Surprises from Site Characterization Data Create a Permitting Impasse for the Kevin Dome Project

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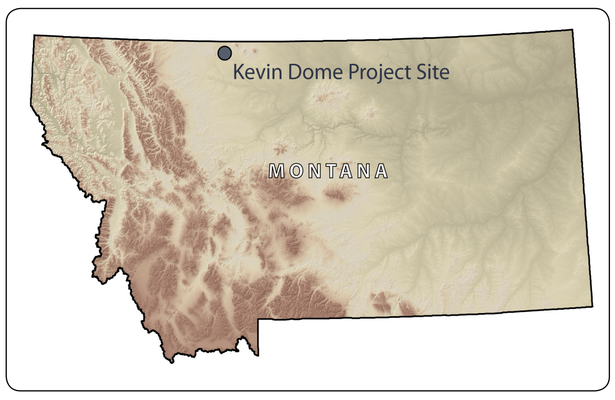
Abstract

The Big Sky Carbon Sequestration Partnership (BSCSP) selected a potential site in northern Montana to conduct a large carbon storage demonstration project as part of NETL's Regional Carbon Sequestration Partnership Program. The site was selected because the Kevin Dome contains a naturally occurring source of CO2, and the site has appropriate geology with a proven caprock that overlies porous rock. Characterization activities that led to the selection of Kevin Dome included collection and analysis of hundreds of wells for formation top depths and acquisition of dozens of well logs for analysis of rock properties. BSCSP also evaluated existing regional seismic data as well as produced water from available databases. The data from the produced water databases was limited in the region, but the existing data indicated that the formation waters were saline and that total dissolved solids (TDS) were above 10,000 ppm.

For further site characterization, the team developed geologic models, completed a large 3-dimensional seismic survey, and drilled, logged and cored two wells within the project area. Formation water samples from the Duperow formation were also taken and analyzed. Despite the water samples being toxic with high levels of H2S, the water quality analysis found that the TDS for the Duperow at the project site is below 10,000 ppm. Following this discovery, BSCSP had discussions with the Environmental Protection Agency (EPA) to determine if there was any exception to the Class VI regulations or to determine if there were any other permitting pathways for the project. This poster discusses the characterization and permitting processes in more detail and lessons learned.



Kevin Dome project area map

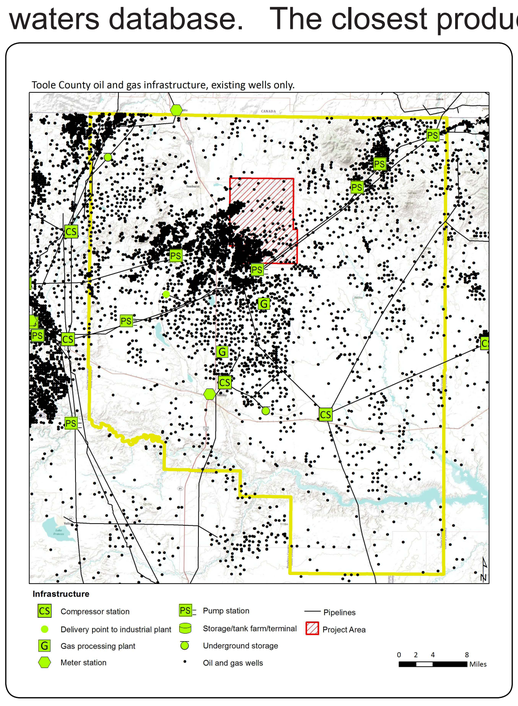
Site Selection Process for Kevin Dome

Oil and gas were first discovered on Kevin Dome in 1922, and the dome has had a long history of exploration and production. Over 4,000 wells have been drilled into the dome, but less than 5% of these wells have been drilled into the Duperow Formation where the naturally occurring CO2 is trapped on the dome.

The selection of Kevin Dome for CO2 injection was based on geologic characterization using available data obtained by reviewing literature, studying nearby outcrops, and collecting and compiling all available subsurface data. Information from oil and gas wells including well locations, elevation data, formation top depths, drill stem test results, available core analyses, and production data were analyzed. Well logs were correlated and formation tops were normalized to provide structural datums for key geologic boundaries and reservoir petrophysical data (porosity and lithology data).

