Cost of Selecting a Storage Site – Staged Investment to Decrease Risk

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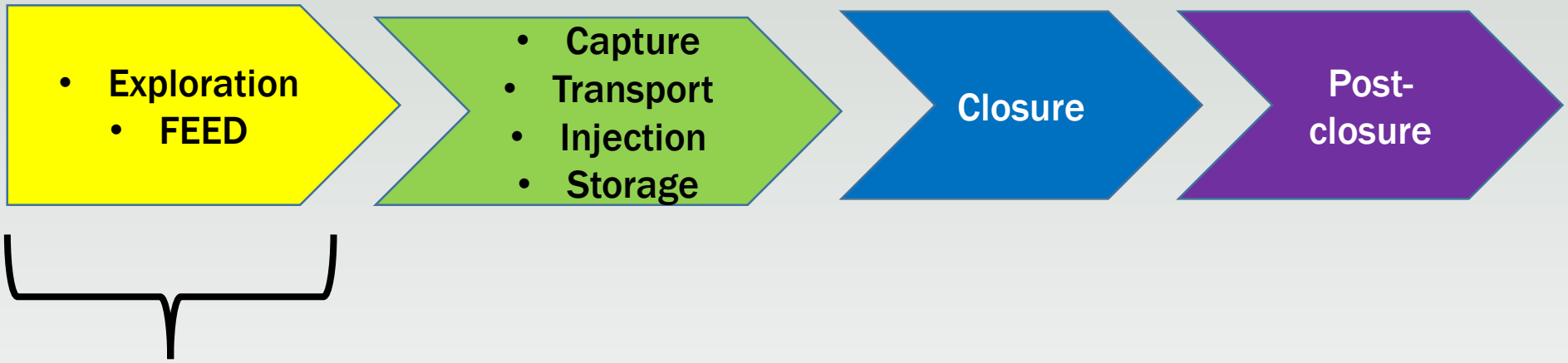
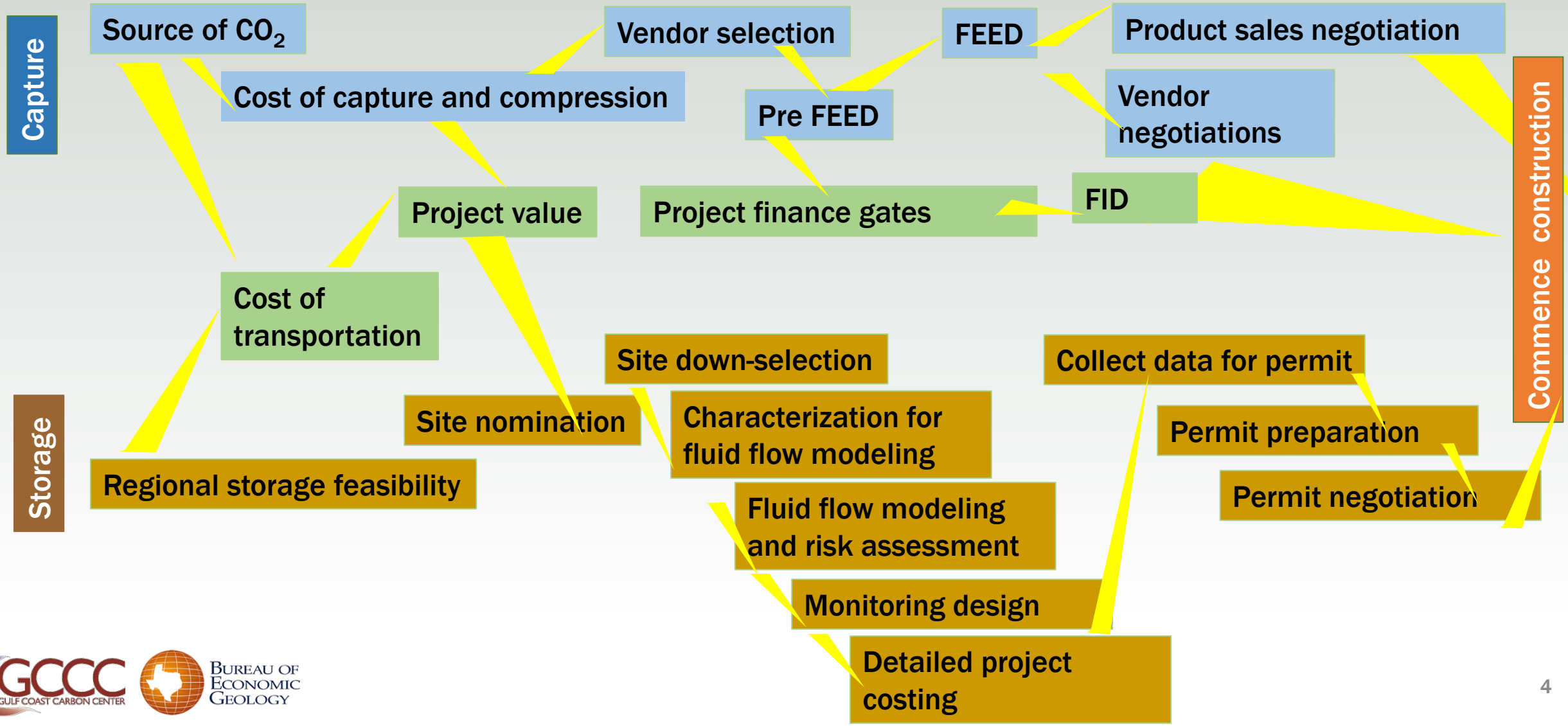
Statement of problem

- As source industries consider storage, they need reliable information on cost & risk of developing suitable storage resource
- Cost and risk are not fixed; vary depending on geology, project characteristics & regulatory conditions
- Uncertain cost = deterrent to project development,
  - Especially early stages when total project risk is high
  - Site characterization = sunk cost whether or not project proceeds

Phases of a CCS project



Cost elements in first phase of CCS project



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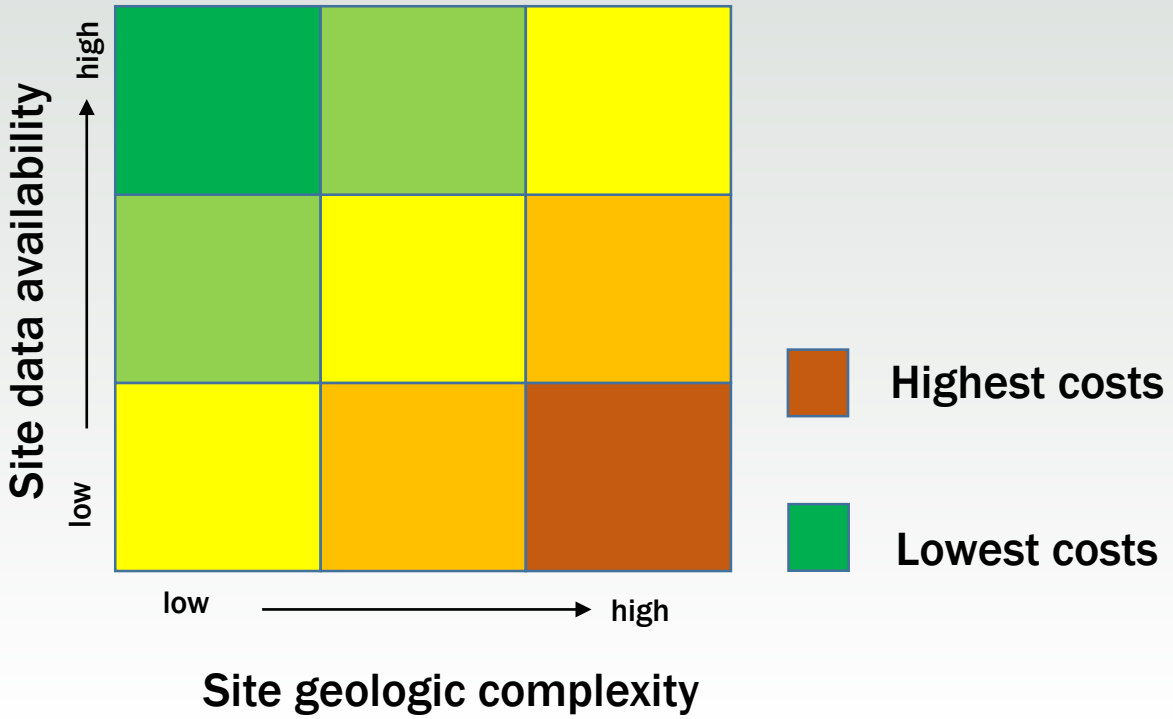
Total Cost Variables



