Regional Assessment of CO_2 Storage - Approach and Progress in China

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Outline

一、 **Approach and Progress on Regional Assessment of CO_2 Storage**

— **Existing activities**

— **Our assessment approach**

二、 **Challenges**

Existing activities

➢**Prof. LI Xiaochun, 2005, 2006, CGS: deep saline aquifers, coal basins, oil & gas basins**

➢**Prof. ZHANG Hongtao, WEN Dongguang, 2005,CGS: deep saline aquifers, coal basins, oil & gas basins**

➢**Prof. SHENG Pingping, 2009, PetroChina: Most and large oil and gas reservoirs**

➢**Prof. LI Yilian, 2008: deep saline basins with numerical simulation method**

➢**Prof. ZENG Rongshu, CAS IGG:……**

➢**Prof. LI Mingyuan, CUP:……**

➢**Others: National(MOST/CGS) and international projects**

Classification of CO_2 Storage Capacity

Matched Capacity

Subset of practical capacity obtained by detailed sink-source matching
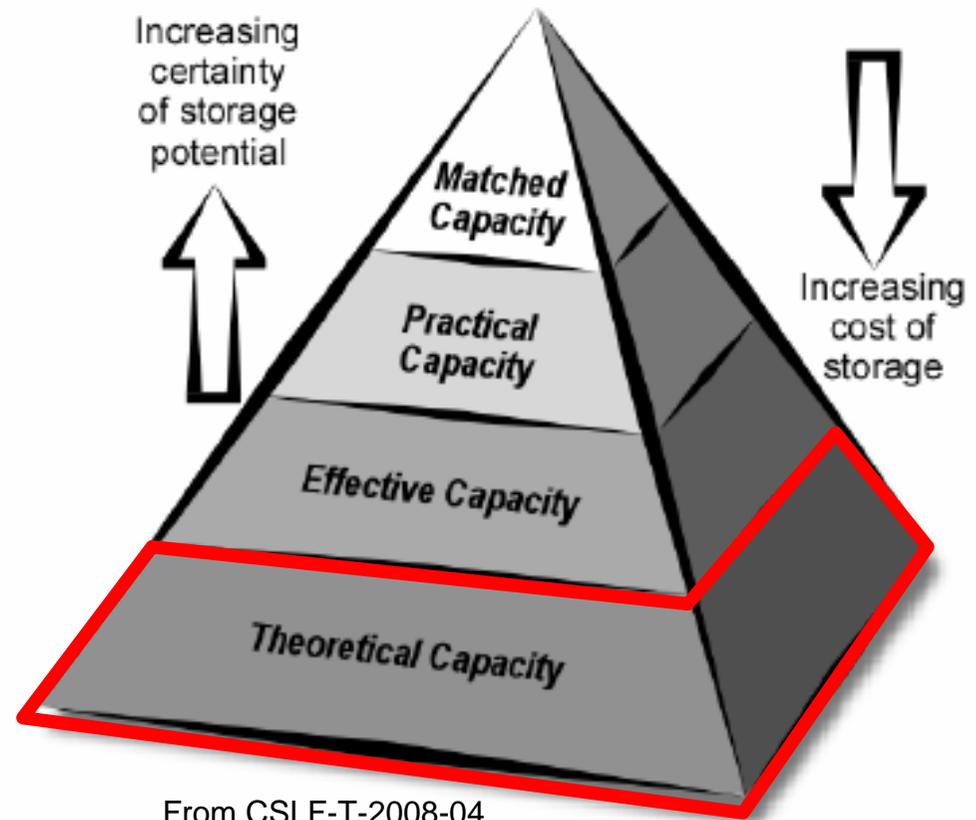
Practical Capacity

Subset of effective capacity limited by technical, legal, regulatory, and economical constraints (e.g., land use, number of wells needed, GW protection,..)

