U.S. Geological Survey 2011 Assessment of Undiscovered Oil and Gas Resources of the Cook Inlet Region, South-Central Alaska

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U.S. Geological Survey Open-File Report 2011-1237

U.S. Department of the Interior
U.S. Geological Survey

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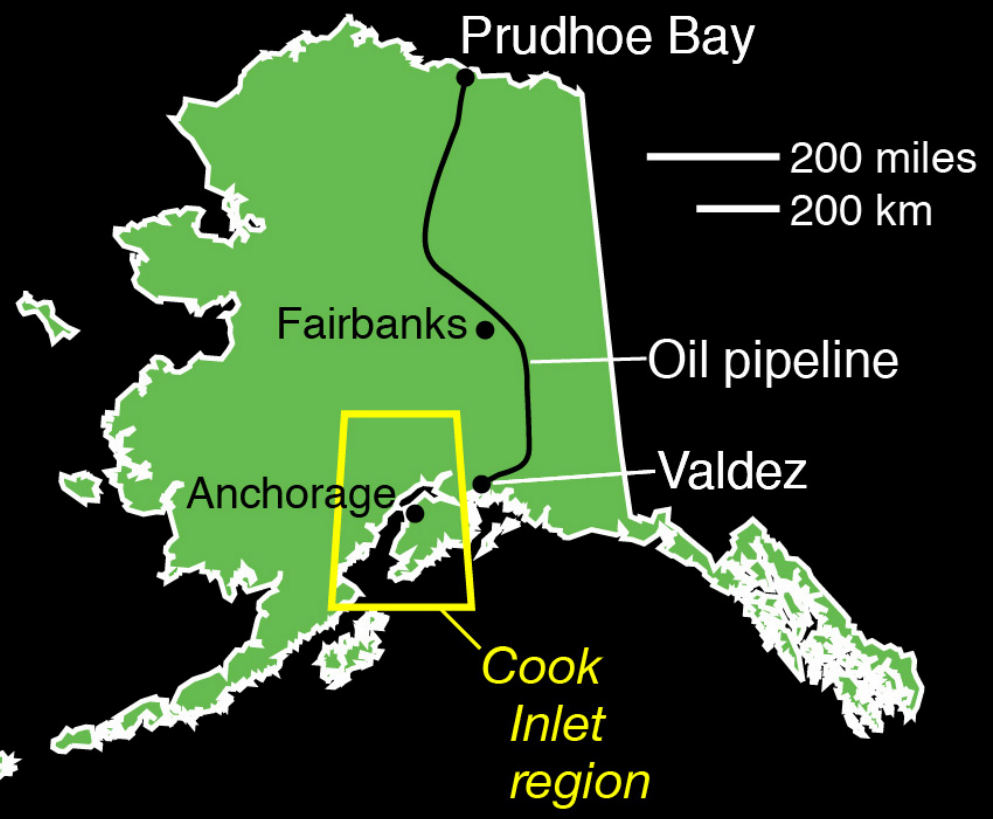
KEN SALAZAR, Secretary

U.S. Geological Survey
Marcia K. McNutt, Director

USGS

Outline of this presentation:

- **Summary of results**
- **What we did**
- **Where the resources might be found**



USGS

USGS estimates of technically recoverable undiscovered resources, onshore & State waters parts of Cook Inlet

Mean, F_{95}, and F_{05}:

- **Oil: mean 599 MMBO, range 108 to 1,359 MMBO**
- **Gas: mean 19,037 BCFG, range 4,976 to 39,737 BCFG**
- **NGL: mean 46 MMBNGL, range 6 to 121 MMBNGL**

Explanation of abbreviations and terms:
MMBO, *million barrels of oil.*
BCFG, *billion cubic feet of gas.*
MMBNGL, *million barrels of natural gas liquids (NGL).*
F_{95} *represents a 95 percent chance of at least the amount shown.*
F_{05} *represents a 5 percent chance of at least the amount shown.*
Technically recoverable resources *are those resources that can be discovered and produced using current technology.*

USGS

Comparison 1:

Mean amount of undiscovered gas in Cook Inlet: ~19,000 BCFG

Compare to:

- **7,800 BCFG: Cumulative gas production in Cook Inlet to 2010**
- **24,140 BCFG: Gas consumption in U.S. in 2010, according to U.S. Energy Information Administration (EIA) web site**
- **35,400 BCFG: Remaining recoverable reserves of discovered gas on the North Slope of Alaska (Alaska Division of Oil and Gas, Annual Report 2009)**

USGS

Comparison 2:

Mean amount of undiscovered oil in Cook Inlet: ~600 MMBO

Compare to:

- **1,300 MMBO: Cumulative oil production in Cook Inlet to 2010**
- **7,000 MMBO: Oil consumption in U.S. in 2010, according to U.S. Energy Information Administration (EIA) web site**
- **5,950 MMBO: Remaining recoverable reserves of discovered oil on the North Slope of Alaska (Alaska Division of Oil and Gas, Annual Report 2009)**

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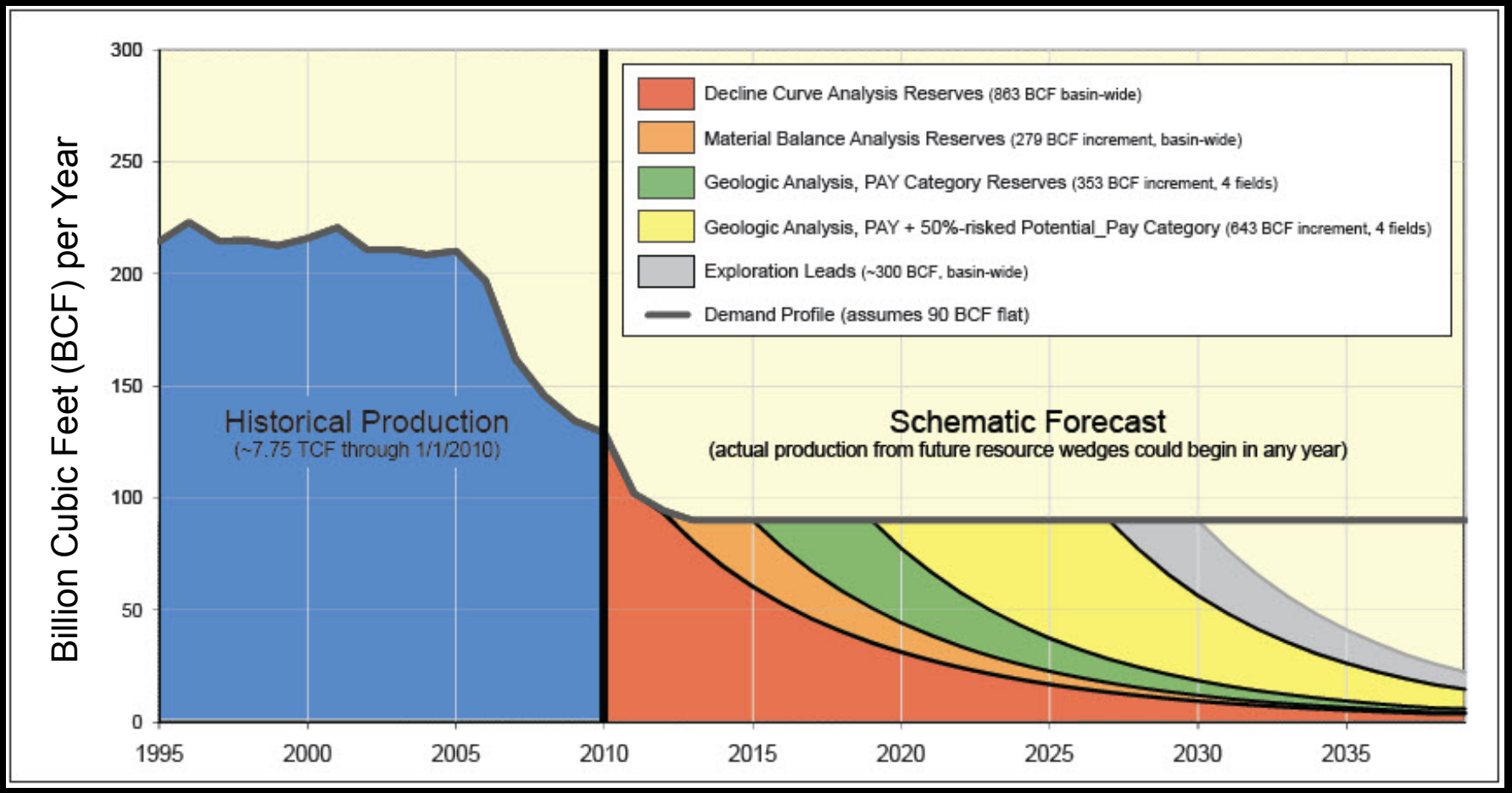
Context 1: Public concern about possible near-term gas shortage in Anchorage and nearby communities

- Assumed future demand for natural gas ~90 BCF per year



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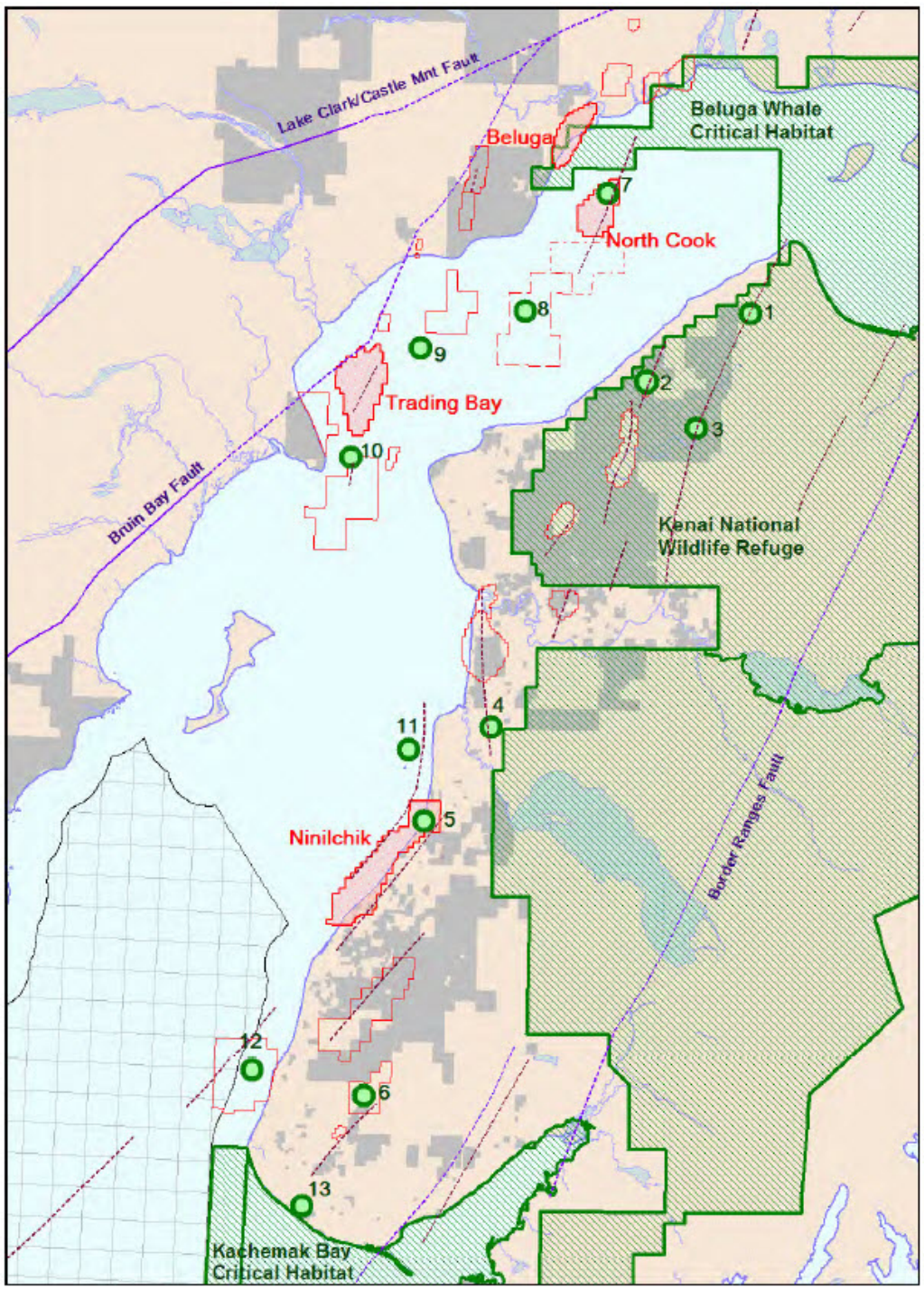
From Hartz and others (2009), Alaska Department of Natural Resources (DNR)

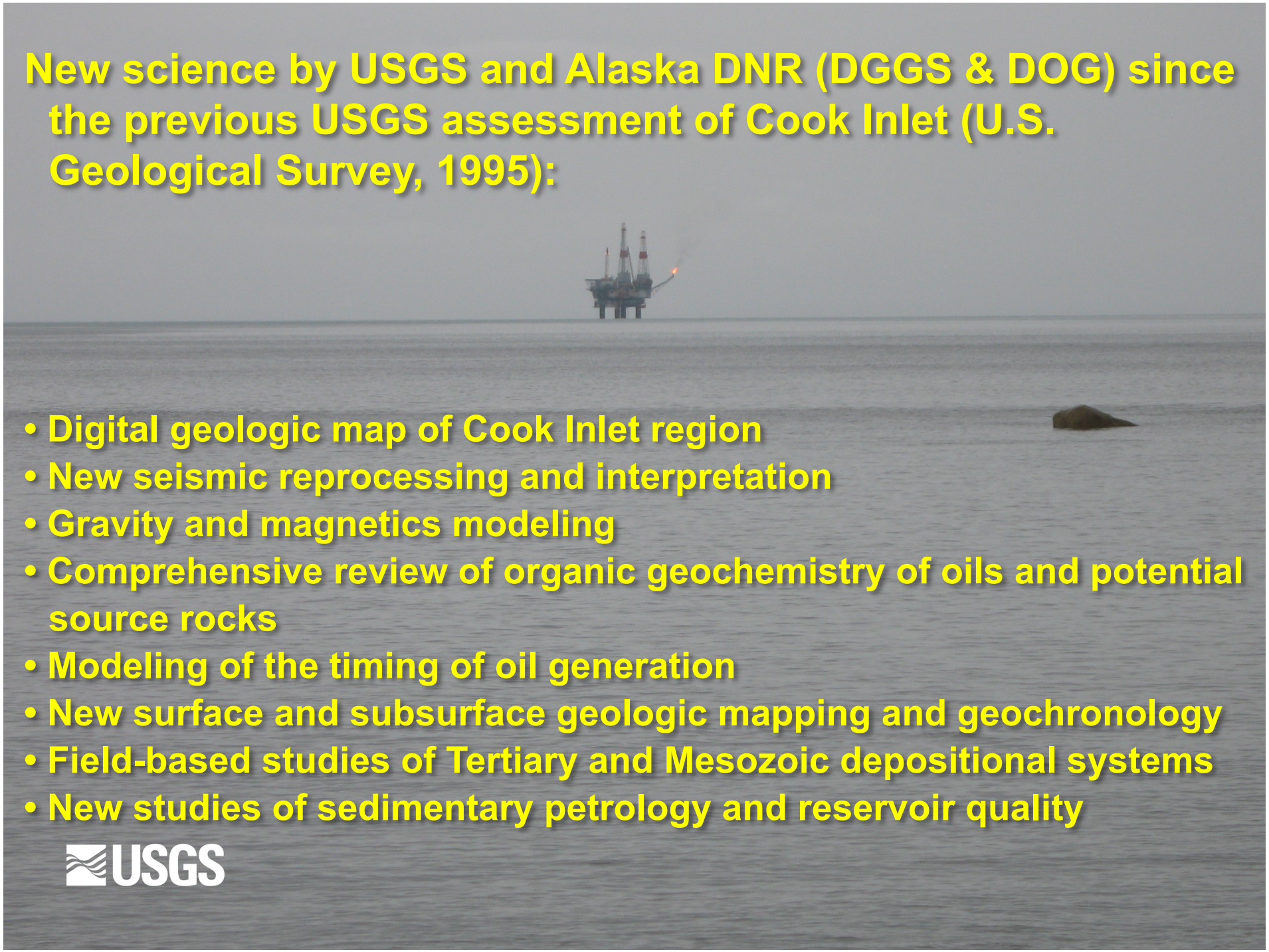
Context 2:

USGS estimates are *Technically Recoverable*

- Not all of the undiscovered oil and gas resources assessed by the USGS are accessible or economically viable
- *For example, on this map from Hartz and others (2009), green shading shows areas with exploration access restrictions*



USGS

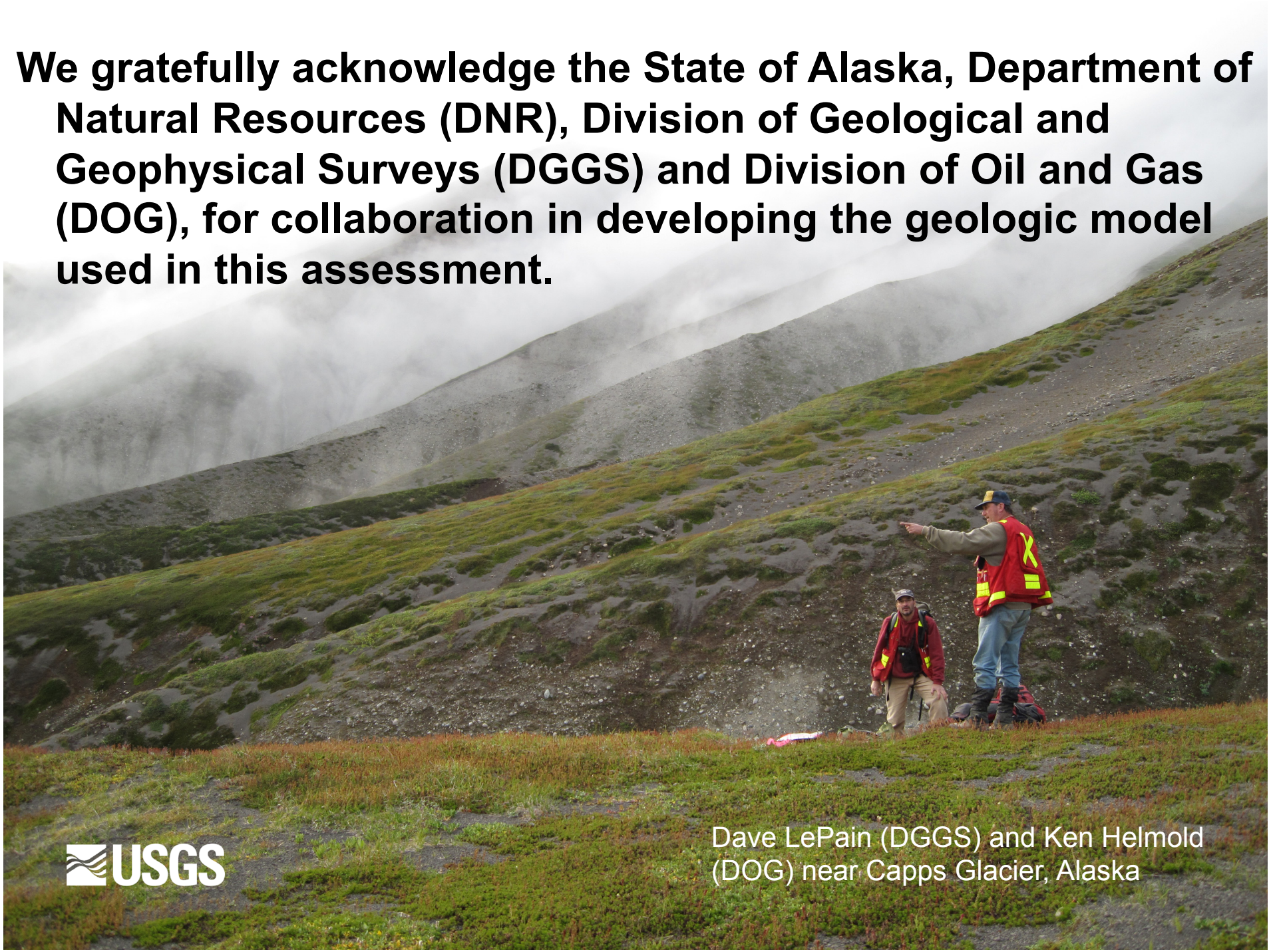


New science by USGS and Alaska DNR (DGGS & DOG) since the previous USGS assessment of Cook Inlet (U.S. Geological Survey, 1995):

- Digital geologic map of Cook Inlet region
- New seismic reprocessing and interpretation
- Gravity and magnetics modeling
- Comprehensive review of organic geochemistry of oils and potential source rocks
- Modeling of the timing of oil generation
- New surface and subsurface geologic mapping and geochronology
- Field-based studies of Tertiary and Mesozoic depositional systems
- New studies of sedimentary petrology and reservoir quality

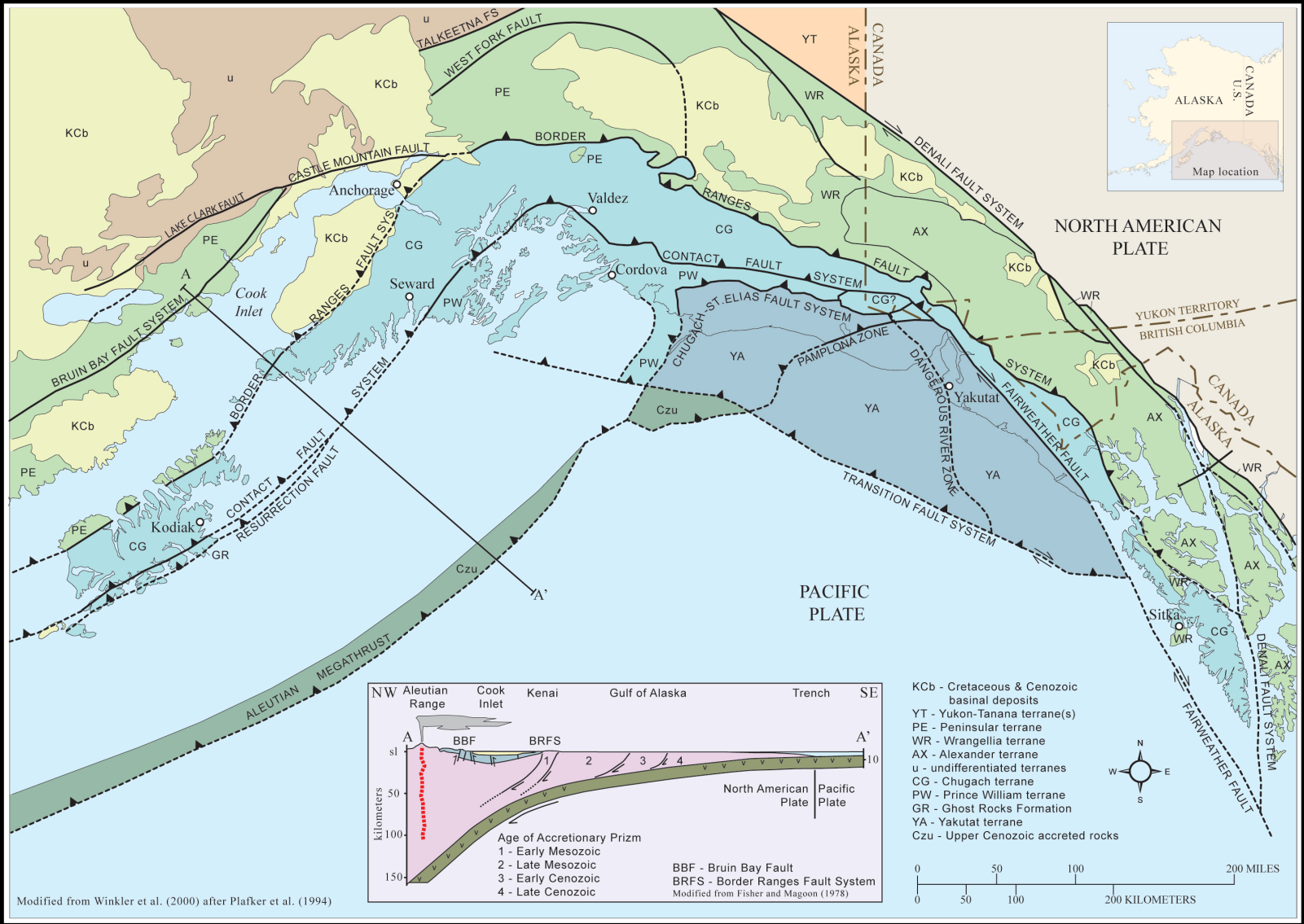
USGS

We gratefully acknowledge the State of Alaska, Department of Natural Resources (DNR), Division of Geological and Geophysical Surveys (DGGS) and Division of Oil and Gas (DOG), for collaboration in developing the geologic model used in this assessment.



Dave LePain (DGGS) and Ken Helmold (DOG) near Capps Glacier, Alaska

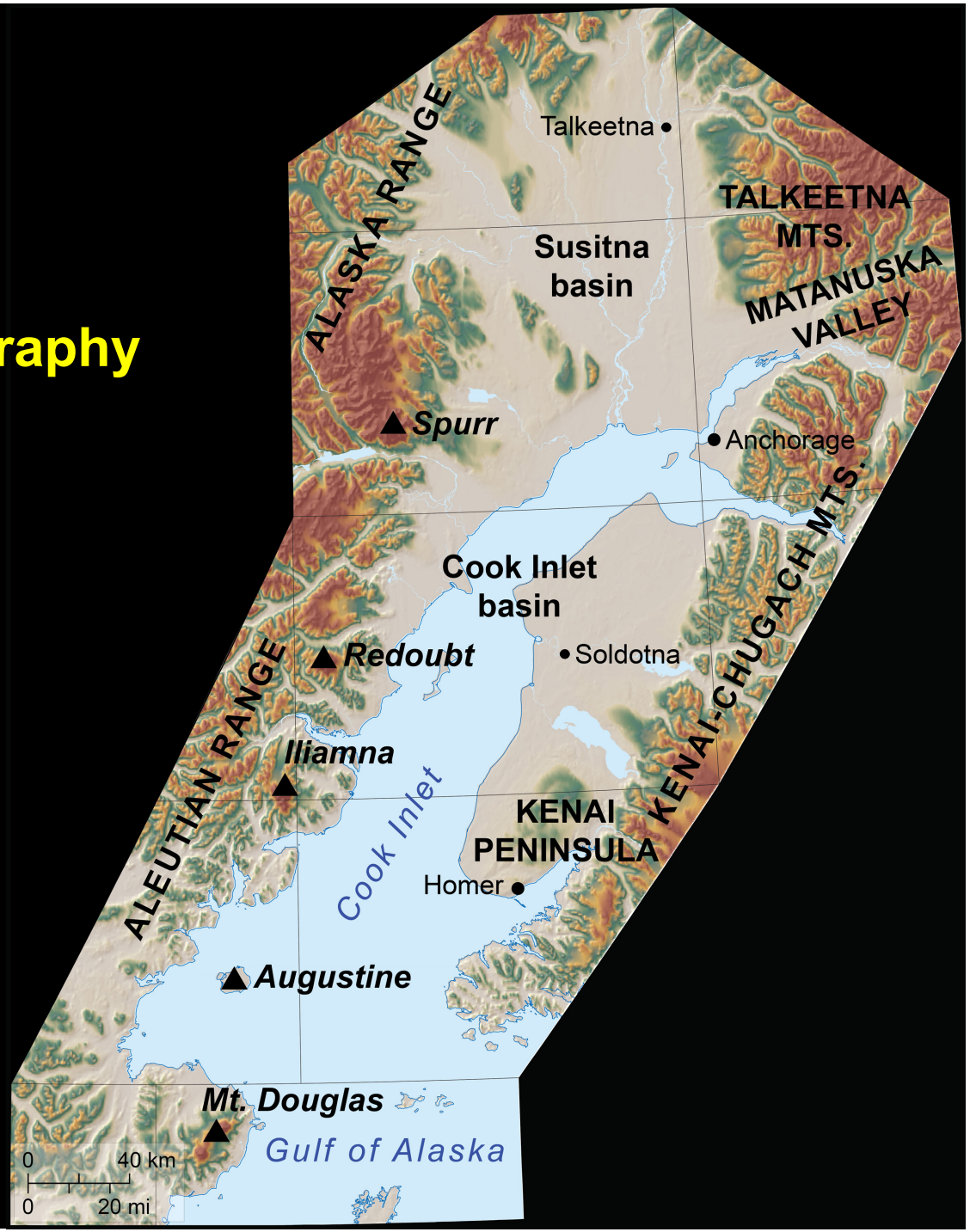
Geologic setting: Cook Inlet is a forearc basin



USGS

Source: Dave LePain (Alaska DGGS), after Winkler (2000)

