

Evaluation on CO₂ geological utilization technologies

CO₂地质利用技术与远景评价



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PRESENTATION OUTLINE 概要

- ◆ 1. Background
背景
- ◆ 2. CO₂ Geological Utilization R&D Activities
CO₂地质利用技术的研发
- ◆ 3. Integrated CO₂ Geological Utilization System
CO₂地质利用全过程集成系统
- ◆ 4. Prospect Evaluation on CO₂ Geological Utilization
CO₂地质利用远景评价



1. Background



背景

Climate Change Compromises the Whole World



CCUS provides important technical options for Addressing Climate Change

CO₂ Geological Utilization
CO₂地质利用

CO₂ Chemical Utilization
CO₂化工应用

CO₂ Biological Utilization
CO₂生物转化应用

CCUS provides
important
technical options
for Addressing
Climate Change

Role of CO₂ Geological Utilization Technology

Environmental benefits

- CO₂ reduction
- Address climate change



Time scale

- Long time
- Security

Economic benefits

- Cost-effective
- Additional output value


Spatial scales

- Underground space
- Large reduction potential

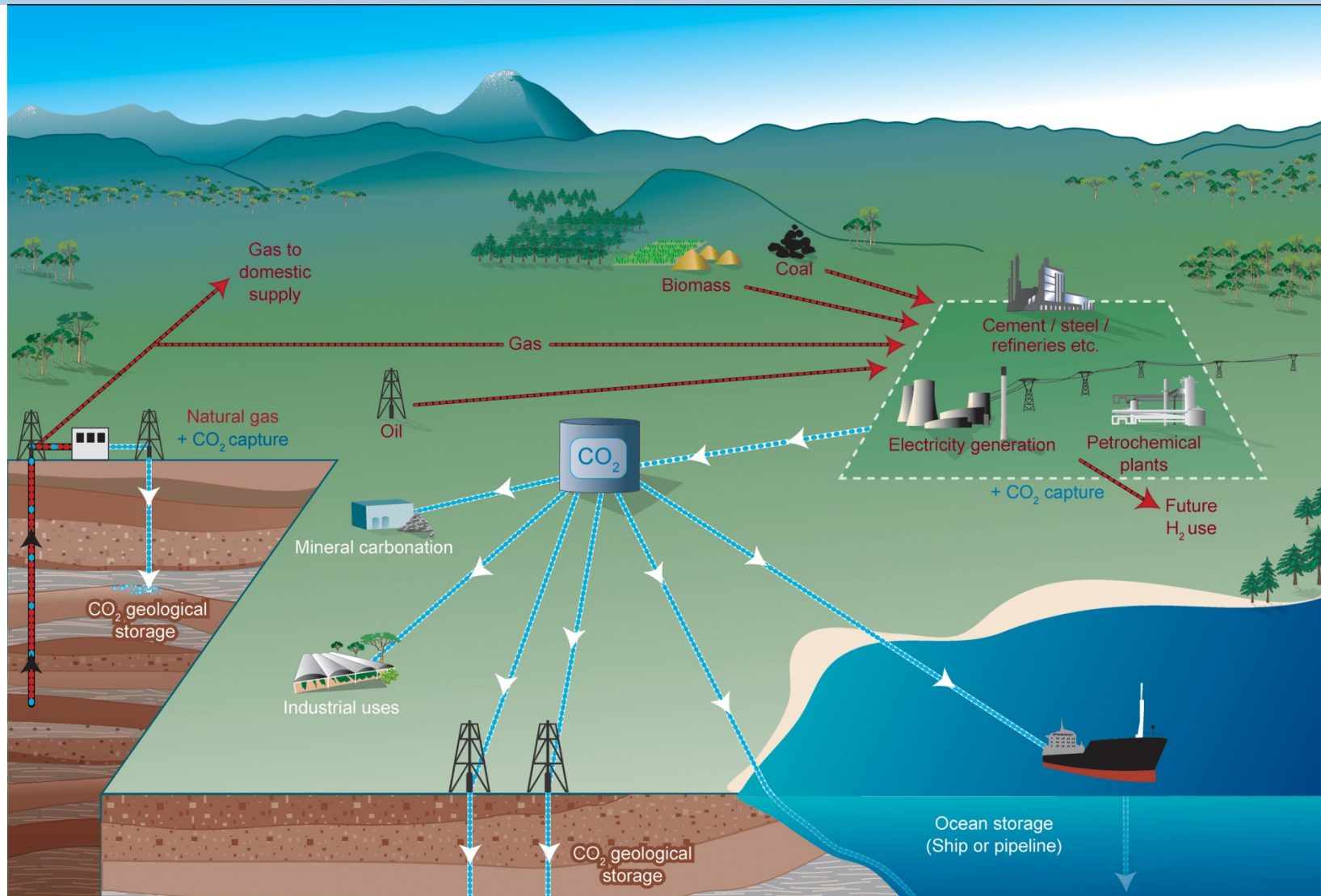


2. CO₂ Geological Utilization R&D Activities

CO₂地质利用技术的研发



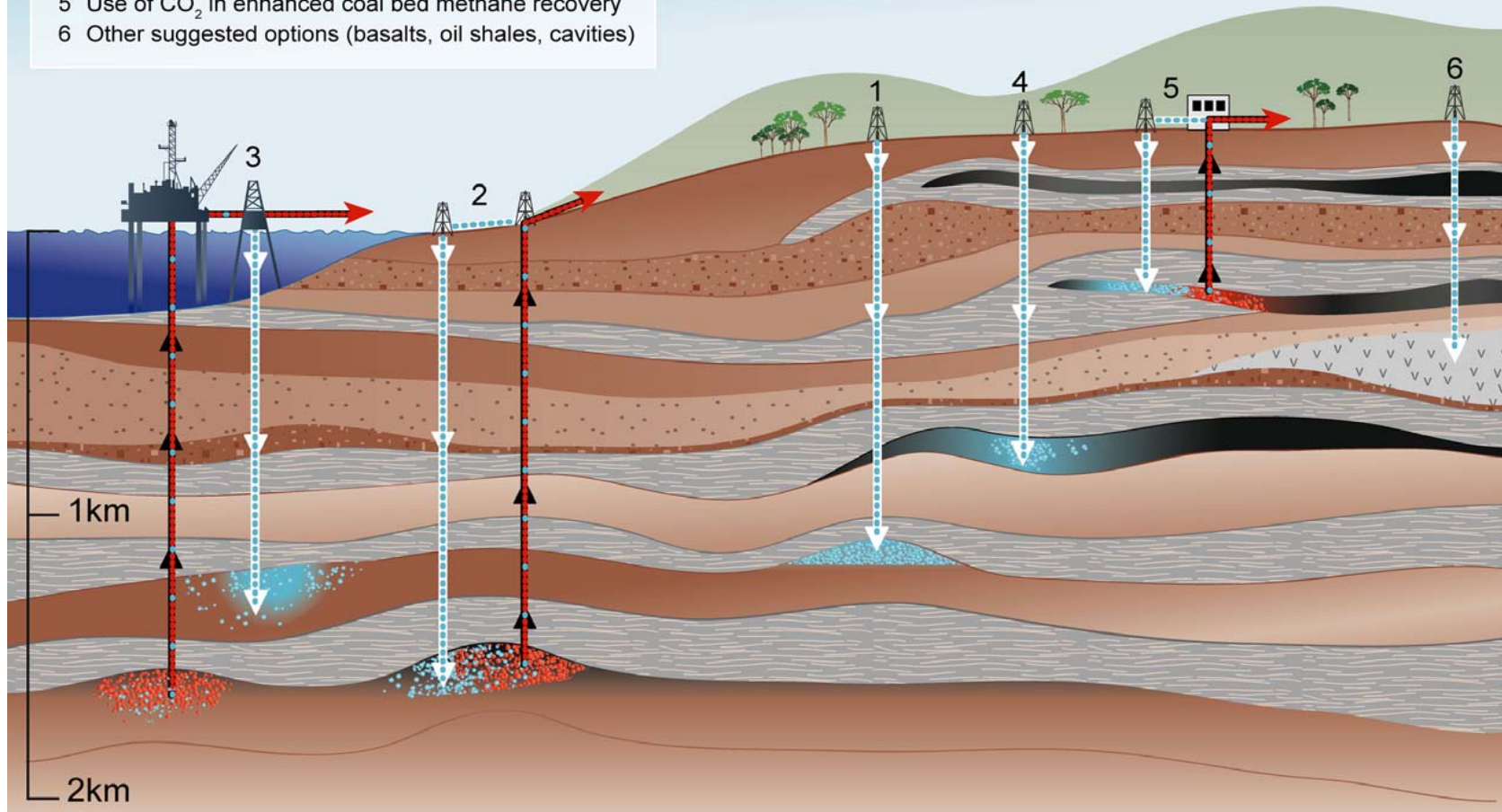
Schematic diagram of possible CCUS systems



