CO_2 Enhanced Saline Water Recovery (CO_2-EsWR)

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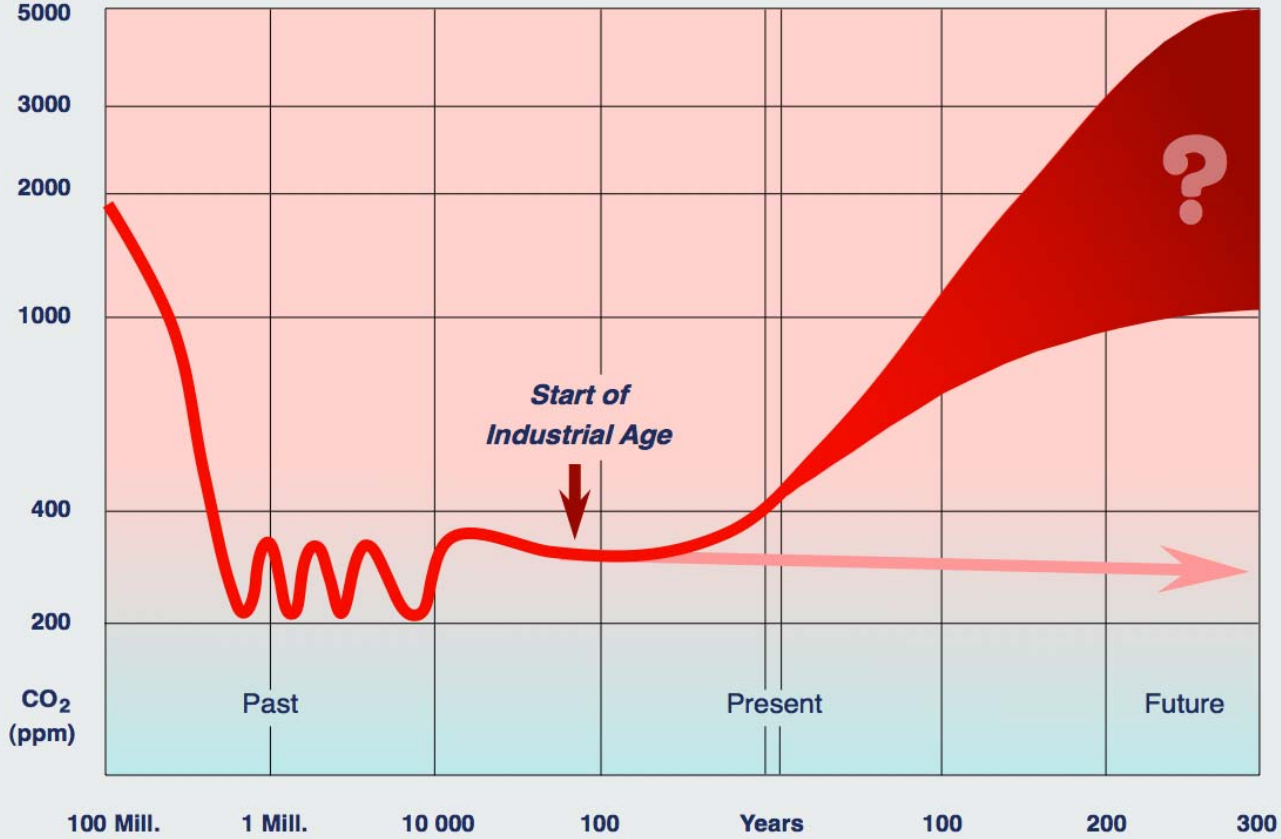
Outline

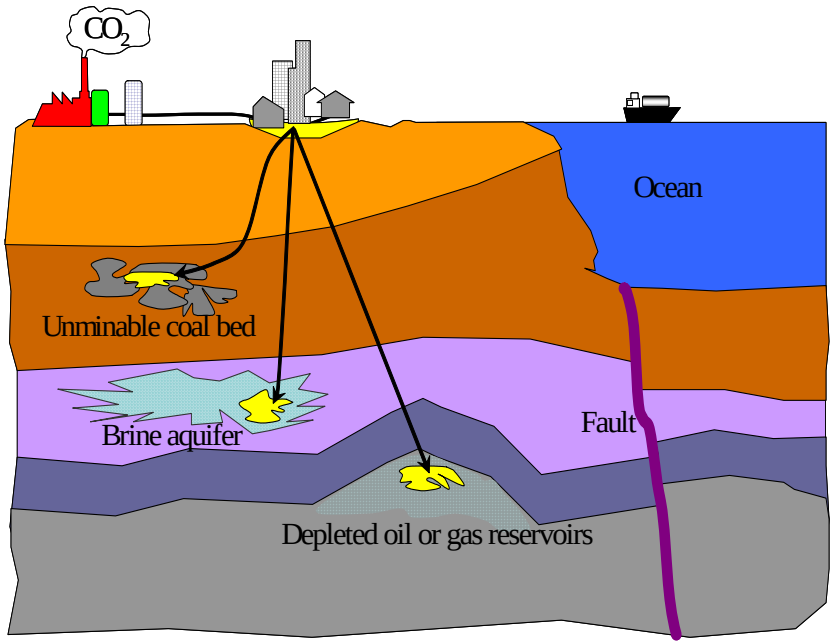
- Saline aquifer storage of CO_2
- Pressure management of CGS
- CO_2 enhanced saline water recovery
- Fundamental of EsWR and EOR
- Feasibility of CO_2-EsWR in China
- Conclusions

