Major Oil Finds and Exploration Potential in the Brookian Sequence, Alaska North Slope

North American Prospect Expo 2018

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Alaska Department of Natural Resources

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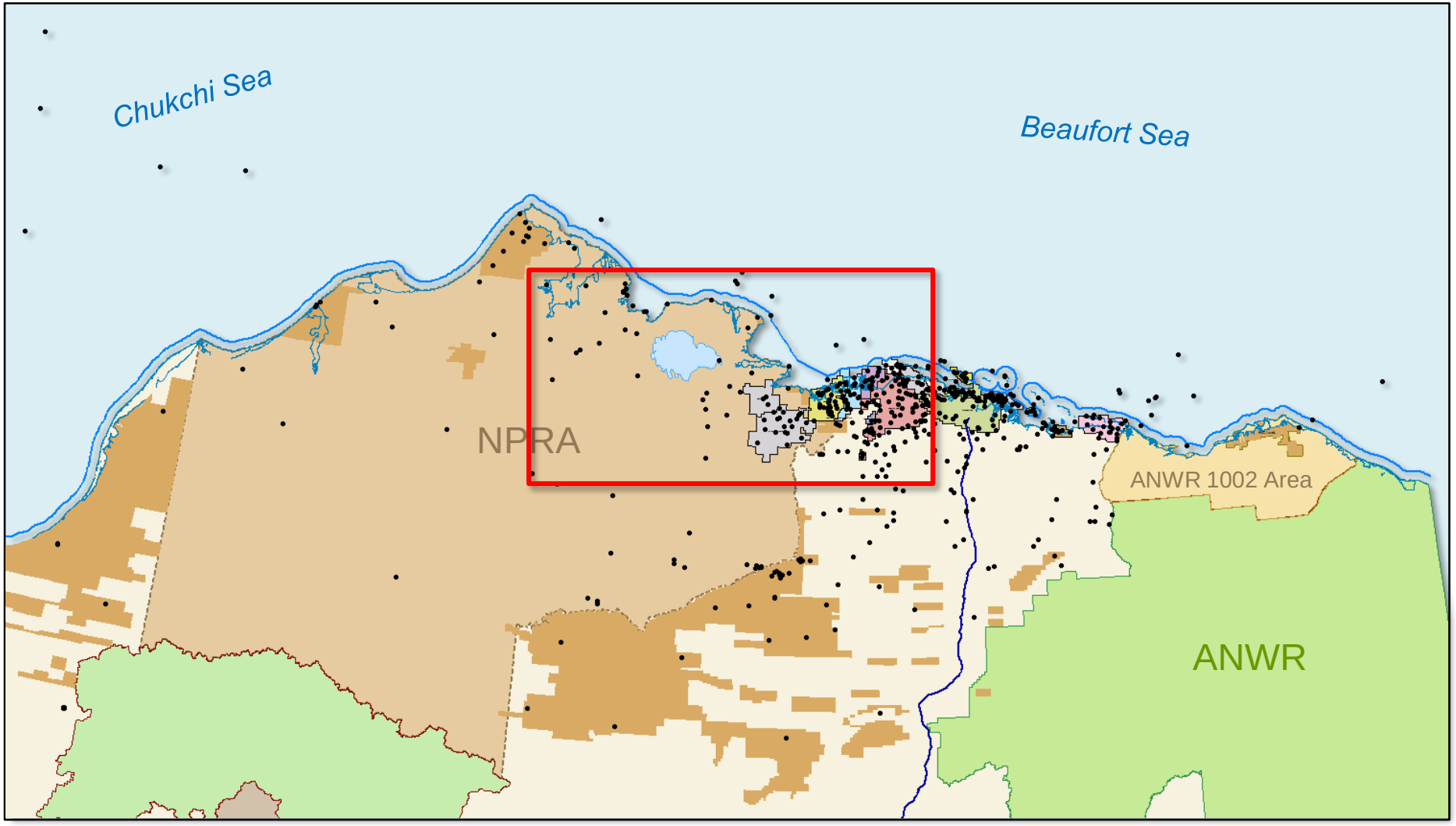
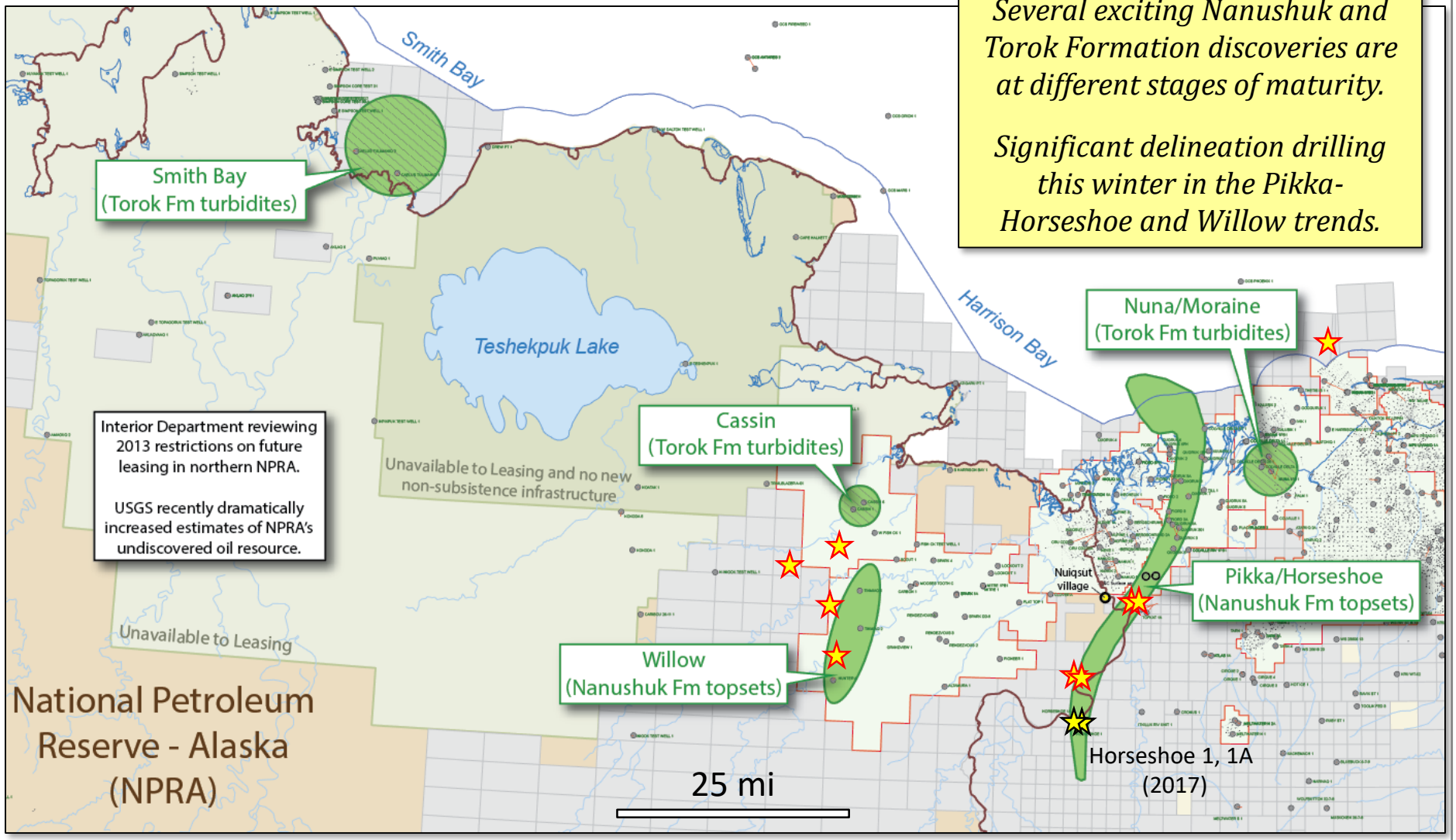
Northern Alaska Locator Map



