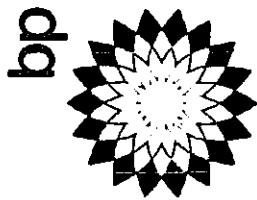


2/16/10
LUNCH &
LEARN:
HEAVY OIL
VS.
LIGHT
OIL



Heavy Oil vs. Light Oil

Legislative Brown bag

February 2010 Juneau



Heavy Oil – Key Properties

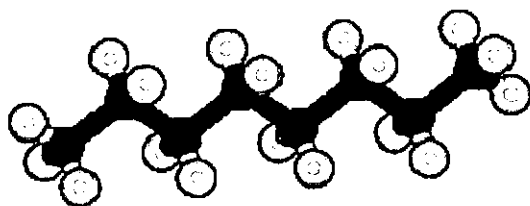
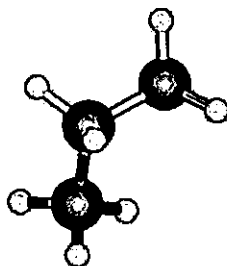
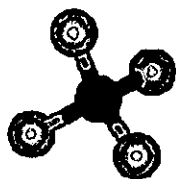
- Viscosity (Physical Property)
 - Flows through a reservoir very slowly: wells produce at lower rates than light oil wells
 - Heavy oil developments involve lots of wells
 - Waterflooding (EOR) is not viable due to the viscosity contrast between heavy oil and water
 - Thermal techniques (e.g. steam) 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



What is heavy oil?

Light End Molecules

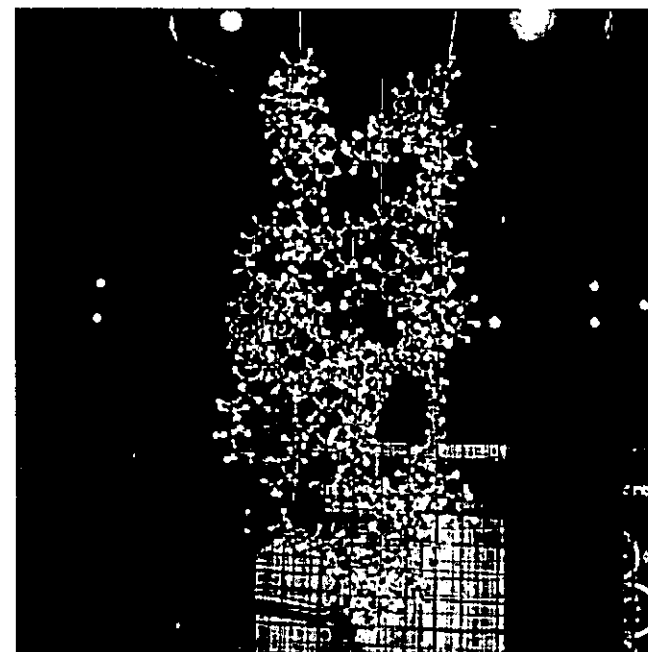


North Slope Heavy oil is a residue formed from light oil that has lost the small (light) molecules leaving the heavy ones. These form hydrocarbon compounds characterized by long, very complex molecules.

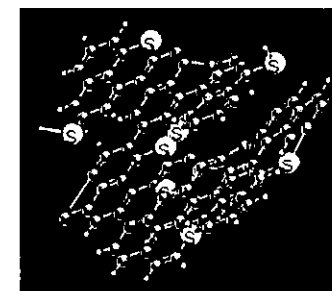
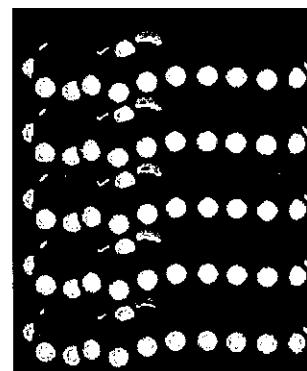
Most of the hydrogen is in the light ends so heavy oil is depleted in hydrogen.

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



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 (Ugnu)	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.

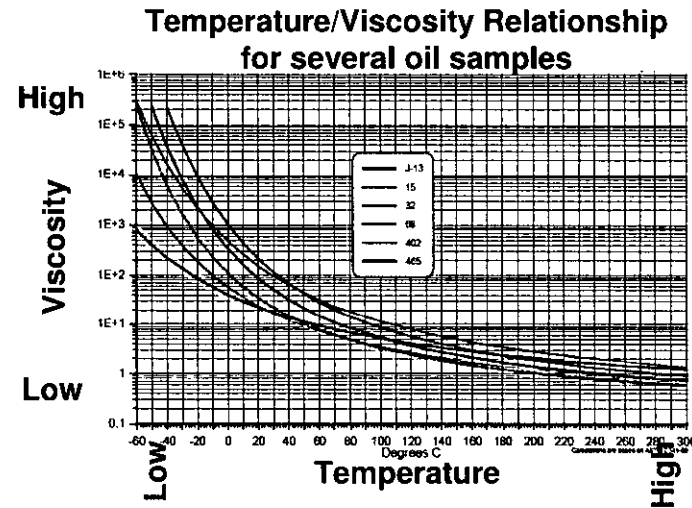
Viscosity



Crude Oils	Viscosity (centipoise)	Familiar substances
Tar, Bitumen	10^8	Window putty
	10^7	Caulk
Extra Heavy Oil	10^6	Vegetable shortening
	10^5	Peanut butter
Heavy Oil	10^4	Tomato ketchup
	10^3	Molasses
Viscous Oil	10^2	Honey
	10	Maple syrup
Light Oil	1	Corn oil
	1	Water



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



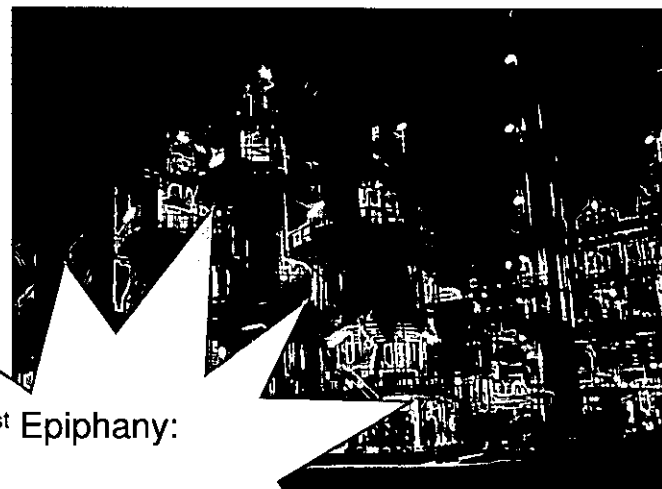
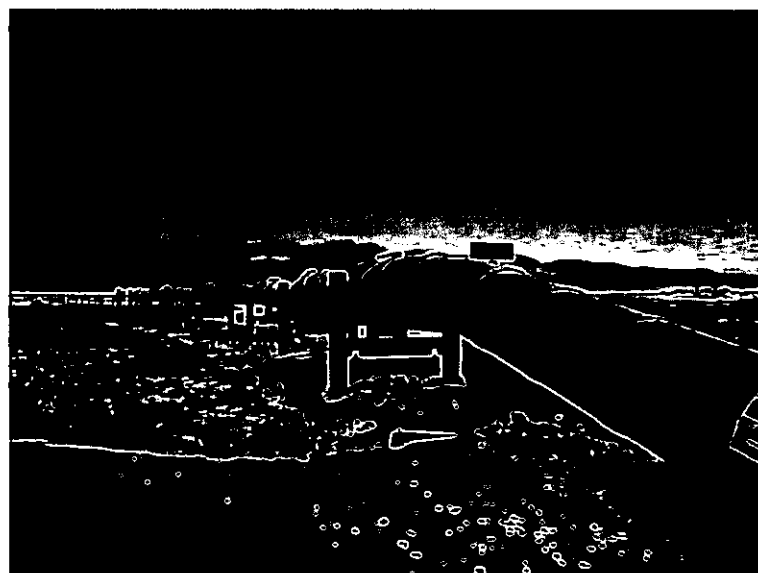
Heavy Oil Export Options



