CAGS -- Geological Storage Workshop

Overview of the COACH and GeoCapcity projects

-- Assessment of CO_2 storage potential in Dagang, Shengli & Huabei oilfield provinces and Kailuan mining area

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2. Huabei oilfield
3. Dagang, Shengli oilfields
4. Huimin sub-basins aquifers
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6. Discussion

1. Introduction

COACH

Cooperation Action within CCS China – EU
(CO2 CAPTURE AND STORAGE) FP6

2006.11.－2009.11.

1.Knowledge sharing and capacity building

2.Storage activities

- **Capacities**
- **Criteria**
- **Standards**

3.Capture activities

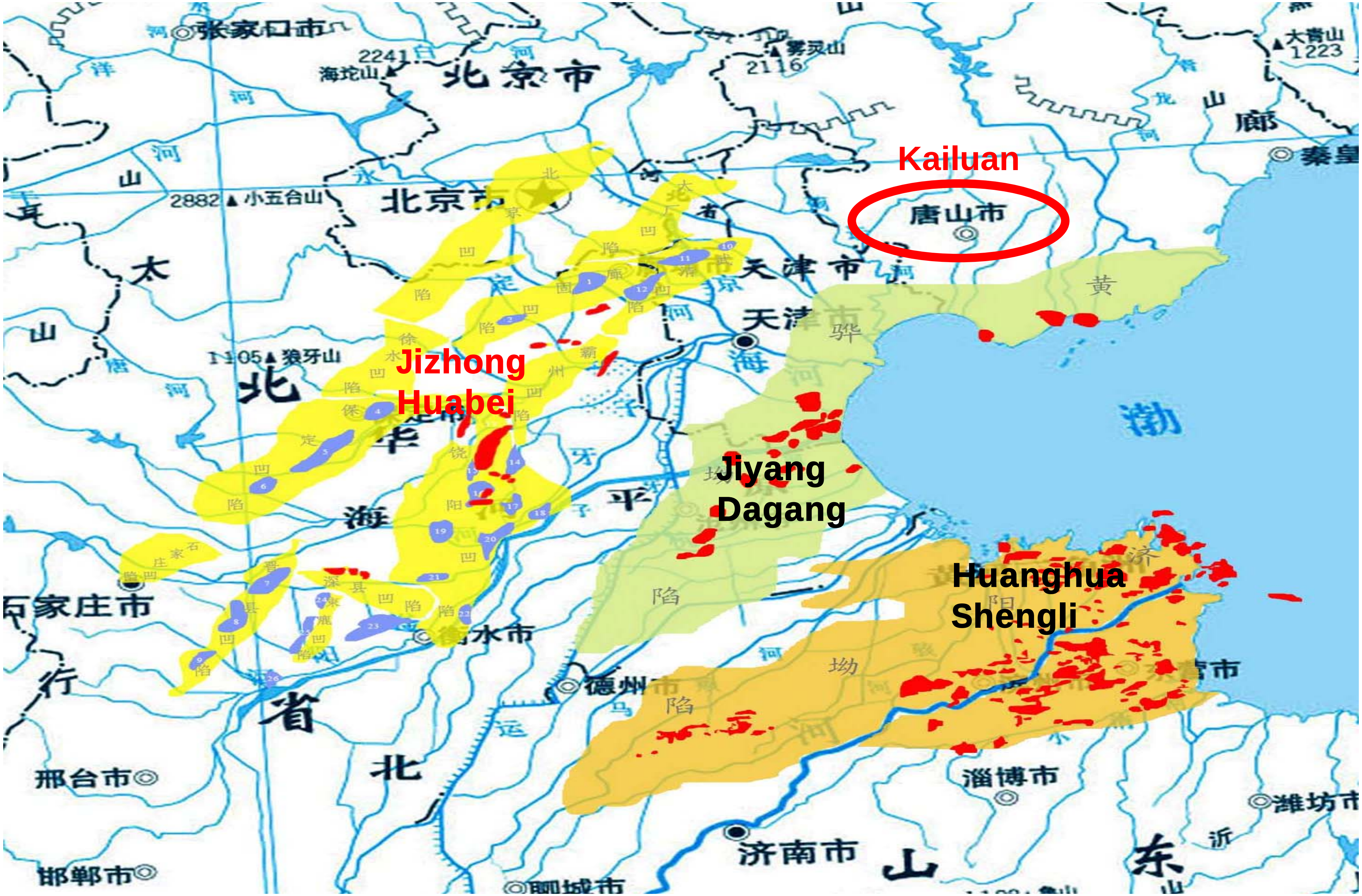
4.Recommendations for a demonstration plant

