Some mechanical stability issues associated with CO_2 geosequestration

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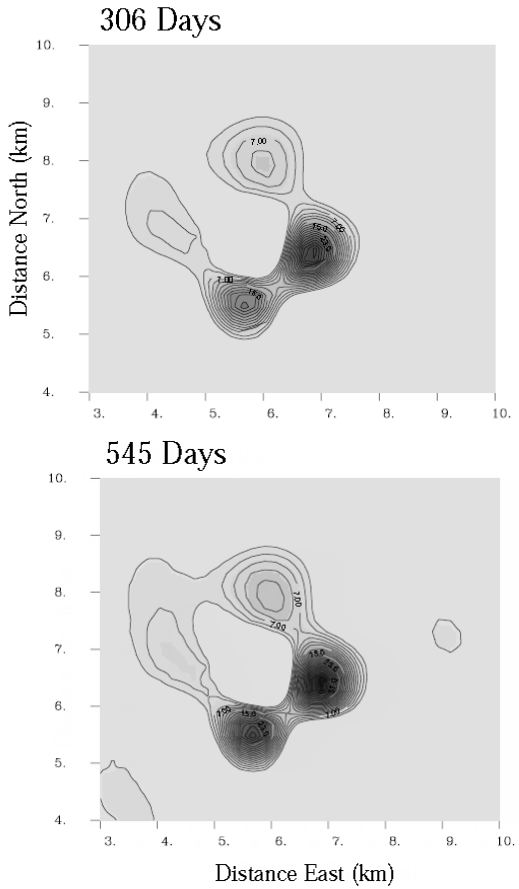
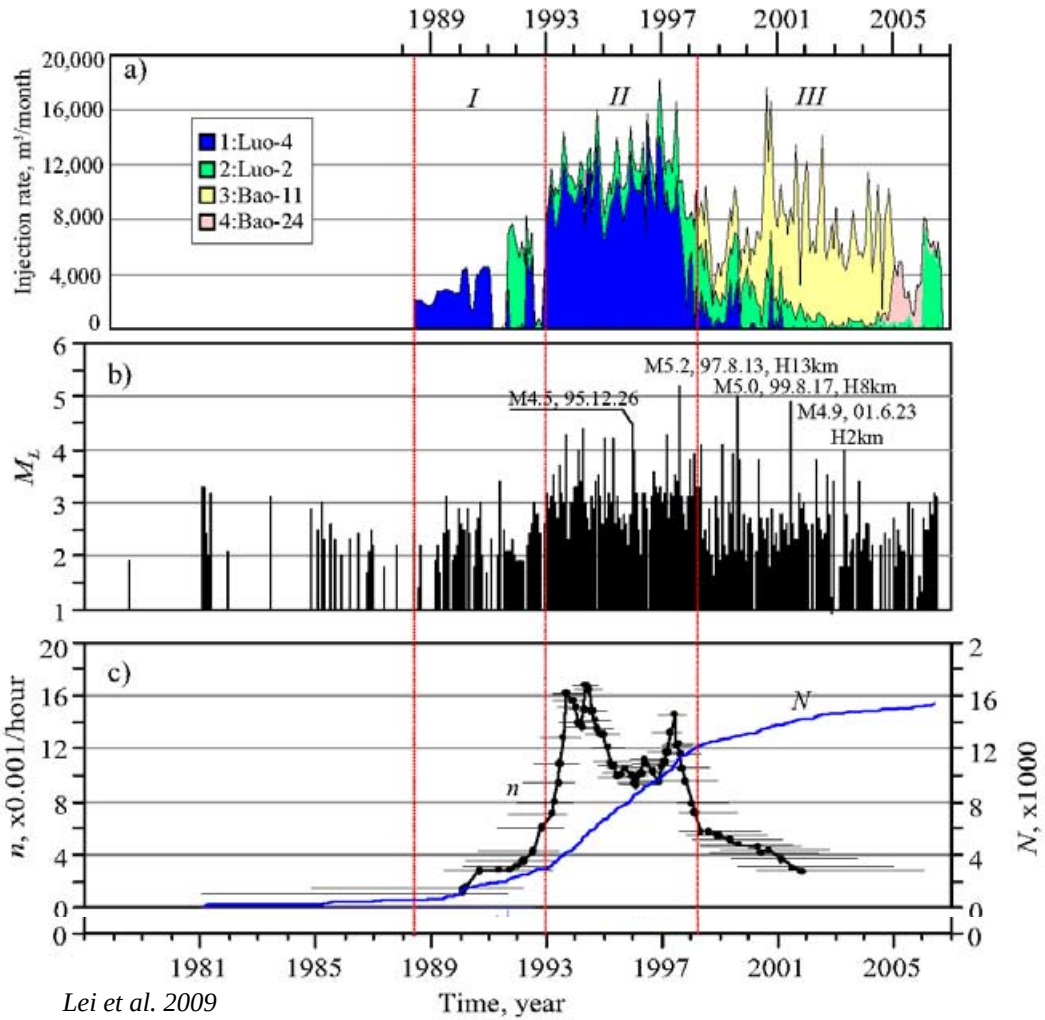
In Salah CCS in Algeria