North Slope Brookian Discoveries
- Nanushuk and Torok Formations -



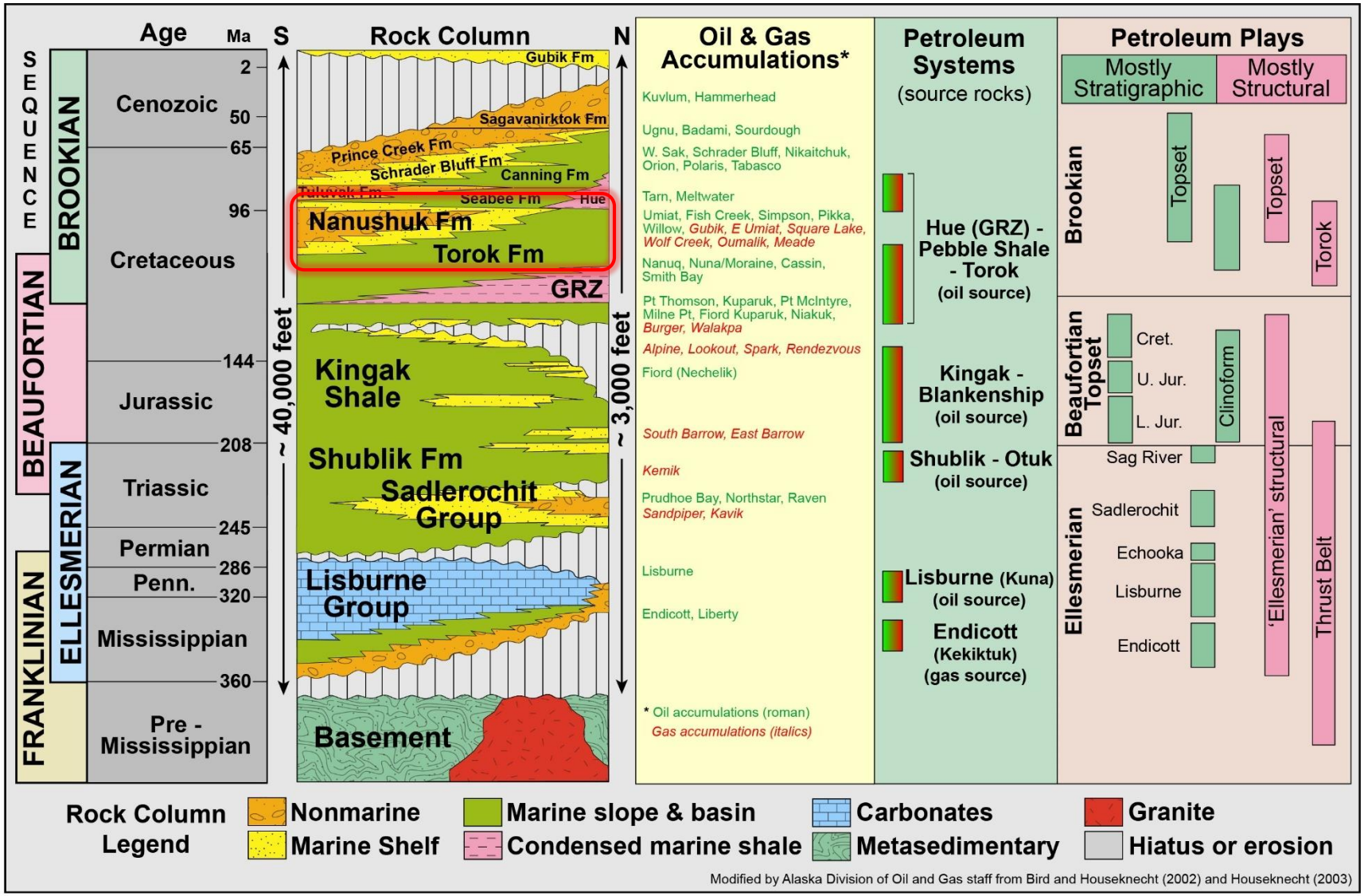
Several exciting Nanushuk and Torok Formation discoveries are at different stages of maturity.

Significant delineation drilling this winter in the Pikka-Horseshoe and Willow trends.

Major Recent Brookian Discoveries

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

North Slope Petroleum Systems



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

Brookian Sequence and Plays

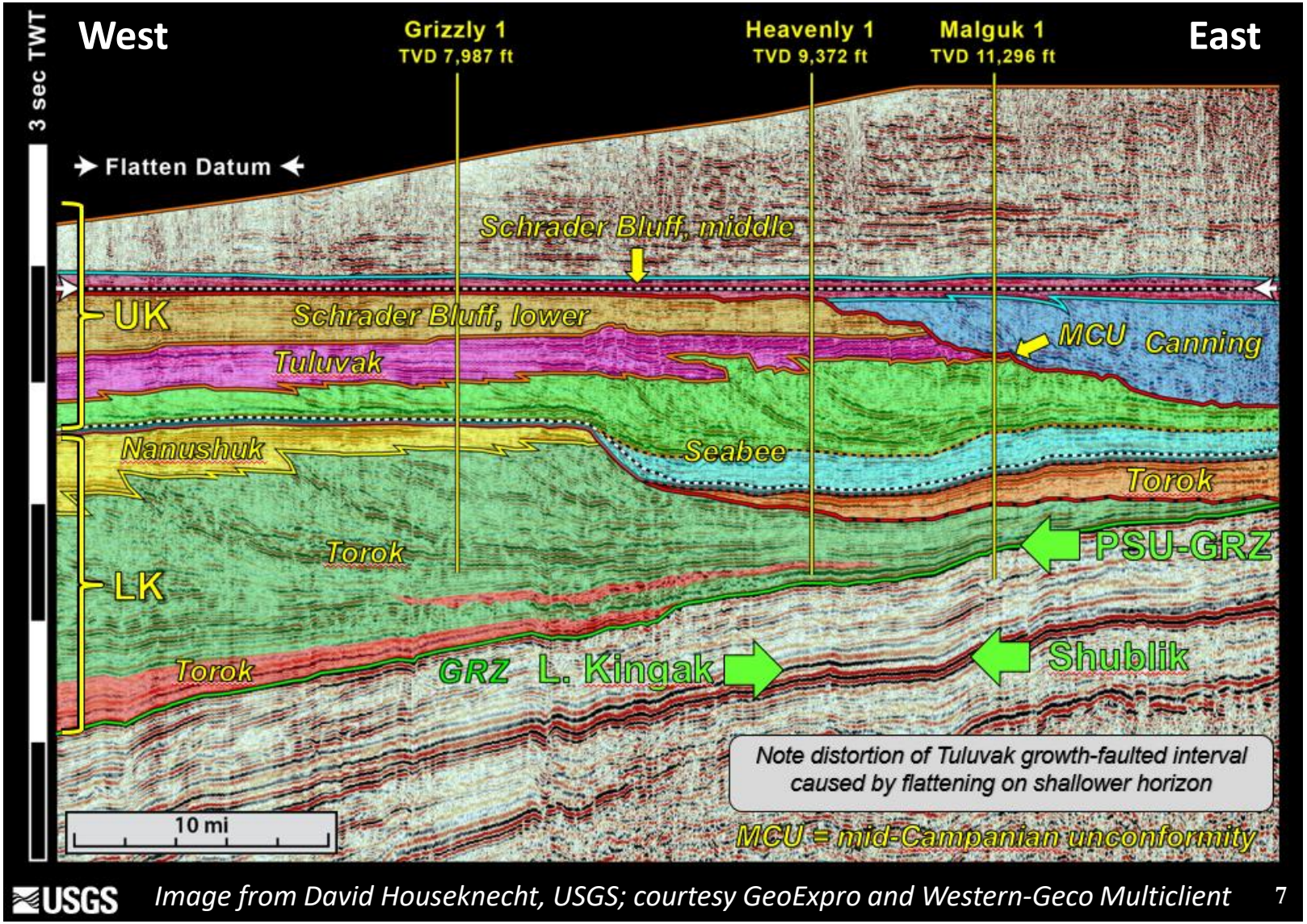
- The Brookian sequence represents a wide range of clastic rocks shed from the Chukotka and ancestral Brooks Range orogens into the Colville foreland basin during Cretaceous and Tertiary time.
- Multiple formations make up the clinoformal succession, which filled the basin from west to east.

