

W. Bill Booth
Chair
Idaho

James A. Yost
Idaho

Tom Karier
Washington

Dick Wallace
Washington



Bruce A. Measure
Vice-Chair
Montana

Rhonda Whiting
Montana

Melinda S. Eden
Oregon

Joan M. Dukes
Oregon

April 30, 2008

MEMORANDUM

TO: Council Members

FROM: Terry Morlan

SUBJECT: Presentation on Carbon Sequestration Demonstration Project

One potential approach to sequestering carbon dioxide is to pump it deep into the basalt flood deposits that cover much of the Pacific Northwest. The theory is that the carbon dioxide would react with basalt to turn into a mineral and remain in the ground. A demonstration project to test this theory on Port of Walla Walla owned land is funded primarily by the U.S. Department of Energy and is being carried out by the Pacific Northwest National Laboratory (PNL).

Peter McGrail from PNL will brief the Council on the project. The viability and cost of carbon sequestration alternatives will have an important effect on how the region and nation can meet various carbon reduction goals. If carbon sequestration is feasible and cost-effective, then the country's abundant coal resources may provide a viable source of energy for many years. If not, other, potentially more expensive, solutions may be required to meet electricity needs.

A summary article about the carbon sequestration demonstration project is attached. If we receive additional information before the Council meeting, it will be sent to Council members.



ENERGY Prospects West

*Western Interconnection
Policy & Resource News*



[Home](#) | [NewsData](#) | [Archives](#)

ALSO IN THIS ISSUE



OPEN SESAME

Not Just Generating,
But Also Meeting Load
Wind Energy Can Be
Firmed With Compressed
Air

DOE Carbon Sequestration Pilot Set for Eastern Washington

Print-Friendly

Around the end of November, field tests will begin in eastern Washington's Columbia Basin to determine if the region's massive basalt formations hold the potential to permanently sequester millions of tons of carbon dioxide emissions.

If the project is successful, it could mean "a new paradigm for how baseload generation will be sited," according to Pete McGrail, project manager and chief scientist of Battelle's Pacific Northwest National Laboratory, which will be conducting the tests.

"If it's going to work, it's going to work here," McGrail said at an Oct. 11 Port of Walla Walla Commission meeting.

The project will take place on land owned by the Port of Walla Walla, beginning with seismic studies, borehole drilling, geochemical and hydrolic tests on the basalt formations, which at their thickest and deepest, exceed 12,000 feet.

By the end of next summer, McGrail's group will inject several thousand tons of carbon dioxide 3,000 to 4,000 feet underground over a period of two to four weeks.

Then, for the next two to three years, McGrail's team of scientists will monitor the test site, taking core samples to see if the injected gases have reacted with the rock to form a solid carbonate, effectively becoming one with the basalt.

If only 3 percent of the Pacific Northwest's 80,000 square miles of basalt is suitable for CO₂ sequestration -- a very conservative estimate, McGrail says -- that could mean permanent storage for 50 to 100 billion tons of emissions, far more than any one power plant would produce over its lifetime.

One such project, a 915-MW integrated gasification combined-cycle power plant proposed for the site by a Gig Harbor, Wash.-based consortium, has a lot riding on the pilot's outcome.

Developers of the \$2-billion Wallula Energy Resource Center -- which include United Power, Quigg Energy LLC, Edison Mission Group and Mitsubishi Heavy Industries -- aim to sequester 65 percent of the plant's carbon emissions from the start of operations, to meet the state's new regulations that prohibit development of new power plants that emit more carbon dioxide than modern natural gas-fired plants.

ENERGY JOBS PORTAL



Check out the fastest growing database of energy jobs in the market today.

- Job Seekers
- Employers

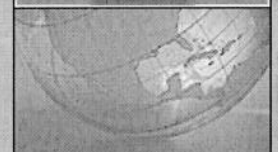
SITE TOOLS

SEARCH

[[Advanced Search](#)]

view by section

DOMAINS



[Indexing Energy
Technology Web Sites](#)

"They'd run out of coal before we'd run out of storage," McGrail said of the planned IGCC, which will sell 760 MW of its output.