CCS : Carbon Capture & Storage

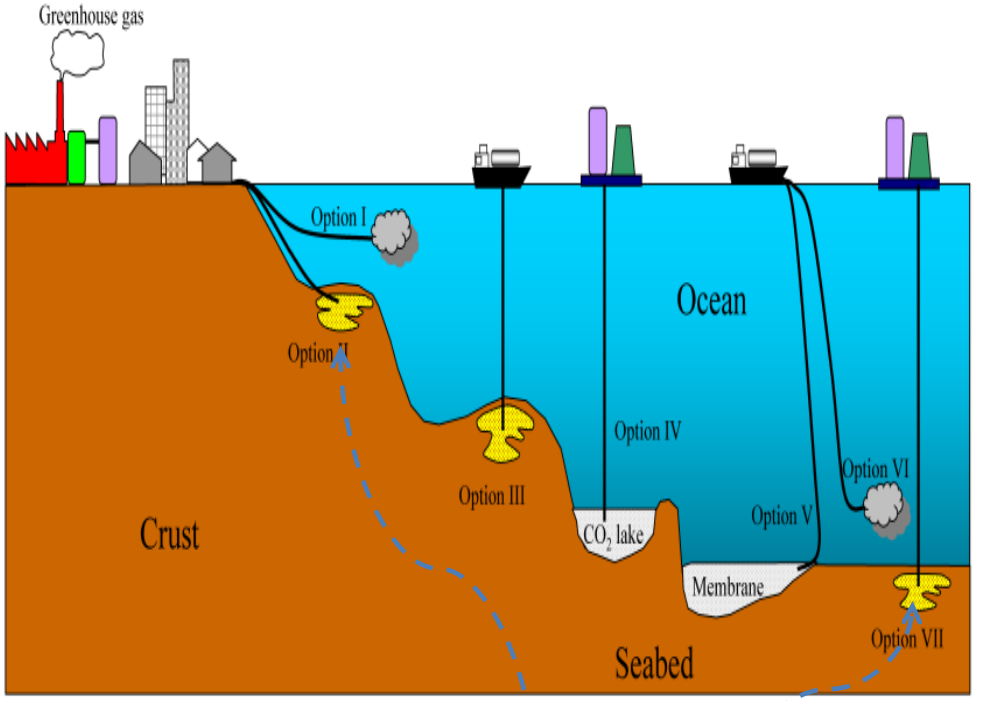


CO_2 Geological Storage

- Terrestrial and seabed storage



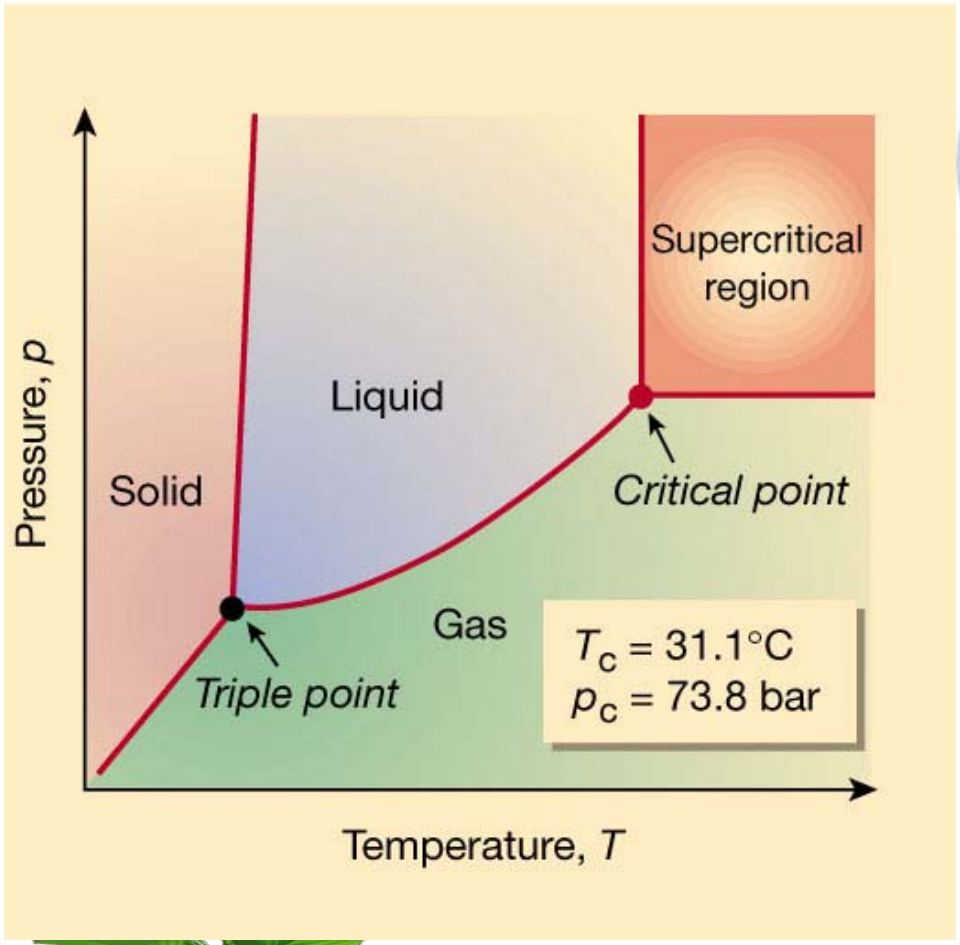
(Source: Li et al., PAGEOPH 2006)

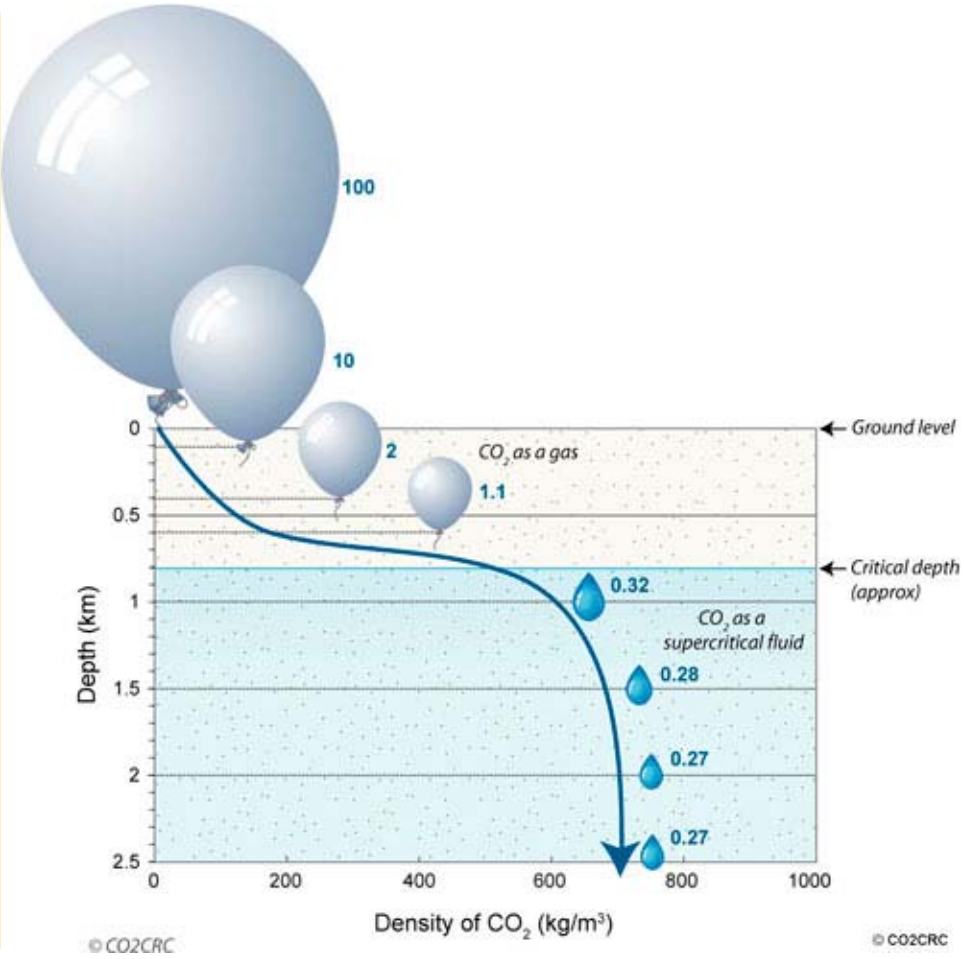


(Source: Li et al., ECM 2008)

