



神华低碳技术发展思路及CCS示范项目进展

Strategy of Shenhua Low-carbon technology and Updating of Shenhua CCS Demonstration Project

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报告内容 Outline

1 神华集团低碳技术发展思路

Development strategy of low carbon technology of Shenhua

2 神华煤直接液化CO₂排放情况分析

CO₂ Emission analysis of Shenhua CTL Plant

3 神华CCS主要研发工作

R&D of CCS technology of Shenhua

4 示范项目主要进展

Updating of Shenhua CCS Pilot Project

5 下步工作和计划

Our vision and Plan



1 神华集团低碳技术发展策略

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神华集团是世界最大的煤炭生产和销售公司
Shenhua : the largest coal production and sale company in the world



煤、电、路、港、油等板块
Coal, power, railway, port, chemicals
et al blocks





为承担相应的社会责任，积极应对气候变化问题，神华集团在温室气体减排方面作出应有的贡献。

Shenhua's responsibility

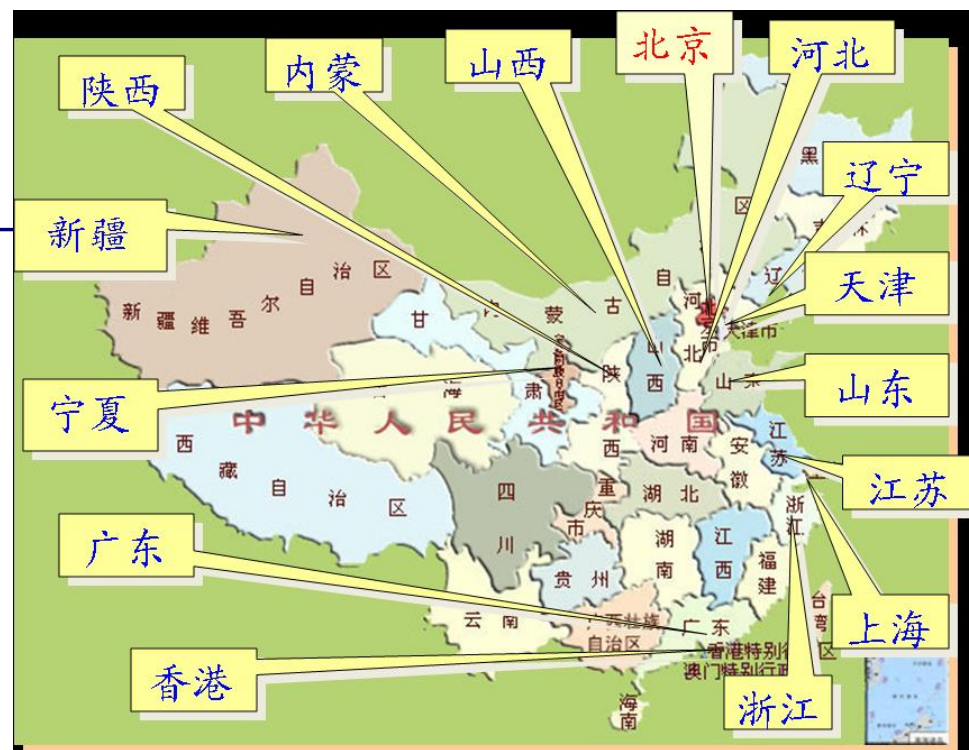


☆节能减排—社会负责

Energy-saving and emission reduction—
society responsibility

☆发展低碳能源技术—发展方向

Developing low carbon energy
technology—development direction



神华机构位置图

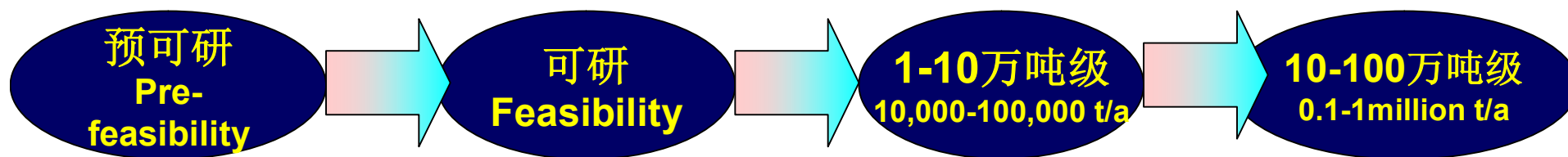


神华积极采取的措施 Shenhua Actions

- 提高能效 Promote Energy Efficiency
- 节约能源 Energy Saving
- 利用可再生能源 Renewable Energy
- CCS技术等 CCS Technology...

前瞻性开展**CCS**相关研究工作，在煤制油项目初期就着手**CO₂**研究，计划以煤直接液化项目为依托，建立**CCS**示范项目。

Prospective Study: Shenhua CCS Project

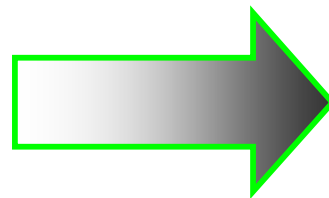




神华CCS技术研发思路 CCS R&D Route

- CCS技术 CCS Technology
- CO₂的资源化利用 CO₂ utilization

先在煤制油厂探索
CCS技术的可行性
Pilot: CTL



将来在电力板块探索
CCS技术的可行性
Pilot: Power

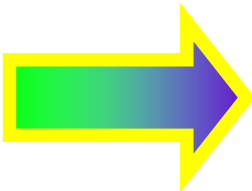




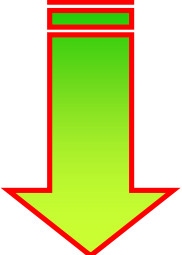
神华CCS技术研发思路 CCS R&D Route

依托神华煤制油厂 Relay on CTL Plant

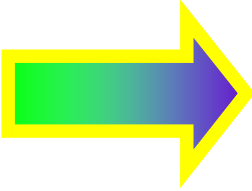
近期: Recent
小规模试验
Small scale



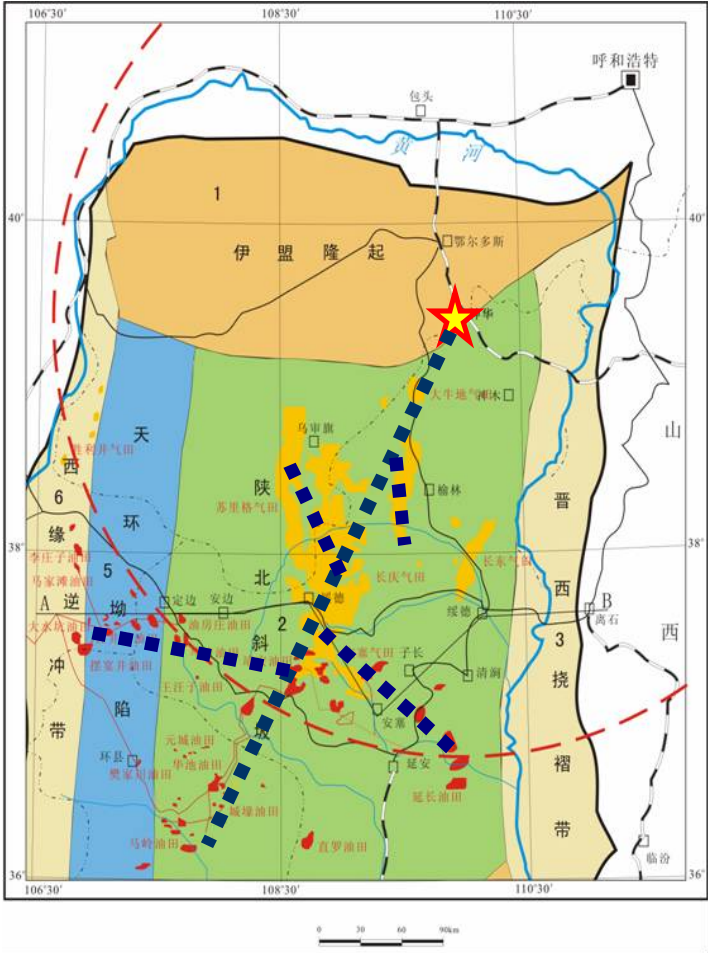
盐水层封存
DSR
微藻吸收
Algae



远期: future
封存及利用
CCUS



油气田
EOR/EGR
煤层 ECBM





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煤制油和煤化工产业CO₂减排策略

CO₂ reduction strategy of CTL Area



- 确定了规模化、大型化、集约化的产业发展方向，实现企业、社会和生态环境的和谐统一。

Identified large-scale and intensive industrial development direction , and realizing the harmony and unity of enterprises, society and ecological environment.

- 在现有的煤转化过程中，煤直接液化过程效率最高，CO₂的排放量最低。高浓度CO₂为实施CCS项目提供了便利条件。

In the existing coal conversion process, the direct coal liquefaction process is the most efficient ,and the emission of CO₂ is minimum. High concentrations of CO₂ provides the facilities for the implementation of CCS project.