- Top costs variables
  1. site geologic complexity
  2. data availability
- Other factors
  1. risk tolerance
  2. permitting demands
  3. existing wells

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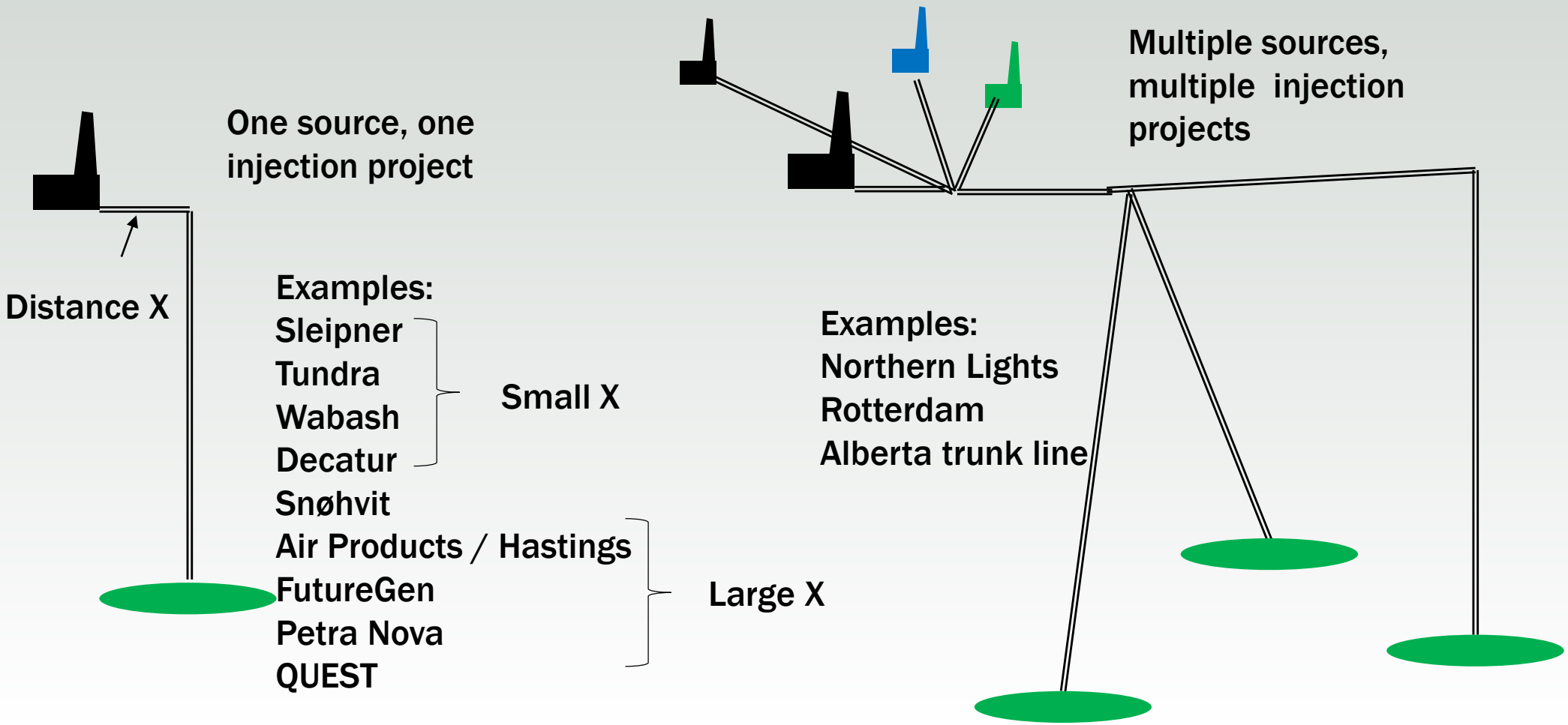
Site selection end members



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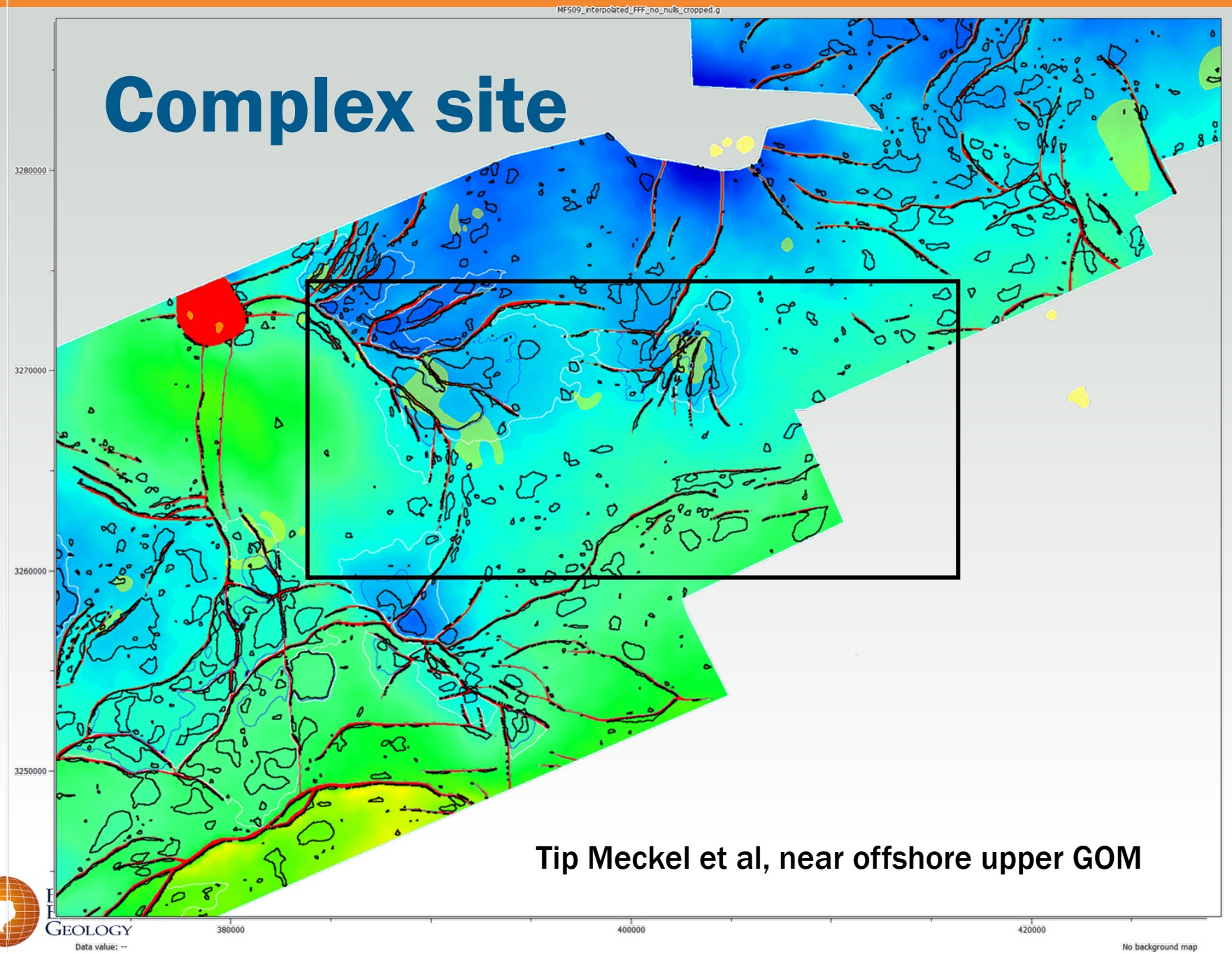
Complex site