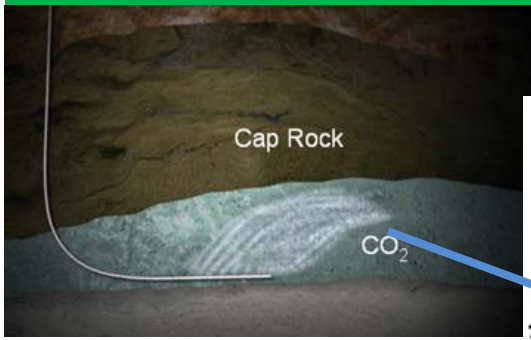
Seabed Storage
海底地层封存

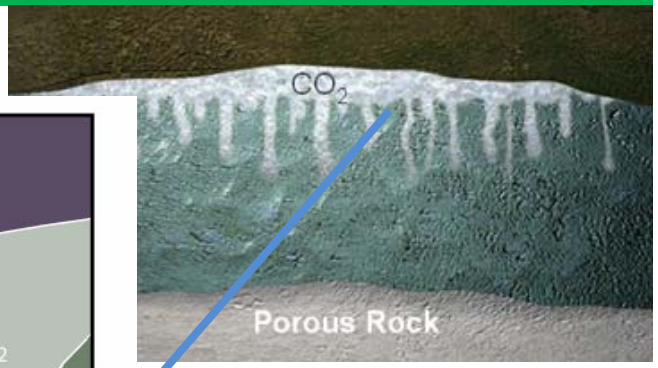
CO_2

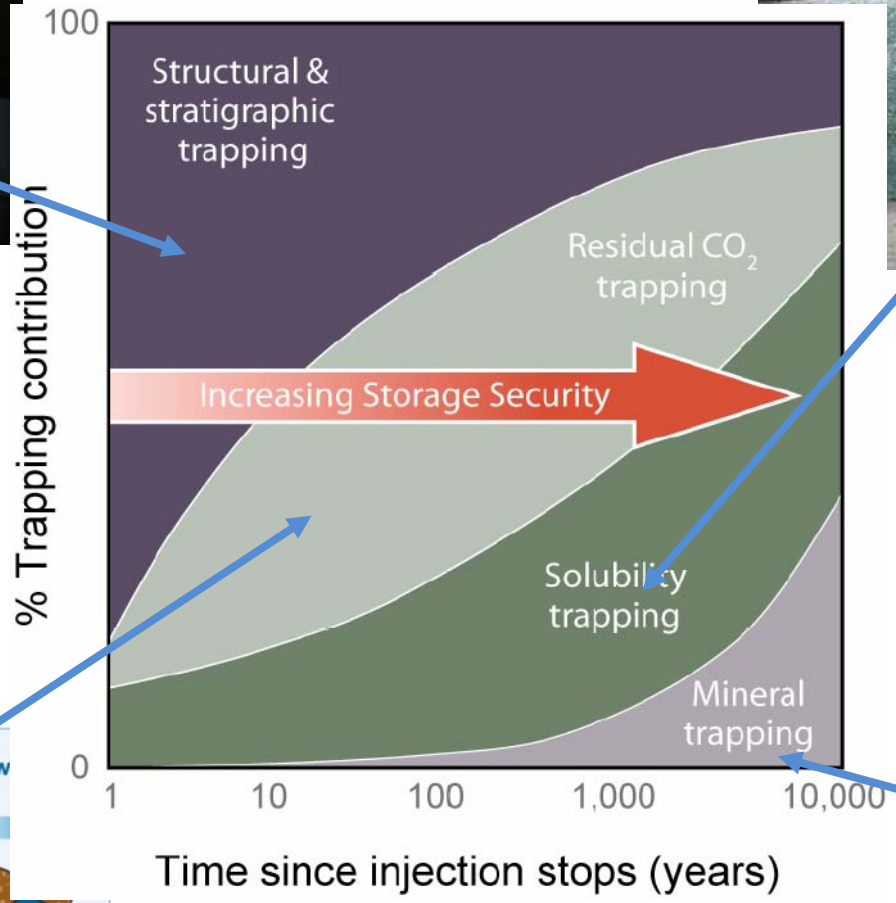

Pressure, p
Temperature, T
Solid
Liquid
Gas
Supercritical region
Critical point
Triple point
T_c = 31.1°C
p_c = 73.8 bar

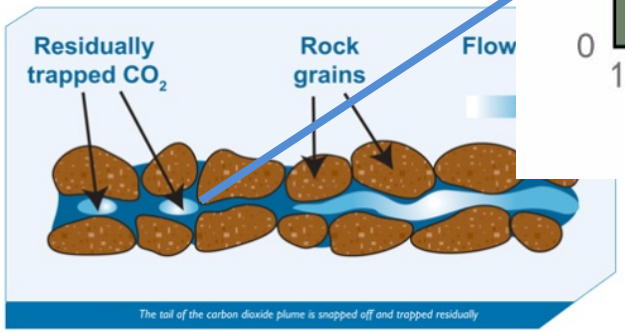

100
10
2
1.1
CO_2 as a gas
Ground level
Critical depth (approx)
0.32
CO_2 as a supercritical fluid
0.28
0.27
0.27
Depth (km)
0
0.5
1
1.5
2
2.5
0
200
400
600
800
1000
Density of CO_2 (kg/m³)
© CO2CRC
© CO2CRC

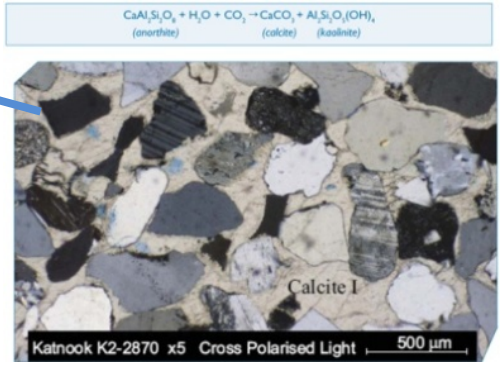
Saline Aquifer Disposal of CO_2











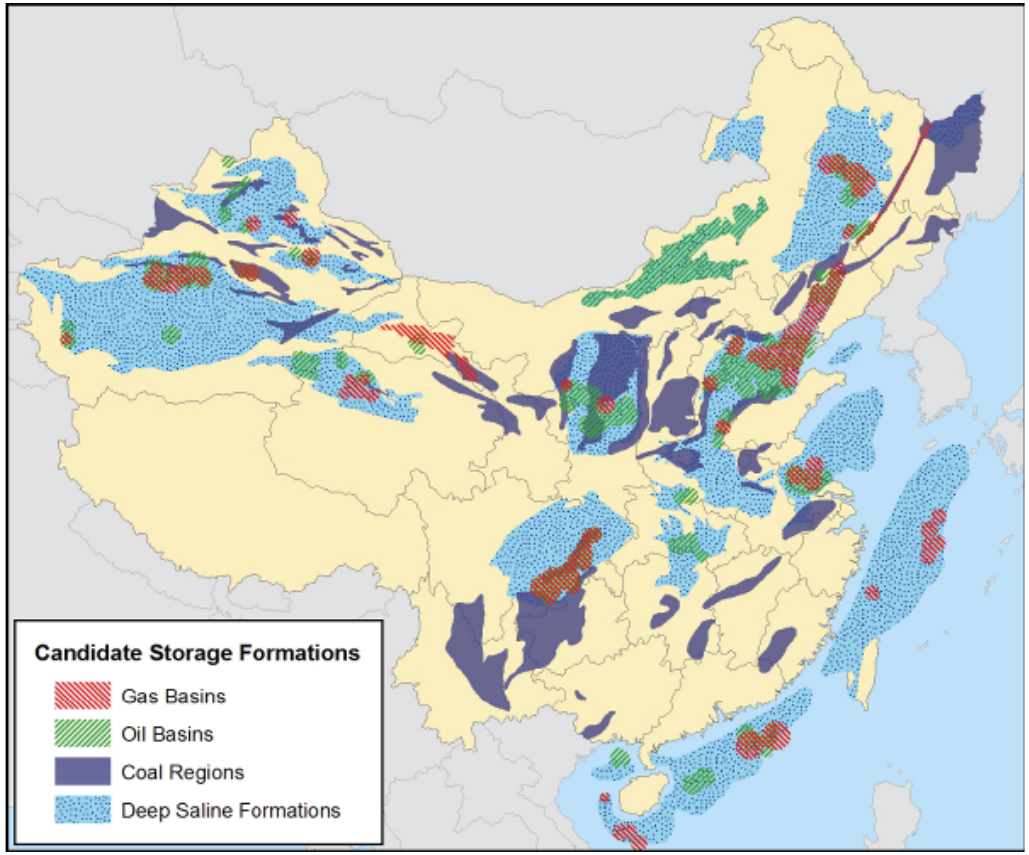
Lecture for CCS School in Beijing, 19-21 April,2012

