



#### Topics

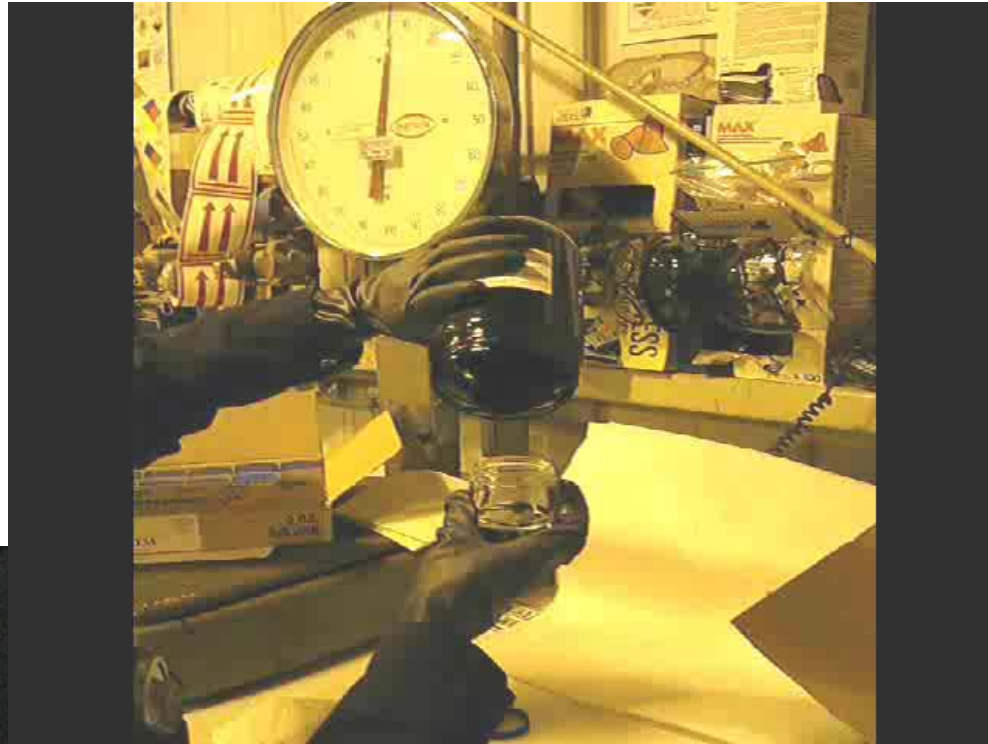
- Heavy Oil vs. Light Oil – the really big picture
- Heavy Oil Properties
- The Heavy Oil Resource on the Alaska North Slope
- Marketing and Transport Issues
- Heavy Oil Depletion Mechanisms
- BP Alaska Milne S-Pad Pilot

## Heavy Oil vs. Light Oil

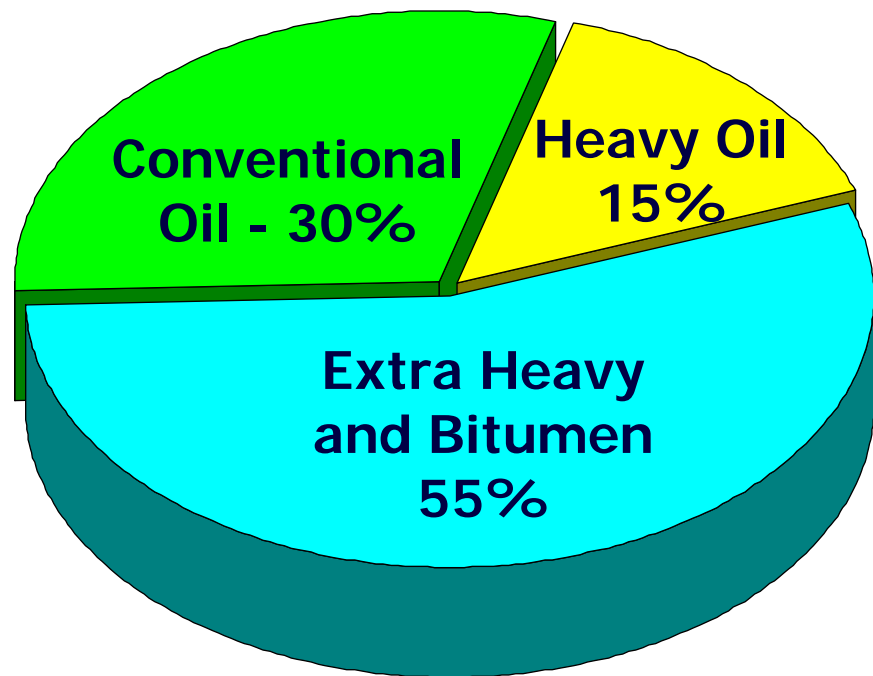
▶ Legislative Brown bag

March 2011

Welcome



- Currently, 90% of production is from conventional oil
- Heavy oil and bitumen are growing rapidly
- Canada and Venezuela together have >35% of the non-conventional oil reserves



Source: MacGregor, 1996 and UNITAR, 1998

# Global Heavy Oil



## Canada

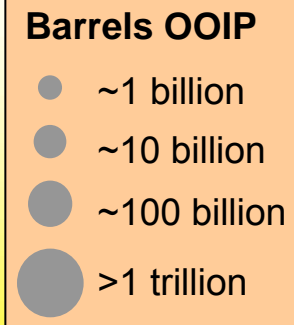
- 40 years of heavy oil development
- **Focus of today's heavy Oil Technologies**

## Alaska

- Historical light oil focus

## Russia

- Decades of heavy oil experimentation but continued focus on light oil



## California

- Cradle of Heavy Oil Technology
- In twilight period

## Venezuela

- Conventional approach to easiest Heavy Oil
- Business climate not inciting innovation and experimentation



Source: JPT, IEA ,Schlumberger OFS Marketing



# Heavy Oil – Key Properties

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- Viscosity (Physical Property)
  - Flows through a reservoir very slowly: wells produce at lower rates than light oil wells
  - Heavy oil developments involve lots of wells
  - Waterflooding is not viable due to the viscosity contrast between heavy oil and water
  - Thermal techniques (e.g. steam) can be effective in increasing recovery but energy balance is an issue and conditions must be just right in the reservoir
- Hydrogen Content (Chemical Property)
  - Heavy oil is depleted in hydrogen relative to light oil
  - Fewer refined products are derived from heavy oil
  - Heavy oil fetches a lower price on the market



# API Gravity of some standard crudes

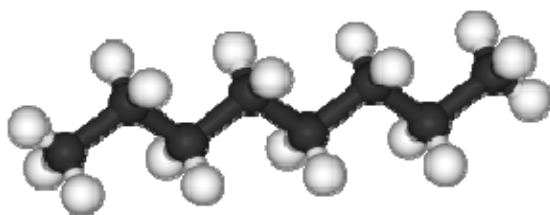
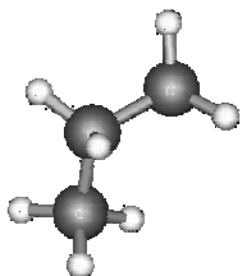
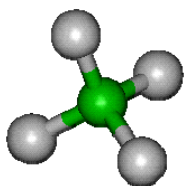
	Gravity	API Definition
• West Texas Intermediate	40	Light
• Canadian Syn-crude	33	
• Arab Light	32	
• Alaska NS Crude	29	Medium
• Arab Heavy	27	
• Alaska Viscous	16 to 24	Heavy
• Alaska Heavy	8 to 14	
• Water	10	Extra Heavy
• Venezuela (Orinoco )	10	
• Canadian Lloydminster	9 to 18	
• Canadian Athabasca	6 to 10	

**Gravity  $\neq$  Viscosity**  
*The term “Heavy Oil” is a reference to the high density (API Gravity) of those oils. The measurement that we care most about today is viscosity since that is the property which governs well productivity. Viscosity is not synonymous with Gravity. There is a positive, but very loose correlation between gravity and viscosity that is specific to a given oilfield - but any quantitative transform from API Gravity to Viscosity is a rough approximation at best and there are no transforms or rules of thumb for oils in general.*



# What is heavy oil?

## Light End Molecules



**North Slope Heavy oil is a residue** formed from light oil that has lost the small (light) molecules leaving the heavy ones. These form hydrocarbon compounds characterized by long, very complex molecules.

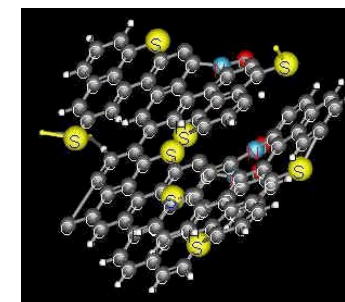
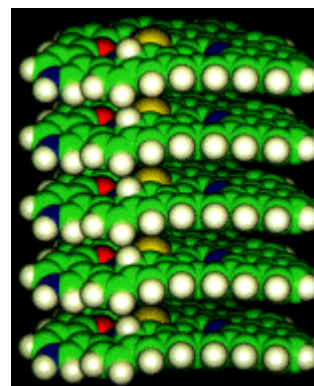
Most of the hydrogen is in the light ends so heavy oil is depleted in hydrogen.

The long molecules of heavy oil impart high internal friction resulting in high viscosity.

