THE DEEP BASIN DEVELOPMENT ENTITY:

ENHANCING EXPLOITATION OF ALBERTA'S DEEP BASIN TIGHT GAS RESOURCE

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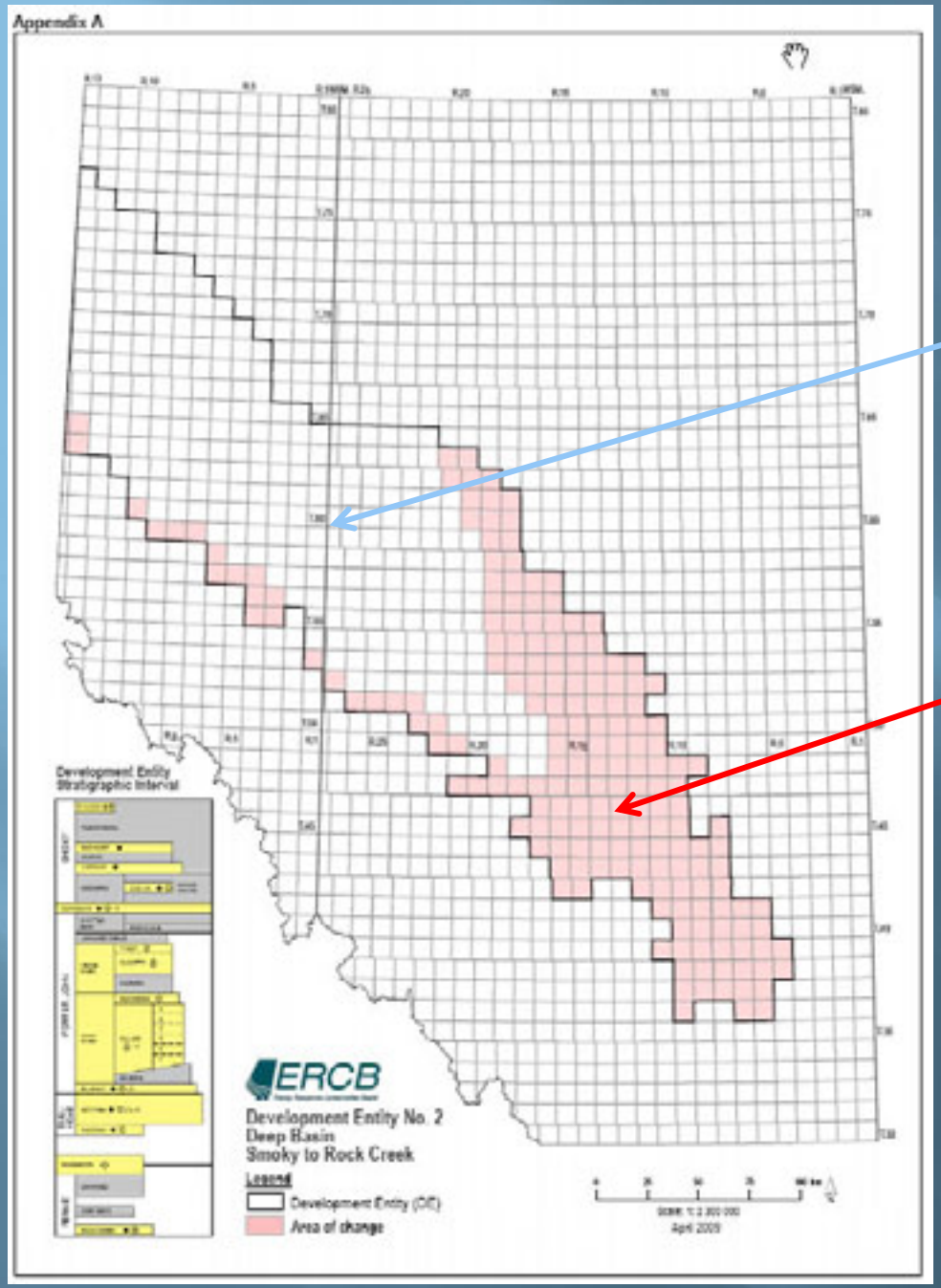
DEEP BASIN DEVELOPMENT ENTITY (DE #2) OVERVIEW

- DE #2 is an area designated by the ERCB, within which special drilling/completion/testing regulations promote efficient and economic gas development
- Facilitates commingling of multiple stacked sands
  - Primary targets: Cardium, Dunvegan, Notikewin, Falher, Bluesky, Gething, Cadomin, Nikanassin, Rock Creek
- Reduces regulatory requirements for drilling and completion programs
  - No requirement for individual pressure and flow tests for each completed interval
  - Marginal zones can be completed cheaply



DE #2 OVERVIEW

Original DE #2 (2006)

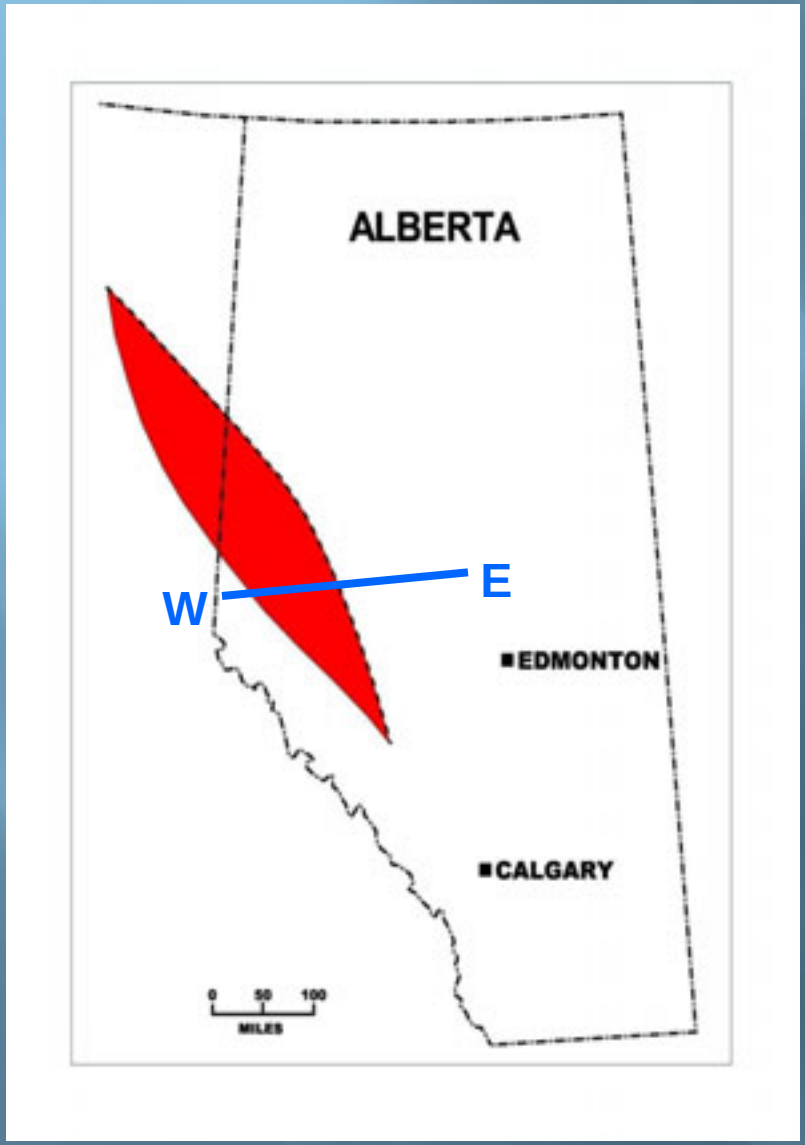
- 275 townships
- southeastern corner 48-17W5

Expansion Area (2009)

