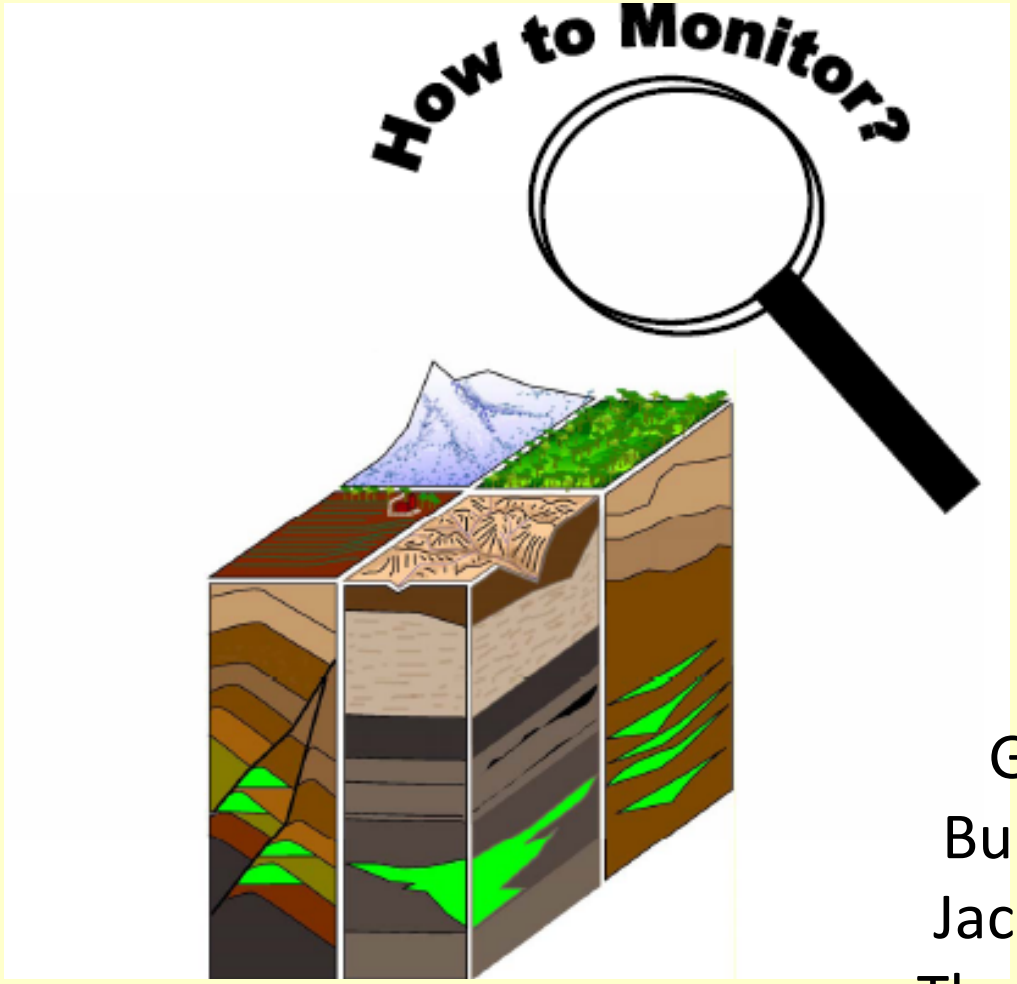

Role of Monitoring Retention in an EOR setting

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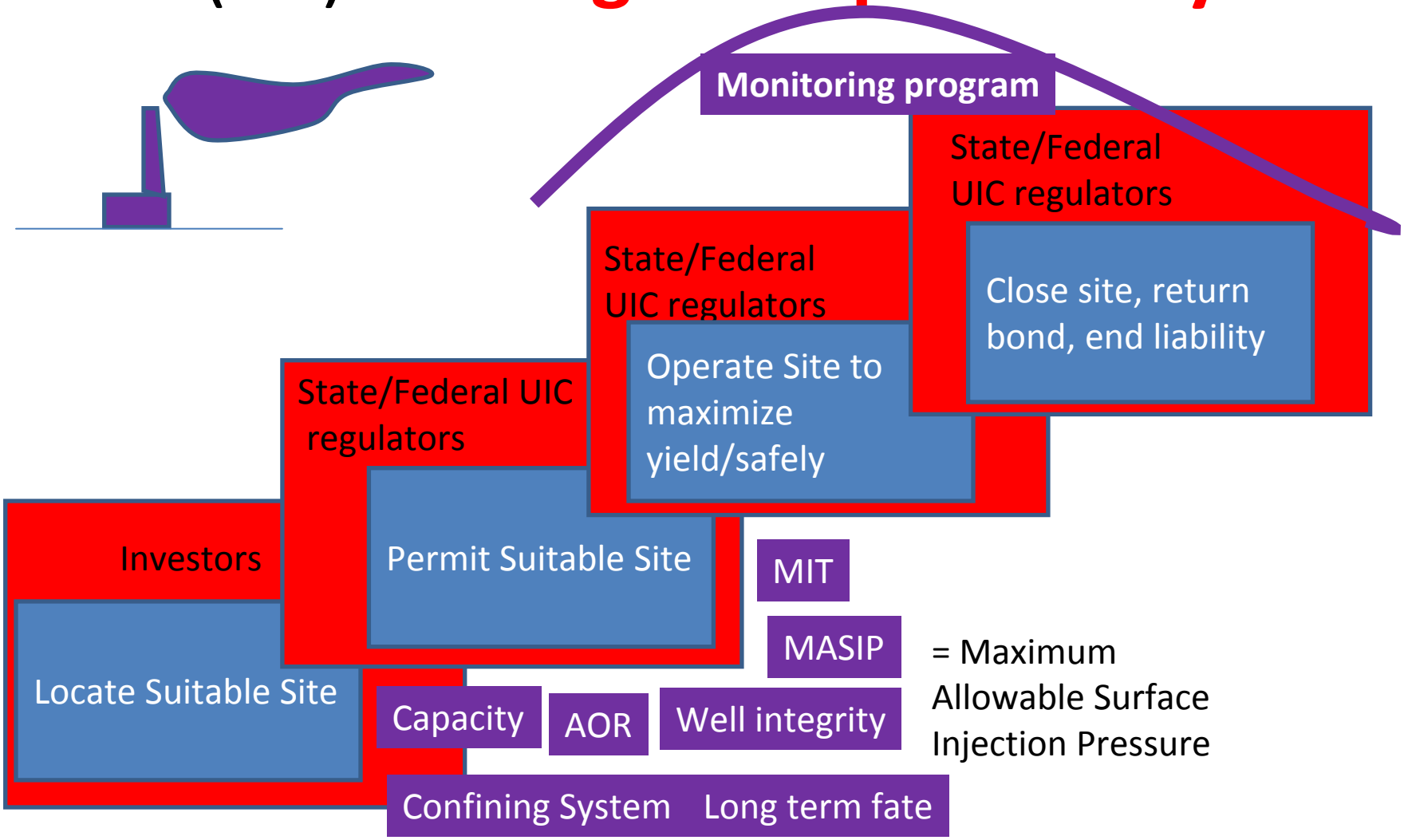
Jackson School of Geoscience
The University of Texas at Austin

