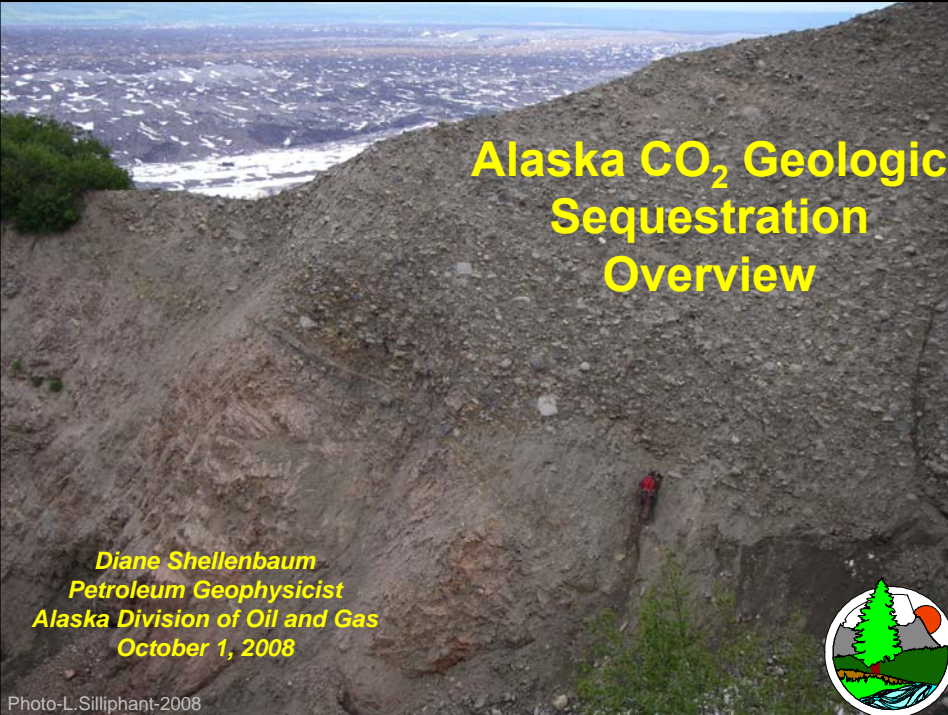



WESTCARB Annual Business Meeting

Alaska CO₂ Storage Potential, Overview

Diane Shellenbaum
Petroleum Geophysicist
Alaska Division of Oil and Gas


Anchorage, AK
October 1, 2008



Alaska CO₂ Geologic Sequestration Overview

Diane Shellenbaum
Petroleum Geophysicist
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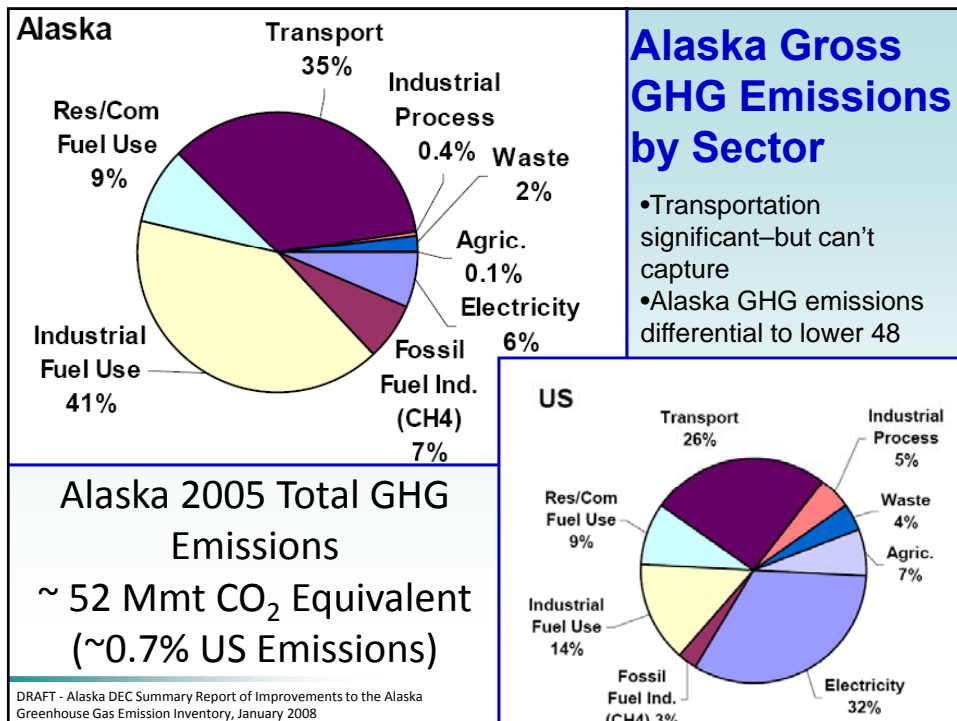
Photo-L.Silliphant-2008

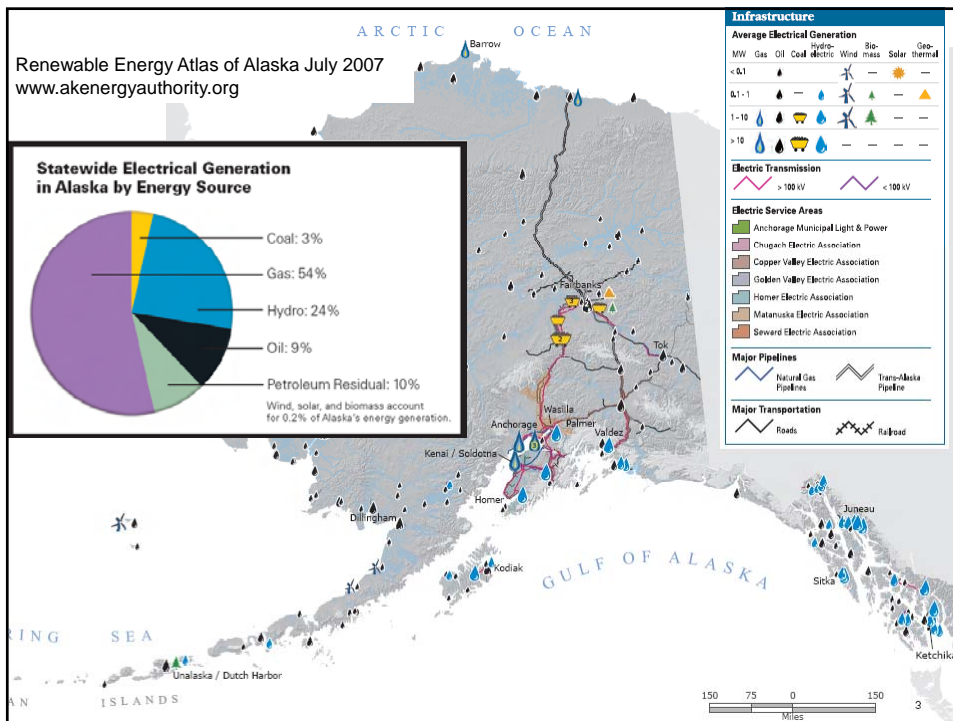
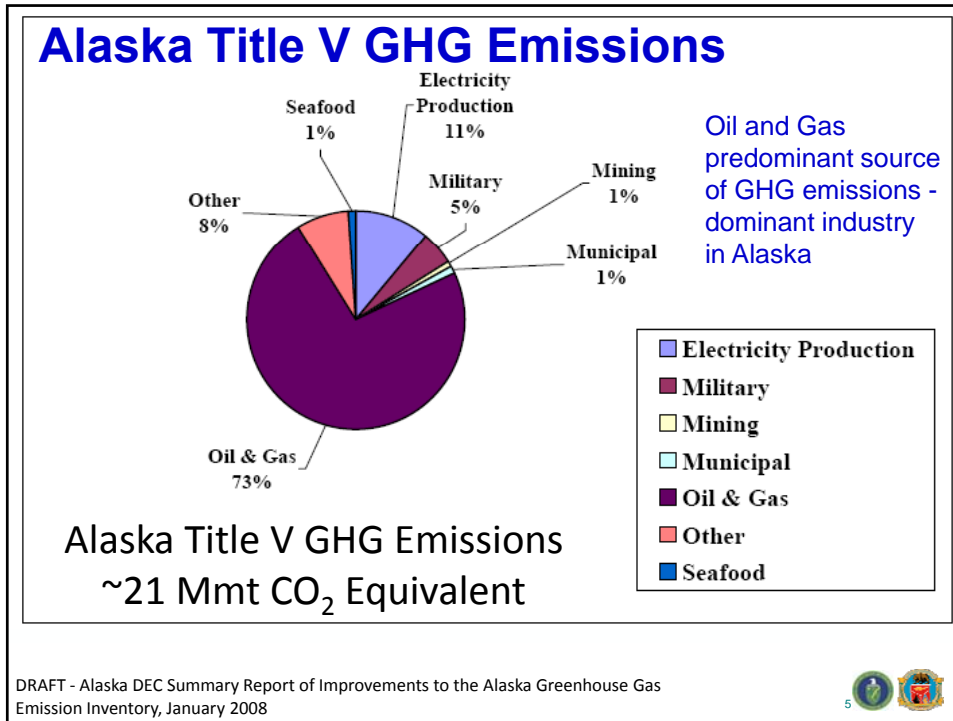