Cook Inlet region geography



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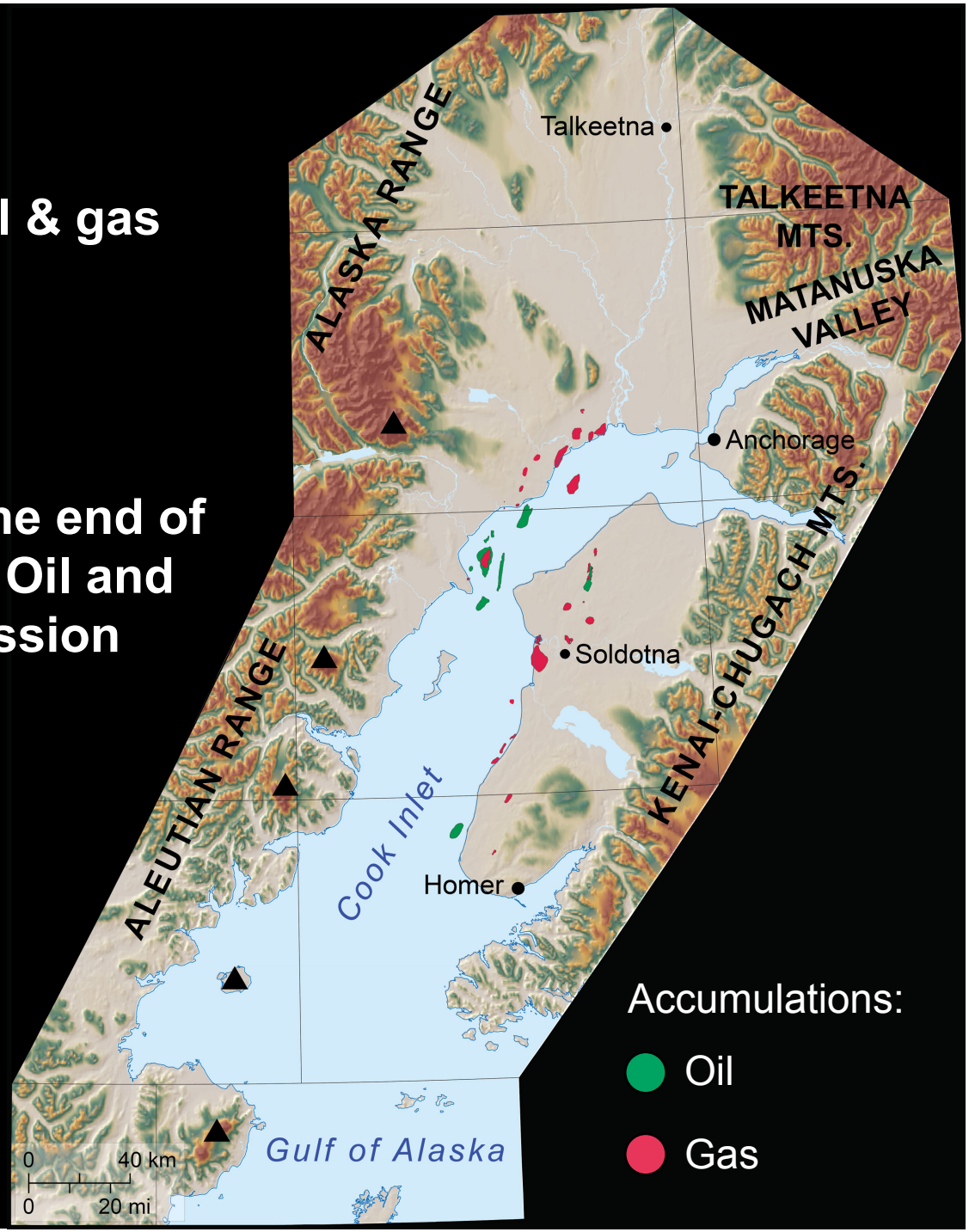
Cook Inlet oil and gas

33 discovered fields with oil & gas production:

- 8 mostly oil
- 25 mostly gas

Cumulative production to the end of 2010, according to Alaska Oil and Gas Conservation Commission (AOGCC):

- Oil, ~1.3 BBO
- Gas, >7.8 TCFG



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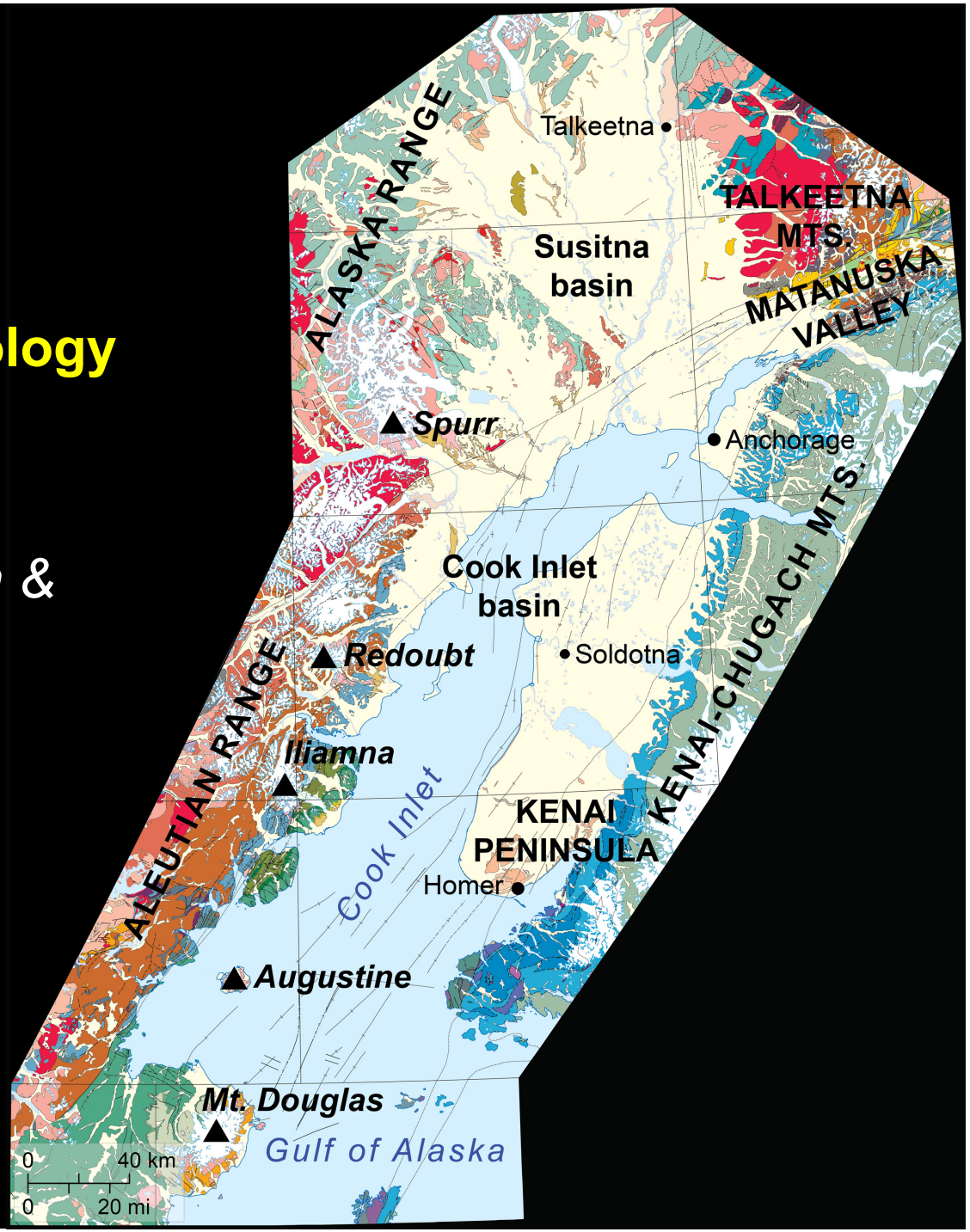
Cook Inlet regional geology

Geologic map by Wilson & others, 2009



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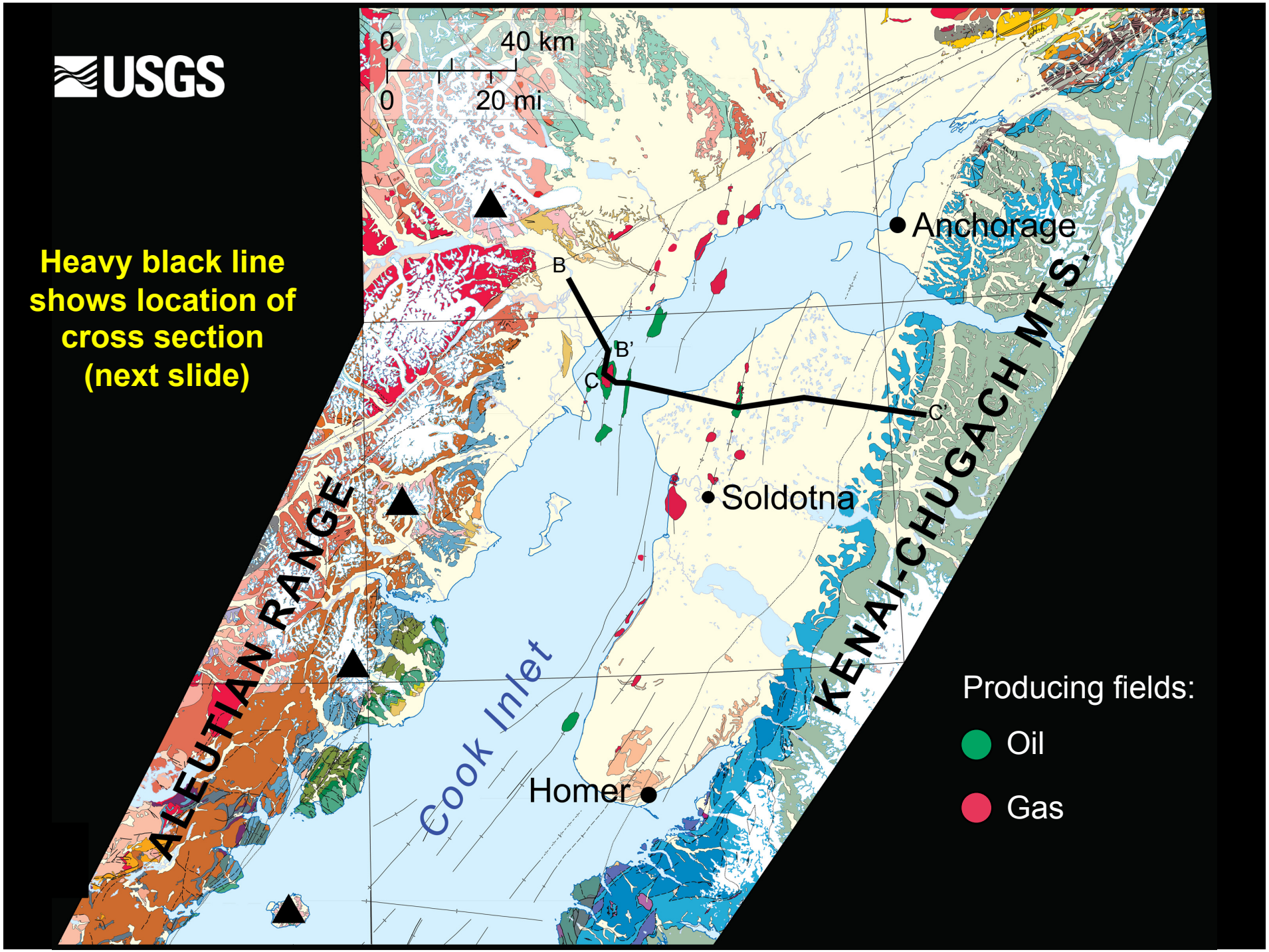
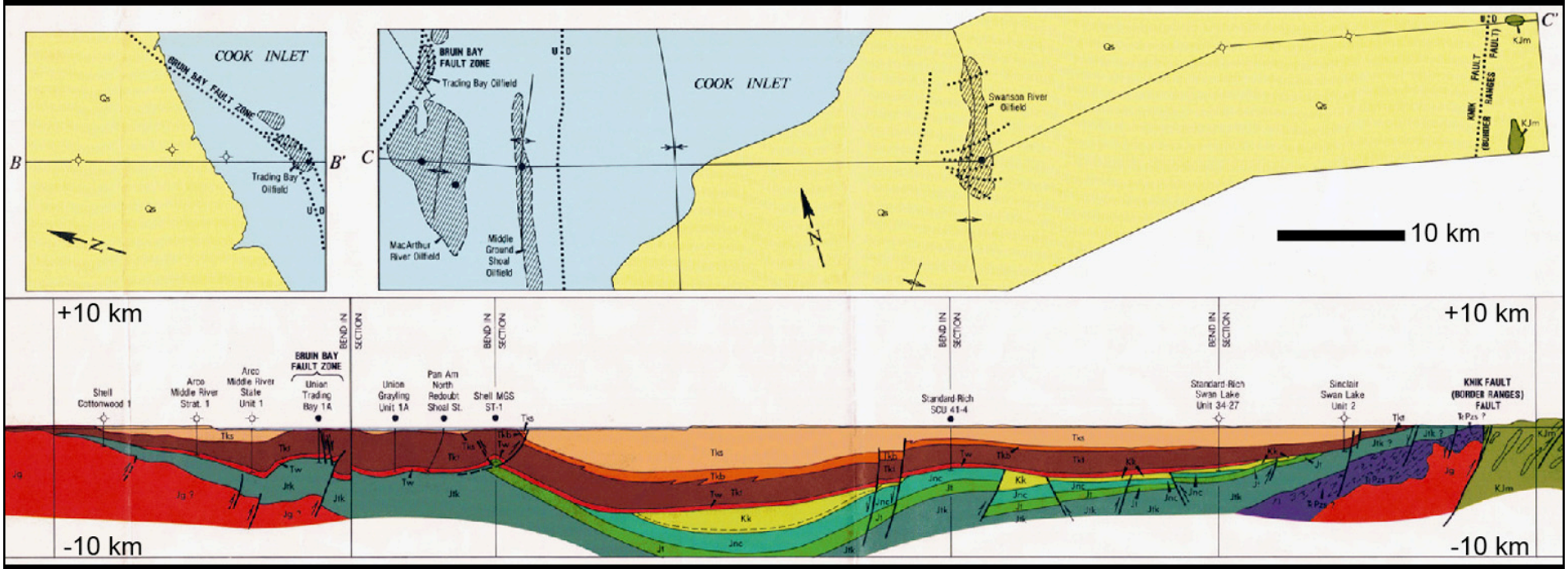

USGS
Heavy black line shows location of cross section (next slide)
0
40 km
0
20 mi
Anchorage
B
B'
C
C'
Soldotna
ALEUTIAN RANGE
KENAI-CHUGACH MTS.
Cook Inlet
Homer
Producing fields:
Oil
Gas

Cross section: Cook Inlet basin is deep

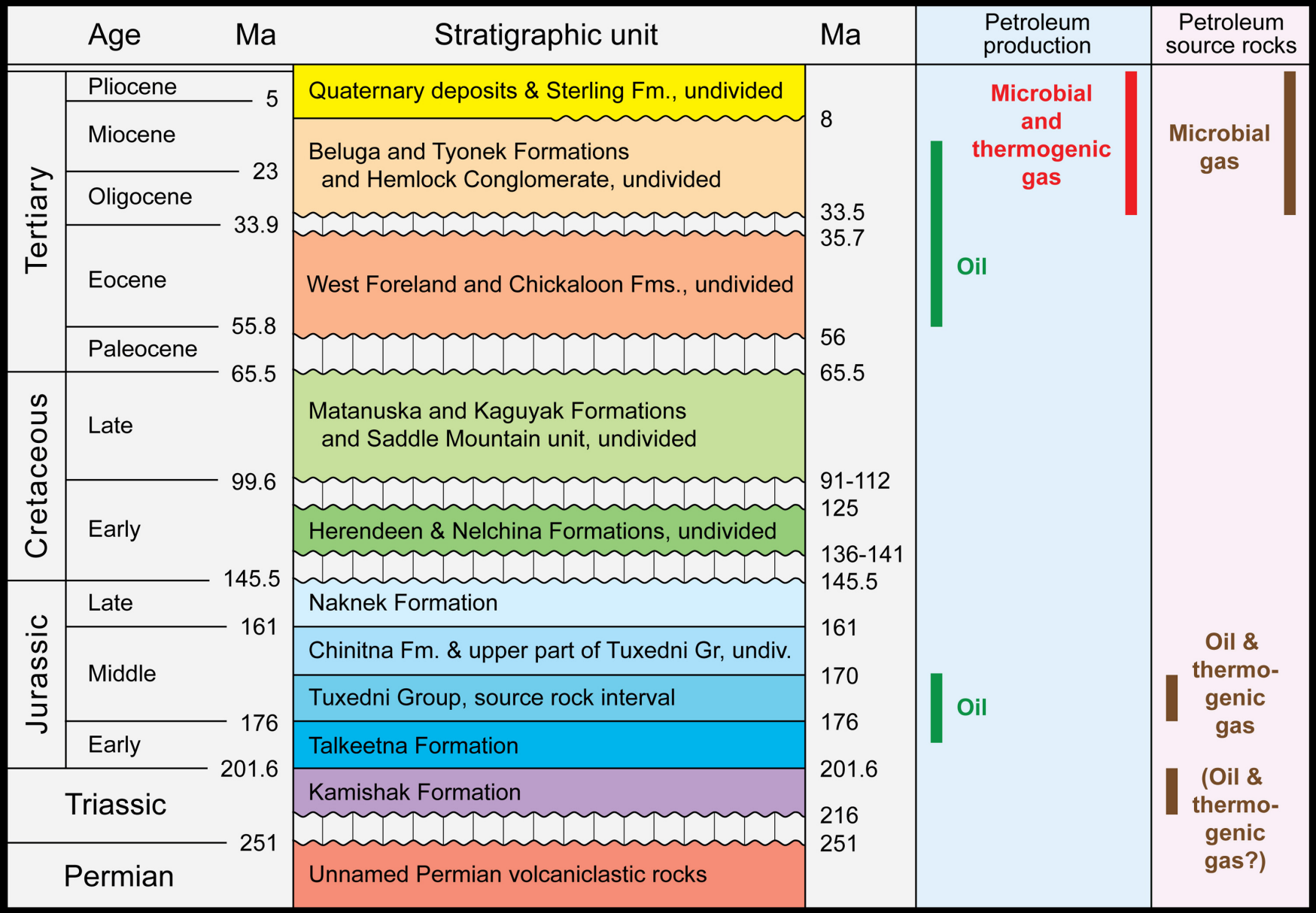


- Tertiary and Quaternary (66 to 0 m.y.) nonmarine strata (brown, orange, tan) about 25,000 ft (8 km) thick
- Jurassic and Cretaceous (200 to 66 m.y.) marine sedimentary rocks (shades of green) about 30,000 ft (9 km) thick, underlain by about 10,000 to 20,000 ft (3 to 6 km) of volcanic rocks
- Folds and related faults are mainly of late Miocene age and younger

