[AV]Observations on Recent Exploration Success in Canada's Arctic Frontier Regions*

John Hogg[1]

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*Adapted from presentation at the AAPG DPA Playmaker Forum 2.0, "DPA: Resources for Explorers," January 23, 2014, Houston, Texas

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Abstract

Exploration is a wonderful combination of science, imagination and detective work. Frontier basins, unlike mature basins, are almost always challenged by unavailable, poor or partial subsurface datasets. Well and seismic databases can be 10 to 40 years old with few wells drilled on a specific play type when the new concepts are forged in the explorationist's mind.

Exploration for hydrocarbons in Mackenzie Basin began in earnest in the 1960's with large discoveries in excellent reservoirs on the Mackenzie Delta and then later offshore in the Beaufort Sea. The hydrocarbons were found in Mid-Tertiary-aged sandstone reservoirs, deposited by the paleo-Mackenzie River which flowed into an ice-free Arctic Ocean. This exploration phase ended in early 1980s due to low commodity prices and lack of pipelines. A new round of exploration in the 2000 timeframe brought new data acquisition and ideas led to a couple of significant discoveries.

A case history of recent exploration success within the Canadian Arctic shows the potential of the Canadian Arctic for high impact discoveries in both conventional and unconventional resources in an area where old data and new technologies combined with an exploration mindset led to the discovery of a new gas field.

Observations on Recent Exploration Success in Canada's Arctic Frontier Regions

John Hogg
Vice President
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Acknowledgments

Our Lady Of Victory Church, *Inuvik*

MGM Staff

- Fred Kierulf
- Murray Cooper
- Michael Enachescu

DPA

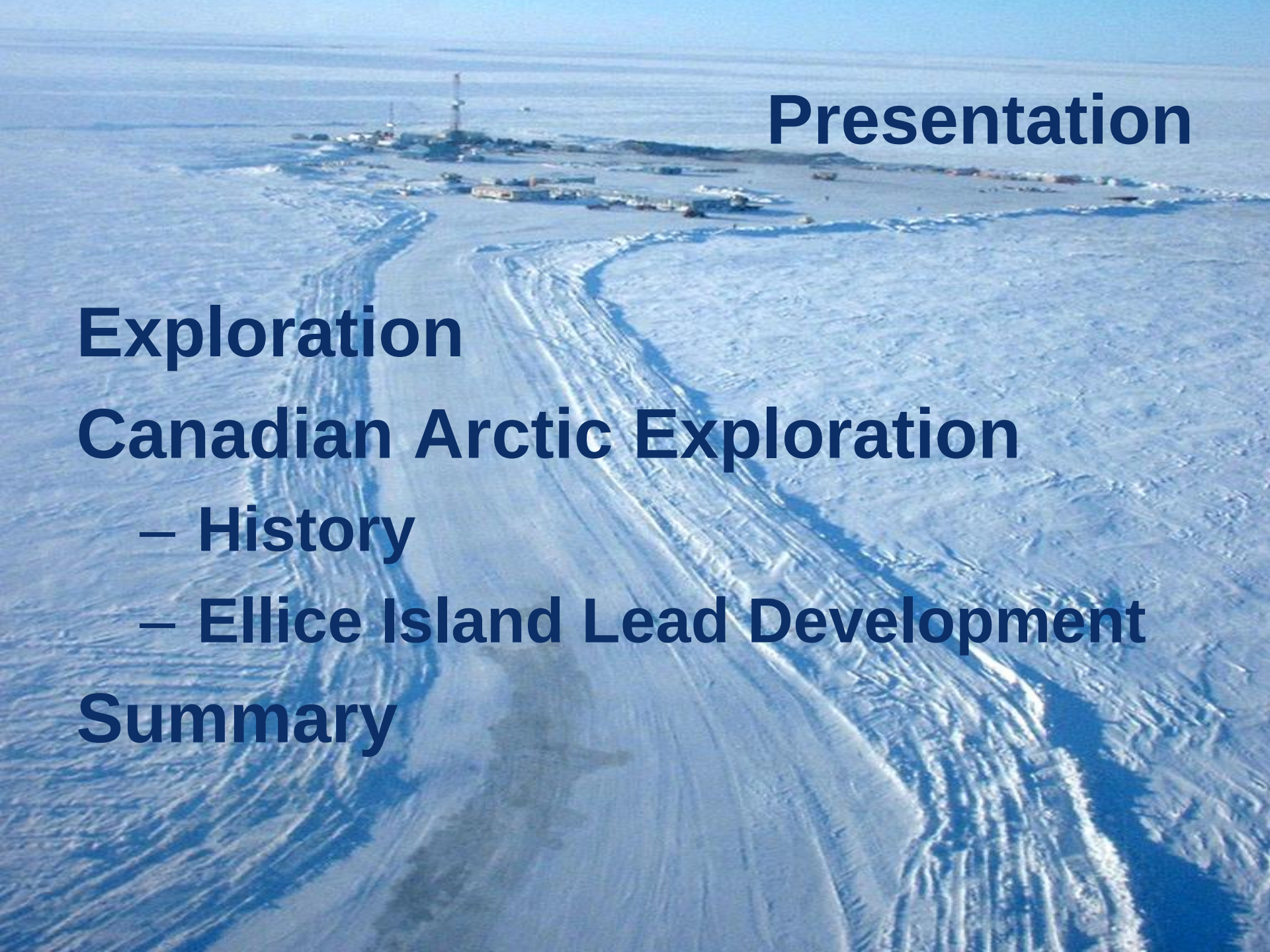
Valary Schulz

Rick Fritz

Charles Sternbach

Canadian Playmakers

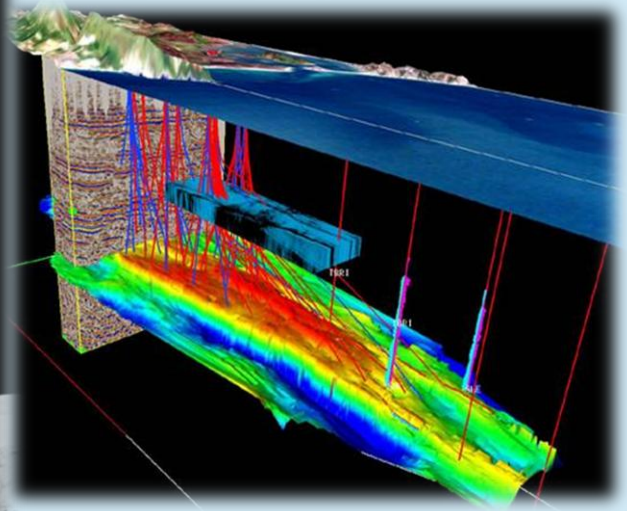
- **Tuesday May 27, 2014 Calgary Alberta**
- **Limited to 300 attendees**
- **Highlights:**
  - Dale Leckie/Lee Krystinik, CSPG/AAPG Presidents
  - Mr. Clay Riddell, Luncheon Speaker, *DPA Heritage Award* Recipient
  - Sessions include: Exploration Thinking, Discovery Histories, New Technologies, Case Histories
  - *Whitehatter* Reception following the day's events



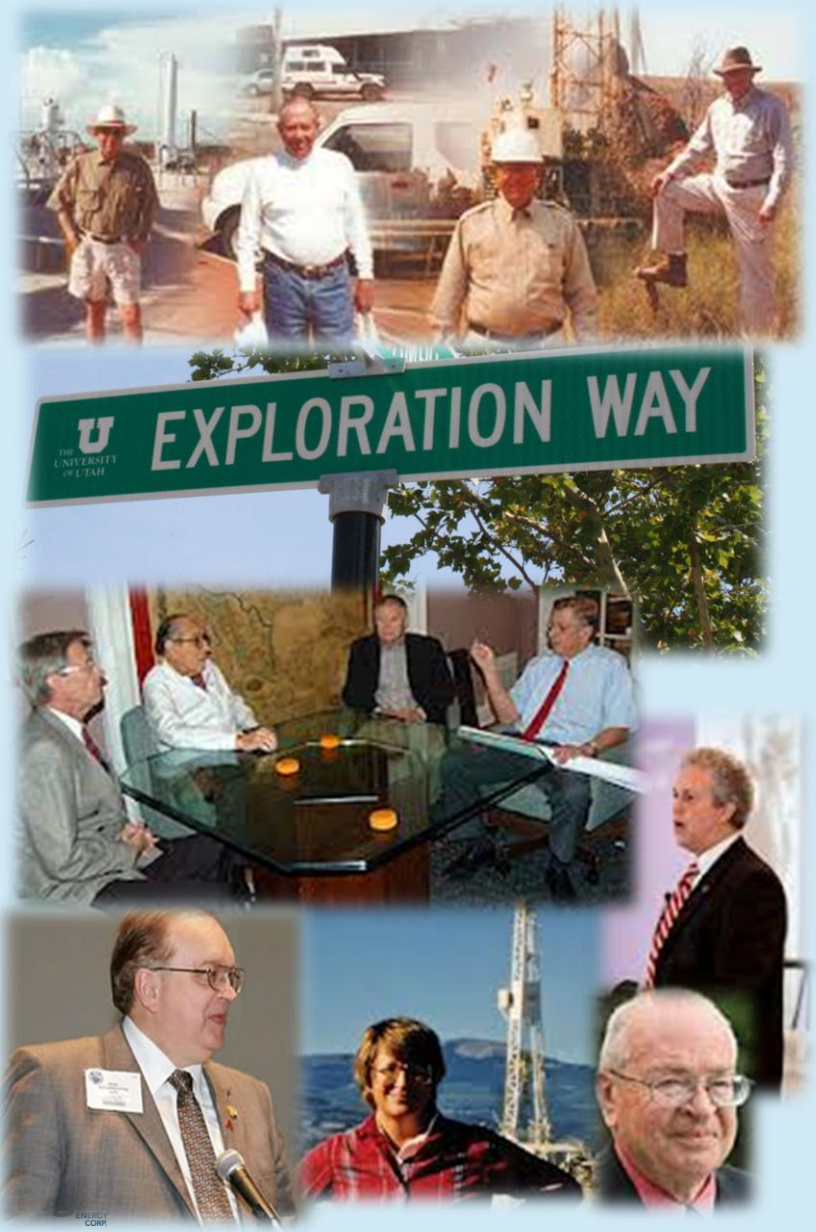
Presentation

- Exploration
- Canadian Arctic Exploration
  - History
  - Ellice Island Lead Development
- Summary

Exploration



What makes an Explorationist?



- Naturally inquisitive
- Passionate
- A life-long learner
- Broad geoscience background
- Willing to fail, again and again
- Little time for "*no*" or "*can't*"
- Finds ways to get things done
- Glass is more than ½ full
- Asks two key questions:
  - *Why?*
  - *What if?*

History of Arctic Exploration

Arctic Ocean Rivers

http://arcticgreatrivers.org/

- The Mackenzie is the 4th largest of all Arctic Ocean Rivers
- Tenth largest River in the World
- Traditional name is Deh Cho "*Great River*"
- Flowing since the Early Cretaceous