Presented at the 16th Annual CO_2 Flooding Conference
December 9-10, 2010, Midland, Texas

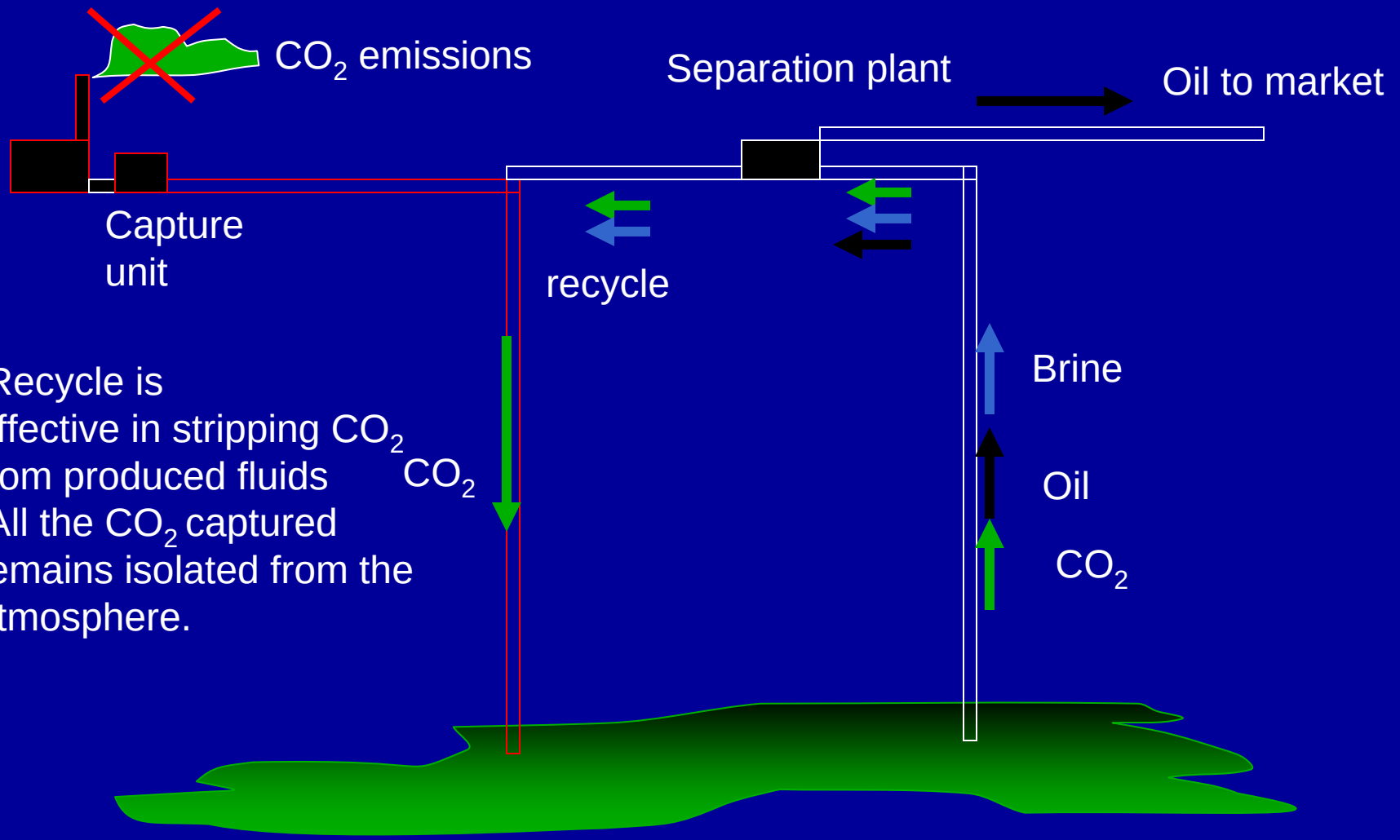
Talk Motivation

- Past research monitoring experience
- EPA/CCP-funded project on site-specific design for monitoring
- Monitoring design applications
  - FOA 15 industrial sources – AP-LLC Hastings
  - CCPI Parrish coal-fired plant slipstream to EOR field
  - Texas HB 469
- GCCC Industrial Associates research design

CCS Project Dynamics: **Proponent Goals** and (US) **Oversight Responsibility**



CO_2 use for Enhanced Oil Recovery is Sequestration



Recycle is effective in stripping CO_2 from produced fluids

All the CO_2 captured remains isolated from the atmosphere.

