



Nanushuk and Torok Oil Plays – Game Changer on the North Slope

lower Nanushuk Formation

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upper Torok Formation



Background Information Ranges from General to Technical



National and Global Petroleum Assessment

Assessment of Undiscovered Oil and Gas Resources in the Cretaceous Nanushuk and Torok Formations, Alaska North Slope, and Summary of Resource Potential of the National Petroleum Reserve in Alaska, 2017

The U.S. Geological Survey estimated mean undiscovered, technically recoverable resources of 8.7 billion barrels of oil and 25 trillion cubic feet of natural gas (associated and nonassociated) in conventional accumulations in the Cretaceous Nanushuk and Torok Formations in the National Petroleum Reserve in Alaska, adjacent State and Native lands, and State waters. The estimated undiscovered oil resources in the Nanushuk and Torok Formations are significantly higher than previous estimates, owing primarily to recent, larger than anticipated oil discoveries.

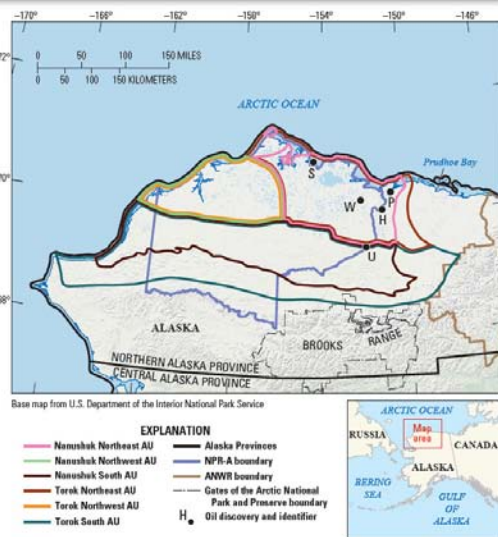
Introduction

Recent exploration drilling has resulted in significant oil discoveries in the Cretaceous Nanushuk and Torok Formations in and near the National Petroleum Reserve in Alaska (NPR-A). These new discoveries have spurred exploration activity in the region and have increased demand for enhanced information regarding the oil-resource potential of these formations.

New U.S. Geological Survey (USGS) estimates of undiscovered, technically recoverable oil and gas resources in conventional accumulations across the entire onshore and State-waters extent of the Nanushuk and Torok Formations update previous assessments for these two formations (Bird and others, 2005; Houseknecht and others, 2010). This fact sheet also includes a summary of 2010 assessment results for older rocks in the NPR-A; no updated assessment was conducted as those rocks have not been penetrated by exploration drilling since 2010, and thus no new information is available about their oil and gas potential.

Recent Oil Discoveries

Prior to 2015, about 150 exploration wells had penetrated the Nanushuk and Torok Formations, yet oil production had been established in just one small oil pool (less than 10 million barrels of recoverable oil [MMBO]).



Basin Research (2009) 21, 644–654, doi: 10.1111/j.1365-2117.2008.00392.x

Seismic analysis of clinoform depositional sequences and shelf-margin trajectories in Lower Cretaceous (Albian) strata, Alaska North Slope

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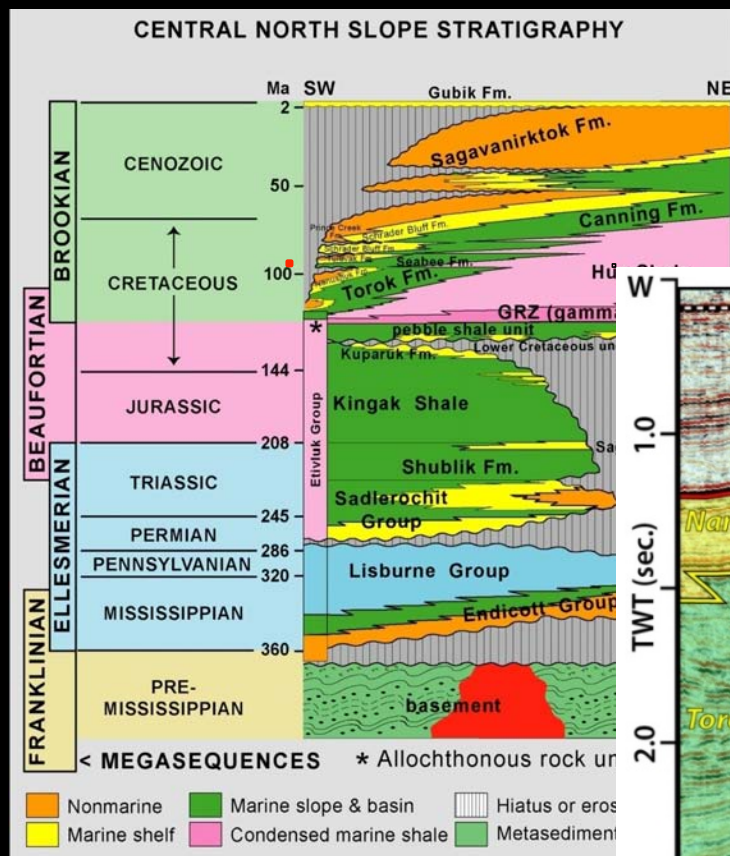
[‡]US Geological Survey, Denver, CO, USA

Petroleum systems framework of significant new oil discoveries in a giant Cretaceous (Aptian–Cenomanian) clinothem in Arctic Alaska

David W. Houseknecht



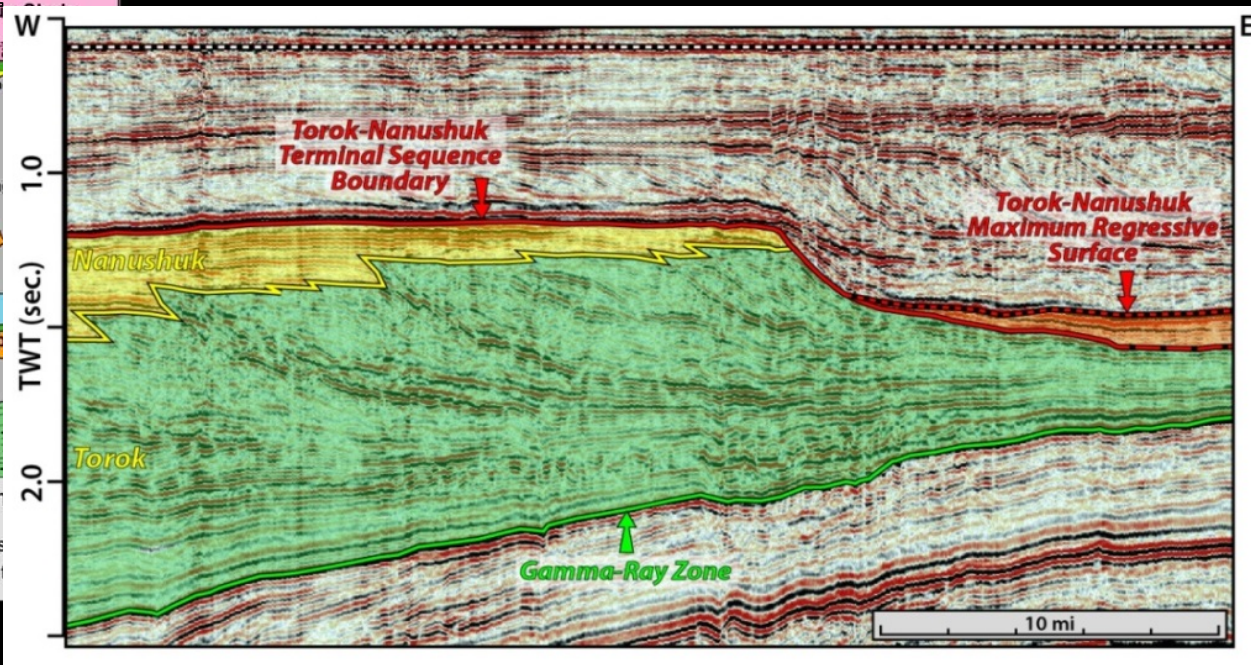
Stratigraphy – Lower-middle Cretaceous Clinothem