Mackenzie River Basin

The longest river in Canada

> 1700 km long

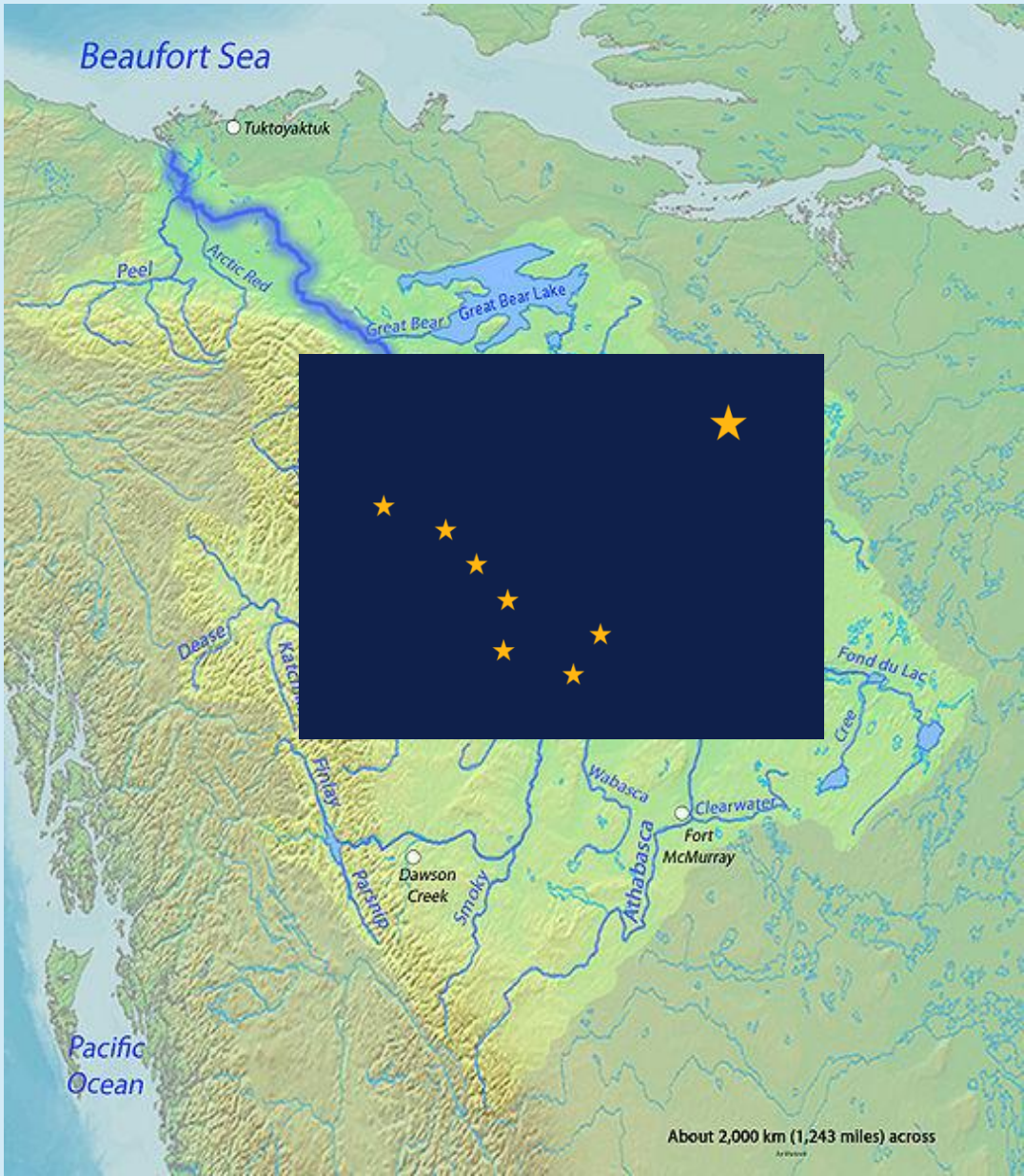
> 4500 km waterways

Watershed includes NEBC, northern Alberta and NW Saskatchewan

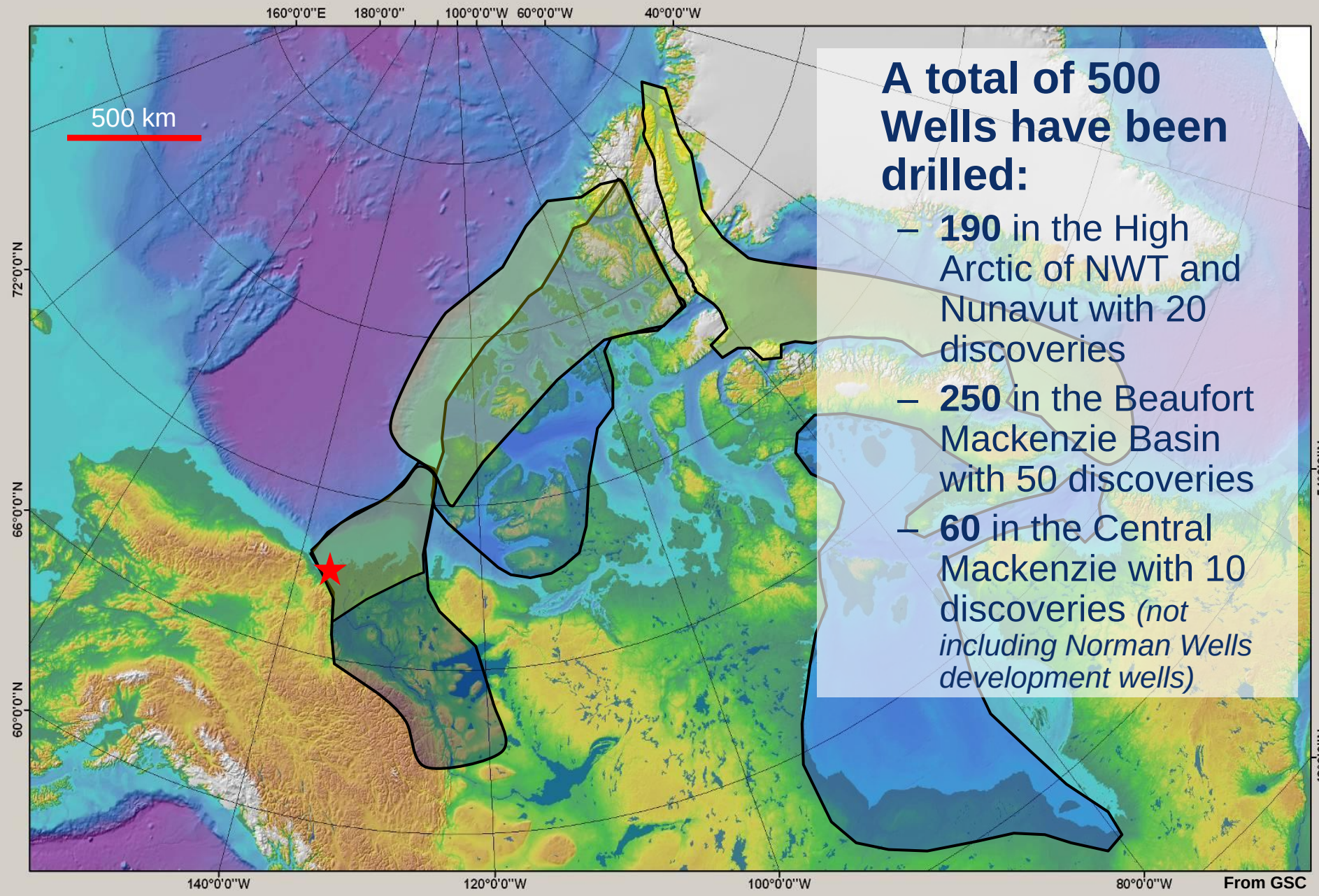
Discharge:

- **10,000 m^3/s Average**
- **33,000 m^3/s Spring**

Drains 1.8 MM km^2



Canadian Arctic Basins

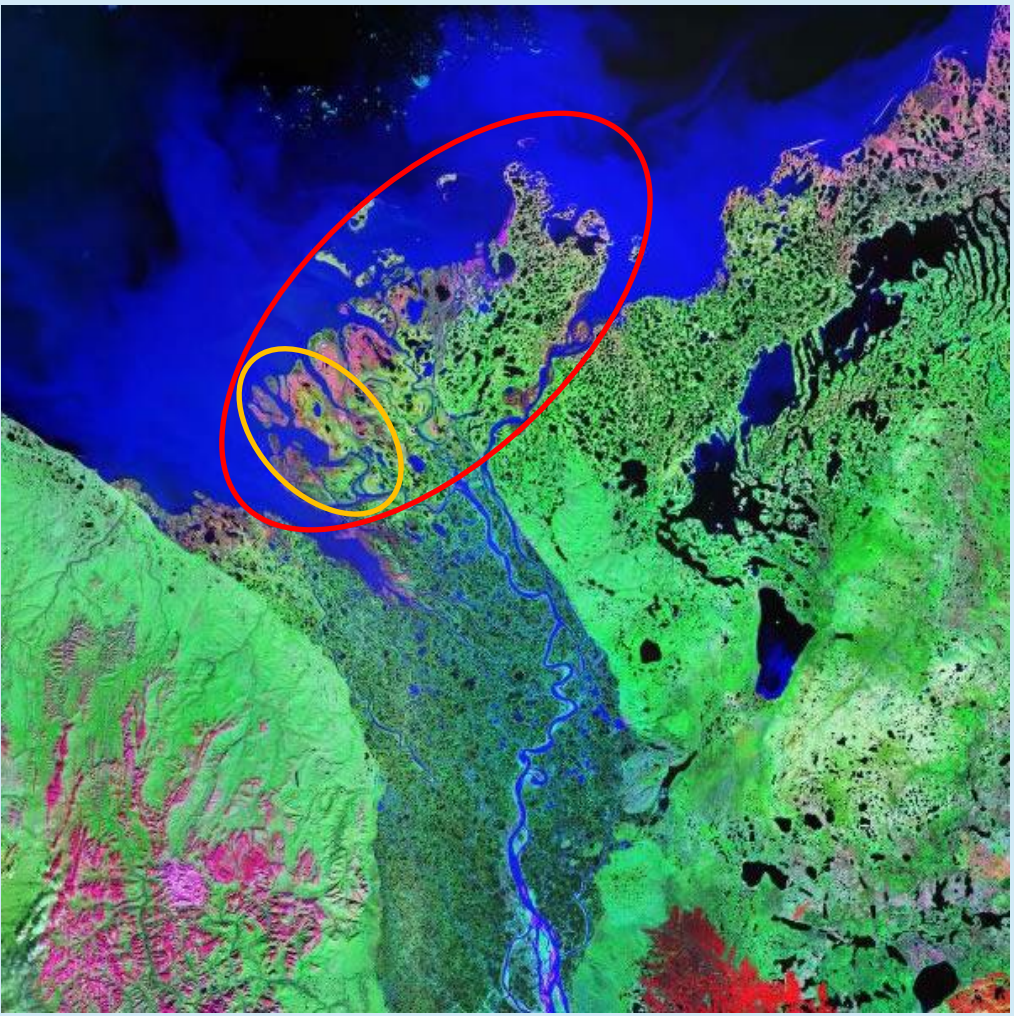


A total of 500 Wells have been drilled:

- **190** in the High Arctic of NWT and Nunavut with 20 discoveries
- **250** in the Beaufort Mackenzie Basin with 50 discoveries
- **60** in the Central Mackenzie with 10 discoveries *(not including Norman Wells development wells)*