- 积极探索CO₂利用技术，例如CCS、微藻固碳和资源化利用技术等。
 - actively explore the technologies of CO₂ using, such as CCS, algae carbon sequestration and resource utilization technology



神华鄂尔多斯煤直接液化项目得到国家领导人的高度关注

The national leaders pay great attention to Shenhua CTL project



对环境问题提出了更高的要求
more strict demand on
environment issues



液化厂排放的CO₂主要来源于2部分:

- 煤制氢工艺产生的CO₂
- 各加热设备产生的烟道气

CO₂ from 2 processes

coal to H₂ process

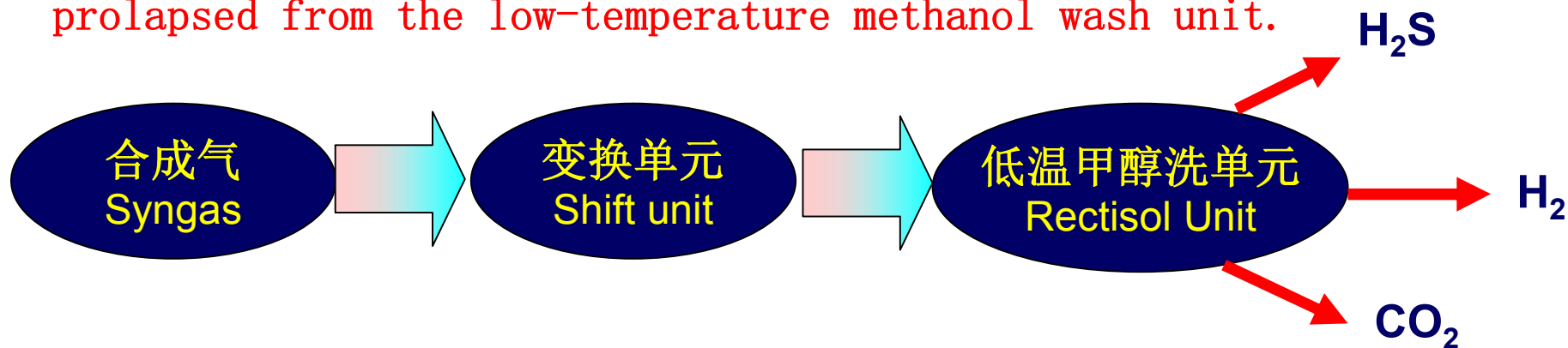
flue gas





合成气经变换后，由低温甲醇洗单元脱出CO₂和H₂S。

After the transformation of the synthesis gas, CO₂ and H₂S are prolapsed from the low-temperature methanol wash unit.



获得的高浓度CO₂气体组成如下 (vol%) **Composition**

| 组成 | CO ₂ | N ₂ | H ₂ | H ₂ O | CO | Ar | CH ₄ | H ₂ S | COS | CH ₃ OH |
|----|-----------------|----------------|----------------|------------------|--------|----------|-----------------|------------------|------------|--------------------|
| 含量 | 87.60 | 10.773 | 0.1828 | 1.396 | 0.0334 | 0.001591 | 0.004724 | 0.00160 | 0.00002798 | 0.007211 |

高浓度CO₂为实施CCS提供了便利条件

The CO₂ from Rectisol is suitable for CCS



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☆ 神华集团科技创新项目 **Shenhua Science and Technology Innovation Project**

神华集团CO₂捕集及处理方案研究 **Shenhua CO₂ Capture and processing program study**

2005

☆ 中美合作项目、其它合作项目 **Sino-US cooperation project/other cooperative projects**

神华直接液化CO₂捕集、封存预可行性研究

CCS Projects Pre-feasibility study of Shenhua

☆ 中美合作项目、集团科技创新项目 **Sino-US cooperation project / Shenhua Technology Innovation Project**

神华直接液化CCS可行性研究

C CS Projects Feasibility study of Shenhua

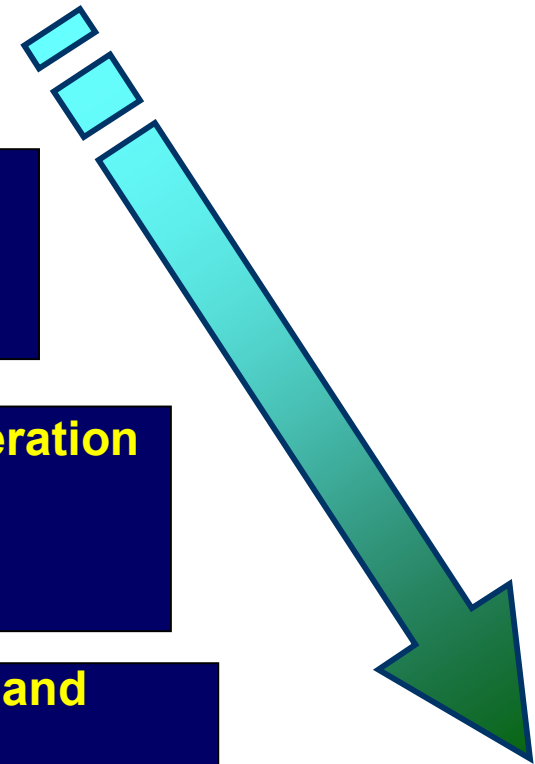
☆ 神华集团科技创新项目 **Shenhua Science and Technology Innovation Project**

神华CCS关键技术研究 **CCS key technology study of Shenhua**

☆ 神华集团**CCS**示范项目/国家科技项目/中美合作项目 **Shenhua project/ International project**

10万吨/年级示范工程项目

100,000 tons / year demonstration project





神华集团
SHENHUA GROUP

CAGS Workshop 2

合作单位 Cooperation





主要研究内容 Research Contents

1 神华各板块CO₂排放研究分析

CO₂ emission investigation and analyses of Shenhua

2 神华CO₂减排技术发展路线图研究

Roadmap of Shenhua Group CO₂ emission reduction

3 煤直接液化项目实施CCS关键技术研究

Key technology research of Shenhua CTL CCS project

4 10万吨/年CCS示范工程

Establish 100,000- 100,000 t/a Demonstration Project



已完成的工作 Completed tasks

1 研究分析了CCS技术的现状、发展趋势和对策。

Investigate and analyze the research and development of CCS

2 研究了神华集团各板块及整体CO₂排放情况。

Complete the Investigation and analyses of Shenhua 4 areas

3 初步形成了神华集团CO₂减排技术路线图，以及利用CDM机制的策略。

Put forward the roadmap of CO₂ emission reduction of Shenhua and route of utilizing CDM mechanism.



已完成的工作 Completed tasks

4 煤制油和煤化工工程项目开展封存潜力的机会研究

Analyze the potential chances for CCS of CTL and coal chemical projects.

5 煤转化基地集中区—鄂尔多斯盆地潜在地层（包括油气田、深部煤层、盐水层）进行了分析和筛选。

Analyze and select the potential formation in Ordos Basin (including oil/gas fields, deep coal seams, deep saline reservoir)

6 调研并整合国内化工工程设计、地质勘探、物探、钻探等专业单位及机构的技术支持资源。

Survey the companies and units of chemical engineering design, geological exploration, physical exploration and drilling et al.

7 完成10万吨/年CCS示范项目的前期研究和建设工作。

Finish the research and construction of the 100,000 t/a Pilot Project



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项目目标

Target of the Shenhua CCS pilot project

掌握盐水层封存CO₂关键技术，建成并运行中国首个具有全流程特点的盐水层封存示范工程，规模为10万吨/年。

完成了CO₂试注工作，开始连续注入和监测。

Finished the injection test, start the injection and monitoring

Size: 100, 000 t/a

Dec, 2010: injection test

主要内容包括：

- 现代煤制油化工行业高浓度二氧化碳提浓技术 CO₂ capture technology
- 盐水层封存的选址、模拟和注入工艺 selection, simulation and injection
- 安全监测评价体系与预警处置技术 safety, monitoring, alarm, treatment
- 形成煤化工领域CO₂盐水层封存的成套技术 DSR sequestration technology