Effective Capacity

Subset of theoretical capacity that is most likely accessible and considers physical limitations

Theoretical Capacity

Total resource provided by geological system and available pore space with trapping capacity

Increasing certainty of storage potential

Matched Capacity

Practical Capacity

Effective Capacity

Theoretical Capacity

Increasing cost of storage

From CSLF-T-2008-04

Techno-Economic Resource-Reserve pyramid for CO2 storage capacity in geological media with a jurisdiction or geographic region. The pyramid shows the relationship between Theoretical, Effective, Practical and Matched capacities.

Our assessment approach

**Lots of choice:** methodologies invented by scientists and organizations

Our choice: the methodologies for CO_2 storage capacity proposed Carbon Sequestration Leadership Forum (CSLF)

✓ estimated at the country, regional and basin scales

✓ are robust and science-and-engineering based
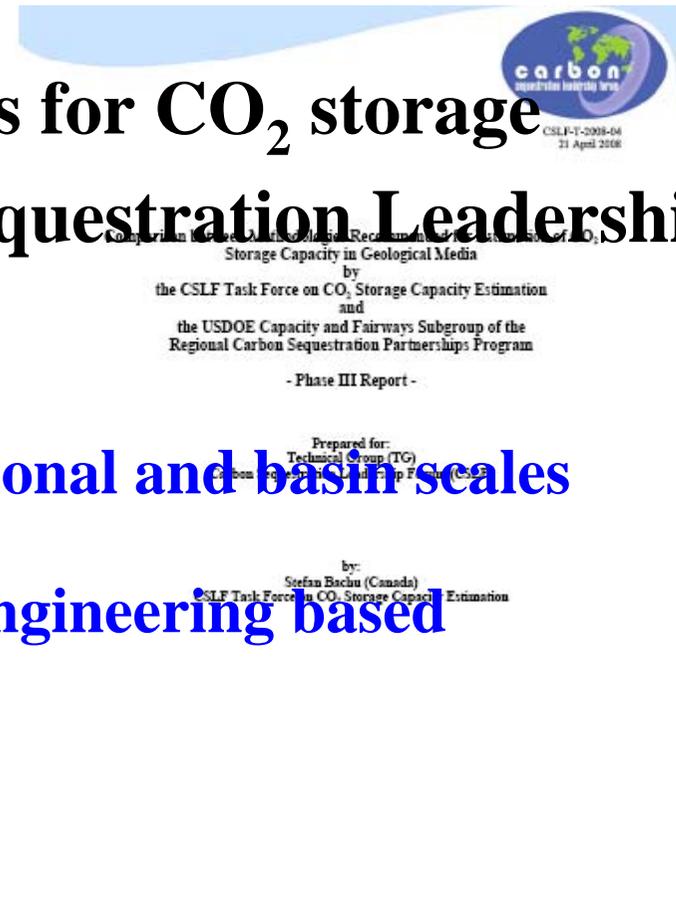
Capacity Estimation — Coal Beds

Principle: Enhanced Coal Bed Methane Recovery (CO2-ECBM)
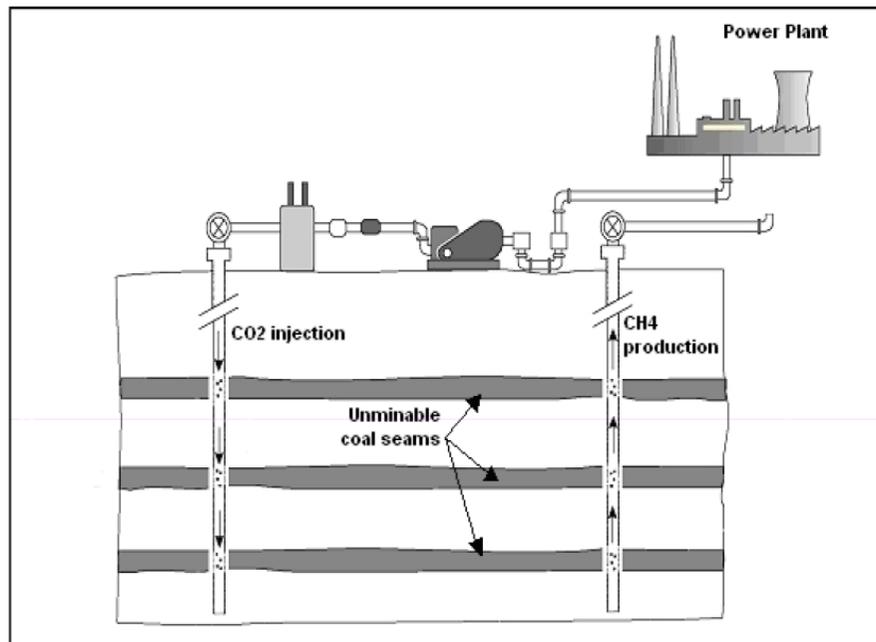
From BGR-CCOP Workshop: Stefan Knopf,2009