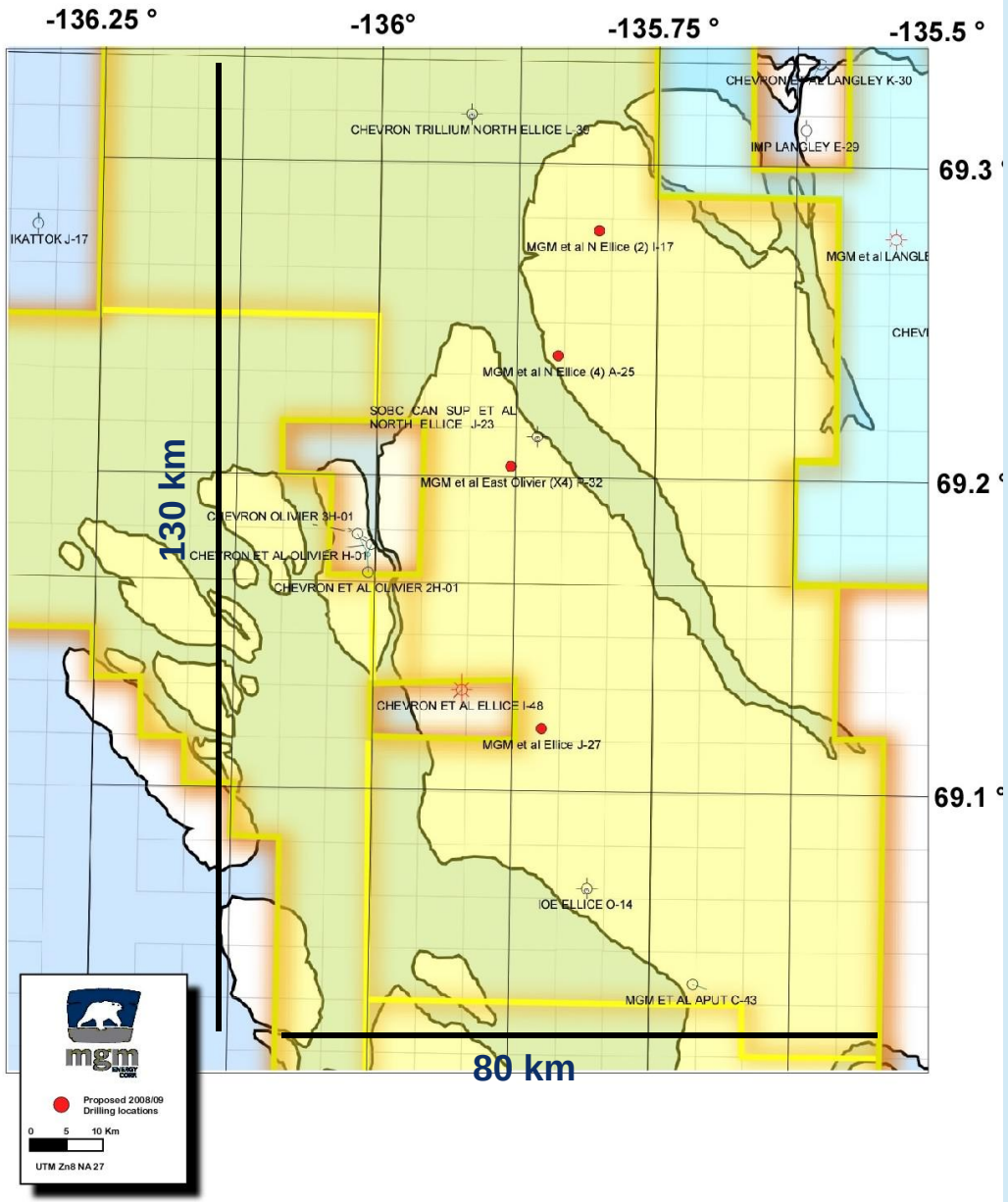
Mackenzie Delta Exploration

Mackenzie Delta Basin



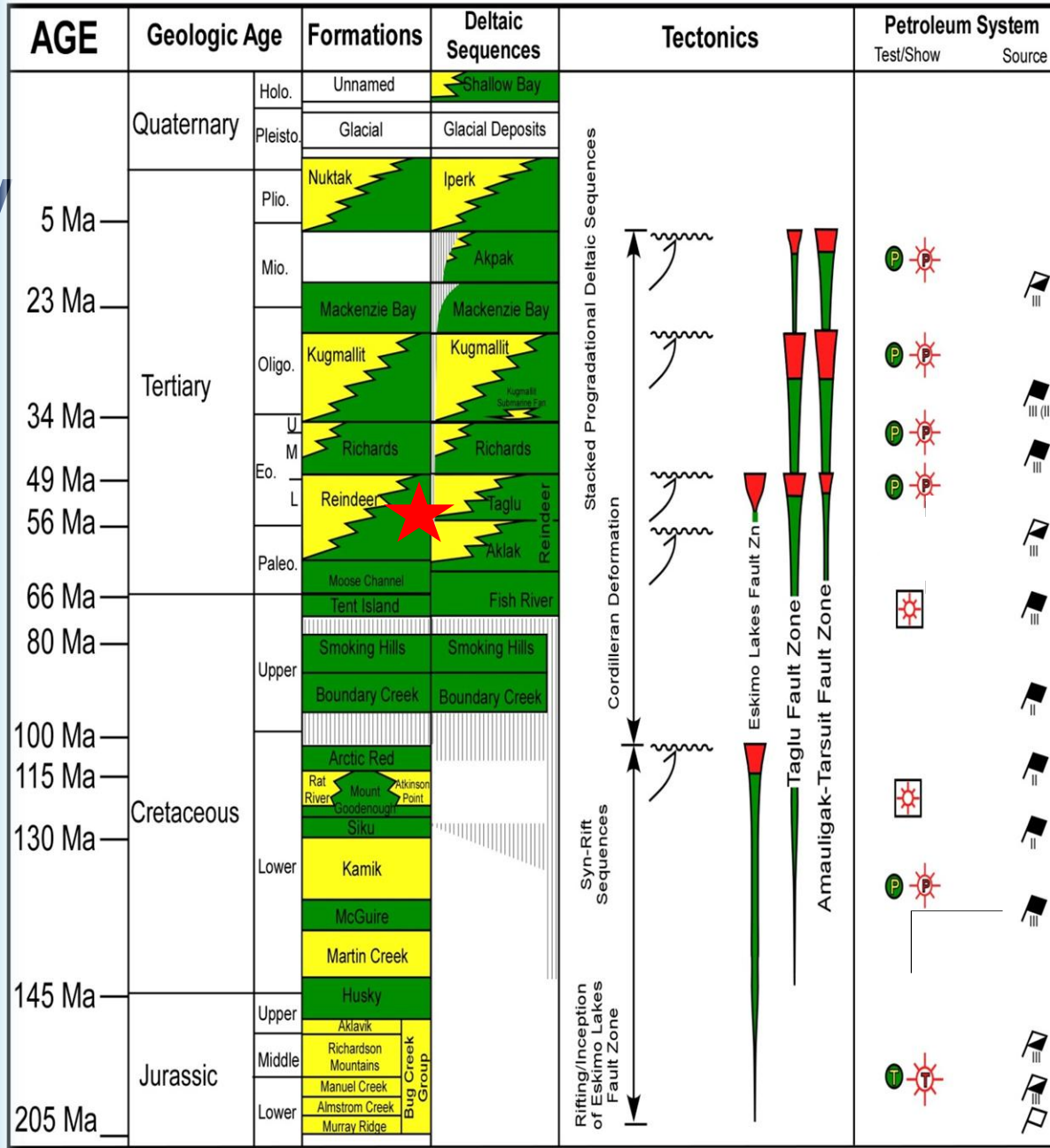
- ***Area***
  - 15,000 km^2
- ***Reservoirs***
  - Cretaceous to Tertiary Deltaic and Marine sandstones
- ***Source***
  - Cretaceous Smoking Hills
  - Paleocene Fish River
- ***Traps***
  - Listric Hangingwall
  - Listric Footwall
  - Modified Anticlines
  - Stratigraphic Pinchouts
- ***Hydrocarbon Potential***
  - 10 -20 Tcf
  - 500 - 1 Billion bbls

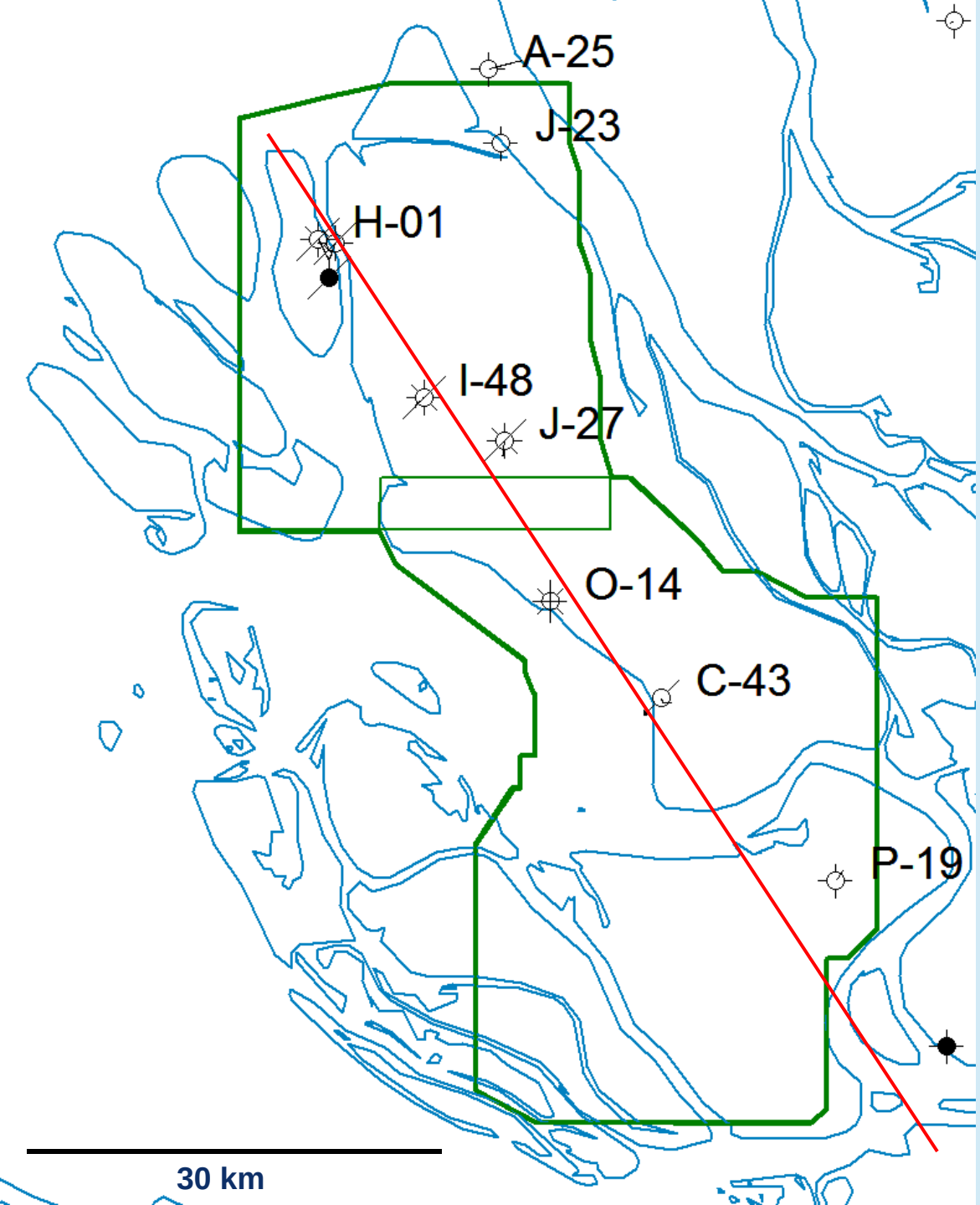
2007 Ellice Island Area



- Area of Exploration Lands in Yellow
- 10,500 km^2 (2,600,000 ac) of land to explore
- Five existing exploration wells, three discoveries
- MGM Leads/Prospects are the red dots
- Focus on MGM Ellice J-27 Lead

Lithostratigraphy and Chronostratigraphy of the Mackenzie Region





Datasets

Historic 2D

- 20-30 years old
- Useless

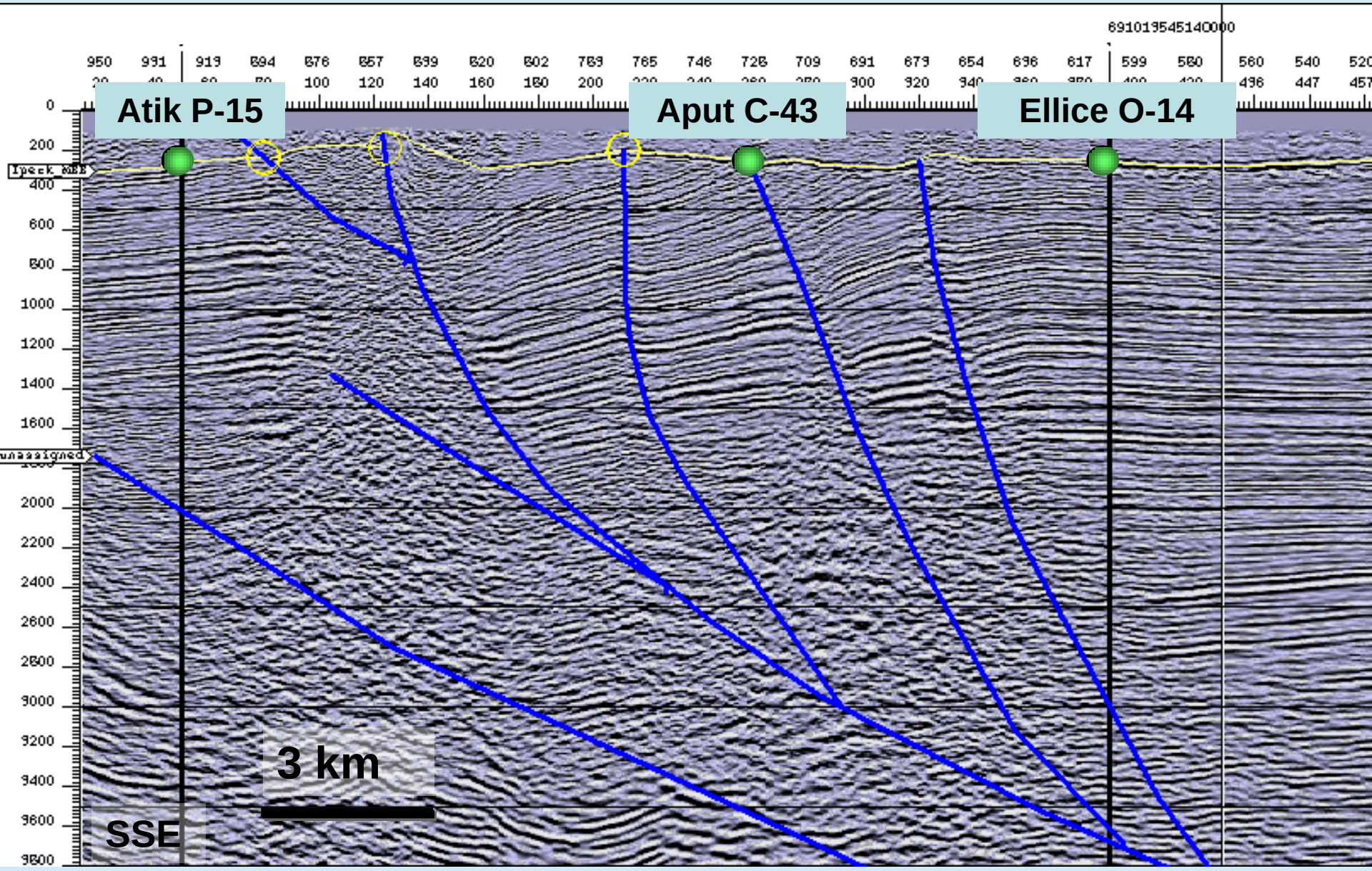
Two 3D datasets

- Acquired 2003 and 2005

Nine Exploration Wells

- Gas Discoveries at
  - J-27
  - I-48
  - Gas/Oil at H-01
- Delineation drilling on the H-01 discovery

Western Mackenzie Delta Onshore Dip Line



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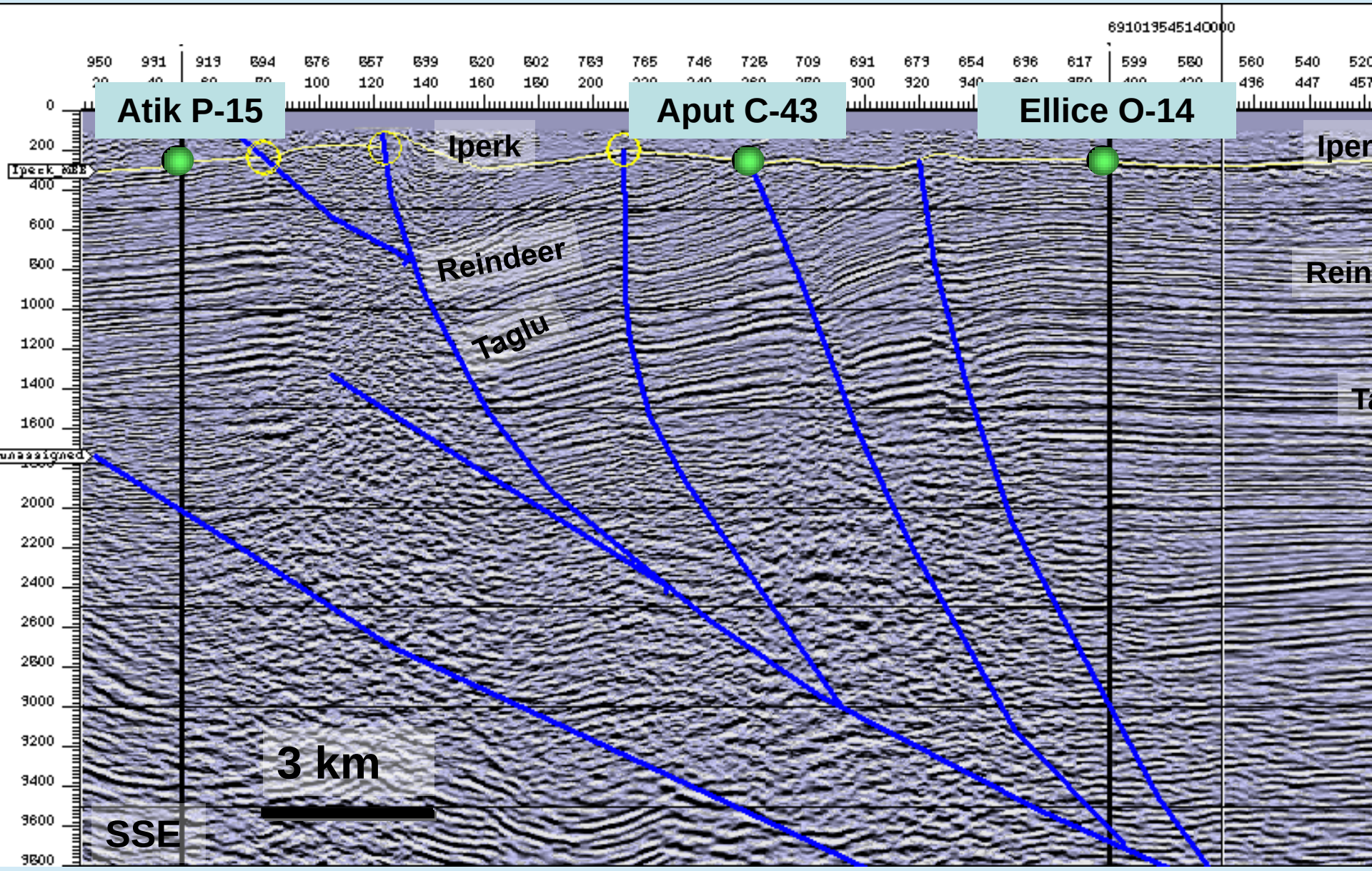

