

BAKKEN OIL RESOURCE PLAY
WILLISTON BASIN (US)
OVERVIEW AND HISTORICAL PERSPECTIVE

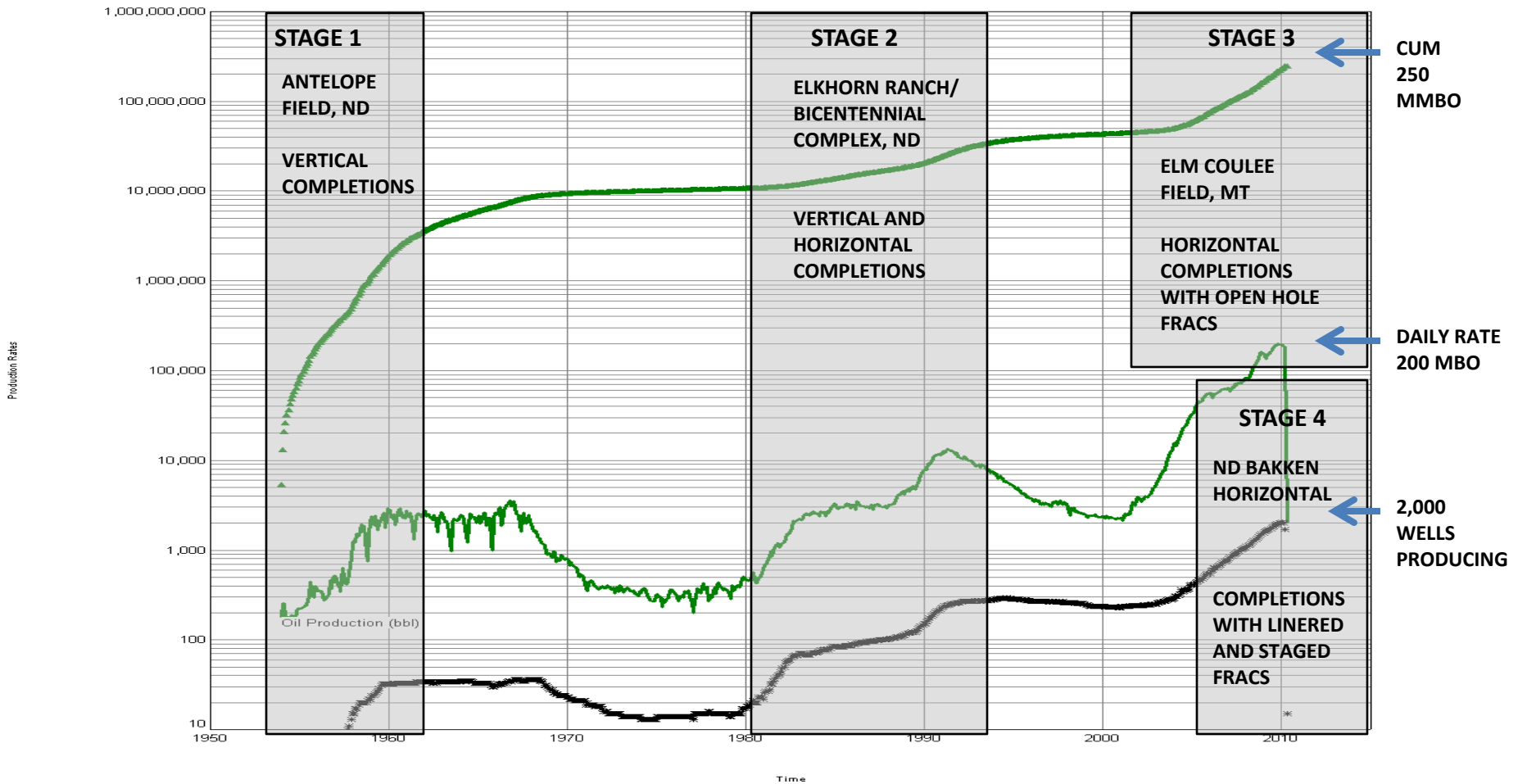
Neil L. Olesen

July 28, 2010

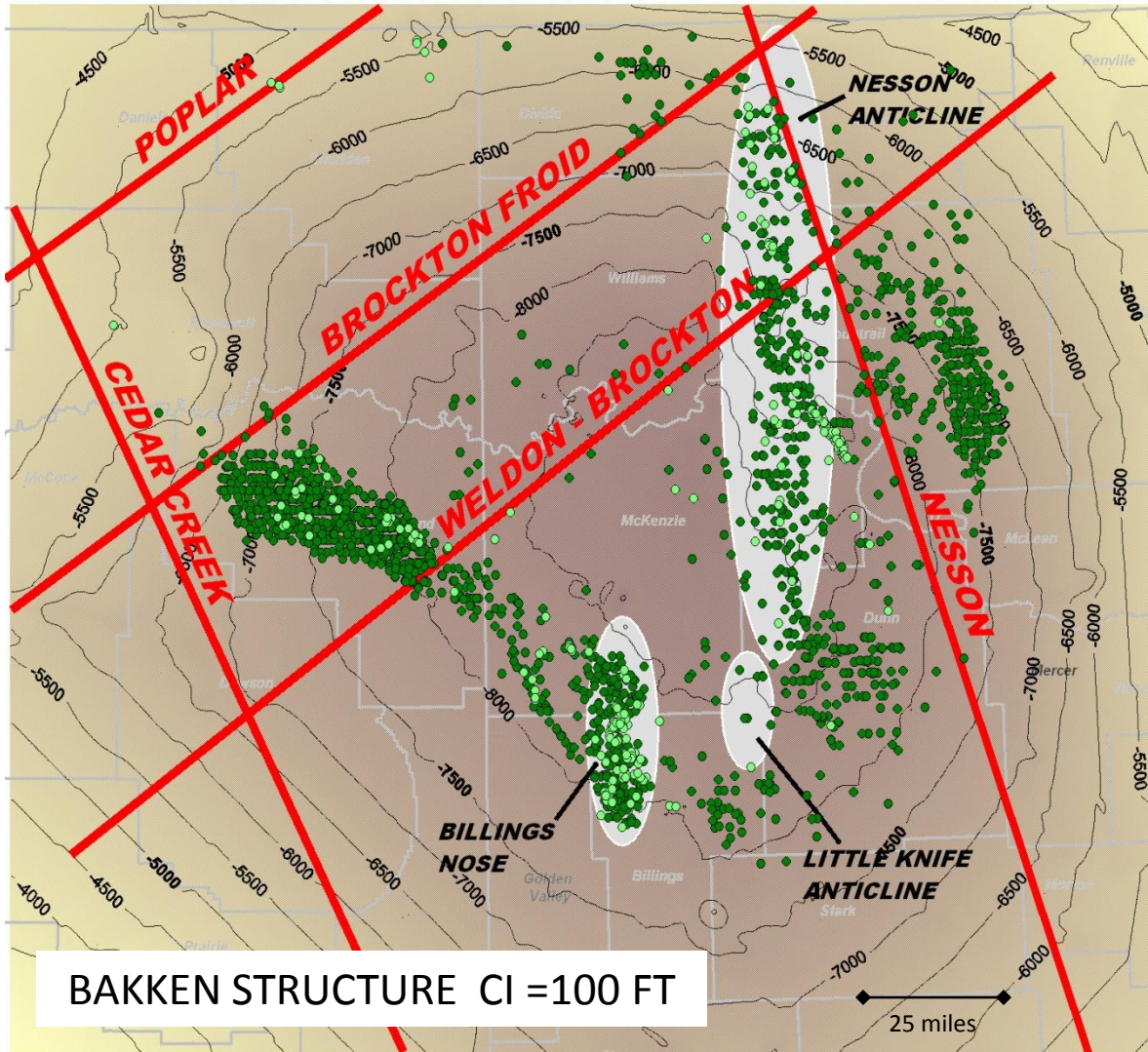
- 🔥 The largest oil reserves for a continuous oil accumulation in the lower 48 states.
- 🔥 Play covers an estimated 15,000 square miles.
- 🔥 Recoverable reserves are estimated at 4.2 billion barrels (USGS).
- 🔥 1,946 horizontal Bakken wells have been completed since 1/2000.
- 🔥 196 million BO have been produced from wells completed since 1/2000.
- 🔥 Daily production is approximately 200,000 BO.
- 🔥 Current rig count at 135.
- 🔥 Bakken has been completed during 4 distinct episodes since 1953, each driven by an advance in drilling or completion technology.

- 🔥 CRI is a leading Bakken player.
- 🔥 Largest leaseholder in the Bakken play with about 807,000 net acres.
- 🔥 CRI 2010 capital budget is \$1.3 billion, about 70% will be spent on the Bakken play.
- 🔥 Currently operate 19 rigs.
- 🔥 CRI will participate in over 200 Bakken wells during 2010, about 60% will be operated.