Developers of the power project are co-sponsoring the \$10-million sequestration study, along with the U.S. Department of Energy's Big Sky Carbon Sequestration Partnership.

"Walla Walla has long been ideal ground for power development," said United Power CEO Robert Divers. "Now, thanks to the research Battelle is doing for Big Sky, the area's subterranean basalt formations can be added to its list of enabling features," which include two rail lines, highway access, high-voltage transmission lines, and an industrial water supply.

This month, Divers' group asked the Washington Energy Facility Site Evaluation Council to begin a Potential Site Study for the proposed project.

The Potential Site Study is similar to the Federal Energy Regulatory Commission's pre-filing process. The developer will consult with EFSEC, other regulatory agencies and the general public to identify issues in advance of filing a formal application for a site certification with EFSEC.

The Washington siting council is already reviewing one other IGCC project, Energy Northwest's 680-MW Pacific Mountain Energy Center, proposed for Kalama, Wash.

The council is conducting a bifurcated review of the project, focusing first on the project's carbon sequestration plan. Energy Northwest plans to mitigate most of the plant's emissions, by paying to take an older, dirty power plant in the Western Interconnect offline.

In the meantime, while the carbon sequestration pilot project near Walla Walla holds promise for many, including Port officials, who feel a successful outcome could attract many carbon-based businesses to the area, it also has its skeptics.

"Whether geologic sequestration will work is a matter of great debate in the engineering community," said Marc Krasnowsky of the NW Energy Coalition. "Some scientists from the Natural Resources Defense Council are very dubious about basalt sequestration and cite a lot of studies that say it's nonsense."

But McGrail says that is precisely why his group is conducting the pilot.

"The objective of the project is to get a better idea if it will work," McGrail told *Energy Prospects West*.

- Penelope Kern

[My Account](#) | [Terms of Use](#) | [Privacy Policy](#) | [Staff](#) | [Contact Us](#) | [Archives](#)

Basalt Sequestration Pilot Project Overview

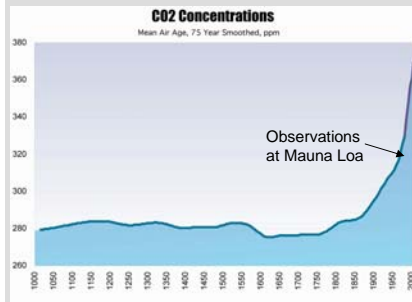
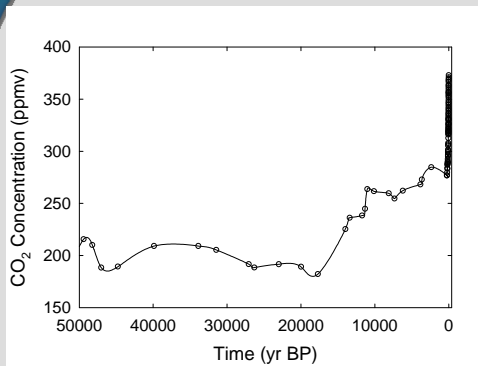
B. Peter McGrail, Ph.D
Pacific Northwest National Laboratory
Richland, Washington

Northwest Power and Conservation Council Briefing

Walla Walla, Washington
May 14, 2008



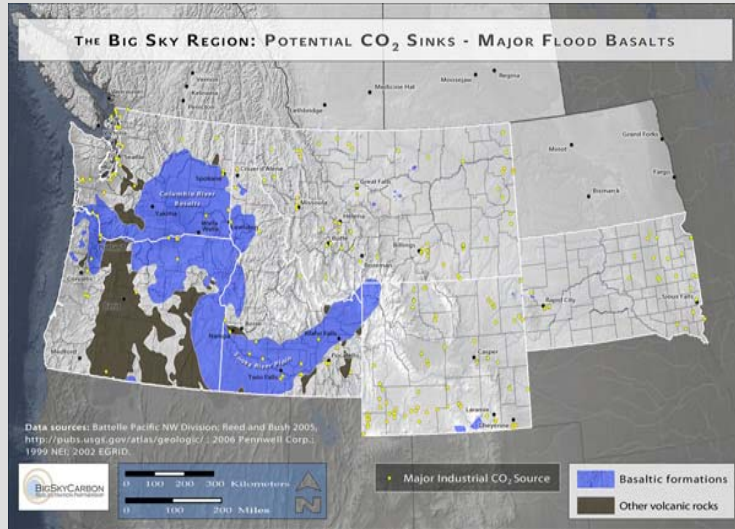
Historical Record of Atmospheric CO₂ Concentrations



