

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

Presented by:

**Jared T. Gooley – Alaska Basins and Petroleum System Project Co-Lead
U.S. Geological Survey, Alaska Science Center (Anchorage)**

2011 Assessment briefing originally presented by:

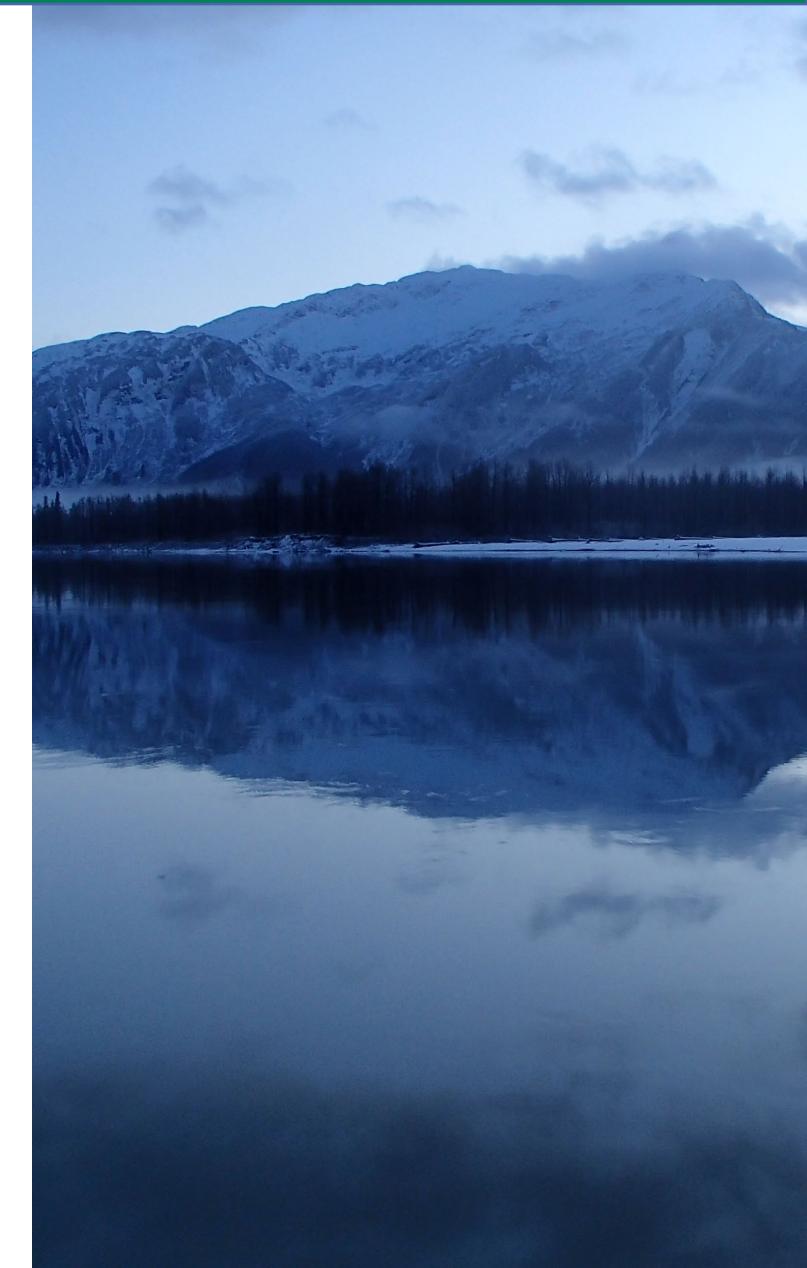
Richard G. Stanley, Brenda S. Pierce, and David W. Houseknecht

The USGS is the science arm of the Department of the Interior

We aim to lead the Nation in 21st-century integrated research, assessments, and prediction of natural processes and resources to meet challenges with actionable information.

- Energy & Minerals
- Natural Hazards
- Computation and Mapping
- Water
- Ecosystems

The Alaska Basins and Petroleum System Project seeks to further our knowledge of energy resources and support decisionmakers considering future development.

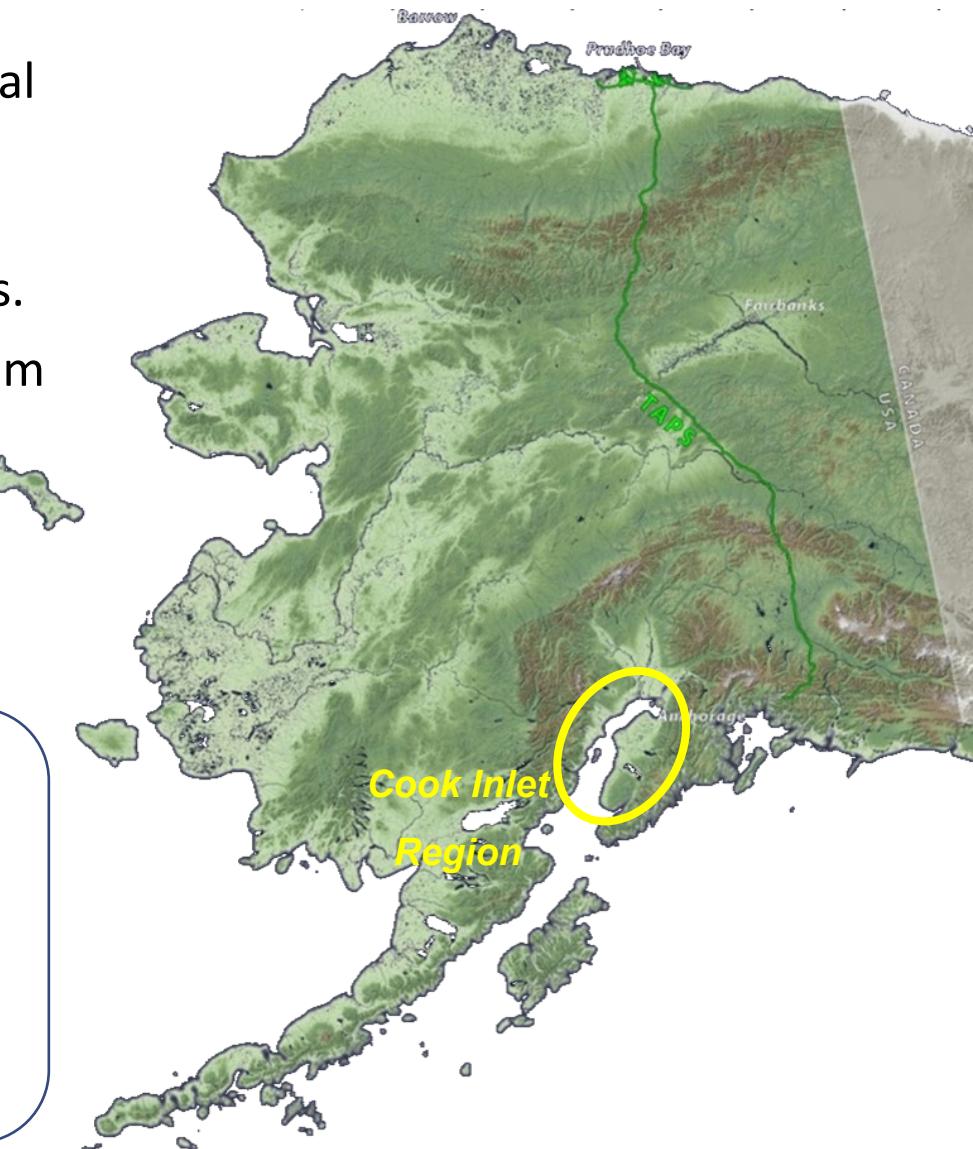


Overall Project Objectives

- Conduct research that increases our understanding of the geological framework of Alaska sedimentary basins and their significance to energy resources.
- Conduct assessments of undiscovered oil and natural gas resources.
- Investigate relationships between natural carbon burial in petroleum source rocks and peak global greenhouse climate conditions.
- Deliver energy resource information to land and resource managers, policy makers, and the public.

Presentation Outline

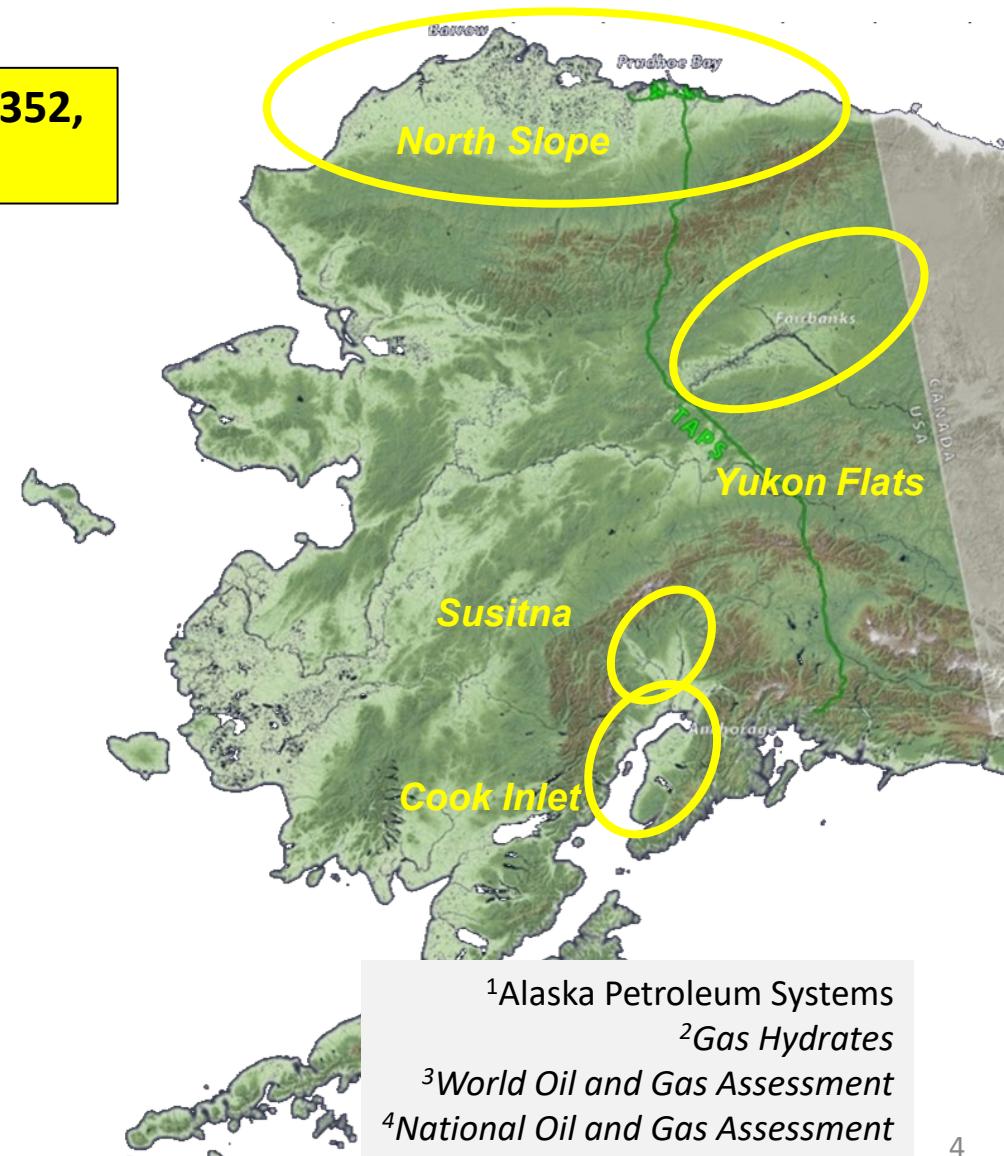
- Summary of 2011 Cook Inlet assessment results
- Methods used by the 2011 assessors
- Results by 2011 Assessment Unit and Land Ownership
- Future anticipated USGS energy resource assessments in Alaska.