Tip Meckel et al, near offshore upper GOM

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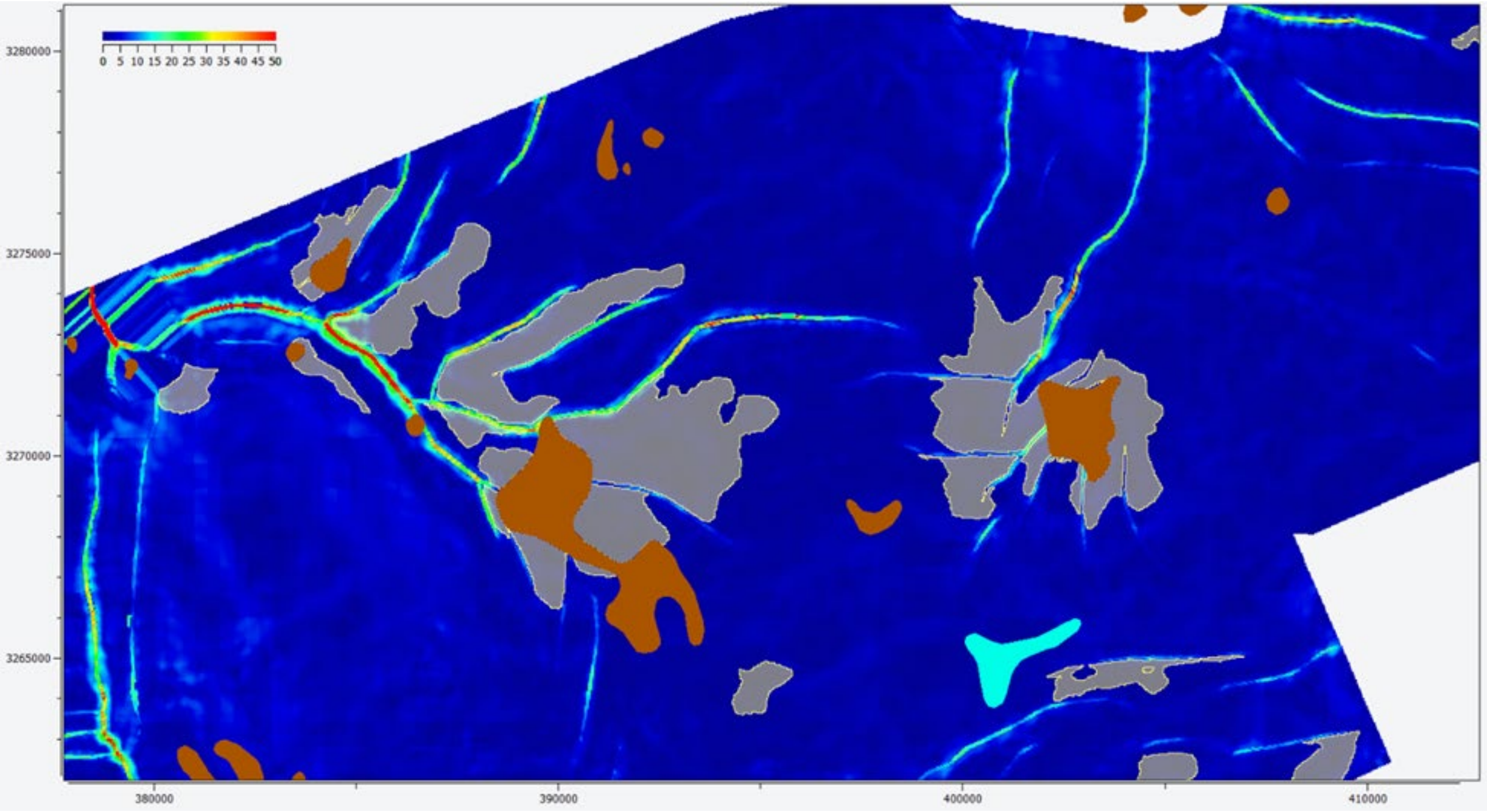
GEOLOGY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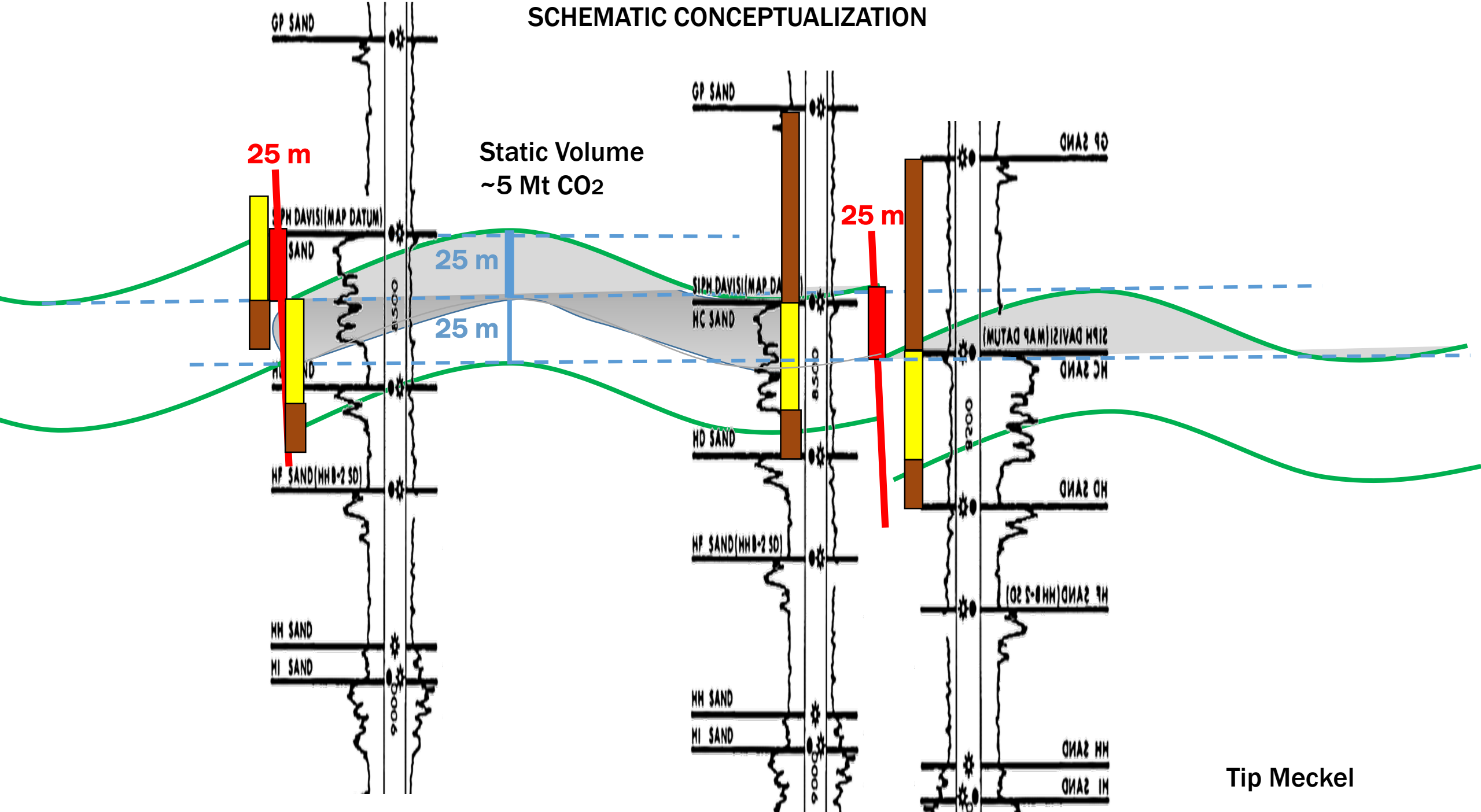
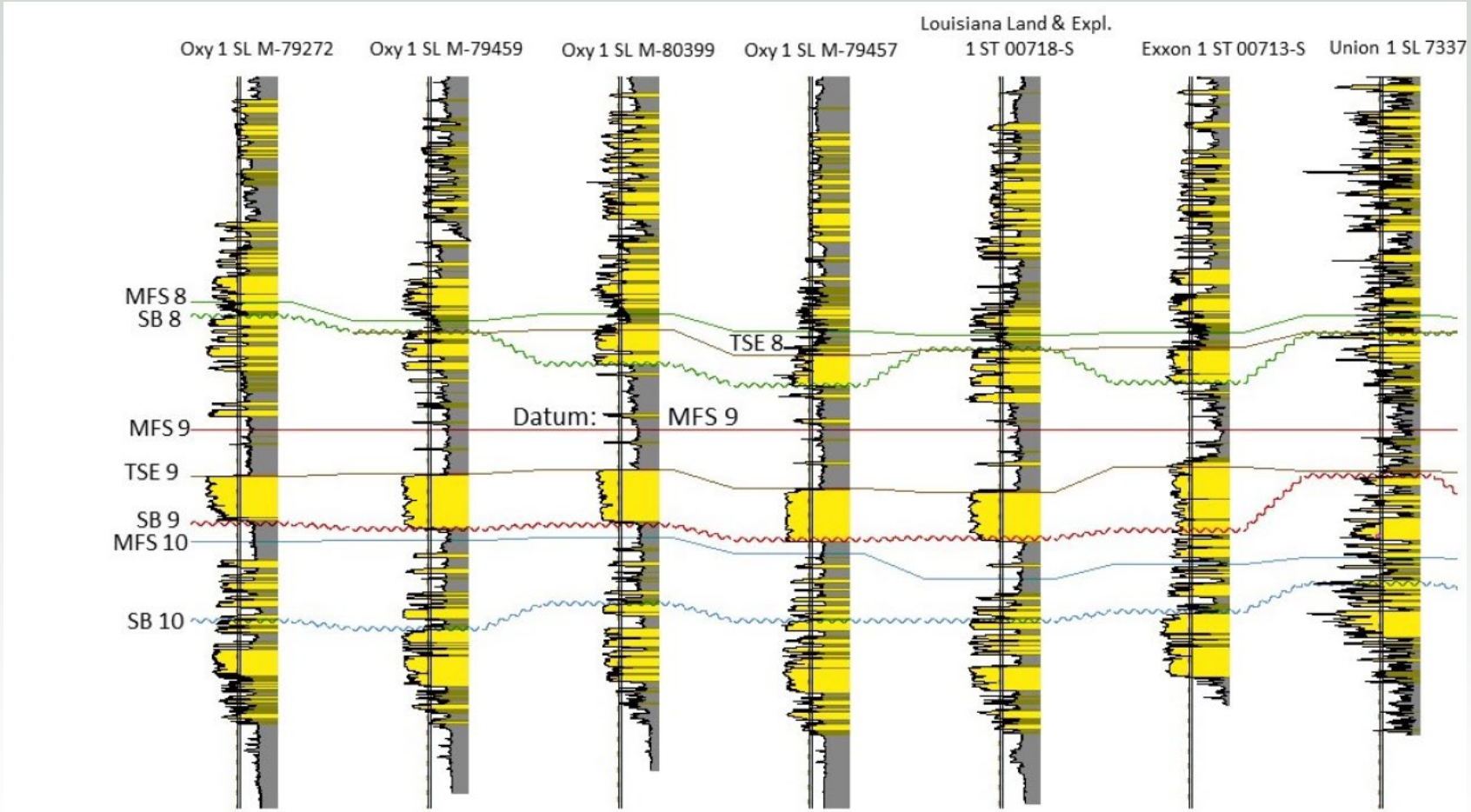
SCHEMATIC CONCEPTUALIZATION