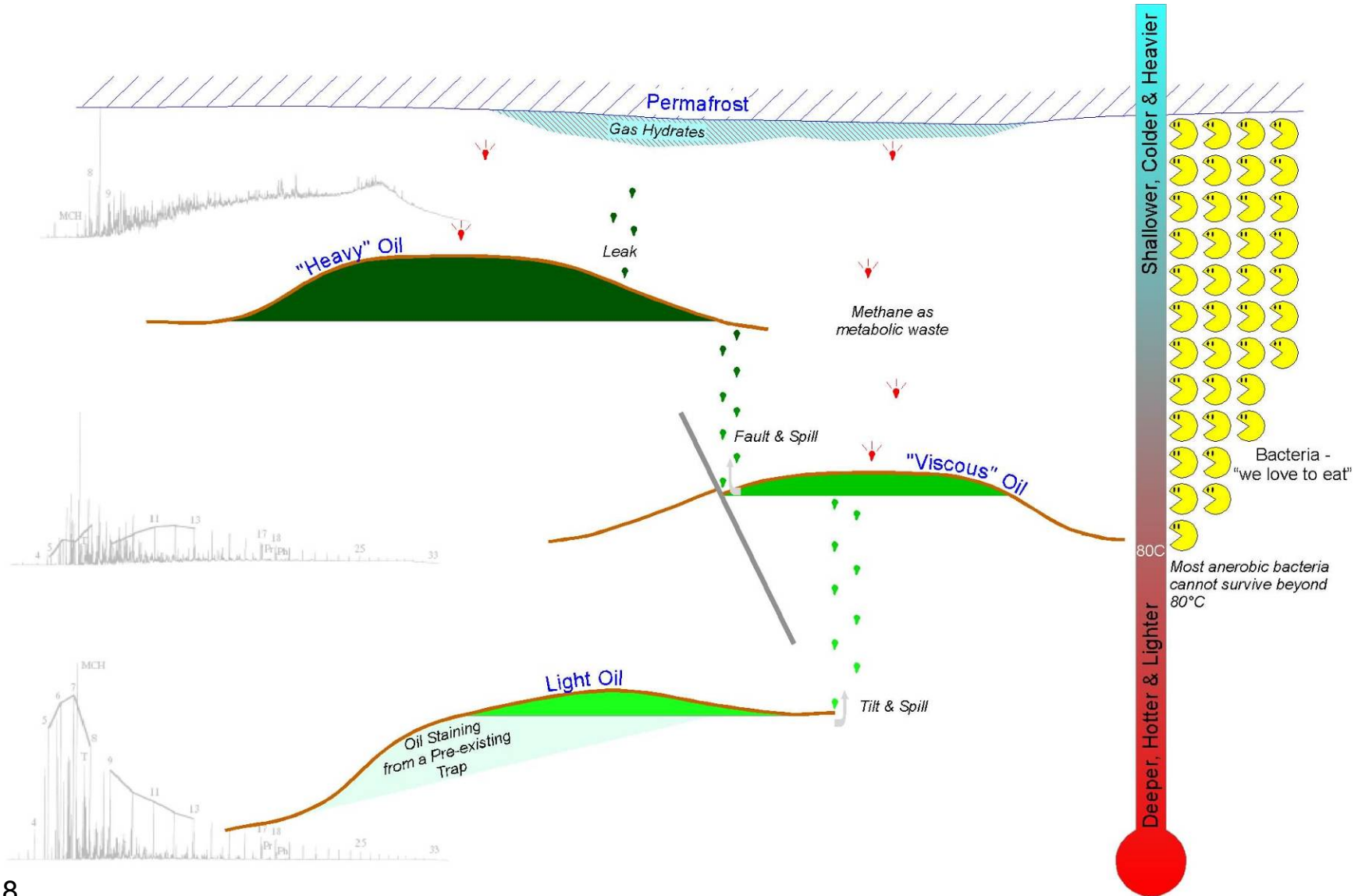
## Heavy End Molecules



A heavy oil model in a Calgary museum

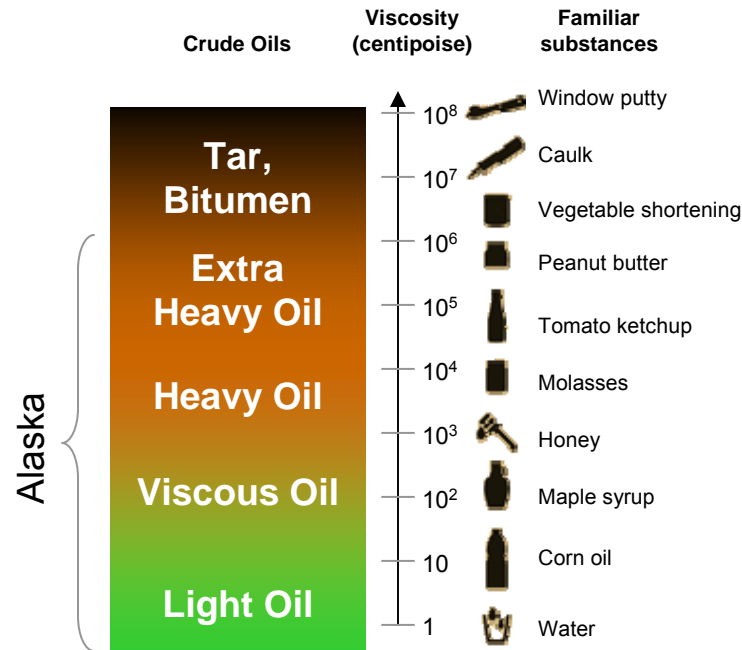


# Oil vs. Bacteria

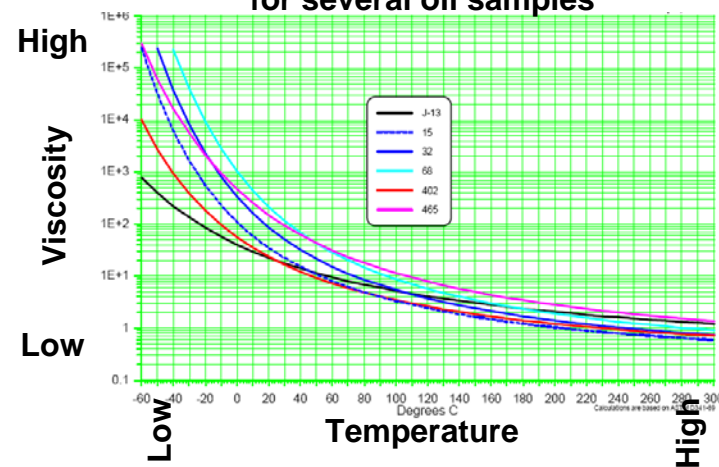




# Viscosity



Temperature/Viscosity Relationship for several oil samples



- Viscosity is the resistance a material has to change in form. It is commonly described as internal friction.
- Viscosity reduction
  - Heat
  - Dilution (Diluent)

# Heavy Oil Export Options



☒ Change physical properties – Upgrade

☒ Add heat to TAPS

☒ Dilute heavy oil with light oil



1<sup>st</sup> Epiphany:

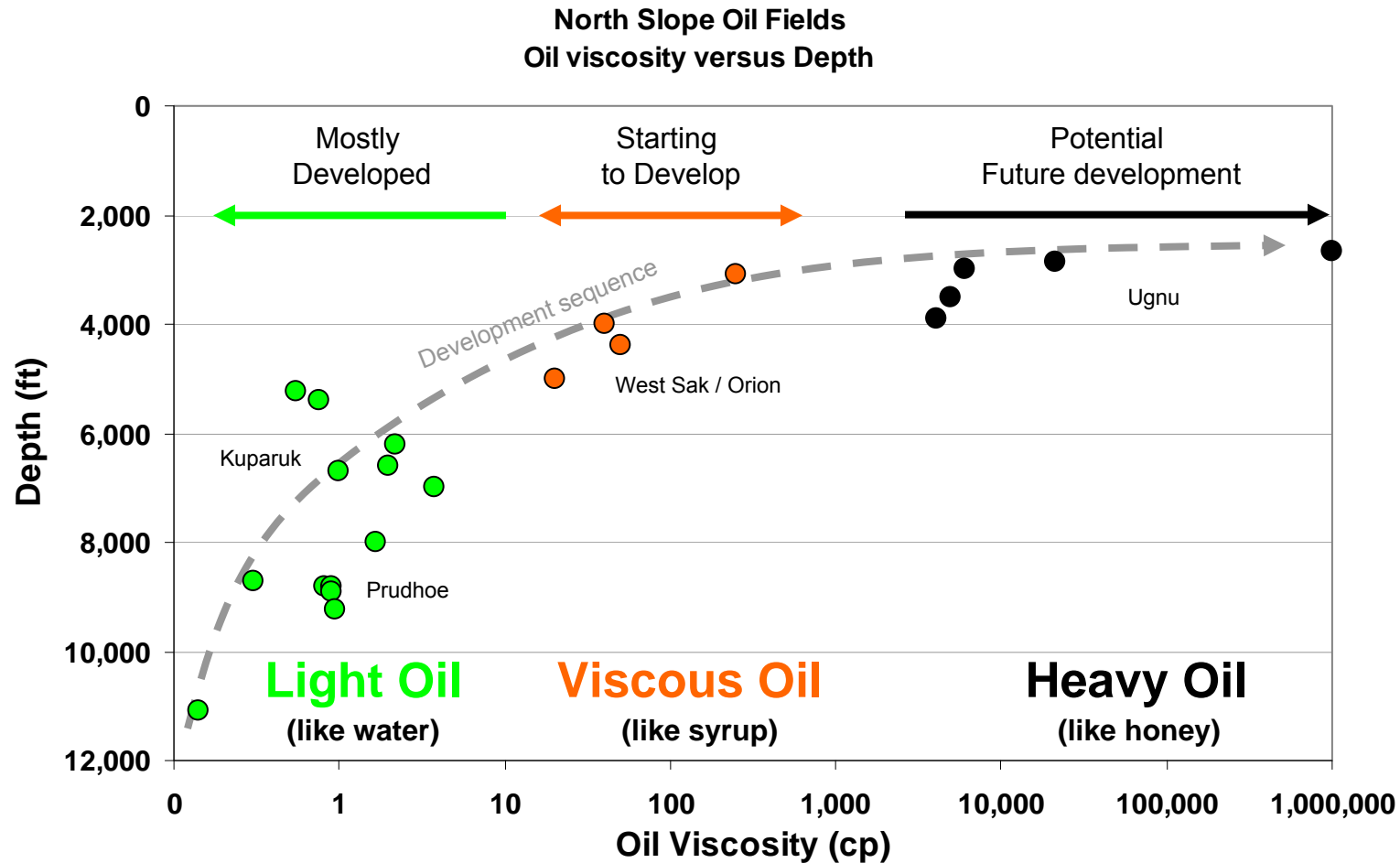
Heavy oil is linked  
to light oil  
by  
Diluent