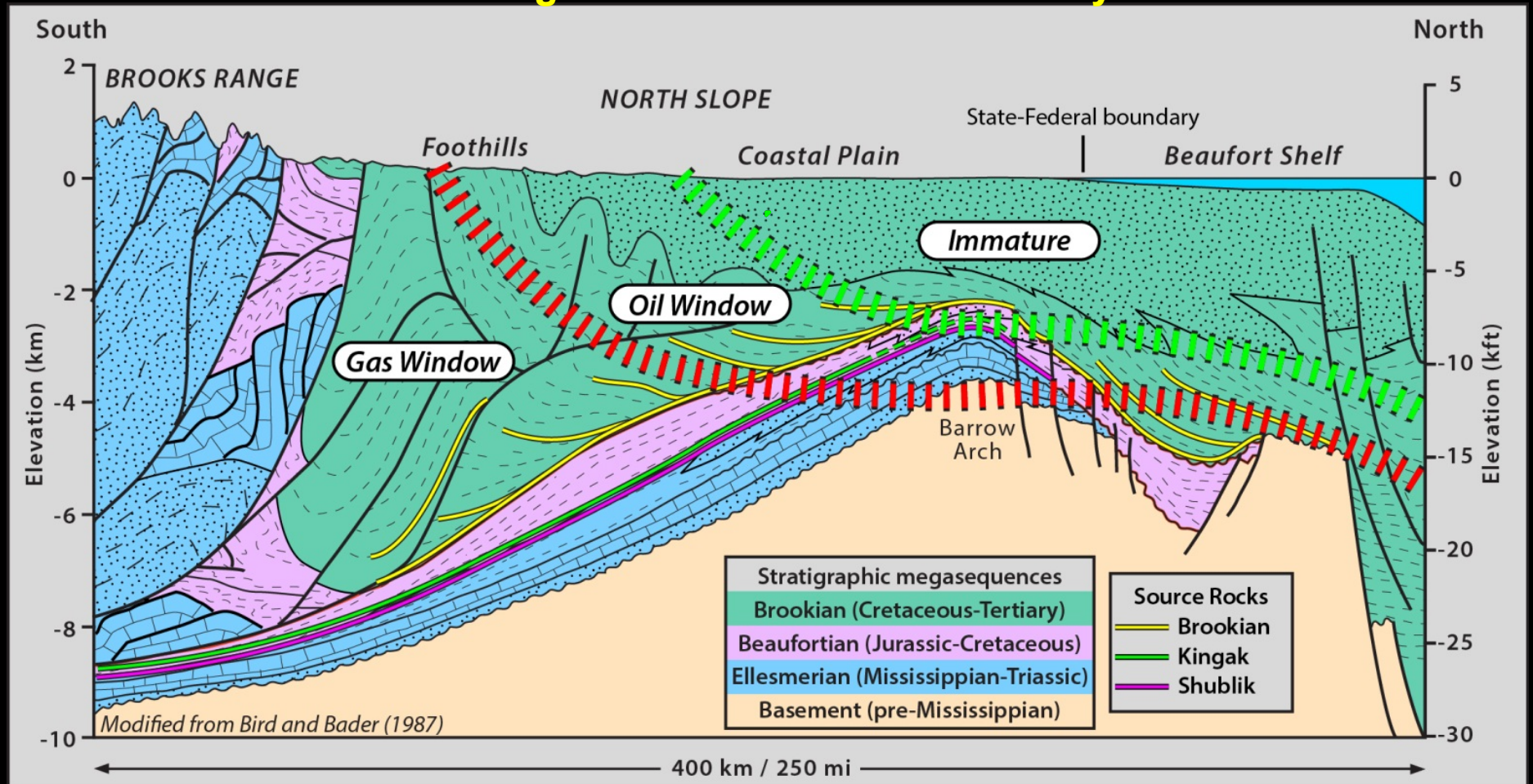
Prior to 2015:

Largest Nanushuk discovery in stratigraphic trap 5 – 10 MMBO

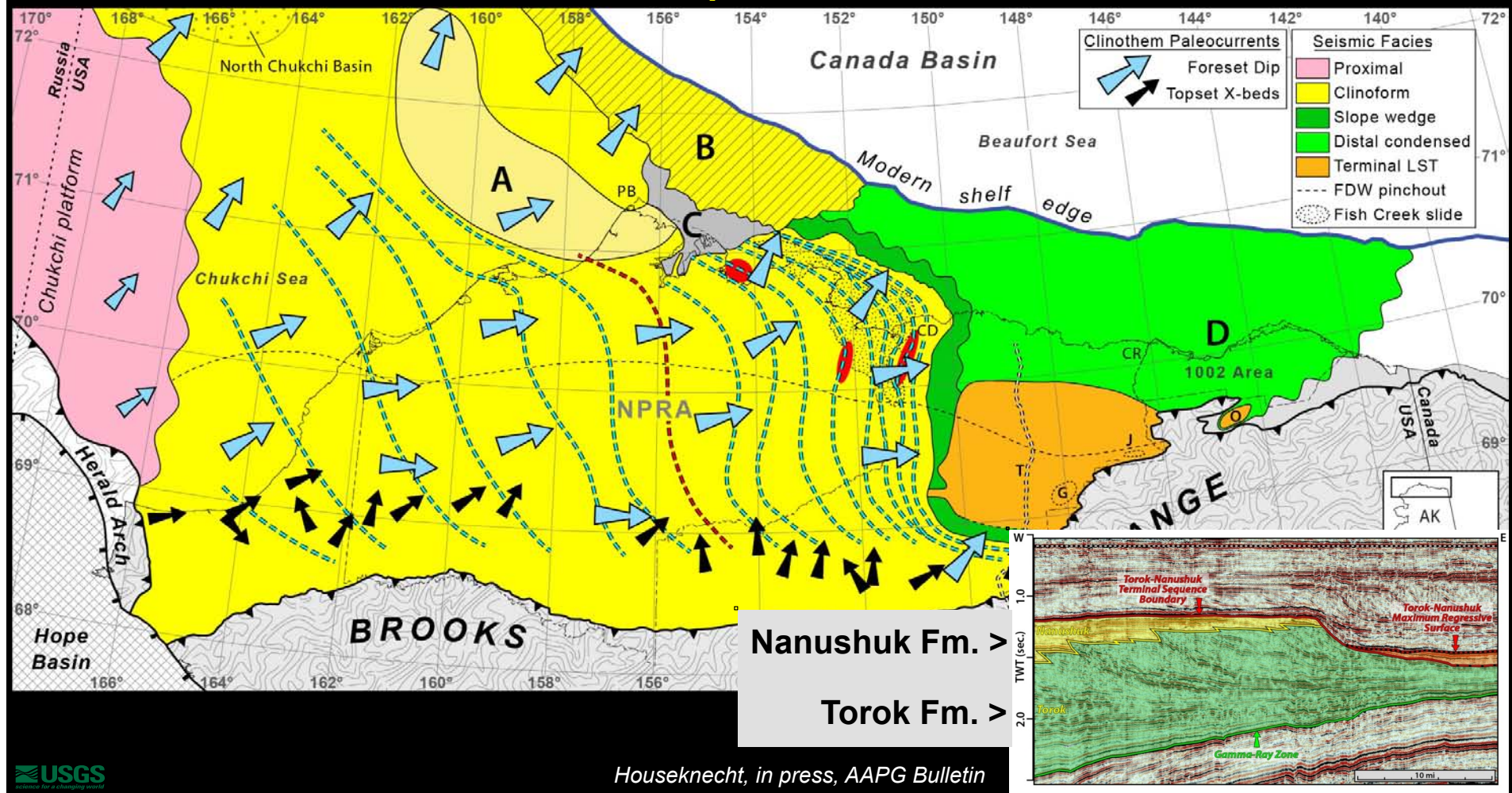
Largest Torok discovery in stratigraphic trap: 3 – 5 MMBO