USGS

Cross section by Plafker and others (1982)

Cook Inlet rock units



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Geologic time from Walker and Geissman (2009)

Cook Inlet assessment units (AU)

- Assessment unit: a mappable volume of rock with common geologic traits

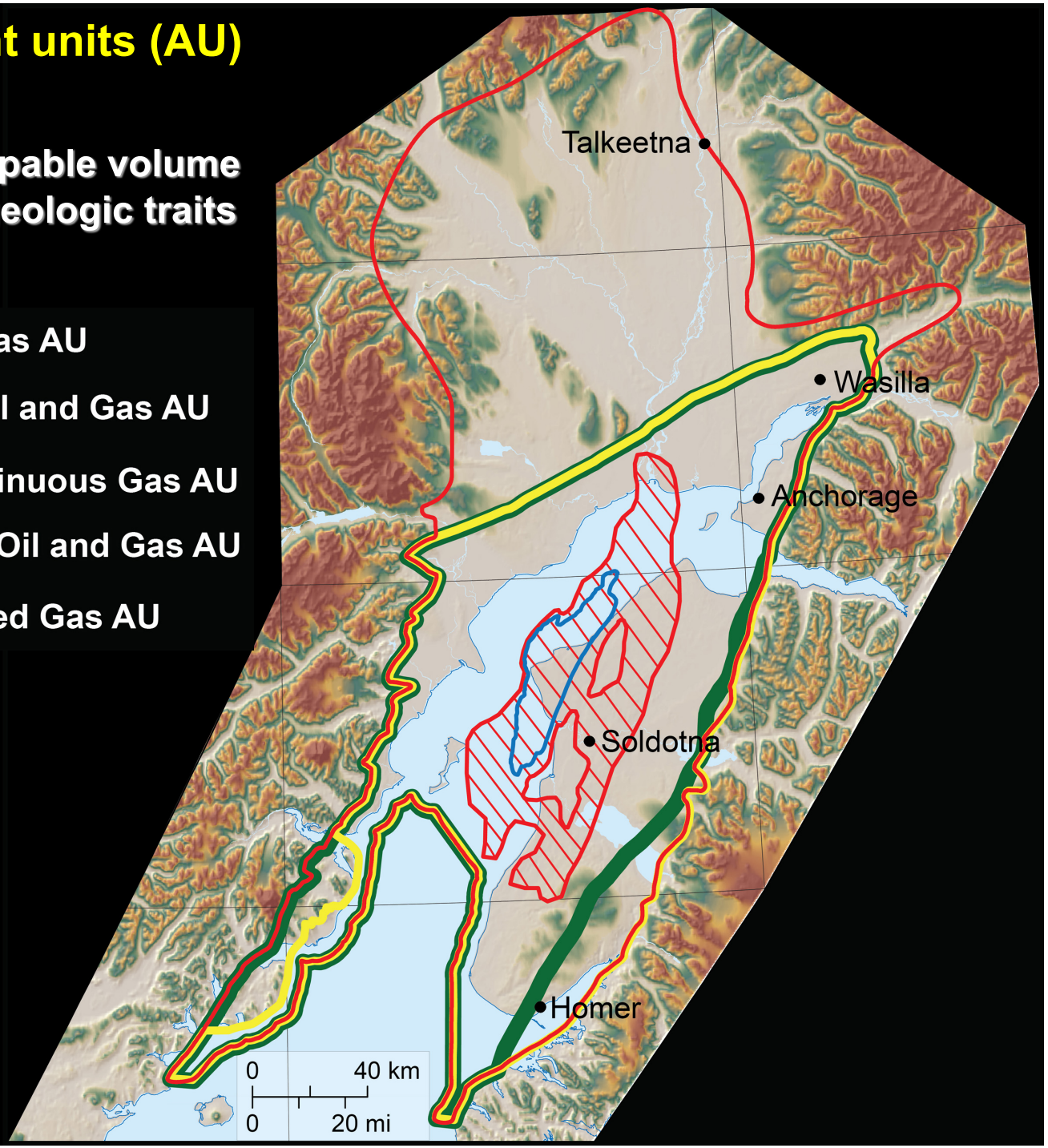
Cook Inlet Coalbed Gas AU

Tertiary Sandstone Oil and Gas AU

Tuxedni-Naknek Continuous Gas AU

Mesozoic Sandstone Oil and Gas AU

Excluded from Coalbed Gas AU



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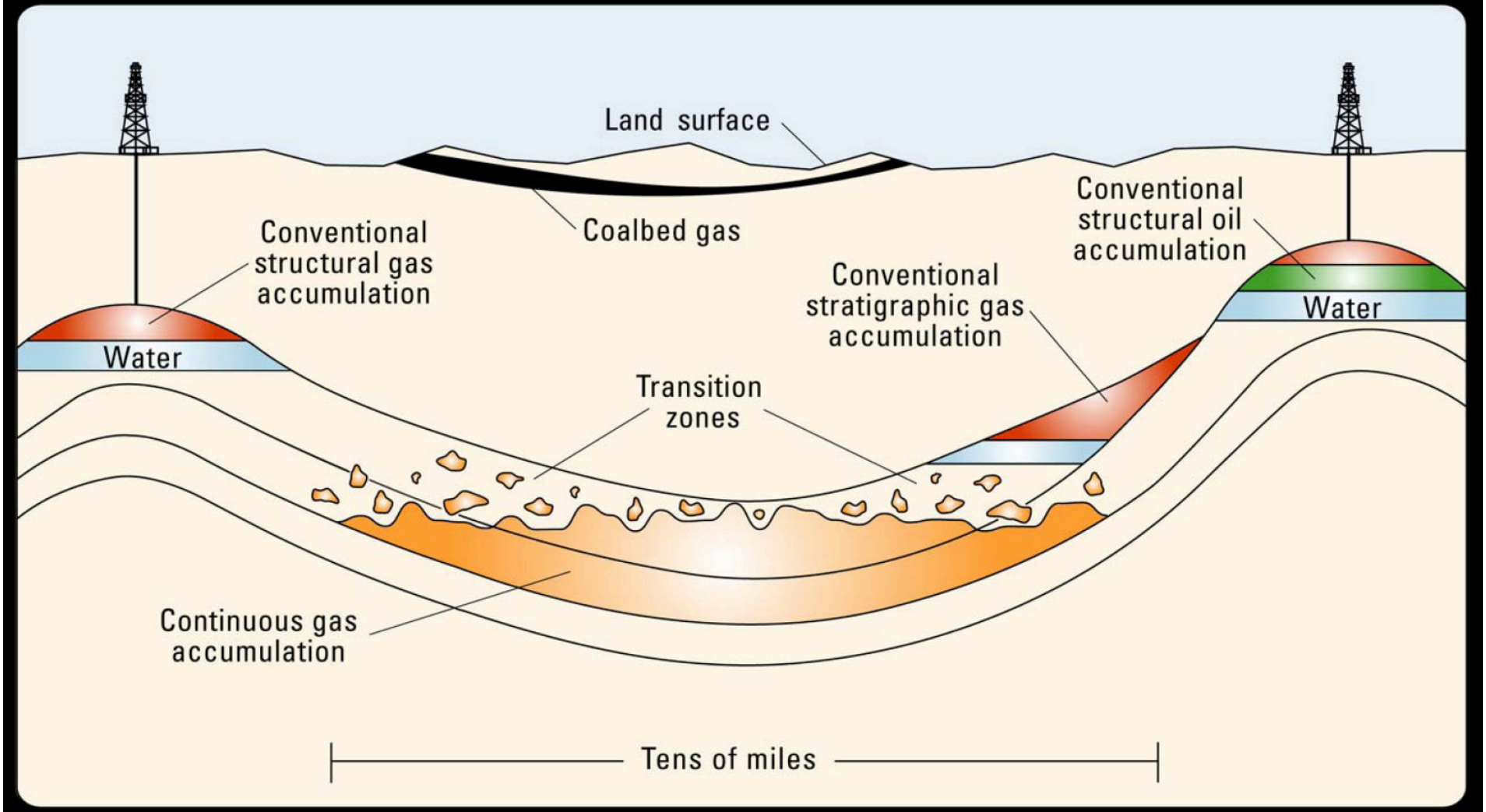
Conventional versus continuous accumulations

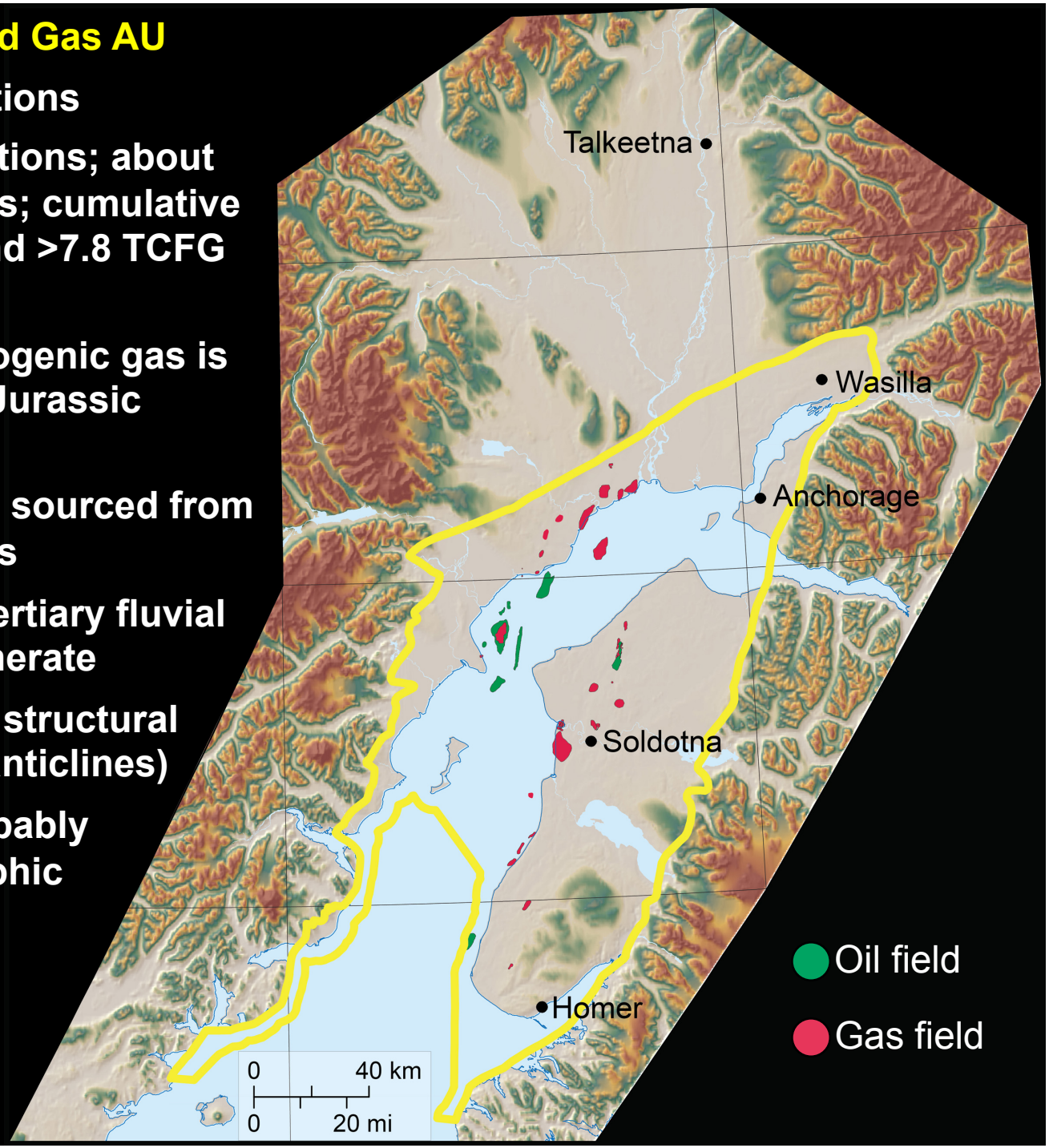


Source: Schenk and Pollastro, 2002

USGS

Tertiary Sandstone Oil and Gas AU

- Conventional accumulations
- About 1200 well penetrations; about 30 known accumulations; cumulative production ~1.3 BBO and >7.8 TCFG to the end of 2010
- Source of oil and thermogenic gas is marine shale in Middle Jurassic Tuxedni Group
- Gas is mostly microbial, sourced from Tertiary nonmarine coals
- Reservoirs are mainly Tertiary fluvial sandstone and conglomerate
- All discovered traps are structural (anticlines and faulted anticlines)
- Undiscovered traps probably structural and stratigraphic



