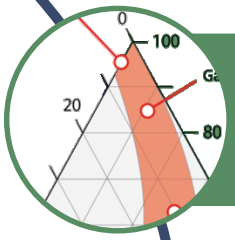
Petroleum Feedstocks:

Crude Oil, Dilbit, Condensate, and Related Products

Session Outline



Sources and Properties of Petroleum Feedstocks

Information Sources for Emergency Response

Environmental Remediation Issues

Today's Presenter

Andy McManus, P.G.

- ARCADIS – Principal Geologist
- Southeast Regional Manager ARCADIS Incident Response and Recovery Team
- 12 years environmental industry experience; joined ARCADIS 2005
- Responded to 100+ freight rail incidents, including 4 crude-by-rail incidents

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Objectives

Describe the composition of petroleum products and regional variation in their characteristics

Identify where to get information on the composition of a particular shipment

Recognize the three primary safety concerns for anyone involved in a petroleum products release

Describe the priorities for protection of surface water and other environmental resources during incident response and recovery

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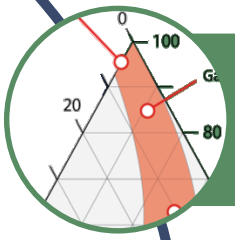

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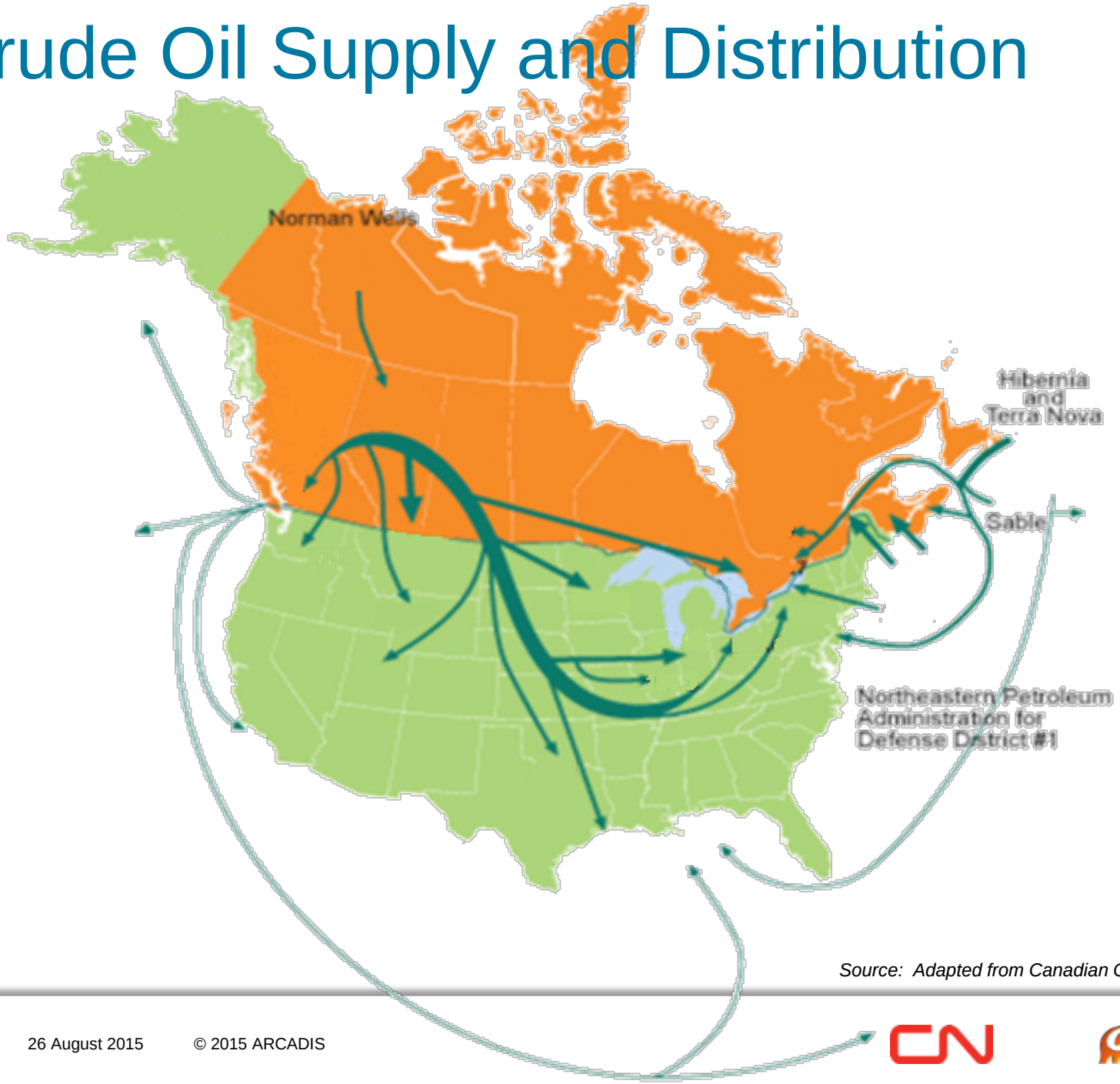
Crude Oil Supply and Distribution

