Integrated Wellbore Integrity Program: Results on Testing CO_2 Wells for Defects

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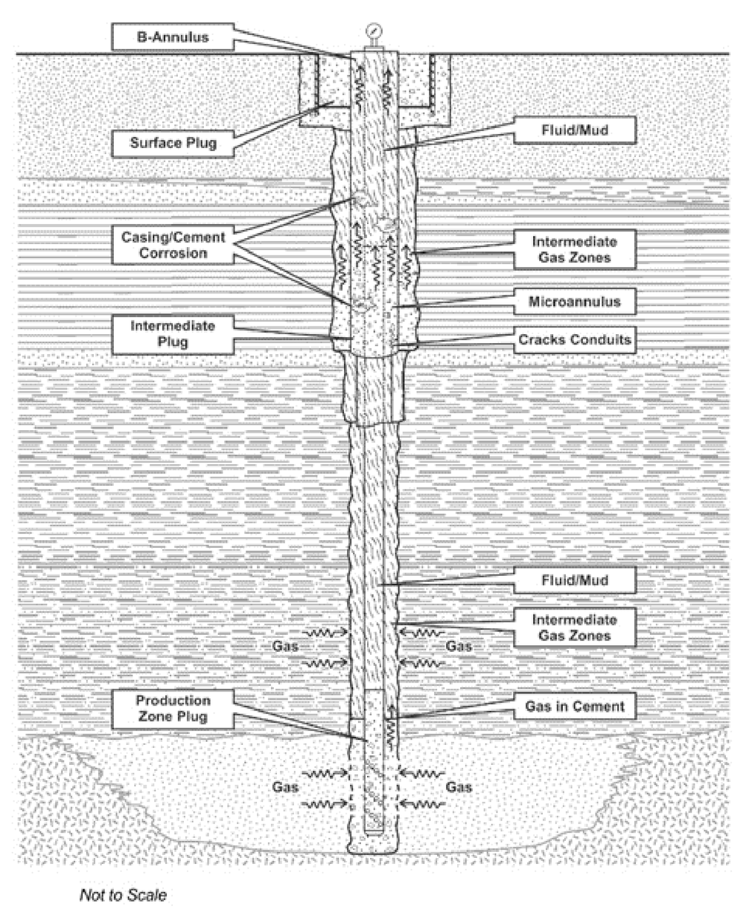
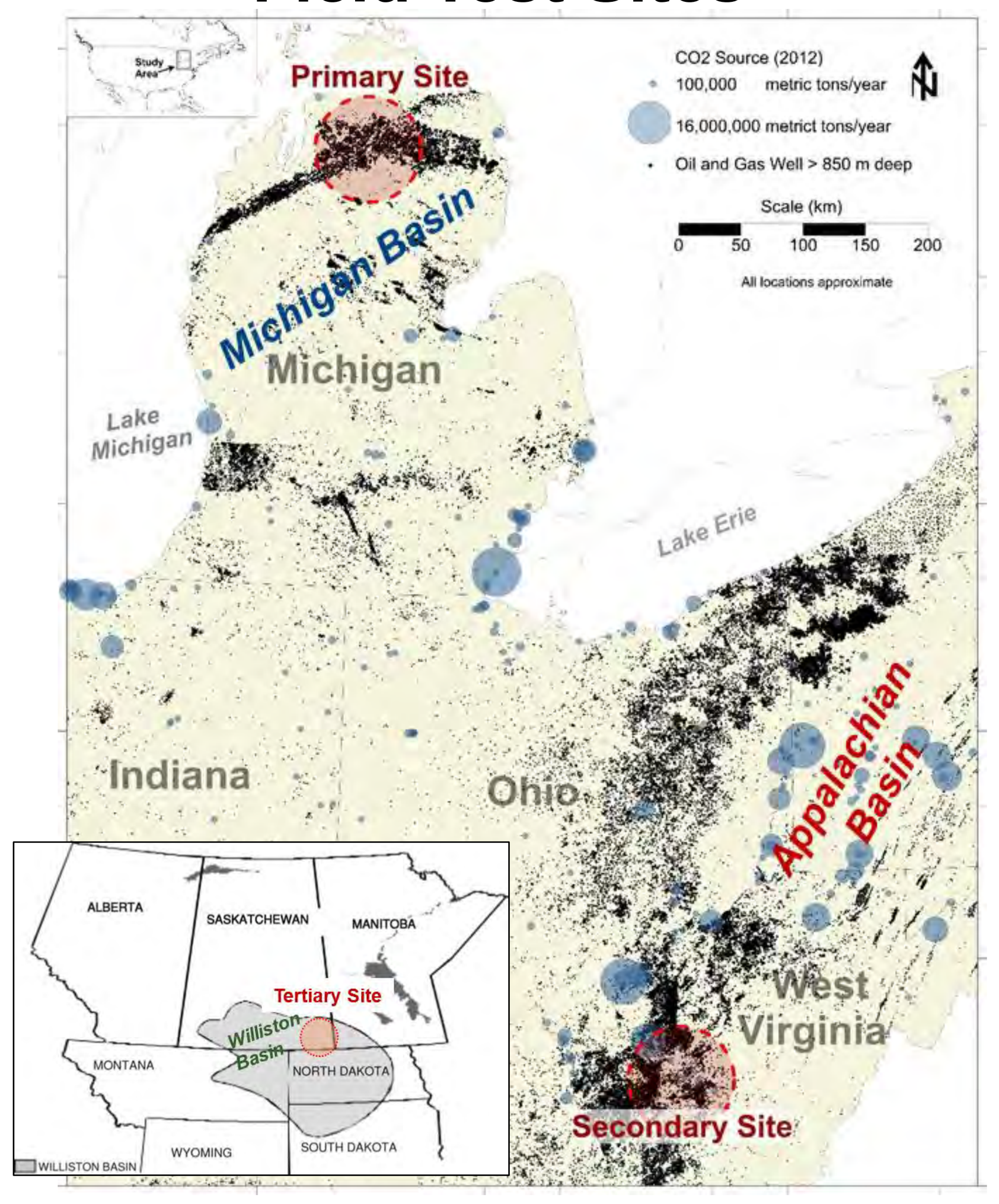
OBJECTIVES