Motivation for Monitoring Programs

- **Historic Motivation**
  - Groundwater and surface water protection
  - Historic damages = salinization

- **Current motivations**
  - Benefit to the atmosphere

- Follow the $ -Who pays gap between cost of capture and purchase price of CO_2? - now taxpayer -- ultimately electricity rate payer
- Liability (is this a real issue?)

- Public concerns/values/standards

Transition From… To

Research Monitoring

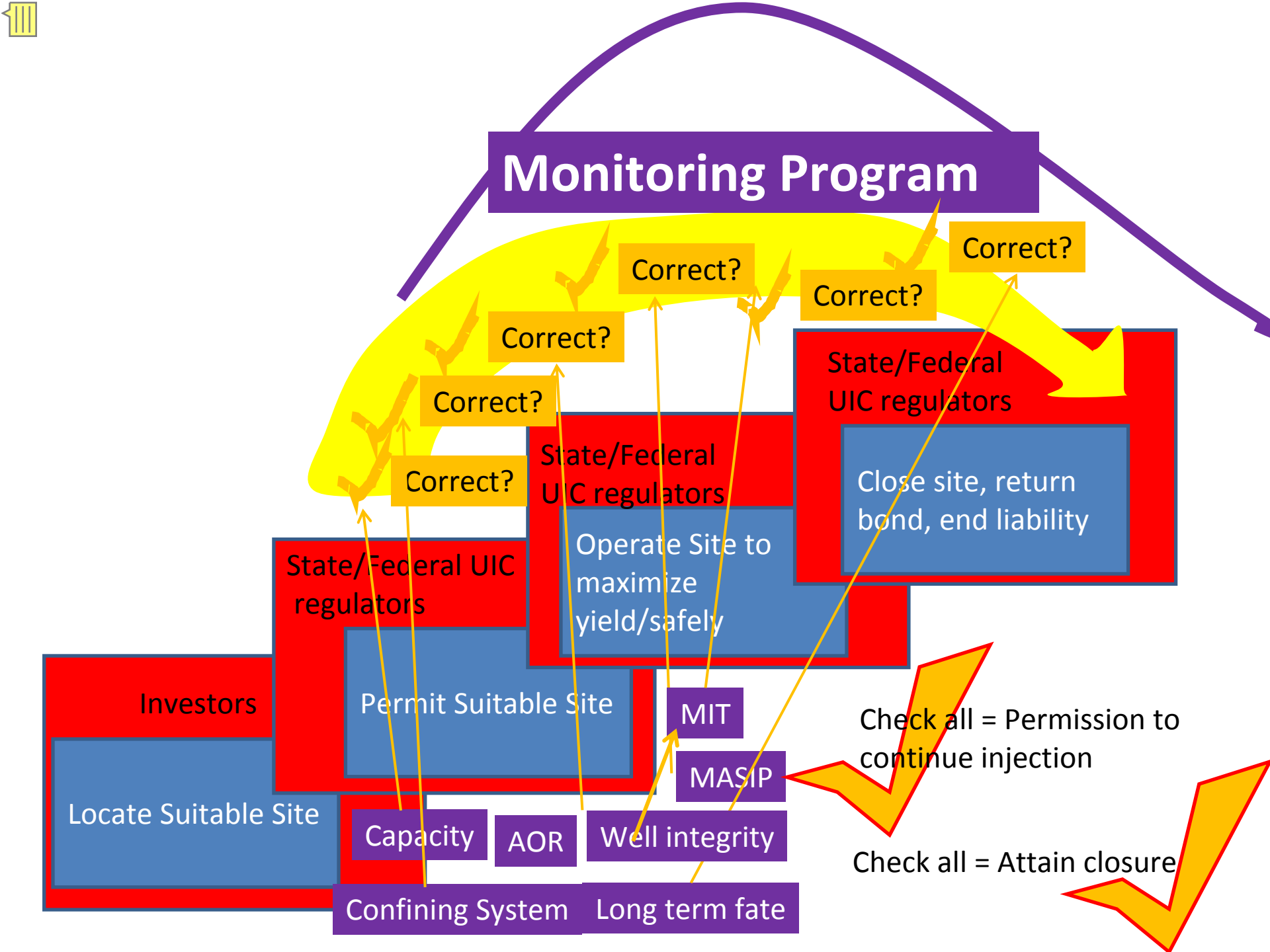
Tests-

- Hypotheses about the nature of the perturbation created
  - compare response modeled to the response observed via monitoring.
- Performance and sensitivity of monitoring tools
  - sensitivity to the perturbation
  - conditions under which tool is useful,
  - reliability under field conditions.

Commercial Monitoring

Confirms -

- predictions of containment based on site characterization at the time of permitting are correct
- Confidence to continue injection is gained
  - monitoring observations that are *reasonably close* to model predictions
  - any non-compliance explained.
  - no unacceptable consequences result from injection
- Monitoring frequency could be diminished through the life of the project
  - eventually stopped, allowing the project to be closed.


Monitoring Program
Correct?
Correct?
Correct?
Correct?
Correct?
Correct?
State/Federal UIC regulators
Close site, return bond, end liability
State/Federal UIC regulators
Operate Site to maximize yield/safely
State/Federal UIC regulators
Permit Suitable Site
Investors
Locate Suitable Site
MIT
MASIP
Capacity
AOR
Well integrity
Confining System
Long term fate
Check all = Permission to continue injection
Check all = Attain closure

Loch Ness Dilemma in a Monitoring Program

Correct?

Correct?