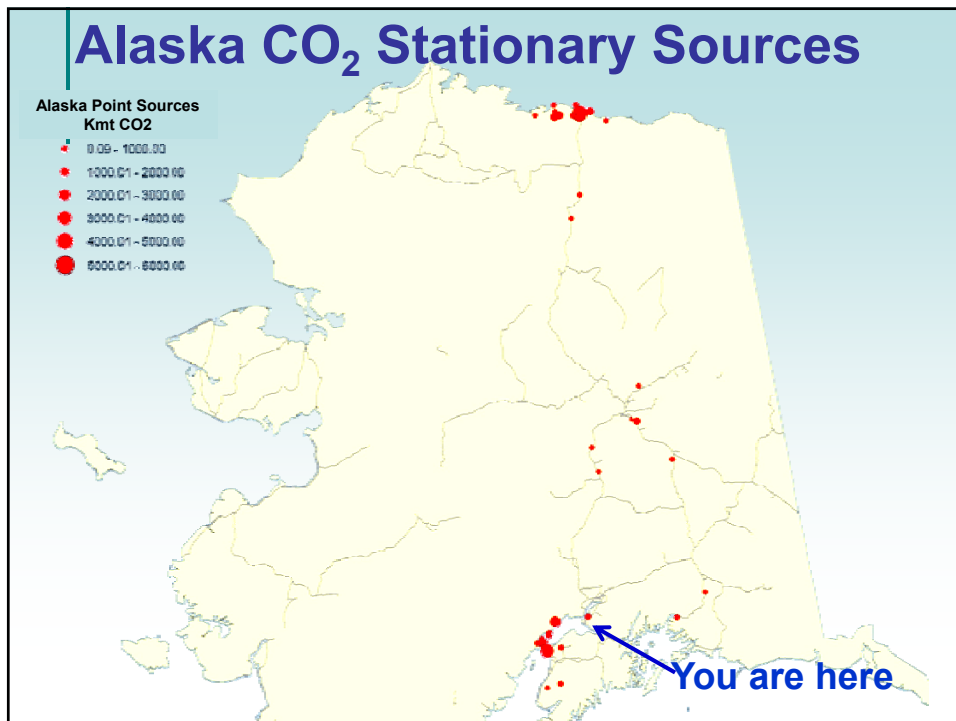
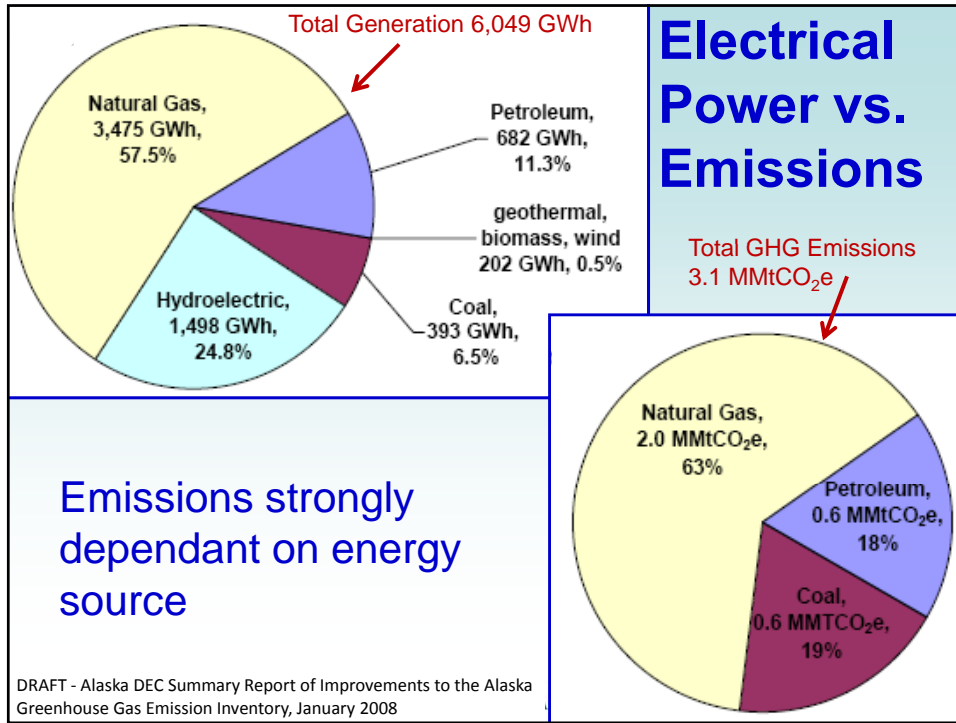
Alaska CO₂ Geologic Sequestration Overview