Tip Meckel

Stratigraphic Complexity



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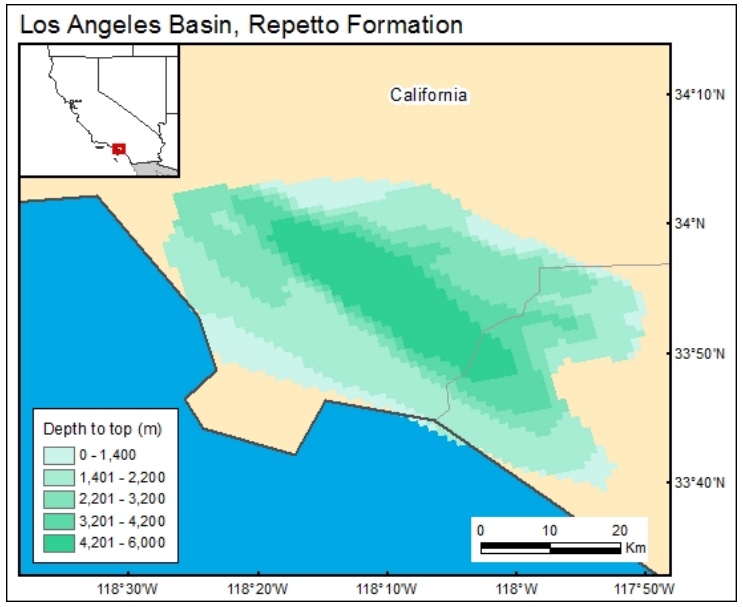
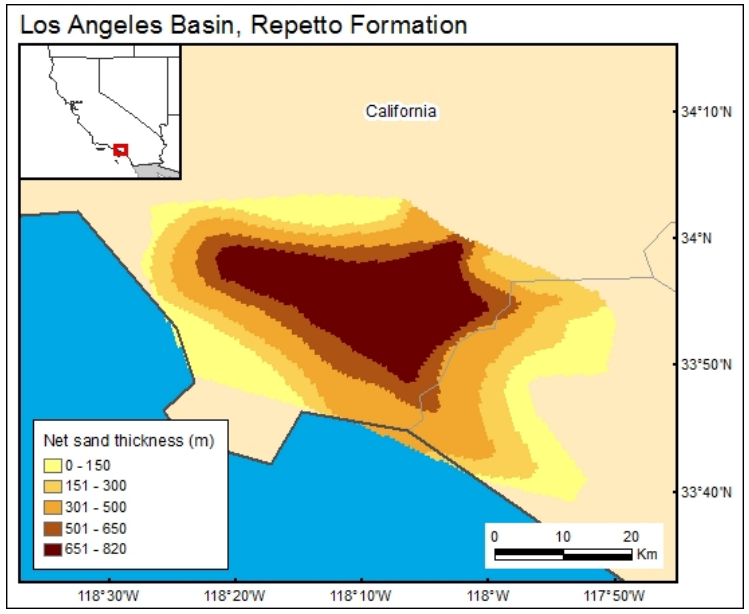
Iulia Olario/ Tucker Heinz