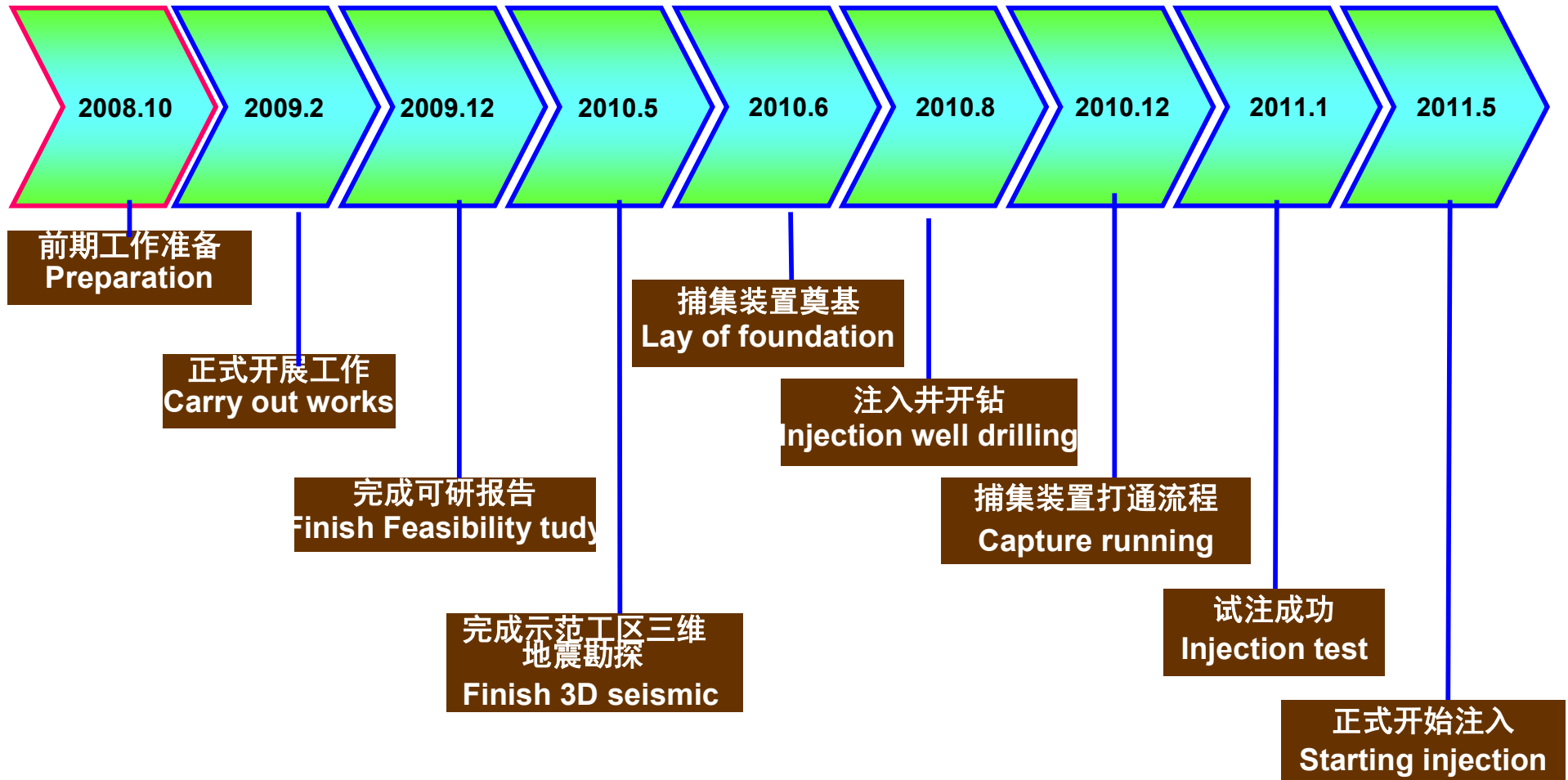
5 神华10万吨级/年CCS示范项目的进展

Workshop 2

The milestone of Shenhua CCS pilot project

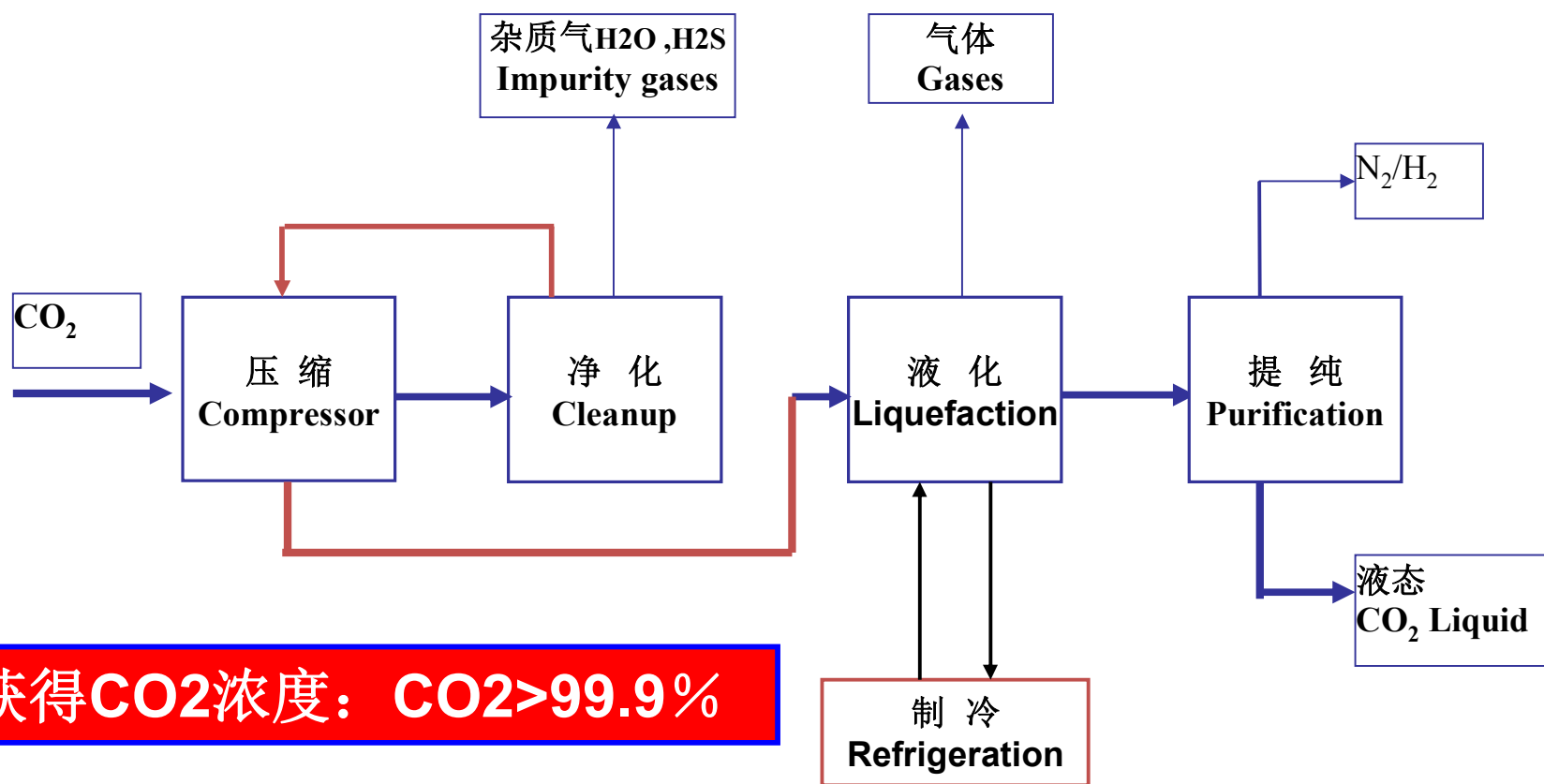
基于已完成的研究工作、中美合作项目等，开始示范项目的研究和建设

Base on the former project, Shenhua begin CCS demonstration project





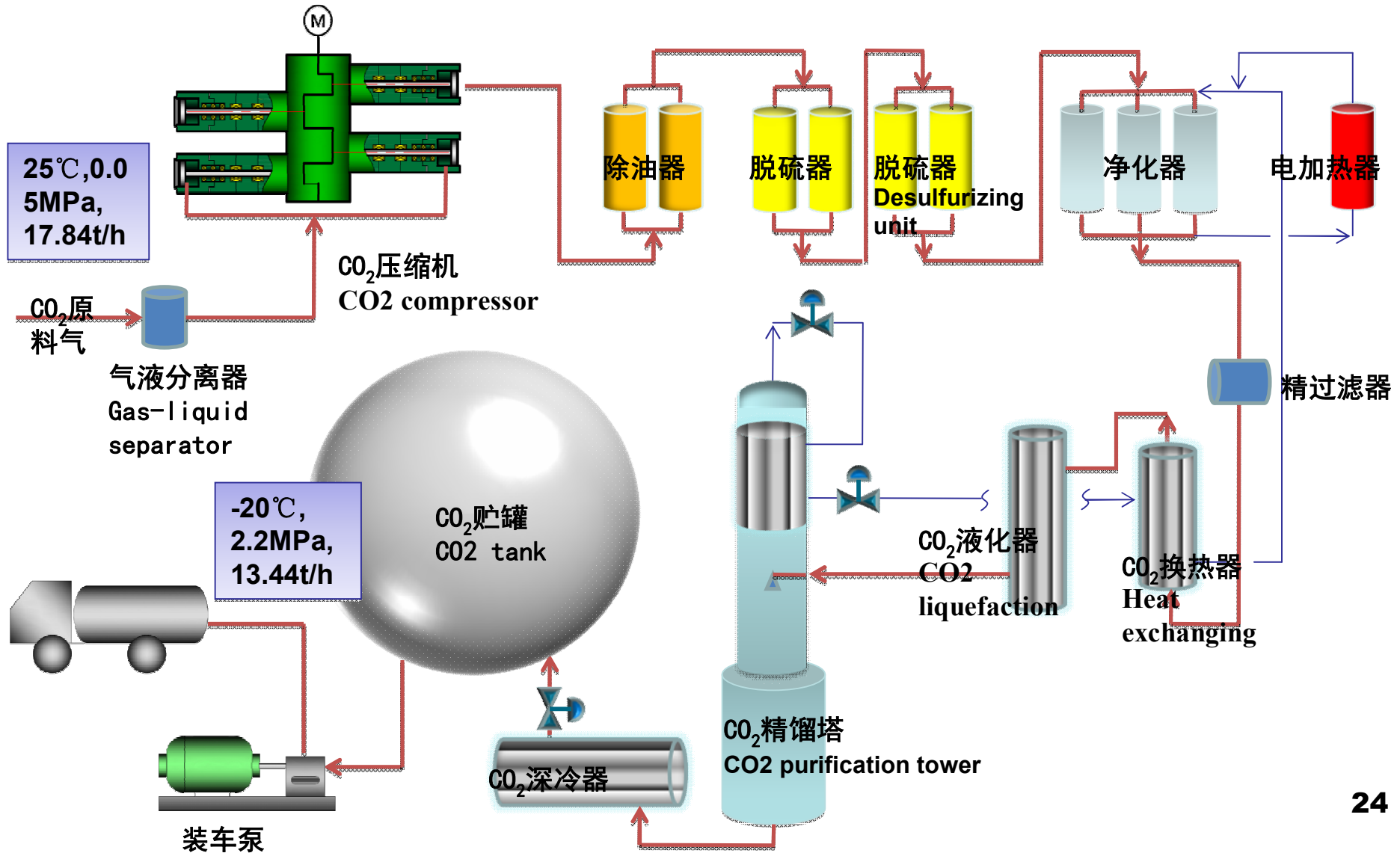
确定了CO₂提浓方案 CO₂ purification process



将获得CO₂浓度: CO₂>99.9%



地面捕集工艺流程 process of capture





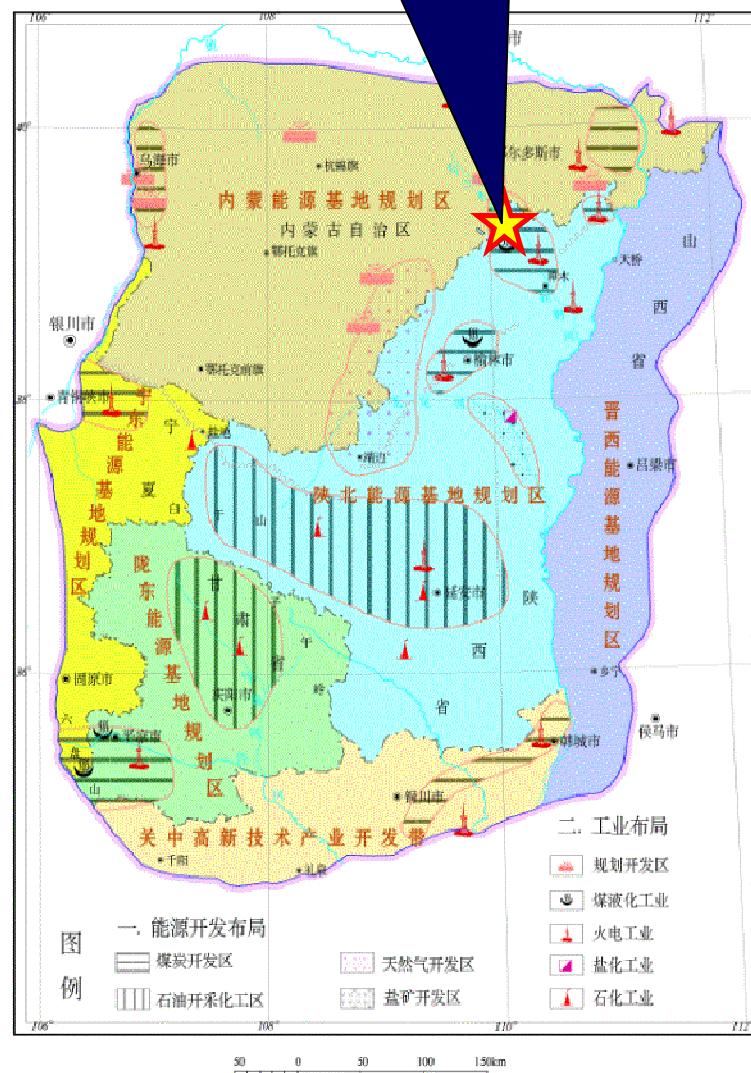
分析鄂尔多斯盆地的封存潜力

Analyzed the potential formation