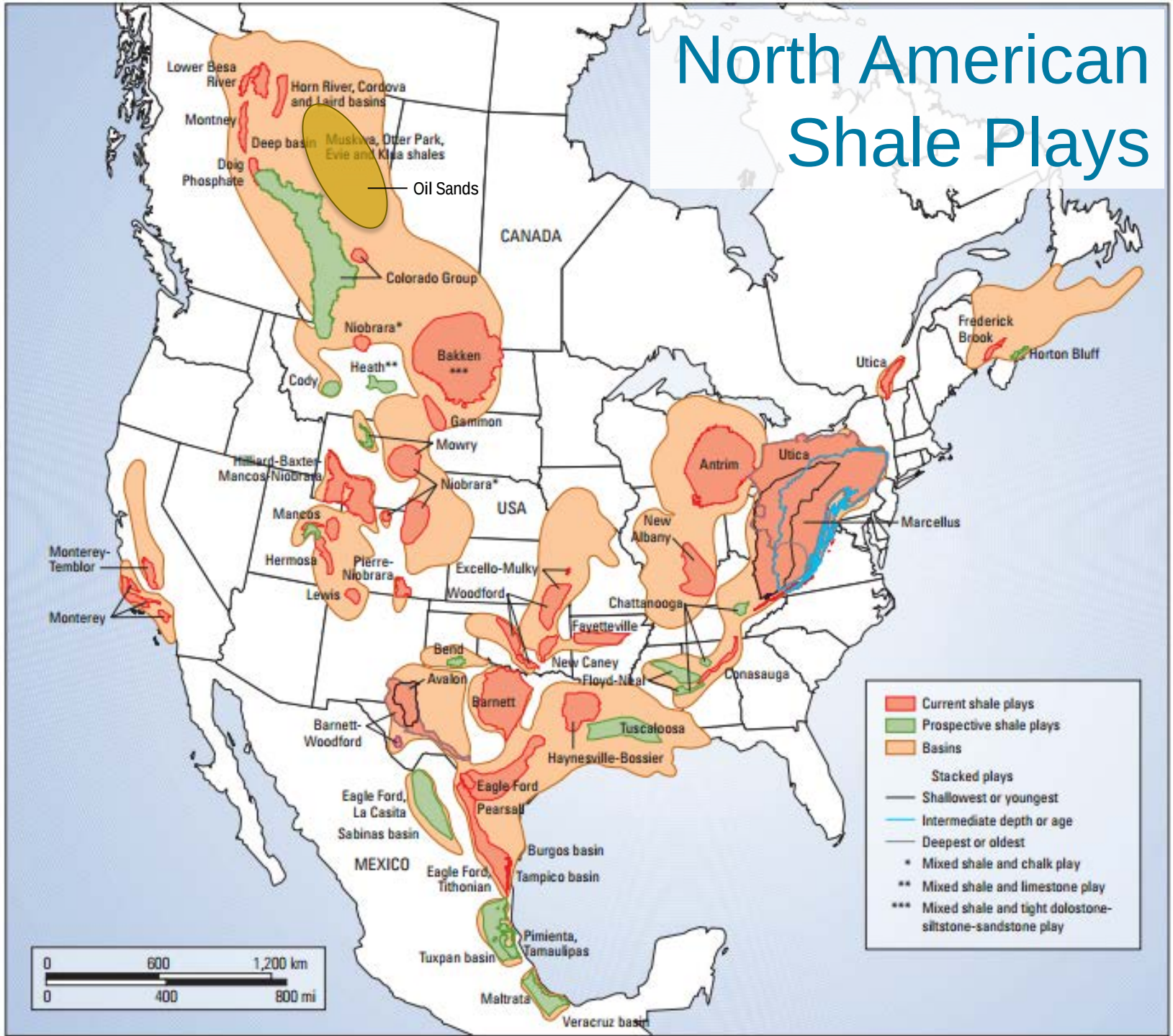


Source: Adapted from Canadian Centre for Energy Information

Summary of Loading Growth

- Rail is becoming a significant complement to pipeline transport
  - Flexibility in destination
  - Shortened transit time
  - Allows multiple types of crude in the same shipment
- Increasing percentage of total freight loadings
- Potential for diluent back-haul from US Gulf Coast facilities