Annother complex case (Repetto Formation, CA)

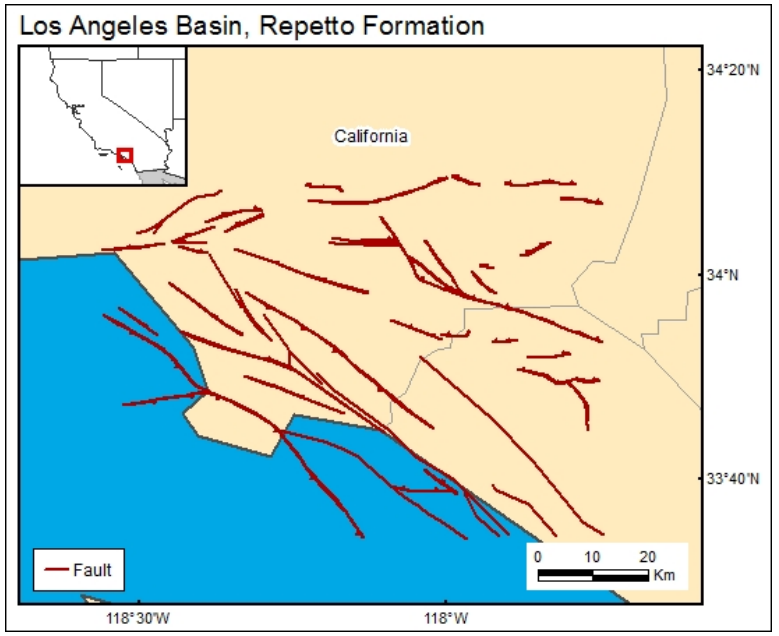
Depth



Net Sand



Mapped Faults

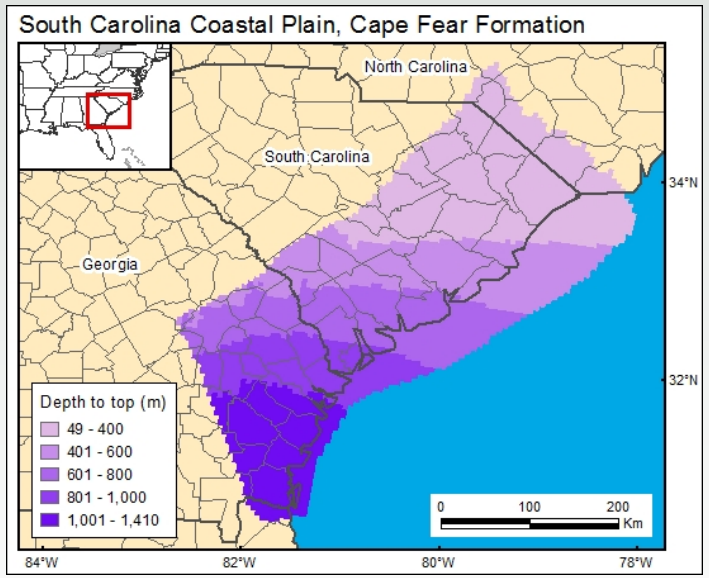


Simpl(er) site

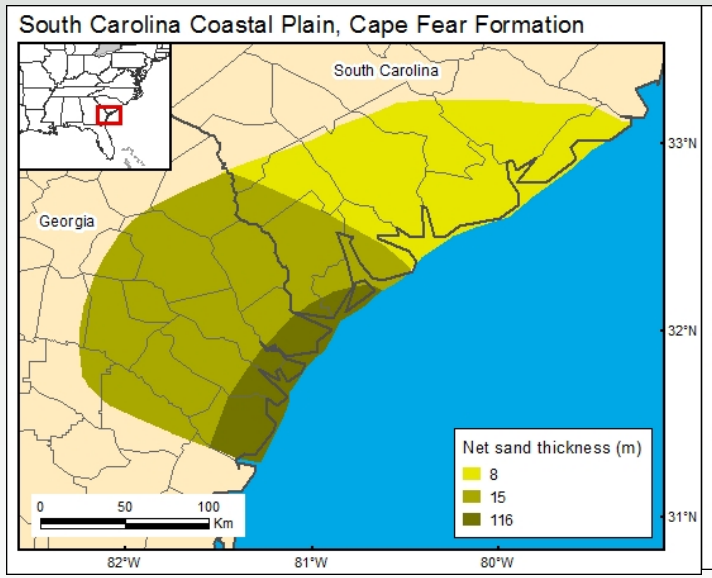
- Little to no structure
- Little to no reservoir heterogeneity
- Confining system thick and laterally extensive