1. CO₂ Sources
2. Geologic Sinks
3. CO₂ Capacity Work Review
4. Summary/Conclusions

Photo -L.Silliphant-2008





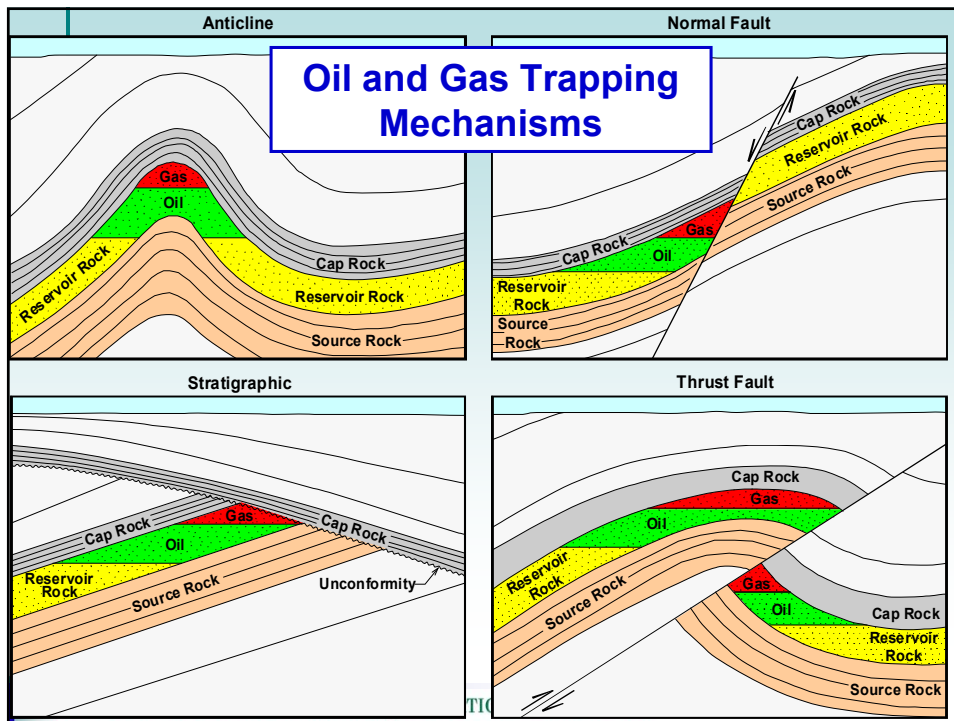


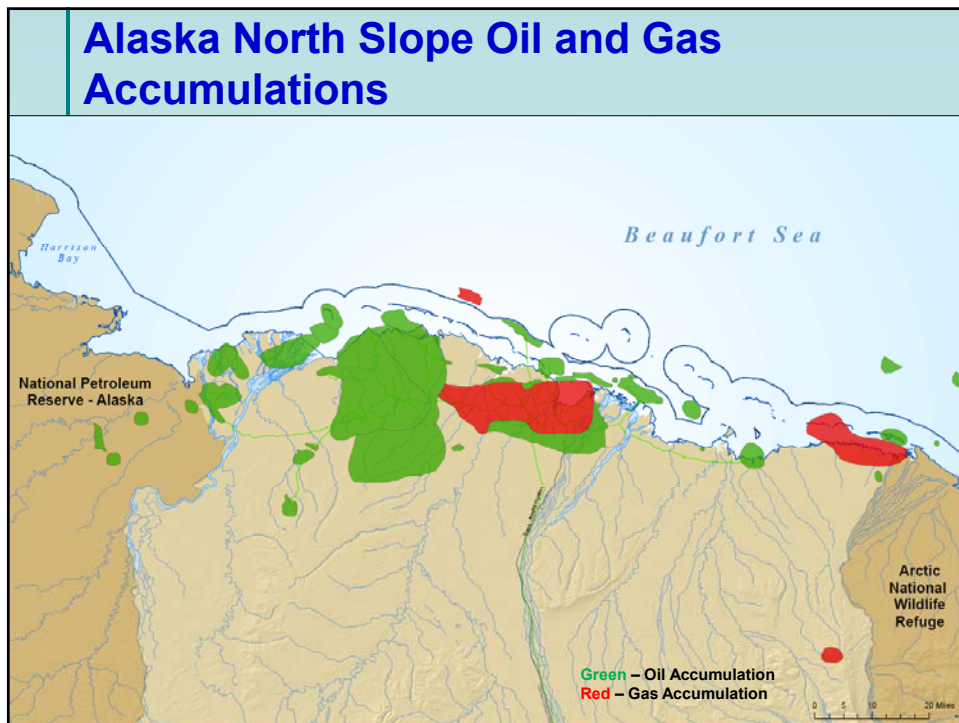
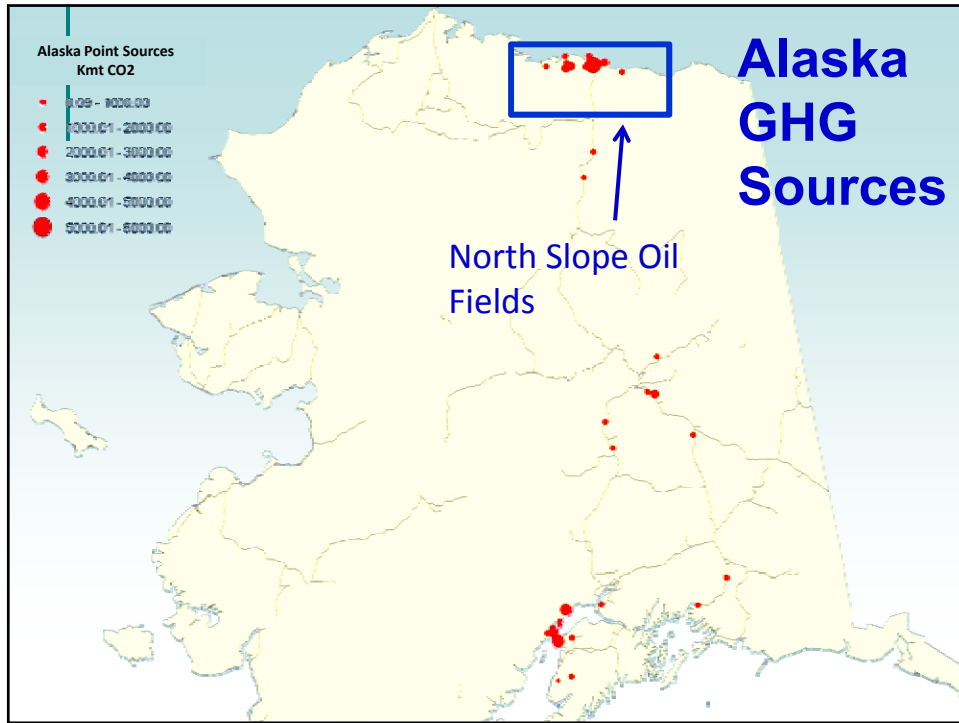
Geologic Sink Types

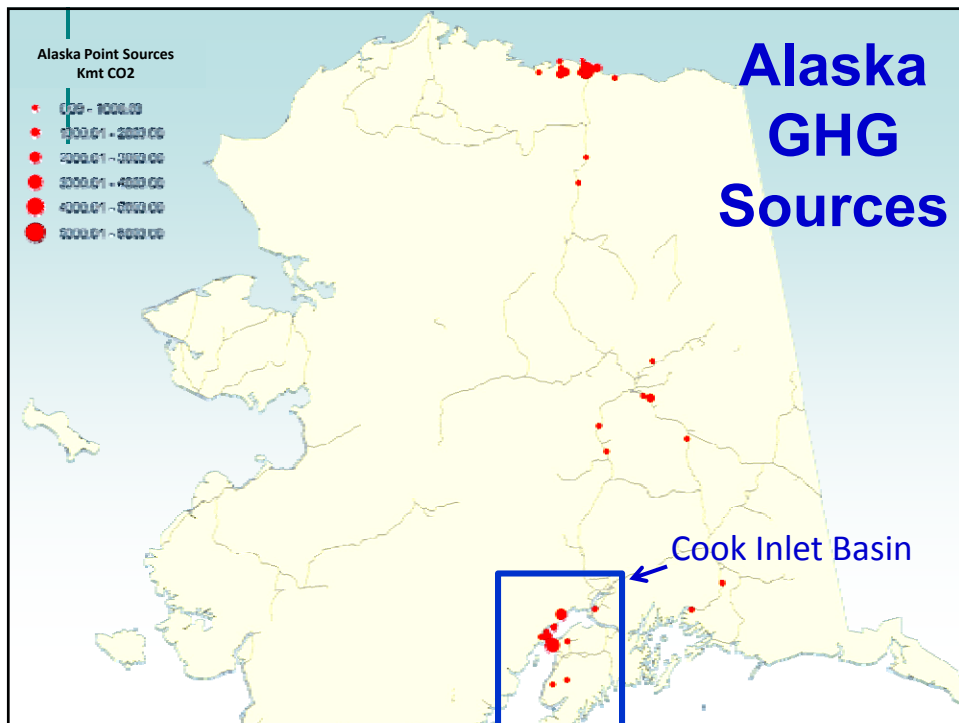
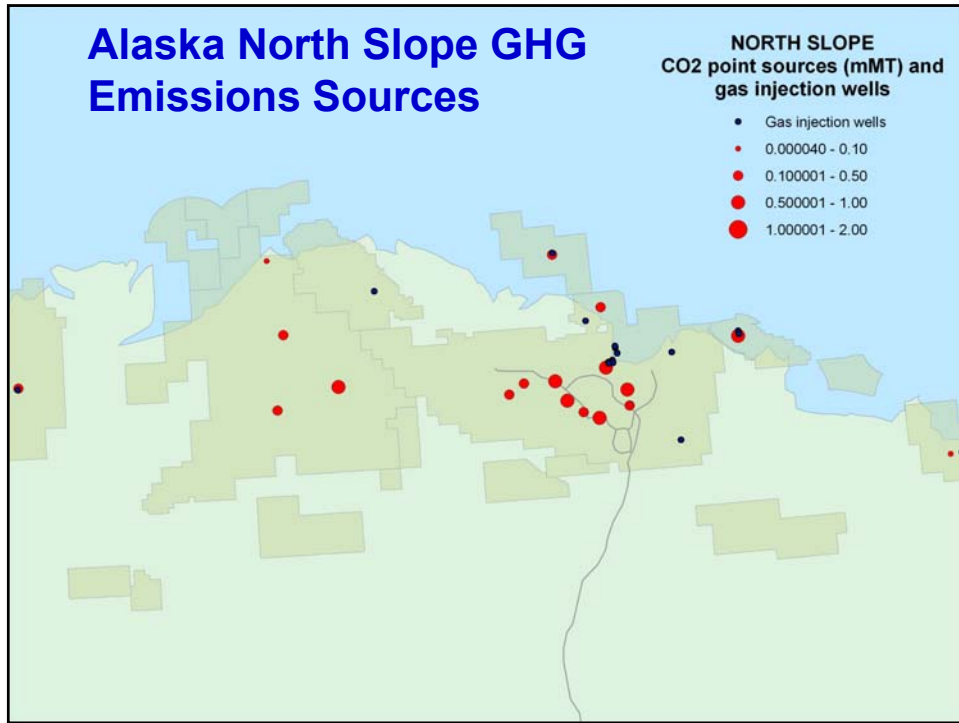
- Saline Reservoirs - need porosity, permeability, and cap rock
 - Oil and Gas Reservoirs - proven porosity, permeability, cap rock, and trap
 - ✓ Enhanced Oil Recovery (EOR)
 - ✓ Enhanced Gas Recovery (EGR)