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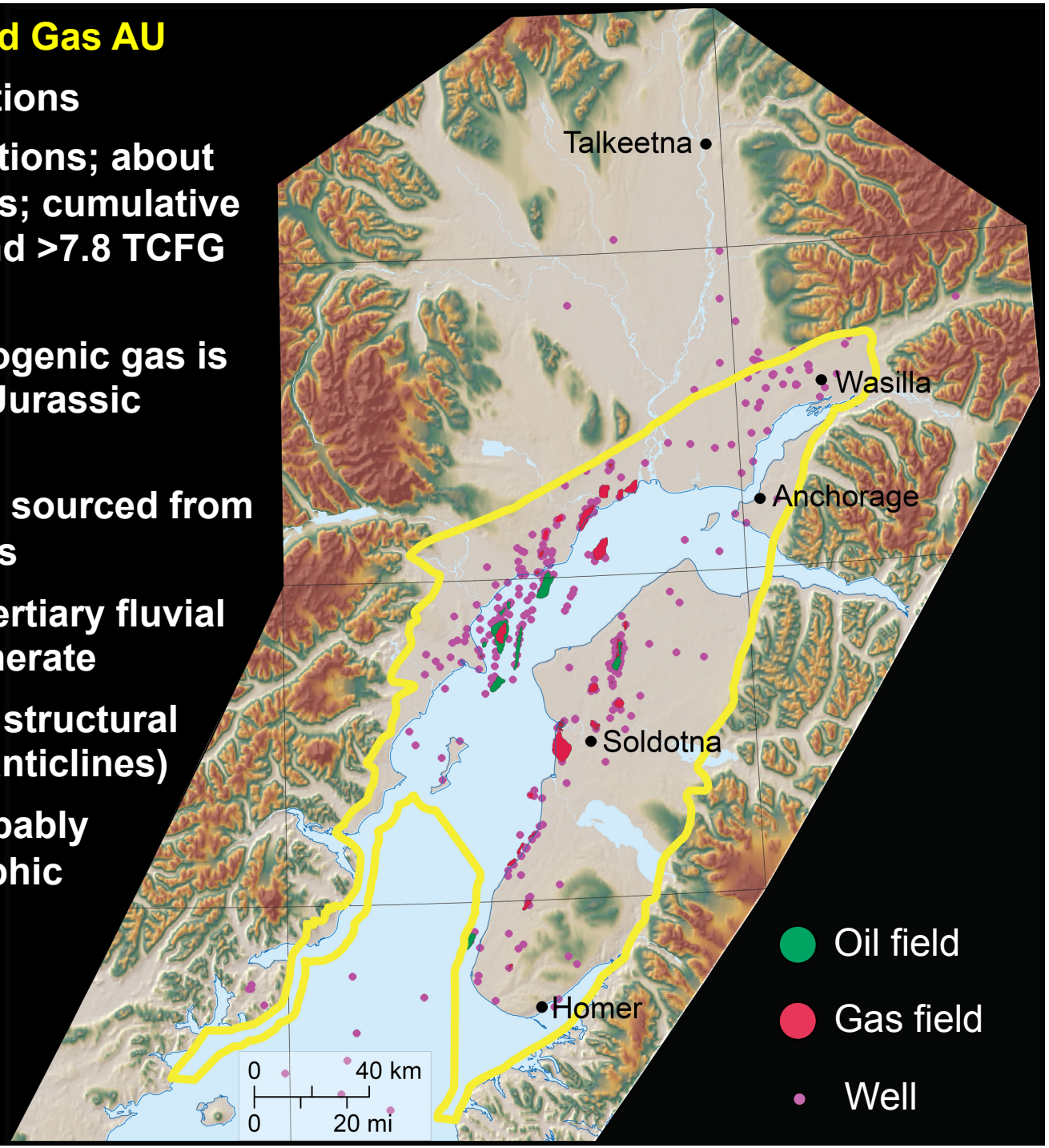
- Undiscovered traps probably structural and stratigraphic
- Underexplored



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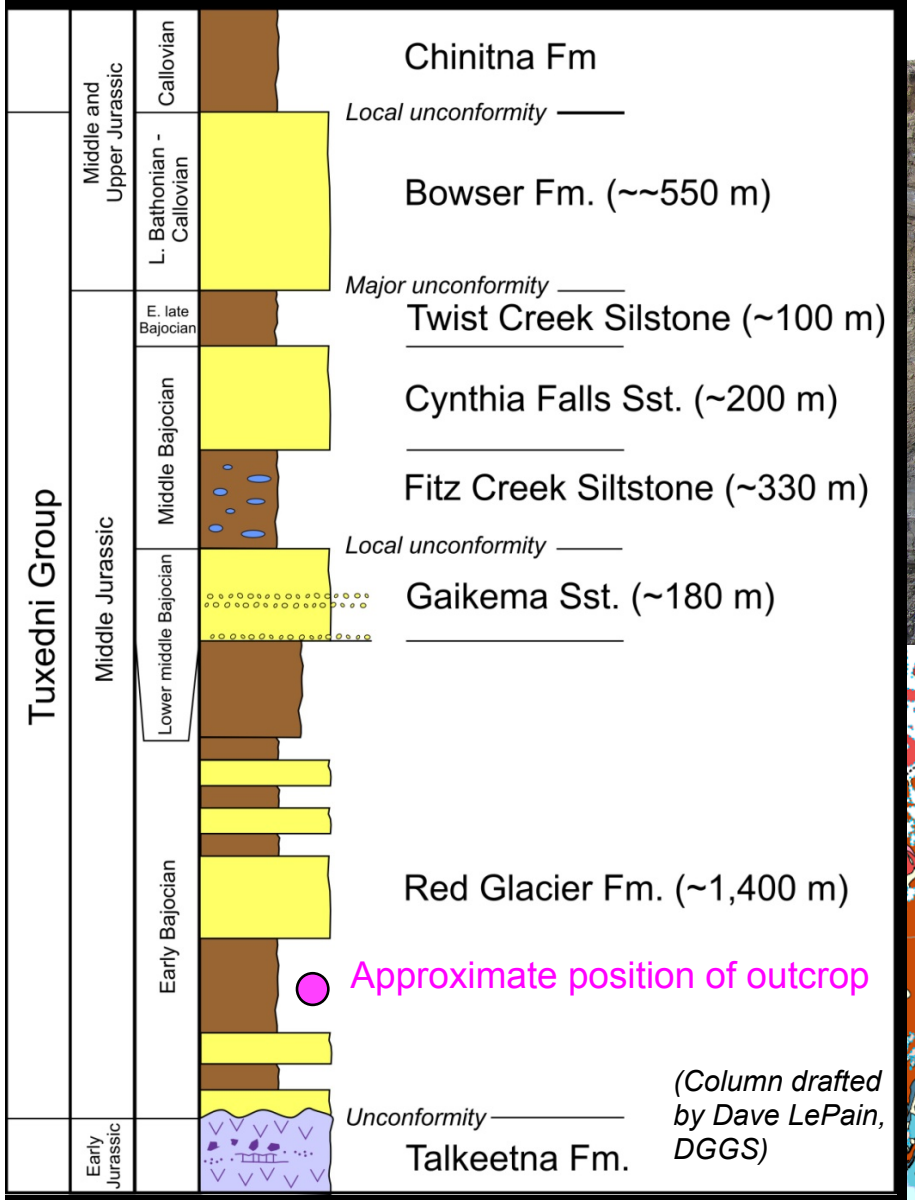
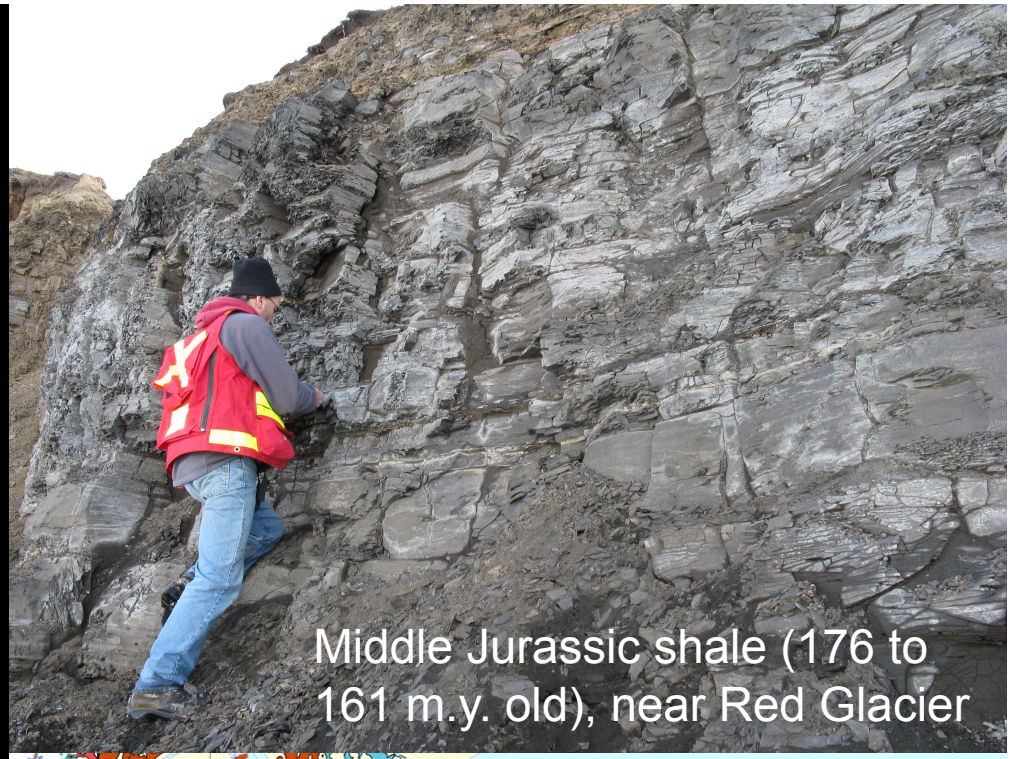
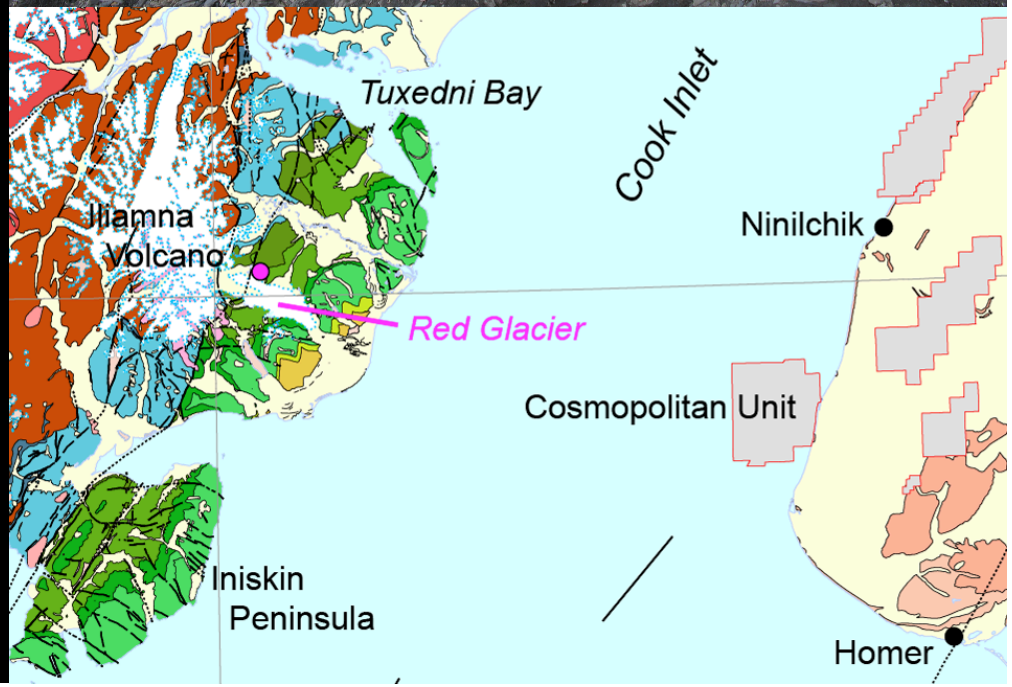
Oil source rocks







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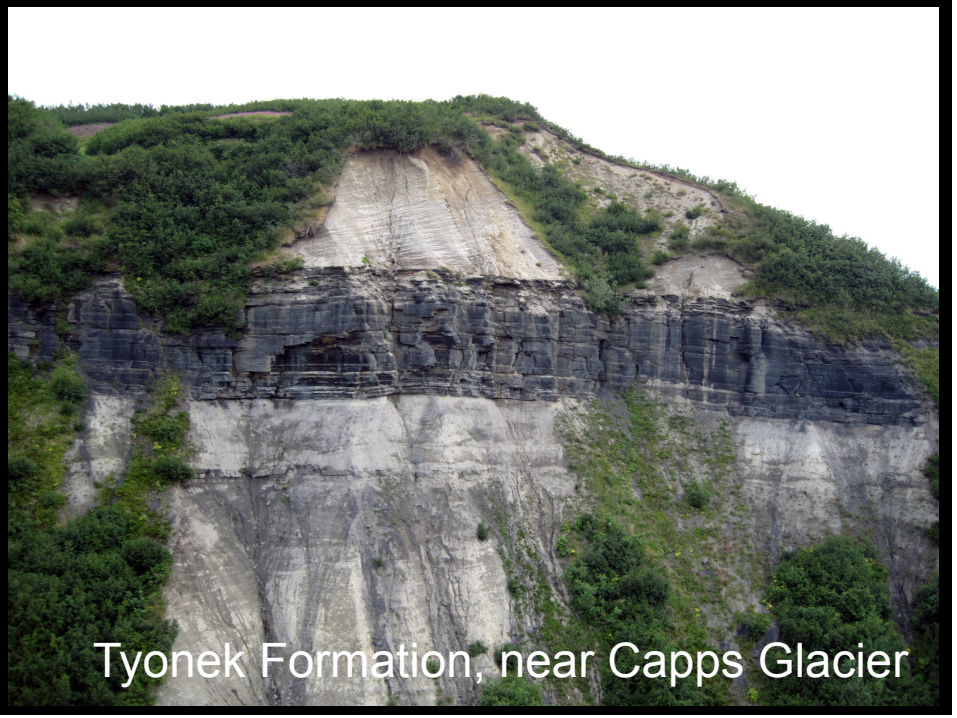
Reservoir rocks, Tertiary Sandstone Oil and Gas AU