Principle:

Injection of CO_2 into coal beds

Desorption of CH_4 from coal beds

Adsorption of CO_2 to coal beds

Production of the desorbed CH_4

Approach for CO_2 capacity assessment:

Estimation of the amount of methane(CH_4)

Capacity Estimation — Coal Beds

Approach

$$M_{CO2t} = \rho_{CO2s} \times A \times h \times \bar{n}_c \times IGIP \times (1 - f_a - f_m)$$
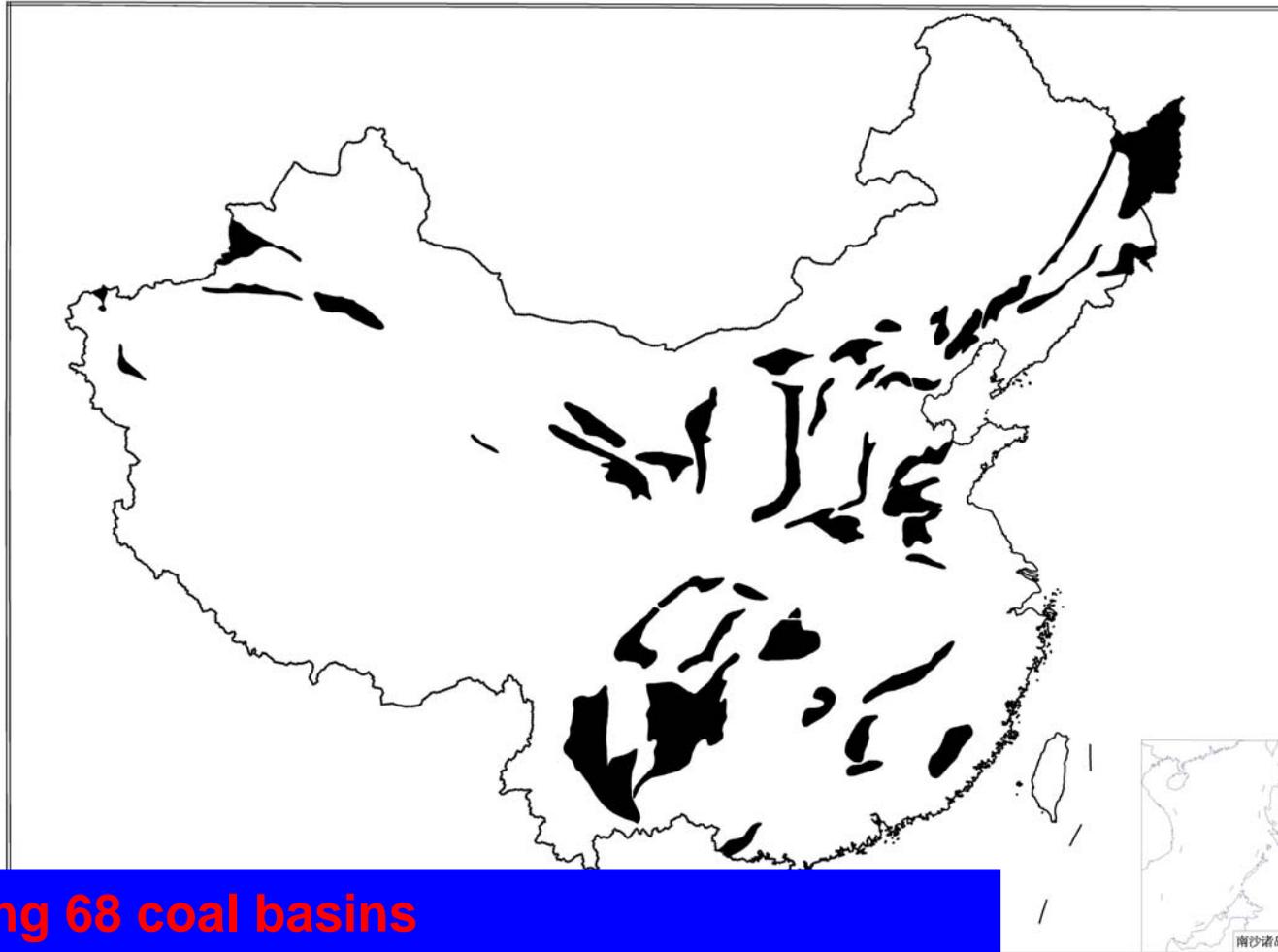
M_{CO2t} - theoretical storage capacity in coal beds [M]

