State of Alaska
Department of Natural Resources
Division of Oil and Gas

Cook Inlet & Alaska Peninsula Areawide Lease Sales

May, 2012

Alaska Department of
NATURAL
RESOURCES
Division of Oil and Gas

Outline

- Tectonic Setting and Depositional Framework of Southern Alaska
- Cook Inlet Basin
  - Basin Overview
  - Petroleum Systems and Basin Analyses
    - - sources of oil and gas
    - - reservoir origins and quality
    - - trap timing and styles
  - Resource Potential
  - Cook Inlet Areawide Lease Sale facts
- Alaska Peninsula – North Aleutian basin
  - Basin Overview
  - Petroleum Systems and Basin Analyses
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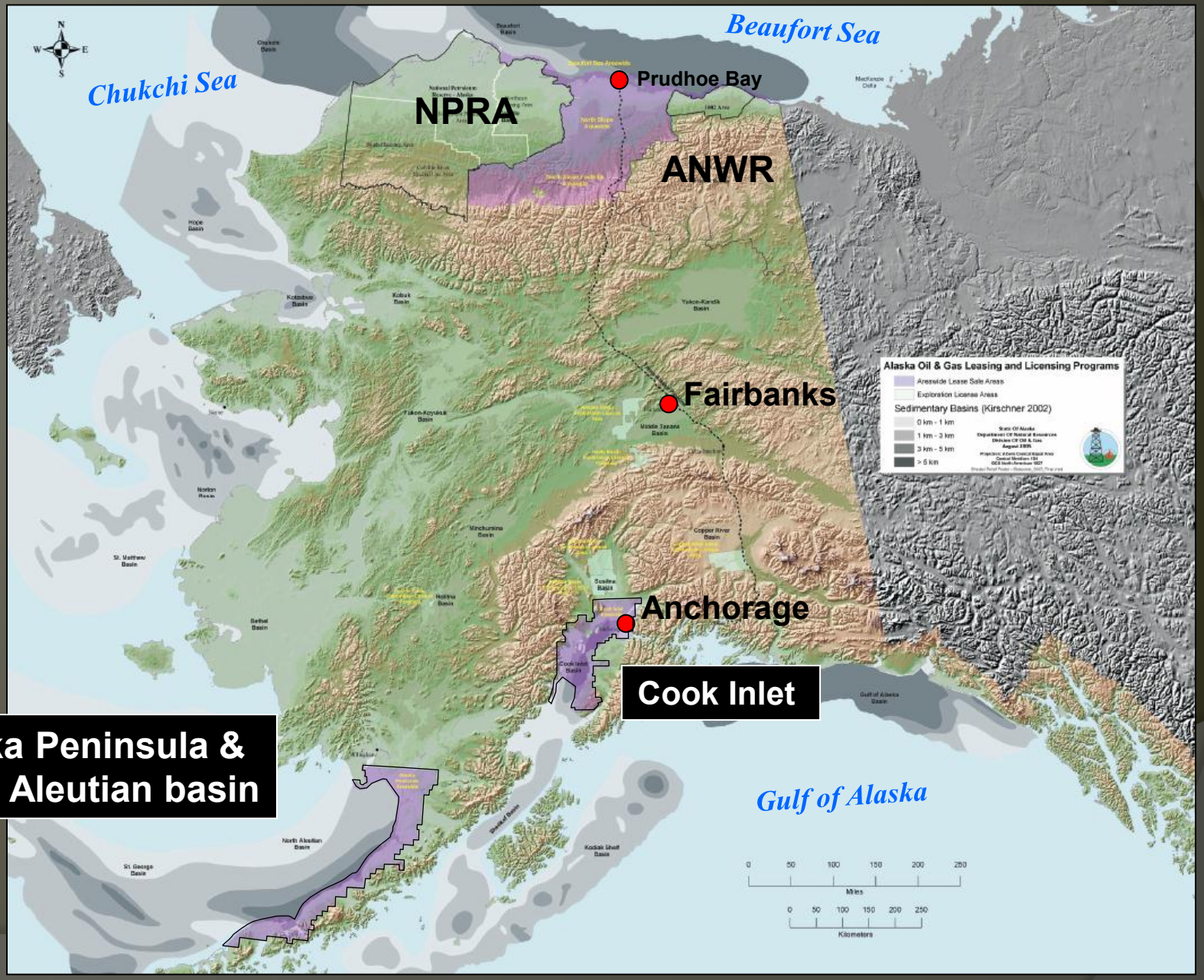
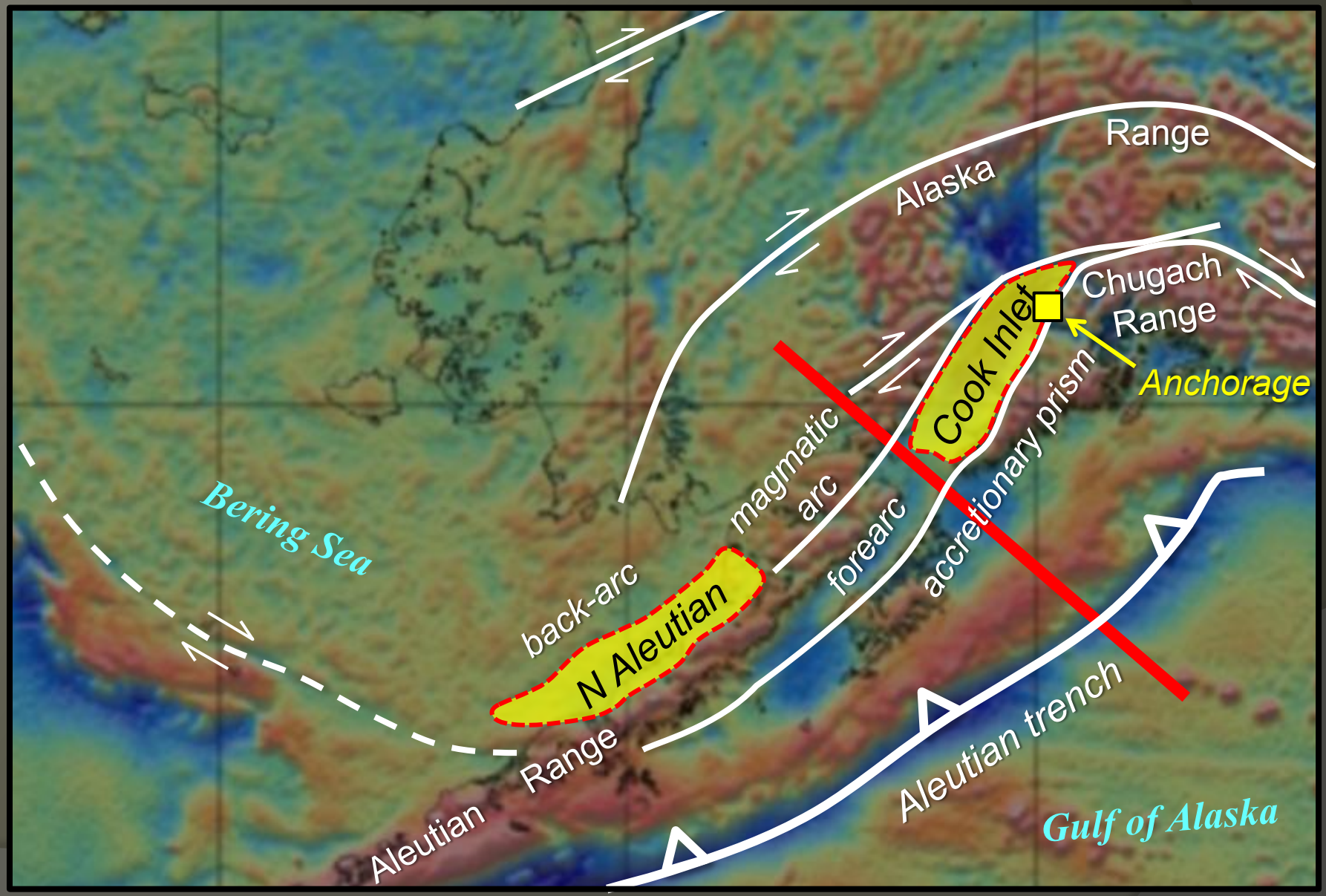
    - - reservoir origins and quality
    - - trap timing and styles
  - Resource Potential
  - Alaska Peninsula Areawide Lease Sale facts

Location Map

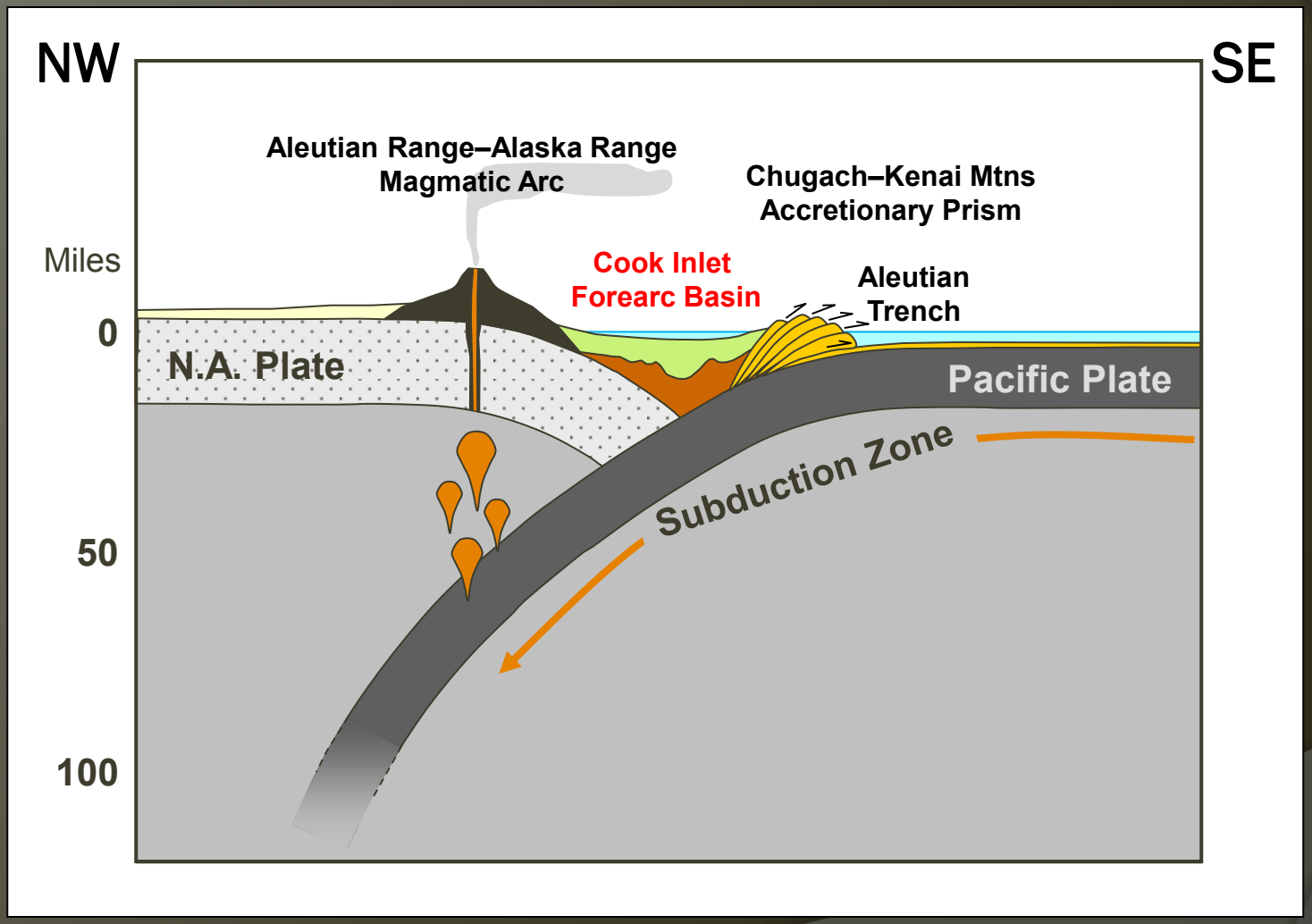


SW Alaska Tectonic Framework

Regional Satellite Gravity



Cook Inlet Basin Tectonic Setting

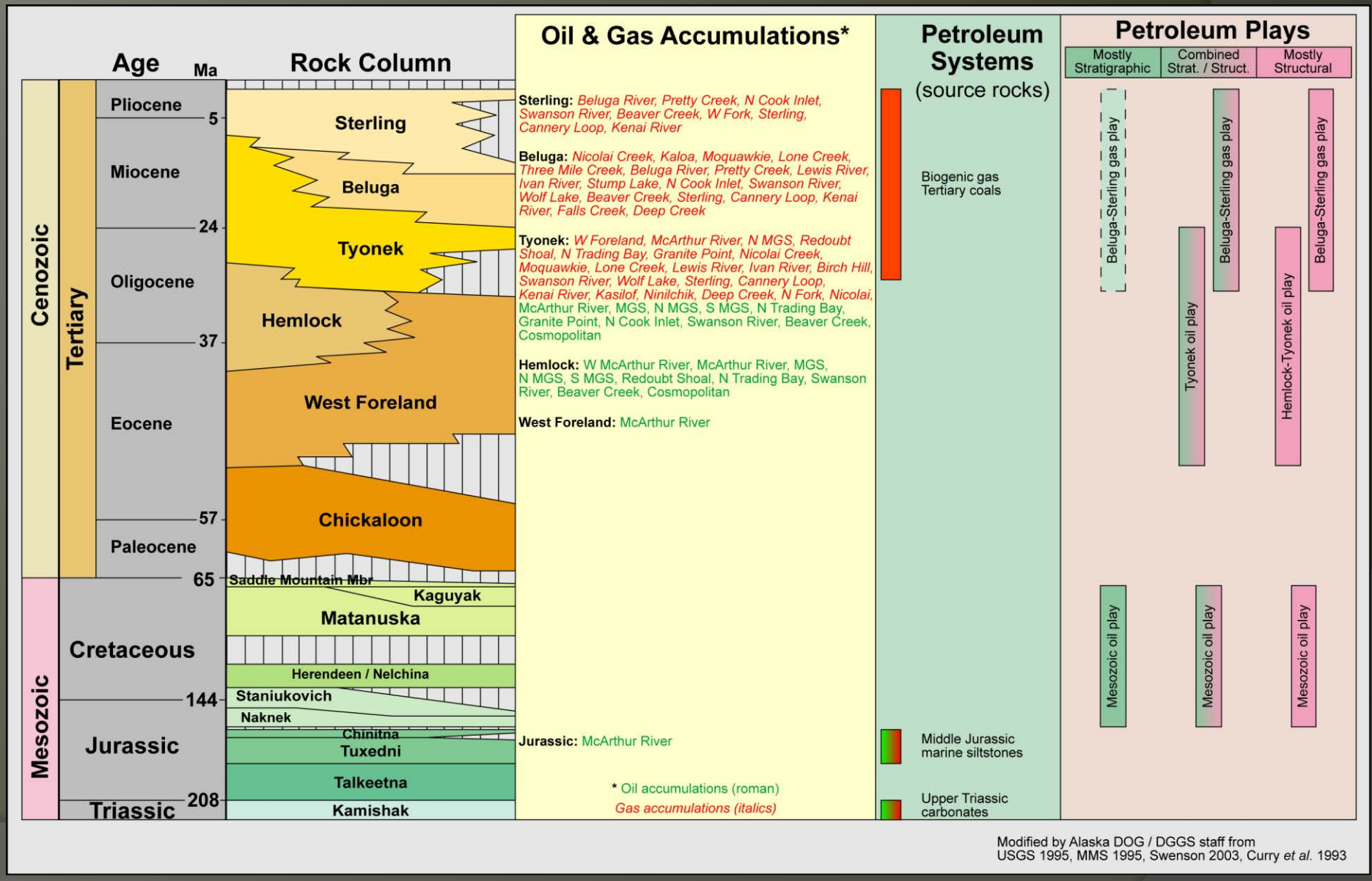


Modified from Steve Davies, AOGCC; modified from Tornqvist, T., 2005, Principles of Sedimentology and Stratigraphy, University of Chicago, http://www.uic.edu/classes/geol/eaes350/