Recent Alaska Energy Resource Assessments:

- 2021 – Gas: Western North Slope¹
- 2020 – Oil & Gas: Central North Slope¹
- 2018 – Oil & Gas: Susitna Basin, southern Alaska¹
- 2018 – *Gas Hydrates: North Slope*²
- 2017 – Oil & Gas: National Petroleum Reserve–Alaska¹
- 2015 – *Unconventional Gas: Upper Cook Inlet Basin*¹
- 2012 – Oil & Gas: Shale source rocks, North Slope Arctic Alaska¹
- 2011 – Oil & Gas: Cook Inlet Region Fact Sheet¹
- 2010 – Oil & Gas: National Petroleum Reserve–Alaska¹
- 2008 – *Gas Hydrates, North Slope*²
- 2008 – *Oil & Gas: Circum-Arctic Resource Appraisal*³
- 2006 – *Coalbed Methane: Northern Alaska*⁴
- 2005 – Oil & Gas: Central North Slope¹
- 2003 – Gas: Yukon Flats¹

**U.S. Sec. Order 3352,
2017–2021**



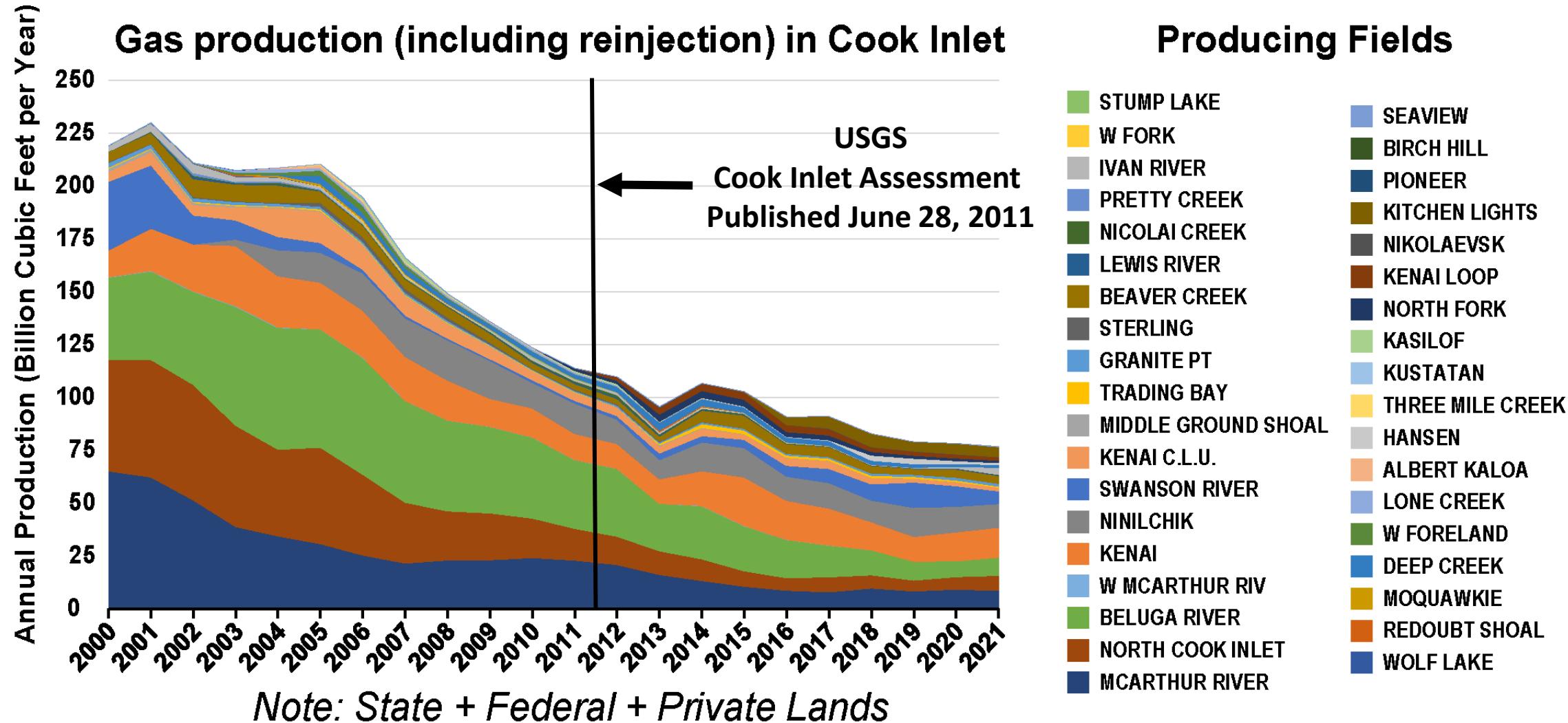
In 2011 the USGS estimated undiscovered, technically recoverable resources in onshore & State waters of Cook Inlet

Estimate range (min to max) and mean volumes:

- Oil: Range of 108 to 1,359 million barrels; mean 599 million barrels
- Gas: Range of 4,976 to 39,737 billion cubic feet; mean 19,037 billion cubic feet
- Natural Gas Liquids: Range of 6 to 121 million barrels; mean of 46 million barrels

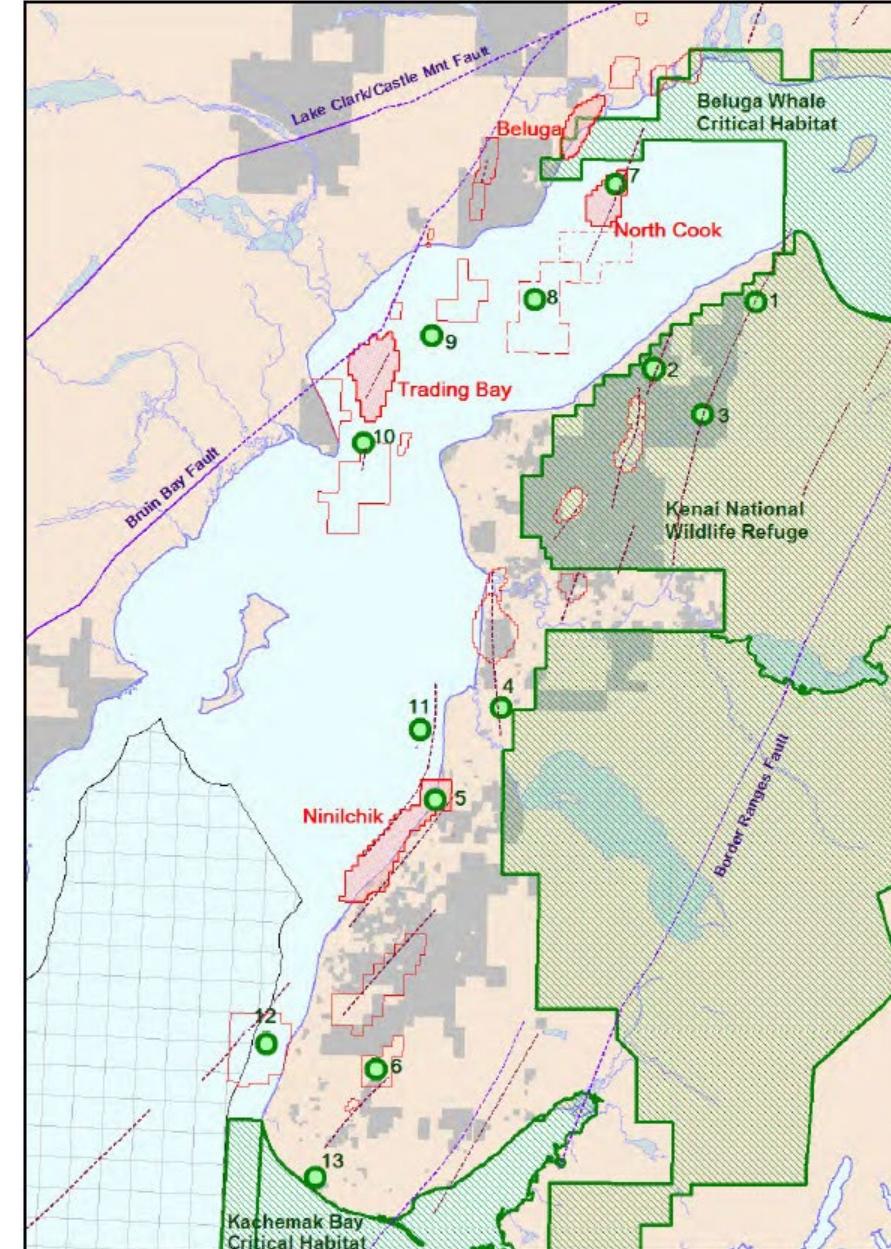
Technically recoverable resources are those resources that can be discovered and produced using current technology.

Min represents a *95 percent chance of at least the amount shown.*
Max represents a *5 percent chance of at least the amount shown.*

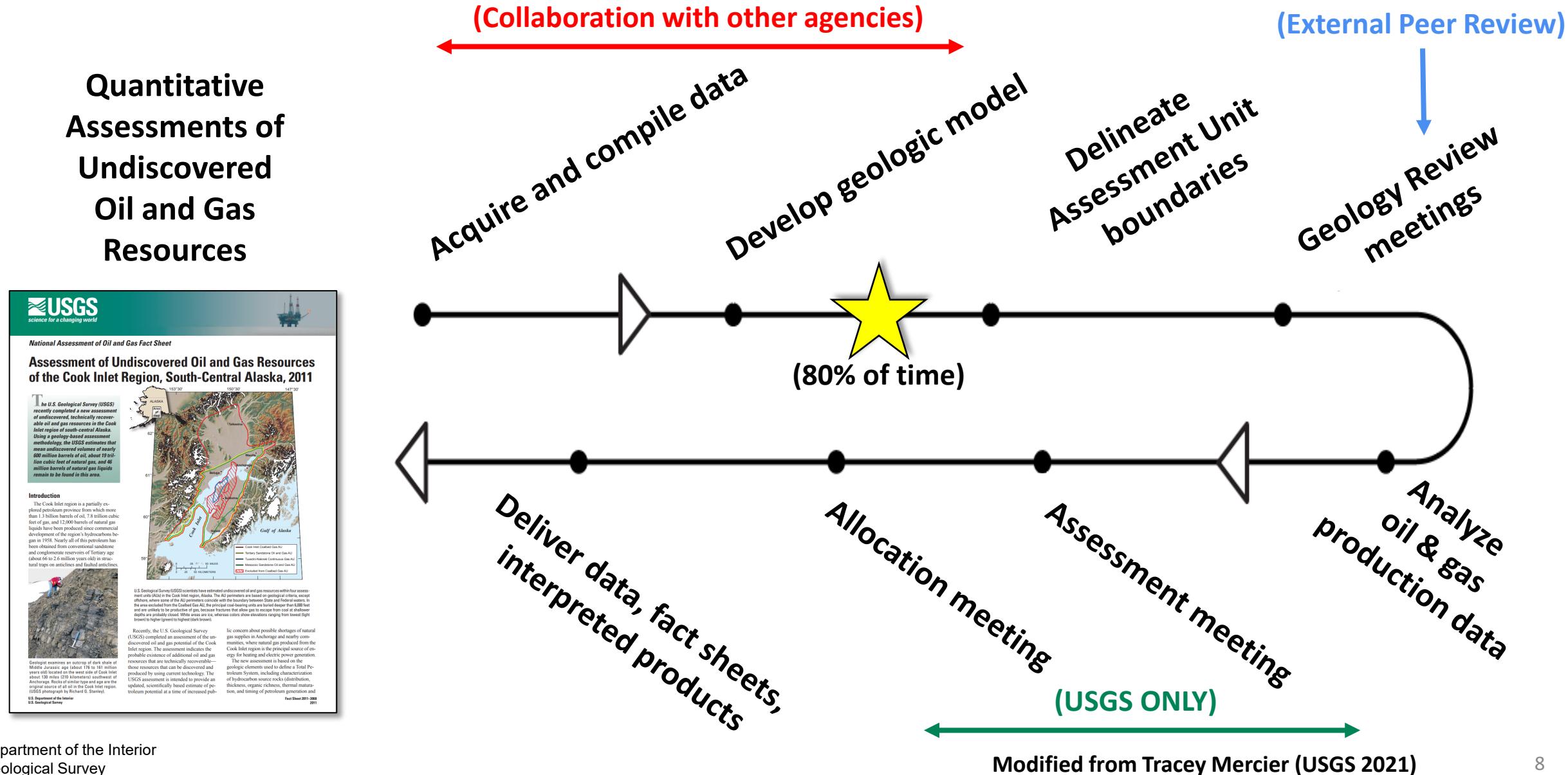


Context 2: USGS estimates are *Technically Recoverable*

- Some of the undiscovered oil and gas resources assessed by the USGS may not be accessible nor economically viable
- *For example, on this map from Hartz and others (2009), green shading shows areas with restrictions to exploration access*



Current USGS Assessment Workflow



U.S. Geological Survey Input-Data Form and Operational Procedure for the Assessment of Conventional Petroleum Accumulations

By T.R. Klett, James W. Schmoker, and Ronald R. Charpentier

Chapter 20 of
Petroleum Systems and Geologic Assessment of Oil and Gas in the Southwestern Wyoming Province, Wyoming, Colorado, and Utah

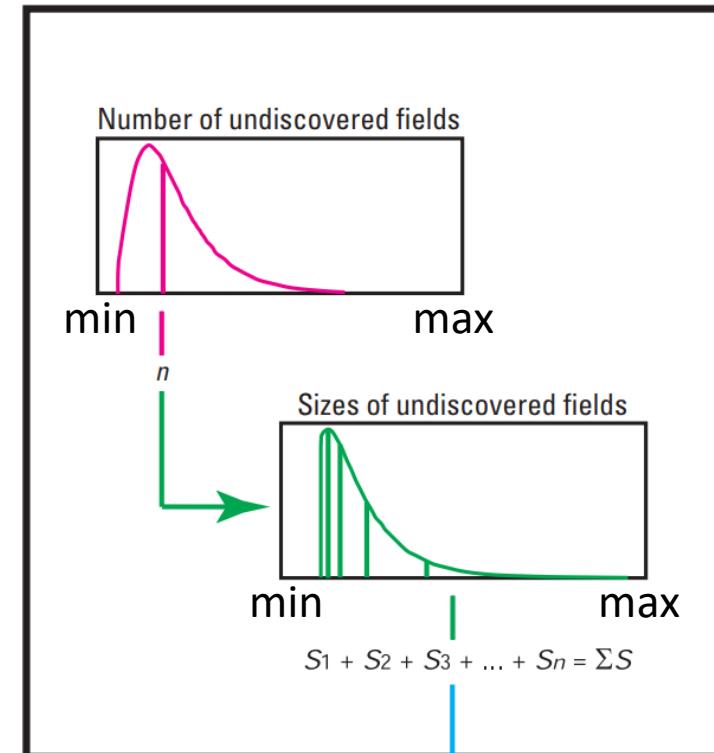
By USGS Southwestern Wyoming Province Assessment Team