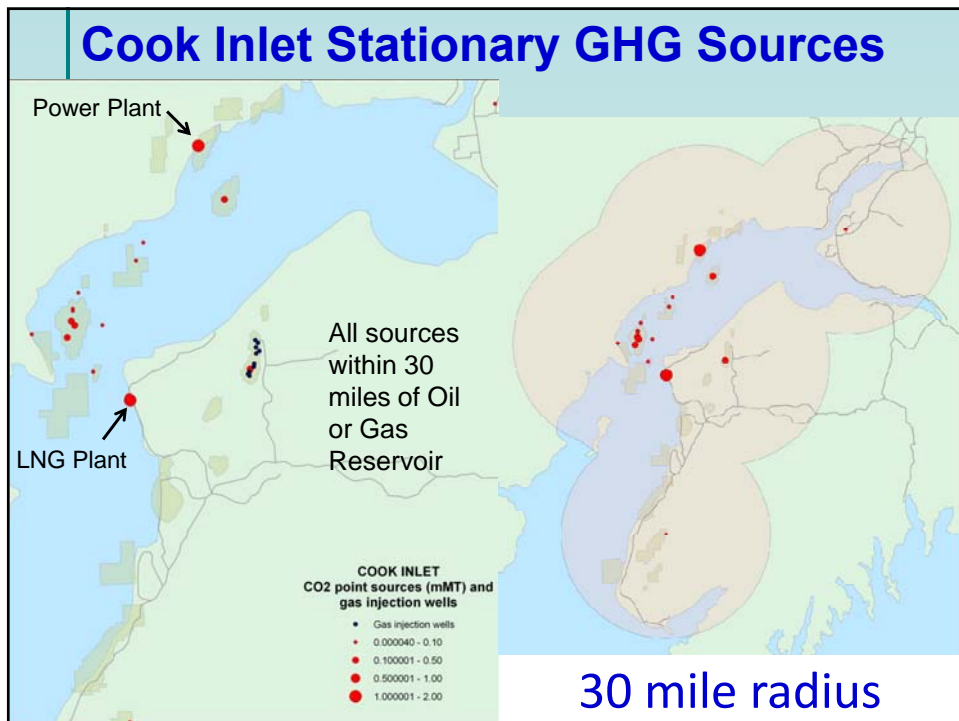
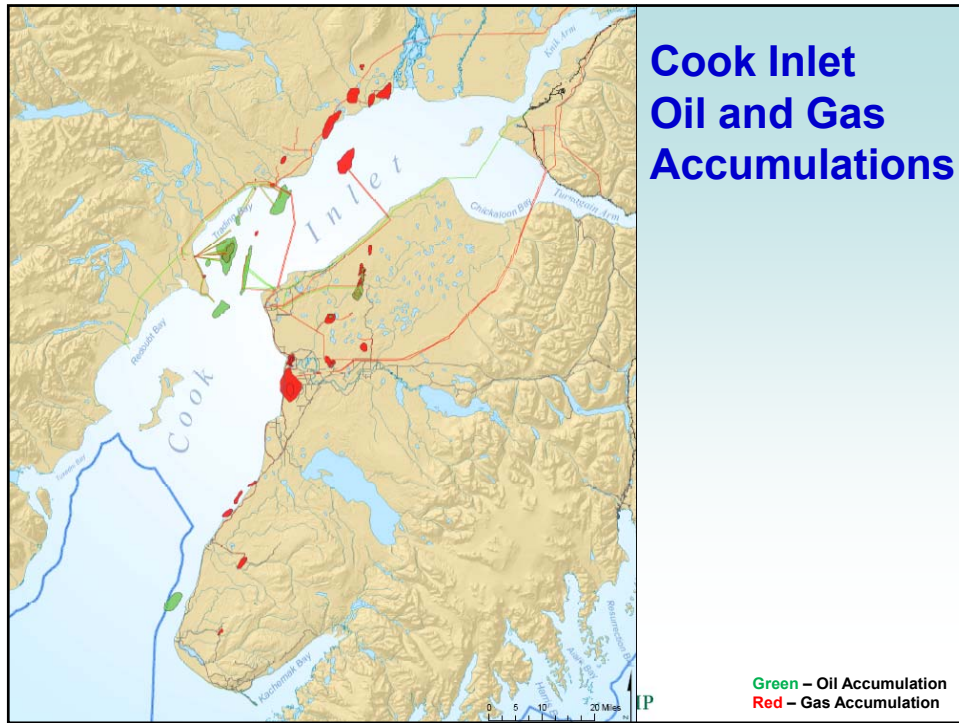
- Unmineable Coal Seams
 - Enhanced Coal Bed Methane (ECBM)

