

Pikka-Horseshoe, Willow & Smith Bay

Unraveling Three New Discoveries with Publicly Available Data

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Alaska Division of Oil & Gas

April 24th, 2018



AGENDA

- 1) Introduction
- 2) Regional Geology
- 3) Pikka-Horseshoe
- 4) Willow
- 5) Smith Bay
- 6) Key Takeaways

THANK YOU

- State of Alaska, DNR:
 - o Paul Decker
 - o Ken Helmold
 - o Seismic Tax Credit Team: Heather Heusser, Kelsey Tucker
Don Krouskop, Holly Fair & Kirk Morgan
 - o Geological Materials Center (GMC)
- State of Alaska, AOGCC
- Conoco-Phillips, Oil Search, Repsol, Armstrong
- Dave Houseknecht (USGS)

ORGANIZATION CHARTS

State of Alaska

Department of Natural Resources

Oil & Gas	Forestry
Geological & Geophysical Surveys	Parks & Outdoor Recreation
Mining, Land & Water	Agriculture
	Others

Department of Administration

AOGCC
Finance
DMV
Others

Department of Revenue

Tax Division
Permanent Fund
Others

U.S. Department of the Interior

**Bureau of Land
Management**

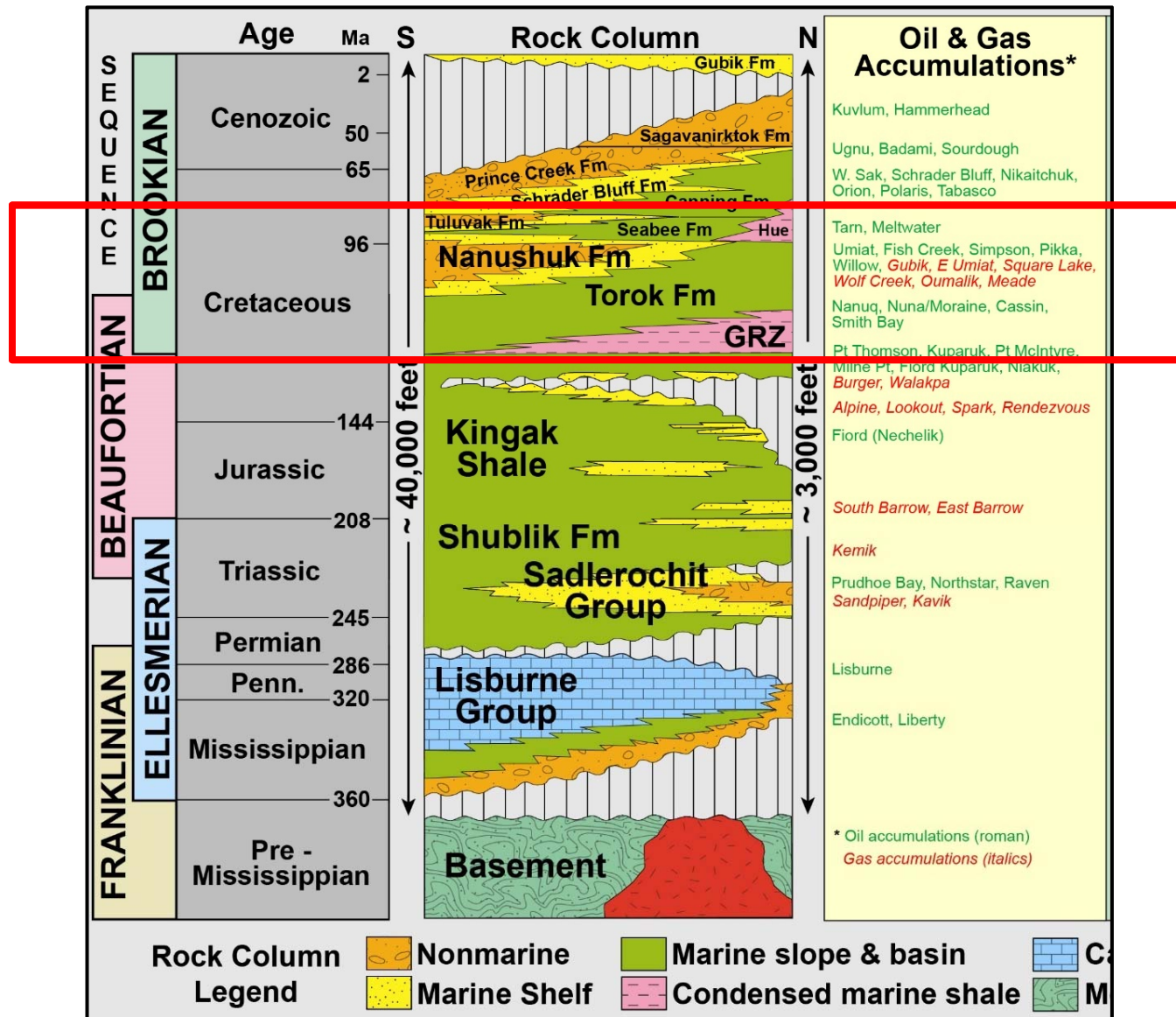
**Bureau of
Ocean Energy
Management**

USGS

**Bureau of Safety
& Environmental
Enforcement**

**U.S. Fish &
Wildlife
Service**

NORTH SLOPE STRATIGRAPHIC COLUMN



Modified by Alaska Division of Oil and Gas from Bird and Houseknecht (2002) and Houseknecht (2003)

NORTHERN ALASKA LOCATOR MAP

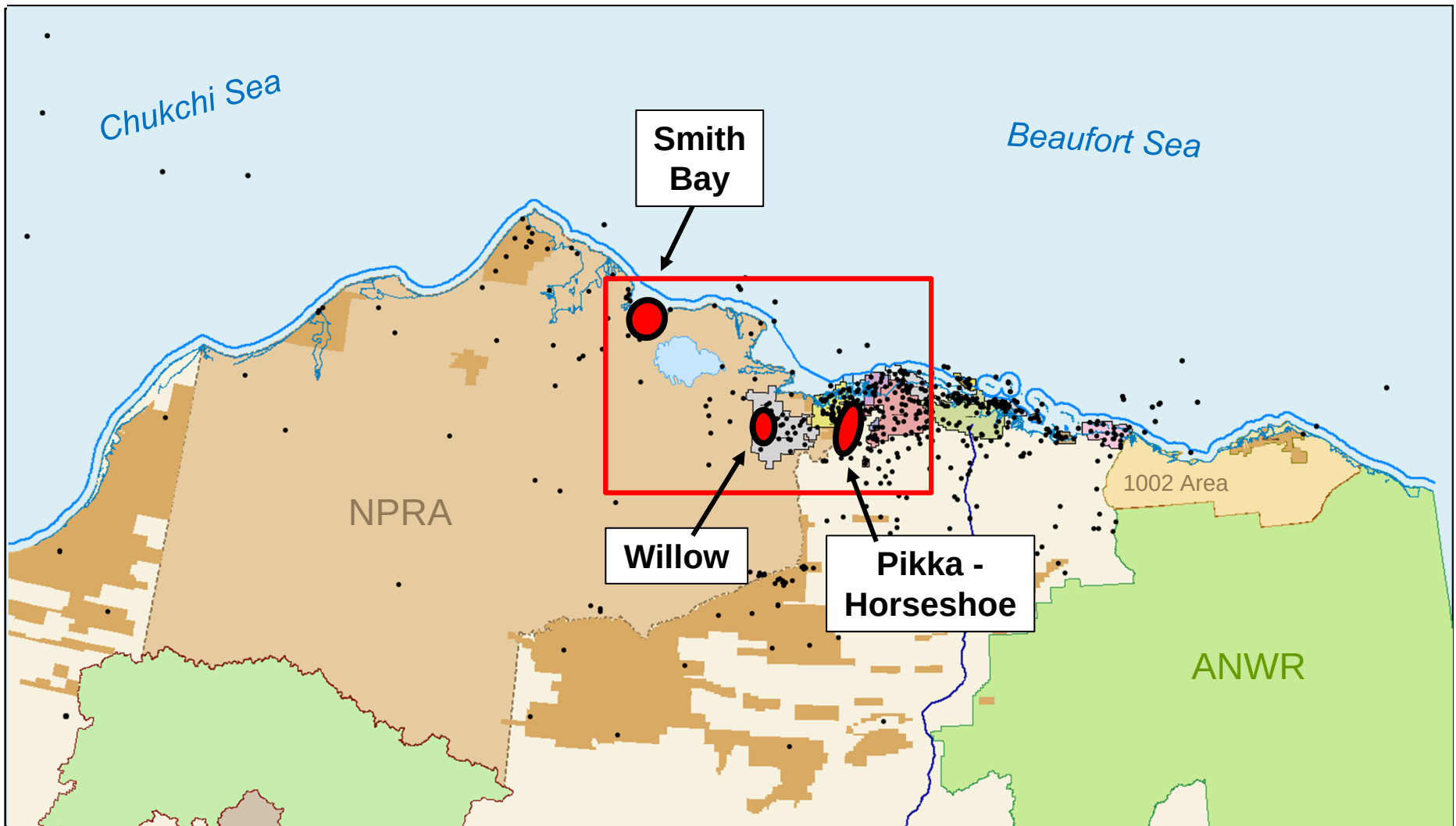


Image from Paul Decker, State of Alaska (DNR)

NORTH SLOPE BROOKIAN DISCOVERIES

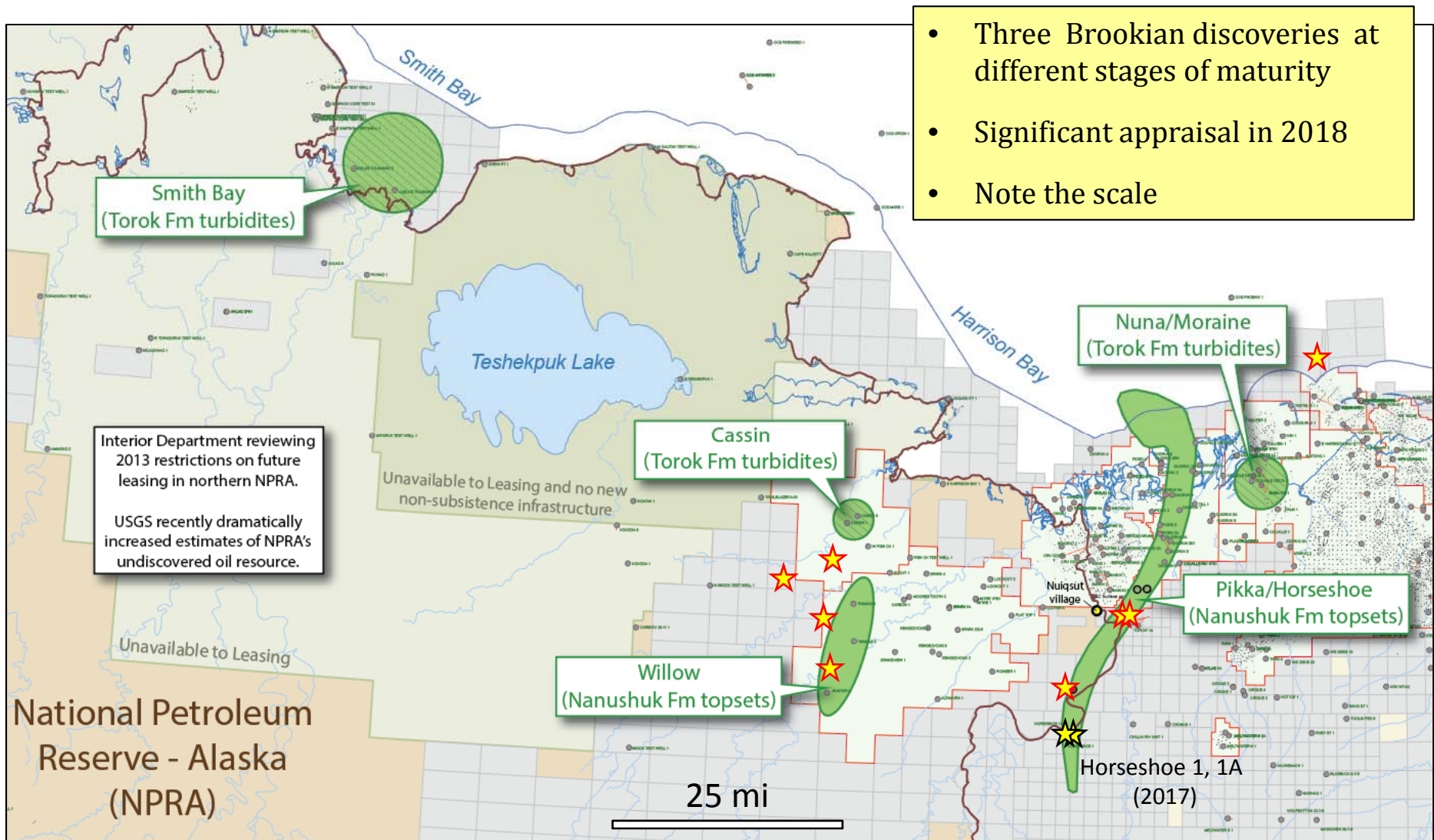


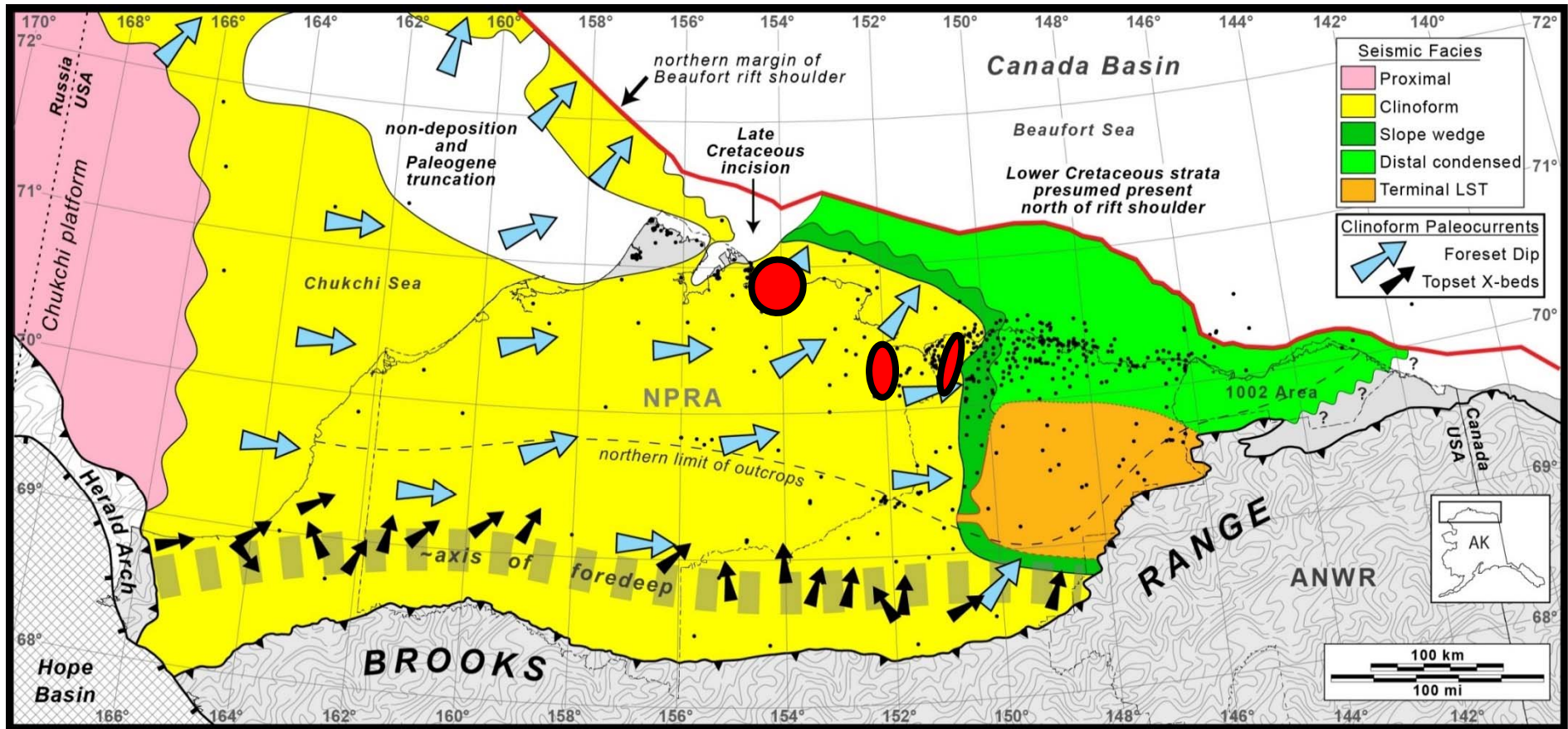
Image from Paul Decker, State of Alaska (DNR)