BAKKEN MILESTONES



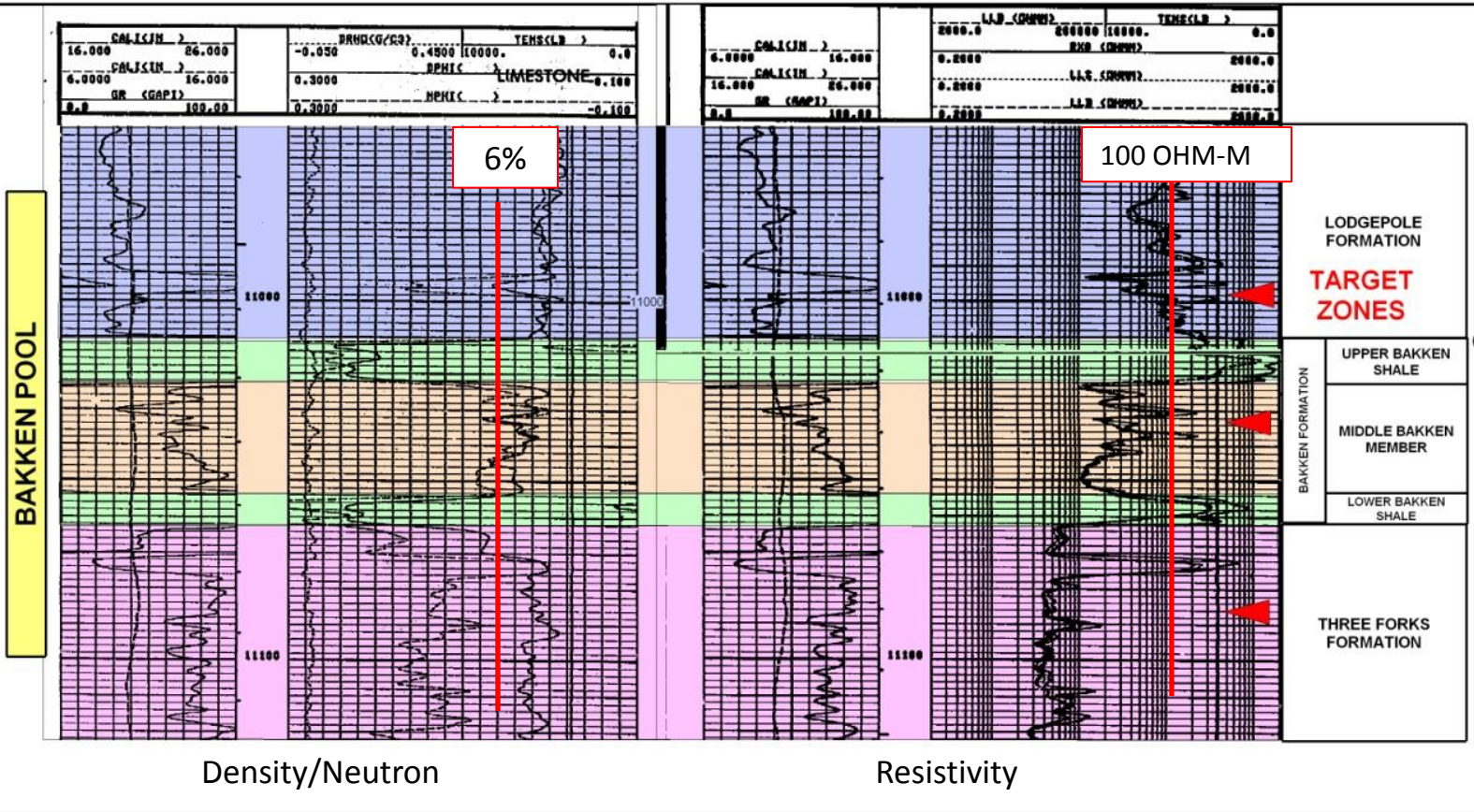
GENERAL GEOLOGY - STRUCTURE



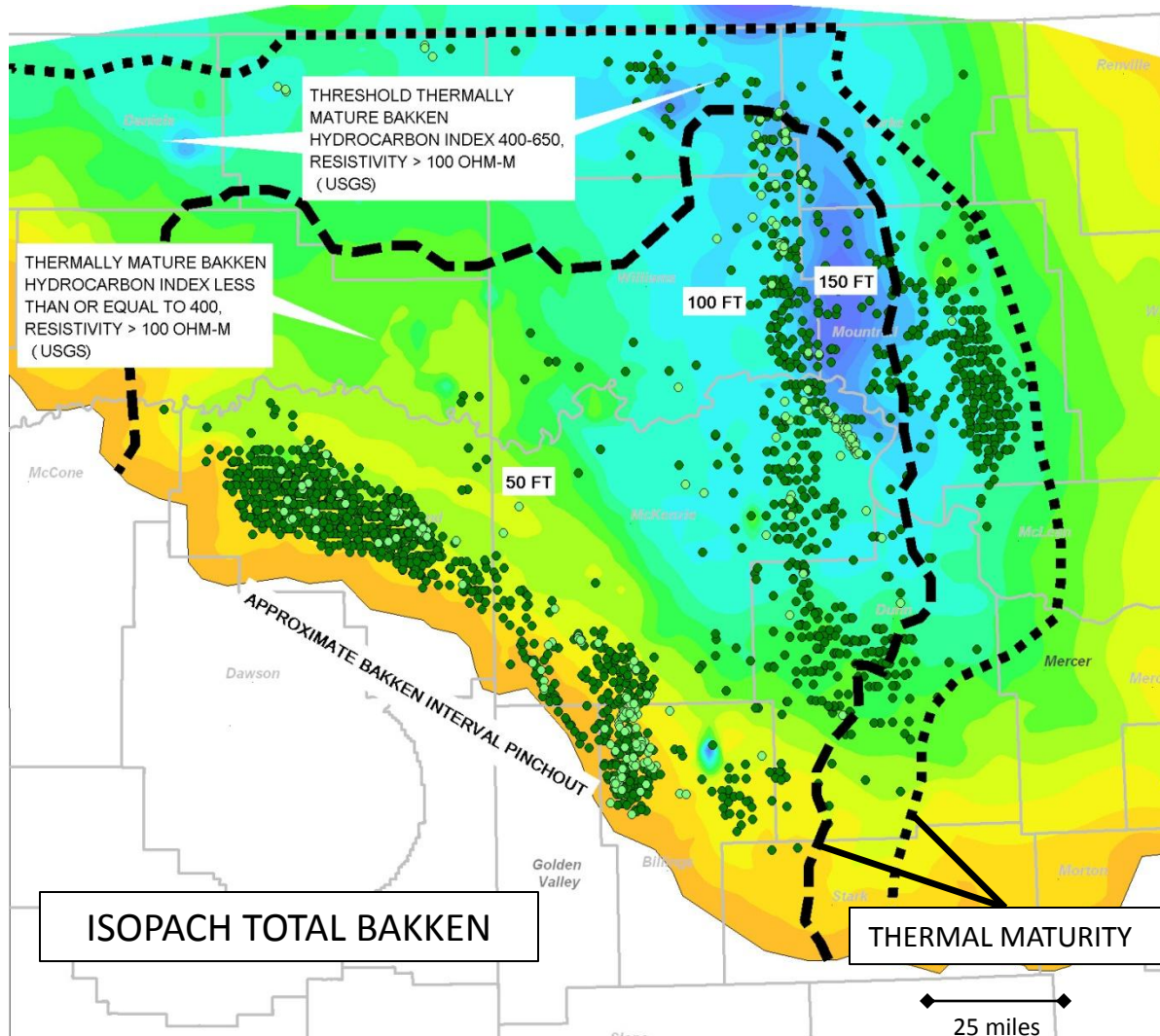
- 🔥 Symmetrical cratonic basin
- 🔥 Bakken play active at depths of 8,500' – 12,000'
- 🔥 Geothermal gradient ranges from 1.8 – 2.0 degrees F/100 feet
- 🔥 Predominantly Laramide structures.
- 🔥 Onset of hydrocarbon generation - Laramide
- 🔥 Key structural factors:
 - Vertical uplift and faulting
 - Regional shear zones
 - Salt dissolution in underlying Devonian

