

CANADA'S GAS RESOURCES

The Picture in 2010

Presentation to the
NATIONAL BUYER / SELLER FORUM
March 24, 2010

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Canada's Gas Resources – the Picture in 2010

- This gas resource picture is only a snapshot – because technology is rapidly making more resources available
- Most gas production to date, in Canada and world-wide, has been from “conventional” reservoir rocks, in traditional producing areas
- “Unconventional” reservoirs offer huge new potential
 - Much of this potential occurs in areas new to the oil and gas industry – which require new facilities and infrastructure

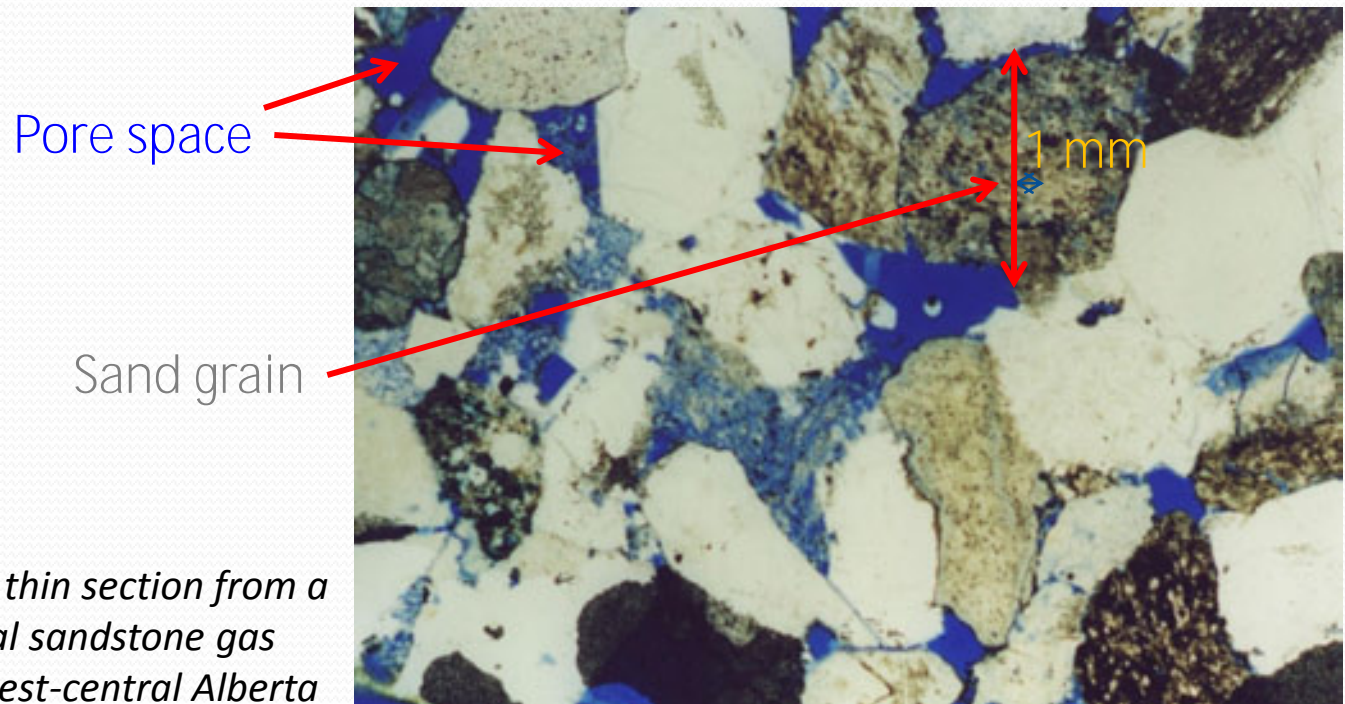


Conventional Reservoirs

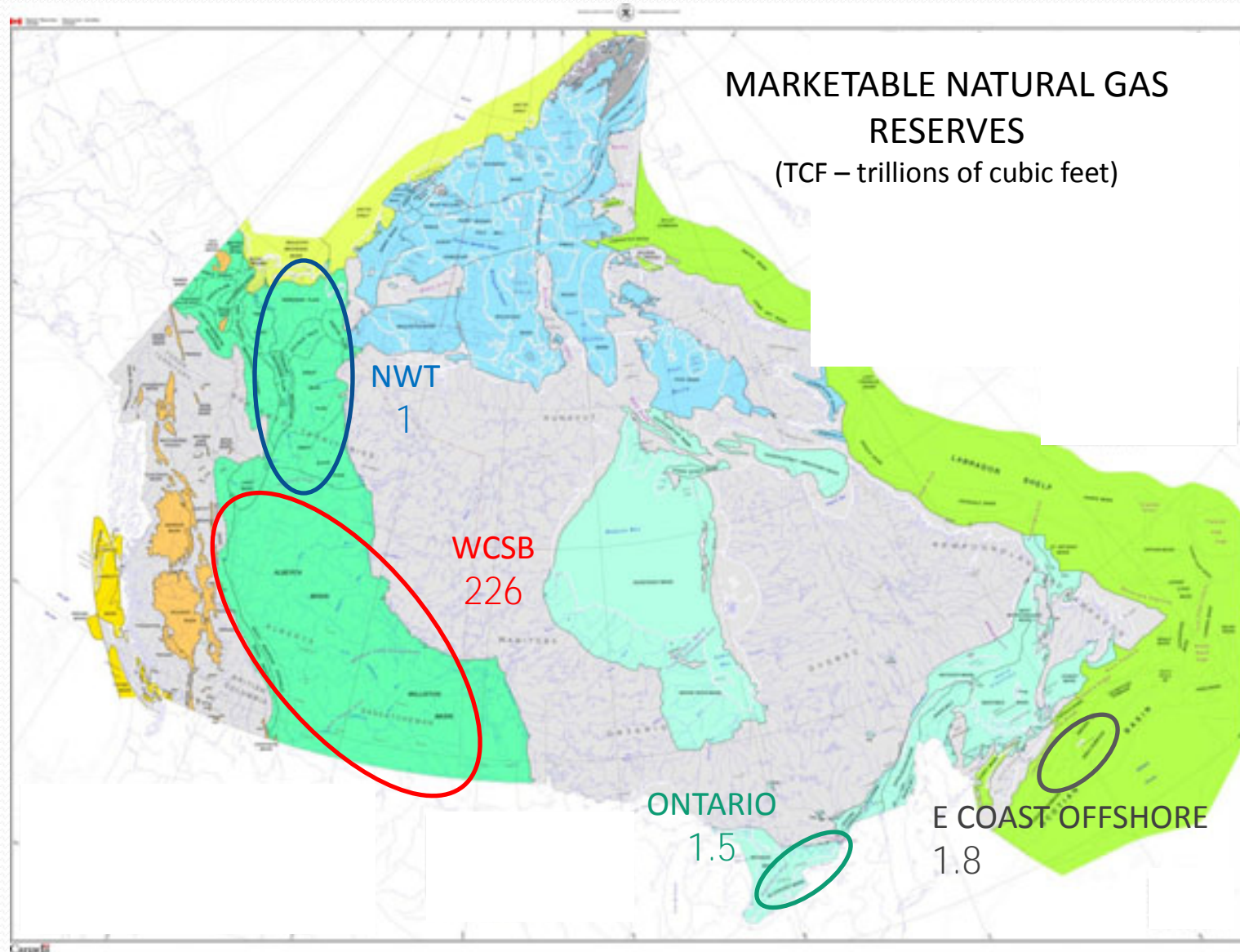


Conventional Reservoirs

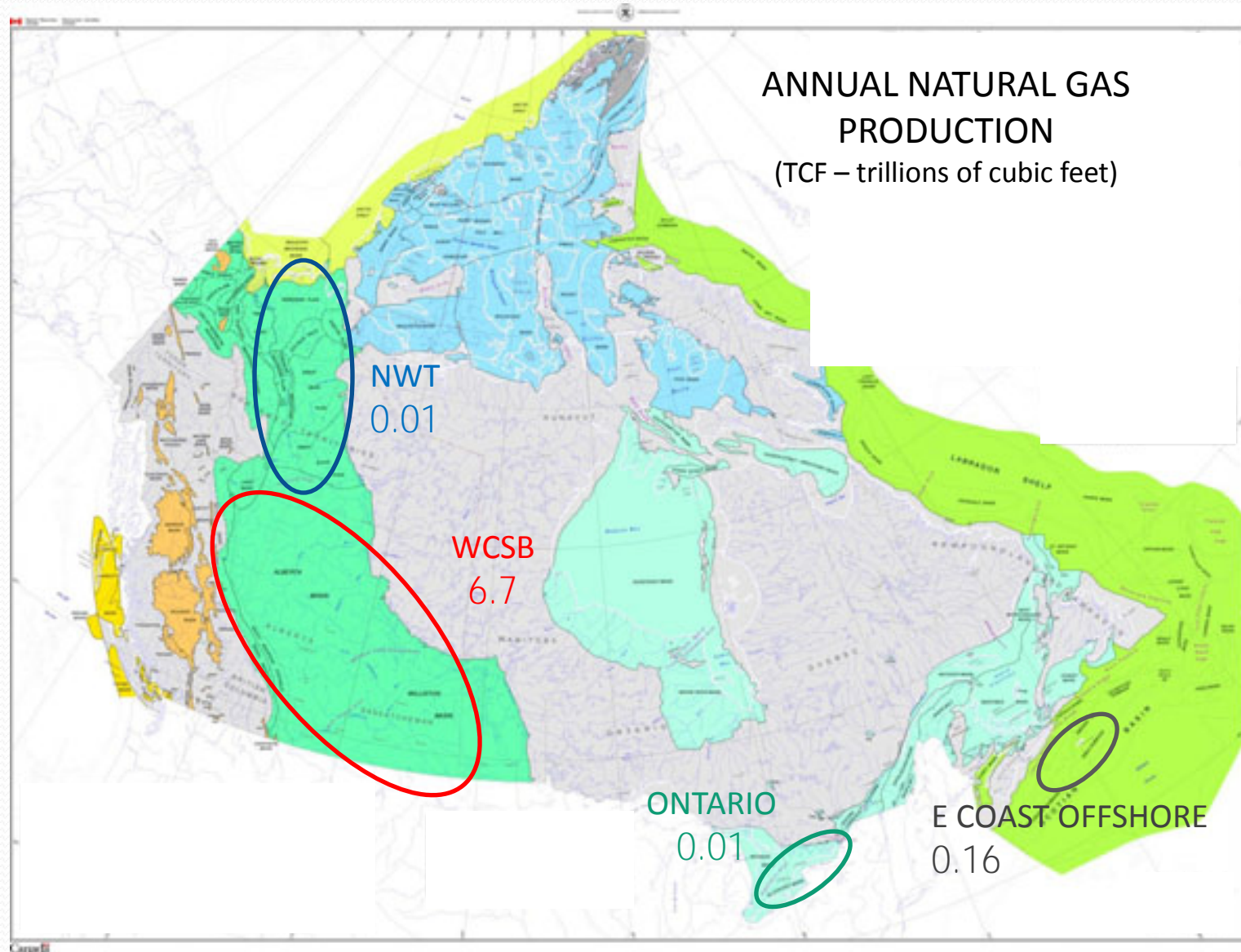
- Rocks with sufficient porosity and permeability to flow oil and gas at economic rates, from a traditional vertical well
- Conventional reservoirs have been the focus of industry until recently



Conventional Reservoirs - Reserves



Conventional Reservoirs - Production



Unconventional Reservoirs

- Three main types, and Canada has an abundance of each:
 - Tight (low permeability) gas sands
 - Recognized in late 1970's – western Alberta (Deep Basin) and NEBC
 - Intensive development began in early 2000's
 - Potential elsewhere is not well understood
 - Hot new play – **Montney** (B.C. and Alberta)
 - Coalbed methane (CBM) – gas from coal beds
 - Alberta, B.C., Nova Scotia – thick, high-rank coals
 - Intensive development in Alberta in late 1990's, but has leveled off with declining prices
 - Shale gas
 - Historical development in U.S., very intense in past 5 years
 - Prospective, but undeveloped, in many areas of Canada
 - Hot new play – **Horn River Basin** (N.E.B.C.)