Change physical properties – Upgrade

Add heat to TAPS

Dilute heavy oil with light oil



1st Epiphany:

Heavy oil is linked
to light oil
by
Diluent

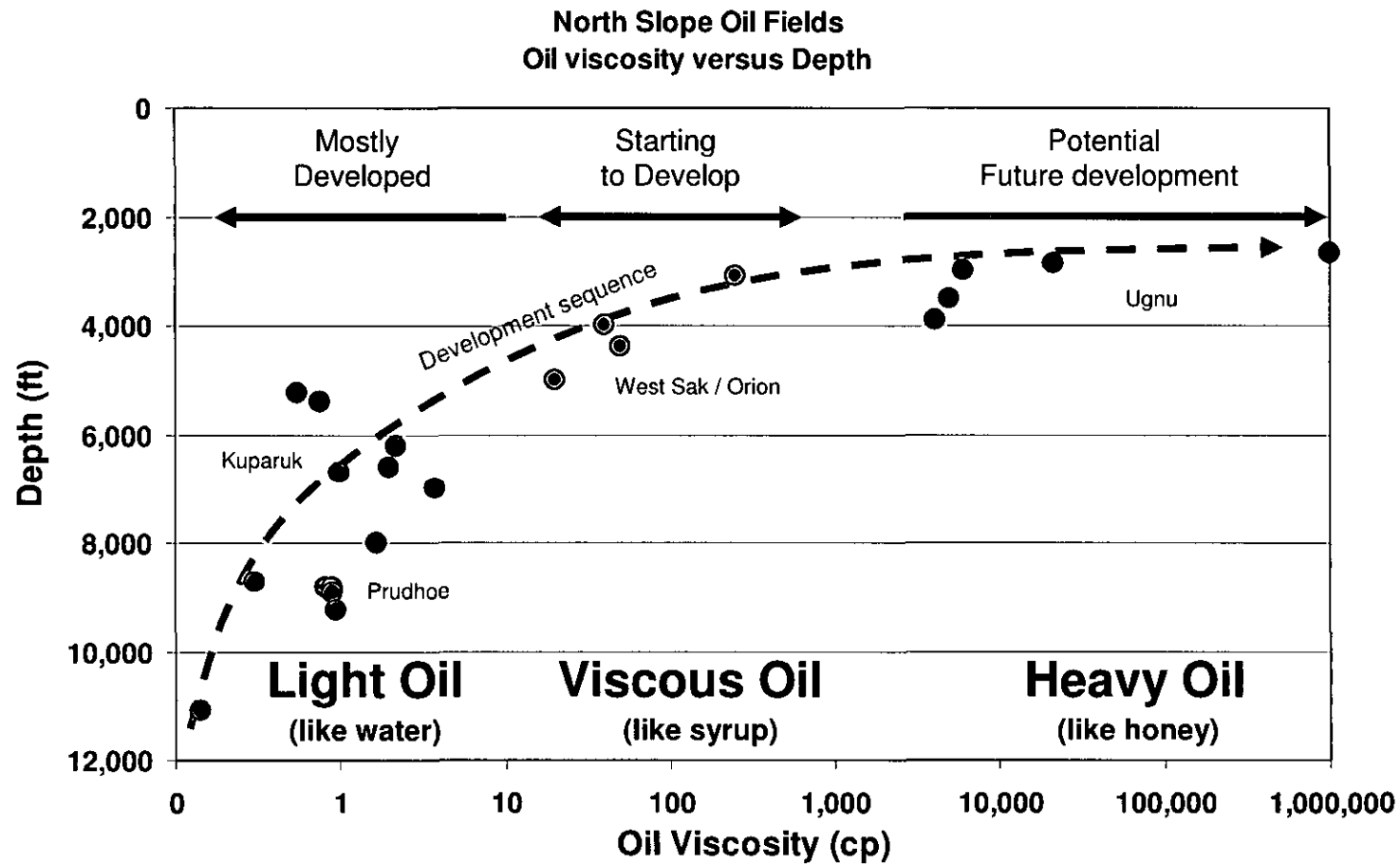
2nd Epiphany:

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



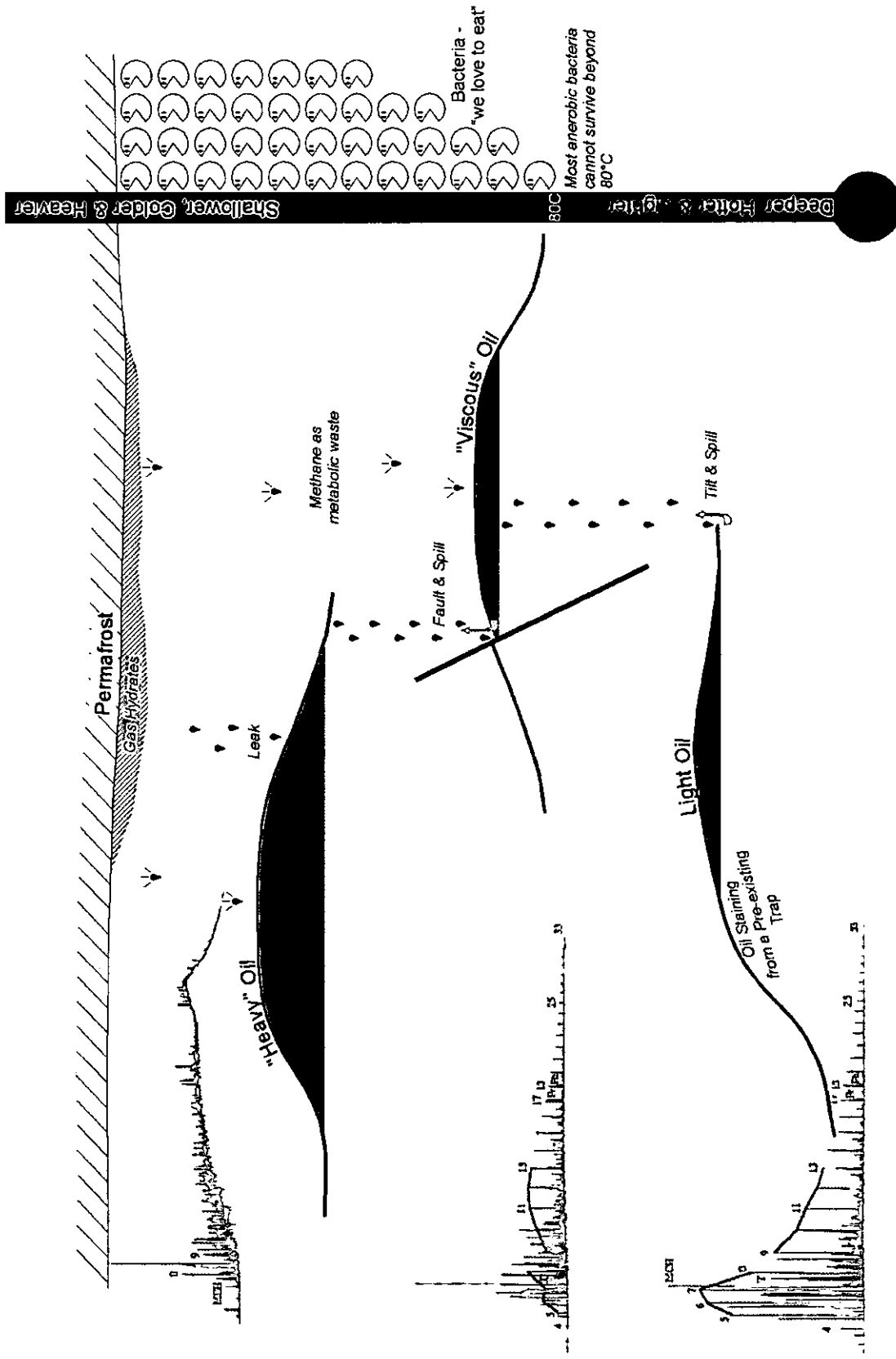
Alaska Fluid Viscosity

Alaska fluids range over a continuum of viscosities



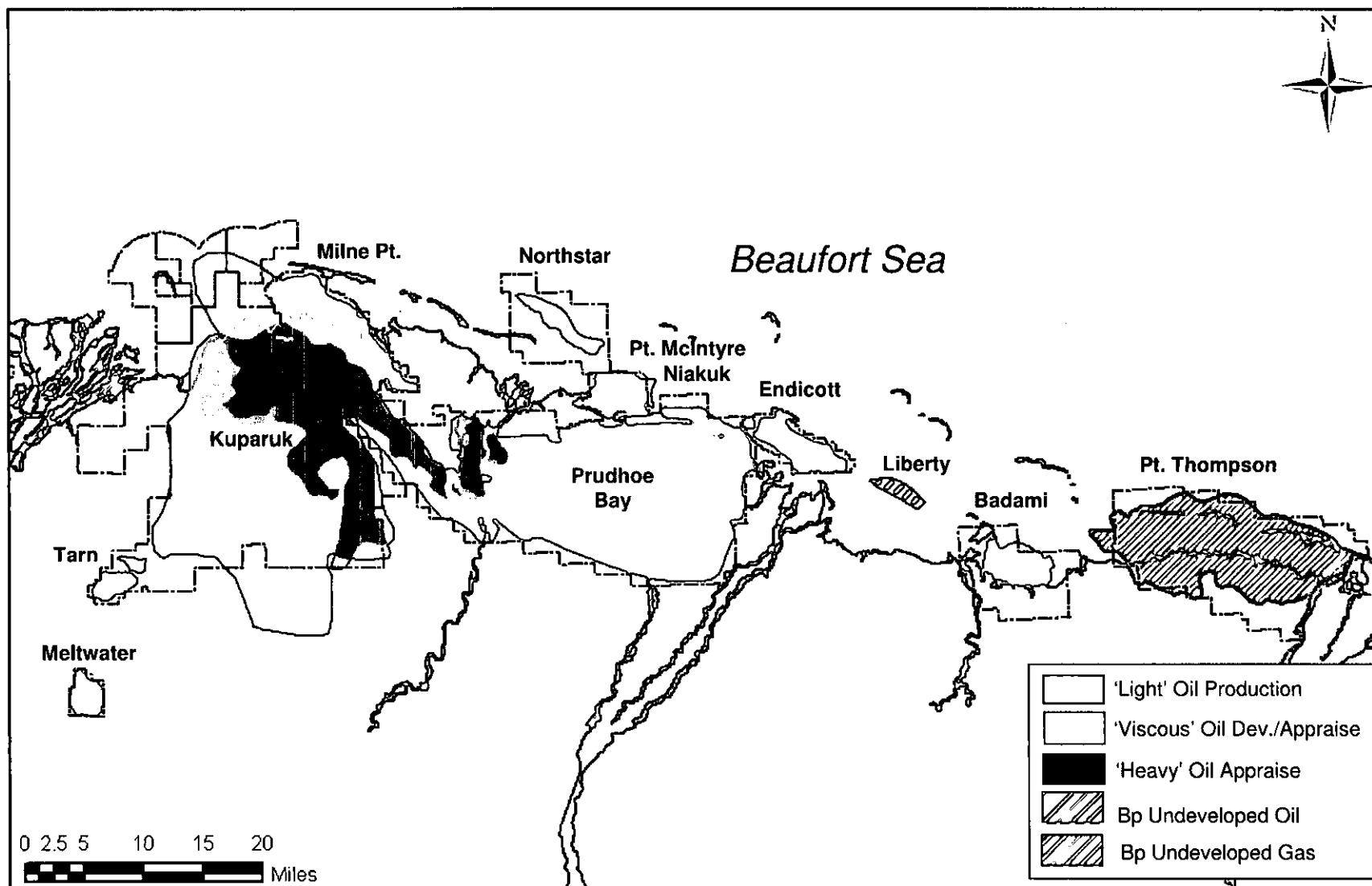
The term "Viscous Oil" is a home grown, Alaska term. You won't find it defined in the literature or used outside of Alaska. What we term Viscous Oil in Alaska is referred to as Heavy Oil in the industry.

Oil vs. Bacteria

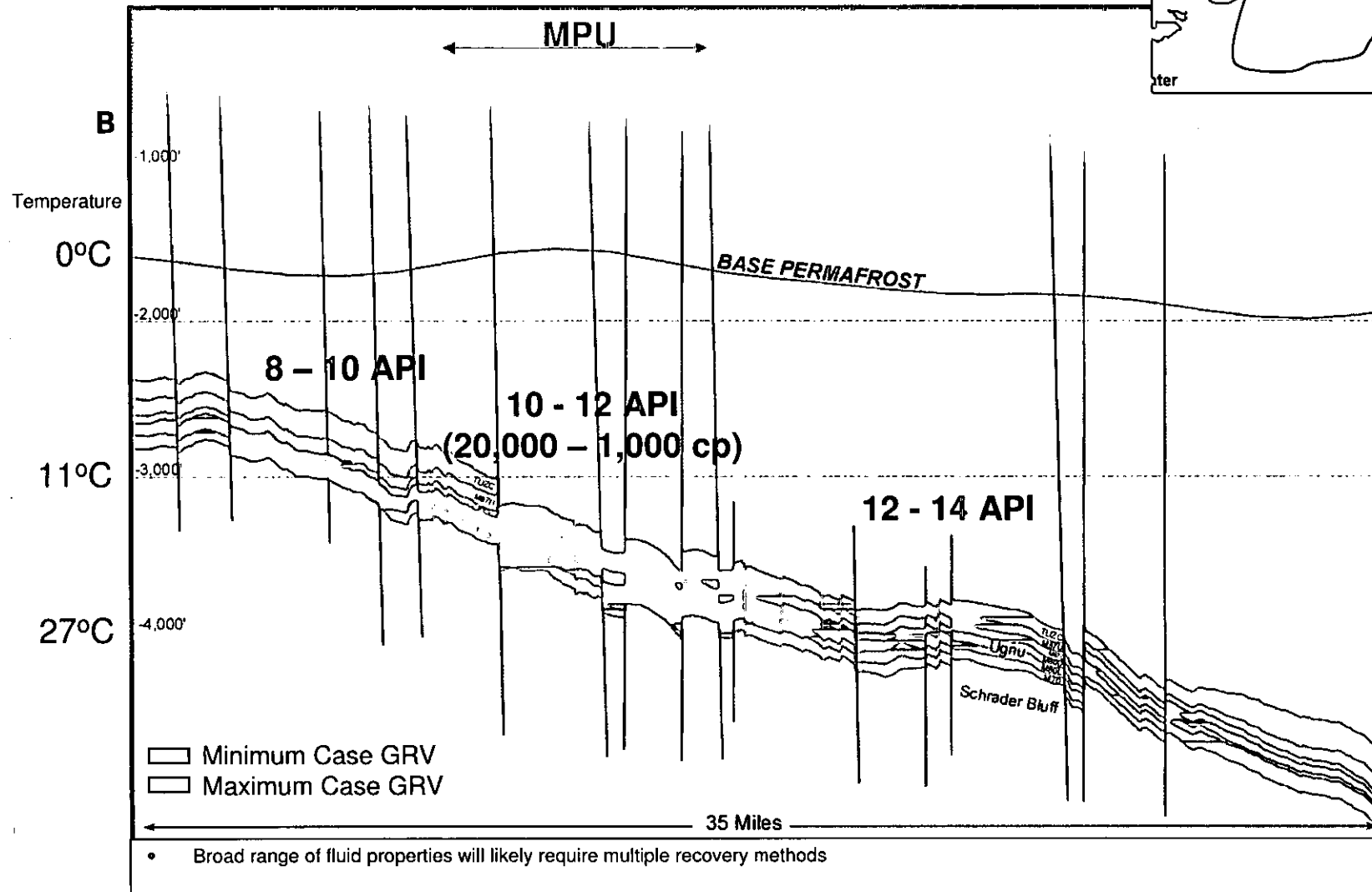
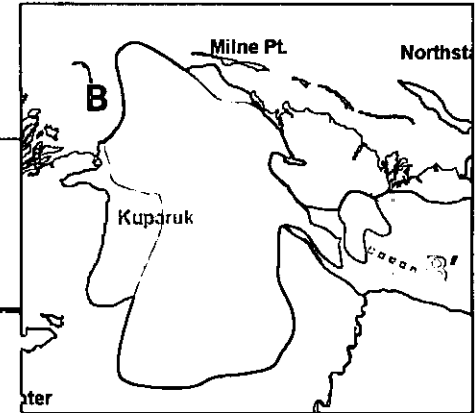