Simpler region- Cape Fear SC

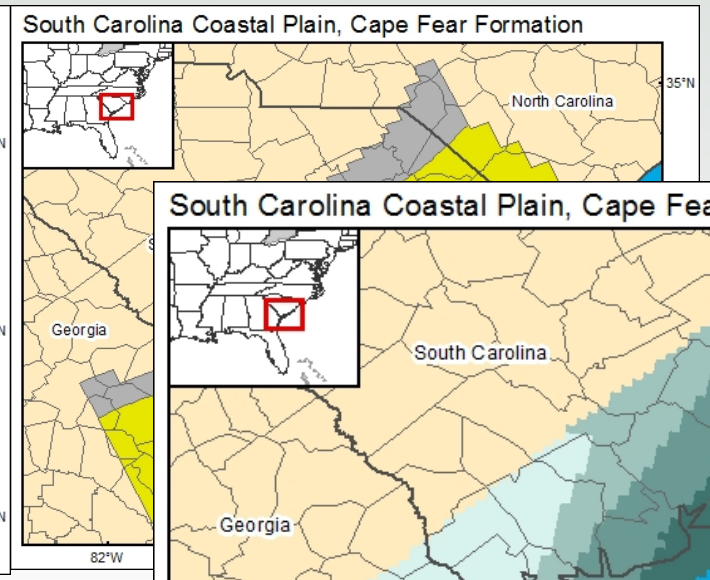
Depth



Sand thickness



Seal coninuity



Salinity

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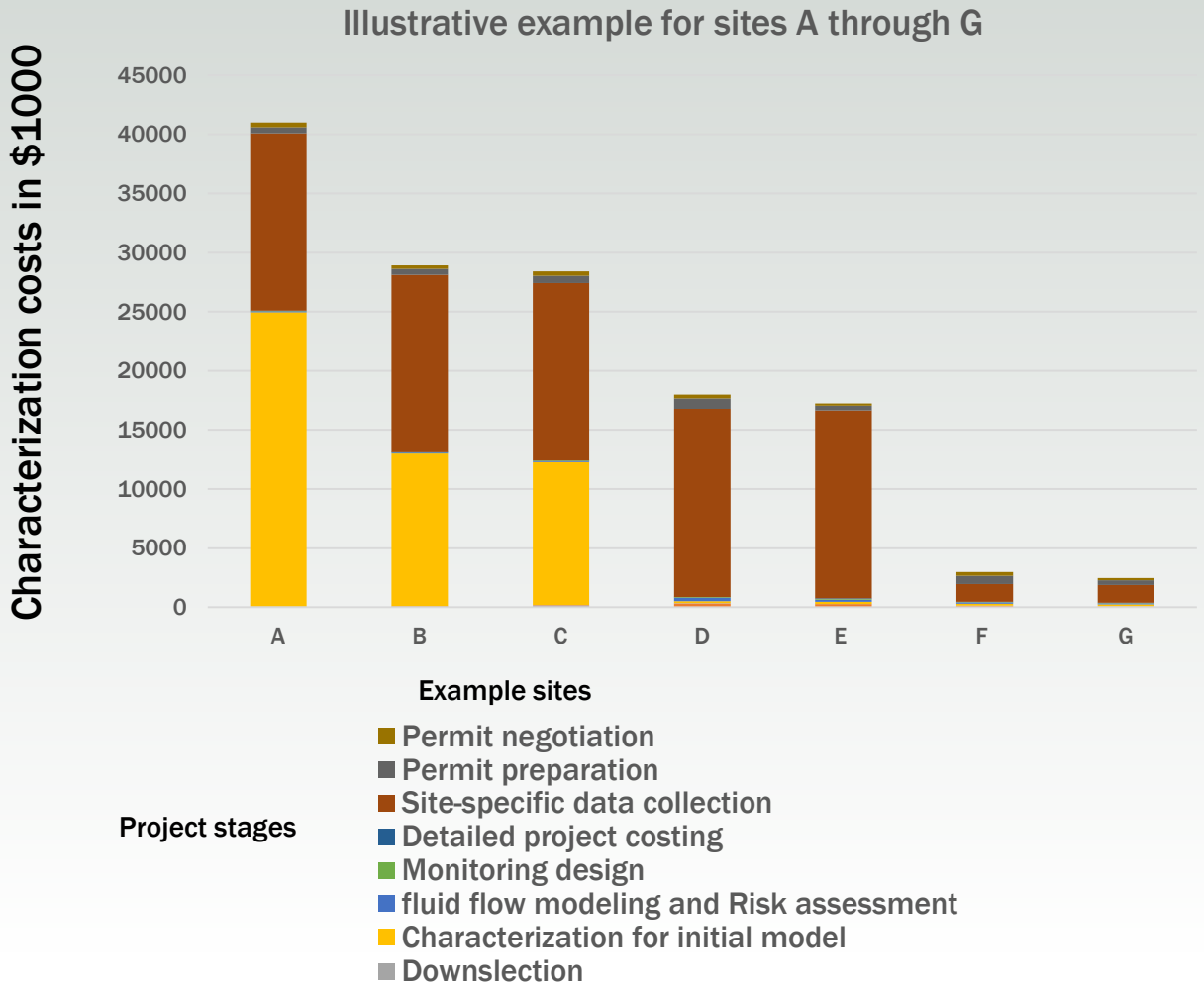
Project Status

- Conducted about a dozen studies (onshore and offshore) - mined for input data
  - What was done
  - Motivation
  - Method
  - Cost
- Use other sites characterized by others (data challenge)

Project Goal



- Develop geologic characterization :
  1. Constrained cost curve
  2. Cost-predictive matrix

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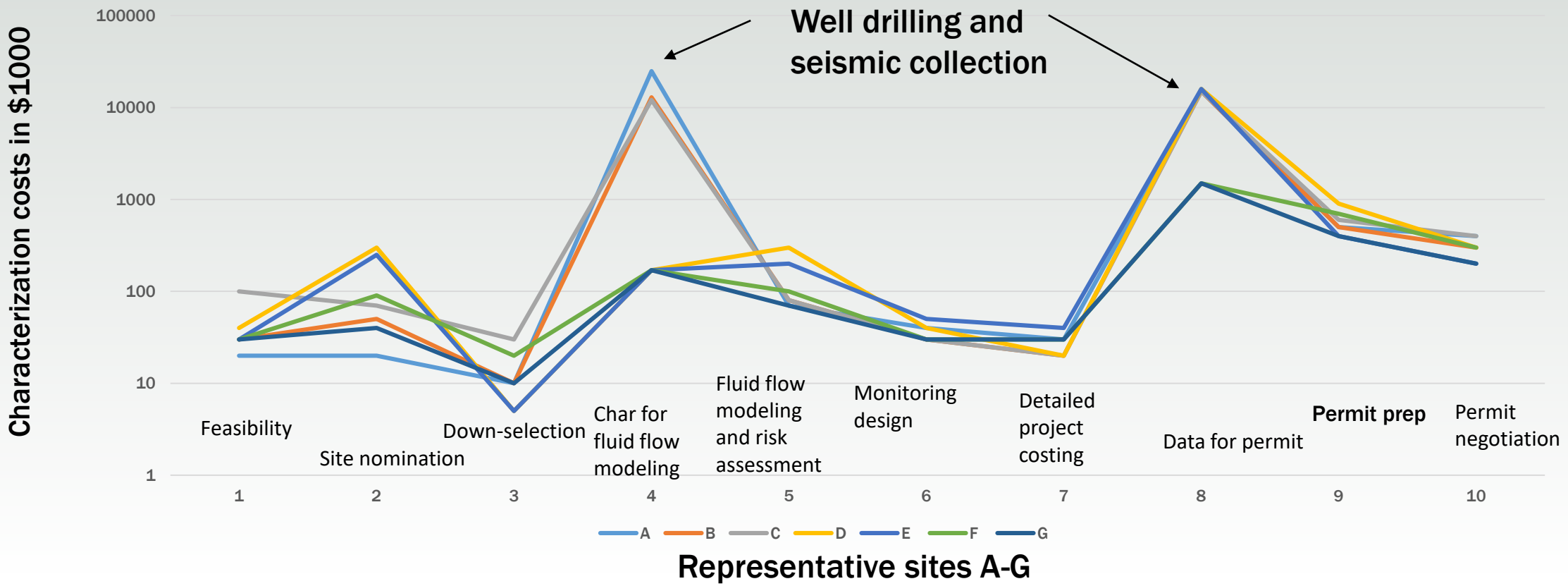
Spending per Project Stage



Site-specific data collection Permit preparation Permit negotiation

Data Types

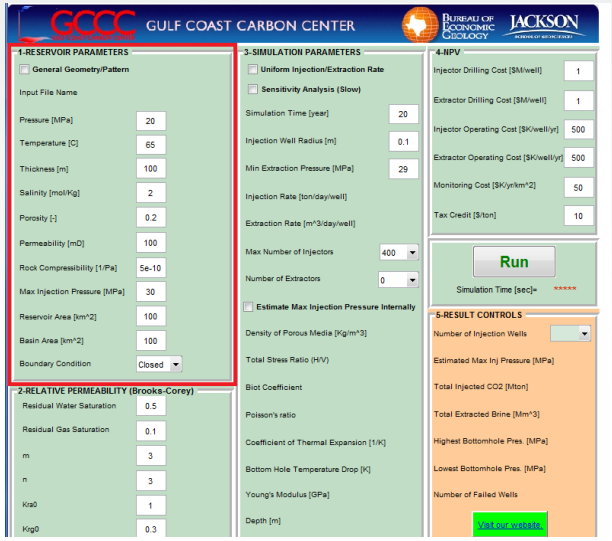
- Comprehensive list of data needs (e.g. reservoir thickness and porosity)
- Types of input
  - core, thin sections, SCAL, logs, log calibration
- Risk based driver
  - thickness and porosity limit project?
  - need large investment?
- Data availability at sites
- Order-of-magnitude cost for acquiring data
  - analyze existing vs. collect new core