GENERAL GEOLOGY - STRATIGRAPHY

OBRIGEWITCH A-1
 CITIES SERV O&G CORP
 TWP: 146 N - Range: 97 W - Sec. 33



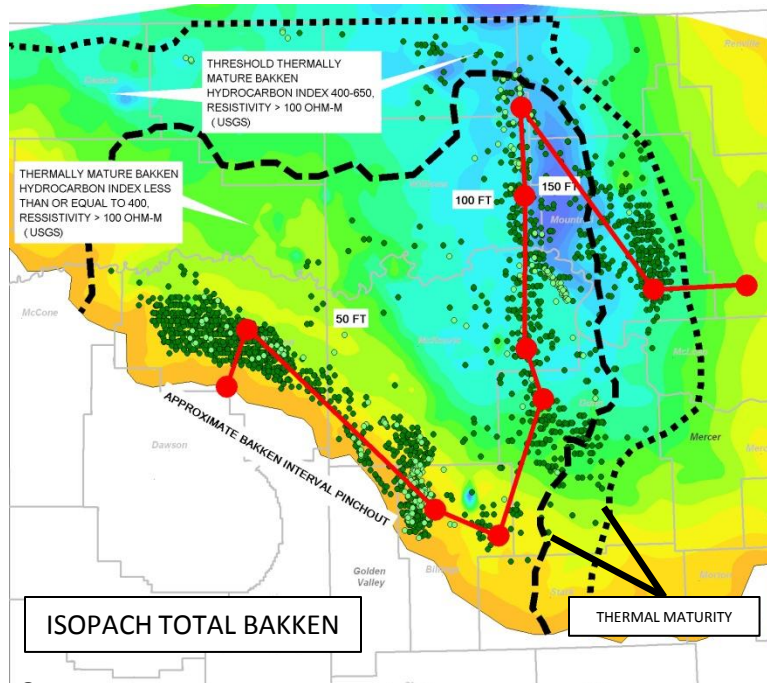
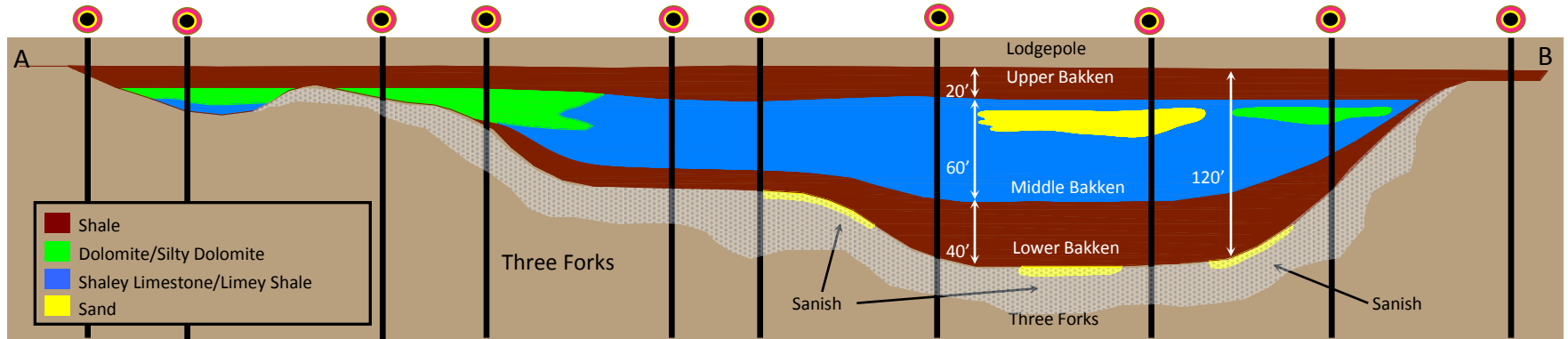
GENERAL GEOLOGY - STRATIGRAPHY



- Productive wells are coincident with areas of thermal maturity.
- Productive wells are located from Bakken pinch out to Bakken depocenter.
- Hydrocarbon generation causes fracture generation via overpressuring.