- 189 townships
- southeastern corner 36-3W5

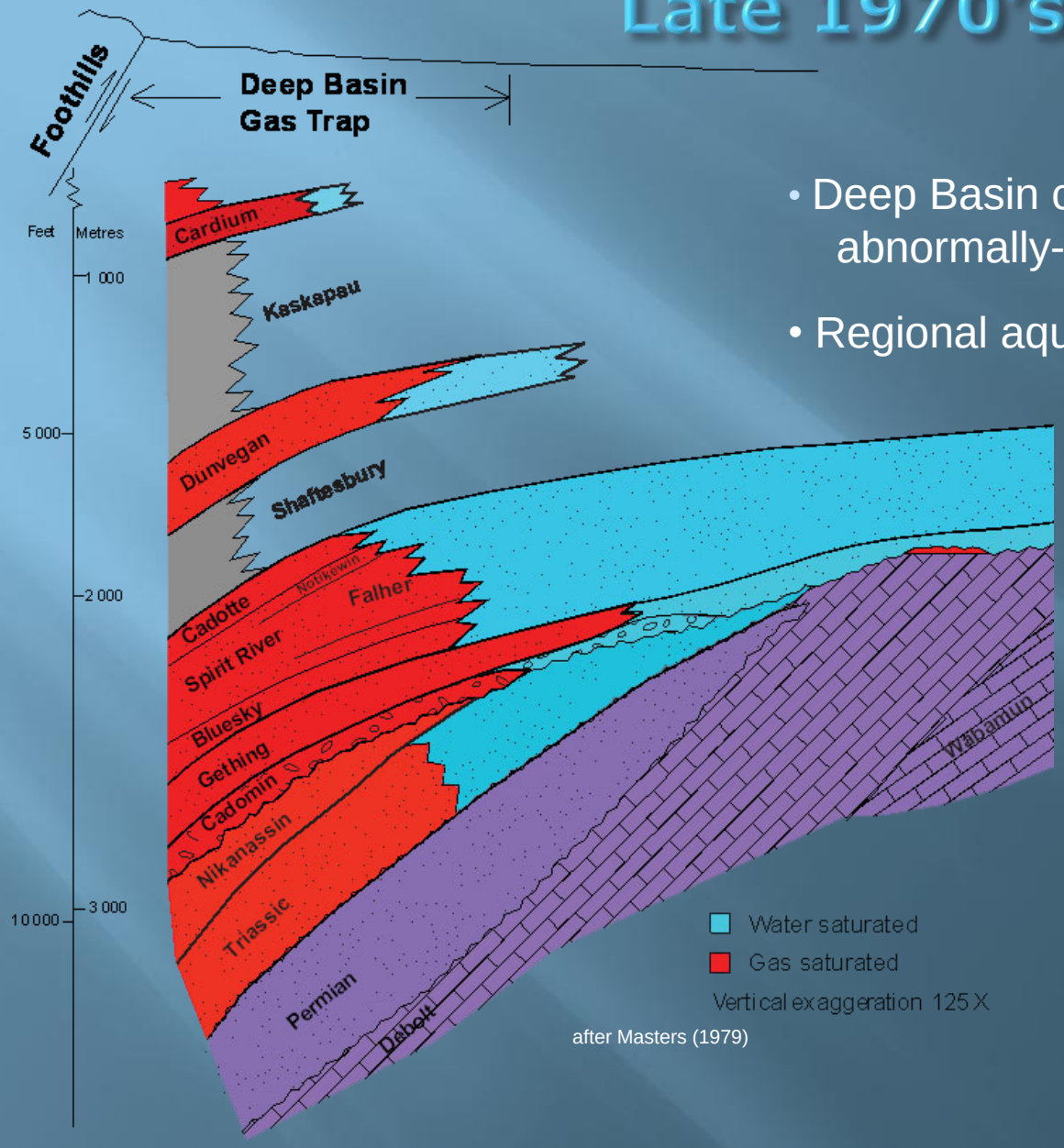
Creation of DE #2 in 2006 and its expansion in 2009 are addressed in this presentation

DEEP BASIN ORIGINS
Late 1970's



Masters (1979) first recognized the WCSB Deep Basin

DEEP BASIN ORIGINS
Late 1970's



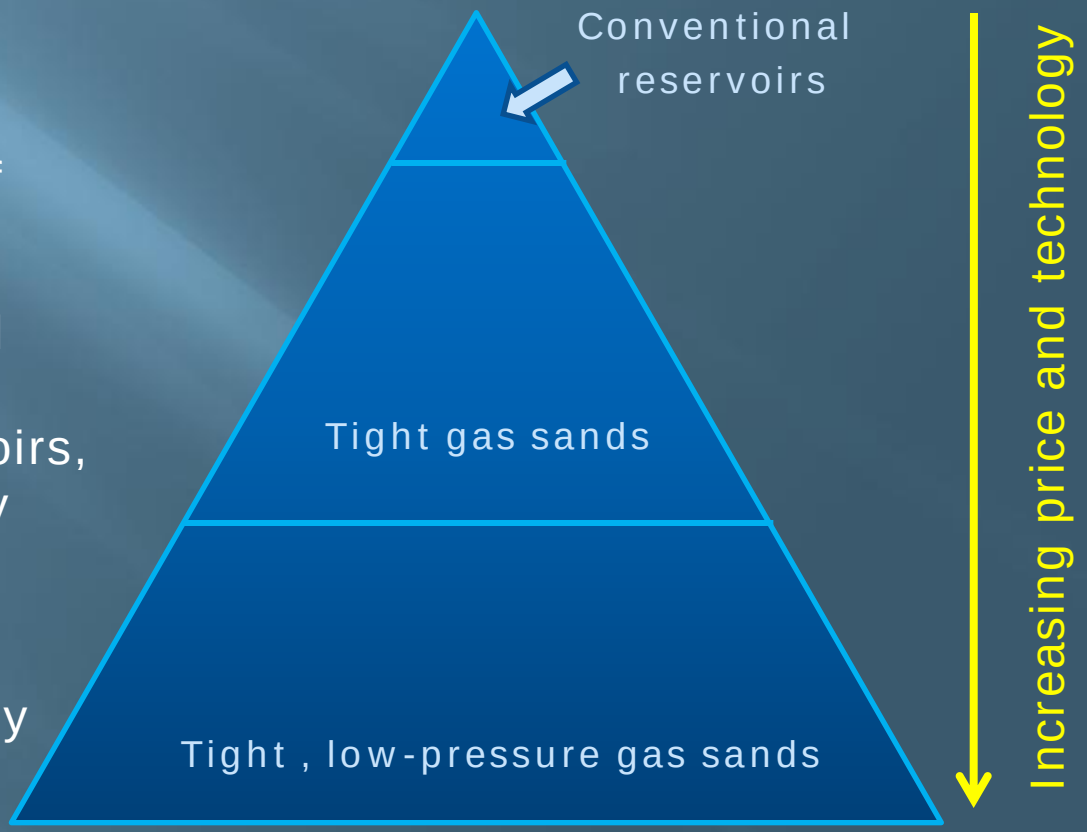
after Masters (1979)

- Deep Basin characterized by gas-saturated, abnormally-pressured reservoirs
- Regional aquifers occur updip in each unit

DEEP BASIN ORIGINS
Late 1970's

Deep Basin Resource Triangle
(Masters, 1979)

- Estimated total gas resource of 440 TCF
- Only a small proportion of total gas resource is in "good" (conventional-quality) reservoirs, accessible to 1979 technology
- Technological advances, higher prices needed to make lower-quality reservoirs economically accessible



DEEP BASIN EXPLOITATION HISTORY 1970's – 1990's

- Systematic exploration for stratigraphic "sweet spots"
  - Conventional reservoir quality
  - Limited resource potential (<10 TCF)
  - Little access to tight gas resource

Cadotte foreshore conglomerate
Φ 9%+ , K up to 500 mD

DEEP BASIN EXPLOITATION HISTORY 2002 – Present

- "Resource play" approach, single target
  - Continuous, mappable, lower-quality reservoirs exploited more efficiently
    - Enhanced drilling and completions technology
      - Vertical and horizontal wells
    - Economies of scale – access, operations, facilities
  - e.g., Cadomin Formation, Cutbank Ridge

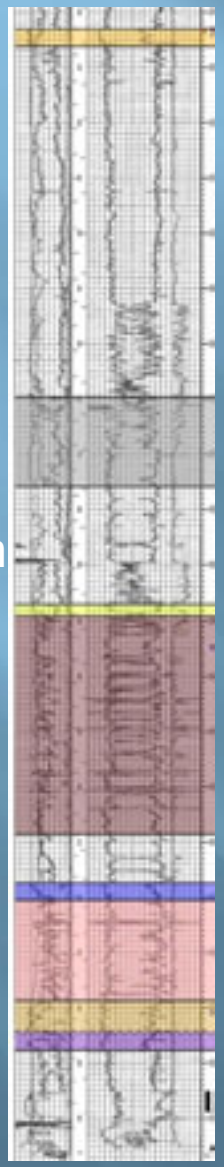
x Conventional spacing

x Resource Play Development wells

DEEP BASIN EXPLOITATION HISTORY 2003 – Present

- Systematic commingling of multiple gas reservoirs in single wellbores
  - Stimulation and tie-in of stacked low-quality reservoirs, many of which would be uneconomic as single-zone producers
  - High resource density (BCF/section) and small drainage areas support downspacing
  - Focus on areas with multiple productive intervals, each demonstrating potential for modest deliverability and reserves
    - Not an exercise in defining single-zone "prospects" with conventional reservoir quality

