



Plains CO₂ Reduction (PCOR) Partnership
Energy & Environmental Research Center (EERC)

BELL CREEK TEST SITE – INITIAL PROCESSING AND ANALYSIS OF HISTORIC InSAR DATA COMPLETED

**Plains CO₂ Reduction (PCOR) Partnership Phase III
Task 9 – Milestone M54**

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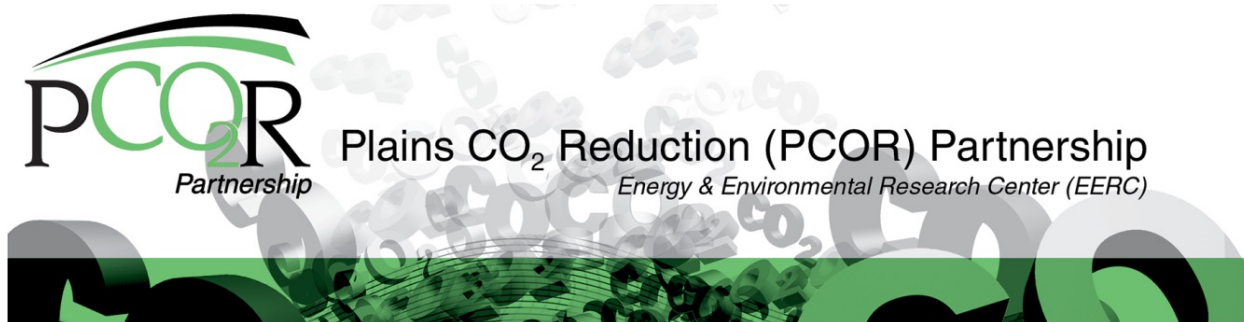
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BELL CREEK TEST SITE – INITIAL PROCESSING AND ANALYSIS OF HISTORIC InSAR DATA COMPLETED

BACKGROUND

The Plains CO₂ Reduction Partnership (PCOR) Partnership, led by the Energy & Environmental Research Center (EERC), is working with Denbury Resources Inc. (Denbury) to study carbon dioxide (CO₂) storage associated with a commercial enhanced oil recovery (EOR) project at the Bell Creek oil field located in southeastern Montana, which is operated by Denbury Onshore LLC. Denbury is managing all injection, production, and recycle activities as part of its commercial CO₂ EOR operation. The EERC, through the PCOR Partnership, is studying the behavior of reservoir fluids and injected CO₂ to demonstrate safe and effective CO₂ storage associated with a commercial EOR project. The PCOR Partnership is developing practices and technologies that will allow future commercial-scale CO₂ storage projects to make informed decisions regarding site selection, injection programs, operations, and monitoring strategies that improve storage efficiency and effective storage capacity in clastic geologic formations.

Interferometric Synthetic Aperture Radar (InSAR) satellite data provide a series of images that can be used to detect subtle movements of the ground surface, known as deformation. Ground elevation measurements from InSAR data have the potential to detect changing reservoir pressure conditions by observing the deformation at the overlying surface.

The objectives for InSAR analysis at the Bell Creek Field are to 1) determine naturally occurring deformation rates prior to the start of field pressurization, 2) determine if deformation has occurred as a result of the injection of CO₂ and/or pressure maintenance prior to CO₂ injection, 3) attempt to identify swept and unswept areas of the field, 4) provide an estimate of injection volumes or pressure differentials required to produce measurable surface deformation, 5) evaluate the potential to use ground deformation and ground motion obtained from InSAR to calibrate geologic models, 6) identify fault activation or reactivation if present, 7) evaluate the applicability of InSAR as an areal monitoring technique with regard to unique challenges imposed by the environment and EOR activities, and 8) compare with data from existing and planned time-lapse 3-D seismic monitoring surveys and passive seismic monitoring as validation and to investigate InSAR as a technique to delineate field compartmentalization and monitor subsurface pressure plumes over large areas.

The InSAR analysis will be completed in two phases. The first phase consists of historical processing of lower resolution from an Advanced Land Observing Satellite (ALOS) data set prior to field pressurization. This phase will determine that ground deformation can be sufficiently detected and will identify natural historical ground movement. Pending proof of concept, the

second phase will consist of using higher-resolution COSMO-SkyMed (CSK) satellite data during the operational phase during and after field pressurization. Initial processing and analysis of InSAR data is being provided by TRE Canada.