CO₂ Geological Utilization and Storage

CO₂ Geological Utilization and Storage

- 1 Depleted oil and gas reservoirs
- 2 Use of CO₂ in enhanced oil recovery
- 3 Deep unused saline water-saturated reservoir rocks
- 4 Deep unmineable coal seams
- 5 Use of CO₂ in enhanced coal bed methane recovery
- 6 Other suggested options (basalts, oil shales, cavities)



CO₂ Geological Utilization Technologies

CO₂地质利用技术

- 1.CO₂驱油 Enhanced oil recovery (CO₂-EOR)
- 2.CO₂提高煤层气采收 Enhanced coal bed methane recovery (ECBM)
- 3.CO₂驱气 Enhanced gas recovery(EGR)
- 4.CO₂封存协助液矿体联合开采 Assisting joint exploration of liquid mineral
- 5.CO₂工质地热系统 Enhanced geothermal system
- 6.CO₂提高页岩气(天然气)采收 Enhanced exploration of shale gas
- 7.CO₂封存于玄武岩 Basalt storage
- 8.CO₂用于尾矿废渣的地质环境修复 Bauxite residue treatment
- 9.制造岩腔 Manufacturing rock cavity
- 10.CO₂地质碳汇作用 Geological carbon sink

CO₂ geological utilization technologies

CO₂地质利用技术

1. Enhanced oil recovery (CO₂-EOR)

CO₂驱油

2. Enhanced coal bed methane recovery (ECBM)

CO₂提高煤层气采收

3. Enhanced gas recovery (EGR)

CO₂驱气

4. Assisting joint exploration of liquid mineral