- Readily apparent in seismic, Brookian clinoforms consist of
  - *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
- In the central to western North Slope, the topsets are the Nanushuk Formation, whereas the time-equivalent foresets and bottomsets represent the Torok Formation.
- Nanushuk tends to have superior reservoir quality due to matrix winnowing and less compaction (shallower burial)

Cretaceous Brookian Sequence
- Line A -

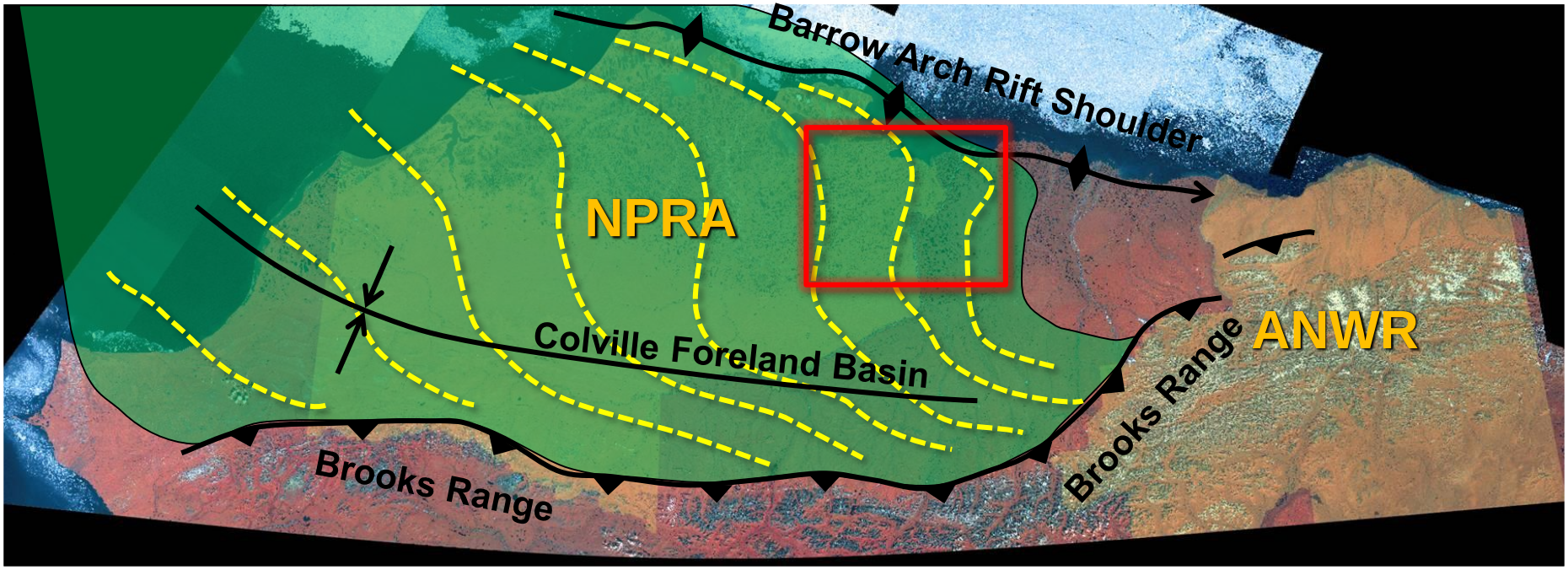
Nanushuk Fm
Topsets

Torok Fm
Slope foresets & Basin-floor bottomsets



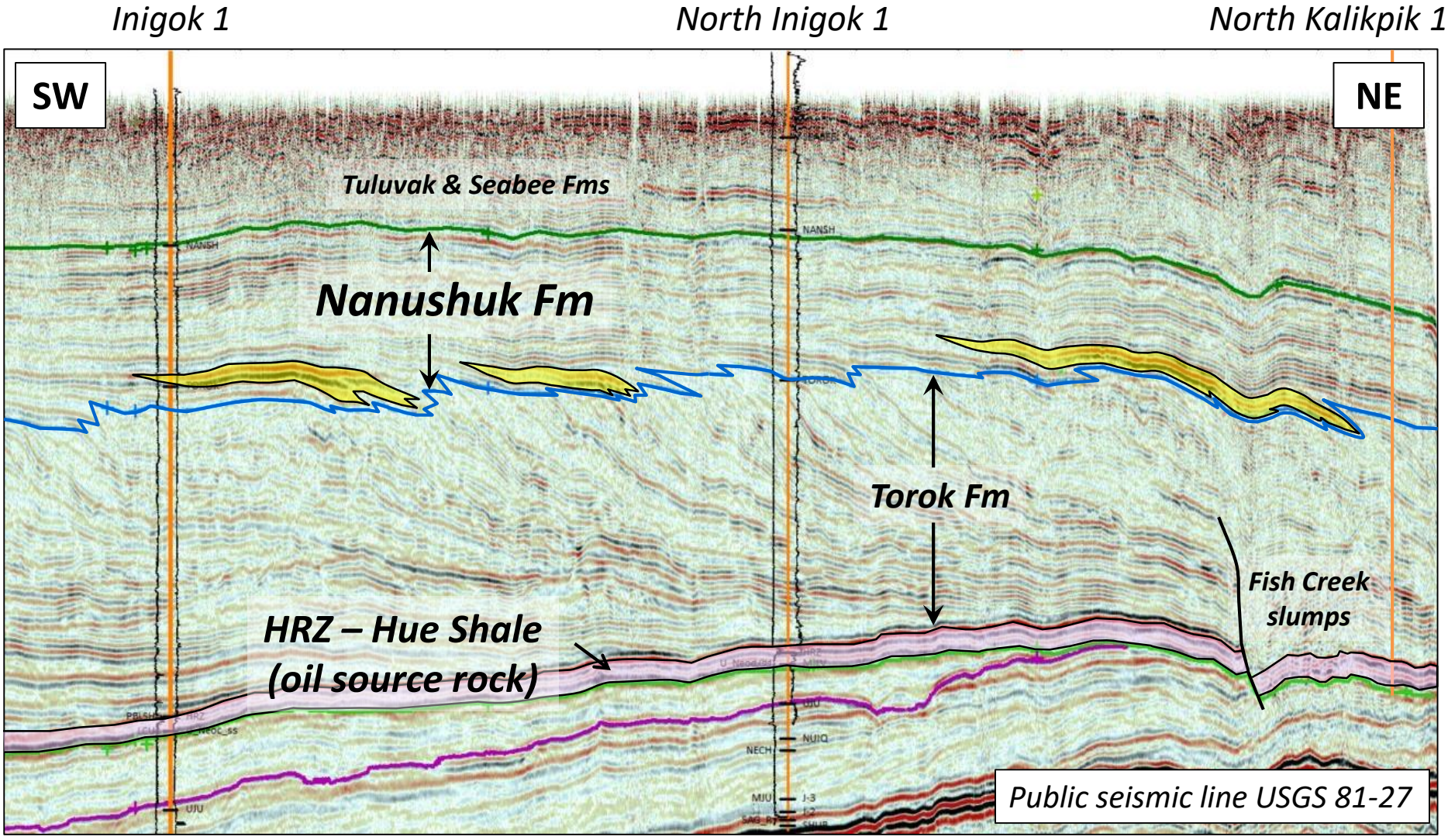
USGS *Image from David Houseknecht, USGS; courtesy GeoExpro and Western-Geco Multiclient*