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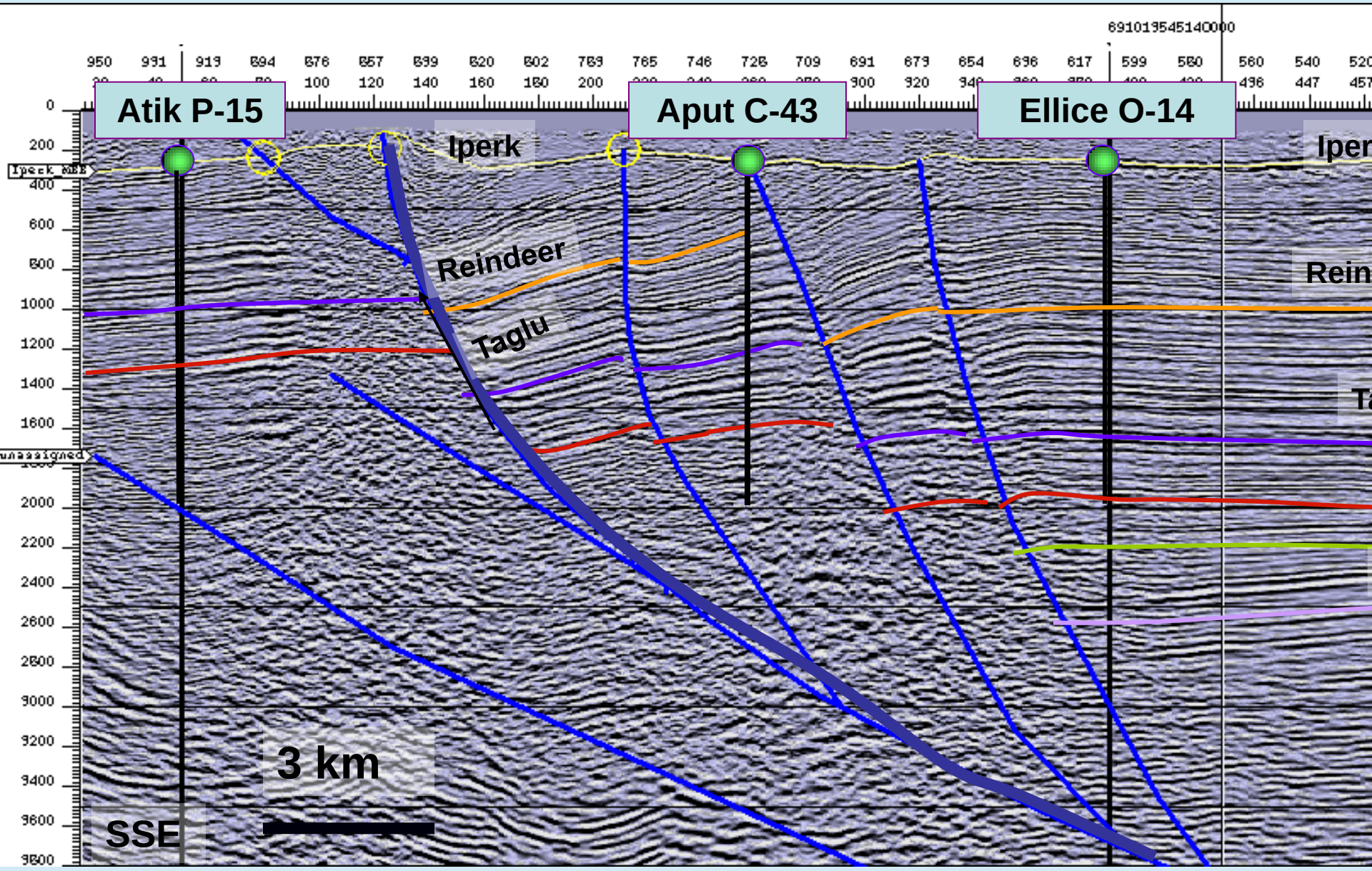
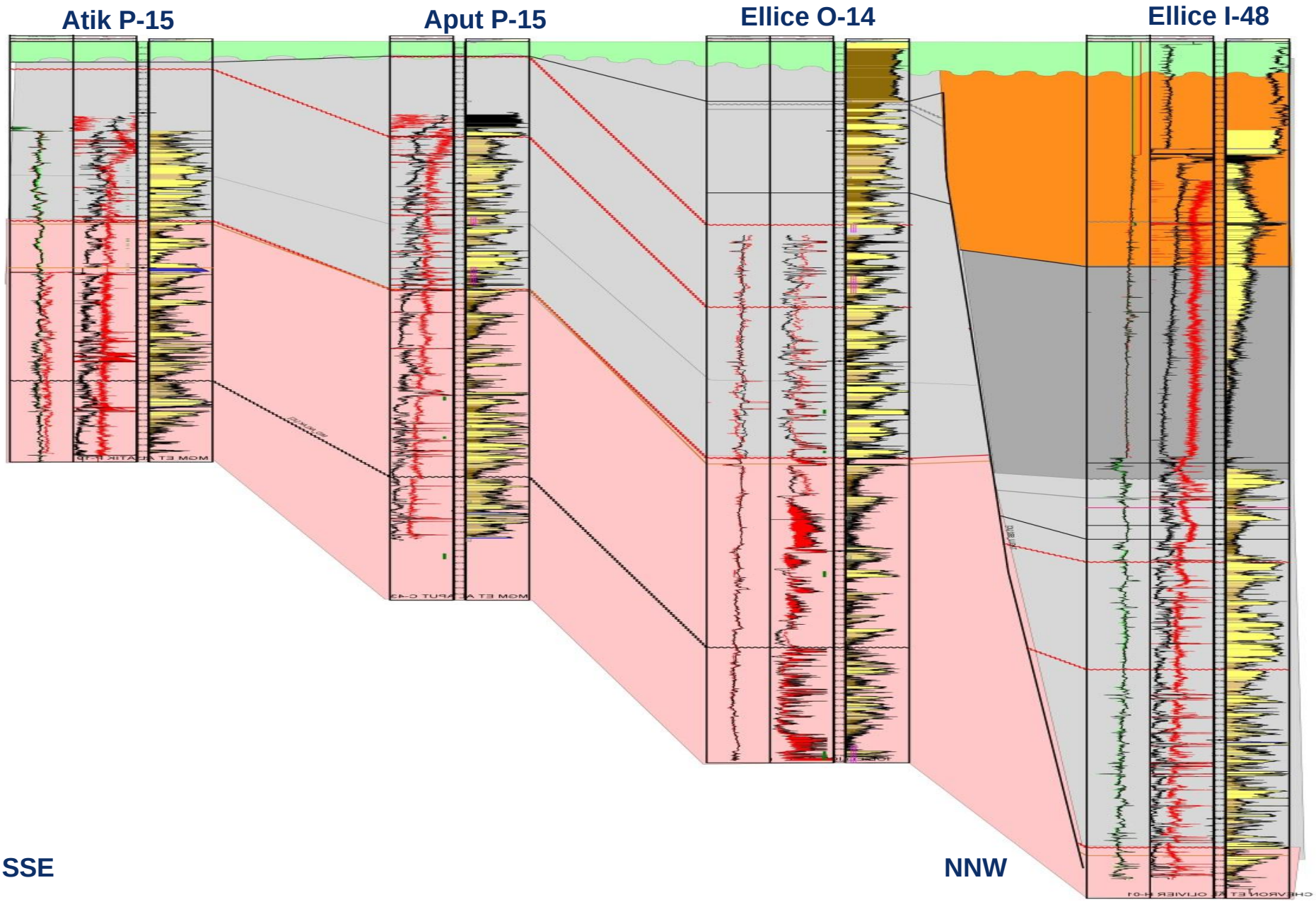
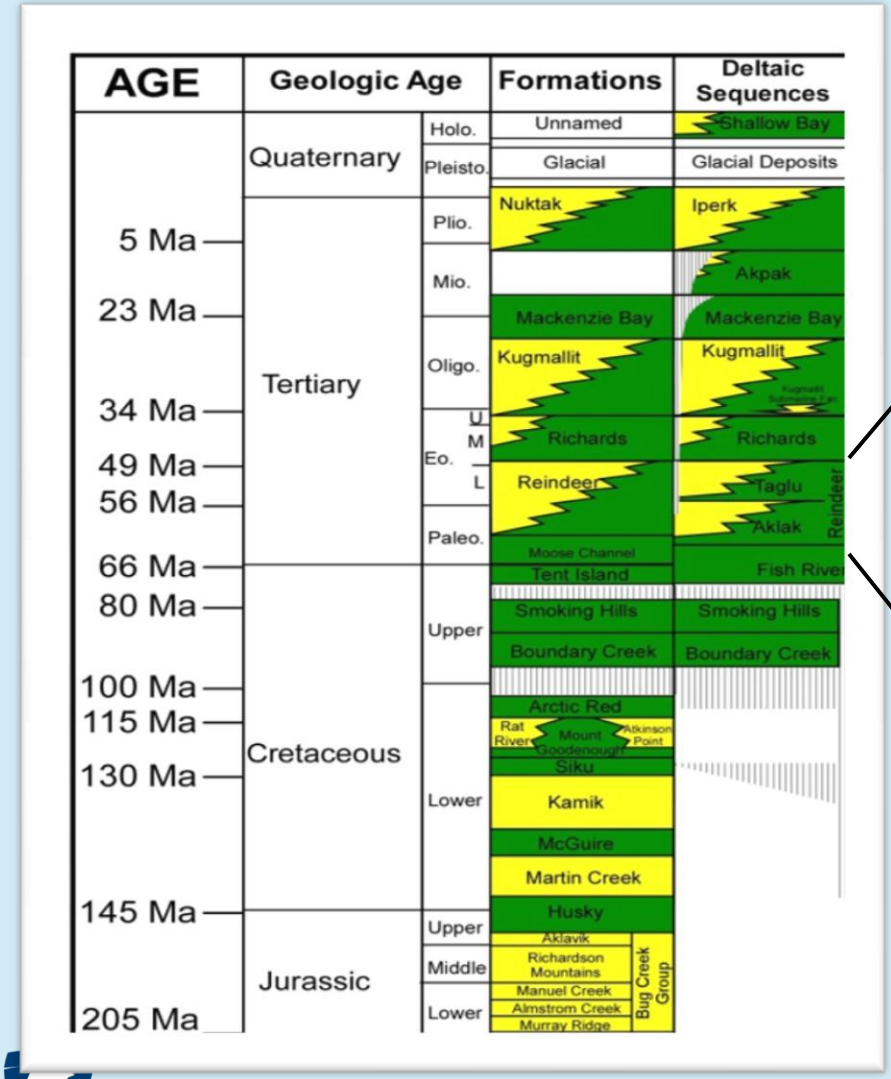
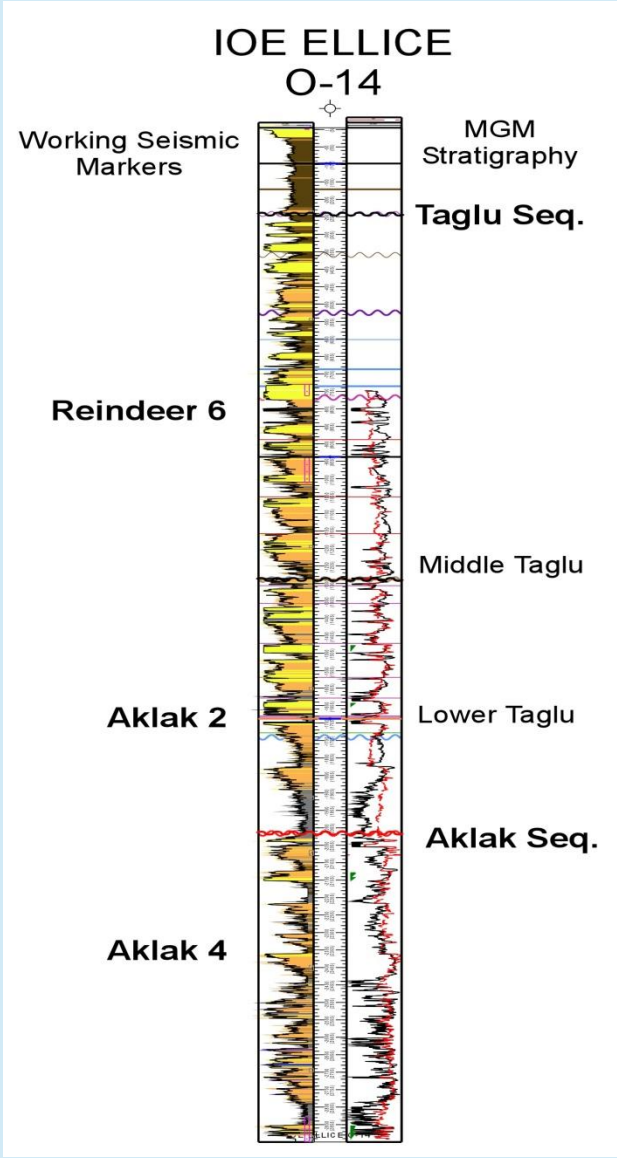