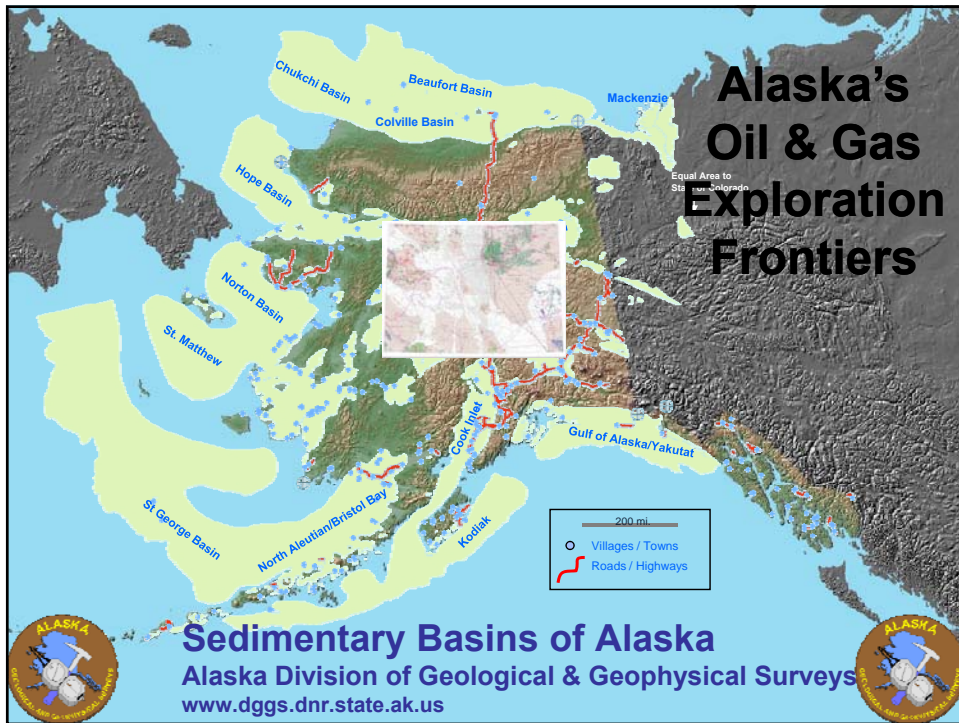
WEST COAST REGIONAL CARBON SEQUESTRATION PARTNERSHIP







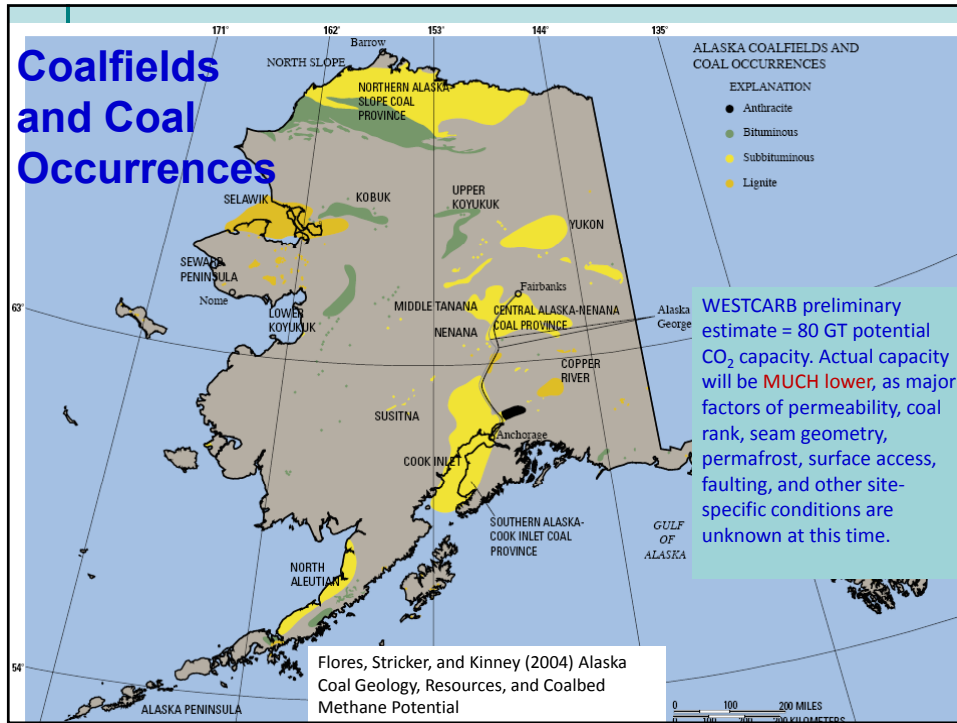




Saline Reservoir Observations

- Most sedimentary basins predominantly unexplored, sparse to no wells, seal integrity unknown
- All basins (except NS) are Tertiary, non-marine (fresh waters) and structurally complex
- Most basins a long way from CO₂ sources



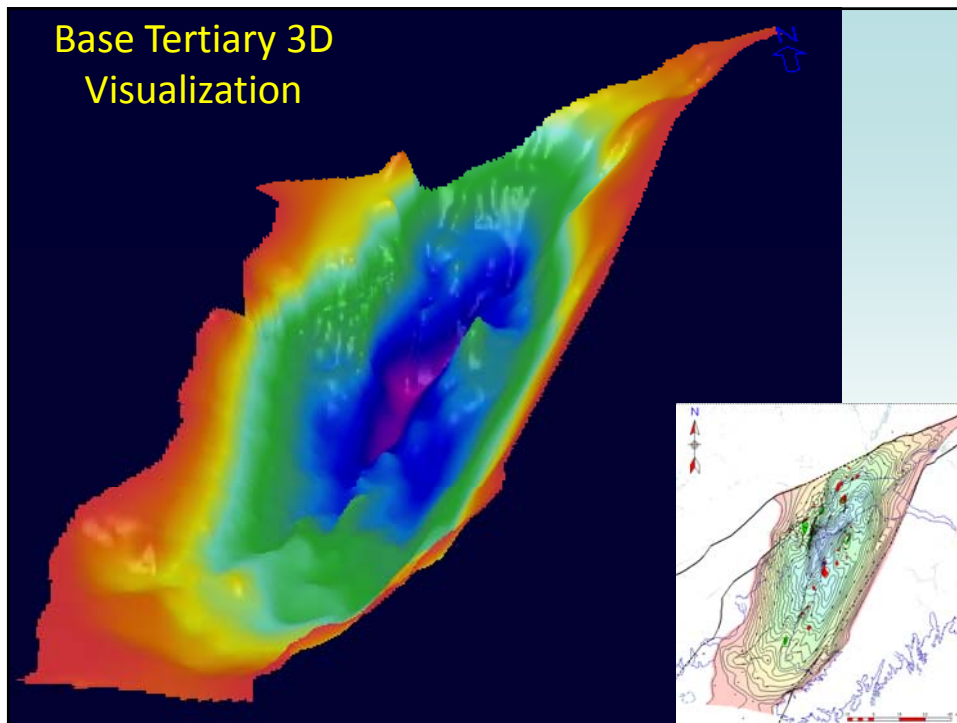
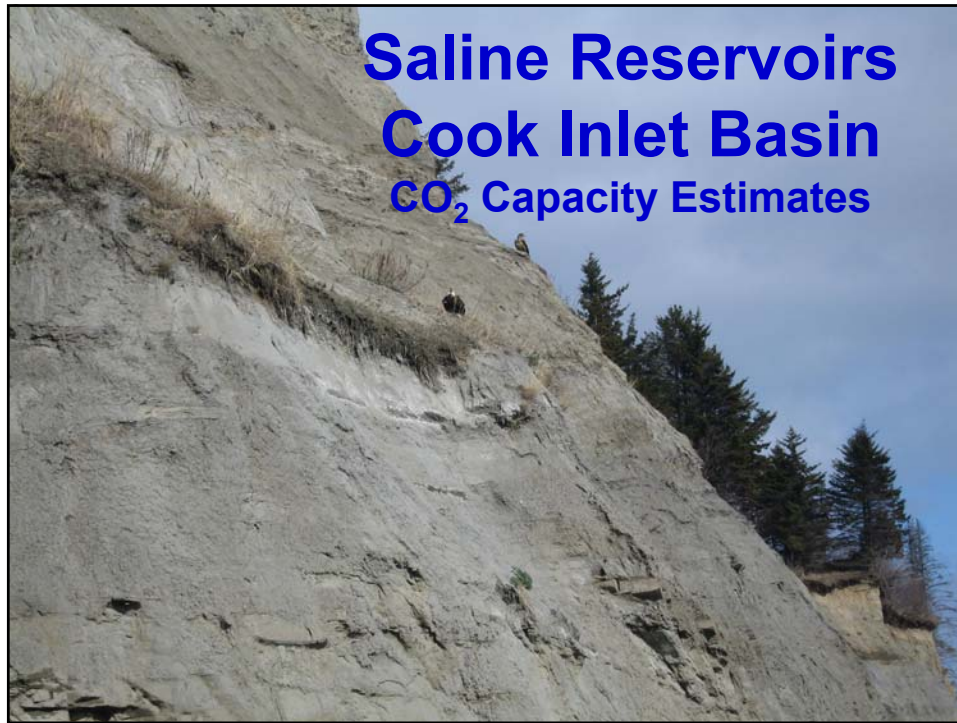


Geologic Sink Types

- Saline Reservoirs - need porosity, permeability, and cap rock
 - **Oil and Gas Reservoirs - proven porosity, permeability, cap rock, and trap**
 - ✓ **Enhanced Oil Recovery (EOR)**
 - ✓ **Enhanced Gas Recovery (EGR)**
- Unmineable Coal Seams
 - **Enhanced Coal Bed Methane (ECBM)**

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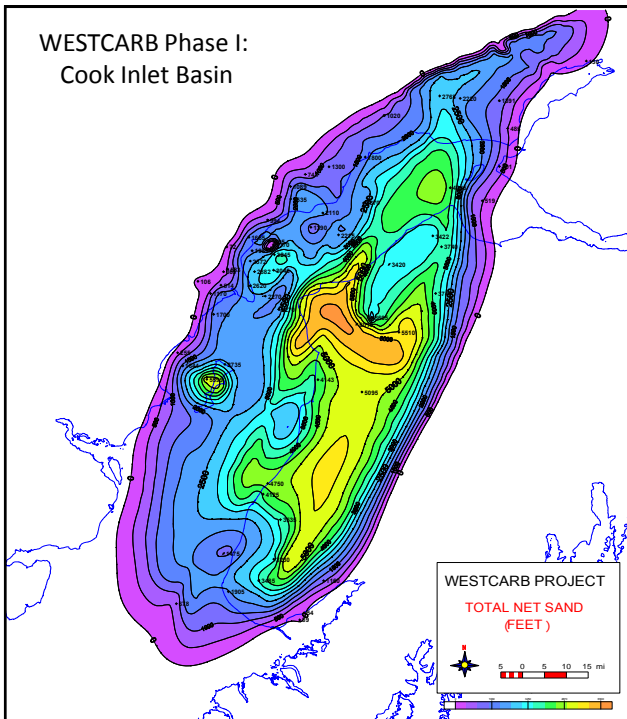
WESTCARB Phase I Review: Cook Inlet Basin