Base Tertiary Depth Structure

Shellenbaum and others, 2010

Cook Inlet Petroleum Systems



Modified by Alaska DOG / DGGS staff from
USGS 1995, MMS 1995, Swenson 2003, Curry *et al.* 1993

Cook Inlet Basin – Key Attributes

- Up to 25,000 ft of high net-to-gross fluvial & alluvial Tertiary strata
- Ubiquitous coal → biogenic gas source
- Depressed geothermal gradient (20 deg C/km) limits Tertiary reservoir diagenesis
- Oil sourced from Jurassic throughout much of Tertiary time
- Late structural uplift key for gas migration out of coals, likely caused some oil re-migration
- Sealing facies distributed throughout section

Cook Inlet Petroleum System

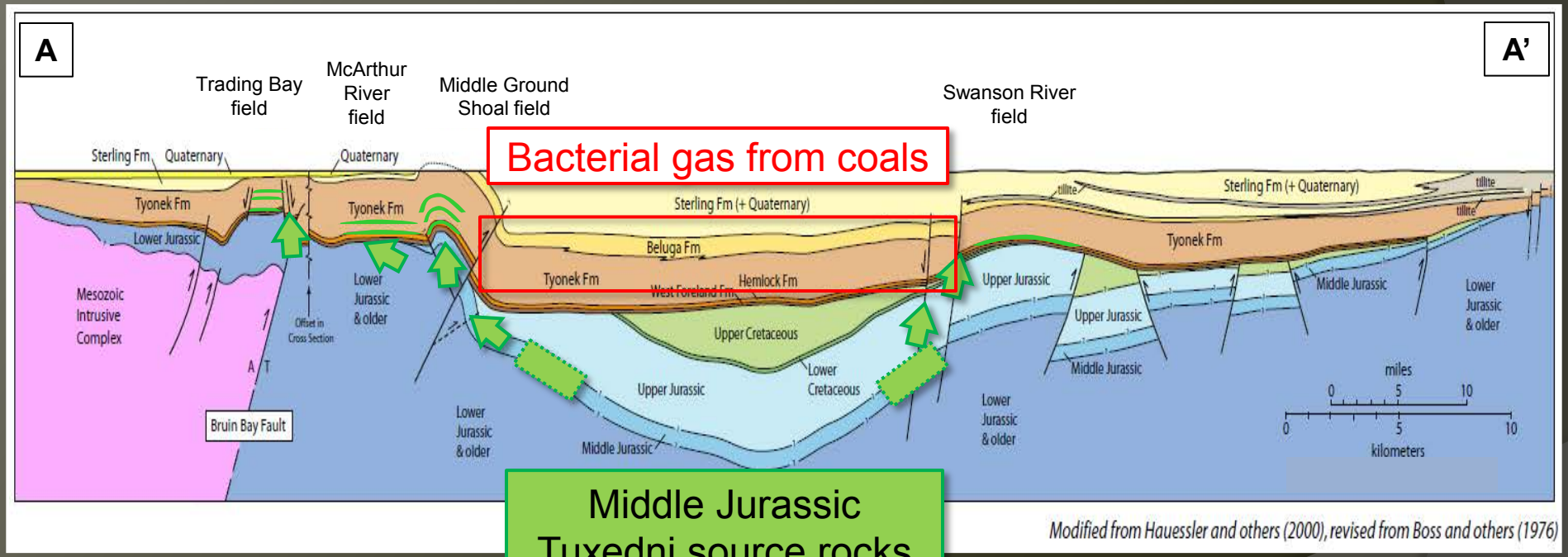
Source of Oil and Natural Gas

- Oil and minor associated oil sourced from middle Jurassic Tuxedni Group
  - marine siltstone facies in outcrop and where penetrated
  - kitchen offshore in upper Cook Inlet; oil window ~21,000 – 26,000 ft depth
  - Tertiary generation and migration across base-Tertiary unconformity
  - < 30 mi lateral migration into commercial reservoirs in lower Tertiary units
  - Typical oil gravity 34 deg API (range 28-42 deg API)

- 94% of known gas in the basin is non-associated biogenic methane
  - derived from coals in the upper part of the Tertiary section
  - produced by bacteria that thrive at temperatures less than ~80^{o}C
  - gas desorbed from coals and migrated into adjacent & overlying fluvial reservoir sands as a result of depressurization during Plio-Pleistocene tectonic uplift

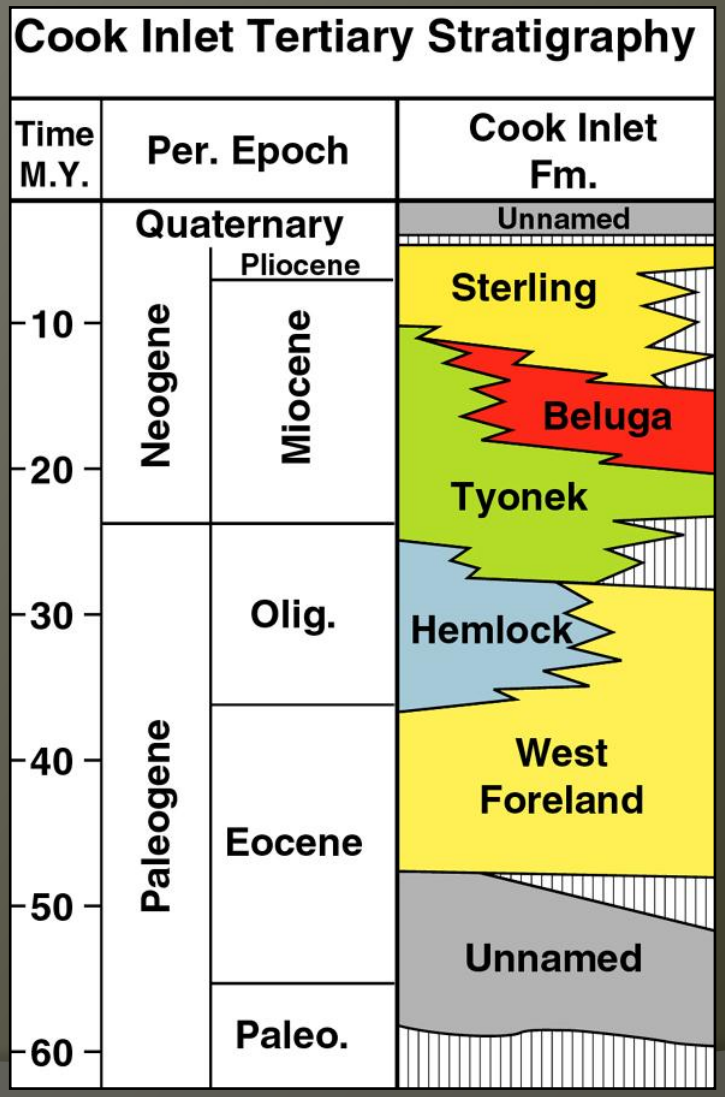
Cook Inlet Basin Schematic Cross Section

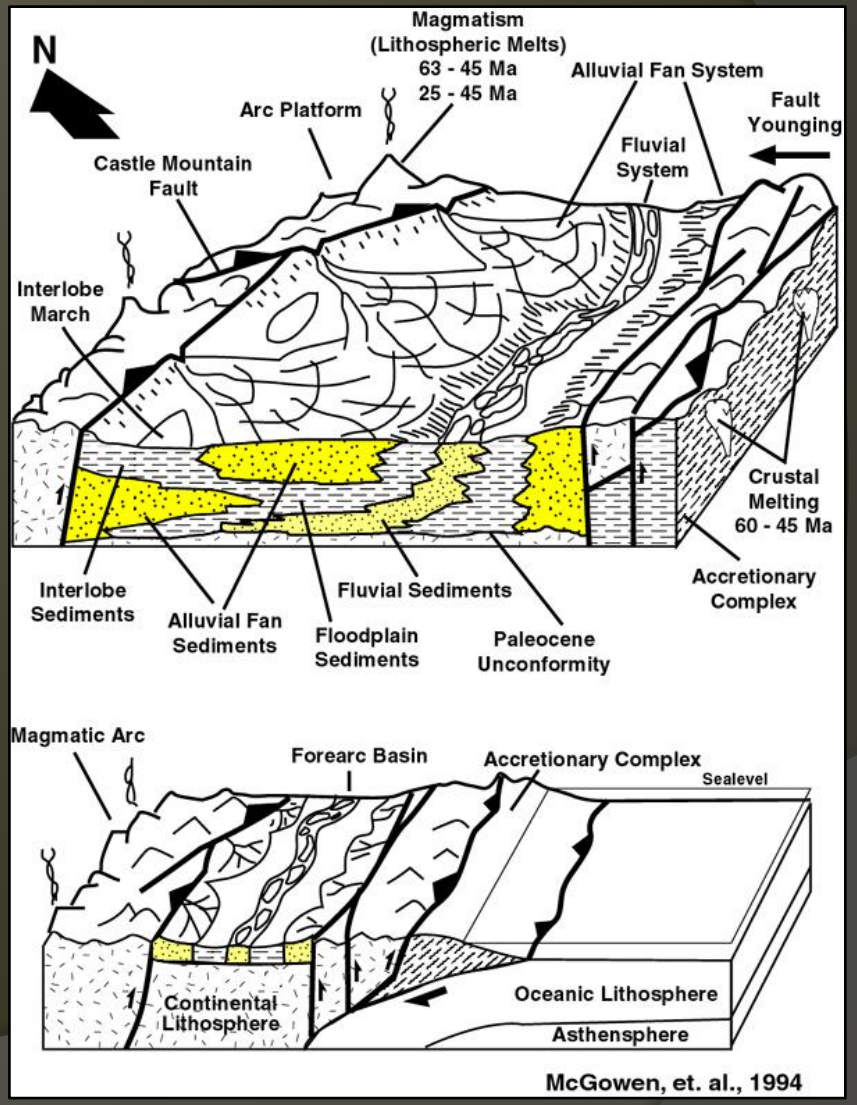
Biogenic Gas & Thermogenic Oil Systems



Tertiary Reservoirs

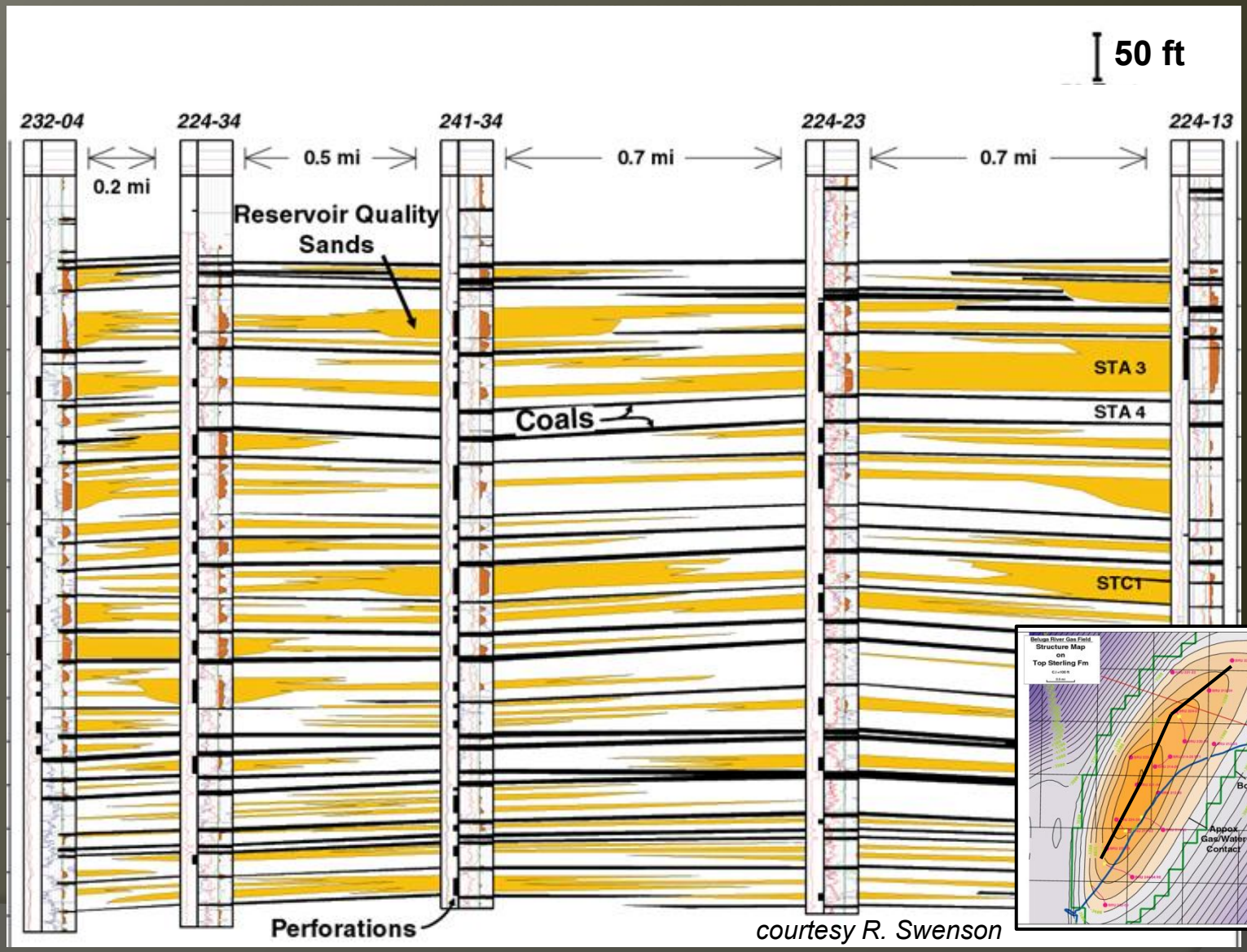
Axial fluvial and alluvial fan depositional settings





Sand Distribution in Fluvial Reservoirs

Beluga River gas field



courtesy R. Swenson

Sandstone Provenance

Magmatic arc (Alaska Range)

- Volcanic cover (Jurassic – Tertiary)
  - Basalt, andesite, tuff, breccia
- Plutonic roots (Jurassic – Cretaceous)
  - Granodiorite, quartz monzonite, diorite, syenite

Accretionary prism (Chugach Terrane)

