

3/24/11

Presentation by  
Bob Swenson,  
State Geologist:  
Sedimentary  
Basins of Alaska

<TARGET><BILL></BILL><SUBJECT>3-24-11 Presentation by Bob  
Swenson, State Geologist Sedimentary Basins of  
Alaska</SUBJECT><COMM>HENE27</COMM></TARGET>

# Sedimentary Basins of Alaska

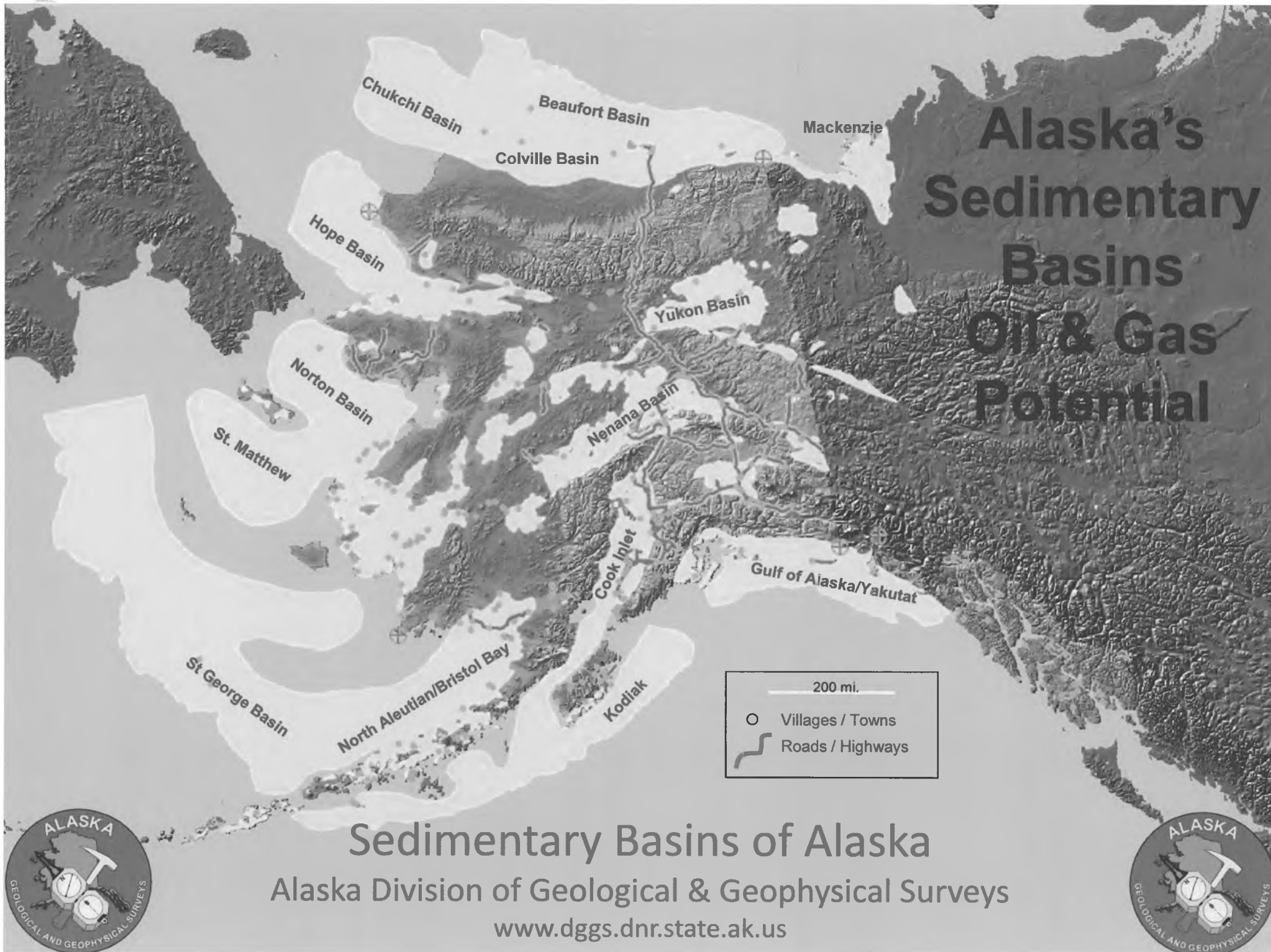


*Bob Swenson*  
*State Geologist*

**Alaska Division of Geological & Geophysical  
Surveys**



# Alaska's Sedimentary Basins Oil & Gas Potential



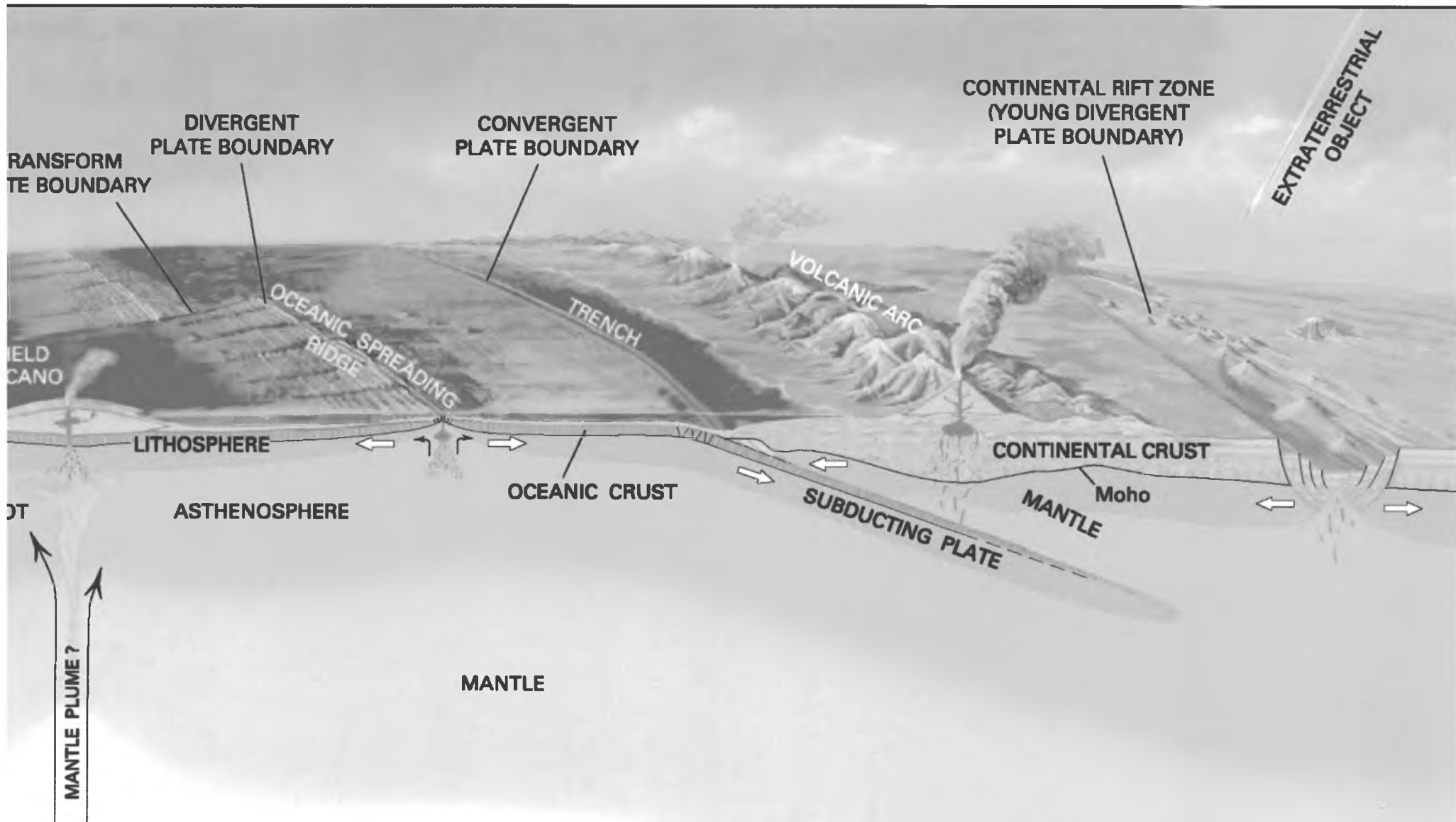
## Sedimentary Basins of Alaska

Alaska Division of Geological & Geophysical Surveys

[www.dggs.dnr.state.ak.us](http://www.dggs.dnr.state.ak.us)