MAJOR RECENT BROOKIAN DISCOVERIES

	Pikka/Horseshoe	Willow	Smith Bay
Operator	Oil Search	ConocoPhillips	Caelus
Reservoir Formation	Nanushuk Fm	Nanushuk Fm	Torok Fm
Location	Onshore Colville Delta	Federal Onshore Northeast NPRA	State Waters Offshore of NPRA
Road/Pipeline Tie-in	~ 20 miles	~ 28 miles	~ 125 miles
Trap type	Topset Stratigraphic	Topset Stratigraphic	Turbidite Stratigraphic
Net Pay	< 225 ft	42-72 ft	183-223 ft (unconfirmed)
Oil Gravity	30 deg API	44 deg API	40-45 deg API (est)
Test Rate	~ 2,100 bopd vertical; 4,600 bopd horizontal	< 3,200 bopd vertical	No Flow Tests
Contingent Recoverable Resource	1.2 BBO	300 MMBO	1.8-2.4 BBO (est)
Expected Production (Operator Releases)	< 120,000 bopd	40,000-100,000 bopd	< 200,000 bopd

Image from Paul Decker, State of Alaska (DNR)

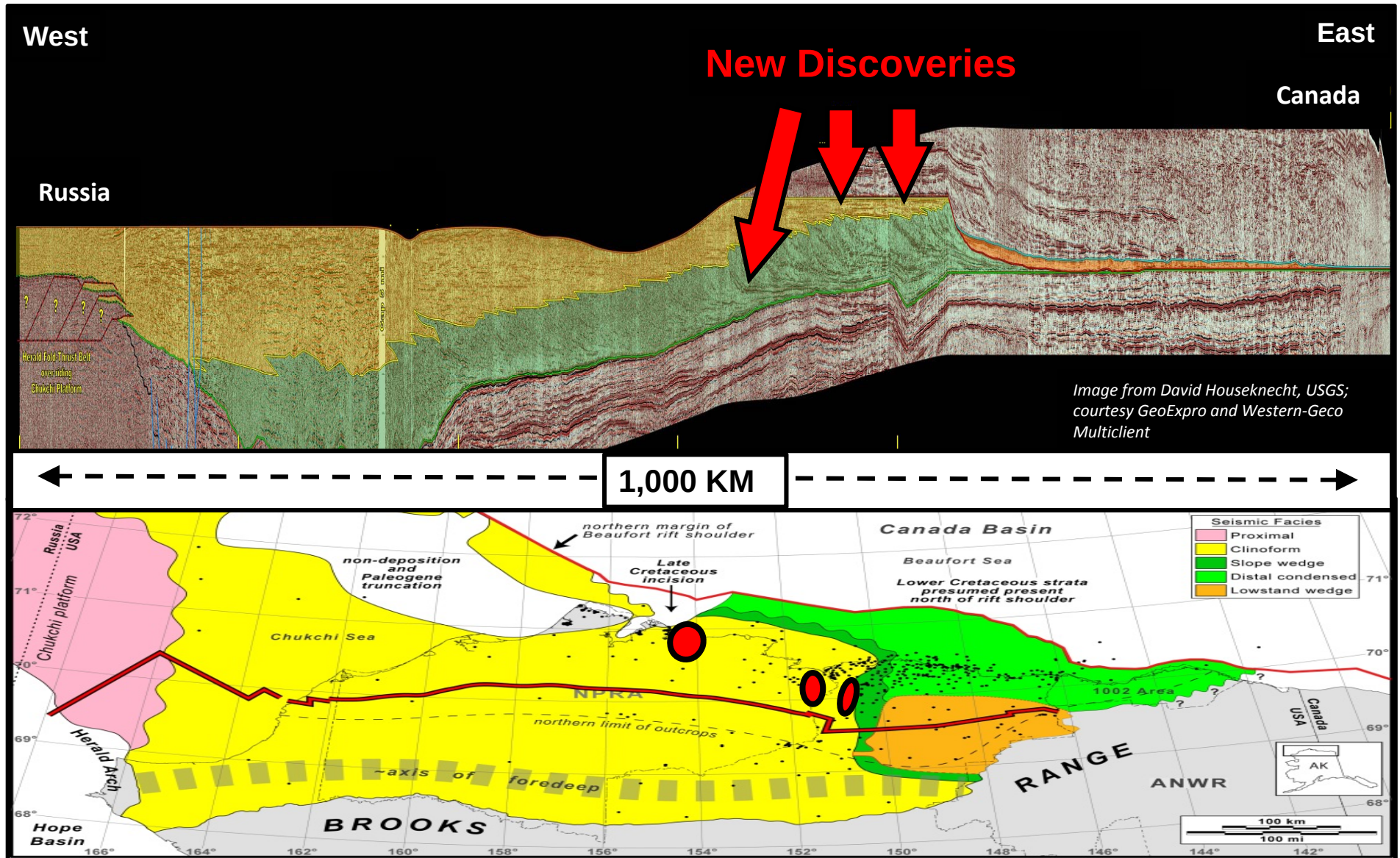
BROOKIAN DEPOSITION SYSTEM



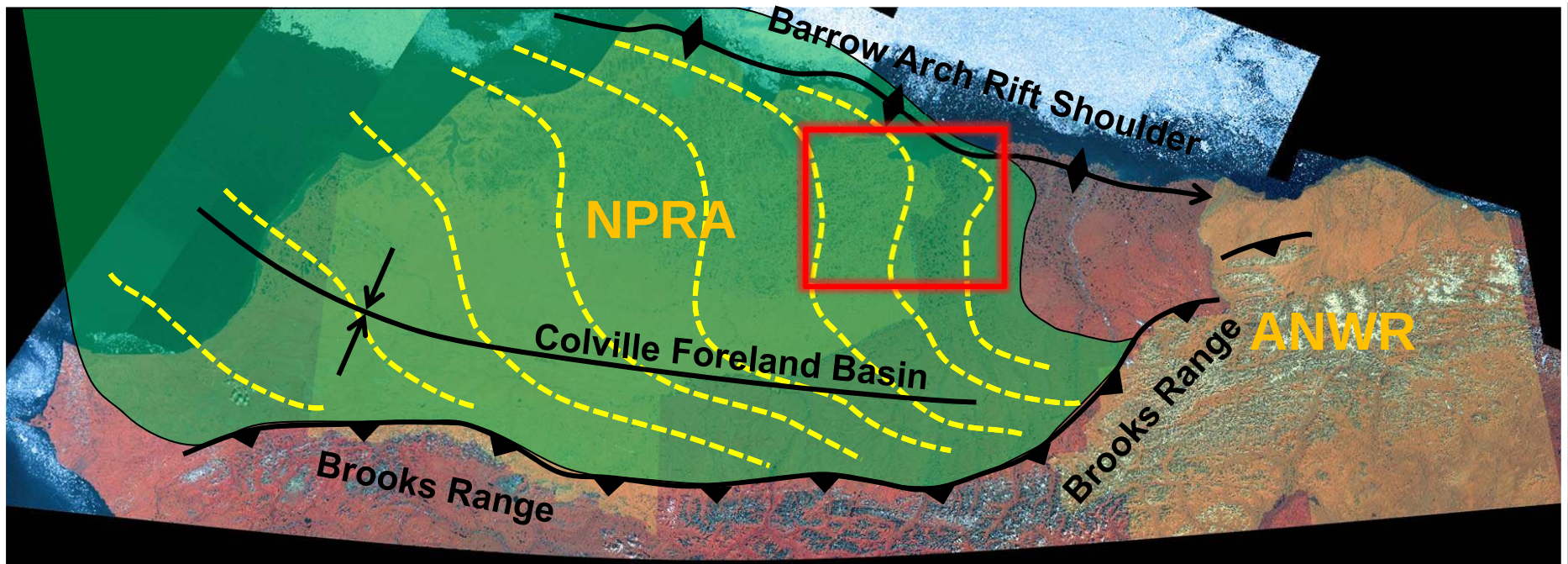
← ————— 1,000 KM ————— →

Image from David Houseknecht, USGS

MAJOR RECENT BROOKIAN DISCOVERIES



LOWER BROOKIAN DEPOSITIONAL SYSTEMS

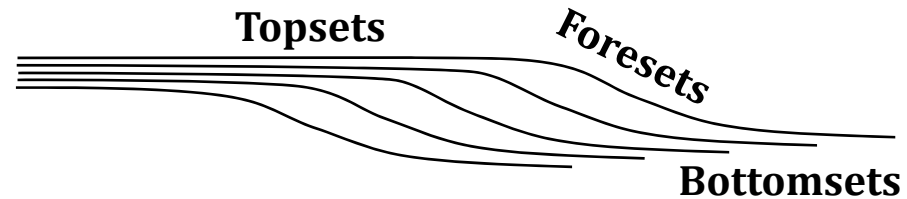


- Nanushuk-Torok progradation illustrated as series of advancing shelf margins
- Sea-level fluctuations repeatedly set up potential for reservoir and stratigraphic traps
- Play extends across western and central North Slope

Image from Paul Decker, State of Alaska (DNR)

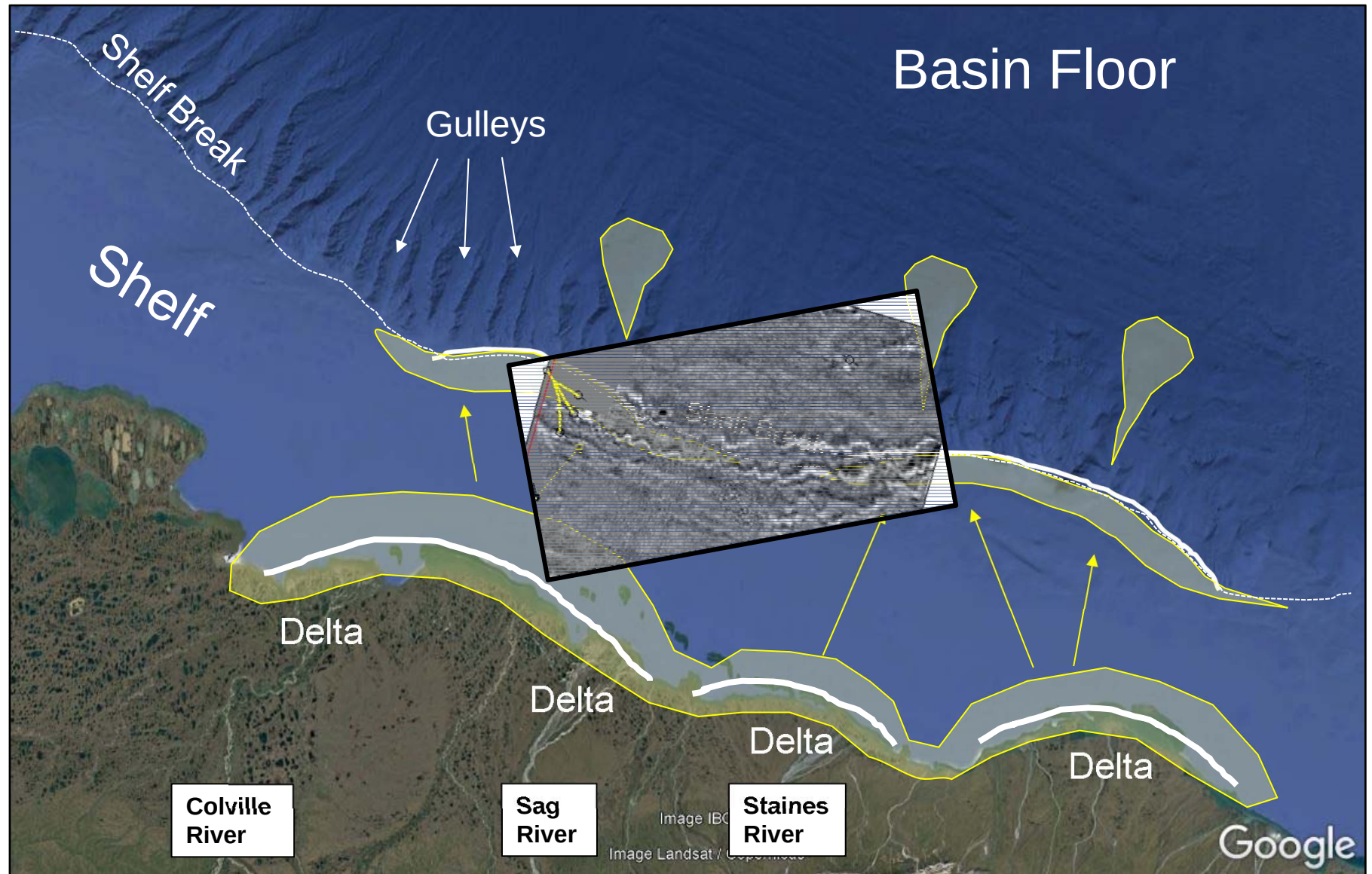
BROOKIAN SEQUENCE AND PLAYS

- **Clinof orm:** A sloping depositional surface commonly associated with strata prograding into deep water:

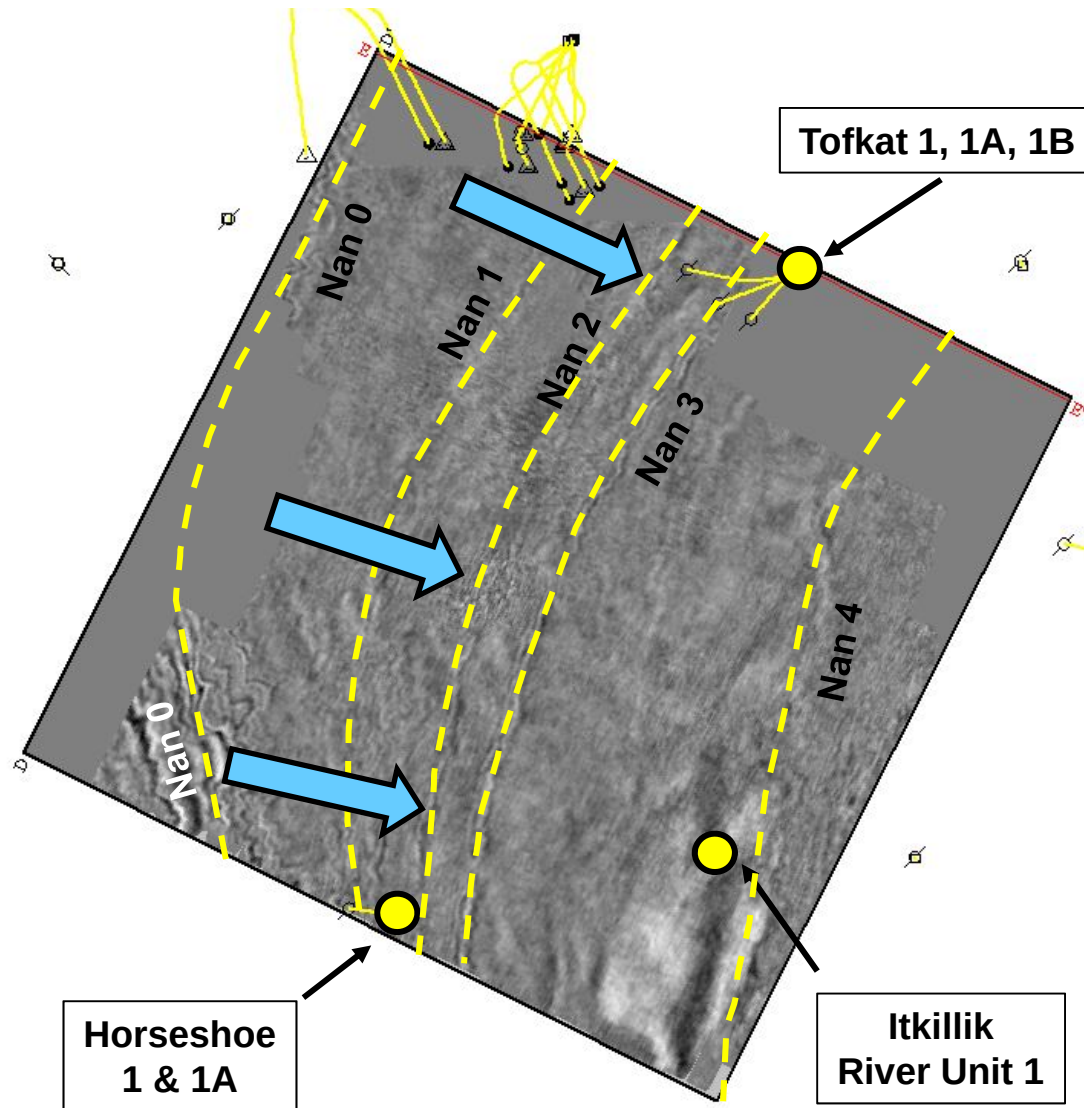


- **Geometry:**
 - *Topsets:* sand-prone coastal plain and shallow marine shelf
 - *Foresets:* muddy slope and sandy turbidite channels and slope apron fans
 - *Bottomsets:* sandy basin-floor turbidites, organic-rich condensed shales
- **Nanushuk – Torok:** topsets are Nanushuk Formation; time-equivalent foresets and bottomsets represent the Torok Formation.
- **Reservoir Quality:** Nanushuk tends to have superior reservoir quality due to less compaction and depositional environment.

NORTH SLOPE THOUGHT EXPERIMENT



TIME SLICE

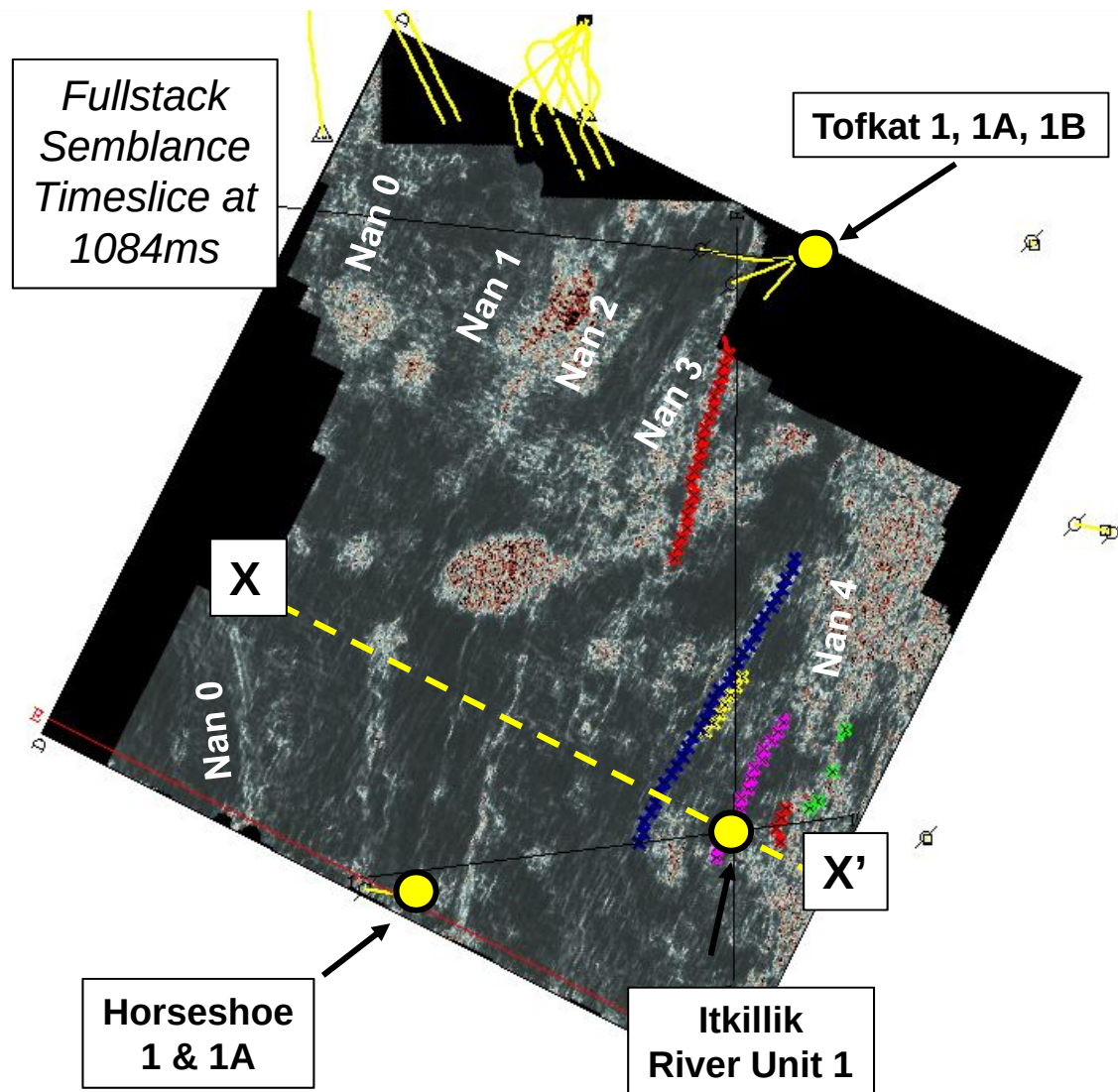


Highlights:

- 1) Shelf Margins
- 2) Progradation Direction

**Fullstack Time Slice at 1156ms*

SEMBLANCE SLICE



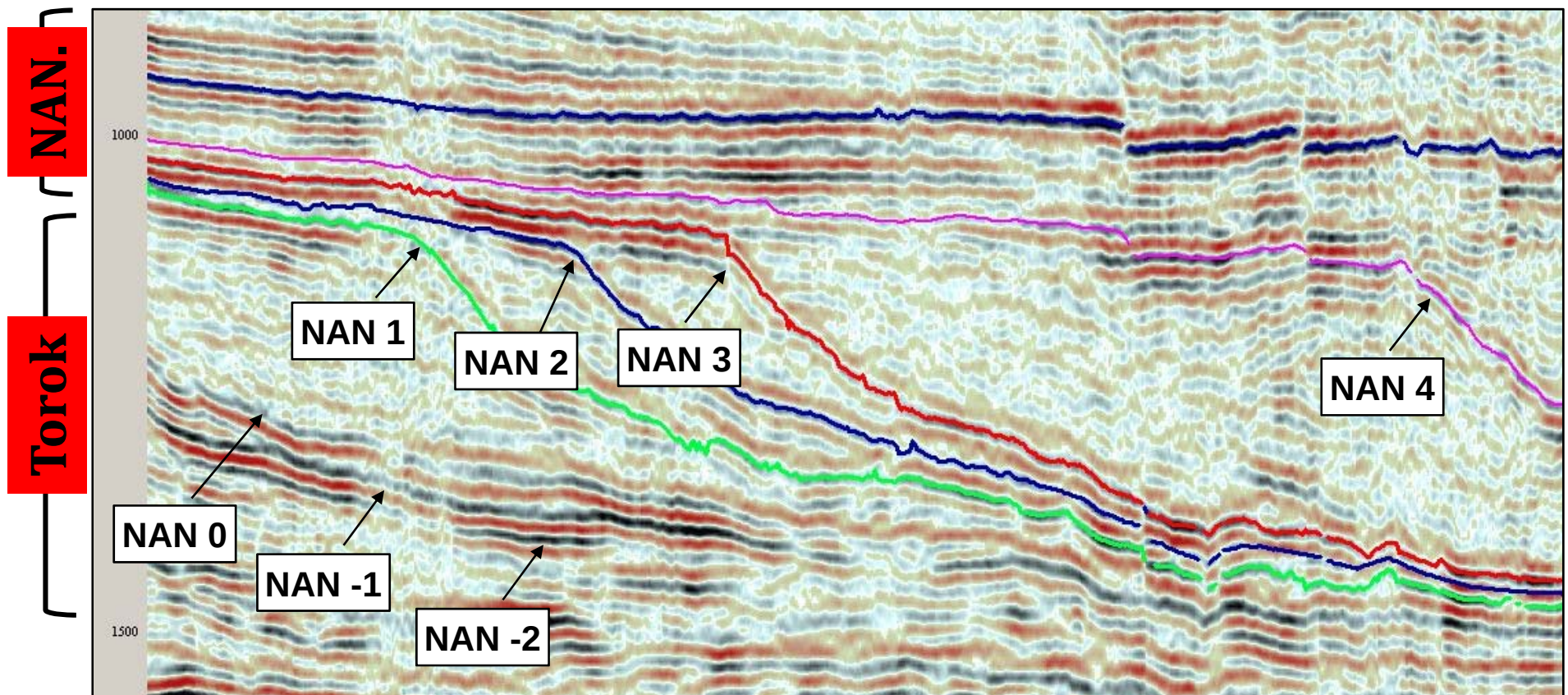
Highlights:

- 1) Shelf Breaks
- 2) Faulting
- 3) Poor Data (Lakes)

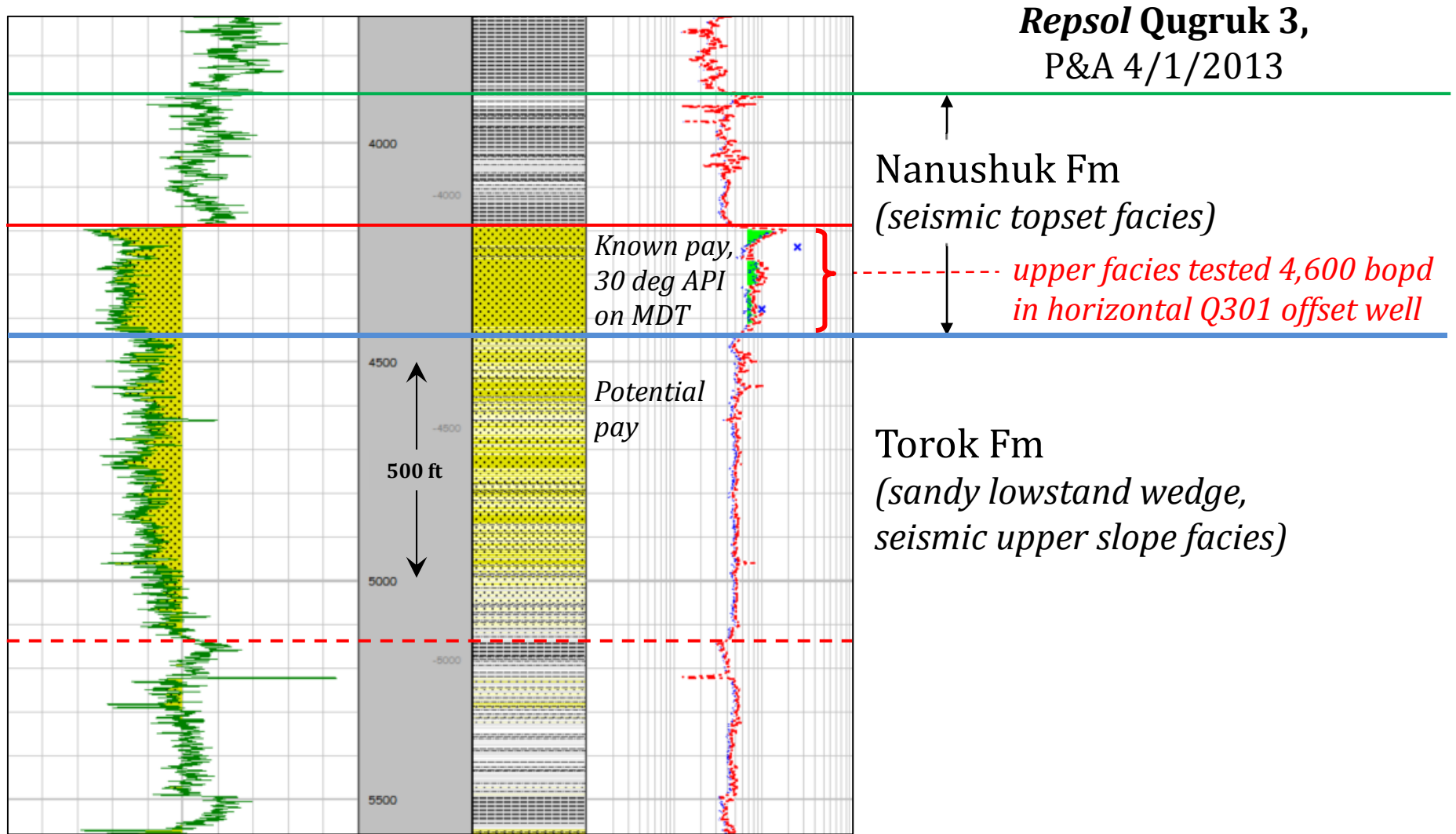
**Fullstack Semblance Time Slice at 1084ms*