A bow wave of regulations is coming to address this problem that will affect everyone. Responding to these changes requires detailed knowledge about technical solutions and their costs.



Big Sky Carbon Sequestration Partnership



Battelle

5

Pilot Project Partners

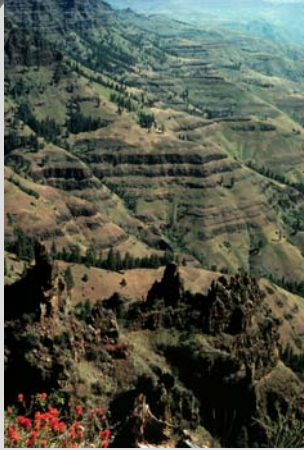
- ▶ Research Institutions (universities, labs, others)
 - MSU, UI, Columbia University, INL, Oregon State University
- ▶ Department of Natural Resources
- ▶ International Collaborators
 - Institut de Physique du Globe (France)
 - National Geophysical Research Institute (India)
 - Vernadsky Institute of Geochemistry and Analytical Chemistry (Russia)
- ▶ Industry
 - United Power
 - Port of Walla Walla
 - Others



Battelle

6

Layered Basalt Flows



- ▶ Interflow zones have properties that allow fluids to move in and out
- ▶ Overlying flow interiors have extremely low permeability and act as caprock seals

Battelle

7

Why this Area?



- ▶ Located where some of the deepest and thickest basalt exists in the region
- ▶ Industry had performed cultural and biological surveys, and installed shallow groundwater wells that were required for the research project
- ▶ Site is located in remote area zoned heavy industrial where drilling and monitoring activities could be done without disturbing neighboring landowner activities

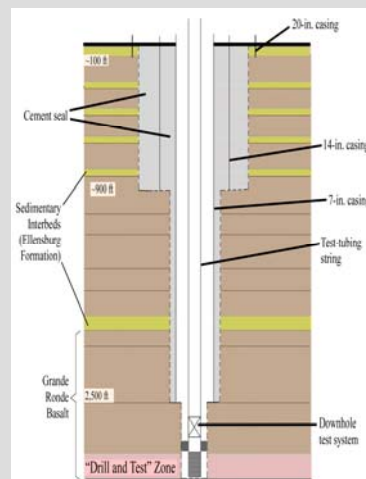
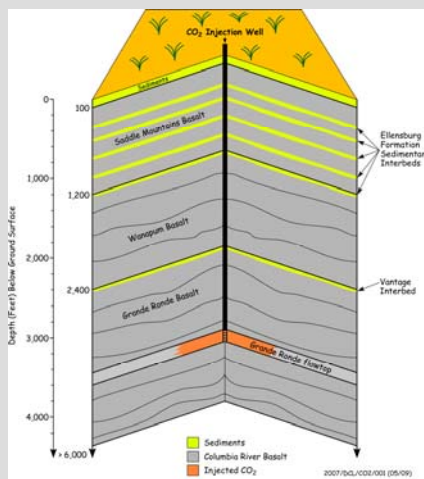
Battelle

