

Kansas CO2 Enhanced Oil Recovery History and Potential

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Improved Hydrocarbon Recovery, LLC,
In collaboration with
Kansas Geological Survey

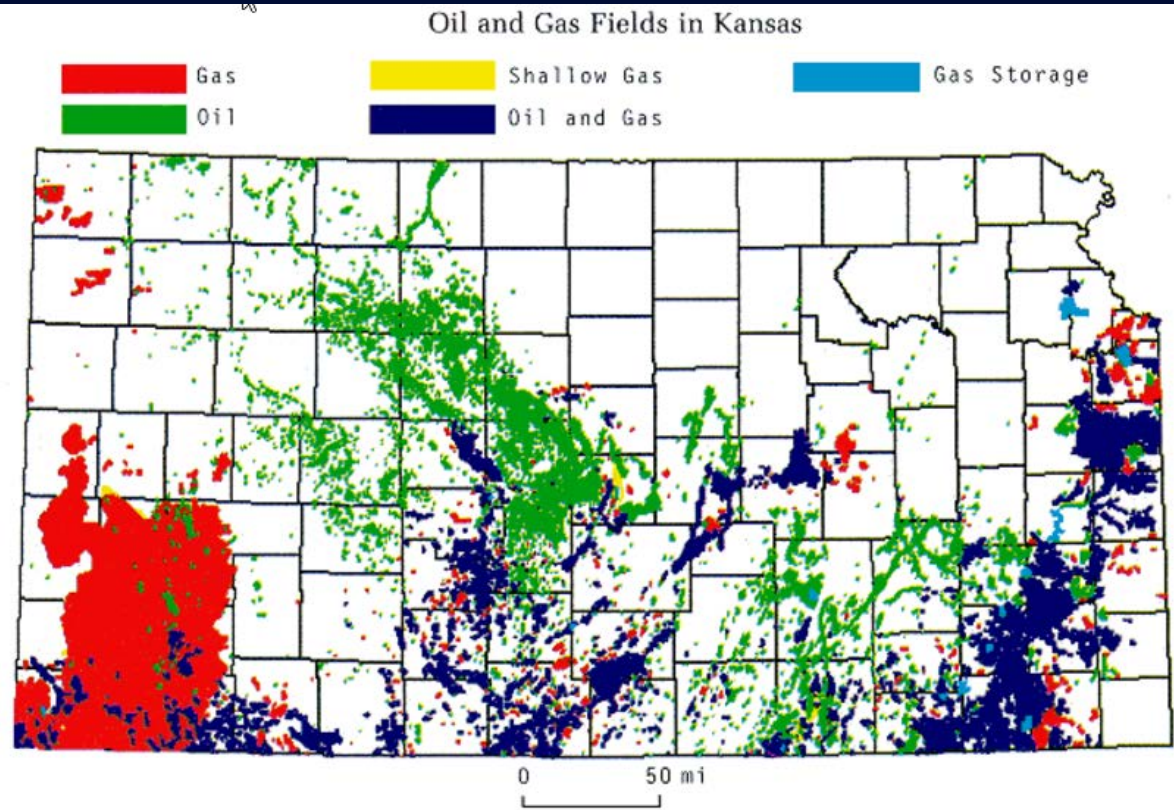


The Prize: 250 million barrels of oil

The Pathway:

- Formative years 1999 – 2017
 - Analysis and pilot projects
 - Initial point-to-point from ethanol plants
- Post 45Q or \$80 oil price