Sterling Formation, Clam Gulch

Beluga Formation, west of Homer

Beluga Formation, west of Homer



Tyonek Formation, near Capps Glacier

All discovered fields are on anticlinal structures

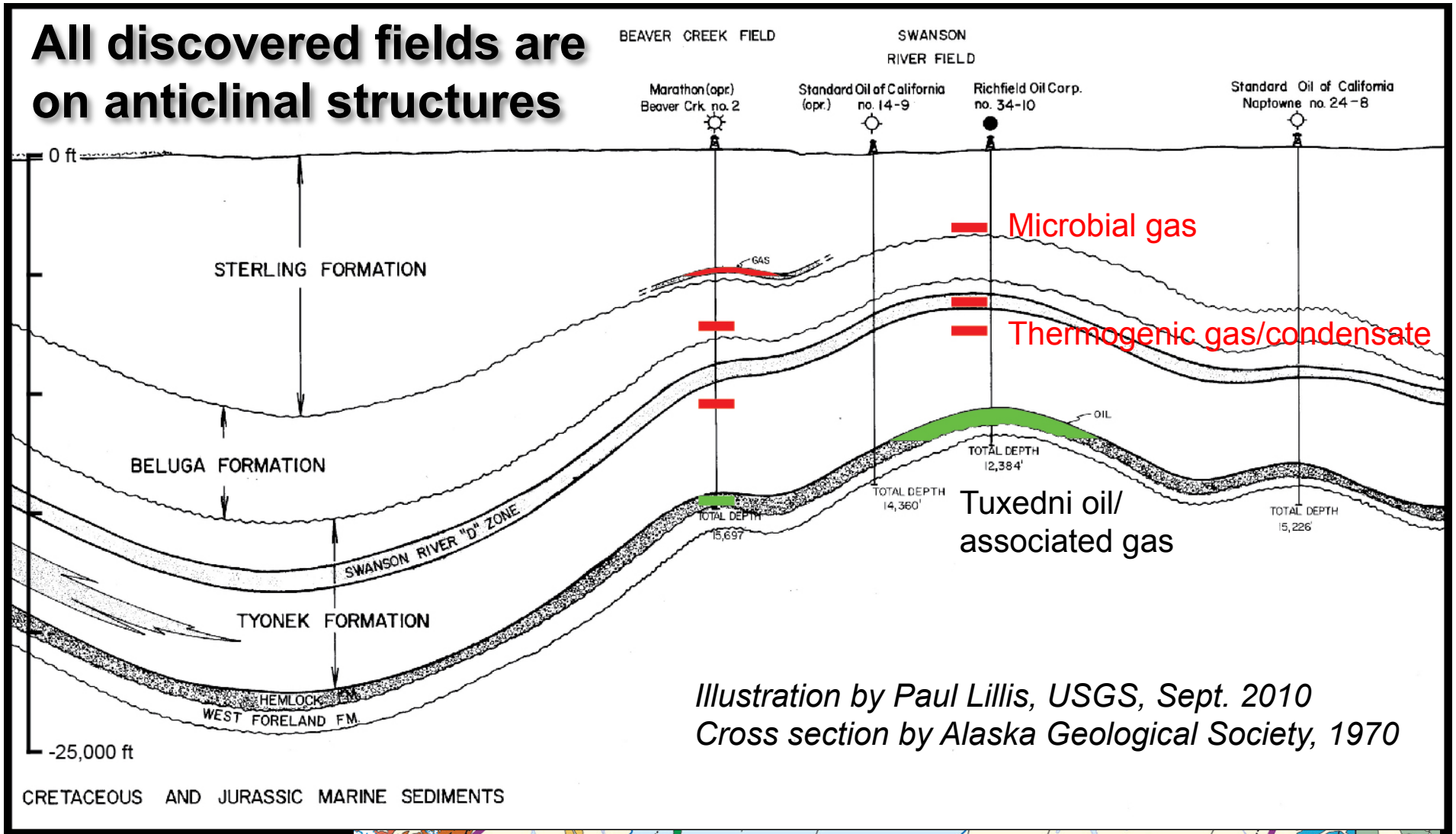
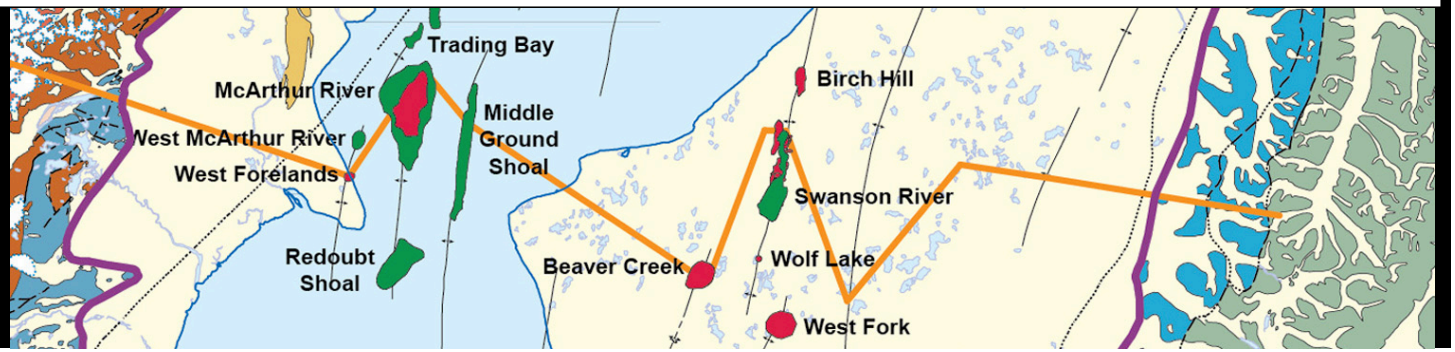


Illustration by Paul Lillis, USGS, Sept. 2010
Cross section by Alaska Geological Society, 1970



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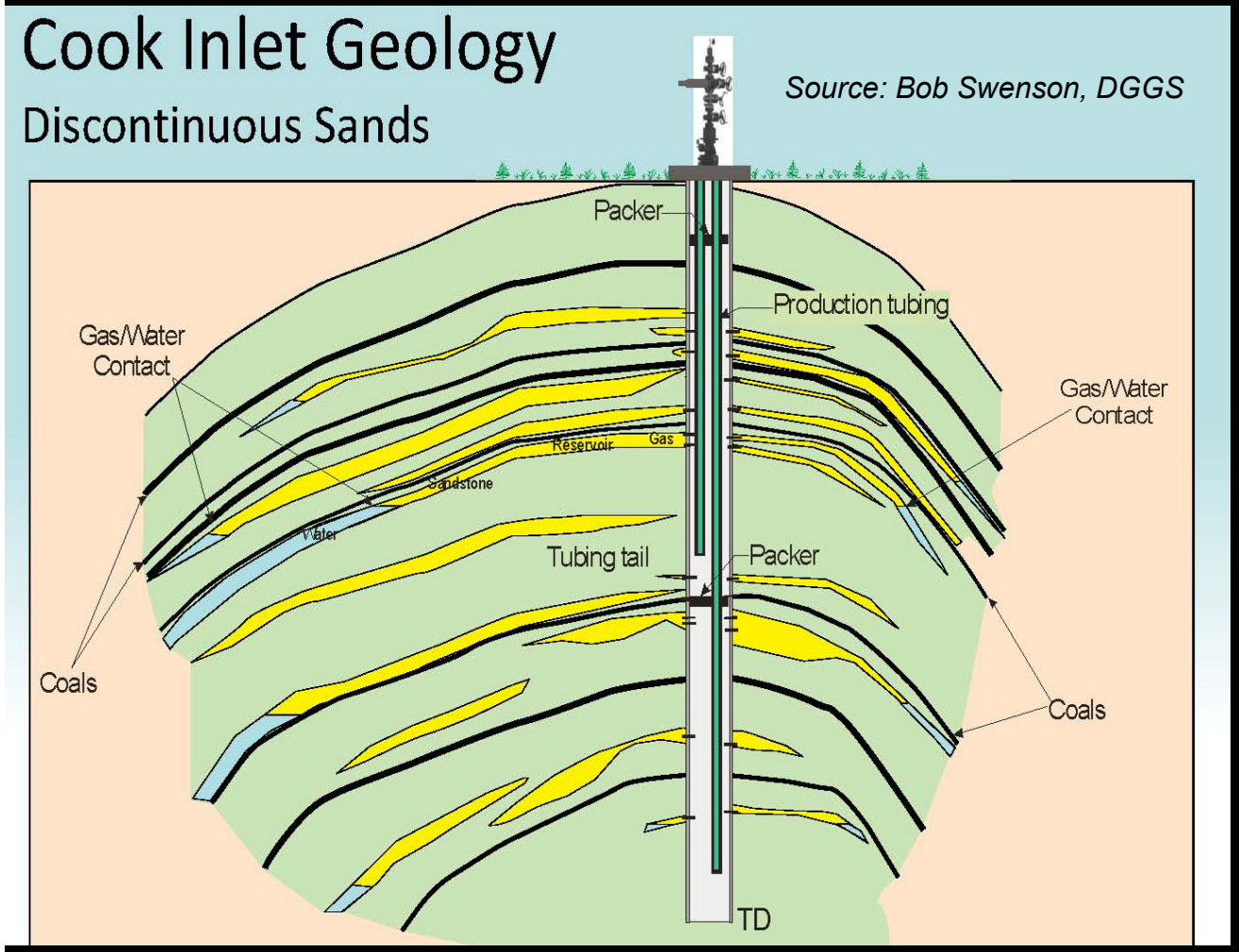
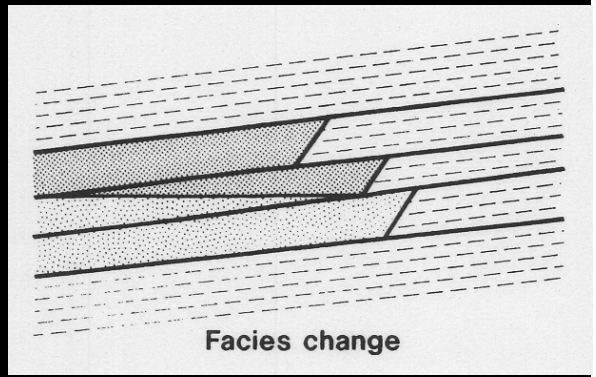
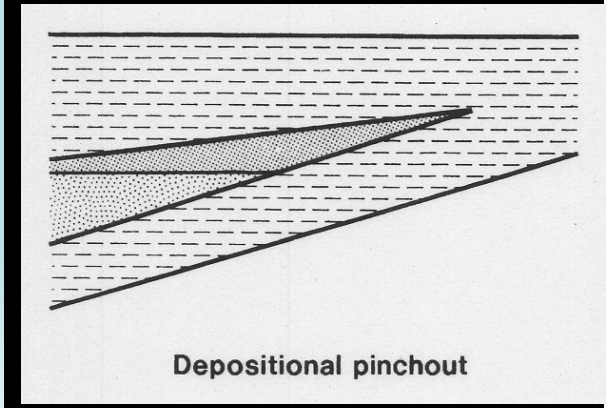
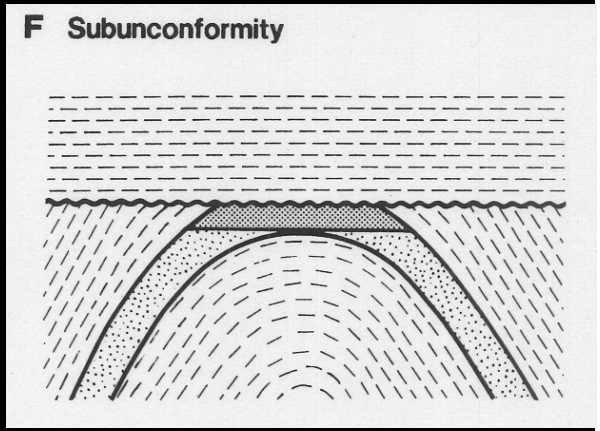
Undiscovered fields probably include stratigraphic and combination traps





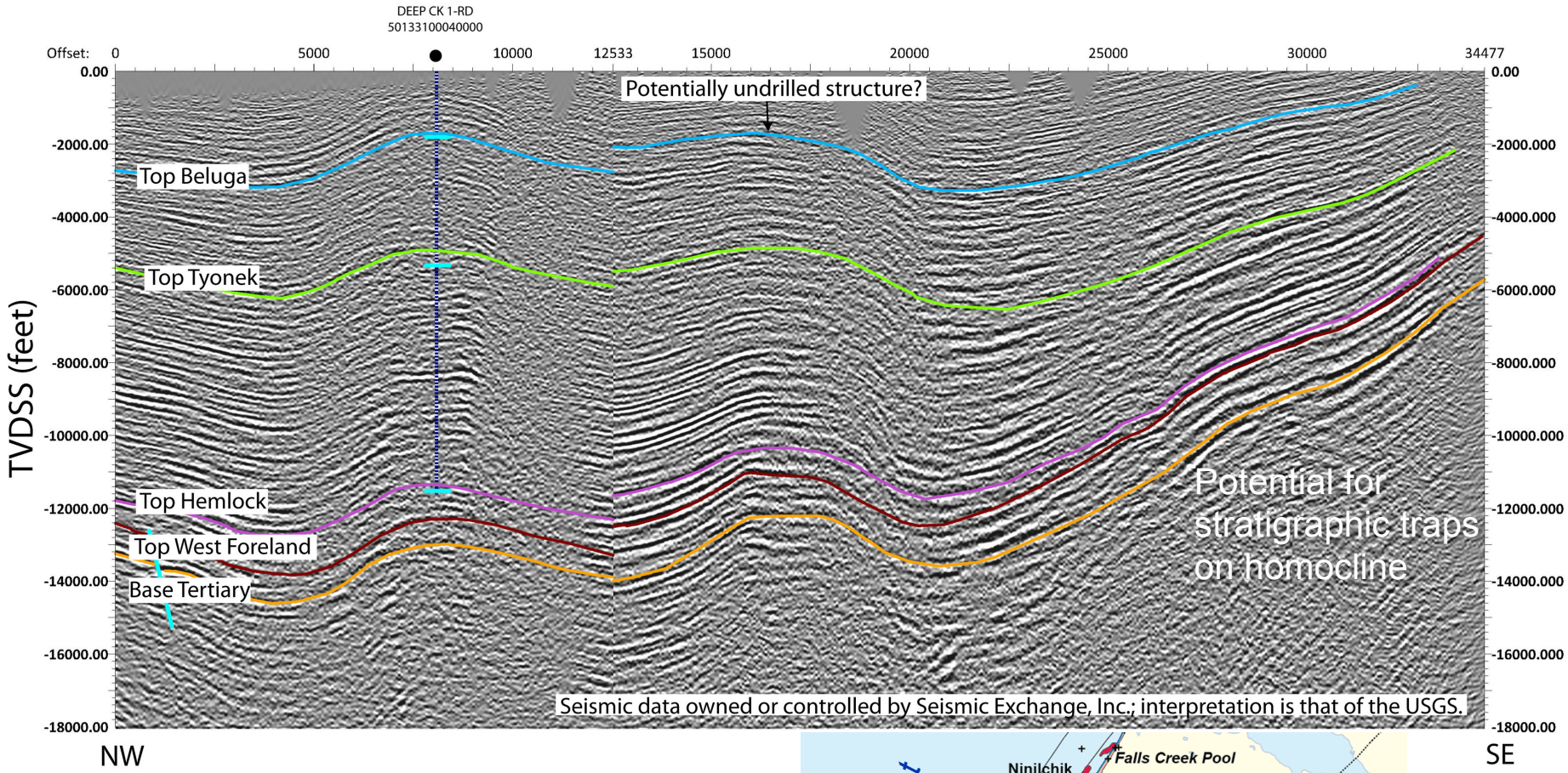




USGS

Source: Biddle and Wielchowsky, 1994, AAPG Memoir 60

Seismic data suggest untested oil and gas potential in the Tertiary Sandstone Oil and Gas AU