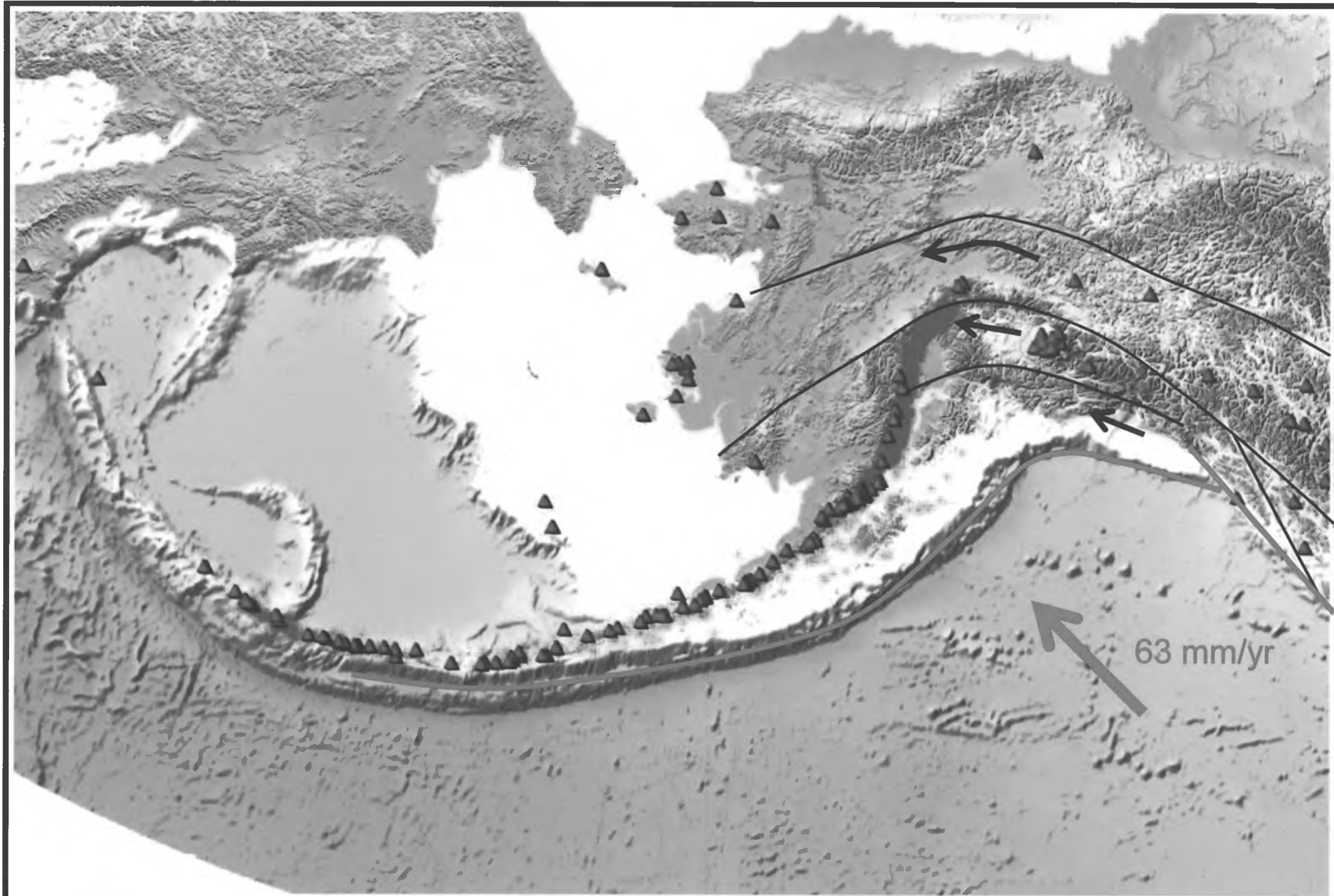


# Subduction and Tectonics Drive the System

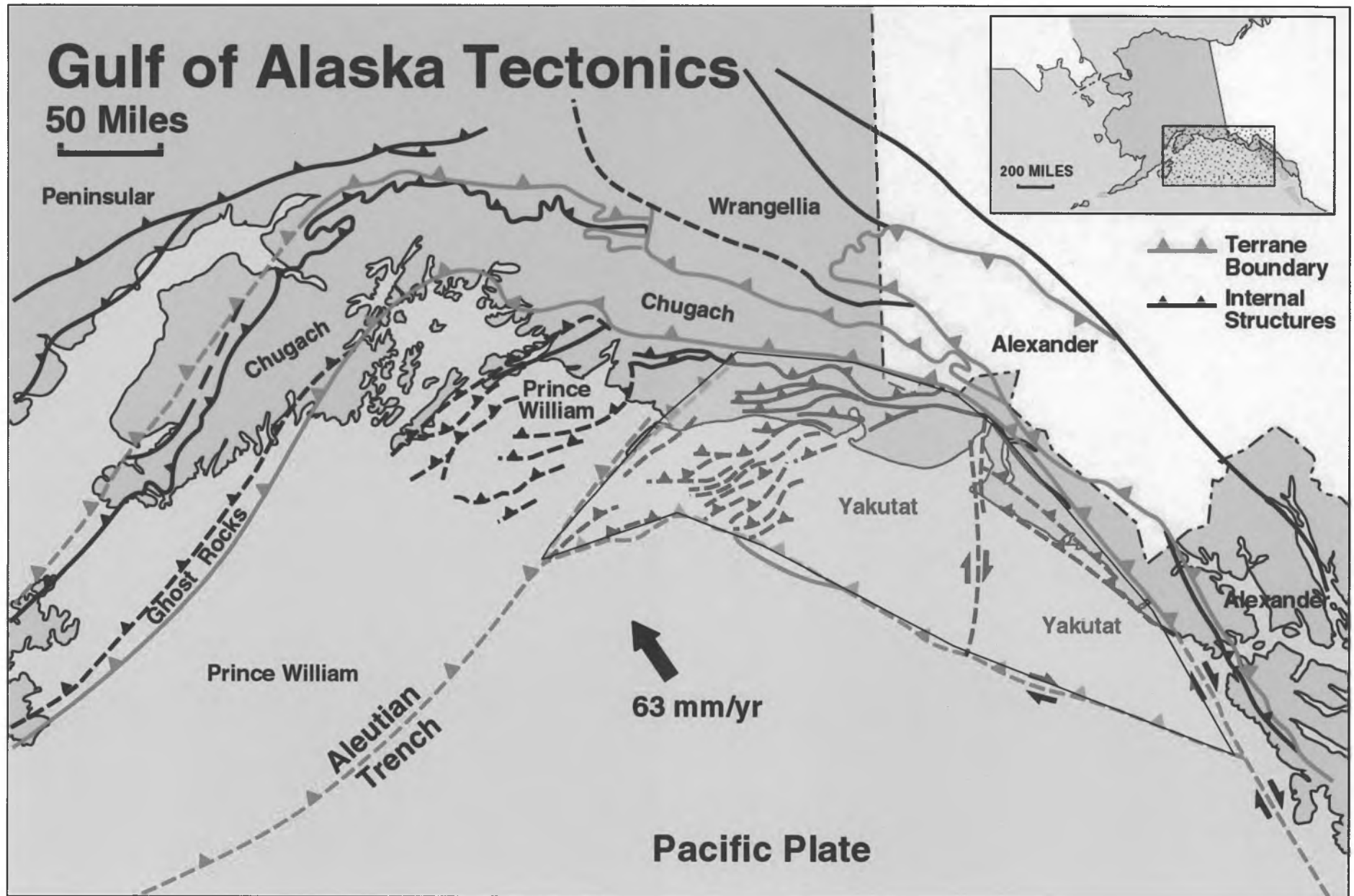


**SCHEMATIC CROSS SECTION OF PLATE TECTONICS**

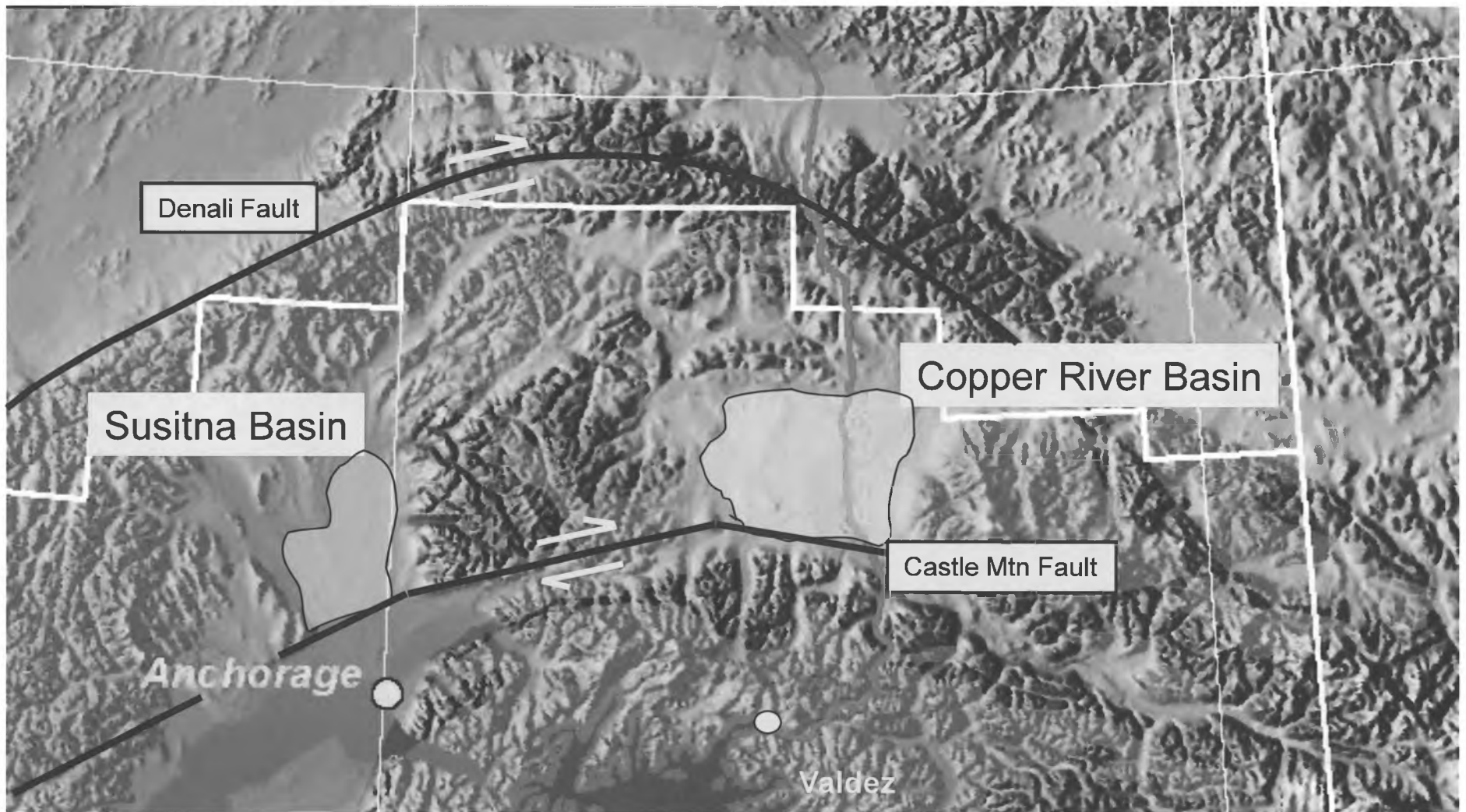
# Alaska is Complex, Both Topographically & Geologically