Correct?

Correct?

Correct?

Correct?

MIT

MASIP

Capacity

AOR

Well integrity

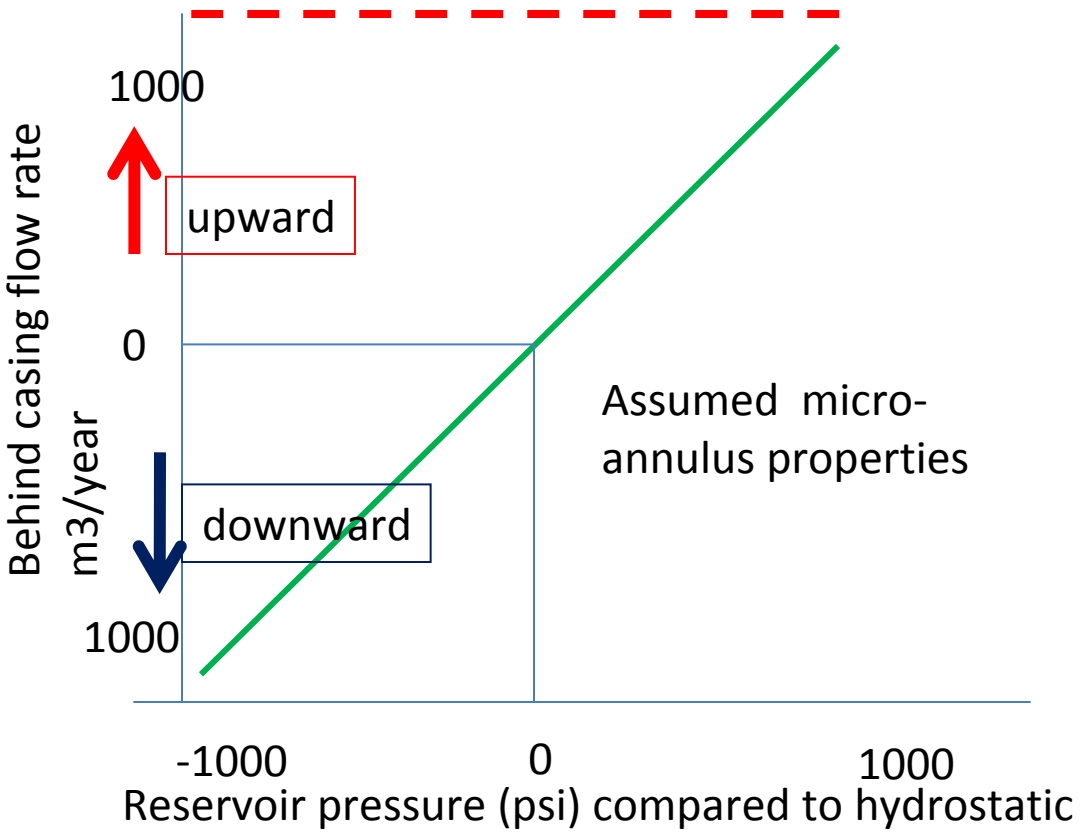
Confining System

Long term fate

Test areas of *significant uncertainly* that might cause a project to fail to meet the performance standard

Define "Significant Uncertainty" (for this problem)

- Uncertainty = a possible range of input values into a conceptual, analytical, fluid flow etc. model
- Significant = the range of uncertainties of cases where the standard was not met