神华煤制油厂位于鄂尔多斯盆地，是一个具有多种能源共同赋存的大型沉积盆地，具有实施CO₂地质封存的巨大潜力(数百亿吨)。

Ordos Basin has giant potential of CO₂ sequestration (several billion tons).

煤制油厂位置
CTL Location

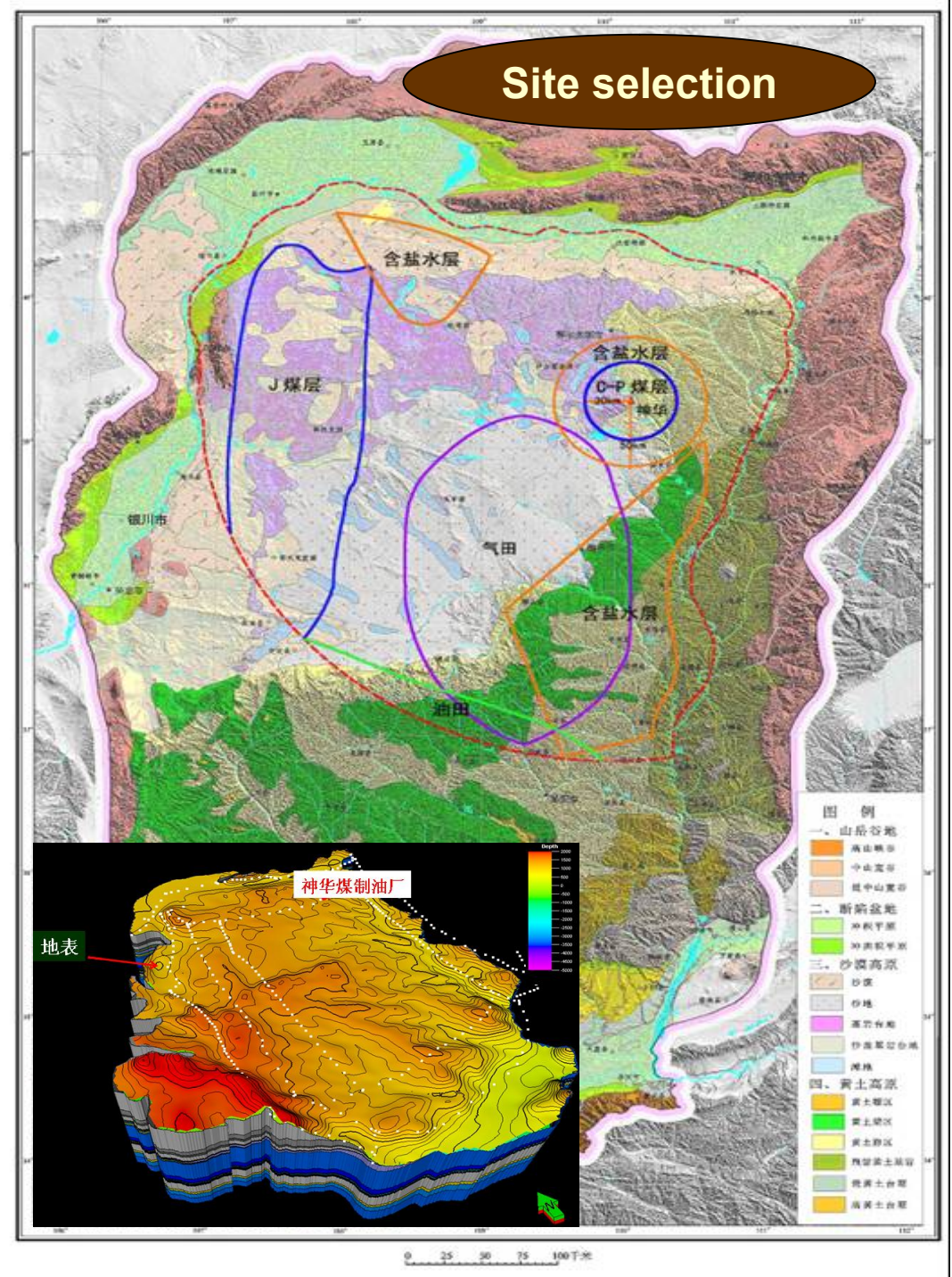




在煤直接液化厂附近 (300KM以内), 选出7个潜在封存区域

7 target formations near CTL Plant (within 300km)

- 3个盐水层
3 deep saline reservoirs
- 1个油储层
1 oil reservoir
- 1个气储层
1 gas reservoir
- 2个煤层
2 deep coal seams

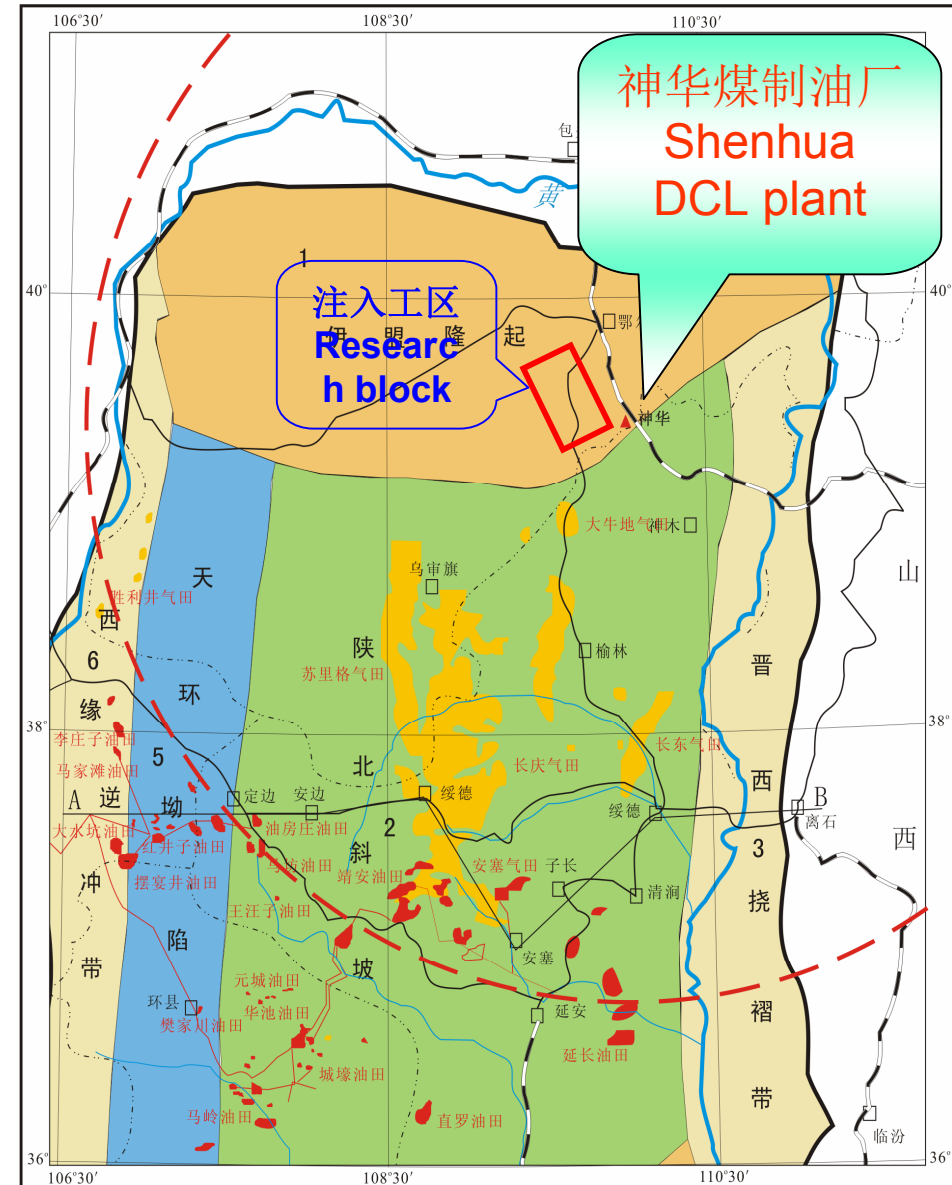
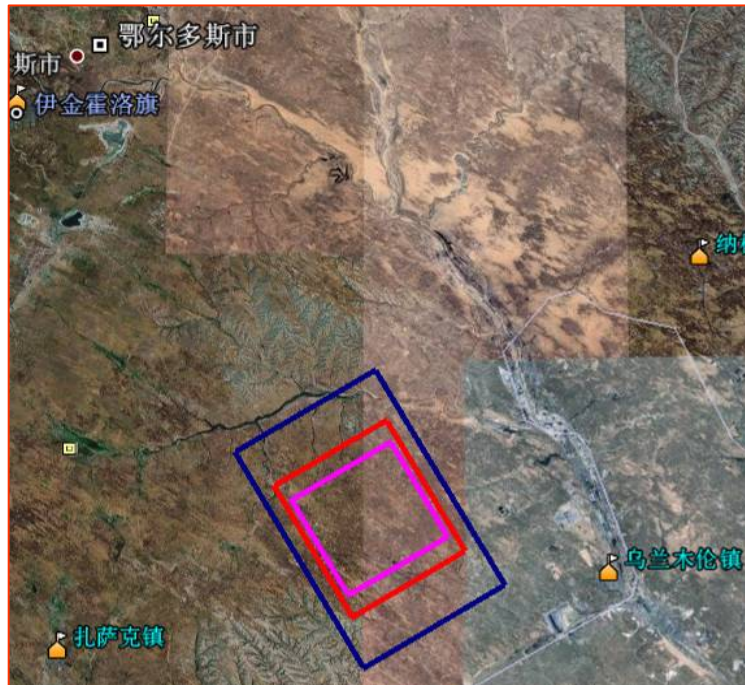