$$HI = S_2/TOC$$

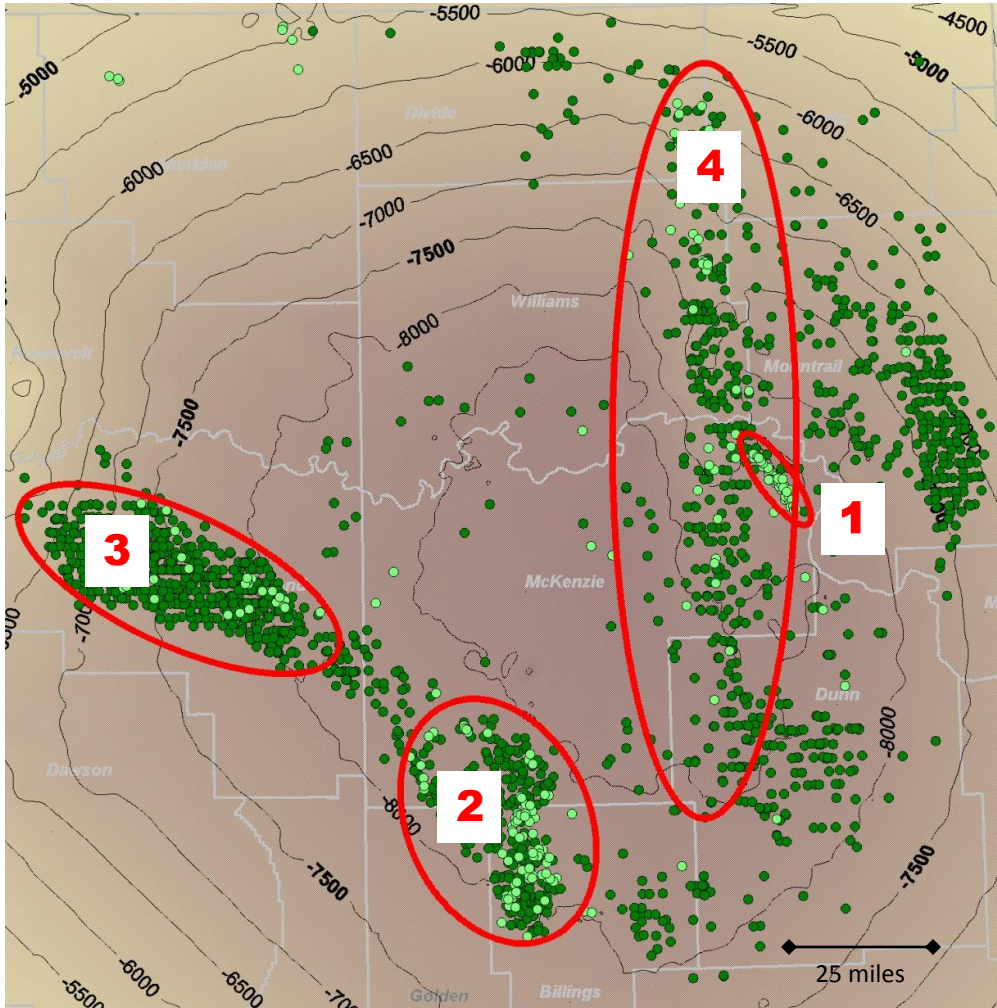
GENERAL GEOLOGY – CROSS-SECTION



- Upper Shale
 - Highly organic (up to 20% TOC).
 - Brittle due to high silica content.
 - Max 28' thick.
- Middle Member
 - Varies from dolomite, sand, shaley lime and shale across the basin.
 - Porosity is low.
 - Max 87' thick.
- Lower Shale
 - Similar to Upper Shale.
 - Max 55' thick.

- 🔥 Basin-centered oil resource play.
- 🔥 Hydrocarbon system is charged by thermally mature and high TOC Bakken shale members.
- 🔥 Hydrocarbon system is overpressured.
- 🔥 Target zones include Middle Bakken member and Three Forks formations.
- 🔥 Storage and deliverability are controlled by matrix porosity and k , tectonic fractures and fractures related to oil generation.

HISTORICAL PERSPECTIVE



AREAS:

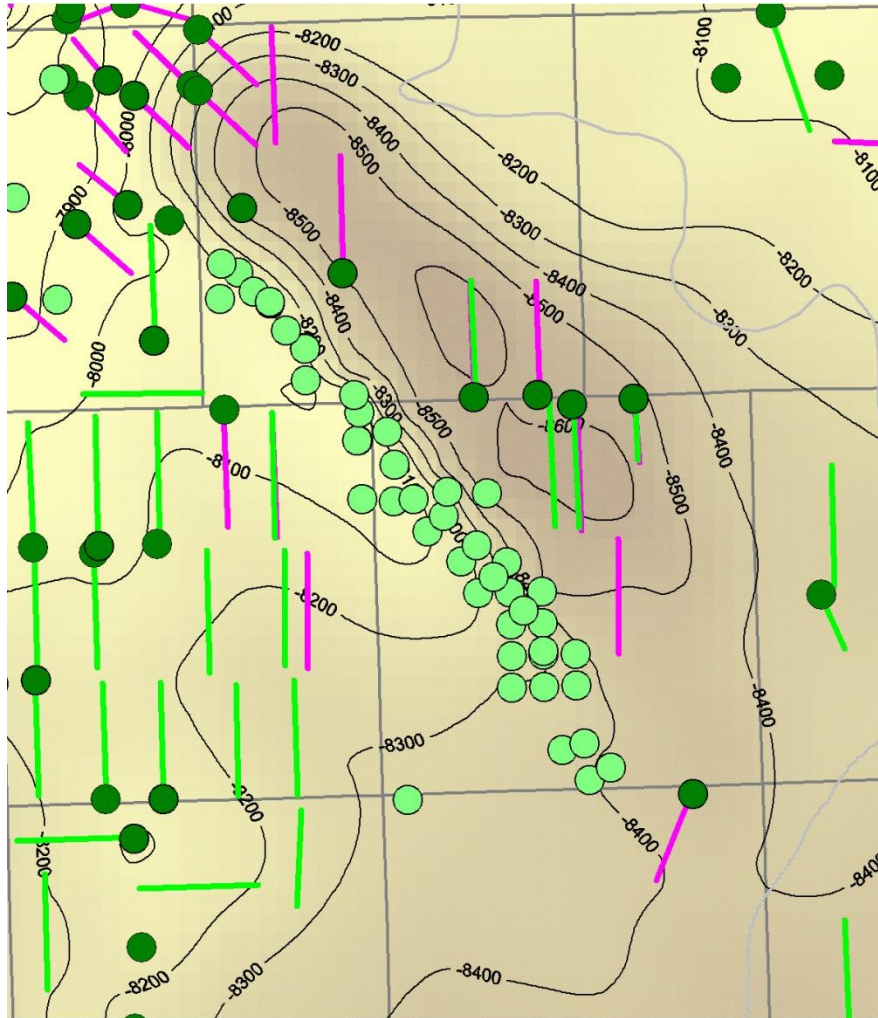
- 1) Antelope Field
- 2) Bicentennial – Elkhorn Fields
- 3) Elm Coulee Field
- 4) North Dakota Anticline