ρ_{CO2s} - CO_2 density at standard conditions [ML^{-3}]

(generally ρ_{CO2s} is 1.977kg/m^3)

IGIP - geological capacity of methane in coal beds [L^3]

Capacity Estimation — Coal Beds

Distribution Map of Main Coal Basins in China

Evaluating 68 coal basins
Theoretical capacity was about 54.6 billion tons

Capacity Estimation — Oil Reservoirs

Approach

$$M_{CO2t}= \rho_{CO2r} \times [R_f \times A \times h \times \phi \times (1-S_w)-V_{iw}+V_{pw}]$$

ρ_{CO2r}- CO_2 density at standard conditions in oil reservoirs[ML^{-3}]

Rf- the recover factor[-]

A -reservoir area[L^2]

h-reservoir thickness [L]

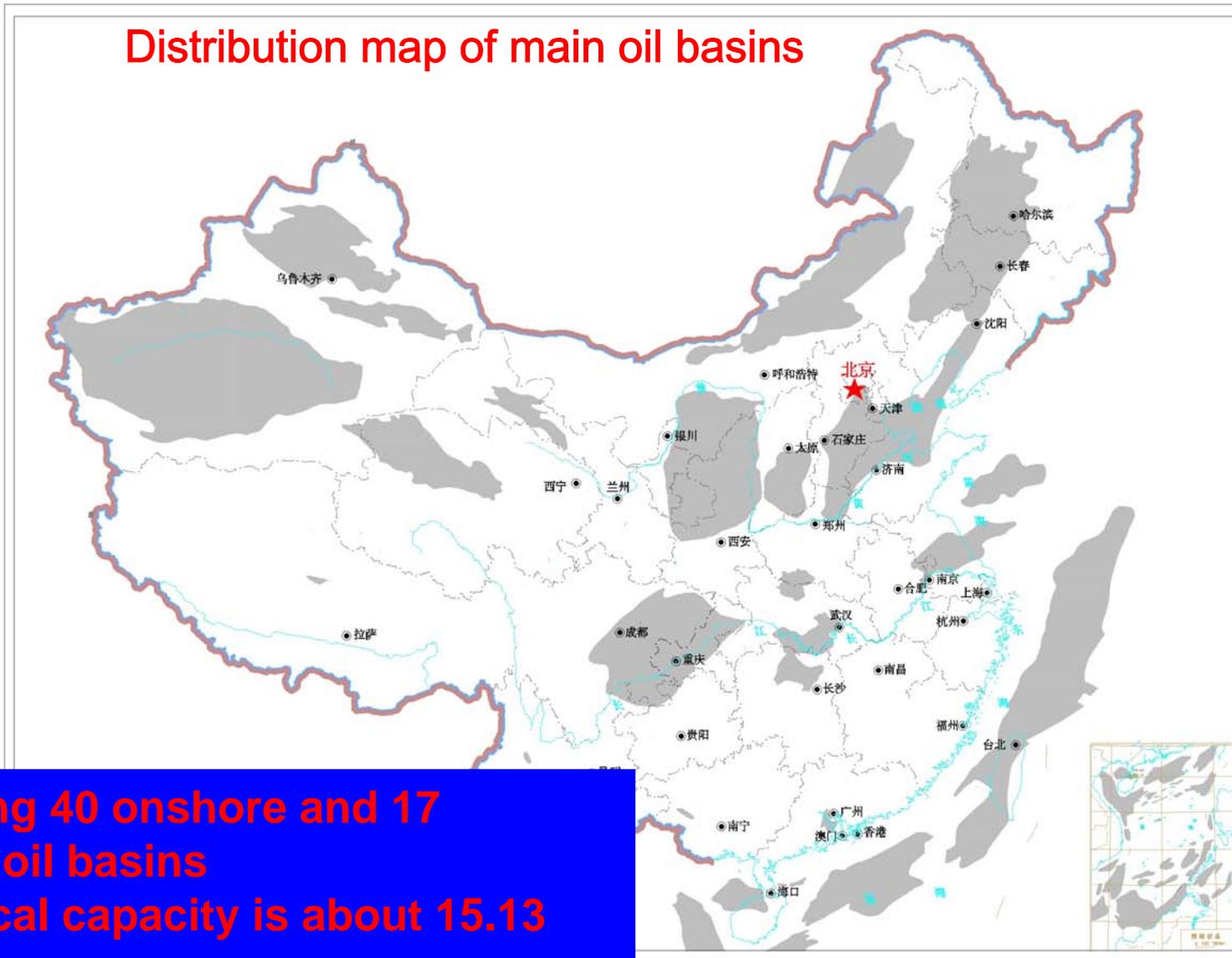ϕ -the porrosity of oil reservoir[-]

Sw- water saturation[-]

Viw –the volumes of injected water[L^3]

Vpw- the volumes of produced water[L^3]

Capacity Estimation — Oil Reservoirs

Distribution map of main oil basins

Evaluating 40 onshore and 17 offshore oil basins
Theoretical capacity is about 15.13 billion tons

Capacity Estimation — Gas Reservoirs

Approach

$$M_{CO2t} = \rho_{CO2r} \times R_f \times (1 - F_{IG}) \times OGIP \times [(P_s \times Z_r \times T_r)/(P_r \times Z_s \times T_s)]$$

Where M_{CO2t}- theoretical storage capacity in gas reservoirs [M] ;

ρ_{CO2r}-CO_2 density at standard conditions [ML^{-3}]

R_f-the recover factor

F_{IG}-the fraction of injected gas[-]