Unconventional Reservoirs

Tight Gas Sands

- Nikanassin Formation
 - Low-permeability sandstone
 - Very fine-grained – small pore throats
 - Heavily cemented – silica cements
 - Solution features – stylolites
 - Brittleness causes fracturing

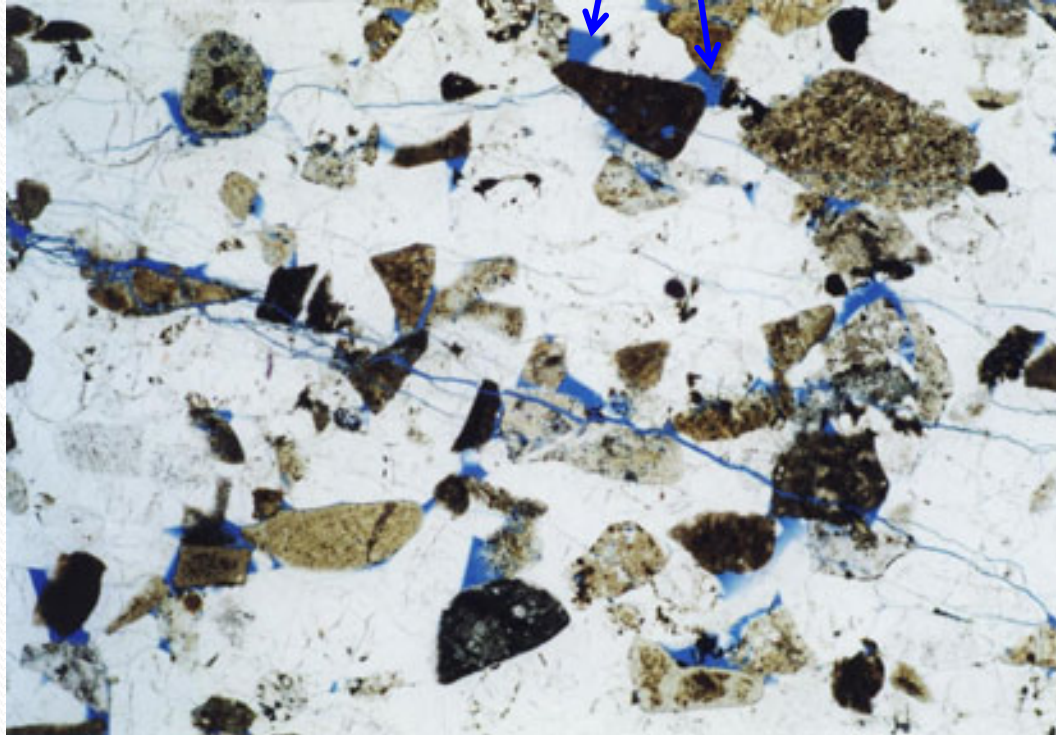


Nikanassin core sample, west-central Alberta

Unconventional Reservoirs

Tight Gas Sands

Pore spaces



- Pore spaces are small and isolated compared to conventional reservoirs
- Sand grains are tightly cemented together
- Hydraulic fracturing (frac job) generally required to establish economic gas flow rates

Microscopic thin section from a tight gas sand, west-central Alberta



Unconventional Reservoirs

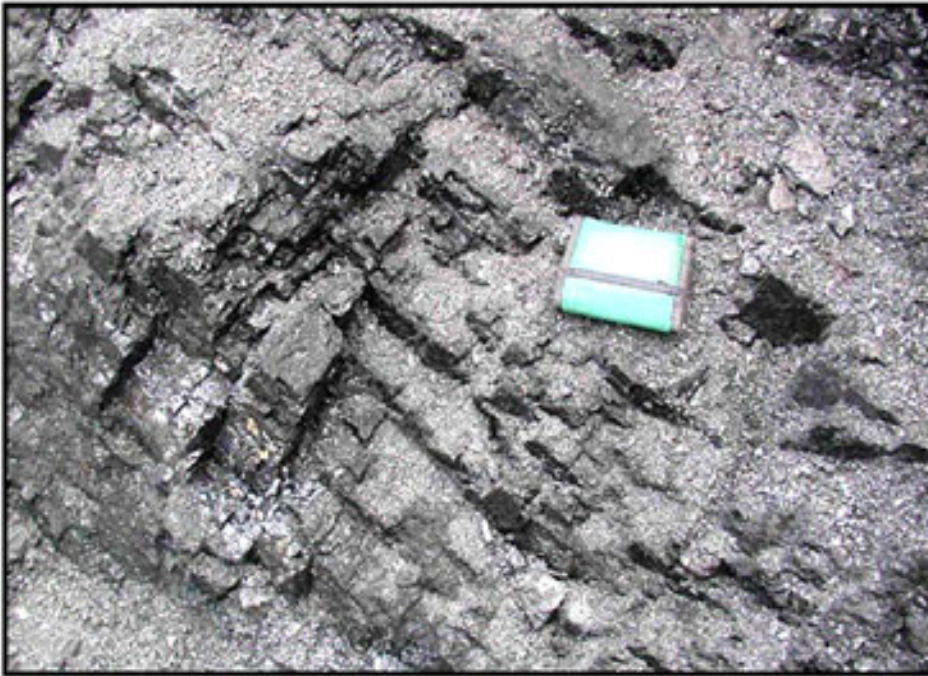
Coalbed Methane (CBM)



Surface coal mine (*Alberta EUB photo*)

Unconventional Reservoirs

Coalbed Methane (CBM)



- Gas is contained in coal seams:
 - Within matrix porosity
 - Adsorbed onto organic material
 - Within cleats (fractures)
- Many coals contain water
 - Initial production involves “de-watering” before gas will flow