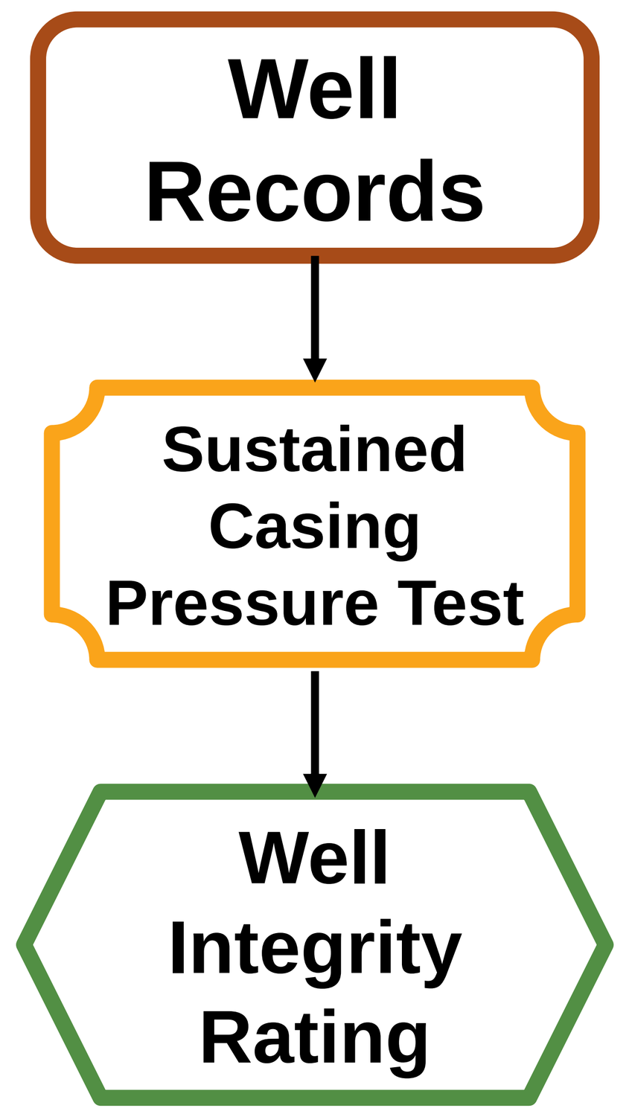
- During a typical life cycle, wells may develop a combination of defects, which may be exacerbated by subsurface CO_2 exposure.
- Defects may include cement degradation, casing corrosion, mechanical breaks, micro-annulus, cracks, porous cement, incomplete cement, and more.



- What can be learned from direct tests on existing wells that have been exposed to CO_2 in the subsurface for 20-50+ years?
- To better understand the condition of oil and gas wells subjected to CO_2, 3 sites were investigated with wellhead sustained casing pressure testing and well history review.