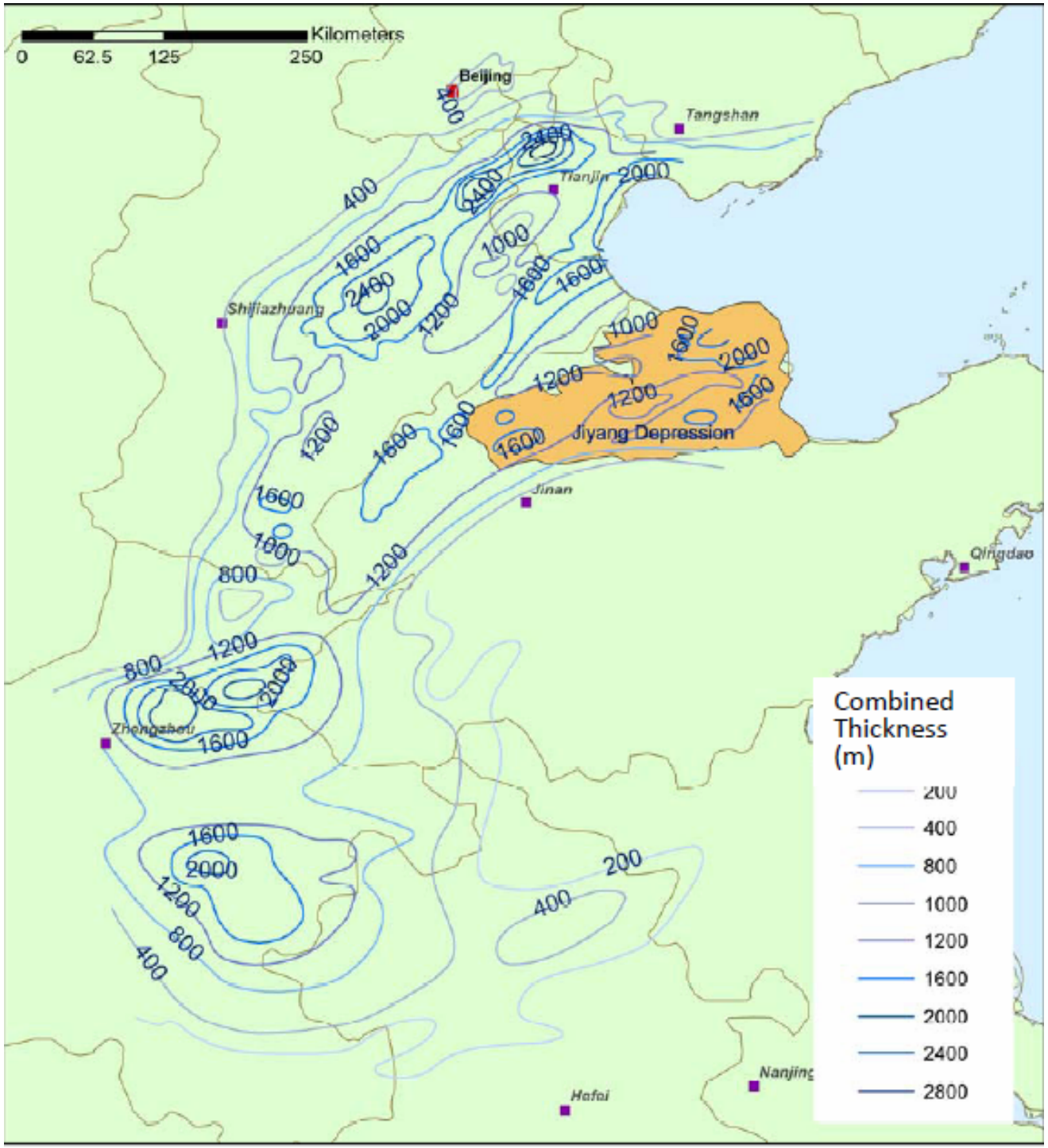
EU GeoCapacity

Assessing European Capacity for Geological Storage of Carbon Dioxide.

2006 January -- 2008 December. FP6

- **focused in eastern, southern and central Europe majority of the EU member states and a number of neighbouring countries.**
- **Detailed information and mapping of emission points, infrastructure and storage sites**
- **International cooperation framework, with CSLF countries such as China, India and Russia, focusing on technology transfer facilitating the countries to undertake similar studies.**


Kailuan
Jizhong
Huabei
Jiyang
Dagang
Huanghua
Shengli
张家口市
北京市
天津市
唐山市
石家庄市
衡水市
德州市
邢台市
邯郸市
济南市
淄博市
潍坊市
东营市
聊城市
秦皇
雾灵山
2116
大青山
1223
海坨山
2241
小五台山
2882
狼牙山
1105
渤
山东
河北省
太行山



Isopach map of the combined thickness of the Guantao and Minghuazhen Formations in North China

(From L.J.Ye, 1983)

CSLF based methodology

Carbon Sequestration Leadership Forum

$$M_{CO2b} = A \times h \times NG \times \phi \times \rho_{CO2r} \times S_{eff}$$

Joule II
GESTCO
Castor
CSLF
GeoCapacity
COACH

Bachu *et al*. 2007

Definitions, concepts and methodologies for estimating CO_2 storage capacity

Resource-Reserve Pyramid concept

Practical = realistic capacity: Case studies

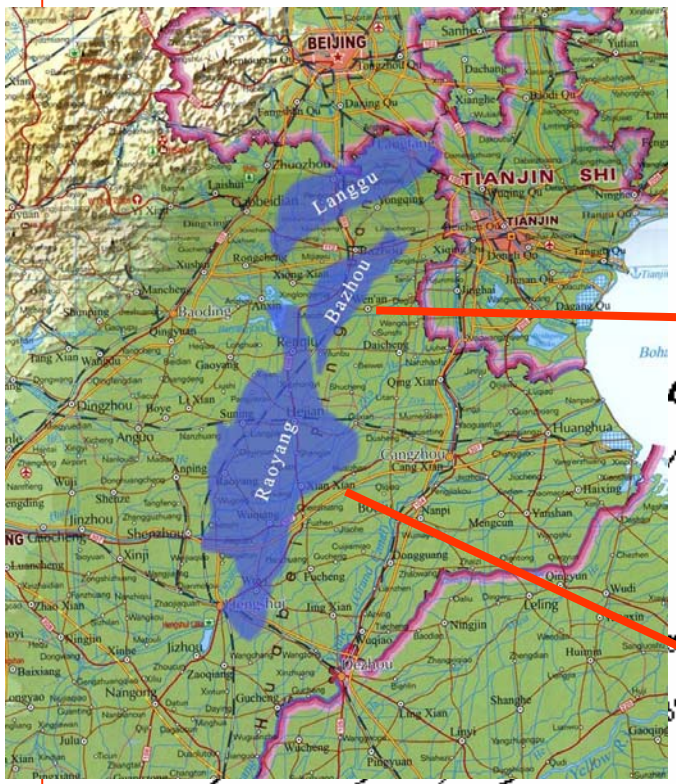
Effective capacity = realistic capacity: site specific/regional estimates

Theoretical capacity = physical limite: regional estimates without storage efficiency

Geological (ranking) criteria

- Sufficient depth ≥ 800 m (≤ 3 km)
- Sufficient CO_2 storage capacity
- Injectivity to be economically viable
- Good seal (cap rock)

2. Huabei oilfield



Baxian

Raoyang

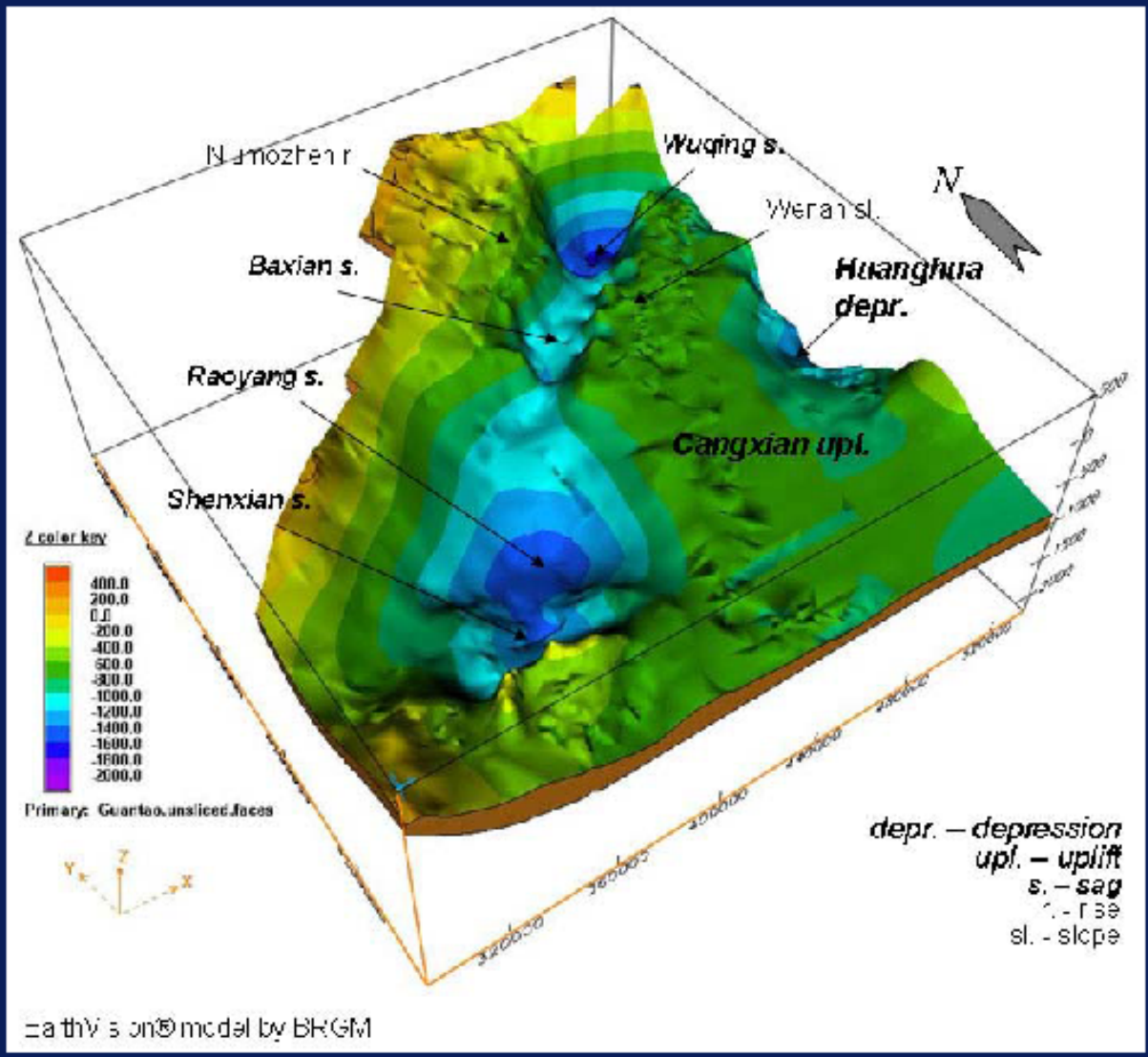
廊坊
固安
霸县
徐水
雄县
保定
任丘
天津
南宁
深泽
石家庄
衡水
500
400
300
200