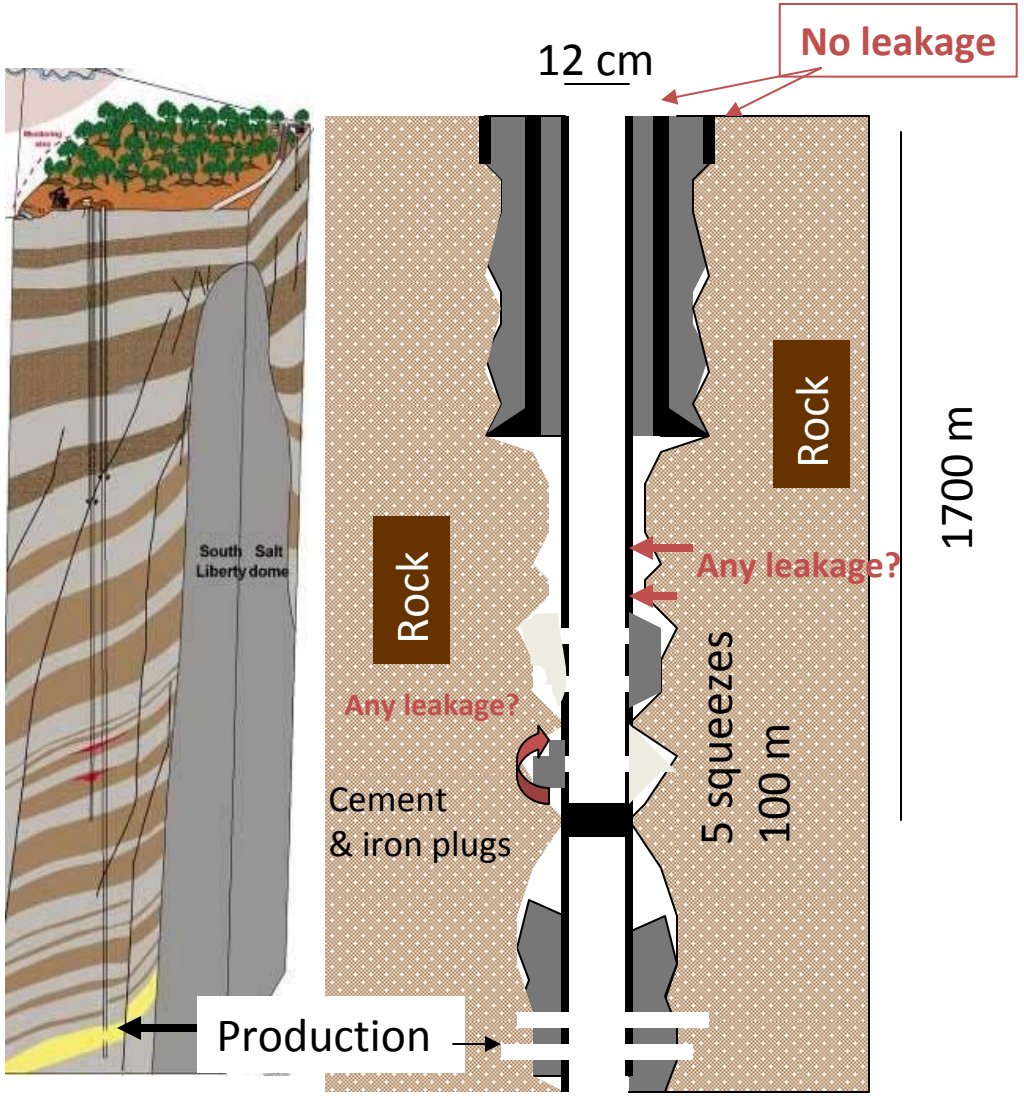


Monitoring question: What are the conditions that would lead to CO_2 migration at rates> 1%/1000 years

1000 ton/year x 1000 years = 100,000 tons leaked/ 10 million injected.