DIP LINE: NANUSHUK SHELF EDGES

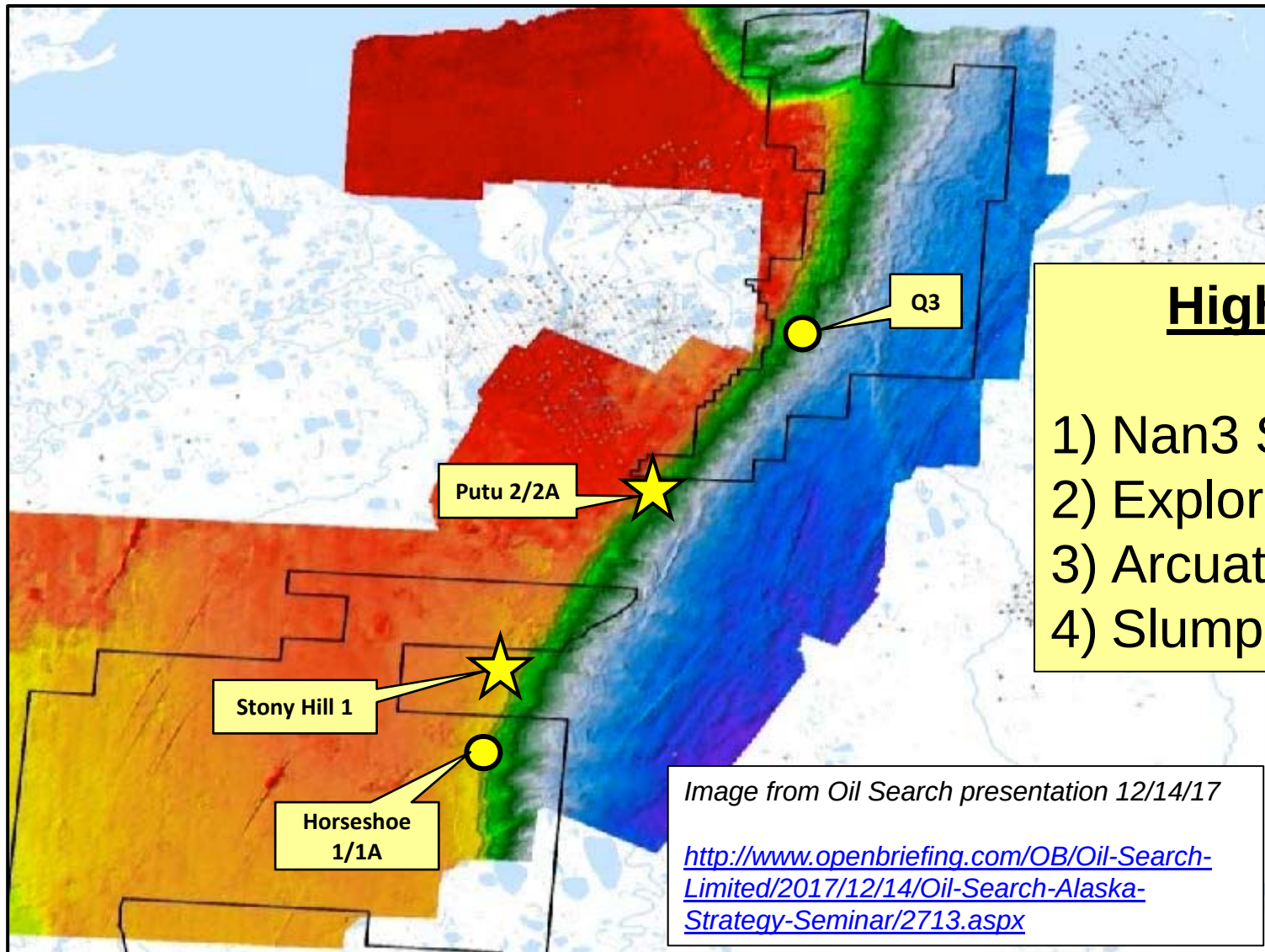
- Nanushuk Formation versus Torok Formation
- Time horizons carried from Nanushuk through the Torok



PIKKA DISCOVERY - NANUSHUK FM



PIKKA-HORSESHOE DISCOVERY



Highlights:

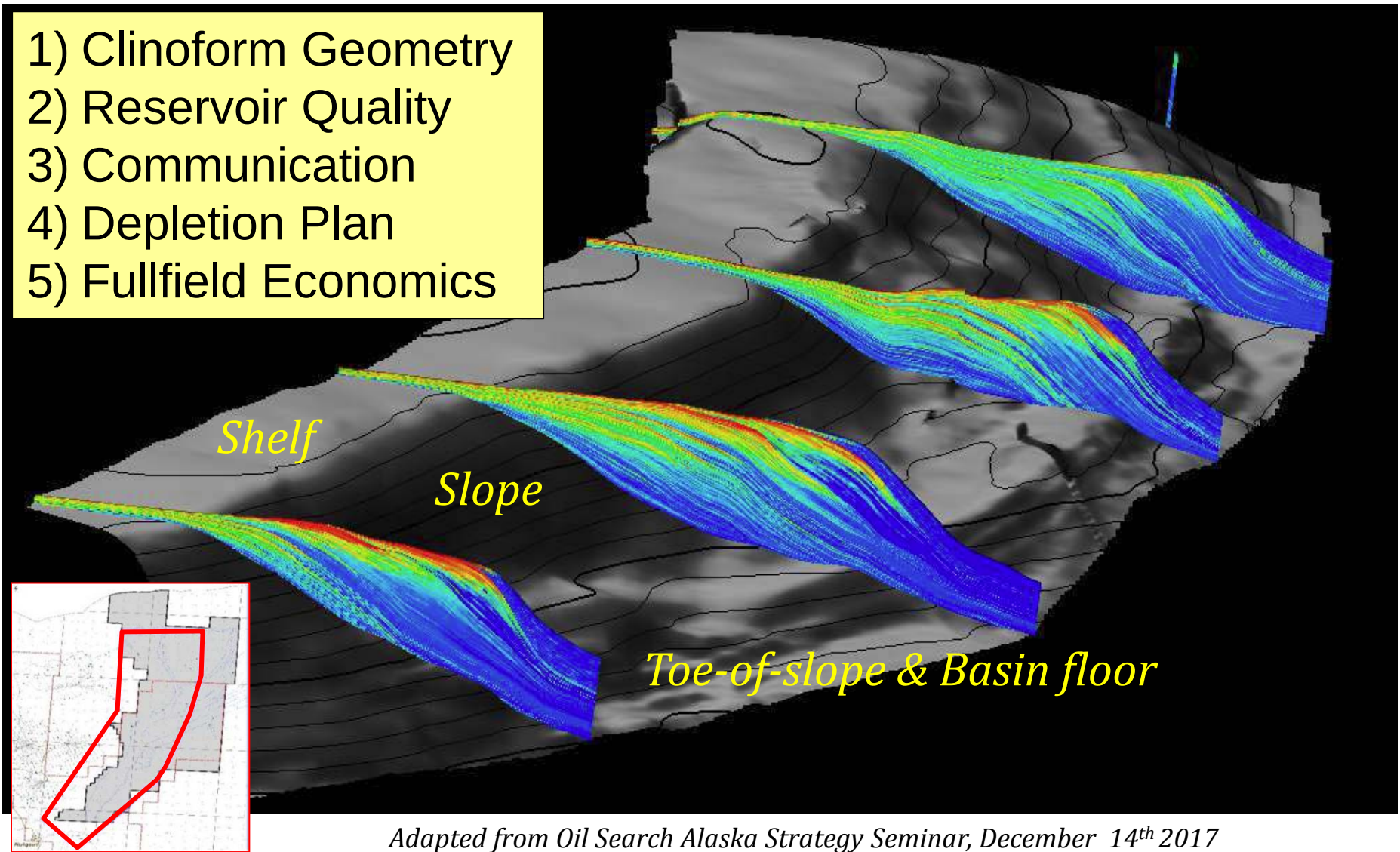
- 1) Nan3 Shelf Break
- 2) Exploration Wells
- 3) Arcuate Geometry
- 4) Slump

Image from Oil Search presentation 12/14/17

<http://www.openbriefing.com/OB/Oil-Search-Limited/2017/12/14/Oil-Search-Alaska-Strategy-Seminar/2713.aspx>

PIKKA NANUSHUK GEO-MODEL

- 1) Clinoform Geometry
- 2) Reservoir Quality
- 3) Communication
- 4) Depletion Plan
- 5) Fullfield Economics