- Incorporated 61 wells distributed around the basin
- Calculated net sand between 2600' TVD and base of Tertiary section
- Net sand includes oil, gas, and saline sands
- Created a net sand to gross interval grid
- Created total thickness grid of Tertiary Section
- Multiplied net to gross grid by total thickness grid
- Calculated average porosity value for net sand
- Calculated volume based on net sand mapping and average porosity value

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WESTCARB Phase I:
Cook Inlet Basin



**Total Net Sand
Map - > 2600 ft
(~1150 psi)**



WESTCARB Phase I: Pore Volume Calculation

**Max CO₂ Volume of CI Basin Net Sand >2600 ft
– No structural constraints – in GMtCO₂**

	10%	19%	30%	Porosity
1200 psi	12	21	33	
2000 psi	23	44	70	
3000 psi	26	49	77	

**Actual capacity much less when structural
complexity is incorporated**

Refined Pore Volume Calculations

Methodologies to refine capacity estimates:

1. Simplified Cook Inlet field case
2. Detailed Cook Inlet field case
3. Limit Cook Inlet Net Sand map by mapping structural traps

Geologic Complications

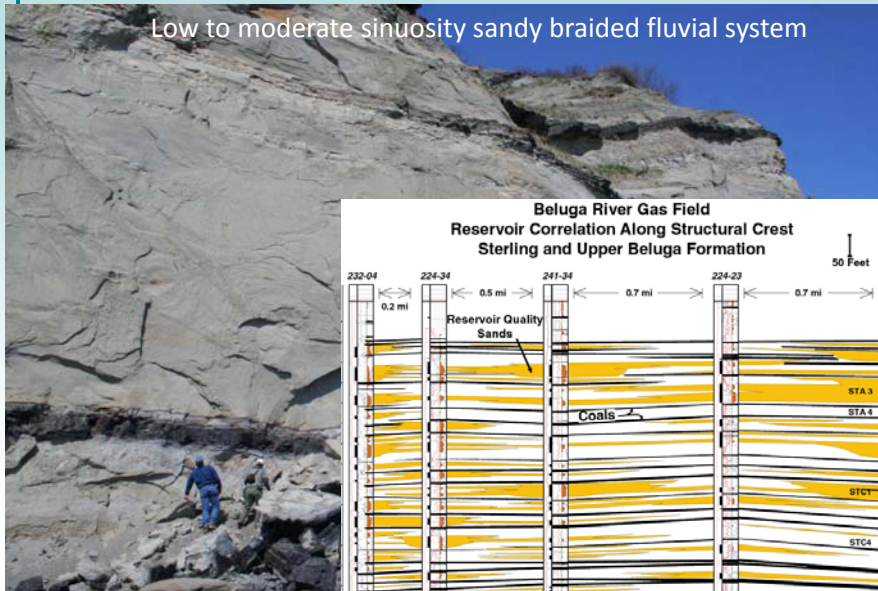
Erosional truncation of lower Beluga below
Quaternary(?) gravel



Photo -D.LePain-2006

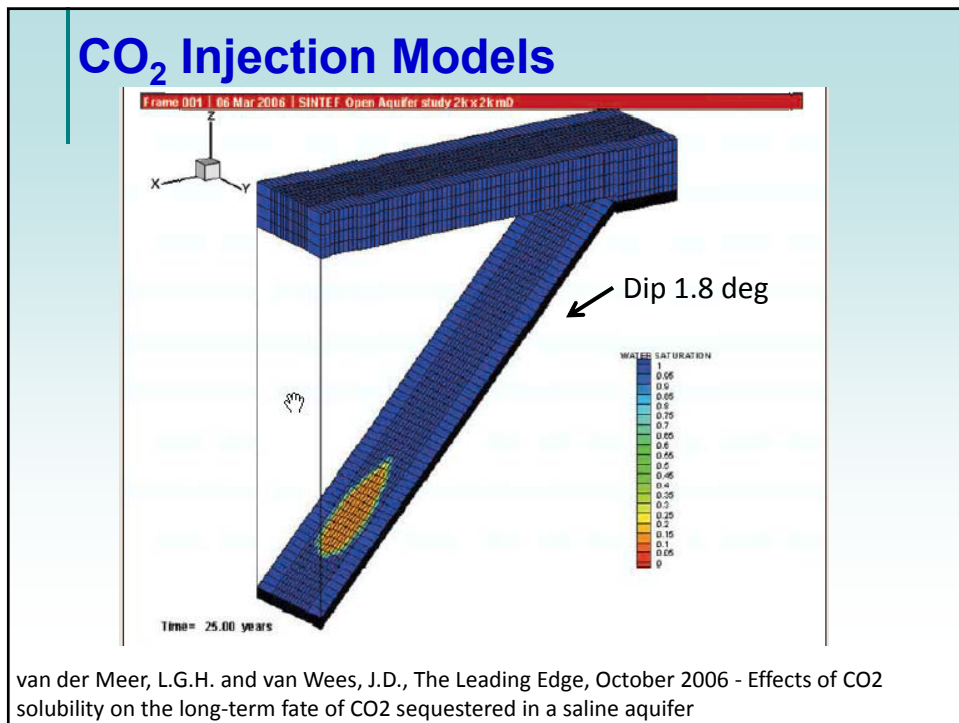
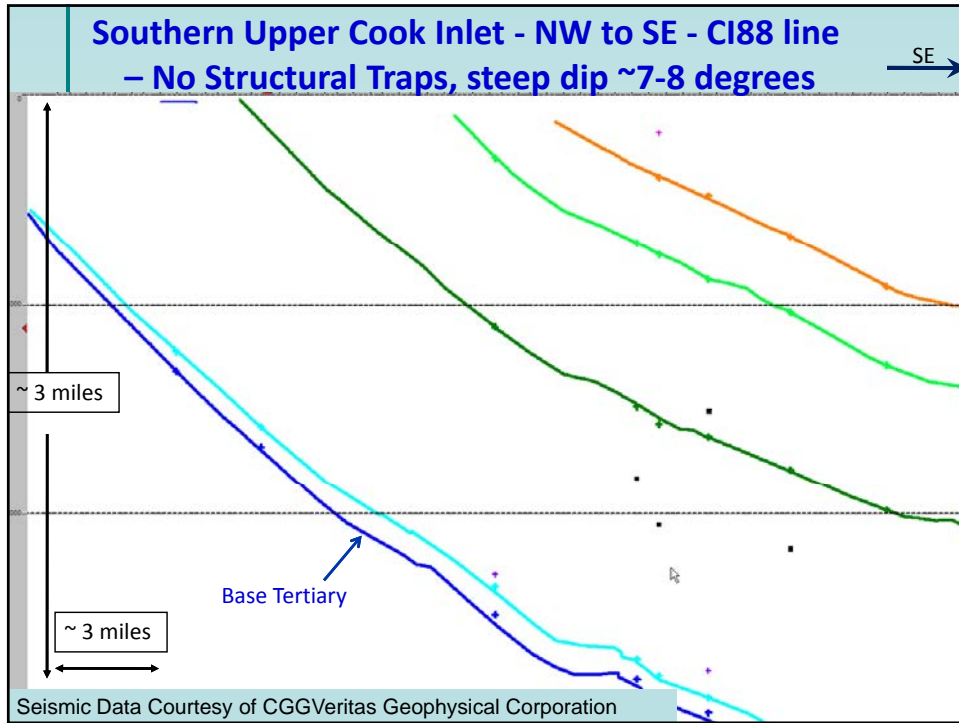
Upper Beluga Formation – Kachemak Bay

