FACTSHEET FOR PARTNERSHIP FIELD VALIDATION TEST

Partnership Name	Big Sky Regional Carbon Sequestration Partnership		
Contacts:	Name	Organization	E-Mail
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Principal Investigator	Lee Spangler		
Field Test Information: Field Test Name	Basalt Phase II Pilot Site Characterization		
Test Location	Near Wallula township in Eastern Washington State		
Amount and Source of CO_2	Tons: NA	Source:	
Field Test Partners (Primary Sponsors)	Batelle – PNWD, United Power, LLC, Edison-Mission Group, Columbia University, University of Idaho, Montana State University.		

Summary of Field Test Site and Operations:

The goal of the Basalt Pilot Site Characterization effort is to prepare for implementation of a small scale CO_2 sequestration project in deep basalts that would be carried out under Phase III. The effort under Phase II will consist of only a seismic survey of the proposed site and initiation of atmospheric and shallow soil gas monitoring to establish background variability. The main objective of the 2D seismic survey is to provide resolution of subsurface geologic features in the basalts to a depth of about 4000 feet to ensure subsurface reservoir and seal integrity prior to commencement of drilling for the Phase III pilot study.

The proposed field test location is situated approximately 16 miles south of Pasco, Washington in lightly inhabited agricultural and heavy industrial-zoned land in western Walla Walla County, within eastern Washington State (see Figure 1). Figure 2 shows a satellite image that displays general features in the immediate area of the proposed field test pilot study, which is located in the northern ~450 acre parcel of the Port of Walla Walla, Attalia Property 1, within the northern half of Section 2, Township 8N, Range 31E, and the southeast quarter of Section 34, Township 8N, Range 31E. The field test site is located ~1 to 2 miles east of the Columbia River and northeast of the Boise Cascade Corporation industrial facility. The test site is surrounded to the north, east, and south by irrigated corporate agricultural land developments. Running approximately N-S adjacent to the western boundary of the site, is U.S. Highway 12. A small gravel road provides access to the site. The site was previously developed for irrigated agriculture.

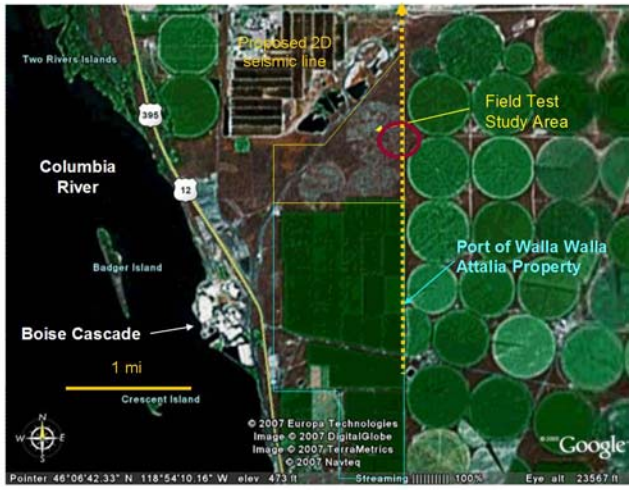

Figure 1. Regional Location Map of Field Test Site

(at right) Figure 2. Google Earth View of Field Test Study Area. The red circle is the location of the proposed injection and monitoring wells. The yellow dashed line is the location of the proposed 2D seismic line, along a section line dirt road and power line right of way.