CO₂封存协助液矿体联合开采

5. Enhanced geothermal system

CO₂工质地热系统



1.CO₂-EOR

CO₂驱油原理

Inject compressed CO₂ into depleted oil fields

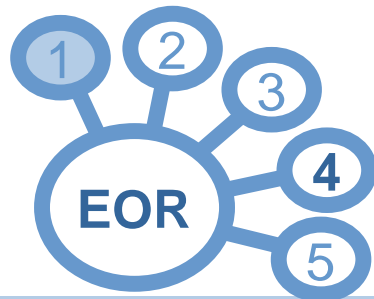
向废弃油田中注入压缩的CO₂

CO₂ mixture with the residual oil and decrease its viscosity

CO₂与油田中残油相混合降低其粘度

Through decrease the crude oil's viscosity, enhanced the oil recovery

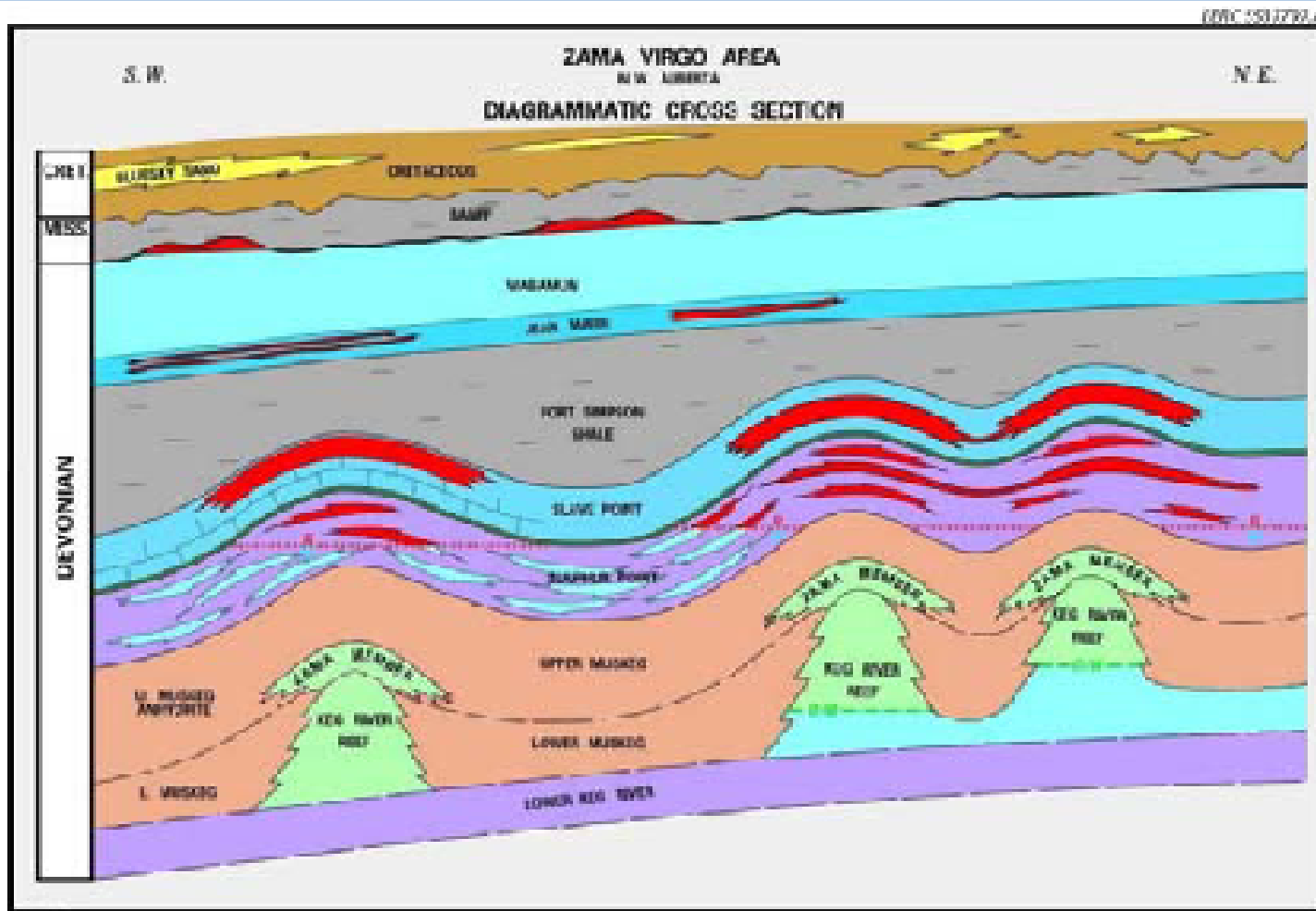
原油粘度降低更易被开采出来



Zama, Canada EOR location 加拿大zama CO₂驱油位置图

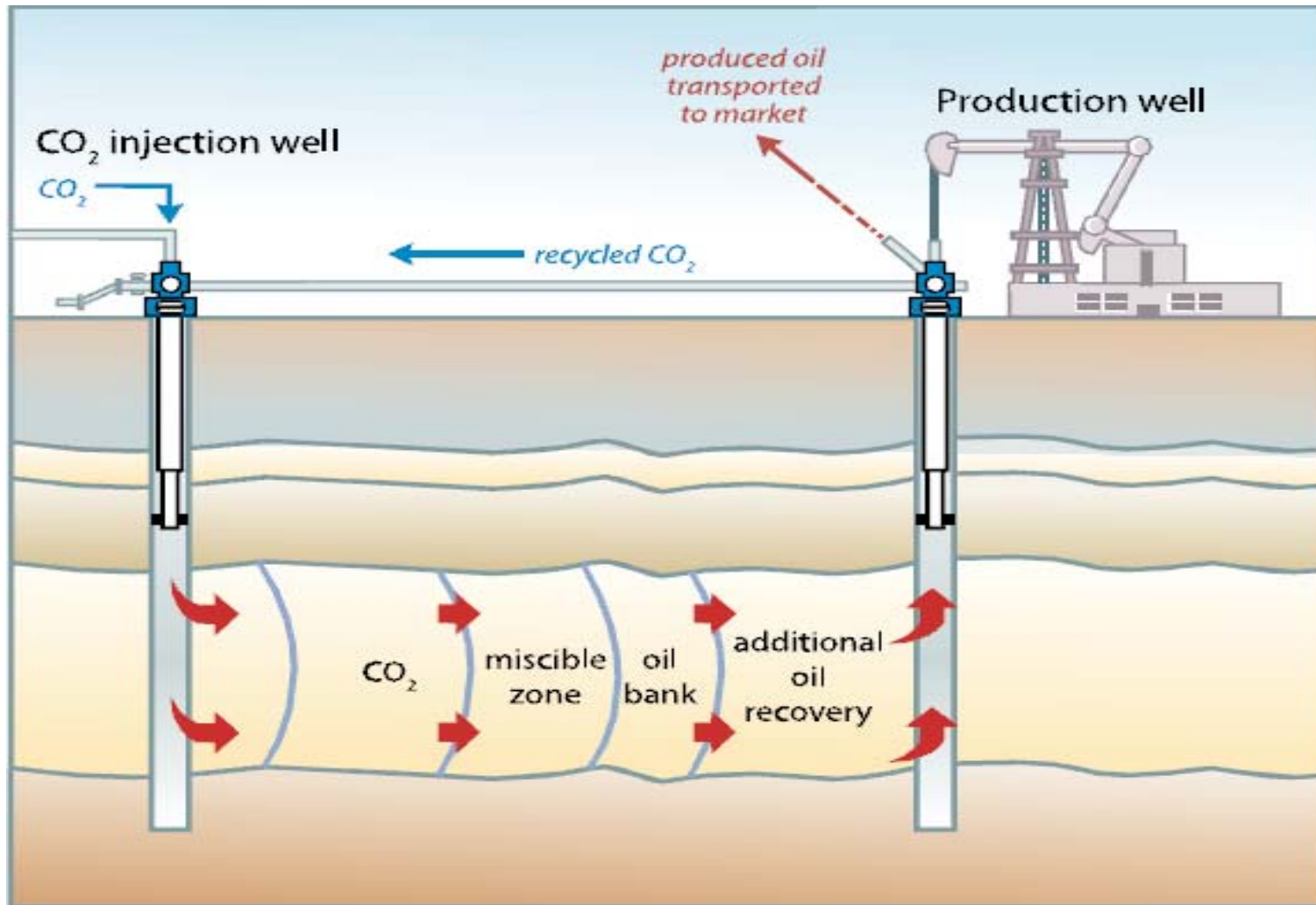


Cross section map 地层剖面图

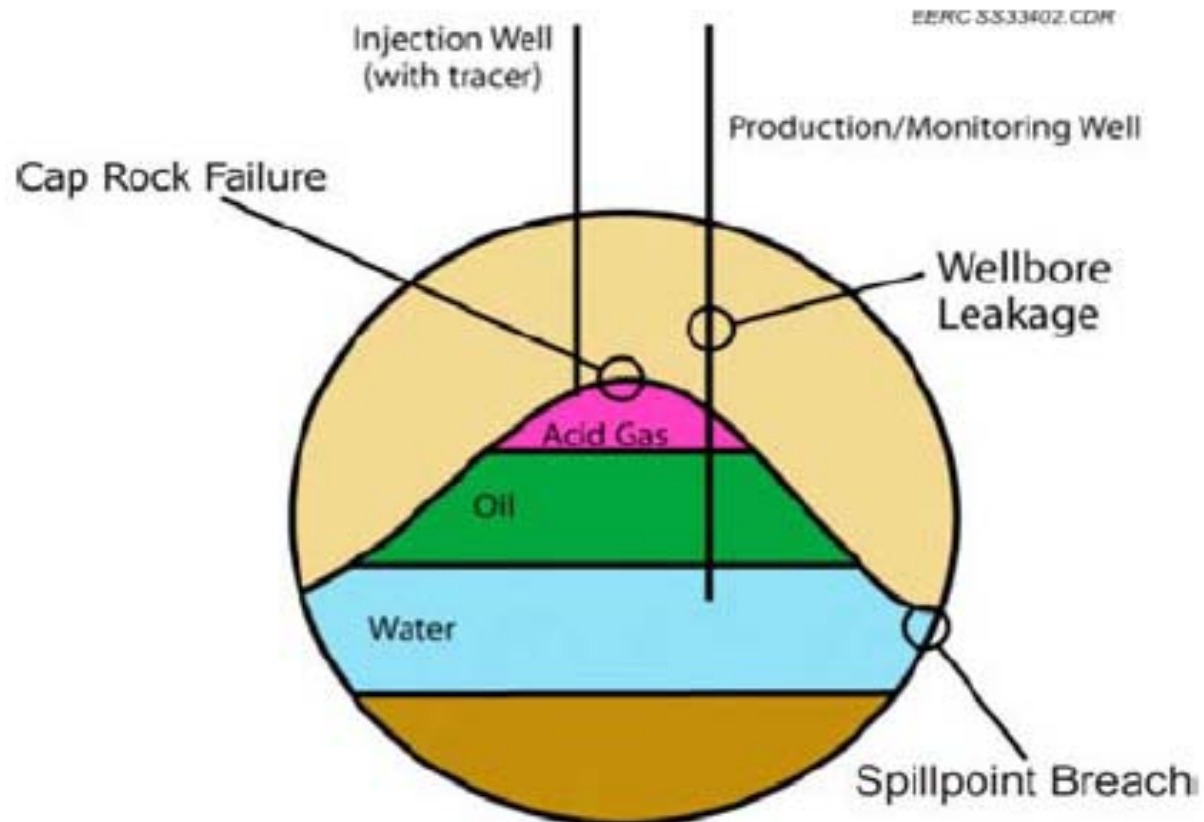


储层为碳酸盐岩，盖层为石膏

CO₂-EOR technology roadmap CO₂驱油技术路线示意图



Injecting schematic 注入示意图



CO₂-EOR效益

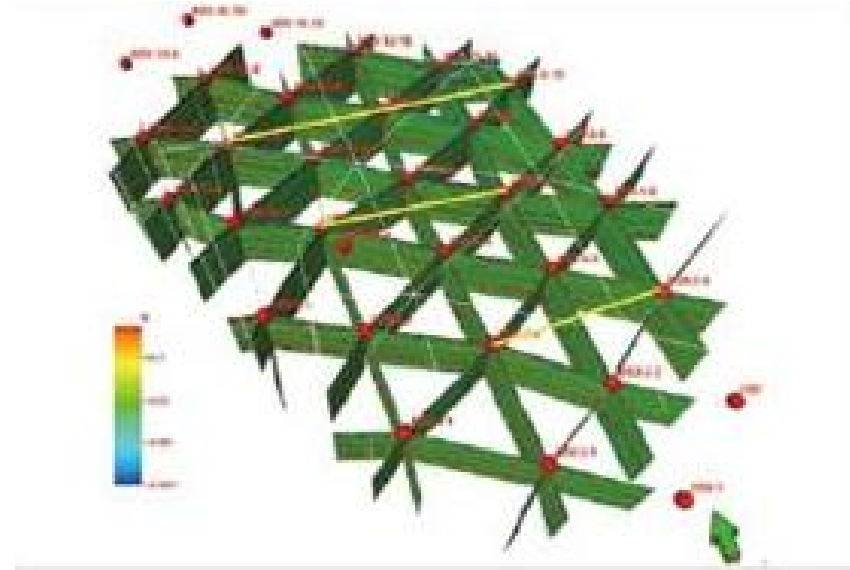
	总量	平均值	时间
注入量	230万立方米	28316.86m ³ /天	2006.12~2011
产油量	25,000桶	100桶/天	2006.12~2009.8.30

- 提高石油采收率**10%~15%**，应用前景广阔。
- **CO₂**驱油技术相对成熟，其应用范围正不断扩大，通过规模化利用降低成本。

PetroChina's CO₂ EOR Research and pilot Injection, Jilin Oilfield



PetroChina EOR Project



Jilin Oil Field CCS-EOR pilot test block
well network design

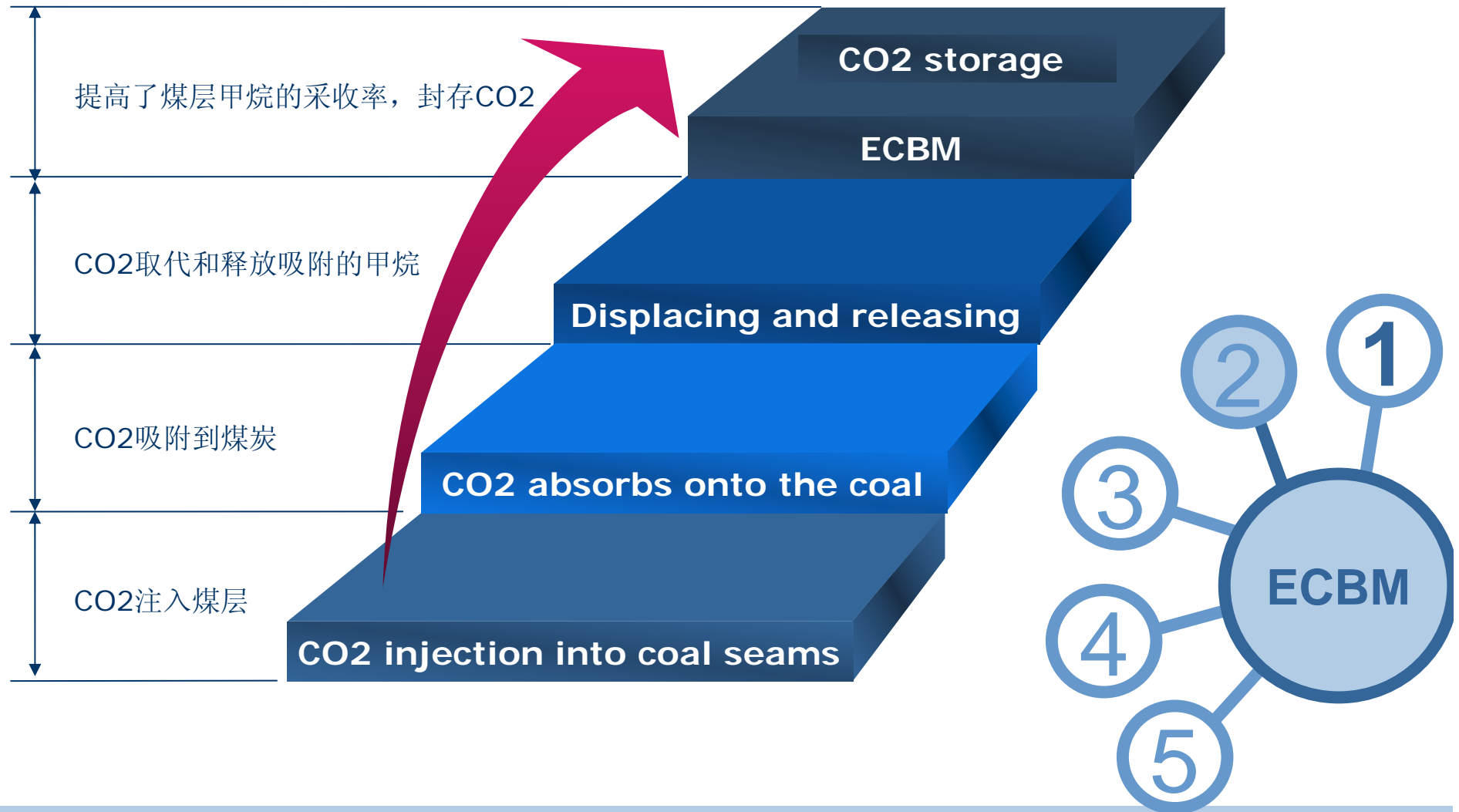
Goal: 0.8-1.0 million tons storage of CO₂ annually (Phase II)