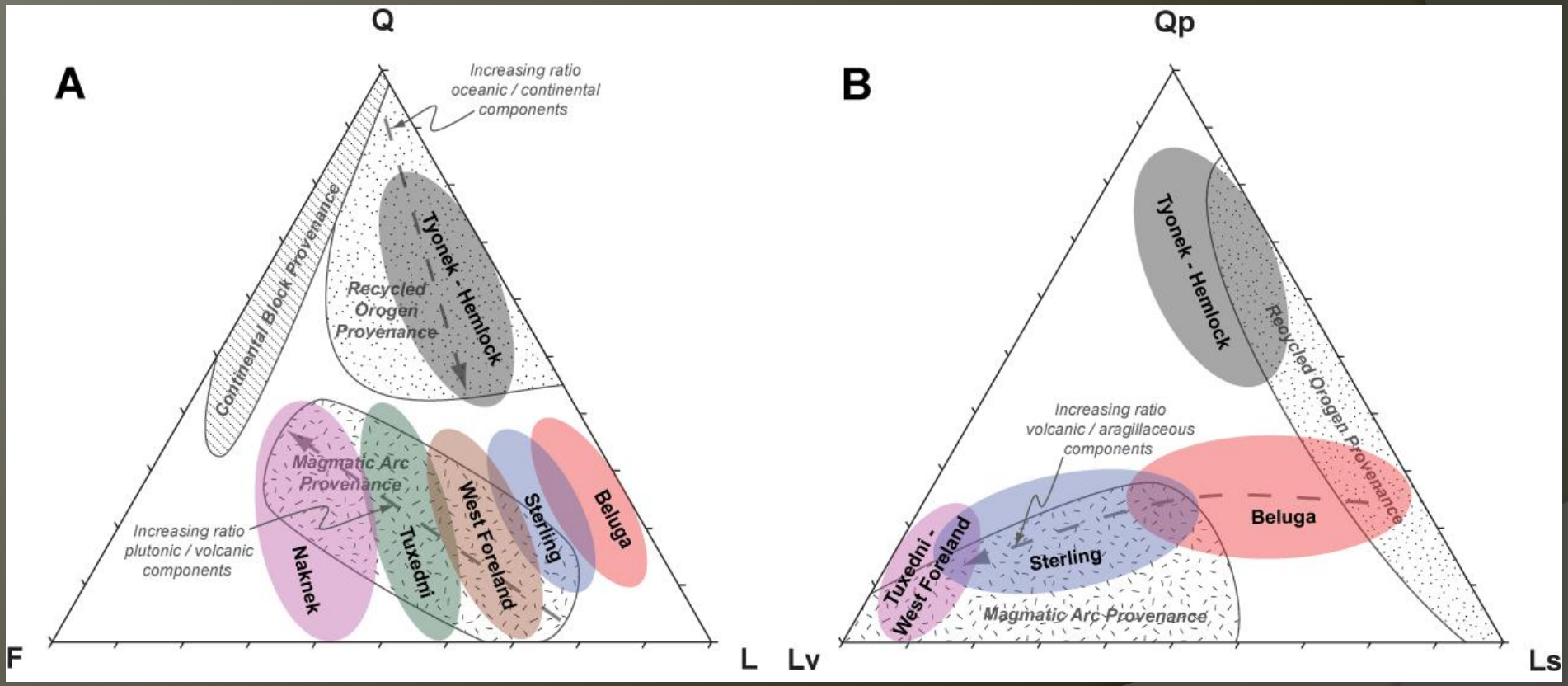
- Valdez Group (Upper Cretaceous)
  - Sandstone, siltstone, shale
  - Schist, phyllite (greenschist facies)
- McHugh Complex (Jurassic – Cretaceous)
  - Argillite, graywacke, limestone, chert
  - Tuff, gabbro, basalt (prehnite - pumpellyite facies)


Alaska Range to northwest

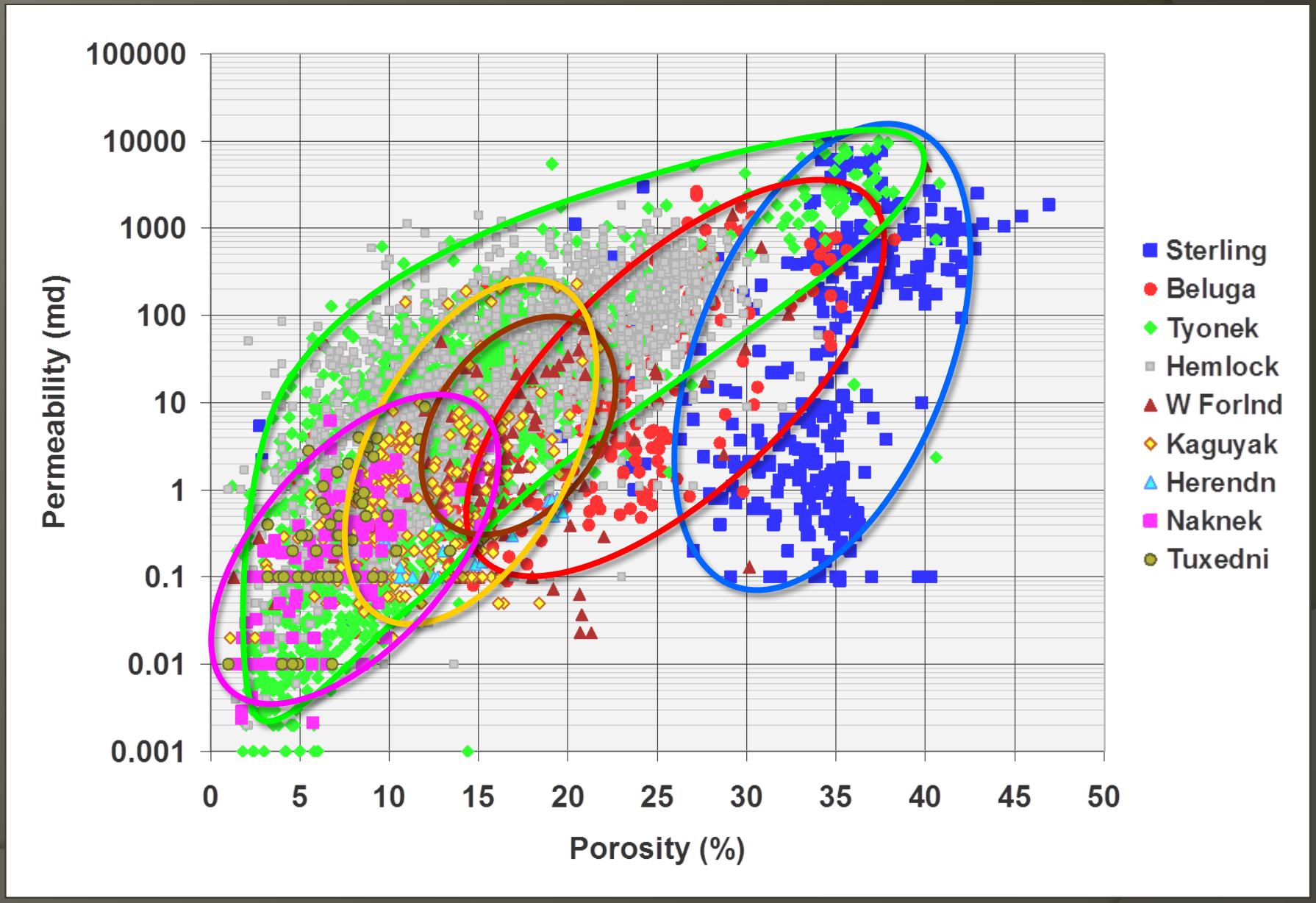

Chugach Mountains to southeast

Framework Composition

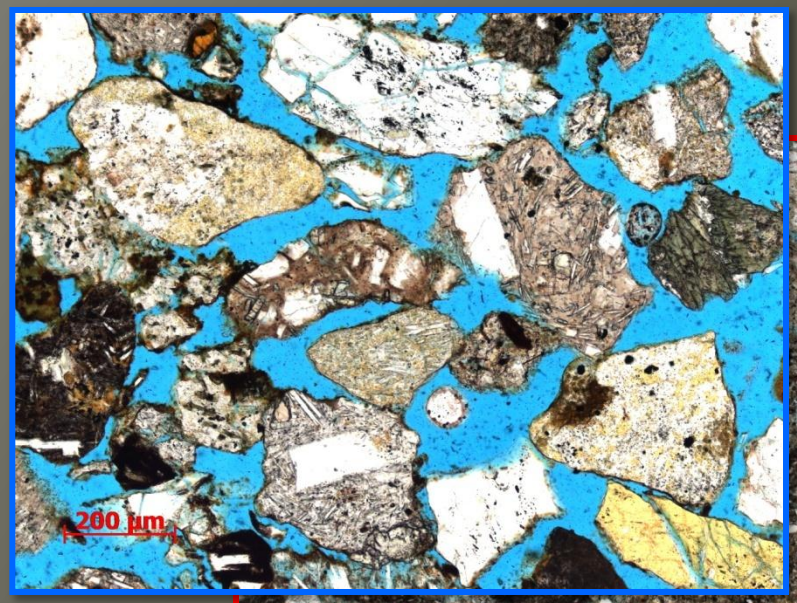
Variations determined by tectonic setting of provenance area



Reservoir Quality by Formation

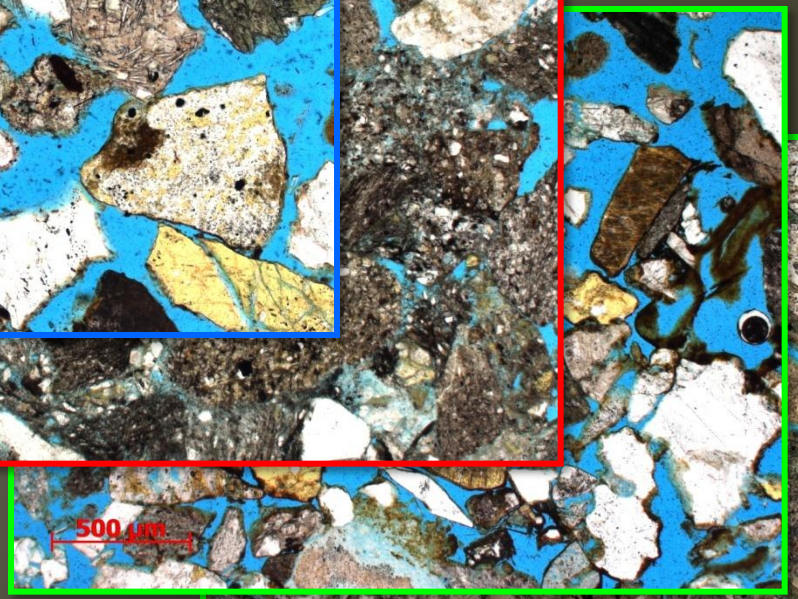


Cook Inlet Reservoir Petrography



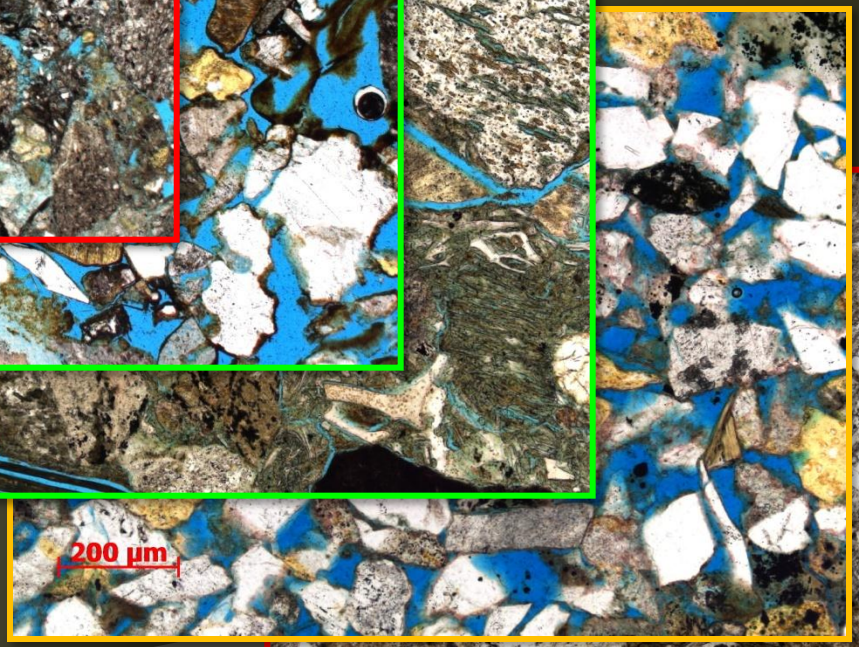
Sterling Fm

Beluga Fm



Tyonek Fm

W Foreland Fm



Tertiary reservoirs

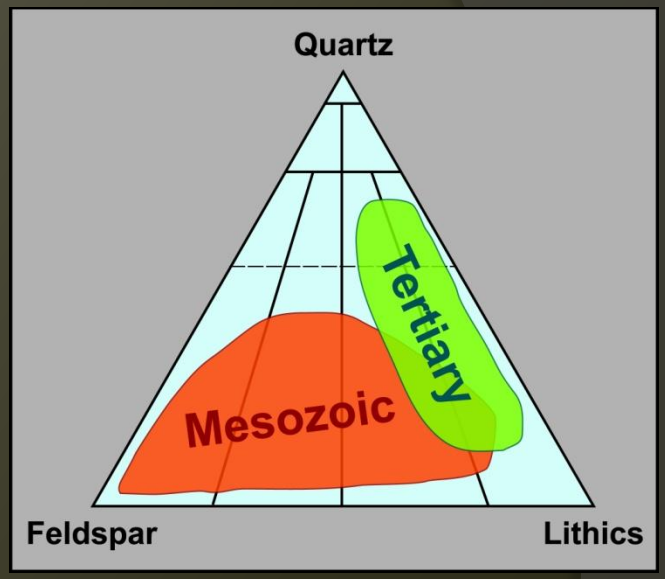
Cretaceous Kaguyak Fm

Jurassic Naknek Fm

Reservoir Quality Summary

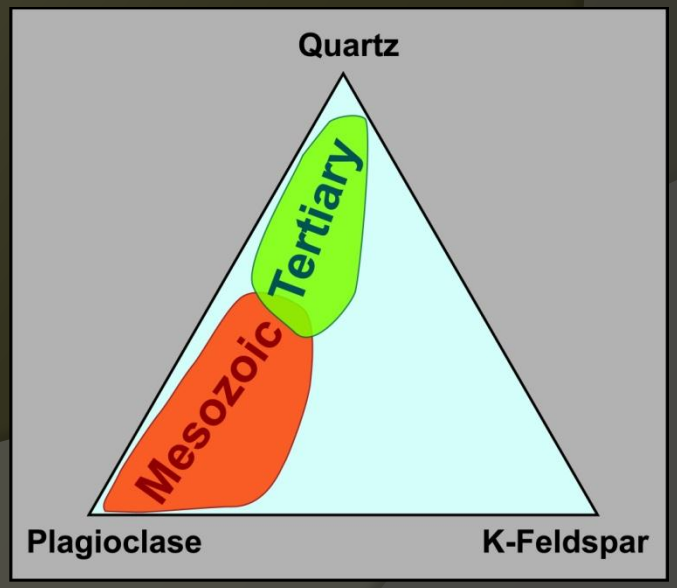
Tertiary Sandstones

- Commonly fair to excellent conventional reservoir quality
- Young age (< 65 million years old)
- Shallow burial (< 10,000 feet)
- Chemically stable mineralogy (Quartz + K-feldspar)