The location of the proposed field test site lies within the Columbia River Basalt province. Anticipated subsurface geologic conditions at the field test site are shown in Figure 3, and are based on extrapolations from surrounding borehole characterization information. As shown, the expected approximate subsurface formation thicknesses at the field test site (from surface) include: 100 ft of surficial alluvial deposits; 1,200 ft of combined Saddle Mountains Basalt Formation (5 basalt flows) and sedimentary interbeds of the Ellensburg Formation (4 to 5 sedimentary interbeds); 1,200 ft of Wanapum Basalt (11 basalt flows); 5 to 40 ft of Vantage interbed/paleosol horizon; >6,000 ft of Grande Ronde Basalt/undifferentiated CRB (>20 basalt flows); >1,000 ft undifferentiated sub-basalt, sedimentary formation deposits; and the underlying crystalline/metamorphic basement complex. Of particular hydrogeologic importance is the presence of the Vantage interbed/paleosol horizon that serves as a regional low permeability horizon separating groundwater within the underlying Grande Ronde and overlying Wanapum Basalts (Reidel et al., 2002). Groundwater within the Grande Ronde Basalt and below is expected to be non-potable containing high concentrations of fluoride and sulfides.

The general topography of the Pasco Basin reflects structural deformation associated with Miocene to Recent folding and uplift of the Columbia River basalts. Prominent ridges form part of the Yakima Fold Belt, a series of asymmetric, generally east-west anticlinal folds. The north limbs of the anticlines are usually steeply dipping and broken by thrust faults.

The Yakima Fold Belt upland ridge closest to the project site area is the Horse Heaven Hills, which lie about 7 miles south of the project site. This is a folded fault block range that is uplifted along the Wallula Fault Zone located on the north side of the range. The bedrock at the sequestration site is covered by alluvium, but the structural dip of the Grande Ronde basalts is expected to be near horizontal, based on regional geology and geotechnical findings (PanGeo, Inc, 2001). There is no closed structure at the site. The axis of the Cold Creek Syncline may cross near the sequestration site, from northwest to southeast. A key objective of the seismic survey is to ensure that no faults playing off the Cold Creek Syncline extend to the test site area.

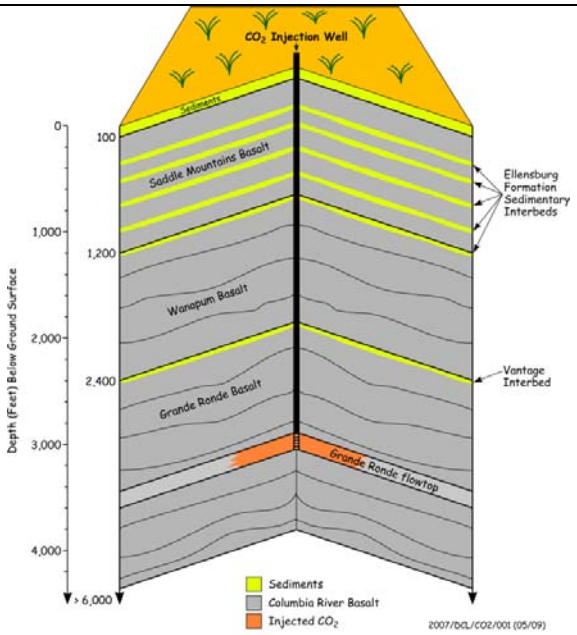

Figure 3. General Stratigraphic/ Depth Relationship of Injection Zone and Overlying Formations

Research Objectives:

The overall objectives of the Basalt Site Characterization Test include:

1. Address the critical technical issues associated with the injection, and fate and transport of supercritical CO_2 in one or more interflow zones in a deep basalt formation
2. Work with industry partners to ensure that Characterization Test activities support their needs (to the extent practicable)
3. Participate in public outreach activities as required or as requested by industry partners
4. Work with state regulators and environmental NGO groups to ensure timely support of necessary permitting.

Field work on the basalt characterization test under Phase II will be limited to those site preparation and characterization activities necessary to proceed into a drilling, injection, and monitoring program that would occur under a Phase III cooperative agreement.

Site characterization activities will be undertaken to enable a transition to a drilling, injection, and monitoring phase to be supported under a Phase III cooperative agreement. These activities will include: 1) installation of shallow soil gas monitoring probes and collection and analyses of gas samples from these probes to begin development of a database on variability in CO_2 and other trace gas concentrations at the site, and 2) conducting a quasi-3D seismic survey at the site to determine overall reservoir thickness (both the basalt and metamorphic strata underlying the basalt) and to identify any faults or fracture zones that must be avoided in locating an injection well at the site.