Baxian 2510 km²

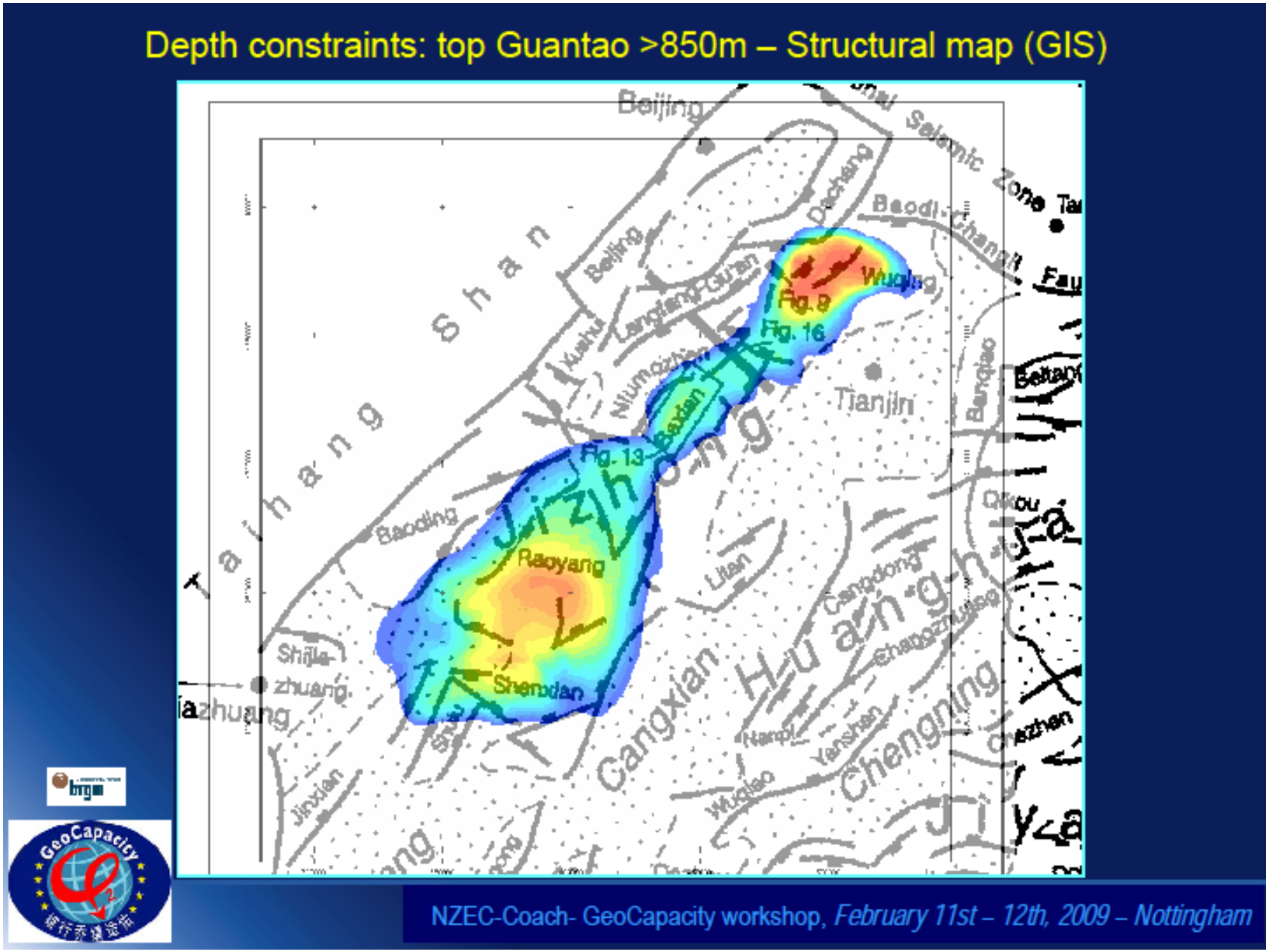
Raoyang 5200

EarthVision model of the Guantao Fm.

(Jizhong and south Huanghua depressions)



EarthVision model of the Guantao Fm. (Jizhong and south Huanghua depressions)



Depth constraints: top Guantao >850m
Structural map (GIS)