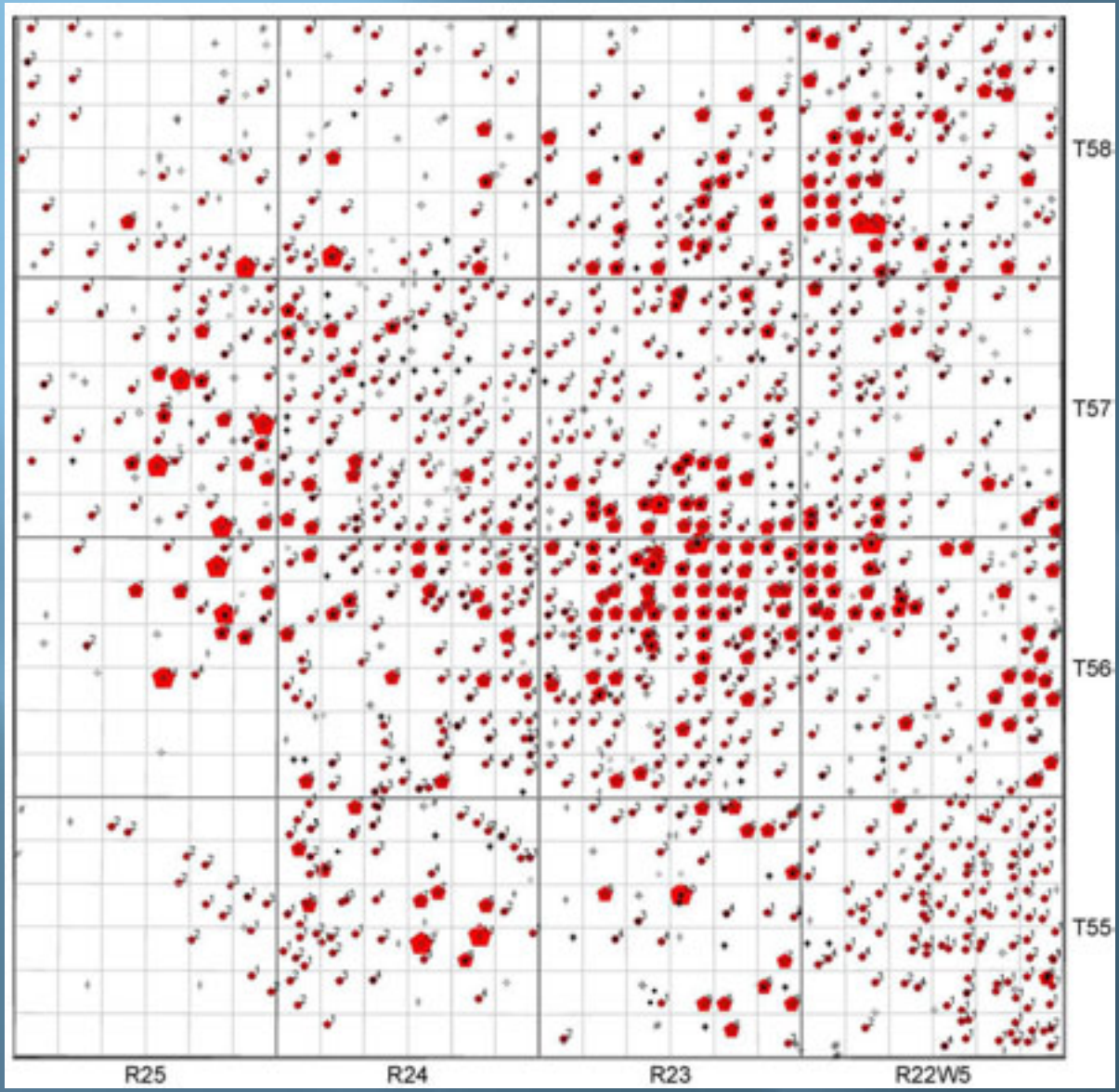
DEEP BASIN EXPLOITATION HISTORY
2003 – Present



Systematic commingling of multiple gas reservoirs

- West-central Alberta commingling targets

DEEP BASIN EXPLOITATION HISTORY
2003 – Present



Systematic commingling of multiple gas reservoirs

- Wild River area
  - bubble map shows number of completions
  - 2-13 zones commingled
  - downspacing to 4(+) wells per section

DEEP BASIN EXPLOITATION HISTORY 2005 – 2006

- PROBLEM – Regulatory requirements hinder efficient application of resource play and commingling technologies
  - Producers required to make application for individual acreage blocks
  - Collecting flow and pressure data in each producing zone adds time and expense to operations
- SOLUTION – the Development Entity

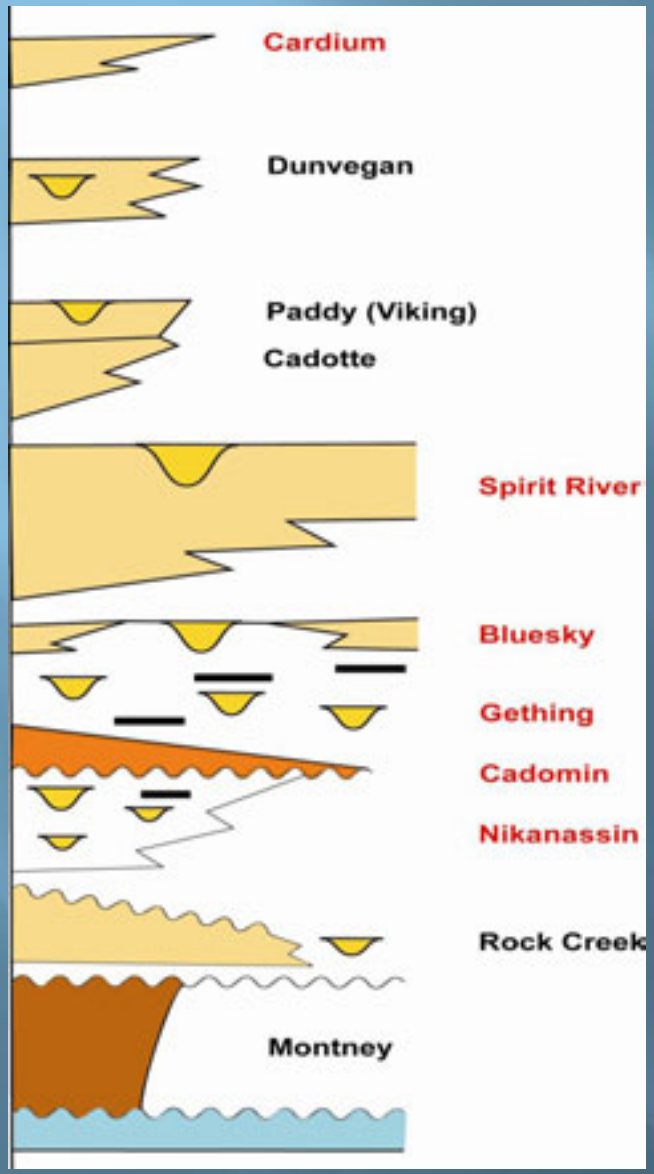
THE DEVELOPMENT ENTITY CONCEPT

- "A Development Entity (DE) is an entity consisting of multiple formations in a specific area described in an order of the ERCB, from which gas may be produced without segregation in the wellbore subject to certain criteria specified in section 3.051 of the Oil and Gas Conservation Act" (ERCB)

DEEP BASIN DEVELOPMENT ENTITY (DE #2) CONCEPT AND CREATION (2006)

- ERCB and industry agreed that characteristics of the Deep Basin support designation of a Development Entity
  - Continuous gas, little risk of water / oil / sour gas
  - Many similar wells; not essential to gather full dataset in each
- Mapping required to establish eligible zones and DE #2 boundaries
- Calculation of in-place gas resource required to ensure that the "size of the prize" would justify undertaking the DE process
- Joint Industry and ERCB working group established
  - Petrel Robertson mapping study commissioned