U.S. Geological Survey Digital Data Series DDS-69-D

National Oil and Gas Assessment
Conventional & Continuous
Methodology Documents:

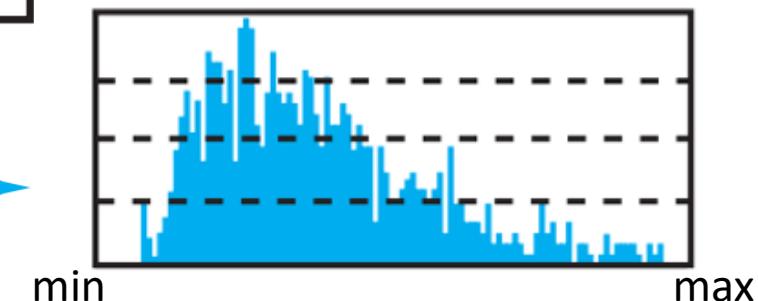
<https://www.usgs.gov/centers/central-energy-resources-science-center/science/united-states-assessments-undiscovered-oil#overview>

Subjected to rigorous review by non-Federal panels



Monte Carlo
Simulation for the
Assessment of
Undiscovered
Resources

Forecast of undiscovered resource



Results: Mean, F95, F50, F5

Collaborators and Contributors for 2011 Cook Inlet Geologic Model:

**State of Alaska, Department of Natural Resources (DNR),
Division of Geological & Geophysical Surveys (DGGS) and
Division of Oil & Gas (DOG)**

- New geophysical data (seismic, gravity, magnetic surveys)
- New geologic maps of the Cook Inlet Region
- Subsurface mapping and modeling
- Studies of reservoir and source rocks exposed at the surface
- Modeling of the timing of oil generation



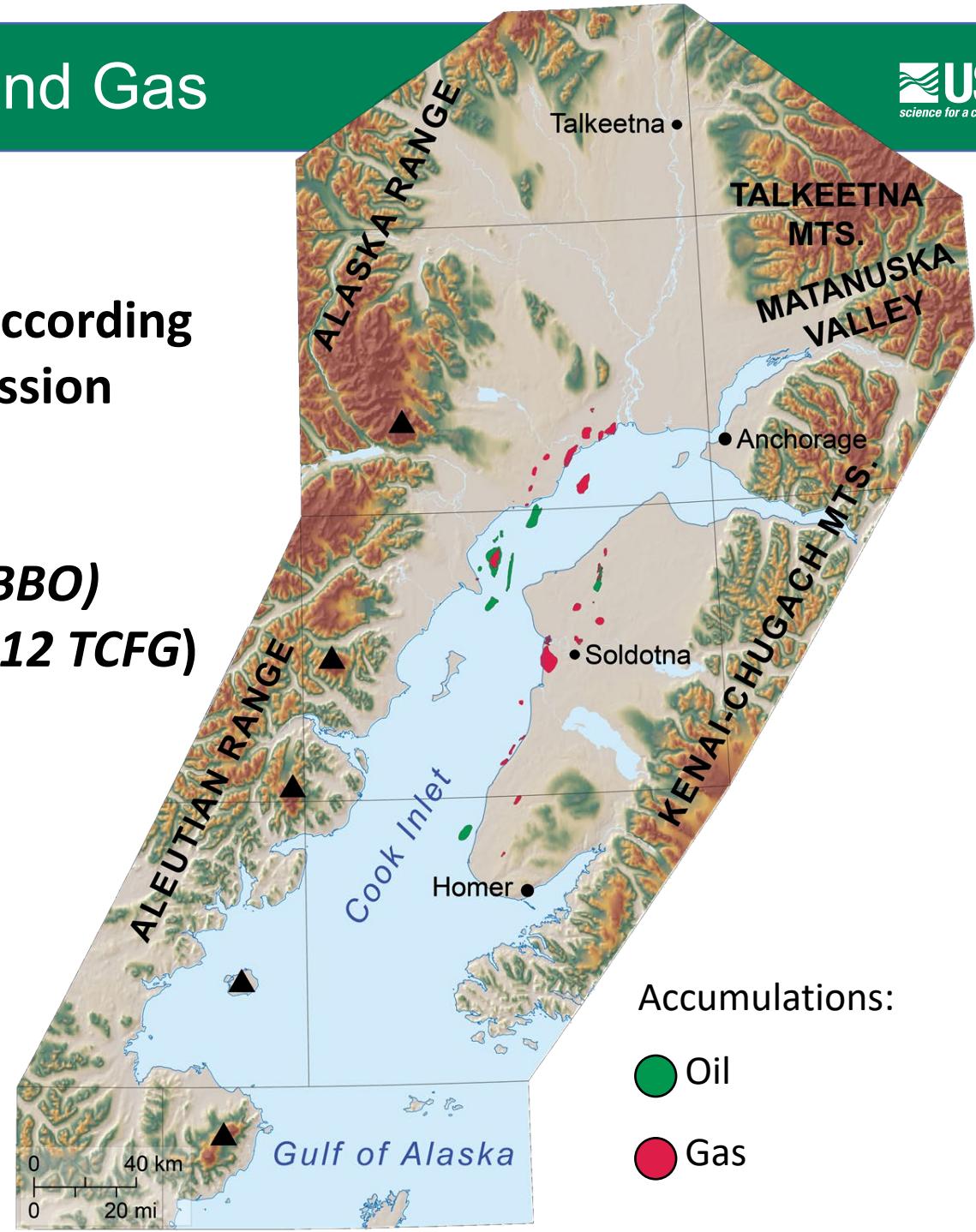
Dave LePain (DGGS) and Ken Helmold (DOG) near Capps Glacier, Alaska



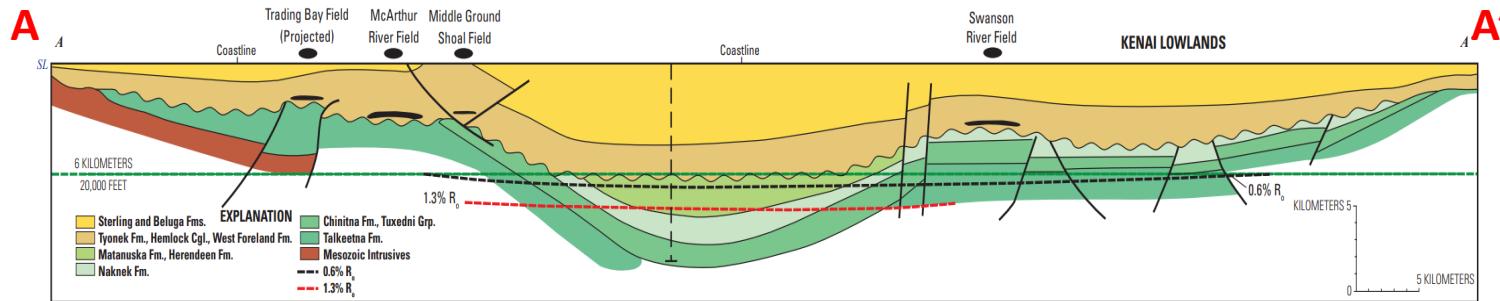
Cook Inlet Region Geography – Oil and Gas

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

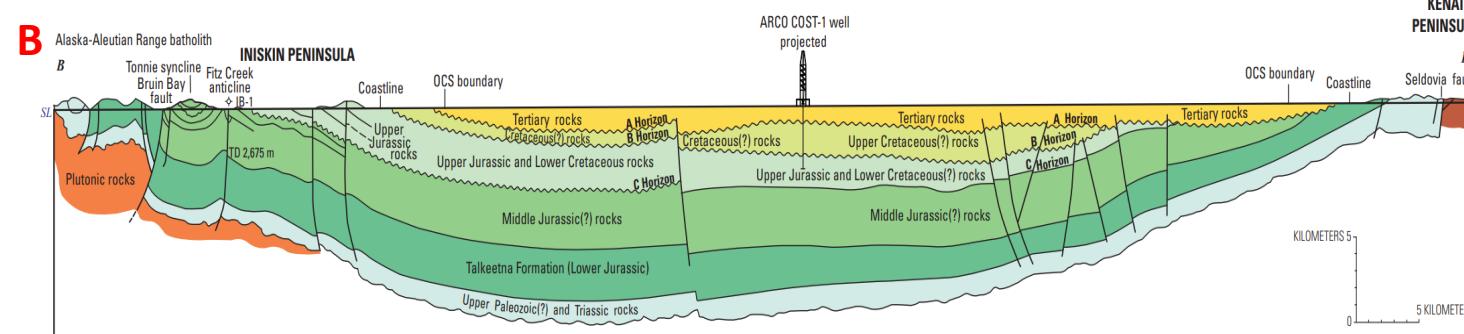
- Oil, ~1.3 Billion barrels (In 2023 ~1.4 BBO)
- Gas, >7.8 Trillion cubic feet (In 2023 ~12 TCFG)



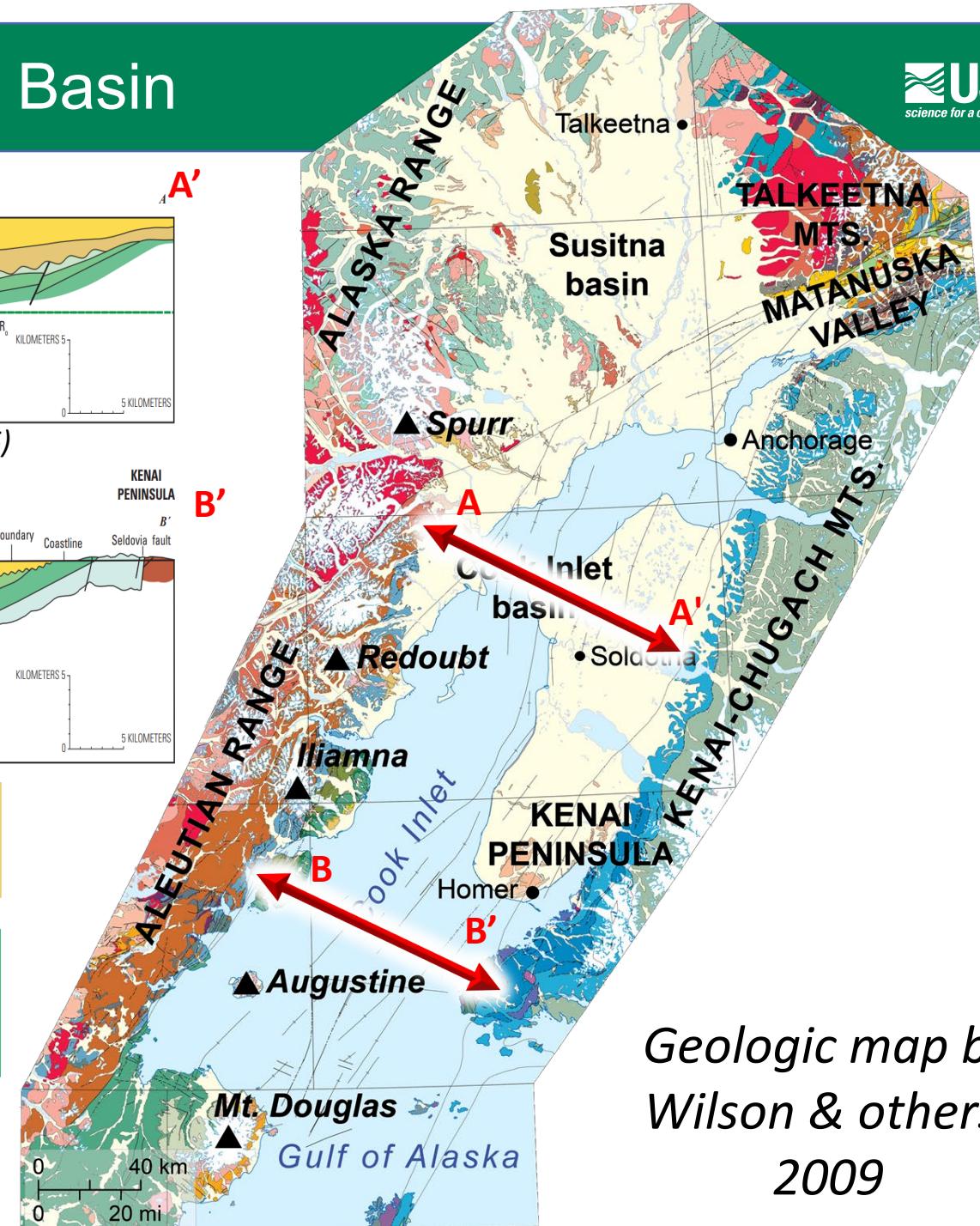
Cook Inlet Regional Geology – Deep Basin