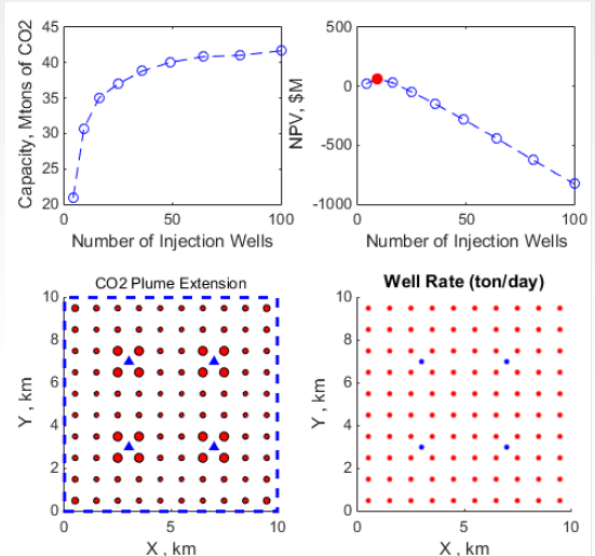
Capacity Estimation

- Rate based because it must match project economics

mass per year x planned project duration < total capacity

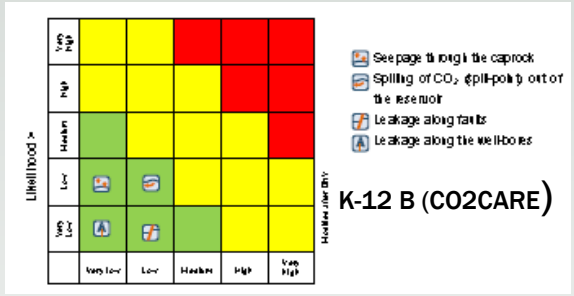
EASi Tool as a first step:
https://www.beg.utexas.edu/gccc/research/easitool

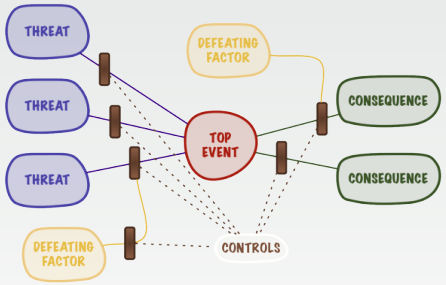


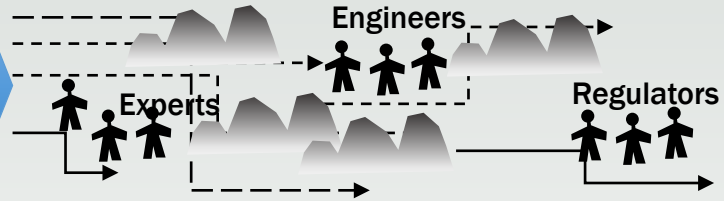


Linking risk assessment with monitoring

Risk Assessment method

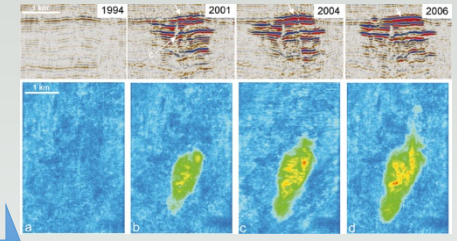




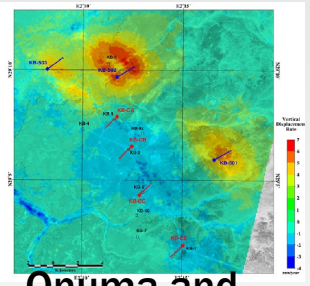


Process of designing and selecting monitoring can be complex, conducted without documented process, non-linear and therefore difficult to duplicate or justify

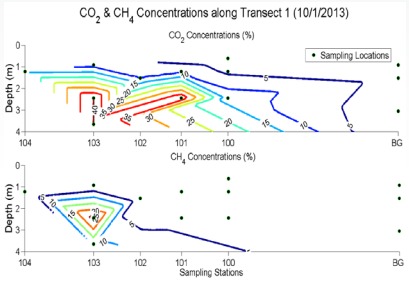
Select monitoring systems



Chadwick BGS



Onuma and Ohkawa, 2009



Hovorka, 2017; Hovorka et al, 2014

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Proposed Method for Linking

- Matching monitoring to risk via forward modeling -variant using an ALPMI* process

Assessment of Low Probability Material Impact (ALPMI)

  - Part 1: Describing *material impact** quantitatively
  - Part 2: Sensitivity of monitoring strategy to *material impact**

- Attaining confidence in retention prior to closure

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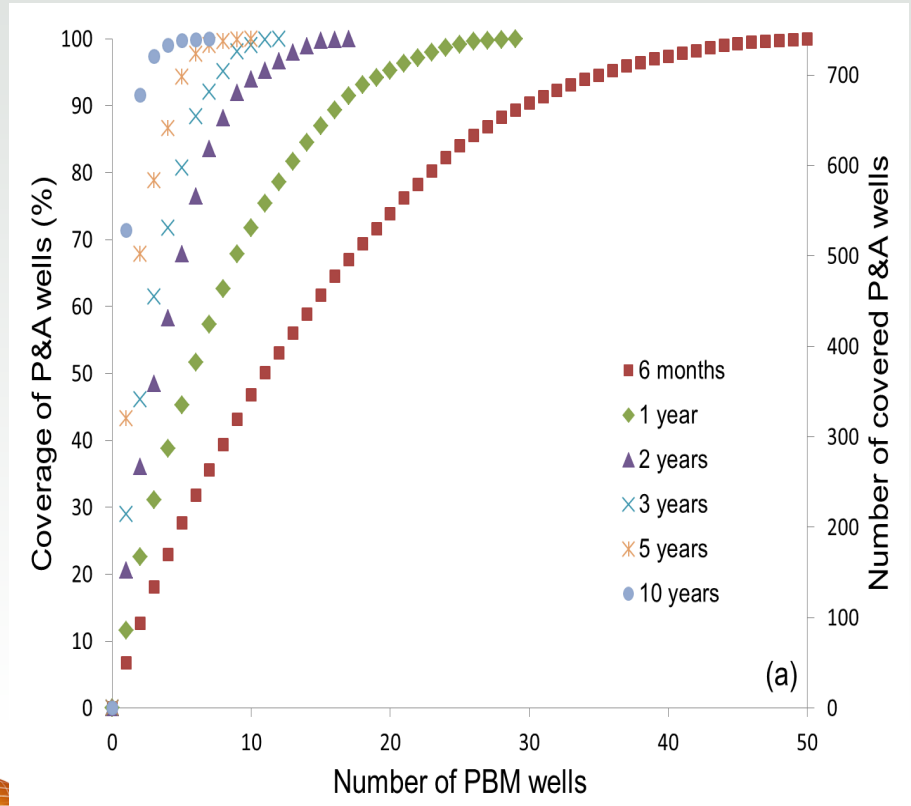
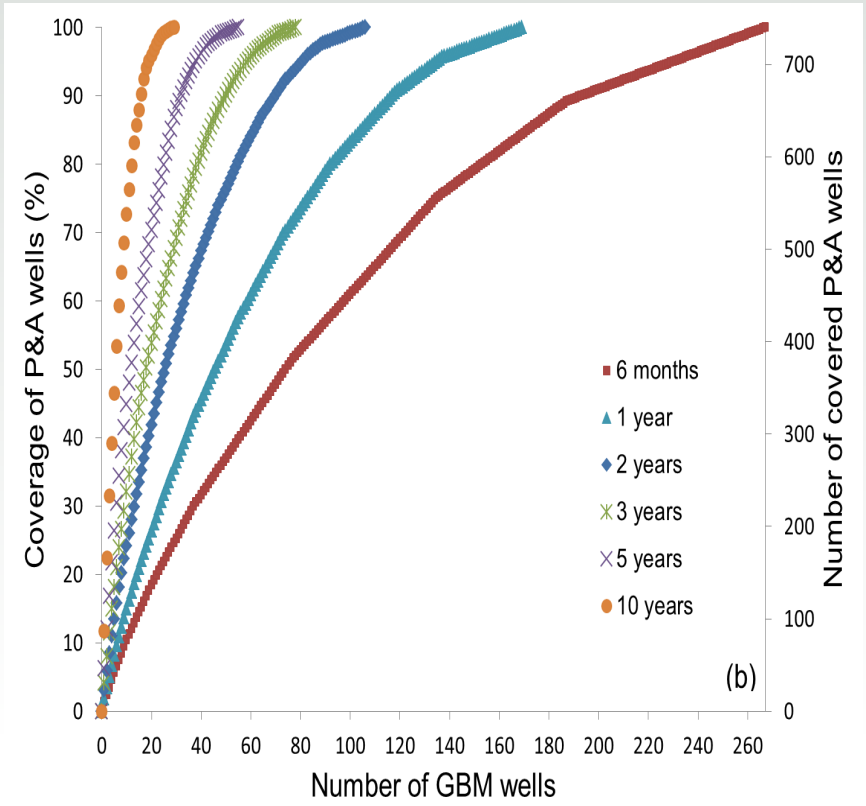
* Defined next slides