Mesozoic Sandstones

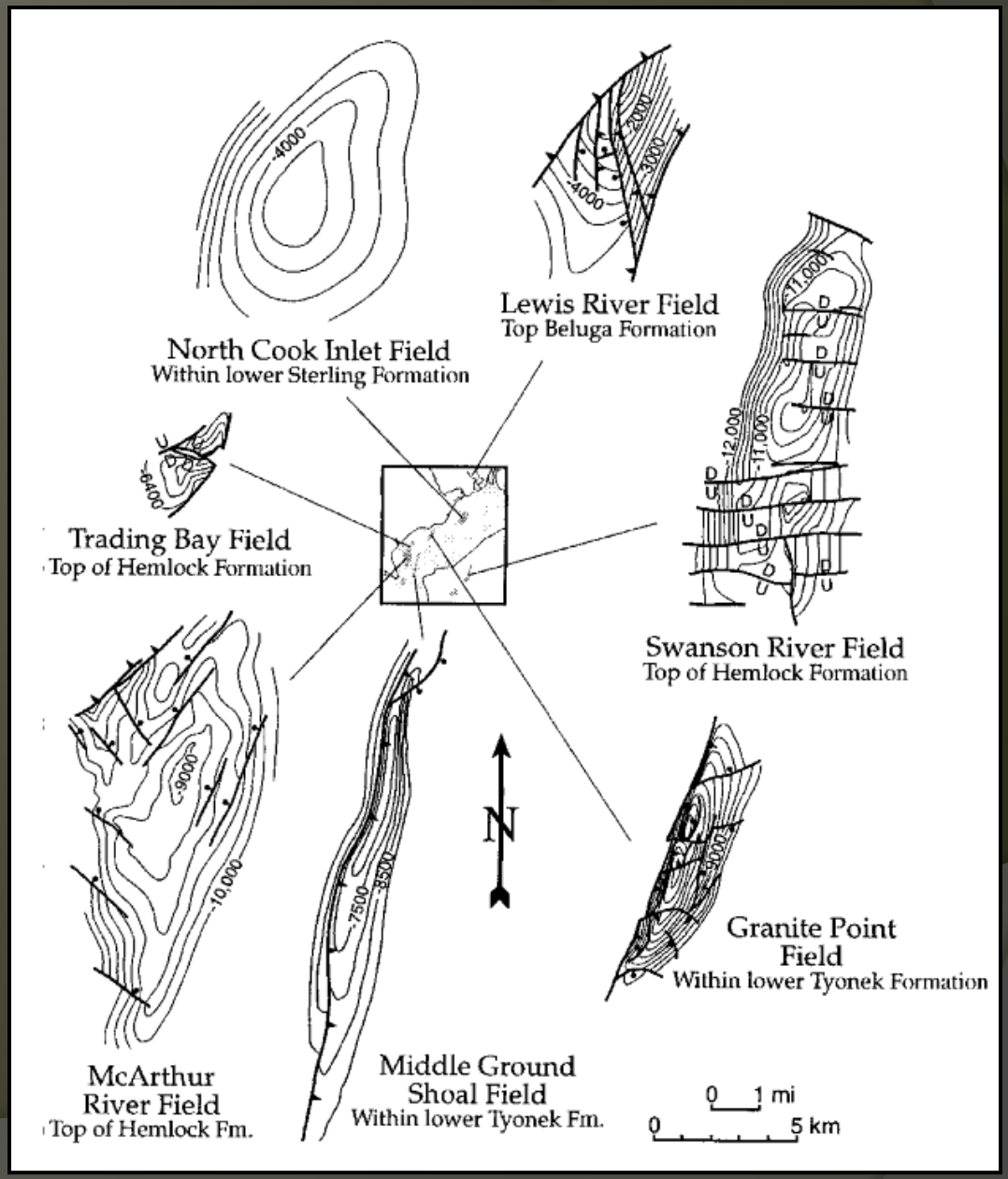
- Upper Cretaceous best; others may have potential as unconventional reservoirs
- Old age (> 65 million years old)
- Deep burial (> 10,000 feet)
- Chemically unstable mineralogy (Plagioclase + VRF's)



Cook Inlet Structural Styles

Anticlinal trap types

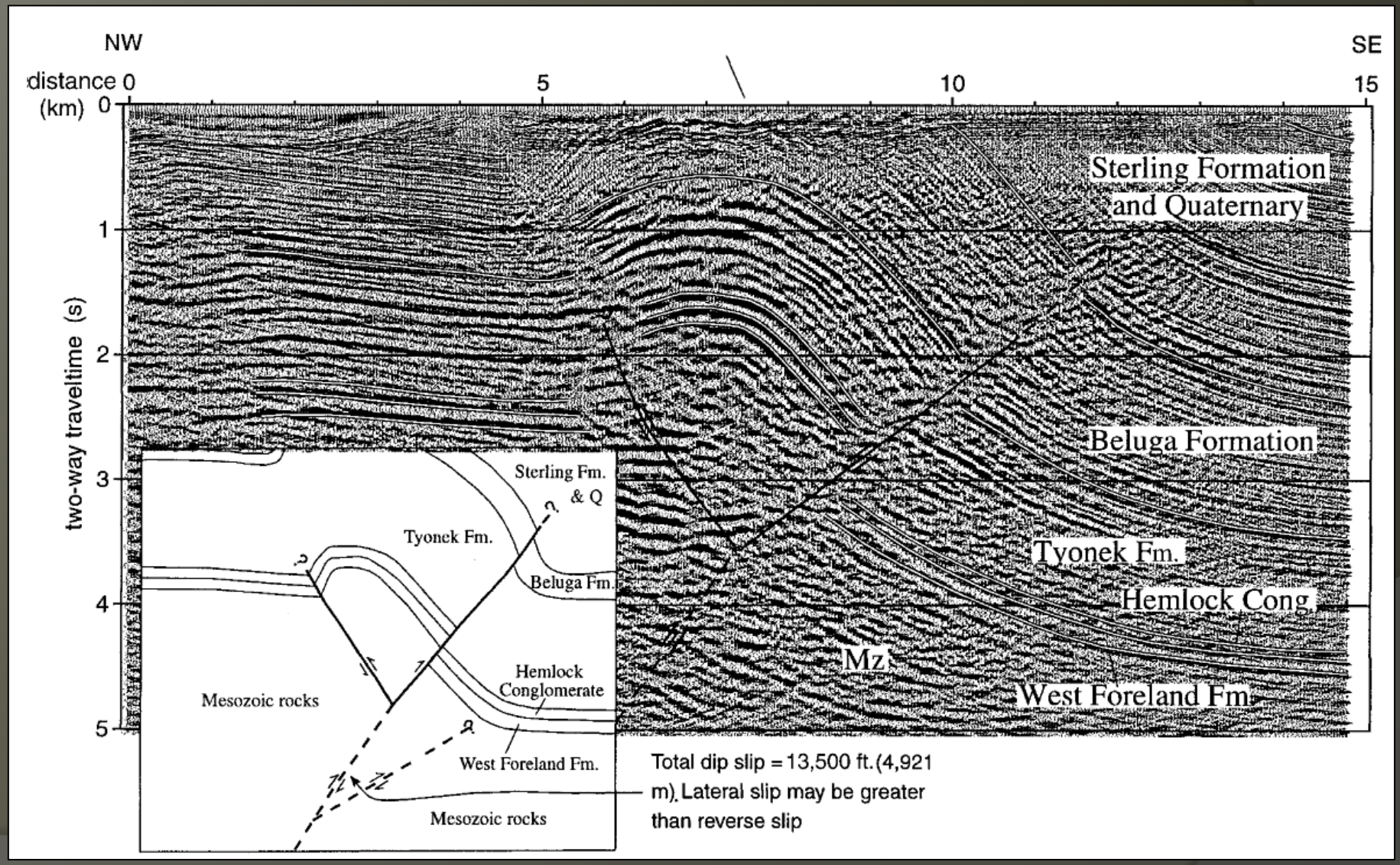
- Various styles, geometry
- Late Tertiary to Quaternary deformation