Site: Jilin Oil Field

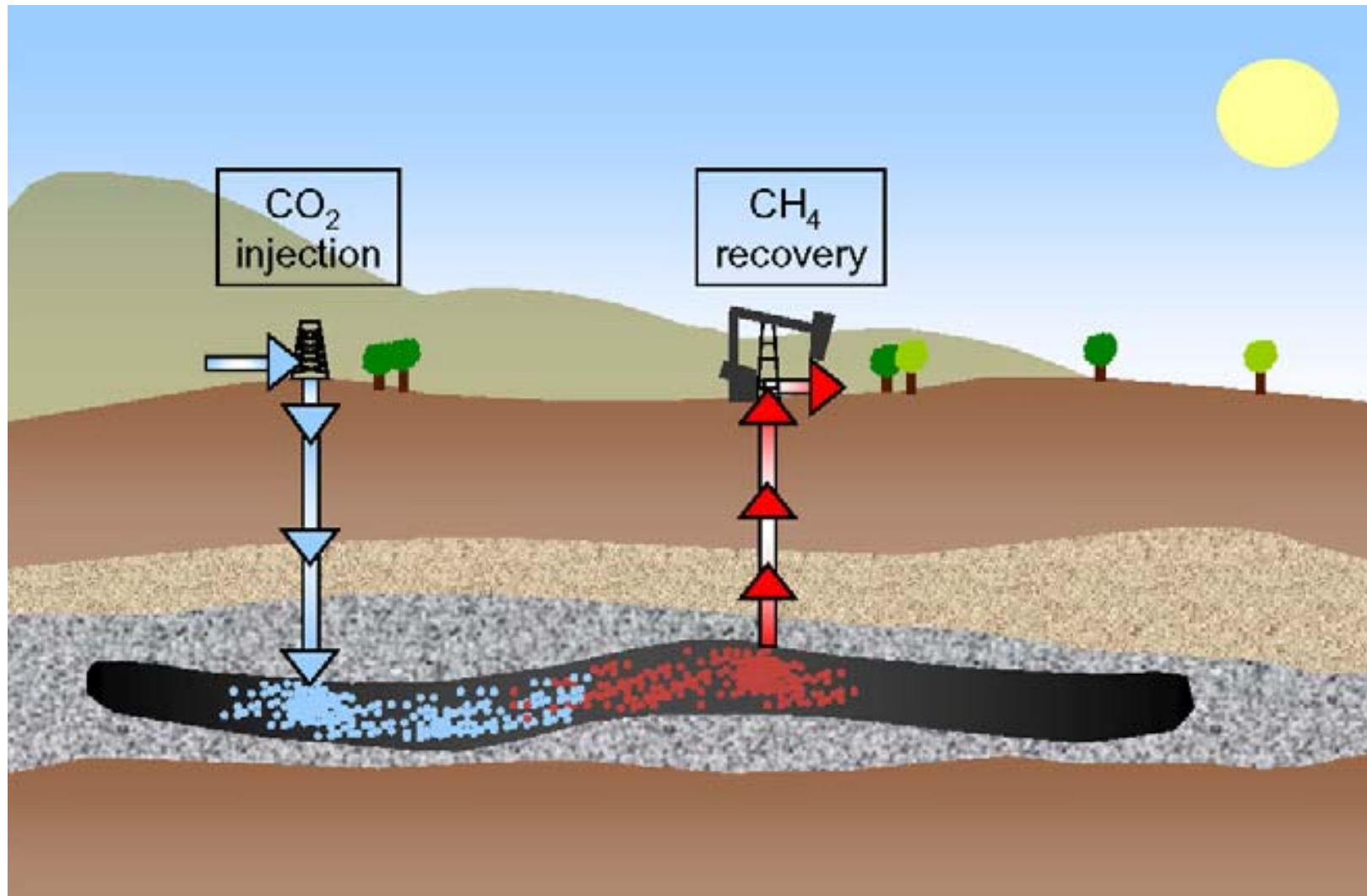
Technologies: Separation of CO₂ from natural gas + EOR

Status: Phase I has been completed and phase II is in progress

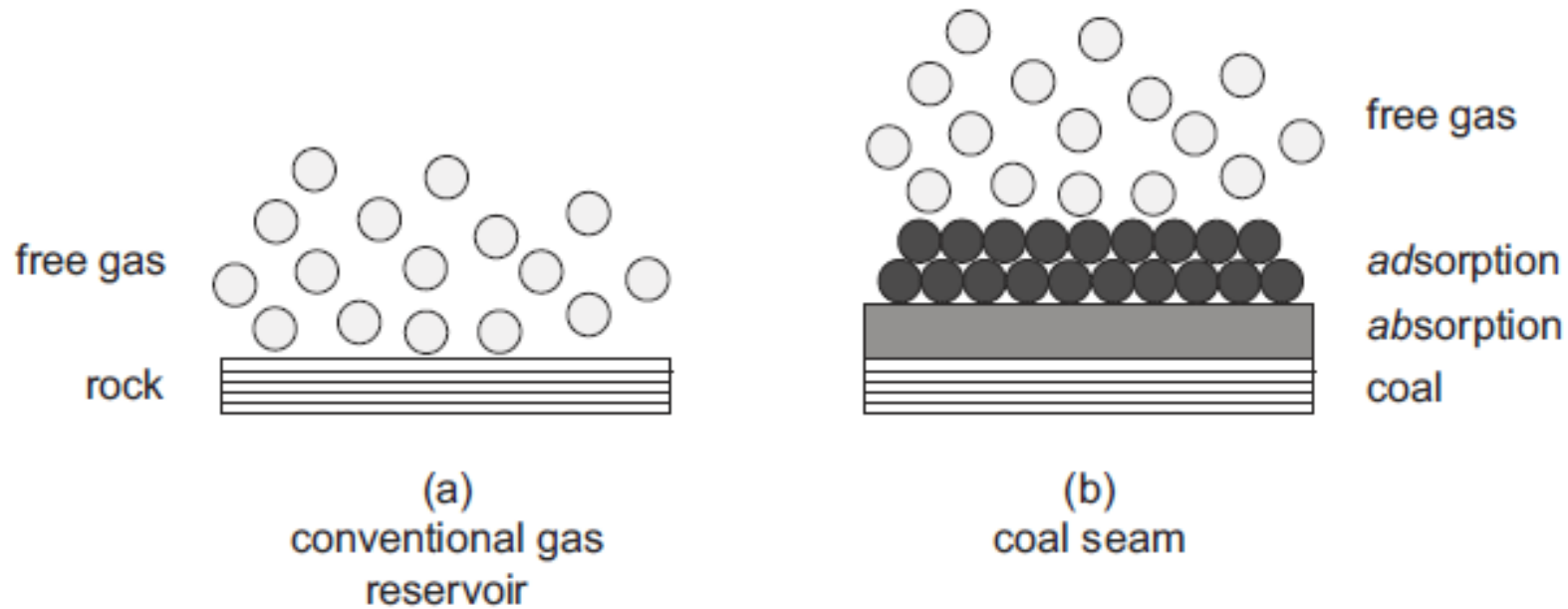
2.CO2提高煤层气采收 Enhanced coal bed methane recovery (ECBM)