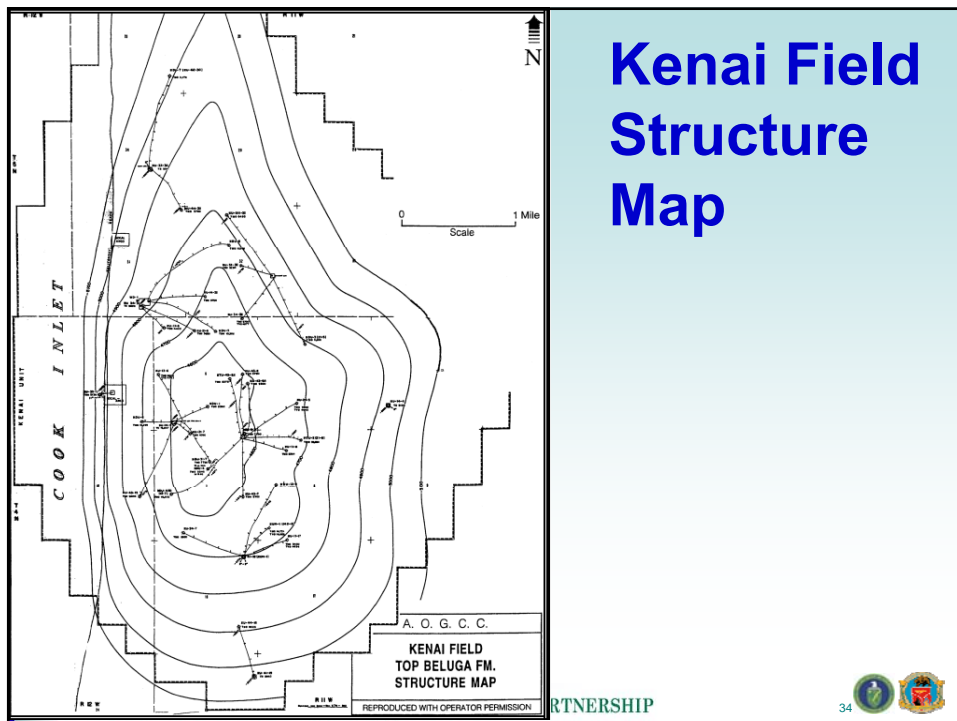
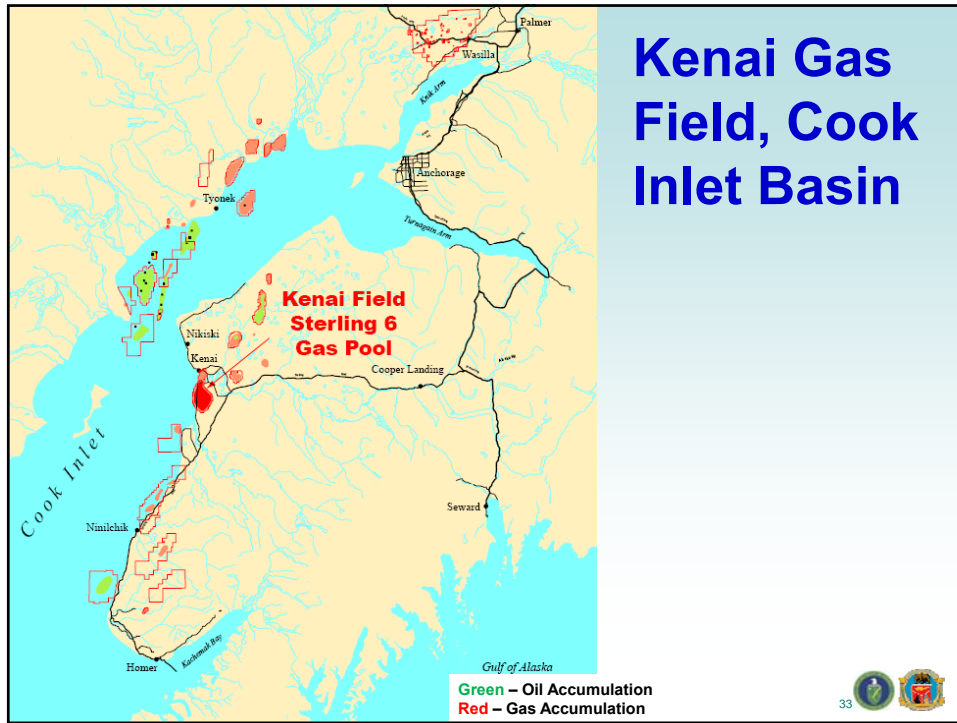
Low to moderate sinuosity sandy braided fluvial system



WEST COAST REGIONAL CARBON SEQ

From Swenson, 1997, courtesy of ConocoPhillips, Chevron, MLP





Kenai Gas Field - Simplified Pool 6

CO₂ Storage capacity ~220 Mmt *

* Using MIDCARB calculator

Alaska Total emissions ~ 52 Mmt/yr
Cook Inlet Stationary emissions ~ 10-12 Mmt/yr

Pool 6 currently being used for Gas Storage

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MidCarb Calculator

MIDCARB Calculators

Sequestration Volume in Metric Tonnes and MCF

Click on any "Update" button to refresh all of the calculations.

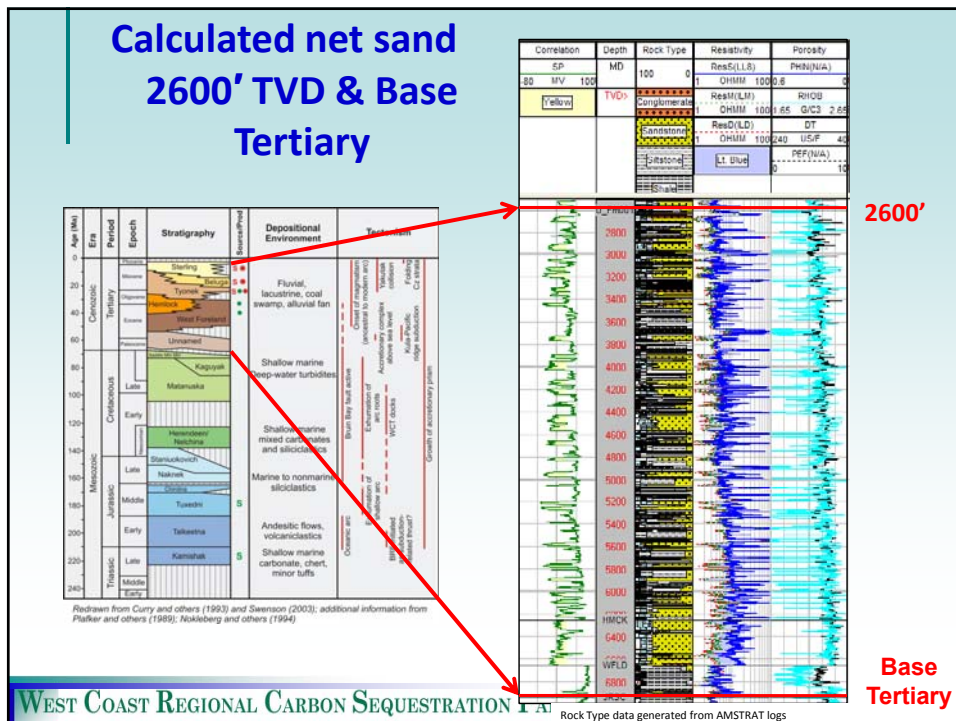
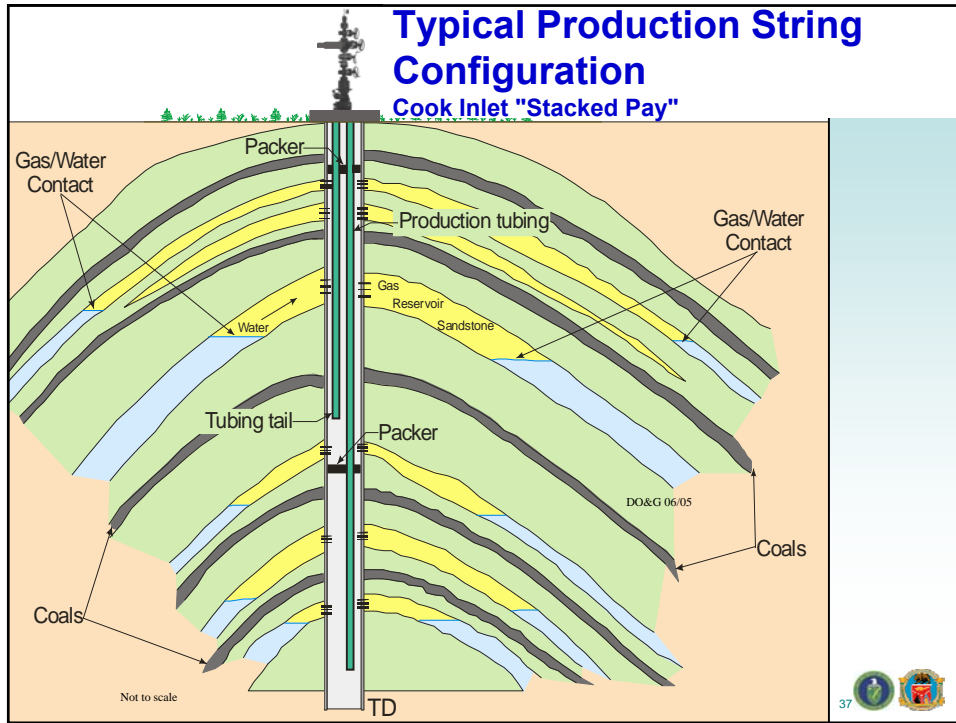
Step 1--Modify Reservoir Temperature and Pressure as required.