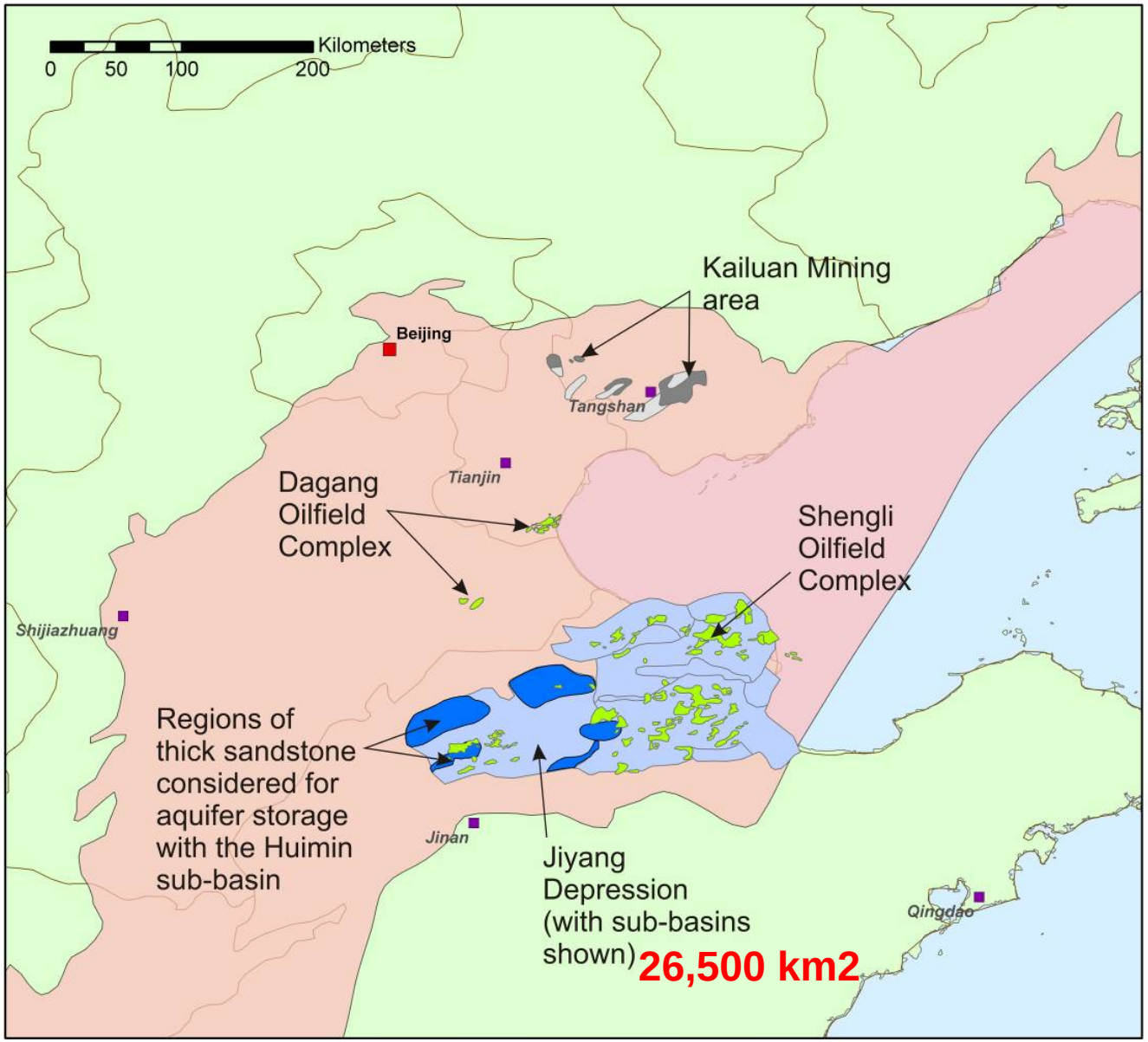
Total estimated CO2 storage capacity

-- in deep saline aquifers (open / single Horizon) **747 (Mt)**

-- in deep saline aquifers (closed / Guantao)

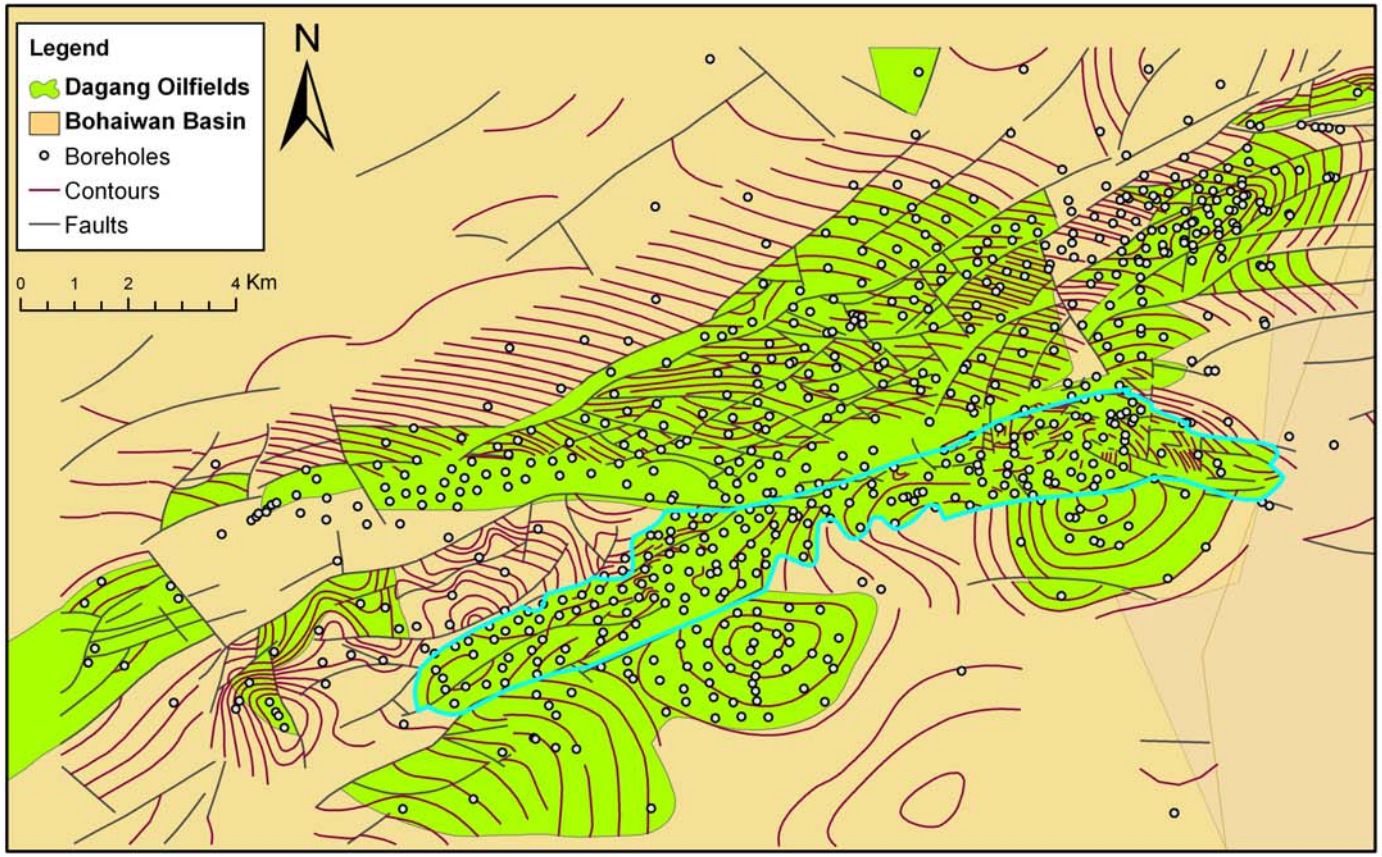
371 (Mt)

3. Dagang, Shengli oilfields



（3.1）Dagang oilfield province

Proven oil-bearing area: 23.7km2
Gas-bearing area: 10.3km2

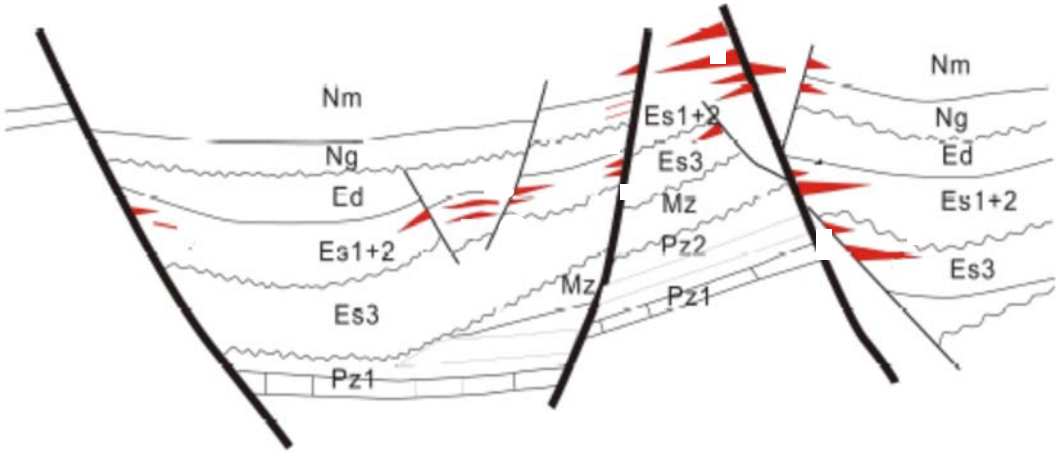


Geology – Dagang Oilfield

- **Seven reservoirs -- suitable geological characteristics for CO_2 storage**
- **Total capacity -- 22 Mt**
- **Gangdong field -- greatest capacity (10 Mt)**