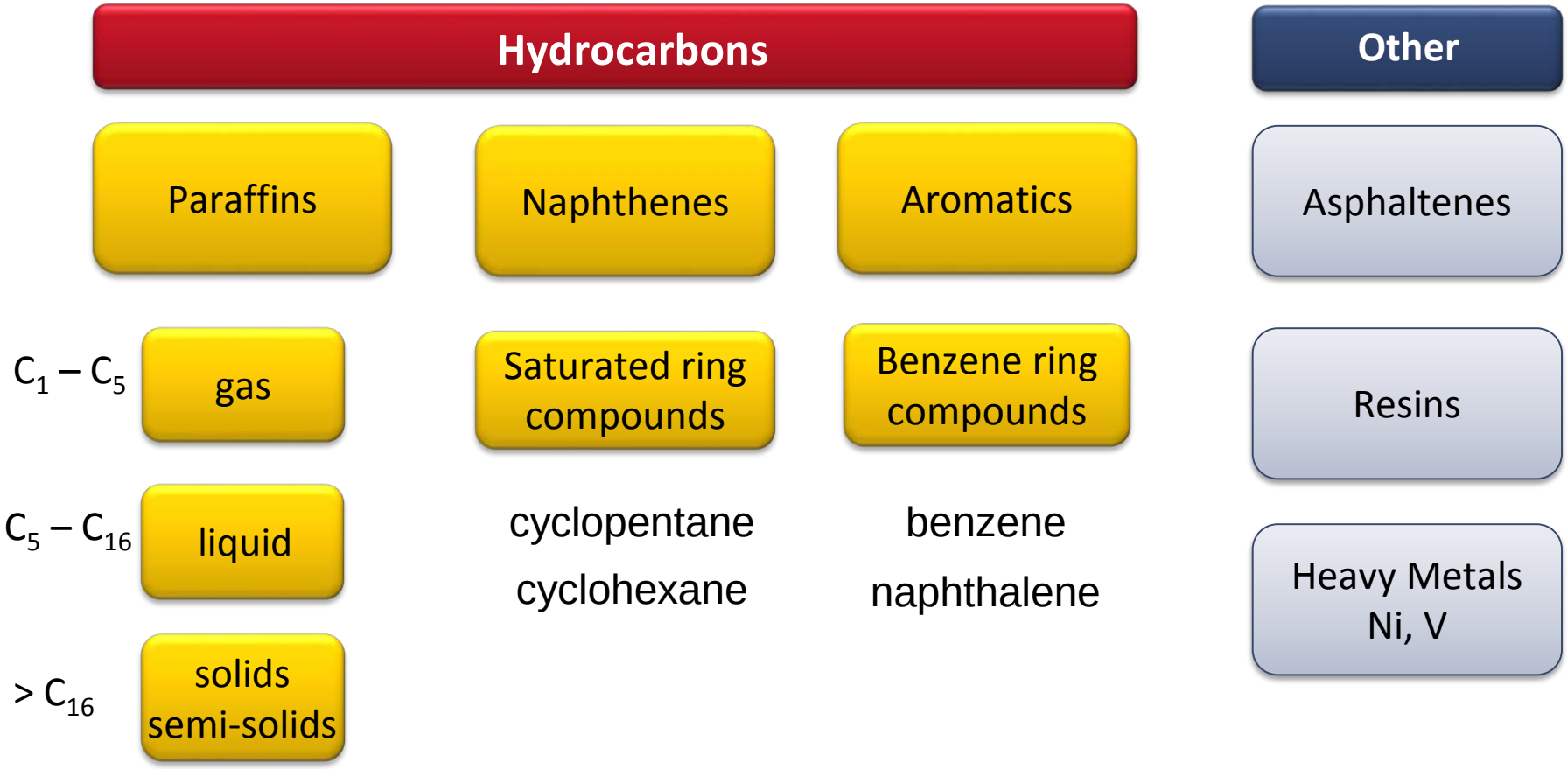
North American Shale Plays

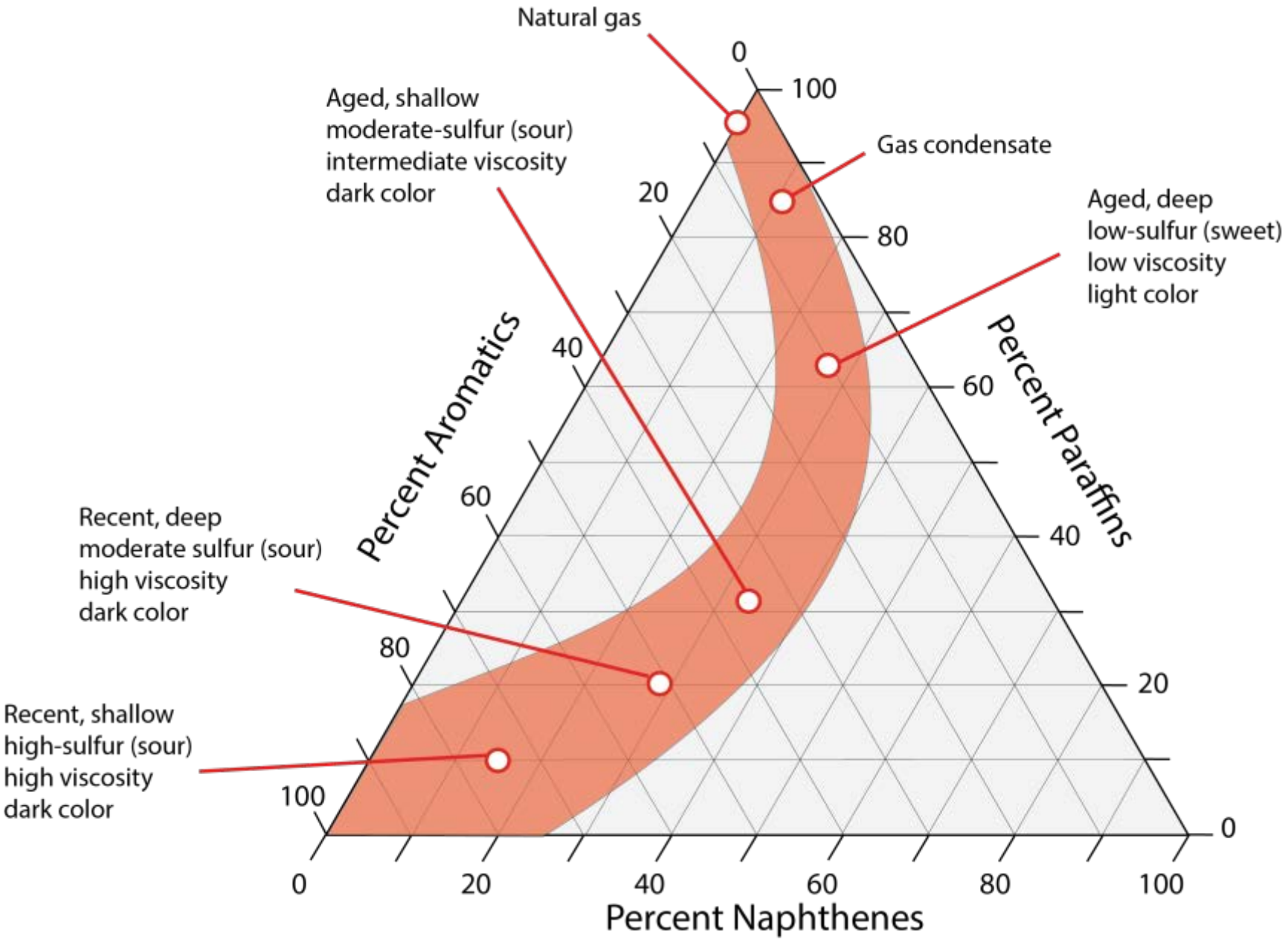


Petroleum Feedstocks in Transport

- Crude Oil
- Dilbit
- Condensate
- Bitumen
- Syncrude
- Diluent

Petroleum Feedstocks Composition





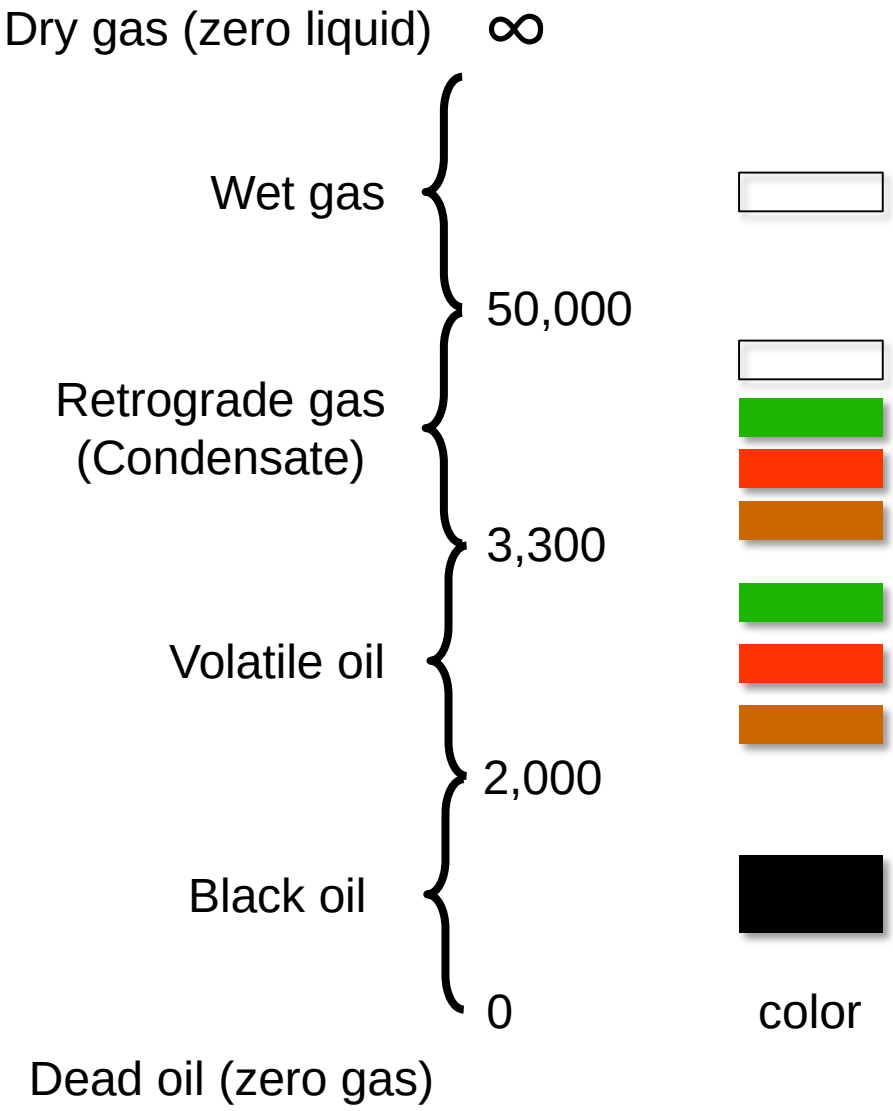
The Gas-Oil Ratio (GOR)