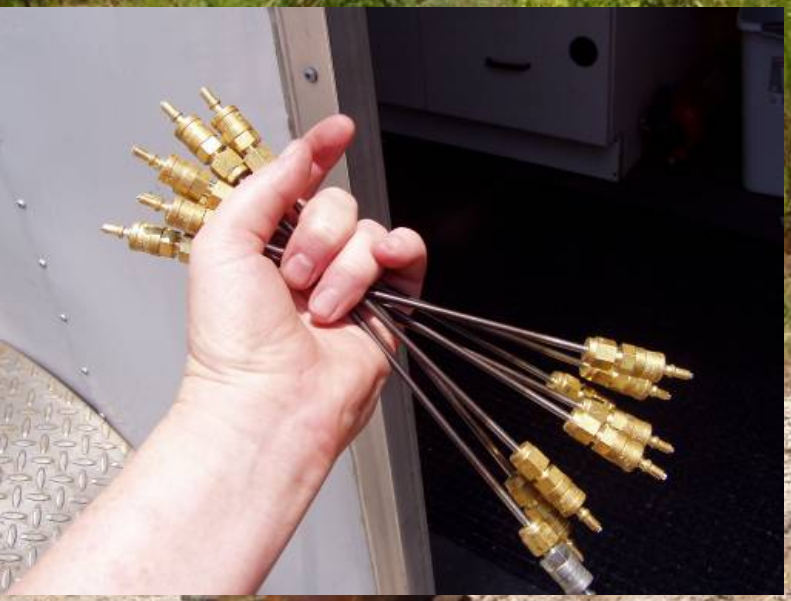
Testing Wells for Flaws

1952 oil production well was retrofit as an observation well

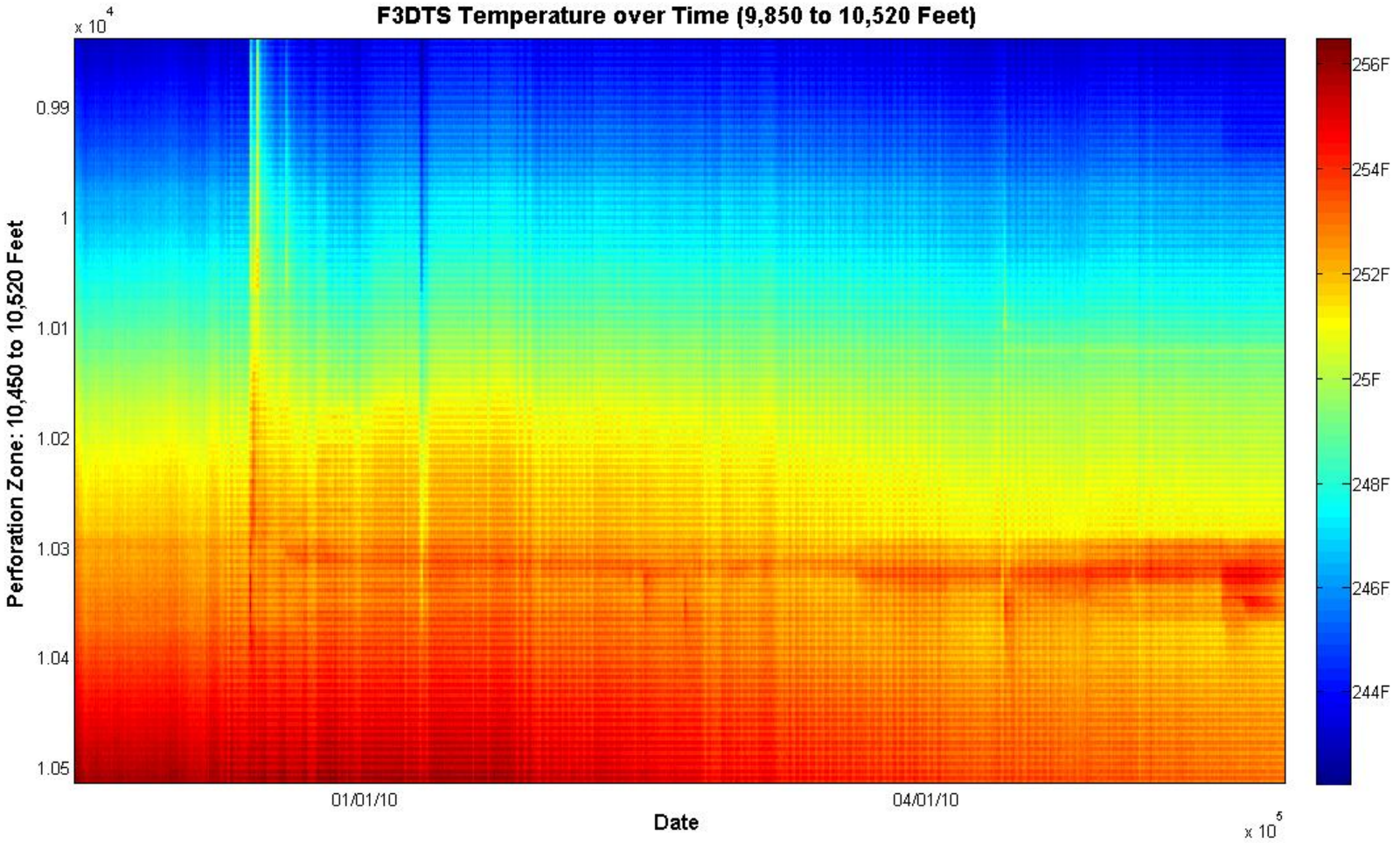


Well construction

Perflorocarbon Tracer = No Detection at the Surface



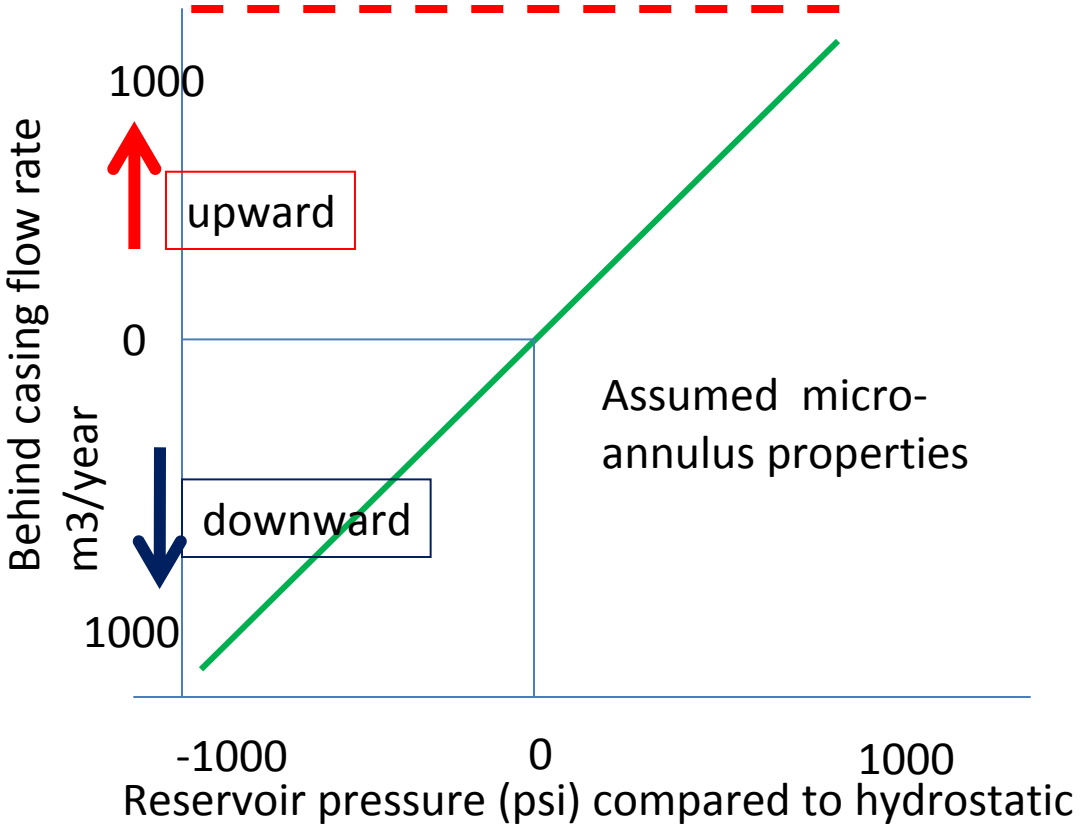
Praxair Seeper Trace


F3DTS Temperature over Time (9,850 to 10,520 Feet)
x 10^4
0.99
1
1.01
1.02
1.03
1.04
1.05
Perforation Zone: 10,450 to 10,520 Feet
01/01/10
04/01/10
Date
x 10^5
256F
254F
252F
25F
248F
246F
244F

Define "Significant Uncertainty" (for this problem)

Uncertainties:

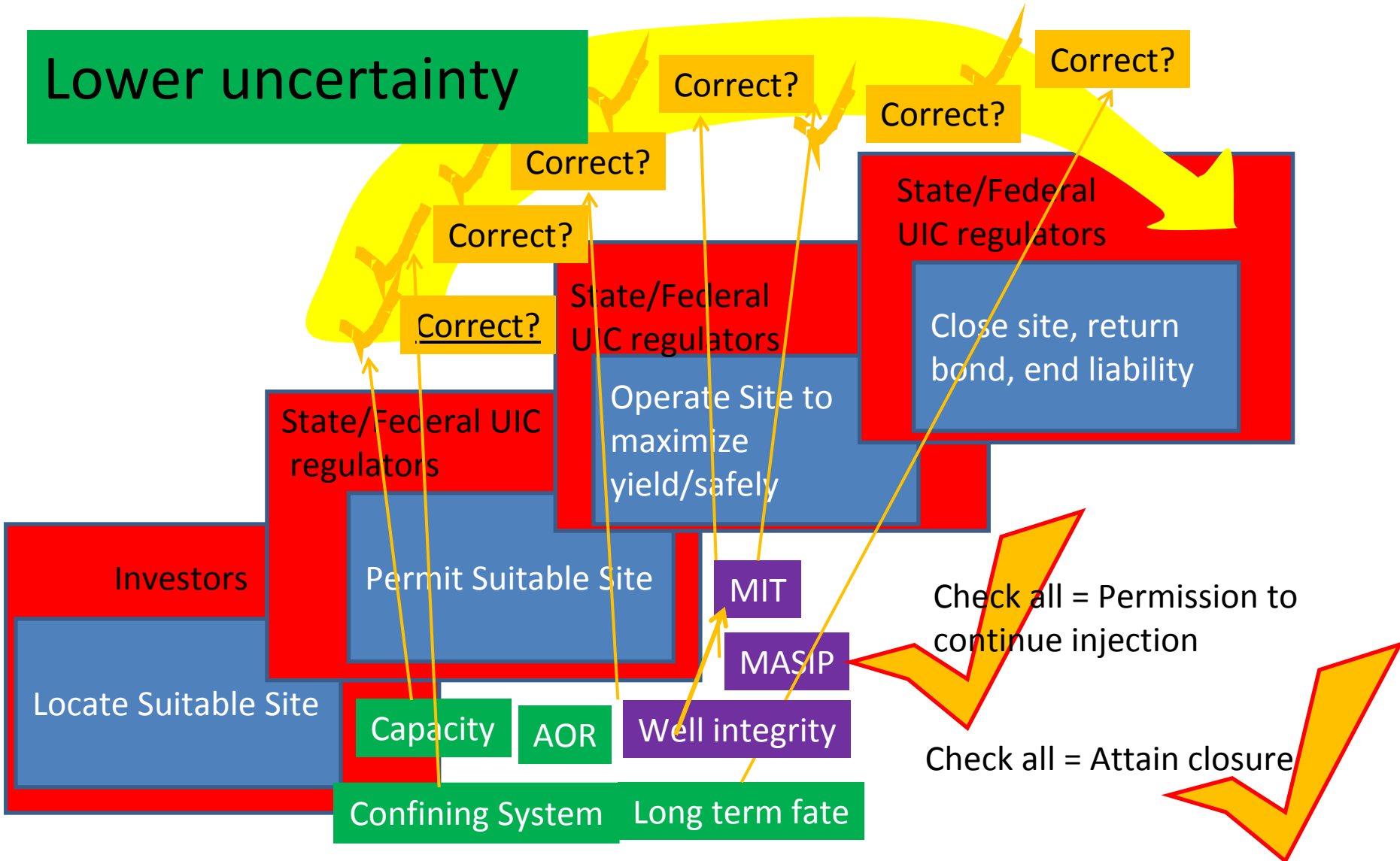
- Possible microannulli aperture and vertical extent
- Number of wells
- Pressure history
- Two phase buoyancy



Monitoring question: What are the conditions that would lead to CO_2 migration at rates> 1%/1000 years

1000 ton/year x 1000 years = 100,000 tons leaked/ 10 million injected.

How is EOR sequestration different than storage-only (brine) sequestration



Permanence: How does EOR compare to storage-only?

Storage only

- CO_2 injection
- Large area of pressure increase
- Inferred trapping
- Brine = CO_2 weakly soluble
- Few wells
  - Sparse information
  - Few potential leak points
- All Cost
- Evolving frameworks for permitting and pore space access
- Public acceptance ??