DEEP BASIN DEVELOPMENT ENTITY (DE #2) STRATIGRAPHIC COLUMN



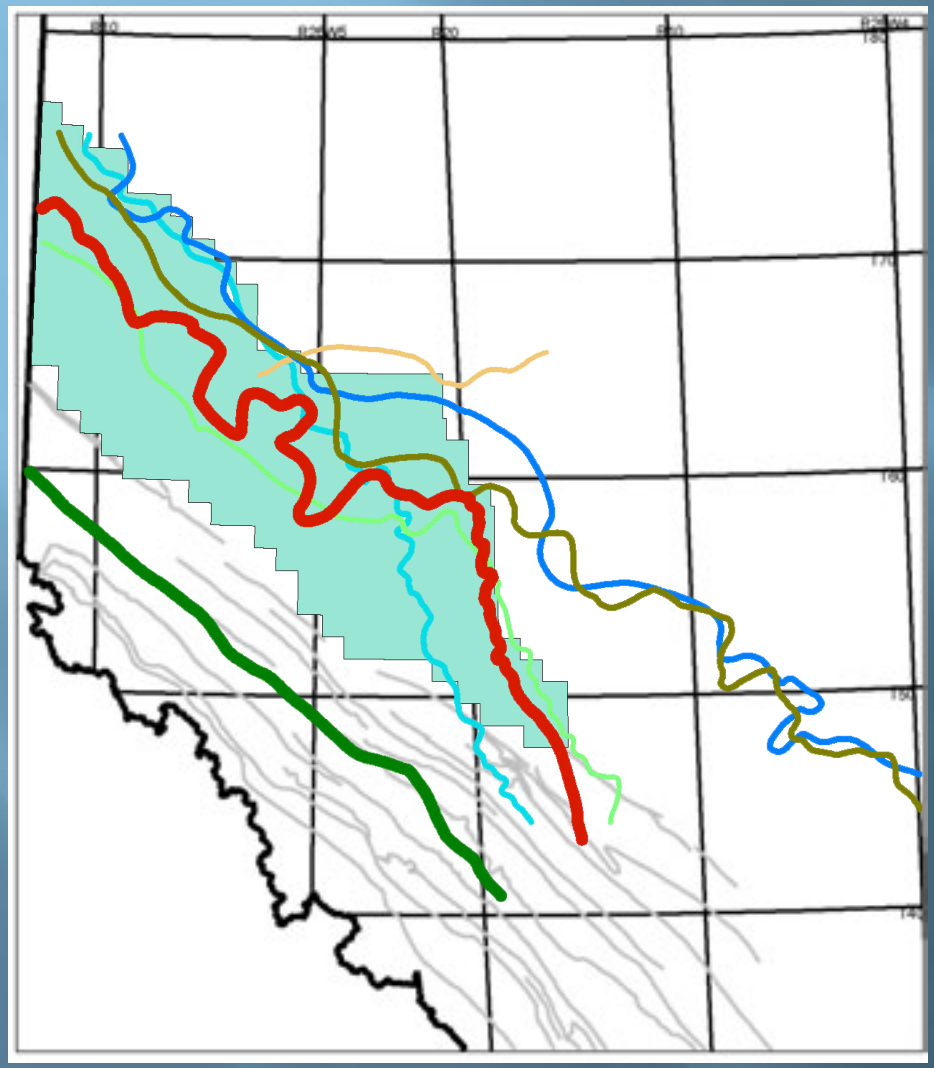
- Deep Basin reservoirs from Nikanassin to Cardium

Reservoirs used in defining DE #2 boundaries

DEEP BASIN DEVELOPMENT ENTITY
DRAWING THE DE #2 OUTLINE

- Eastern limit – composite of updip Deep Basin edges of individual reservoir units
  - Cadomin edge most critical – proven Deep Basin producer
- Western limit – major Foothills thrust faults that could breach Deep Basin pressure and fluid regimes
  - Used easternmost significant fault traces mapped at surface
- Well control
  - ERCB requires at least 3-4 gas tests in each township to be included in DE #2

DEEP BASIN DEVELOPMENT ENTITY
DRAWING THE DE #2 OUTLINE



1. Cadomin DB edge
2. DB edges, other reservoirs
3. Eastern edge Foothills
4. DE #2 (2006)

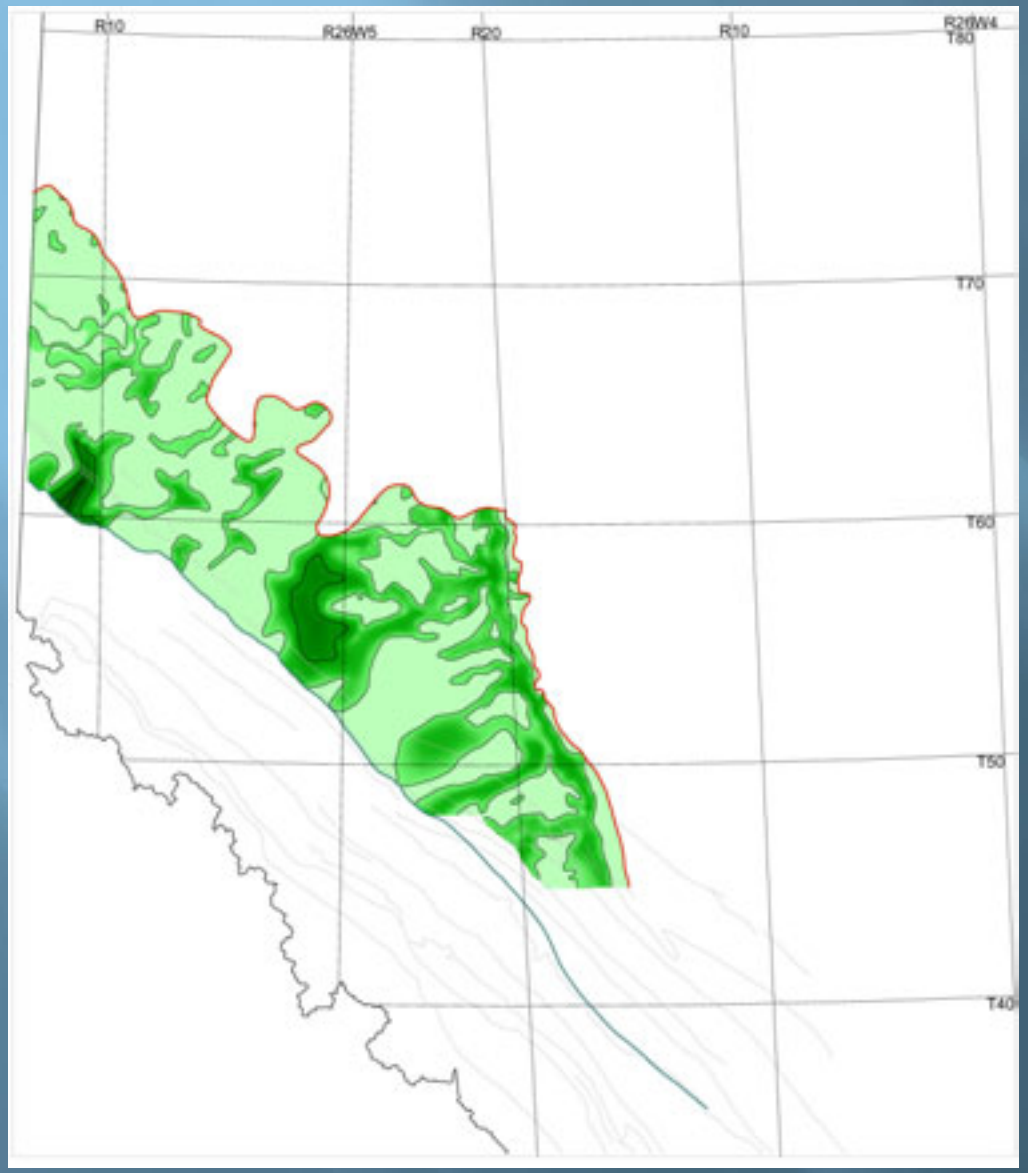
DEEP BASIN DEVELOPMENT ENTITY
GAS RESOURCE MAPPING

- Calculation of in-place gas resource was required to ensure that the "size of the prize" would justify creating the Development Entity
- Seven reservoirs with largest in-place gas volumes
  - Nikanassin
  - Cadomin
  - Gething
  - Bluesky
  - Spirit River
  - Cadotte
  - Cardium