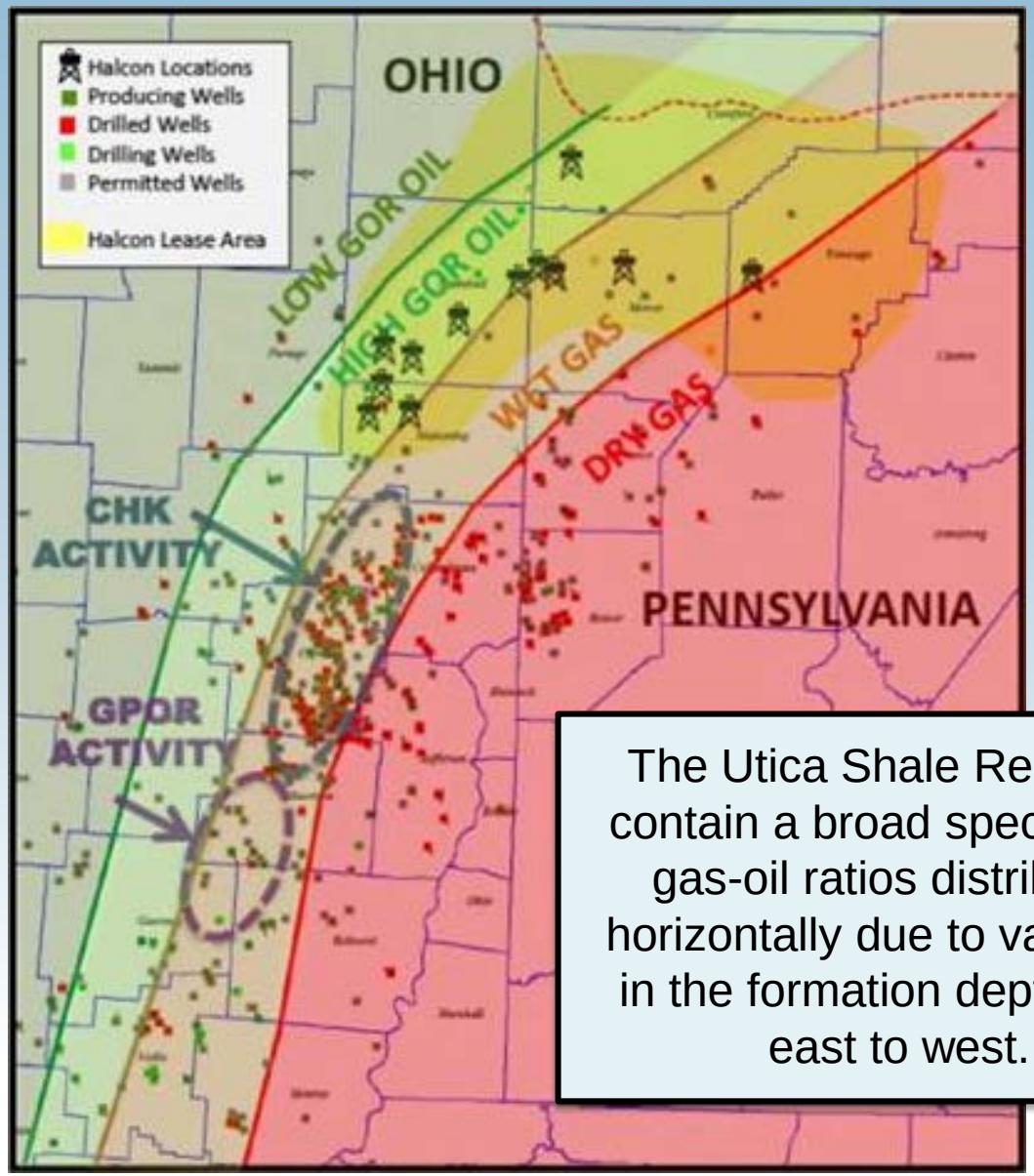
Gas/oil by volume

GOR = scf/stb

scf = standard cubic feet of gas

stb = storage tank barrel of oil

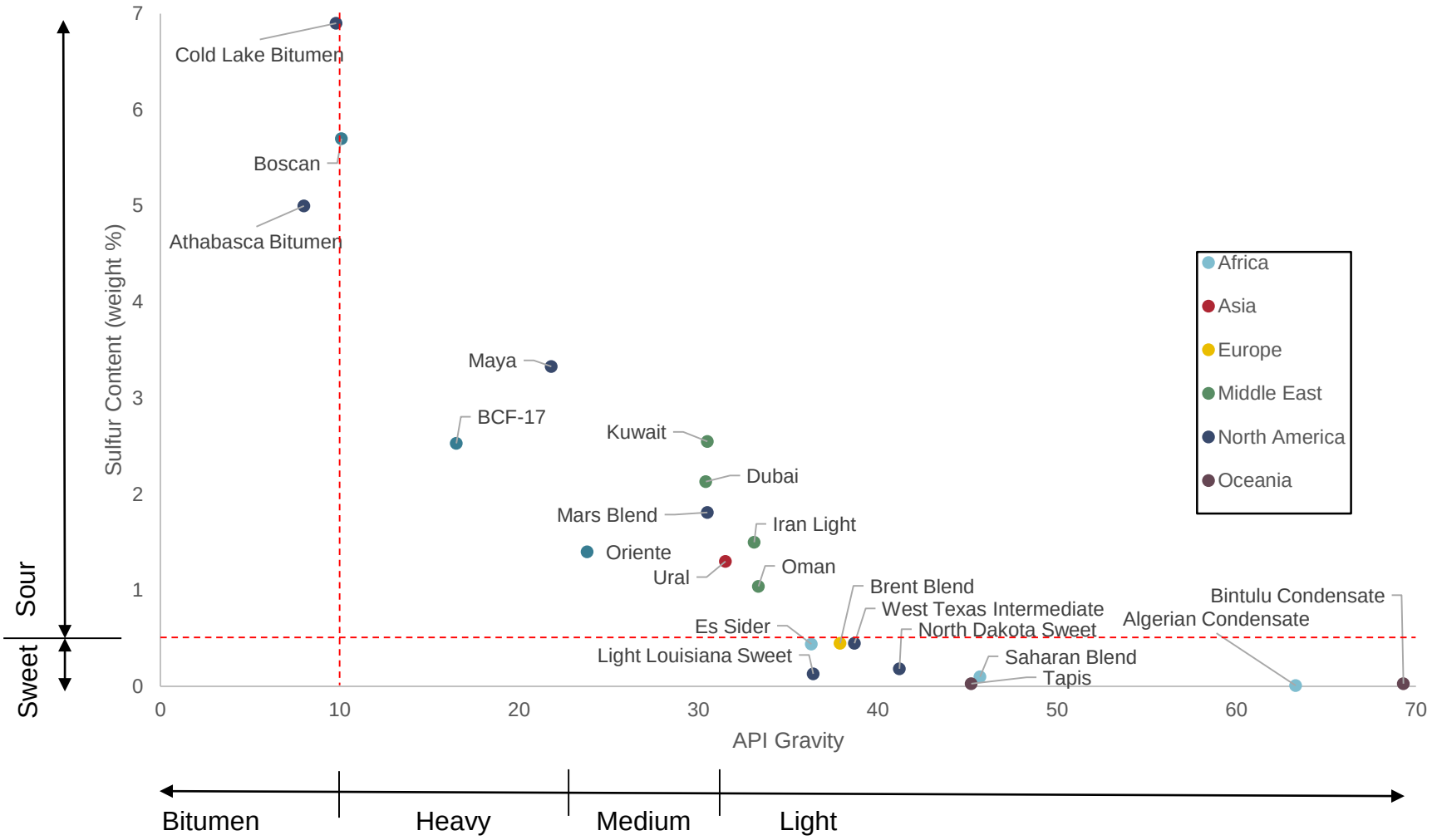




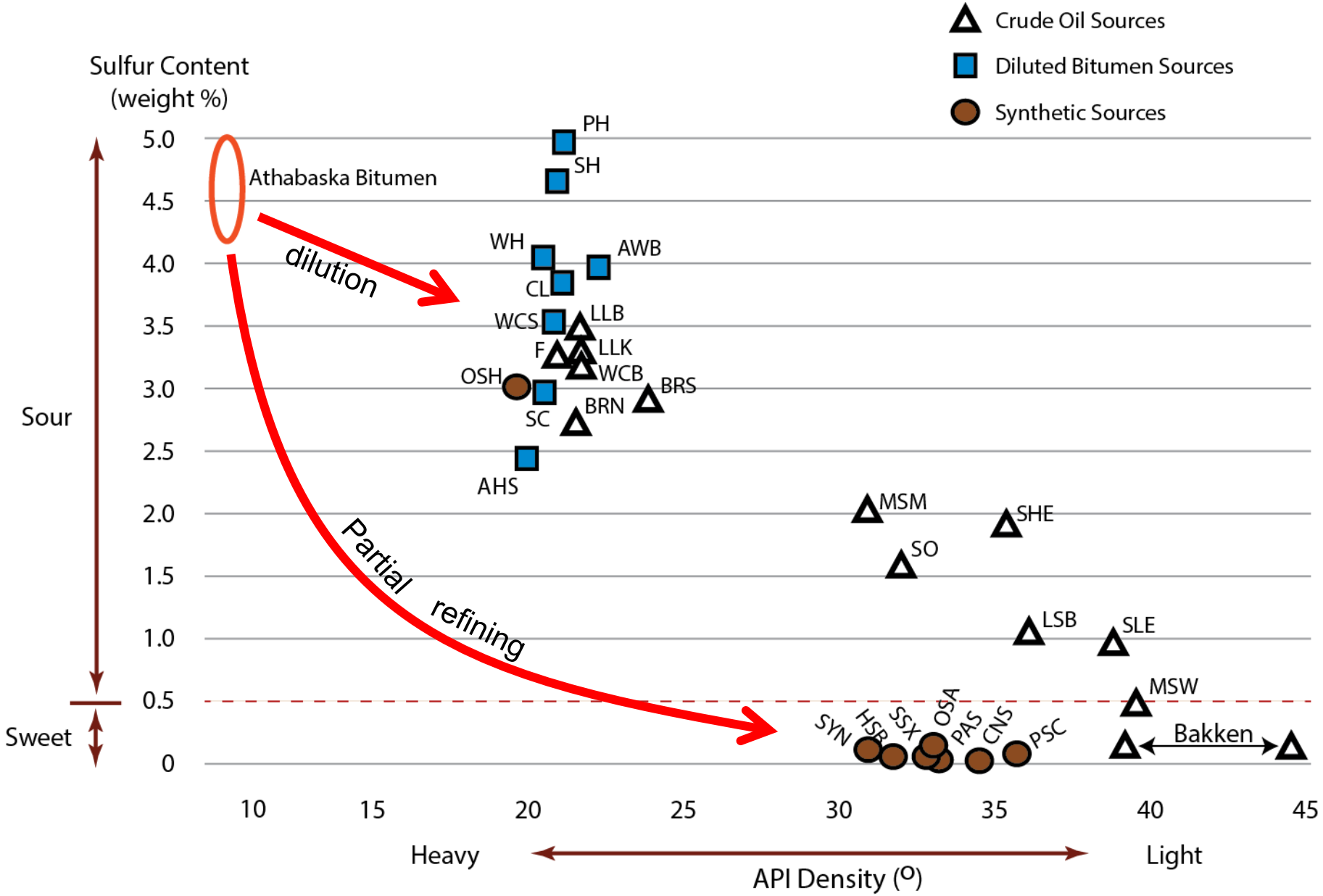
Horizontal and Vertical GOR Variability

The Utica Shale Reserves contain a broad spectrum of