Haeussler and others, 2000, after AOGCC records

Cook Inlet Structural Styles

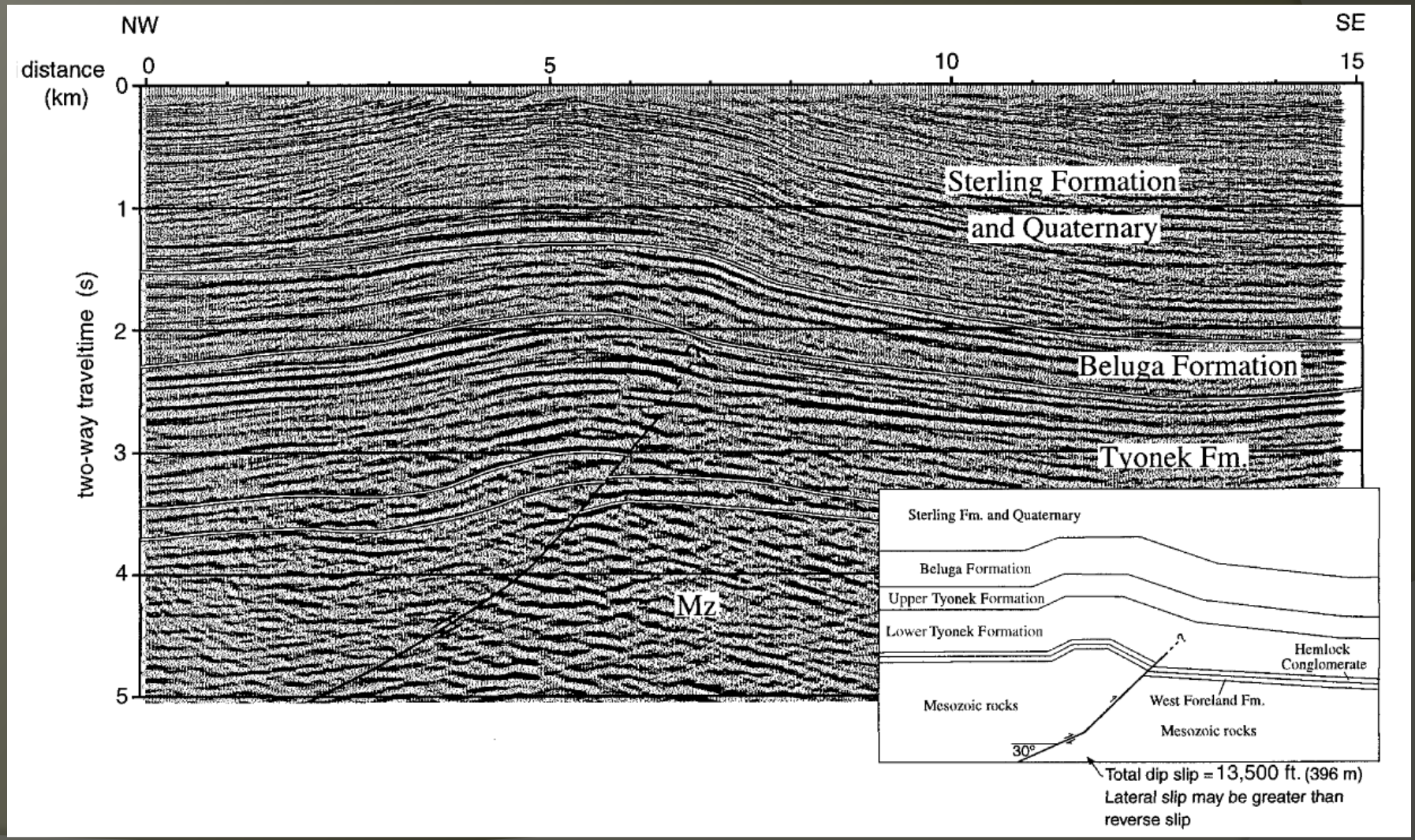
Middle Ground Shoal field



Haeussler and others, 2000

Cook Inlet Structural Styles

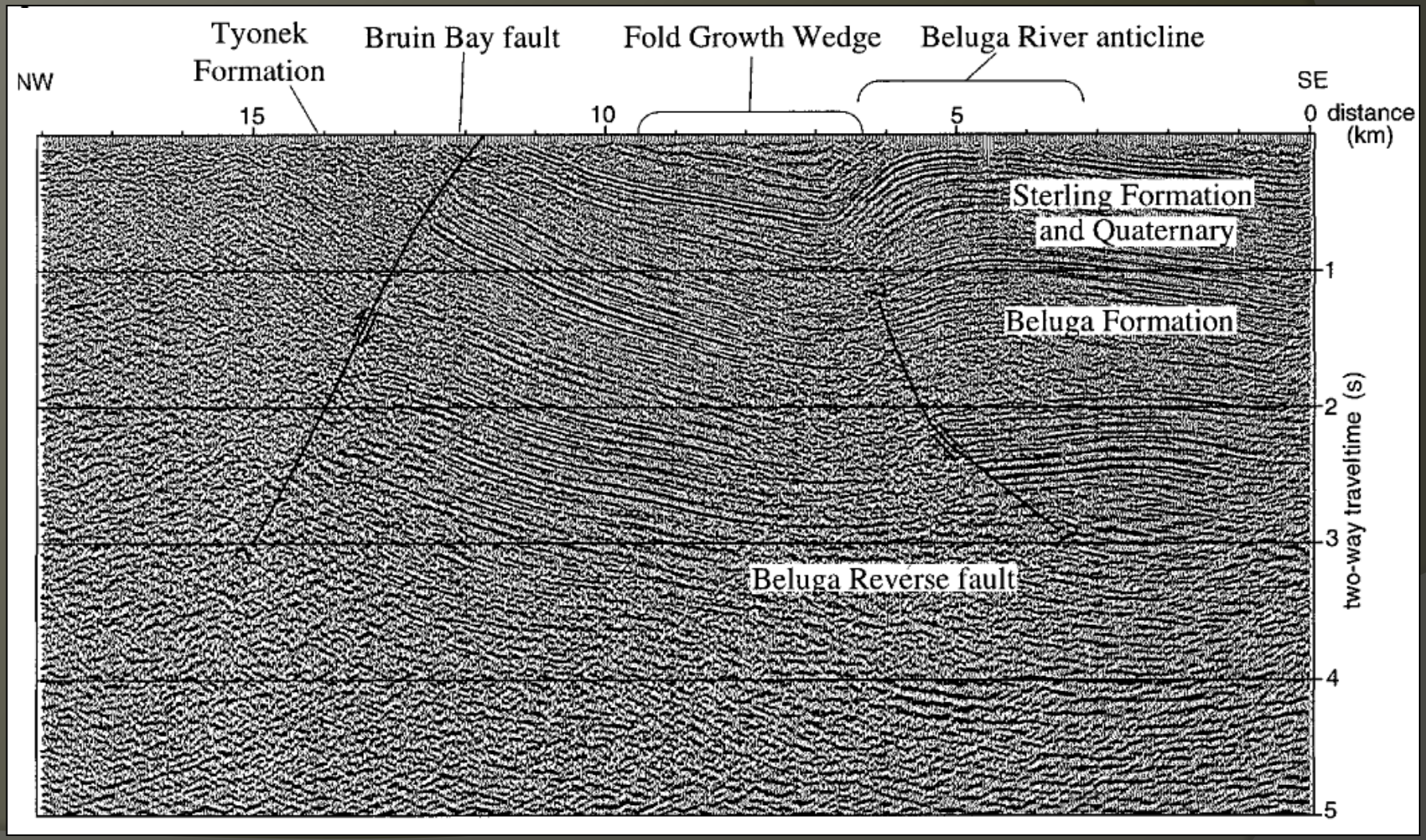
North Cook Inlet field



Haeussler and others, 2000

Cook Inlet Structural Styles

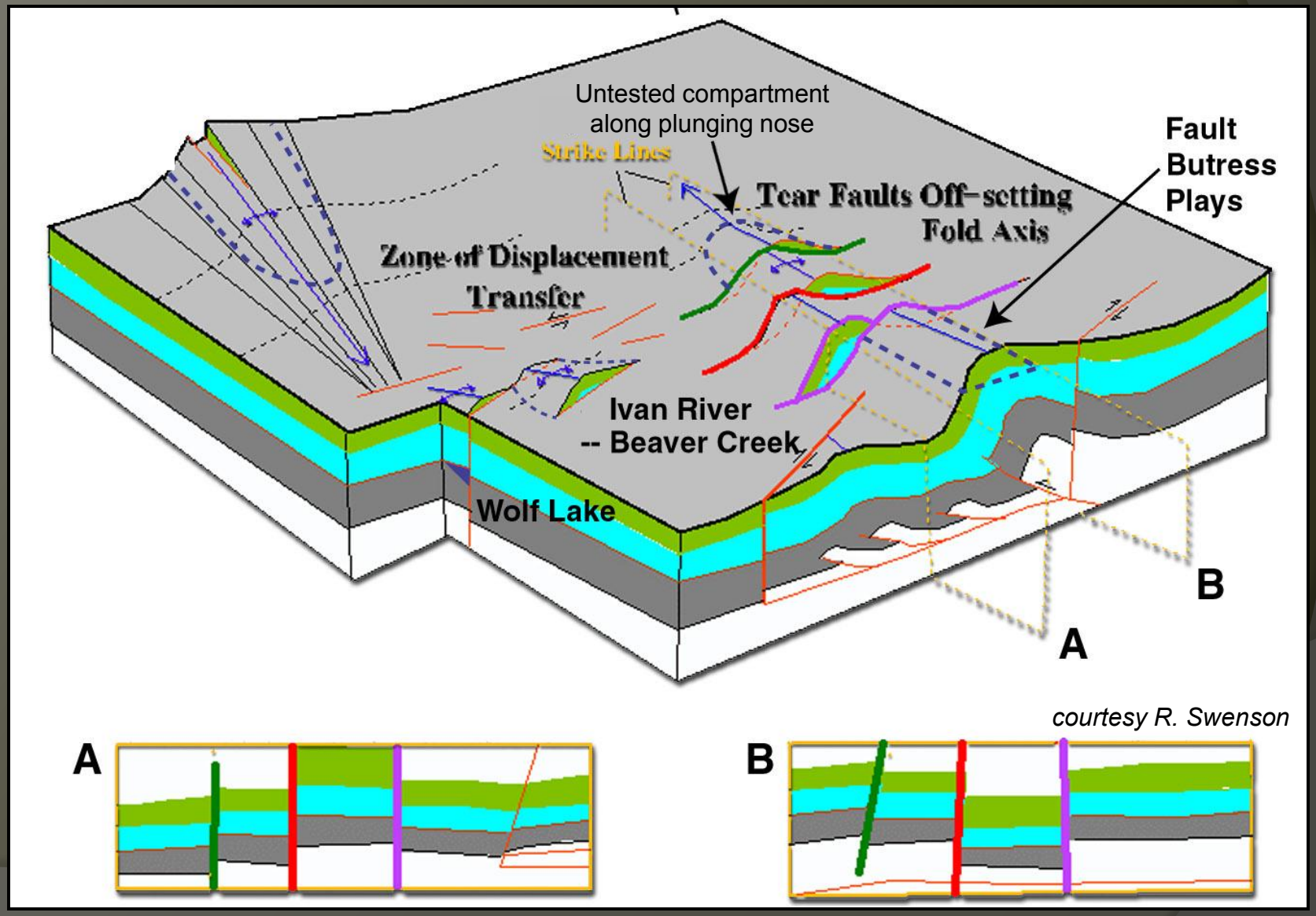
Bruin Bay fault and Beluga River field



Haeussler and others, 2000

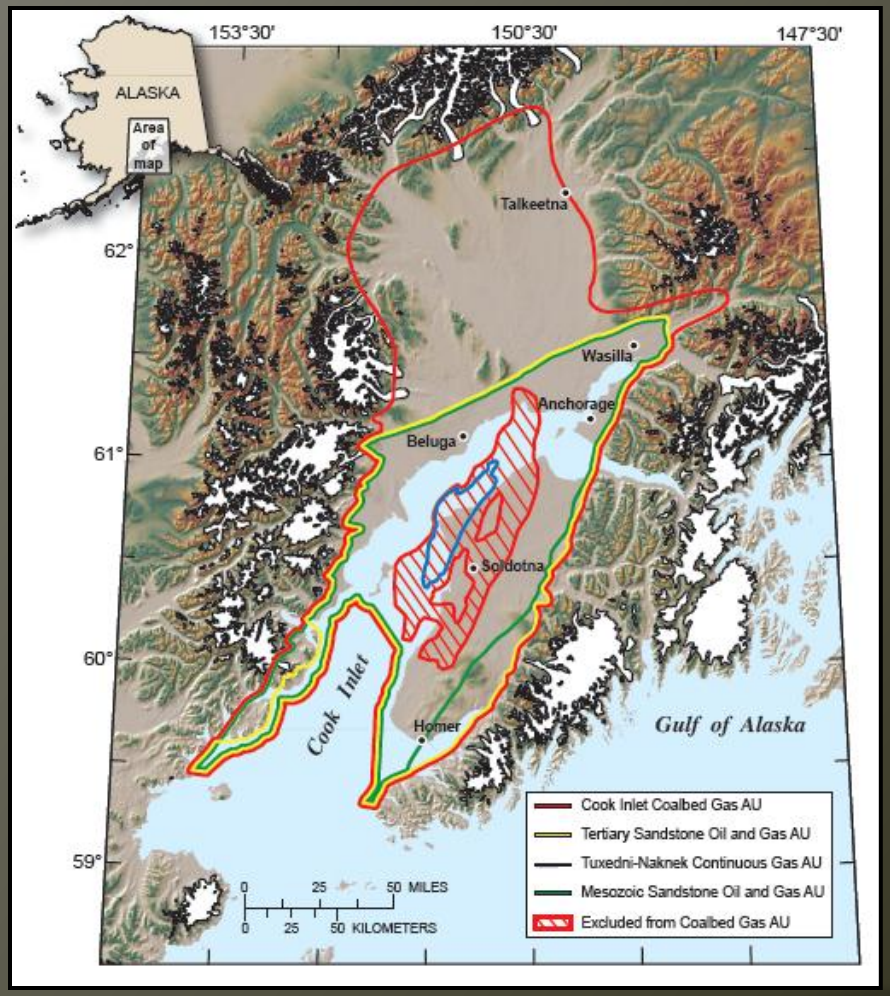
Cook Inlet Transpressional Structures

En echelon anticlines, common cross-fault compartmentalization



Cook Inlet Resource Potential

USGS Resource Assessment, 2011



Undiscovered, Technically Recoverable Oil and Gas

- mean conventional oil 599 MMBO

372 MMBO in Tertiary Ss play

227 MMBO in Mesozoic Ss play

- mean conventional gas 13.7 TCF

12.2 TCF in Tertiary Ss play

1.5 TCF in Mesozoic Ss play

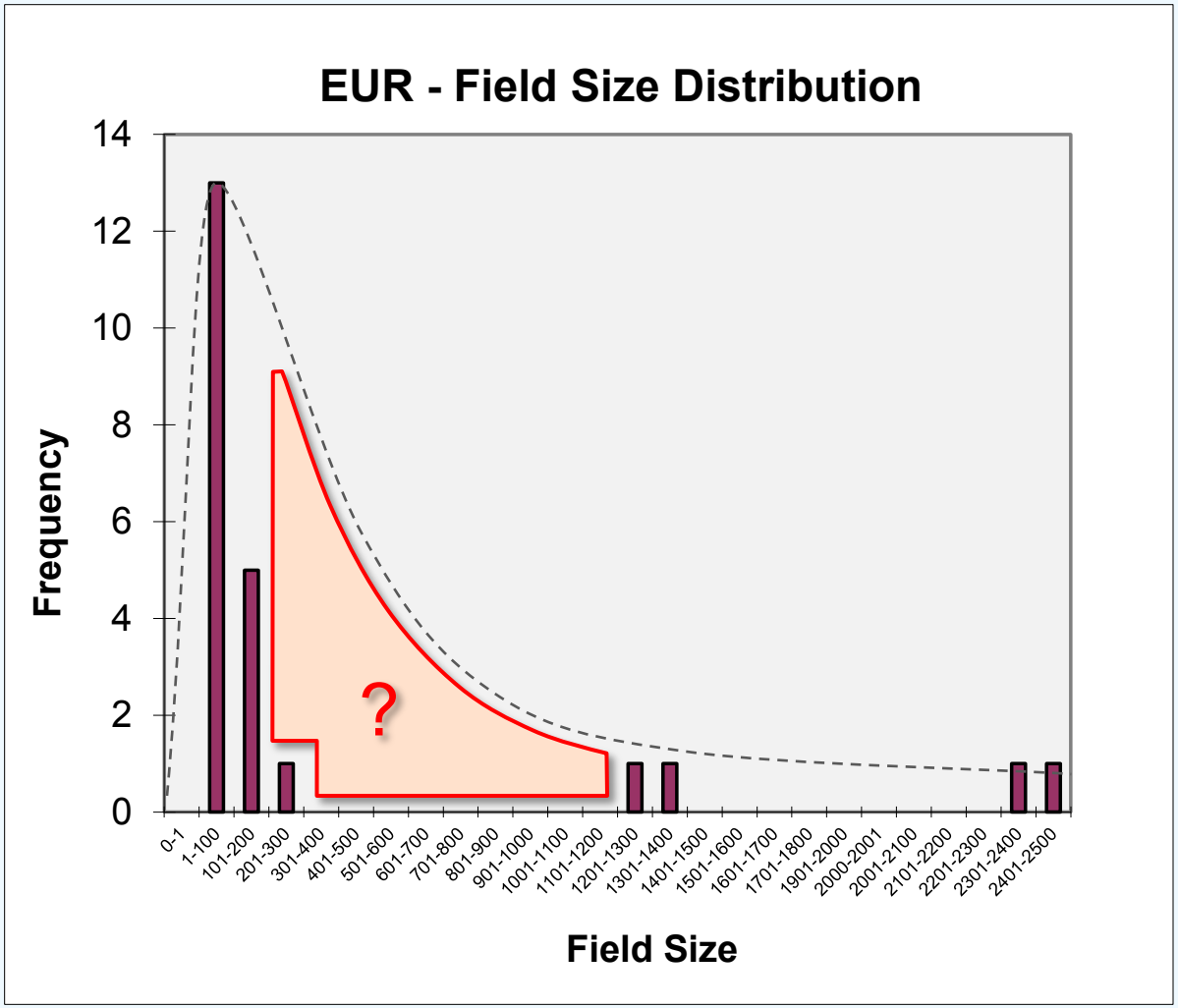
- mean unconventional gas 5.3 TCF

0.6 TCF Mesozoic tight ss play

4.7 TCF Tertiary Coalbed play

Gas Field Size Distribution - EUR

Gaps in lognormal distribution suggest undiscovered fields



Stump Lake	6
Pretty Creek	6
West Fork	7
Lewis River	9
North Fork	12
Falls Creek	13
Birch Hill	22
Sterling	26
N Trading Bay Unit	30
Moquakie	43
Wolf Lake	50
Trading Bay	90
Ivan River	104
M G S	112
Cannery Loop	116
Granite Point	137
Swanson River	145
Beaver Creek	242
BRU	1266
McAurther River	1384
NCI	2328
Kenai	2425

TOTAL = 8576 Bcf

Mean = 373 Bcf

Dashed curve is schematic, for illustrative purposes only

Cook Inlet Gas Resource Potential

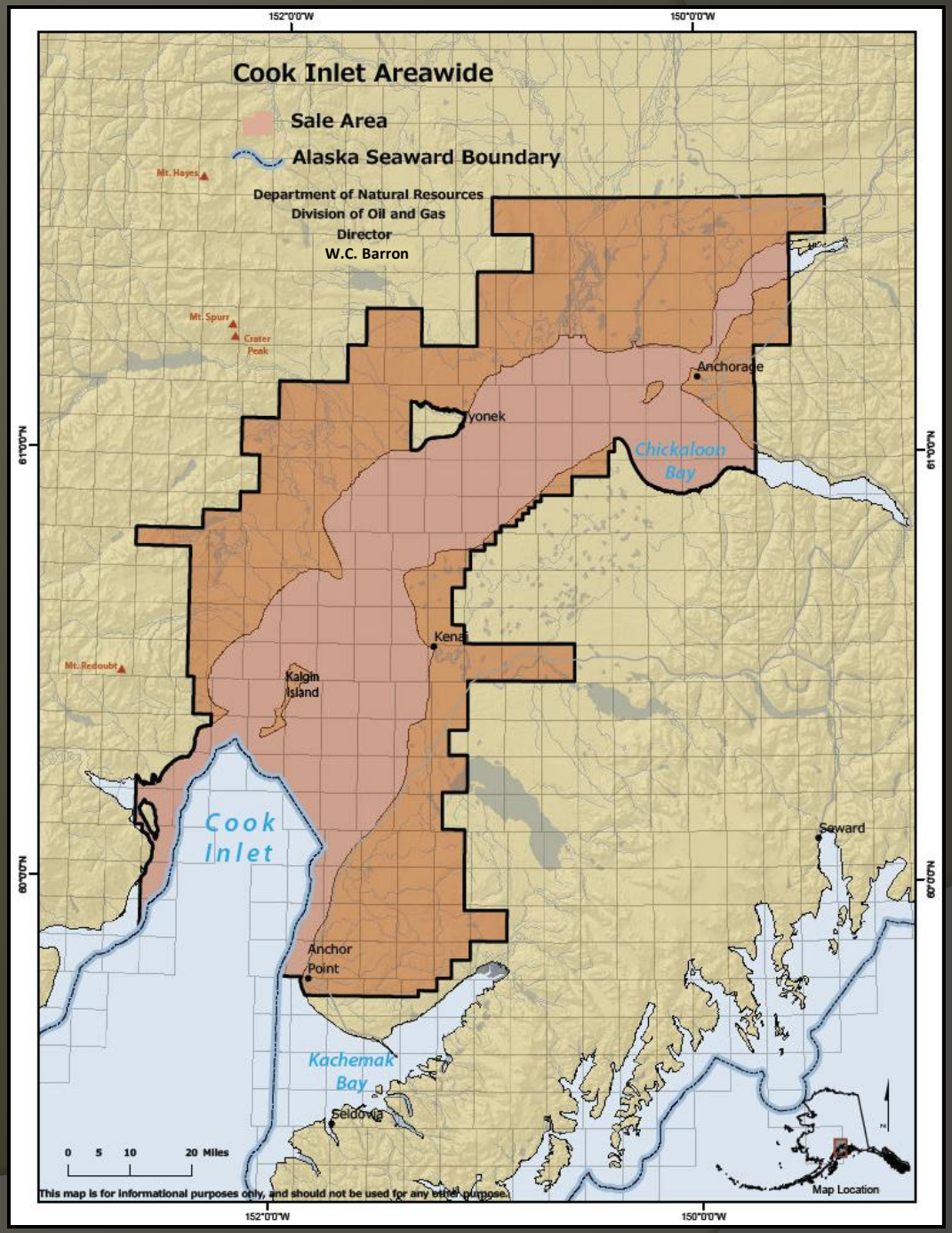
- Only structural traps have been explored for or developed
- 4 largest fields have 86% reserves
- 85% of gas discovered early in exploration cycle while drilling for oil
- Nearly one in ten fields >2 Tcf
- Field-size distribution lacks fields in 300-1300 Bcf range
- Only ~35 exploration wells drilled strictly for gas

Cook Inlet Exploration Potential

- Biogenic gas in Tyonek, Beluga, and Sterling Fms. Thermogenic oil mainly in Hemlock and lower Tyonek Formations.
- Tertiary formations prospective as both conventional reservoirs and tight gas sands.
- Mesozoic formations are mostly reservoir-challenged. Upper Cretaceous Kaguyak Fm appears most prospective.
- Most major structures have been drilled, though some nonproducing structures still have potential. Smaller structural traps and perhaps numerous stratigraphic traps remain to be discovered.