- **Dagang field -- potential for a small-scale pilot, but not for large-scale storage**

Cross section through North to central Huanghua Depression



Nm – Minghuazhen Formation, Ng – Guantao Formation,
Ed – Dongying Formation, Es1+2 – Shaejie Formation,
Mz - Mesozoic, Pz1 - Palaeozoic

Image: courtesy RIPED

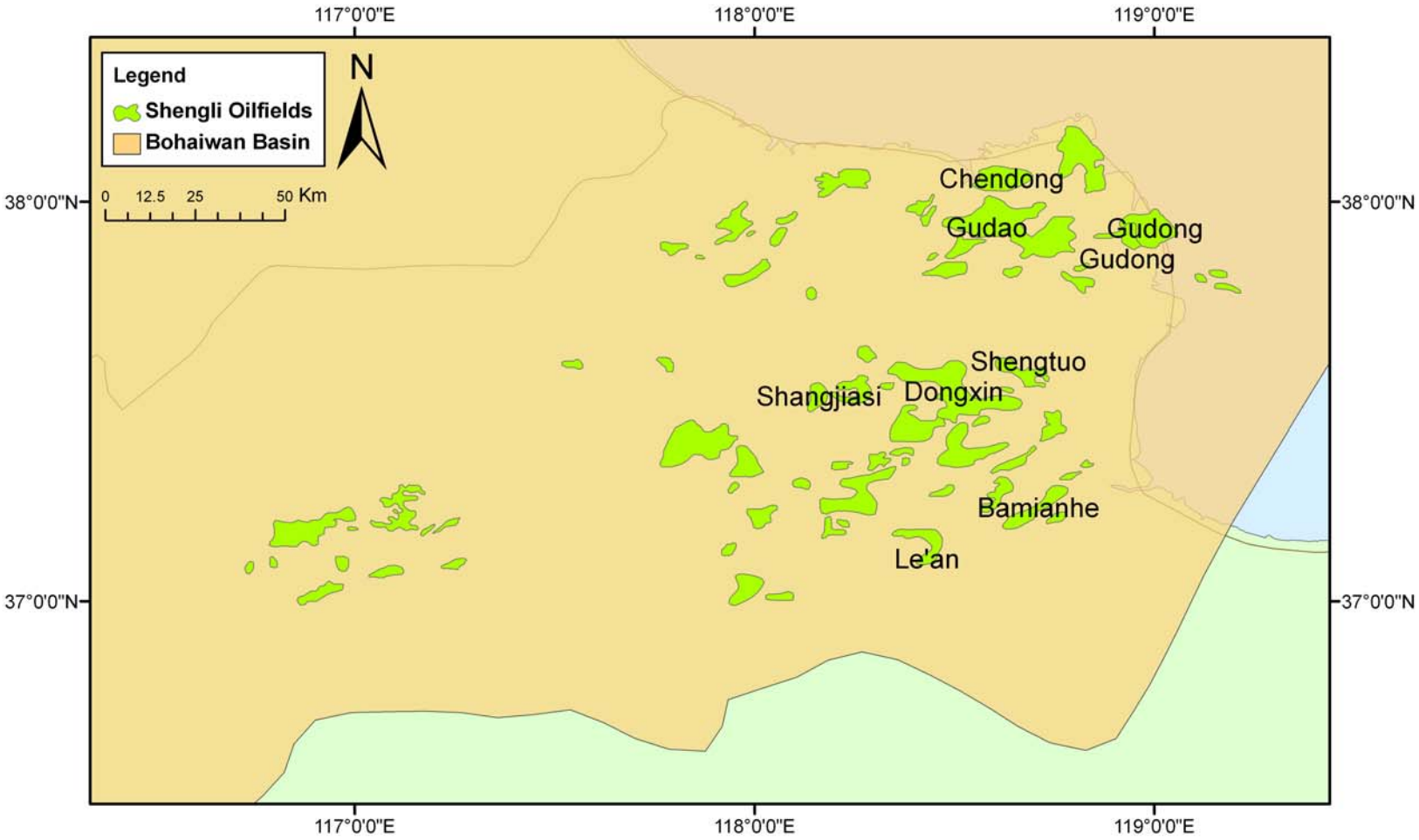
The Dagang field may have potential *for a small-scale pilot*, but *not for large-scale storage.*

- **Low permeability reservoir:**
  Wangguantun (13 Mt CO_2)

(3.2) Shengli oilfield province

the second largest oilfield in China.

By the end of 2000, Shengli oilfield has discovered 65 oil-gas fields (two gas fields), oil-bearing area is about 2117 km2 .



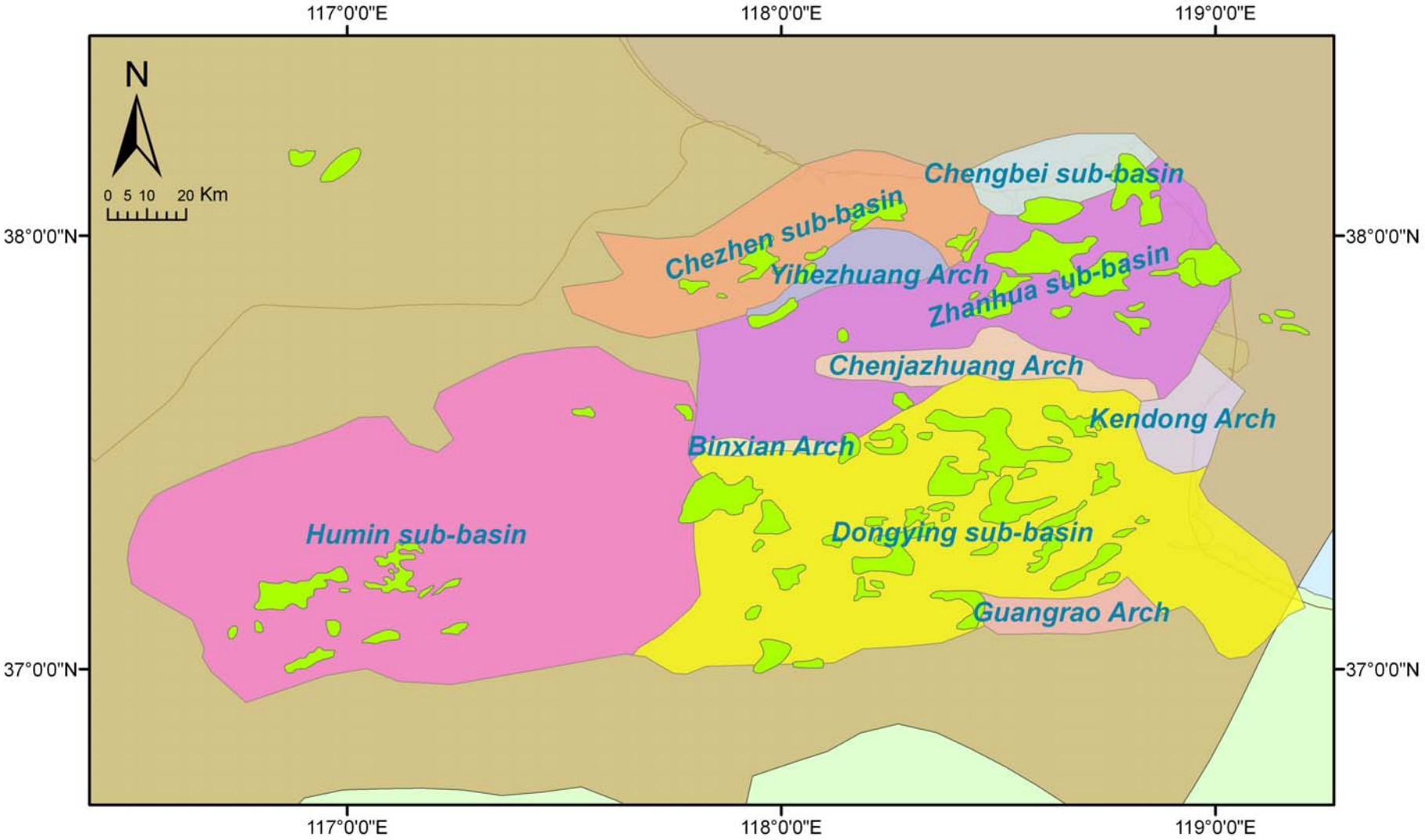
- **CSLF methodology (Bachu et al 2007) (used for all storage sites) – displacement of pore fluids (for effective capacity)**