- ***InSAR data is used to compare predited uplift at the In Salah sequestration site in central Algeria at one year.***

Vasco et al. 2008

Water Injection Induced Earthquake



Lei et al. 2009

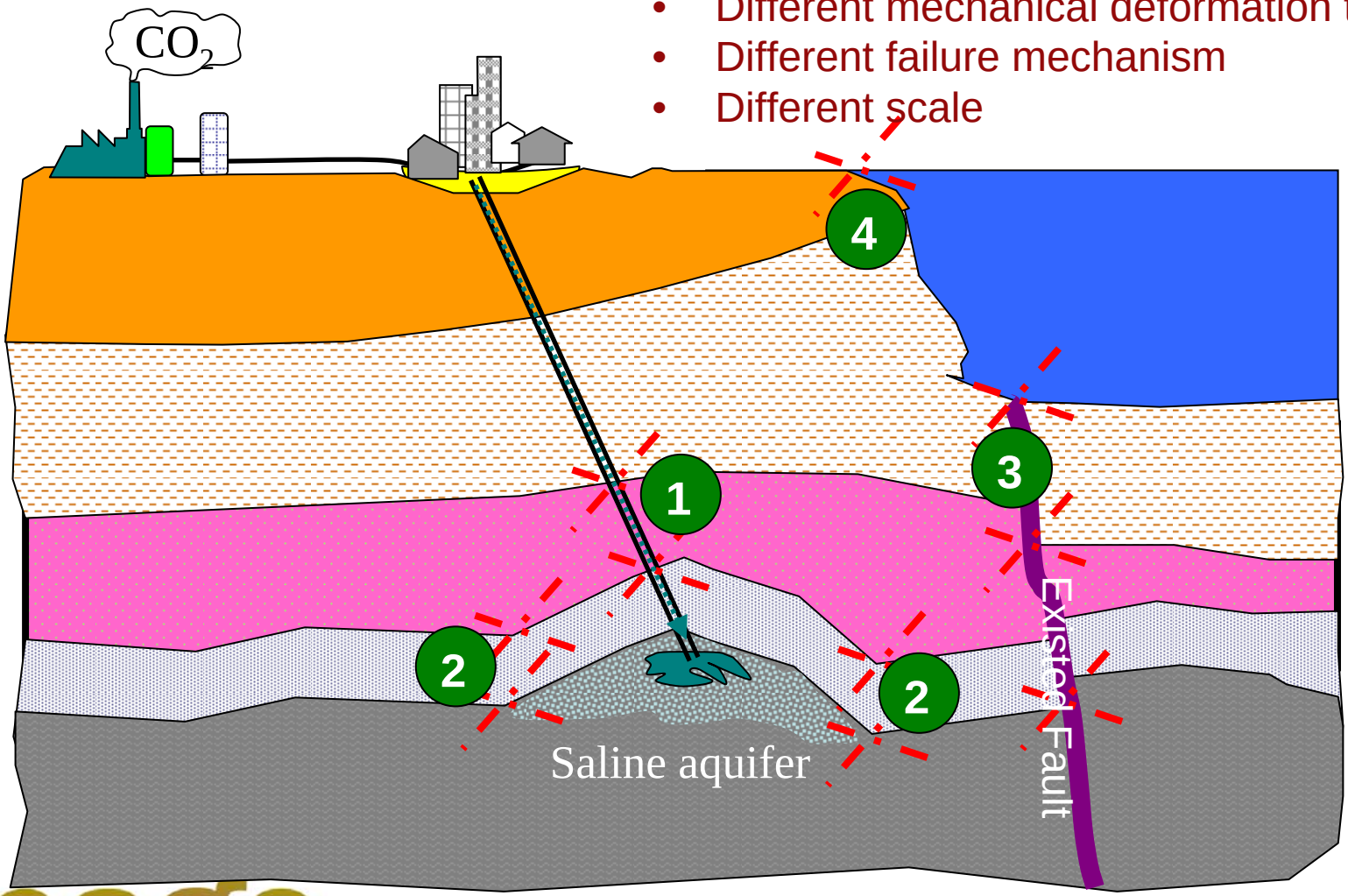
Earthquakes induced by water injection at ~3 km depth within the Rongchang gas field, Chongqing, China.