While the difficulties in seismic imaging in basalts are well recognized, discussions with world renowned geophysical experts have indicated that a properly designed survey combined with advanced data processing should overcome most of the attenuation and scattering problems associated with seismic imaging in basalts. The seismic survey data are considered critical to verifying site geological characteristics before commencing drilling at the site. This work will also significantly advance the state-of-the-art in seismic imaging deep flood basalts required for site characterization and monitoring injected CO_2 that is critical to broader application in support of future commercial

operations.

Summary of Modeling and MMV Efforts: (Use the table provided for MMV)

Preliminary simulations of CO_2 injection into the flow tops of two individual basalt flows in the Grande Ronde (GR) basalt formation were executed using the STOMP-H_2O-CO_2-NaCl simulator (White and Oostrom 2006). The two flows considered were the GR-5 flow and the Umtanum flow. Both flow tops have high permeabilities and are good candidates for injection. The objective of the simulations was to determine the radius of a CO_2 plume injected during a proposed pilot scale test needed for submission of permit documents. Two basalt flow tops in the Grande Ronde Basalt formation were considered, the RRL-2/GR-5 (unnamed flow), 26 ft thick, and the RRL-2/GR-9 (Umtanum Flow).

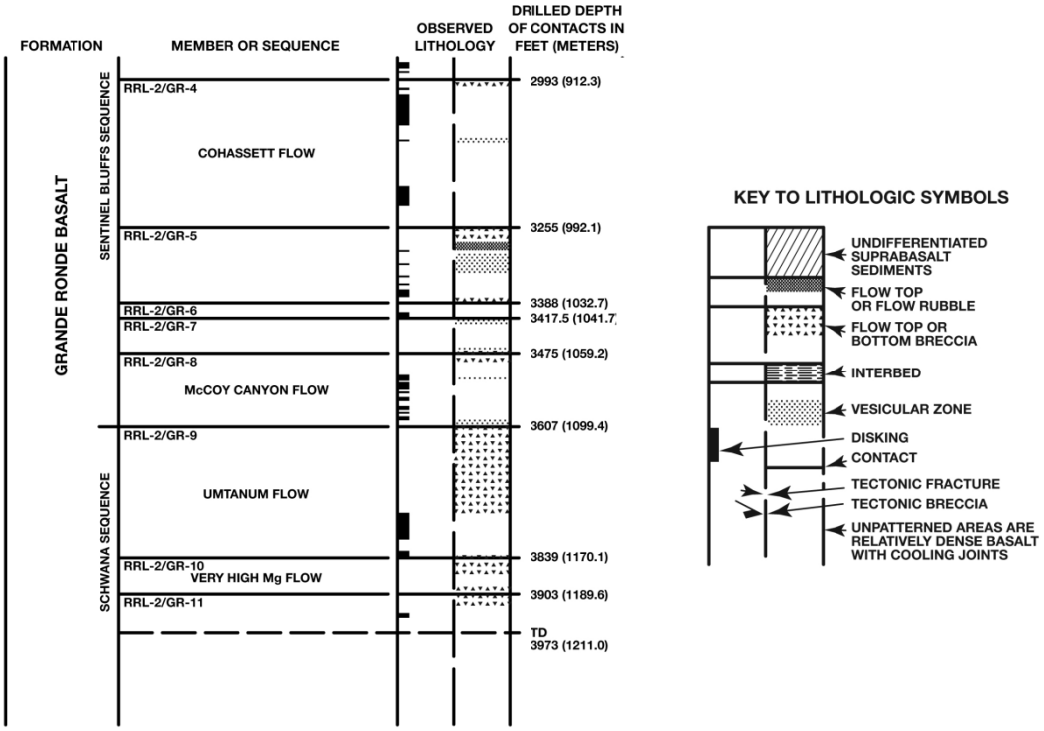

Figure 4. Lithologic Unts in the RRL-2 Corehole based on (Wintczak 1984) used to estimate properties at the Wallula test site.

