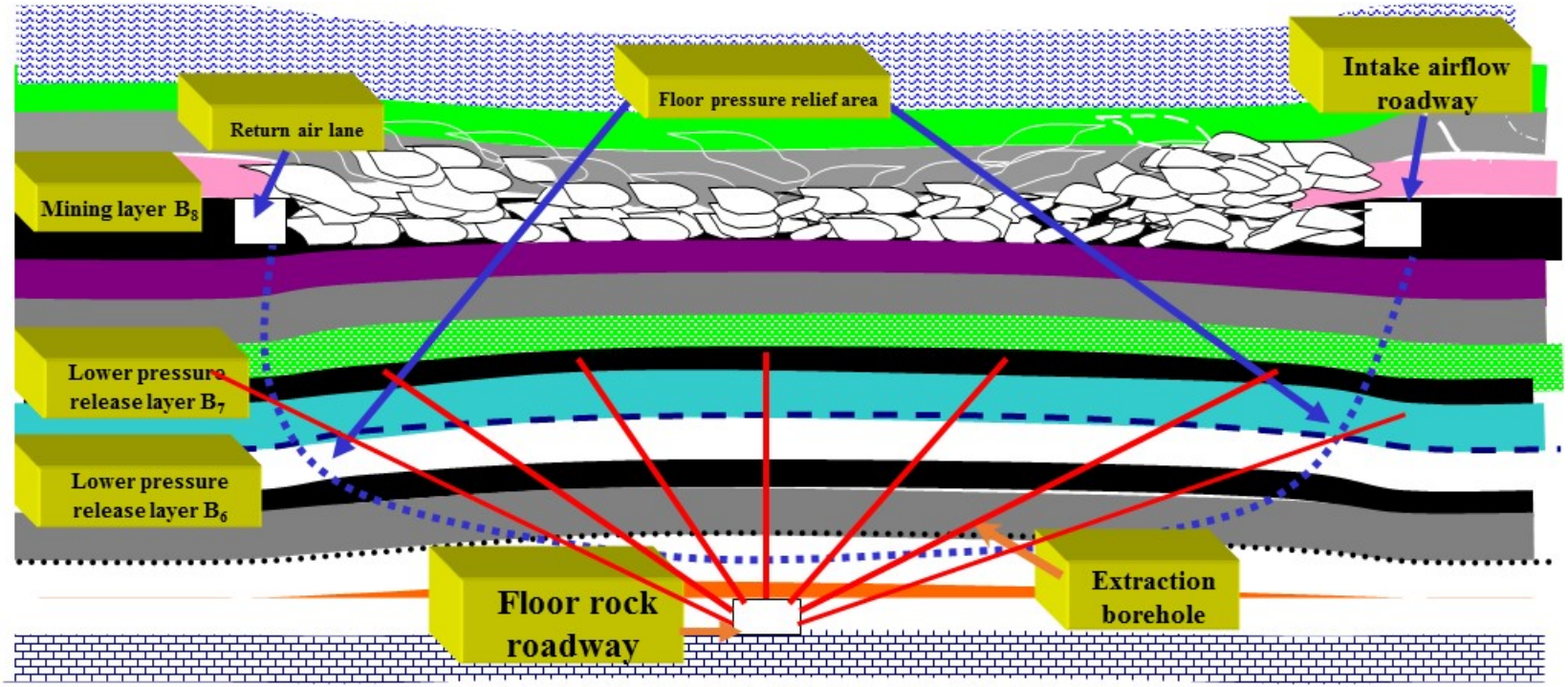
二、煤与瓦斯共采关键技术

- **大间距上部煤层抽采被卸压煤层解吸瓦斯技术**
  - 走向卸压角80.8～84.7º，倾向卸压角83～85º，卸压高度达10～150m，该区域内瓦斯抽采率达90%以上
- **Technology of gas drainage from upper stress-relief coal seam with large seam spacing**
  - The stress relief angle is 80.8~84.7° along the panel length. The stress relief angle is 83~85º along the panel width. The de-stressed height is 10~150m. The gas recovery rate is more than 90% in this region.



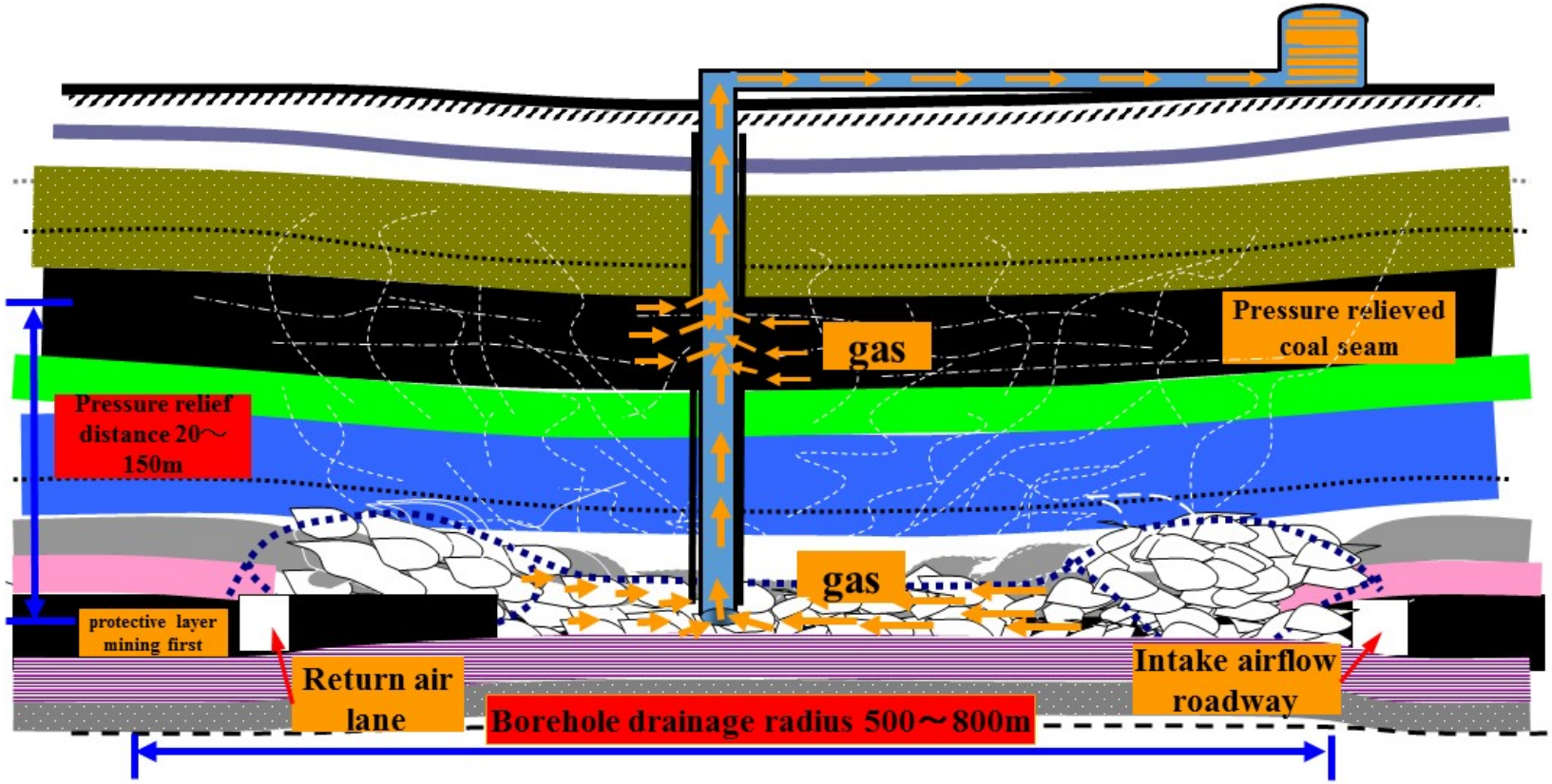
二、煤与瓦斯共采关键技术

- **多重开采下向卸压增透瓦斯抽采技术**
  - 走向卸压角99.3～100.1º，倾向卸压角为102～110º，卸压距离达15～100m，瓦斯抽采率达80%以上
- **Technology of gas drainage of underlying seams with stress relief & permeability enhancement**
  - The stress relief angle is 99.3~100.1° along the panel length and 102~110º along the panel width. The de-stressed height is 15~100m. The gas recovery rate is more than 80% in this region