DEEP BASIN DEVELOPMENT ENTITY
GAS RESOURCE MAPPING

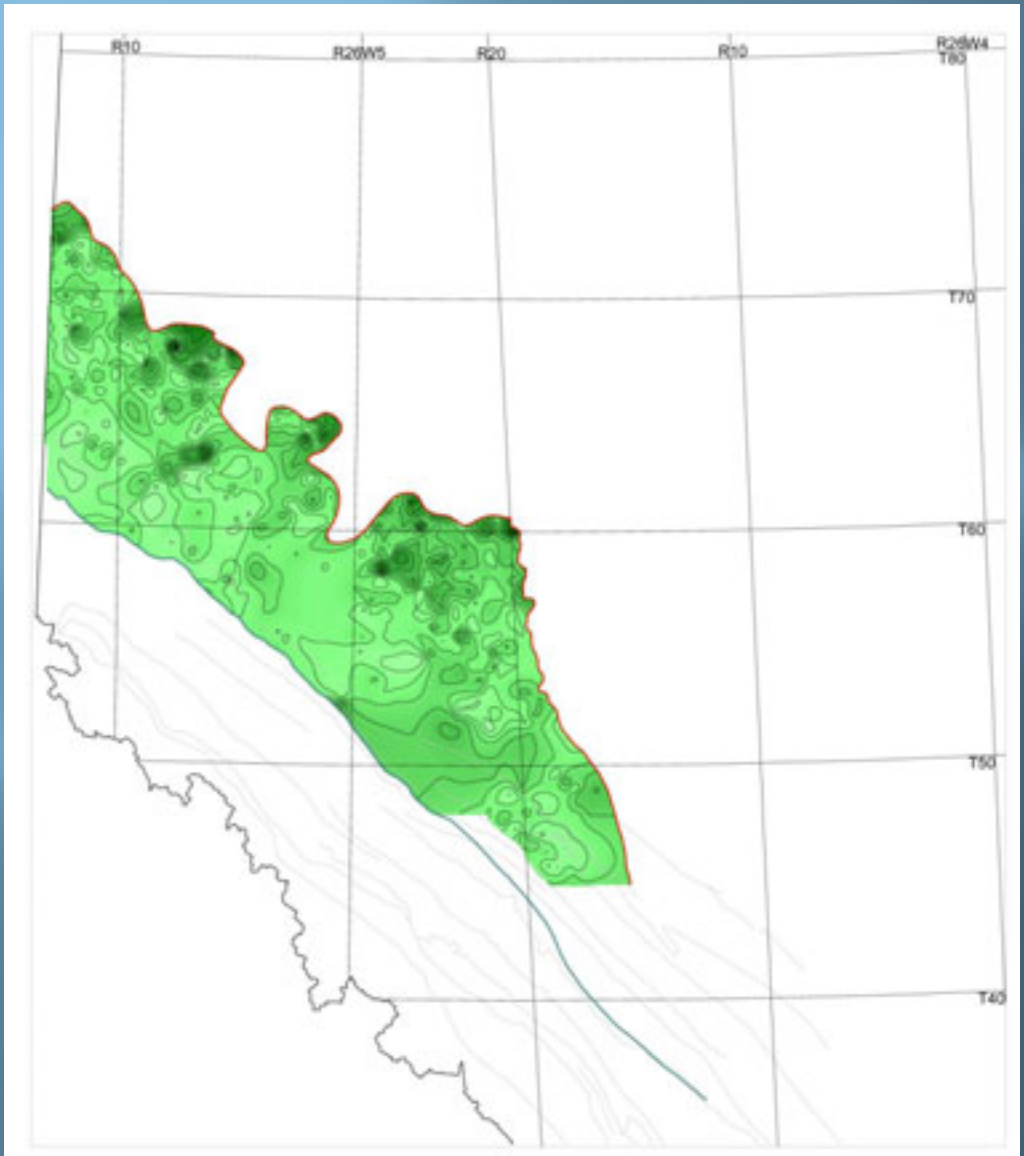
- Map each reservoir using four wells per township (where available)
  - Twp. 45-75, from Foothills margin east to Deep Basin edge
  - Gross isopach, net porous sand, average porosity picked on logs
  - Gas saturation, formation pressure, temperature, Z factor mapped from ERCB pool data
- Each variable contoured and gridded in GeoGraphix
- Grids combined to produce "resource density" map, expressed as BCF/section
- Total gas resource calculated for proposed DBDE
- EXAMPLE – Cadomin Formation

CADOMIN GAS RESOURCE MAPPING
1. NET POROUS SAND ISOPACH



1. Net porous isopach values picked on logs
   - Cadomin cutoff 3% Φ
   - Hand contoured and digitized (0 - 45 m)

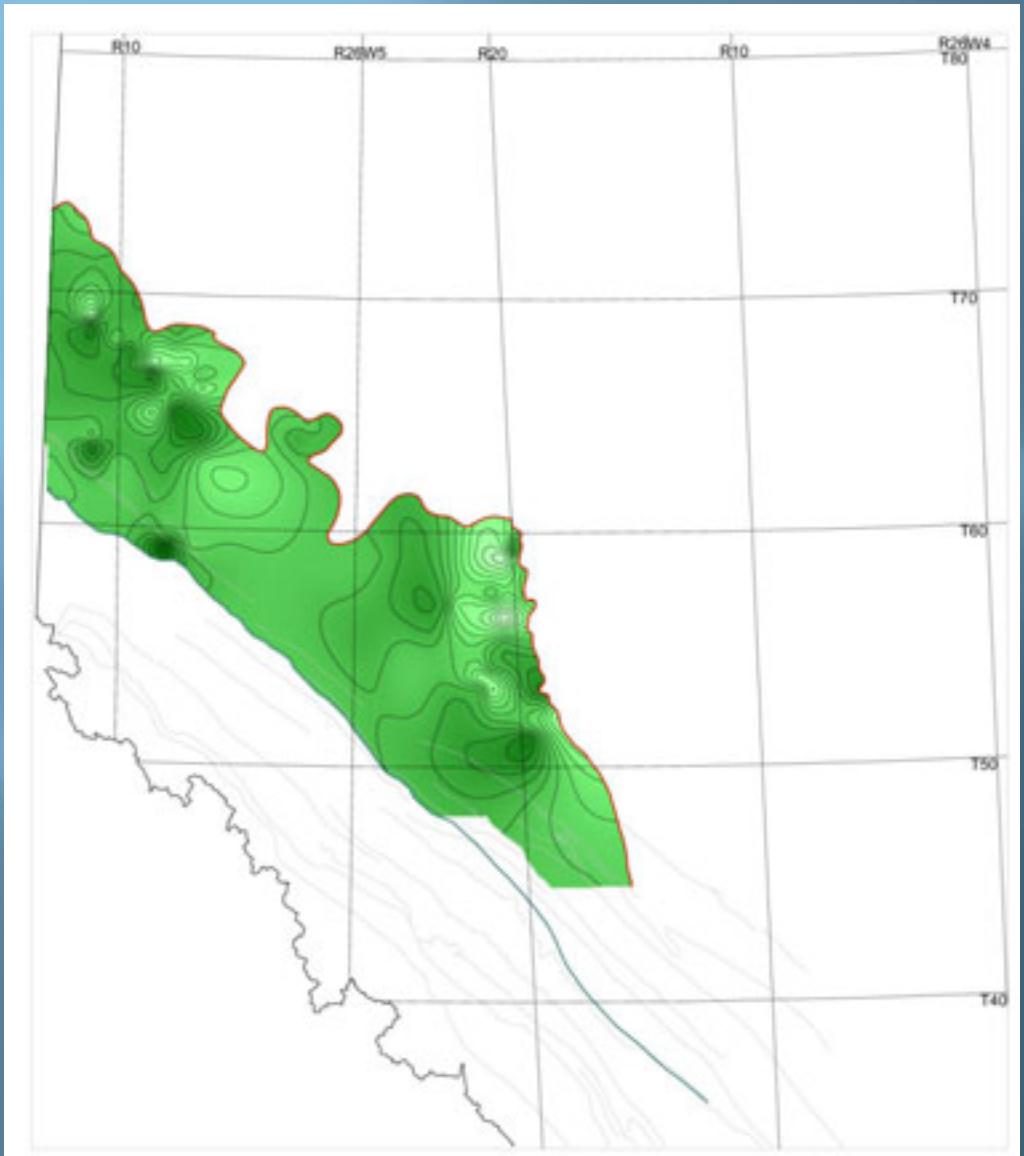
CADOMIN GAS RESOURCE MAPPING
2. AVERAGE POROSITY



1. Net porous isopach

2. Average porosity values picked on logs
   - Values up to 12%
   - Computer contoured, no geological bias imposed
     - Contour values 3 - 8%, with scattered spots to 11%

