SYSTEMATIC ASSESSMENT OF WELLBORE INTEGRITY USING REGULATORY AND INDUSTRY INFORMATION

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Presentation Outline

- Statement of the Problem
- Project Objectives
- Technical Status
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- Summary / Results and Conclusions
Statement of the Problem

- Areas in the Midwest have perceived risk for carbon capture utilization and storage (CCUS) due to long drilling history.
- However, many of the old wells may not present high risk for CCUS because they are shallow or effectively plugged and abandoned.


Titusville, PA, 1865

Morrow Co., OH, 1964
Project Objectives

• The objective of the project is to complete a systematic assessment of wellbore integrity using regulatory and industry information.

• The project will determine the distribution of wellbores in a study area through collection and analysis of well records.

• The data review will be linked to analysis of well casing annulus pressure data as they relate to well condition.

• Project results will identify and develop methodologies that can indicate future wellbore integrity risks from available public domain data with high confidence.
Project Objectives

• The project will summarize remediation and plugging methods, costs, and level of effort for potential CO$_2$ storage zones.

• Based on the well integrity evaluation, guidance will be developed for siting CO$_2$ storage applications.

• Key storage targets will be identified with least risk from abandoned wells.

• Technology guidance will be provided for well completion and abandonment applications.
Technical Status

• Regional well data collection task was completed on June 20, 2013. Oil and gas well records for Ohio and Michigan were collected in three categories:
  – Well construction information,
  – Plugging and abandonment details, and
  – Cement bond logs.

• The dataset includes over 4 million items related wellbore construction in Ohio and Michigan.
Technical Status

- A total of 53,825 oil and gas well records were acquired from the Michigan Department of Environmental Quality, of which a total of 34,612 wells (66%) are listed as plugged and abandoned.

- A total of 229,992 oil and gas well records were acquired from the Ohio Department of Natural Resources database, of which 102,246 (44%) were listed as plugged and abandoned.
Well History Review - NE Ohio

Majority of vintage wells were drilled to shallow producing formations which pose little risk of CO2 leakage from deep storage wells.

Majority of deep wells were recently drilled and constructed under modern regulations which reduces the risk of leakage pathways.
Plugging and Abandonment Well Records Analysis

• Michigan plugging and abandonment records were collected and a random subsample of 5% was generated.
• Plugging and abandonment records for these 1730 wells were tabulated.
• Ohio plugging and abandonment records were available from 6390 wells.
• A quality assurance/quality control (QA/QC) review of the dataset was completed to identify errors in data entry.
Analyzing Cement Bond Log Data

• Current work includes developing a systematic procedure for consistency in interpreting CBLs.

• Cement bond logs were reviewed for Michigan and Ohio. All of the public cement bond log data was mapped and a 5% subset (145 logs) was assembled for the study.

• A total of 1,720 cement bond logs were available for Michigan and 1,060 cement bond logs were available for Ohio.

• These records were randomly sub-sampled to obtain 5% of the logs. The 5% subset was collated with well records for further analysis.
Ohio & Michigan Plugged Wells

Explanation:
- County Boundry
- Plugged Borehole Location
- 6,390 Total Plugged Holes With Data

Date Plugged Wells Completed

- 1900-1939
- 1940-1949
- 1950-1959
- 1960-1969
- 1970-1979
- 1980-1989
- 1990-1999
- 2000-2013

All Locations Approximate
Cement Bond Logs

Simple CBL with VDL Display

CBL/VDL with Cement Map
Sustained Casing Pressure (SCP) Analysis

• Casing annulus pressure can occur from thermal expansion of the annular fluid. However, once the annular pressure is bled down to atmospheric pressure and the valve is closed, the annular pressure should remain at atmospheric pressure. If the casing annulus pressure builds after the valve is closed, then the well is said to exhibit SCP.

• A SCP monitoring program is planned for a gas storage field in Eastern Ohio.
  – Initial review of records and geologic setting was completed for the field.
  – Eight (8) SCP candidate wells were selected for data gathering
Sustained Casing Pressure (SCP) Analysis

- SCP casing pressure buildup over time can be analyzed to determine cement permeability, location of leak and the nature of the migration pathway.

Source: Huerta et al., 2010
Sustained Casing Pressure (SCP)

Pressure on the tubing “A” annulus is normal and expected.

Pressure on the “B”, “C”, or “D” casing annulus is not expected and is considered SCP.

Source: R. Xu et al., 2001 SPE 67194
Accomplishments to Date

- Collaborated with BP Alternative Energy and NiSource to develop technical approach for well record collection, sustained casing pressure analysis, cement bond log analysis and field monitoring locations.

- Well data from Ohio and Michigan was summarized with maps and graphs illustrating well status, age, formation, and total depth.

- Plugging and abandonment information was compiled for Michigan and Ohio.
  - These datasets include information on number of plugs, plug depth, plug material, additives, and date. Data was summarized with graphs and maps.
Lessons Learned

• Data gathering can be a slow and laborious process
  • Public well information prior to 1940 is inconsistent in accuracy and content
  • QA/QC is required due to data entry errors and inconsistencies in data
  • Old well files are sometimes handwritten and hard to interpret
  • Lots of data in well files is not pertinent to the project
• Vintage data requires manual data entry and processing
• Many Vintage wells have little or no public data
Summary - Results/Conclusions

- This project is in its preliminary stage.
- Well status and construction information was analyzed for Ohio and Michigan.
- Records indicate 53,800 oil and gas related wells in Michigan. 65% are listed as plugged.
- Records indicate 229,992 oil and gas related wells in Ohio. 44% are listed as plugged.
- Few sustained casing (SCP) pressure measurements are available from the region.
- Future work will include:
  - field pressure monitoring of SCP, and
  - applying this data to the larger regional dataset to evaluate geologic CO$_2$ storage zones.
Development of Subsurface Brine Disposal Framework in the Northern Appalachian Basin

• Objective: Complete a systematic assessment of brine disposal wells in the region to support unconventional resource development.
  – Develop a geologic framework with regard to injection zones, regional and local extent, reservoir performance parameters, and operational data.
  – Complete local reservoir simulations for injectivity, pressure buildup, geomechanical constraints of stress magnitude and orientation.
  – Evaluate aspects of disposal based on demand, storage capacity, and well costs.
  – Provide guidance for developers, gas producers, regulatory agencies, and public stakeholders.
Questions?