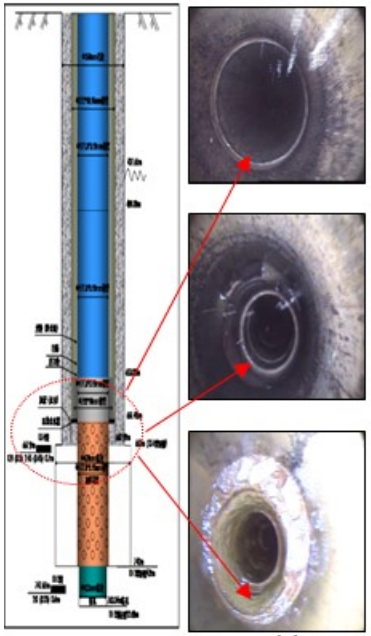
二、煤与瓦斯共采关键技术

- **地面布置钻孔抽采被卸压煤层解吸瓦斯技术及装备**
  - 深井(800~1000m)大直径(Φ250mm)地面钻井瓦斯抽采技术取得重大突破
- **Gas drainage technology & equipment with surface boreholes**
  - Great breakthrough has been made in gas extraction technology with deep surface boreholes (800~1000m) of large diameter (Φ250mm)

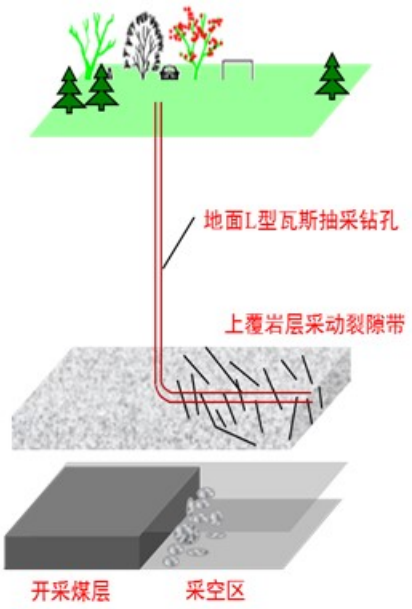


二、煤与瓦斯共采关键技术

- 成功实现了地面井下联合抽采
- Successful in the combination of underground and surface gas drainage



新型防断钻井结构



地面L型钻孔采空区瓦斯抽采

198口采动区钻井共抽采瓦斯量30460万m^3，平均单井抽采量154万m^3，最大单井抽采量696万m^3。

建成两淮矿区煤层群开采条件下煤与瓦斯共采示范工程

研究成果入选中国科协首次发布的“中国科技期刊2016年度优秀论文”。

Research results won the award of “the excellent papers of China S&T Journal in 2016".

二、煤与瓦斯共采关键技术

- **研究成果获2003年度国家科技进步二等奖**
- **The research results won the 2003 National Science and Technology Progress Prize**

➢ 历时8年，首次提出了“煤与瓦斯共采”的瓦斯治理新理论和技术路线，把卸压开采作为瓦斯治本措施，获2003年度国家科技进步二等奖

➢ After years of hard work, the new theory and technologies of gas control for integrated coal mining and gas extraction were established for the first time. The stress relief mining was taken as the fundamental measure of gas control and the research results won the 2003 National Science and Technology Progress Prize


国家科学技术进步奖

证 书

为表彰国家科学技术进步奖获得者，特颁发此证书。

项目名称：复杂特困条件下高瓦斯煤层群瓦斯抽放理论研究与工程实践

奖励等级：二 等

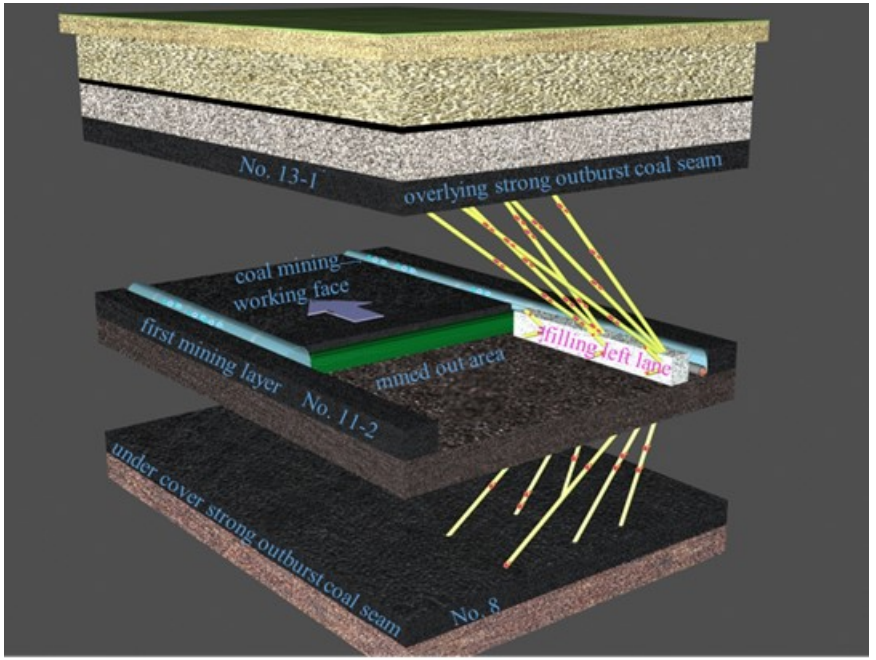
获 奖 者：袁 亮

2004 年 1 月 20 日

证书号：2003-J-210-2-07-R01

二、煤与瓦斯共采关键技术

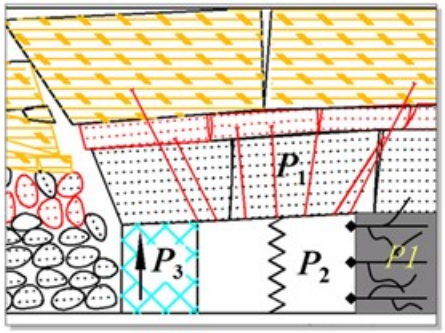
- **无煤柱煤与瓦斯共采关键技术**
- **工程技术方法**
  - 在煤层群中选择瓦斯含量低、安全可靠的薄煤层先开采，采用Y型通风改变通风流场，形成首采保护层工作面前部采煤、后部在采空区护巷并抽采卸压解吸瓦斯的煤与瓦斯共采工程技术新方法
- **关键技术**
  - 留巷钻孔连续抽采采空区瓦斯技术



- **Key technology of integrated and pillarless coal mining and gas extraction**
- **Engineering technology method**
  - Thin coal seam with low gas content is first mined. Using Y type ventilation to change airflow, gas is extracted in goaf
- **Key technology**
  - Gas extracted through borehole in retained roadway

二、煤与瓦斯共采关键技术

- 围岩结构应力优化控制技术
- Optimization control technology of surrounding rocks

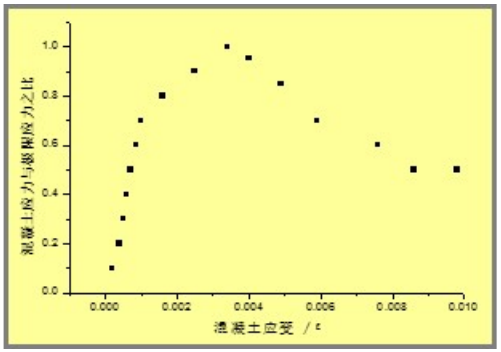


三位一体围岩控制技术
Three in one surrounding rock control

自移辅助加强支架(P_2)
Self moving auxiliary strengthening bracket

充填墙体（P_3）
Filling waill

- 高承载性能的巷旁充填墙体支护材料配置技术
- Fill materials for supporting wall with high load-bearing capacity