  -- Storage capacity 472 $MtCO_2$

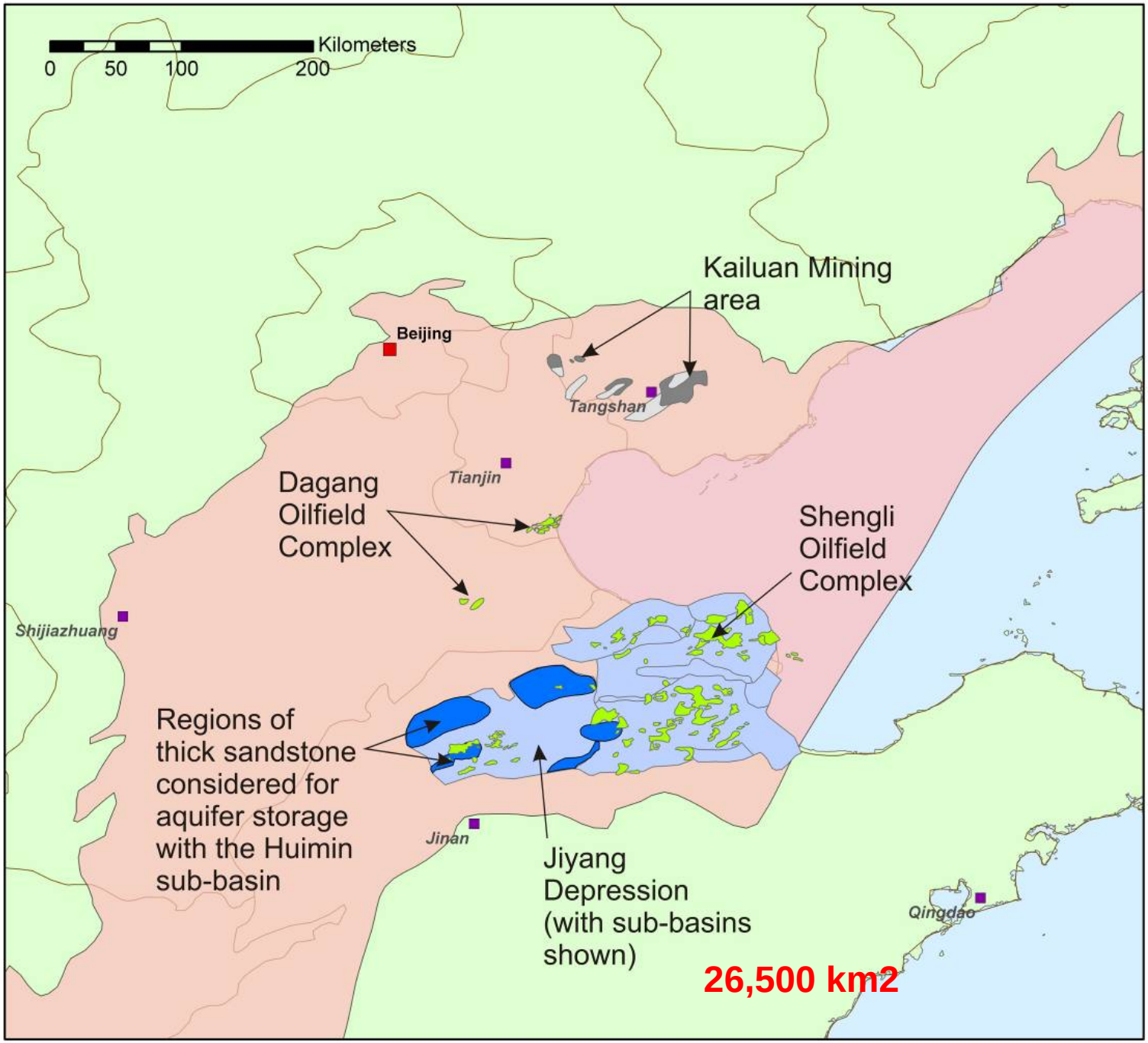
- **CUP methodology (based on Tanaka et al 1995) – displacement of pore fluids and dissolution into pore fluid (assumes underlying aquifer volume is equal to reservoir volume to compensate for lack of data)**
  - **Storage capacity 463 $MtCO_2$ (or 791 Mt when field depleted)**