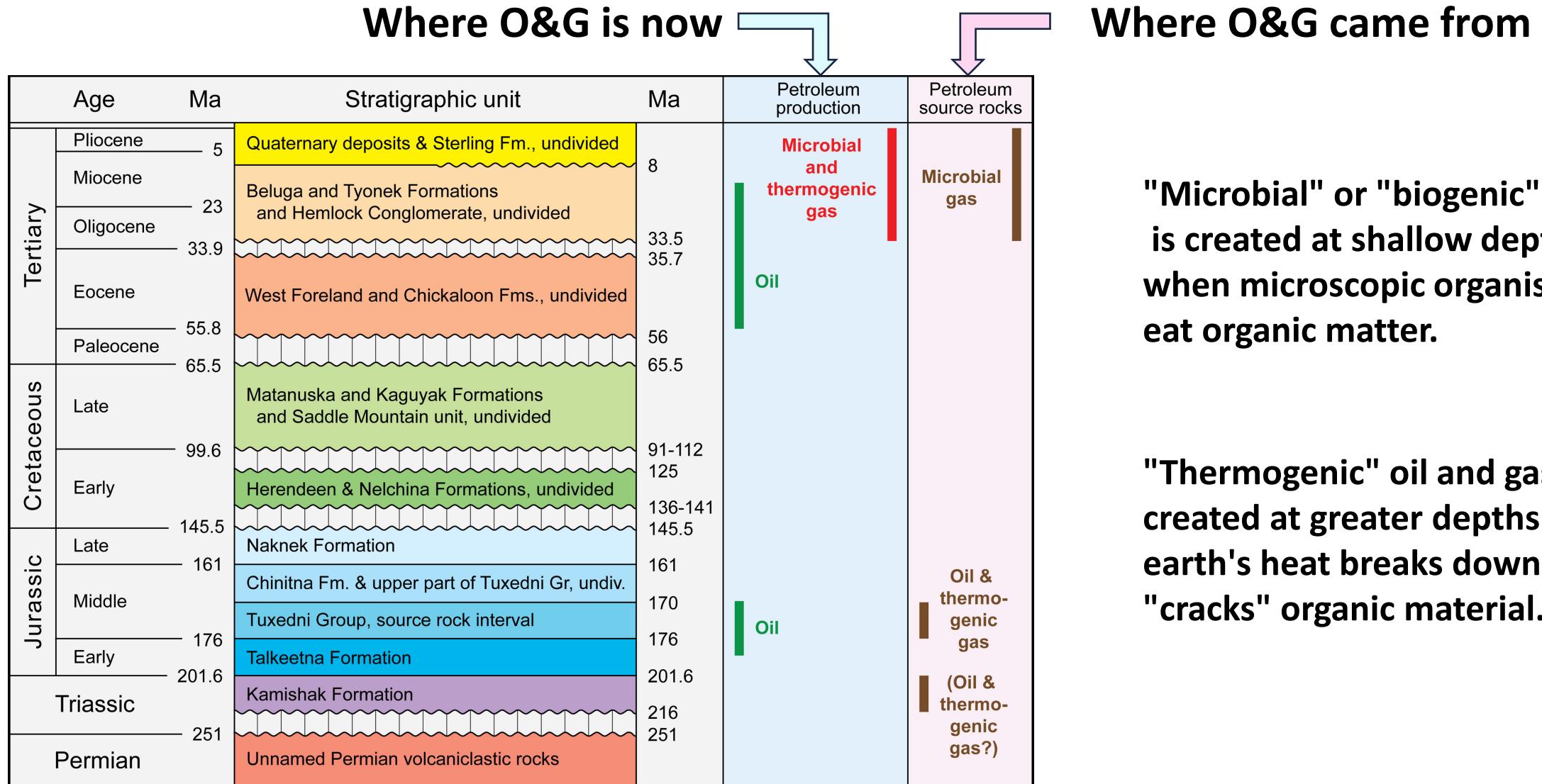
Cross section by Schenk and Nelson (2015) modified from Boss and others (1976)



- **Tan & Yellow Units:** Tertiary and Quaternary (66 to 0 million years old) non-marine sedimentary rocks. Up to >25,000 ft (8 km) thick.
- **Green Units:** Jurassic and Cretaceous (200 to 66 million years old) marine sedimentary rocks. Up to >30,000 ft (9 km) thick. Below are about 10,000 to 20,000 ft (3 to 6 km) of volcanic rocks.
- Most structures (folds and faults) occurred after the middle Miocene (~12 to 0 million years ago).



Cook Inlet Rock Units & Petroleum Production



Where O&G came from

"Microbial" or "biogenic" gas is created at shallow depths when microscopic organisms eat organic matter.

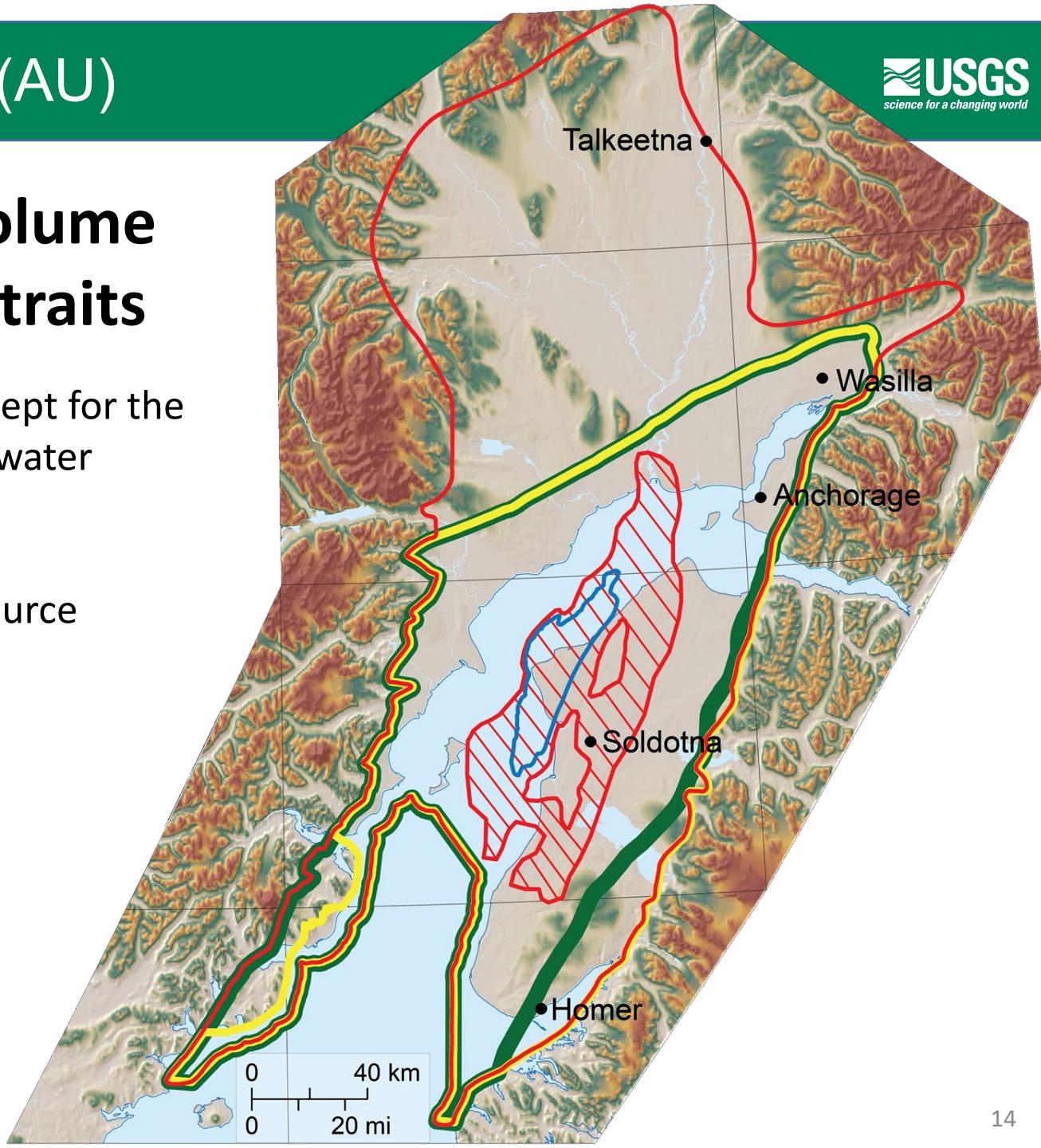
"Thermogenic" oil and gas is created at greater depths when earth's heat breaks down or "cracks" organic material.

Geologic time from Walker and Geissman (2009)

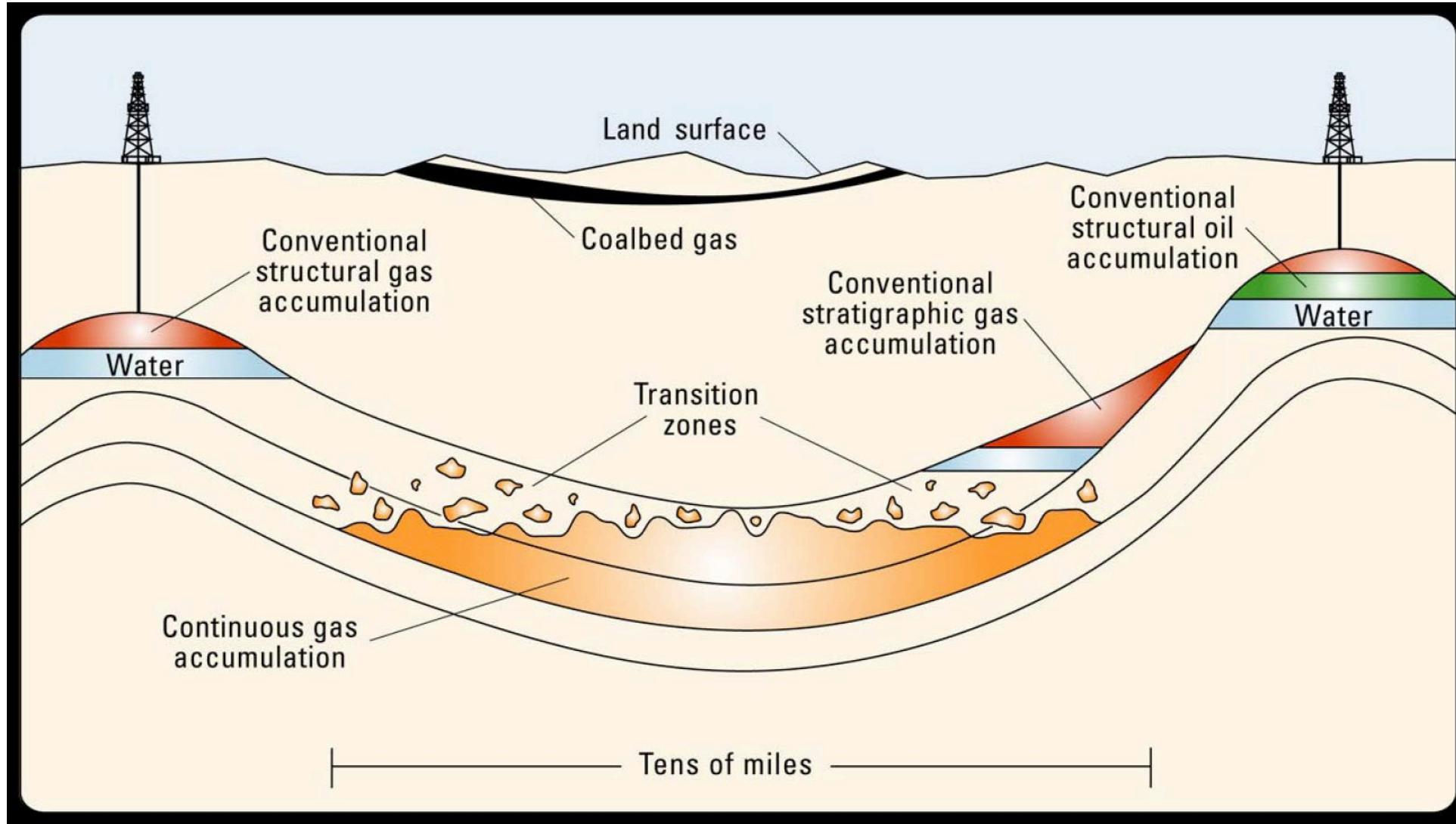
Assessment unit: a mappable volume of rock with common geologic traits

- AU boundaries are based on geologic criteria, except for the southern limit that corresponds to State-Federal water boundary.
- Each AU is evaluated independently, and the resource estimate applies to the entire volume.