Performance test of filling material

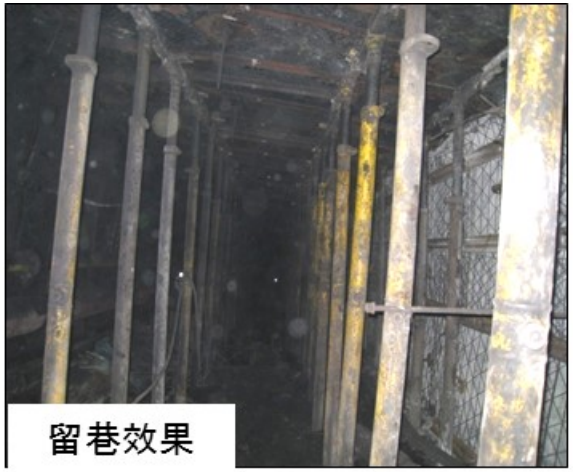
测试时间	抗压强度(MPa)
1d后	4～7
3d后	9～12
7d后	20～28
28d后	＞50

二、煤与瓦斯共采关键技术

- 自主研制成功巷旁充填一体化快速构筑模板支架，满足了综采工作面日推进10m以上快速推进的要求
- 首次实现900m深井护巷断面8～10m^2，长度达2900m的世界纪录，是国外的2～3倍，成本仅为欧洲的1/3
- Mechanized support was developed to meet the requirement of 10m/d advance speed
- The retained roadway has a cross-sectional area of up to 8～10m^2 at the depth of 900 m and 2900 m long, which is the world record, and the cost is only 1/3 that in Europe.

Formwork support for side filling

Formwork support after side filling



Roadway in -900m underground

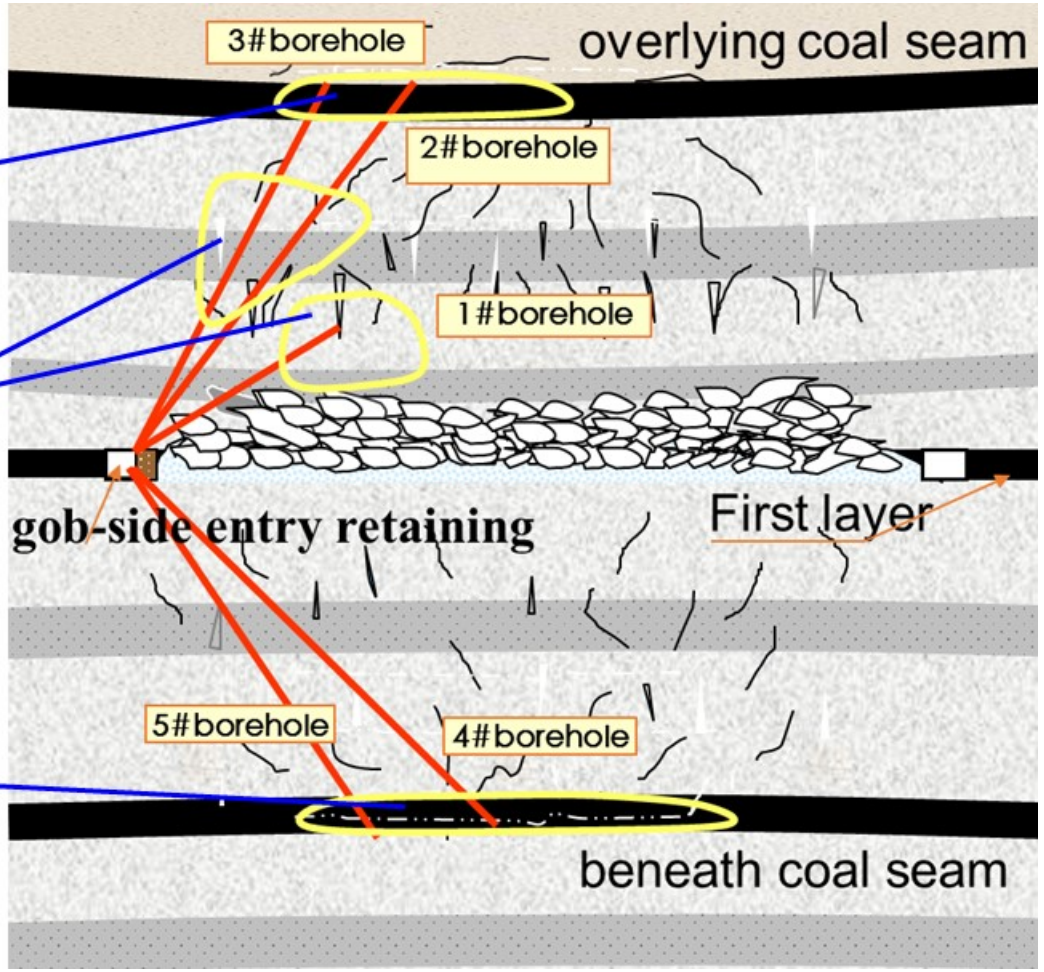
二、煤与瓦斯共采关键技术

- 首次开发成功无煤柱(护巷)Y型通风留巷钻孔法抽采瓦斯关键技术
- Key technology of gas drainage by drilling in remained roadway of Y-type ventilation without coal pillar for the first time

上卸压层瓦斯抽采
gas extraction with stress relief in upper seams

采空区瓦斯抽采
Goaf gas extraction

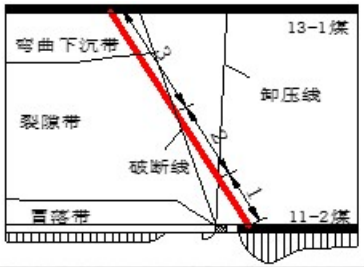
下卸压层瓦斯抽采
gas extraction with stress relief in lower seams



二、煤与瓦斯共采关键技术

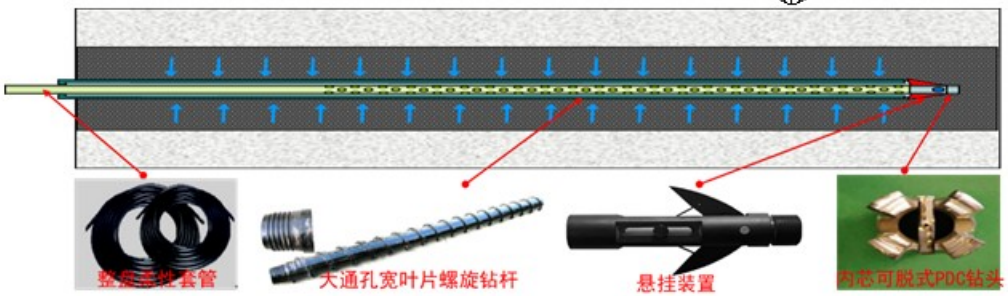
- 研发了深井煤层群卸压瓦斯抽采布孔、护孔、封孔等关键技术，显著提高了钻孔稳定性、封孔质量和瓦斯抽采效果，瓦斯抽采率由50%提高到80%以上
- The key technology of hole arrangement, hole protection and hole sealing has been developed in deep coal seams. The gas extraction rate has increased from 50% to over 80%