Ellice Island Cross Section



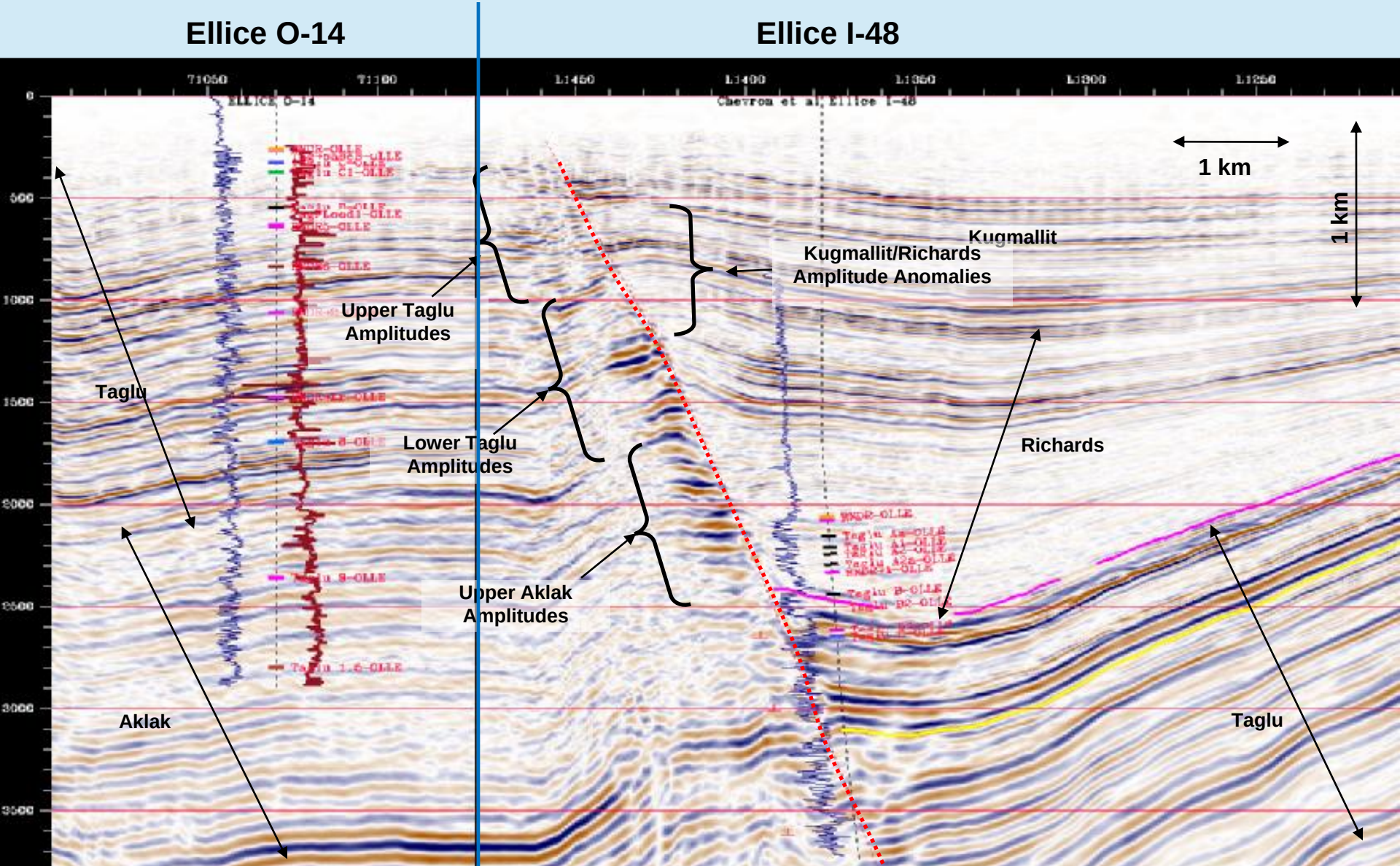
Regional Geology - Stratigraphy



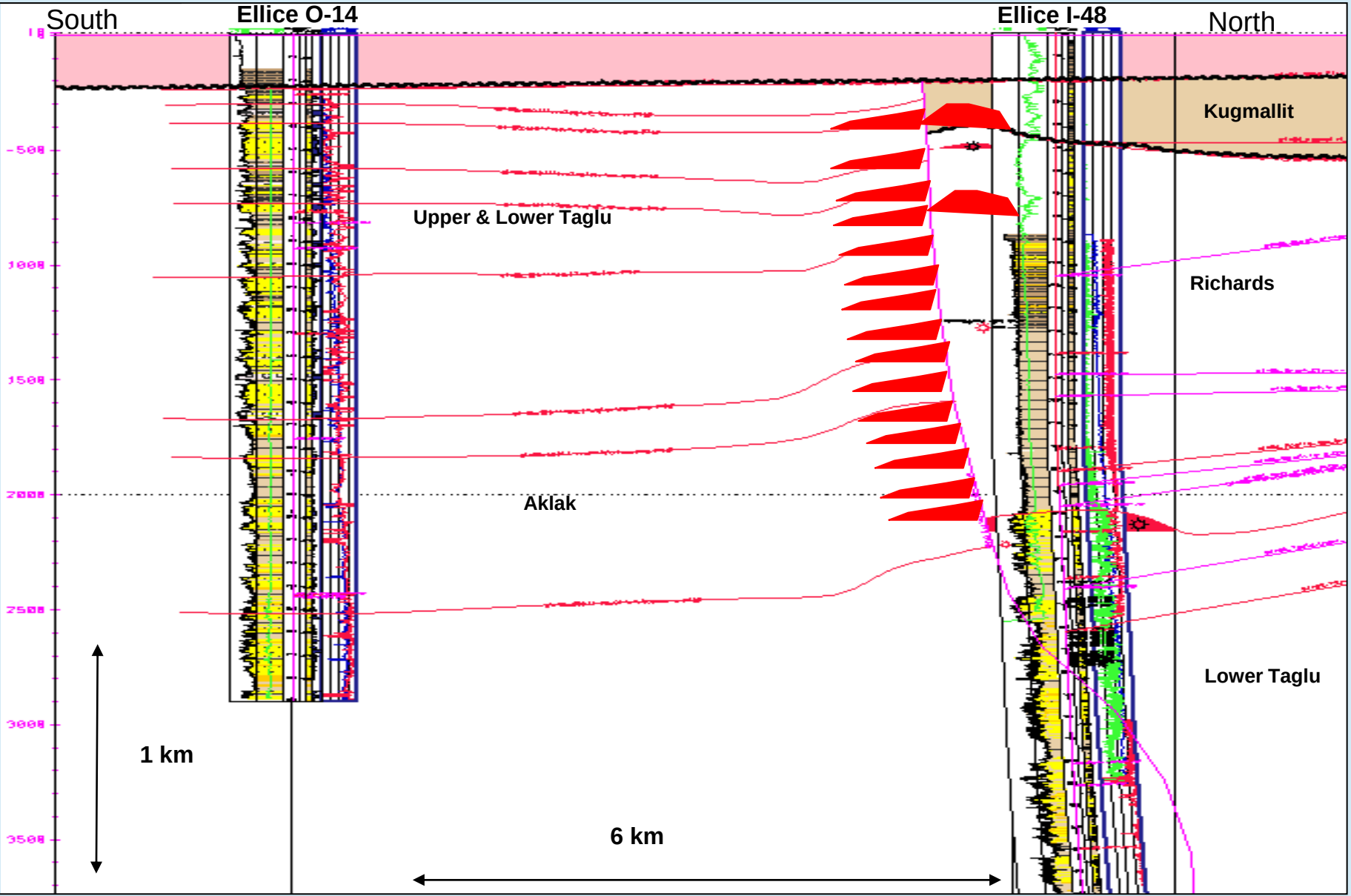


Ellice Seismic Lead

Seismic Stretched to Depth



Ellice Lead Structural Cross Section



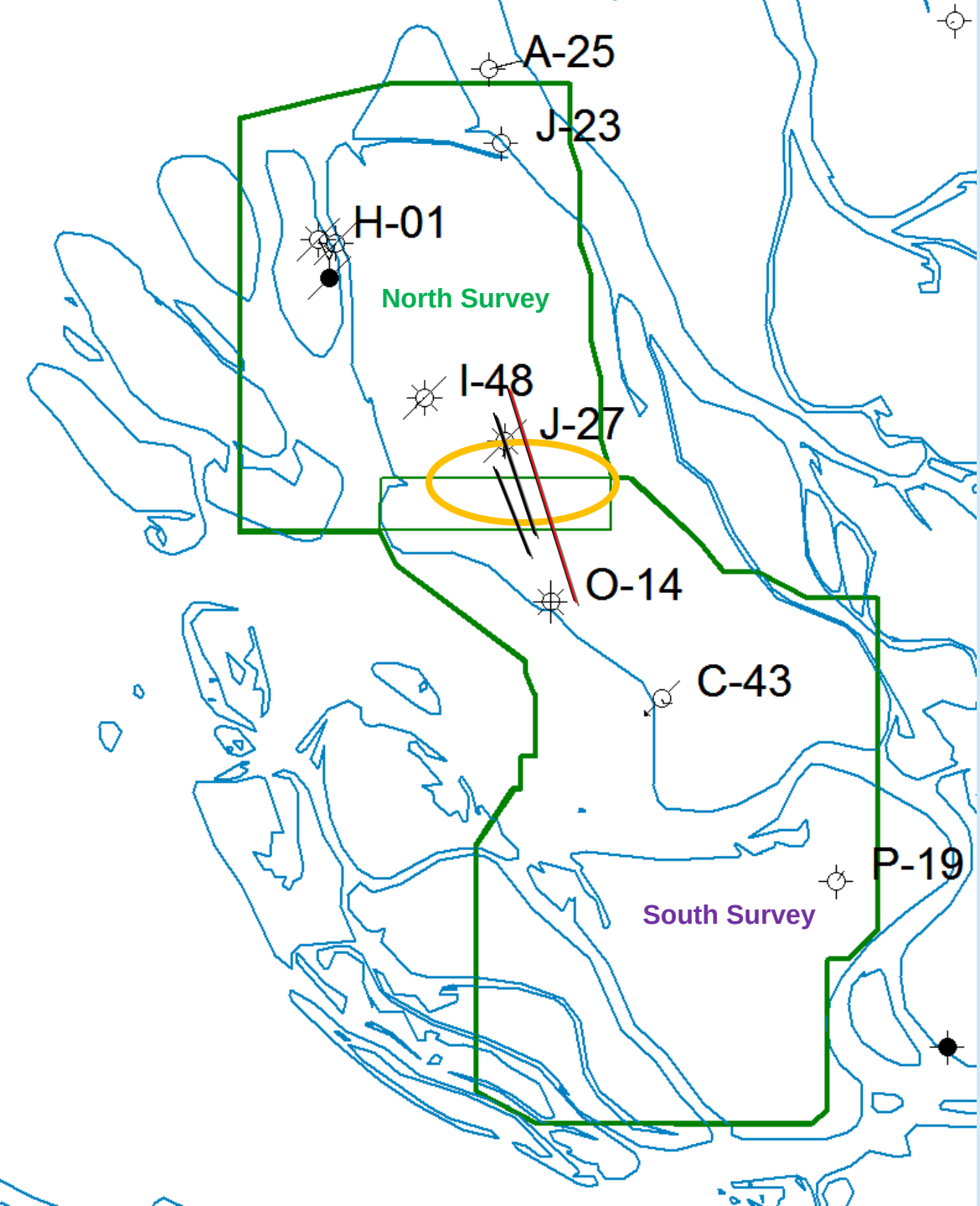

Why?
What if?

Why?

- Are the sands seen as an amplitude anomaly only against the fault?
- Is the seismic data depth stretched?
- Did they drill Ellice O-14?

What if?

- The sands on the footwall were not truncated?
- We clean up the velocity issues in the fault shadow?
- We attempt a 3D data merge and process in both time and depth?