研究区位置和范围 location and range of research

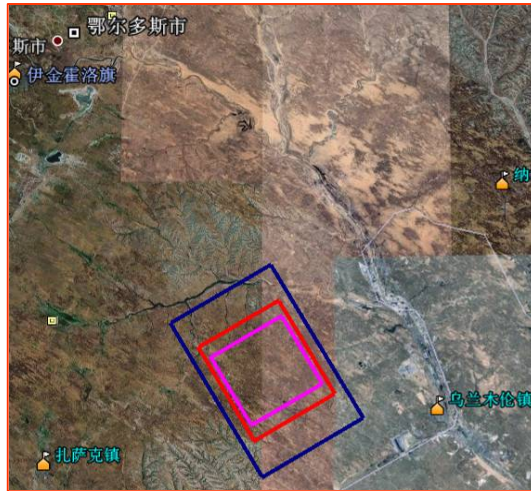
注入工区位于煤液化工厂西约9Km处，行政区划隶属于伊金霍洛旗的乌兰木伦镇，构造位置位于鄂尔多斯盆地伊盟隆起，工区南部为中石化大牛地气田。

The research block: 9km from DCL plant in the north of Ordos basin

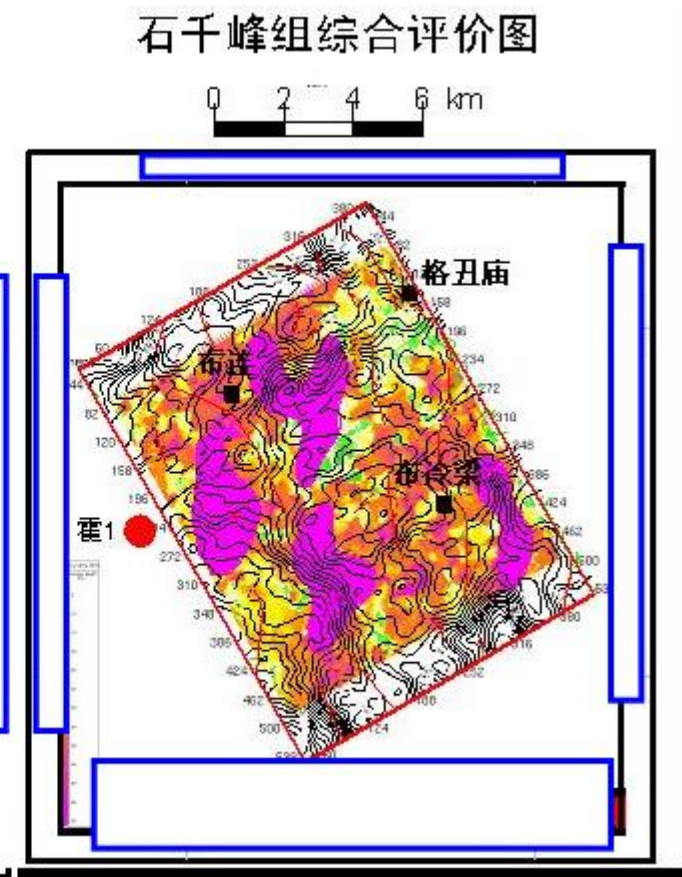
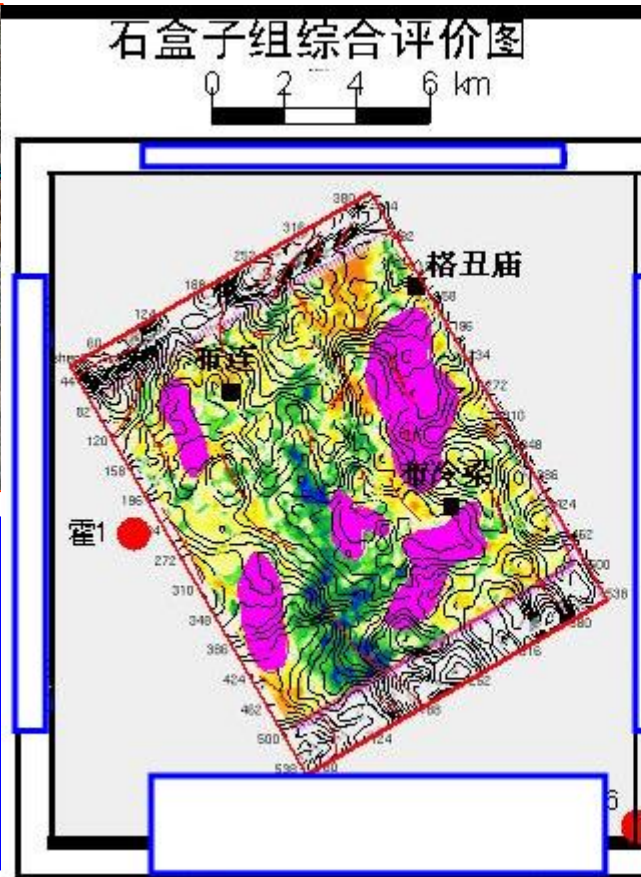