8

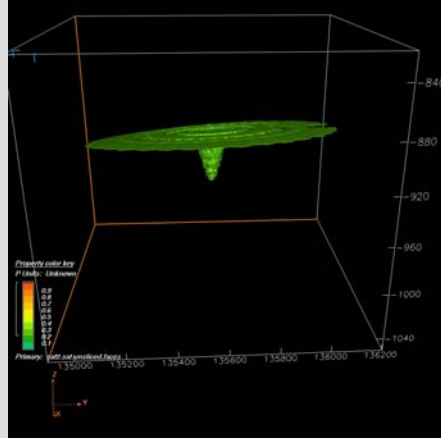
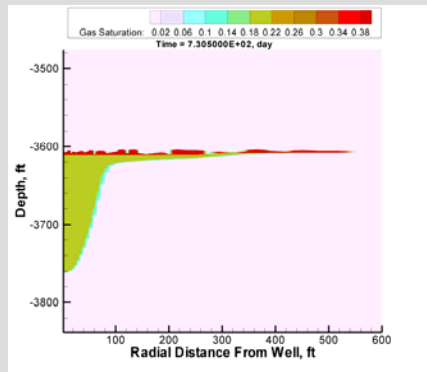
Basalt Pilot Project Summary

- ▶ Pre-Injection Site Characterization
 - Soil gas and shallow well water geochemistry
 - Seismic survey
 - Well logging and geochemical sampling during borehole drilling phase
 - Hydrologic tests
- ▶ Injection Facts
 - Water is non-potable at target depth
 - 1000 MT of CO₂ total (1/2 Olympic-sized pool)
 - Injection would occur over a 2 to 4 week period
 - Initial radius of CO₂ bubble is only about 100 ft. Maximum spread radius is about 250 ft
 - The CO₂ will dissolve in the formation water and eventually become mineralized over a period of several years
- ▶ Monitoring Program
 - An extensive monitoring program is planned that includes air, shallow subsurface, and deep monitoring components
 - Water samples will be obtained periodically to monitor geochemical changes
 - Core sample extraction (2-3 years post-injection)
- ▶ Closure
 - Wells would be plugged and abandoned according to state regulations
 - Site would be restored to pre-test condition
 - Closure option will depend on possible future use for follow-up studies

Stratigraphy and Well Construction



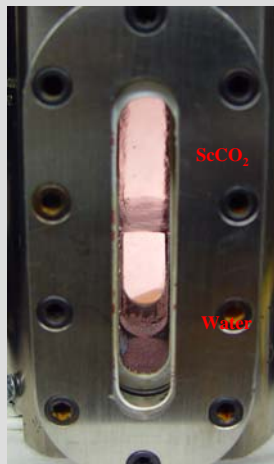
Supercomputer Modeling of Plume Behavior for Pilot



Battelle

11

Phase State of CO₂ Under Reservoir Conditions

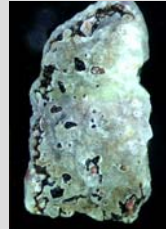
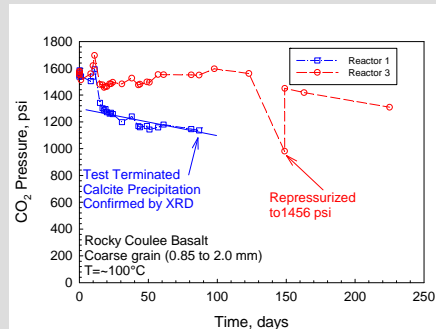


Cell Conditions
45°C, 1128 psi
Water, Supercritical CO₂

Battelle

12

Supercritical CO₂ Pressure Cell Experiments with Columbia River Basalt



Long-term experiments showing transition from calcite to ankerite, Ca(Fe, Mg, Mn)(CO₃)₂

Field Work Status

- ▶ Data collection from soil gas probes in progress since August 2008
 - No gas phase composition or isotopic anomalies detected
- ▶ Seismic survey completed December 2008
 - Data processing in progress
 - Initial results show no faults or fracture zones
- ▶ Well construction design has been coordinated with WADOE
- ▶ Subcontracts with drilling, equipment, and other field service providers being negotiated