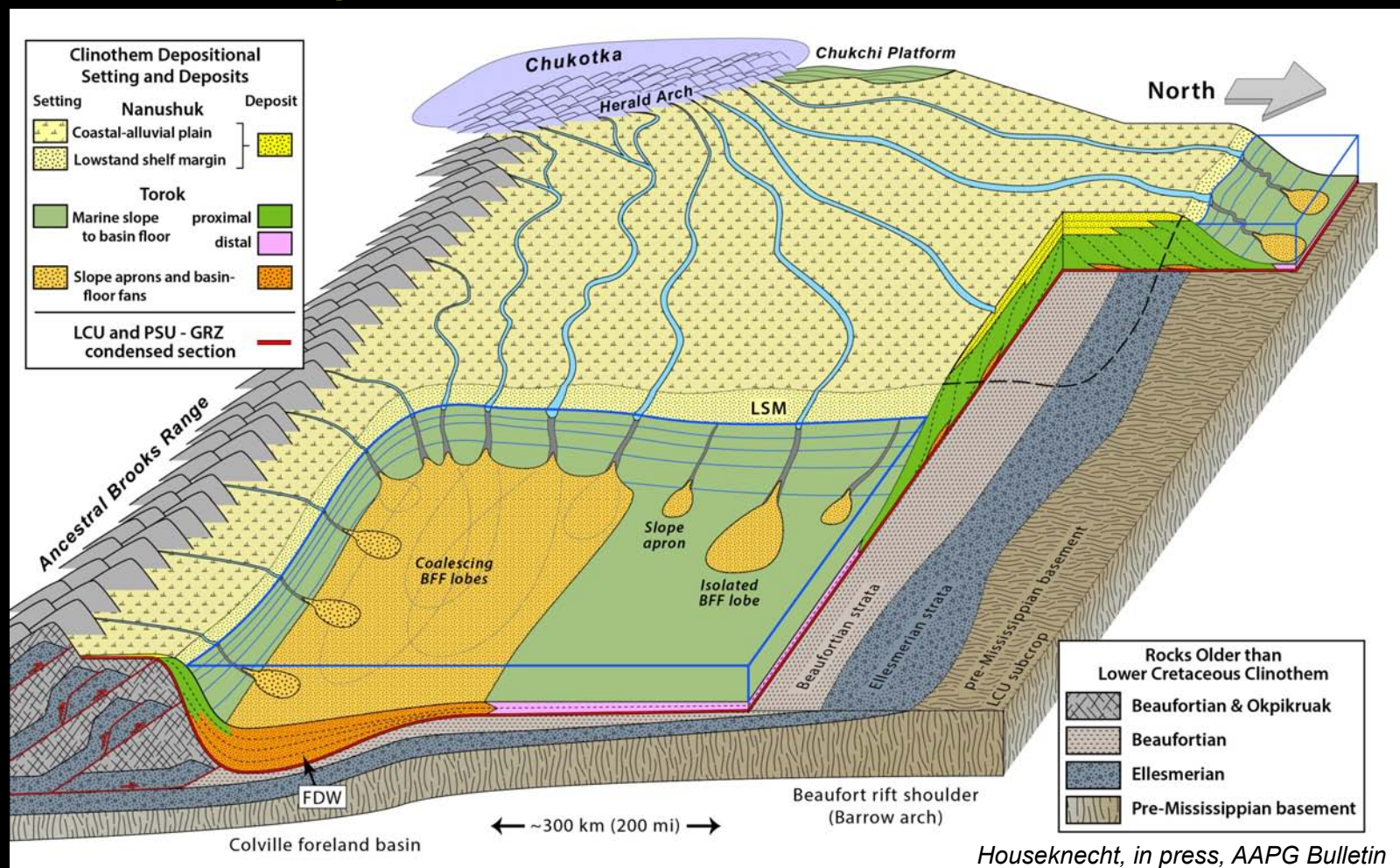
Favorable Oil and Gas Charge – Nanushuk & Torok Ideally Positioned



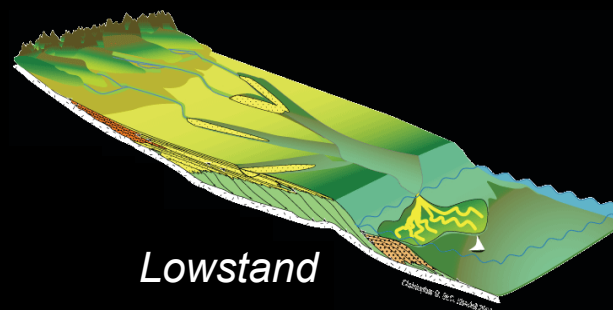
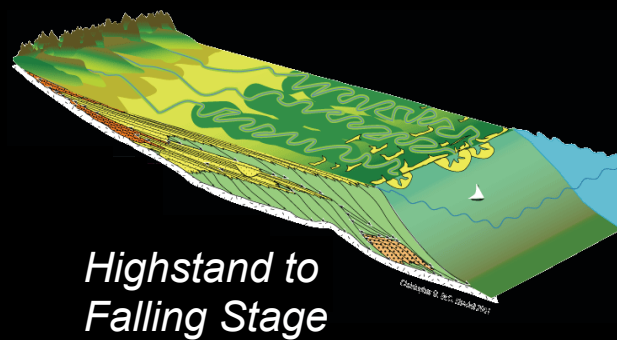
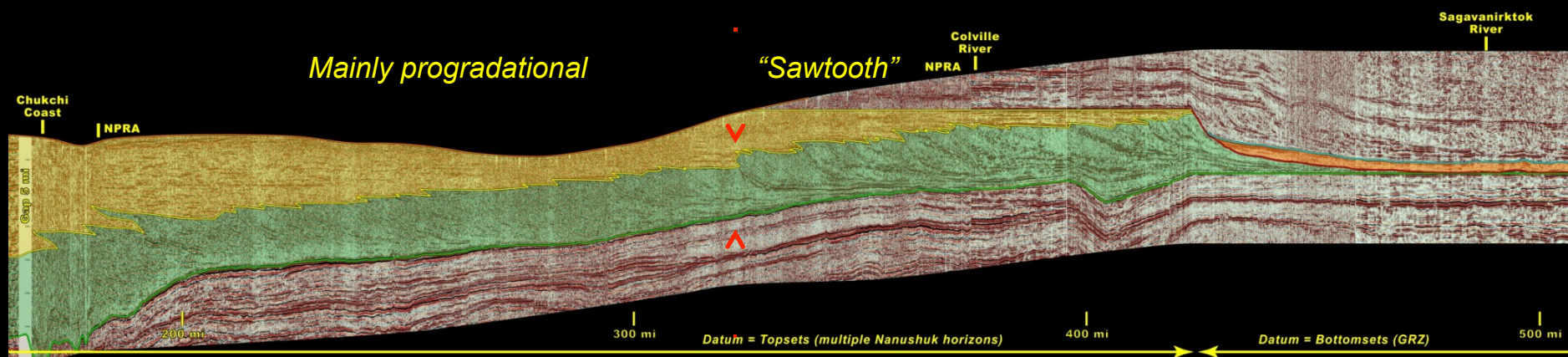
Nanushuk – Torok Seismic Facies Map