2<sup>nd</sup> Epiphany:

Given that linkage,  
we need to  
figure out heavy oil  
NOW - not after  
light oil

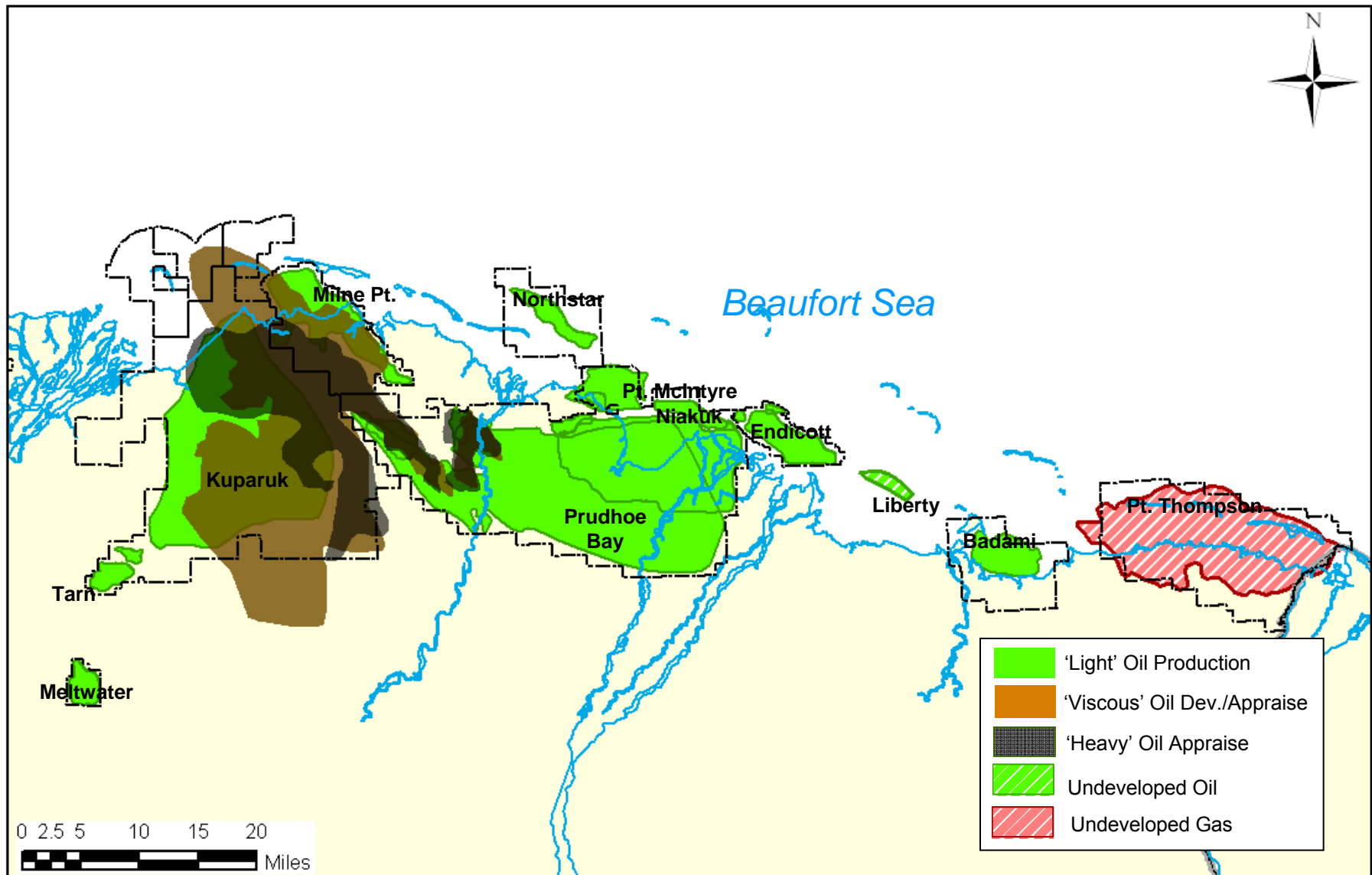
# Alaska Fluid Viscosity

*Alaska fluids range over a continuum of viscosities*

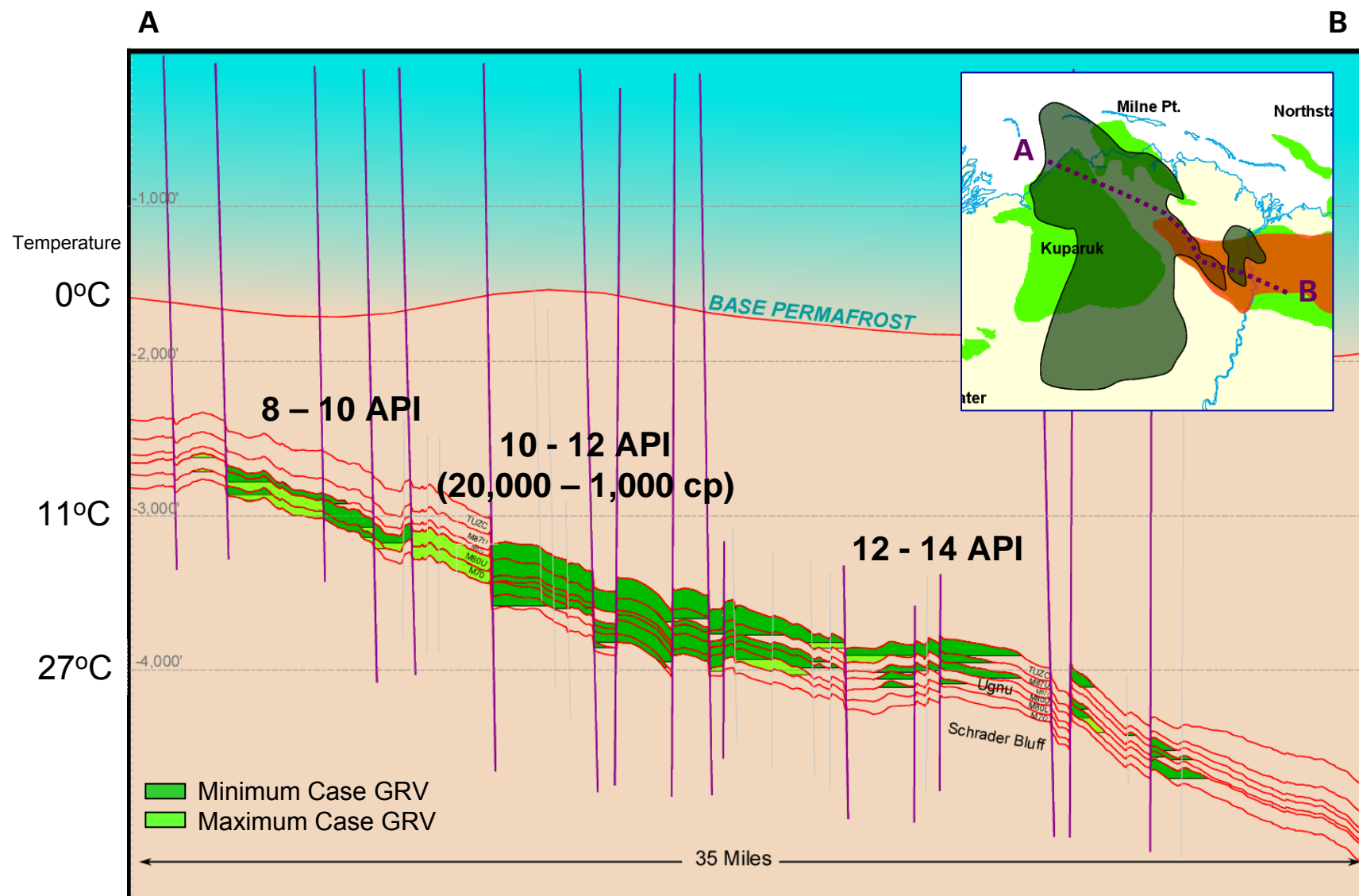


*The term "Viscous Oil" is a home grown, Alaska term. You won't find it defined in the literature or used outside of Alaska. What we term Viscous Oil in Alaska is referred to as Heavy Oil in the industry.*