Lower Brookian Depositional Systems

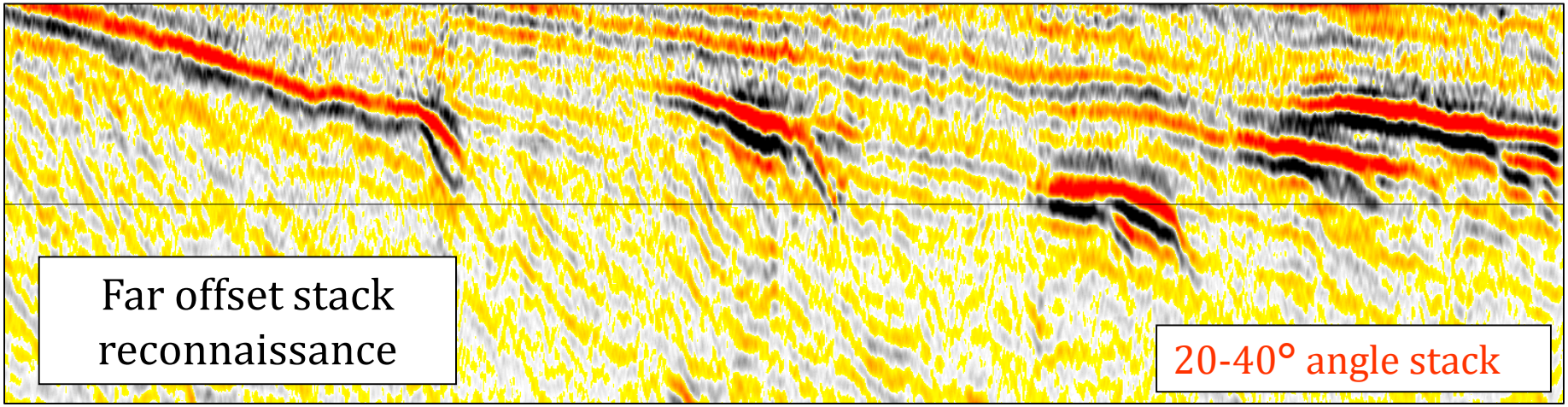


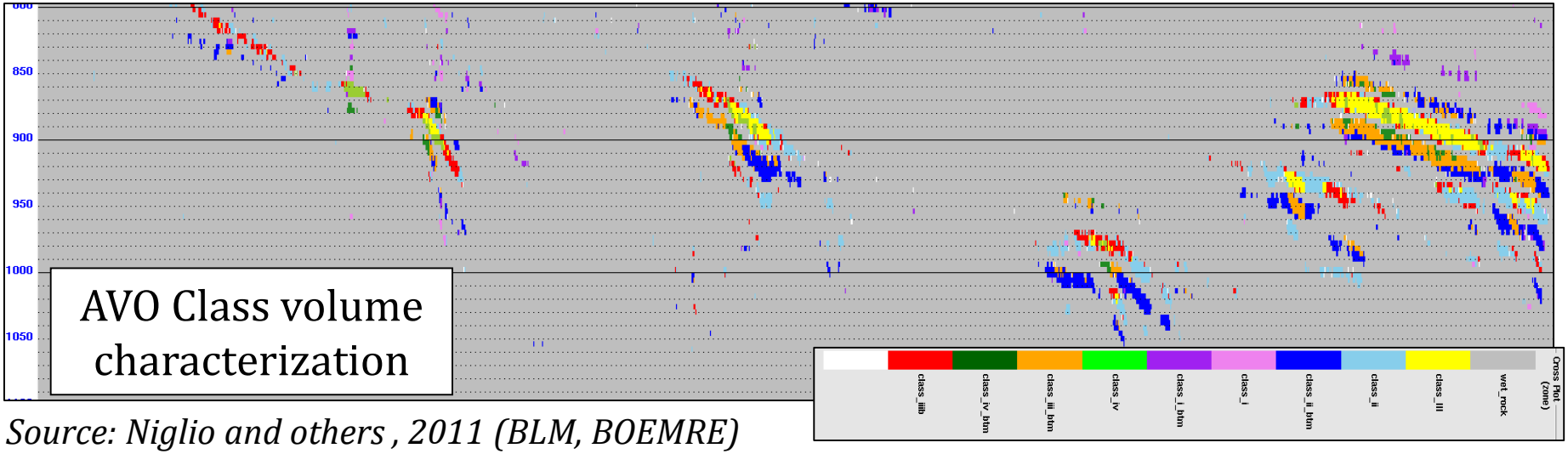
- *Overall progradation of Nanushuk-Torok clinothem across foreland basin illustrated schematically as series of advancing shelf margins.*
- *Numerous higher-order sea-level fluctuations repeatedly set up potential for enhanced reservoir and stratigraphic traps.*
- *Play extends across central and western North Slope.*

Basal Nanushuk Seismic Anomalies - 1981 2D data, NPRA -



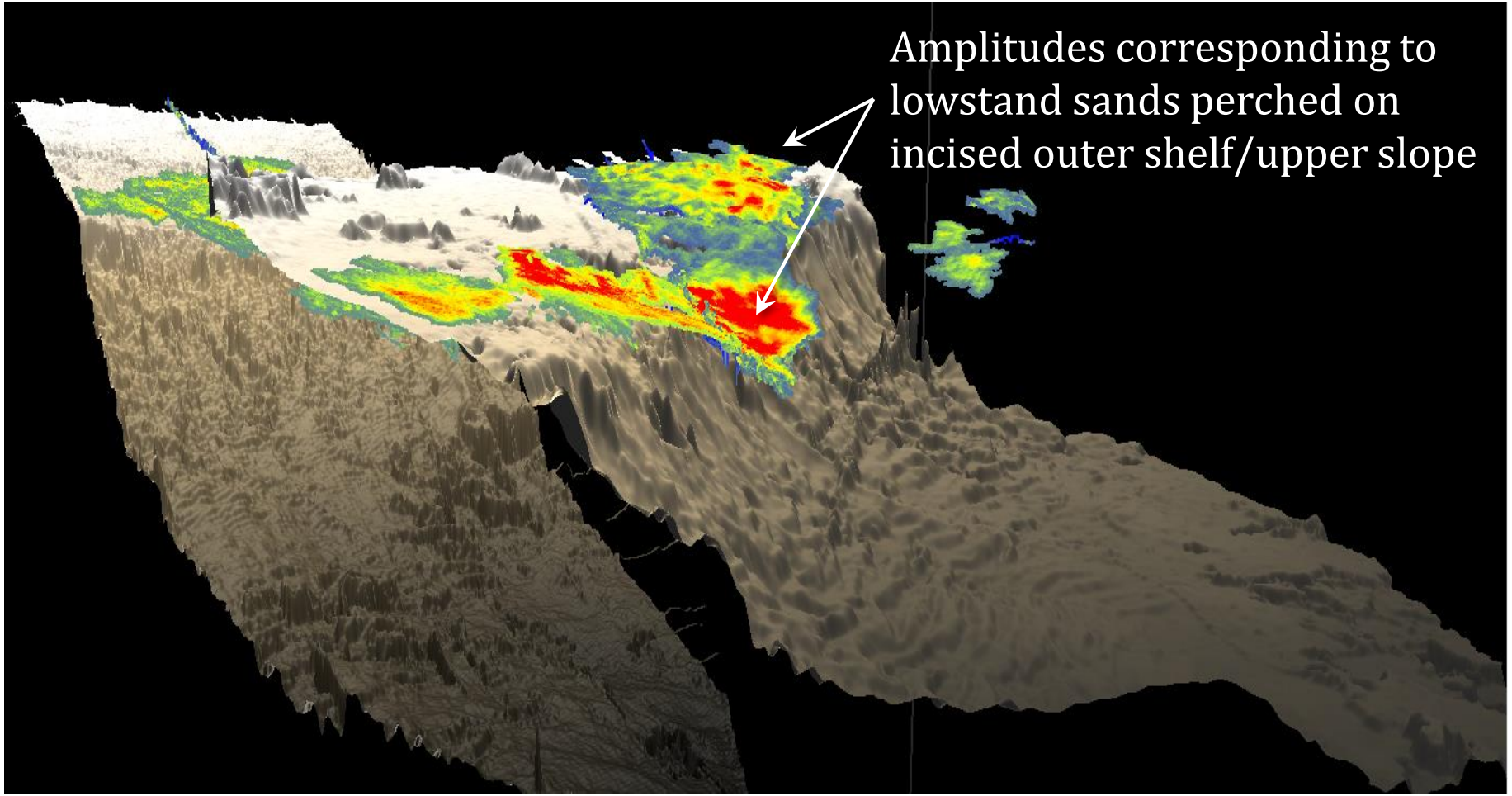
Nanushuk Shelf-Margin Anomalies
- Northern NPRA -





Source: Niglio and others , 2011 (BLM, BOEMRE)
with permission of data owners WesternGeco, LLC and Geokinetics