Alaska Viscous and Heavy Oil

Geographic coincidence is no coincidence



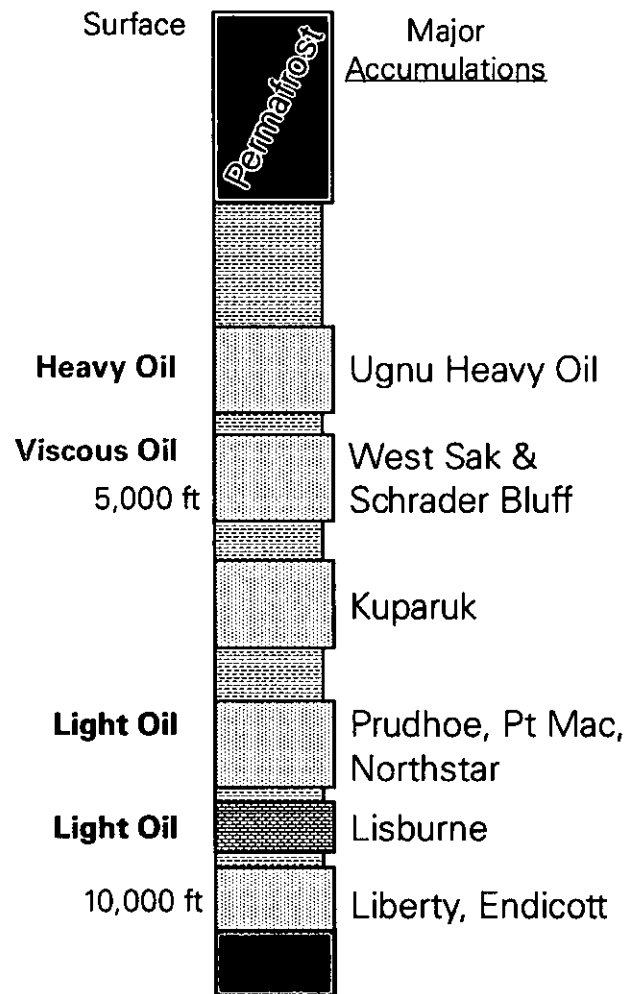
Ugnu Structure & Fluid Quality



Stratigraphic and Volumetric Distribution



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

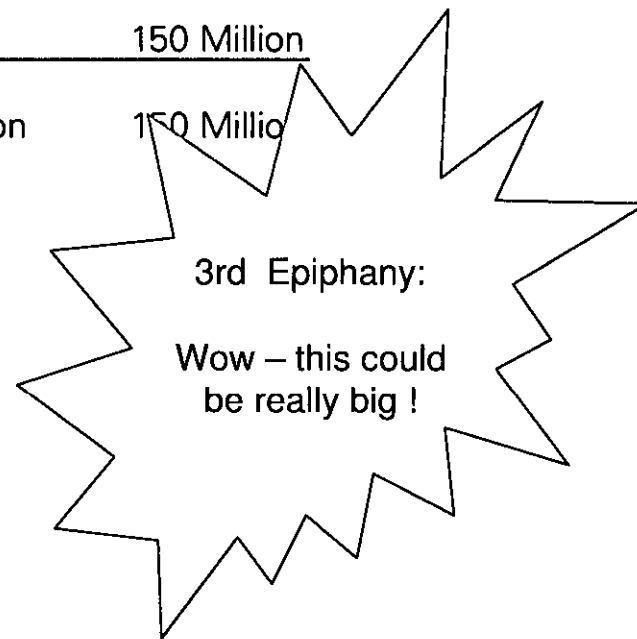


OOIP Produced

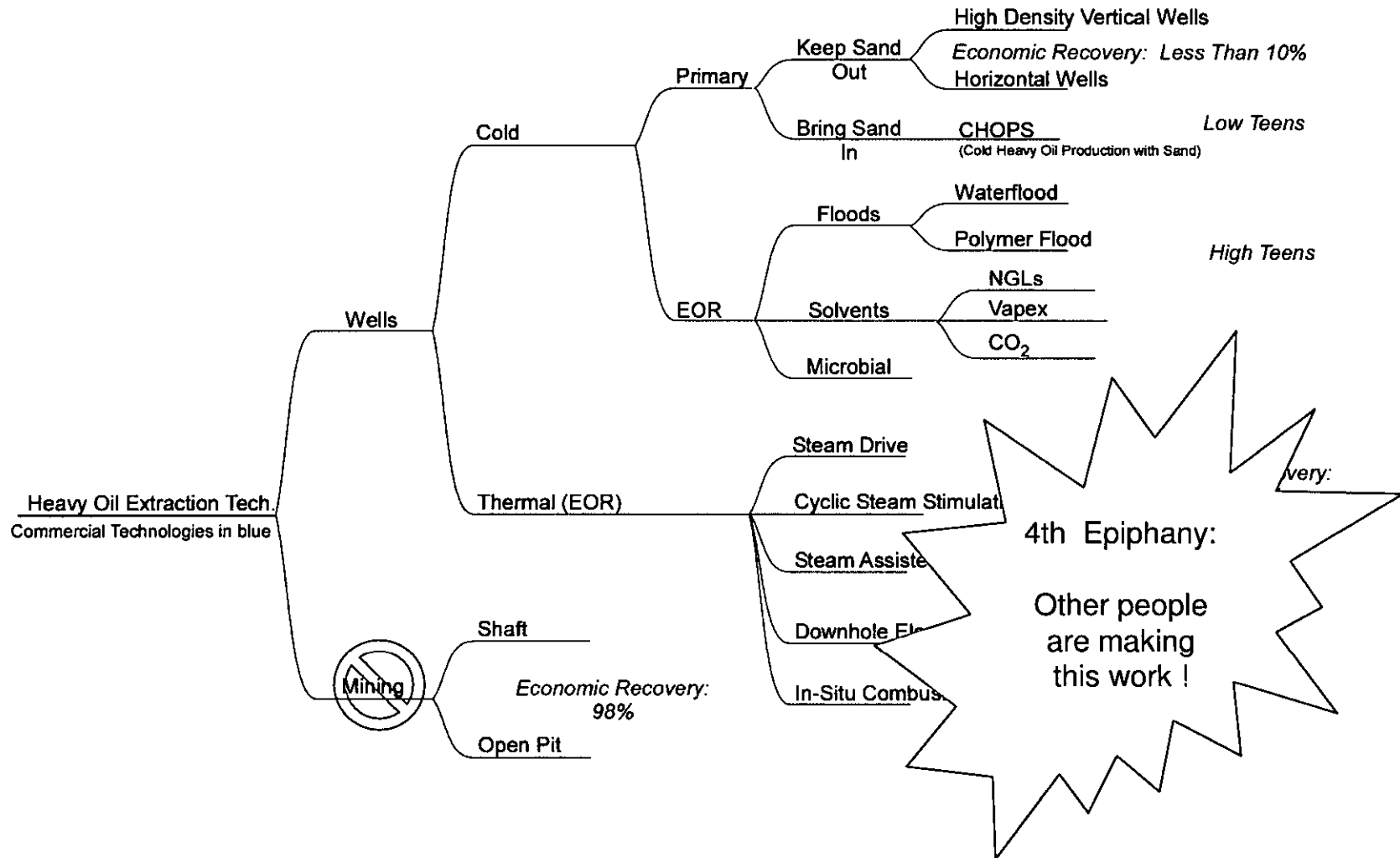
13 to 21 Billion 0