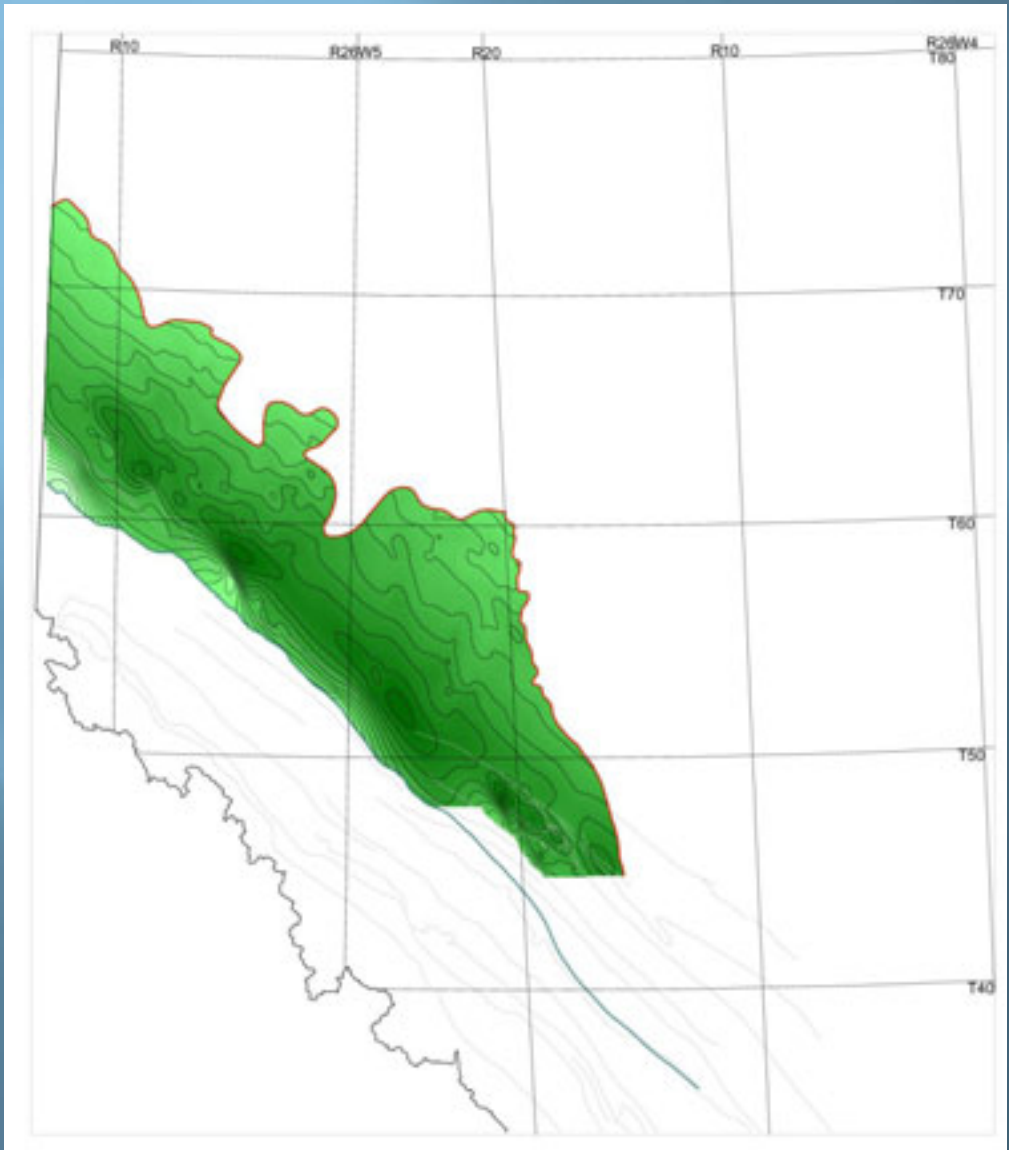
CADOMIN GAS RESOURCE MAPPING
3. GAS SATURATION



1. Net porous isopach
2. Average porosity

3. Gas saturation values from ERCB pool data
   - Computer contoured, no geological bias imposed
     - Values 60 - 85%

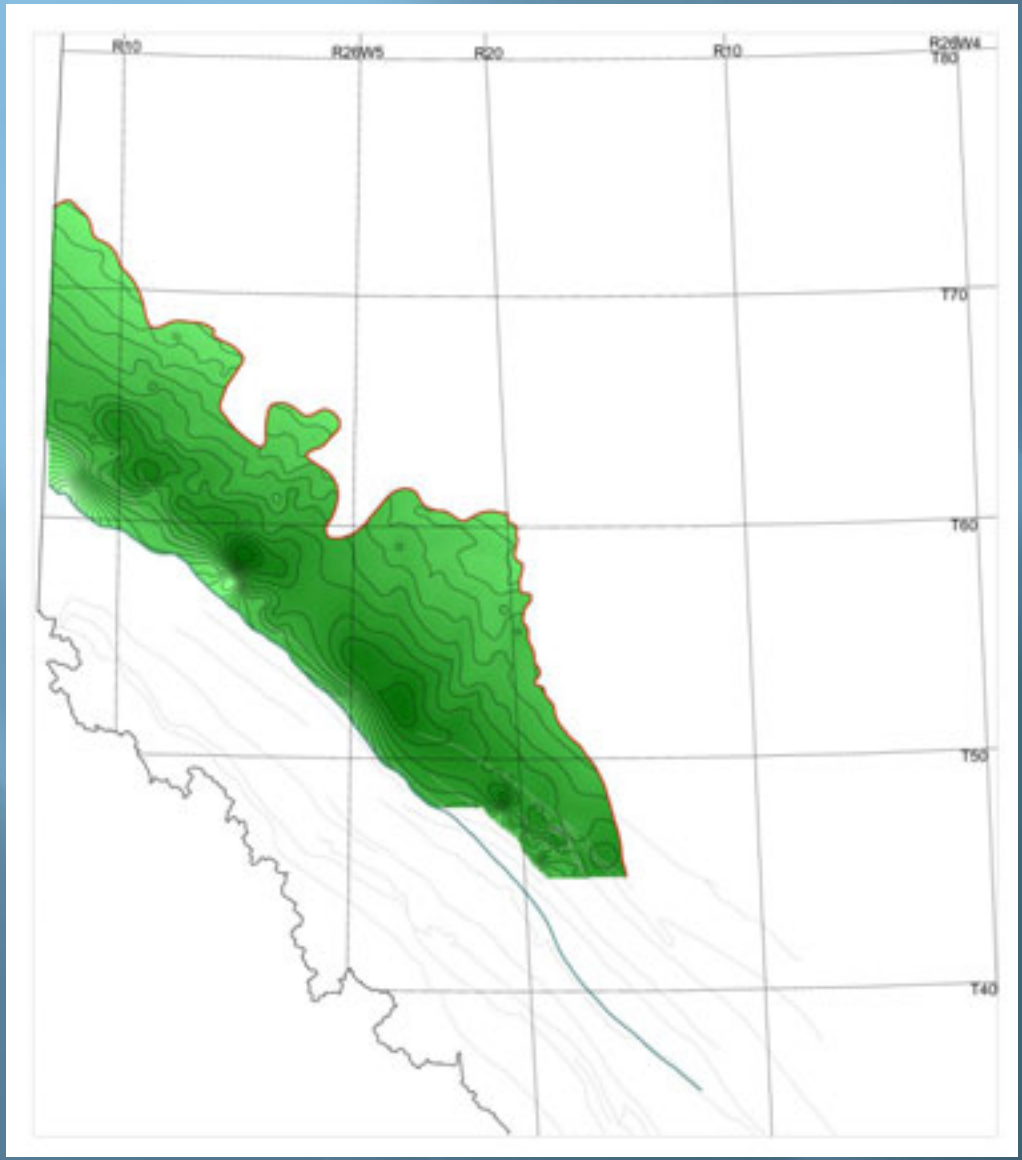
CADOMIN GAS RESOURCE MAPPING
4. TEMPERATURE



1. Net porous isopach
2. Average porosity
3. Gas saturations

4. Temperature values from ERCB pool data
   - Values 355 - 395º K
     - Insufficient data to contour
   - Temperature data plotted against depth to derive temperature / depth relationship
   - Temperature mapped as function of depth