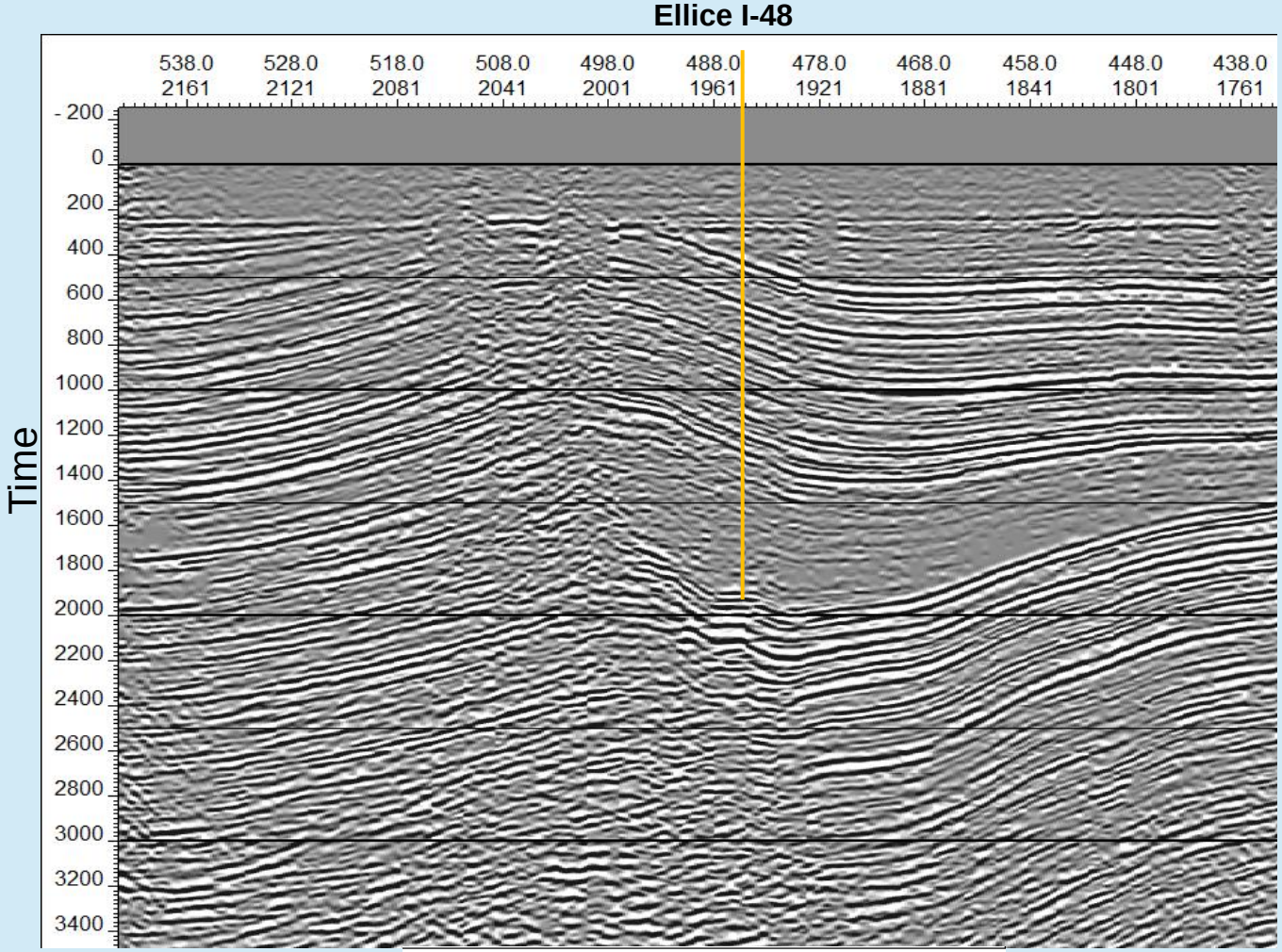


3D Datasets

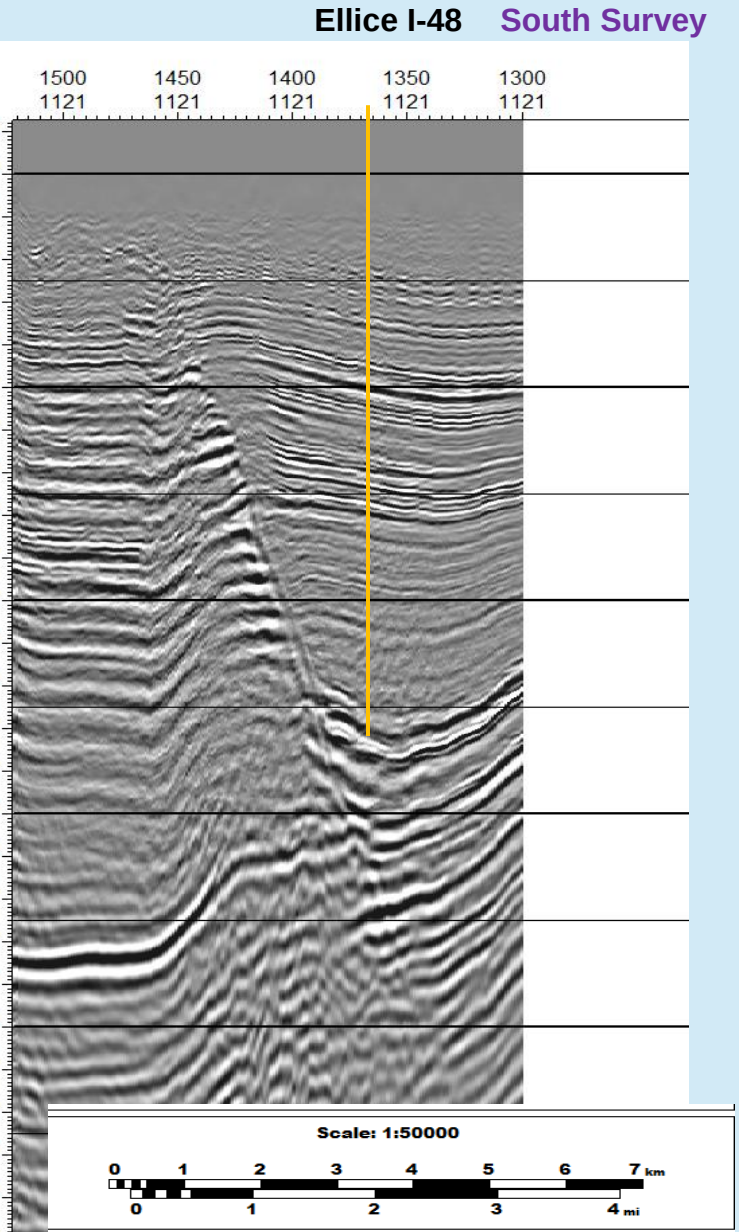
Two 3D datasets

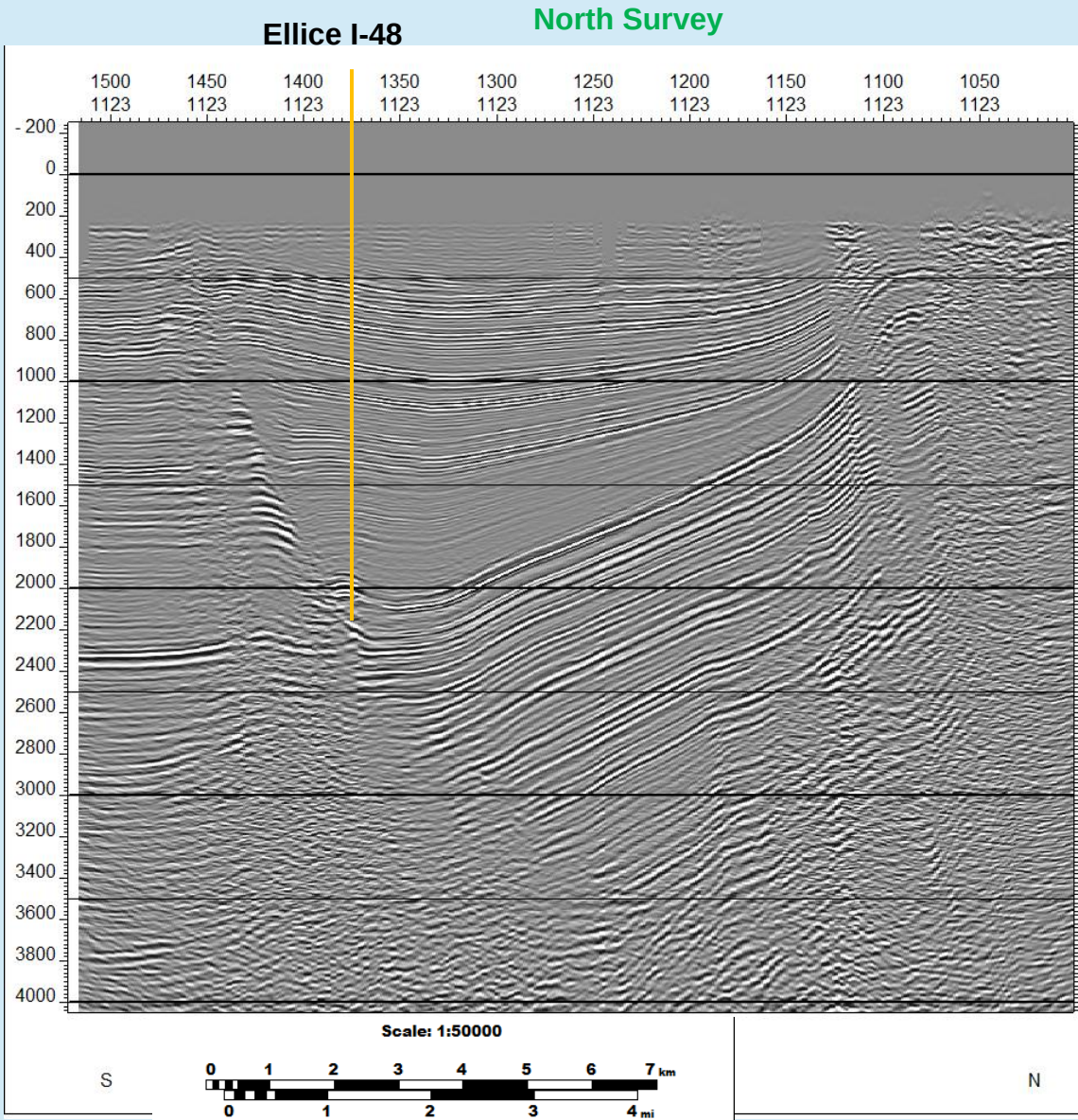
- Acquired twice over the lead
- How to work the merged dataset to find a drillable target
- Footwall wall fault dependent closures with increased amplitude within closure
- Multiple potential reservoirs from Upper Taglu down into Lower Aklak