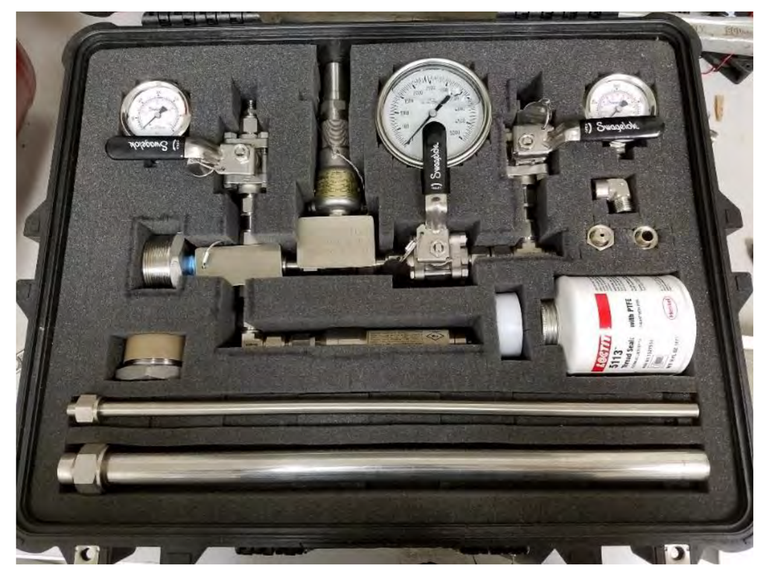
Field Test Sites



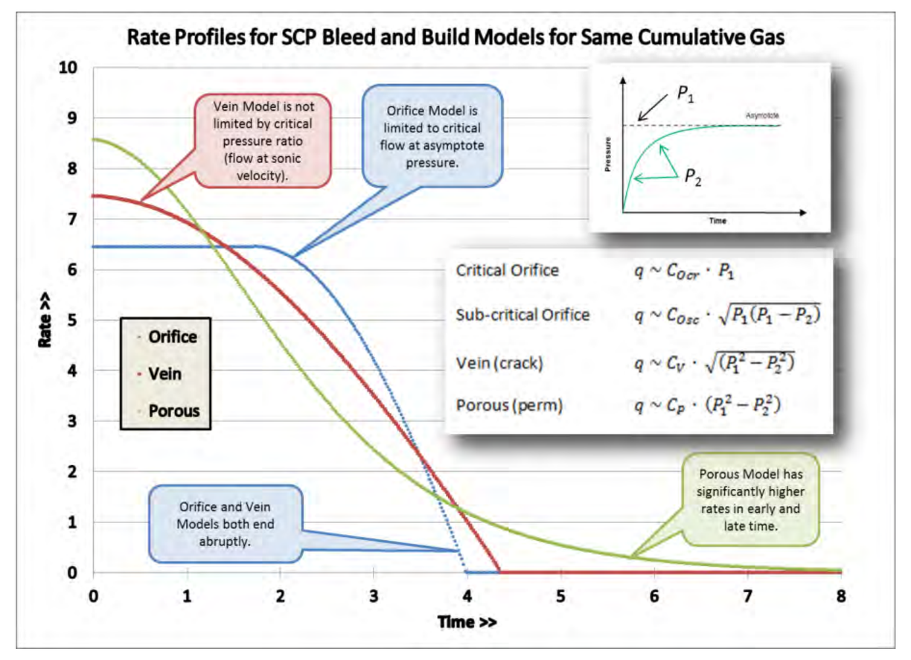


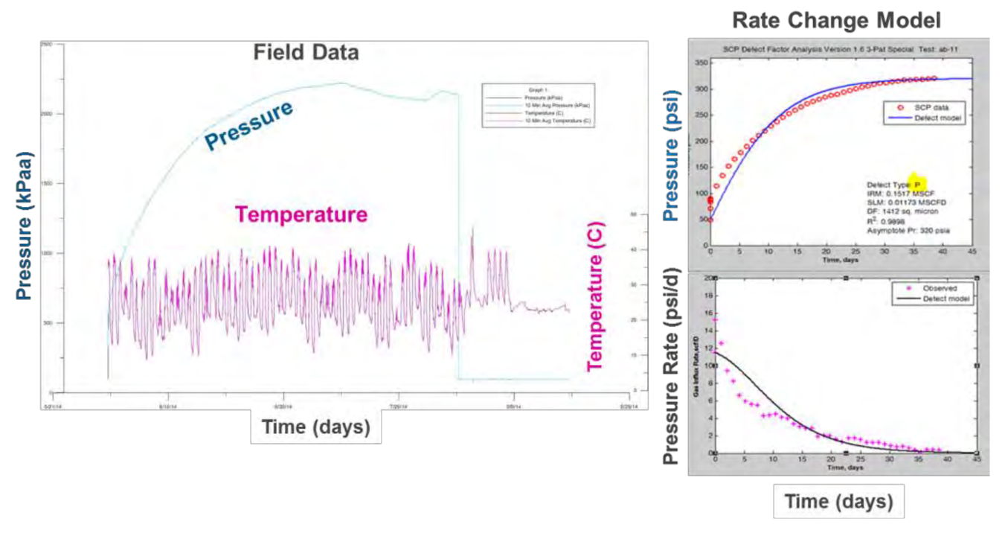
METHODS

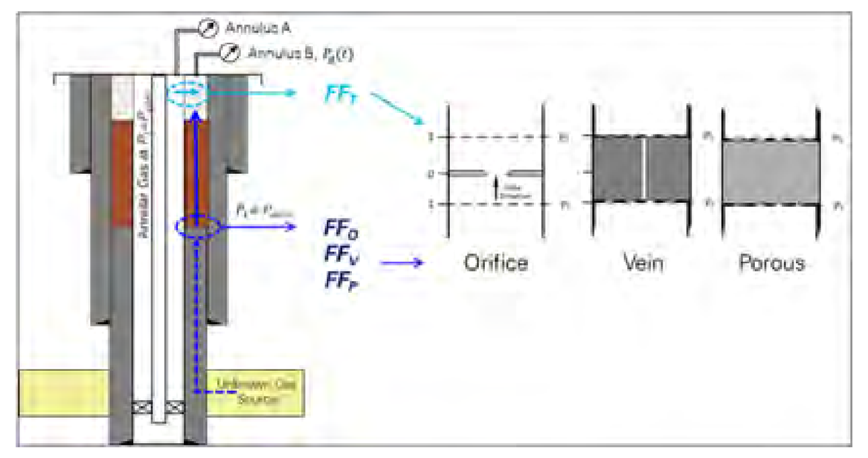
- ~1,500 wells at three field sites were reviewed, and a sampling of 53 CO_2 wells were measured for casing pressure.
- 23 wells were tested with a methodology developed to diagnose wellbore defects based on testing sustained casing pressure buildup curves directly at the wellhead.



- Testing provided a **direct measurement of well conditions** thru a non-invasive method to assess the nature, severity, and general location of well defects. (Method has limitations, requires defect leading to gas migration to the wellhead).
- The test data was compared to well records (well repairs, workovers, inspections, bond logs) to better define well history/construction.
- Together, this information was analyzed to better understand the risks that legacy boreholes may pose for CO_2 storage.