Seismic interpretation by Krissy Lewis, USGS

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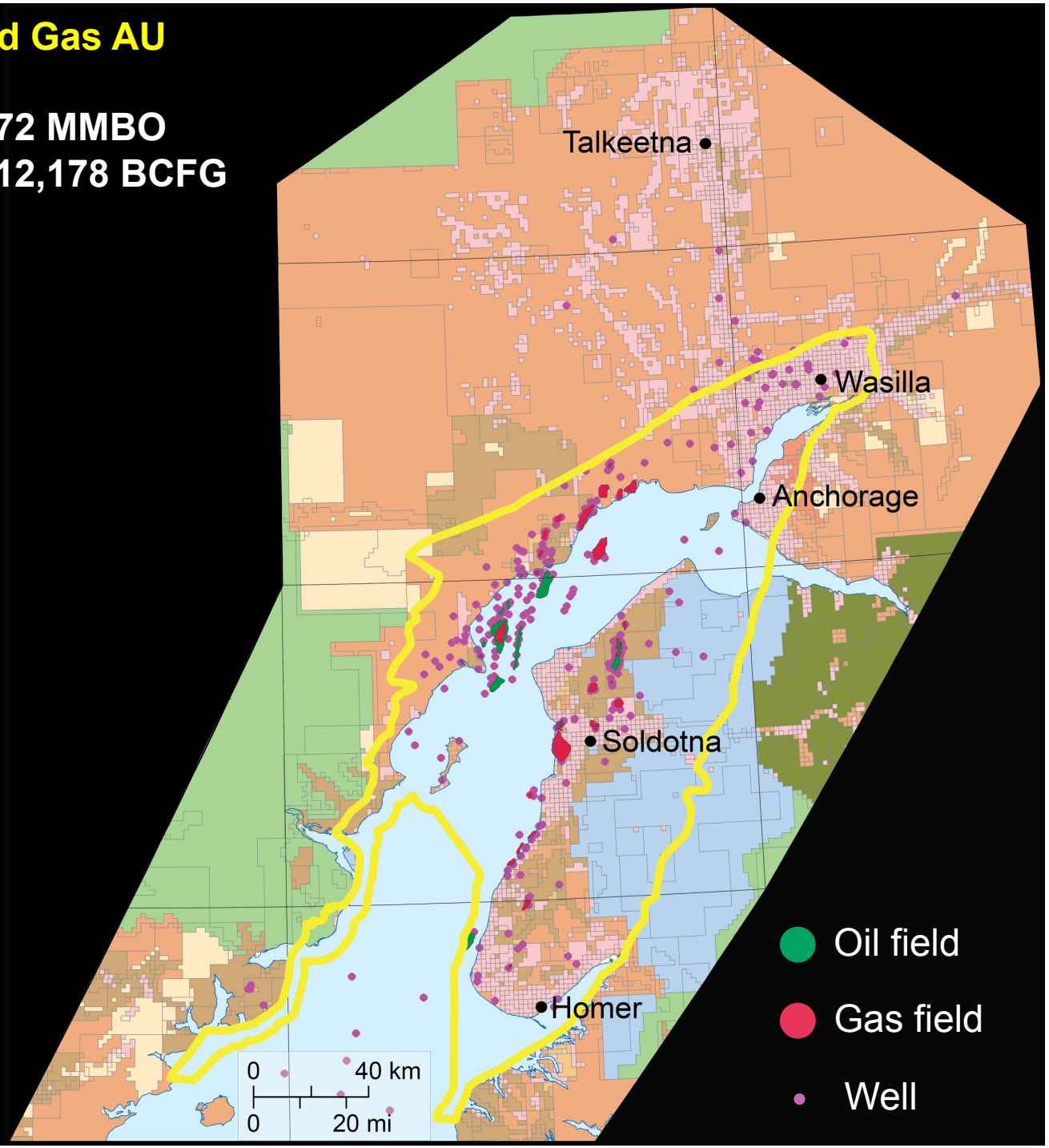
Tertiary Sandstone Oil and Gas AU

Mean undiscovered oil: 372 MMBO
Mean undiscovered gas: 12,178 BCFG

Area ~21,800 km^2
Federal, 21%
Private/municipal, 13%
Native, 8%
State onshore, 27%
State offshore, 31%

- BLM
- USFS
- Military
- NPS
- FWS
- Native
- Private/Municipal
- State
- State & Native



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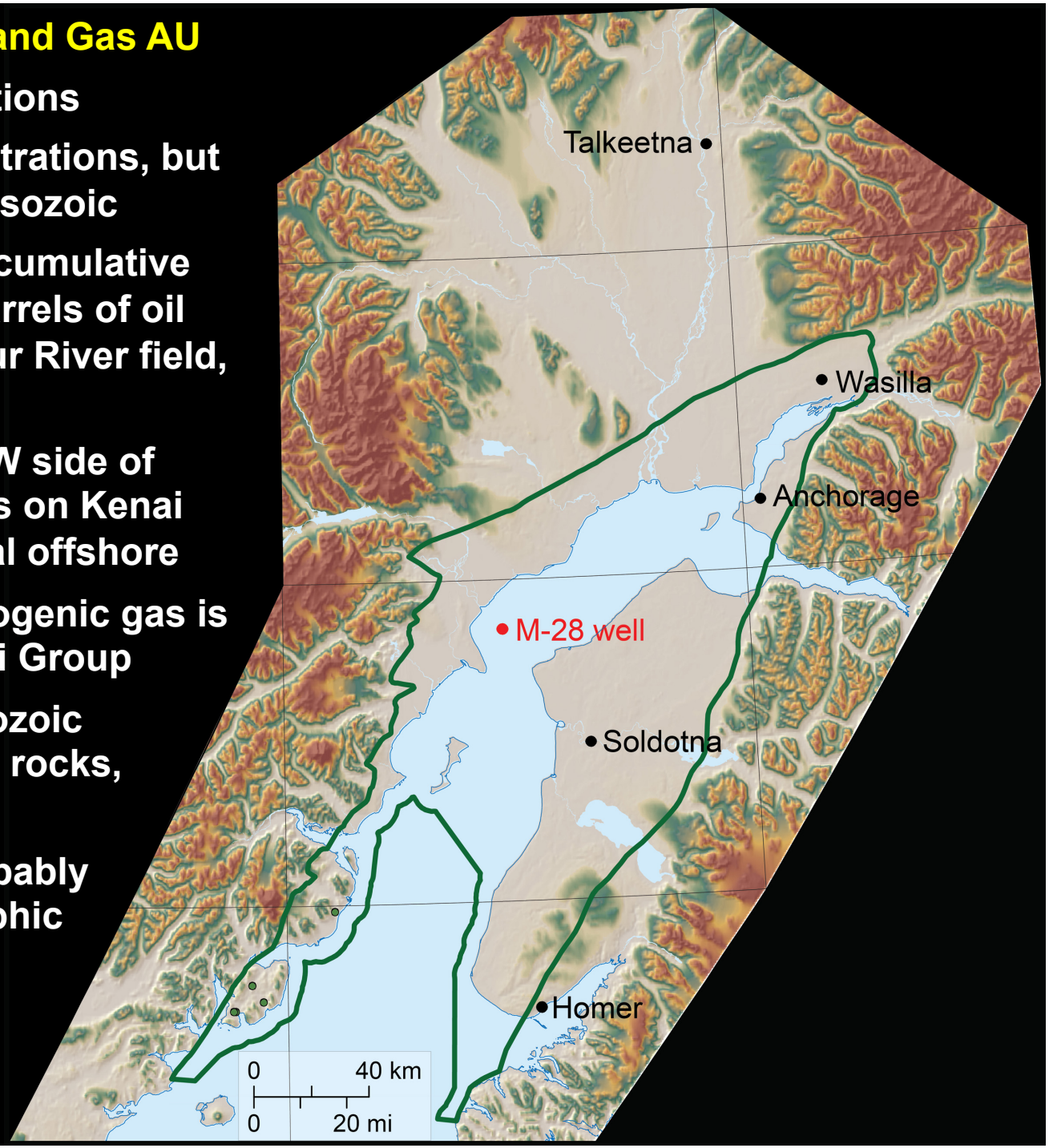
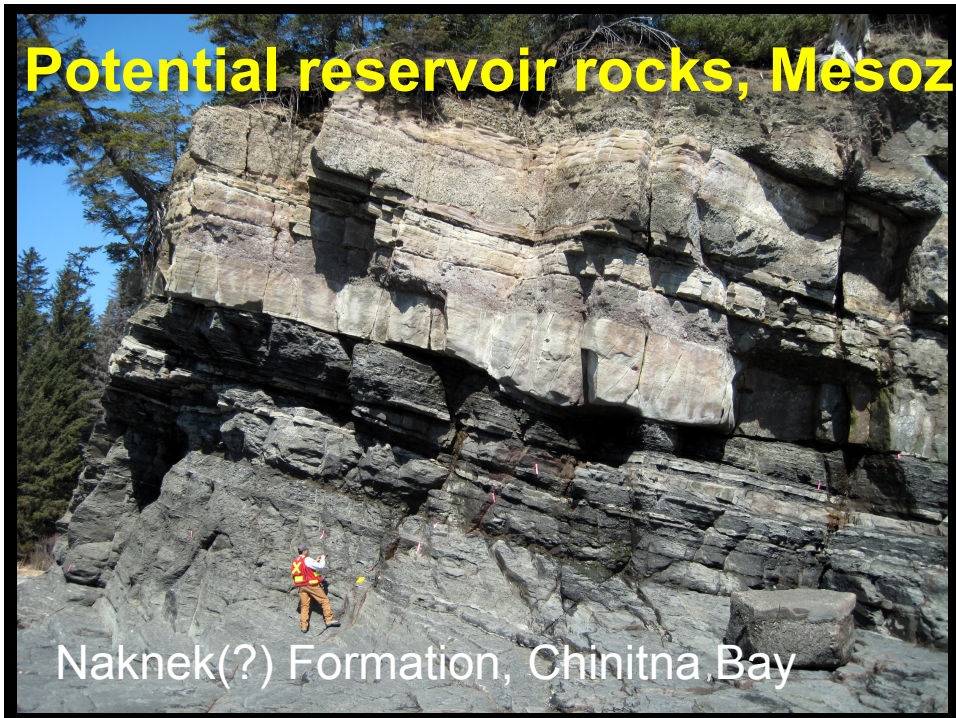
Mesozoic Sandstone Oil and Gas AU

- Conventional accumulations
- More than 100 well penetrations, but few drilled deep into Mesozoic
- 1 oil accumulation with cumulative production ≤ 332,951 barrels of oil from M-28 well, McArthur River field, 1990-1999
- Oil seeps onshore on SW side of basin; oil shows in wells on Kenai Peninsula and in Federal offshore
- Source of oil and thermogenic gas is Middle Jurassic Tuxedni Group
- Reservoirs may be Mesozoic sandstone and volcanic rocks, fractured
- Undiscovered traps probably structural and stratigraphic
- Mostly unexplored



USGS

Potential reservoir rocks, Mesozoic Sandstone Oil and Gas AU

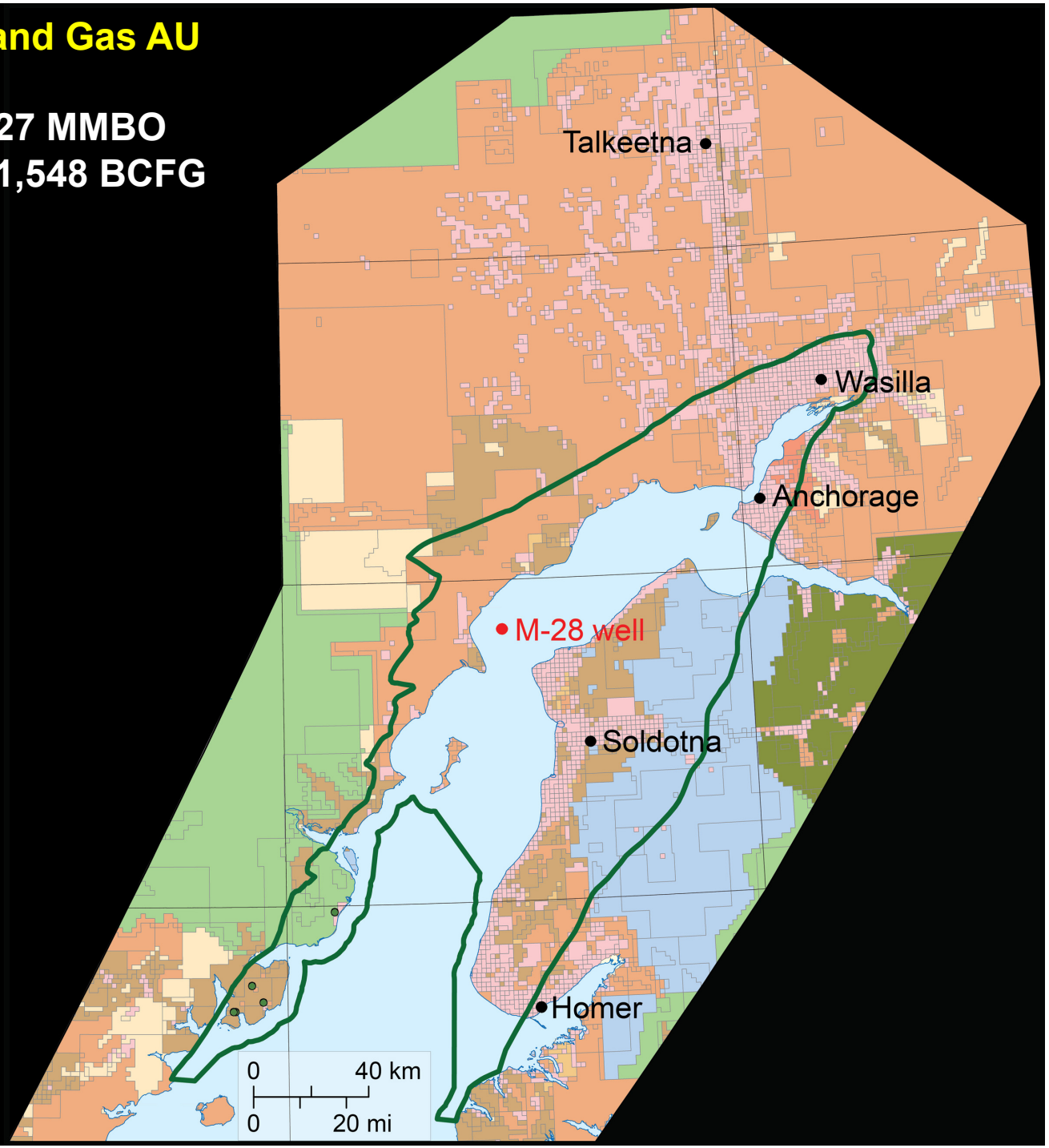


Mesozoic Sandstone Oil and Gas AU

Mean undiscovered oil: 227 MMBO
Mean undiscovered gas: 1,548 BCFG

Area ~20,100 km^2
Federal, 21%
Private/municipal, 11%
Native, 10%
State onshore, 26%
State offshore, 31%

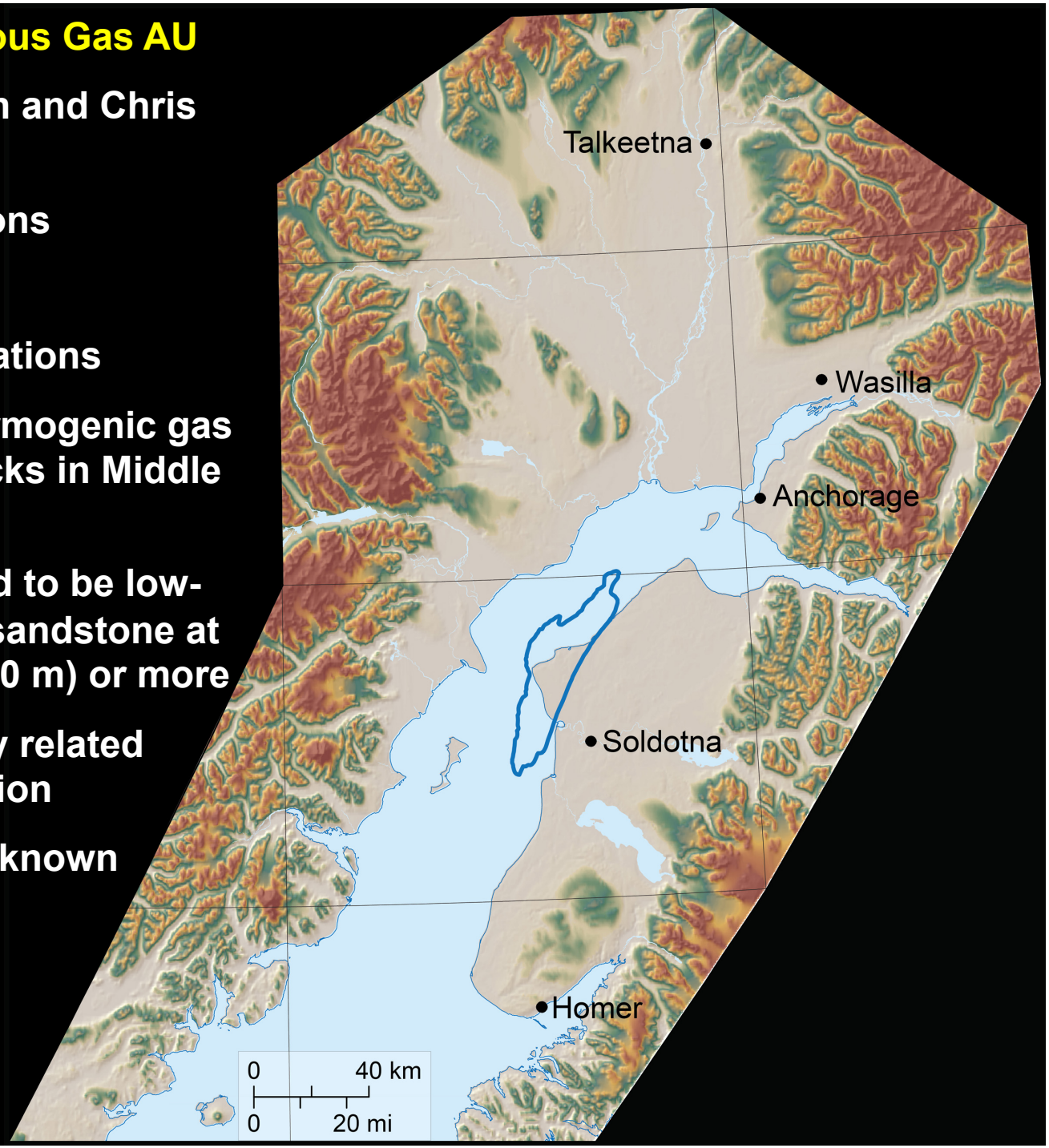
- BLM
- USFS
- Military
- NPS
- FWS
- Native
- Private/Municipal
- State
- State & Native