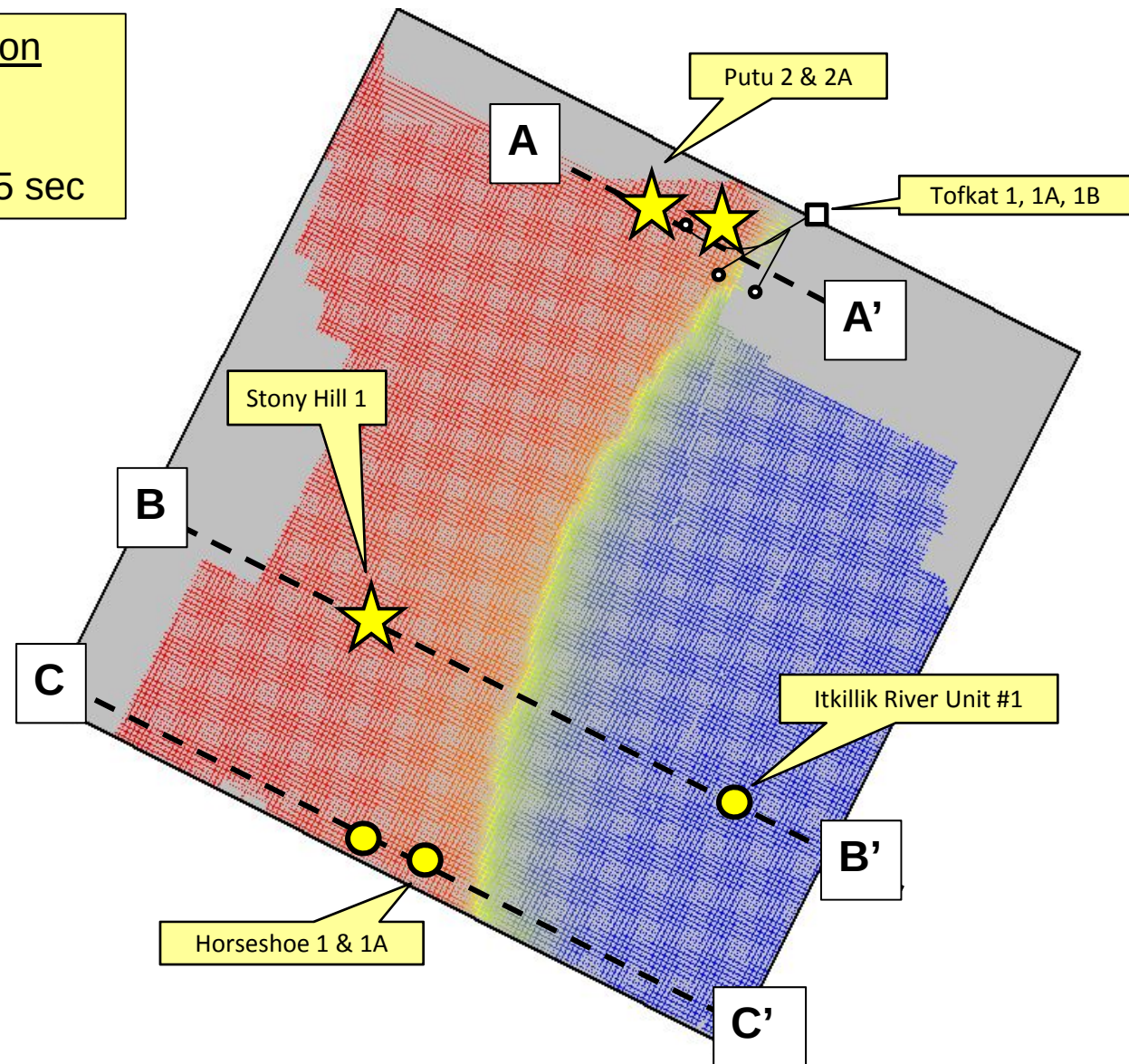


Adapted from Oil Search Alaska Strategy Seminar, December 14th 2017

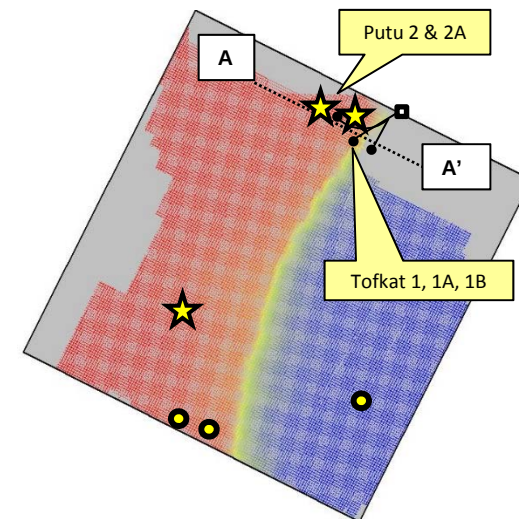
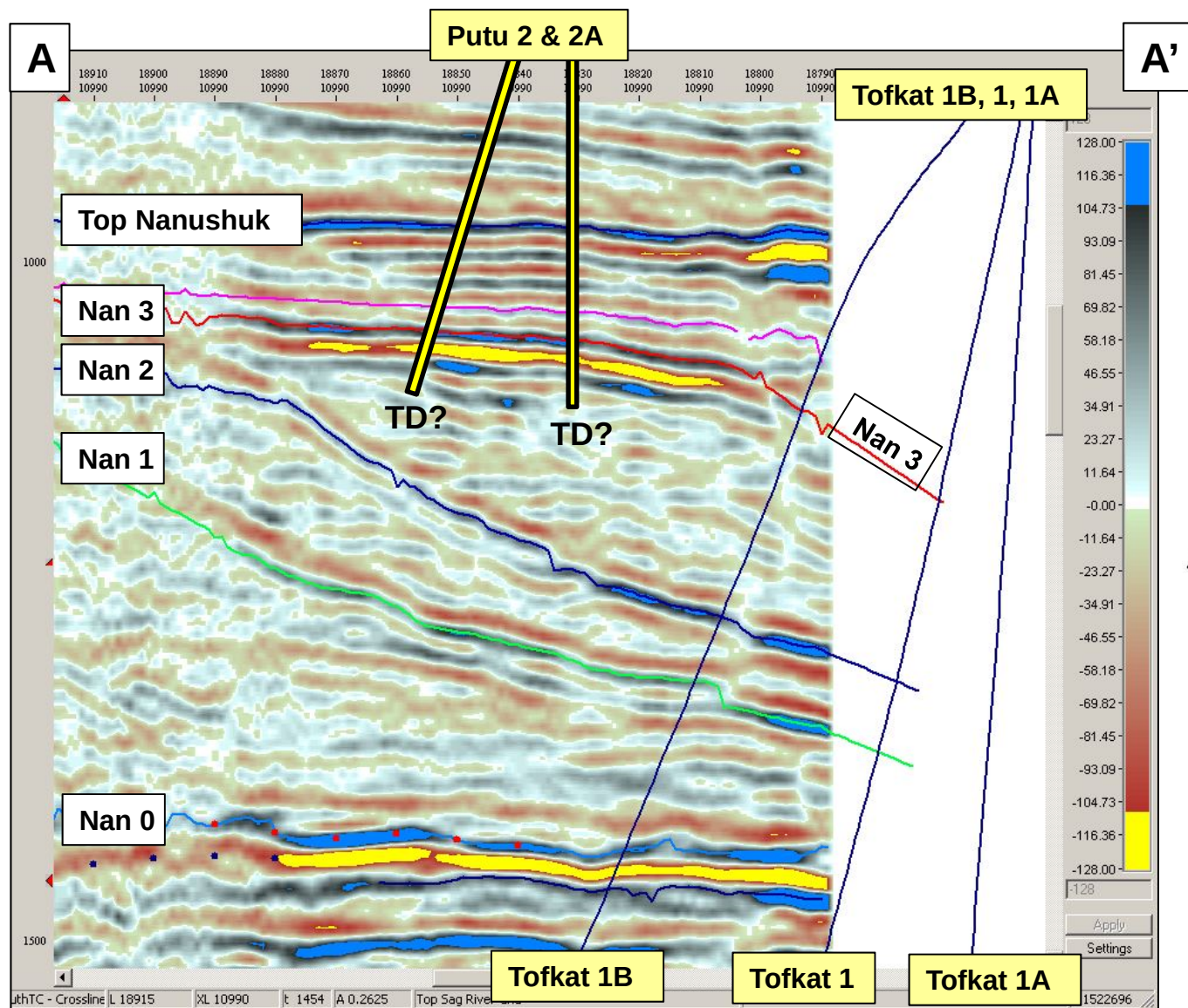
NANUSHUK 3 Two-Way-Time Horizon

Nan3 Two-Way Time Horizon

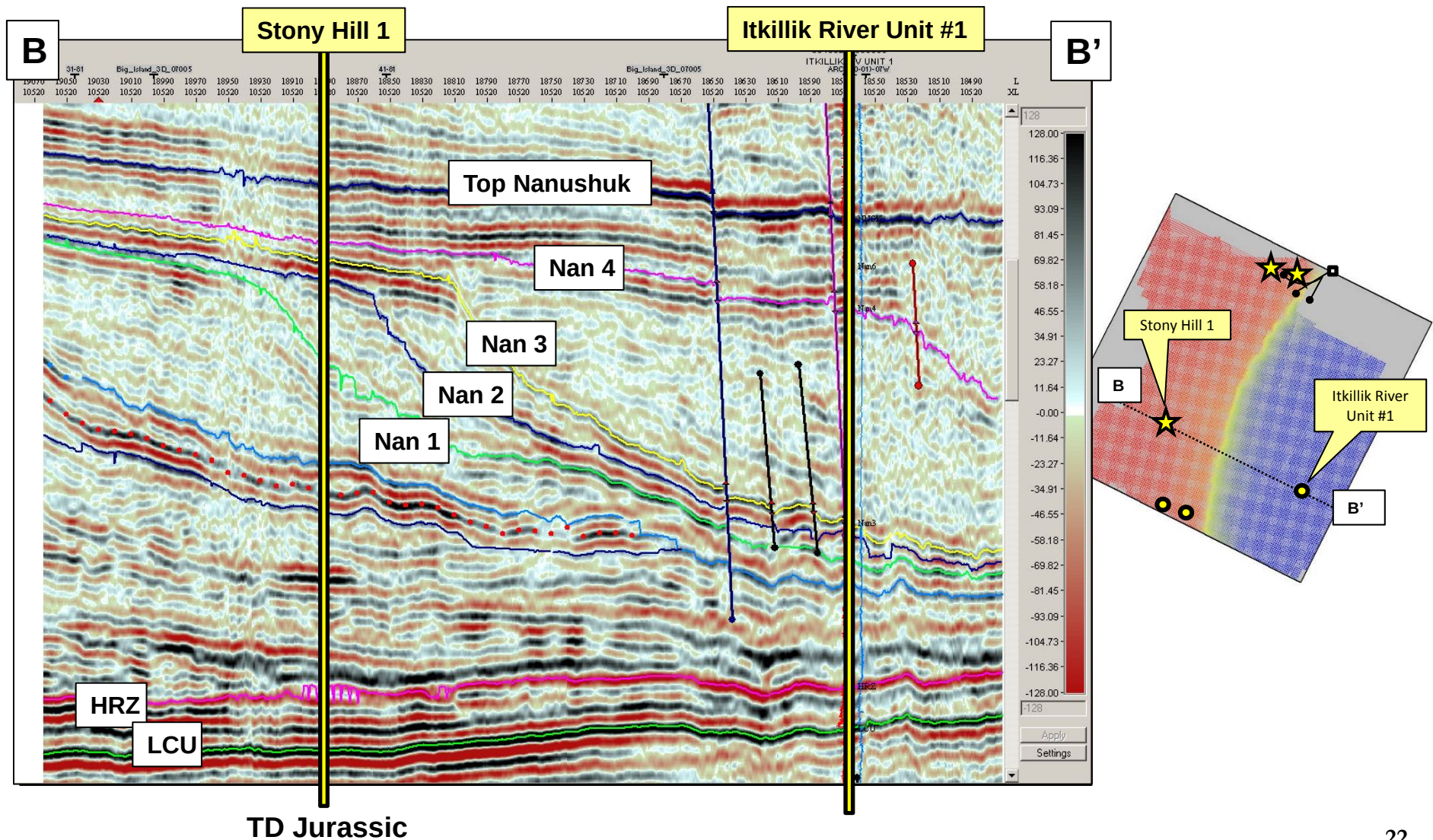
- Fullstack EES Volume
- Picked on 5X5 Grid
- TWT range: 0.95 to 1.45 sec