Schematic of an ECBM operation, where captured CO₂ from a power plant is injected into the coal seam and CH₄ is produced



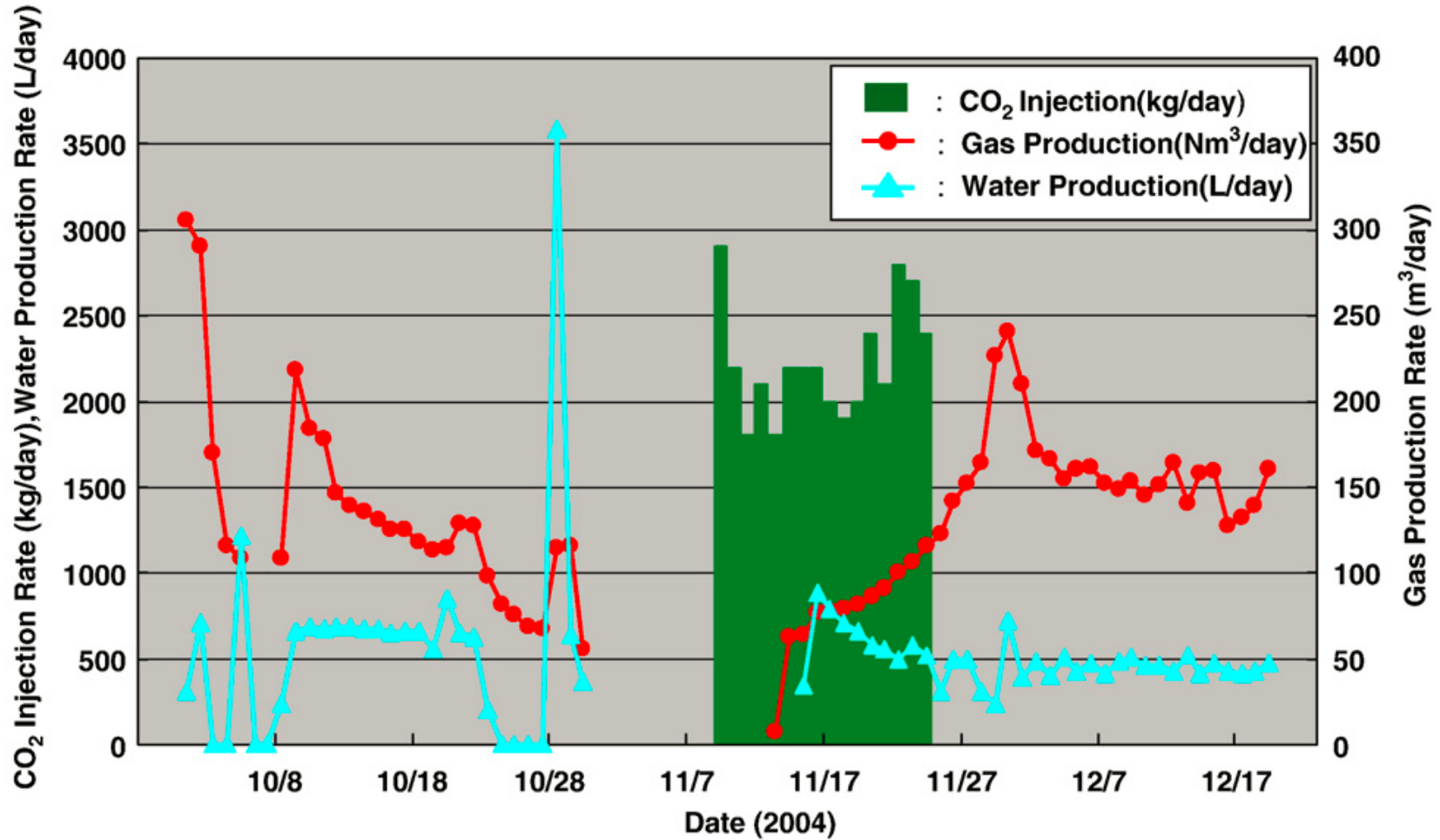
Simplified schematic for the storage mechanism in a conventional gas reservoir (a) and in a coal seam (b).



The injected gas fills the available pore volume as a compressed fluid

The gas is additionally adsorbed and absorbed

CO₂-ECBM 效益



Production and injection rates of multi well pilot test in the Ishikari Coal Basin of Japan in 2004

China United Coalbed Methane Co. ECBM Pilot Project



CUCBM CO₂-ECBM Well Site



CUCBM CO₂-ECBM Well Site

Project Entity: China United Coalbed Methane Company (CUCBM)

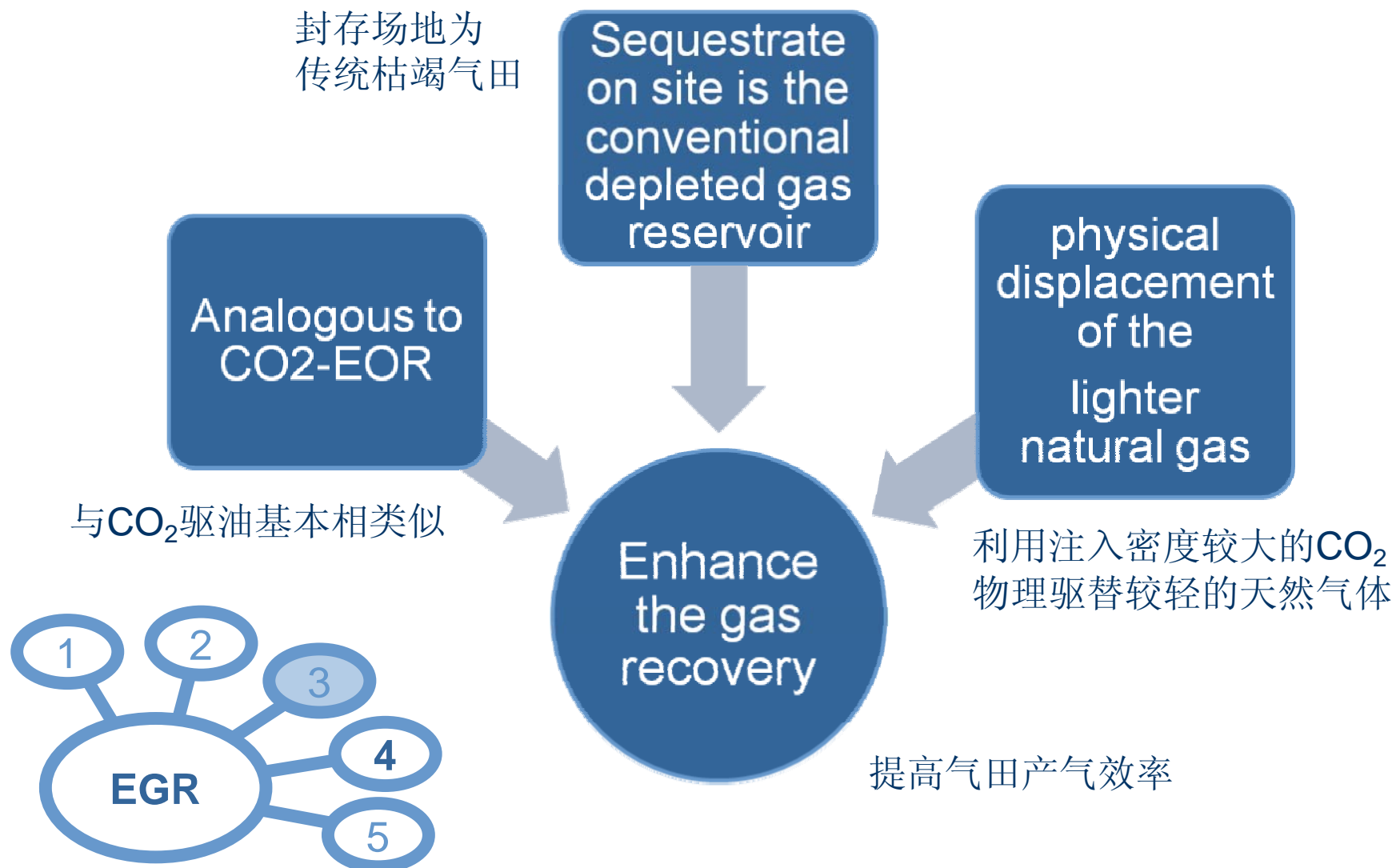
Goal: Studying and developing ECBM and CO₂ storage technology, testing safety and permanence of CO₂ sequestration.