Cool Inlet Areawide Lease Sale

- Recent exploration buzz
  - new players
  - new discoveries
- 4.2 million acres
- All open acreage offered
- Notice of Sale with sale details due ~ April 1, 2012
- Bids due May 14, 2012
- Bid opening May 16, 2012



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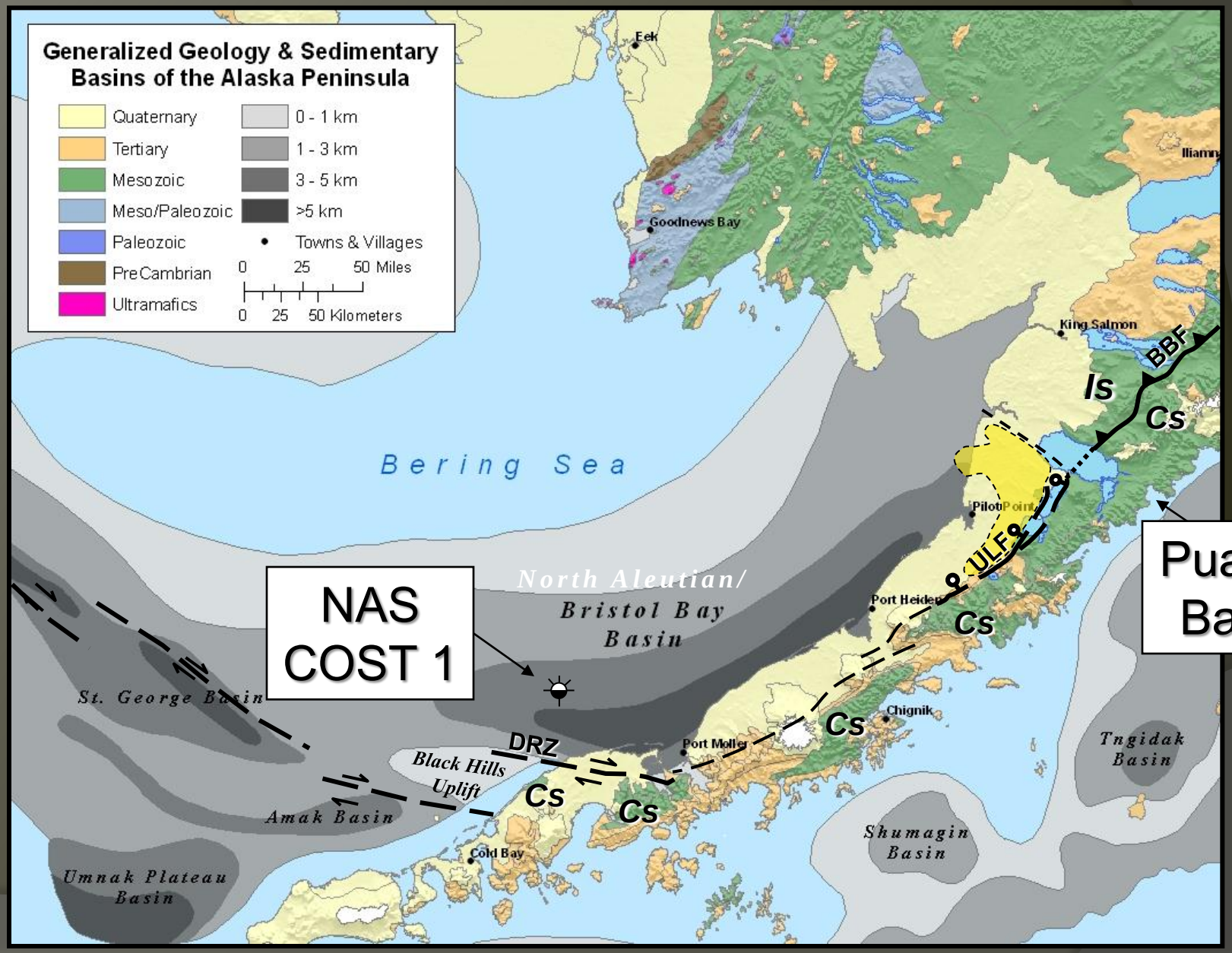
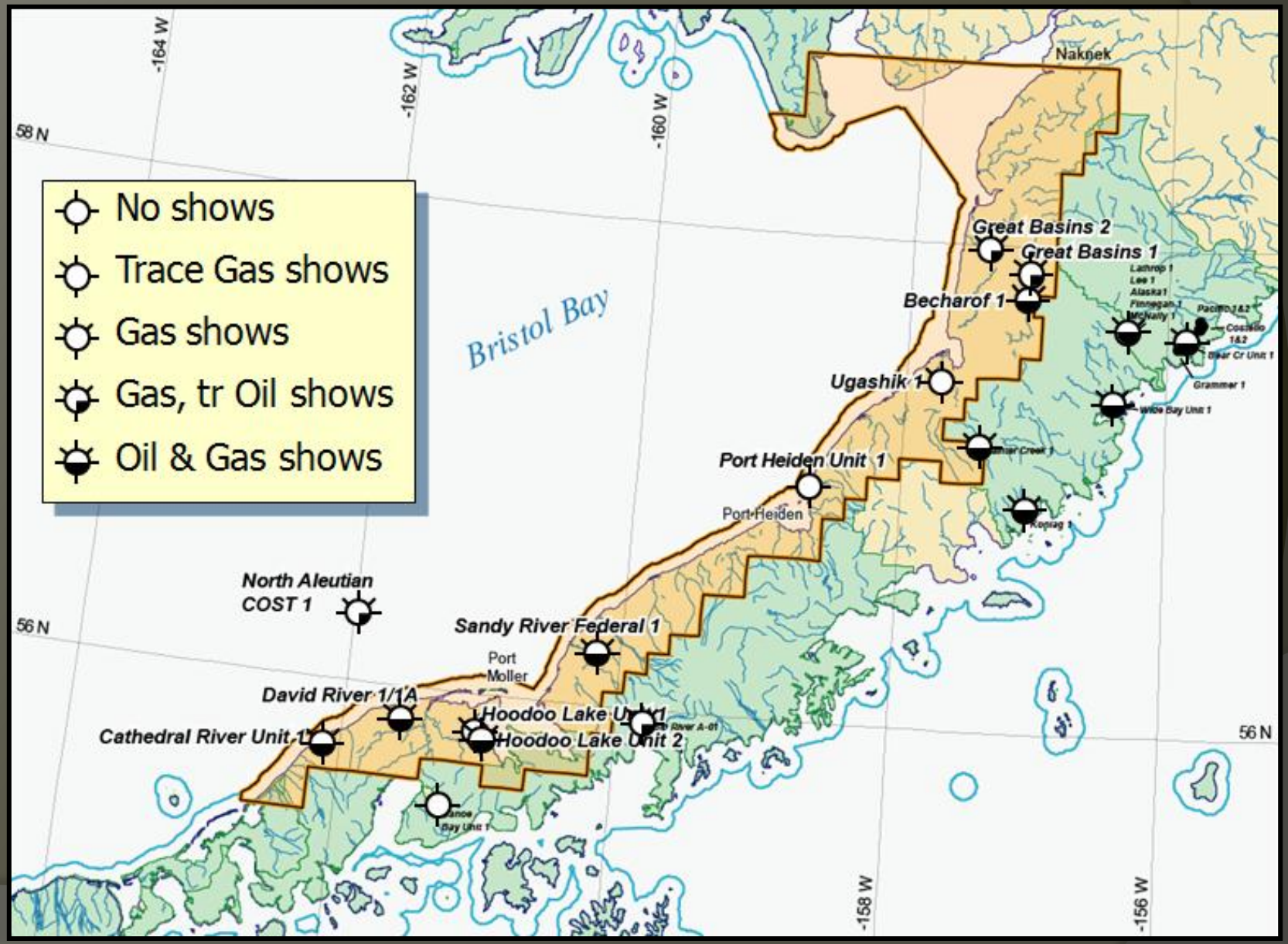
Alaska Peninsula Geologic Overview



Alaska Peninsula is Underexplored

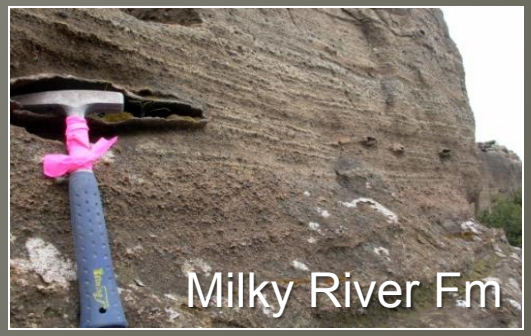
11 wells in sale area, all drilled prior to 1986 Federal moratorium

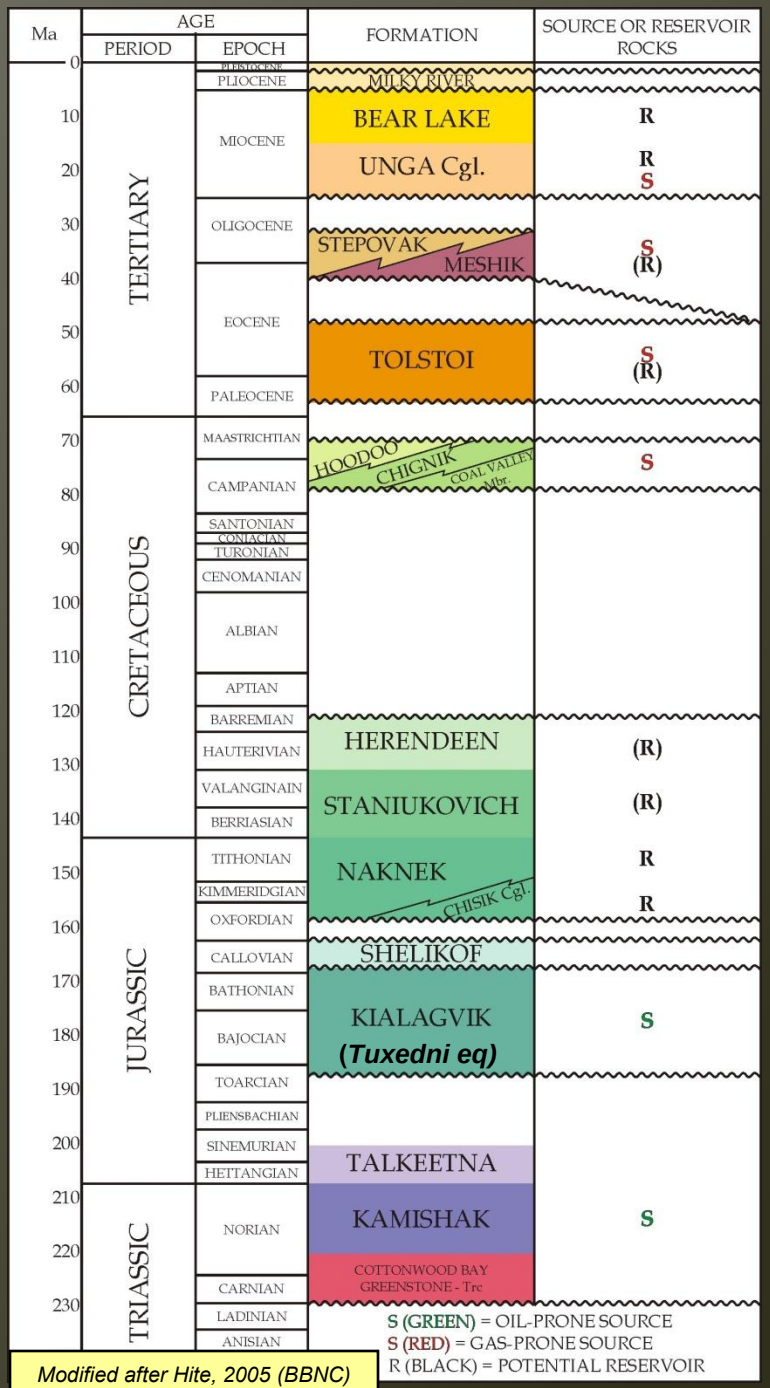


Alaska Peninsula – Key Attributes

- Tertiary back-arc basin superimposed on accreted Peninsular Terrane
- >17,000 ft of nonmarine to shallow marine Tertiary strata in North Aleutian basin depocenter offshore, up to ~14,000 ft onshore – fair to excellent reservoir quality
- Abundant coal → likely source for biogenic and thermogenic gas; liquids potential from associated carbonaceous mudstones
- Excellent Mesozoic oil source rocks, but their presence beneath sale area is uncertain. Tertiary obscures distribution of two contrasting subterranes onshore:
  - Chignik subterrane: oil-window maturity with excellent Triassic and Jurassic oil source rocks (SE)
  - Iliamna subterrane: plutonic and thermally overmature metasedimentary rocks (NW)
- Multiple structural episodes → structural and stratigraphic traps likely
- Sealing facies distributed throughout section

Stratigraphy

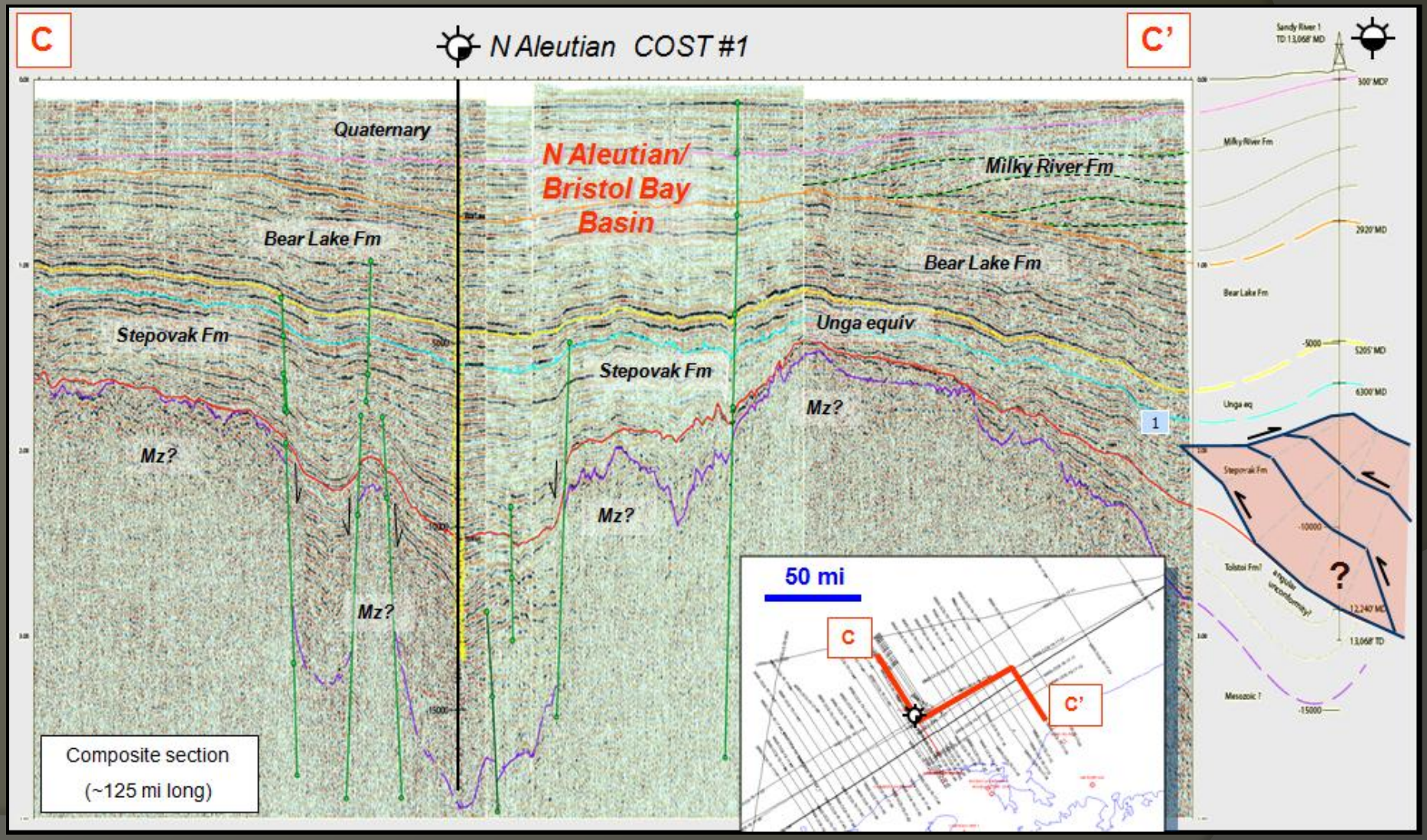




Modified after Hite, 2005 (BBNC)