The transmissivity of GR-5 flow top in the RRL-2 well was determined to be 9.87 ft^2/day ($1.06x10^{-5}$ m^2/s) using hydraulic tests (Strait and Spane 1983). The transmissivity of the Umtanum flow top was determined to be 480 ft^2/day ($5.16x10^{-4}$ m^2/s) using hydraulic tests (Strait and Spane 1982). The permeabilities assumed for the basalt flow materials were $1x10^{-11}$ m/s for the dense flow interiors, $1x10^{-4}$ m/s for the GR-5 flow top breccia, $1x10^{-5}$ m/s for the Umtanum flow top breccia, $2x10^{-7}$ for rubble, and $1x10^{-7}$ for vesicular basalt. Two-dimensional simulations with a cylindrical coordinate grid were developed. Vertical grid spacing was 1 ft, while radial grid spacing was variable, ranging from 0.08 m to 5.9 m. Homogeneous layers were assumed based on the observed lithology surrounding the GR-5 flow top and the Umtanum flow top. The contacts between the layers were given a random amount of roughness to simulate the heterogeneity of those contacts.

In the Umtanum flow top simulations, the CO_2 is injected over an interval between 3607-3761 ft below ground surface (bgs) and the injected CO_2 quickly rises to the top of the formation where it is trapped by the low-permeability overlying McCoy Canyon flow. The resulting plume has a radius of 550 ft. After 2 years, 26% of the injected CO_2 has dissolved into the aqueous phase.

In the GR-5 flow top simulations, the CO_2 is injected over a smaller interval between 3255-3278 ft bgs. The injected CO_2 is trapped by the overlying Cohassett flow interior. The resulting plume has a radius of 700 ft, with higher gas concentrations than seen in the Umtanum flow top simulations. After 2 years, 21% of the injected CO_2 has dissolved into the aqueous phase. The dissolved CO_2 fraction is lower than in the Umtanum flow top simulations due to the smaller volume of the plume.

The results of the numerical modeling indicate that both the Umtanum flow top and the GR-5 flow top are good candidates for CO_2 injection due to their high permeability. There is uncertainty in the results of these simulations because the unsaturated flow properties (e.g., air entry pressure) of the basalt flow tops were estimates and the data are taken from wellbore data approximately 30 miles from the pilot injection site.

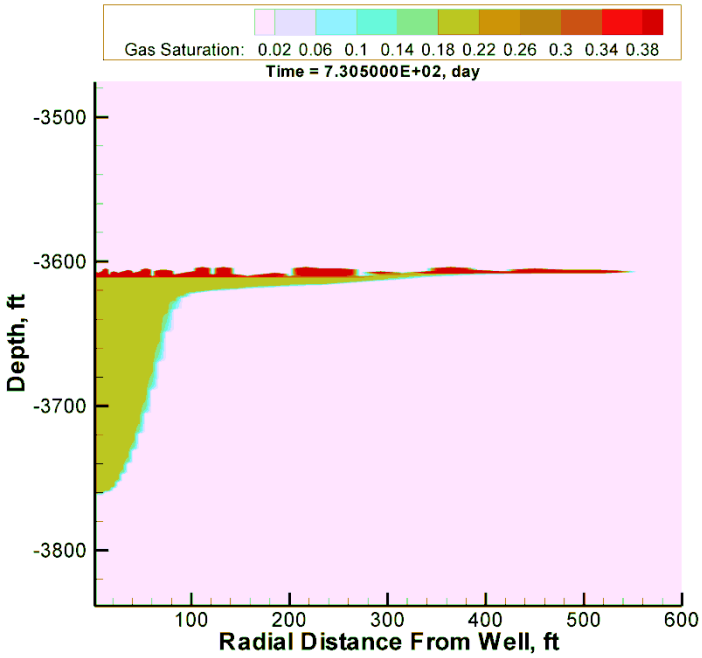

Figure 5. CO_2 Gas saturation in the Umtanum Flow Top 2 Years Post-Injection at the rate of 100 tonnes/day for 30 days