Location: Shizhuang, Qinshui County, Shanxi Province

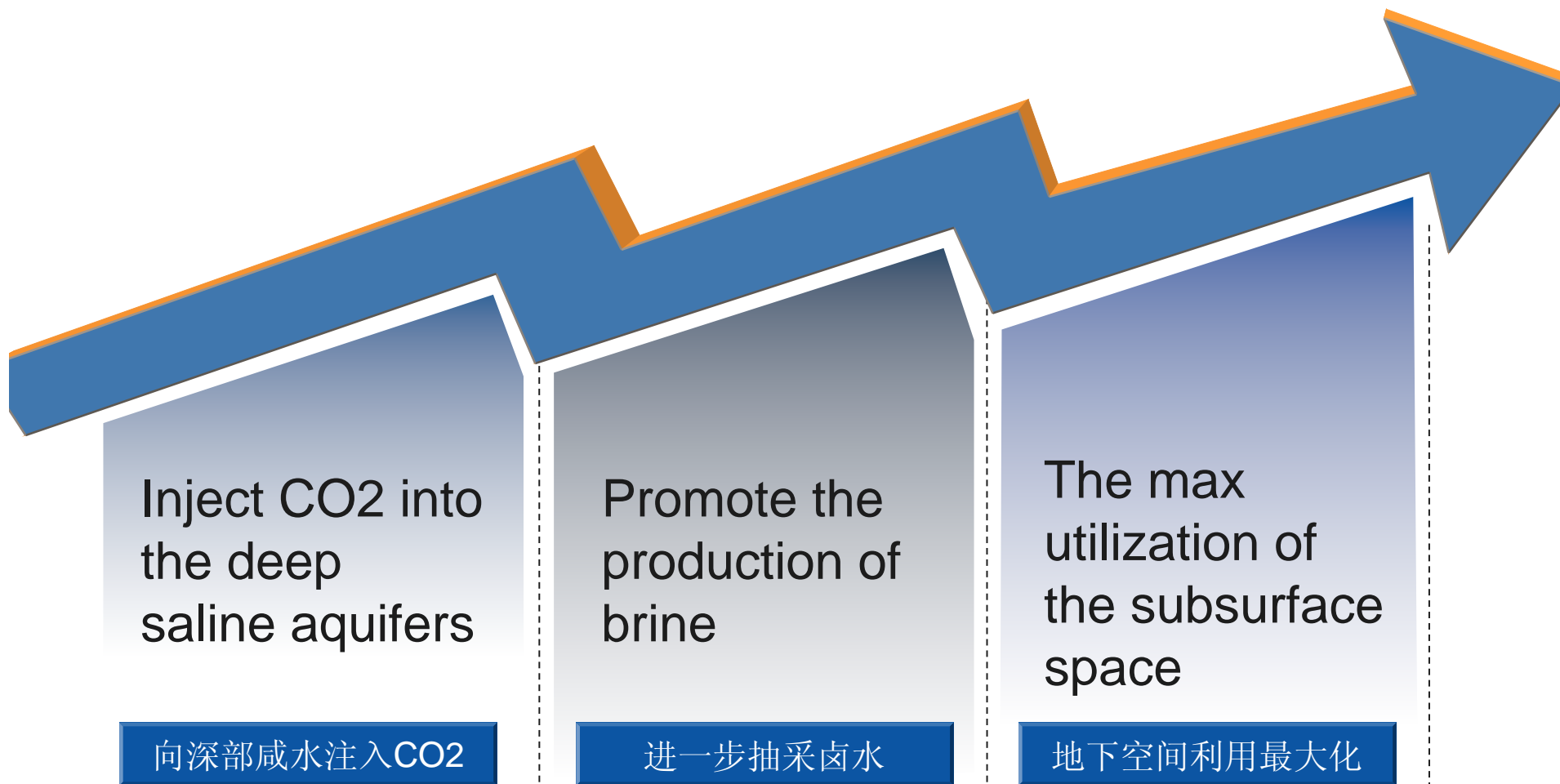
Technique: CO₂ Storage for ECBM

Current Status: Ongoing, injection test started since April 2010

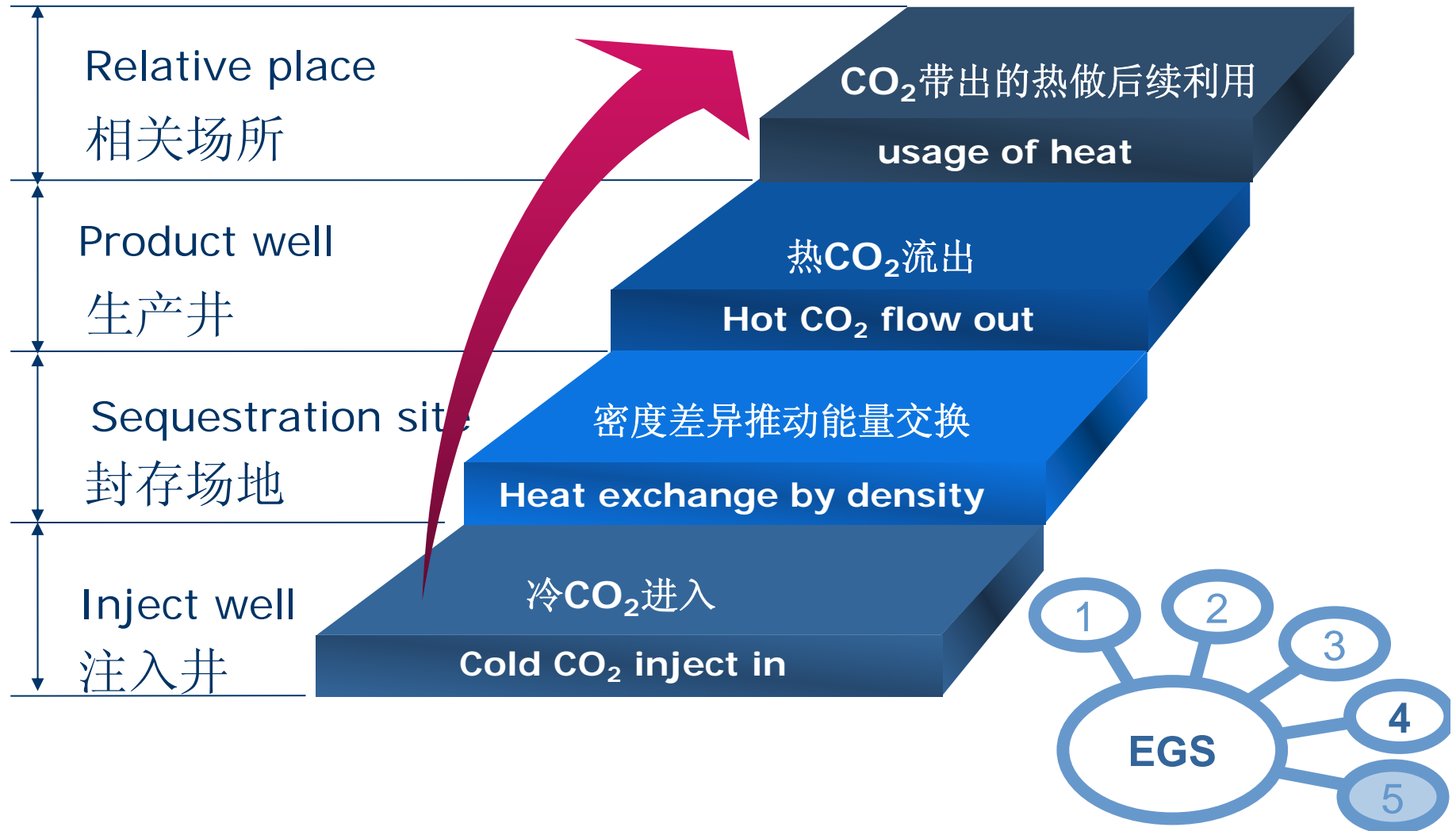
3.EGR——CO₂驱气机理



4.CO2封存协助液矿体联合开采 Assisting joint exploration of liquid mineral



5. Enhanced geothermal system(EGS) CO₂工质地热系统



二氧化碳地质利用

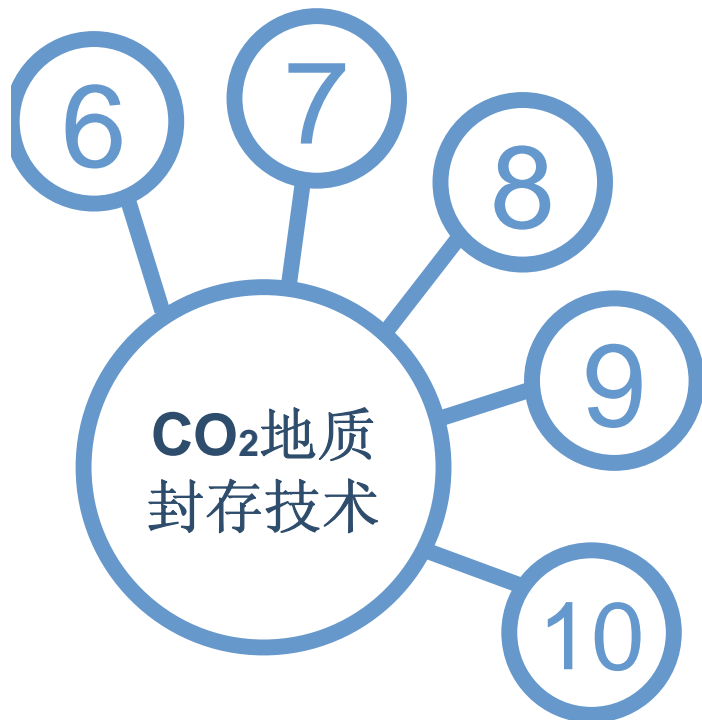
6.CO₂提高页岩气（天然气）采收
Enhanced exploration of shale gas