Sensitivity analysis for leakage detection time in models

Detecting pressure signal



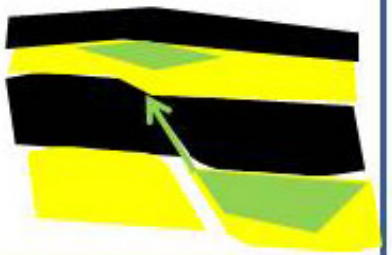
Detecting geochemical signal



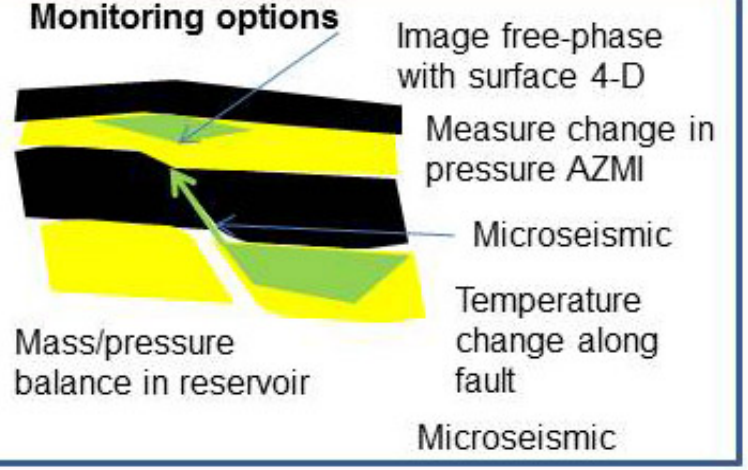
Behni Bollhassani, UT MS thesis

Characterization Uncertainty: Fault-seal?

ALPMI

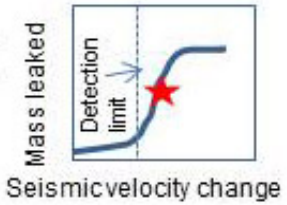


Monitoring options

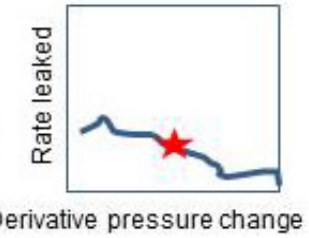


Test Sensitivity of Monitoring Options

Image free-phase leaked CO_2 with surface 4-D

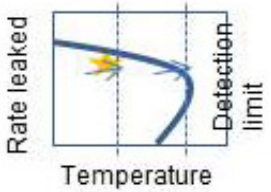


Change in rate pressure increase in reservoir



Measure change in pressure AZMI

Temperature change along fault



Set triggers, stage monitoring options

- Select microseismic as pre-failure trigger
- AZMI pressure as most sensitive trigger
- Select Image with surface 4- D and change in rate of pressure change in reservoir as post-trigger follow up.
- Decrease analysis of microseismic after pressure peaks and plateaus

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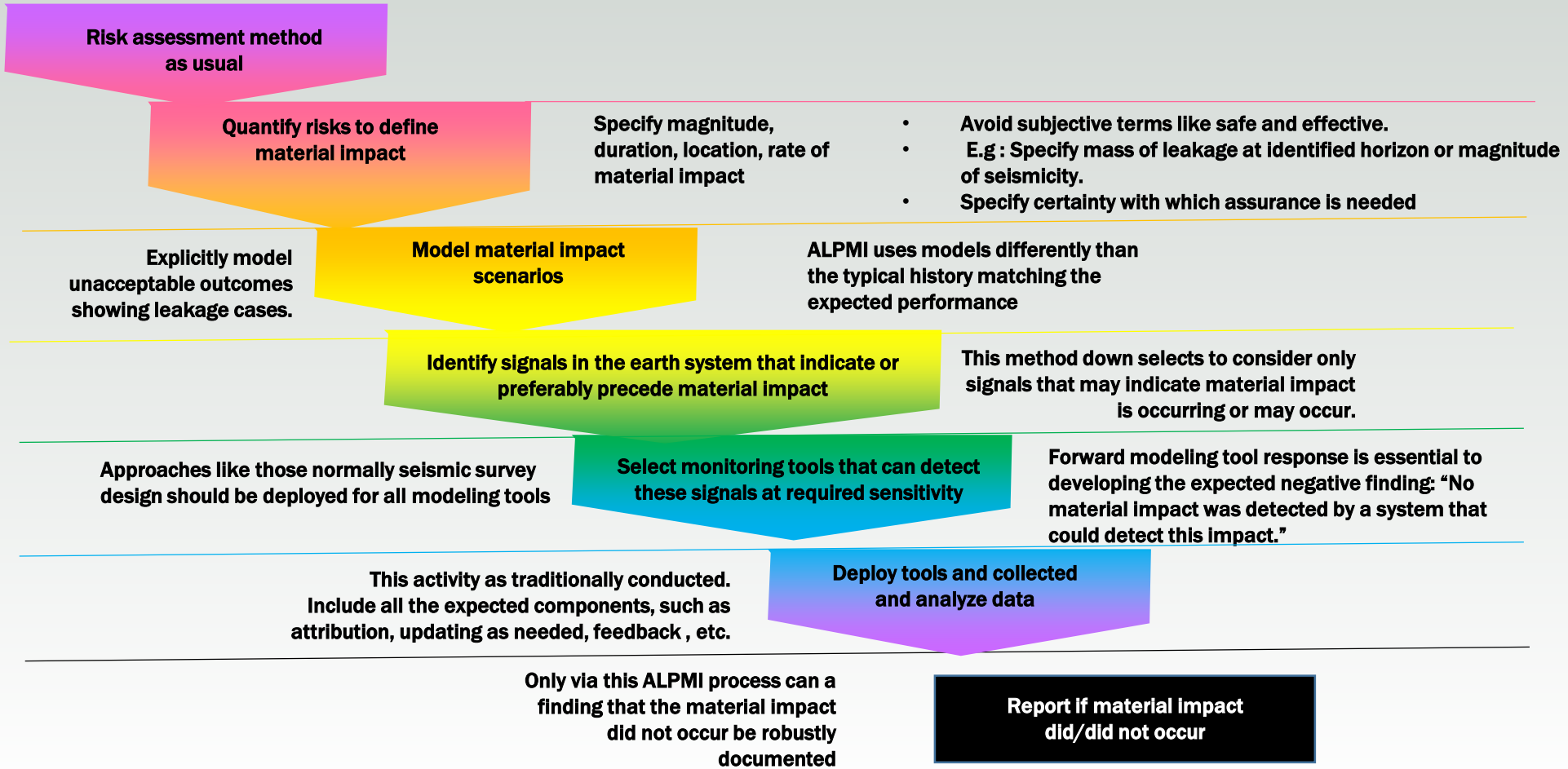
ALPMI method overview



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Suggestions?

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