gas-oil ratios distributed horizontally due to variability in the formation depth from east to west.

Global Crude Oil Spectrum



Western Canadian Petroleum Feedstocks

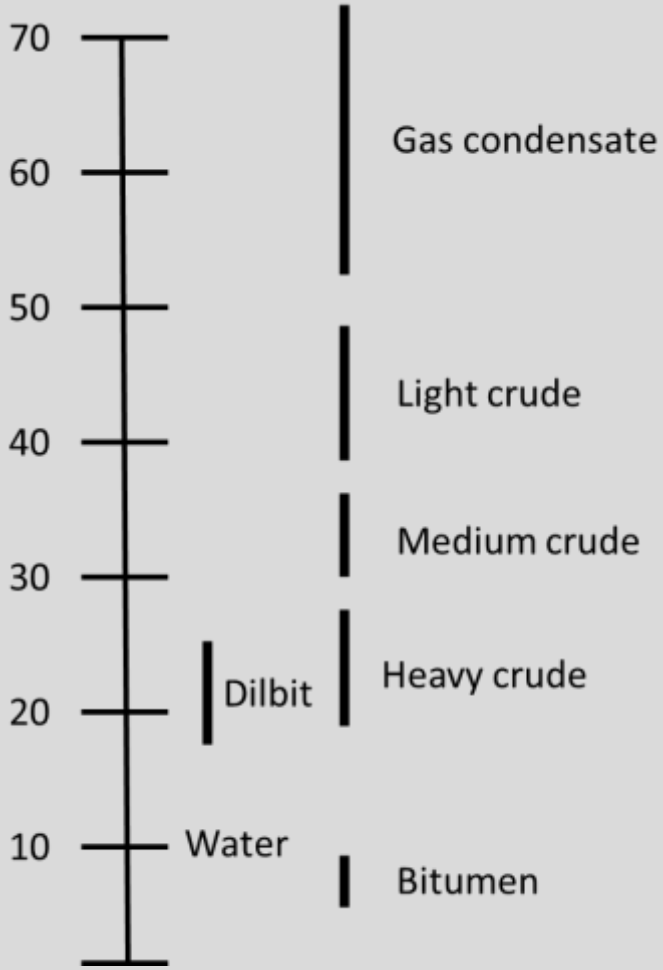


API Gravity (API º)

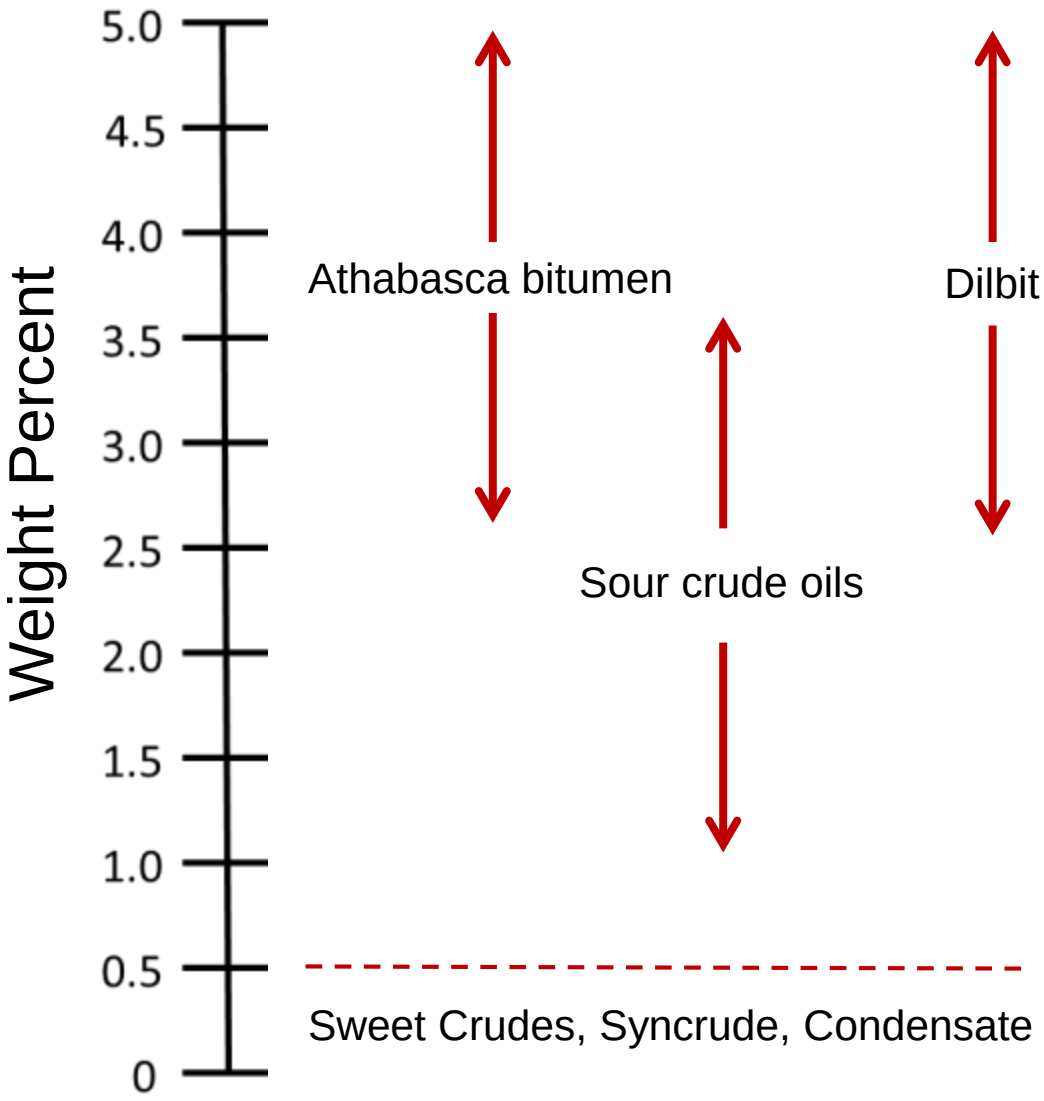
$$API\ Gravity = \frac{141.5}{Sp.Grav.} - 131.5$$