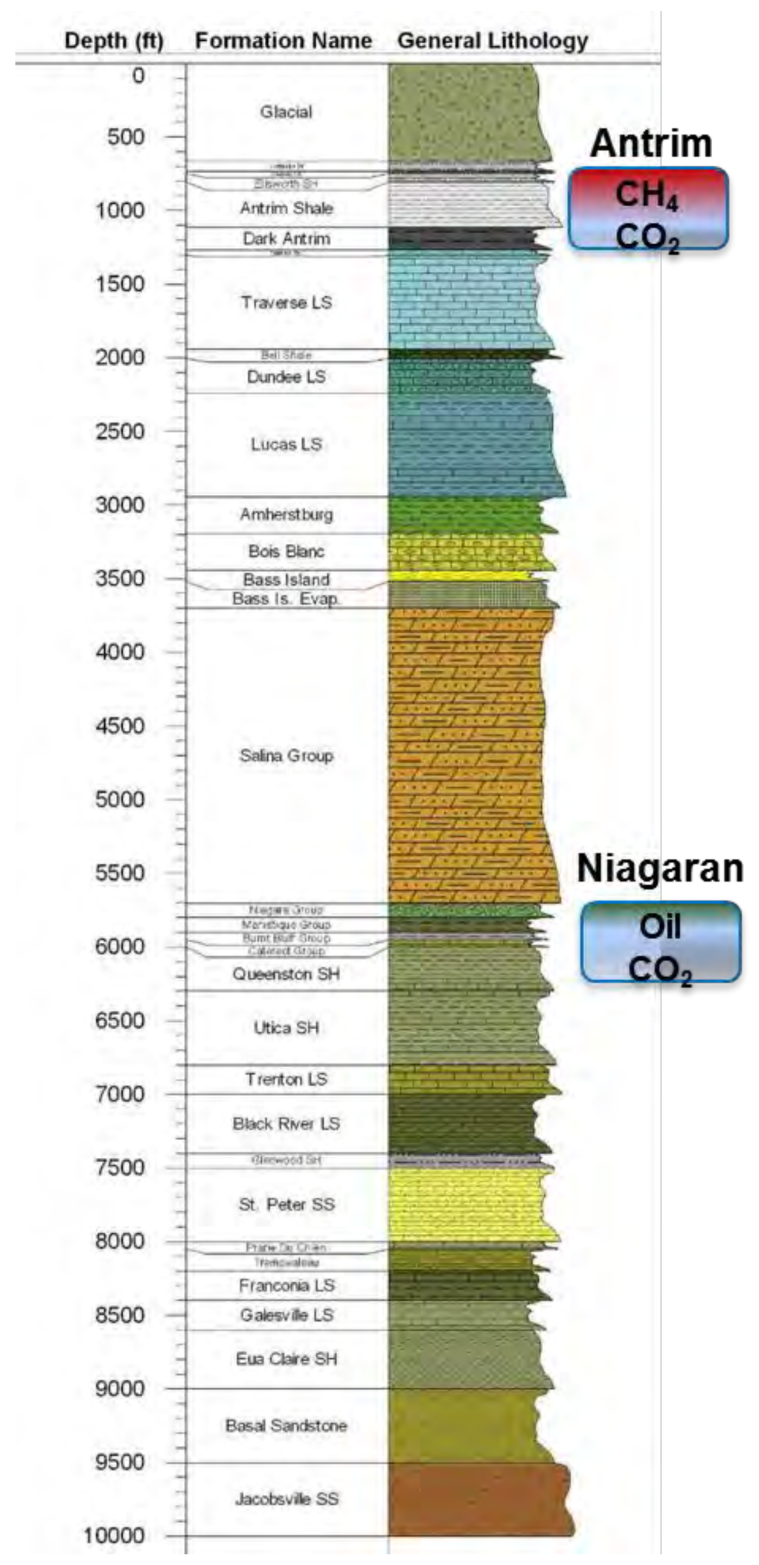




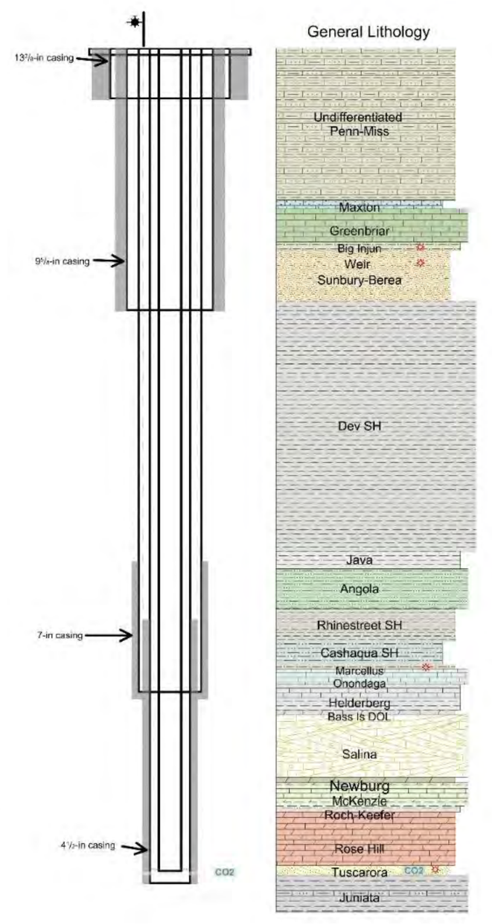
*Sustained Casing Pressure Diagnosis Using the Wellhead Model, Mark Moody, Bryan Dotson, and Matthew Place, SPE/CSGM Gas Migration Challenges – Identification and Treatment Workshop, 13-14 May 2015, Banff, Alberta, CA.

