ABSTRACT
The CarbonSAFE Cascadia project is conducting a pre-feasibility study under award from the U.S. Department of Energy (DE-FO0029219) to evaluate technical and nontechnical aspects of collecting and storing 50 MMT of CO2 in a safe, ocean basalt reservoir offshore from Washington State and British Columbia. The primary project goal is to conduct a pre-feasibility assessment for an industrial-scale CO2 storage project in a subsea basalt reservoir complex in the Cascadia Basin. This involves conducting laboratory and modeling studies to evaluate the potential capacity of this reservoir for CO2 mineralization and long-term storage, developing potential source/transport scenarios, and completing an economic evaluation of specific source/transport scenarios and a ranked project risk registry. Important accomplishments in the project to date include selection of a potential location for the storage complex area and potential scenarios for sources and transport in USA and in Canada.

SOURCES AND TRANSPORT

Example Source/Transport Scenario
Two representative source options are shown, collecting CO2 from Shell’s Puget Sound refinery and/or from Alcoa’s aluminium production facility. The transportation component considers two alternatives - via ship and via pipeline. With pipeline, a 80 km-long line would connect the Puget Sound refinery to the offshore injection site. An offshore pipeline of ~2.5 MMT/yr capacity would be required to connect the pumping station to the injection site located ~250 km offshore. For shipping, a tanker collecting CO2 from each source facility, with a multi-source design concept, would transport CO2 to the offshore injection site. Different combinations of these transport options are also considered.

RESERVOIR AND MONITORING

Target Basalt Reservoir
Targeted injection formations for the project are sub-ocean basalt layers below the Cascadia Basin on the Juan de Fuca plate. The reservoir is comprised of both pillow basalts, fractured and massive flows containing plagioclase, olivine, and clinopyroxene, which are geochemically reactive (see Laboratory Studies below).

Monitoring CO2 Transport and Injection
An active cabled network (NEPTUNE) is in place from Victoria BC to the Cascadia Basin. In situ instrumentation could enable real-time monitoring for:
- Pipeline leakage (pressure, temperature, acoustic)
- Injection pressure changes
- Well pipe and head corrosion
- Reservoir pore water, and rock matrix chemistry (e.g., mass spectroscopy, titration)
- Fracturing and induced seismicity (seismometers, hydrophones, borehole strain)
- Seafloor deformation and compliance (pressure, tilt, broadband seismometer, gravimeter)

Laboratory Studies
Laboratory experiments are underway using representative ocean basalt samples from the Cascadia Basin and other locations.
- Measured dissolution rates of basalt indicate that flow channels are much more reactive than the massive basalts, with Ca ion extraction efficiencies reaching ~11-12% at low pH.
- Compared with kinetic data in basalt.

PHASE 1 ACCOMPLISHMENTS TO DATE
- Contacted potential industry-sourced CO2 streams in the region and developed different source/transport scenarios in the USA and Canada
- Conducted laboratory analysis and injection modeling studies to optimize mineralization in basalt
- Compiled inventory of existing petrophysical, hydrological, and regional data in vicinity of the offshore reservoir
- Reviewed framework for offshore storage regulations in US and Canada
- Constructed initial risk registry for project-related risks and related NRAP modeling
- Evaluated cost variables and potential economic incentives to optimize for this offshore storage location