5 to 6 Billion 150 Million

18 to 27 Billion 150 Million



Heavy Oil Depletion Technology

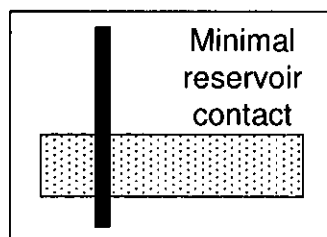




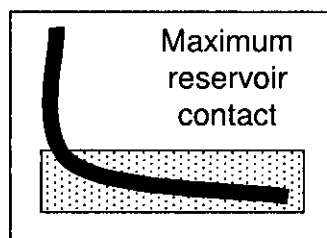
Horizontal Wells & Motherbores

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

Vertical Wells



Horizontal Wells



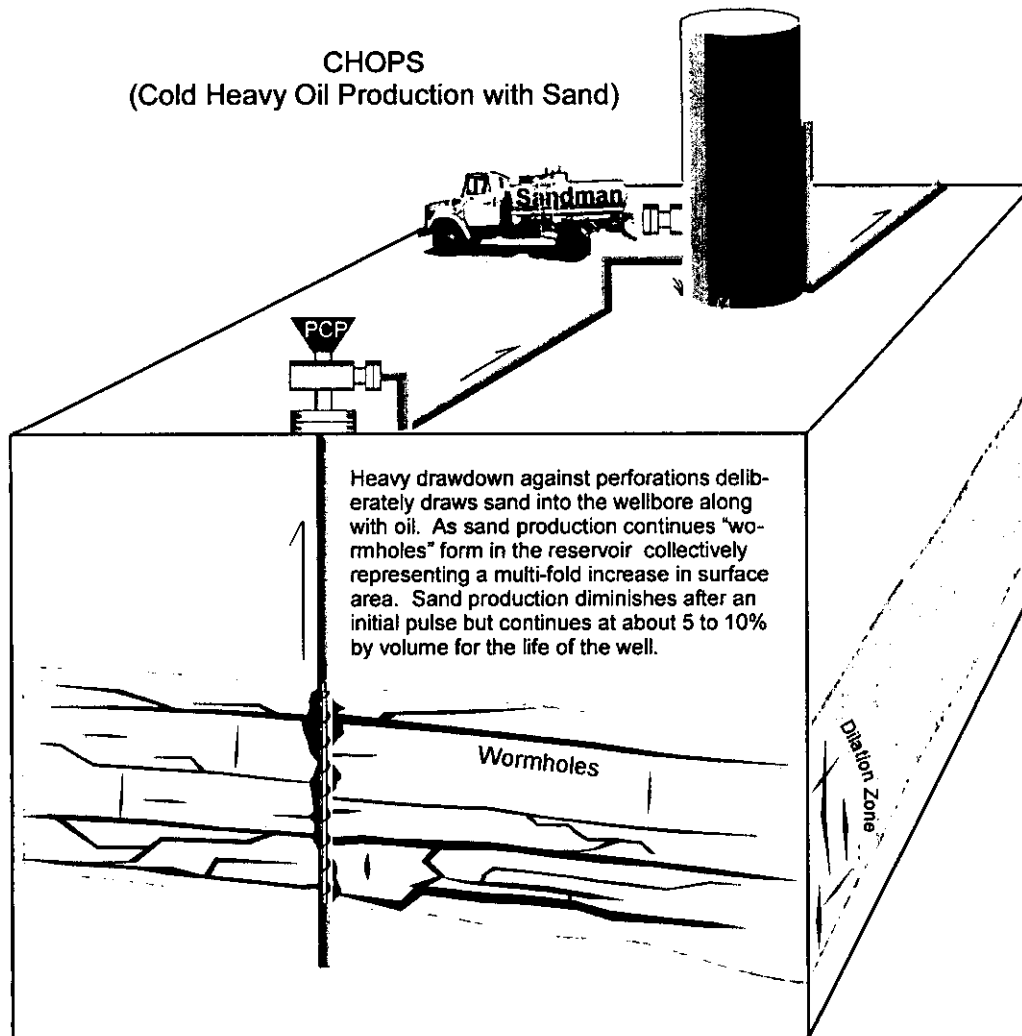
Piloting at S-Pad

Motherbores - Many Horizontal laterals in one well