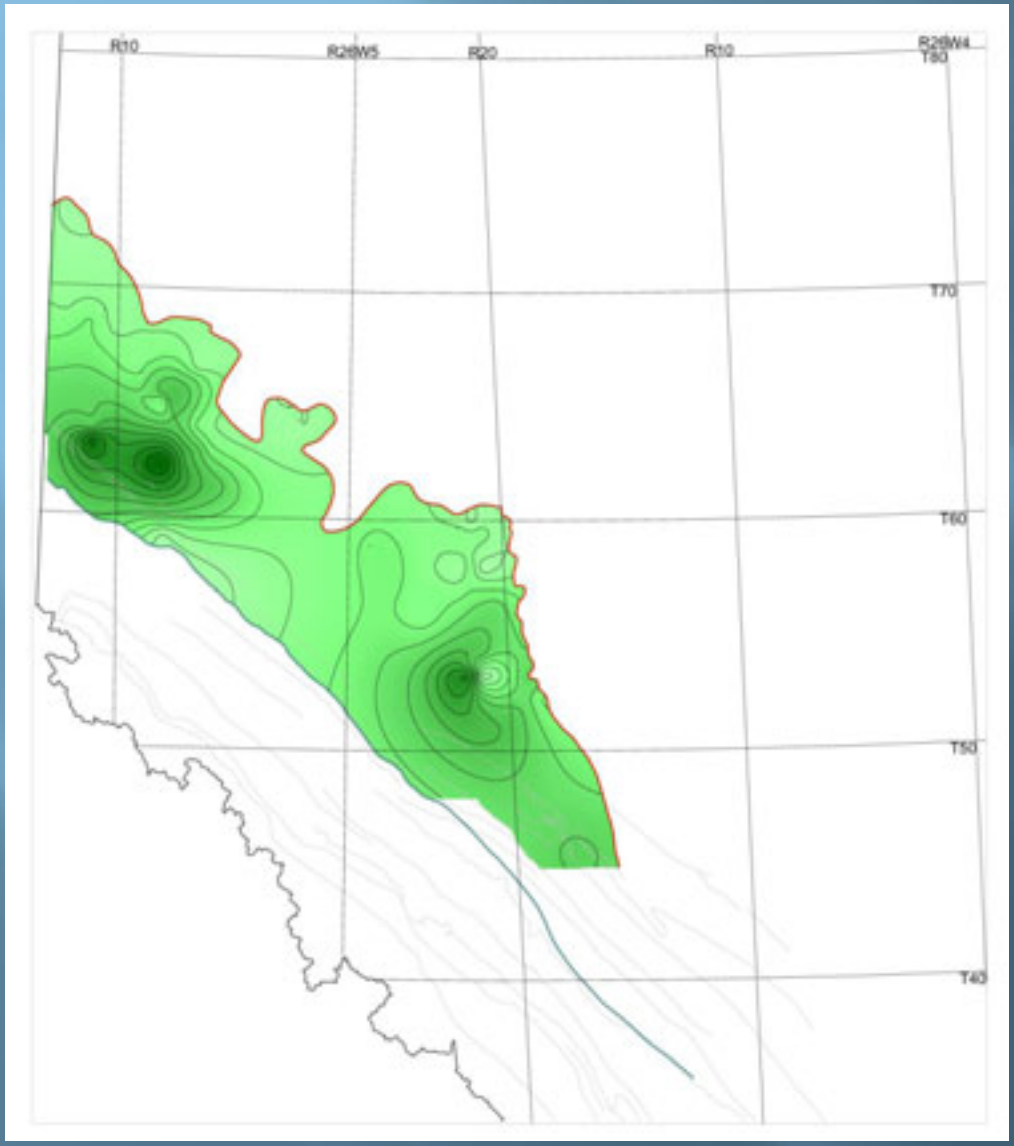
CADOMIN GAS RESOURCE MAPPING
5. RESERVOIR PRESSURE



1. Net porous isopach
2. Average porosity
3. Gas saturations
4. Temperature

5. Pressure values from ERCB pool data
   - Values 17,500 - 42,500 kPa
     - Insufficient data to contour
   - Pressure data plotted against depth to derive pressure / depth relationship
   - Pressure mapped as function of depth

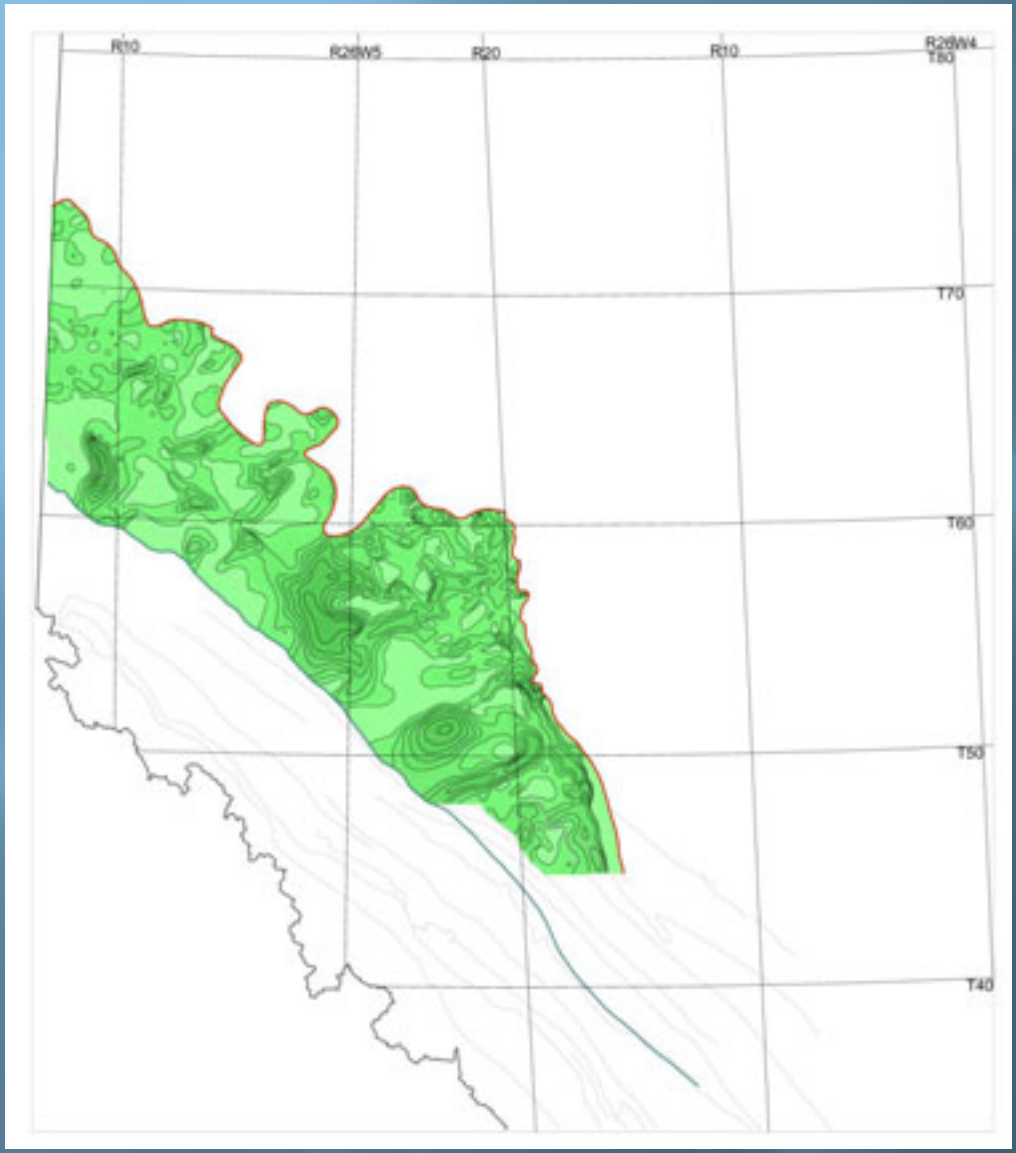
CADOMIN GAS RESOURCE MAPPING
6. Z FACTOR



1. Net porous isopach
2. Average porosity
3. Gas saturations
4. Temperature
5. Pressure

6. Z factor values from ERCB pool data
   - Values range 87.5 - 107.5
   - Computer contoured, no geological bias imposed

CADOMIN GAS RESOURCE MAPPING
7. RESOURCE DENSITY (BCF / SECTION)



1. Net porous isopach
2. Average porosity
3. Gas saturations
4. Temperature
5. Pressure
6. Z factor

7. Gas resource density calculated at up to 35 BCF/section
   - Total 78 TCF Gas in Place

DEEP BASIN DEVELOPMENT ENTITY
GAS RESOURCE MAPPING - RESULTS

Formation	TCF (in place)	Area (km2)
Nikanassin	88.0	19,653
Cadomin	77.9	21,082
Gething	68.5	36,689
Bluesky	24.3	41,559
Spirit River	93.2	28,947
Cadotte	32.2	8,897
Simonette	5.7	2,744
Cardium	40.7	17,322
TOTAL	430	