# Alaska Viscous and Heavy Oil



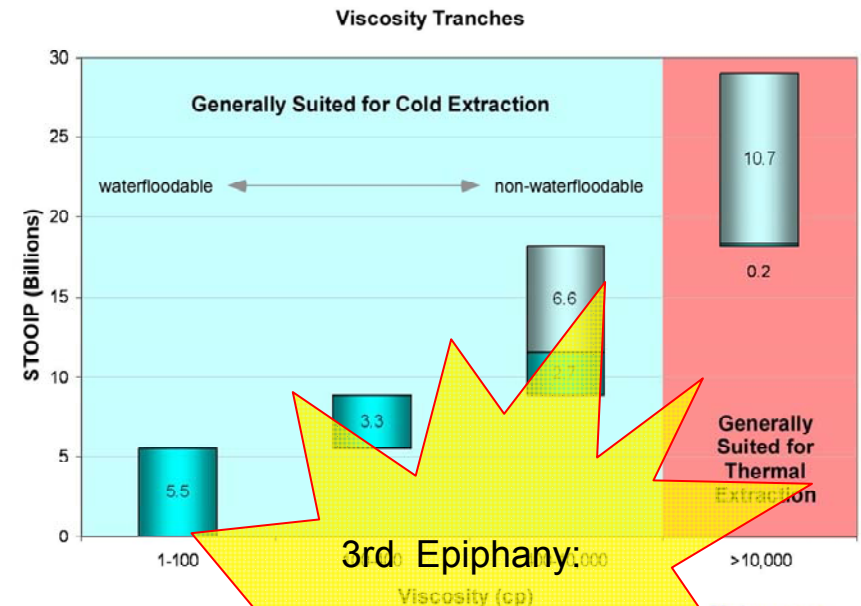
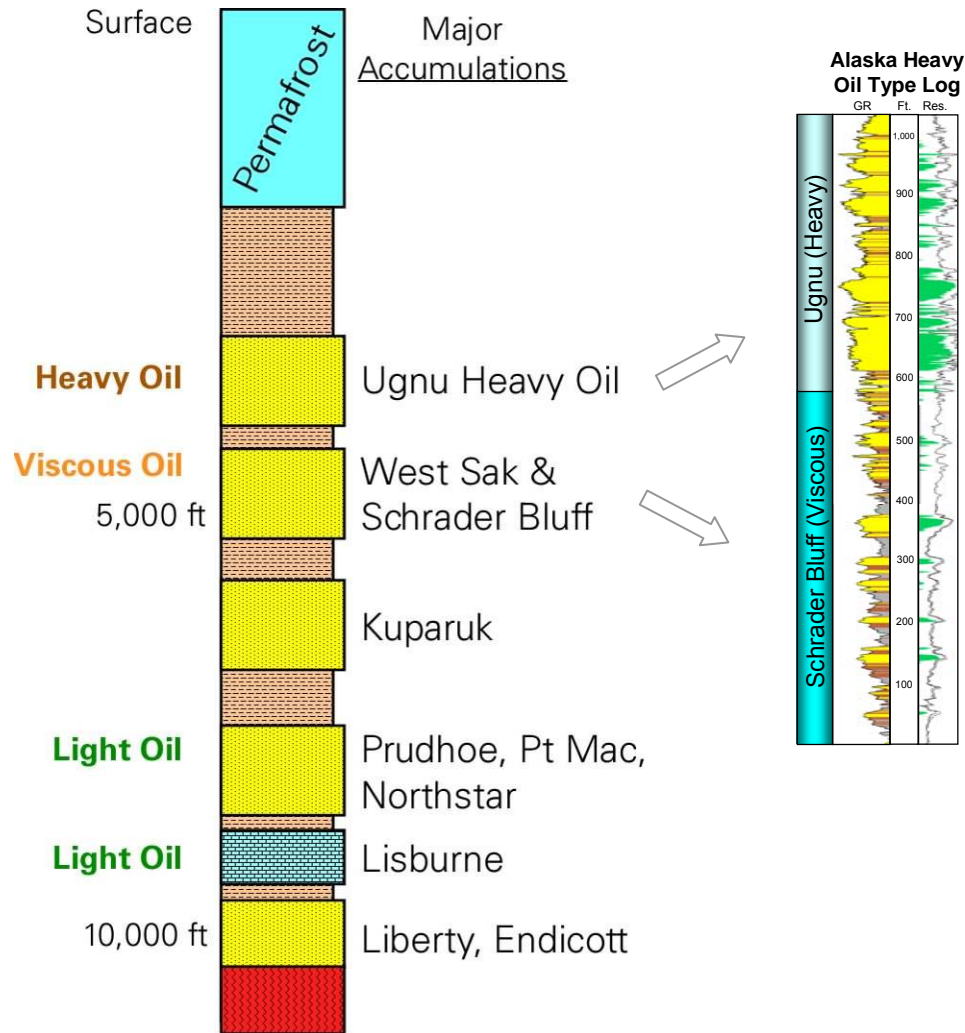
# Ugnu Structure & Fluid Quality



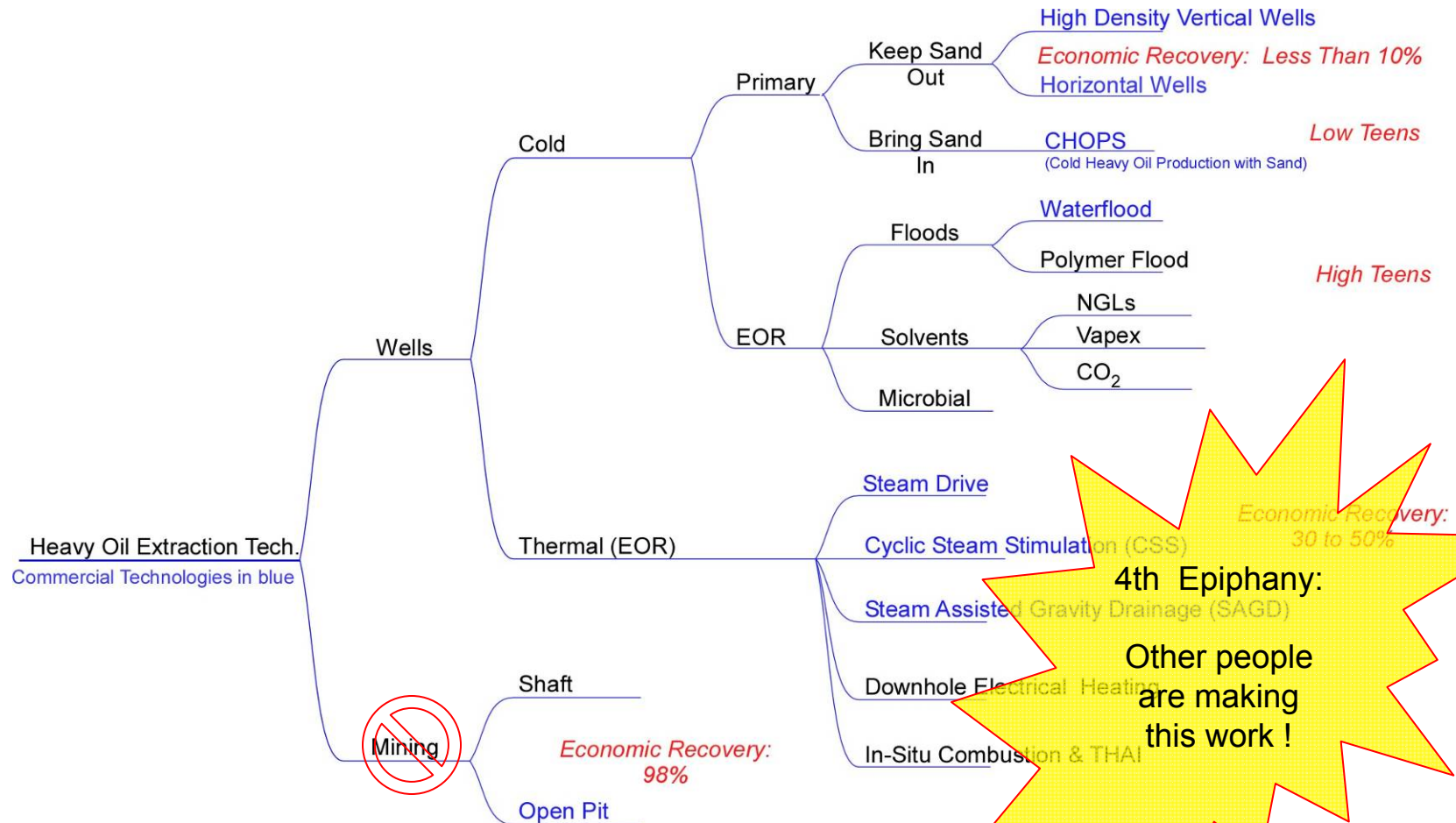


# Stratigraphic and Volumetric Distribution

*Heavy oil is found in the shallowest reservoirs (Ugnu), light oil in the deepest*



# Heavy Oil Depletion Technology



4th Epiphany:

Other people  
are making  
this work !