Oil-rich state, but no appreciable CO2

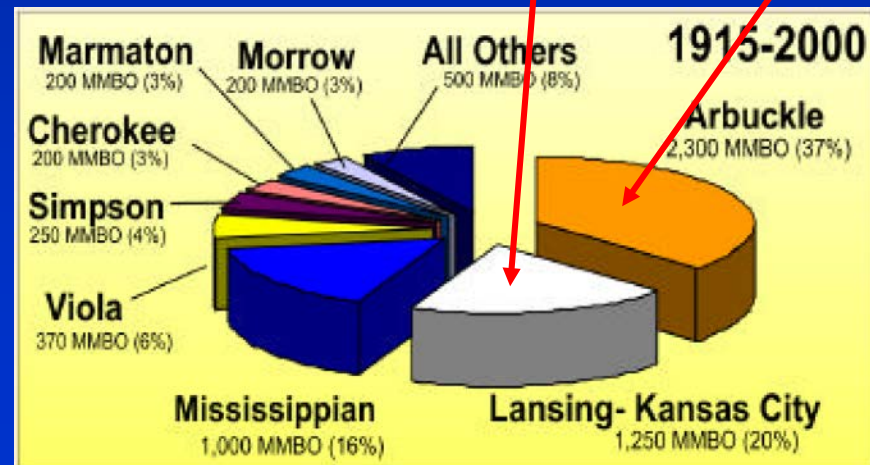
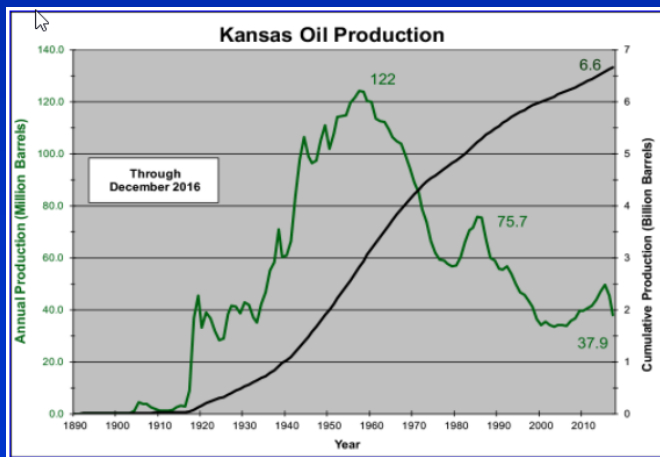


6.6 Billion barrels

Now at 36 mmbo/yr

CO2 EOR +10 mmbo/yr possible??

Most prolific are LKC and Arbuckle



The Big Picture

From the Midwest Governor's Association and ARI (2009)

- Kansas holds > **750 million barrels** of technical CO₂-EOR potential.
- Kansas has the largest oil resources in the MGA region.

Basin	EOR potential (Mil bbl)	Net CO ₂ Demand (MMT)	Direct Jobs Created
Illinois/Indiana	500	160 – 250	1,550 – 3,100
Ohio	500	190 – 300	1,550 – 3,100
Michigan	250	80 – 130	800 – 1,800
Kansas	750	240 – 370	2,300 – 4,600
TOTALS	2,000	670 – 1,050	6,200 – 12,400

Byrnes et al., 1999 (Kansas Geological Survey)