OGIP-the initial gas

P_s-pressure at surface conditions

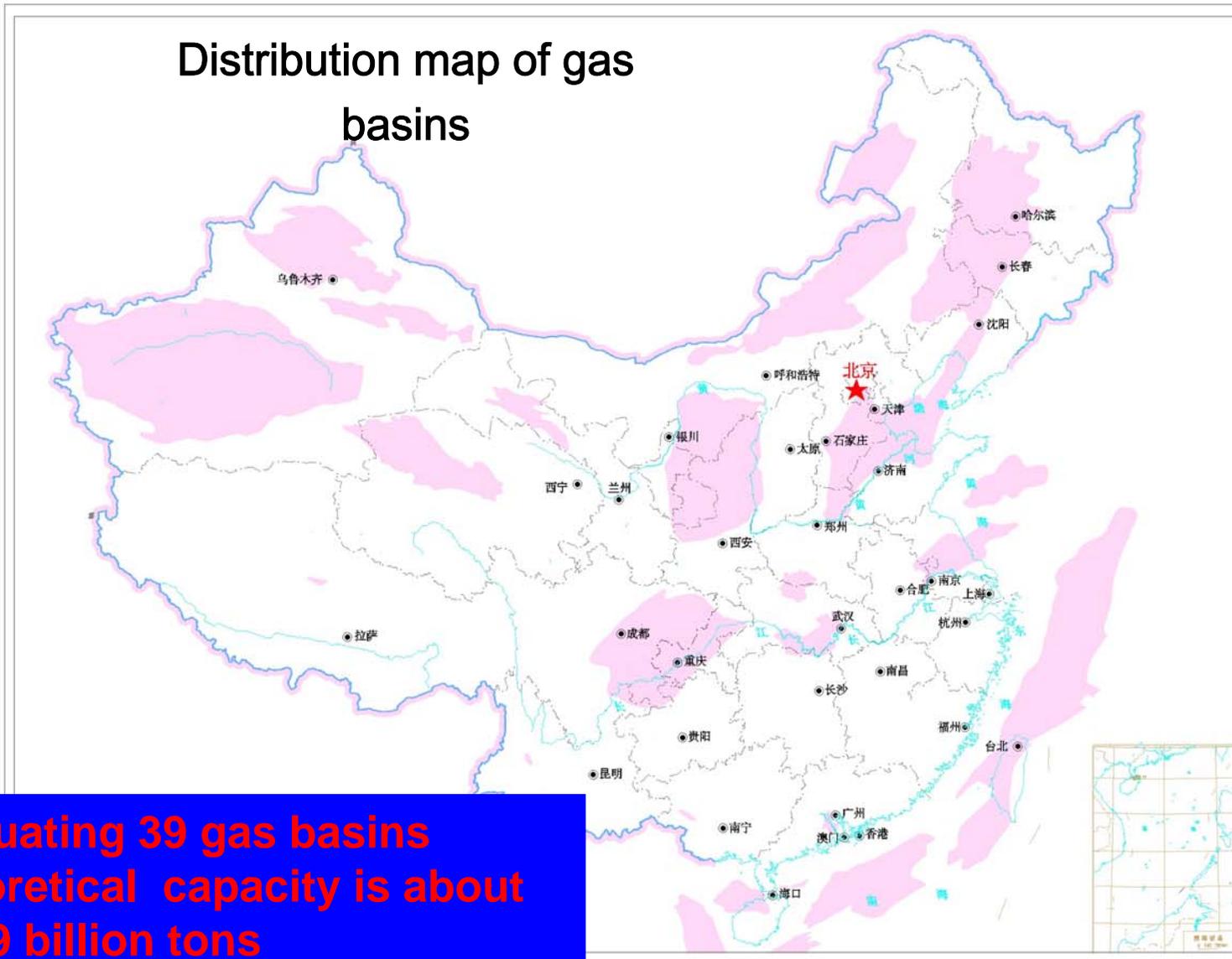Z_r-the gas compressibility factor at reservoir conditions

T_r-the temperature at reservoir conditions

P_r-press at reservoir conditions

Z_s-the gas compressibility factor at surface conditions

T_s- the temperature at surface conditions

Capacity Estimation — Gas Reservoirs

Distribution map of gas basins

哈尔滨
长春
乌鲁木齐
沈阳
呼和浩特 北京 天津
银川 太原 石家庄
济南
西宁 兰州
郑州
西安
合肥 南京 上海
拉萨 武汉 杭州
成都 重庆
长沙 南昌
贵阳 福州 台北
昆明 广州
南宁 澳门 香港
海口

Evaluating 39 gas basins
Theoretical capacity is about
46.79 billion tons

Capacity Estimation — Deep Saline aquifers

Approach

$$M_{CO_2t} = A \times H \times \phi \times (\rho_s X_s^{CO_2} - \rho_0 X_o^{CO_2})$$

M_{CO2t}-theoretical storage capacity in deep saline aquifers based on CO_2 dissolution into formation water [M]

A-aquifer area[L^2]