Largest M=5.2

- Injection MUST induce earthquake, and KEY is magnitude.
- If operating scientifically and systematically, HAZARD may be AVOIDED.

Mechanical Stability Issues

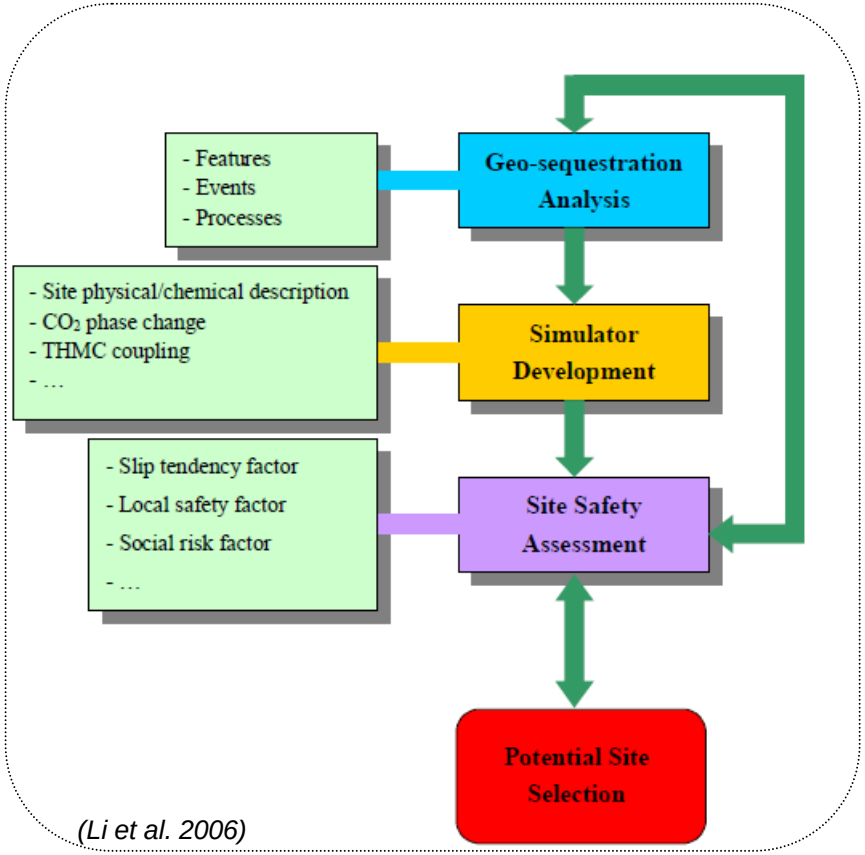
- Different mechanical deformation type
- Different failure mechanism
- Different scale