Minimal  
reservoir  
contact

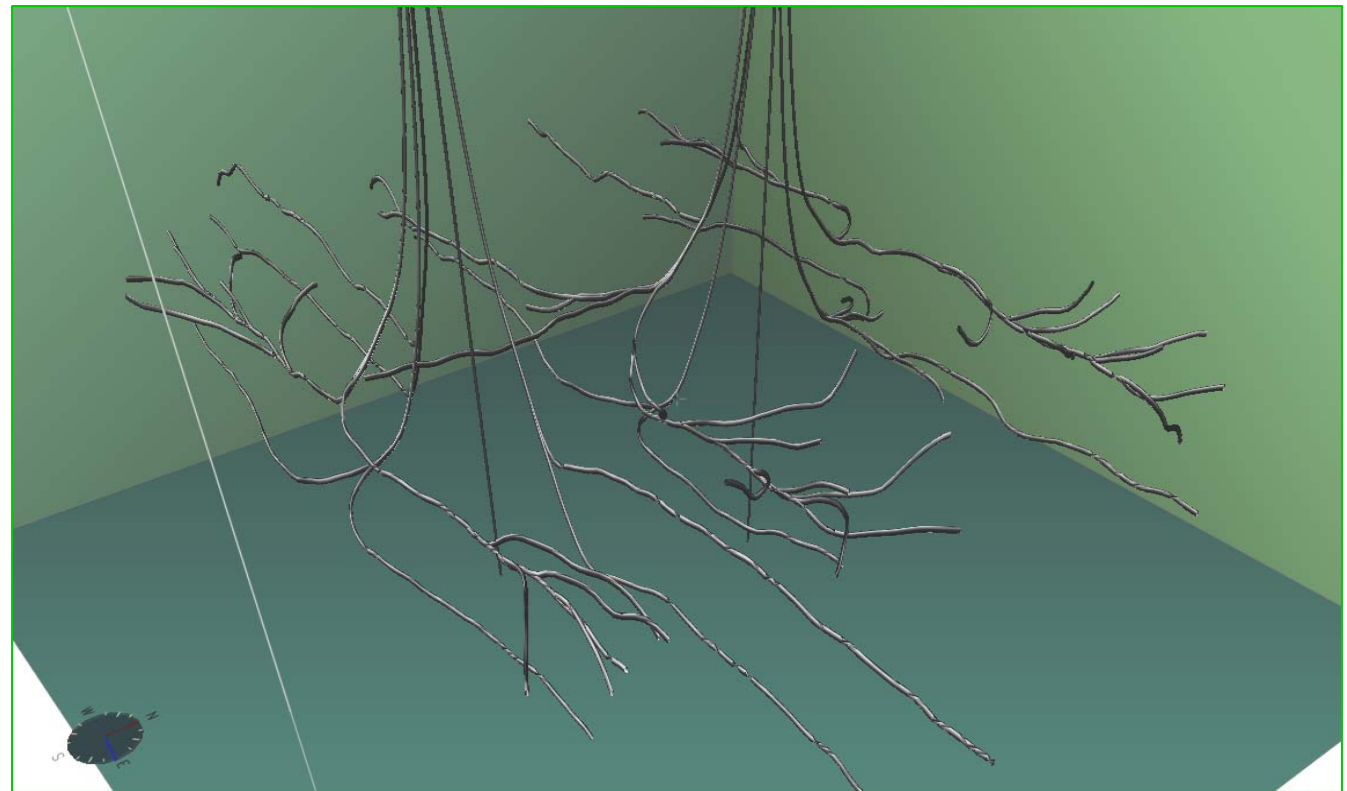


Maximum  
reservoir  
contact

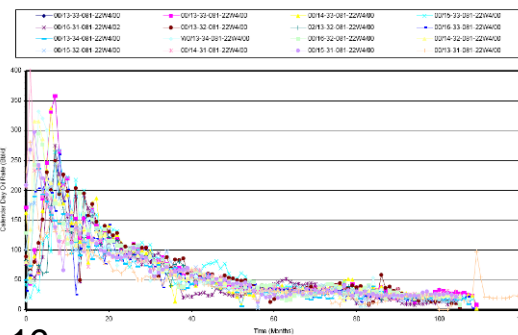
## Piloting at S-Pad

The horizontal well concept is to maximize contact with the reservoir. Horizontal wells are operationally simple as they keep sand out, but recovery factor is likely low and well density must be high to compensate

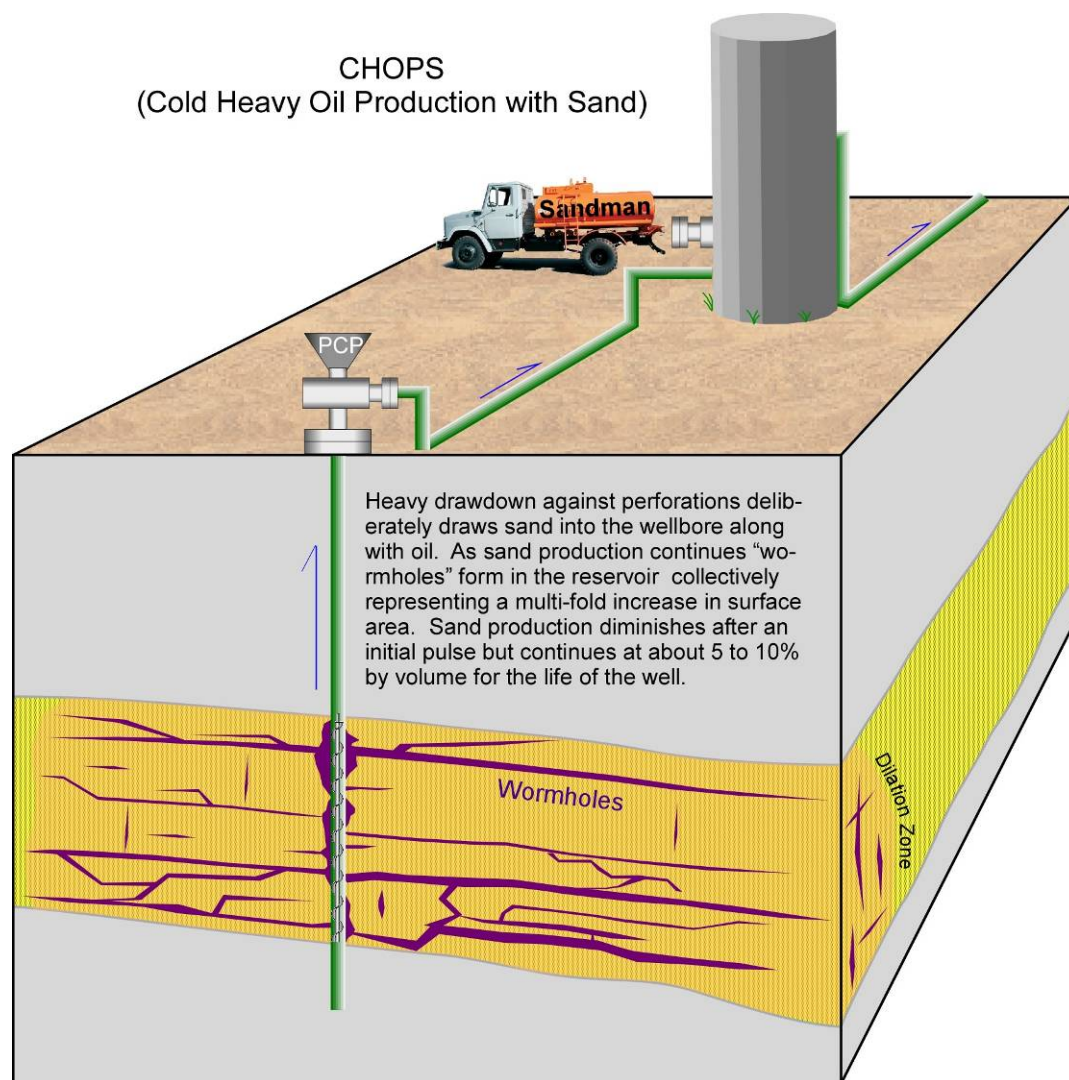
## Motherbores - Many Horizontal laterals in one well



## HORIZONTAL PRODUCTION PROFILES

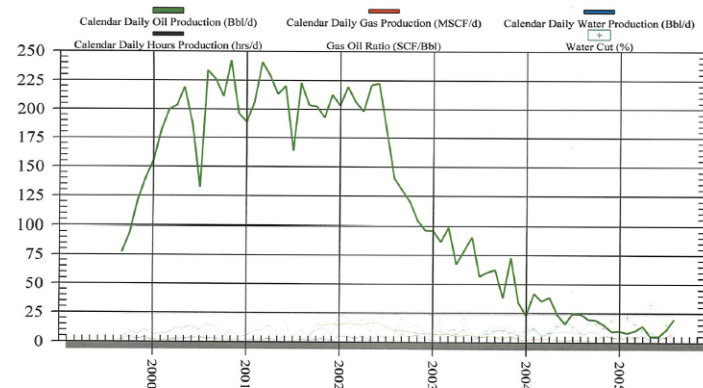


# CHOPS Elements



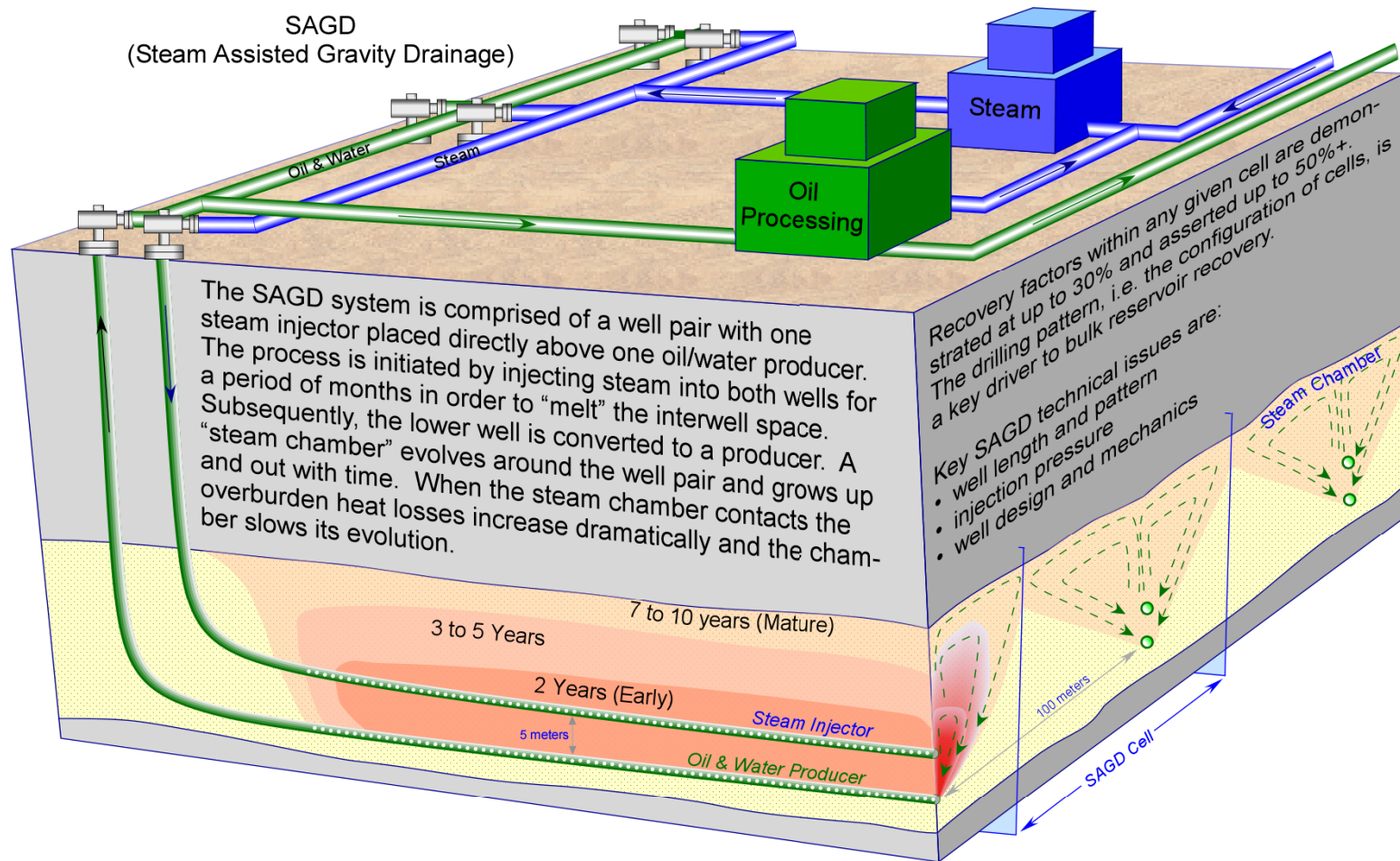
- Unconsolidated rocks
- PCP Pump
- Surface Drive
- Heated Separation Tank
- Sand Disposal

