Monitoring Stored CO_2 to Document Permanence

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Hovorka, S.D.

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GOING THE DISTANCE
CELEBRATING 50 YEARS OF OTC

Paper No. 29525

Monitoring Stored CO_2 to Document Permanence

Susan Hovorka (presented by Ramón Treviño)
Gulf Coast Carbon Center
Bureau of Economic Geology
Jackson School of Geosciences
The University of Texas at Austin

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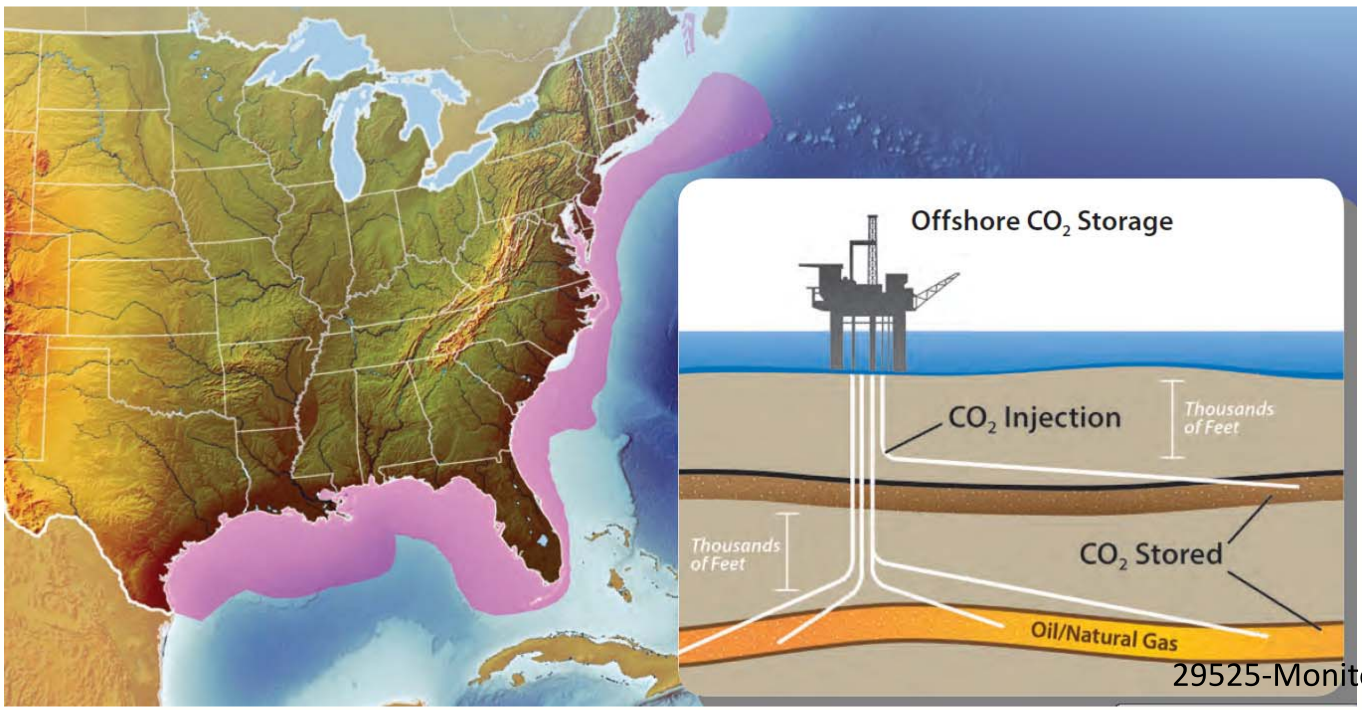
Subsea deep saline storage:

» Adds storage resource for the US

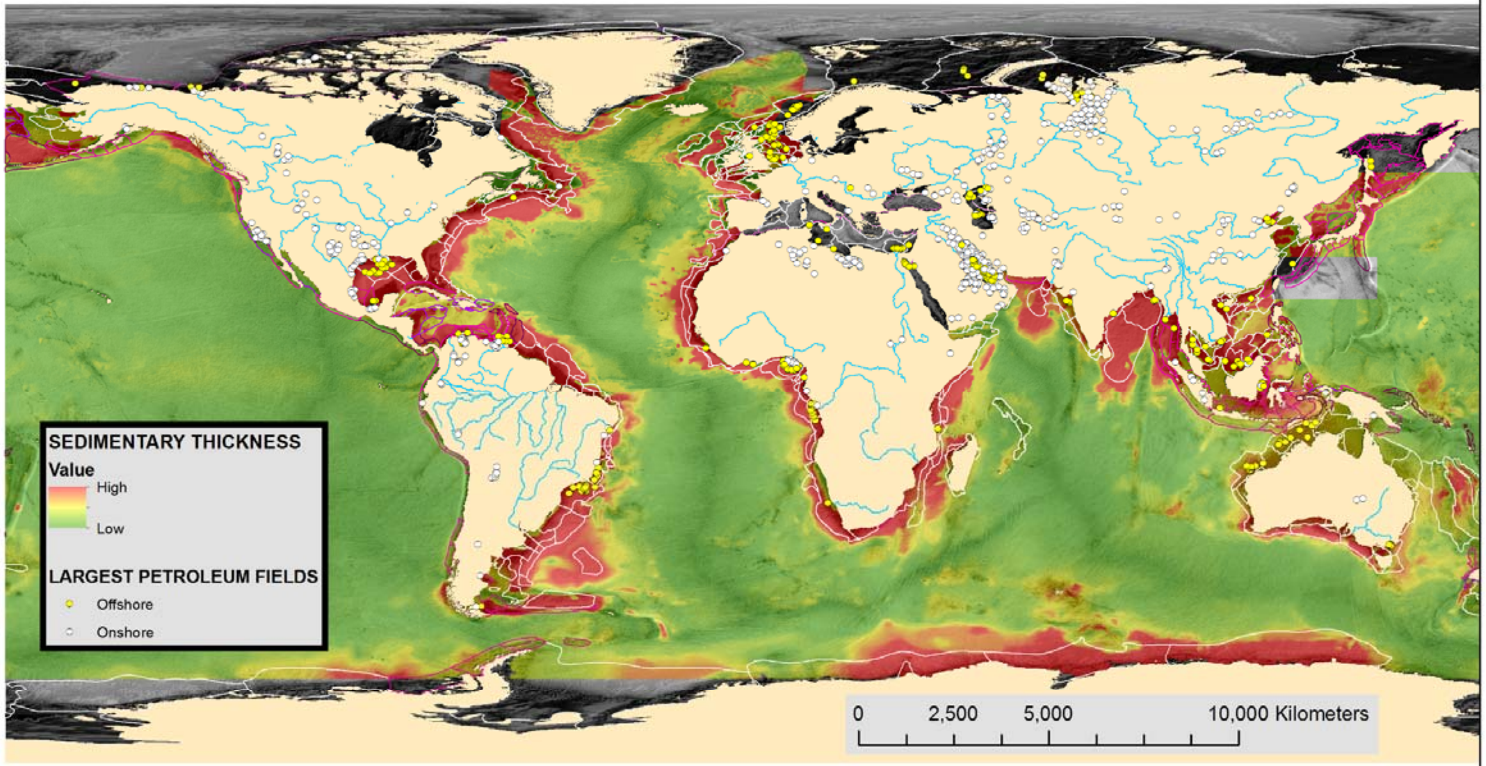
» Reduces multiple risks of onshore storage