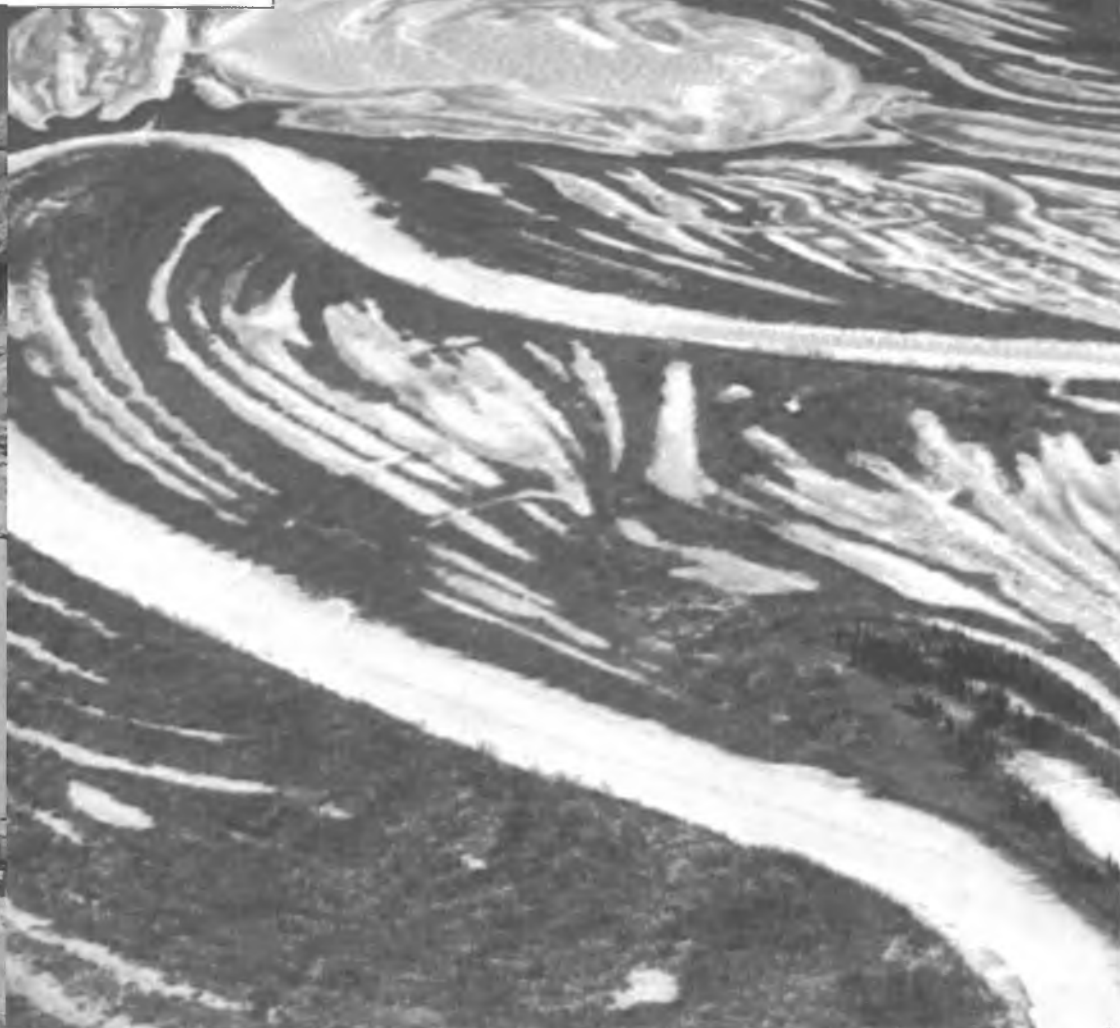
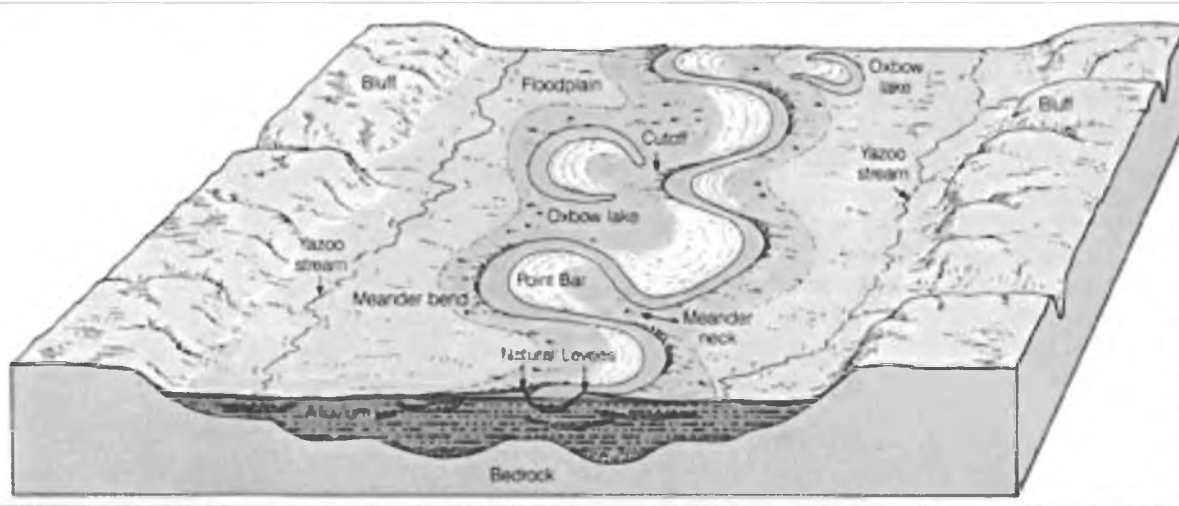
# South Alaska Terranes