CHOPS: CHARACTERISTIC PRODUCTION PROFILE  
scatter is intrinsic to process



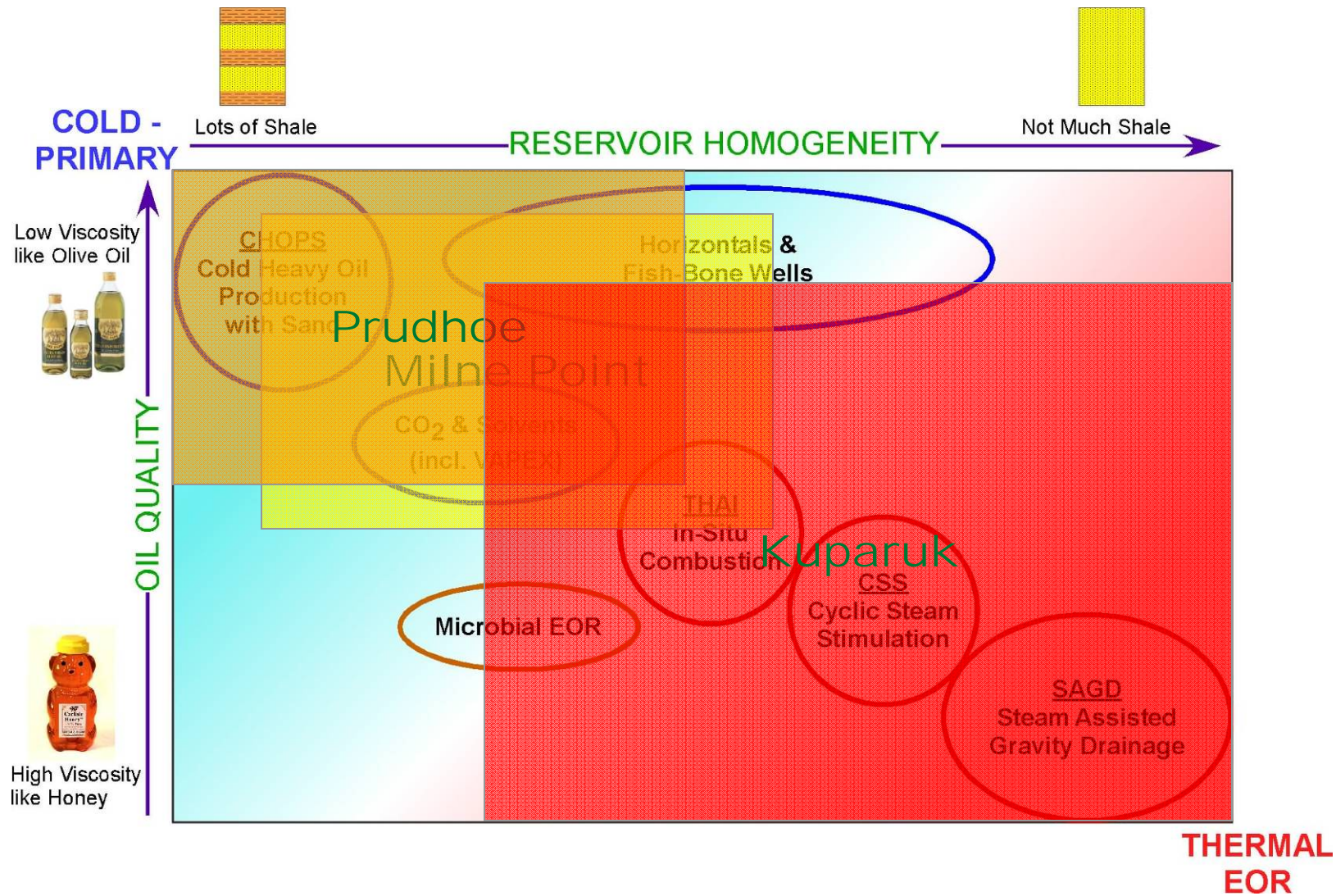


# SAGD (Steam Assisted Gravity Drainage)





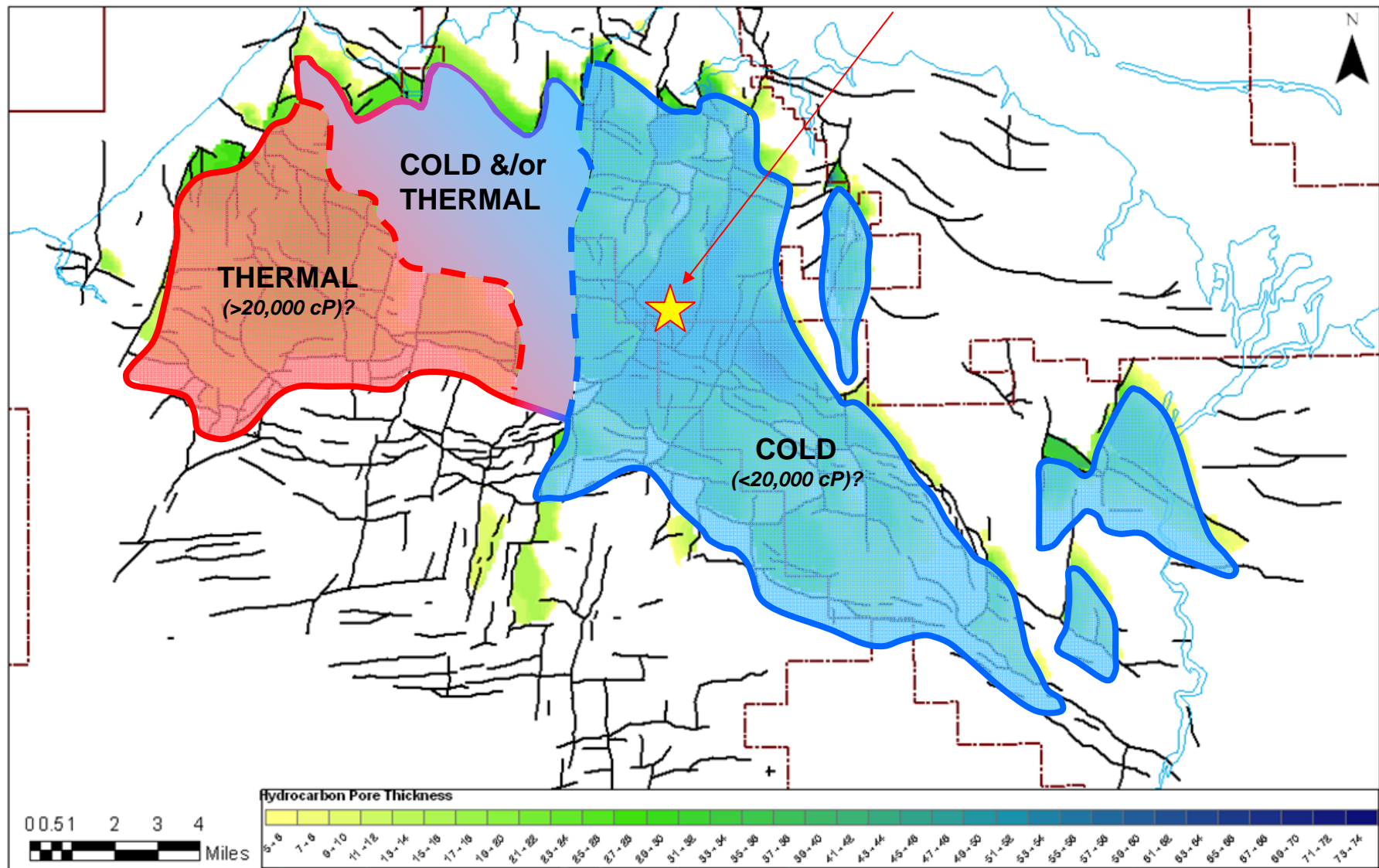
# Recovery Methods



# North Slope Heavy Oil Accumulation



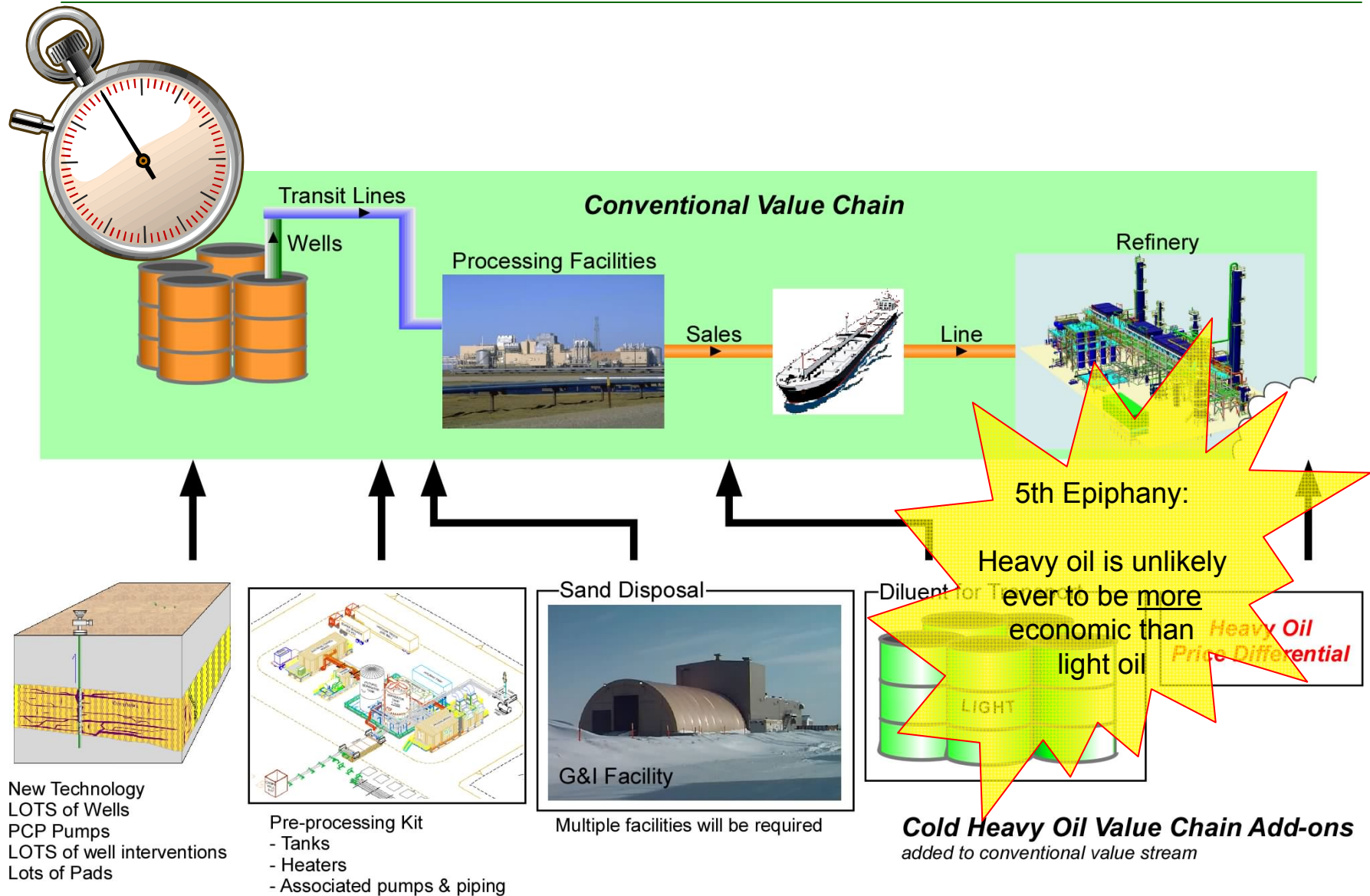
BP's Milne Point Heavy Oil Pilot





# Heavy Oil Value Chain

*Time dependency given viability/longevity of existing architecture is driver of pace*