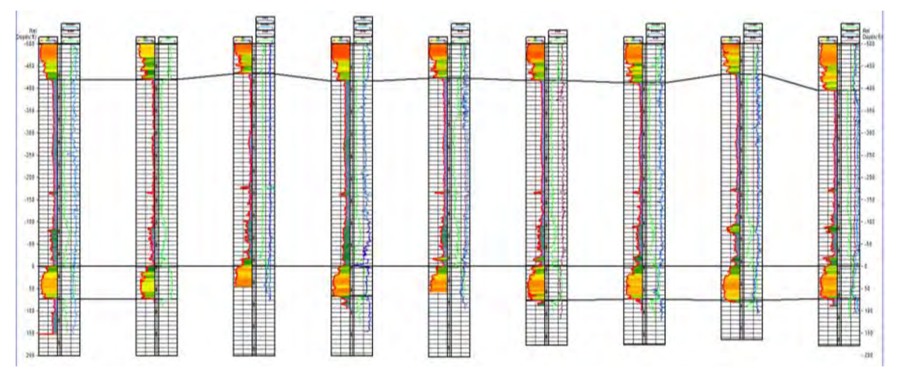
FIELD SITES

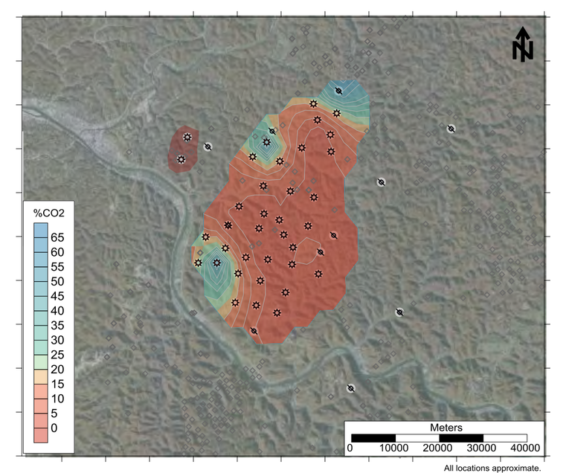
- **Michigan Basin site**- high natural CO_2 in a relatively shallow (350 m) shale gas play, & deeper (1850 m) carbonate CO_2 EOR field.
- 5-30% CO_2 in Antrim Shale, 300-500 m
- 95-99% CO_2 in EOR zone at 1,500-2000 m



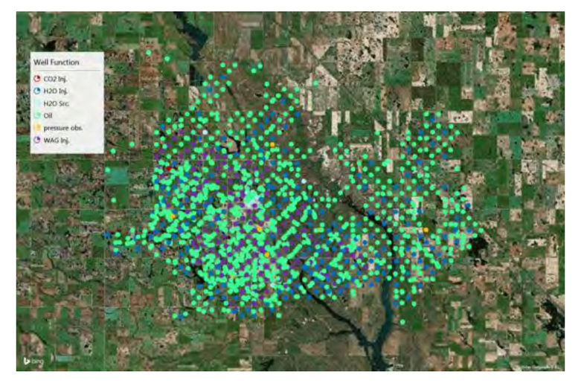
- **Appalachian Basin site**- high natural CO_2 levels in a sandstone reservoir at a depth of ~1,850 m.
- 20-83% natural CO_2 in areas of the field. ~58 existing wells circa 1960-2003. *Site sold to new operator so no field tests were possible at this site.*

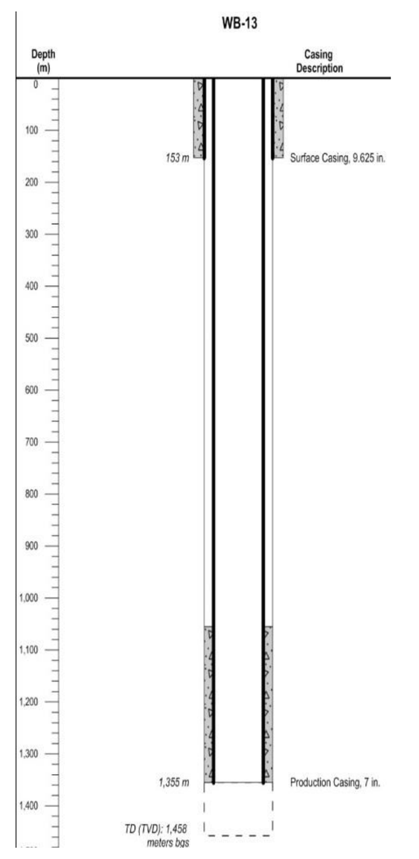






- **Williston Basin site-** 1,400+ wells, primarily oil producers along with H_2O or CO_2 EOR.
- Well age 1950s-2000s, EOR at 1500 m.