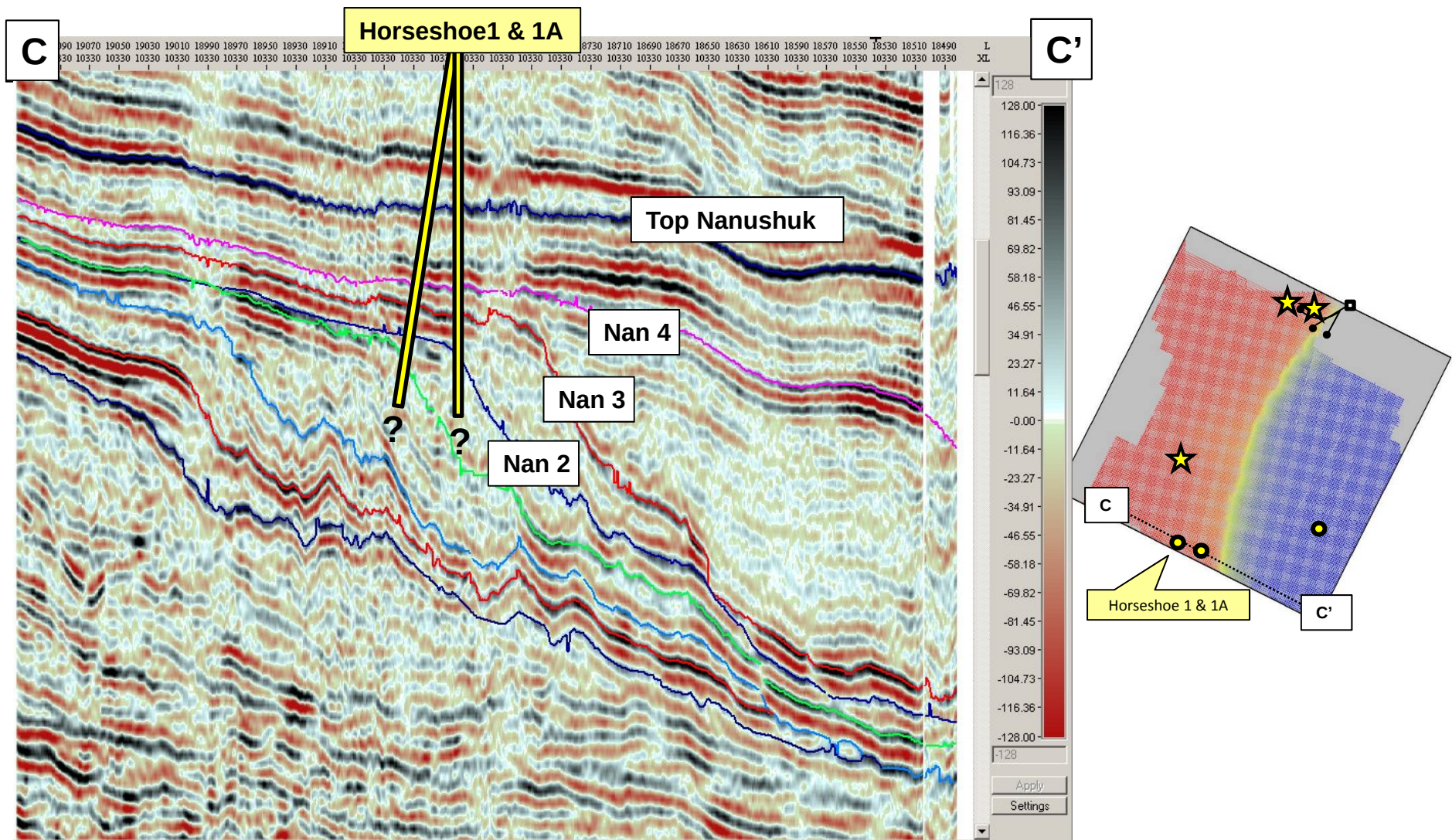
PUTU PROSPECT



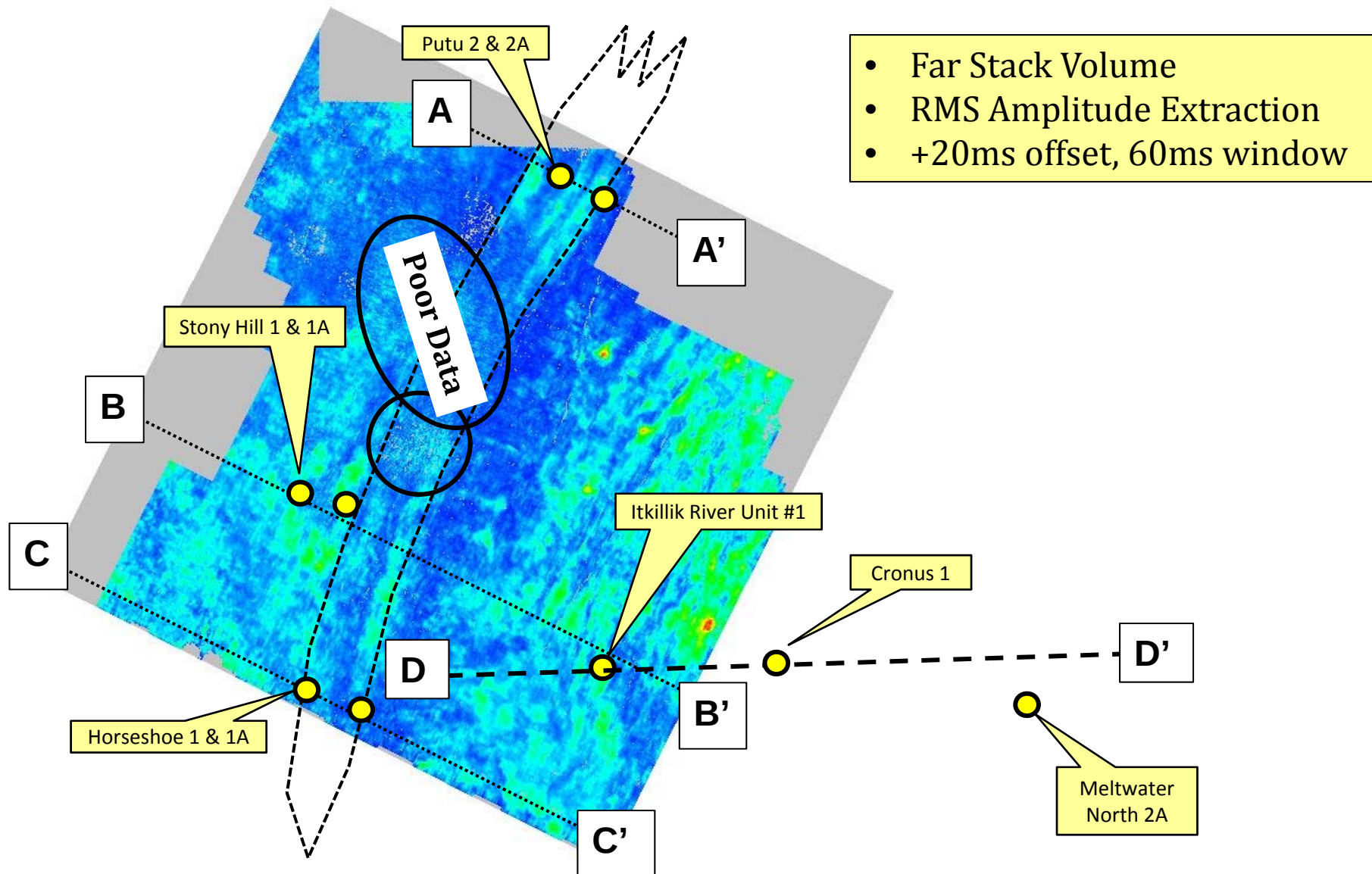
STONY HILL: NANUSHUK TARGET



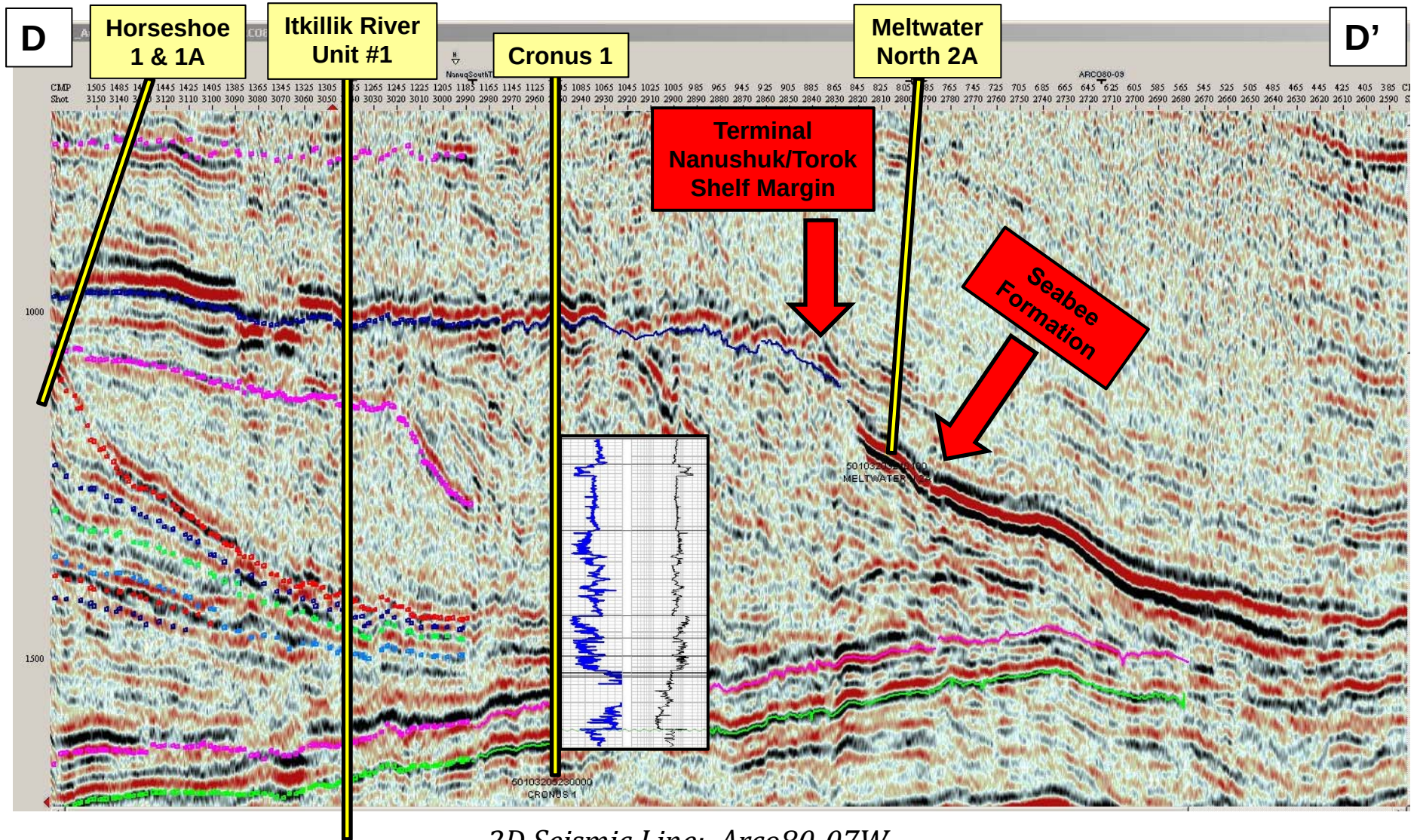
HORSESHOE PROSPECT



NANUSHUK 3 AMPLITUDE EXTRACTION



REGIONAL 2D LINE #1



2D Seismic Line: Arco80-07W

BROOKIAN EROSION MAP

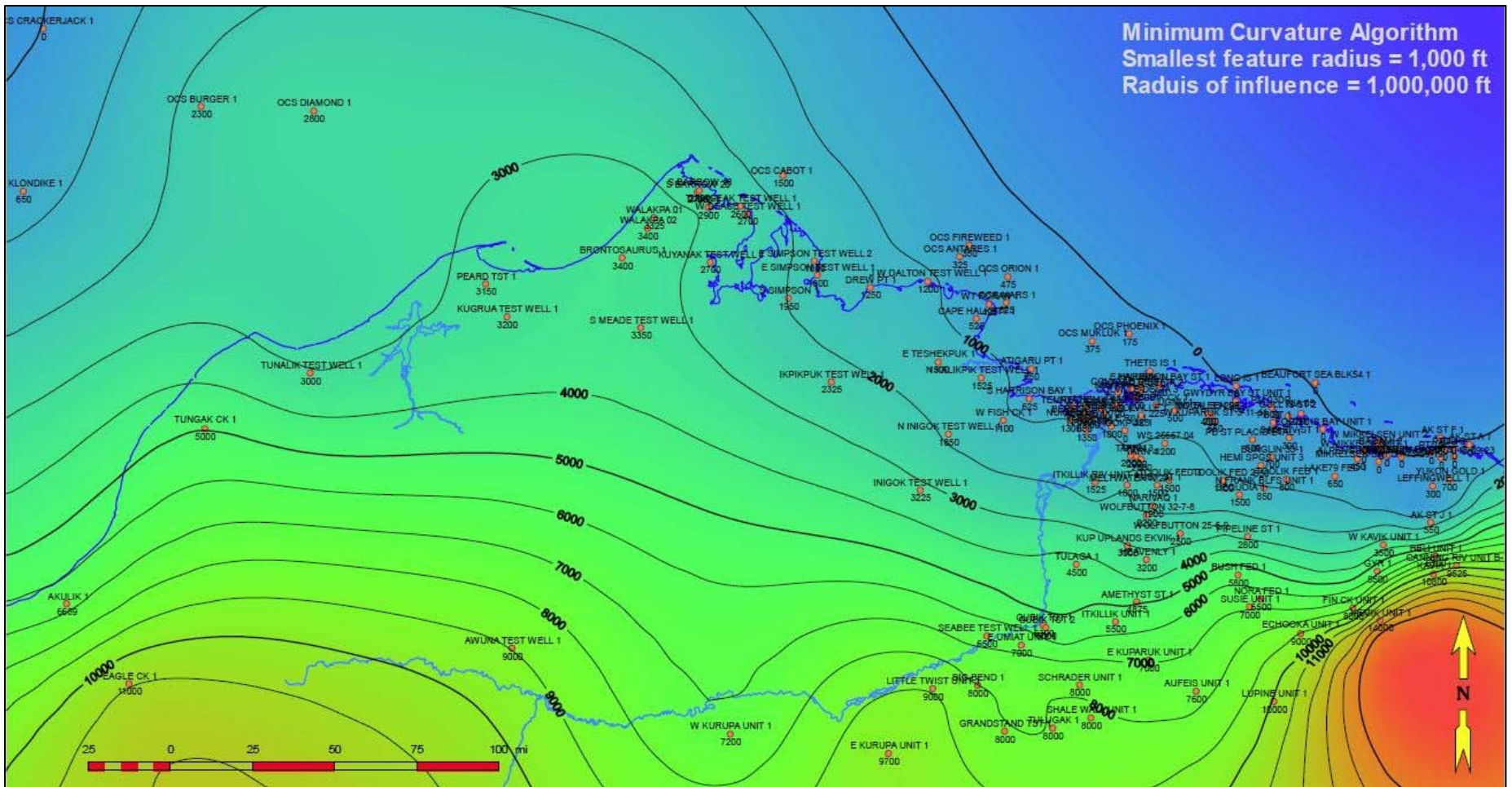
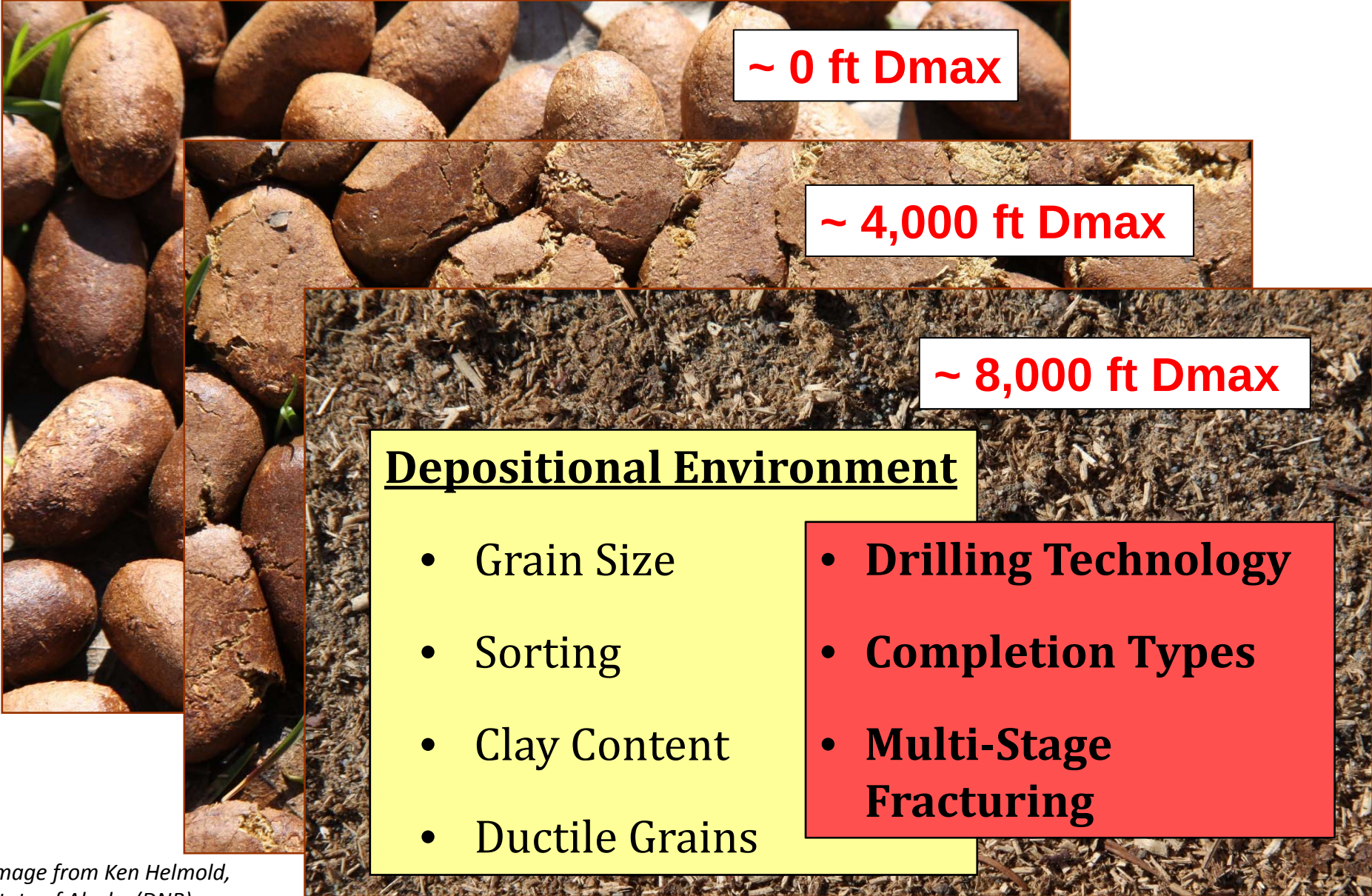


Image from Ken Helmold, State of Alaska (DNR), map contours based on data from USGS.