Expressed as: degrees (API˚)

Specific gravity of water at 60 ˚F = 1.0 … API˚ = 10



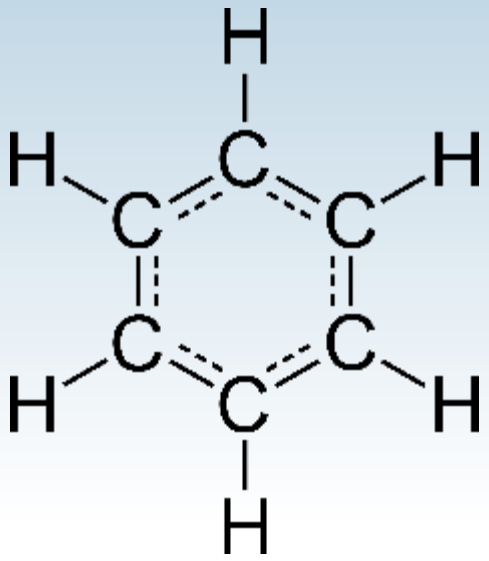
Sulfur Content

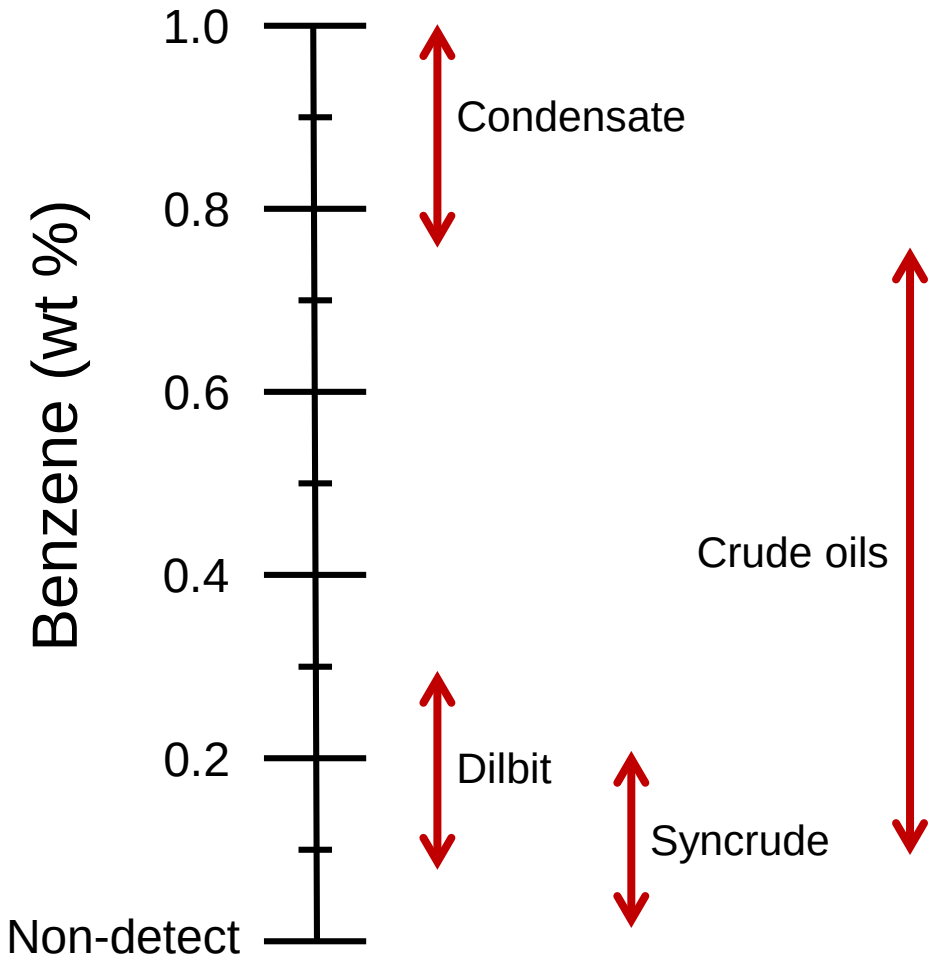


Viscosity at 15 ºC (60 ºF)

Liquid	Viscosity (cSt)
Water	1
Diesel fuel	2 to 6
Light Crude and Syncrude	4 to 15
Light machine oil or olive oil	100
Dilbit	200
Heavy Crude Oil	220
Glycerin or castor oil	1,000
Honey	10,000
Molasses	100,000
Sucrose (cane sugar)	1,000,000
Athabasca Bitumen	> 2,000,000