# Vision vs. Reality



## Canadian Design

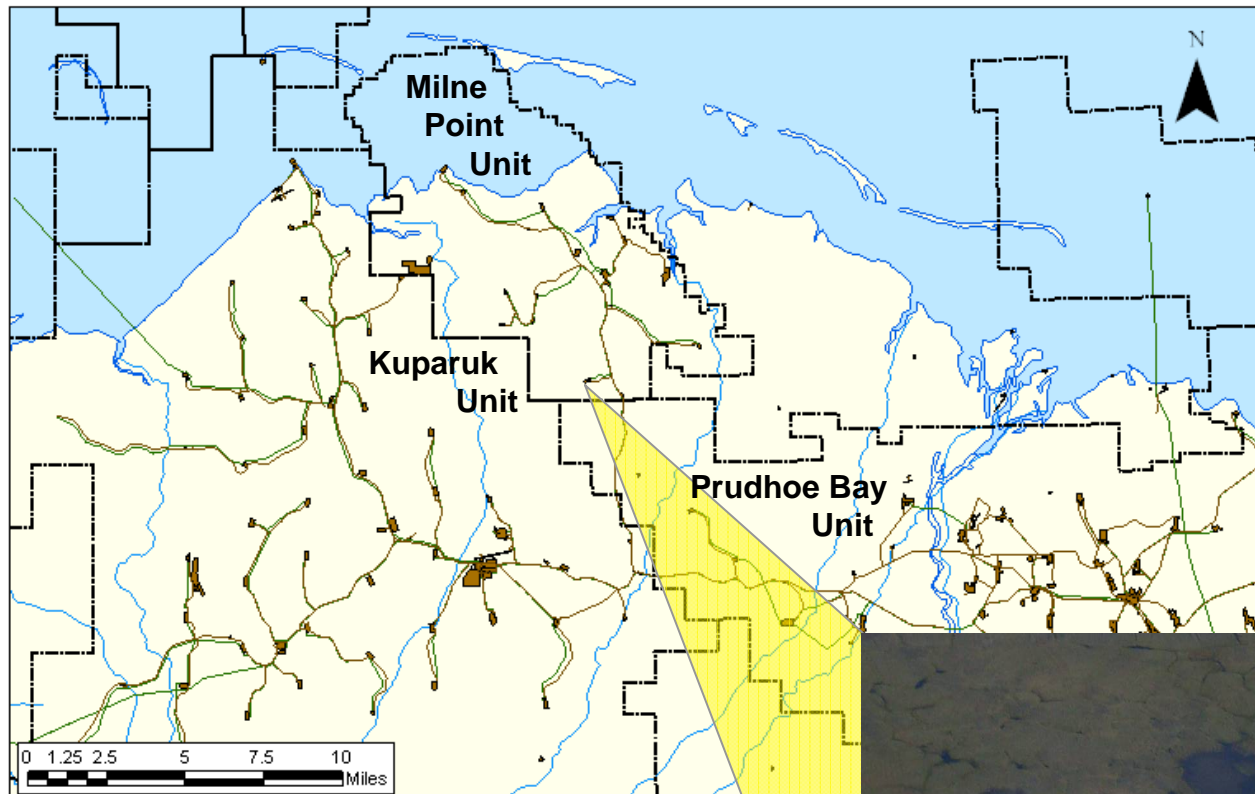
- Single well tank battery
- Oil, water and solids trucked separately
- Gas burned or vented
- Direct fired heater
- 20+ years experience



## Alaska Design

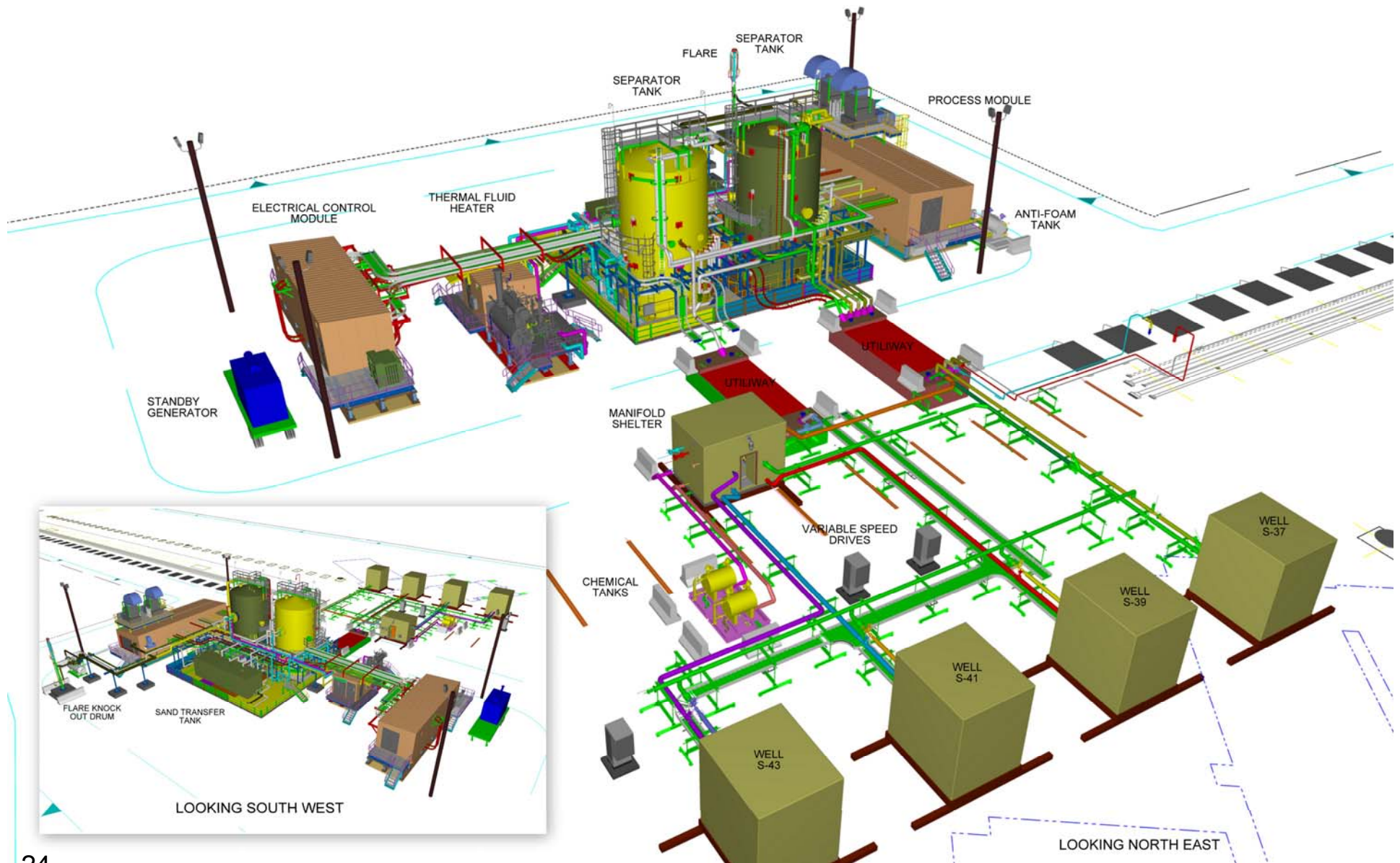
- Safety & environmental constraints
  - No direct fired heaters in tanks
  - No venting of gas
  - No spills
  - Operate safely over a multi-year period
- Unknown fluid properties and behavior
- First of its kind in Alaska