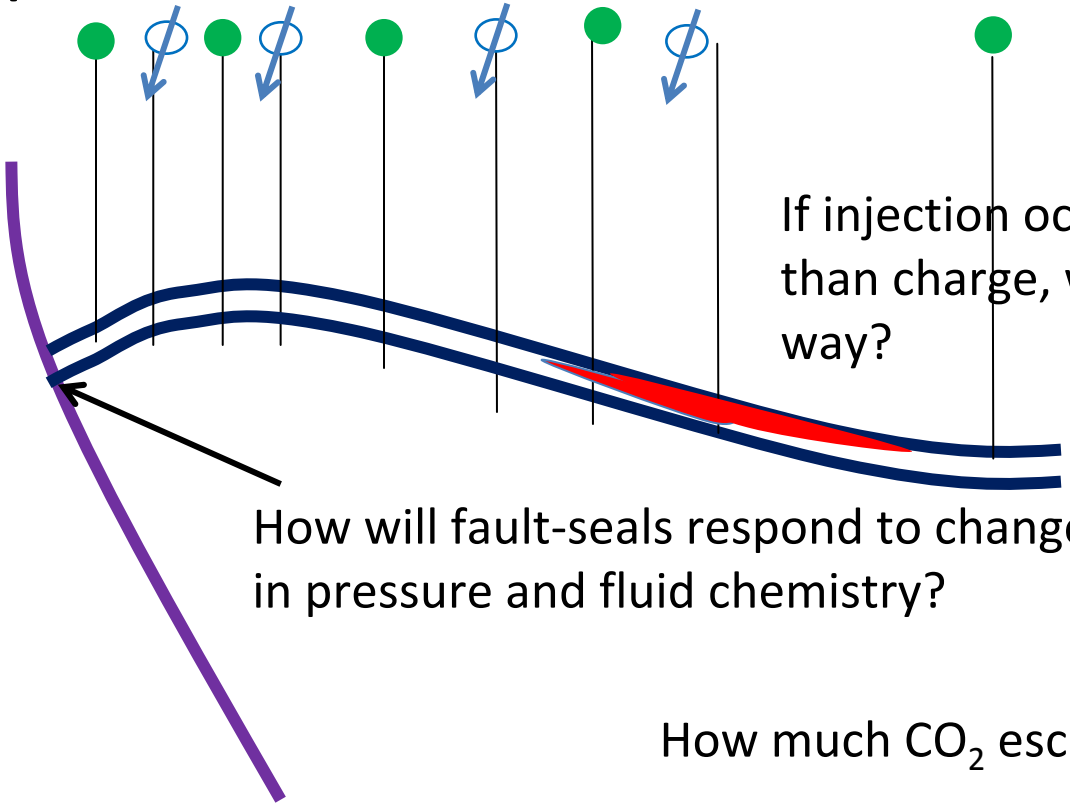
EOR

- CO_2 injection + oil and CO_2 production + CO_2 recycle
- Pressure control
- Demonstrated trapping
- Oil + water = CO_2 very soluble
- Many wells
  - Dense information
  - Well performance?
- Cost + revenue
- Historic frameworks for permitting and pore space access
- Public acceptance good

Pay attention to the data that disturbs our entrenched beliefs

Jonah Lehrer "How we decide"

Traps and seals that held oil will hold CO_2



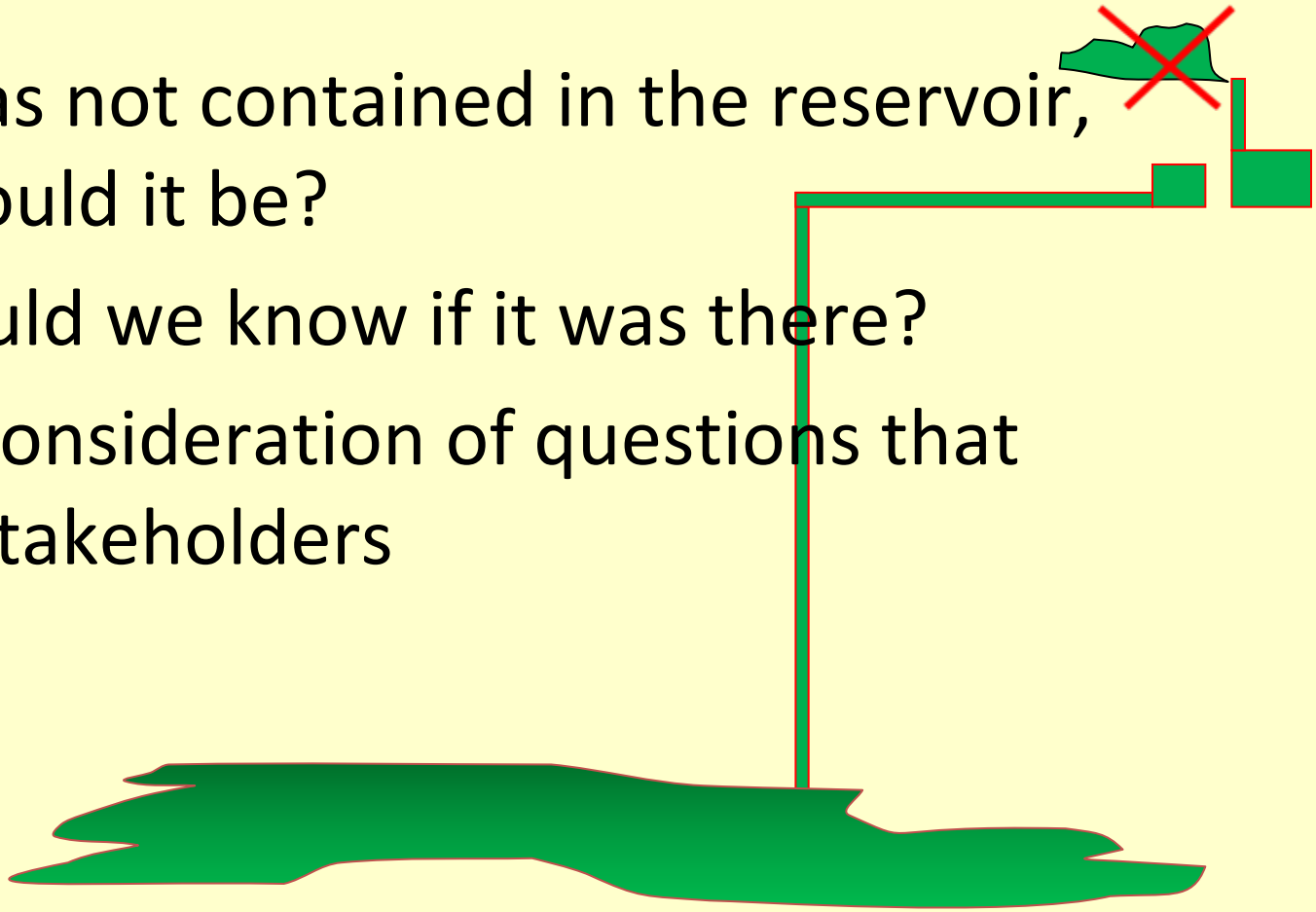
If injection occurs much more rapidly than charge, will it fill the trap the same way?

How will fault-seals respond to changes in pressure and fluid chemistry?

How much CO_2 escapes from pattern floods?

Monitoring For a Sceptic

- If CO_2 was not contained in the reservoir, where could it be?
- How would we know if it was there?
- *Serious* consideration of questions that disturb stakeholders



Conclusions

- Attracting anthropogenic CO_2 is a promising way to expand EOR
- Monitoring to add assurance that the promised favorable storage conditions exist will attract supplies of anthropogenic CO_2
- Monitoring skills are practiced by EOR operators today.
- Successful monitoring involves an attitude adjustment

Gulf Coast Carbon Center

Gulf Coast Carbon Center (GCCC)

Gulf Coast Carbon Center

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SWP
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