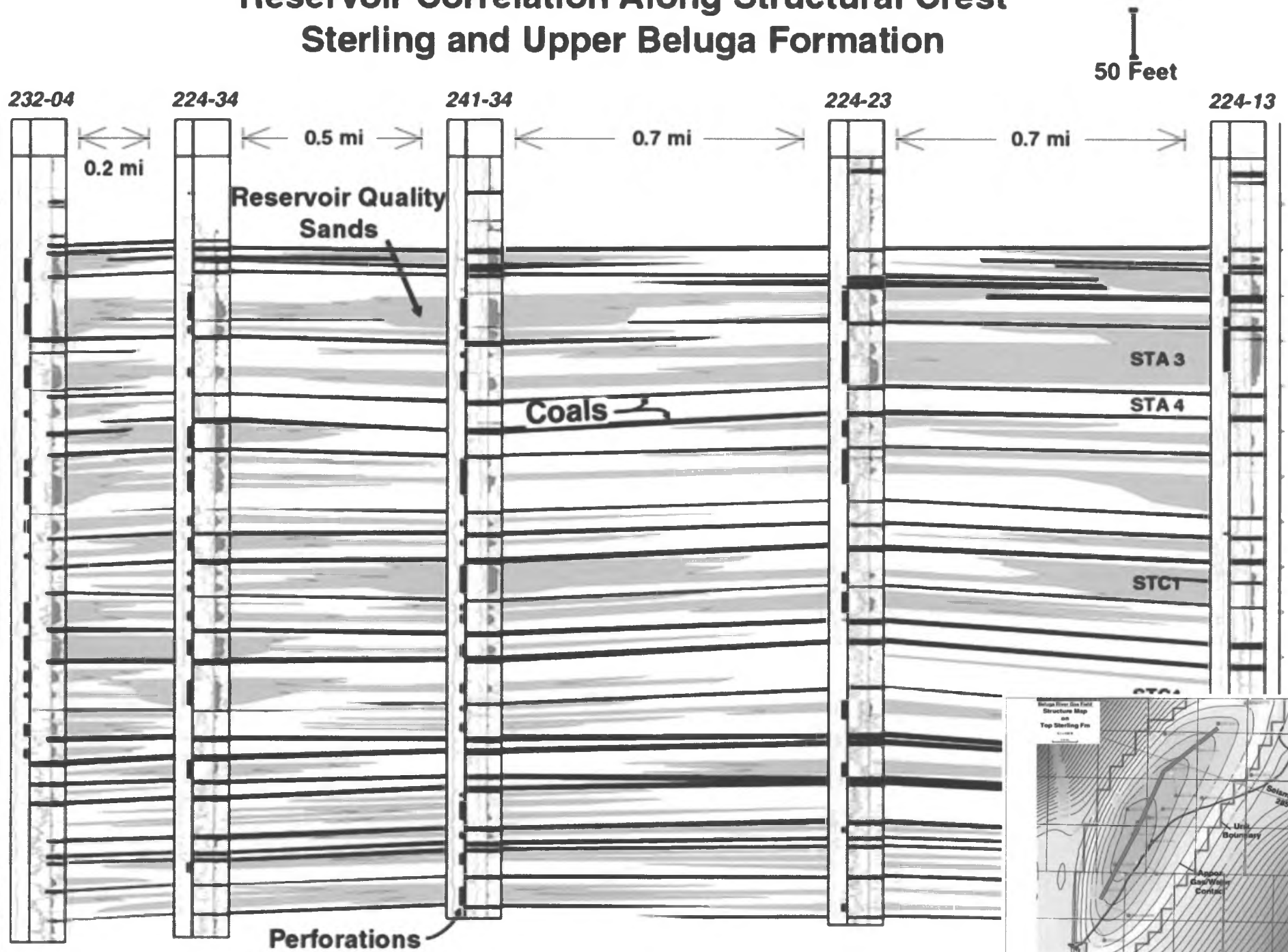
# Mountain Building and Depressions

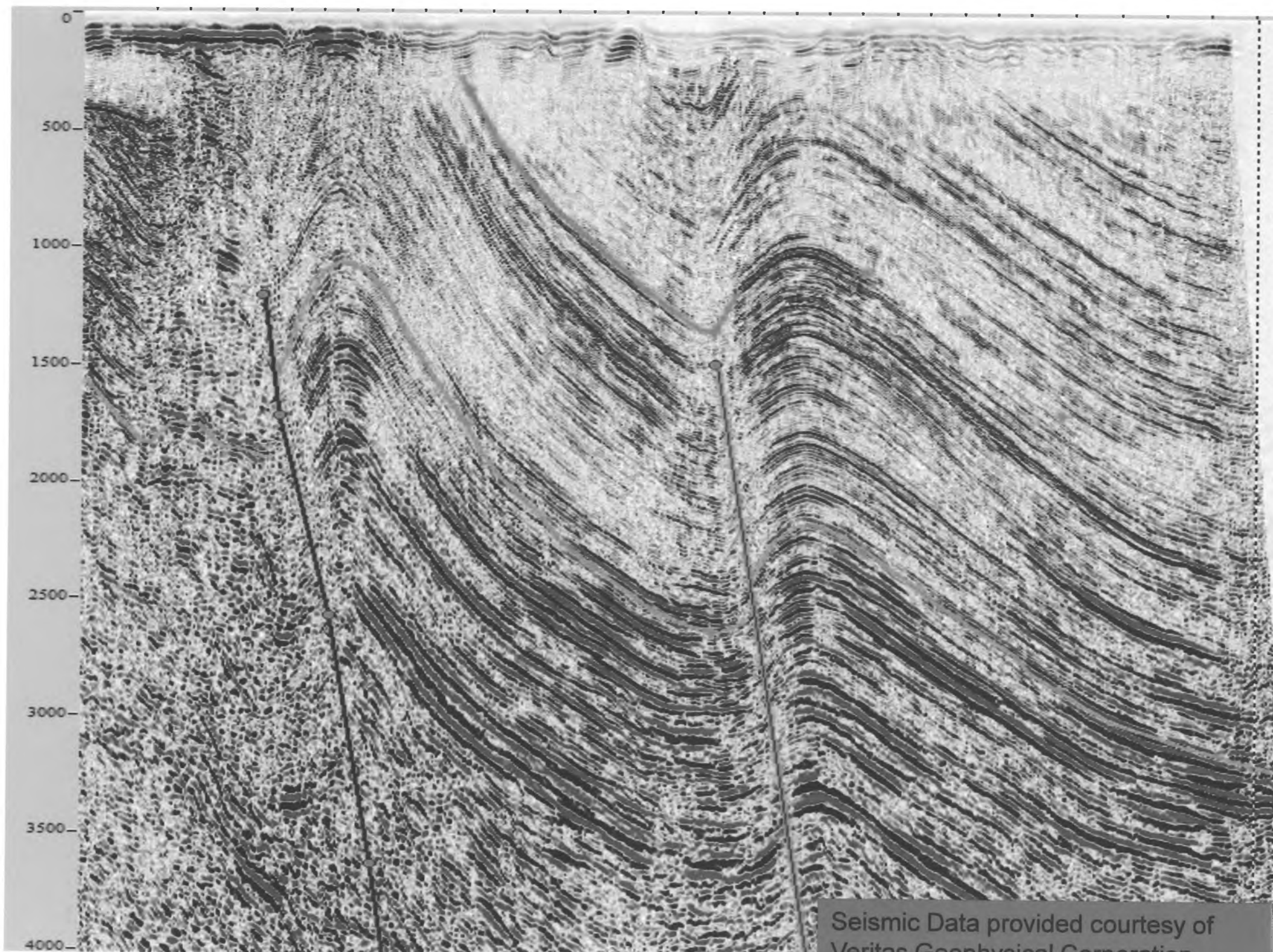


# Tertiary Basin Depositional Systems



# Beluga River Gas Field Reservoir Correlation Along Structural Crest Sterling and Upper Beluga Formation





Seismic Data provided courtesy of Veritas Geophysical Corporation





# Alaska Natural Gas Resources

USGS Estimates of Onshore and State Offshore Natural Gas Resources

MMS Estimates of OCS Natural Gas Resources

**Explanation**  
Sedimentary Basins

**Assessment Boundaries**  
— USGS  
— MMS

**Chukchi Sea OCS**  
Range 13.6 - 154.3 tcf  
Mean 60.1 tcf

**Beaufort Sea OCS**  
Range 12.9 - 63.3 tcf  
Mean 32.1 tcf

**NPRA**  
Range 40.4 - 85.3 tcf  
Mean 61.4 tcf

**Non-Federal Area**  
Oil & Gas updates  
In progress

**ANWR 1002 Area**  
Range 0.0 - 10.9 tcf  
Mean 3.8 tcf

**Hope Basin OCS**  
Range 0.0 - 11.1 tcf  
Mean 3.4 tcf

**Norton Basin OCS**  
Range 0.0 - 8.7 tcf  
Mean 2.7 tcf

**Central Alaska**  
Range 0.5 - 7.3 tcf  
Mean 2.8 tcf

**St. Matthew-Hall OCS**  
Range 0.0 - 0.7 tcf  
Mean 0.2 tcf

**St. George Basin OCS**  
Range 0.0 - 9.7 tcf  
Mean 3.0 tcf

**North Aleutian Basin OCS**  
Range 0.0 - 17.3 tcf  
Mean 6.8 tcf

**Cook Inlet OCS**  
Range 0.7 - 2.5 tcf  
Mean 1.4 tcf

**Southern Alaska**  
Range 0.7 - 4.3 tcf  
Mean 2.1 tcf

**Shumagin & Kodiak OCS**  
Range 0.0 - 11.4 tcf  
Mean 2.7 tcf

**Gulf of Alaska OCS**  
Range 0.9 - 10.6 tcf  
Mean 4.2 tcf

## Natural Gas Resources Reported

Numbers posted are for technically recoverable\*, undiscovered volumes of conventional natural gas resources  
Range - Estimates of volumes of gas at 95% and 5% probabilities  
Mean - Mean estimates of gas volumes

tcf = trillion cubic feet of gas

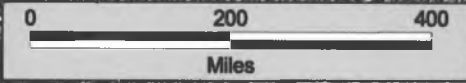
\*No estimates of economically recoverable gas resources are given

## Additional Gas Resources

Alaska also contains huge *in-place* resources of coalbed methane and gas hydrates, but the amount of technically recoverable gas in these resources is uncertain.

### Sources of Information

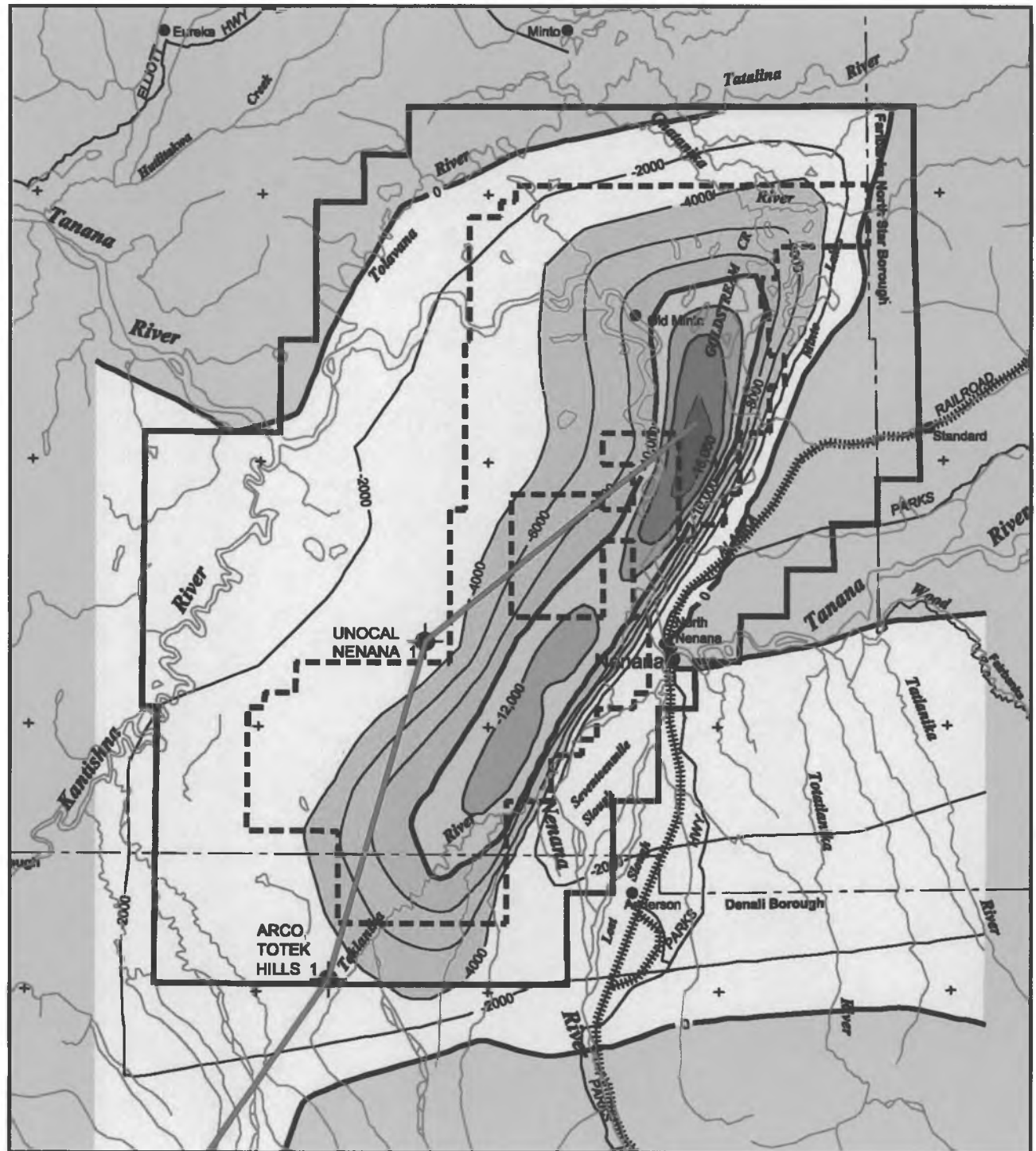
NPRA natural gas: USGS Fact Sheet 045-02 (2002)  
ANWR natural gas: USGS Fact Sheet 028-01 (2001)  
Other onshore natural gas: USGS Circular 1118 (1995)  
OCS natural gas: MMS Alaska Federal Offshore Update (2000)





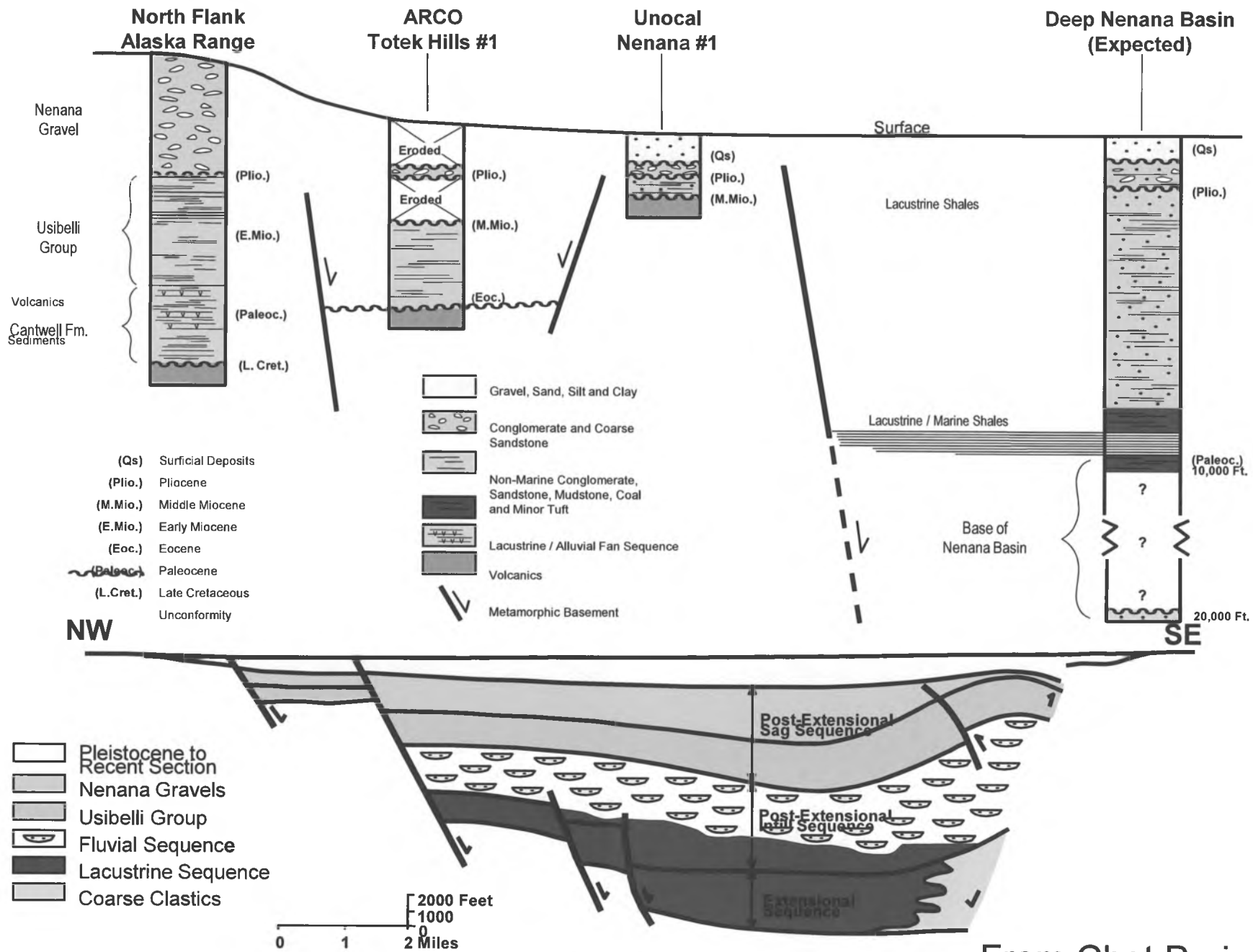
# Nenana Basin

Thickness of Sedimentary Basin  
(Tertiary)



Contour Interval = 2,000 Ft.