Saline Aquifer Disposal of CO_2

Total amount of China CO_2 emission: 6.5 Gt/a

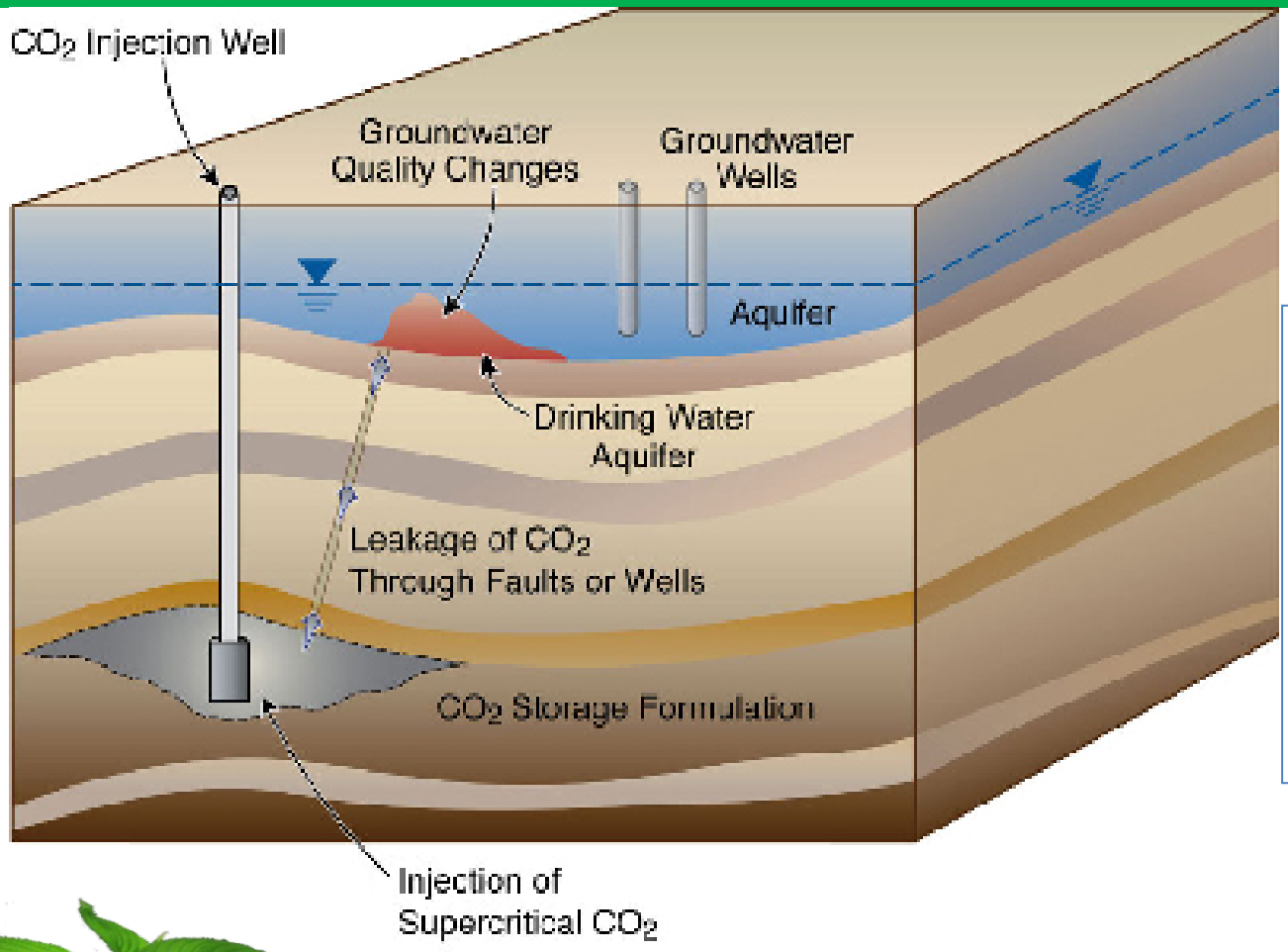
Theoretical capacity：	
Saline aquifer:	3066 Gt
Oil field:	4.8 Gt
Gas field:	5.2 Gt
Coalbed:	12 Gt

- China's theoretical capacity: very huge
- Percentage of saline aquifer storage: 99%



(Li et al., Energy Procedia, 2009)