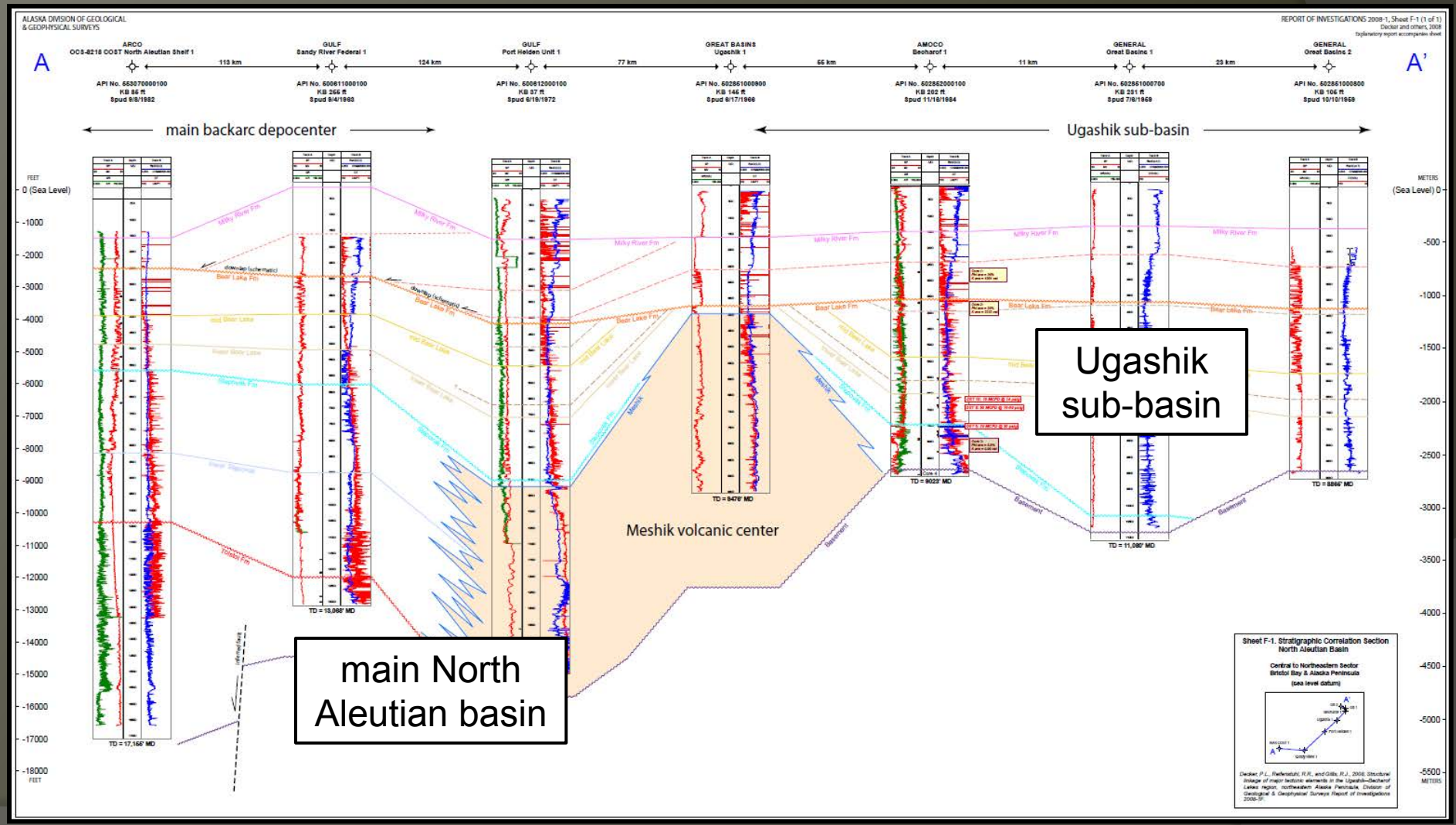
Offshore to Onshore Correlation

North Aleutian COST #1 to Sandy River #1

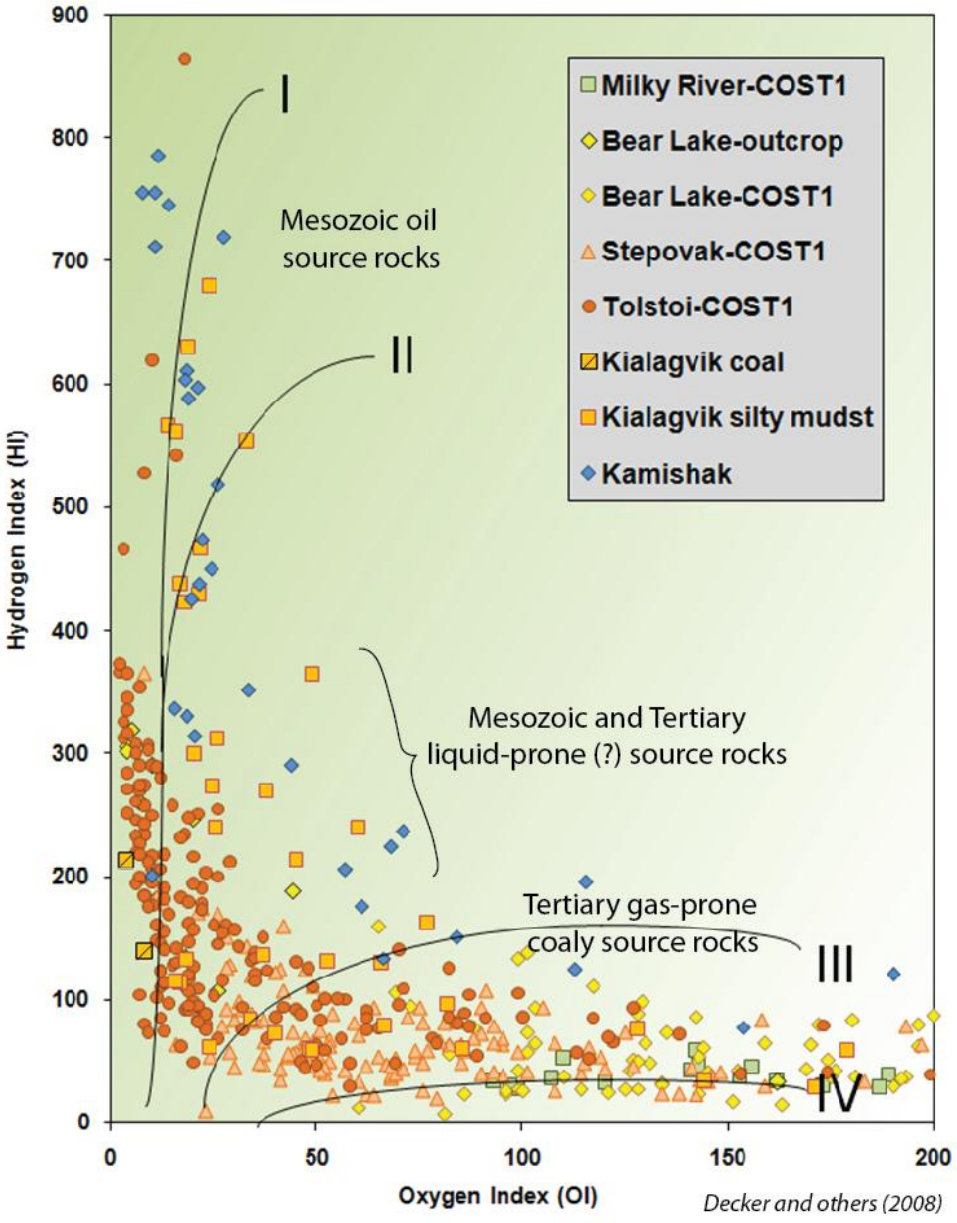


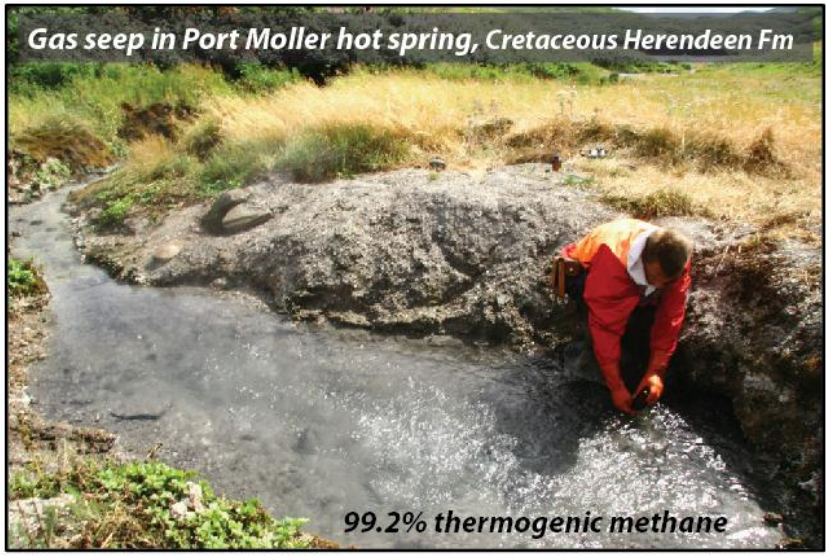
Alaska Peninsula Onshore Correlation

North Aleutian basin & Ugashik sub-basin

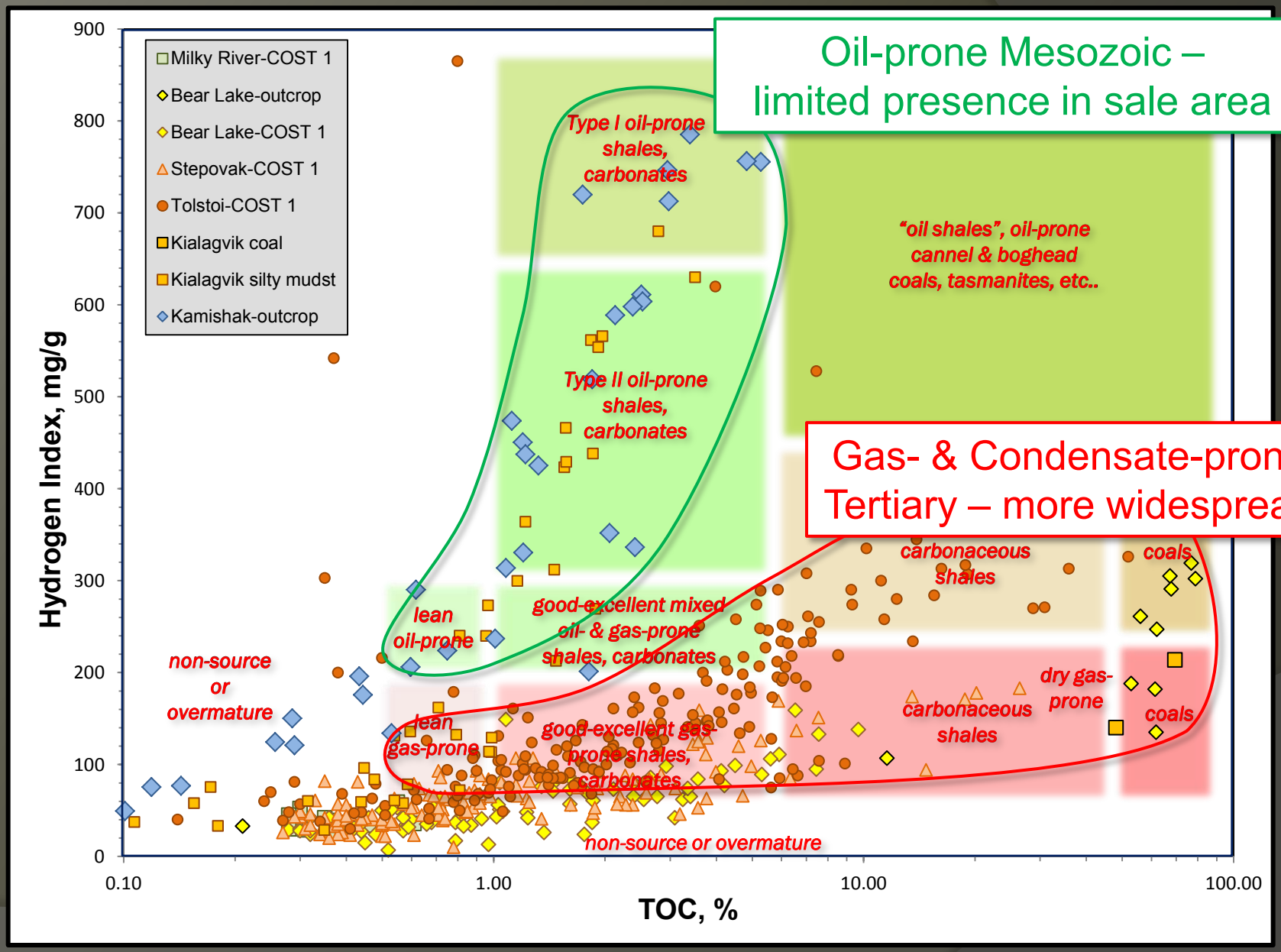


Oil and Gas Source Rocks and Seeps

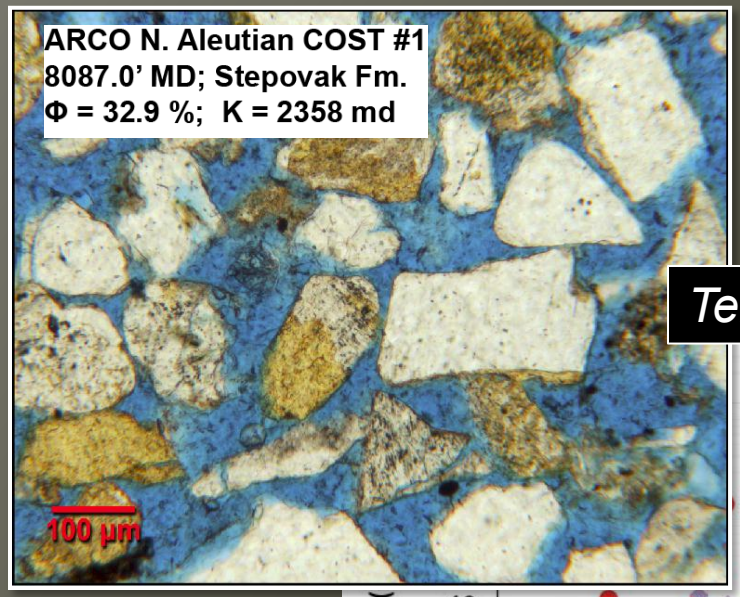




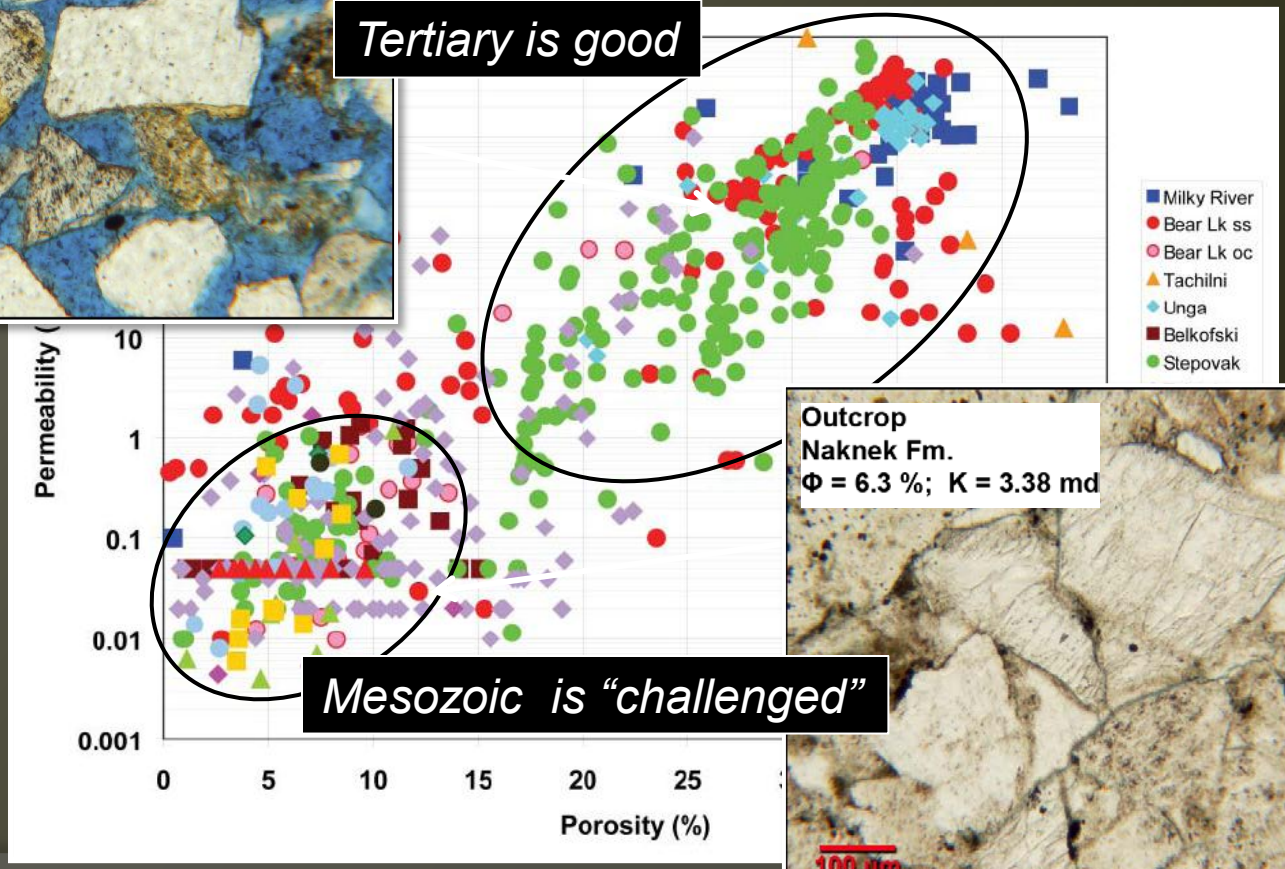
Oil and Gas-prone Source Rocks



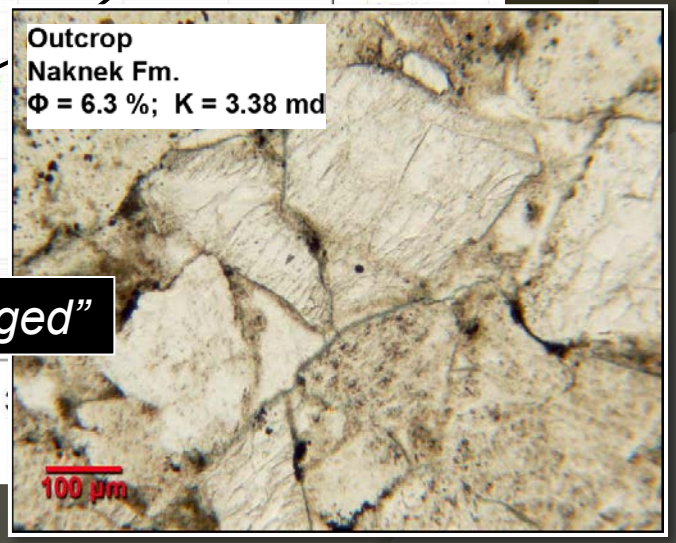
Tertiary Reservoir Potential



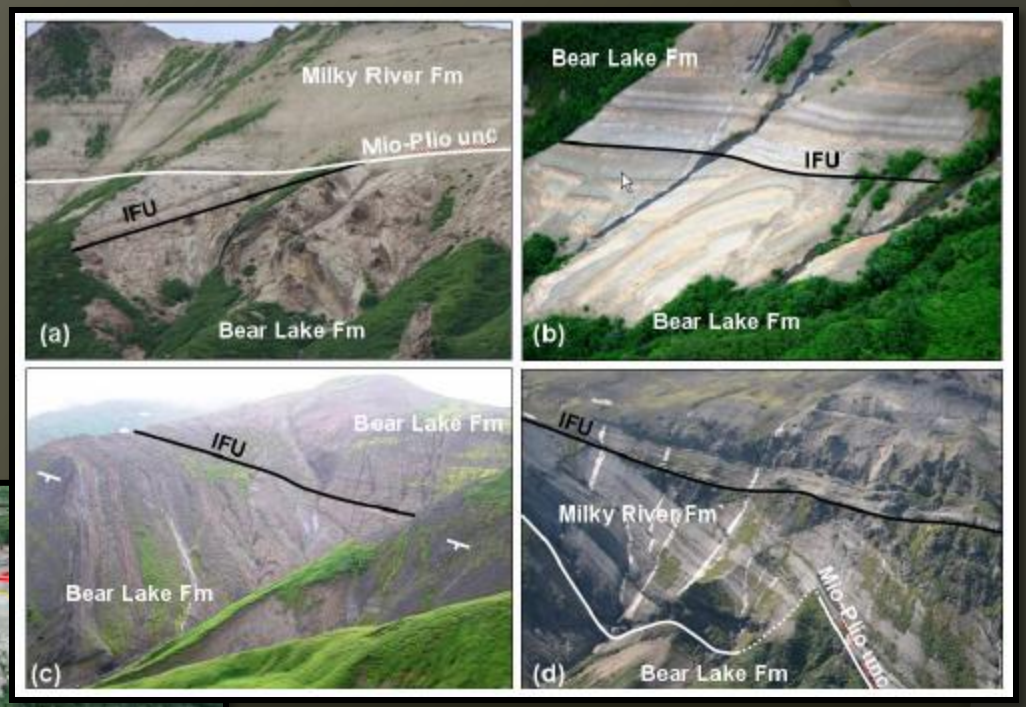
Tertiary is good



Mesozoic is "challenged"



Structural and Stratigraphic Traps



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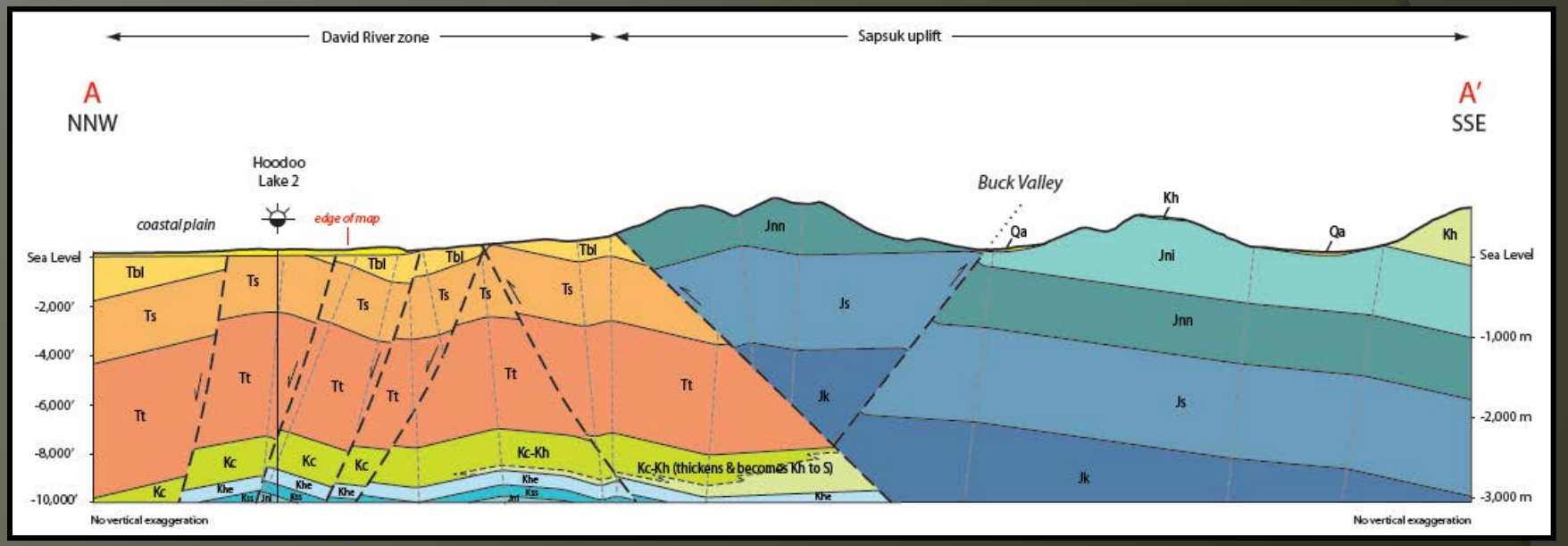
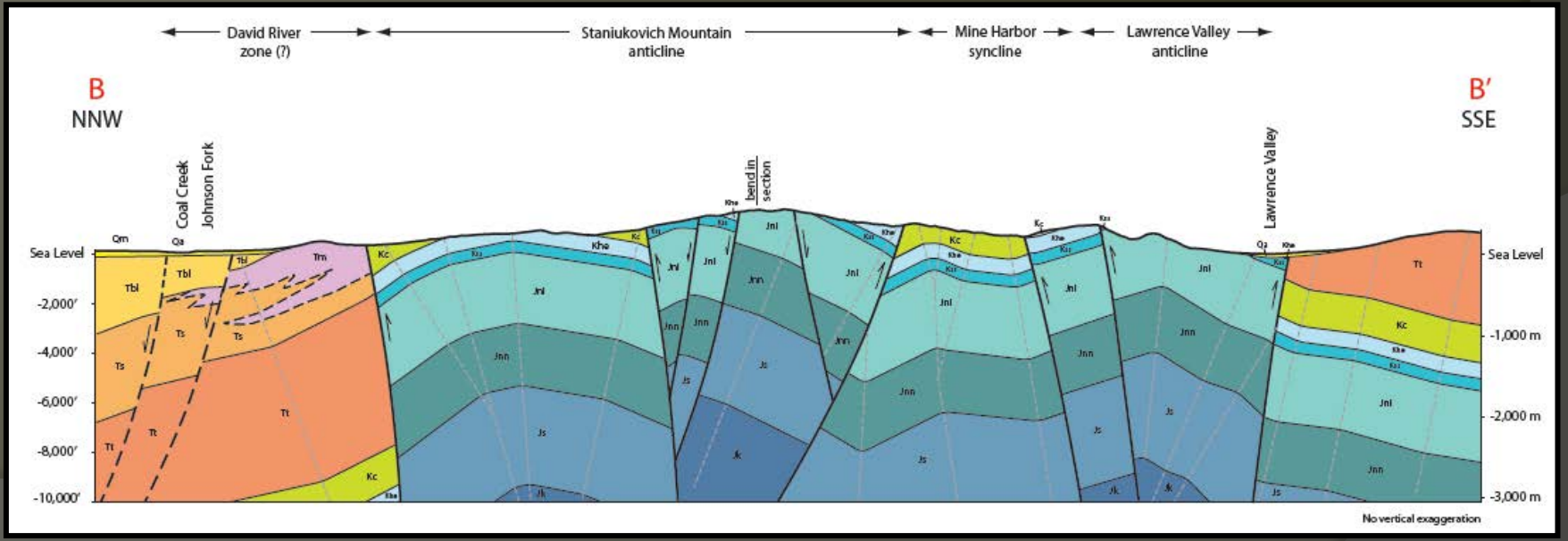


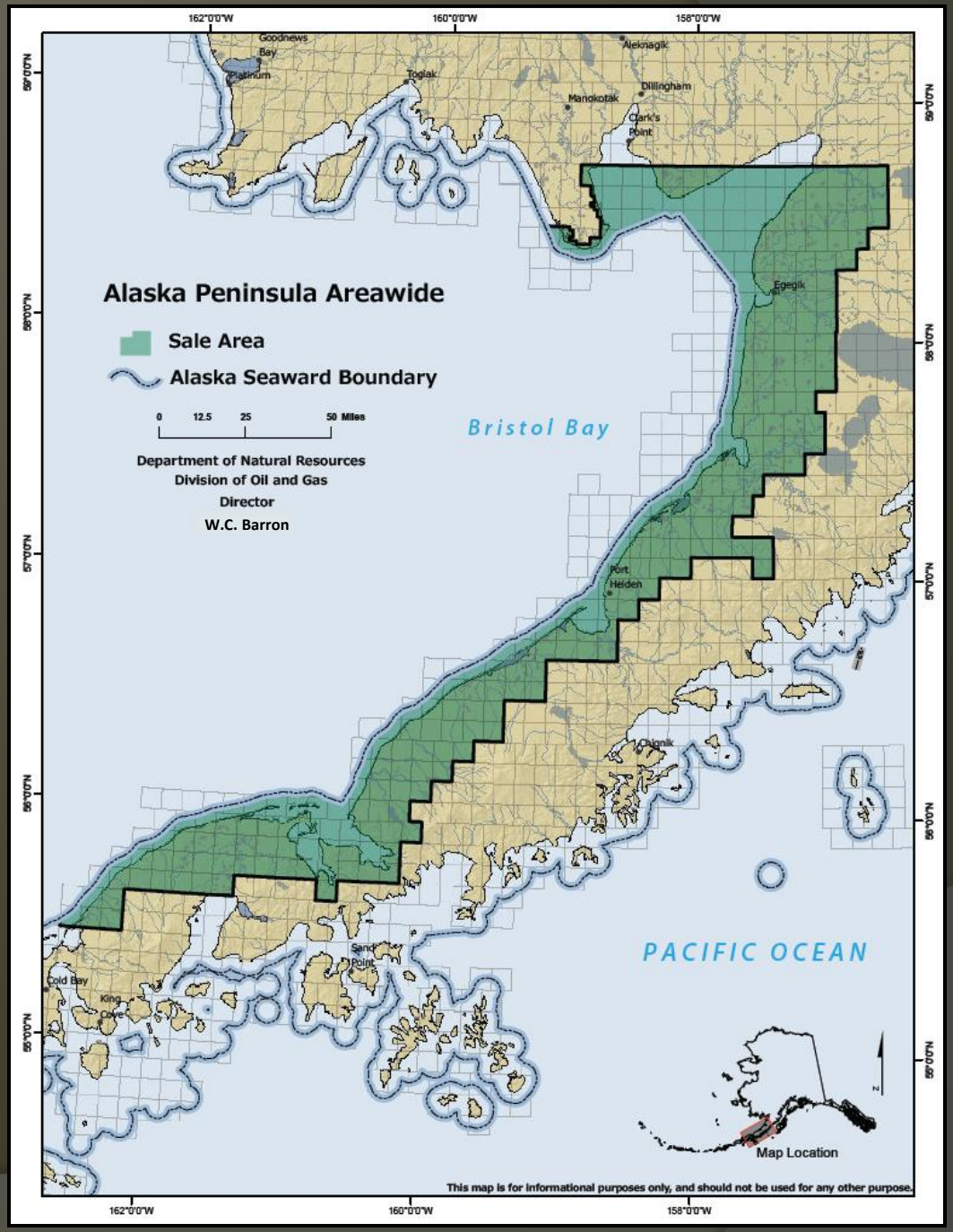


Alaska Peninsula Resource Potential

- DNR has made significant data available since 2004, including offshore and limited onshore public seismic, outcrop studies, and interpretive reports
- Very little onshore seismic data available to State or industry for prospect-level analysis
- Gas (& possible NGLs) more likely than oil
- Tertiary formations have sufficient porosity & permeability to serve as conventional reservoirs
- Mesozoic formations are reservoir-challenged
- Structural and stratigraphic complexity → traps are probably present but may be difficult to define

Alaska Peninsula Areawide Lease Sale

- Frontier area
- Gas potential at tidewater
- 5.8 million acres
- All tracts available in sale
- Notice of Sale with sale details due ~ April 1, 2012
- Bids due May 14, 2012
- Bid opening May 16, 2012



Recommended Information Sources

- DOG website: http://dog.dnr.alaska.gov/
- DGGS website publications page
- AOGCC website: http://doa.alaska.gov/ogc/
- Annotated Alaska Oil & Gas Laws & Regulations published by Lexis / Nexis
- MapMaker's® lease map of Cook Inlet
- Petroleum News Alaska