完成注入区的三维地震勘探工作 Finished the 3D seismic exploration

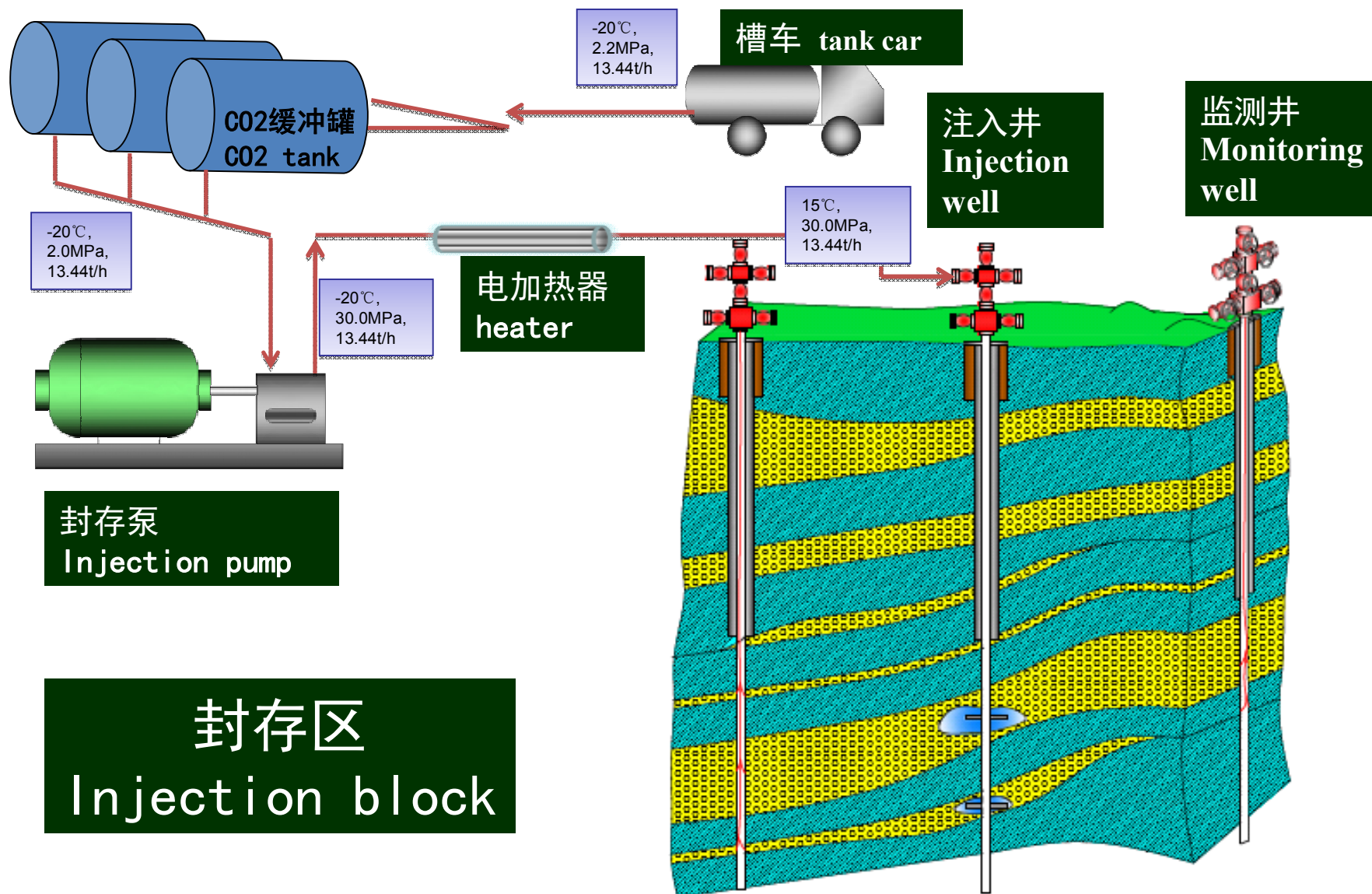


勘探面积100km²
提出潜在地层
Potential formation



例如 For example: 石盒子组5个有利区----5 potential blocks in Shihezi Group

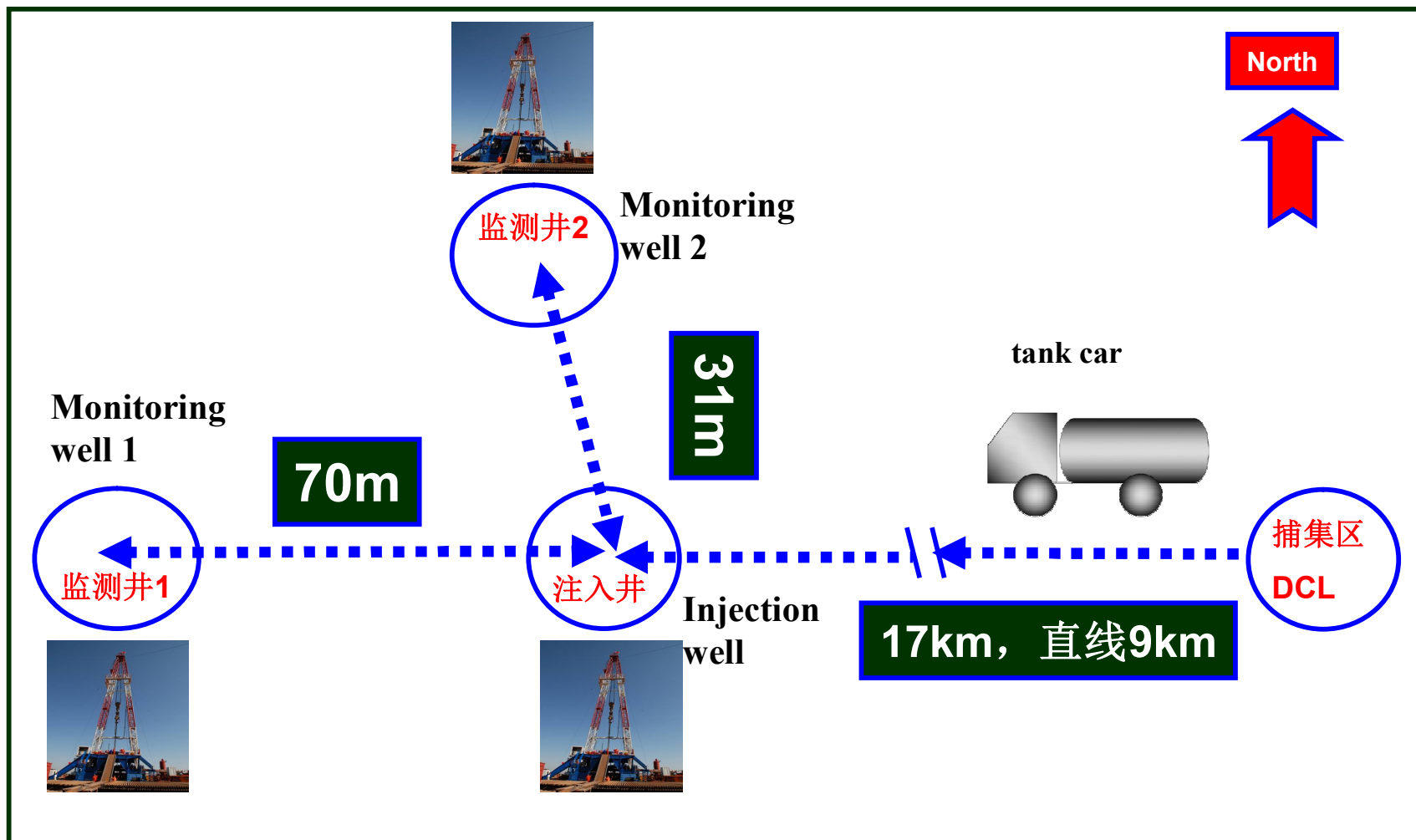
石千峰组有4个有利区----4 potential blocks in Shiqianfeng Group





注入区井位布置

wells location in injection block

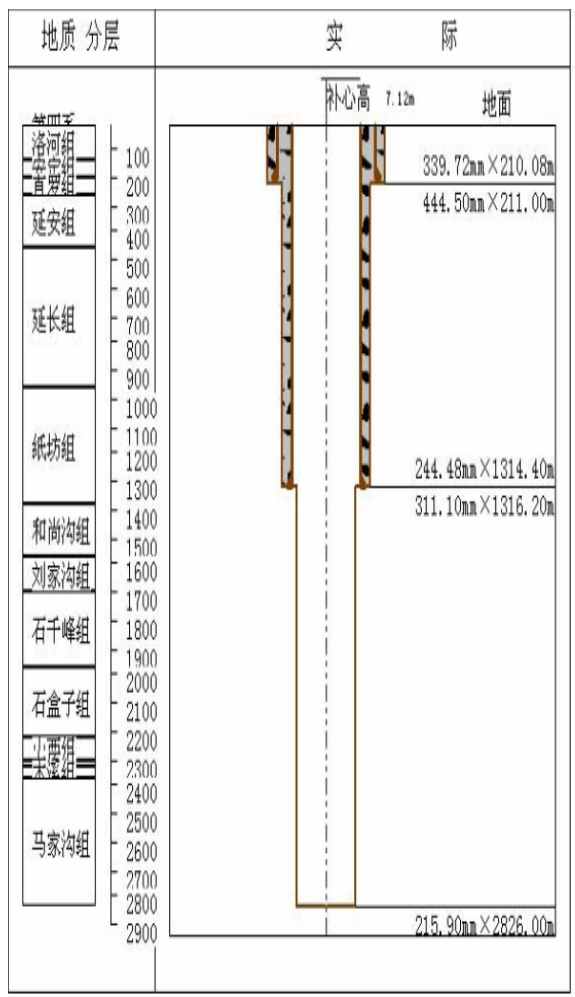


封存区位置图

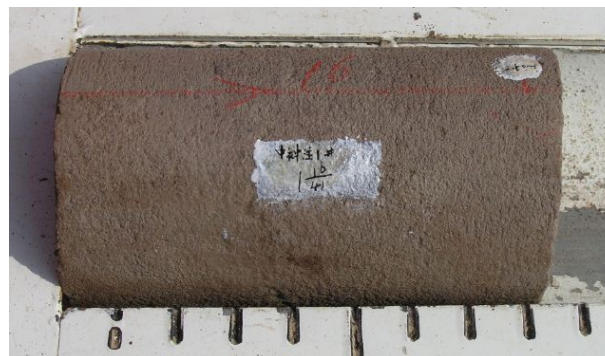
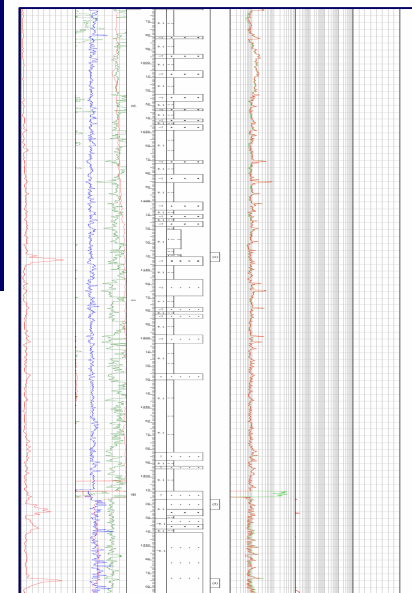
well location