- 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



Conventional versus Continuous Accumulations



Source: Schenk and Pollastro, 2002

Tertiary Sandstone Oil and Gas AU

Mean undiscovered oil: 372 MMBO

Mean undiscovered gas: 12,178 BCFG

Area ~21,800 km²

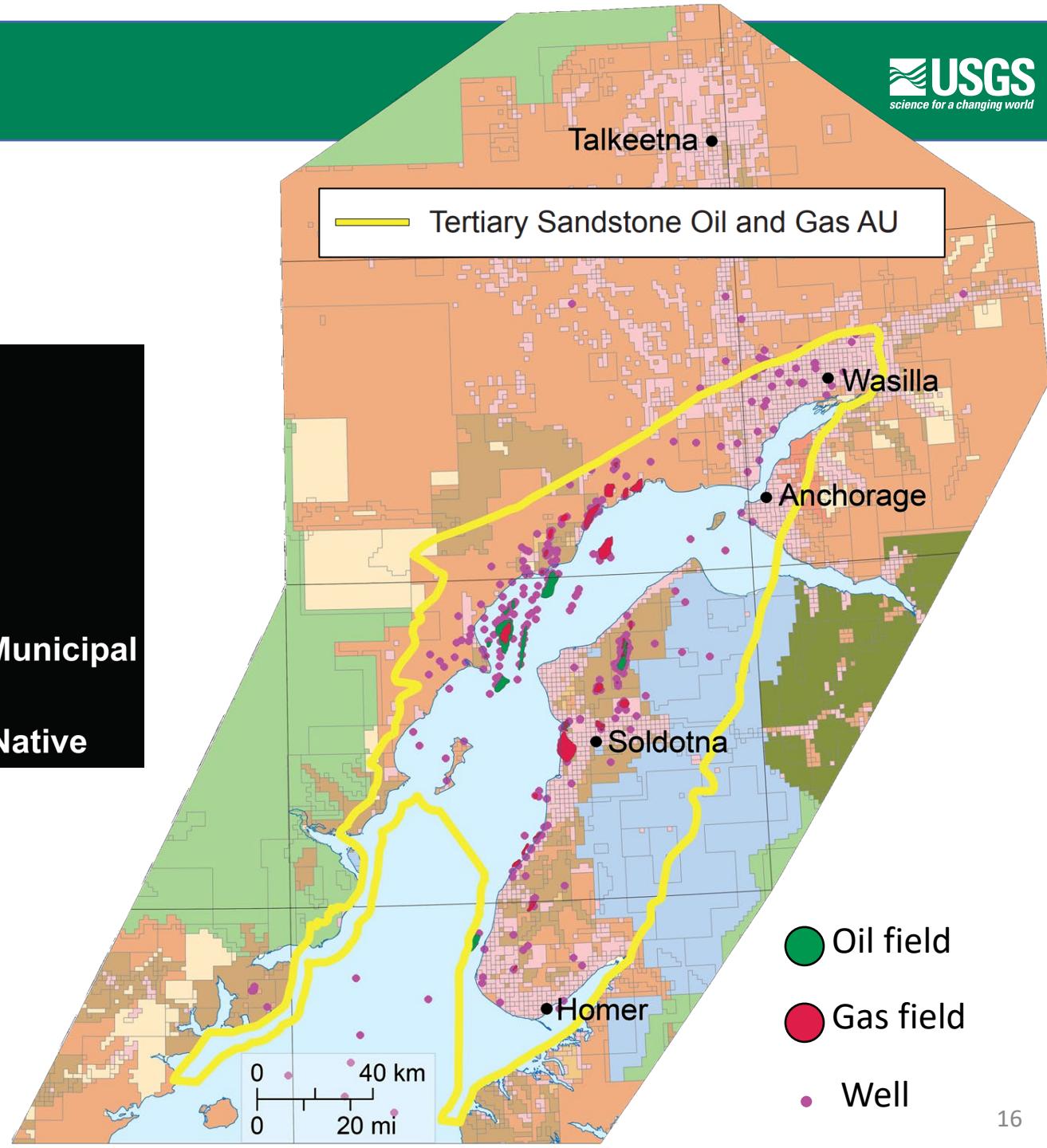
Federal, 21%

Private/municipal, 13%

Native, 8%

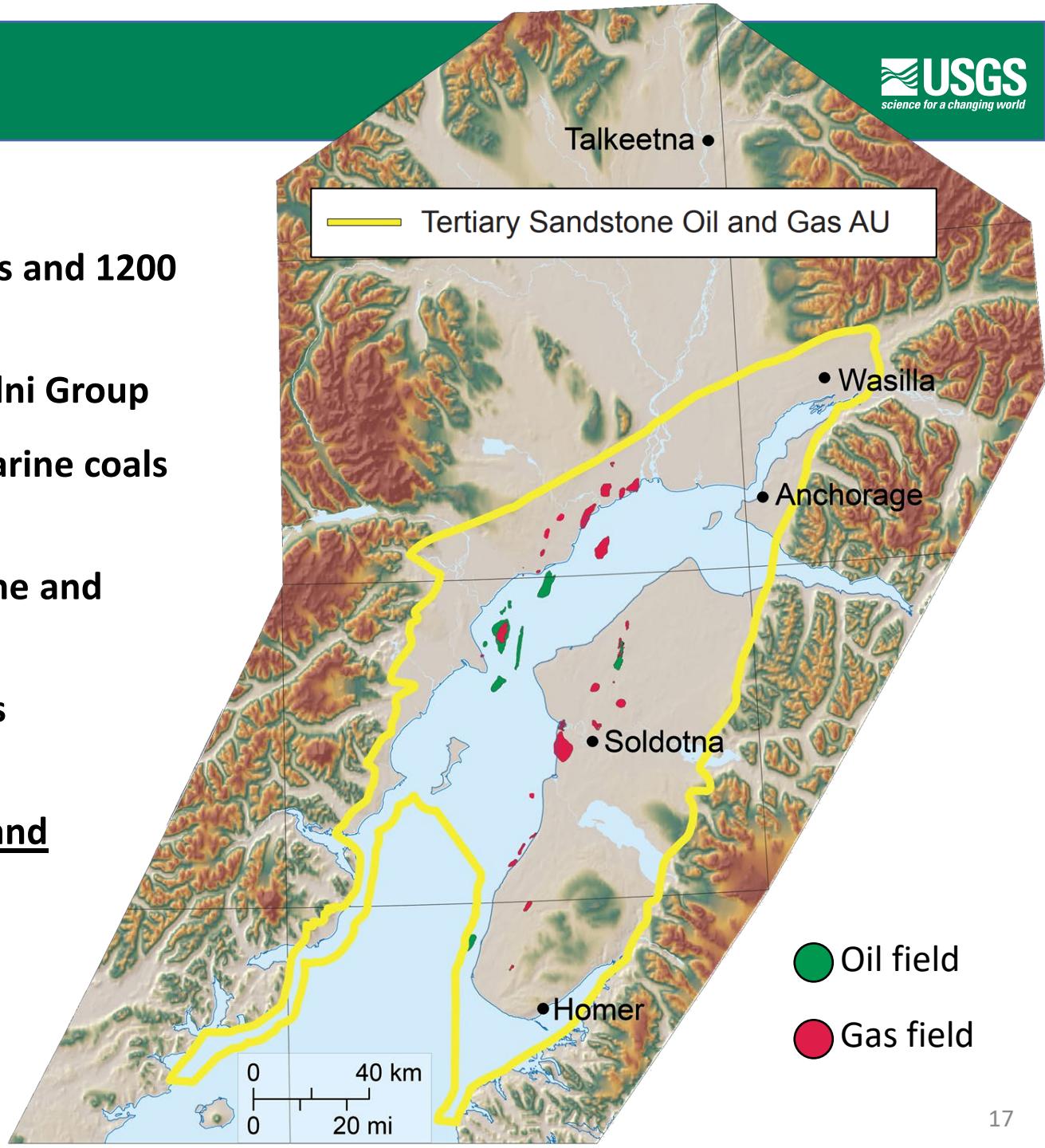
State onshore, 27%

State offshore, 31%



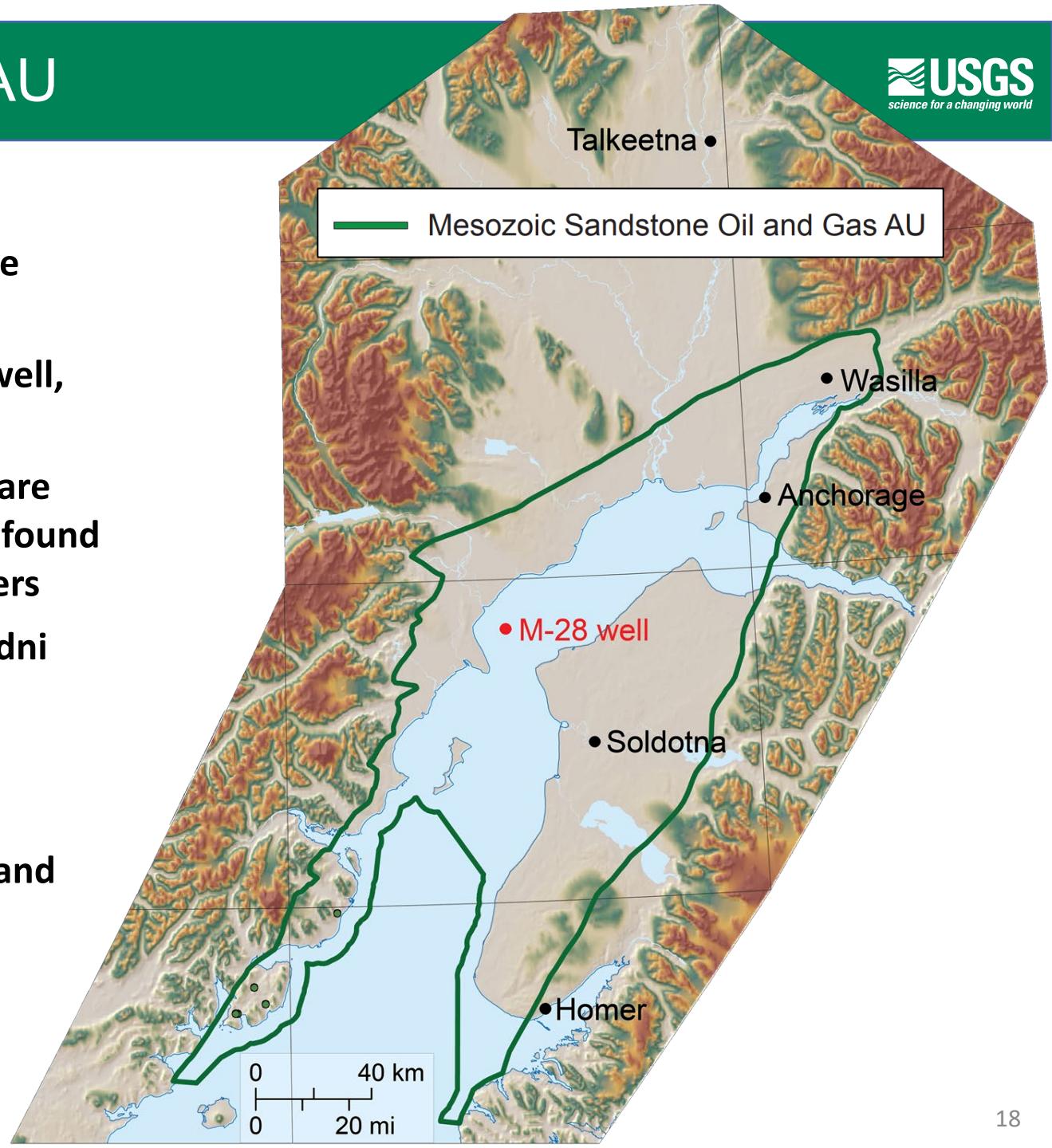
Tertiary Sandstone Oil and Gas AU

- "Conventional" type oil and gas accumulations
- As of 2011, there were about 30 known accumulations and 1200 well penetrations .
- Source of thermogenic oil is the Middle Jurassic Tuxedni Group
- Gas is mostly microbial (shallow sourced) from nonmarine coals within this unit
- Reservoirs are mainly paleo-river deposits of sandstone and conglomerate
- All discovered accumulation were in "structural" traps (folds and faults)
- Undiscovered accumulations are probably structural and stratigraphic (wedging of reservoir thickness)



Mesozoic Sandstone Oil and Gas AU

- "Conventional" type oil and gas accumulations
- Few wells have been drilled deep enough to target the Mesozoic Sandstone AU
- 1 significant oil accumulation discovered from M-28 well, McArthur River field, 1990-1999
- Oil seeps (indicators of a working petroleum system) are found onshore southwest of the basin. Oil shows are found in wells on Kenai Peninsula and Federal offshore waters
- Source of oil and gas is from the Middle Jurassic Tuxedni Group
- Reservoirs may be Mesozoic sandstone and fractured volcanic rocks
- Undiscovered accumulations are probably structural and stratigraphic traps
- Mostly unexplored