USGS

Tuxedni-Naknek Continuous Gas AU

- Proposed by Phil Nelson and Chris Schenk, USGS, Denver
- Continuous accumulations
- Speculative
- No discovered accumulations
- Inferred resource is thermogenic gas derived from source rocks in Middle Jurassic Tuxedni Group
- Reservoirs hypothesized to be low-permeability Mesozoic sandstone at depths of 20,000 ft (6,000 m) or more
- Overpressured, possibly related to hydrocarbon generation
- Entirely unexplored (no known well penetrations)



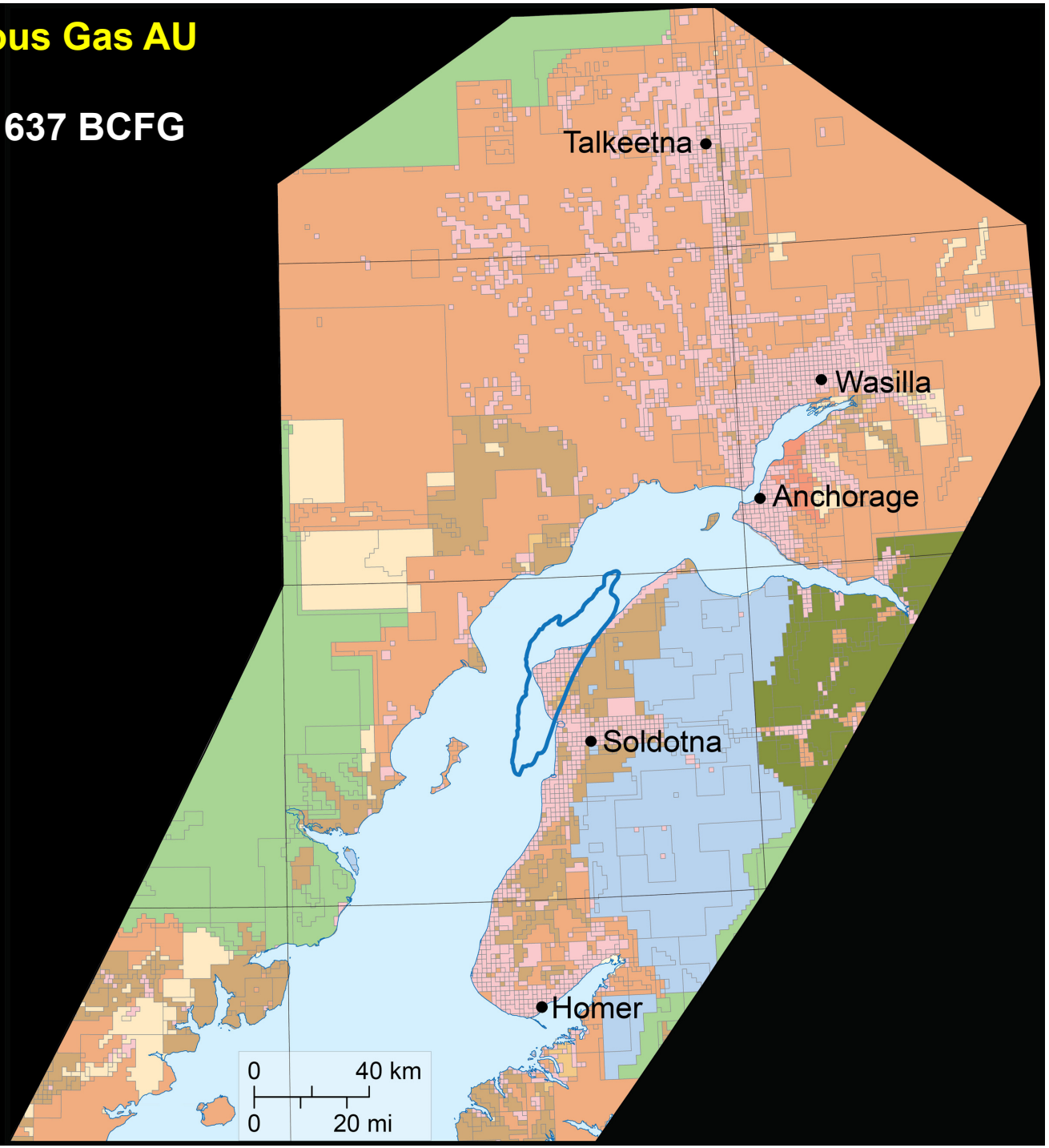
USGS

Tuxedni-Naknek Continuous Gas AU

Mean undiscovered gas: 637 BCFG

Area ~900 km^2
Federal, 1%
Private/municipal, 20%
Native, 5%
State onshore, 2%
State offshore, 72%

- BLM
- USFS
- Military
- NPS
- FWS
- Native
- Private/Municipal
- State
- State & Native



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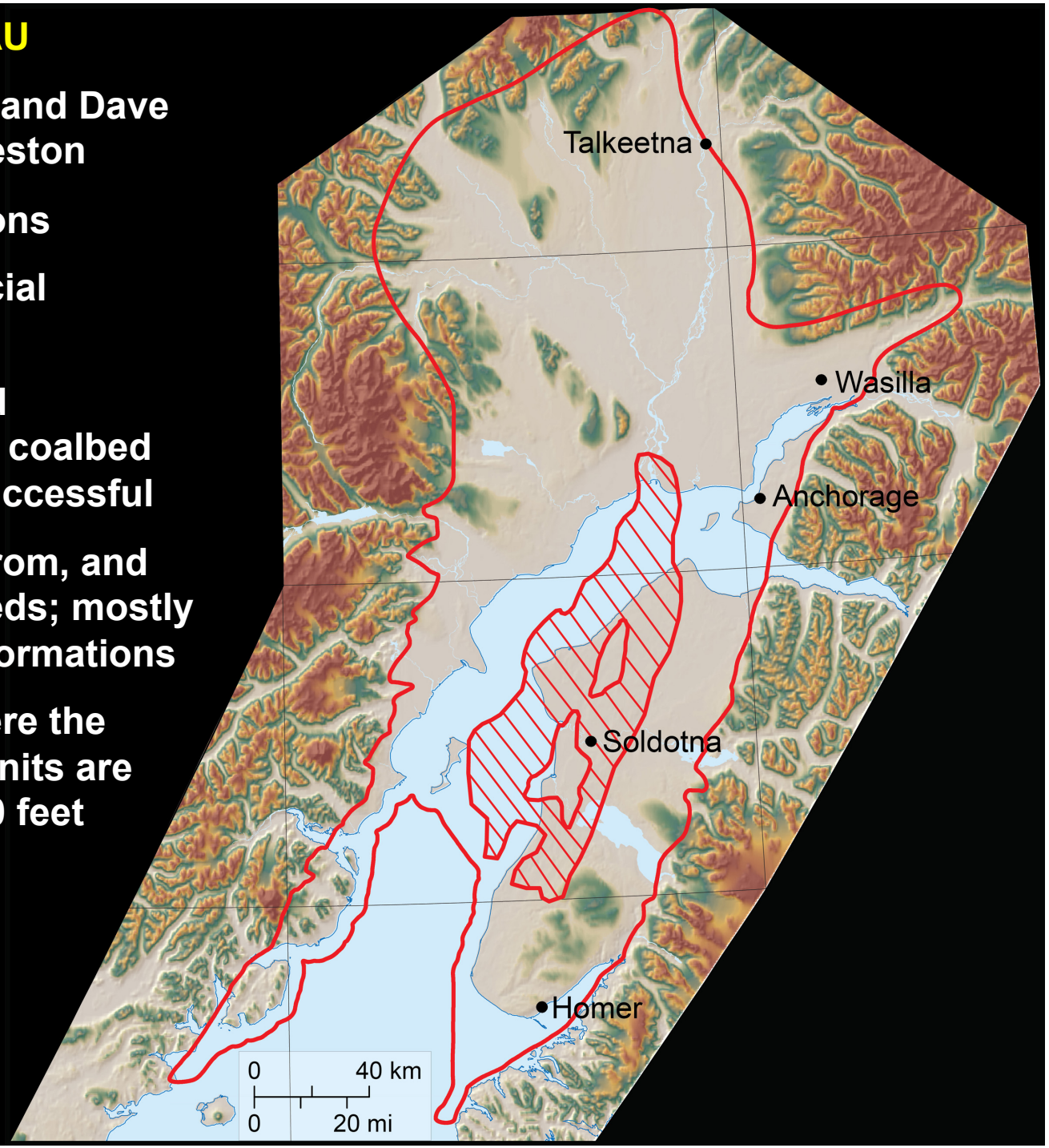
Cook Inlet Coalbed Gas AU

- Proposed by Bill Rouse and Dave Houseknecht, USGS, Reston
- Continuous accumulations
- No discovered commercial accumulations
- About 20-25 wells drilled specifically in search of coalbed gas, 1994-2005, all unsuccessful
- Microbial gas sourced from, and trapped in, thick coal beds; mostly in Beluga and Tyonek Formations
- Excluded is an area where the principal coal-bearing units are buried deeper than 6000 feet
- Mostly unexplored



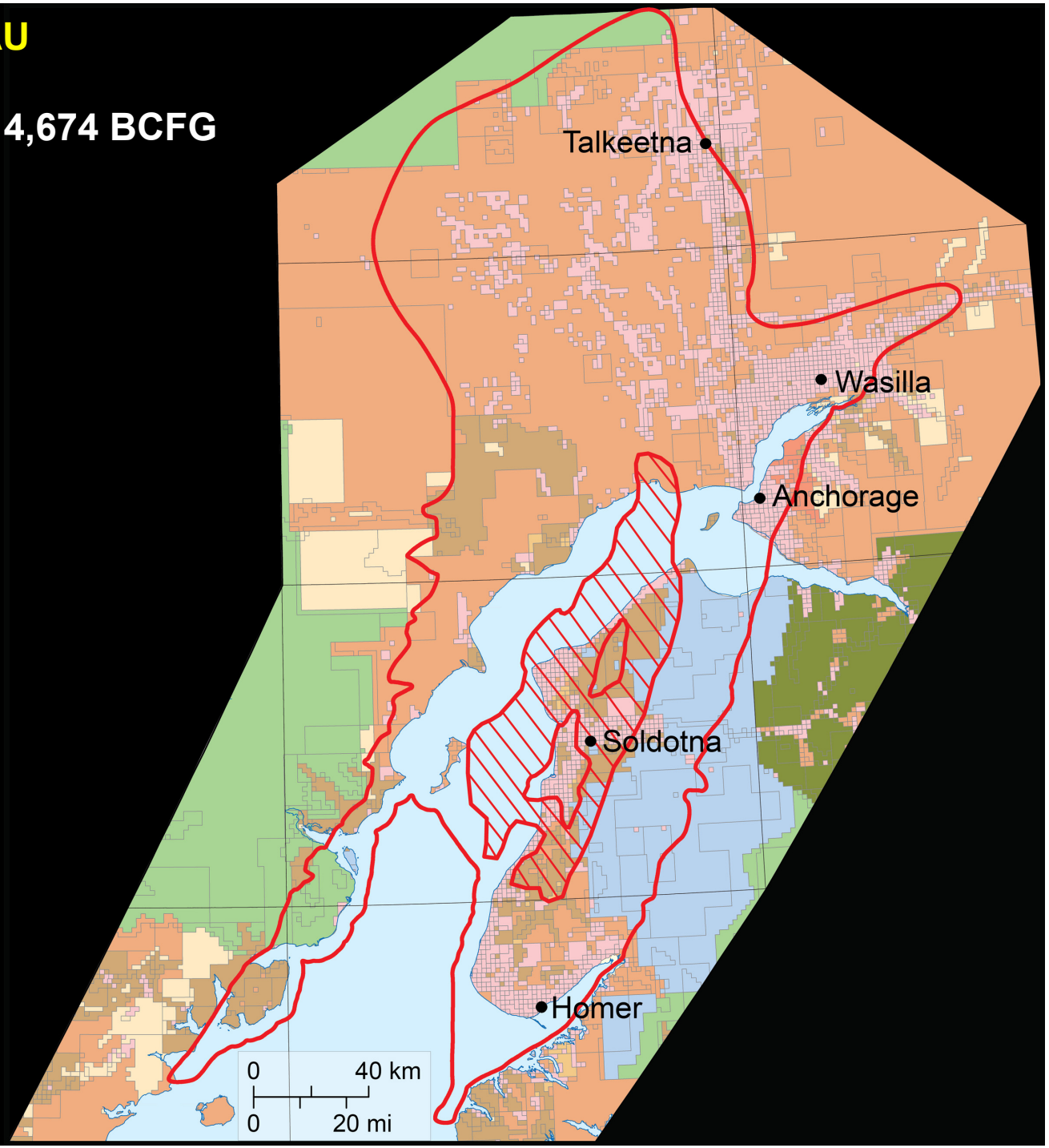
USGS

Cook Inlet Coalbed Gas AU

Mean undiscovered gas: 4,674 BCFG

Area ~34,300 km^2
Federal, 14%
Private/municipal, 8%
Native, 8%
State onshore, 56%
State offshore, 14%

- BLM
- USFS
- Military
- NPS
- FWS
- Native
- Private/Municipal
- State
- State & Native



USGS

SUMMARY

- The USGS has completed an assessment of the volumes of undiscovered, technically recoverable oil and gas resources in conventional and continuous accumulations in Cook Inlet.

- The assessment used a geology-based methodology and results from new scientific research by the USGS and the State of Alaska DGGS and DOG.

- In the Cook Inlet region, the USGS estimates mean undiscovered volumes of nearly 600 million barrels of oil, about 19 trillion cubic feet of gas, and about 46 million barrels of natural gas liquids.

USGS

For Additional Information:

Cook Inlet assessment fact sheet available at

http://pubs.usgs.gov/fs/2011/3068/

Other USGS petroleum fact sheets available at

http://energy.usgs.gov/

Other inquiries may be directed to

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USGS

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