7.CO₂封存于玄武岩
Basalt storage

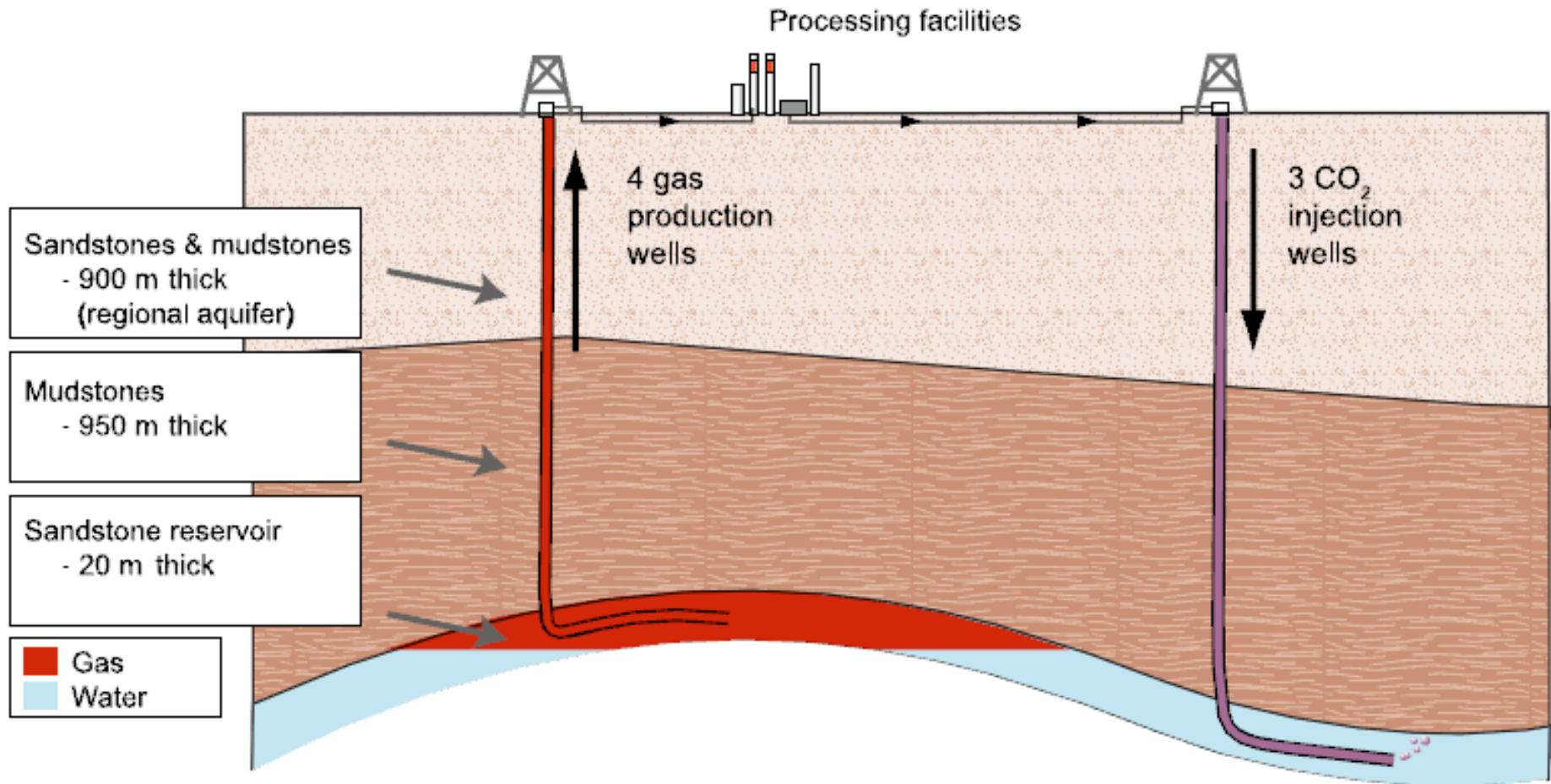
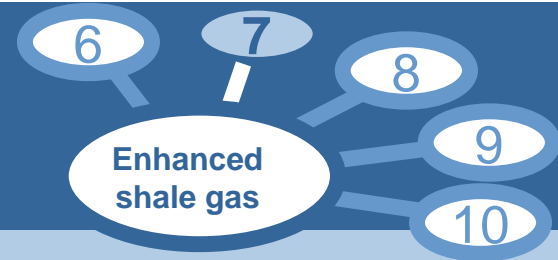
8.CO₂用于尾矿废渣的地质环境修复
Bauxite residue treatment

9.Manufacturing rock cavity
制造岩腔

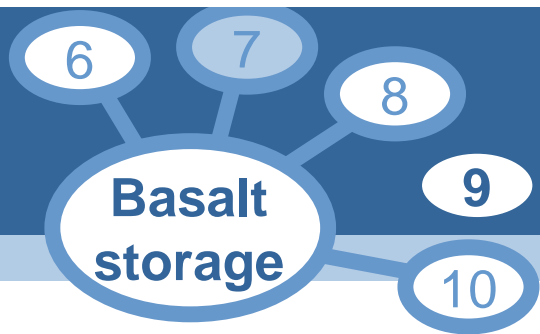
10.Geological carbon sink
CO₂地质碳汇作用



6.CO2提高页岩气（天然气）采收 Enhanced exploration of shale gas



7.CO2封存于玄武岩 Basalt storage

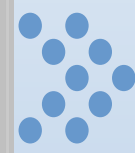


- CO2注入与玄武岩发生反应

Injection of CO₂ and the reaction between CO₂ and basalt



- 注入系统中硅酸盐矿物发生碳酸盐化
- Make the silicate carbonatation



- 形成稳定的碳酸盐矿物，减少CO2的泄露风险
- Stable carbonates decrease the risk of CO₂ leakage

8.CO2用于尾矿废渣的地质环境修复 Bauxite residue treatment



- CO2 注入到高碱性的赤泥浆中

CO2 can be injected into the highly alkaline bauxite residue

- CO2 形成的酸性成分可与泥浆中产品中和抵消

CO2 can partially neutralize the product and then is converted to mineral form

- 降低处理成本，限制赤泥浆潜在的环境影响

Reducing the disposal costs and limiting the potential environmental impacts

9&10.Manufacturing rock cavity and as carbon sink

CO₂用于制造岩腔与其天然碳汇作用

Manufacturing rock cavity

- injecting CO₂ into the dissolved rock formations which lead to the occurring of huge ground karst rock cavity.
- can be used for national strategic material reserves, and special dangerous materials storage.

制造岩腔

- CO₂注入可溶岩体，产生地下岩溶空腔。
- 空腔可作为国家战略物质储备，特种危险物质储存等。

Carbon sink

- the long-term chemical interactions among CO₂ in the atmosphere, surface and ground rock minerals help absorb and transport large sums of CO₂ in the atmosphere.