防错断布孔
Borehole arrangement against breaking

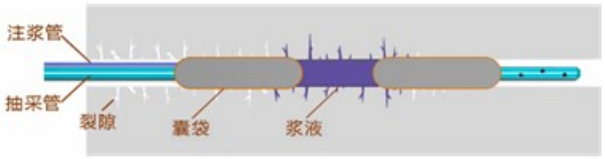


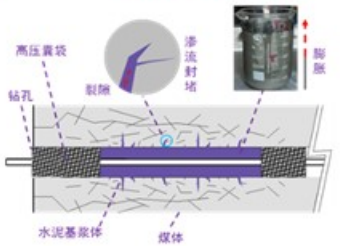
1-挤压剪切破坏区；
2-压剪-剪拉过渡区；
3-剪切拉伸破坏区

全程柔性套管快速护孔
Quick hole protection by flexible casing



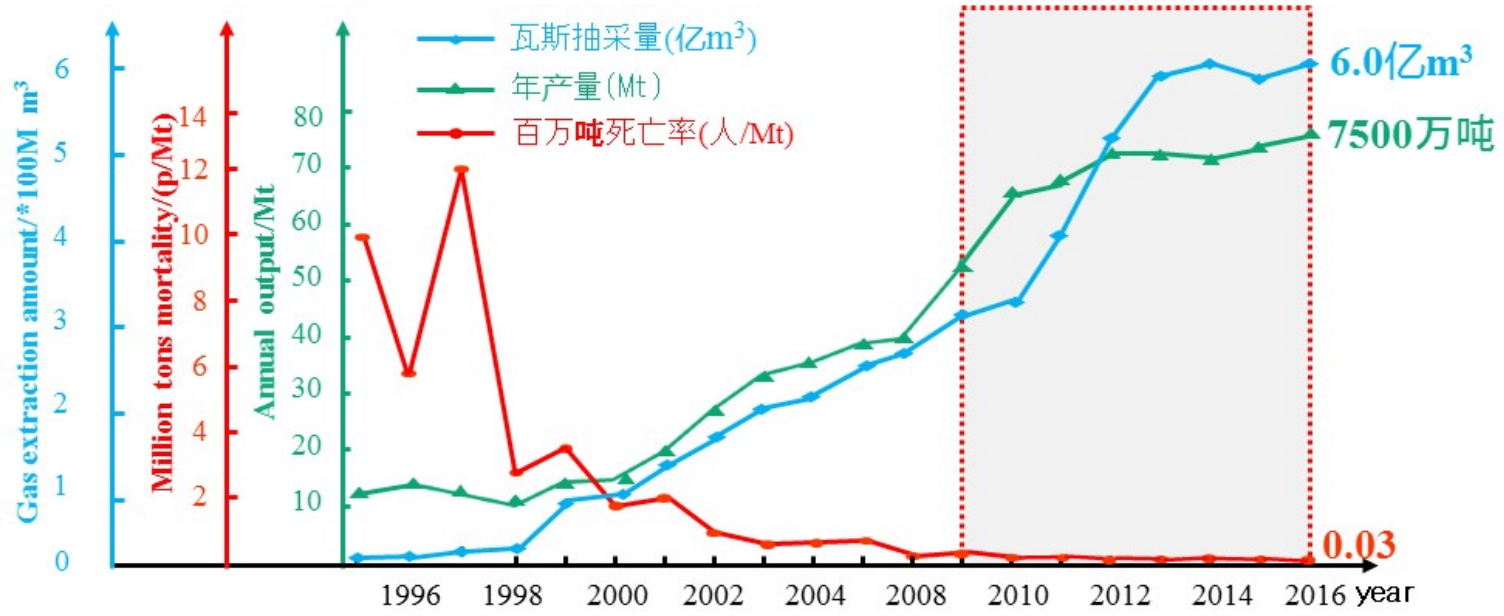
囊袋式封孔
Pocket-assay sealing





二、煤与瓦斯共采关键技术

- **淮南矿区推广应用效果**
- 研究成果在淮南矿区应用效果显著：瓦斯抽采量由2009年的3.2亿m^3增加到2016年的6.0亿m^3，抽采率由50%提高到80%，杜绝了瓦斯事故
- **Application in Huainan mining area**
- The gas extraction amount increased from 320 million m3 in 2009 to 600 million m3 in 2016, the extraction rate increased from 50% to 80%, and the gas accident has been eliminated



淮南矿区2009年以来产量、百万吨死亡率及瓦斯抽采量状况

The output, the fatality per million tons and the gas extraction in Huainan mining area since 2009

二、煤与瓦斯共采关键技术

- **国内外推广应用效果**
- 2009年以来，研究成果在焦煤集团、晋煤集团、陕煤化、平煤集团、龙煤集团、澳大利亚、俄罗斯等国内外广泛应用，效果良好
- **Application at home and abroad**
- Since 2009, research results are widely used in China, Australia, Russia and other countries

- 试验和推广工作面85%实现瓦斯零超限，杜绝了瓦斯事故
- 帮助建成全国瓦斯治理示范矿井12对，全国瓦斯治理先进单位7家

成果以“采空区水平抽采设计”项目在全澳大利亚推广，该项目被全球甲烷倡议组织（GMI）列为最佳瓦斯抽采案例。

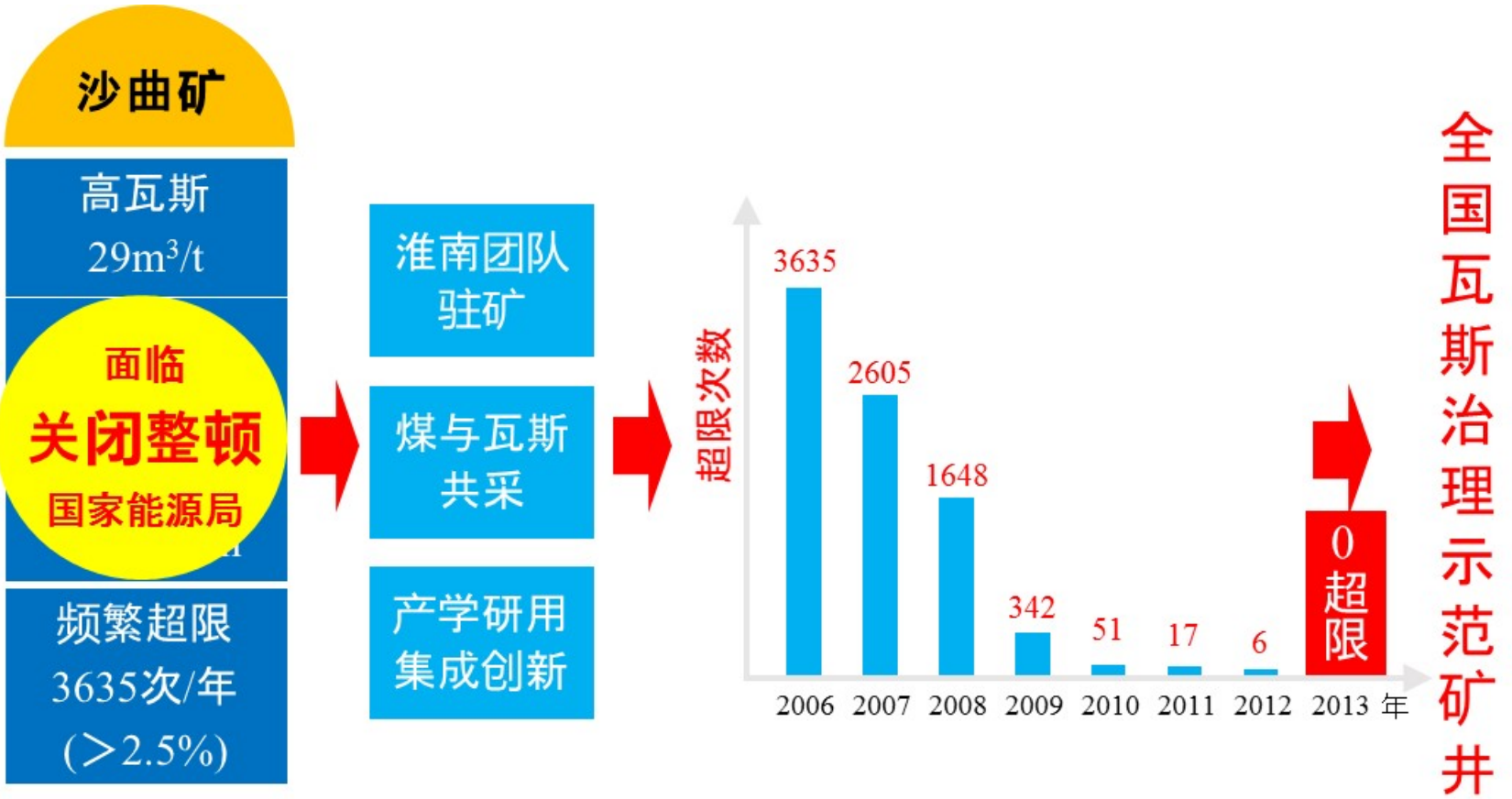
The results of “goaf gas drainage design with horizontal boreholes" are applied in Australia. The project is listed as the best gas extraction case by the Global Methane Initiative (GMI).