Mesozoic Sandstone Oil and Gas AU

Mean undiscovered oil: 227 MMBO

Mean undiscovered gas: 1,548 BCFG

Area ~20,100 km²

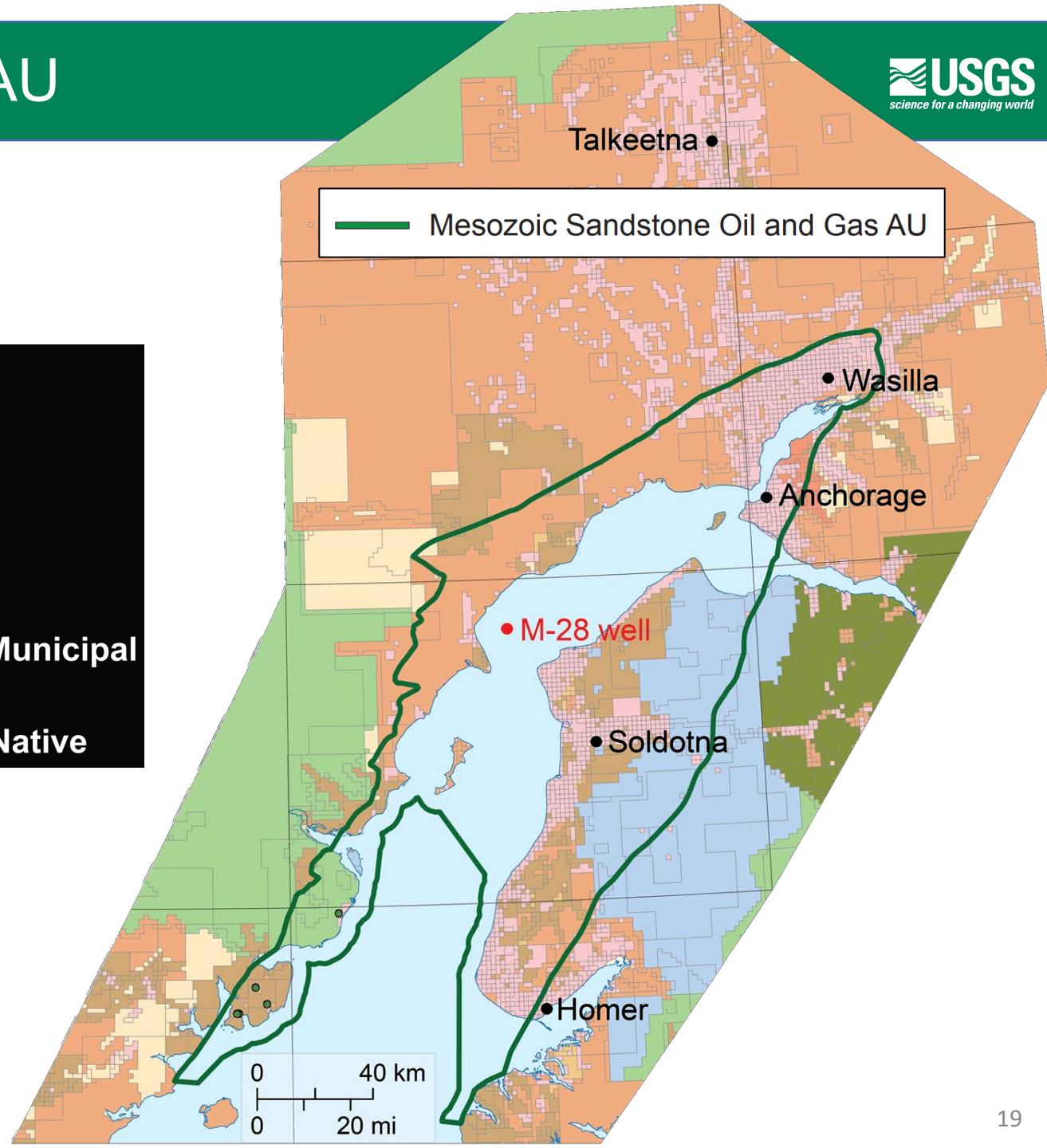
Federal, 21%

Private/municipal, 11%

Native, 10%

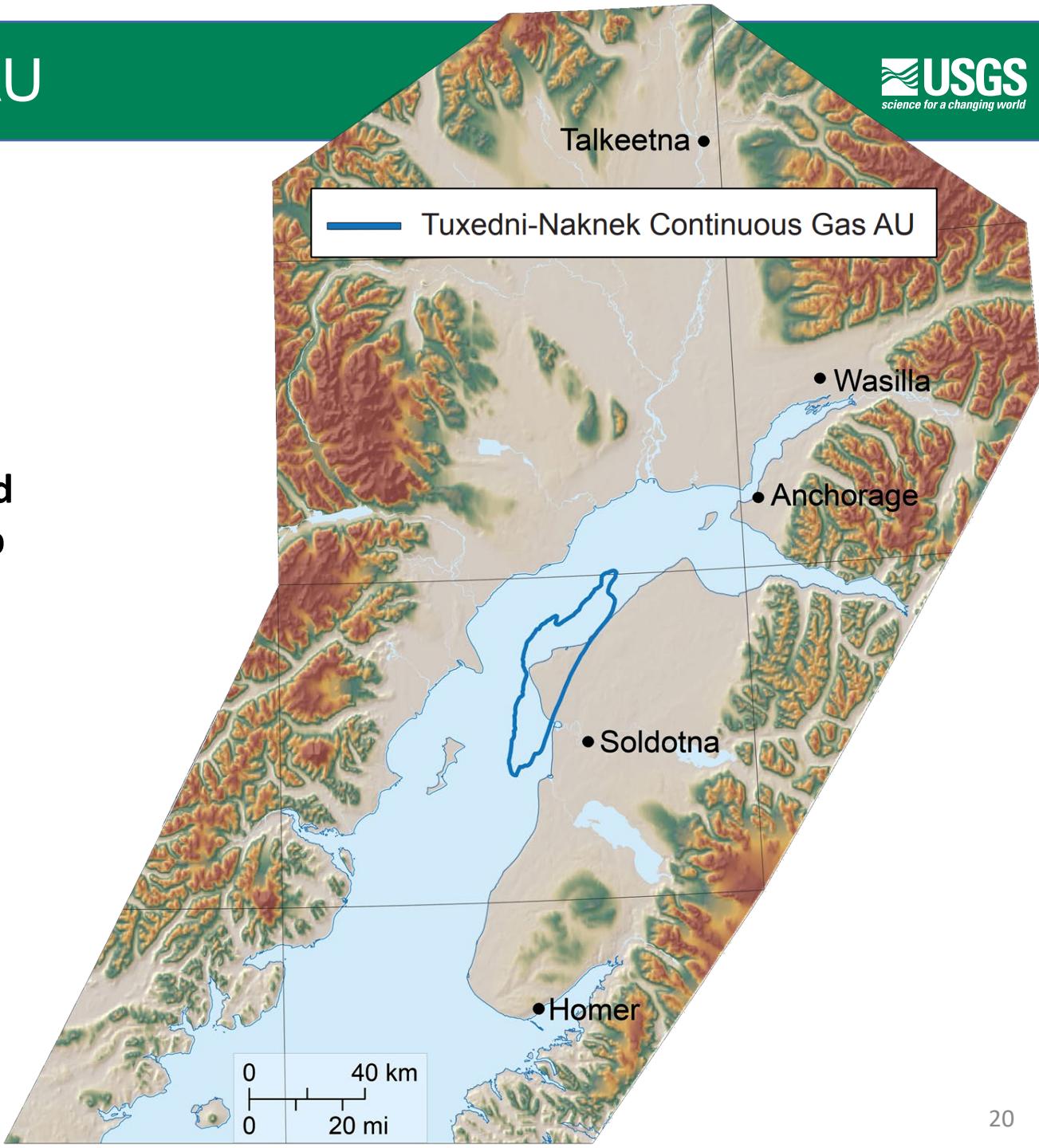
State onshore, 26%

State offshore, 31%



Tuxedni-Naknek Continuous Gas AU

- Play concept proposed by the USGS (2011)
- "Continuous" type accumulation of gas
- Speculative & no accumulations have been discovered
- Inferred resource is thermogenic (deep) gas derived from source rocks in Middle Jurassic Tuxedni Group
- Reservoirs hypothesized to be low-permeability sandstone at depths of 20,000 ft (6,000 m) or more
- Entirely unexplored (no known well penetrations)