Unconventional Reservoirs

Shale Gas

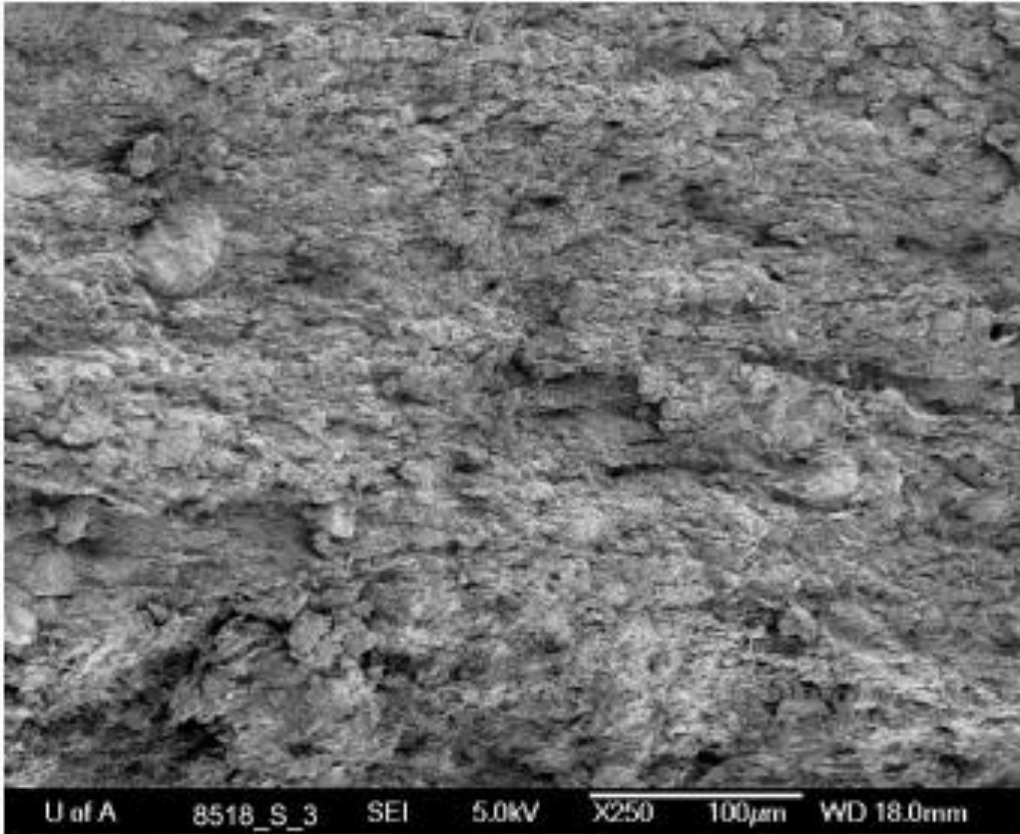


Blackstone Shale, Ram River Falls

Unconventional Reservoirs

Shale Gas

Alberta Geological Survey



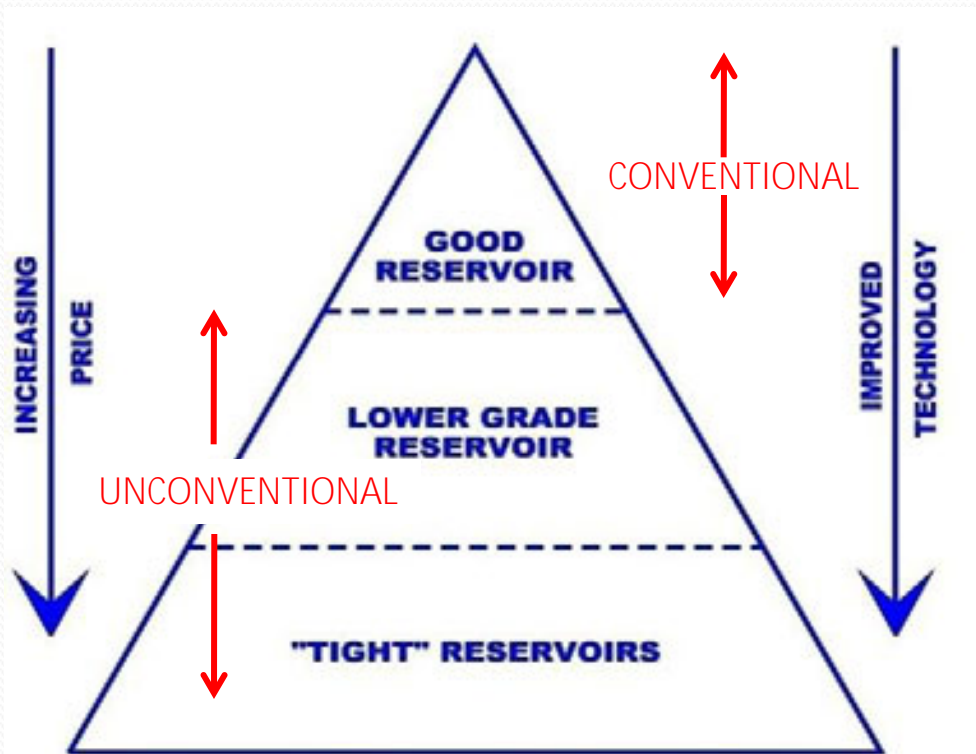
*Scanning Electron Microscope image,
shale gas reservoir*

- Shales consist largely of very fine clay minerals, with very small, poorly-connected pore spaces
- Gas will not flow without special treatment to increase permeability
 - optimal treatments must be developed for each shale gas reservoir, as each is unique
- We do not fully understand how gas is contained in shales, or how to evaluate and measure it