Li et al. 2006

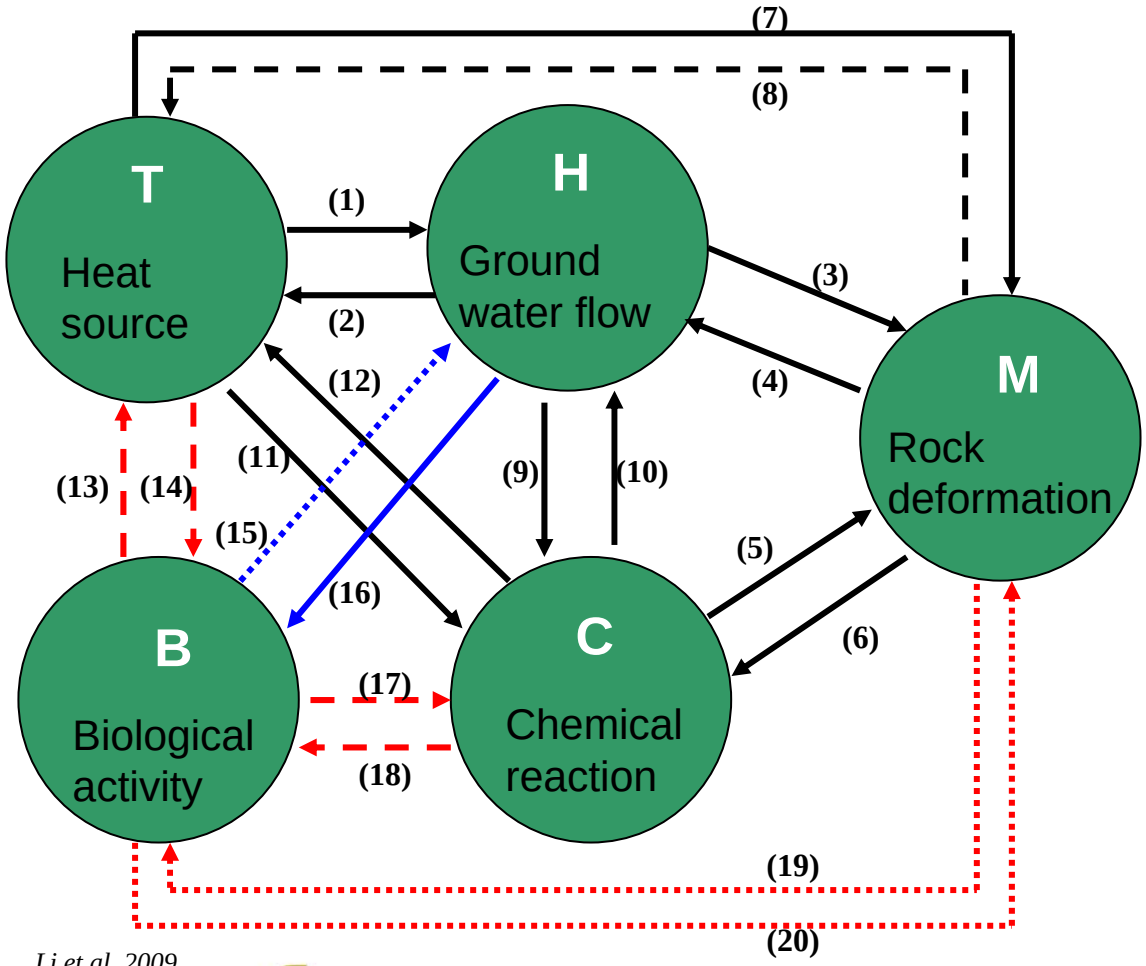
Systematic Assessment Flow for Mechanical Stability

- Technical index
- Failure criteria
- Platform
- Multiscale method
- AI Integrated



(Li et al. 2006)

Complex Process Couplings Related to Deep Geologic Sequestration



Li et al. 2009

T: Fourier's law for energy balance
H: Darcy's law for mass balance
M: Hooke's law for force equilibrium
C: Fick's law for mass balance
B: Empirical law for mass balanace

Coupling processes:

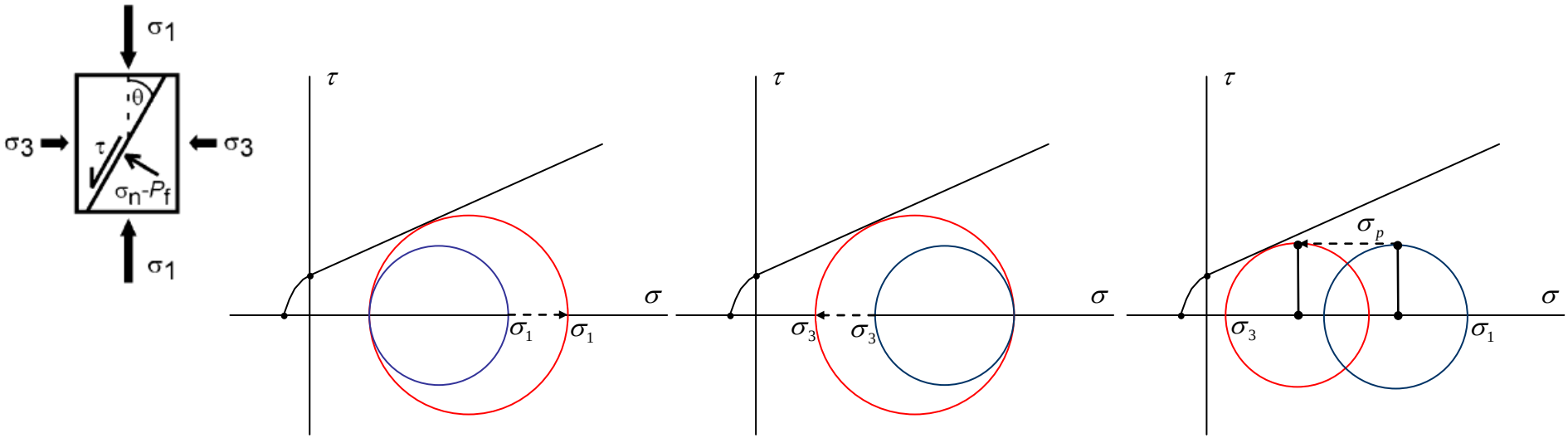
(1) Density viscosity
(2) Advective heat transport
(3) Rock stress and strength
(4) Porosity permeability
(5) Porosity
(6) Pressure solution
(7) Thermal expansion
(8) Friction heating
(9) Advective solute transport
(10) Density viscosity
(11) Reaction rates
(12) Exothermic/endothermic processes