二、煤与瓦斯共采关键技术

典型示例一　Typical example 1

沙曲矿4.2m大采高无煤柱煤与瓦斯共采关键技术

Pillarless coal and gas co-extraction with 4.2m mining height in Shaqu mine

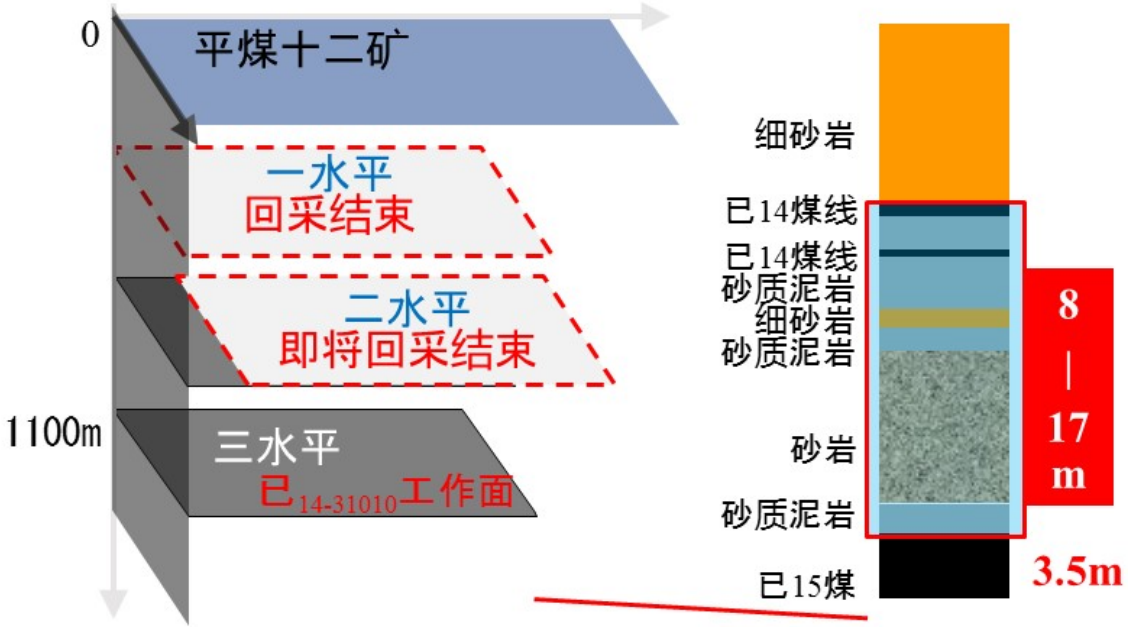


二、煤与瓦斯共采关键技术

典型示例二 Typical example 2

平煤十二矿大采深高应力厚层坚硬顶板留巷控制与瓦斯治理

Pillarless coal and gas co-extraction in No.12 mine of over 1000 m deep with high stress & thick roof



- -1100m大采深高地应力、高瓦斯、厚层坚硬顶板直覆
  - 存在大面积悬顶
  - 顶板大面积来压
  - 巷道底鼓剧烈……

国内尚无成功经验，先后有三家科研单位与其合作均告失败！

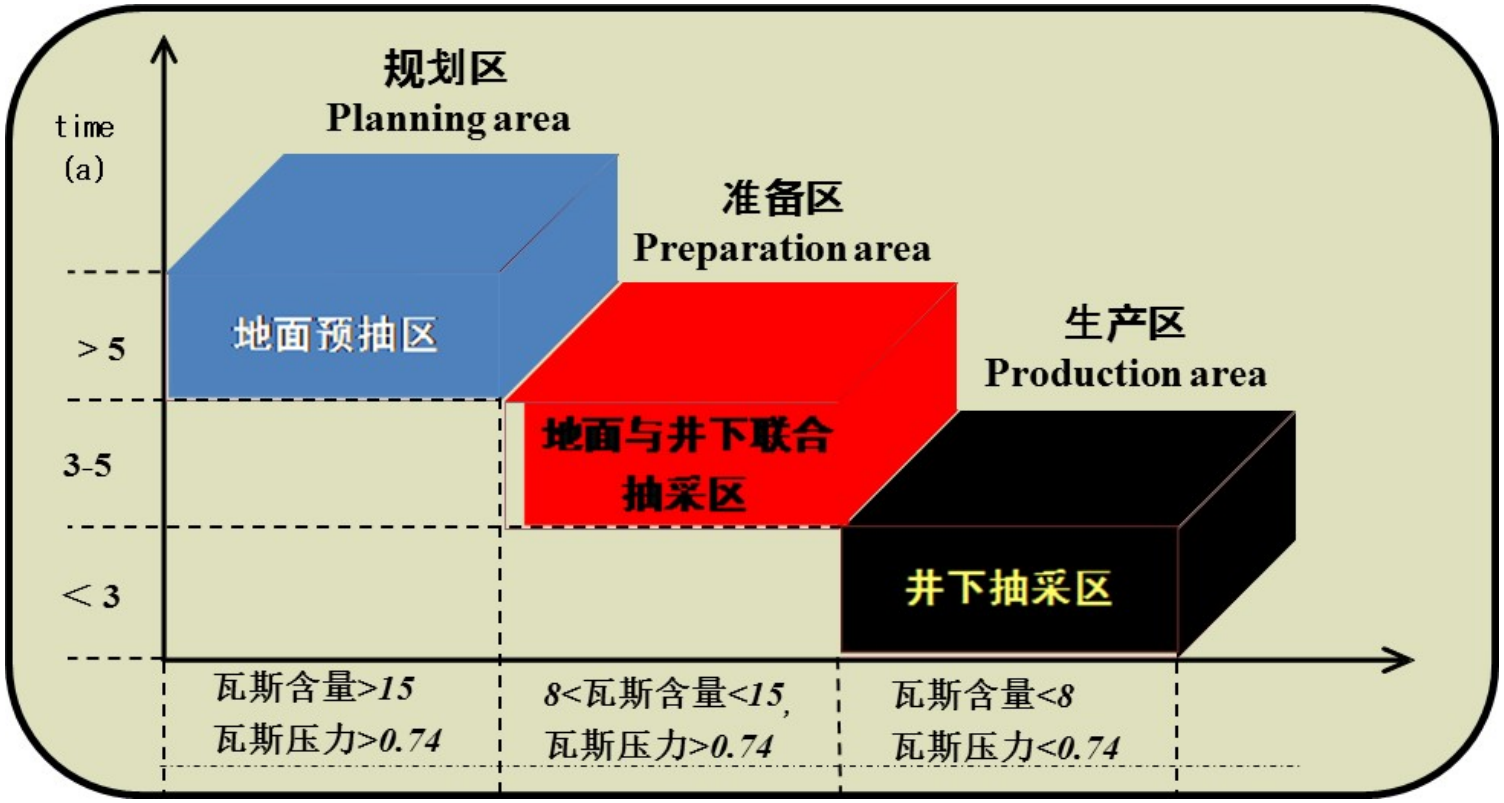
研究团队成功实施大采高强矿压无煤柱煤与瓦斯共采工程实践，**突破了平顶山矿区千米深井开采禁区，成功打开了呆滞多年的三水平，矿井得到重生！**

二、煤与瓦斯共采关键技术

- 研究成果获2008年度中国煤炭工业科技进步特等奖（排名第一）、2009年度国家科技进步二等奖（排名第一）…
- **Research results won the 2008 China Coal Industry Science and Technology Progress Award (First Prize), 2009 National Science and Technology Progress Award (Second Prize)…**