Saline Aquifer Disposal of CO_2



Close storage system
Deep flow: very slow

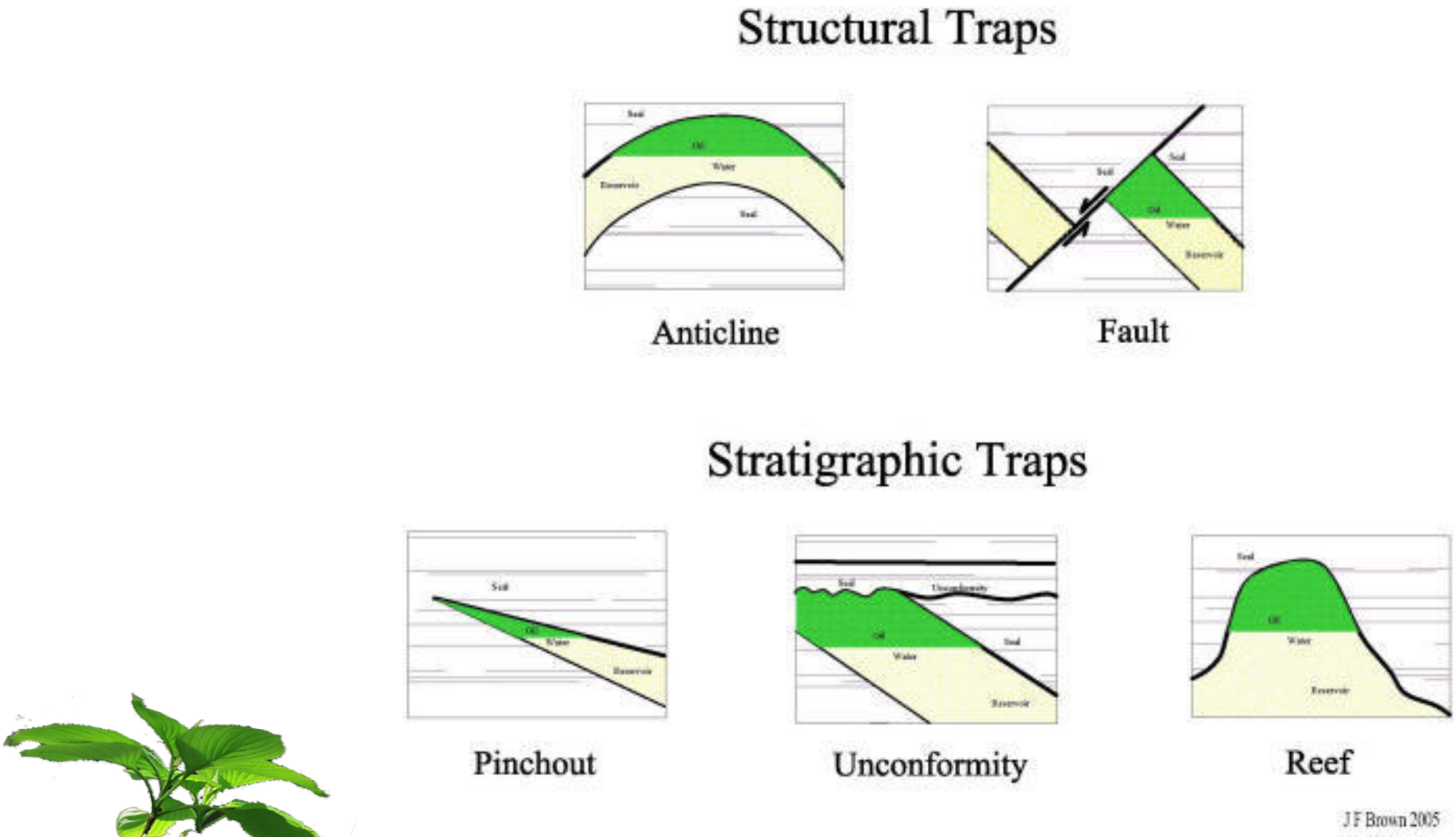
↓

Pressure uptake

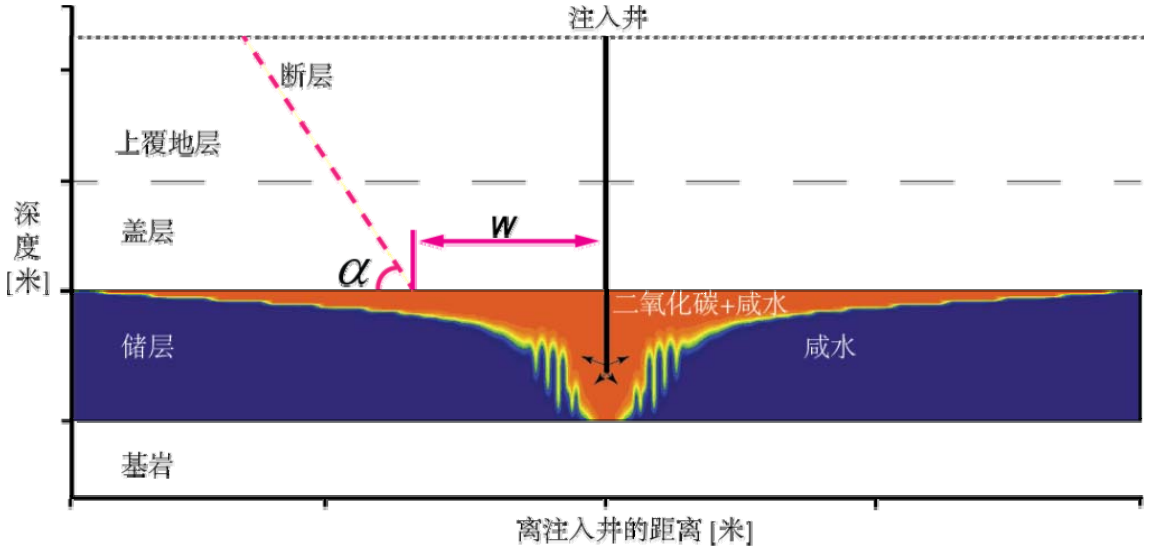
↓

Ground uplift

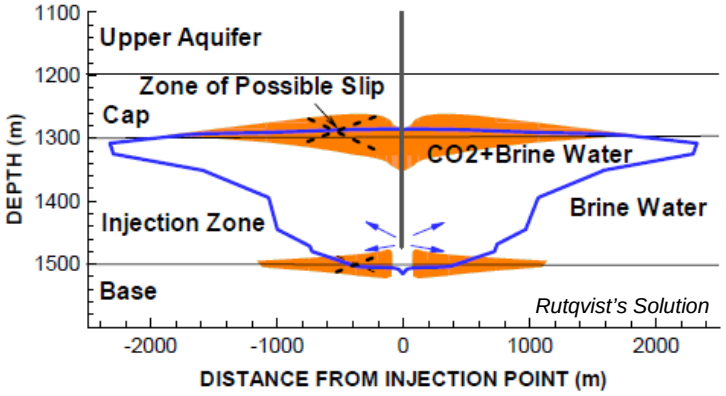
Saline Aquifer Disposal of CO_2