TOPICS ADDRESSED:

- Activity date
- Geologic overview
- Drilling and completion methods
- Results
- Conclusions

CASE HISTORY (1) – ANTELOPE FIELD



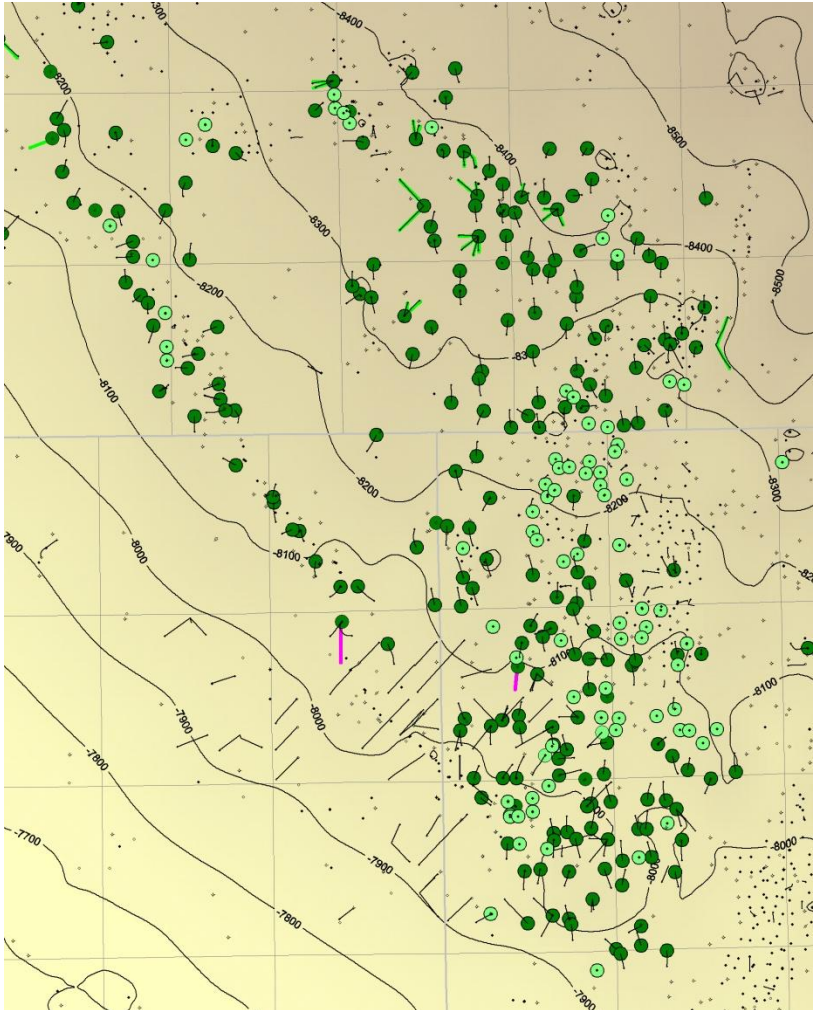
General data:

- 🔥 Discovery date: 1953
- 🔥 59 Vertical wells
- 🔥 Production from Sanish/Three Forks and Bakken interval
- 🔥 Cum Field: 18 MMBOE
- 🔥 Cum average well: 1.4 MMBOE, 4-5% porosity
- 🔥 Spacing: ≥ 40 acres
- 🔥 Predominantly no frac
- 🔥 Volumetric problem with Sanish Sand

Conclusions:

- ❖ Matrix storage & deliverability in Three Forks and Bakken
- ❖ Strong tectonic fracture enhancement