二、煤与瓦斯共采关键技术

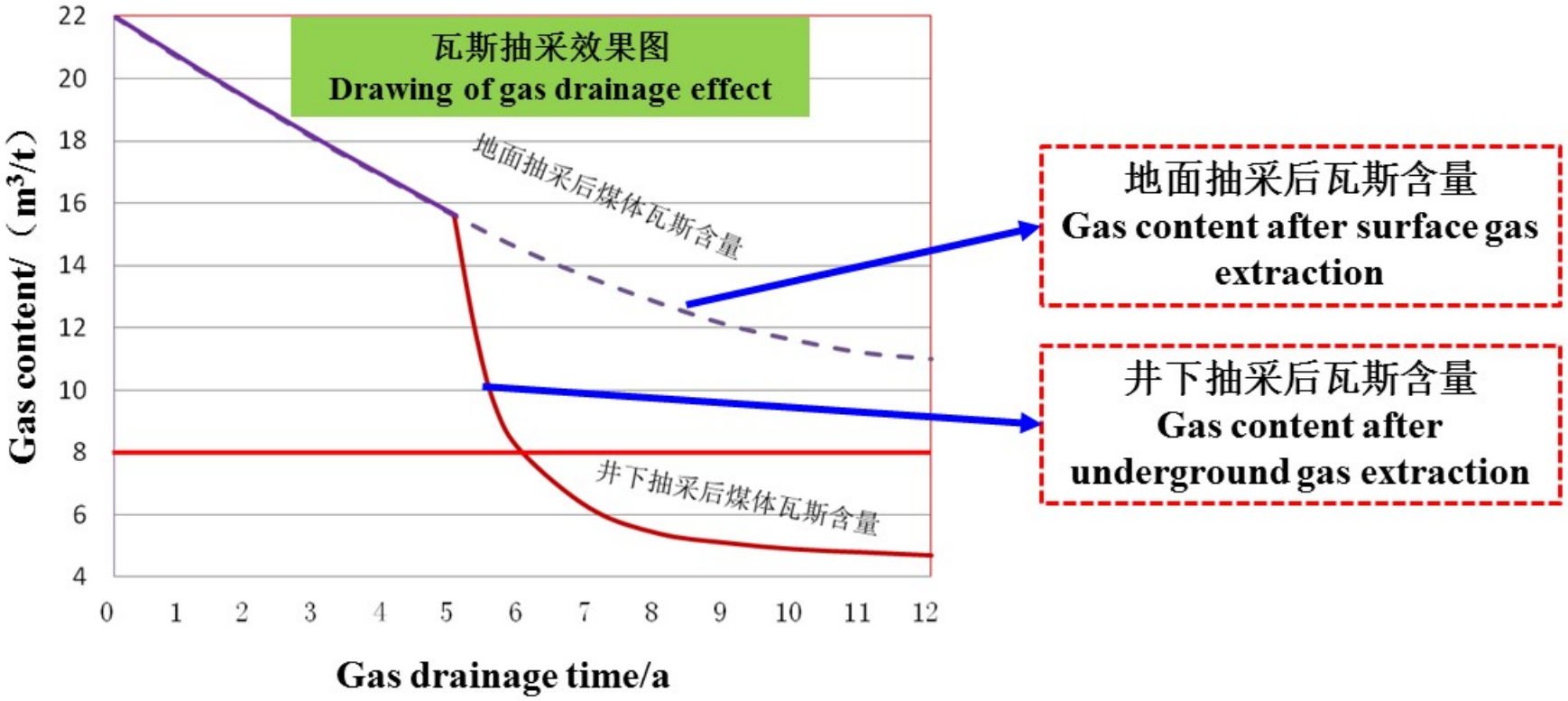
- “晋城模式”煤与瓦斯共采
- "Jincheng model" for coal and gas co-extraction



将煤炭开采和煤层气开发统筹规划，使地面抽采与井下抽采在时间和空间上与煤矿生产相结合。

The coal mining and gas extraction are considered as one process, so that the surface and underground drainage could combin with coal mine production in time and space.

二、煤与瓦斯共采关键技术

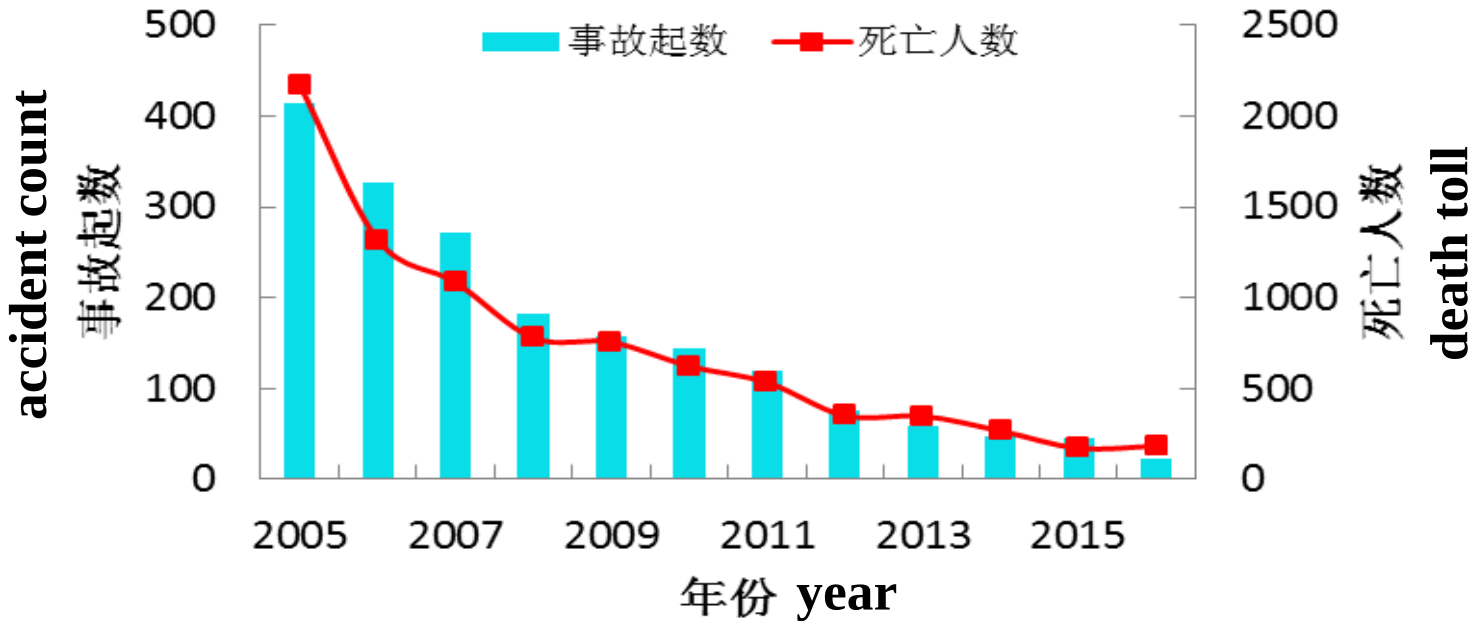


先采气后采煤，采煤采气一体化的“晋城模式”煤与瓦斯共采适用于地质构造条件相对简单，煤层高渗较硬地势平缓的区域。

Coal mining after gas drainage. The “Jincheng model” for coal and gas simultaneous mining is suitable for the condition where coal seams are hard, simple and flat with high permeability.

二、煤与瓦斯共采关键技术

- 煤与瓦斯共采成果
- Achievements of coal and gas simultaneous mining



瓦斯事故得到有效控制，解决了低透气性煤层煤矿瓦斯治理这一世界性、历史性的难题，极大地解放了煤矿生产力，探索出了一条煤炭科学开采，煤炭工业绿色发展新路。

The gas-related accidents have been effectively controlled and productivity in coal mines is improved, and a new approach of green mining in coal industry is provided .