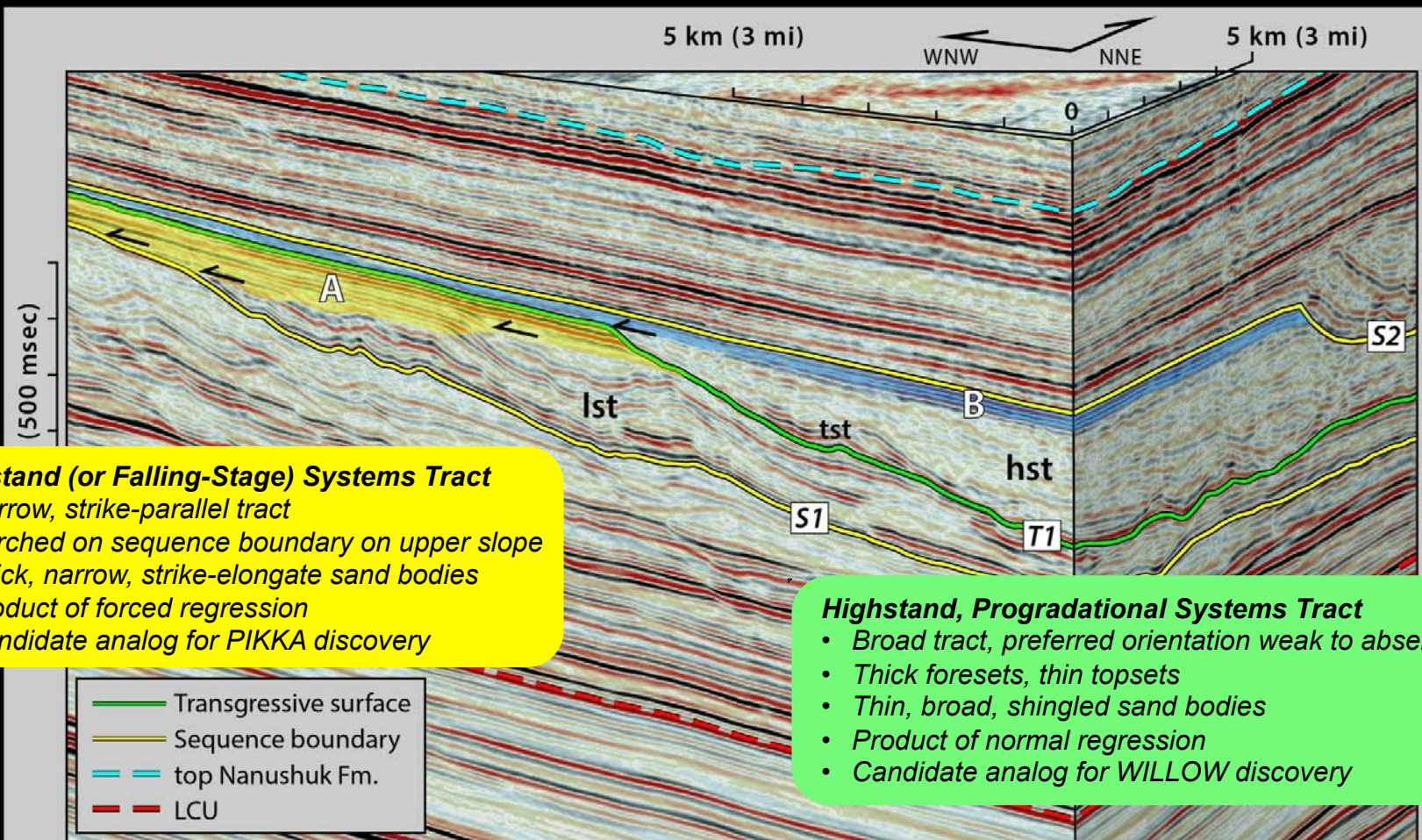
Nanushuk – Torok Regional Depositional Model



Shelf-Margin Trajectory –Stratigraphic Trap Implications



Nanushuk – Inferred Sequence Stratigraphy of Stratigraphic Traps



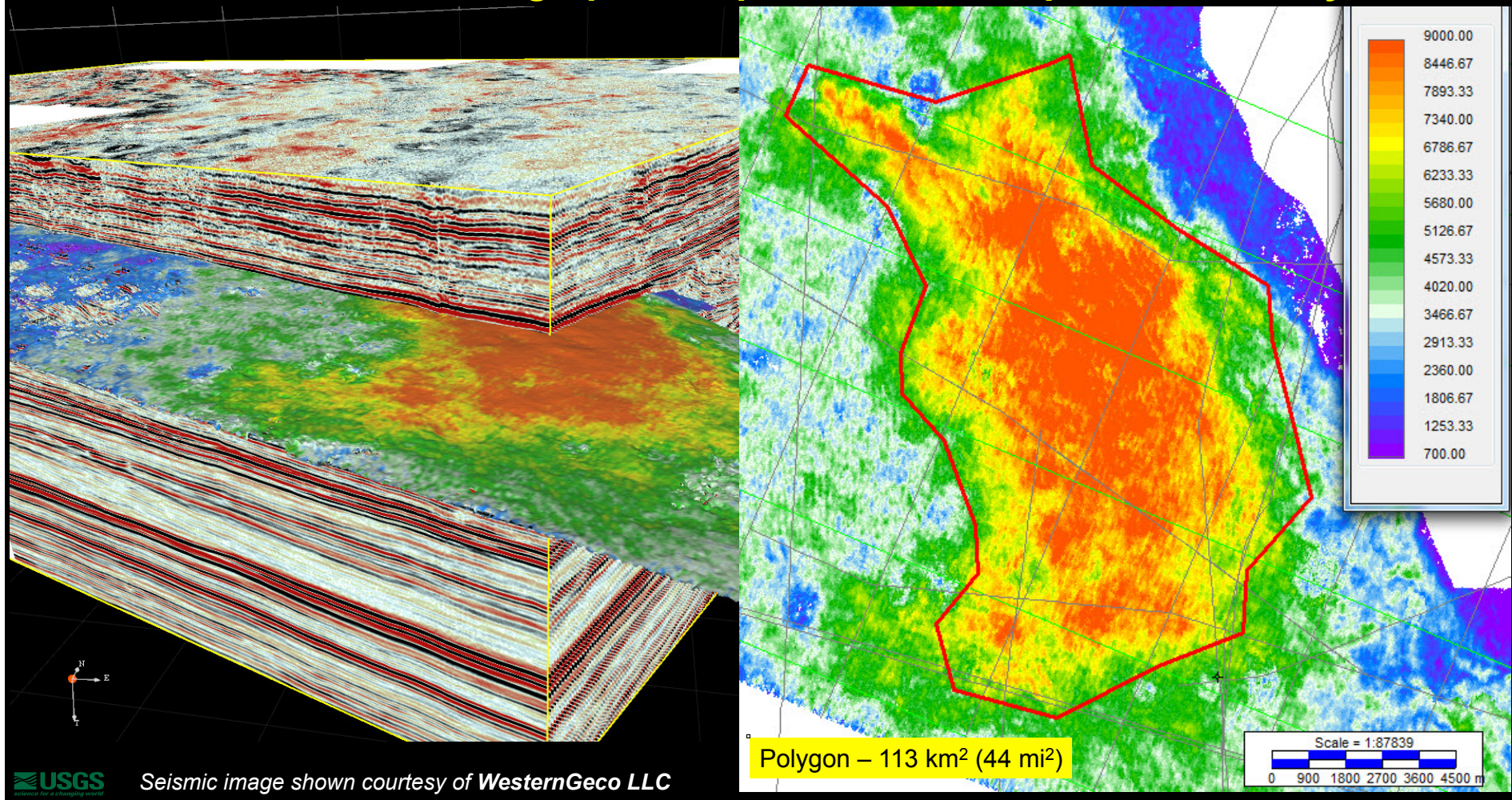
Lowstand (or Falling-Stage) Systems Tract

- Narrow, strike-parallel tract
- Perched on sequence boundary on upper slope
- Thick, narrow, strike-elongate sand bodies
- Product of forced regression
- Candidate analog for PIKKA discovery