Distribution of Canadian Gas Resources

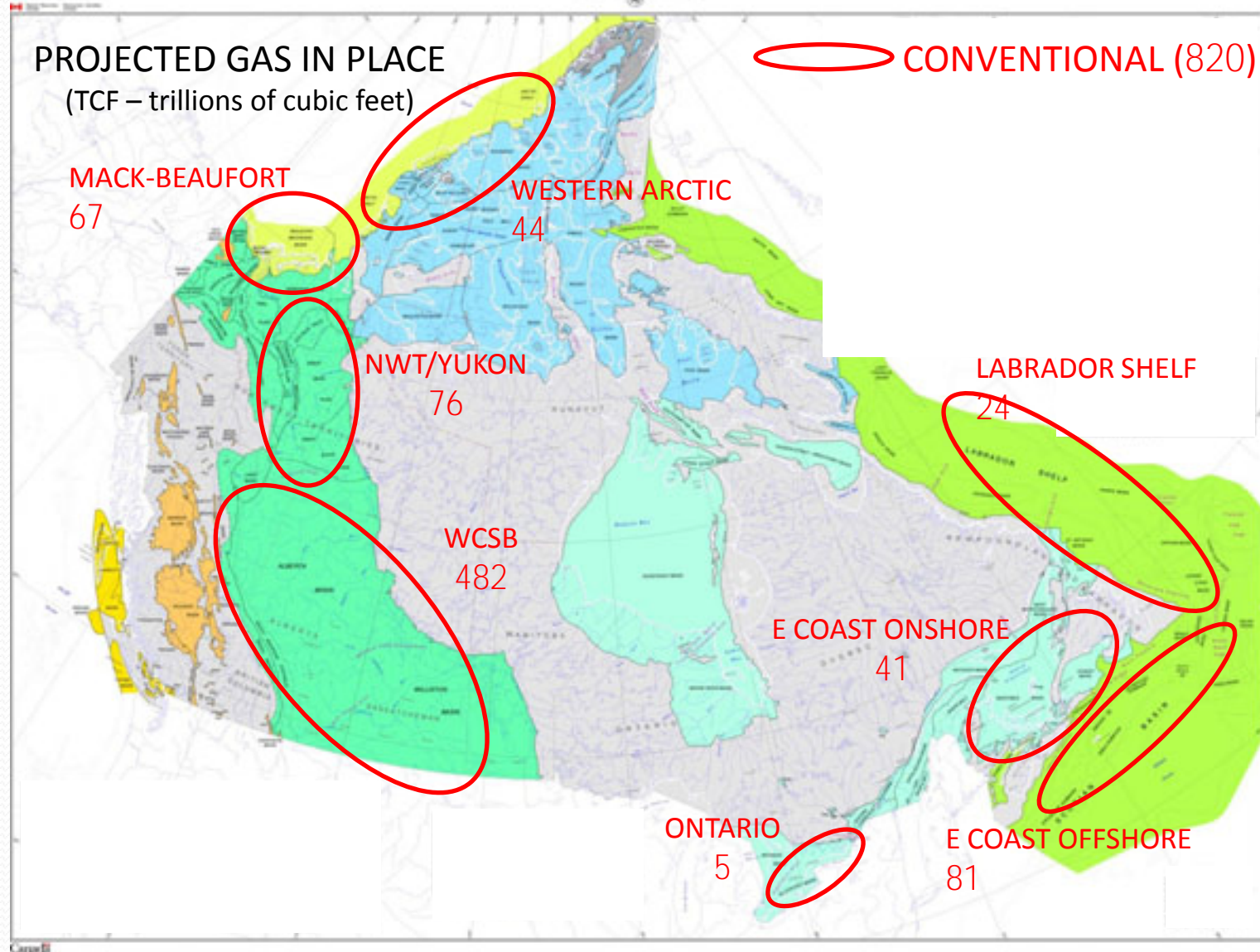
RESOURCE TRIANGLE



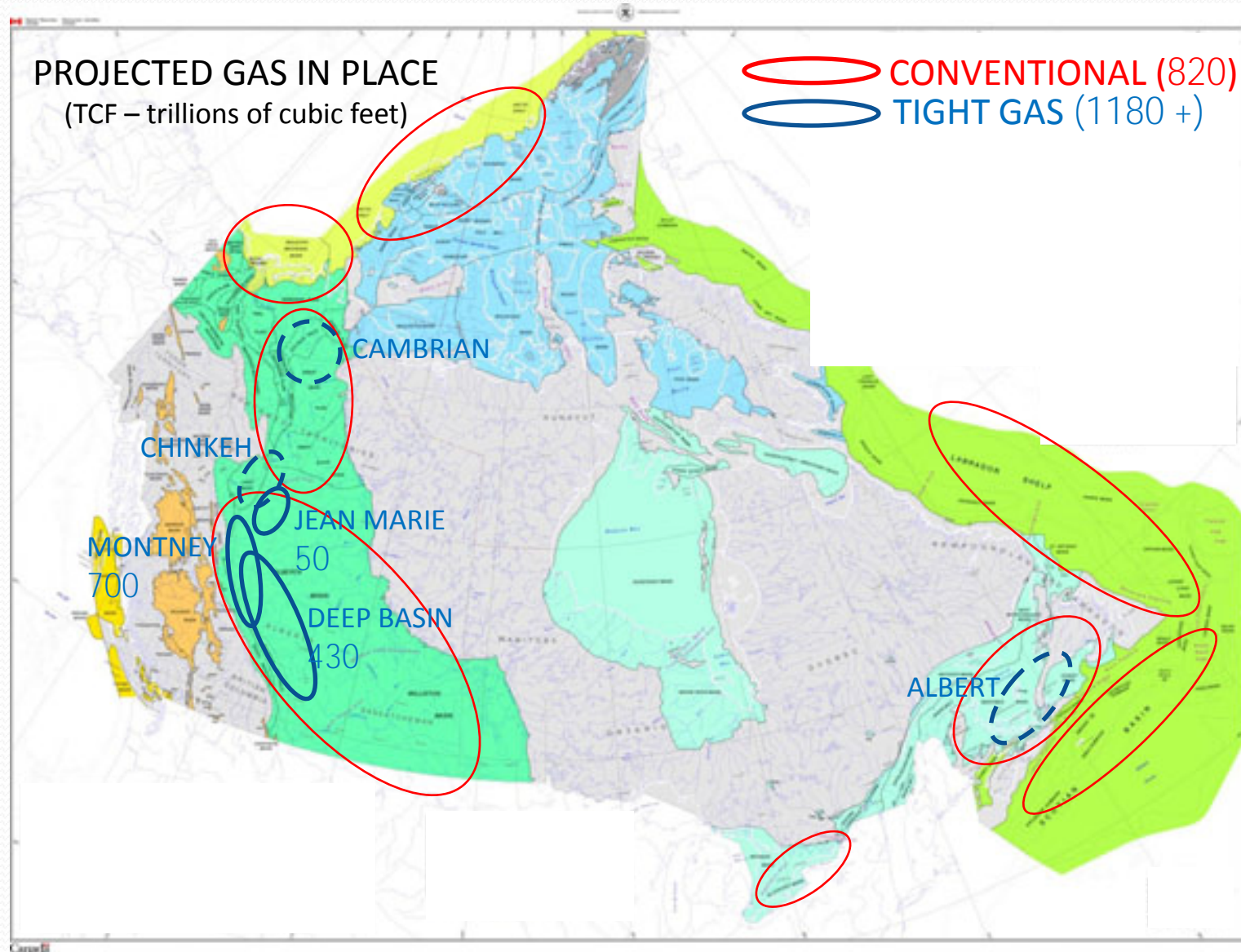
- Exploitation of conventional gas resources has allowed us to access only the upper apex of the “Resource Triangle”
- Economic access to unconventional gas resources will greatly increase the total volume of available gas resource