完成注入井的钻井、测井工作 Finished the well drilling and logging



完钻井深: drilling depth 2826m
 人工井底: artificial well bottom 2519m
 共取心: coring 98m



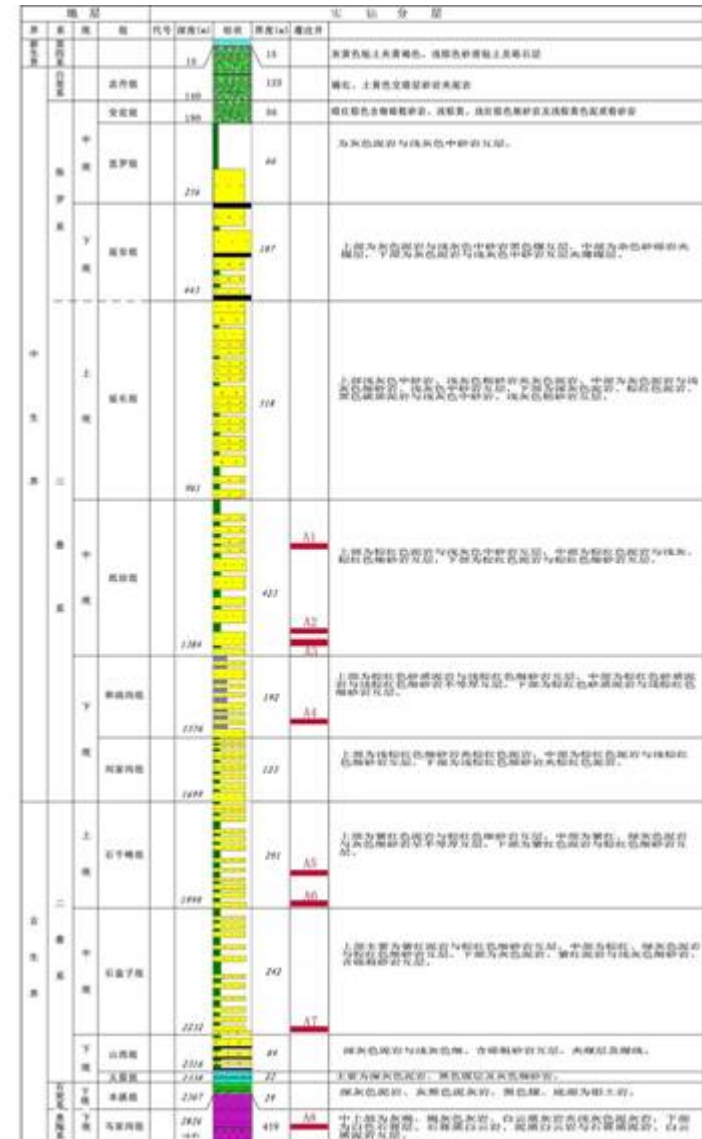


地层优选

Reservoir selection

对钻孔、地震等资料进行分析，认为目标区地质条件稳定，构造简单，埋深在1000—2500m之间具有封存CO₂的潜在地层。

From 1000 to 2500m, has several reservoir-cap rock combination in the vicinity area of CTL plant.





根据三维地震勘探和注入井的钻探结果，并考虑安全性问题，在1690~2453m之间共优选出21层112.6m的储层。

Total thickness of reservoir is 112.6 m from 1690-2453m.

储层包括: **reservoir**

三叠系刘家沟组底部

二叠系石千峰组

二叠系石盒子组

二叠系山西组和奥陶系马家沟组

上部盖层: **cap rock**

三叠系的延长组、纸坊组、尚沟组和刘家沟组的泥岩都可作所有储层的上部盖层。

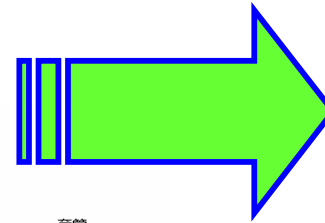
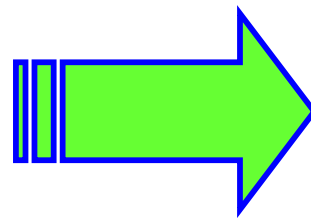