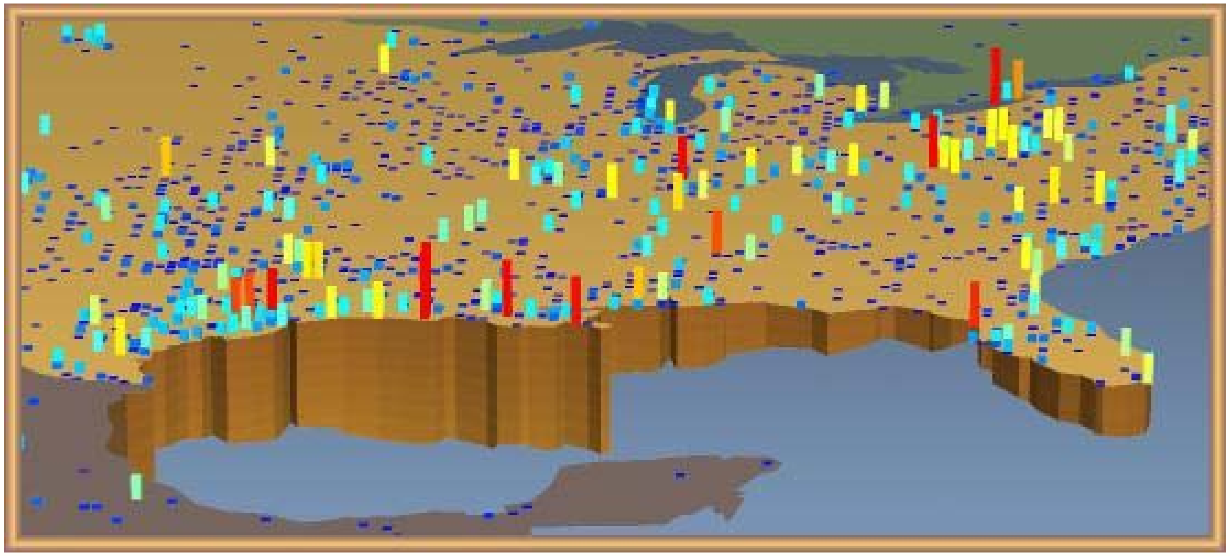
NETL
NATCARB Atlas 2015

Global distribution of Offshore Storage Prospects

Image made by Tip Meckel using data from Laske, Gabi and Masters, Guy, 2010

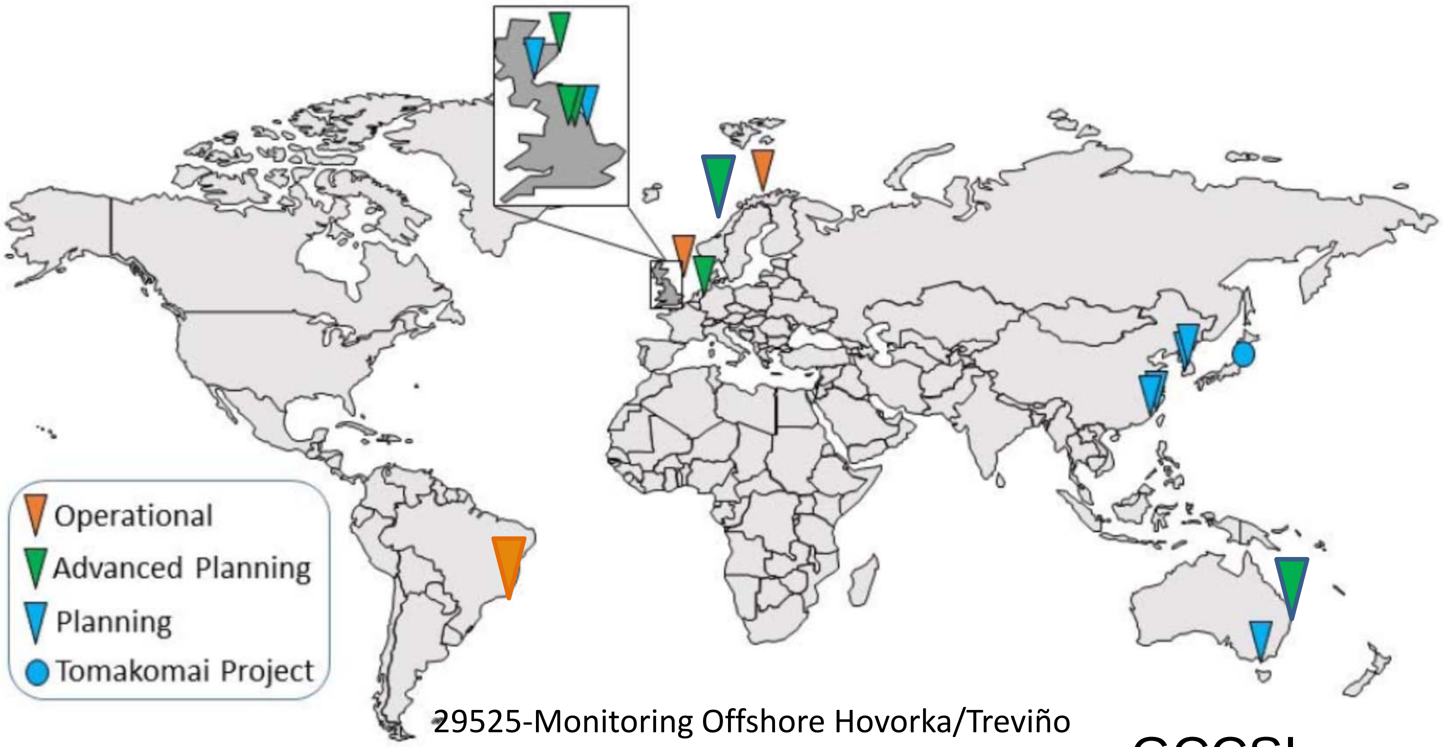


Unique Opportunities and Risks in the Gulf Coast



The problem and the opportunity:
Numerous sources of CO_2 in high concentrations are co-located on thick sedimentary rocks

Ready for investment in US?



GCCSI

Geologic storage has intrinsically low risk of leakage

- Layered sedimentary rocks limit vertical flow
- Capillary trapping in the pore system limits migration
- Dissolution of CO_2 into brine and sorption and reaction limit transport
- Hydrocarbons provide strong evidence of trapping
- Wells are designed to limit migration
- Permitting processes have been shown to be effective in injecting fluids