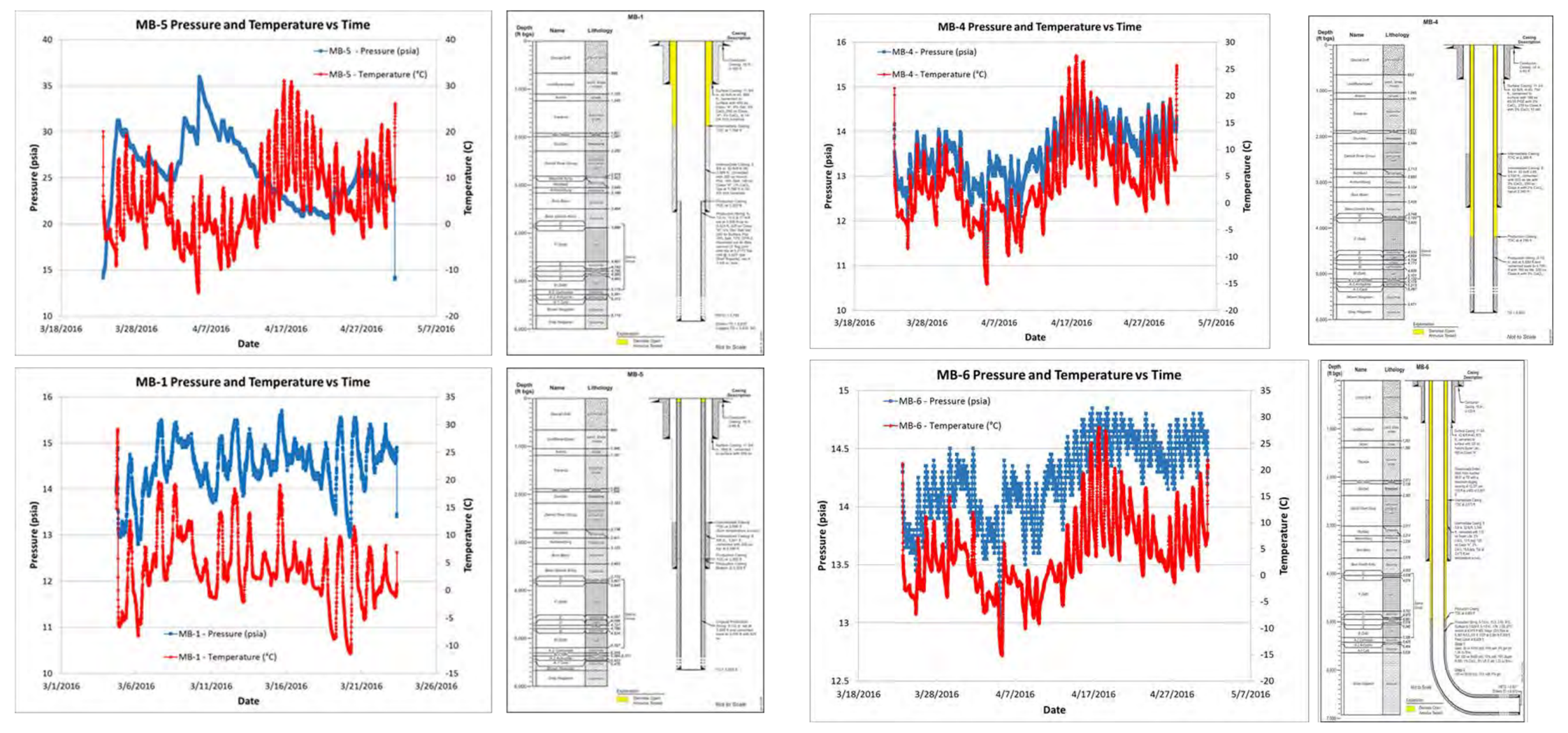




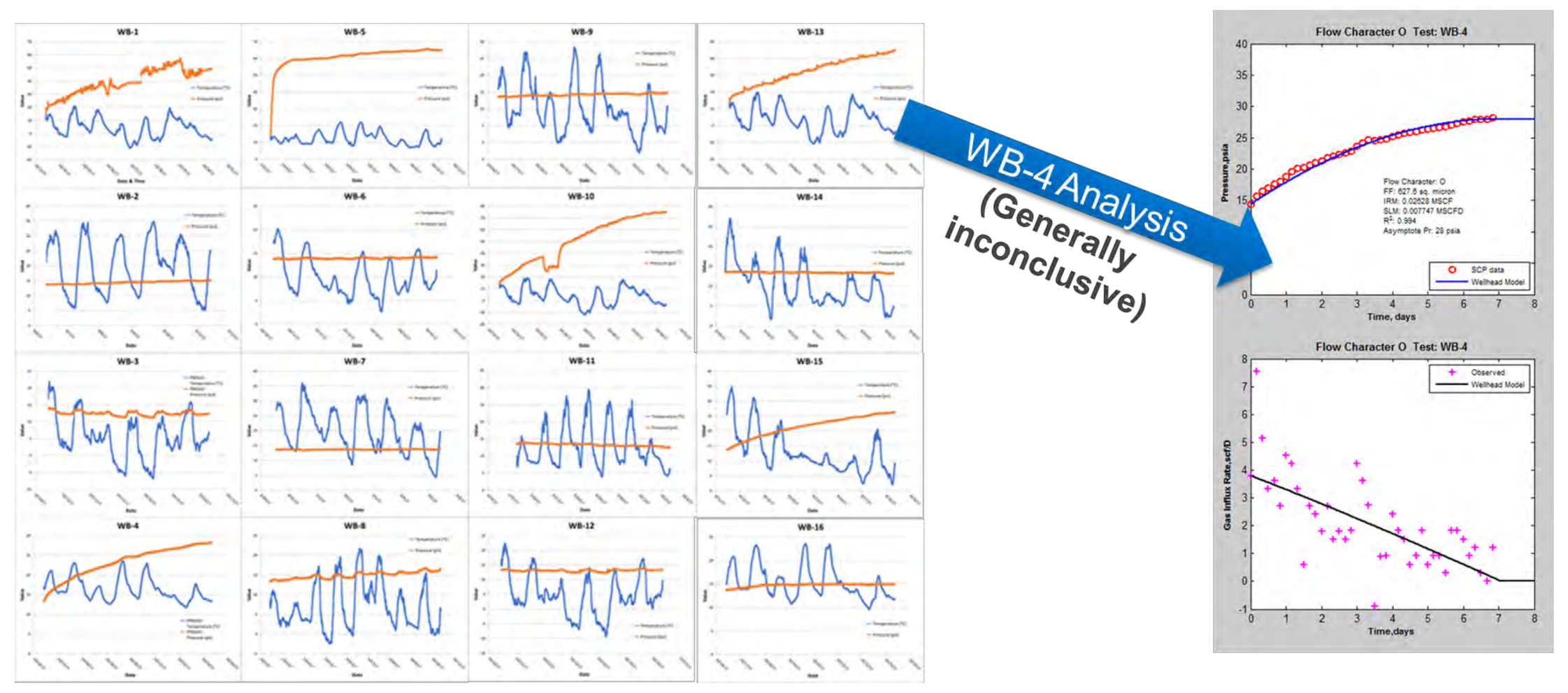
RESULTS

- Overall, sustained casing pressure was not a common problem for the tested wells.
- The tested wells had minor casing pressure (1<MPa) related to thermal effects or shallow gas. Pressure buildup was insufficient for analysis.

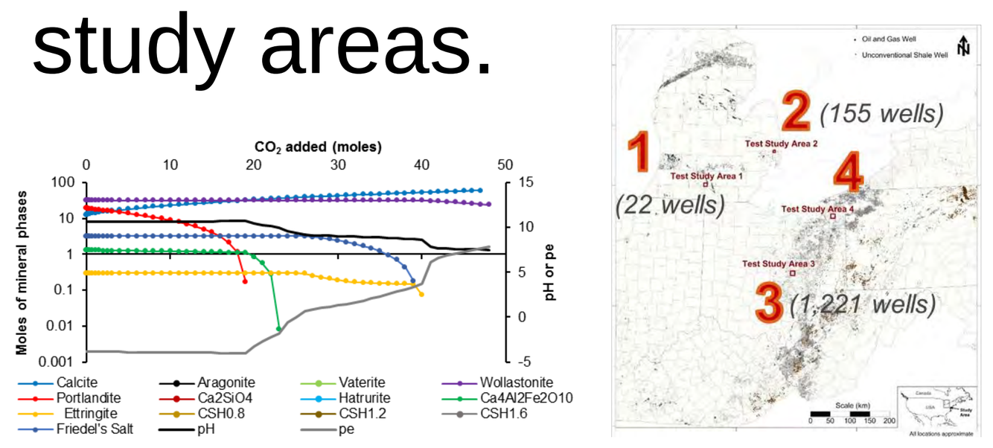
Michigan Basin site

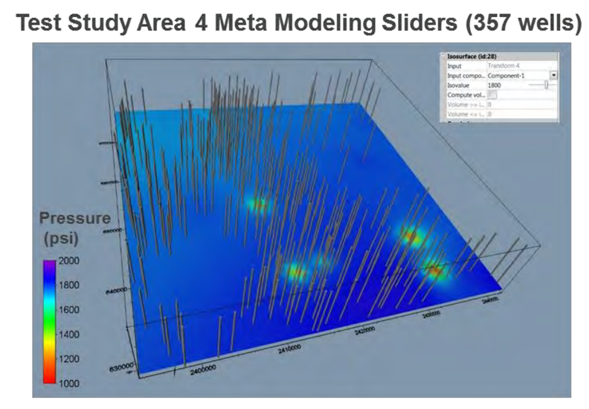


Williston Basin site



- Meta models developed based on PHREEQC geochemical analysis and applied to 4 test study areas.





- 1,500 wells were reviewed, 53 CO_2 wells were measured for SCP, and 23 wells were tested for SCP at three field sites.
- The wells exhibited zonal isolation with no indication of significant well defects.
- Well construction and/or cement carbonation sealing may have contributed to well integrity.

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