250 to 1,000 million barrels

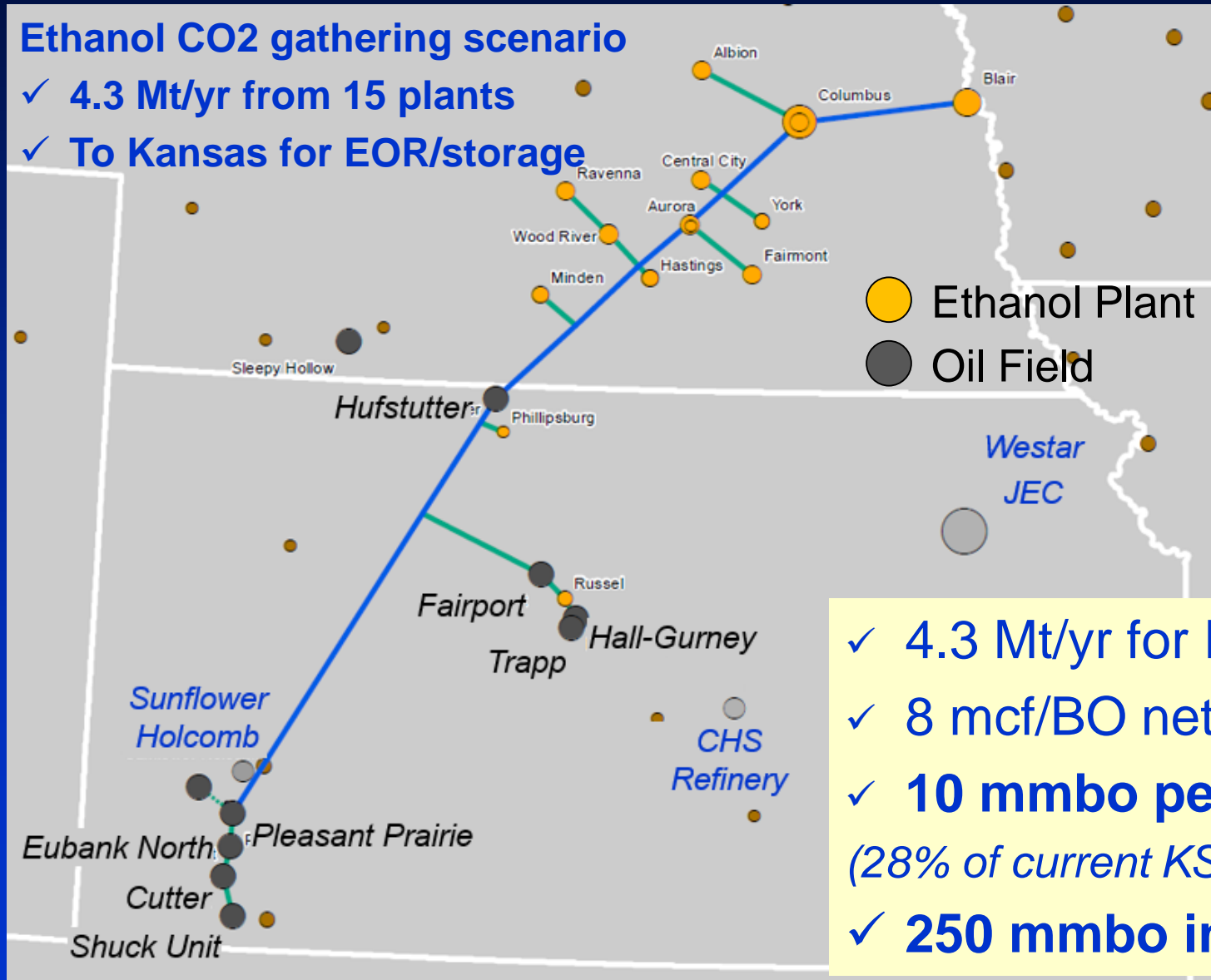
What's required for 250 mmbo?

4.3 M tonne / yr CO₂ (220 mmcfd) for 25 yrs

Ethanol CO₂ gathering scenario

✓ 4.3 Mt/yr from 15 plants

✓ To Kansas for EOR/storage



✓ 4.3 Mt/yr for EOR

✓ 8 mcf/BO net utilization

✓ **10 mmbo per year**

(28% of current KS production)