# Nenana Basin



From Chet Paris, PRA

**Usibelli Group in Outcrop Belt South of  
Nenana Exploration License Area**

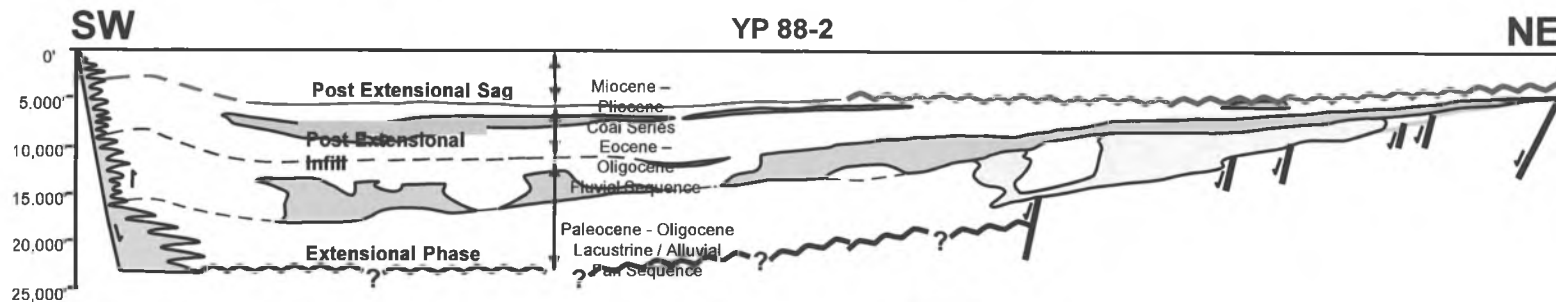
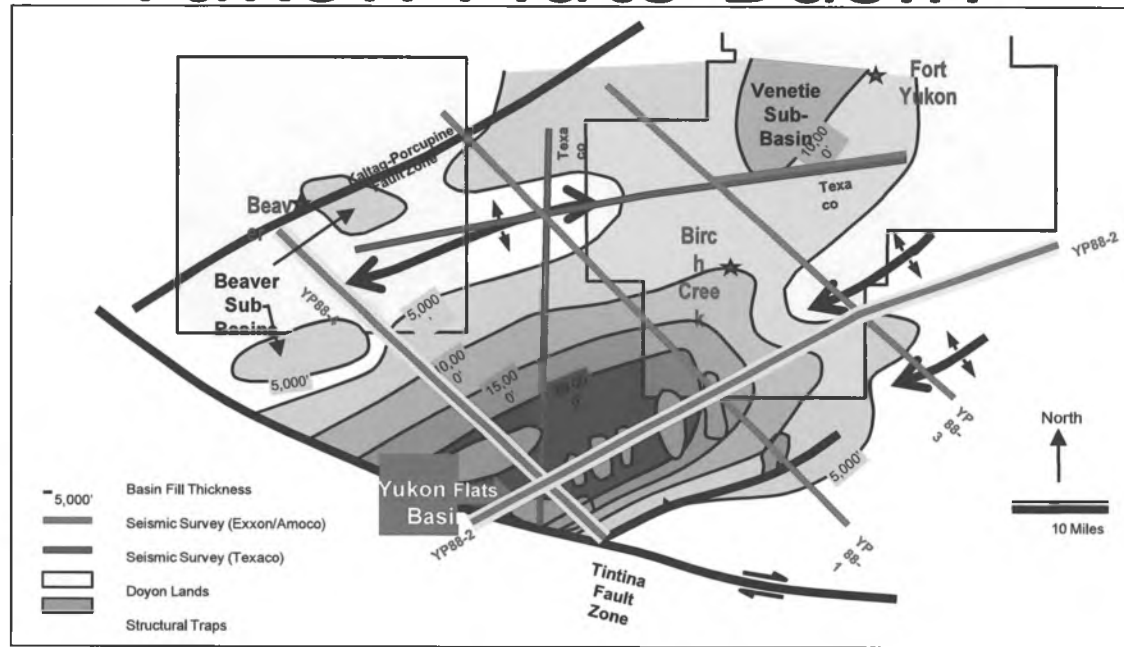


# Nenana Basin Statistics



- Tertiary Non Marine Basin Fill
  - Up to 18,000 Ft Thick (Seismic).
  - Time-equivalent to Cook Inlet's productive Kenai Group.
  - Potential for oil is low due to thin low-organic source rocks & thermal history.
  - 350 miles 2-D seismic data in southern and central basin areas (1981-82)
- The range of possible reserve outcomes is wide and poorly constrained
  - Terrestrial Kerogens and Coal Sourced Gas
- 2 Wells Drilled on Basement Highs
  - Unocal Nenana #1 (1962) – 3,062' deep, coal seam gas shows.
  - ARCO Totek Hills #1 (1984) – 3,590' deep, coal seam gas shows.
  - Entire Section not Penetrated
  - Good Reservoir in Shallow Section
  - Potential for CBM and conventional gas is good
- Significant Deformation on Southern Margin
  - Likely Associated with Strike Slip on Basin Bounding Faults
- Recent Seismic Work and Exploration Well
  - No commercial discovery announced

# Yukon Flats Basin

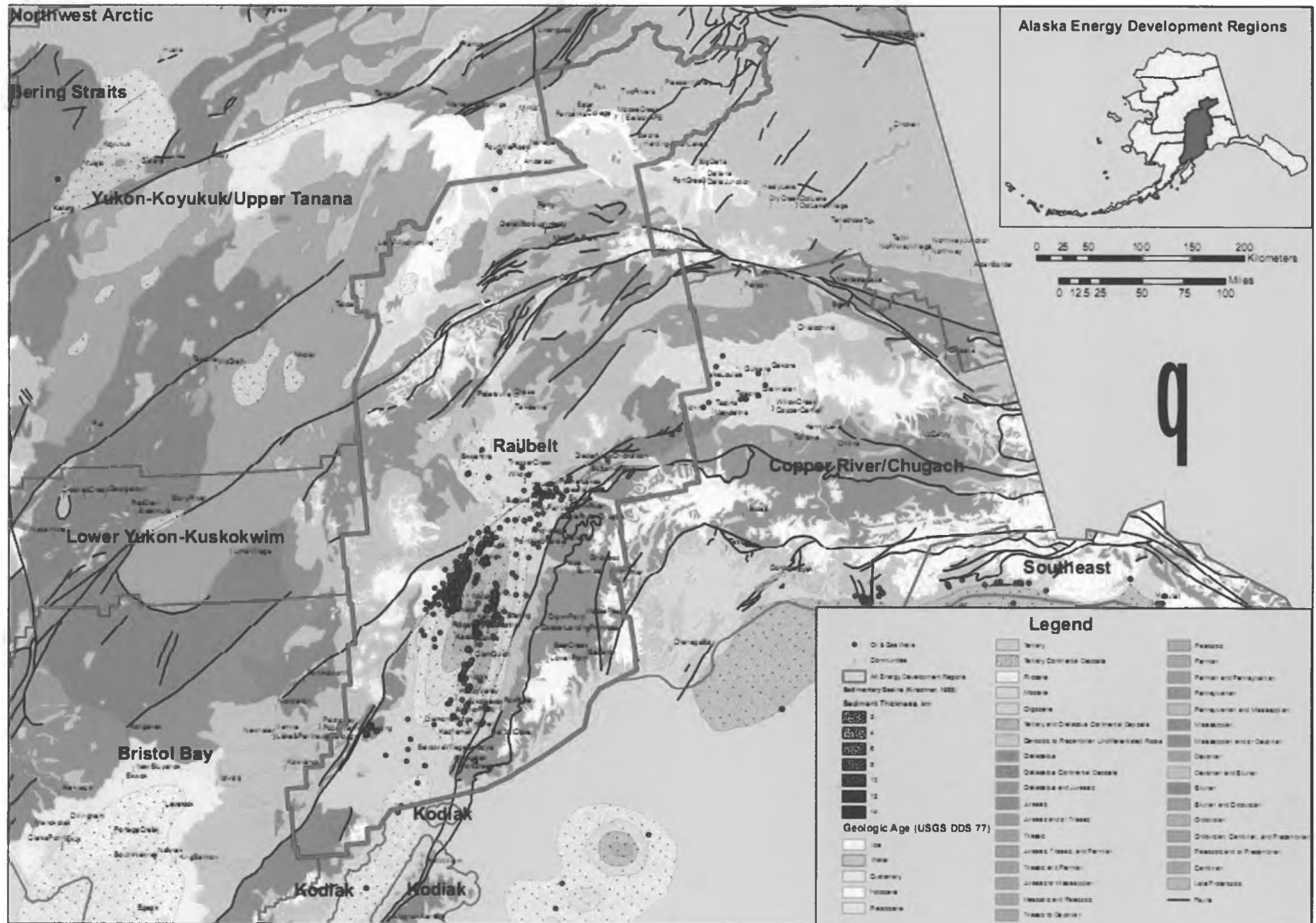


0 5 40 Miles  
Horizontal Scale

- Extensive, strong amplitude, high frequency reflectors
- Extensive, strong amplitude, low frequency reflectors
- Local, strong amplitude, low frequency reflectors
- Coarse clastic wedge

From Chet Paris, PRA

# Geology of the Railbelt Energy Region, Alaska

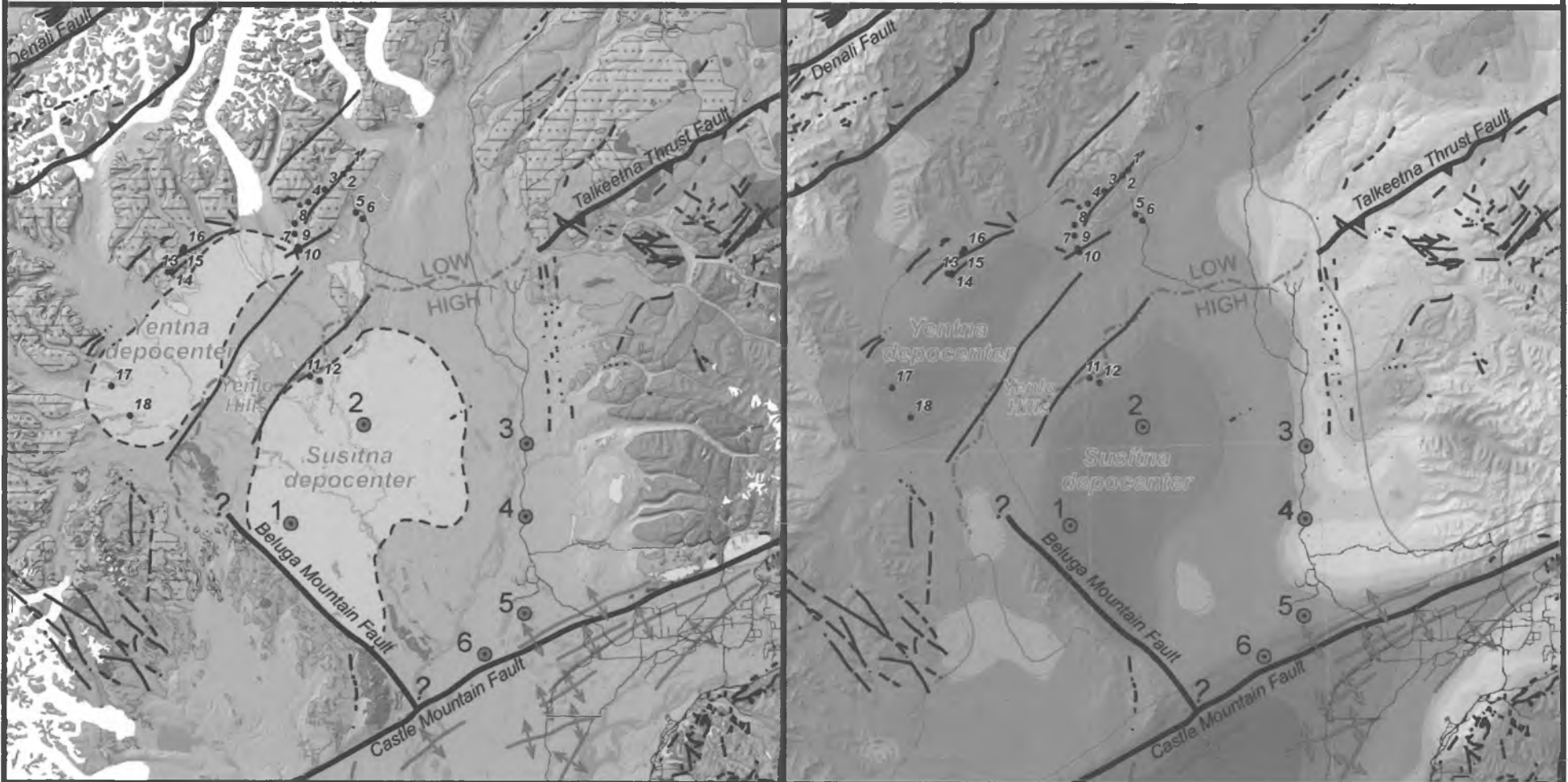


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# Susitna Basin

Generalized geologic map of the Susitna lowlands  
(adapted from Wilson and others, 2009)