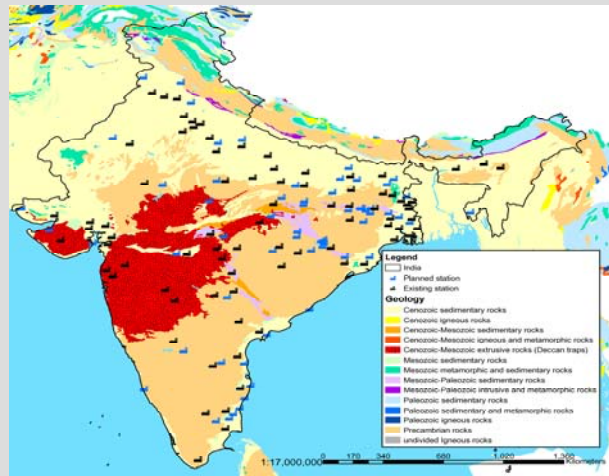
Permitting Status

- ▶ NEPA Categorical Exclusion granted by USDOE
- ▶ SEPA Application submitted to Walla Walla County
 - Determination of no land use application issued on January 31, 2008
- ▶ “Special Permit” application to be submitted to WADOE
 - Permit will ensure compliance with all applicable Washington state regulations regarding UIC and groundwater protection
- ▶ Land Use Agreement
- ▶ Mineral rights and CO₂ storage deed

Conclusions

- ▶ The pilot project is a scientific research study only. It was never designed and cannot in and of itself permit any power plant to be built.
- ▶ The pilot project has been designed to address key questions about sequestration in basalts that simply cannot be done in a laboratory setting
- ▶ Extensive site characterization and testing is planned prior to any CO₂ injection
 - Consultations with the WADOE, DNR, our project partners, and independent consultants will occur every step of the way
- ▶ Post-injection monitoring is planned to continue over the entire study period to ensure that CO₂ is not migrating out of the injection zone and to track progress toward mineralization

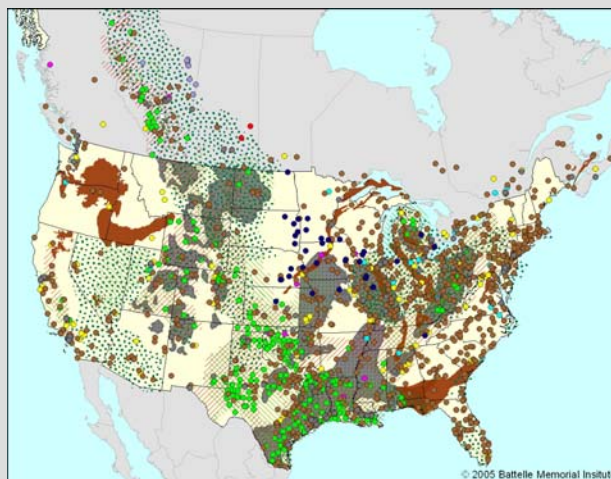
Geologic Map of India with Coal-Fired Power Generation Plants



Battelle

17

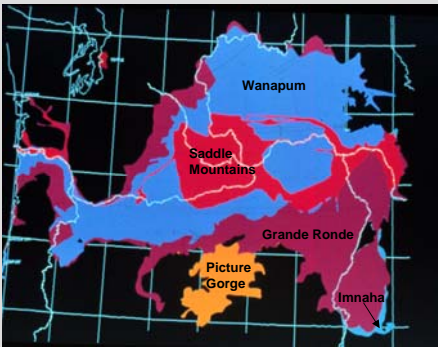
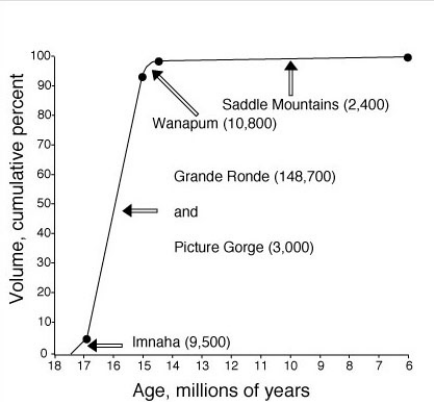
GIS Database of CO₂ Sources and Potential Geologic Storage Reservoirs