Nanushuk Shelf-Margin Anomalies
- Northern NPRA -



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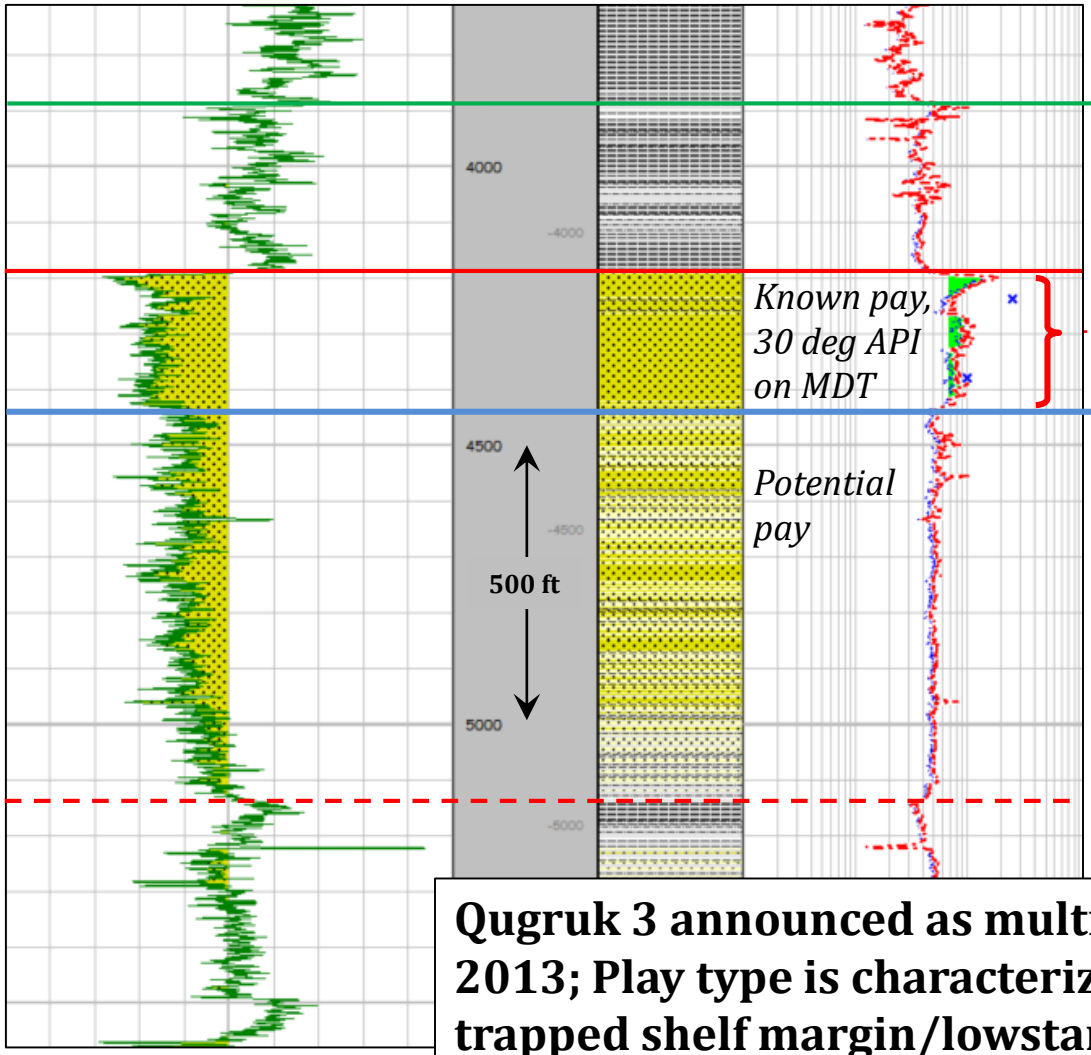
Pikka Discovery - Nanushuk Fm



***Repsol* Qugruk 3,**
P&A 4/1/2013

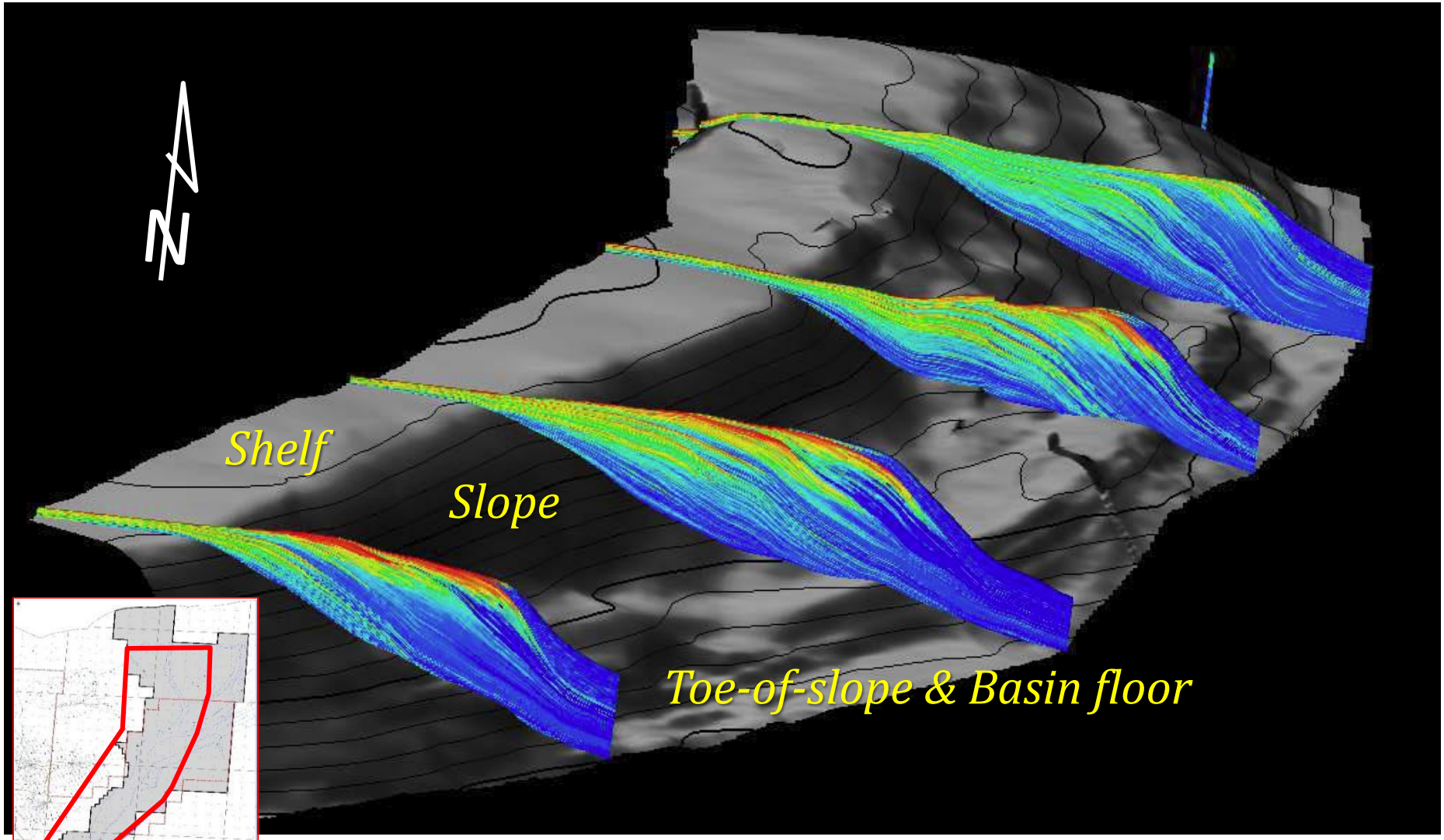
Nanushuk Fm
(seismic topset facies)

upper facies tested 4,600 bopd in horizontal Q8 offset well

Top Torok Fm
(sandy lowstand wedge, seismic upper slope facies)