Benzene Content

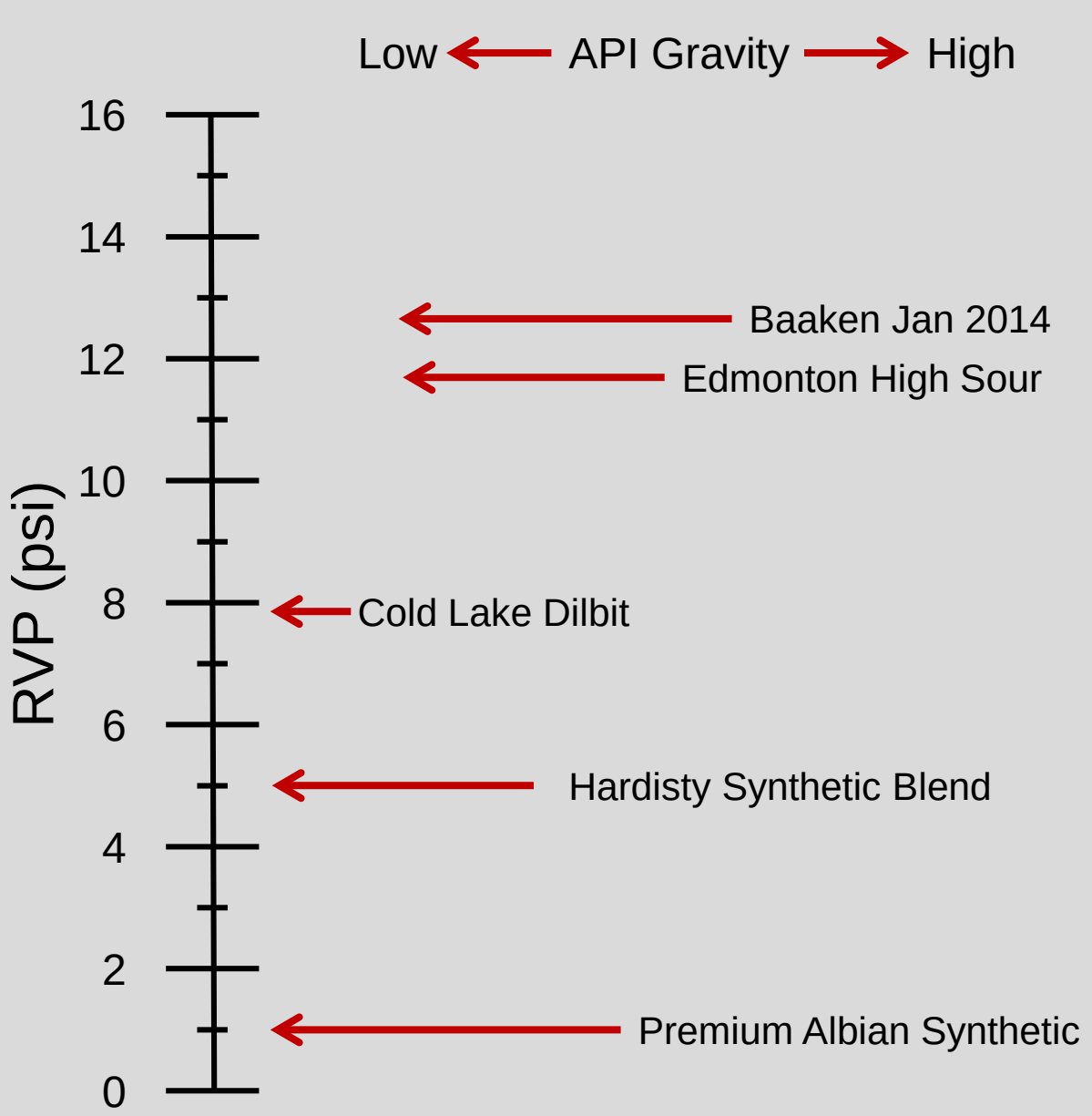




Reid Vapor Pressure

ASTM D323

100 ºF
Head space =
4 x liquid volume



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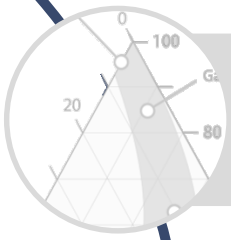

Sources and Properties of Petroleum Feedstocks

Information Sources for Emergency Response

Environmental Remediation Issues

Challenges for Incident Response

- Wide range of characteristics
- What information do we need?
- Where can we obtain descriptive data?
- What measurements can we make quickly in the field?

Fire Suppression

- Class B: Flammable liquid

- Source isolation
- Significant re-ignition potential
- Low-volume-expansion foams
- Water mist or fog
- Risk of boil-over

Petroleum Crude Oil

Excerpt from Emergency Response Guidebook 128: Flammable Liquid – Non-Polar/Water-Immiscible

EMERGENCY RESPONSE – FIRE

CAUTION: All these products have a very low flash point: Use of water spray when fighting fire may be inefficient.

CAUTION: For mixtures containing alcohol or polar solvent, alcohol-resistant foam may be more effective.

Small Fire

- Dry chemical, CO_2, water spray, or regular foam.

Large Fire

- Water spray, fog, or regular foam.

Do not use straight streams.

- Move containers from fire area if you can do it without risk.

Fire Involving Tanks and/or Car/Trailer Loads

- Fight fire from maximum distance or use unmanned hose holders or monitor nozzles.
- Cool containers with flooding quantities of water until well after fire is out.
- Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank.
- ALWAYS stay away from tanks engulfed in fire.
- For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn.

Example Crude Oil Assay

Poseidon - Summary Crude Oil Assay Report

Source of Sample	
Reference:	T09POS1
Name:	Poseidon
Origin:	United States of America
Sample Date:	8/1/2009
Comments:	

Light Hydrocarbon Analysis		
H2S*	ppm wt	-
Methane	%wt	0.00
Ethane	%wt	0.02
Propane	%wt	0.30
Isobutane	%wt	0.21
n-Butane	%wt	0.84
Isopentane	%wt	0.72
n-Pentane	%wt	1.04
Cyclopentane	%wt	0.09
C6 paraffins	%wt	2.05
C6 naphthenes	%wt	0.67
Benzene	%wt	0.08
*Dissolved in liquid		

Assay Summary / TBP Data		
Gravity (°API)	**29.7**	
Sulphur (%wt)	**1.65**	
Yield on Crude	%wt	%vol
Gas to C4 (corrected)	1.37	2.15
Light Distillate to 149°C	13.23	16.26
Kerosene 149 - 232°C	11.81	13.09
Gas Oil 232 - 369°C	21.93	22.36
Vacuum Gas Oil 369°C - 550°C	27.16	25.59
Residue above 550°C	24.50	20.55
Volume expansion:	*0.3 per cent vol*	
on crude distributed across whole distillation		

Cut Data	Crude	Distillates									Residues			
		Light Naphtha	Heavy Naphtha		Kero	Light Gas Oil	Heavy Gas Oil	Light Vacuum Gas Oil	Heavy Vacuum Gas Oil		AtRes	VacRes		
Start (°C API)	**IBP**	C5	95	149	175	232	342	369	509	550	369	509	550	585
End (°C API)	**FBP**	95	149	175	232	342	369	509	550	585	FBP	FBP	FBP	FBP
Yield on crude (% wt)	**100**	6.00	7.23	3.83	7.98	17.71	4.23	19.95	7.20	4.90	51.65	31.70	24.50	19.60
Yield on crude (% vol)	**100**	7.76	8.50	4.37	8.72	18.20	4.16	18.99	6.60	4.41	46.14	27.15	20.55	16.14
Density at 15°C (kg/litre)	**0.8774**	0.6753	0.7444	0.7660	0.8002	0.8507	0.8883	0.9185	0.9544	0.9722	0.9788	1.0210	1.0424	1.0616
Total Sulphur (% wt)	**1.65**	0.008	0.015	0.057	0.145	0.704	1.35	1.65	2.22	2.51	2.81	3.54	3.92	4.28
Mercaptan Sulphur (ppm wt)	**1**	1	4	2	3	4	-	-	-	-	-	-	-	-
Total Nitrogen (ppm wt)	**1300**	0	0.2	0.8	2.3	31	180	690	1600	2100	2500	3700	4300	4900
Basic Nitrogen (ppm wt)	**414**	-	-	-	-	10	46	225	500	650	795	1154	1346	1521
Acidity (mgKOH/g)	**0.48**	0.002	0.021	0.066	0.214	0.66	0.74	0.43	0.30	0.05	0.21	0.08	0.01	0.00

Additional Response Data Needed

- Flash point
- Viscosity at field temperature
- Temperature – H_2S relationship
- Diluent volume and composition

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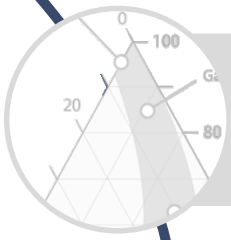