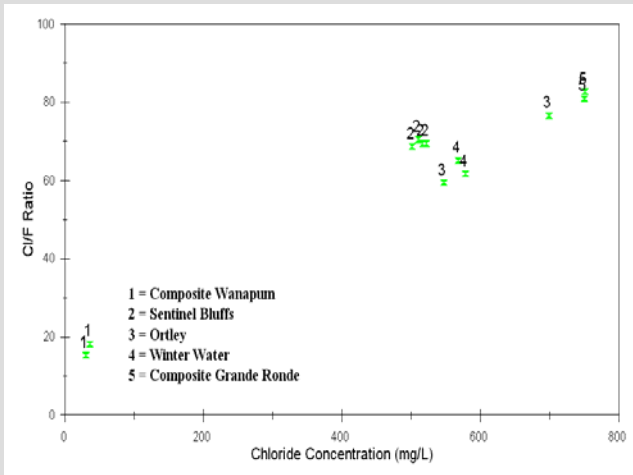
Battelle

18

Extent of Columbia River Basalt

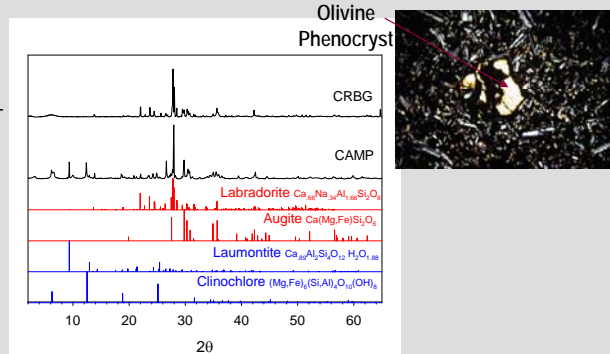


Water Chemistry Across Basalt Flows



Chemical Makeup of Columbia River Basalts

Oxide	Mass %	
	Sentinel Bluff	Rocky Coulee
Na ₂ O	2.817	2.777
MgO	3.133	5.139
Al ₂ O ₃	14.27	14.98
SiO ₂	54.35	51.21
P ₂ O ₅	0.353	0.463
K ₂ O	1.464	0.435
CaO	7.430	8.815
TiO ₂	2.088	2.098
MnO	0.219	0.172
FeO	12.39	11.93
Total	100.2	99.67



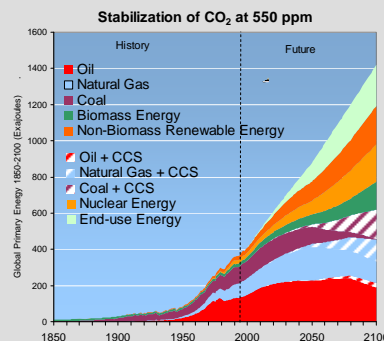
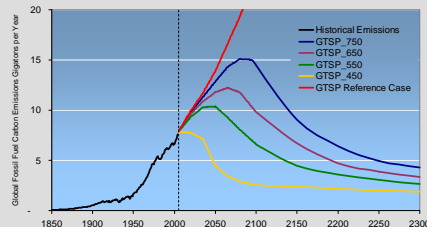
- ▶ Contains mineral and glass phases that are high in Ca, Mg, and Fe
- ▶ These phases are chemically unstable at pH < 6

Battelle

21

Climate change is a long-term strategic problem with implications for today

- ▶ Stabilizing atmospheric concentrations of greenhouse gases and not their annual emissions levels should be the overarching strategic goal of climate policy
- ▶ A fixed and finite amount of CO₂ can be released to the atmosphere over the course of this century
 - Every ton of emissions released to the atmosphere reduces the budget left for future generations
 - As we move forward in time and the planetary emissions budget is drawn down, the remaining allowable emissions will become more valuable
- ▶ CO₂ capture and storage (CCS) plays a large role but...
 - Government and industry must make adequate provision for its use
 - CCS is not a silver bullet



Battelle

22