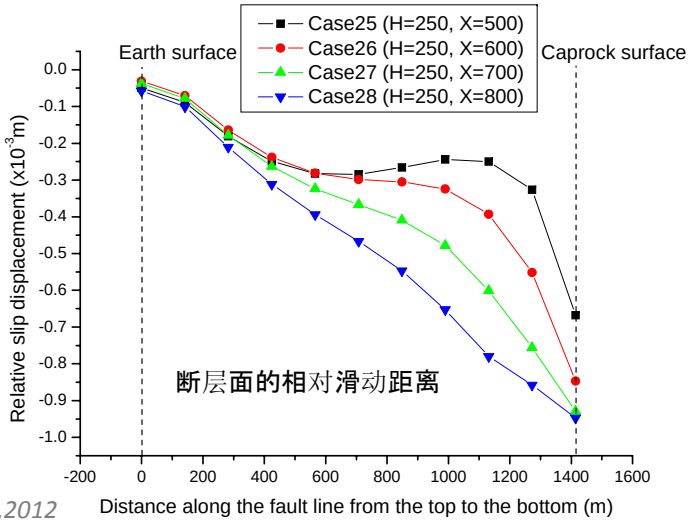


Saline Aquifer Disposal of CO_2



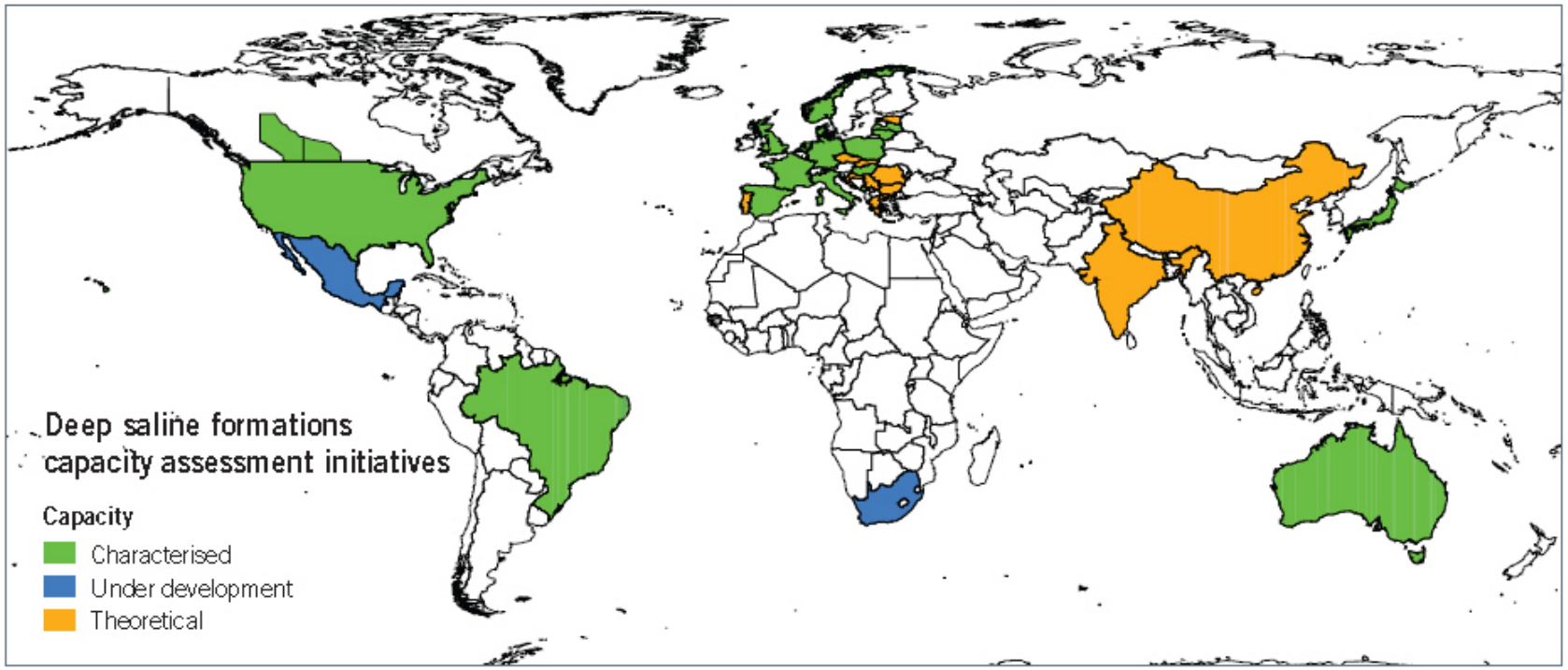
Li et al., 2002 J. Applied Mechanics





Pressure management of CGS

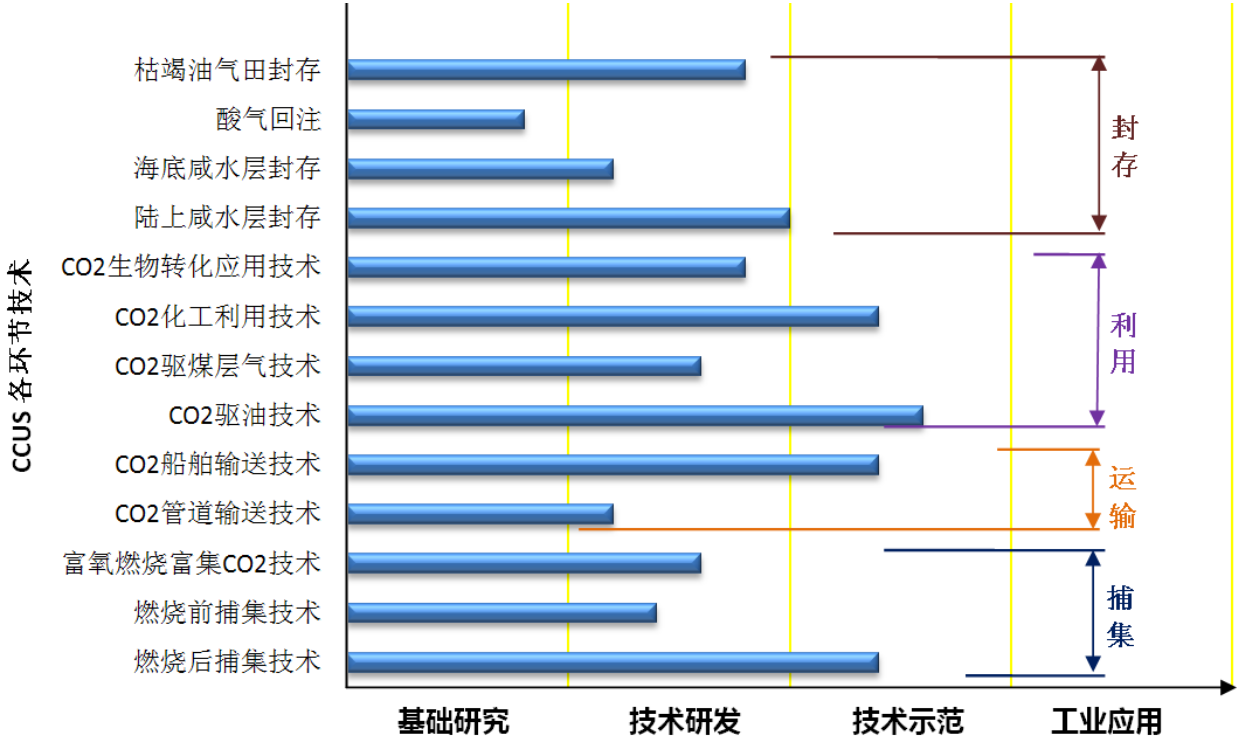
Current status of country-scale storage screening assessments