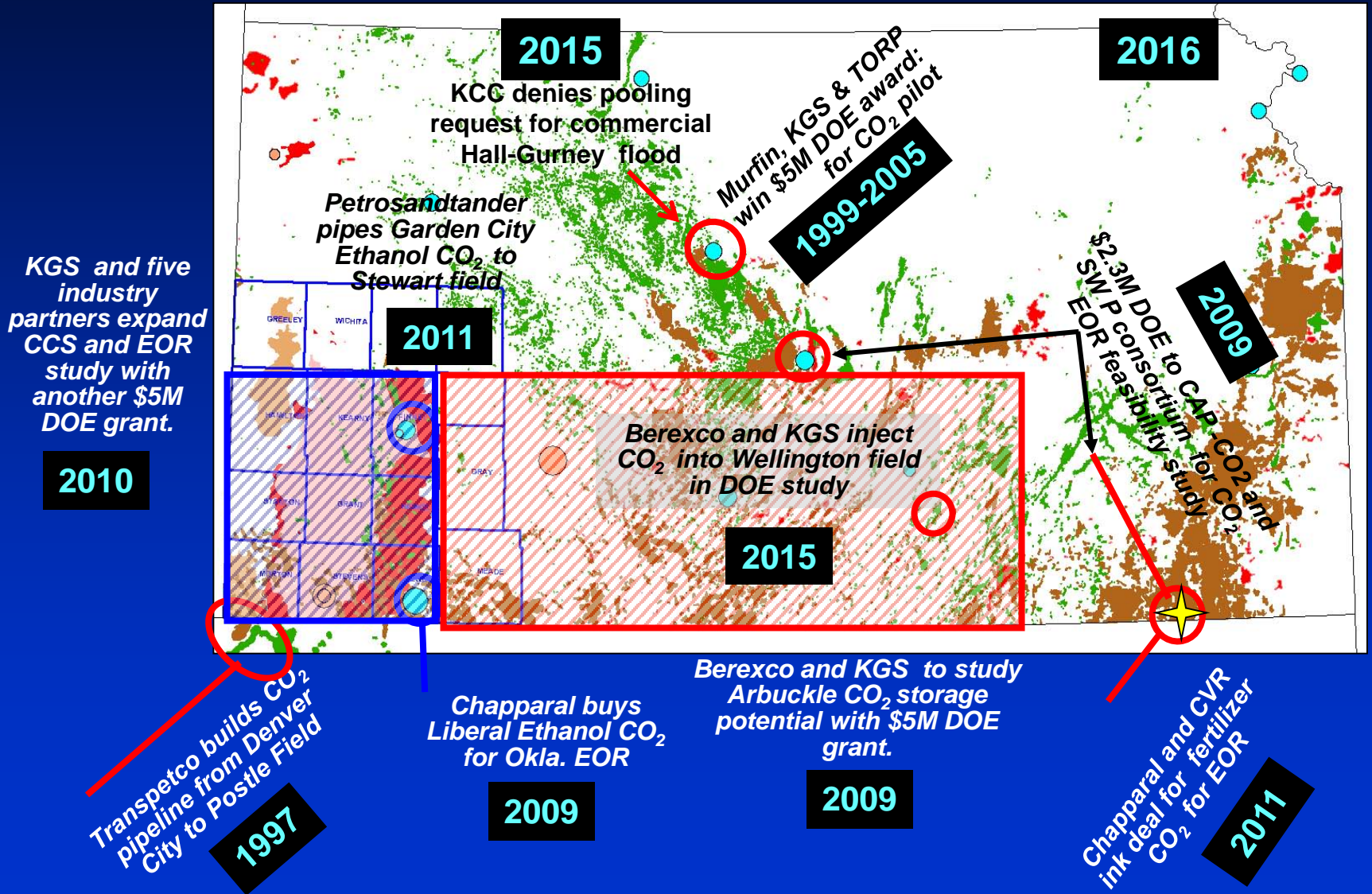
✓ **250 mmbo in 25 years**

CO2 EOR and CCUS Headlines (1997-present)

KGS and industry partners land \$1.5M for Phase I in DOE CarbonSAFE program

Kansas Ethanol Plants (2008)