DUCTILE DEFORMATION ALASKA-STYLE



~ 0 ft Dmax

~ 4,000 ft Dmax

~ 8,000 ft Dmax

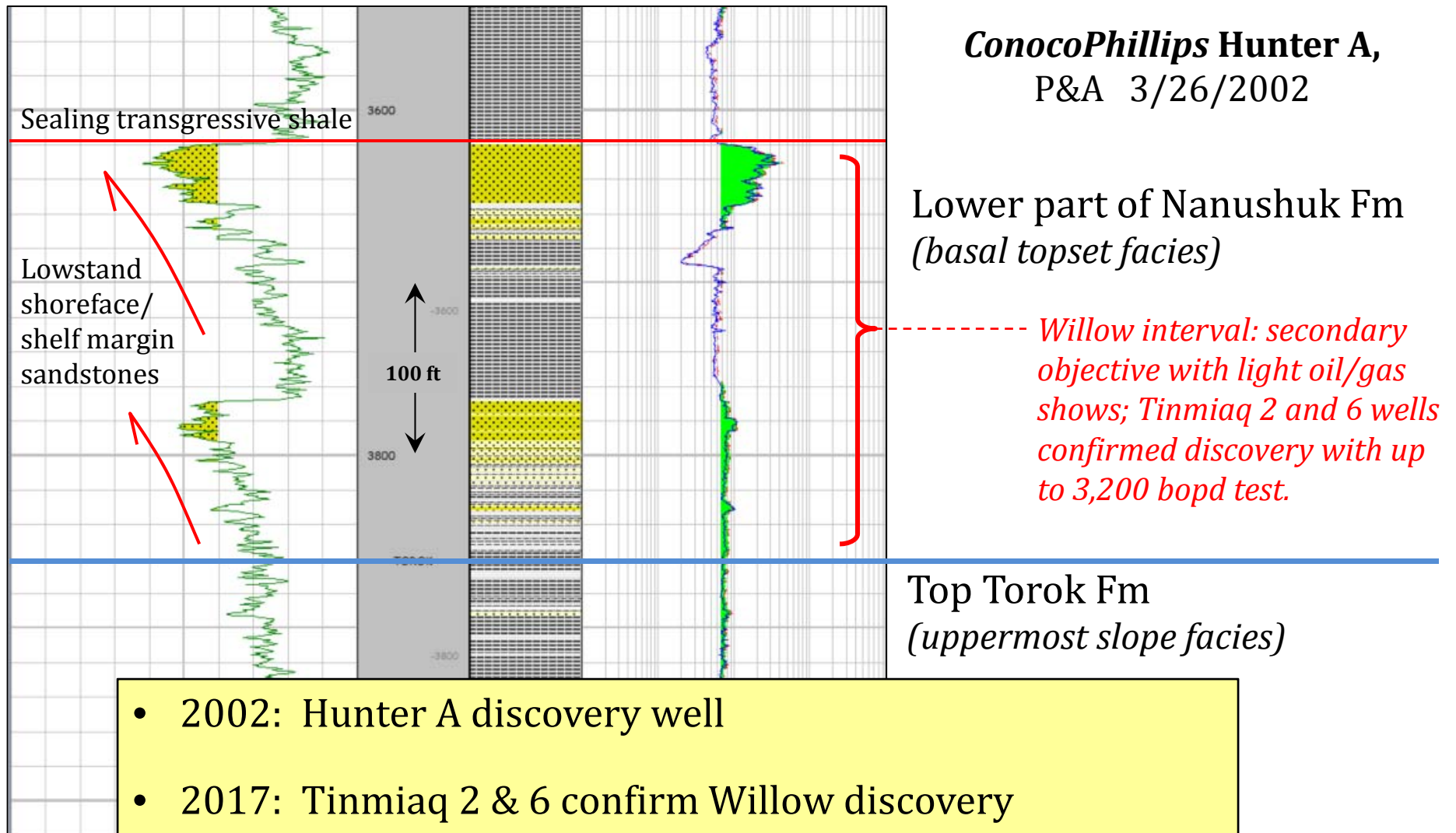
Depositional Environment

- Grain Size
- Sorting
- Clay Content
- Ductile Grains

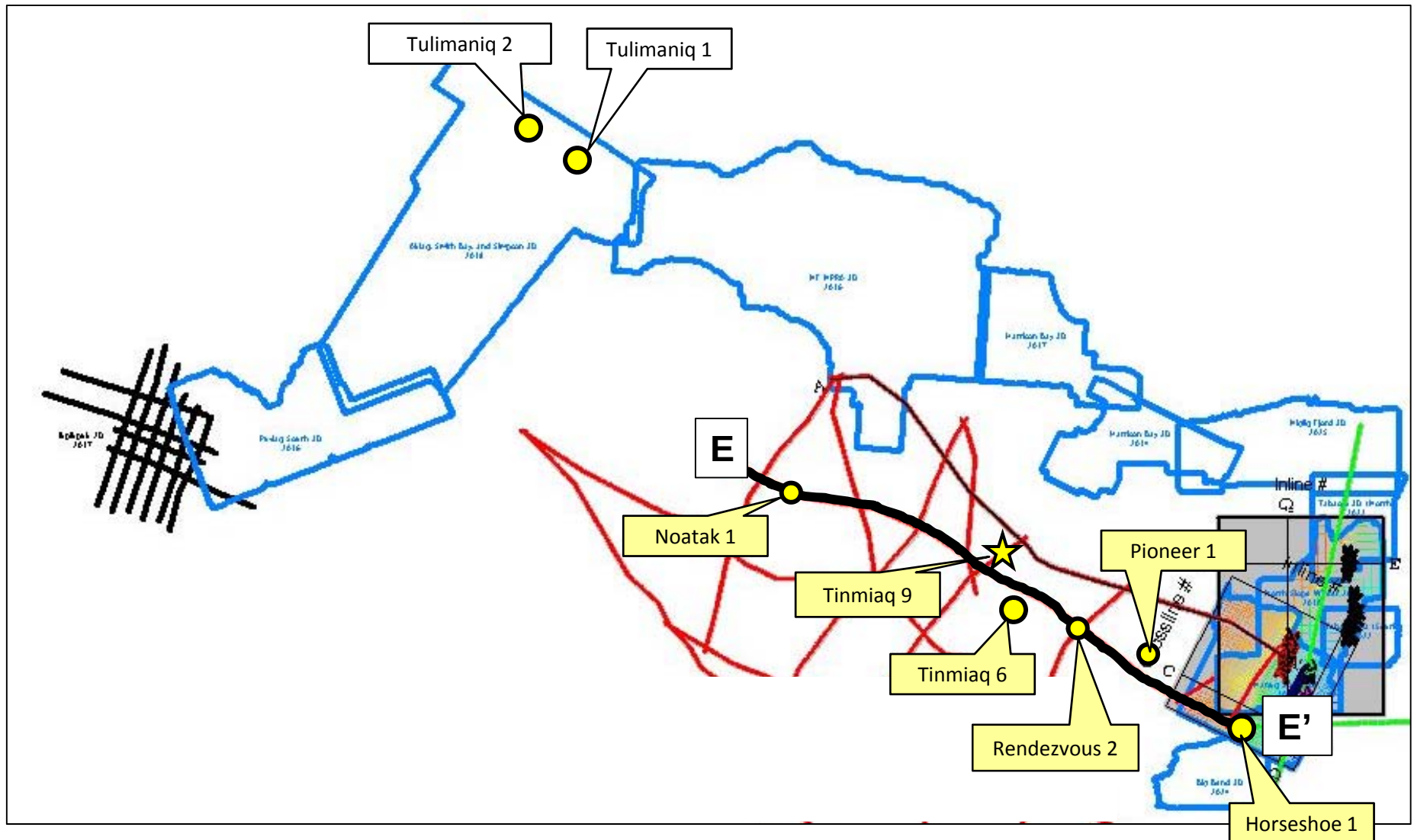
- Drilling Technology
- Completion Types
- Multi-Stage Fracturing

Image from Ken Helmold,
State of Alaska (DNR)