However...

– Injection volumes are large and injection rates are high
– CO_2 is buoyant
– Geologic environments are complex and uncertainty cannot be completely eliminated
– Monitoring can be designed to reduce post-site selection / permitting uncertainty

Key monitoring tools

» 4-D (time lapse) seismic for imaging

» Gravity surveys to detect density change

» Seismic sensors to detect natural or induced seismicity

» Advanced environmental tools

Monitoring approaches

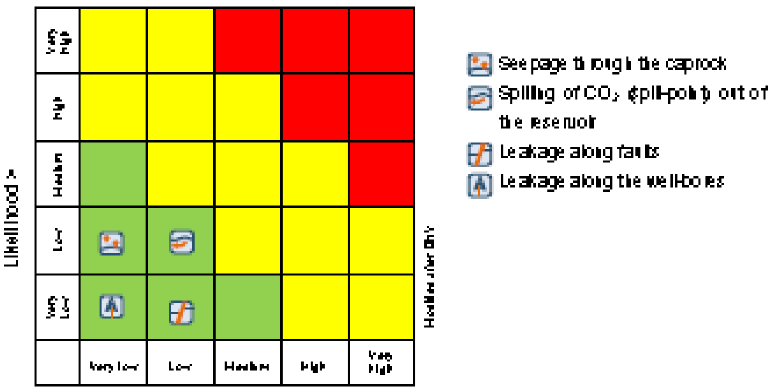
» Conformance monitoring – fluid flow history match

» Containment monitoring – no out-of-zone migration

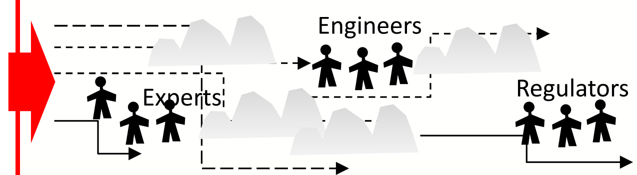
» Assurance monitoring – no harm is being done

Linking risk assessment with monitoring

Risk Assessment method

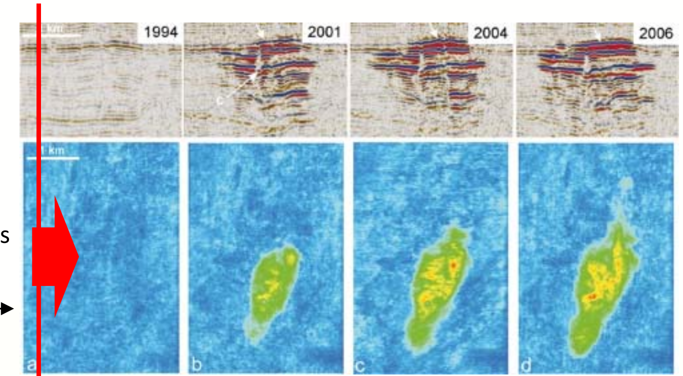


K-12 B (CO2CARE)