# Pilot Location, S-Pad Milne Point Alaska

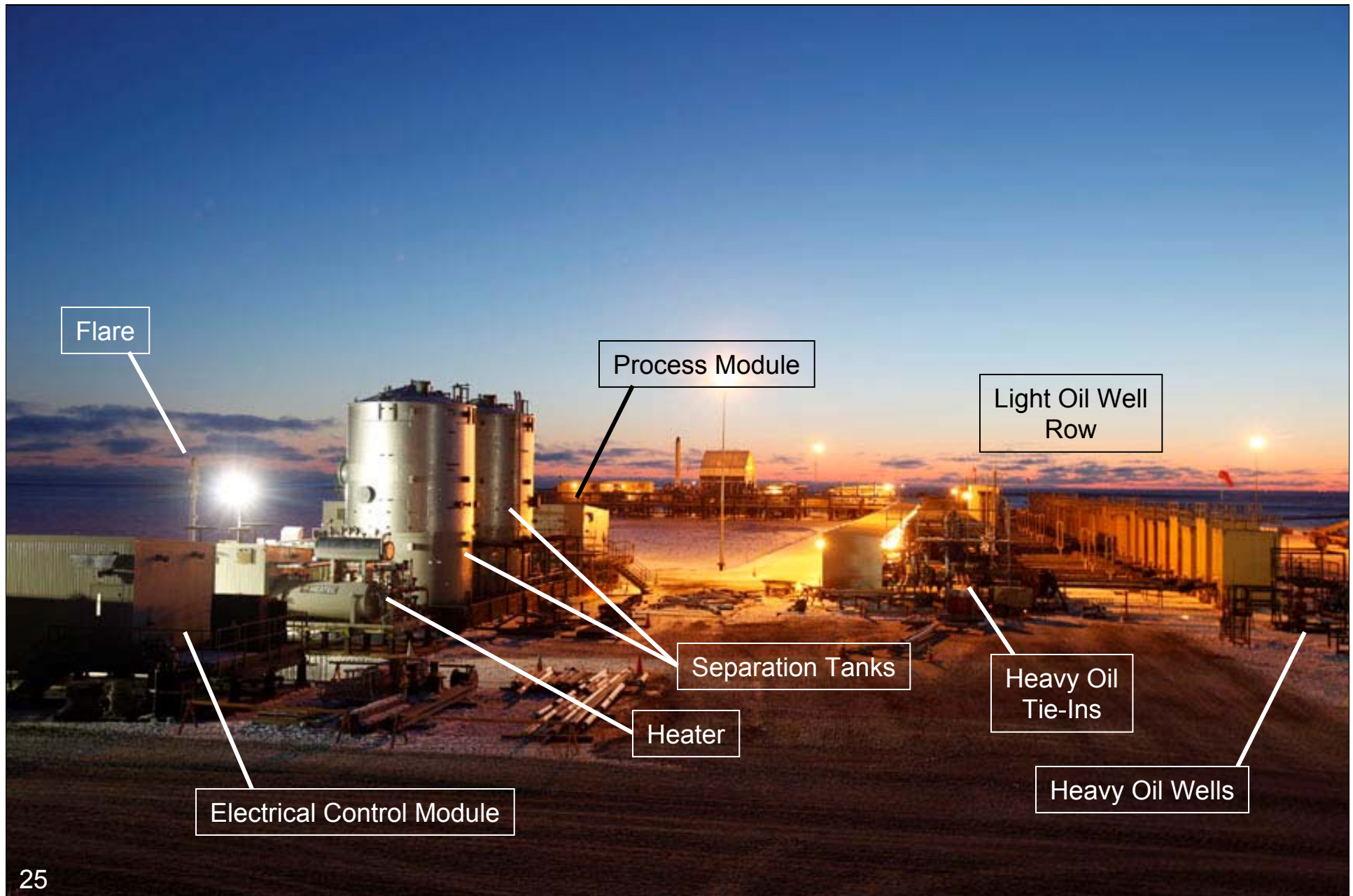




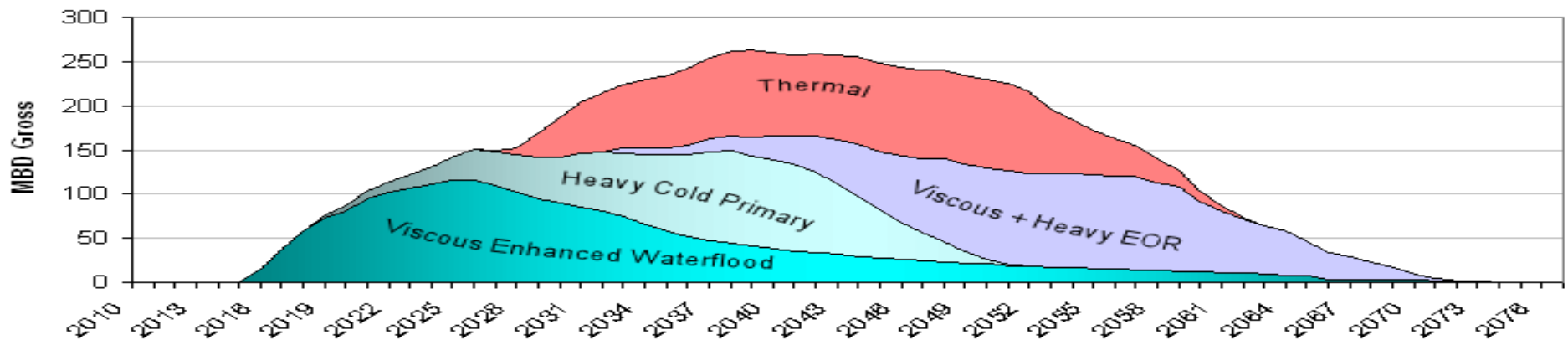
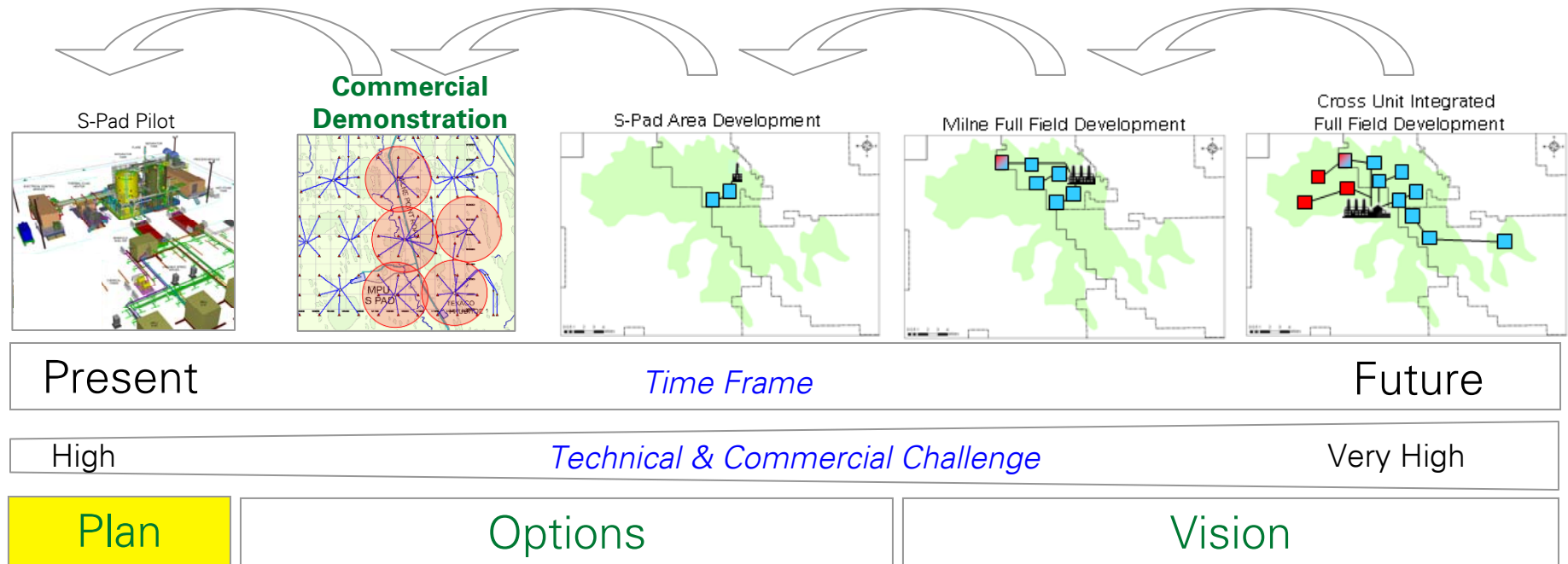
# Milne Point S-Pad Heavy Oil Facility



# New BP Heavy Oil Pilot Project, Milne Point Alaska



# Viscous and Heavy Oil Appraisal







# Take Away Messages

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- Heavy oil (including Viscous) is a world scale resource base that is intrinsic to the BP Alaska strategy
- The time for heavy oil is now due to light oil linkage through diluent and infrastructure
- Heavy oil is a different commodity than light oil with respect to extraction techniques, technical challenges, understanding, environmental challenges and market
- The technical viability of Alaska Heavy Oil is unknown, so commercial outcome remains large range - must answer technical viability question first
- BP's Milne S-Pad pilot is a technology trial and its design and appearance do not necessarily reflect what an ultimate development will look like