2D Line across Ellice Prospect

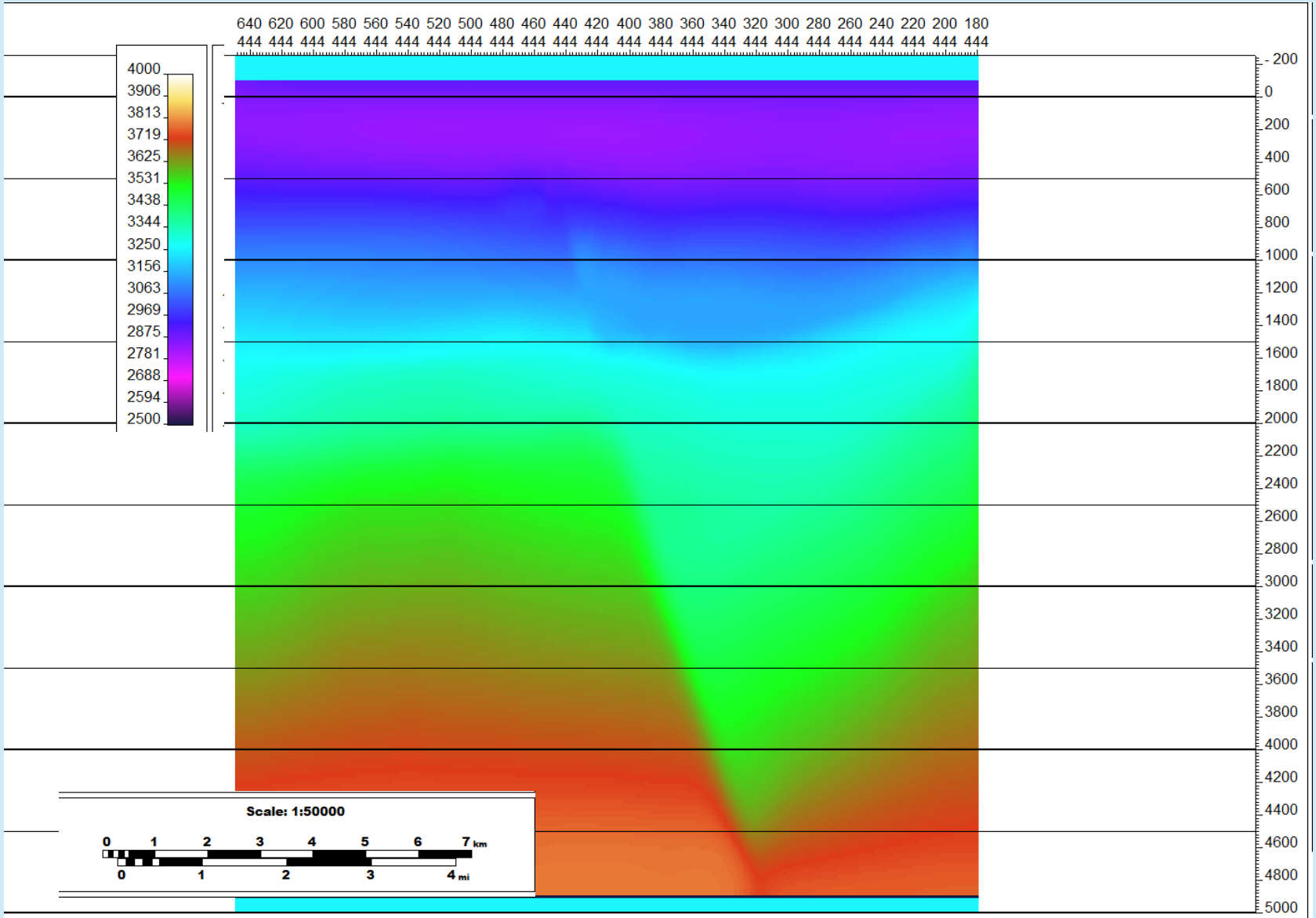


Arbitrary 3D Lines across Ellice Lead

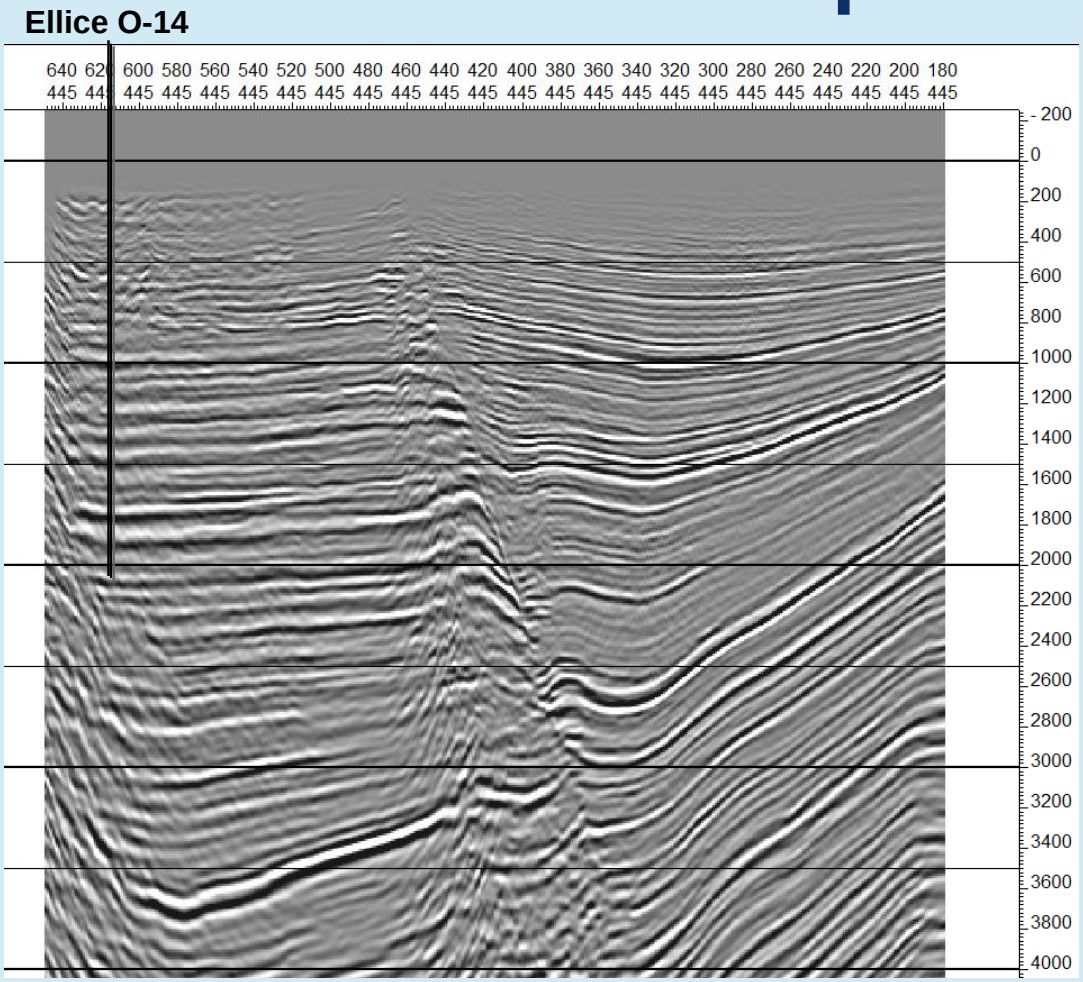


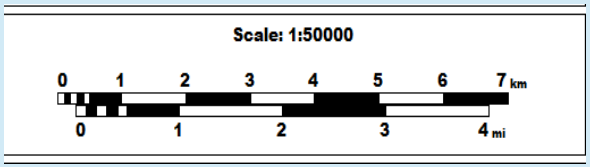


New Velocity Field

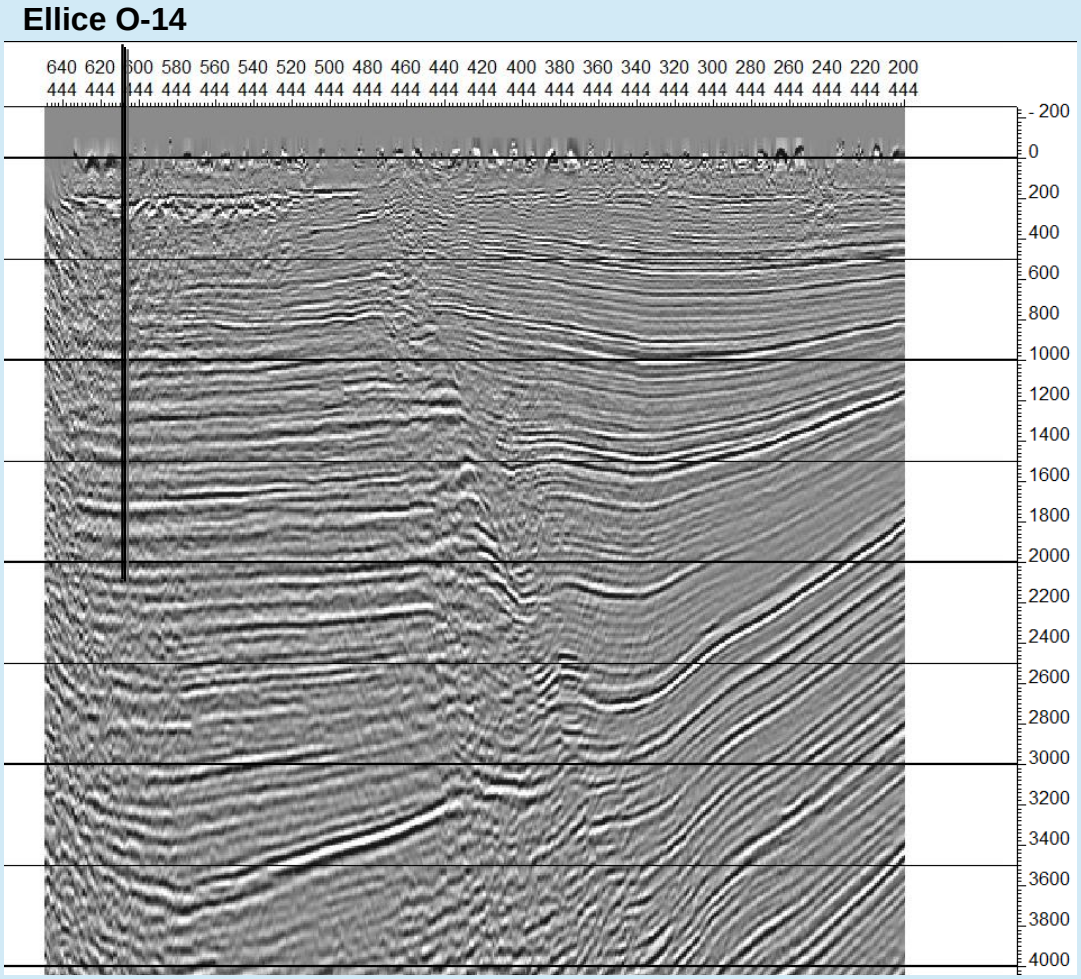


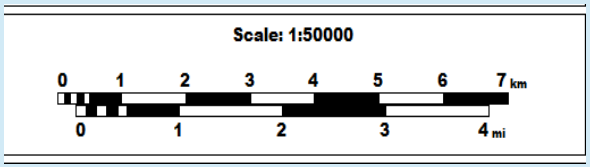
Merged Dataset
Pre-Stack Depth Migration