Source: IEAGHG 2011, modified by the Global CCS Institute

CCUS: CCS + Utilization

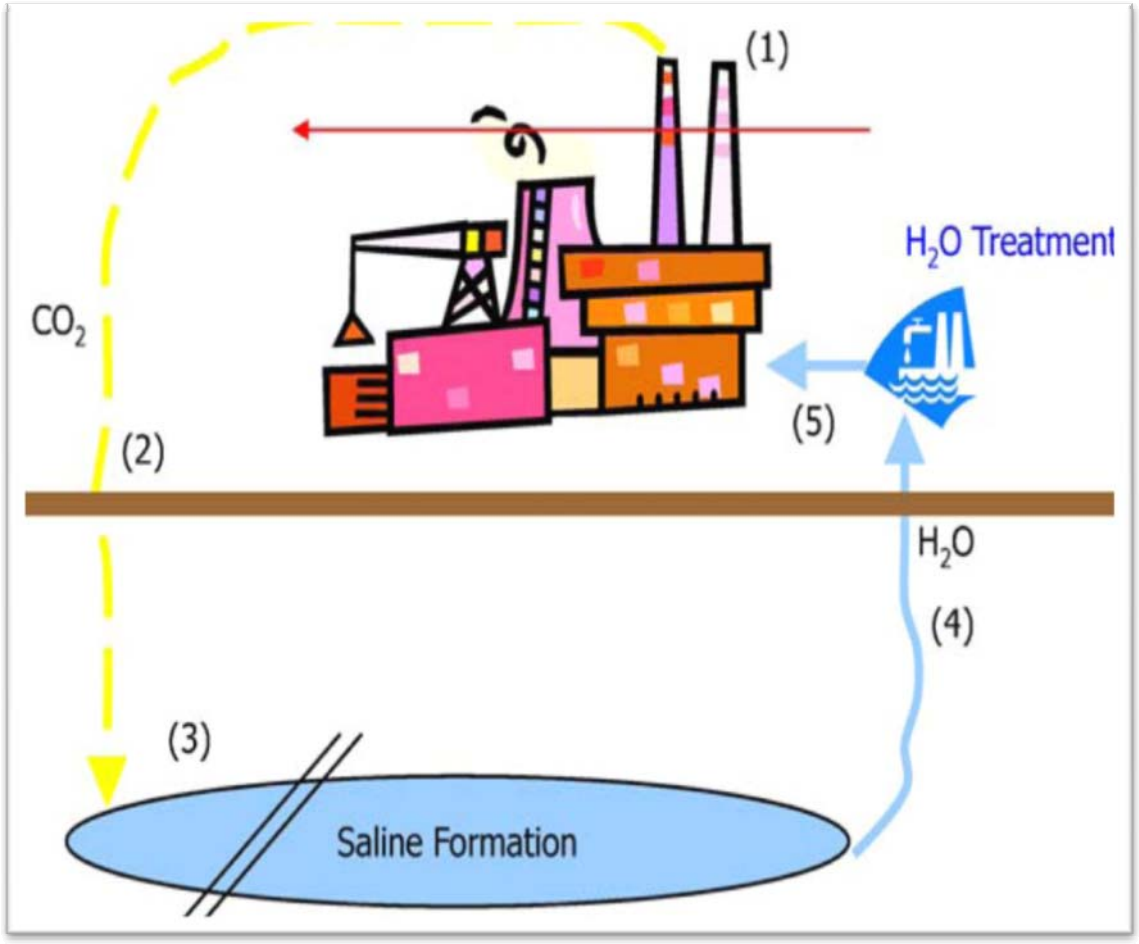
- EOR
- ECBM
- EGS
- EsWR



(China CCUS Roadmap, 2011)