Bouguer gravity map of the Susitna lowlands  
(from Meyer, 2005)

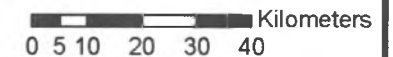


- Tertiary sedimentary rocks, undivided
- Tertiary volcanic rocks, undivided
- Tertiary intrusive rocks, undivided
- K-T intrusive & volcanic rocks, undivided
- Jurassic-Cretaceous Kahiltna assemblage, undivided

- Mesozoic sedimentary, metasedimentary, and volcanic rocks undivided
  - Mesozoic intrusive rocks, undivided
  - Triassic sedimentary rocks, undivided
  - Paleozoic sedimentary rocks, undivided
- Location of Dickinson (1995) Kenai Group measured sections

- Well location
- Well Labels:
1. Trail Ridge Unit #1
  2. Pure Kahiltna Unit #1
  3. Sheep Creek #1
  4. Kashwitna Lake
  5. Red Shirt Lake #1
  6. Fish Creek #1

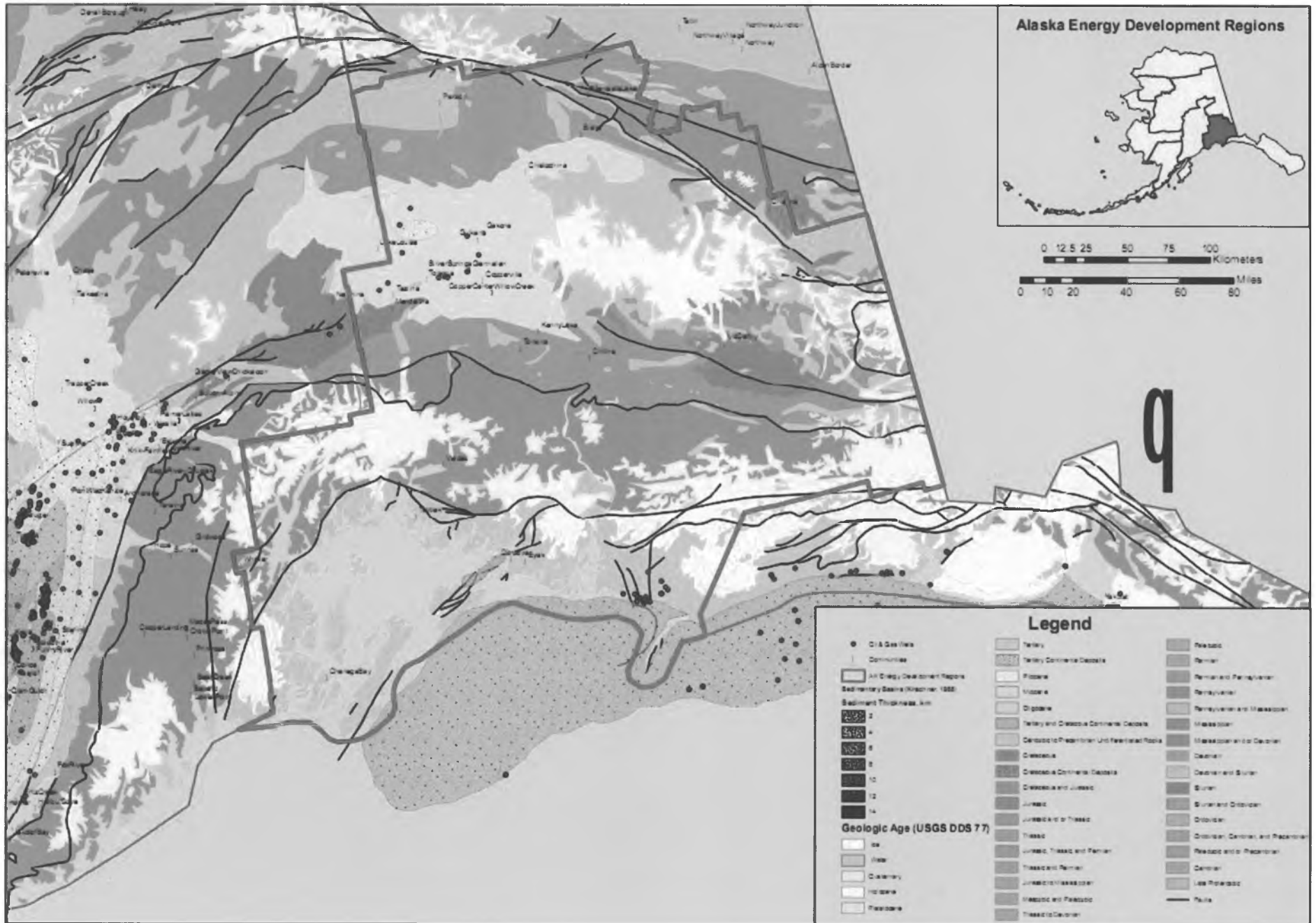
Magnetic discontinuity (after Saltus and Shah, unpublished data)



# Susitna Basin Statistics

- **Similar Stratigraphy Cook Inlet**
  - Separated by Crustal Scale Castle Mountain Fault
  - Up to 15,000 Ft of Tertiary Section (Based on Gravity in Sub-basins)
    - Overlies Mesozoic Metamorphic Complex and Tertiary Volcanics
  - Lacks Paleocene and Early Oligocene Strata
- **2 Wells and Limited '60's Vintage Seismic**
  - Some Gravity and Magnetic Data Available
- **Tertiary Gas Prone Basin**
  - No Viable Oil Source Identified
- **Currently Under Exploration License by Cook Inlet Energy**
- **Focus of detailed mapping and analysis in 2011 by DGGS**

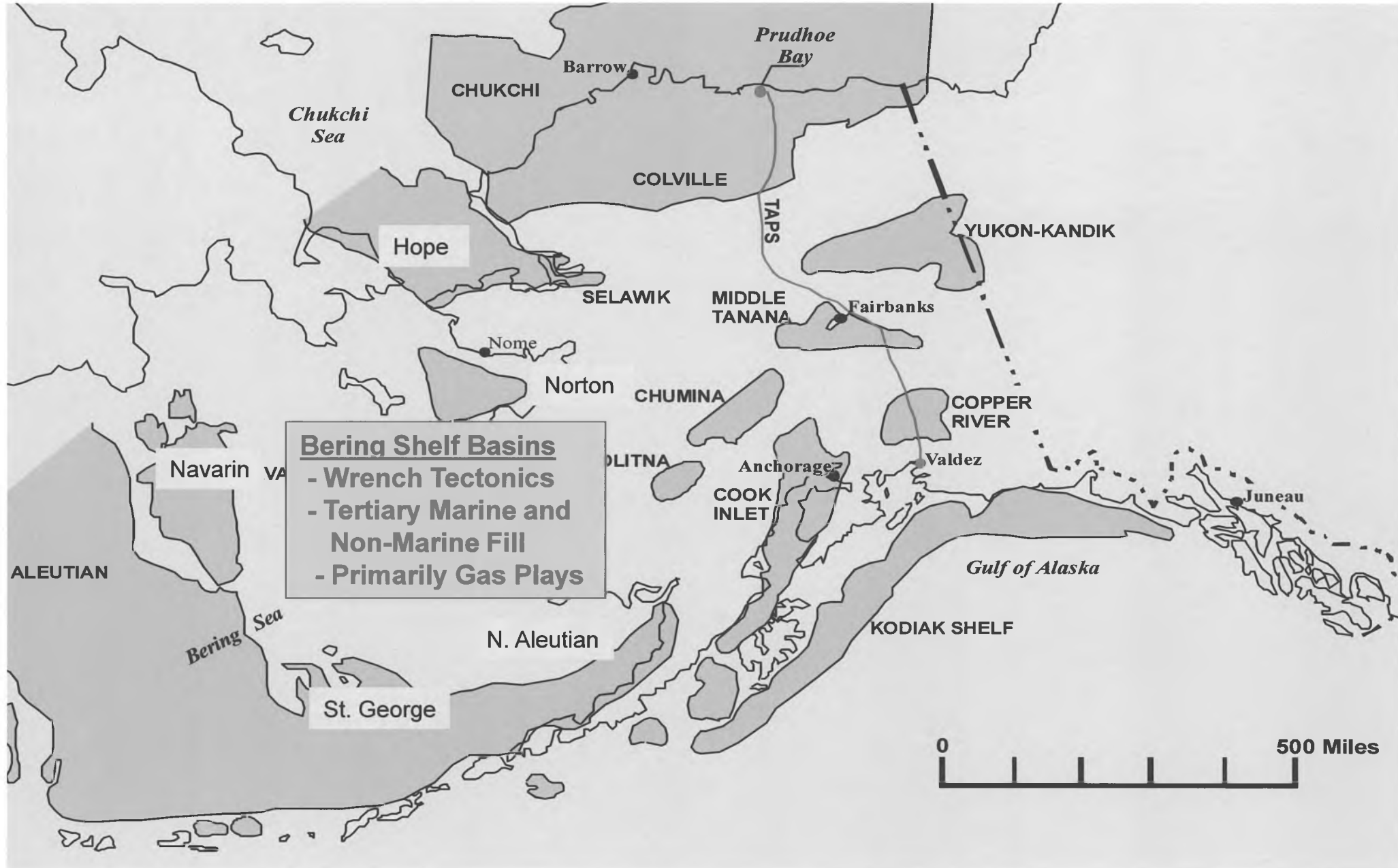
# Geology of the Copper River/Chugach Energy Region, Alaska