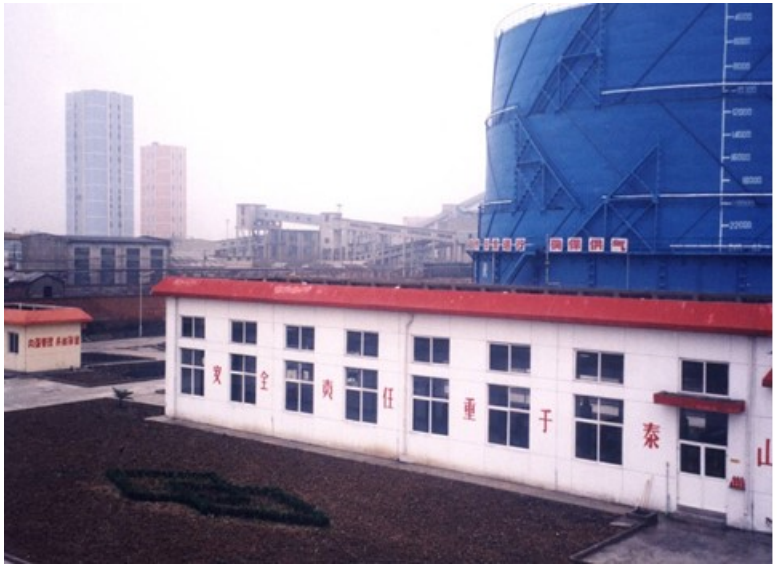
3 瓦斯综合利用技术途径

Mine gas utilization

三、瓦斯综合利用技术途径

- 瓦斯综合利用技术途径
- Technical methods of gas comprehensive utilization

● 民用燃气 ● Civil gas



民用瓦斯气站
gas station

居民使用瓦斯做饭
Residents use gas to cook

瓦斯广泛应用于淮南、淮北、平顶山、晋城、阳泉等矿区居民用气，全国居民用户超过127万户。

Drainage gas is widely used in Huainan, Huaibei, Pingdingshan, Jincheng, Yangquan and other mining areas, over 1.27 million households use the gas.

三、瓦斯综合利用技术途径

- 瓦斯发电
  - 高浓度瓦斯发电
- power generation
  - High concentration gas for power generation

2×1360kw瓦斯发电站

2×1360kw gas power generation

2×1416kw瓦斯发电站

2×1416kw gas power generation

实现浓度30%以上瓦斯发电效率80%以上，达国际先进水平。

The drainage gas is used for power generation and its efficiency is more than 80% when gas concentration >30%

三、瓦斯综合利用技术途径

- 低浓度瓦斯发电
- Low concentration gas power generation

国内外首座6×500kw低浓度瓦斯发电站

The first 6 x 500kw low concentration gas power station

瓦斯安全输送、检测规范

Specification for gas safety transportation and inspection

制定并实施了低浓度瓦斯气水两相流安全输送、检测标准，实现了5%以上超低浓度瓦斯直接发电。

The safety transportation and detection standards of two-phase flow (low concentration gas and water) were formulated and implemented, and power generation plants with gas concentration of 5% are operational.

三、瓦斯综合利用技术途径

- 瓦斯发电热电冷联供
- Combined cooling, heating and power by gas power generation

淮南潘一矿瓦斯发电热电冷联供项目
Project of combined cooling, heating and power by gas power generation in Panyi coal mine

瓦斯发电热电冷联供机组
Equipment of combined cooling, heating and power by gas power generation

利用瓦斯进行发电，并利用发电余热制冷进行矿井降温，瓦斯的热利用效率较高，是热害矿井瓦斯综合利用较理想的途径。

Use gas for power generation and then extract the energy from the waste heat to cool ventilation air in underground coal mines. This increases the efficiency of gas utilization and is one way to make comprehensive utilization of gas in mines

三、瓦斯综合利用技术途径

- 乏风氧化
- Ventilation air oxidation

高河能源公司乏风氧化发电项目

Project on oxidation of methane from ventilation air in Gaohe energy company

煤矿乏风瓦斯氧化装置结构图

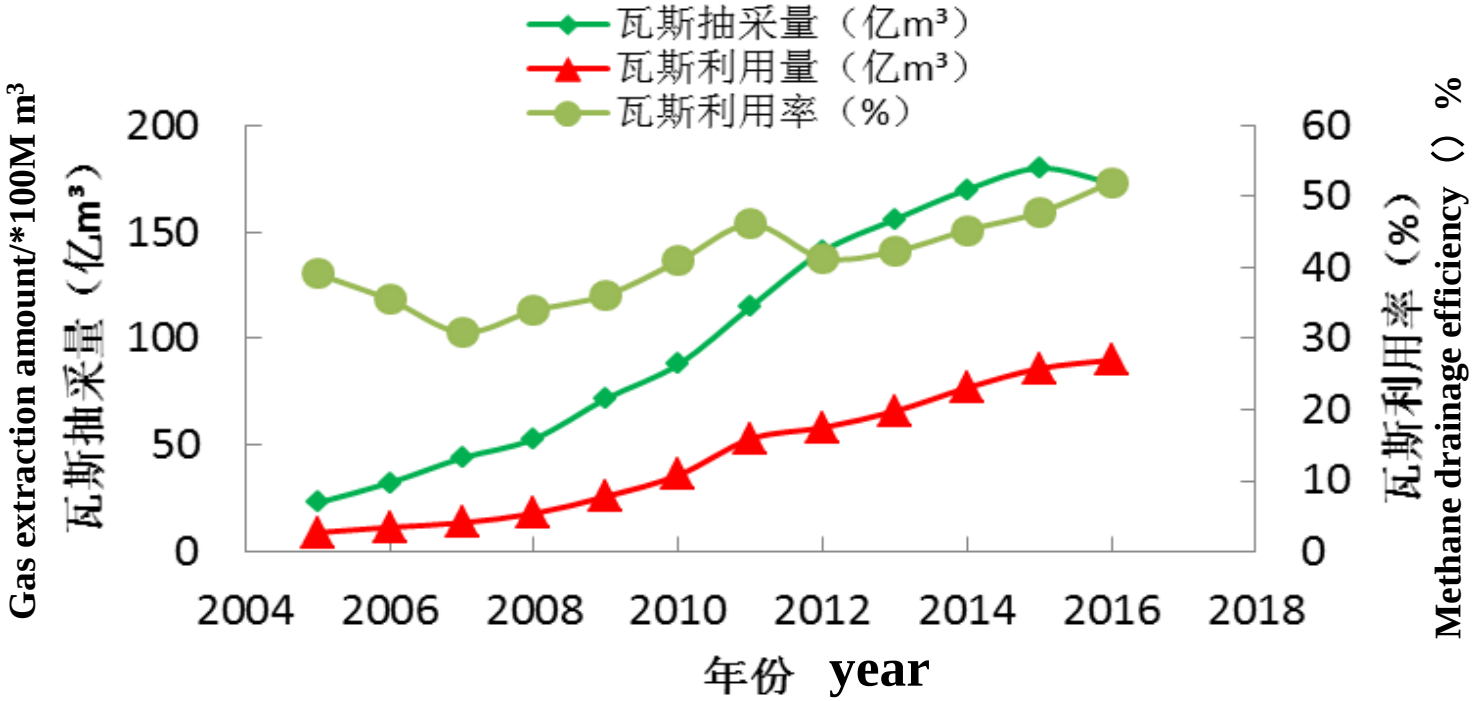
Schematic diagram of device on oxidation of coal mine methane from ventilation air

建成了全球最大30MW煤矿乏风（甲烷浓度<0.75%）氧化利用工程，每年可减少温室气体排放140万吨二氧化碳当量。

The largest 30MW mine air (methane concentration <0.75%) oxidation and utilization project can reduce 1.4 million tons of carbon dioxide equivalent per.

三、瓦斯综合利用技术途径

- 瓦斯综合利用成果
- Achievements in comprehensive utilization of gas



全国瓦斯利用率52%，2011-2015年累计利用瓦斯340亿m³，相当于节约标准煤4080万t，减排二氧化碳5.1亿t。

The national gas utilization efficiency is 52%. From 2011 to 2015, the cumulative gas utilization amount is 34 billion m³. This is equivalent to 40.8 million tons of standard coal. Carbon dioxide emission is reduced by 510 million tons.