- *Not including Options of Carbon Utilization Only*

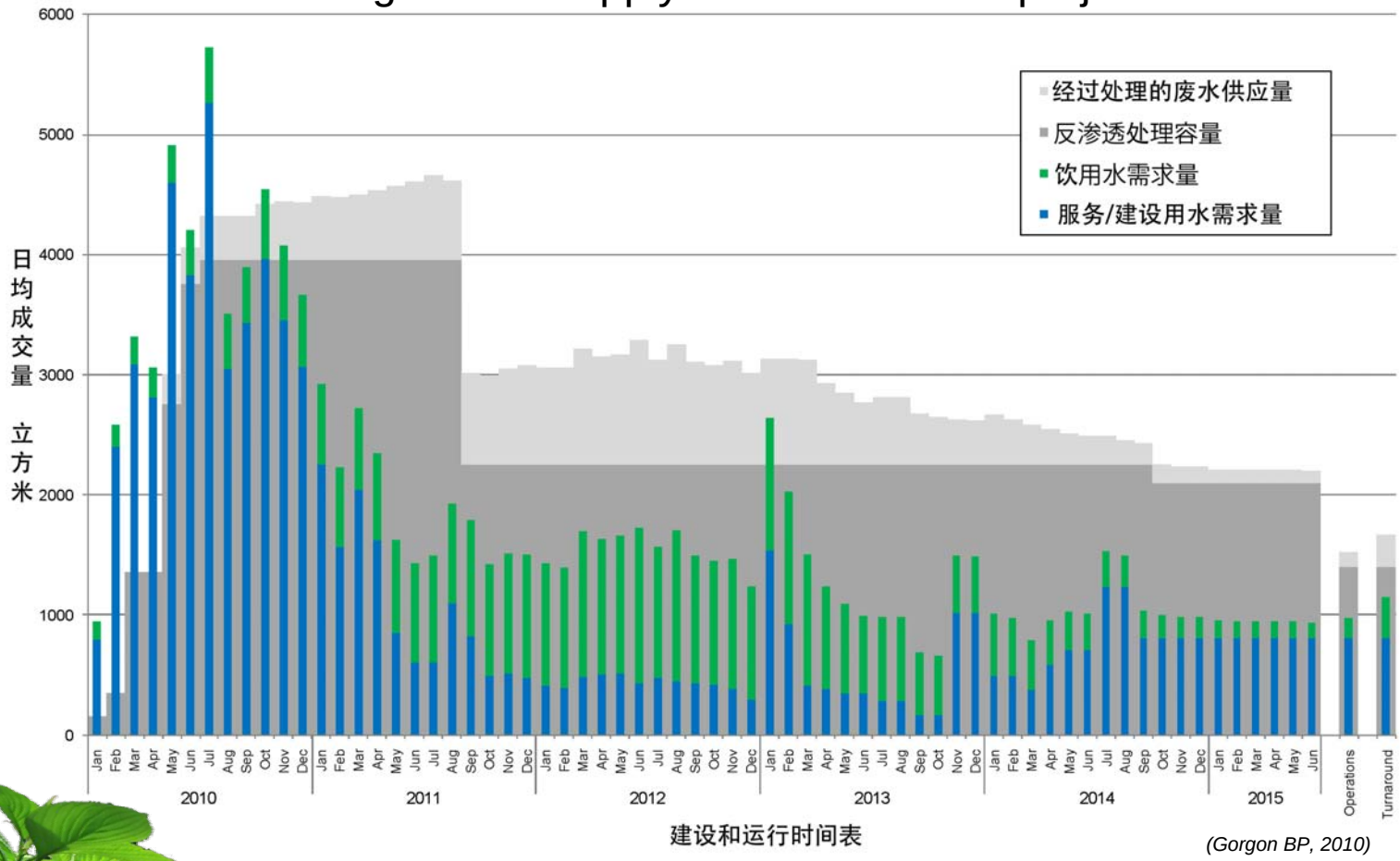
CO_2-EsWR: Charming CCS+U



1. Plant Module
2. CO_2 Capture Module
3. CO_2 Sequestration Module
4. Extracted Water Module
5. Water RO Module

CO_2-EsWR: Background

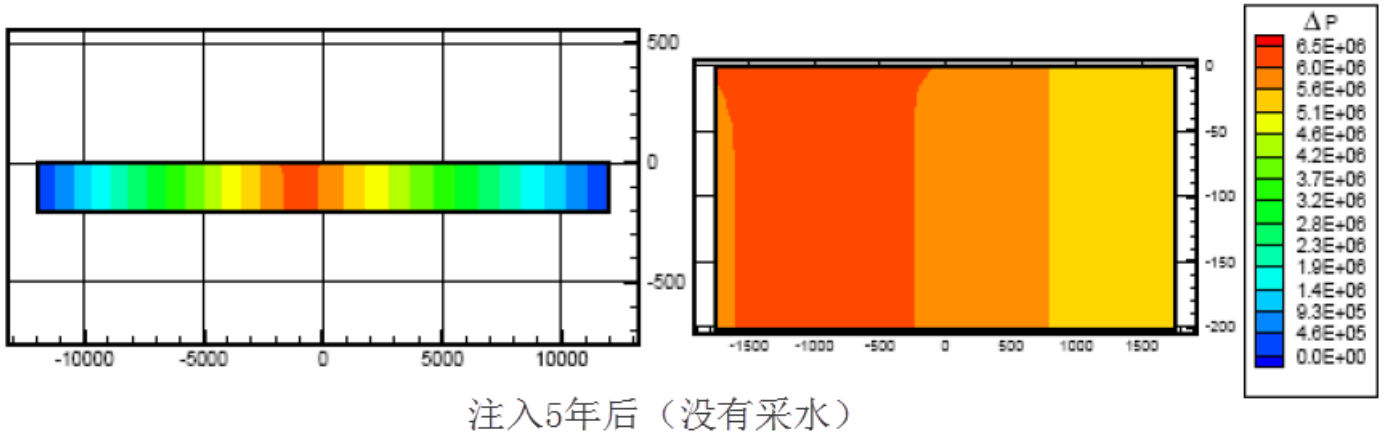
Huge water supply demand of CCS project



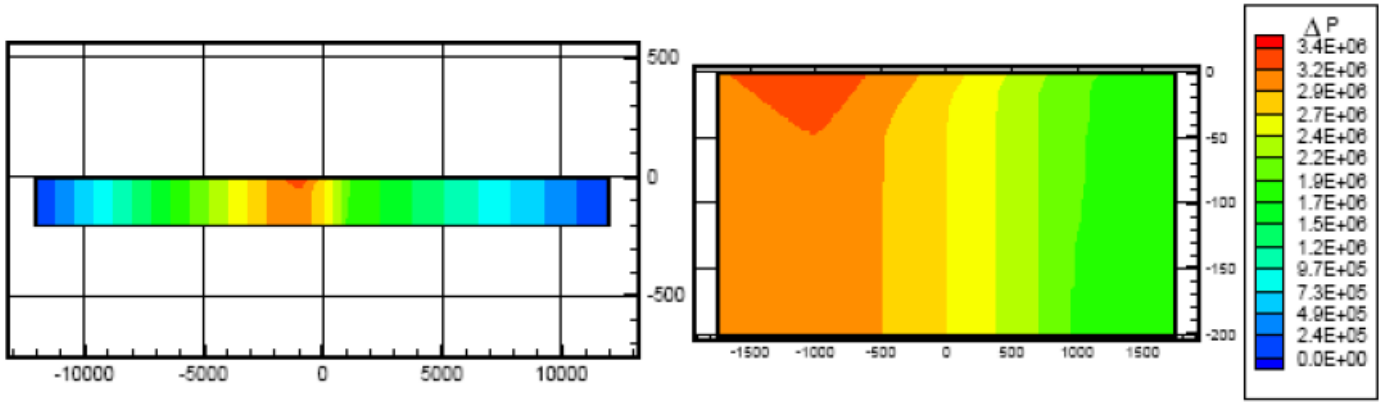
(Gorgon BP, 2010)

CO_2-EsWR: Background

- Cost effective pressure relief of CCS close system



注入5年后（没有采水）



注入5年后（同时采水）

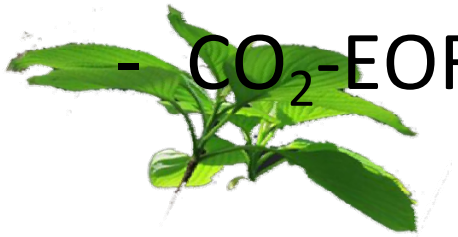
(Wolery, T. et al., 2009)

CO_2-EsWR: Background

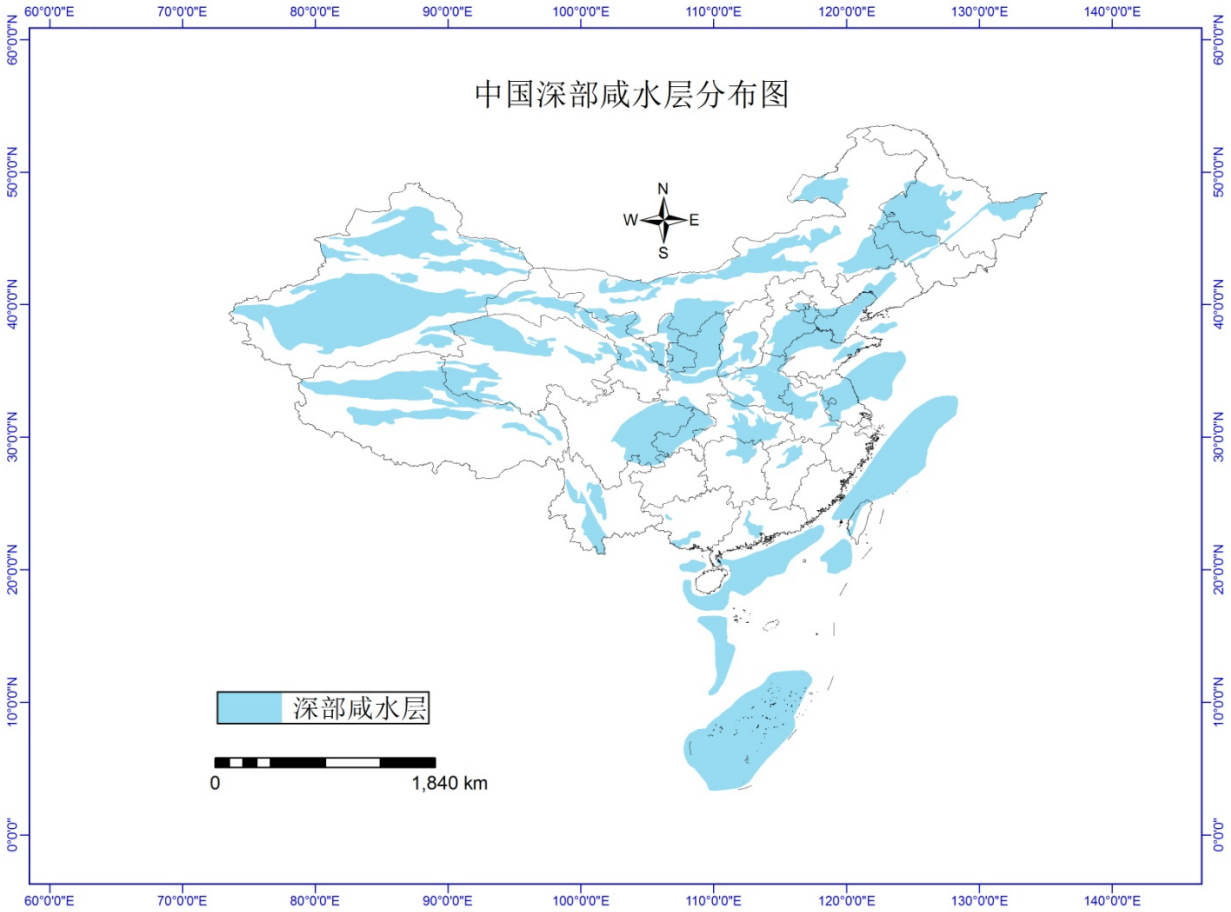
- CCS+U
- Water shortage in West CHINA
- Subsidence induced by Over exploration of groundwater in North CHINA and Changjiang delta

CO_2-EsWR vs. CO_2-EOR

- Commons:
- Enhanced some fluid
- Differences:
- Few injection wells of CO_2-EsWR
- Huge amount (e.g. >>1 Mt/a) of injected CO_2
- High pressure gradient of CO_2-EsWR
- CO_2-EsWR: Storage plus water recovery
- CO_2-EOR: Oil recovery plus storage



Feasibility of CO_2-EsWR in China



GB/T 14157 – 93

	TDS (g/L)
Fresh water	1.0
Saltish water	1.0-3.0
Saline water	3.0-10.0
Brine water	>50.0

Conclusions

- CO_2-EsWR is an attractive option of CCUS.
- CO_2-EsWR is very suitable for water shortage area, e.g. North-West China, to implement CCS in the future.
- CO_2-EsWR is a challenging offset to mitigate and rehabilitate subsidence induced by over-exploitation of groundwater in North China and Su-Xi-Chang area.

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