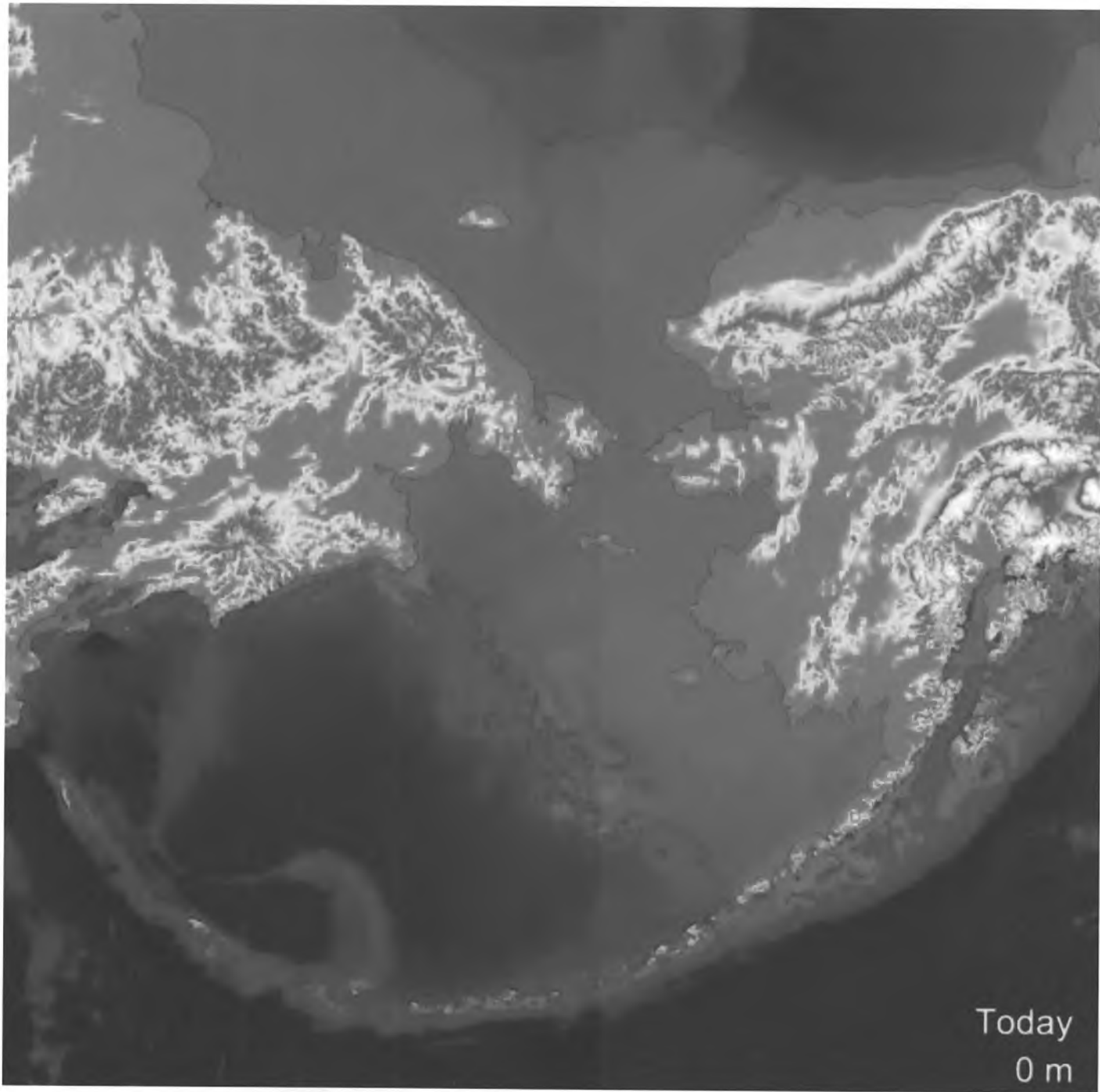


# Copper River Basin Statistics

- Tertiary Stratigraphy Similar to Cook Inlet
  - Less Than 3,000 Ft of Tertiary Section
  - Immature Mesozoic Source Terrane on Western Boundary
    - Remainder of Basin Surrounded by Metamorphic and Volcanic Rocks
    - Some potential in Mesozoic marine section
- 11 Wells and Limited '70's Vintage Seismic
  - Limited Gravity and Magnetic Data Available
- Tertiary Gas Prone Basin
  - Oil Source in Mesozoic Section Immature where Encountered
- Recent Exploration Well
  - No Commercial Discovery

# Bering Shelf Basins



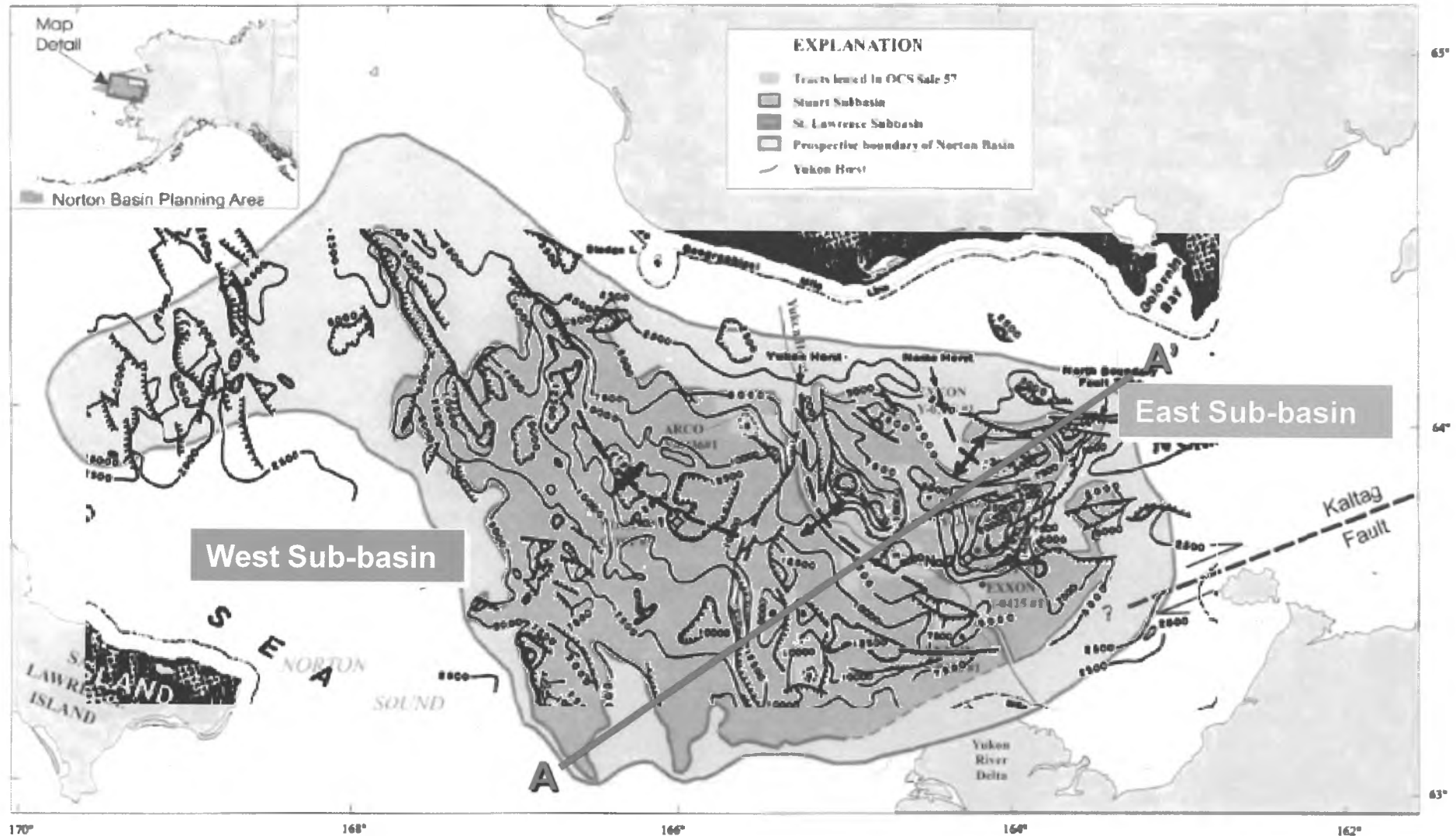


Manley, W.F., 2002, *Postglacial Flooding of the Bering Land Bridge: A Geospatial Animation: INSTAAR, University of Colorado*, v1, [http://instaar.colorado.edu/QGISL/bering\\_land\\_bridge](http://instaar.colorado.edu/QGISL/bering_land_bridge).



# Depth Structure: Base Tertiary unconformity

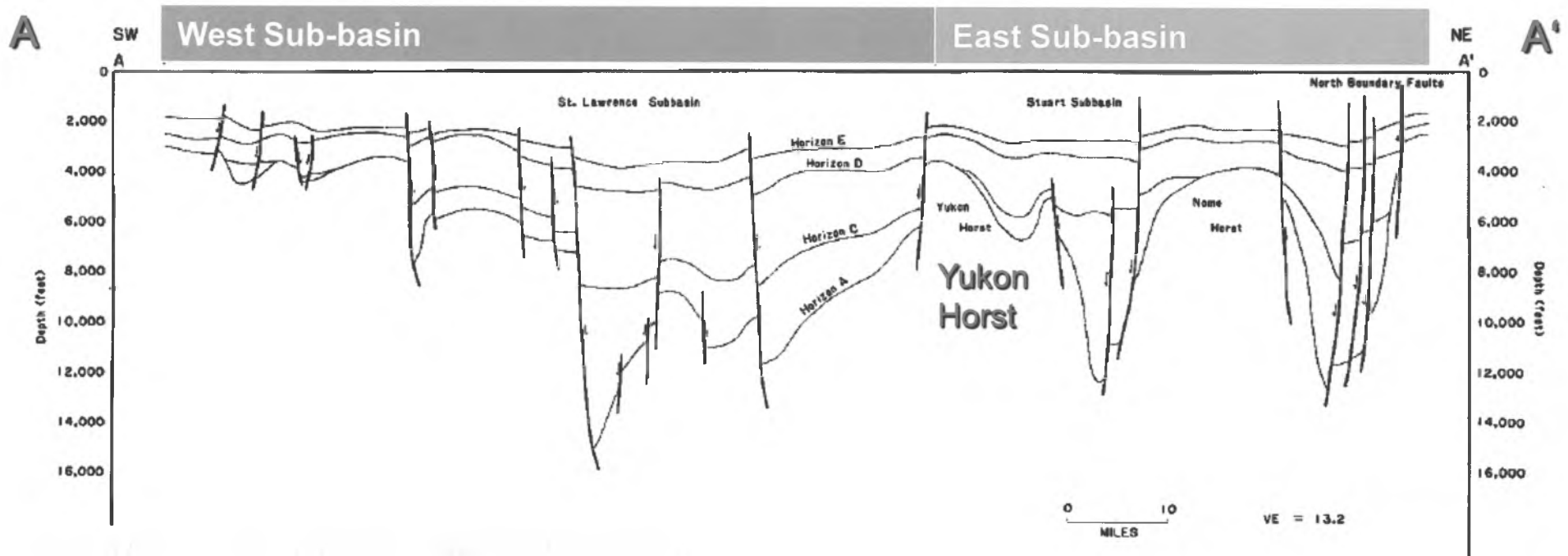
## NORTON SOUND SEDIMENTARY BASIN



Modified from "Exploring the Frontier – Alaska's Norton Sound" (MMS) and Turner and others, 1986 (MMS 86-0033)