BSCSP conducting a 3-D seismic survey

The Environmental Protection Agency's (EPA) regulations for Class VI injection wells require that formation waters targeted for CO2 injection must have a TDS value of 10,000 ppm or greater. This is because the EPA's regulatory definition of an Underground Source of Drinking Water is a water source that has 10,000 ppm TDS or less. Water quality data for initial site selection was obtained from the U.S. Geological Survey (USGS) produced waters database. The closest produced water sample data point to the targeted injection location was 27 miles to the south and had TDS values of 218,595 and 216,329 ppm. The next closest TDS data point was 30 miles west with a value of 55,176 ppm. At approximately 50 miles from the site, TDS values for Duperow equivalent waters in two additional wells ranged from 9,997 to 17,299 ppm.



Detailed Site Characterization at Kevin Dome

To ensure the project site met requirements for both production and injection of CO2, steps were taken at the onset of the project to fill data gaps and reduce uncertainty. BSCSP conducted a 37 square mile 3D 9C seismic survey to map the subsurface and look for faults and fractures. BSCSP also drilled two characterization wells. One well was intended to be a CO2 production well (Danielson 33-17) and the other well was near the injection area and was intended to be a monitoring well (Wallewein 22-1). The CO2 well was drilled to a depth of 3,800 feet, and the monitoring well was drilled to 4,704 feet. In both wells, multiple logs were taken, core samples were collected, and the wells were perforated in multiple zones. In the Wallewein well, the formation water was sampled from the targeted injection zones at depths of 4,185' to 4,190' and 4,040' to 4,057'.

Wallewein Water Samples

Water Quality Data

The downhole sampling in the Wallewein well took place during two campaigns. The first set of samples had very high levels of hydrogen sulfide (H2S). Because of this, some water quality labs refused to analyze the samples out of safety concerns for their lab personnel. This resulted in all of the samples from the first sampling campaign exceeding the holding times set forth by EPA methodologies.

During the second sampling campaign, a new lab was found that could handle the high H2S toxicity of the samples. The samples from the second campaign were analyzed within the method's holding times. During the second campaign, the water was sampled in duplicate and one set of the samples were acidified. The TDS values from the samples ranged from 2,815 to 11,000 TDS. Two of the samples came in over 10,000 ppm TDS.

Water Sampling Operations

Permitting Process at Kevin Dome

After reviewing the data, the BSCSP set up a conference call with EPA Region 8 staff to discuss the water quality results and the Class VI permit. BSCSP informed EPA that the majority of the TDS values were below 10,000 ppm despite the presence of extremely toxic quantities of H2S. Additionally, the samples did not meet the National Primary Drinking Water Standard for Arsenic. The water quality also didn't meet National Secondary Drinking Water Standards for Aluminum, Iron, Manganese and TDS. EPA Region 8 indicated that TDS is the sole water quality standard that Class VI injection wells are permitted by. They held firm for this research project and stated that there are no exceptions for Class VI permits if the aquifer's TDS values are below 10,000 ppm. EPA Headquarters in Washington DC was also informed of the case, and they confirmed that no exceptions are made for Class VI wells if TDS values are lower than 10,000 ppm. The project is not allowed to use the Duperow for CO2 injection and is not going forward as originally planned due to this permitting impasse.

Lessons Learned and Future Recommendations

- When selecting well locations for CO2 injection, project proponents should attempt to identify potential well locations with ample nearby well control including pre-existing TDS data. Having this data will reduce risk and costs of drilling a well that may have TDS values lower than 10,000.
- Project teams should identify water quality analysis labs in advance and screen them for any potential processing issues with samples that may have dissolved 'sour gases' or other unexpected water quality parameters. If H2S may be present, be sure to have a robust safety program in place and methods to safely collect and transport the samples to labs.
- It is important to always track legislative regulation that may change or impact CCS projects and to continually reassess projects based on potential changes to regulations. The EPA's Class VI rules were not in place when BSCSP's project came online and was initially funded. The project was originally anticipating applying for a Class V well permit from the EPA. When the Class VI regulations rolled out, the permitting pathway changed dramatically.
- For future CCS projects in the Rocky Mountain West and the Pacific Northwest, the EPA's 10,000 ppm TDS rule for Class VI underground injection wells will greatly reduce the areas that could serve as reservoirs for geologic carbon storage. This could create limitations for electrical generating facilities and other point sources of CO2 that are looking to use carbon storage as an option to meet new regulations such as the Clean Power Plan.

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