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完成压裂、试采、试注等工艺设计

shop 2

design fracture, production test and injection test



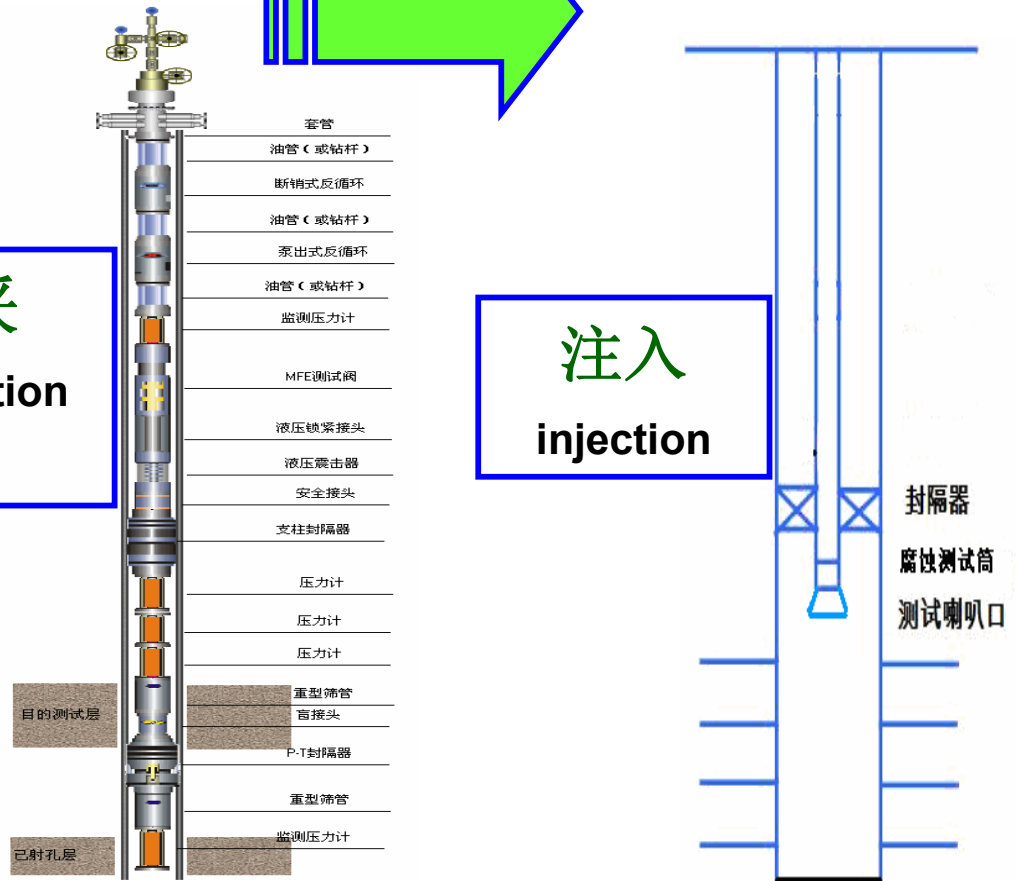
射孔完井
Perforating Completion

正进行试井、压裂

Well testing
Fracture

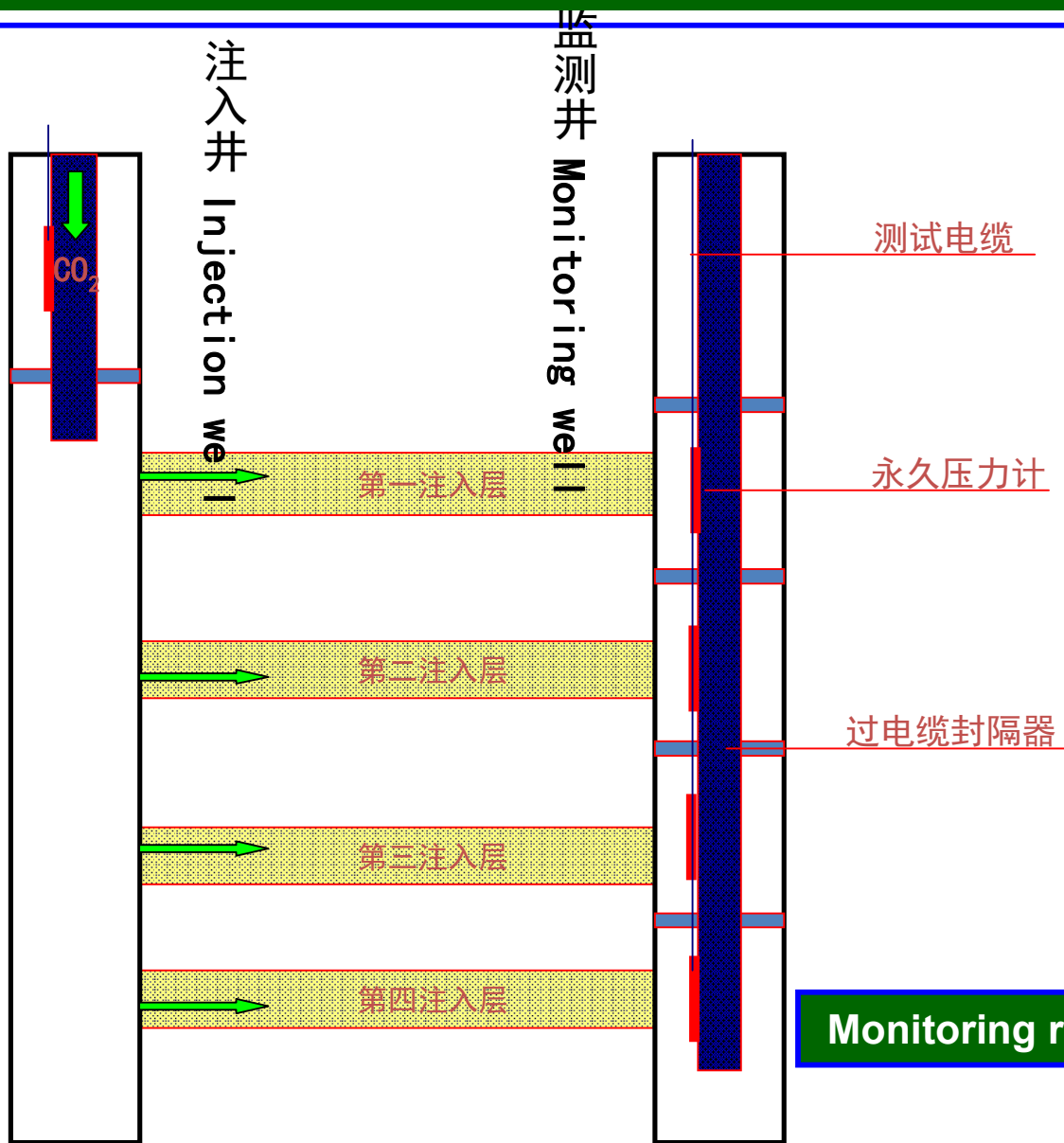
试采
Production test

注入
injection





笼统注入、
分层监测方案



Injection together

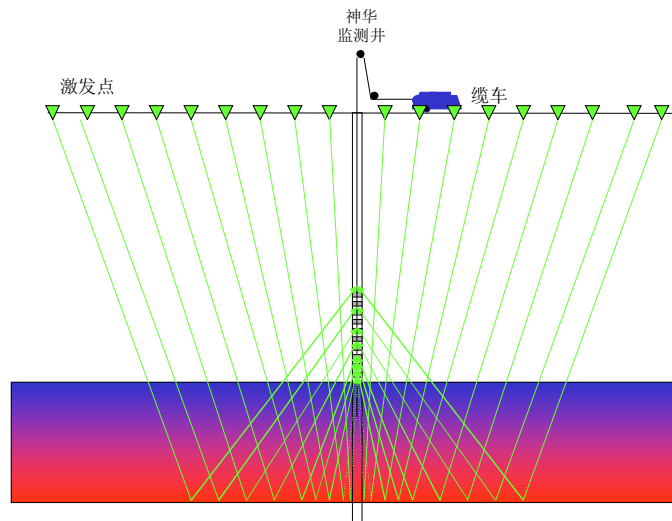
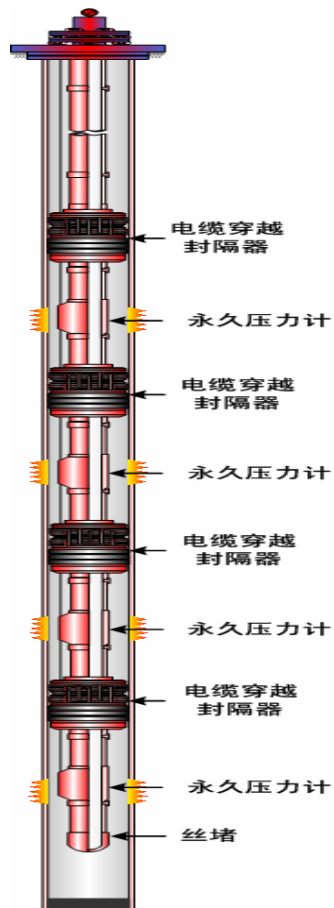
Monitoring respectively



完成监测设计 Finish monitoring design

1 监测井完井管柱 Pipe string of monitoring well

压力、温度等测量仪器及取样 P and T transducer and sampling



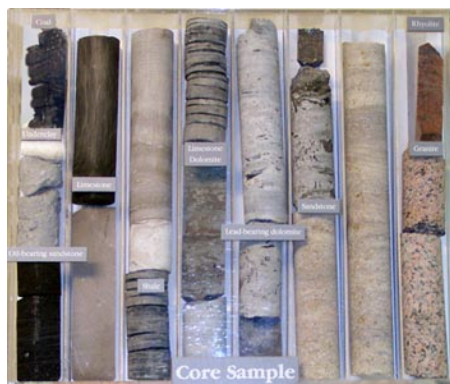
2 时移VSP地震监测 time-lapse VSP

3 地下水、 土壤、大 气等的监 测

- Underground water
- Soil
- atmosphere



进行的测试项目 coring and test



水
Water

组成、性质、年龄、溶解度等
Composition, property, age and
solubility et al

气
Gas

组成、同位素分析
Composition, isotope test

岩石
Rock

物化性质、力学性质、封存模拟
Physical and chemical property,
Mechanical property,
Storage simulation test

进行了多次模拟

Several simulation for target formation

★ 多层次共注才能满足10万吨/年的规模

Multi-formations injection simultaneously

★ 对注入CO₂羽流前缘和压力分布进行模拟

Simulation of CO₂ plume and pressure distribution

★ 低渗低孔隙性地层：注入性差、难度大，需要压裂，具体规模仍需验证

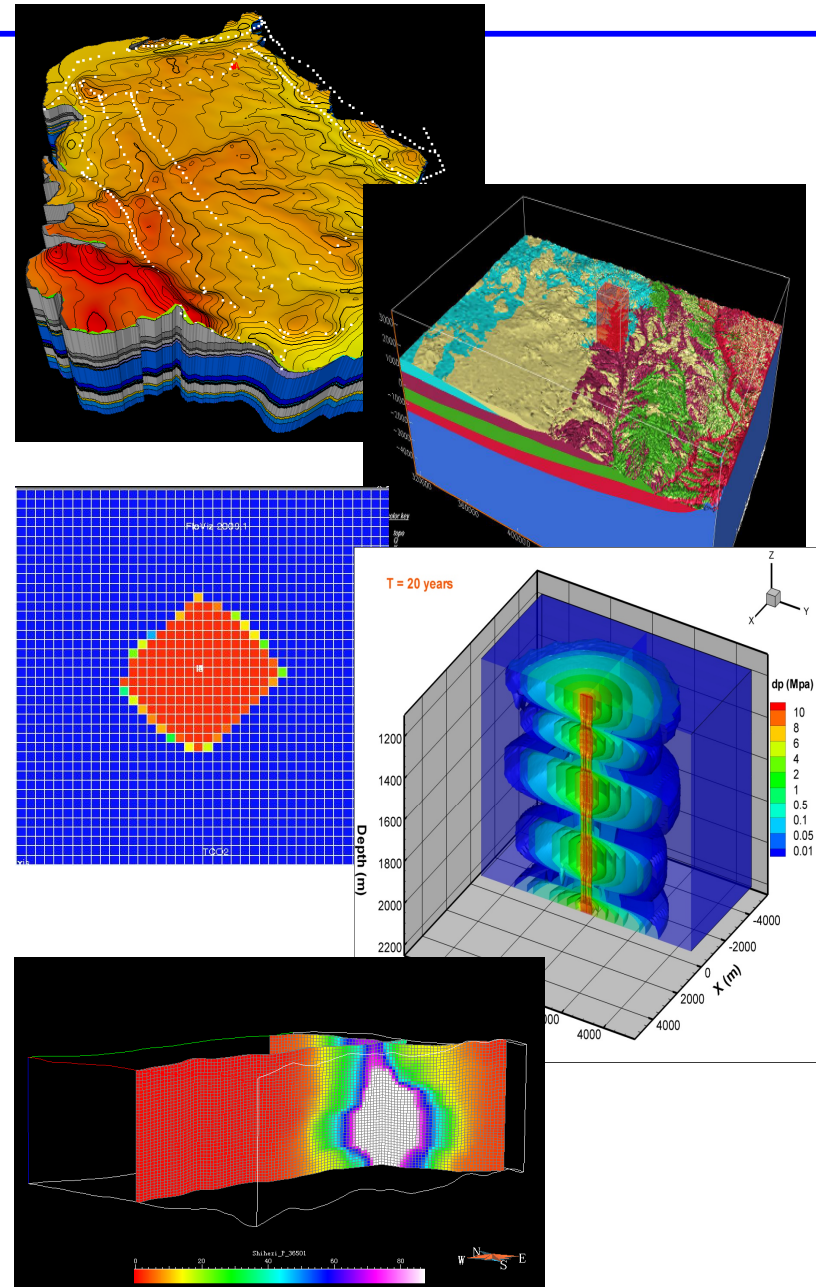
Low permeability and low porosity, low inject-ability and more difficult,

Fracturing is needed and need verification

★ 为封存层选择提供依据

Providing the basis for storage formations selection

CAGS Workshop 2





2011年1月 打通全流程并试注成功 injection test

In January 2011, the process flow of Shenhua CCS pilot project and the injection test were successful

- 试注为单层注入
Inject to single formation
- 累计注入122.9吨
accumulate quantity is 122.9t

初步证明了低渗地层进行增
渗改造的必要性

The injection test indicates it's
necessary to enhance the
injectability for low
permeability formation.





2011年5月份开始连续注入、并进行分层地质评价

In May, performed the continuing injection, and evaluated the different formations respectively

连续注入开始分四级逐步增加单位时间注入量，根据注入参数及监测井数据对各注入层进行综合评价。

The preliminary injection was divided into 4 stages, the next step is to evaluate the each reservoirs according to the parameters and data collected from the injection and monitoring well.

第一级 注入量 **quantity injected 159t**, 稳定注入压力 **stable pressure 6.79MPa**

第二级 注入量 **quantity injected 300t**, 稳定注入压力 **stable pressure 8.05MPa**

第三级 注入量 **quantity injected 442t**, 稳定注入压力 **stable pressure 8.63MPa**

第四级 注入量 **quantity injected 587t**, 稳定注入压力 **stable pressure 8.15MPa**



四级注入井口温度均为 0°C 。 The CO₂ temperature at wellhead is 0°C

初步判断渗透性最好的为
第三层

**No3 reservoir is proved
with the highest
permeability.**

灰岩渗透性及吸气性能暂
未充分展示，有待进一步
观察。

**The permeability and
absorbability of limestone
has not been well proved.
More inspection and
analysis are needed.**





1 神华集团低碳技术发展思路

Development strategy of low carbon technology of Shenhua

2 神华煤直接液化CO₂排放情况分析

CO₂ Emission analysis of Shenhua CTL Plant

3 神华CCS主要研发工作

R&D of CCS technology of Shenhua

4 示范项目主要进展

Updating of Shenhua CCS Pilot Project

5 示范项目下步计划

Our vision and Plan



10万吨/年级示范项目下步工作
Plan of demonstration(100,000t/a)

1 捕集装置长周期运行

long-term running of CO₂ capture unit

2 示范项目的长期注入

long-term injection of pilot project

3 不同手段的监测

monitoring by different means

4 CCS示范项目的全方位评价

evaluate the CCS pilot project

5 完成年注入目标

Achieve the injection target



2011年5月 开始正式注入
Formal injection in May,2011



神华CCS示范项目是中国首个全流程的CO₂盐水层封存项目，希望能和国内外相关机构外展开合作。

Shenhua CCS demonstration project is the first fully process of CO₂ sequestration in saline reservoir in China.

And wish cooperate with you.



神华集团
SHENHUA GROUP

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Thanks!