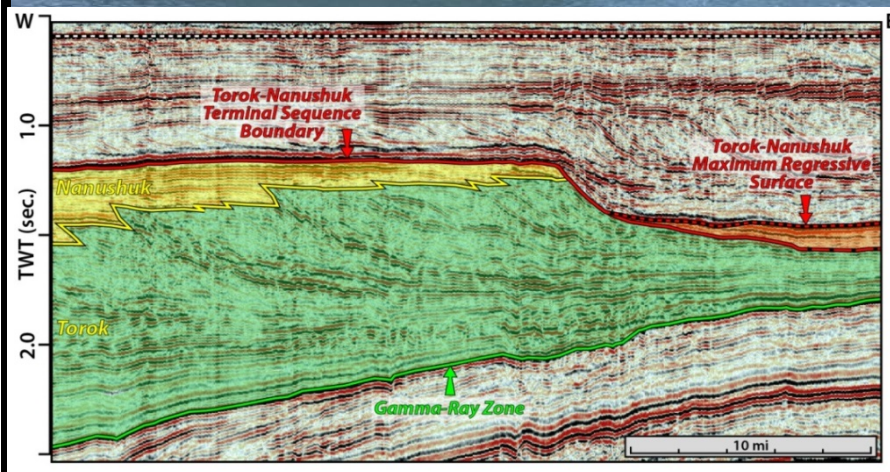
Highstand, Progradational Systems Tract

- Broad tract, preferred orientation weak to absent
- Thick foresets, thin topsets
- Thin, broad, shingled sand bodies
- Product of normal regression
- Candidate analog for WILLOW discovery

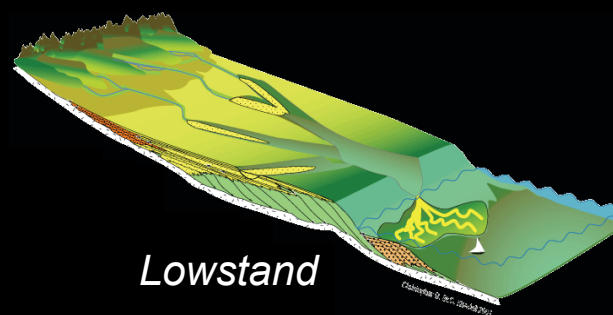
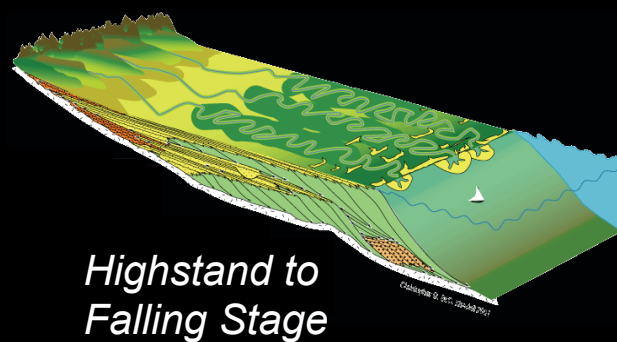
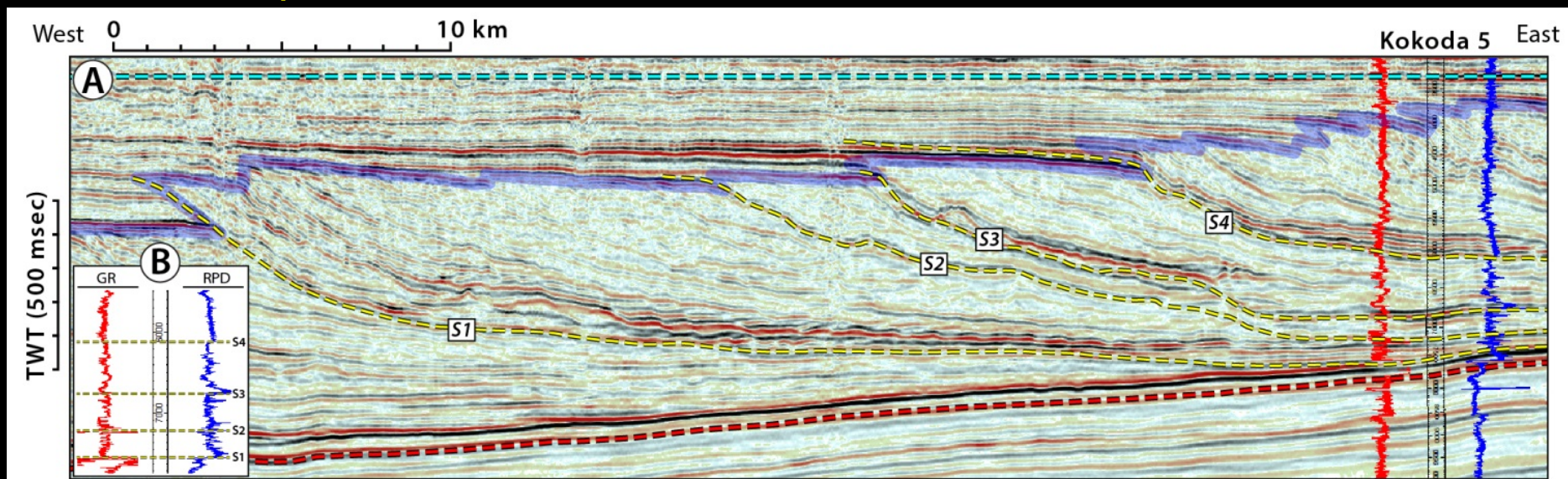
Nanushuk – Potential Stratigraphic Trap – Untested Amplitude Anomaly



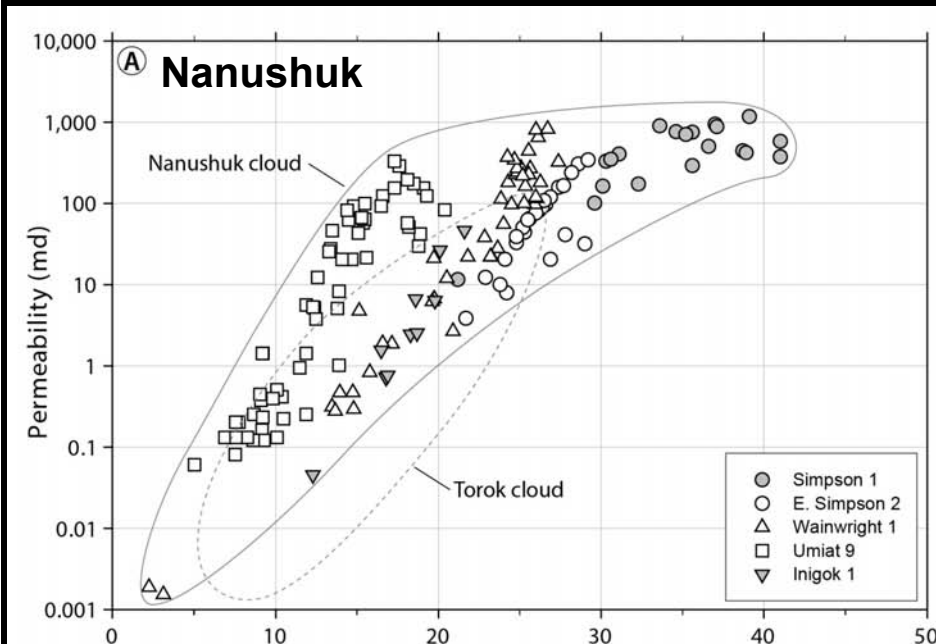
Torok Slope-Channel, Slope-Apron, and Basin-Floor Fan Facies