CASE HISTORY (2) – BICENTENNIAL/ELKHORN FIELD



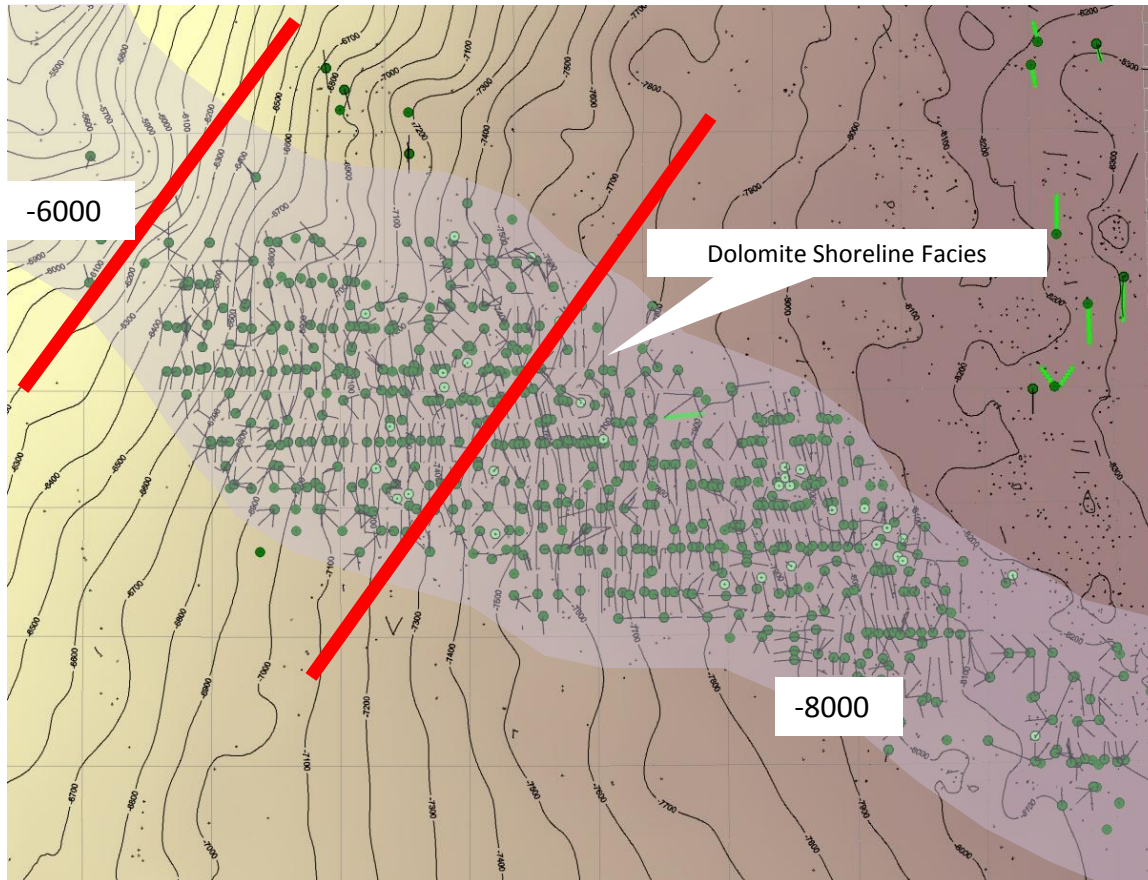
General Data:

- 🔥 A living laboratory for vertical/horizontal wells and new/old technology
- 🔥 Two stages of development: Vertical 1953-87, “old” horizontal from 1987-1994
- 🔥 84 Vertical wells
- 🔥 Average vertical well EUR 111 MBO
- 🔥 176 Horizontal wells
- 🔥 Average “old” horizontal well 144 MBO
- 🔥 Best horizontal well 605 MBOE
- 🔥 GOR’s reflect tank-like behavior
- 🔥 No frac’s on horizontal wells
- 🔥 Short lateral horizontals, 2200’
- 🔥 Middle Bakken member not present in numerous wellbores
- 🔥 Interference between wells in less than 18 months

Conclusions:

- ❖ Three Forks matrix and tectonic fracture play
- ❖ Middle Bakken not required for production

CASE HISTORY (3) – ELM COULEE



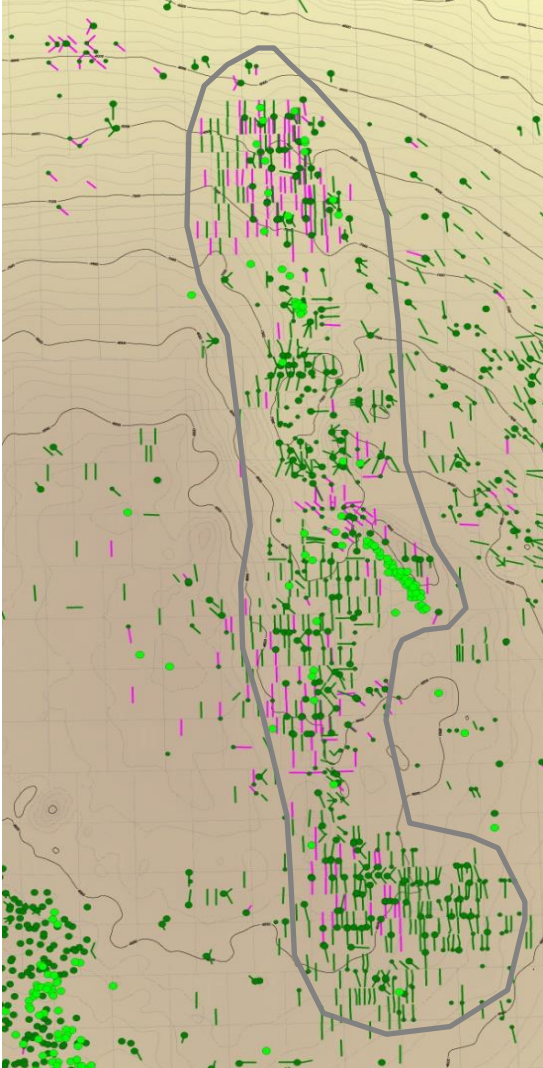
General Data:

- 🔥 6/2000 to present
- 🔥 640 wells, 550 sq. mi. area
- 🔥 107 MMBOE produced
- 🔥 Best wells have EUR's of 500-1000 MBOE
- 🔥 Dolomite shoreline facies, porosity 5-10 %, permeability up to 0.3 md
- 🔥 Single, dual and triple laterals on 640's and 1280's
- 🔥 Open hole fracture stimulation

Conclusions:

- ❖ Primarily a matrix driven play
- ❖ Minor tectonic fracture influence

CASE HISTORY (4) – ND ANTICLINE



General Data:

- 🔥 2004 to present
- 🔥 Estimate 750 wells completed
- 🔥 2400 sq. mi. area, 125 miles from north to south
- 🔥 Vertical displacement of over 500 feet on Nesson Anticline
- 🔥 Middle Bakken and Three Forks are targets
- 🔥 Middle Bakken member has a highly variable lithology
- 🔥 Porosity for both reservoirs averages 5-6%, permeabilities average in the 0.1's md.
- 🔥 Dual reservoir model is substantially proven
- 🔥 Currently determining optimum spacing
- 🔥 Drilled first as dual laterals on 1280's, then dual lateral coplanars and currently single lateral 1280's
- 🔥 Initially open hole fracs, lined fracs, and now lined-staged fracs
- 🔥 EUR's and IP's have approximately doubled as a result of changes in frac technology

Conclusion:

- ❖ The ND anticline play is successful due to fracture enhanced porosity and advancements in drilling and completion technology

Typical CLR Horizontal Well Configuration

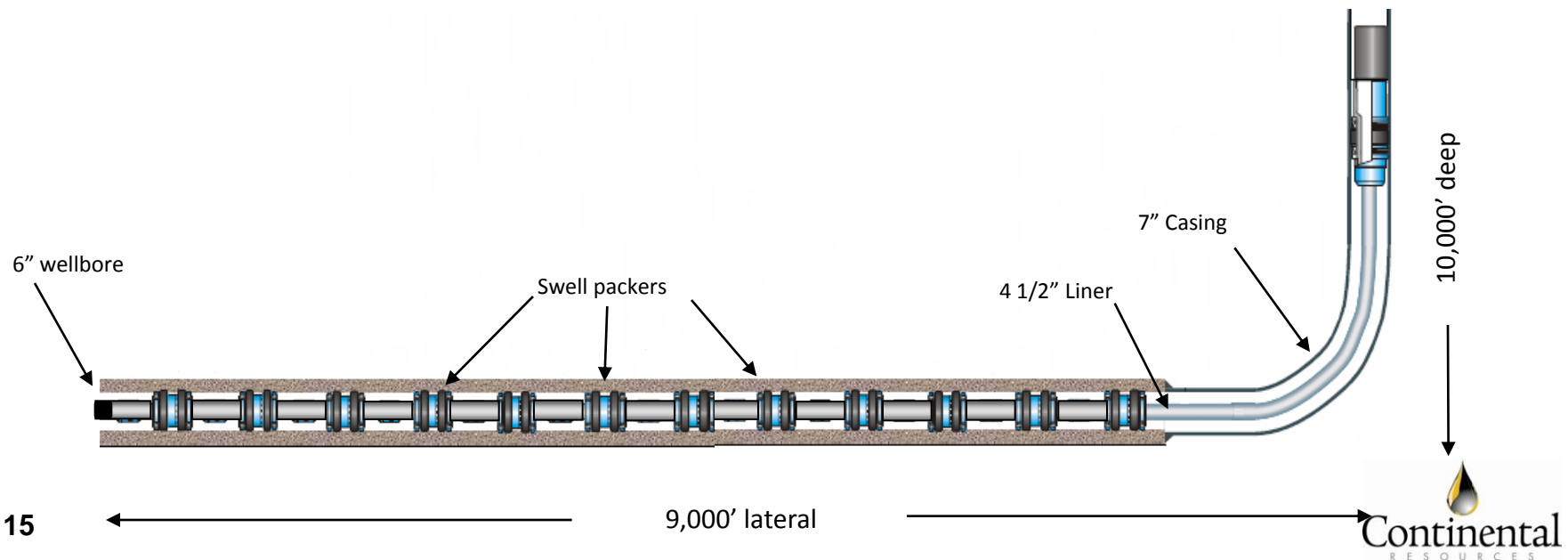
🔥 Drilling

- 🔥 1,280 acre spacing
- 🔥 10,000' avg. TVD
- 🔥 ~9,000' single leg lateral
- 🔥 23 days to drill

🔥 Completion

- 🔥 Currently using 24 stage fracs with some wells treated with as many as 30 stages
- 🔥 Isolated with swell packers and plugs
- 🔥 40,000 bbls of x-link gel
- 🔥 2,000,000 pounds of proppant
- 🔥 Treating pressures 6,000-8,000 psi @ 40 bbls / minute
- 🔥 Complete 6-8 stages per day

INDUSTRY TREND IS TOWARD MORE STAGES



- 🔥 Williston Basin (US) Bakken play is a basin-centered oil resource play.
- 🔥 Geology can high-grade opportunities within the play.
- 🔥 Each area has required a leap forward in drilling and fracture stimulation practices to optimize production.
- 🔥 With respect to drilling and completion practices, necessity has been the mother of invention.
- 🔥 Early entry into the play and staying power through the determination of best methods are critical to success.