Tuxedni-Naknek Continuous Gas AU

Mean undiscovered gas: 637 BCFG

Area ~900 km²

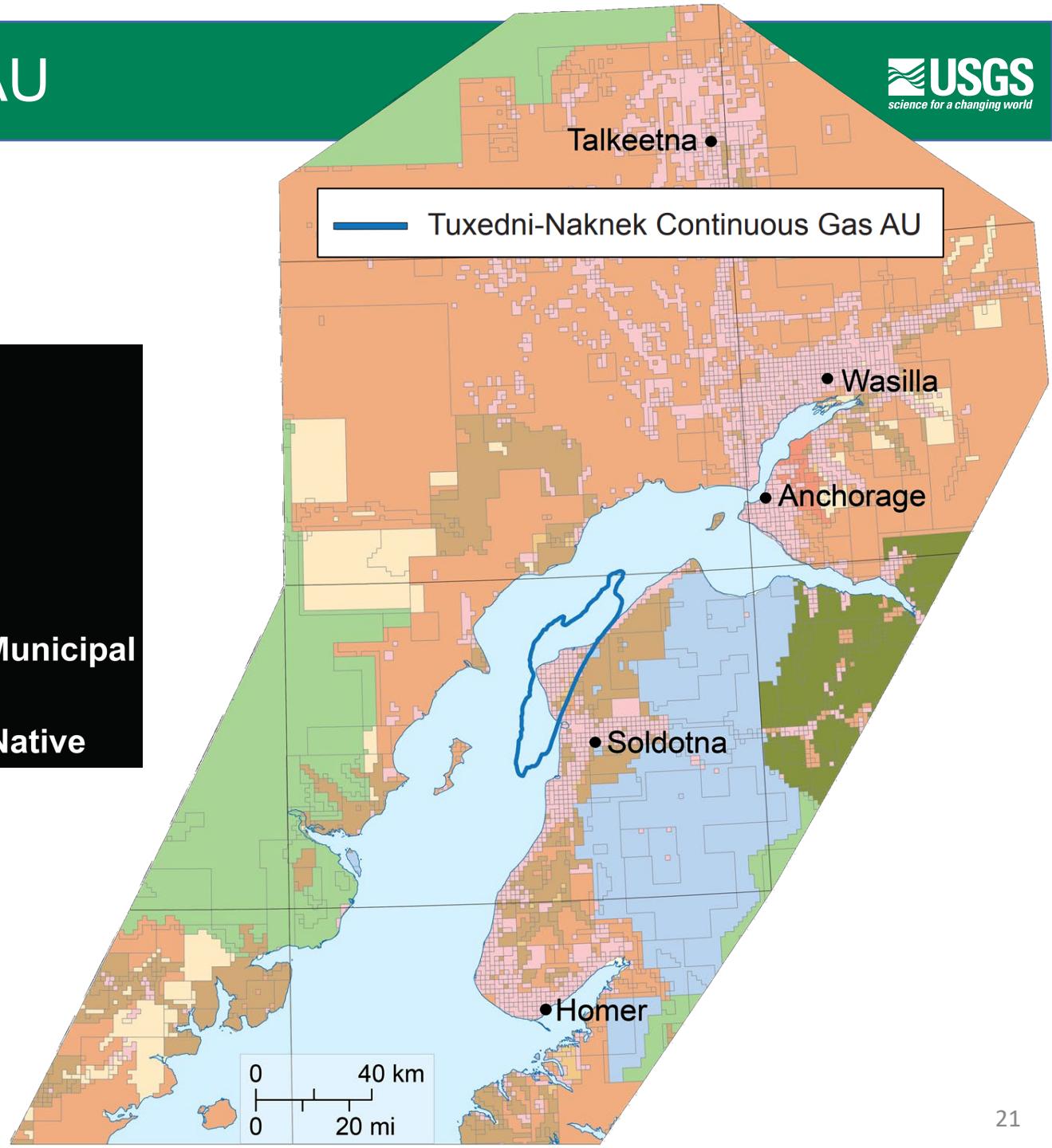
Federal, 1%

Private/municipal, 20%

Native, 5%

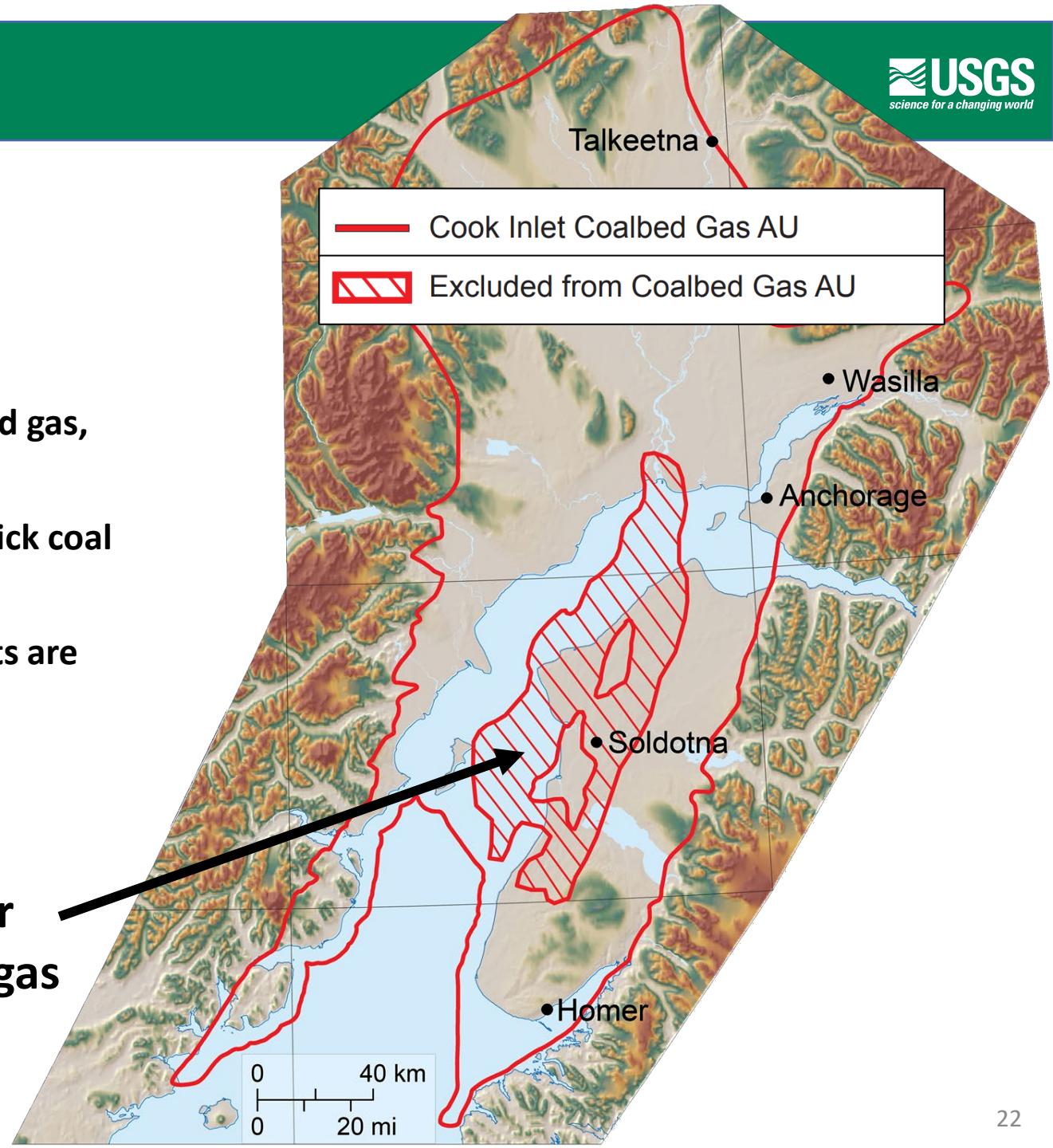
State onshore, 2%

State offshore, 72%



Cook Inlet Coalbed Gas AU

- Play concept proposed by the USGS (2011)
- "Continuous" type accumulation of gas
- No discovered commercial accumulations
- About 20–25 wells drilled specifically in search of coalbed gas, 1994–2005, all unsuccessful
- Microbial (shallow) 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



Mean undiscovered gas: 4,674 BCFG

Area ~34,300 km²

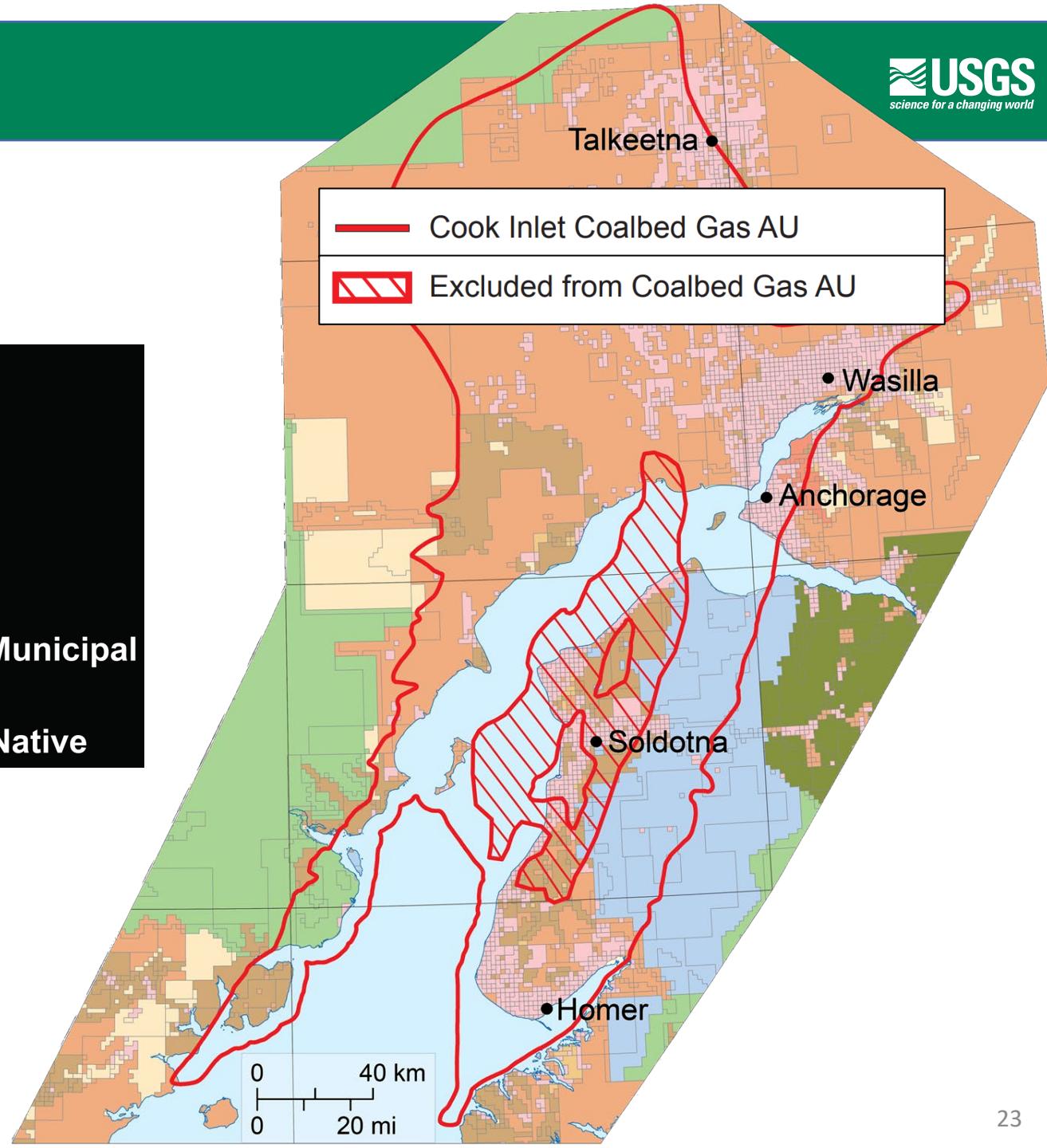
Federal, 14%

Private/municipal, 8%

Native, 8%

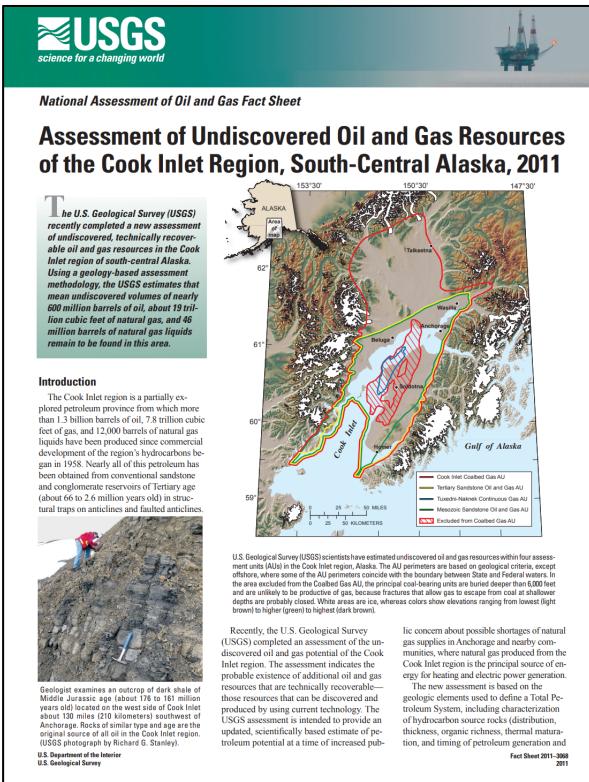
State onshore, 56%

State offshore, 14%



Principal Assessment Related Products:

2011



National Assessment of Oil and Gas Fact Sheet

Assessment of Undiscovered Oil and Gas Resources of the Cook Inlet Region, South-Central Alaska, 2011

The U.S. Geological Survey (USGS) recently completed a new assessment of undiscovered, technically recoverable oil and gas resources in the Cook Inlet region of south-central Alaska. Using a geology-based assessment methodology, the assessment estimates that mean undiscovered volumes of nearly 600 million barrels of oil, about 19 trillion cubic feet of natural gas, and 46 million barrels of natural gas liquids remain to be found in this area.

Introduction

The Cook Inlet region is a partially explored petroleum province from which more than 1.3 billion barrels of oil, 7.8 trillion cubic feet of gas, and 12,000 barrels of natural gas liquids have been produced since commercial development of the region began in the mid-1950s. Nearly all of this petroleum has been obtained from conventional sandstone and conglomerate reservoirs of Tertiary age (about 66 to 2.6 million years old) in structural traps on anticlines and faulted anticlines.



Geologists examine an outcrop of dark shale of Middle Jurassic age (about 178 to 161 million years old) located on the west side of Cook Inlet about 10 miles west of the downtown area of Anchorage. Rocks of similar type and age are the only outcrops known in the Cook Inlet region. (USGS photograph by Richard G. Stanley.)

U.S. Department of the Interior

U.S. Geological Survey

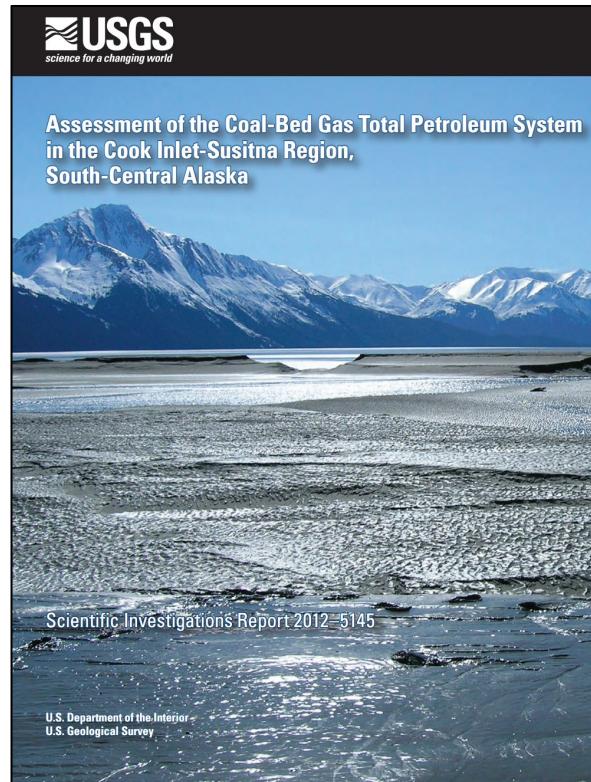
Stanley et al. (2011)

USGS Fact Sheet 2011-3068

- 2 Page Fact Sheet

<https://doi.org/10.3133/fs20113068>

2012



Assessment of the Coal-Bed Gas Total Petroleum System in the Cook Inlet-Susitna Region, South-Central Alaska

Scientific Investigations Report 2012-5145

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

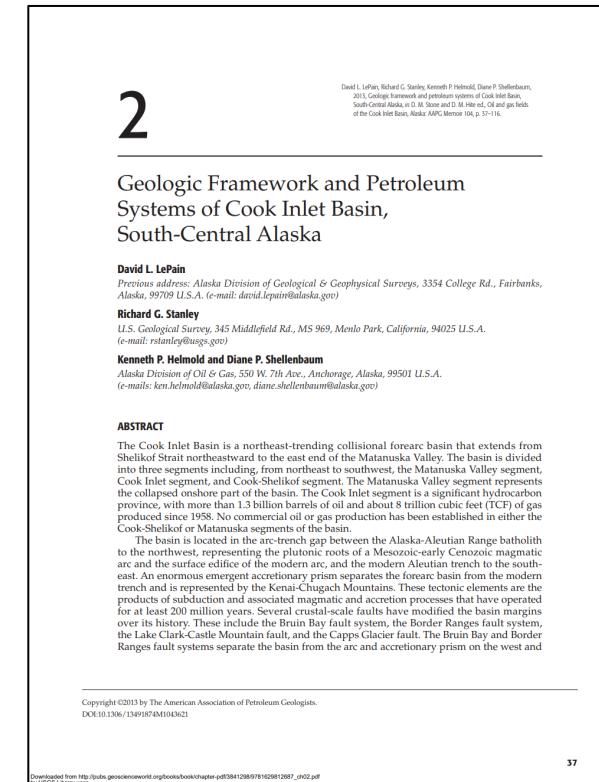
Rouse and Houseknecht (2012)

USGS Scientific Report 2012-5145

- Coal-Bed Gas Geologic Model

<https://doi.org/10.3133/sir20125145>

2014



2

Geologic Framework and Petroleum Systems of Cook Inlet Basin, South-Central Alaska

David L. LePain

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Kenneth P. Helmold and Diane P. Shellenbaum

Alaska Division of Oil & Gas, 550 W. 7th Ave., Anchorage, Alaska, 99501 U.S.A. (e-mails: ken.helmold@alaska.gov, diane.shellenbaum@alaska.gov)

ABSTRACT

The Cook Inlet Basin is a northeast-trending collisional forearc basin that extends from Shelikof Strait northeastward to the east end of the Matanuska Valley. The basin is divided into two segments, including, from northeast to southwest, the Matanuska Valley segment, Cook Inlet segment, and Cook Inlet basin. The Matanuska Valley segment represents the collisional margin of the basin. The Cook Inlet segment is a significant hydrocarbon province, with more than 1.3 billion barrels of oil and about 8 trillion cubic feet (TCF) of gas produced since 1958. No commercial oil or gas production has been established in either the Cook-Shelikof or Matanuska segments of the basin.