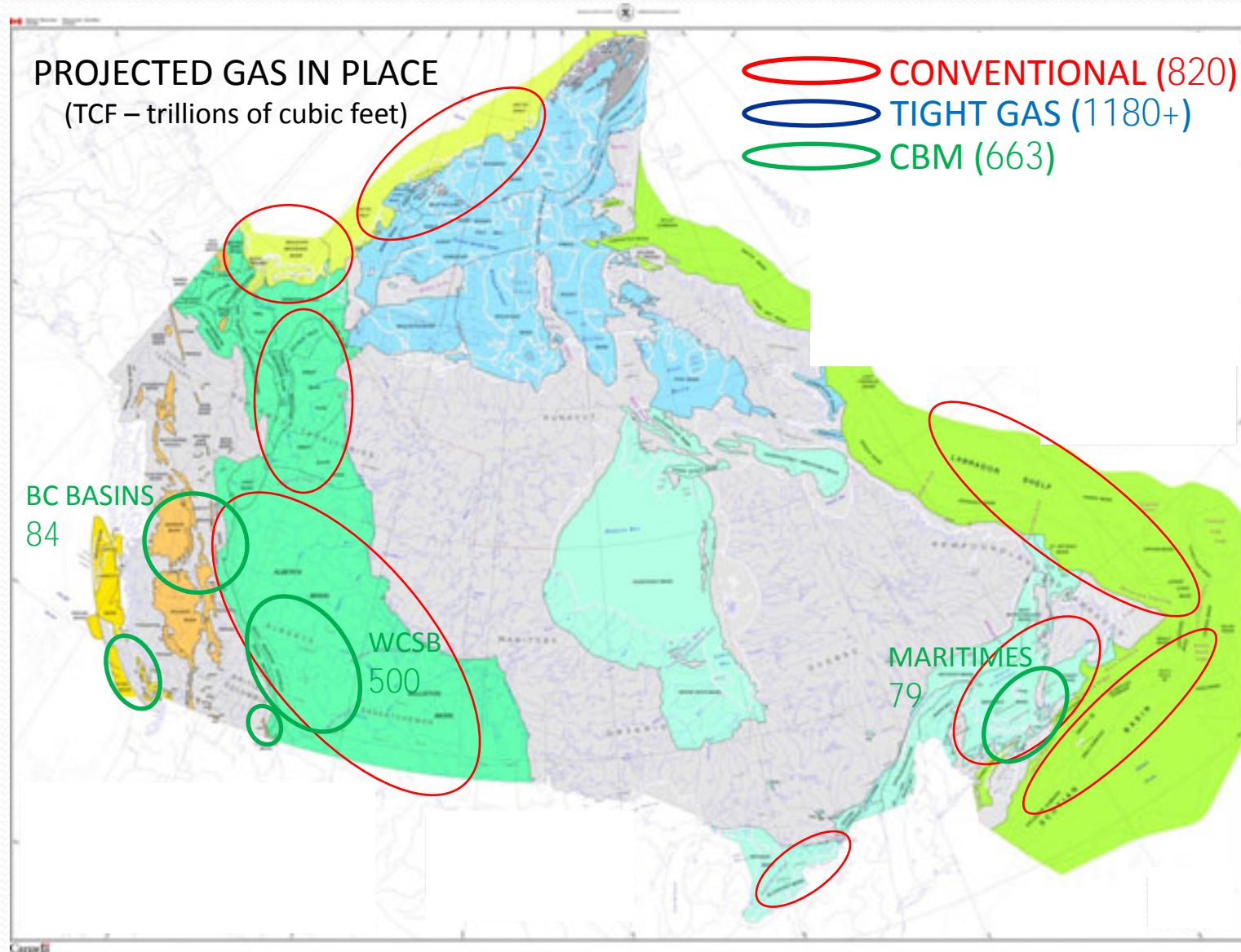
Distribution of Gas Resources



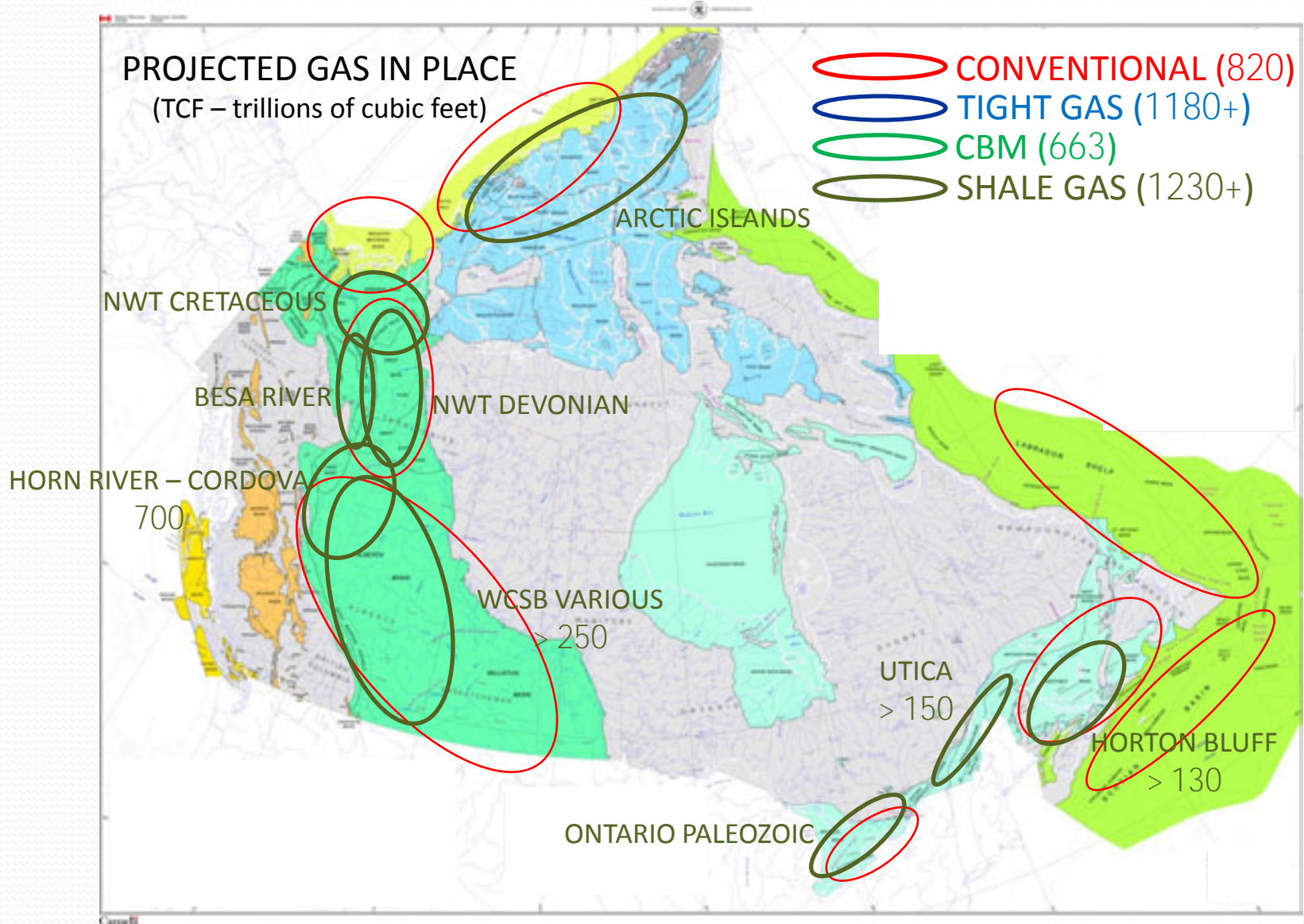
Distribution of Gas Resources



Distribution of Gas Resources



Distribution of Gas Resources

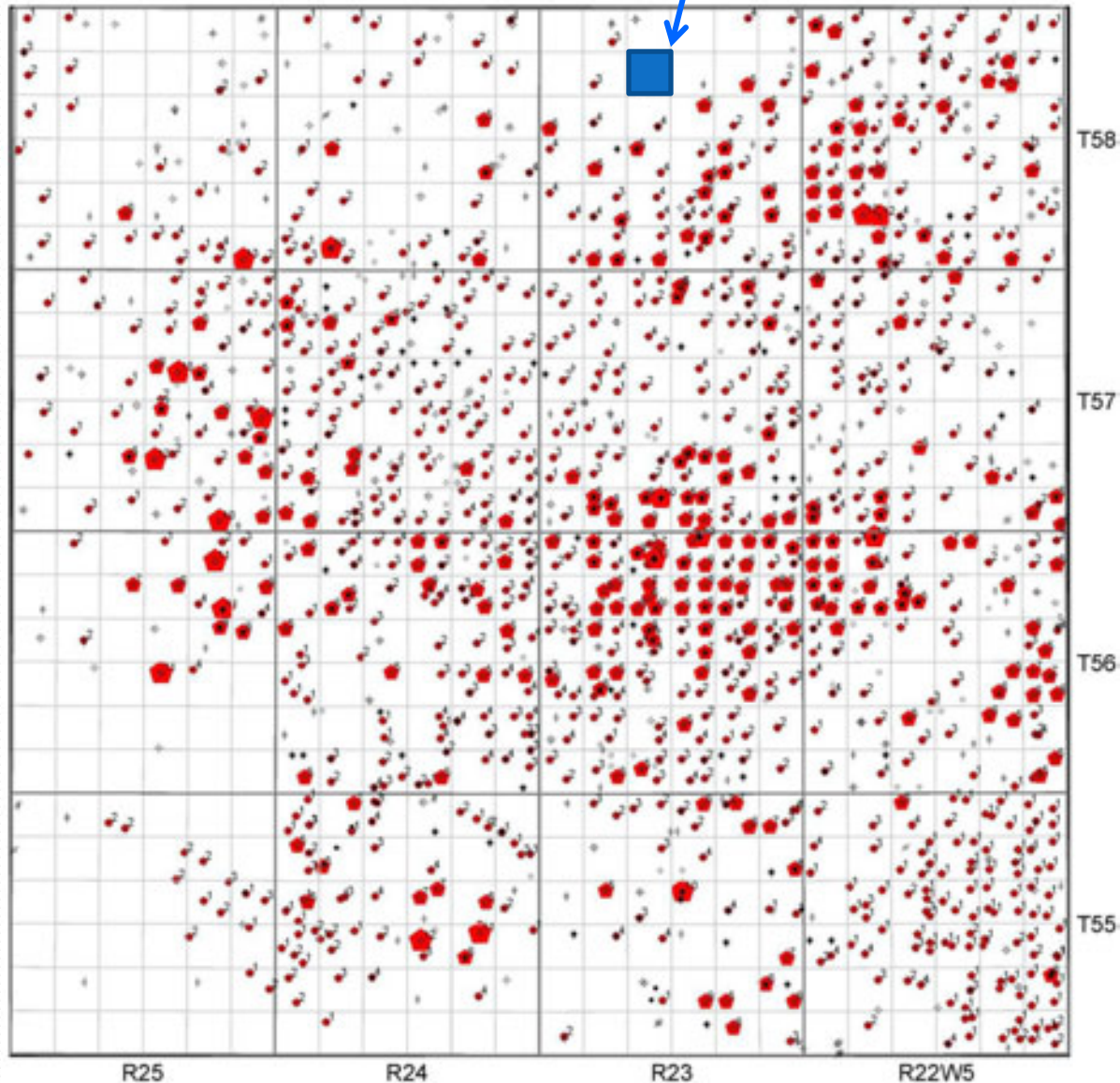


Gas Development Strategies

- Conventional gas reservoirs are typically developed by drilling one well every square mile (one well/section)
 - Reflects high permeability – gas can flow a long way to the wellbore