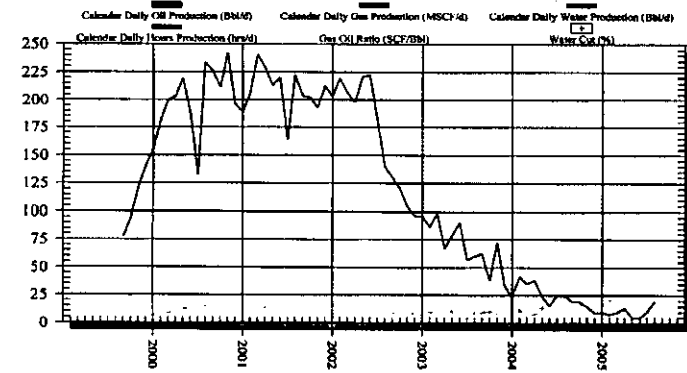


CHOPS Elements



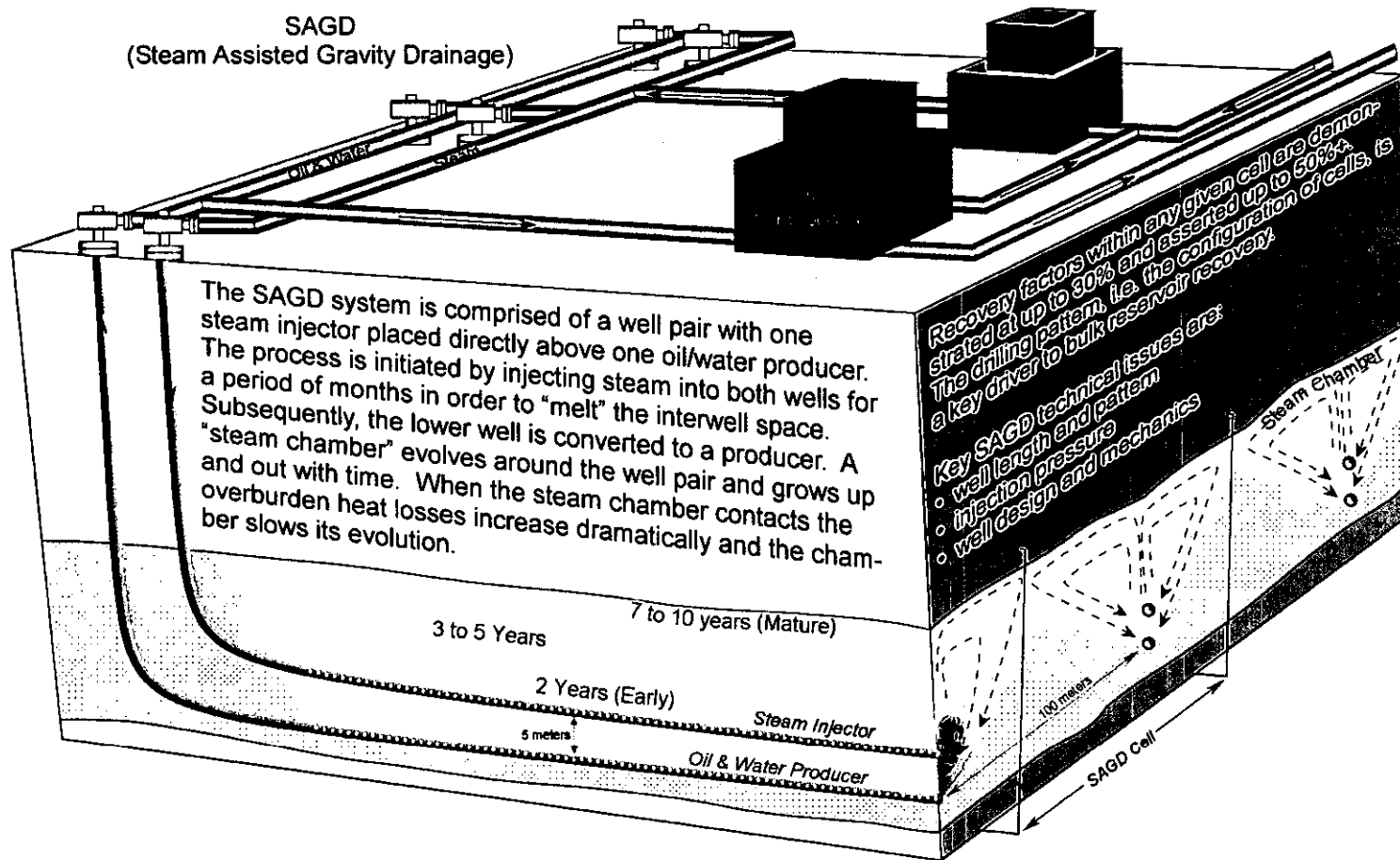
- Unconsolidated rocks
- PCP Pump
- Surface Drive
- Heated Separation Tank
- Sand Disposal

CHOPS: CHARACTERISTIC PRODUCTION PROFILE
scatter is intrinsic to process



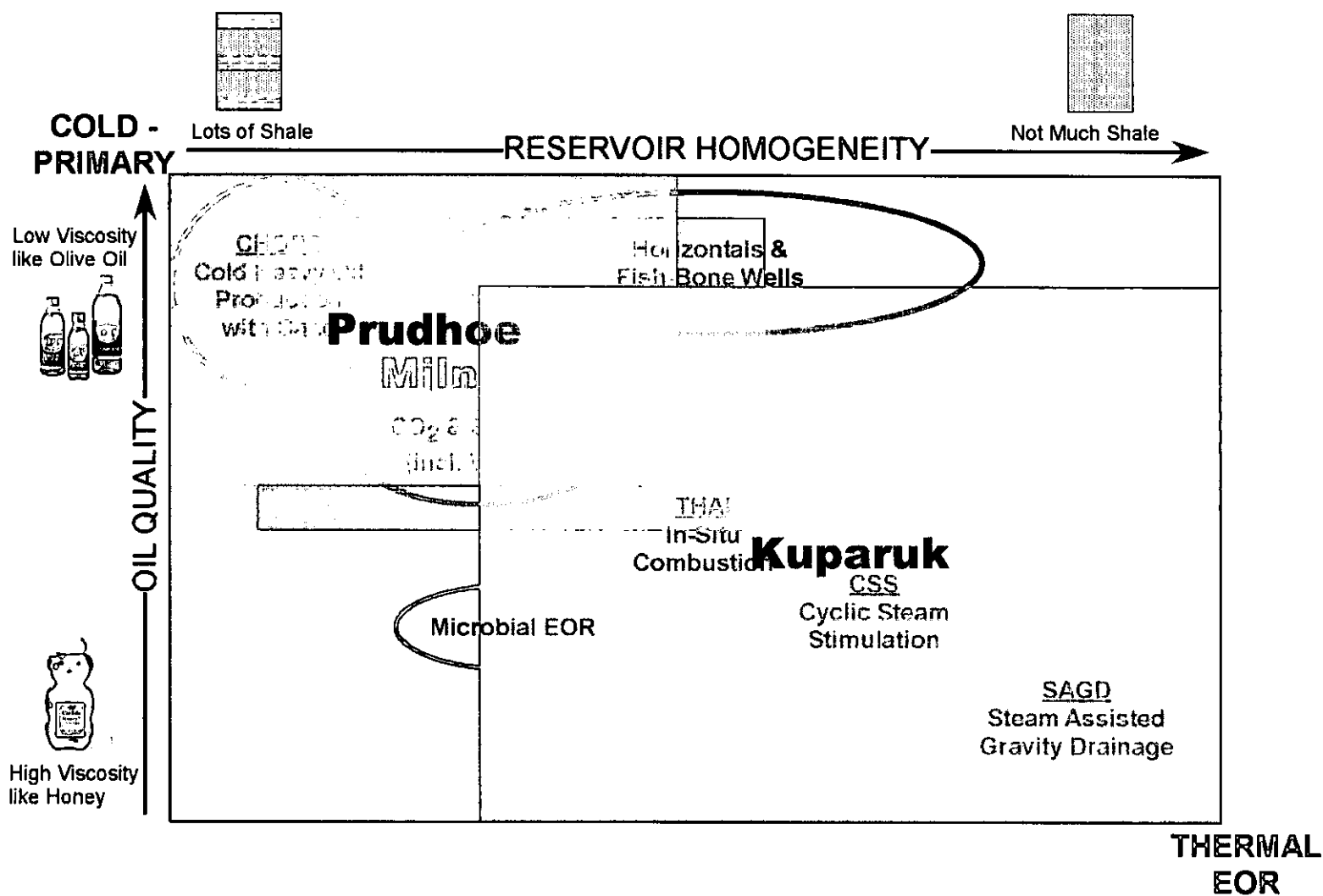


SAGD (Steam Assisted Gravity Drainage)