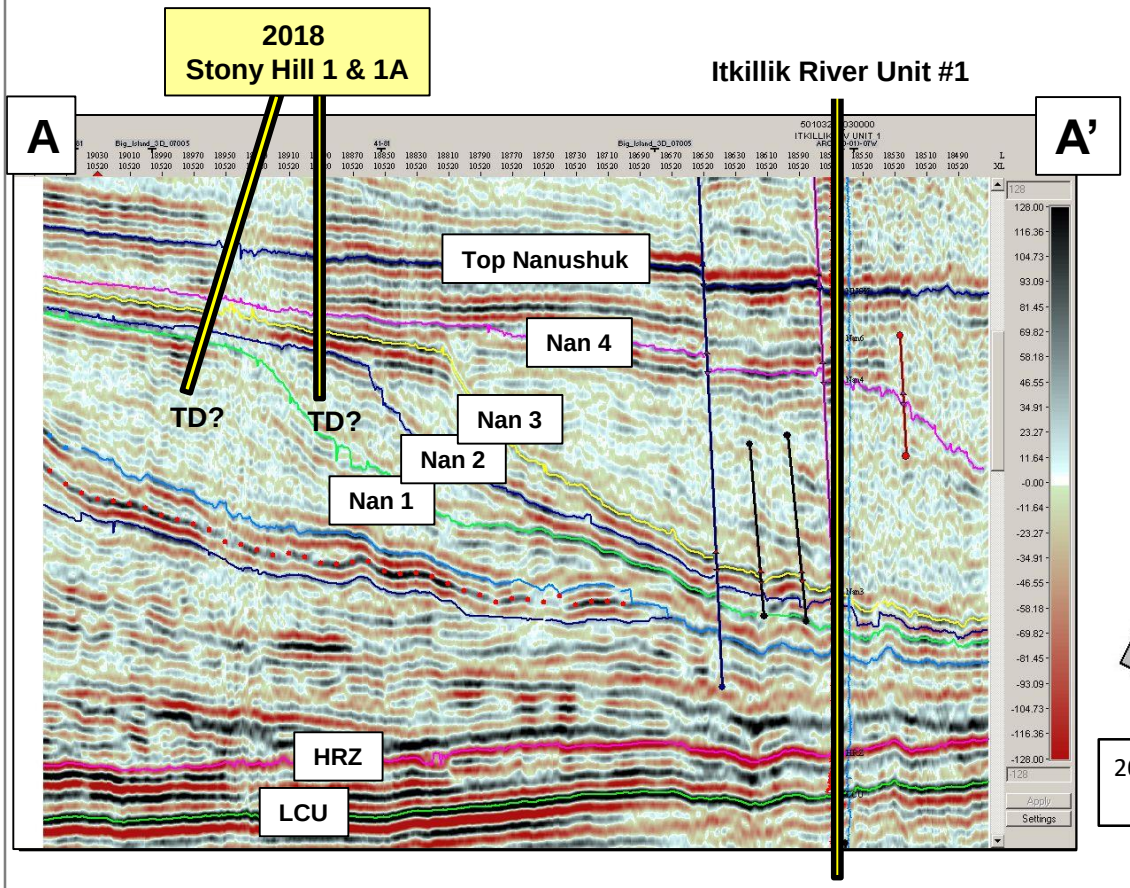
Qugruk 3 announced as multi-horizon discovery April 2013; Play type is characterized by stratigraphically-trapped shelf margin/lowstand wedge sandstones in lower Nanushuk and underlying sandy slope Torok Formation.

Pikka Nanushuk Geo-Model
- Nanushuk 3 Interval -



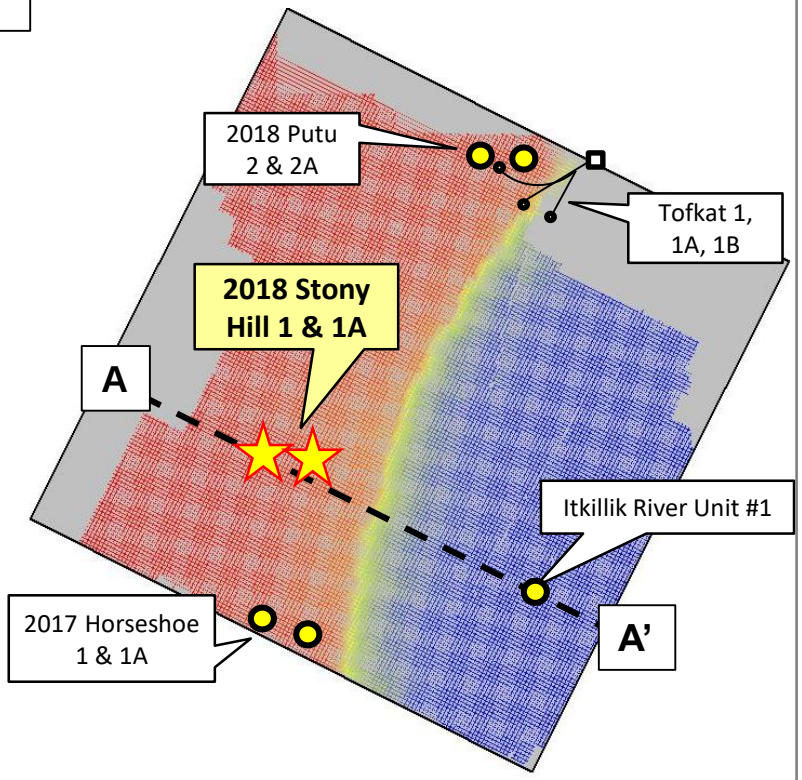
Adapted from Oil Search Alaska Strategy Seminar, December 2017