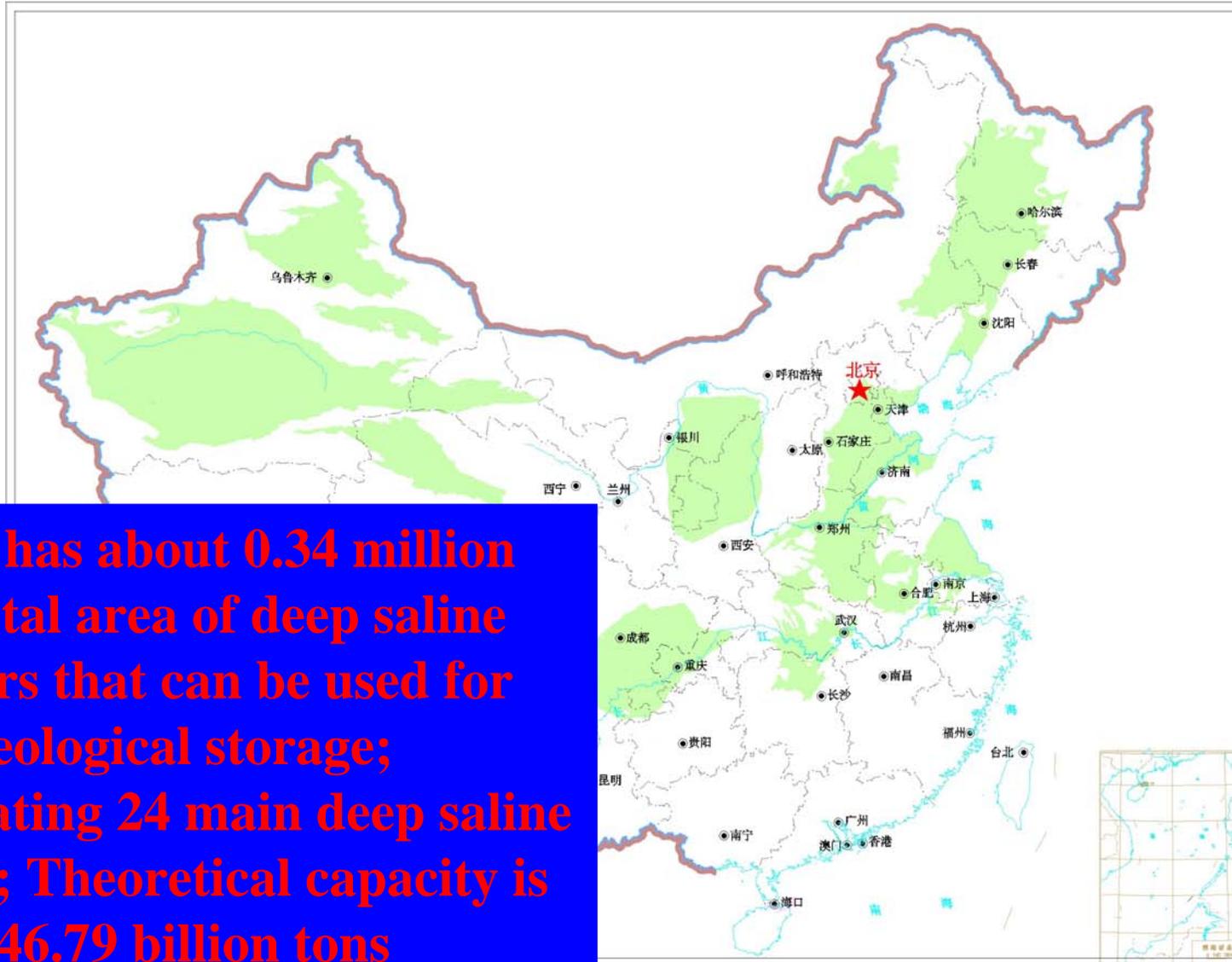H-aquifer average thickness [L]

ϕ -average porosity [-]

ρ_s-density of saturation CO2 content in formation water[-]

ρ_o-density of initial CO2 content in formation water[-]