…

Solid-line: strong coupling
Dash-line: medium coupling
Dot-line: weak coupling
Line-in-black-color: developed
Line-in-blue-color: developing
Line-in-red-color: planning

Possible Explanation for Failure Mechanisms

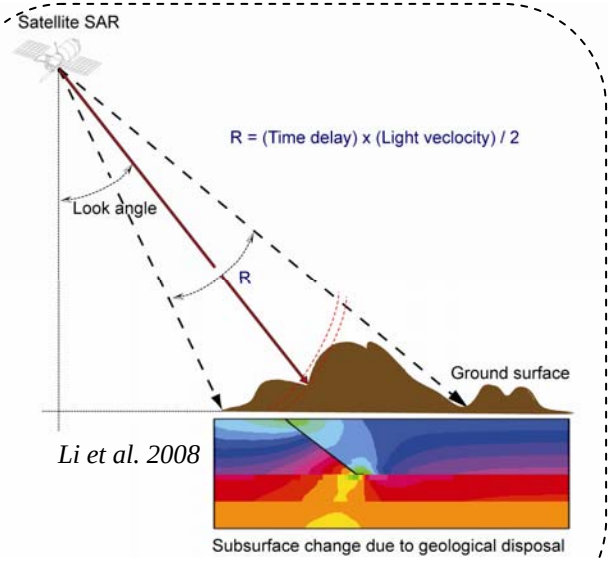
Three major kinds of failure mechanisms of faults around the injected sites are depicted by Mohr's circles.



Li et al. 2009

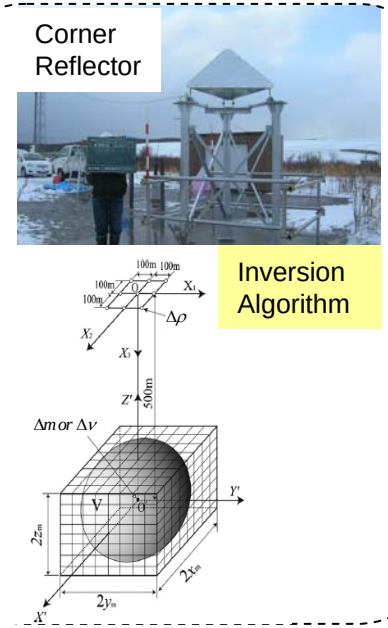
- If Failure may be predicted, it also can be controlled.

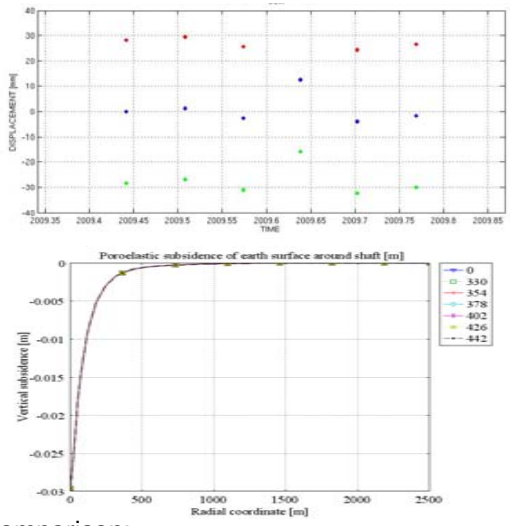
Coupled Inversion of Subsurface Characterization with CR-PS-InSAR Surface Deformation



Li et al. 2008

Monitoring Mechanism





Comparison:
Monitoring (up) vs. Forward Computation (down)

Li et al. 2009

Concluding Remarks

- It should be noted that geologic environments are intrinsically complex and heterogeneous, which make the application of general assessment principles and numerical relations difficult and uncertain in any specific situations.
- While the details of the computing models that turn out to be optimal for different problems vary widely, the concepts and fundamental frameworks are at the basis of most important 3M approaches.
- Maybe someday there will be a sequel of new research field titled Zen *and the Art of CCS GeoSystems*.