天然碳汇

- 大气中CO₂与地表、地下岩石矿物长期的化学作用，产生沉淀的碳酸盐矿物，或溶蚀矿物，吸收并转移大量大气中的CO₂。

CO₂ geological utilization and Storage Activities



Qinshui Basin



Comparison of Built CO₂ geological utilization Demonstration Projects in China and Other Countries

Technology chain		Project #		Largest Project		Longest Experience	
		Abroad	Home	Abroad	Home	Abroad	Home
Geological Utilization and Storage	CO ₂ EOR Technology	>100	10	1.2 MT/a	100,000 T/a	Nearly 40 Years	6 Years
	CO ₂ ECBM Technology	>5	1	>200,000 s	192 s	7 Years	4 Years
	Onshore Saline aquifer Storage	>2	1	1 MT/a	100,000 T/a	7 Years	0.5 Year
	Offshore Saline aquifer Storage	2	-	1 MT/a	-	15 Years	-
	Depleted Oil and Gas Field Storage	1	-	about 10,000 T/a	-	7 Years	-



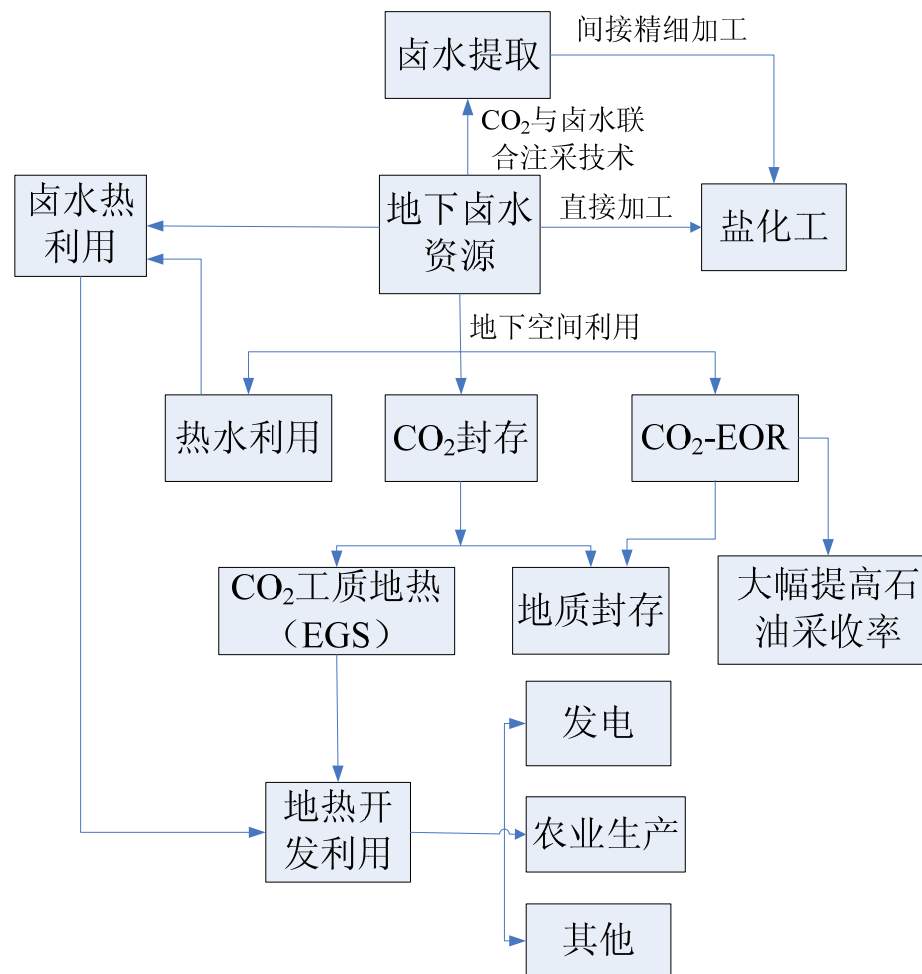
◆ 3. Integrated CO₂ Geological Utilization System
CO₂地质利用全过程集成系统

Integrated CO₂ Geological Utilization System

CO₂地质利用全过程集成系统

CO₂地质利用集成系统

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- 4.CO₂工质地热系统 Enhanced geothermal system



Integrated CO₂ Geological Utilization System

CO₂地质利用全过程集成系统

本系统通过抽采咸水层中卤水，降低了地层压力，留出了储存空间，运用**CO₂**与高盐卤水的联合注采技术，向地下深部咸水层注入**CO₂**过程中，进一步抽采咸水层中的卤水，改变单纯性注入模式，实现地下空间最大化利用，获取卤水和地热资源，实现热水型和**CO₂**工质型地热卤水的长期开发利用。

同时开展**CO₂-EOR**项目联动二氧化碳地质封存，提高石油产量，实现规模化与资源化，极大地降低**CCS**成本，并产生附加经济效益和环保效益，从而推动**CCS—CCUS**的真正实现。

形成多种CO₂地质利用全过程集成系统



◆ 4. Prospect Evaluation on CO₂ Geological Utilization
CO₂地质利用远景评价

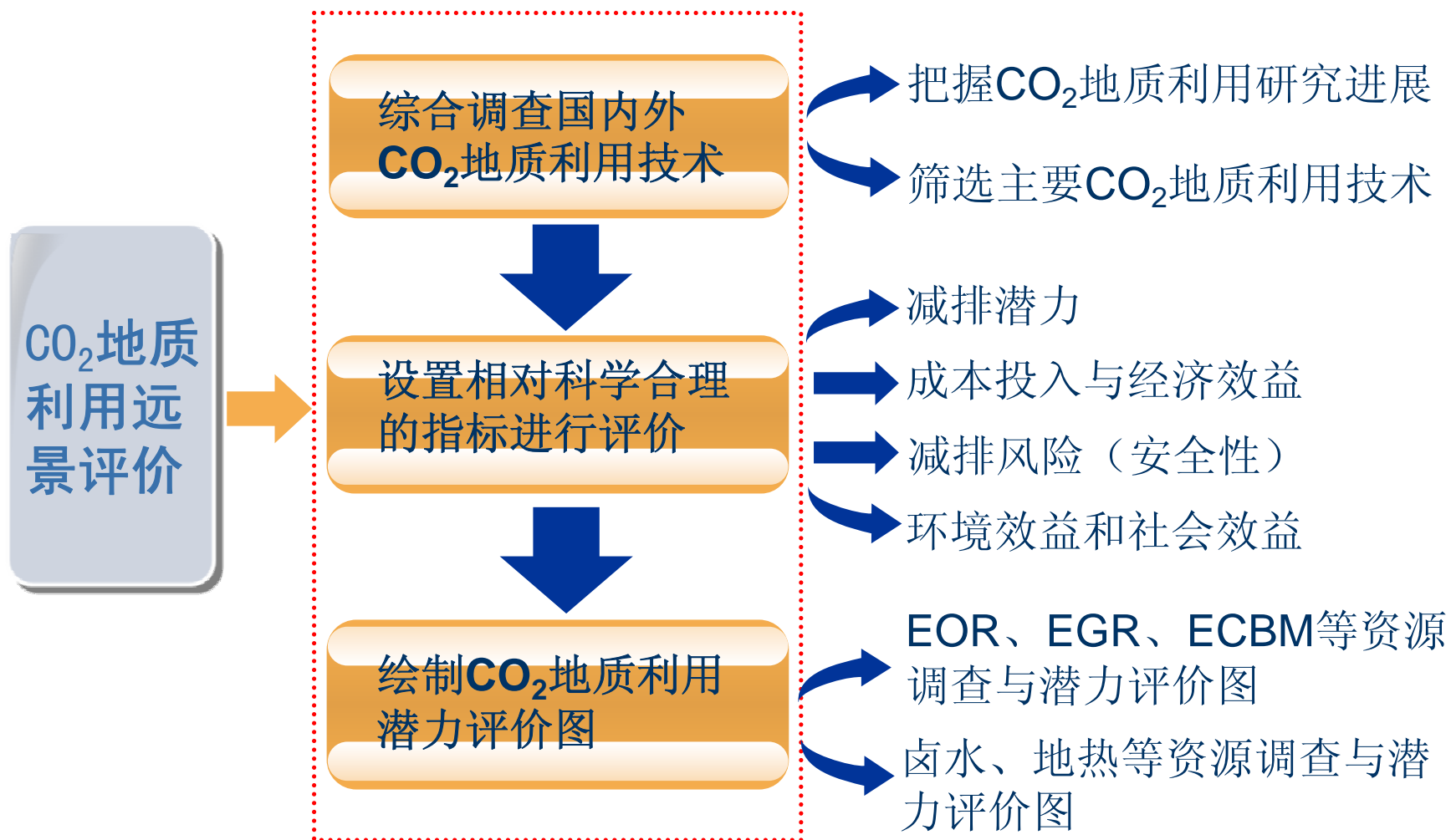
Prospect Evaluation on CO₂ Geological Utilization

CO₂地质利用远景评价指标

Primary Index	Secondary Index
Emission Reductions Potential	Overall Potential for Effective CO ₂ Emission Reduction
	Maximum Annual Volume of CO ₂ Capture
	Maximum Annual Volume of CO ₂ Storage
	Other Environmental Benefits
Cost	CO ₂ Capture and Compression Cost (t/CO ₂)
	Transportation, Storage and Additional Revenue Summation (t/CO ₂)
Risk	Technological Perfection
	Leakage and Security Risk
	Future Resource Conflicts
Development	Decline Magnitude of Overall Costs after Large-scale Promotion
	Decline Magnitude of Risk after Putting into Practice
	Future Changes in Emission Sources
	Degree of Future Public Recognition
Goal Congruence	Consistent with the Vision of Technological Development and Goals in Every Stage
Coverage	Demonstration Project Should Cover All the Critical Technological Elements
Reality	CCUS Systems Having Been or to Be Demonstrated by Enterprises

Prospect Evaluation on CO₂ Geological Utilization

CO₂地质利用远景评价





Thank You !