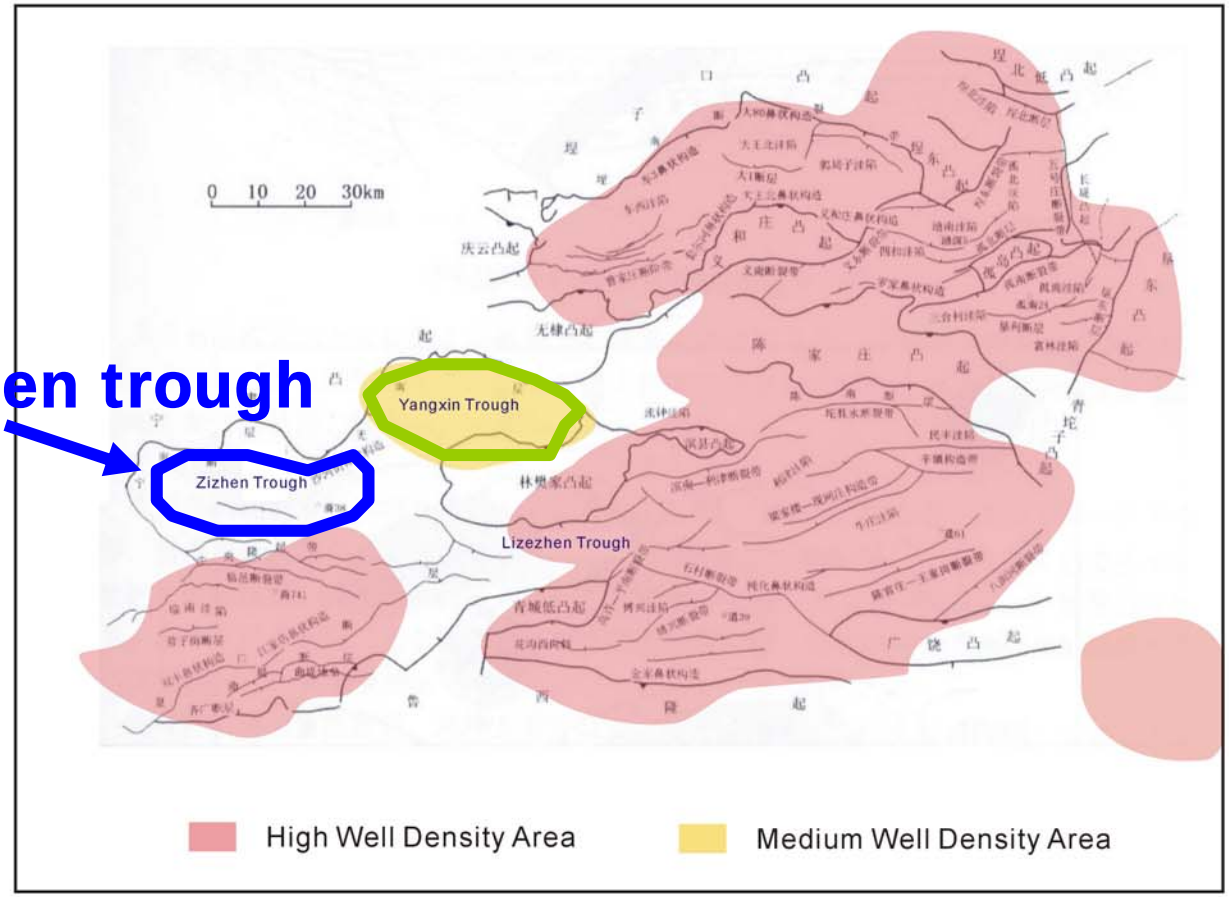
- **CUP estimated EOR could recover 173 – 840 million barrels of additional oil (recovery factor 2 – 10%)**

4. Huimin sub-basins aquifers



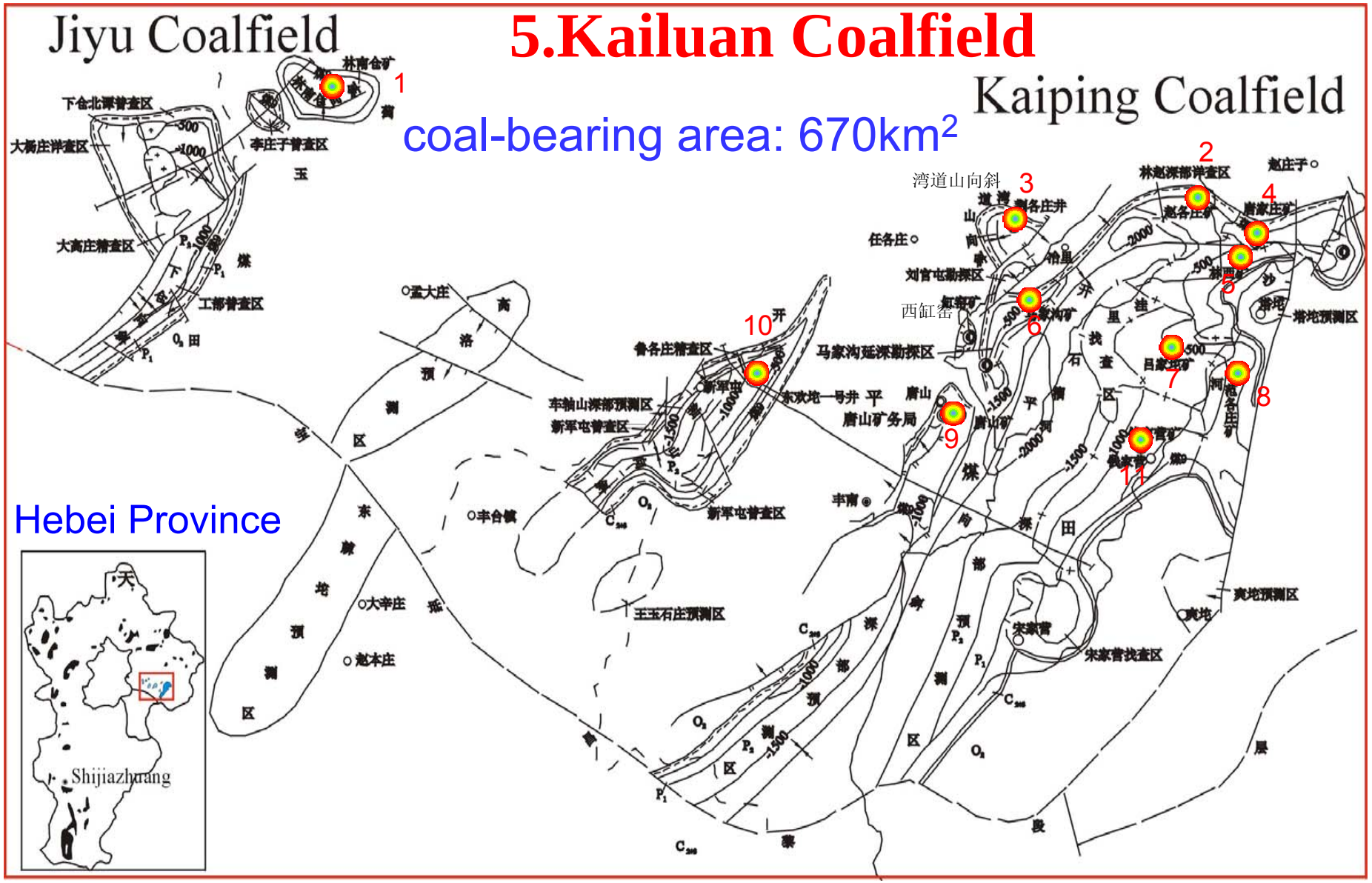
50 oilfields in Zhanhua and Dongying sub-basin mainly in Guantao and Shahejie formations


Kilometers
0
50
100
200
Kailuan Mining area
Beijing
Tangshan
Tianjin
Dagang Oilfield Complex
Shengli Oilfield Complex
Shijiazhuang
Regions of thick sandstone considered for aquifer storage with the Huimin sub-basin
Jinan
Jiyang Depression (with sub-basins shown)
Qingdao
26,500 km2