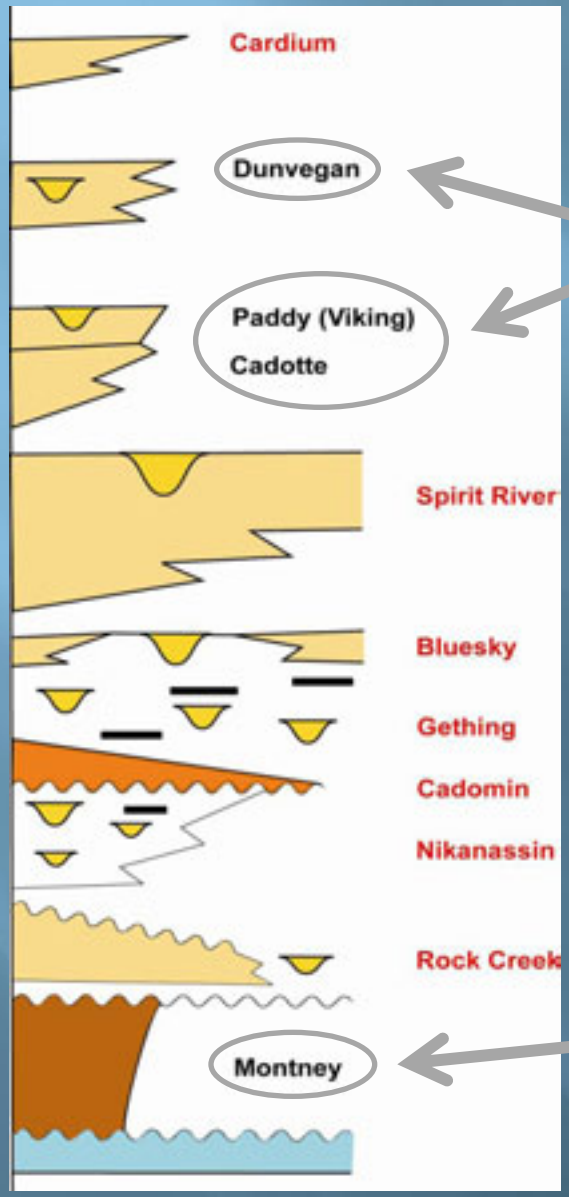
DEEP BASIN DEVELOPMENT ENTITY
SITUATION IN 2008 / 2009

- Success of original DBDE concept proven by production and drilling results
- New drilling and more comprehensive mapping demonstrates that systematic commingling is required beyond the original DBDE boundaries
- THE CHALLENGE – Make the case that DBDE concepts can be extended successfully to areas where significant resource exists beyond existing DE #2 boundaries

DEEP BASIN DEVELOPMENT ENTITY
2008 / 2009 EXPANSION

- Joint CAPP / ERCB Initiative
- Review stratigraphic column to see whether other reservoirs add significantly to Deep Basin commingled production potential
- Revise eastern DE #2 boundary by refining updip DB edges in all reservoirs
- Revise western DE #2 boundary using test and production data to establish extent of DB pressure and fluid regime
- Address concerns regarding potential inclusion of sour and/or oil-bearing zones in DE #2

DE #2 2008 / 2009 EXPANSION
STRATIGRAPHIC COLUMN



Dunvegan / Paddy / Viking / Cadotte

- Geographic ranges do not expand DE #2
- Can be commingled where encountered

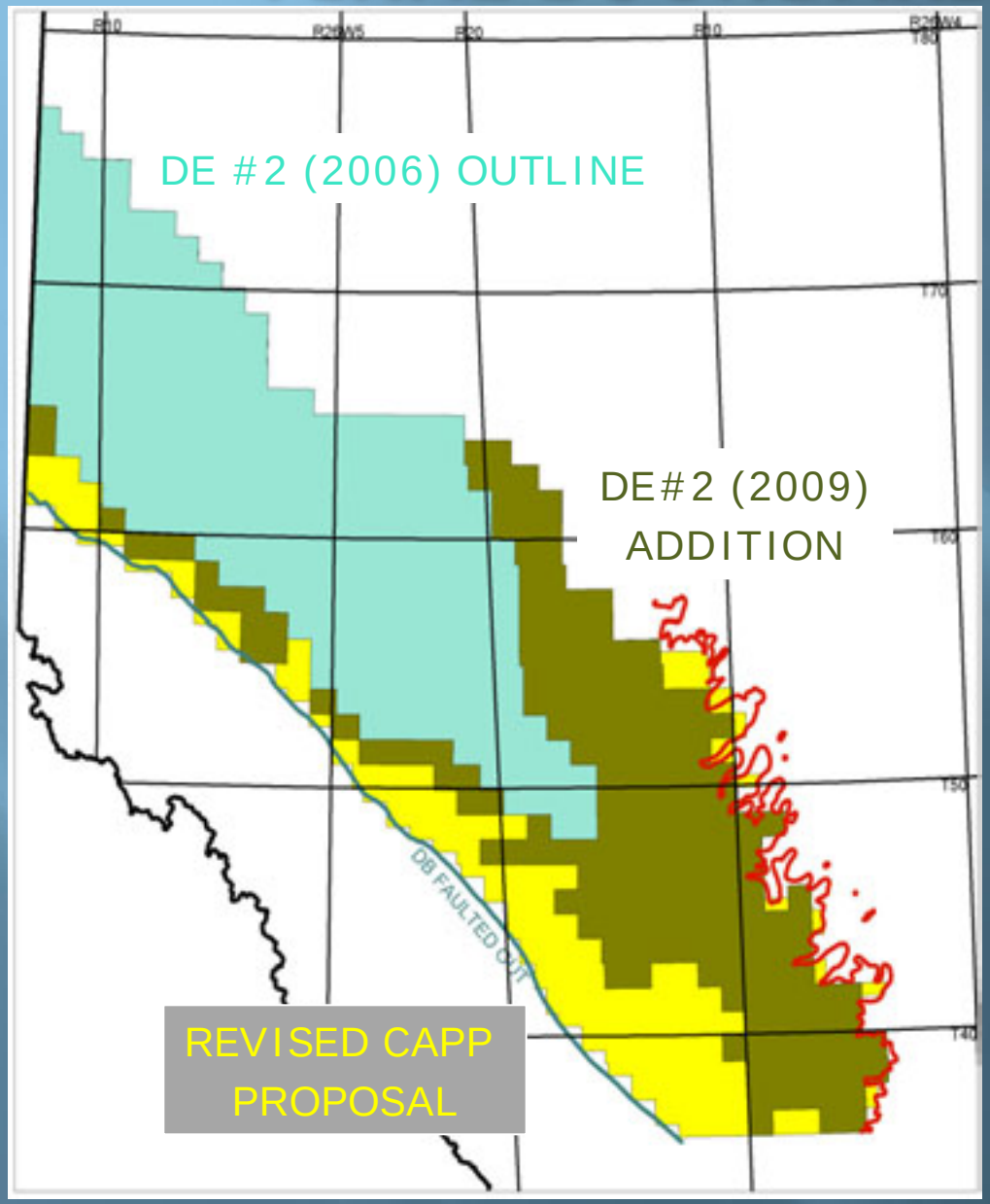
ADD Rock Creek

- Proven Deep Basin regime
- Concerns re oil and sour gas

Montney

- Unproven Deep Basin regime
- Concerns re sour gas

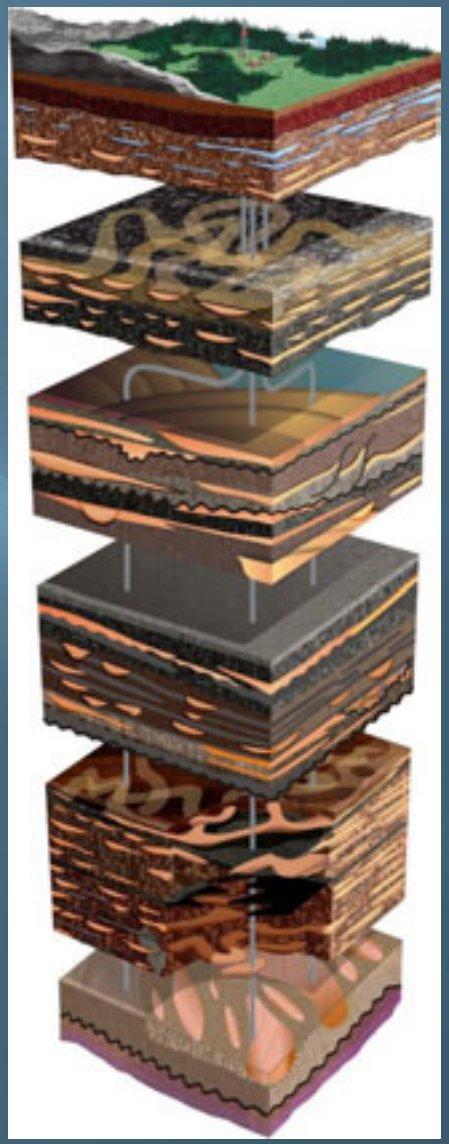
DE #2 2008 / 2009 EXPANSION
FINAL BOUNDARIES and LIMITS



- Fernie edge is delimiter to southeast
  - separates Jurassic / Cretaceous sands
- CAPP proposed western limit at Deep Basin edge
  - ERCB recognizes principle, but requires 3-4 gas wells per township to allow inclusion in expanded DE
  - Boundary can be reviewed as drilling density increases
- Operators are responsible for dealing with "problem zones" (sour, oil) appropriately by excluding them from commingling

DEEP BASIN DEVELOPMENT ENTITY
CONCLUSIONS

- The Deep Basin remains highly prospective, and is a key resource for Alberta
- DE #2 is instrumental in enabling efficient exploitation, and allowing maximum capture of gas resources



Modified after Leroux 2004, 2006