Pikka-Horseshoe Trend
2018 Stony Hill Targets, Nanuq South 3D



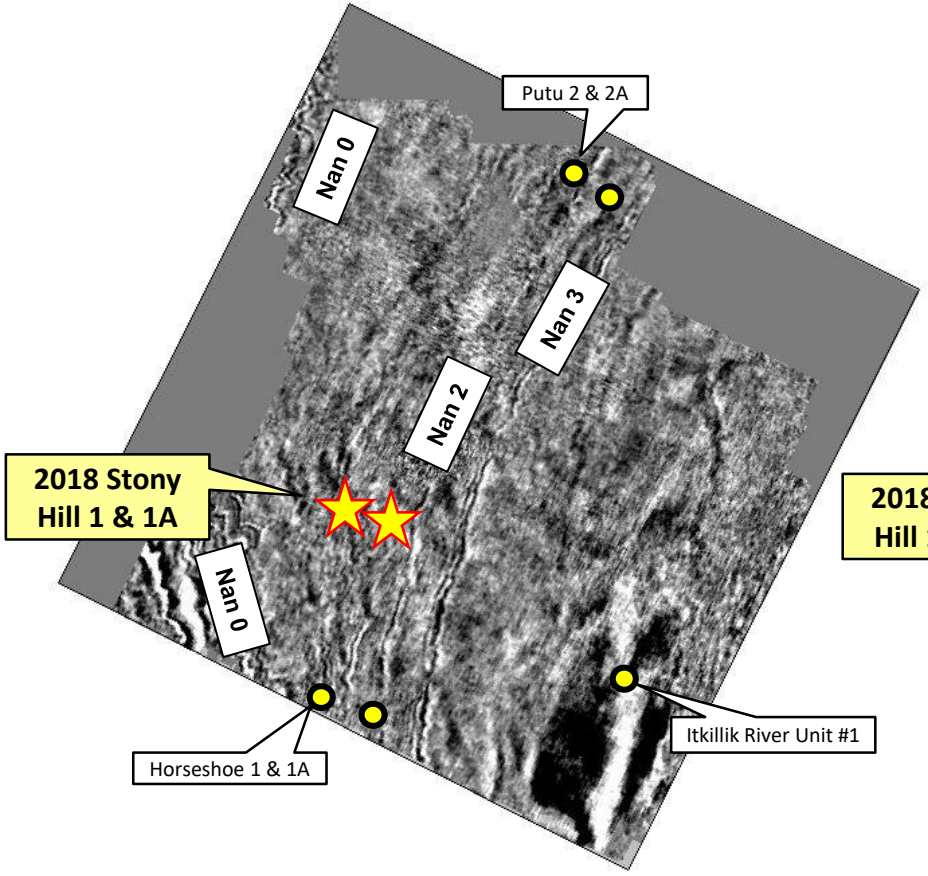
Nan3 Two-Way Time Horizon

- *Picked on 5X5 Grid*
- *TWT range: 0.95 to 1.45 sec*

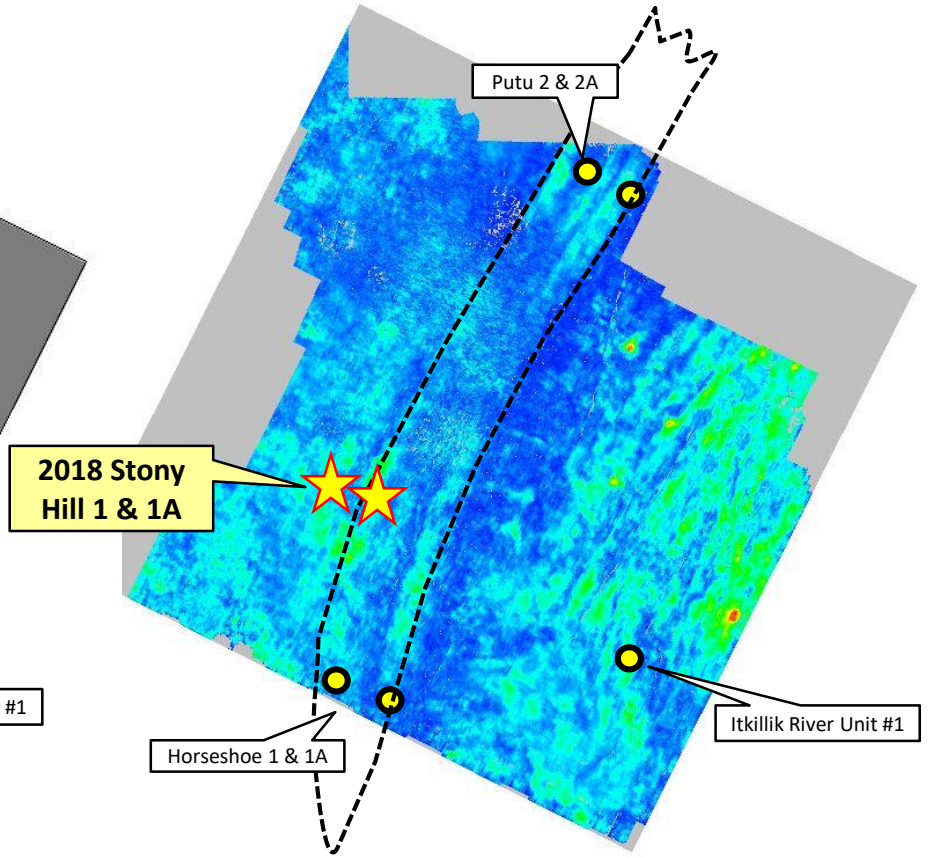


Pikka-Horseshoe Nanuq South 3D
Time Slice vs. Far Stack Amplitudes

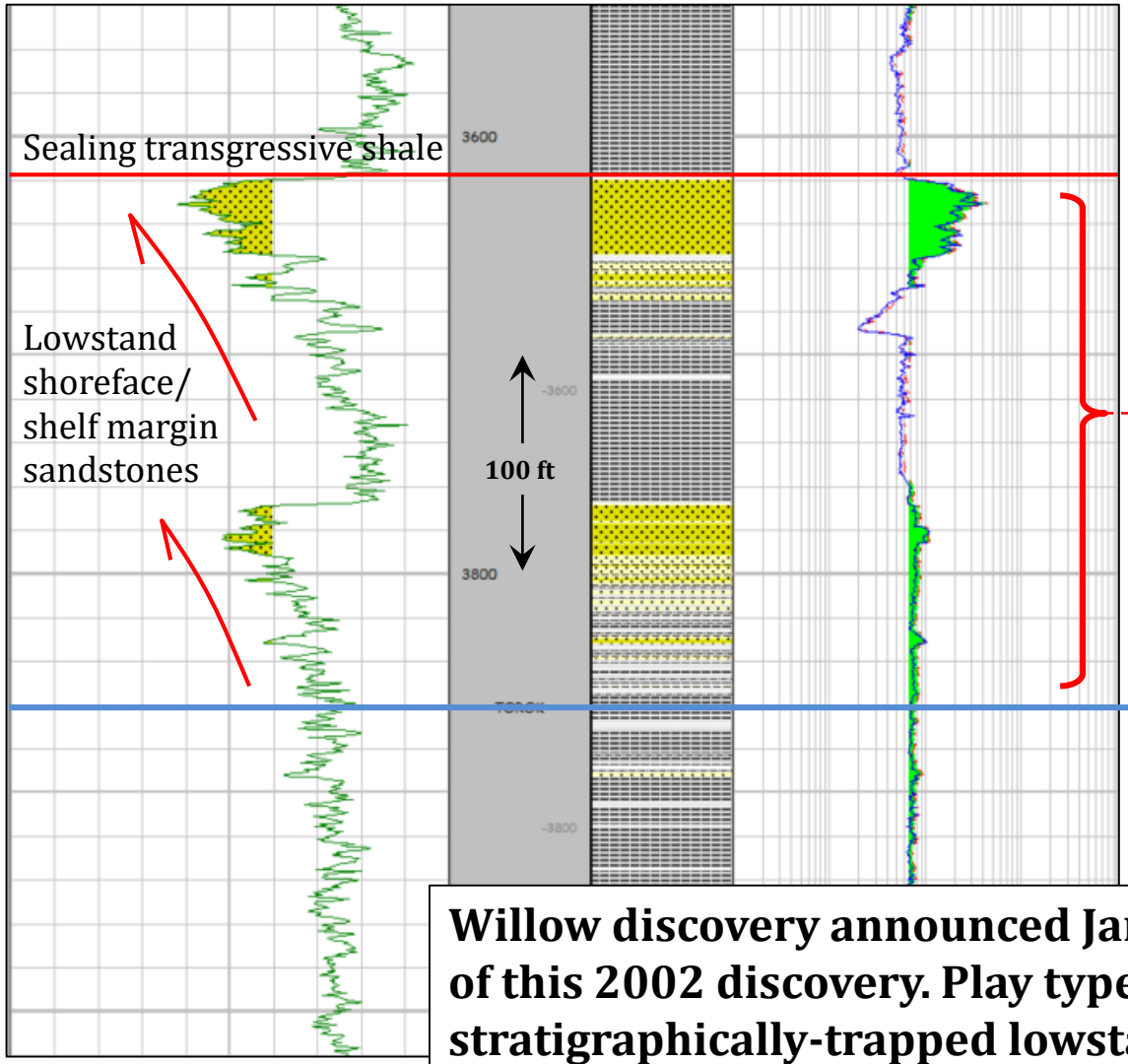
Full Stack Time Slice *(1156ms)*



Far Stack RMS Amplitude Extraction
(20ms offset, 60ms window)