- Unconventional gas reservoirs have lower permeability
 - Well spacing must be closer (denser) for adequate drainage
 - Multiple zones may be commingled
 - Horizontal wells can contact more reservoir area
 - Hydraulic fracture stimulation (fracs) needed in both vertical and horizontal wells to enhance permeability



1 section = 1 mi²



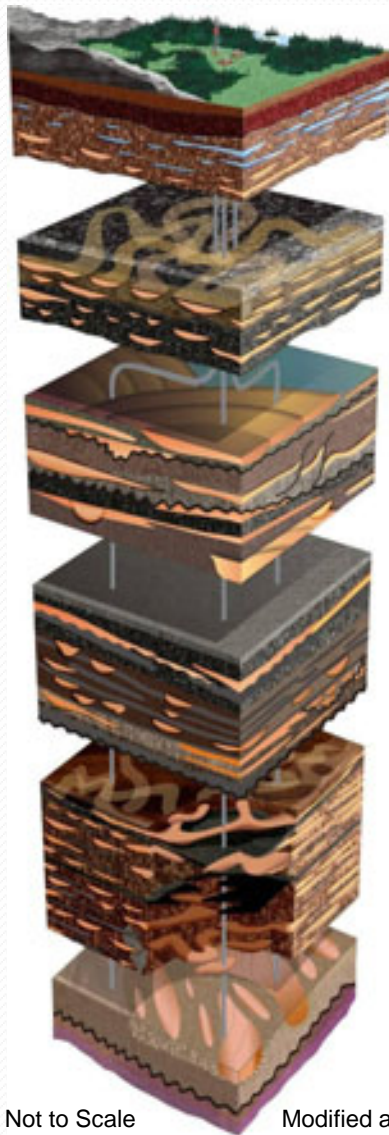
Gas Development Strategies

Conventional

- 1 well/section

Tight Gas (Alberta Deep Basin)