Lowstand Sequence Boundaries and Turbidites

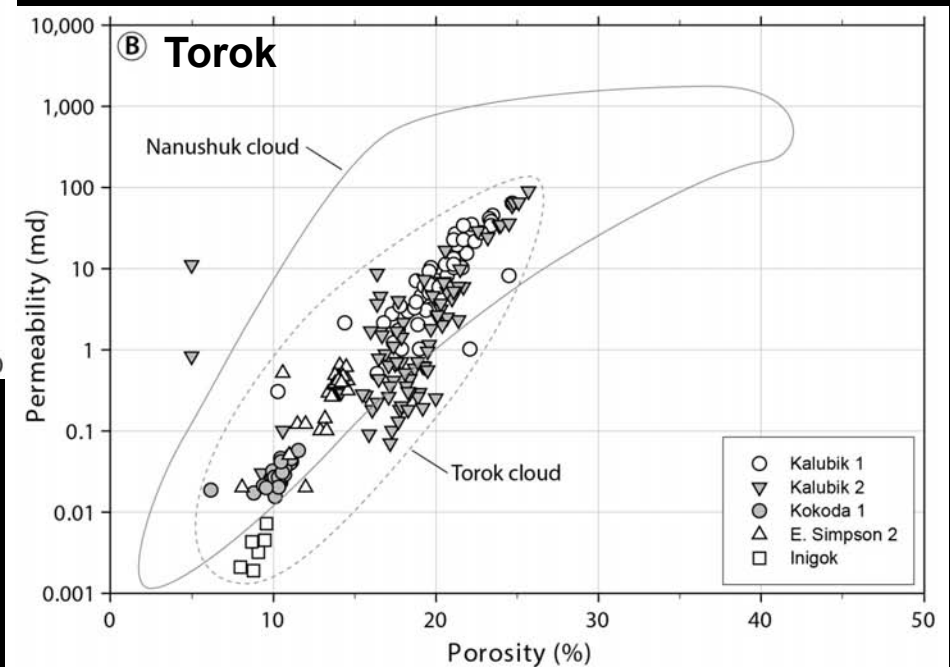


Nanushuk and Torok Reservoir Quality – Influence of Maximum Burial Depth

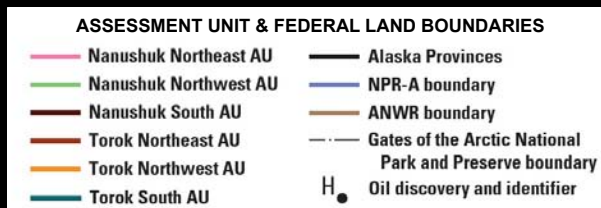
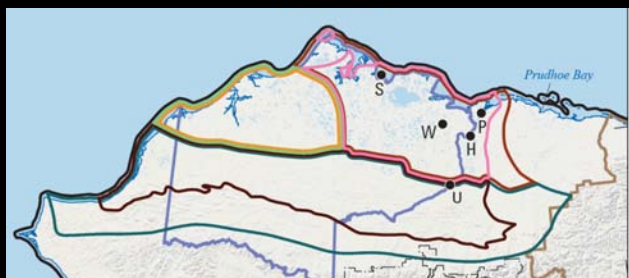


Nanushuk – best reservoir quality generally in north; decreases to south

Torok – regional trend similar to Nanushuk, but generally poorer reservoir quality

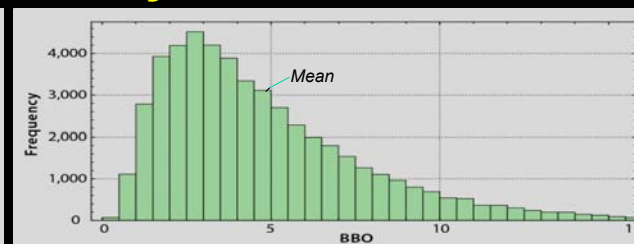
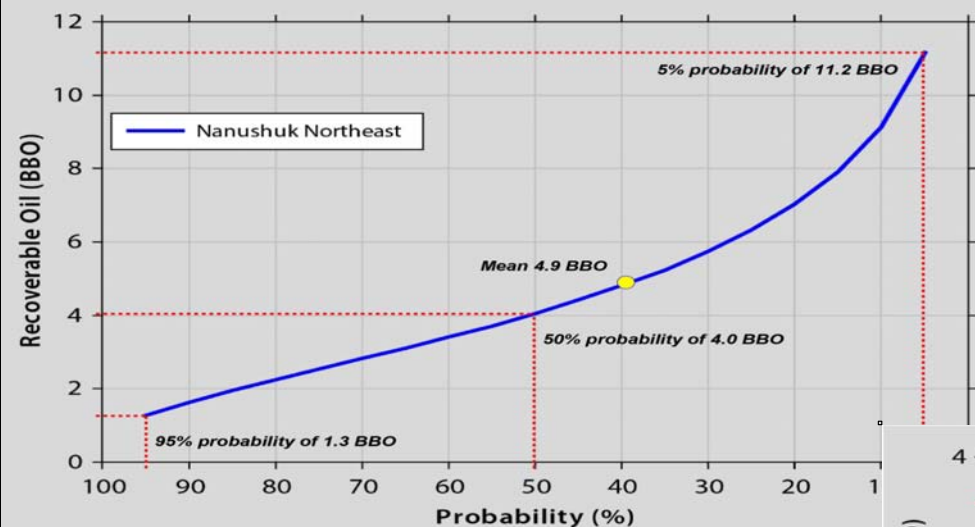


Assessment Results 2017 – Nanushuk and Torok Formations



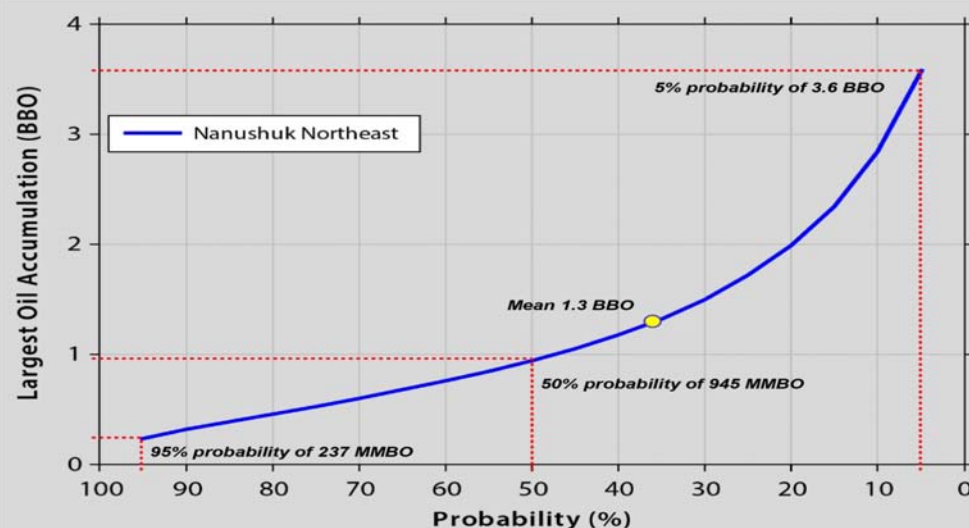
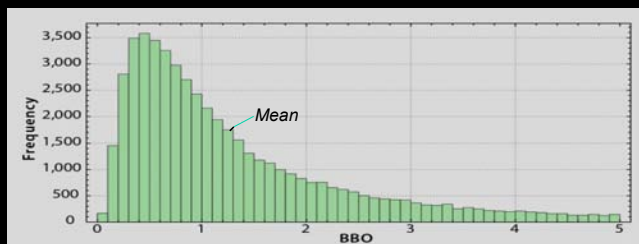
Assessment units (AUs)	AU prob-ability	Accumu-lation type	Total undiscovered resources											
			Oil (MMBO)				Gas (BCFG)				NGL (MMBNGL)			
			F95	F50	F5	Mean	F95	F50	F5	Mean	F95	F50	F5	Mean
2017 Nanushuk and Torok Assessment Units														
Nanushuk Northeast AU	1.0	Oil	1,271	4,042	11,162	4,862	945	3,164	9,304	3,884	9	32	95	39
		Gas					553	2,998	15,538	4,805	4	22	115	35
Nanushuk Northwest AU	0.9	Oil	0	878	3,152	1,146	0	688	2,574	917	0	7	25	9
		Gas					0	1,940	9,923	3,029	0	14	74	22
Nanushuk South AU	1.0	Oil	6	26	266	71	5	20	212	57	0	0	2	1
		Gas					873	3,098	11,901	4,264	6	23	93	33
Torok Northeast AU	1.0	Oil	466	1,720	5,417	2,177	348	1,342	4,479	1,738	5	20	71	27
		Gas					277	1,446	8,887	2,590	3	15	100	29
Torok Northwest AU	0.9	Oil	0	267	1,379	421	0	210	1,121	336	0	3	18	5
		Gas					0	388	3,148	845	0	4	35	9
Torok South AU	1.0	Oil	11	27	161	50	10	32	196	60	0	0	2	1
		Gas					550	1,539	5,220	2,020	4	12	41	16
Subtotals			1,754	6,960	21,537	8,727	3,561	16,865	72,503	24,545	31	152	671	226

