Costs and Experience with CO$_2$ Storage Monitoring and Verification

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Monitoring and verification

- Operational monitoring
  - short term, alarms

- Verification monitoring
  - keeps the project within the acceptable risk framework of stakeholders

- Environmental monitoring
  - monitoring of last resort (no news is good news)
Operational monitoring

- High frequency
  - pressure
  - temperature
  - volume
  - rate
Verification monitoring

- Plume monitoring
- Storage integrity monitoring:
  - caprock
  - wells
Verification monitoring

- Requires baseline data for comparison
  - static models (original state)
  - dynamic models (make predictions about future)
Verification monitoring

- Stakeholders must agree on an acceptable risk framework
- Over time, verification ensures that the project stays within the framework
Risk framework
Risk informed action

- Collect more data to reduce uncertainty (likelihood of a negative event)
- Create an operational plan that can be adapted over time, includes:
  - which measurements (site related)
  - what resolution (level of detail)
  - when (time interval: short, medium, long)
  - where (3-D placement)
- Change plan based on new information (must history match)
Monitoring quality - resolution

- Narrow azimuth: 15k ft aperture
- Wide azimuth: 34k ft aperture
Environmental monitoring

- Requires baseline data
- Looking for impacts. (no anomaly is good news yet subject to interpretation - uncertainty)

Types:
- soil sampling
- water sampling
- atmospheric monitoring
- cement sampling
Costs

- Operational monitoring (very small – pennies per ton)
- Environmental monitoring (very small – pennies per ton)
- Verification monitoring (small relative to CCS - dollars per ton ?)
  - depends on site
  - driven by risk tolerance - “risk informed decisions”
  - overlaps with characterization and operational costs (baselines needed)
Commercialization timeline, costs and uncertainty

* Per ton estimates and total costs (in current day $USD) are based on 100Mton lifetime storage volume
Conclusions

- The costs of monitoring and verification are small relative to the overall cost of CCS
- Monitoring and verification costs depend on the level of risk stakeholders are willing to take
- The key to keeping monitoring and verification costs low is selecting a good site