- Downspacing to 4-6 wells/section
- Commingling up to 12 zones / well



Tertiary
Scollard

Wapiti
Belly River
Chinook

Cardium
Dunvegan

Paddy
Cadotte
Harmon
Notikewin
Falher
Wilrich

Gething

Cadomin
Nikanassin
Triassic

3900m

Gas Development Strategies (Tight Gas – Alberta Deep Basin)

- Systematic commingling of multiple tight gas reservoirs in a single wellbore
- Each zone contributes to deliverability and reserves
 - few would be economic on their own

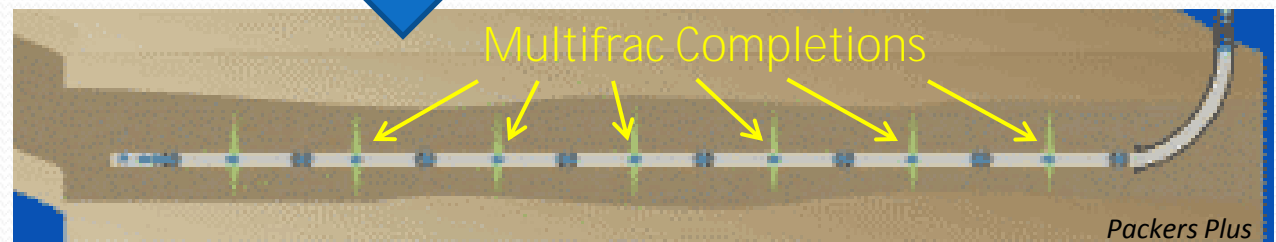
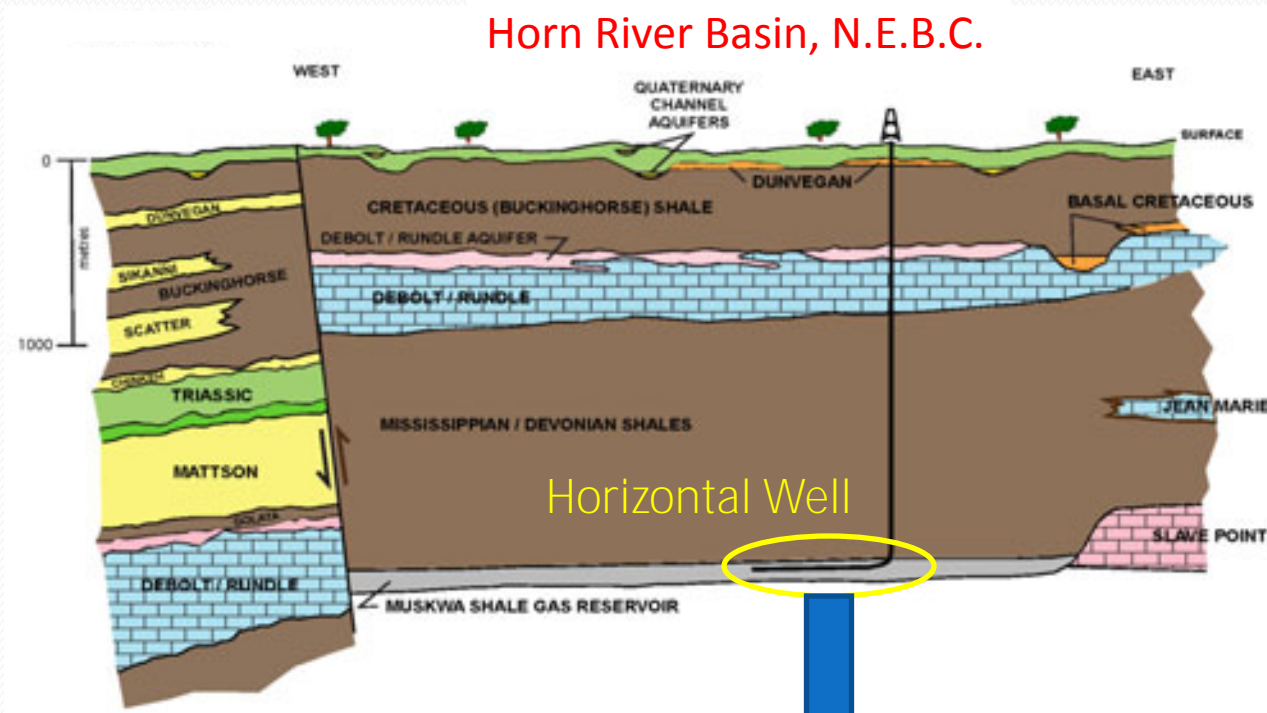
Note: Not to Scale

Modified after Leroux 2004, 2006



Gas Development Strategies – Horizontal Drilling

Horn River Basin, N.E.B.C.



How does Canada's Evolving Gas Resource Picture Impact Future Development Activity ?

- Most of today's gas production is from conventional reservoirs in traditional producing areas – especially WCSB
 - Limited scope for additional development
 - Most new wells will feed existing infrastructure
- Most of Canada's future gas resources are unconventional
 - Technological advances have made unconventional gas reservoirs economically accessible
 - Future production will come increasingly from unconventional reservoirs



How does Canada's Evolving Gas Resource Picture Impact Future Development Activity ?

- Unconventional gas coming on stream now is in or near traditional producing basins
 - New regional facilities and pipelines will be required to service new unconventional play areas
 - Example – Horn River Basin shale gas
 - Cabin gas plant
 - New and expanded pipelines into Fort Nelson area
- Future unconventional gas developments will require processing facilities and gathering systems in new areas
 - Utica Shale (Quebec)
 - Horton Bluff (New Brunswick)



How does Canada's Evolving Gas Resource Picture Impact Future Development Activity ?

- Intensity of unconventional gas development will require a lot of equipment and material
 - Downspacing – a lot more wells
 - Horizontal drilling – prolonged and intensive drillings ops
 - Some Horn River Basin rigs on a pad for up to 1 year
 - Large frac jobs – water, chemicals, proppant
 - Issues regarding water supply and disposal – e.g., Horn River Basin
- Sheer volume of unconventional gas coming onstream, both in Canada and the U.S., will change market dynamics
 - Alternative marketing – e.g., LNG exports from Kitimat



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