Probabilistic Results Reflect Range of Uncertainty

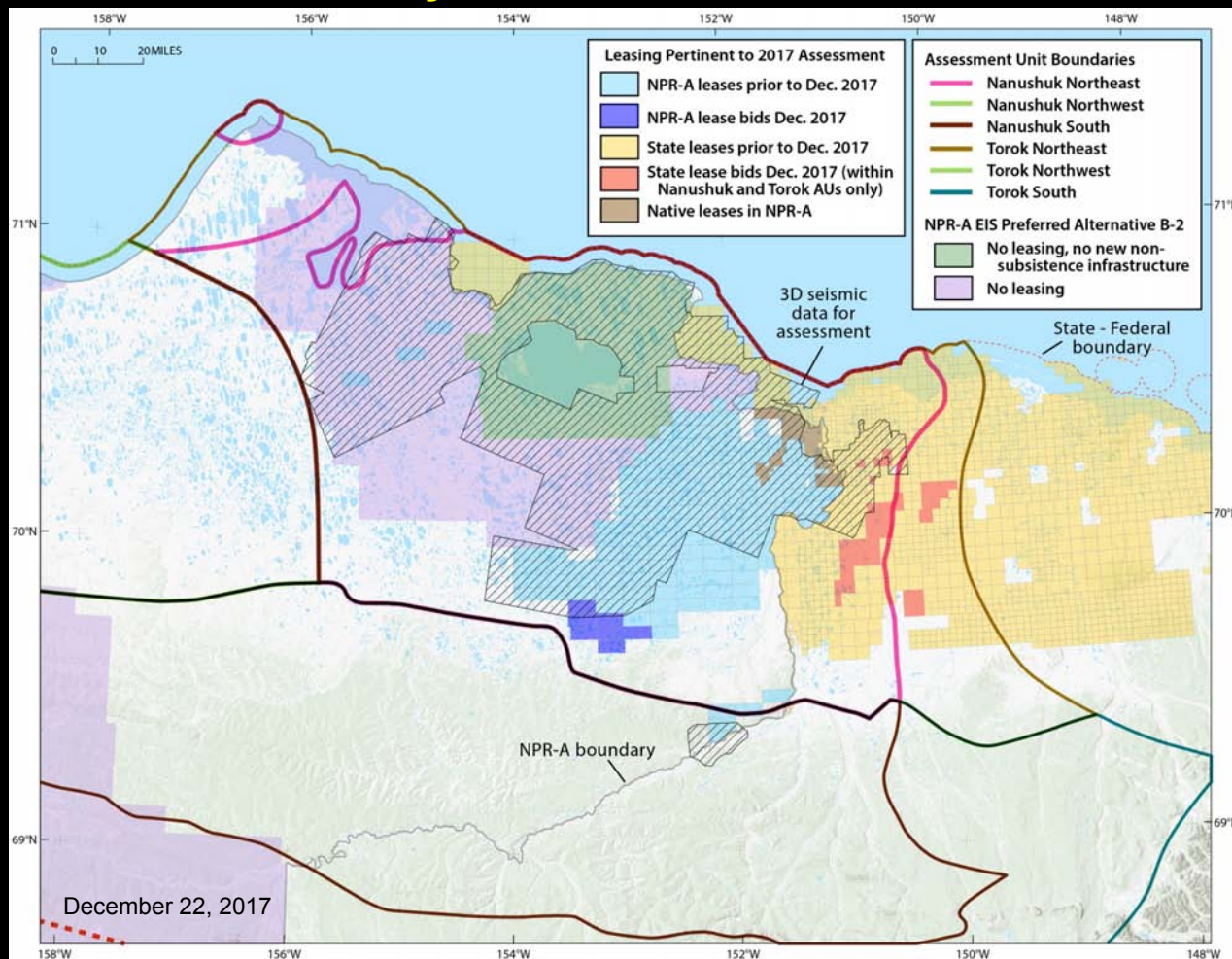


Probabilistic estimate of total oil in AU

Probabilistic estimate of largest oil pool in AU



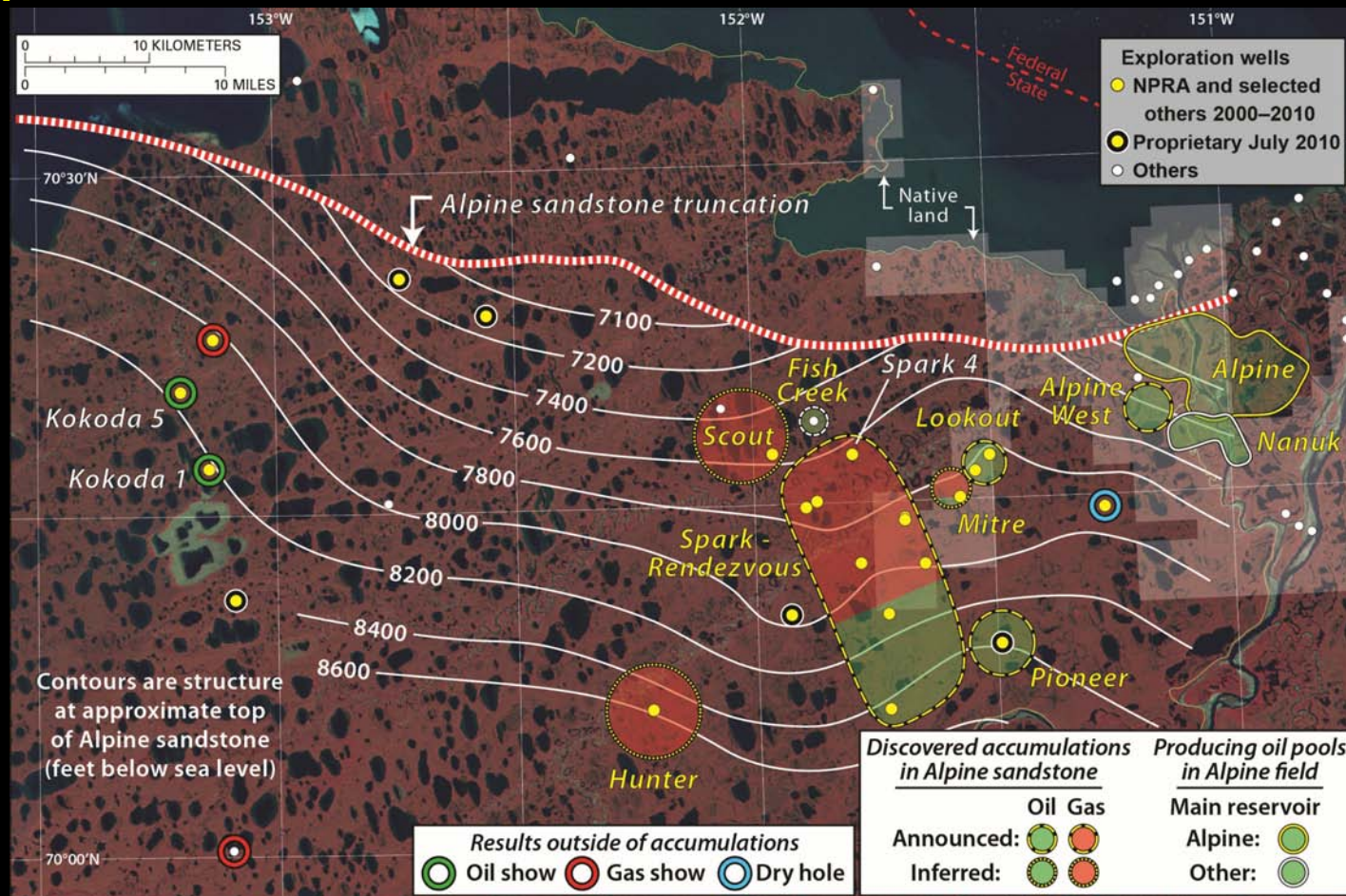
Leases and Accessibility, Eastern Part of AUs