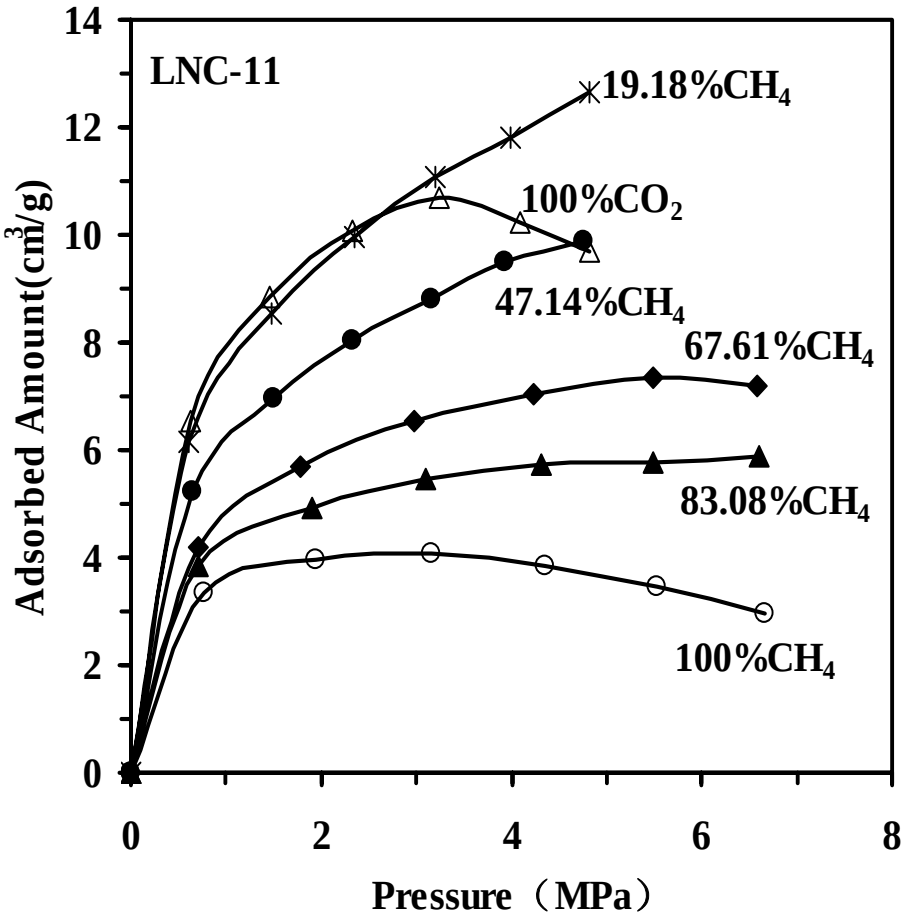


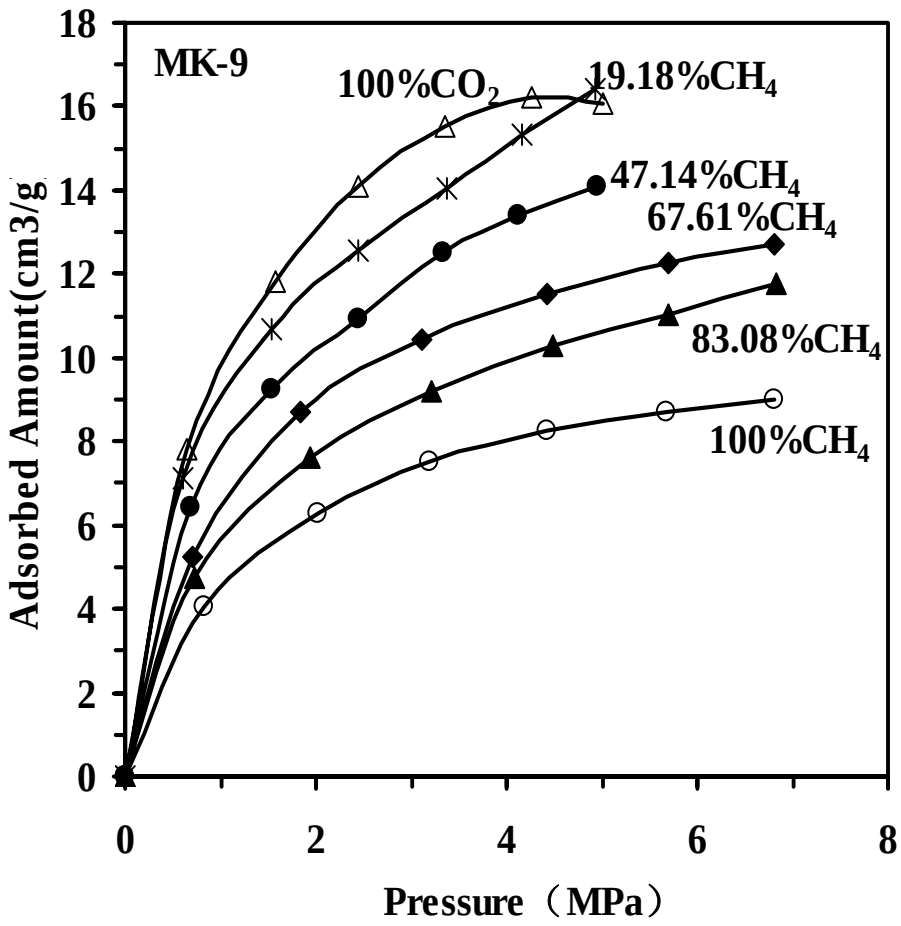
Zizhen trough in Huimin sub-basin

5.Kailuan Coalfield



1. Linnancang Mine
2. Zhaogezhuang Mine
3. Jinggezhuang Mine
4. Tangjiazhuang Mine
5. Linxi Mine
6. Majiagou Mine
7. Lvjiatuo Mine
8. Fangezhuang Mine
9. Tangshan Mine
10. Donghuantuo Mine
11. Qianjiaying Mine





Comparison between experimental adsorption isotherms of pure CH_4, pure CO_2 and their binary gas on the No.11 coal from Linnancang Mine and on the No.9 coal from Majiagou Mine

Identification of coal beds suitable for CO_2 storage

- **Technical Limitations (e.g coal properties and adsorption properties)**
- **Economic Limitations (e.g. thickness and number of seams)**
- **Regulatory Limitations: (e.g. future use of the coal as an energy mineral)**

- **Kaiping coals: porosity 3 – 13%, cleat porosity 0.89% - 1.27%, permeability 0.03 – 3.5 mD**

- **Estimated storage capacity based on adsorption experiments carried out by CUMT was 504 Gt, *but not all this can be accessed as some coals will be mined in the future and permeability is very low.***

6.Discussion

Storage Sites	Capacity	Injectivity	Seal	Comments
Dagang oilfield	Selected 7 fields 22 Mt, largest Gangdong field 10 Mt	1000mD. Some compartmentalisation by faulting and stratigraphy	Minghuazhen Fm. Mudstone	Possible demo project. Potential clash with gas storage. Large number of wells.

Storage Sites	Capacity	Injectivity	Seal	Comments
Shengli oilfield	**472 Mt using CSLF methodology and 463 Mt using CUP dissolution method**	**1000-2500mD. Some compartmentalisation by faulting and stratigraphy**	**Mudstones of Minghuazhen, Guantao and Shahejie Formations**	**Greater potential for storage than the Dagang oilfield. Large number of wells.**

Storage Sites	Capacity	Injectivity	Seal	Comments
Huimin sub-basins aquifers	For Huimin sub-basin 20Gt in all aquifer Fm, for selected troughs in Sub-basin; 0.7Gt in Guantao Fm.	Permeability around 1600mD in oilfields. Heavy faulting around oilfields – maybe less in the aquifers, or is this just lack of data?	Minghuazhen Formation mudstone	No oil in the aquifer areas where source rocks immature – no conflict of interest with oil exploration but also no proven seals

Storage Sites	Capacity	Injectivity	Seal	Comments
Kailuan coalfield	**504 Gt adsorbed onto coal (effective capacity) and 38 Gt Mt void capacity**	**Permeability generally low 3.7mD Taiyuan Formation and 0.1mD in Shanxi and Xiashihezi Fm.**	**Mudstone**	**Active mine. Seismicity**

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Thank you !