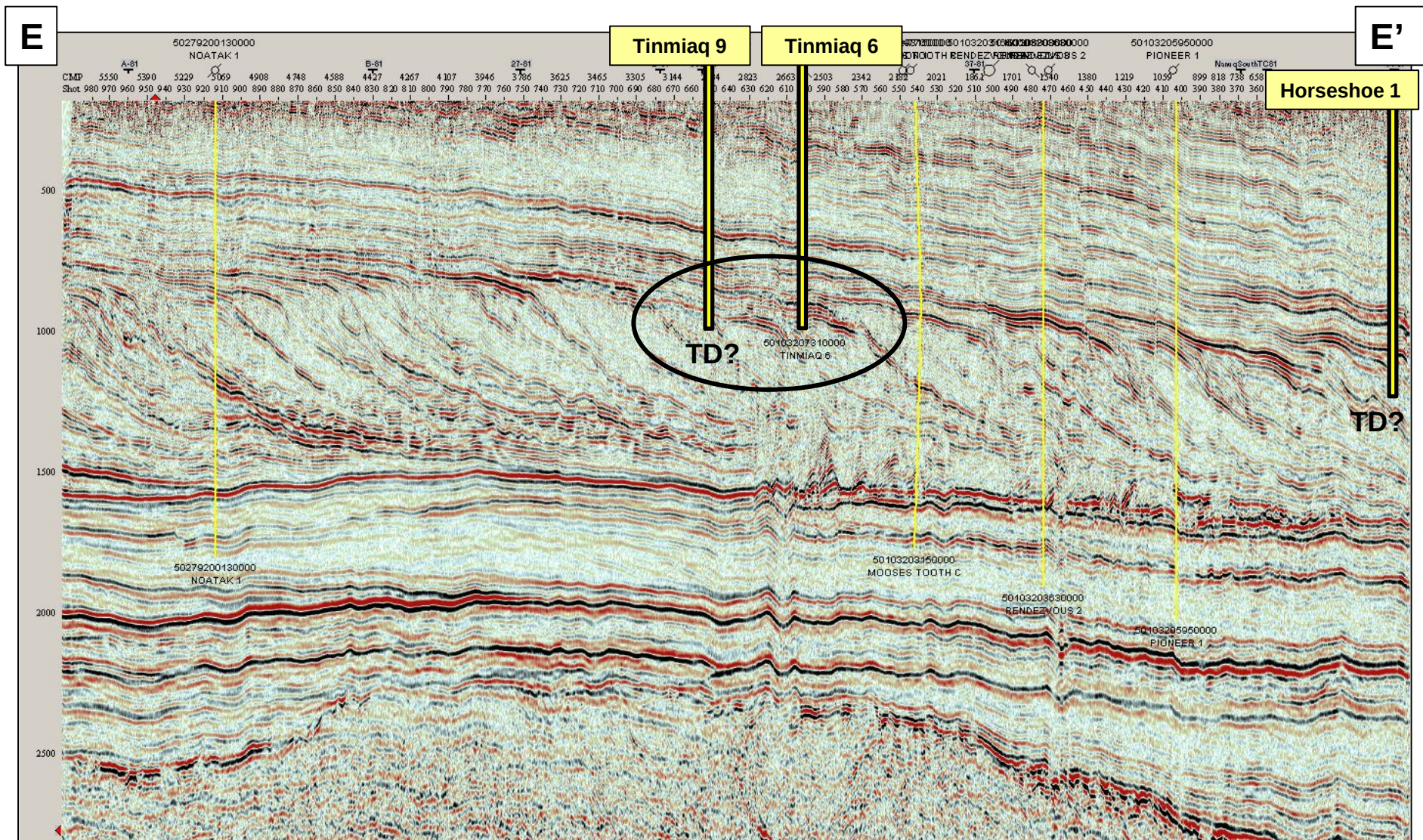
WILLOW DISCOVERY - NANUSHUK FM



2D SEISMIC LOCATOR MAP

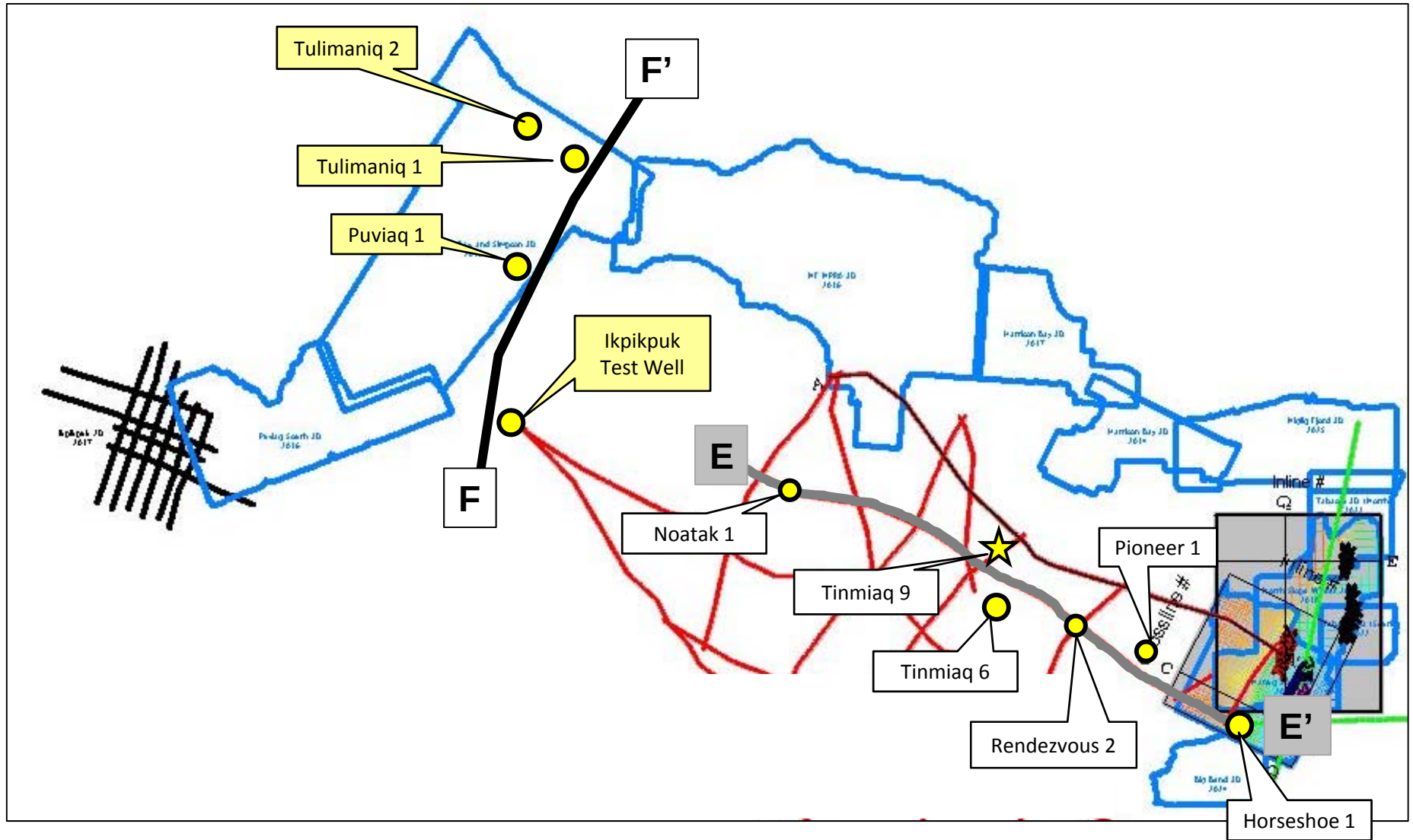


REGIONAL 2D LINE #2

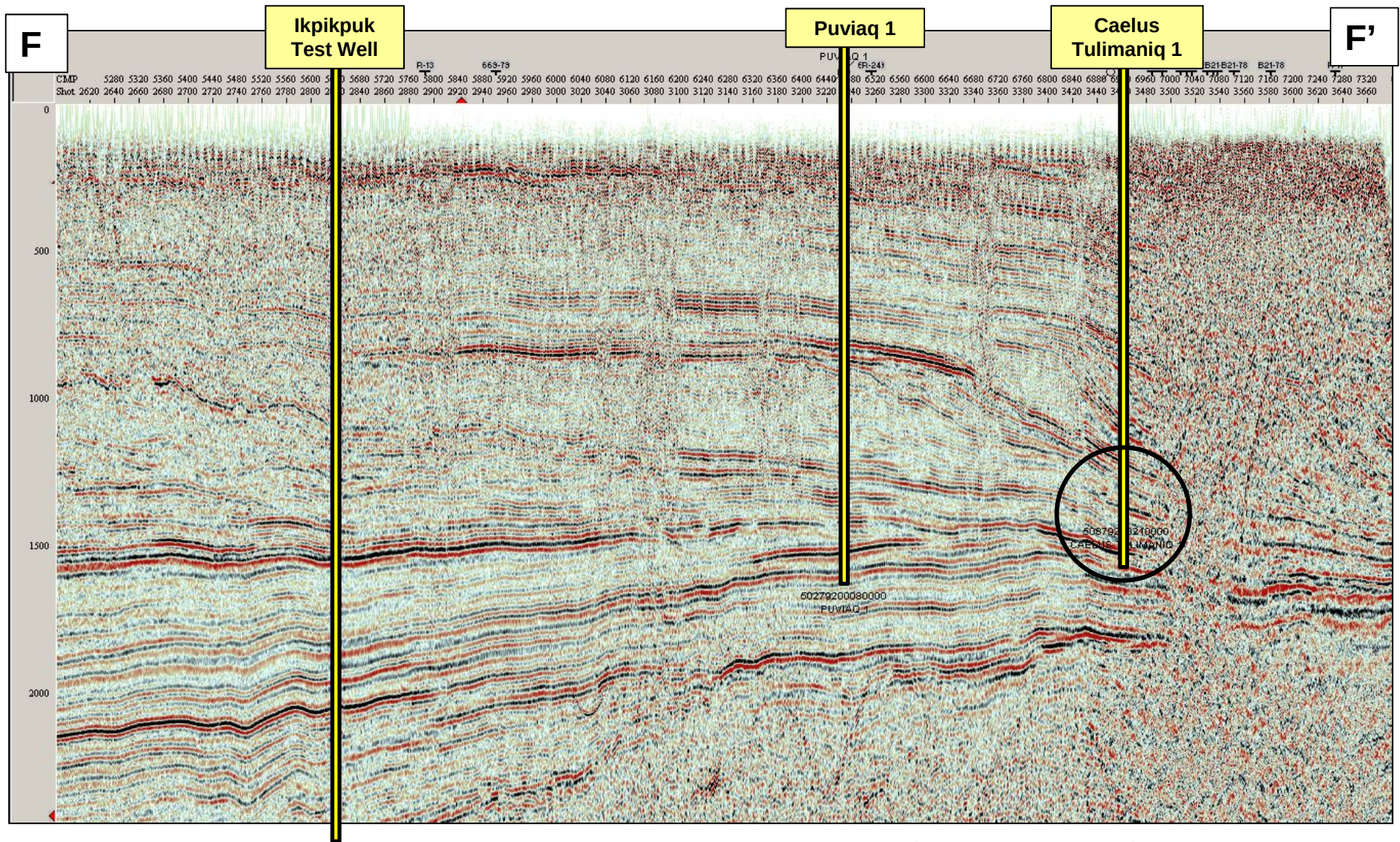


2D Seismic Line: NPRA USGS 1981-16-81-migrated

SMITH BAY SEISMIC DATA

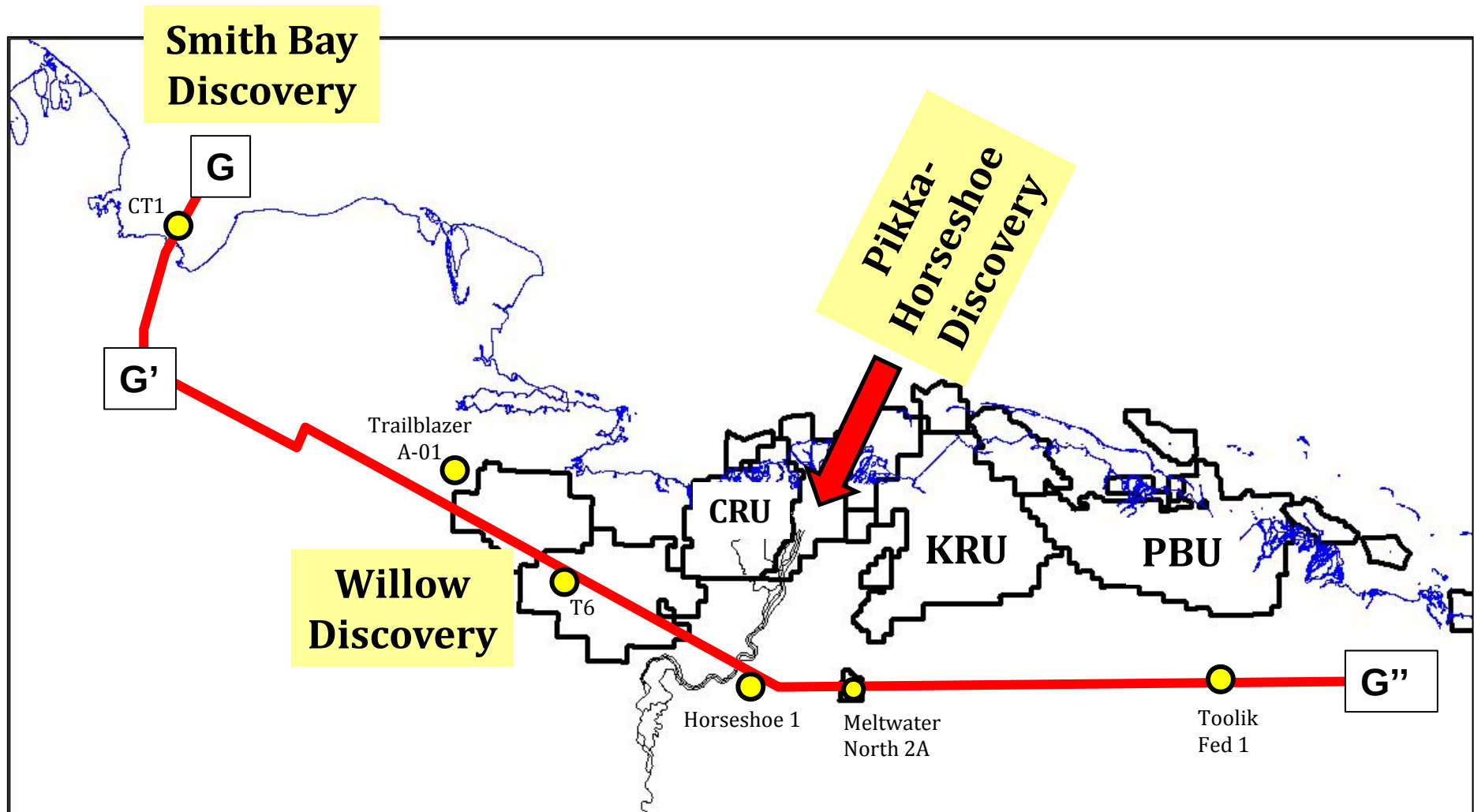


SMITH BAY: TOROK FAN SYSTEM

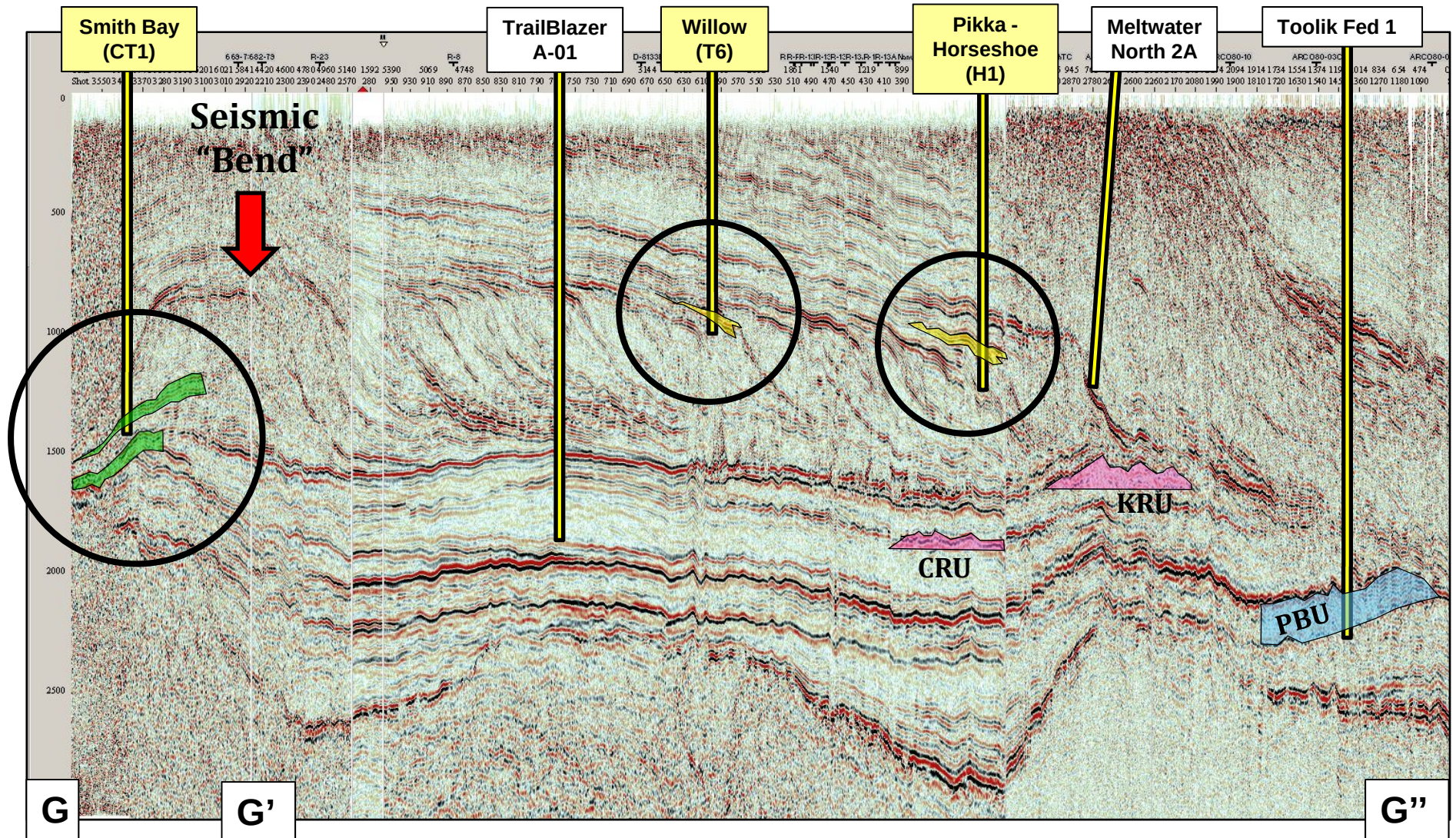


2D Seismic Line: USGS NPRA Regional 2D-R-7-original

COMPOSITE SEISMIC 2D LINE

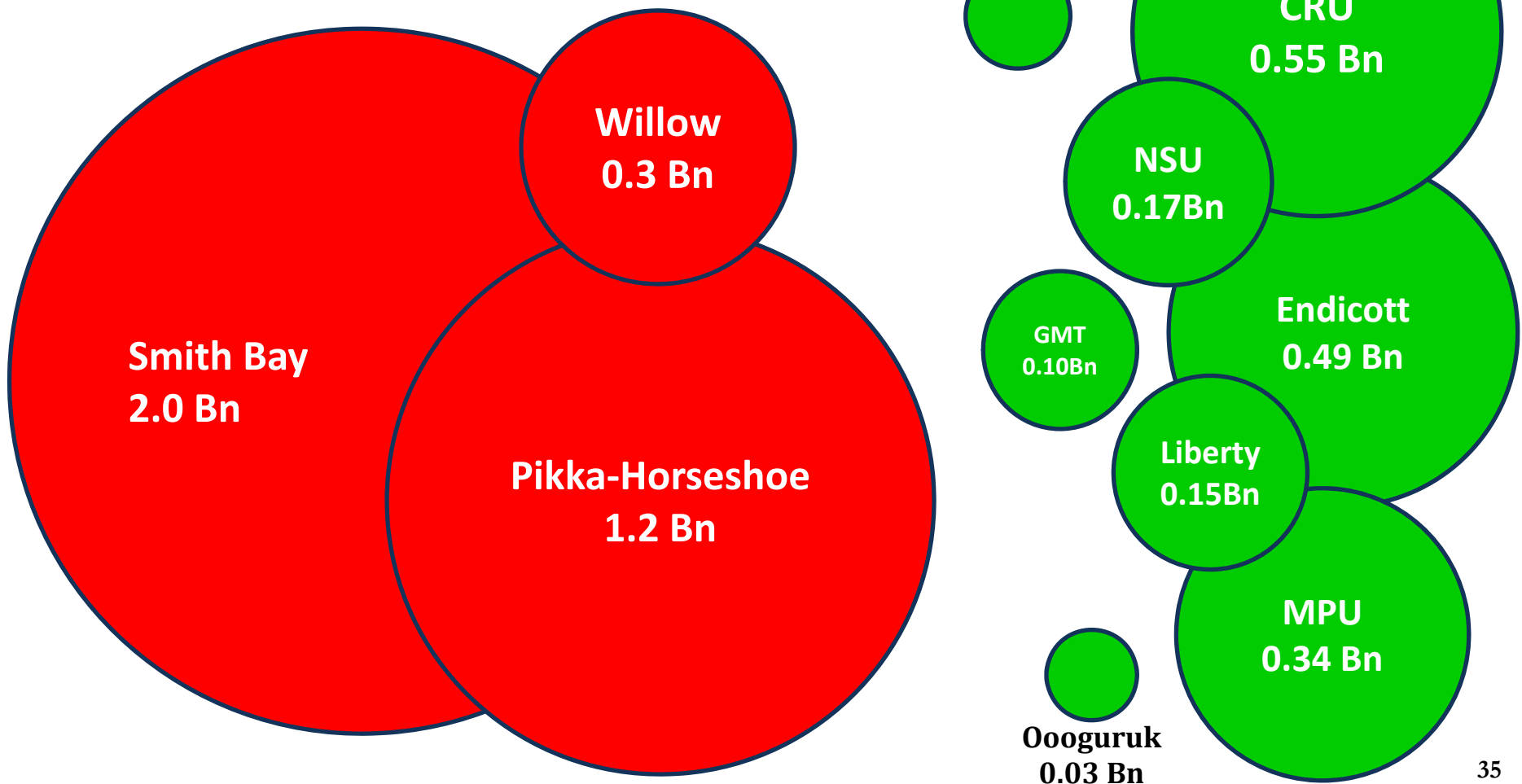


COMPOSITE SEISMIC 2D LINE



NORTH SLOPE FIELDS

PBU 12.8 Bn bbls = 11.5"
KRU 2.7 Bn bbls = 5.2"
PTU 1.4 Bn boes = 3.8 "



UNDISCOVERED RESOURCES

- **2017 Reassessment:** onshore NPRA (USGS) and offshore (BOEM)
- **Undiscovered Resources:** mean, technically recoverable, conventional
- **Brookian:** far more prospective than previously recognized
- **Example:** Willow (~300 MMBO) alone exceeds the 2010 USGS upside estimate of ~249 MMBO (F5 case)

Play	2017 USGS	2017 BOEM
Nanushuk	6,100 MMBO	1,100 MMBO
Torok	2,600 MMBO	150 MMBO

Onshore & SOA Waters

Federal OCS Waters

2017 USGS Fact Sheet ISSN-6916 and 2017 BOEM Fact Sheet RED-2017-12b

KEY TAKEAWAYS

- **Regional Understanding:** Nanushuk-Torok system
- **2018 Exploration Wells:** why they are where they are
- **New Discoveries:**
 - o Varying levels of exploration/appraisal maturity
 - o Large in-place volumes
 - o Under-explored region
- **Tax Credit Program:** high quality 2D/3D seismic currently available with several more released per year until 2025

QUESTIONS