X_s^{CO2}-mass fraction of saturation CO2 content in formation water[-]

X_o^{CO2}-mass fraction of initial CO2 content in formation water[-]

Capacity Estimation — Deep Saline aquifers

China has about 0.34 million km² total area of deep saline aquifers that can be used for CO_2 geological storage; Evaluating 24 main deep saline basins; Theoretical capacity is about 46.79 billion tons

Data Sources for Capacity Estimation

Mainly collect data from:

➢ Oil and gas companies

➢ Coal and methane companies

➢ Deep wells from geological exploration institutions

CO$_2$ Storage Capacity Estimation

Preliminary estimating, the Total Country-scale Theoretical CO$_2$ Storage Capacity is about 14466.9 billion tons in China:

Coal beds: 54.6 billion tons

Oil reservoirs: 15.13 billion tons

Gas reservoirs: 46.79 billion tons

Deep saline basins: 14350.4 billion tons

Outline

一、 **Approach and Progress on Regional Assessment of CO_2 Storage**

— **Existing activities**

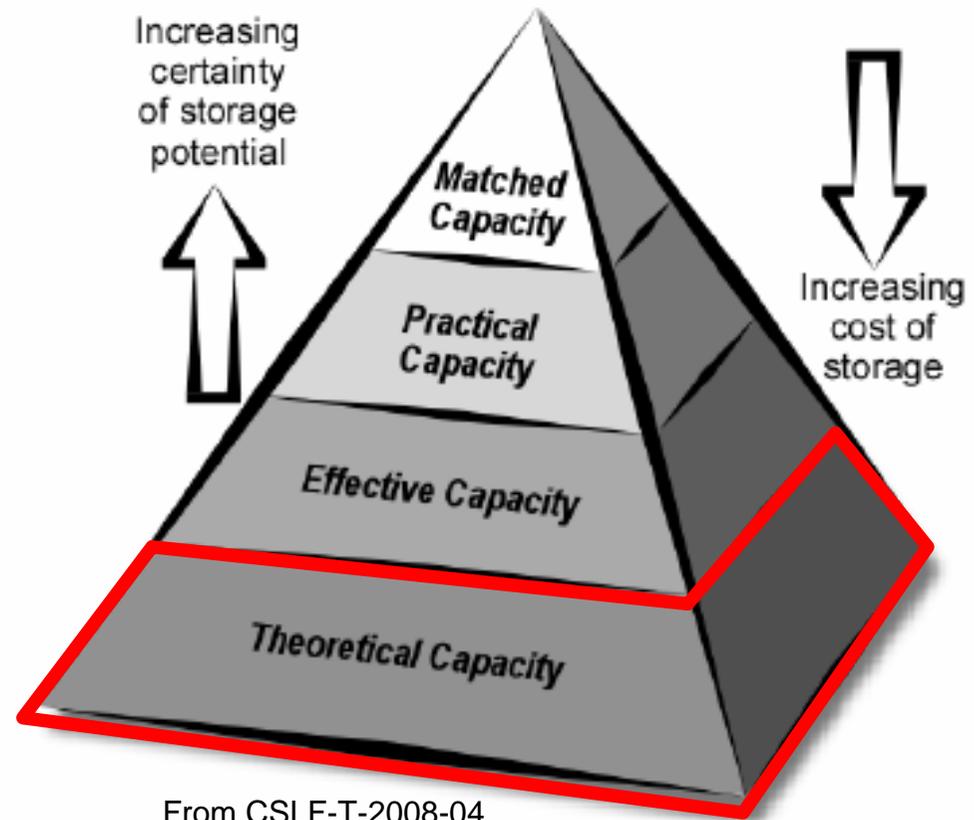— **Our assessment approach**

二、 **Challenges**

Challenges

(1) In China all regional assessments are primary, the evaluation capacity may be change with the data refreshed.（the parameter database on capacity）

(2) We have lots of work to do according to the roadmap proposed by the CSLF.

(3)Demo projects in typical areas

From CSLF-T-2008-04

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