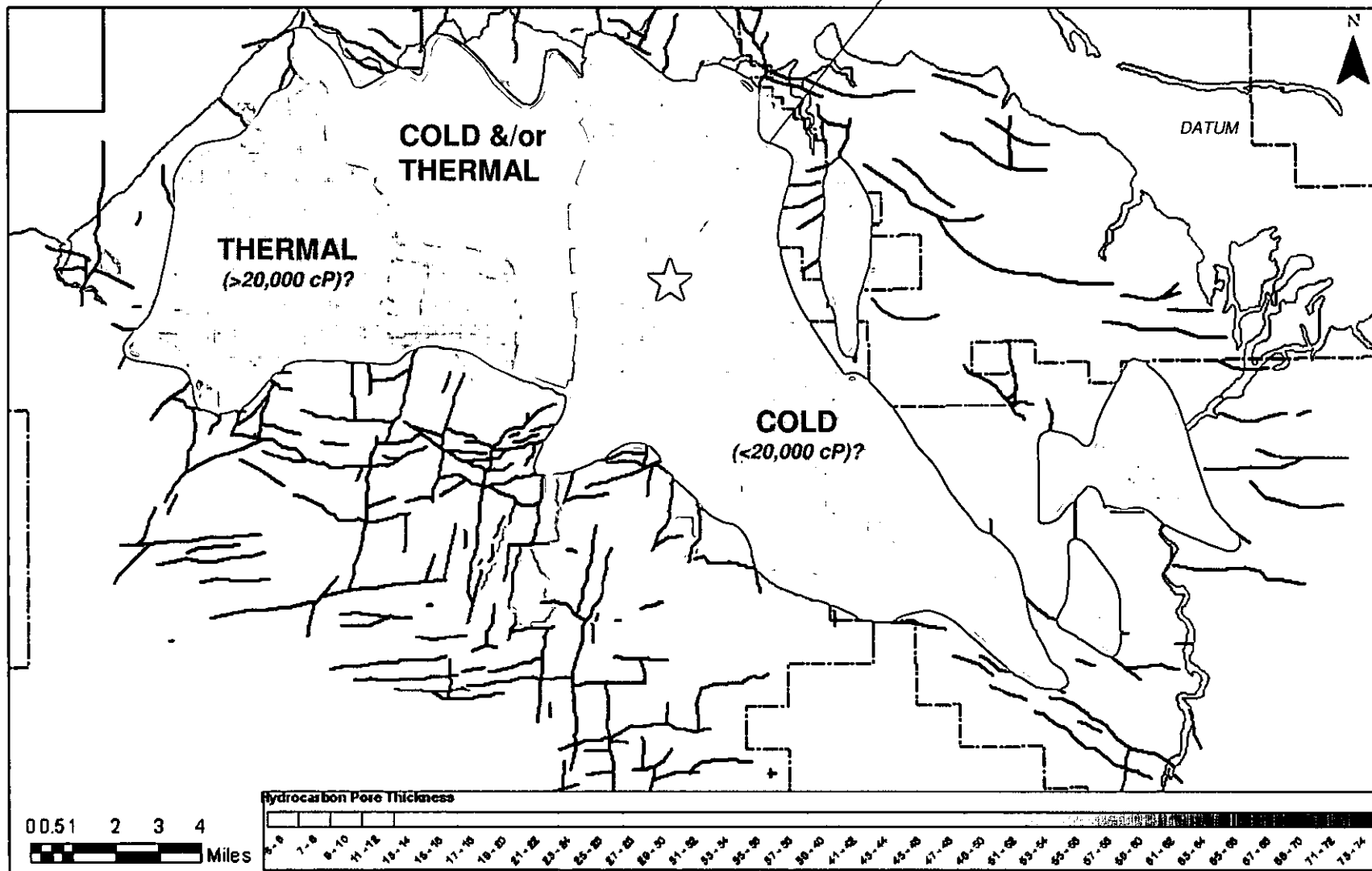
Recovery Methods



North Slope Heavy Oil Accumulation

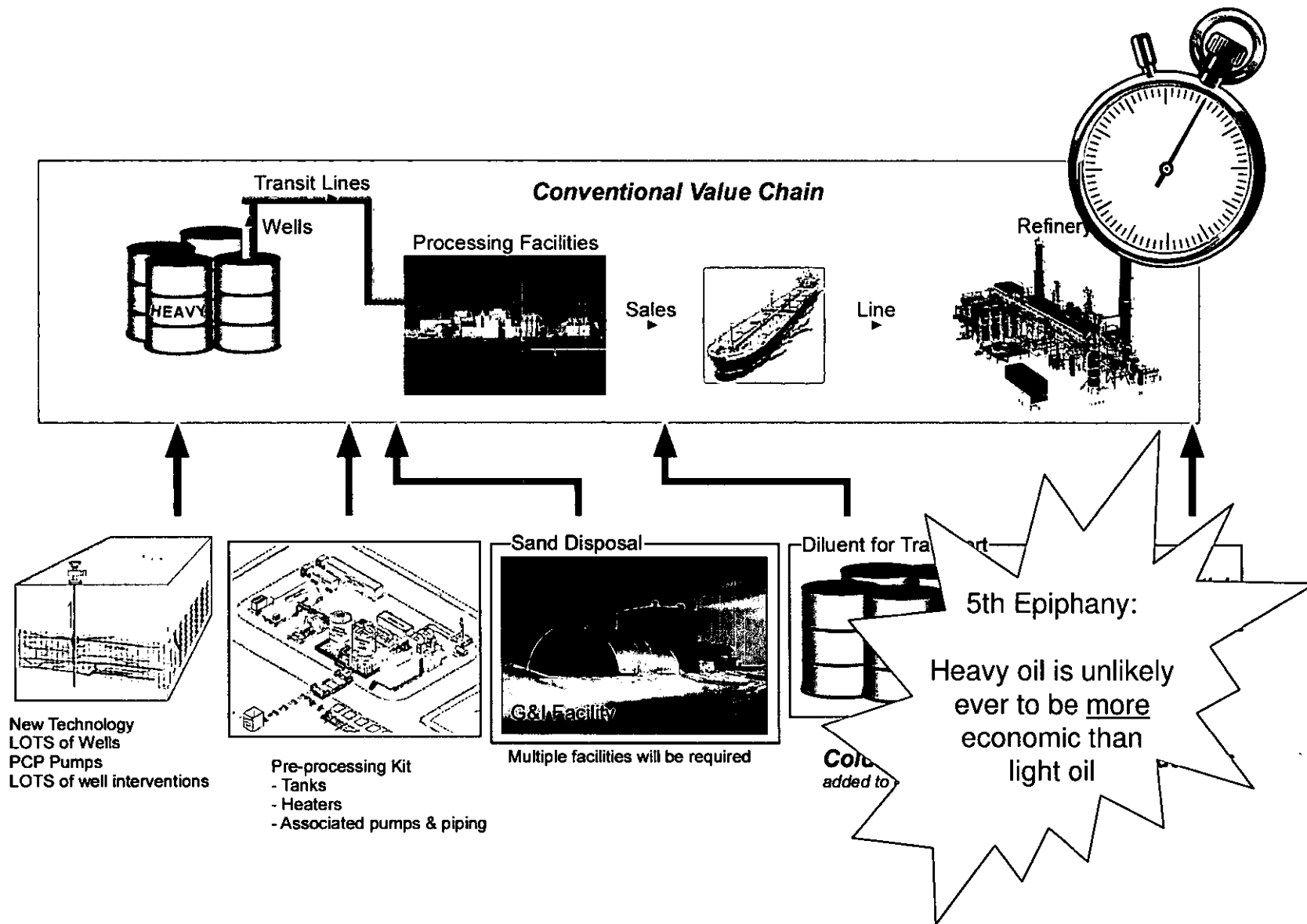


BP's Milne Point Heavy Oil Pilot

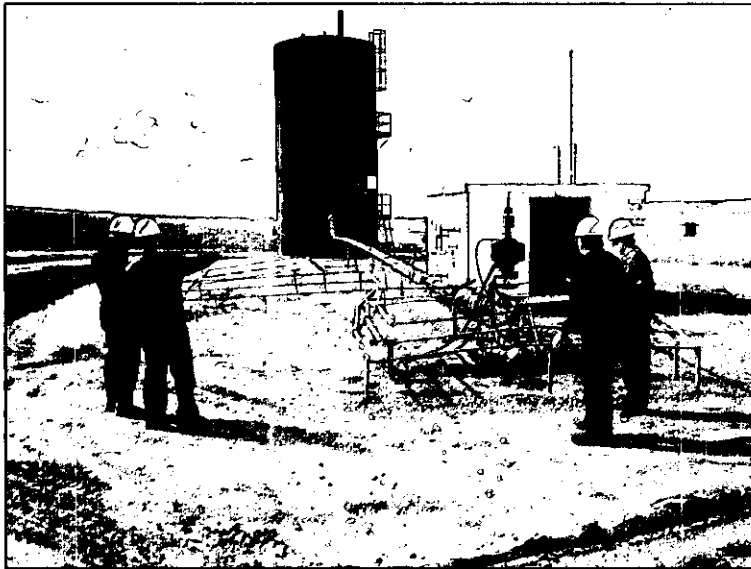


Heavy Oil Value Chain

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

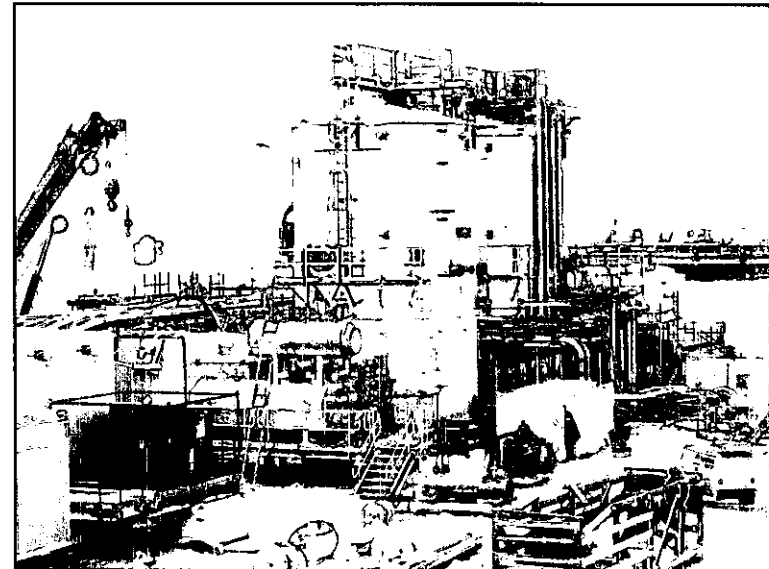


Vision vs. Reality



Canadian Design

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

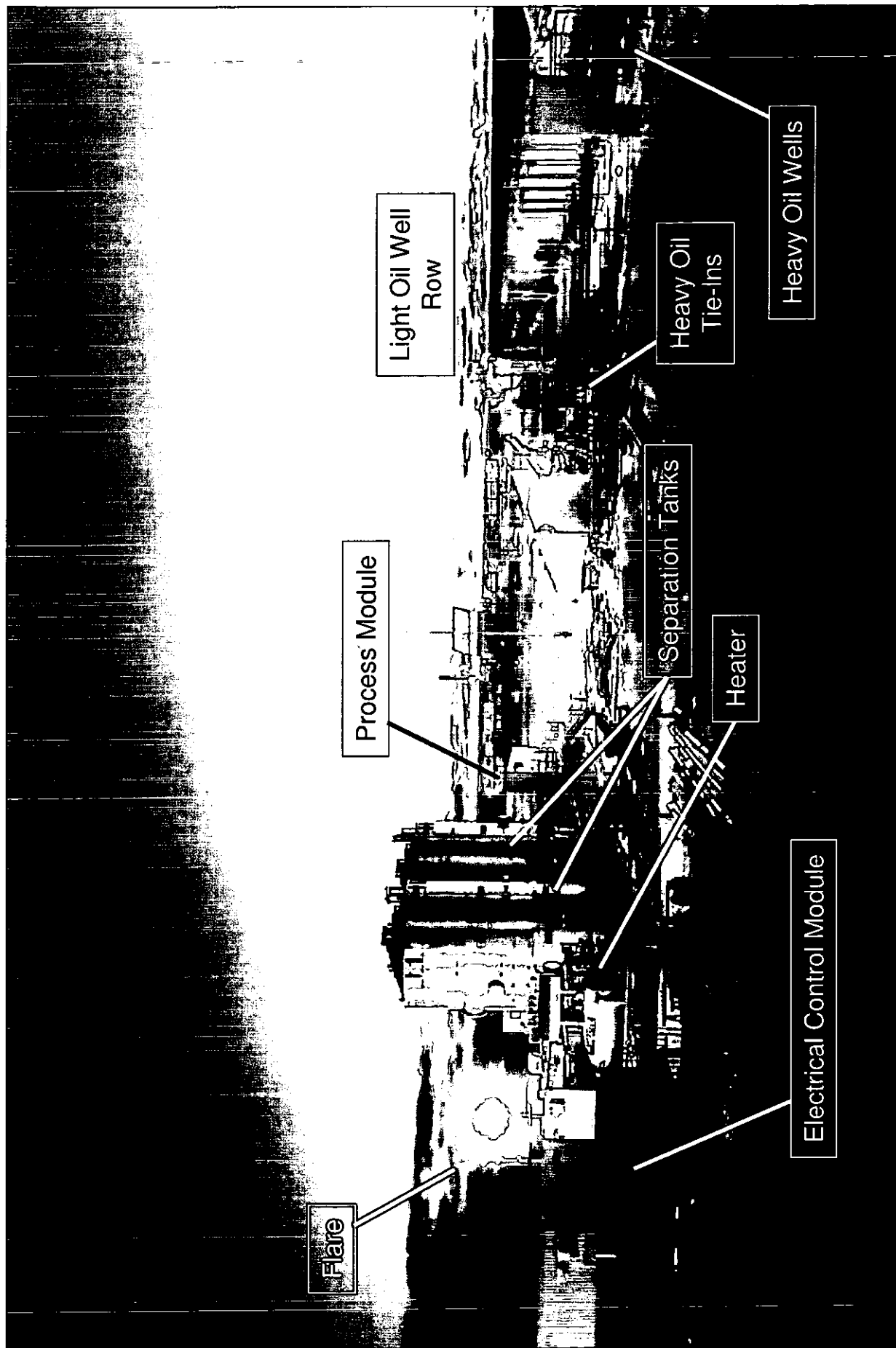


Alaska Design

- 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



New BP Heavy Oil Pilot Project, Milne Point Alaska





Take Away Messages

- Heavy oil 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 this Alaska Heavy Oil is unknown, so commercial outcome remains large range - must answer technical viability question first
- BP's Milne S-Pad pilot is an experiment and its design and appearance do not necessarily reflect what a development will look like