Process of designing and selecting monitoring can be complex, conducted without documented process, non-linear and therefore difficult to duplicate or justify

Select monitoring systems



Chadwick BGS

Proposed method for matching monitoring to risk

» using an ALPMI* process

Assessment of Low Probability Material Impact (ALPMI)

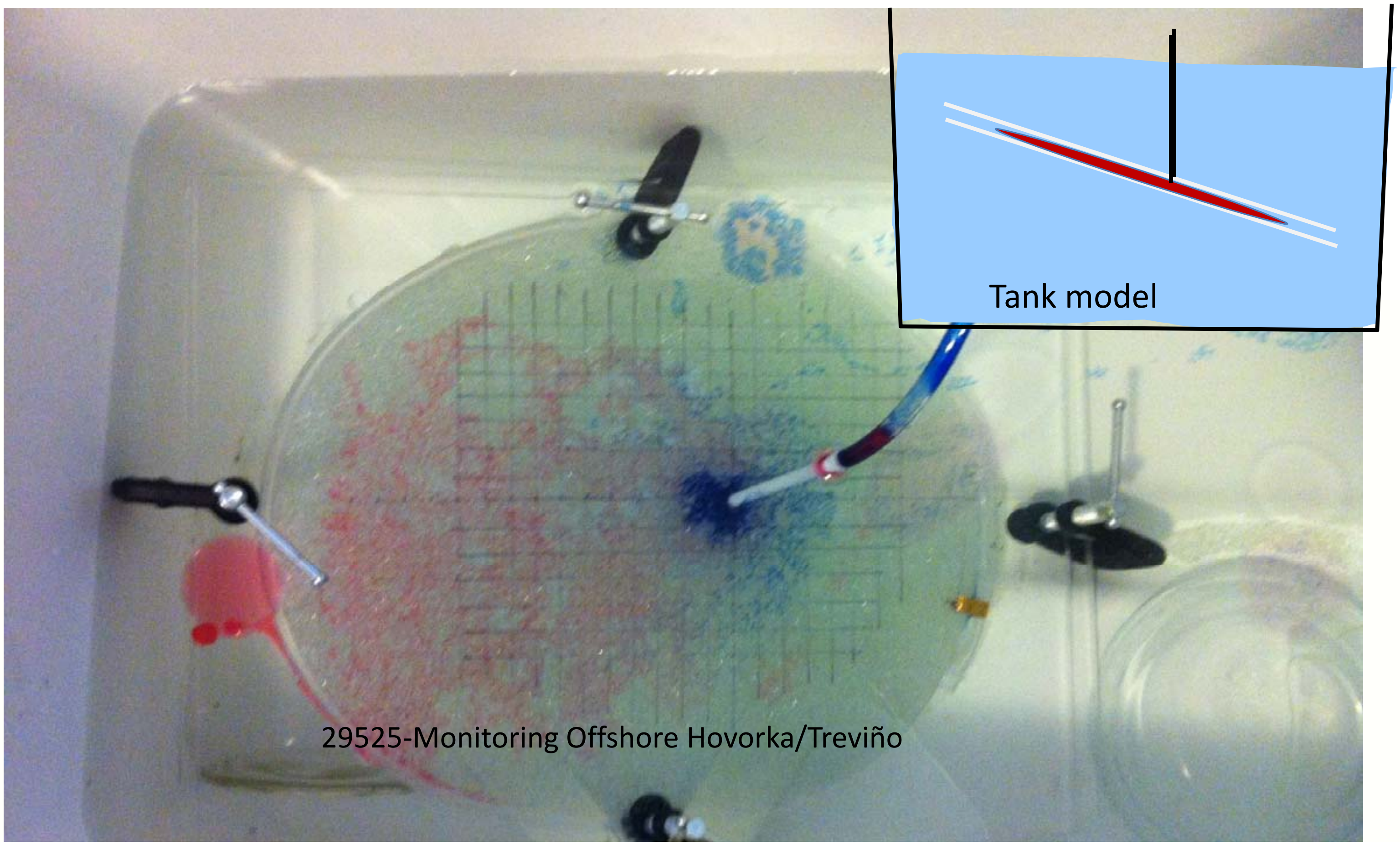
- Part 1: Describe *material impact** quantitatively
- Part 2: Sensitivity of monitoring strategy to *material impact**
- Examples of optimizing leakage detection