MMV Summary

The only MMV activity scheduled under Phase II is shallow soil gas monitoring. Both compositional analysis and isotope fraction mass spectrometry will be conducted on these samples.

Accomplishments to Date:

- **A Field Activity Plan for the field pilot study was issued:**
  Spane, F. A., B. P. McGrail, E. C. Sullivan, D. S. Goldberg, T. L. McLing, R. S. Weeks, and R. W. Smith. 2007. *Field Activity Plan: Characterization Test for CO_2 Sequestration in the Columbia River Basalt Group*. PNWD-3844, Pacific Northwest National Laboratory, Richland, Washington.
- A draft NEPA checklist was prepared and submitted to DOE to cover the limited scope of field activities planned under Phase II. A draft SEPA checklist was completed and submitted to United Power and Washington State Department of Ecology for review.
- A vendor contract was awarded to Allstate Permit Services to secure the necessary permits from business farm owners that immediately adjoin the field site to allow access for vibroseis trucks to conduct a seismic survey on the site.
- A RFP was issued to conduct Seismic Design, Survey Acquisition, and Processing Services for one high-fold, 3-5 mile 2D seismic line on the across basalts in eastern Washington, with the goal of imaging porous

and permeable zones between basalt flows at a depth of approximately 4000 feet. Three high quality proposals were received and underwent technical and legal review. Paragon was awarded the contract will be mobilized to the field site the last week of November.

- Two shallow soil gas probes were installed, 1000 ft apart, at the approximate location anticipated for the CO_2 injection well. Gas samples will be collected on a monthly basis to look for any anomalous gas composition readings and to establish background concentrations for CO_2 and other gases well ahead of injection.

Summarize Target Sink Storage Opportunities and Benefits to the Region:

Within the BSCSP region, there are several major geological provinces with high potential for geologic sequestration. One of these is the Columbia Plateau Volcanic Province, which represents the dominant regional geologic feature occupying much of Idaho, Oregon, and Washington states. The CO_2 storage potential of the Columbia River Basalt Group (CRBG) within this volcanic province has been estimated at between 50 to 100 $GtCO_2$, making it one of the most significant potential deep geological storage formations in the region. The ultimate goal of the Basalt Pilot Test is to demonstrate and validate the safe, permanent storage of CO_2 in reactive mafic formations that underlie this site and surrounding region. A successful field demonstration of CO_2 sequestration at this site has important implications for future development of a sub-bituminous coal fueled IGCC unit (nominal 700 MWe net) that has been announced for development at this site.

Cost:

Total Field Project Cost: $1,075,165

DOE Share: $849,055 79%

Non-Doe Share: $226,110 21%

Field Project Key Dates:

Baseline Completed: 03/30/2008

Drilling Operations Begin: NA

Injection Operations Begin: NA

MMV Events: Soil gas monitoring in progress

Field Test Schedule and Milestones (Gantt Chart):

Task 16.0 - Basalt Hosted Saline Aquifer Characterization Test	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
	FY 2006				FY 2007				FY 2008				FY 2009			
Task 16.1 Planning and Industrial Engagement																
Public Outreach and Regulatory Briefings								Gm31								
Task 16.2 Characterization Options Simulations																
Transport and Reactive Process Modeling Simulations								Gm32								
Task 16.3 Site Characterization Activities																
Submit Field Activity Plan								Gm33								
Complete Seismic Survey								Gm34								

Additional Information