INITIAL PROCESSING AND ANALYSIS OF HISTORIC InSAR DATA COMPLETED

Initial processing and analysis of historic InSAR data has been completed, satisfying Milestone 54 (M54). Historical preinjection data covering an area of approximately 143 square miles, spanning the time period between January 13, 2007, through January 24, 2011, and incorporating 21 frames of archived InSAR data, have been processed and analyzed to investigate naturally occurring ground deformation rates prior to the start of pressurization of the Bell Creek oil field. The objective of this work is to determine if the predicted ground deformation during field pressurization will likely be within the measurement resolution of the InSAR data. Initial analysis indicates regional stability with an average ground deformation during the preinjection period of -5.6 mm. Multiple anomalies with higher than average ground deformation were identified. Each of the anomalies was investigated and determined to be a direct result of agricultural soil tilling practices. Hence, these areas were cropped from the InSAR data set (Figure 1) and will not be included in further analysis. It is expected that fully processed, interpreted, and analyzed results for the baseline data set will be completed in February, followed by a determination of whether or not to proceed with the subsequent phase of operational monitoring.

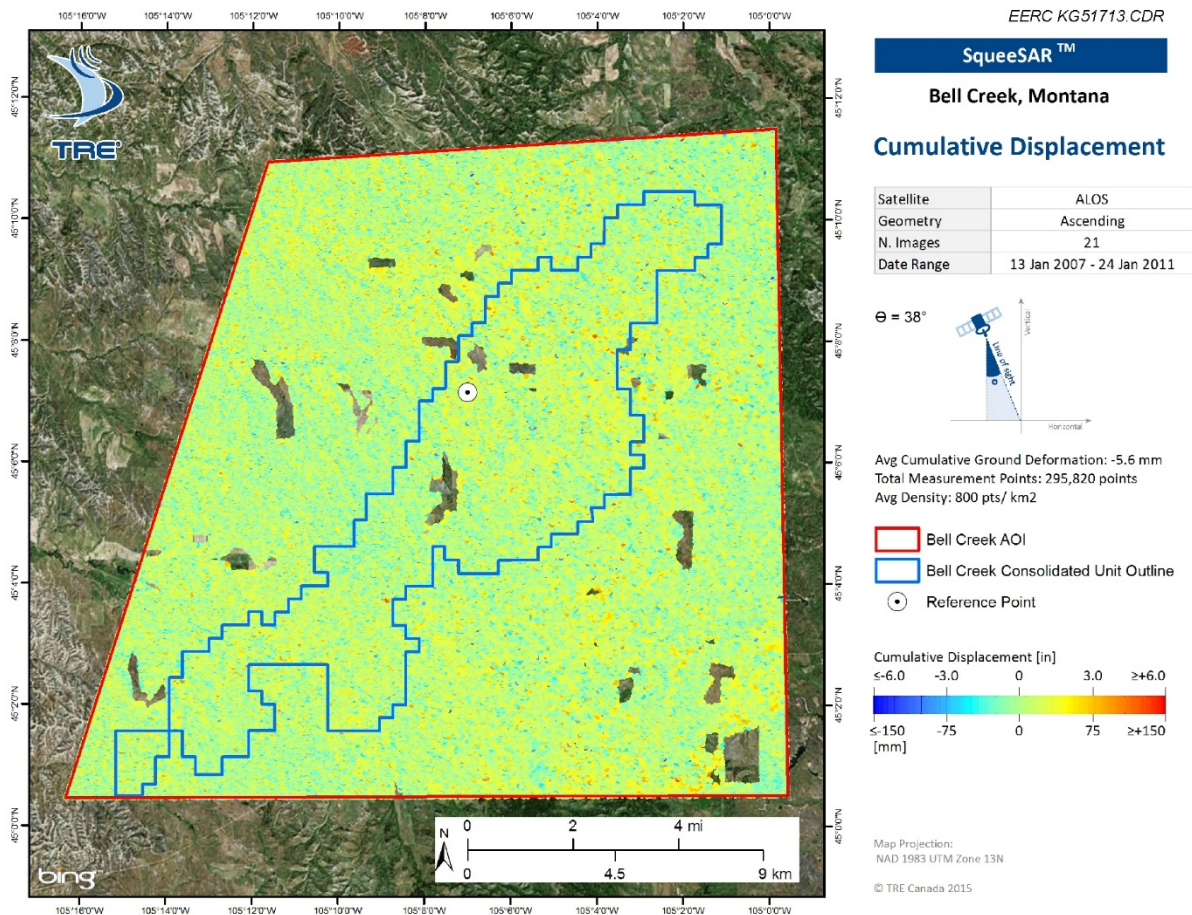


Figure 1. Map illustrating ground deformation based on historic InSAR data prior to start of pressurization of the Bell Creek Field (image source: TRE Canada).