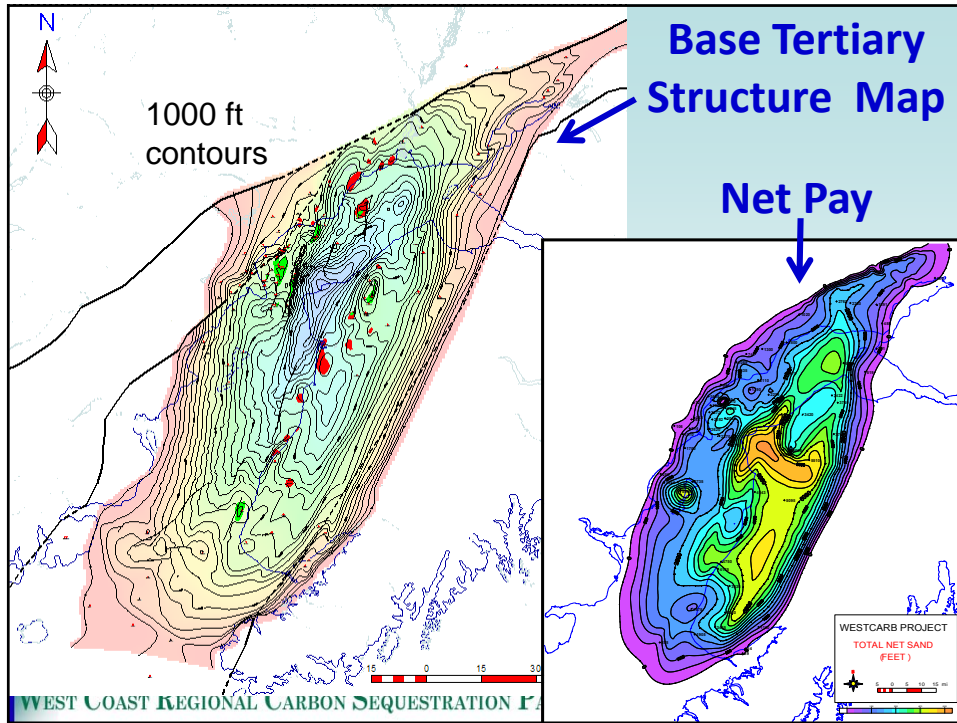
Reservoir Temperature	100	Degrees F
Reservoir Pressure	2000	psia
<input type="button" value="Update"/>		

Step 2--Reservoir Volumetrics.
Enter reservoir parameters or skip to step 2a.

Reservoir Thickness	110	feet
Reservoir Area	13170	acres
Porosity	16	%
Sequestration Volume	222,727,542	metric tonnes
<input type="button" value="Update"/>		

http://abyss.kgs.ku.edu/pls/abyss/midcarb.co2_calc.volume





Ongoing or Planned Work

- Detailed Kenai Field CO₂ storage volume estimate
- Detailed Cook Inlet Saline reservoir storage capacity – with structure/seal constraints
- **Economic analysis for a Cook Inlet Field**

Pore Volume Estimate Observations

- Procedures define pore space available for CO₂ storage
- Final estimates will be dramatically smaller when structural and stratigraphic complexities are integrated.
- **Costs for capture, transport, and re-plumbing for corrosive gases have not been analyzed, and are expected to be significant.**

Summary by Geography: Stationary Sources and Geologic Sinks

- **North Slope**
EOR and depleted Oil and Gas Reservoir space >> expected CO₂ volumes
- **Cook Inlet**
EOR and depleted Oil and Gas Reservoir space > expected CO₂ volumes
- **Other (e.g., Fairbanks-sources → Interior Basins sinks)**
Saline most likely sinks, will need extensive work to confirm seals

Summary by Geography

- **For North Slope and Cook Inlet, pore space is probably not the issue**
 - ✓ Carbon Capture
 - ✓ Need for re-plumbing for acid gas
 - ✓ Monitoring
 - ✓ Regulatory
 - ✓ Other?

Acknowledgements

Alaska Department of Natural Resources

Bob Swenson
Laura Silliphant
Shaun Peterson

David Hite – ***Geologic Consultant***

Alaska Department of Environmental Conservation

Alaska Energy Authority

Photo - P. Decker-2007

Climate Change Links

Alaska Department of Environmental Conservation (DEC)

DRAFT - Summary Report of Improvements to the Alaska Greenhouse Gas Emission Inventory (includes Final Alaska GHG Inventory and Reference Case Projection, Center for Climate Strategies, July 2007)

http://www.climatechange.alaska.gov/docs/qhg_ei_rpt.pdf

Intergovernmental Panel on Climate Change

IPCCC Special Report on Carbon dioxide Capture and Storage

http://www.mnp.nl/ipcc/pages_media/SRCCSfinal/IPCCSpecialReportonCarbondioxideCaptureandStorage.htm

U.S. Department of Energy – DOE

Storing CO₂ with Enhanced Oil Recovery DOE/NETL - 402/1312/02-07-08

www.netl.doe.gov/energy-analyses/pubs/storing%20co2%20w%20eor_final.pdf

10 CO₂-EOR basin assessments for CO₂-EOR (Including Alaska)

http://www.fossil.energy.gov/programs/oilqas/eor/Ten_Basin-Oriented_CO2-EOR_Assessments.html

Use of CO₂ in EOR Background and Potential Application to Cook Inlet Oil Reservoirs

http://www.aogcc.alaska.gov/EnergyForum/06_ppt_pdfs/27_hite.pdf

Beluga Coal Gasification Feasibility Study

http://www.netl.doe.gov/technologies/coalpower/gasification/pubs/pdf/Beluga%20Coal%20Gasif%20Feasibility%20Study9_15_06.pdf

Alaska Coal Gasification Feasibility Studies-Healy Coal-to-Liquids Plant

<http://www.netl.doe.gov/technologies/coalpower/gasification/pubs/pdf/FINAL-Healy%20FT%201251%2007062007.pdf>

Carbon Sequestration Atlas of the United States and Canada

http://www.netl.doe.gov/technologies/carbon_seq/refshelf/atlas/

U.S. Environmental Protection Agency

EPA – Proposing new federal requirements under the Safe Drinking Water Act (SDWA) for the underground injection of CO₂. For the purpose of long term storage, or geologic sequestration.

http://www.epa.gov/safewater/uic/wells_sequestration.html

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Alaska Department of Natural Resources

Division of Oil and Gas

Activity Maps, Unit maps, sale information, Annual Reports, presentations...

<http://www.dog.dnr.state.ak.us/oil/>

Division of Geologic and Geophysical Surveys

Geologic and Geophysical Publications, Projects, Energy, Volcanology...

<http://www.dggs.dnr.state.ak.us/>

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