* Defined next slides

ALPMI Part 1: Quantify possible unacceptable outcomes "Material Impacts"

» Increase recognition of project success and lower cost of monitoring by describing material impact in quantitative terms
  - "Material impact" specifies what is considered "failure" or "unacceptable" to key stakeholders
  - Replace generalities: "safe" "effective"
  - Specify magnitude: frequency, duration, probability of material impact

Experiments: Long term plume stabilization
Wrong imbibition curve: plume migrates too far



ALPMI Part 2: Assess sensitivity of monitoring strategy to material impact

» Essential to forward model impact

1. Create material impact scenarios

   e.g. for CO_2 leakage or change in pore pressure that would increase seismic risk

2. Evaluate sensitivity of instruments, spacing, frequency of data collection, other statistical measures against scenarios

Example of ALPMI approach to plume migration

Predicted plume footprint year 5 of >5% CO_2 saturation in zone

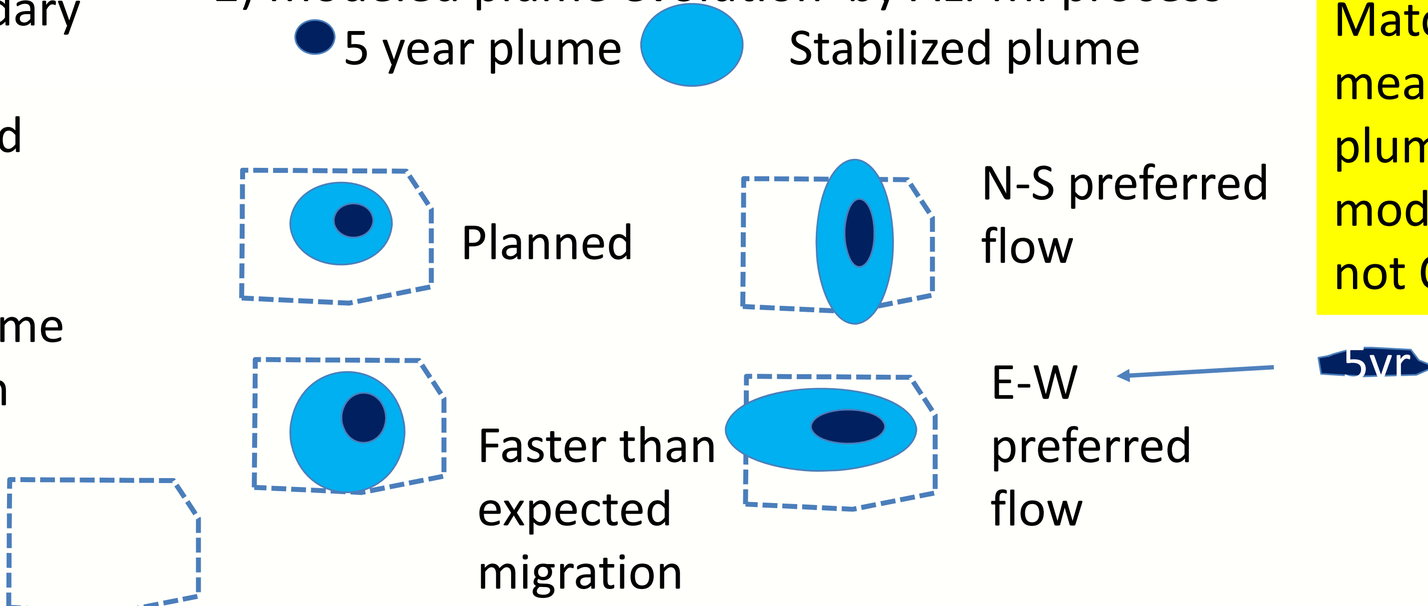
Measured plume footprint year 5 of >5% CO_2 saturation in zone

Match to model OK or not OK?

Example of ALPMI approach to plume migration

1) Stakeholder –defined boundary between acceptable and unacceptable extent of >5% saturation plume at stabilization

2) Modeled plume evolution by ALPMI process



Match measured plume to model shows not OK

Thank you!

More Information:
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