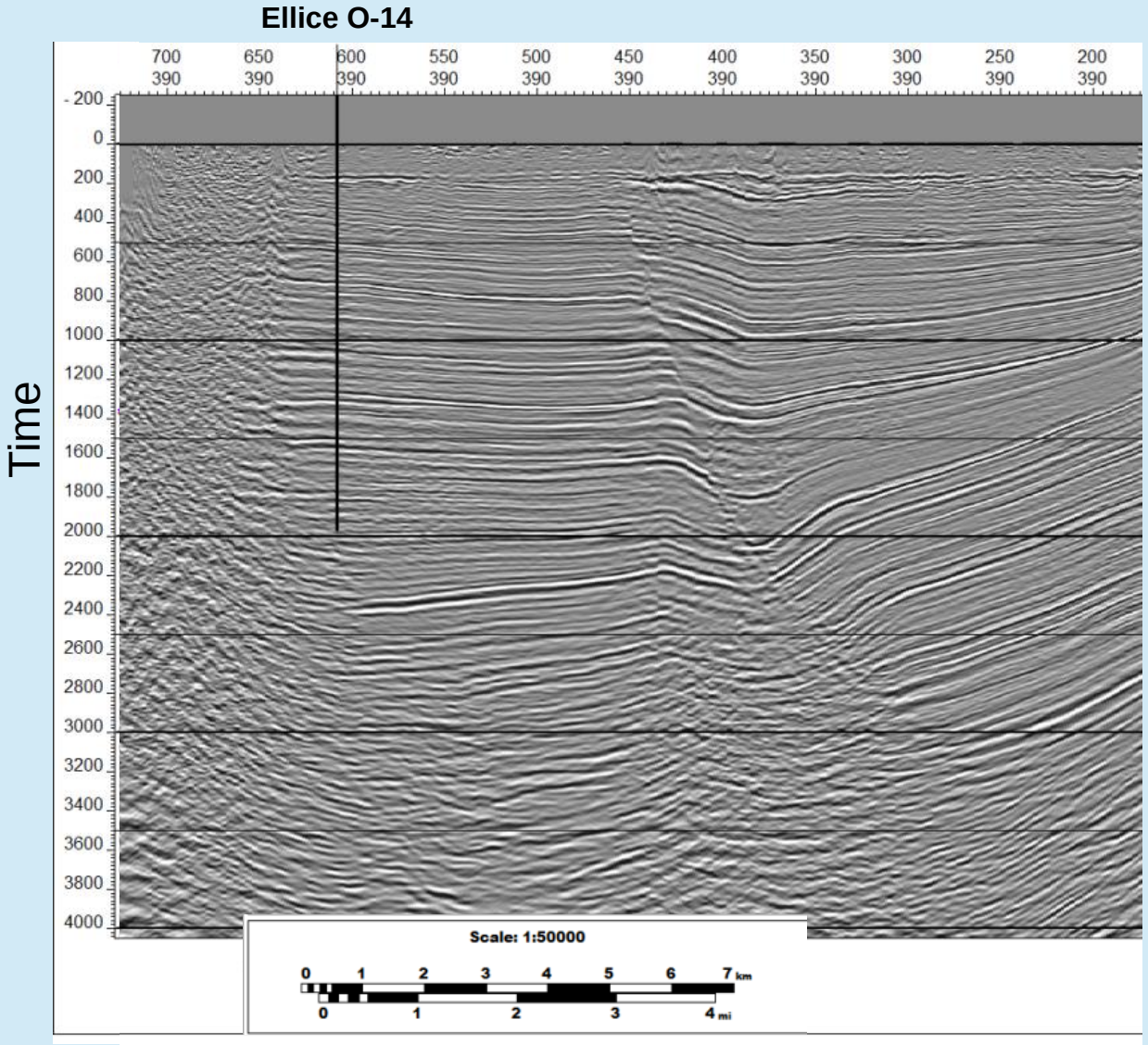


Merged Dataset Post-Stack Depth Migration

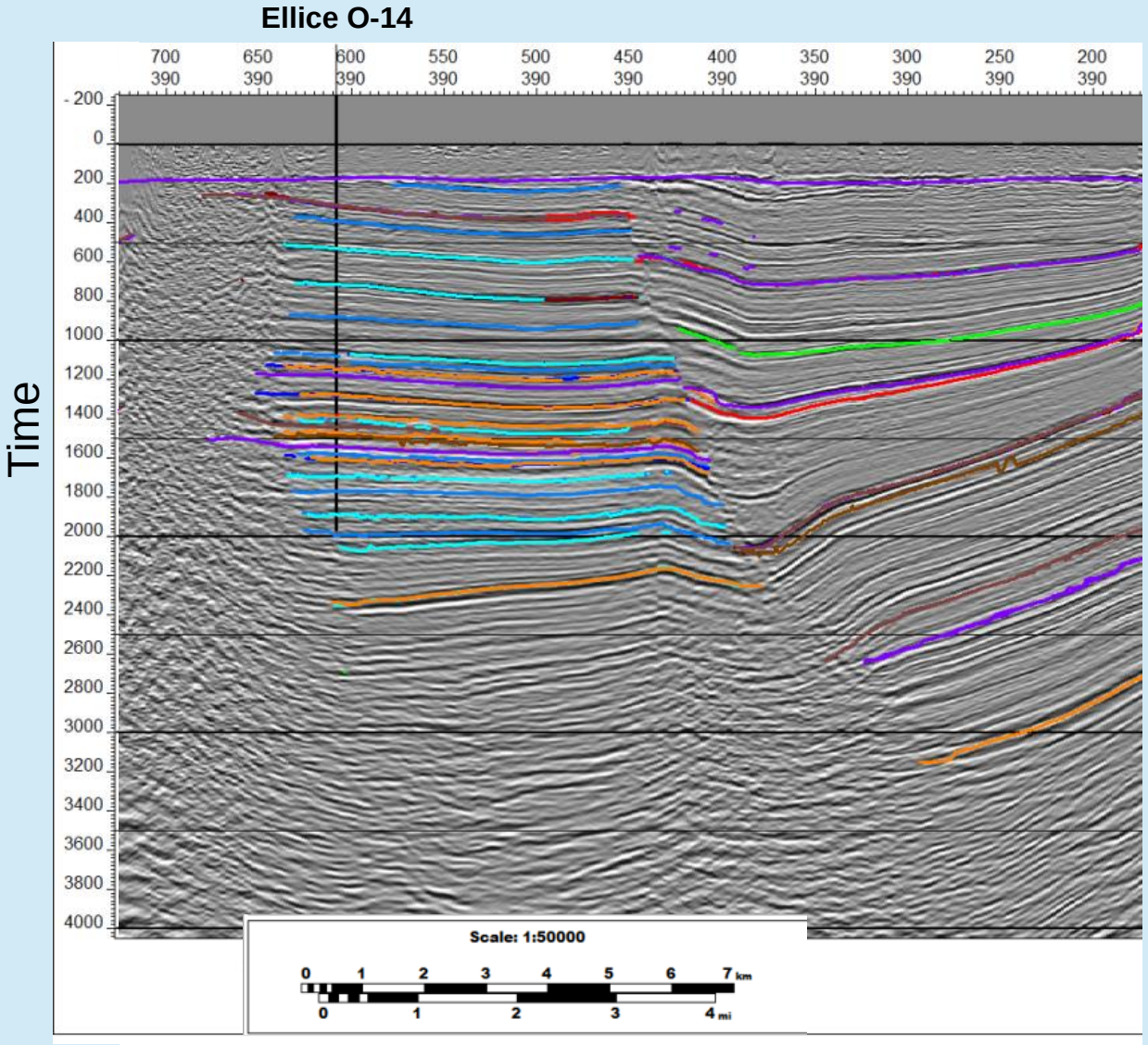




Merged Dataset Time Migration

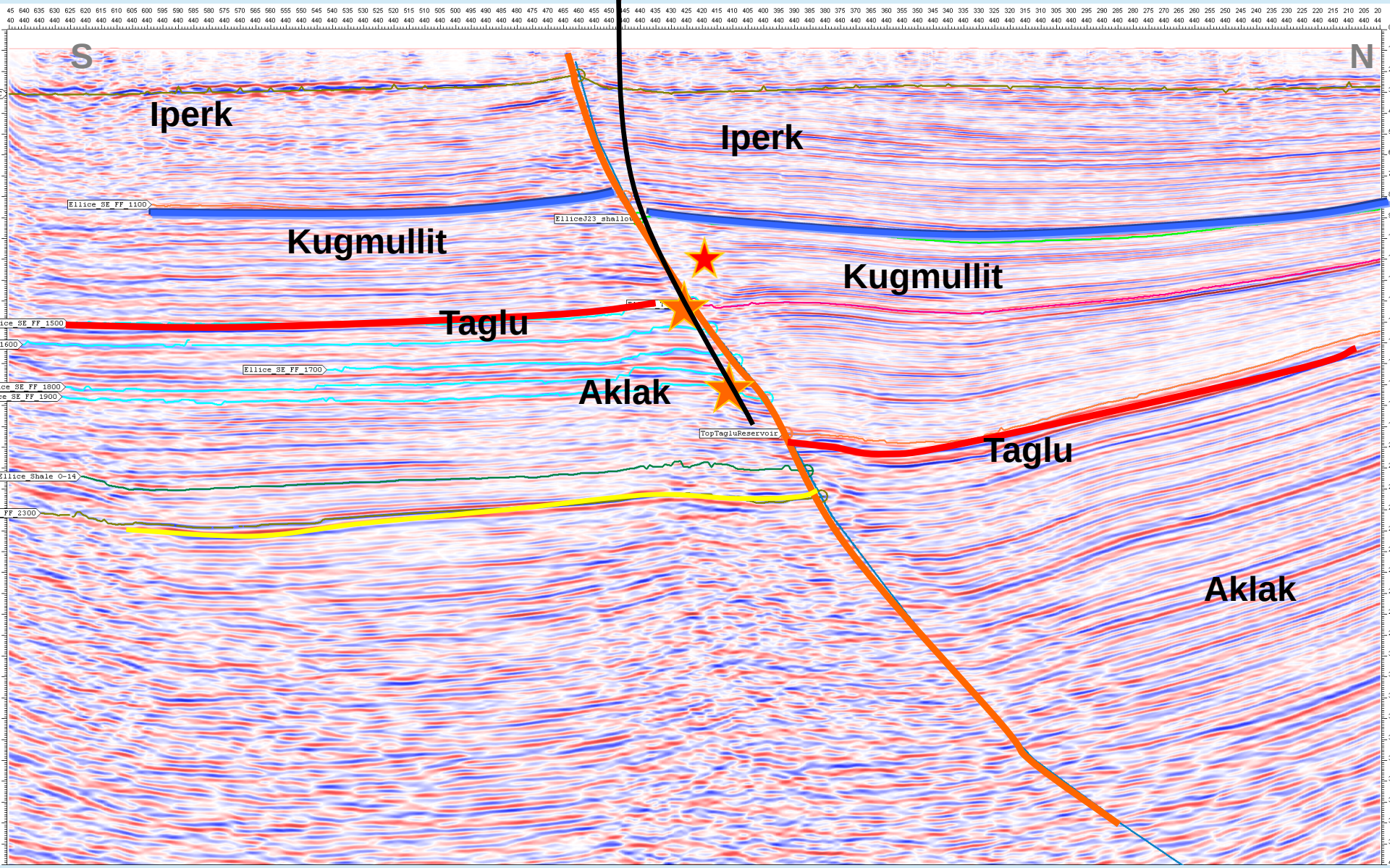


Merged Dataset Time Migration



Pre-drill Seismic Line Ellice J-27

3-D merged dataset depth line



Ellice J-27 Pre-drill Risks

Key Risks

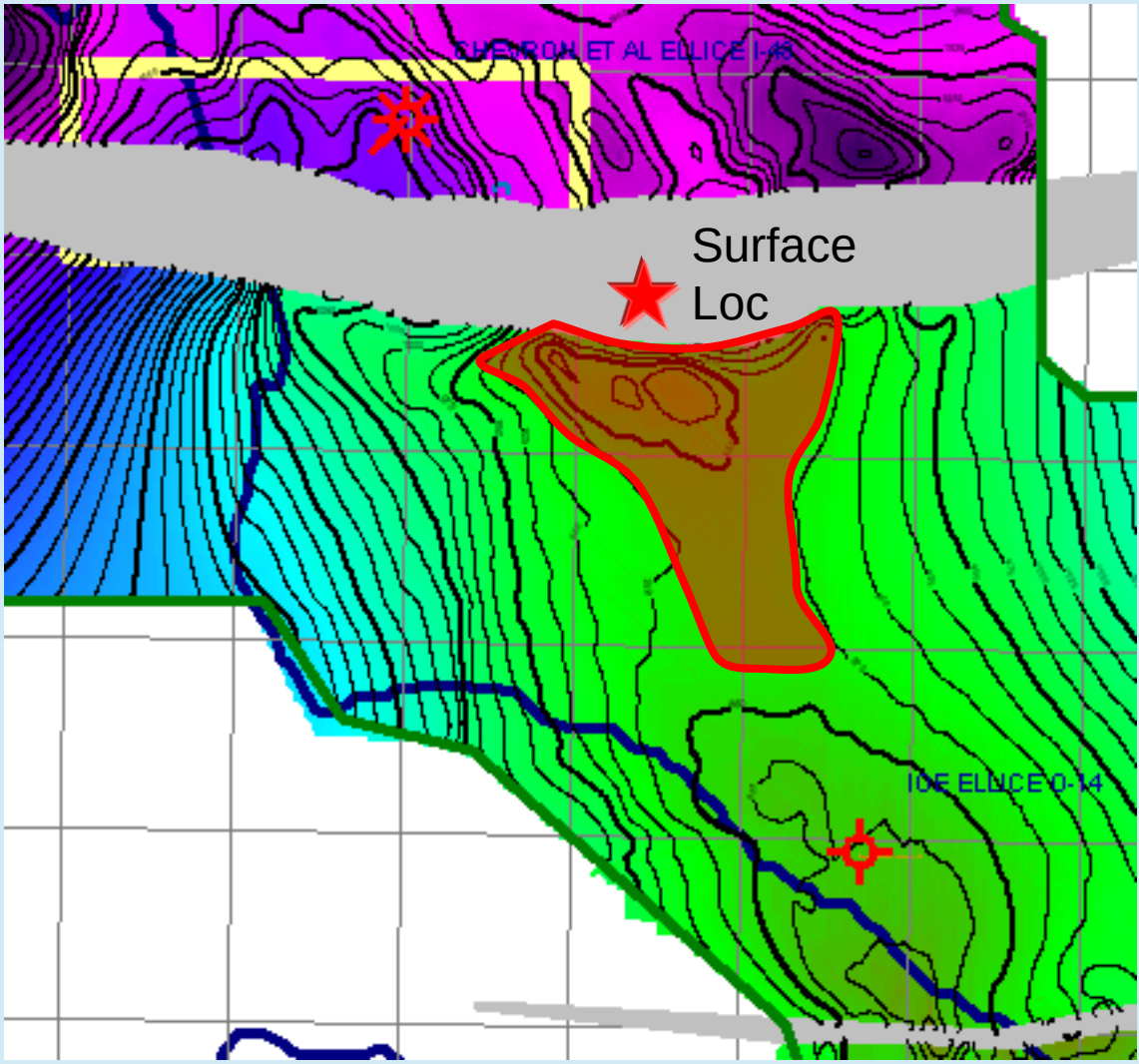
- Seal across fault and vertically
- Migration of hydrocarbons

Key Attributes

- Footwall-fault-dependent closures with increased amplitude within closure
- Multiple potential reservoirs from Upper Taglu down into Lower Aklak

Key Considerations

- Land tenure



Barging to Site

Ellice J-27 Location

Ellice J-27 Testing Operations

Highly prolific discovery well

DST #1 38 MMcf/d, 99% Methane, 7% drawdown

Surface Permafrost preserved by 2m thick Ice Pad

- Snow continuously added to hot spots during testing

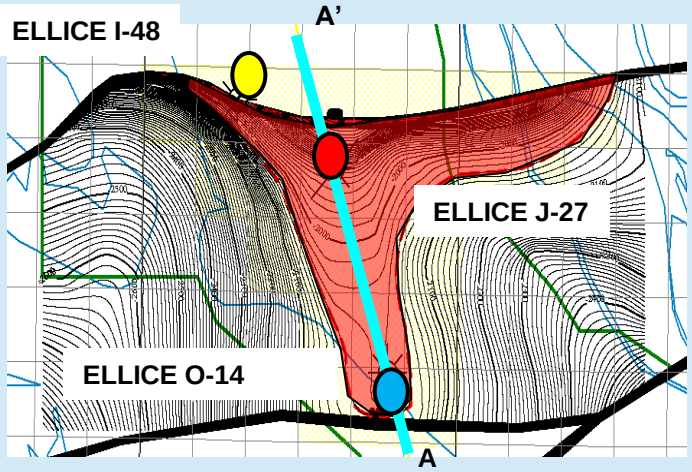
Ellice J-27 Post Drill

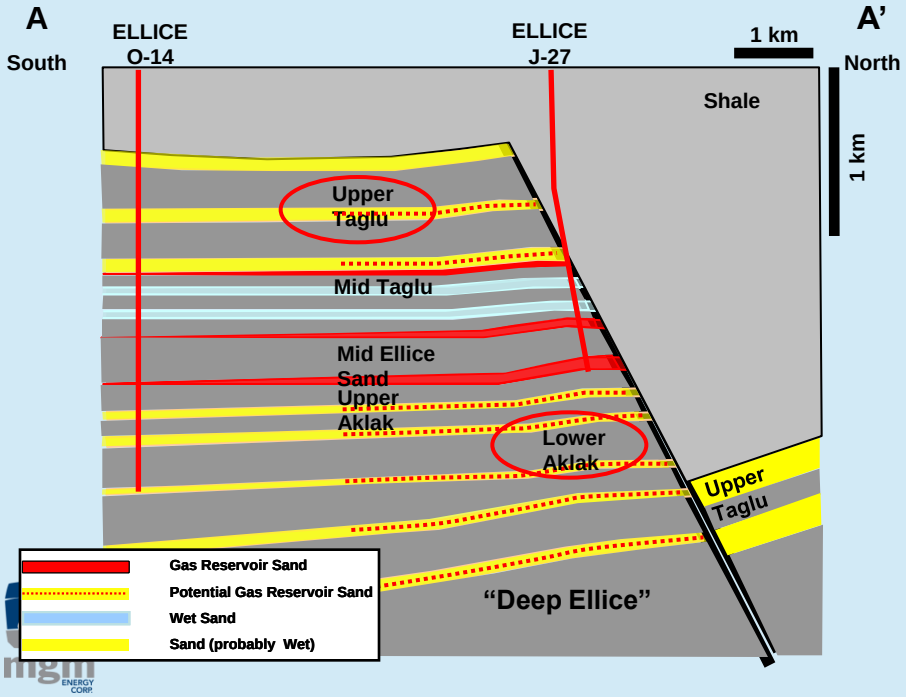
Discovered Reservoirs

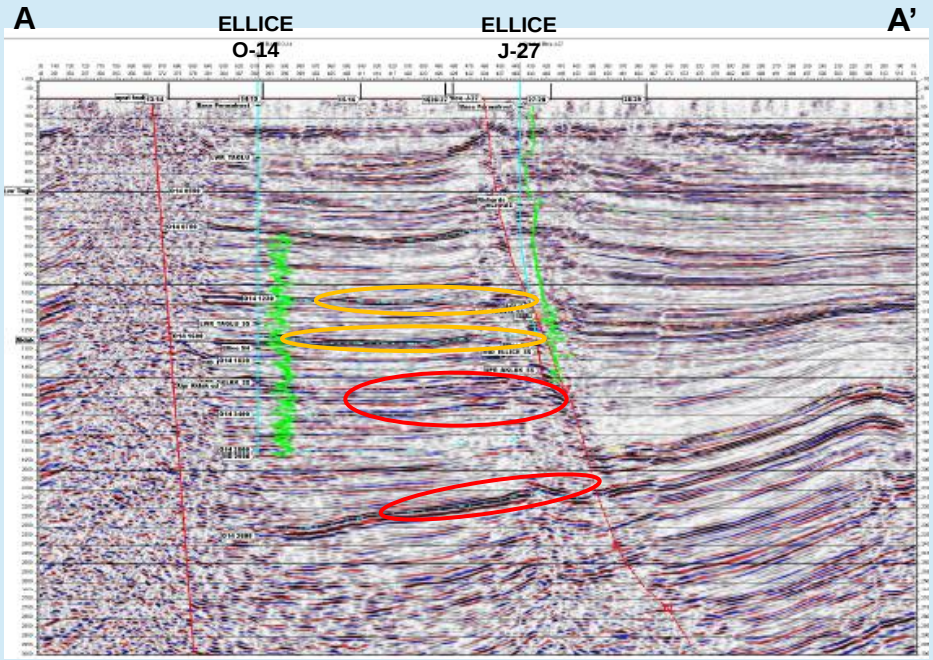
Tertiary Upper Taglu and
Lower Aklak Sands

P_{Mean}- P_{10} Gas Resource

350 - 500 Bcf







Post-Drill

Summary

- **Exploring**
  - Asking key questions
  - Believing that the 3D data merge would change image
  - Testing the Play
  - Remaining upside potential is large
- **Secondary Potential in the**
- **Potential of > 500 Bcf Discovery**
- **Deeper potential if successful**