Willow Discovery - Nanushuk Fm



***ConocoPhillips* Hunter A,**
P&A 3/26/2002

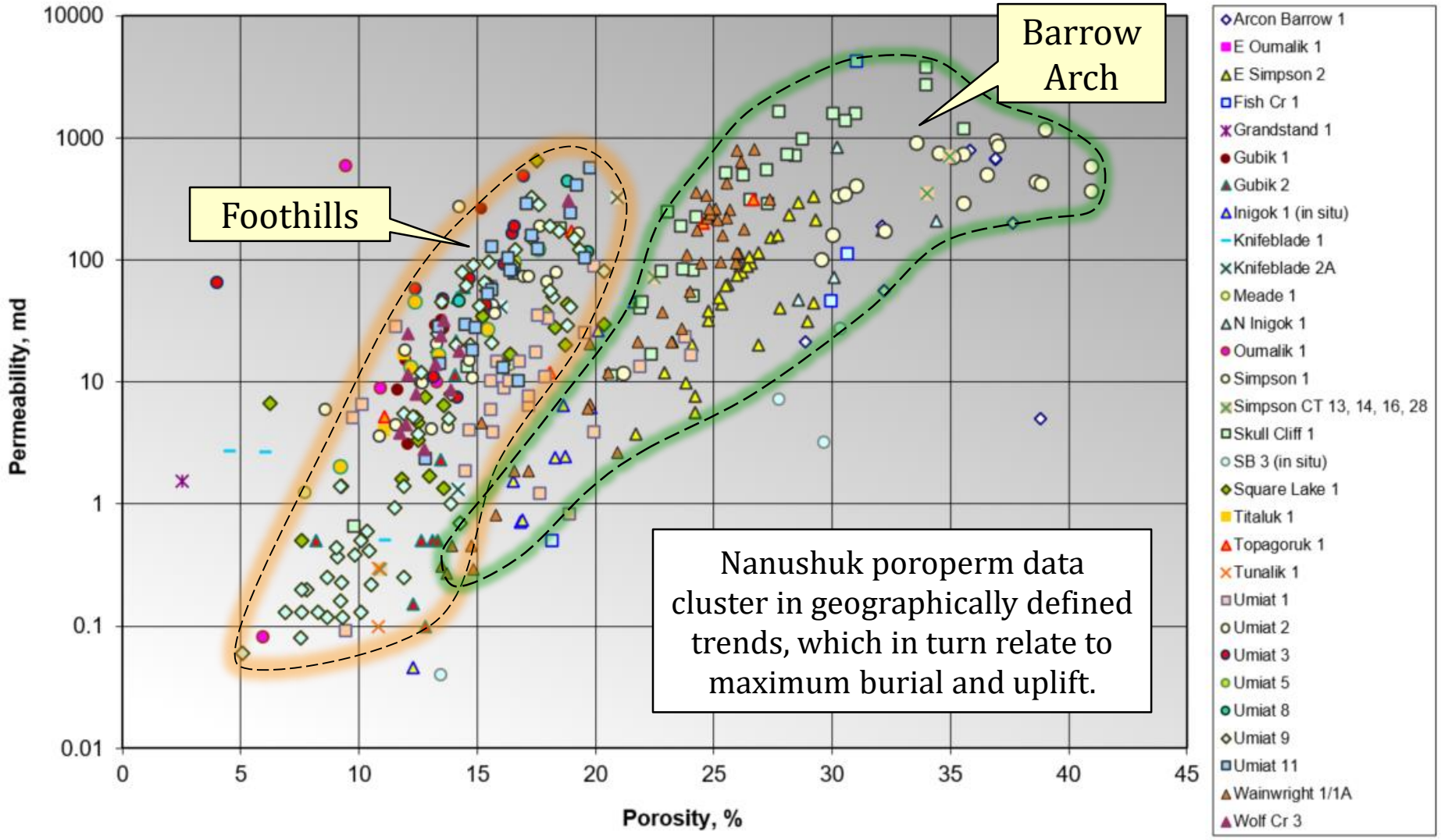
Lower part of Nanushuk Fm
(basal topset facies)

Willow interval: secondary objective with light oil/gas shows; Tinmiaq 2 and 6 wells confirmed discovery with up to 3,200 bopd test.

Top Torok Fm
(uppermost slope facies)

Willow discovery announced January, 2017 was a follow-up of this 2002 discovery. Play type is characterized by stratigraphically-trapped lowstand shoreface shelf margin sandstones in lower Nanushuk Formation.

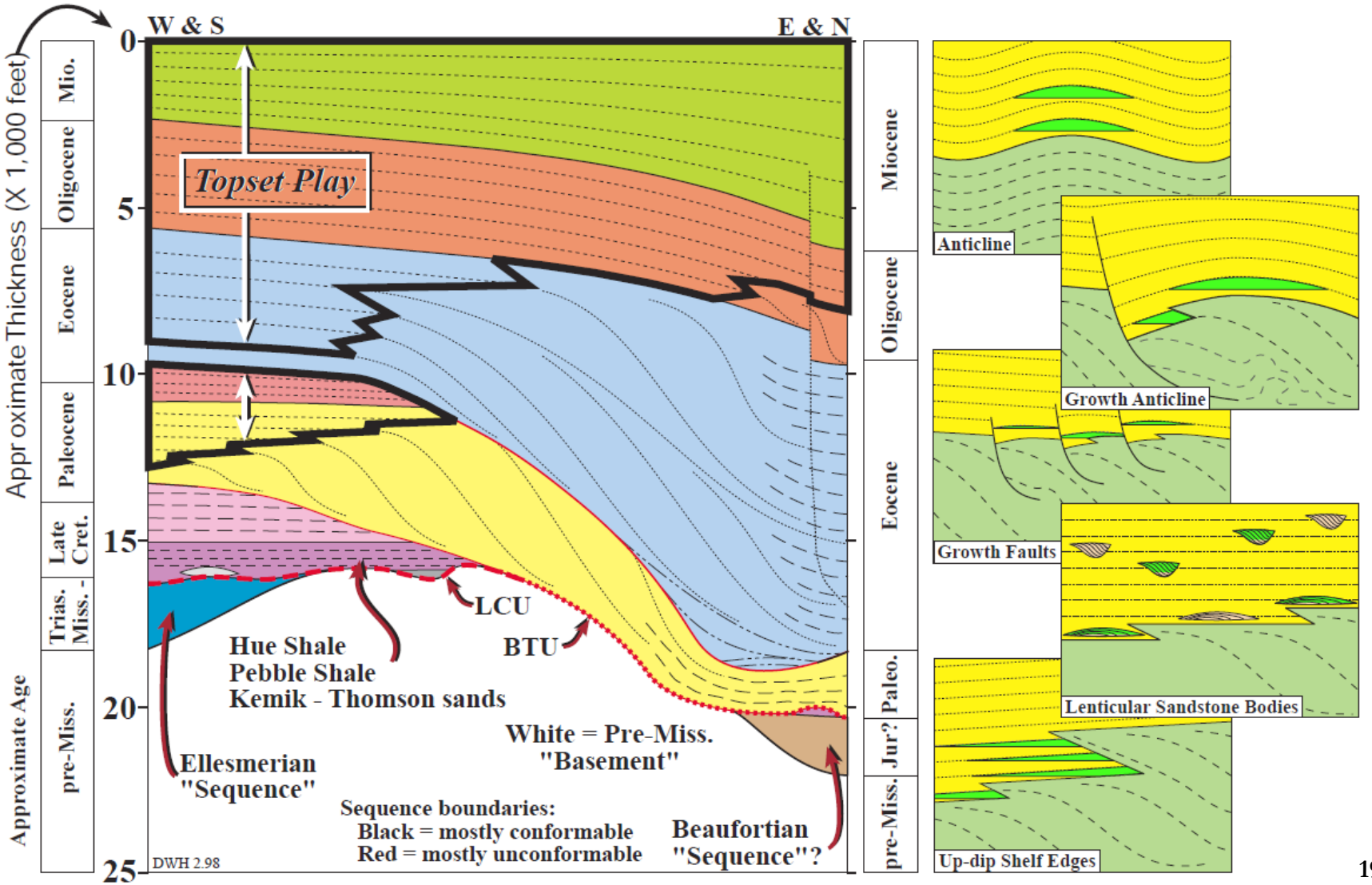
Nanushuk Fm Reservoir Quality



Undiscovered Resources

- USGS and BOEM are actively reassessing the Arctic Alaska region's mean undiscovered, technically recoverable conventional resources.
  - As of December 2017, interim revisions raise the mean estimate for all of Arctic Alaska by ~9 billion barrels to nearly 50 billion barrels of oil + NGL.
  - Mean onshore and offshore resource estimates each total to more than 24 billion barrels of oil + NGL.
- The Nanushuk topset play of the central and western North Slope is far more prospective than recognized in previous resource assessments.
  - For example, at 300 million barrels recoverable, the Willow discovery alone far exceeds even the 2010 USGS upside estimate (F5 case) for the entire Stratigraphic Brookian Topset play in NPRA.
  - By itself, the Nanushuk Fm play (NPRA, state lands, and nearby OCS) is now assessed with a mean of 7.3 billion barrels of oil + NGL.

Related Topset Play - ANWR



Tax Credit Seismic Surveys
- Public Release in Progress -