4 煤与瓦斯共采发展展望

Outlook of coal and gas co-extraction

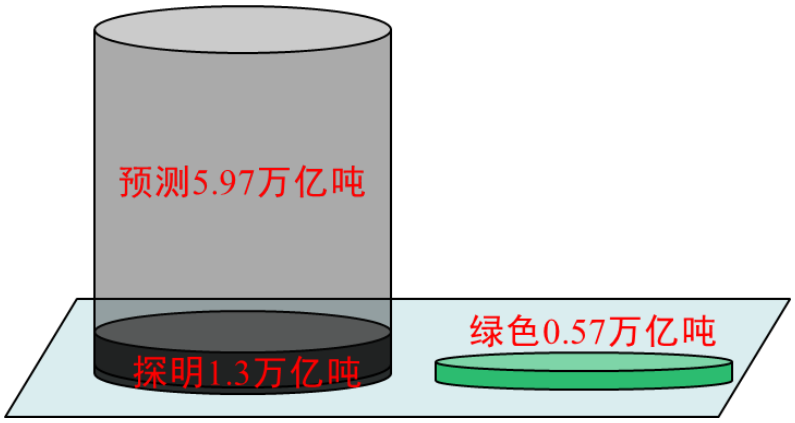
四、煤与瓦斯共采发展展望

中国煤炭开采面临的挑战

- 绿色煤炭资源量少，回收率亟待提高
- 开采条件复杂、安全形势依然严峻

China coal mining challenges

- Limited green coal resources and low resource recovery ratio
- Complex mining conditions and severe safety issues in coal mines



Major accidents occur frequently

序号	时间	事故	死亡人数
1	2015/1/30	安徽淮北朱仙庄煤矿突水	7
2	2015/4/19	山西大同姜家湾煤矿发生透水事故	21
3	2015/4/27	四川乐山老林头煤矿瓦斯爆炸事故	8
4	2015/6/27	福建龙岩陈坊煤矿有害气体中毒事故	9
5	2015/8/11	黔西南政忠煤矿有害气体中毒与窒息事故	13
6	2015/10/9	江西上饶永吉煤矿重大瓦斯爆炸事故	10
7	2015/11/20	黑龙江鸡西杏花煤矿重大火灾事故	22
8	2015/12/16	黑龙江鹤岗向阳区煤矿瓦斯爆炸事故	19
.....			

中国煤炭走向精准开采势在必行

Precise mining of coal – a future trend

四、煤与瓦斯共采发展展望

■ 煤炭精准开采新构想 ■ New vision

安全核心
Safety

- 精准开采核心：智能无人安全开采
- Precise mining: intelligent & fully-automated

零事故
Zero accident

- 智能无人开采：地面远程控制的智能化、自动化、信息化、可视化技术
- Fully-automated mining: remote control, intelligent, automation, informatisation, visualisation

零死亡
Zero fatality

- 无人安全开采：精确、智能感知、灾害智能预警防治
- Unmanned mining: precision, intelligent hazard monitoring, pre-warning and control

智能无人开采
Intelligent & fully-automated mining

- 互联网+煤炭科学开采，实现大数据云计算信息技术与采矿业跨界融合。
- IT + traditional coal mining technology, achieving the integration of big data, cloud computing, web-based technology and traditional coal mining

四、煤与瓦斯共采发展展望

■ 与传统开采比较 ■ Comparison

Traditional mining

- 动辄3000~4000人/矿
- 90%长期井下作业，阴暗、潮湿，工作环境恶劣
- 信息化、自动化、智能化水平及回收率、效率低
- 高危劳动密集型艰苦行业
- 3000~4000 employees/mine
- UG harsh underground working environment
- Low level of automation and intelligence
- Labour intensive and risky industry

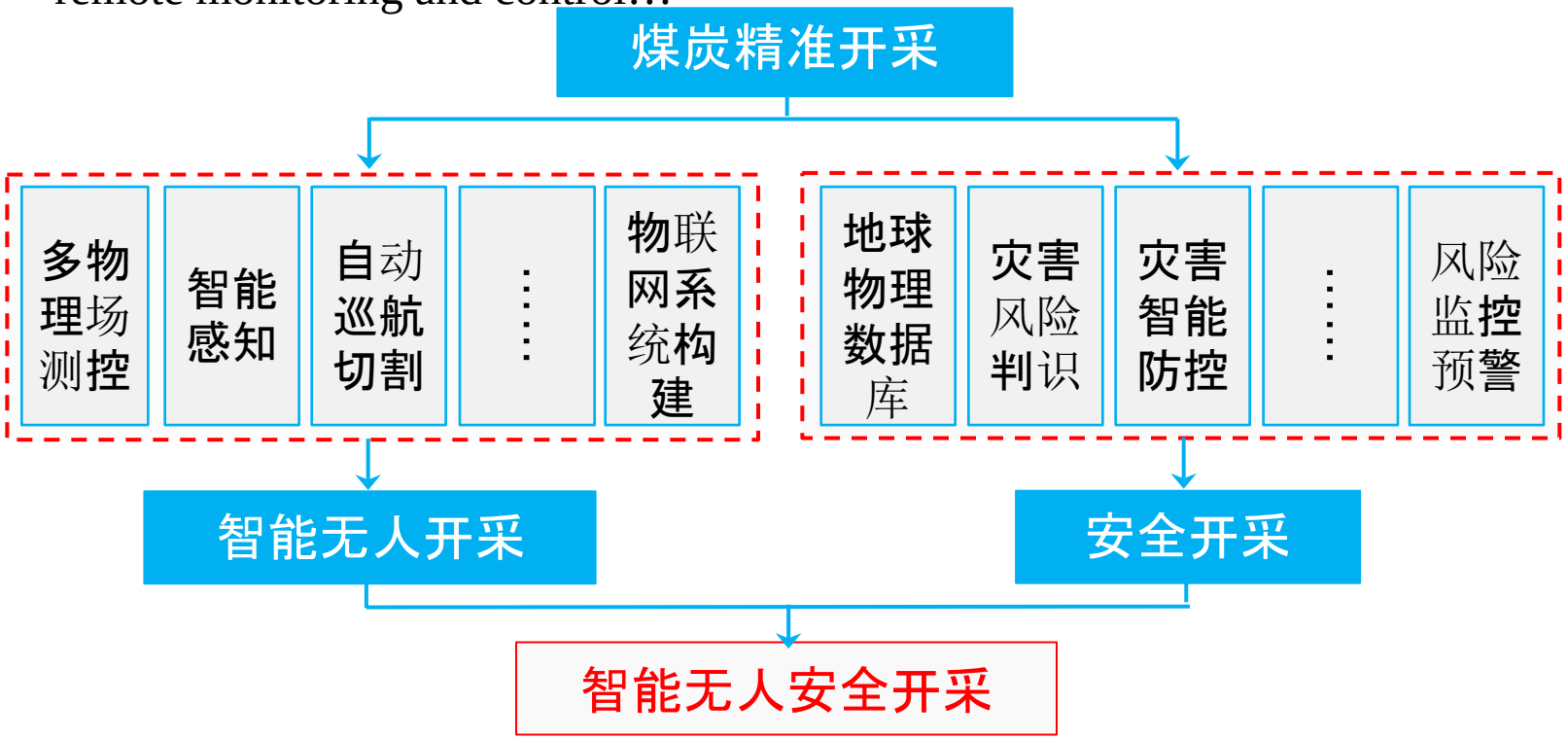
Precision mining

- 每个矿100人以内
- 90%人在地面作业，10% 人在井下生产准备、巡检
- 信息化、自动化、智能化水平及回收率、效率高
- 高精尖技术密集型行业
- <100 employees/mine
- 90% working on surface, 10% UG inspection
- High level of automation and intelligence
- Technology-intensive industry

Precision mining of coal is the future!

四、煤与瓦斯共采发展展望

- **煤炭精准开采科学内涵及理念**
  - 基于透明空间地球物理和多物理场耦合，以智能感知、智能控制、物联网、大数据云计算等信息技术做支撑，具有风险判识、监控预警等处置功能，能够实现时空上准确安全可靠的智能无人安全精准开采新模式新方法
- **Precision coal mining – scientific connotation**
  - Intelligent and unmanned safe mining technology. It is based on geophysics, multiple physical fields coupling, automation, intelligent risk identification, remote monitoring and control…



四、煤与瓦斯共采发展展望

- 煤炭精准开采技术路线
- Technology roadmap

第一步：地面和井下相结合的远程遥控无人开采
Step 1:
Unmanned mining with both surface-based and UG remote control

第二步：智能化无人精准开采
Step 2:
Intelligent unmanned precise mining

Thank You!


煤炭开采国家工程技术研究院
National Engineering & Technology Academy of Coal Mining