The basin is located in the arc-trench gap between the Alaska-Aleutian Range batholith to the west and the emerald green plume margin of a Mesozoic-Cenozoic continental magmatic arc and the surface edifice of the modern arc, and the modern Aleutian trench to the southeast. An enormous emergent accretionary prism separates the forearc basin from the modern trench and is represented by the Kenai-Chugach Mountains. These tectonic elements are the products of subduction and associated magmatic and accretion processes that have operated for at least 200 million years. Several crustal-scale faults have modified the basin margins over its history. These include the Bruin Bay fault system, the Border Ranges fault system, the Lake Clark-Castle Mountain fault, and the Capps Glacier fault. The Bruin Bay and Border Ranges fault systems separate the basin from the arc and accretionary prism on the west and

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DOI:10.3997/1344-9176.14042

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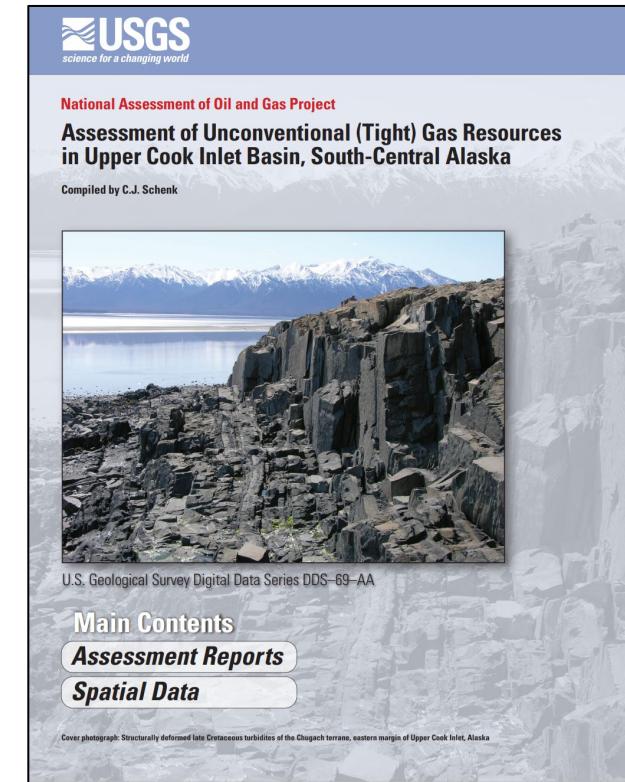
LePain et al. (2014) – DGGS/USGS/DOG

AAPG Memoir 104 Chapter 2

- Detailed Cook Inlet Geologic Framework

<https://doi.org/10.1306/13491874M1043621>

2015



National Assessment of Oil and Gas Project

Assessment of Unconventional (Tight) Gas Resources in Upper Cook Inlet Basin, South-Central Alaska

Compiled by C.J. Schenk



U.S. Geological Survey Digital Data Series DDS-69-AA

Main Contents

Assessment Reports

Spatial Data

Cover photograph: Structurally deformed late Cretaceous turbidites of the Chugach terrane, eastern margin of Upper Cook Inlet, Alaska

Schenk et al. (2015)

USGS Digital Data Series DDS-69-AA

- Chapter 1: Tight Gas Geologic Model
- Chapter 2: Input Data for 2011 Assessment
- Chapter 3: GIS Project

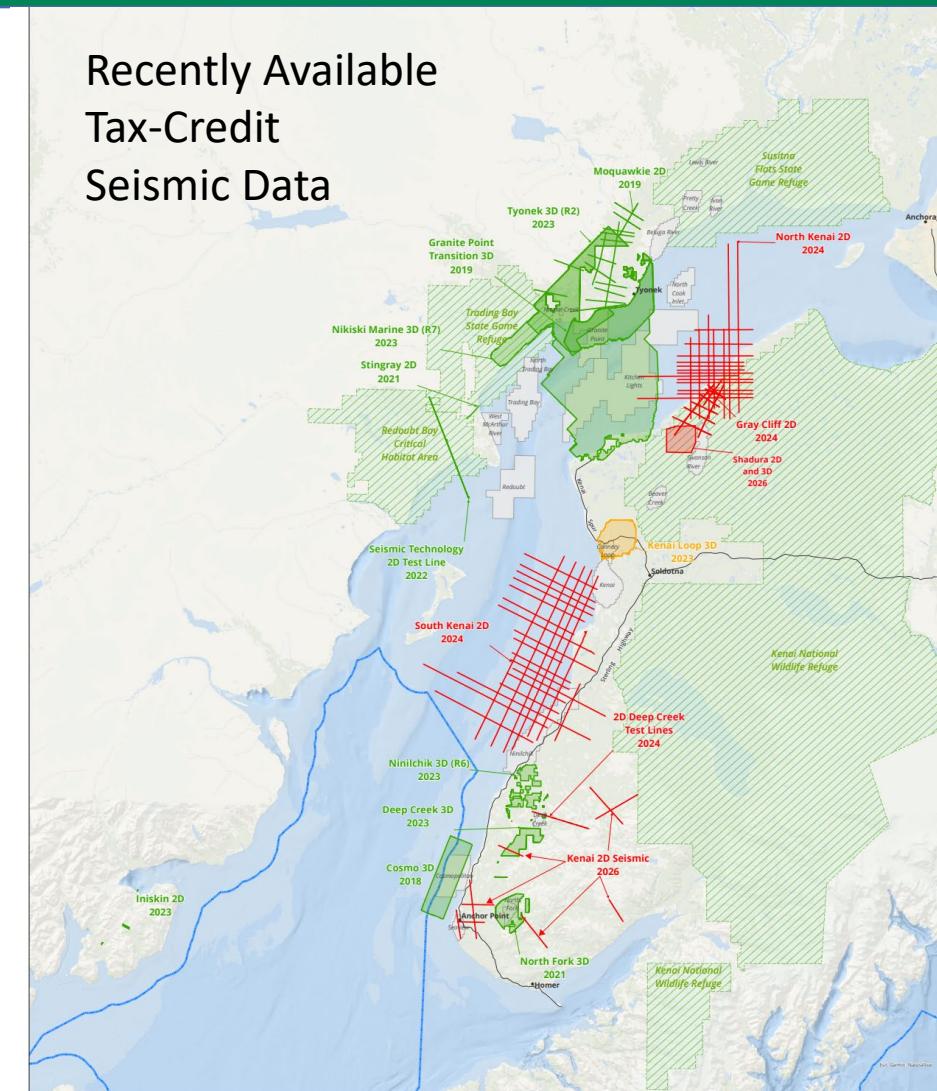
<https://doi.org/10.3133/ds69AA>

New Data Since the 2011 Cook Inlet Assessment

New data since the 2011 Assessment include:

- Oil and Gas well production data
- Publicly available subsurface datasets: well and seismic data (see right)
- Licensable seismic data
- Geologic Mapping
- Petrographic and provenance data (reservoir quality)
- Geochronology (age dating of rocks)

Recently Available Tax-Credit Seismic Data



Seismic Data Release Status

Seismic survey, showing data coverage:

2D survey	3D survey	Release Status
		Survey released and available at Geological Materials Center
		Statutory confidentiality period expired; survey eligible for and in preparation for release (see notes 2, 3, and 4)
		Survey with tax credit certificate, statutory confidentiality period still in effect; survey not yet eligible for or prepared for release (see notes 2, 3, 4, and 5)

Tax Credit Seismic Survey for Public Release

Cook Inlet, Alaska
State of Alaska Department of Natural Resources
Division of Oil and Gas

January 16, 2024

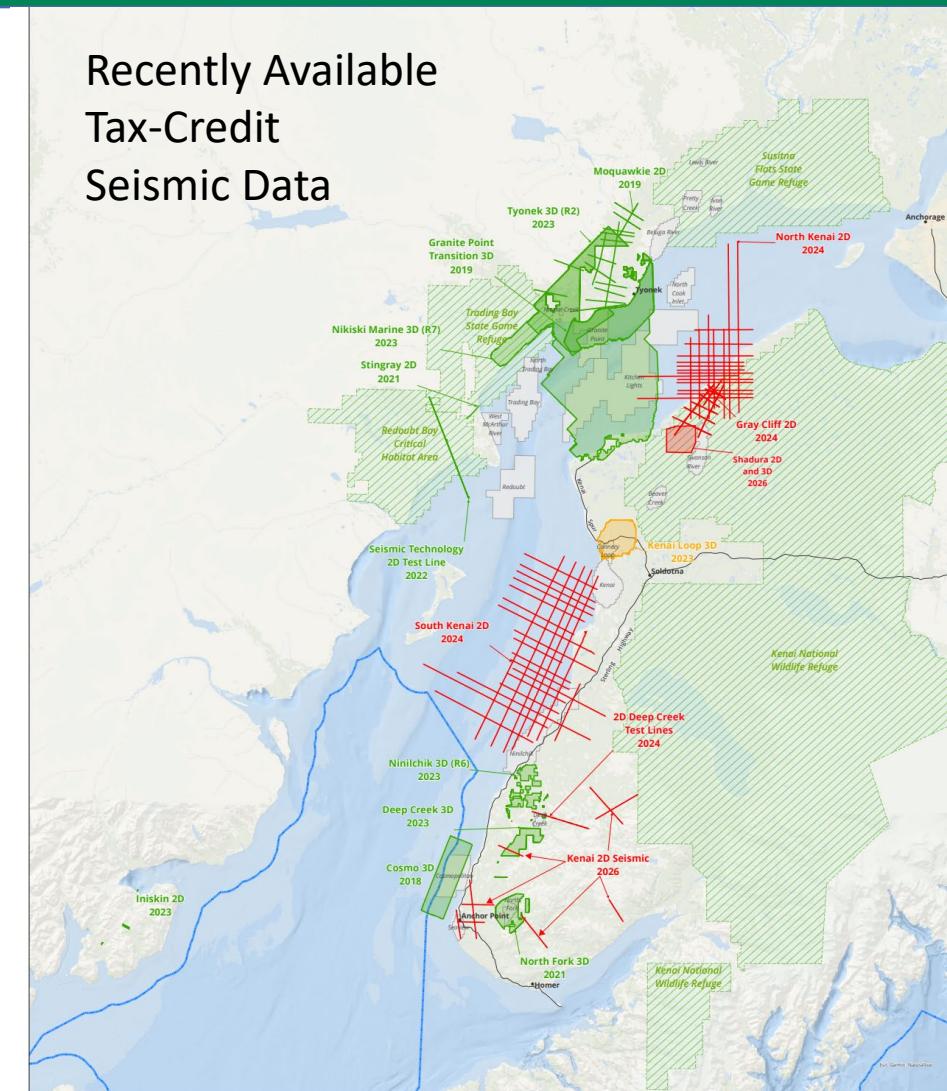


Alaska Basin and Petroleum Project

Proposed Tasks:

- Staff assigned to build new Cook Inlet geologic model
- Compilation of new datasets has commenced
- Collaborations with Alaska DGGs and DOG
- Proposed updated assessment of Cook Inlet Oil & Gas Resources (2025 Target)
- May include CO₂ and Energy Storage Assessment

Recently Available Tax-Credit Seismic Data



- In 2011, the USGS completed an assessment of the *estimated* 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 scientific research by the USGS and the State of Alaska DGGS and DOG.
- In the Cook Inlet Region, the USGS estimated 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. The assessment included a range of minimum to maximum estimates.
- The USGS has begun a renewed task to update the geologic model for the Cook Inlet, starting with the data collection and acquisition phase.

Other USGS petroleum fact sheets available at:

<http://energy.usgs.gov/>

Alaska Basins and Petroleum Systems Project:

<https://www.usgs.gov/programs/energy-resources-program/science/alaska-petroleum-systems>

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William Craddock, *Project co-Lead*, Reston VA,

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Alicia Lindauer, *Energy Resources Program Coordinator*, Denver CO

alindauer@usgs.gov

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2011 (During Assessment)

U.S. Department of the Interior

KEN SALAZAR, Secretary

U.S. Geological Survey

Marcia K. McNutt, Director

2024 (Present)

U.S. Department of the Interior

DEB HAALAND, Secretary

U.S. Geological Survey

David Applegate, Director