# Norton Basin Structure

## Cross Section from Seismic Transect

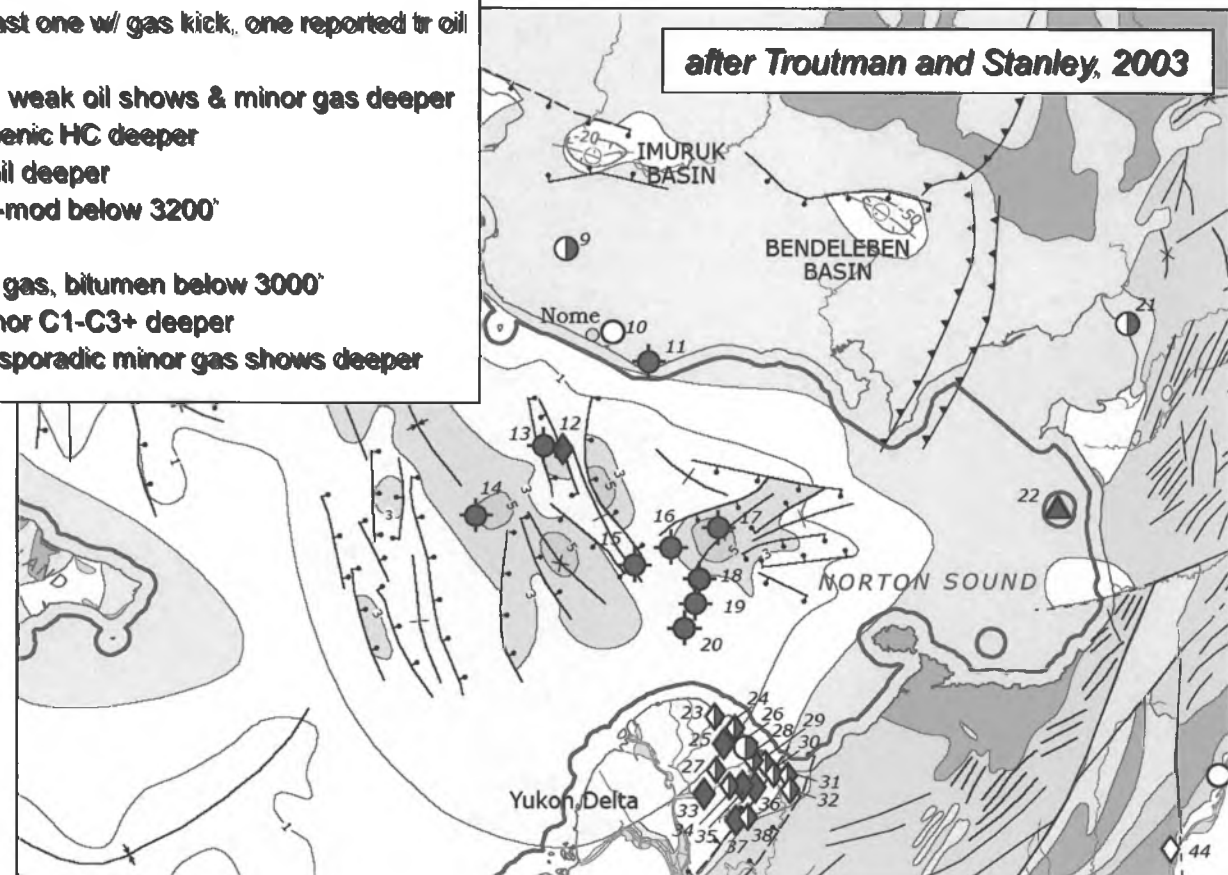


# Norton Basin Exploration History

- 2 COST wells in 1980, 1982 (ARCO)
- OCS Sale 57 in March 1983: 59 tracts sold for \$325 million
- 6 exploration wells 1984-85 (Exxon-ARCO)
- Gas shows in all wells (moderate to strong shows in 2), weak oil shows in 3 wells

## Key to Wells and Hydrocarbon Occurrences Shown on Map

- 9, 10 Reported oil seeps, unconfirmed and/or regarded as doubtful
- 11 Four wells (2 in 1906, 2 in 1918): All < 210' deep, at least one w/ gas kick, one reported tr oil
- 12 Gas seep: 98% CO<sub>2</sub>, < 0.1% C<sub>1</sub>-C<sub>8</sub> hydrocarbons
- 13 ARCO OCS Y-0436, 1984: Strong gas shows shallow, weak oil shows & minor gas deeper
- 14 ARCO COST 1, 1980: Biogenic C<sub>1</sub> shallow, tr thermogenic HC deeper
- 15 Exxon OCS Y-0414: 1984, Mod-strong C<sub>1</sub> shallow, tr oil deeper
- 16 Exxon OCS Y-0407: 1985, Mod-strong C<sub>1</sub> shallow, wk-mod below 3200'
- 17 Exxon OCS Y-0398: 1985, Minor C<sub>1</sub> shows
- 18 ARCO COST 2, 1982: Biogenic gas shallow, minor oil, gas, bitumen below 3000'
- 19 Exxon OCS Y-0425, 1985: Mod-strong C<sub>1</sub> shallow, minor C<sub>1</sub>-C<sub>3</sub>+ deeper
- 20 Exxon OCS Y-0430, 1984: Abdt minor shows shallow, sporadic minor gas shows deeper



# Norton Basin Geology Summary

- Tertiary extensional basin associated with strike-slip on Kaltag fault
- Tertiary clastic basin fill up to 23,000 ft thick overlies Paleozoic and Mesozoic metamorphosed sedimentary and igneous rocks
- Two sub-basins separated by narrow horst system that controlled depositional environments; east sub-basin mostly nearshore marine to shelfal deposits, west sub-basin mostly shelfal to deep water units

## Mid-Tertiary West Sub-basin Fill Play

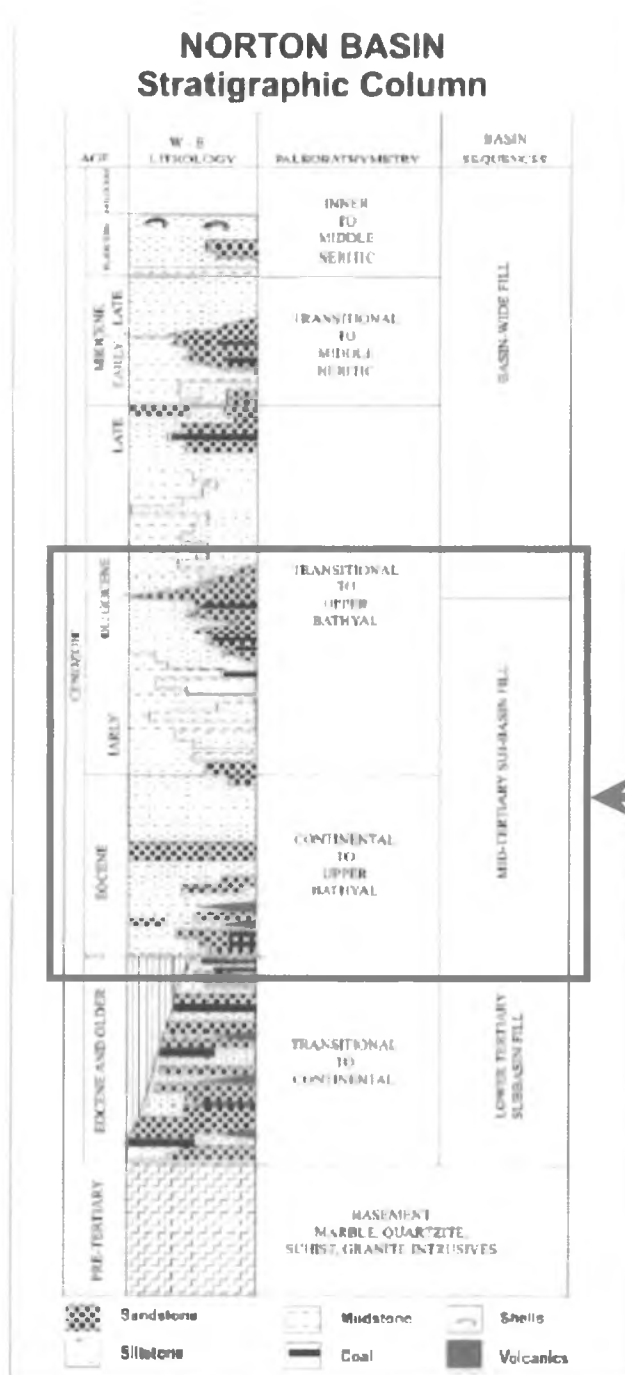
**Age:** Eocene to middle Oligocene clastic sediments of St. Lawrence sub-basin

**Reservoirs:** Shelf sands and turbidites, possible alluvial fan and deltaics on flank of Yukon horst and basin margin; avg depth ~ 5500 ft, avg porosity 14%, avg permeability 0.9 md, avg net pay 178 ft

**Traps:** Faulted anticlines and stratigraphic onlap against basement

**Source:** Thermally mature, mostly Eocene strata, Type III (gas-prone) terrestrial kerogen, lean in total organic carbon (TOC)

**Potential:** MTWSF play contains > 50% of basin's assessed endowment (1.6 TCF Mean); 1 COST well + 1 prospect tested



Source: "Exploring the Frontier – Alaska's Norton Sound" (MMS)

# Navarin Basin Statistics

- Largest and Most Remote Bering Shelf Basin
  - 32,000 sq. mi
  - Wrench Fault Related Structures
  - Up to 36,000 Ft. of Tertiary Strata
- 1 Cost Well and 8 Exploratory Wells from 1983 to 1987
  - Gas and Limited Oil Prone Source Rocks in Eocene and Paleocene
  - 7 Marine Reservoir Quality Intervals in Tertiary Section
  - Trace to Minor Gas and Oil Shows in 5 of the Wells
- Considered Gas Prone Basin
- Not on Federal Lease Sale Schedule
  - Future Sales (post 2007) Will Depend on Industry Interest
- Mean Risked Resource ( MMS)
  - 500 mmbob; 6 tcf Gas / Conventionally Recoverable

# Alaska Energy Data Inventory

- Consolidating Alaska's energy resources data
  - Resource data suitable for electrical power generation and space heating needs
  - Natural gas, coal, coalbed and shalebed methan gas hydrates, geothermal, wind, hydro, and biomass
  - Available energy meeting local needs?
- Making the data accessible
  - Alaska Mapper, Google Earth, and Terrago Technologies' GeoPDF format
  - <http://energyinventory.alaska.gov>
  - Query and download data; view data with existing infrastructure
- Involvement
  - DGGs, Alaska Energy Authority, DNR Division of Forestry, DNR LRIS, UAF/GINA
  - CCHRC, USGS, USDOE, DNR DOG, BLM, DMLW, Div. Agriculture, DEC