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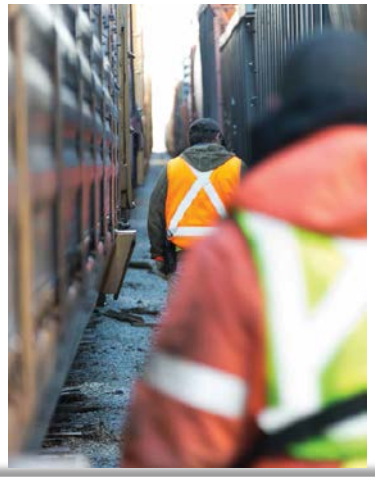
Environmental Response

- Environmental action priorities
- Crude oil, dilbit, and syncrude characteristics
  - Crude Assay
  - Field tests
- Response experience – case studies
- Summary of lessons learned
- Preparation for a possible incident



Environmental Action Priorities

- Air monitoring
  - LEL metering
  - H_2S monitoring
  - Benzene and related HAPs monitoring
- Prevent migration to surface waters
- Contain and remove crude oil that reaches surface waters
  - At the surface
  - At the bottom
- Block subsurface migration
- Remove oil from upland surfaces

Key Site Safety Issues

- LEL
- Hydrogen Sulfide Gas
- Benzene

Typical Monitoring Gear

MultiRAE

Colorimetric Gas Detection Tubes

AreaRAE

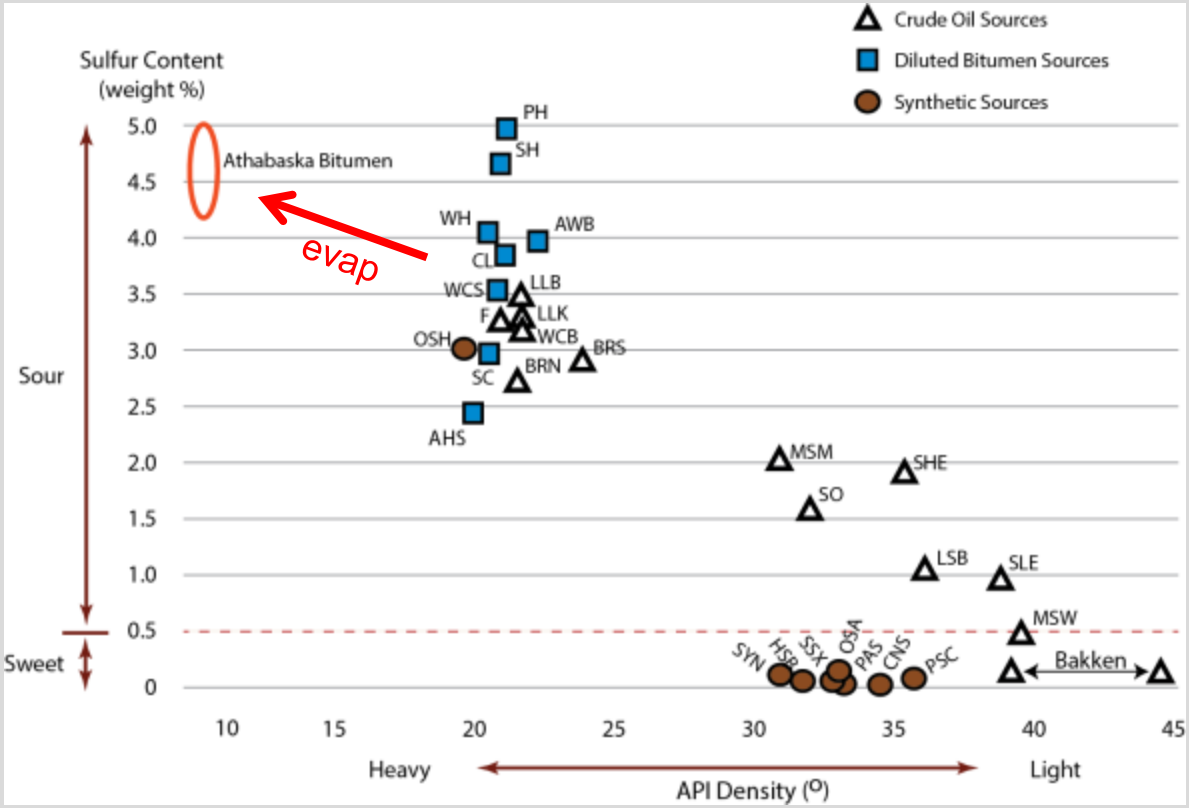
UltraRAE

Weathering

- Oil will degrade rapidly with exposure
- Subsurface oil protected from degradation
- Light ends are volatilized first, color can change
- Recoverability is enhanced initially
- Recoverability decreases as emulsion forms

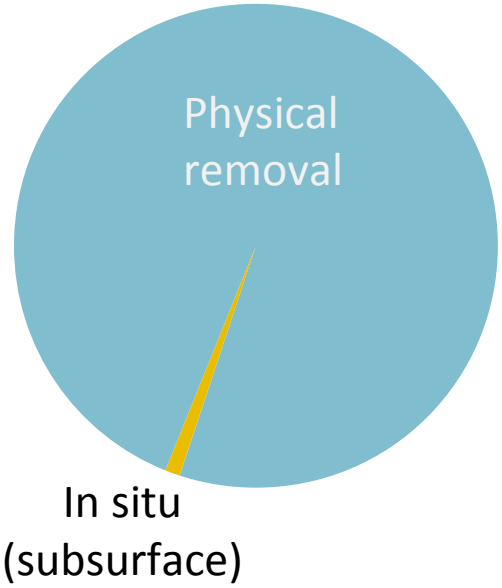
Dilbit behavior in surface water

- Initially floats
- Evaporation of diluent
- Formation of dense bitumen mass
- Downstream subsurface transport

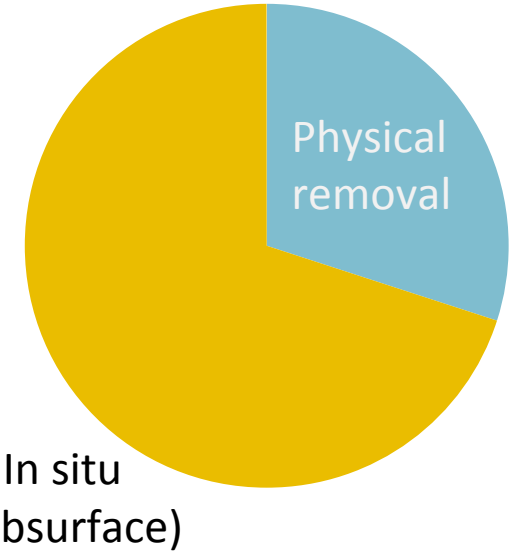


Comparative Remedial Approaches

Crude Oils, Dilbit, Syncrude



Diluent and Gas Condensates



Summary: Lessons Learned

- Crude oil, dilbit, and syncrude – ***primarily physical removal***
- Diluent and condensate – ***similar to gasoline response***
- Work site air toxics management is always an issue
  - Is monitoring gear readily available?
  - Benzene, H_2S, and LEL can control site access and may determine the pace of cleanup
  - Evacuation of the public may be required
- Prevention of migration to surface waters is a ***high priority***

Objectives Review

Describe the composition of petroleum products and regional variation in their characteristics

Identify where to get information on the composition of a particular shipment

Recognize the three primary safety concerns for anyone involved in a petroleum products release

Describe the priorities for protection of surface water and other environmental resources during incident response and recovery

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