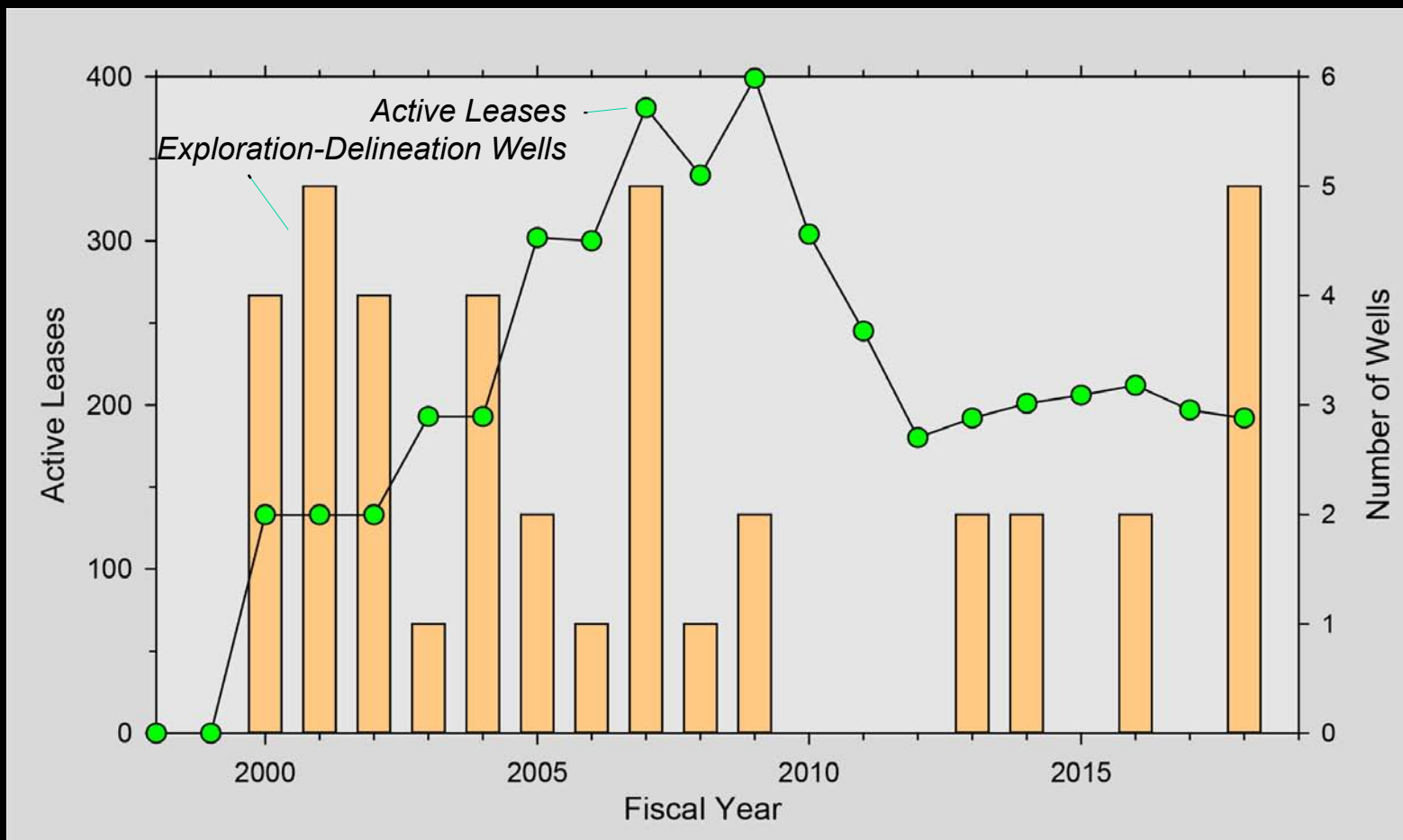
How many turkeys?



NPRA Exploration Results as of 2010 – Jurassic Discoveries



NPRA Active Leases and Exploration-Delineation Wells Drilled 1998–2018



Main Conclusions

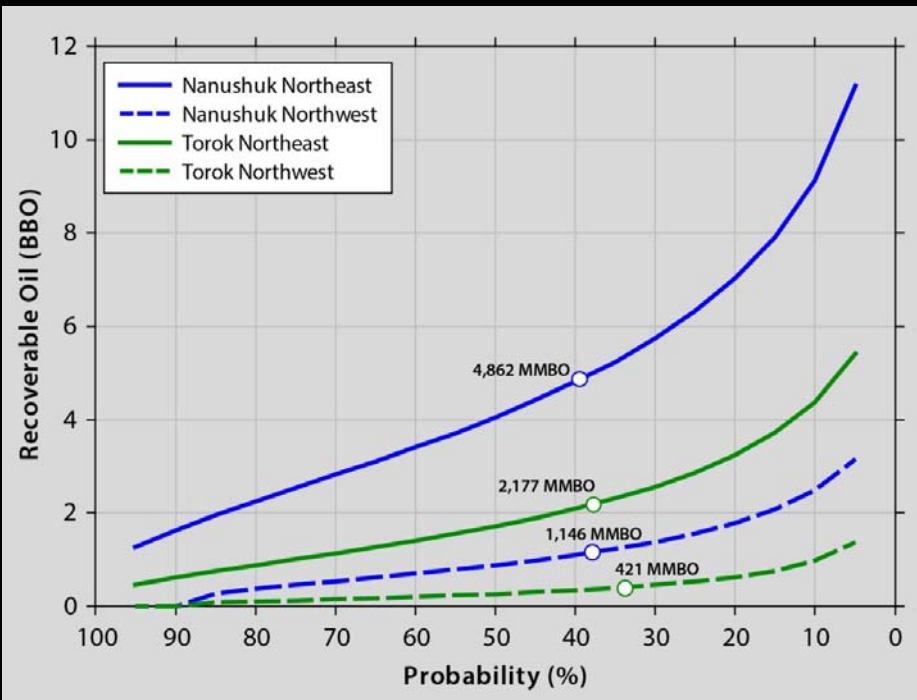
- Nanushuk and Torok Formations estimated to hold 8.7 BBO and 25 TCFG in NPR-A, adjacent State & Native land, and State water
- Largest oil resources estimated in northeastern NPR-A and adjacent areas
 - Nanushuk: Mean 4.9 BBO (1.3 to 11.2 BBO, 95 to 5 % probability)
 - Torok: Mean 2.2 BBO (0.5 to 5.4 BBO, 95 to 5 % probability)
- Reservoirs in both formations are fine-grained sandstone prone to reduction of reservoir quality with burial
 - Deeper parts of plays may have reduced reservoir quality that jeopardizes economic viability
 - This is likely to affect Torok reservoirs more than Nanushuk reservoirs
- Near term exploration likely will focus on Nanushuk prospects
- Torok prospects likely will await infrastructure development and increased oil prices

Thanks for your attention!

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Probabilistic Results for Four Northern AUs



Probabilistic estimate of largest oil pool in each of the four northern AUs

Probabilistic estimate of total oil in the four northern AUs