Blue – active, Tan - planned



“CO2 Ready” EOR candidates

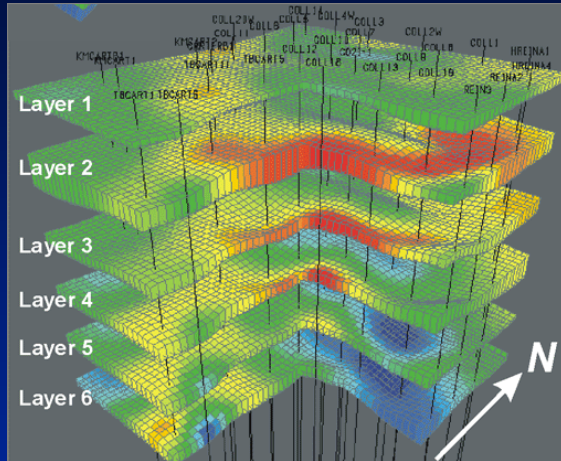
	CO2 EOR Ready Level	Inject. Rate (Mt/yr)	CO2 Stored (Mt)	Primary & Secondary (mmbo)*	CO2 EOR (mmbo)	Basis for Estimate
Shuck	1	0.4	1.5	7.9	3.6	DE-FE000256
Cutter	1	0.5	1.3	5.4	2.8	DE-FE000256
N Eubank	1	0.6	1.5	7.4	4.6	DE-FE000256
Pleasant Prairie	1	0.3	0.5	4.7	2.2	DE-FE000256
Hall Gurney	1	1	11.3	62.5	26.8	DE-AC26-00BC15124 PILOT & C12 Energy
Trapp	2	0.5	4.3	31.3	10.3	KGS reports
Wellington	1	0.6	2.2	16.2	5.3	DE-FE0002056 and PILOT
		3.9	22.8	135.4	55.7	

* P&S production is for portion of field that could be flooded

“CO2 Ready” fields could take
3.9 million tonnes /year (200 mmcf/d)
And recover 56 mmbo

Murfin's (and KGS) Hall-Gurney Pilot

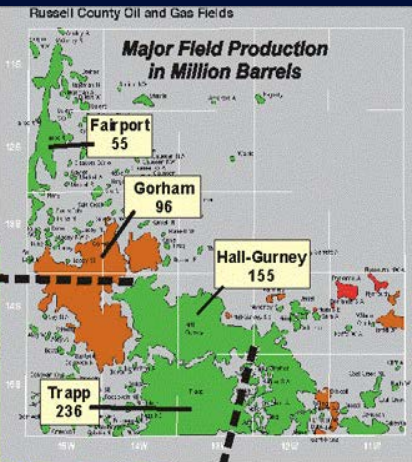
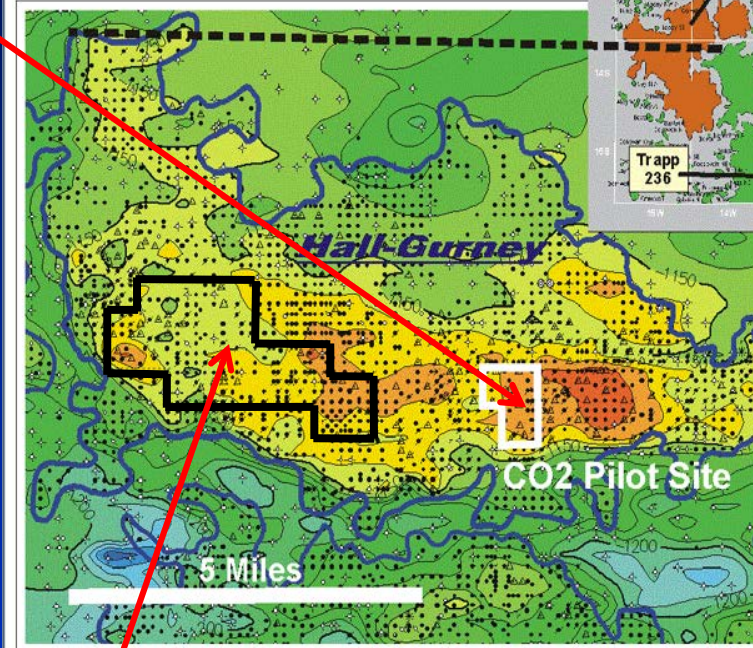
LKC "C" Zone model



Murfin's Hall Gurney (Russell) Pilot (2005)

- Trucked CO₂ from USEP Russell ethanol plant
- Injected 140 mmcf (7400 tonnes CO₂)
- Produced an estimated 27.9 mbo incremental oil
- Gross Utilization: 5 mcf/BO

Hall-Gurney Field Area Lansing Structure Map Contour Interval = 10 Feet

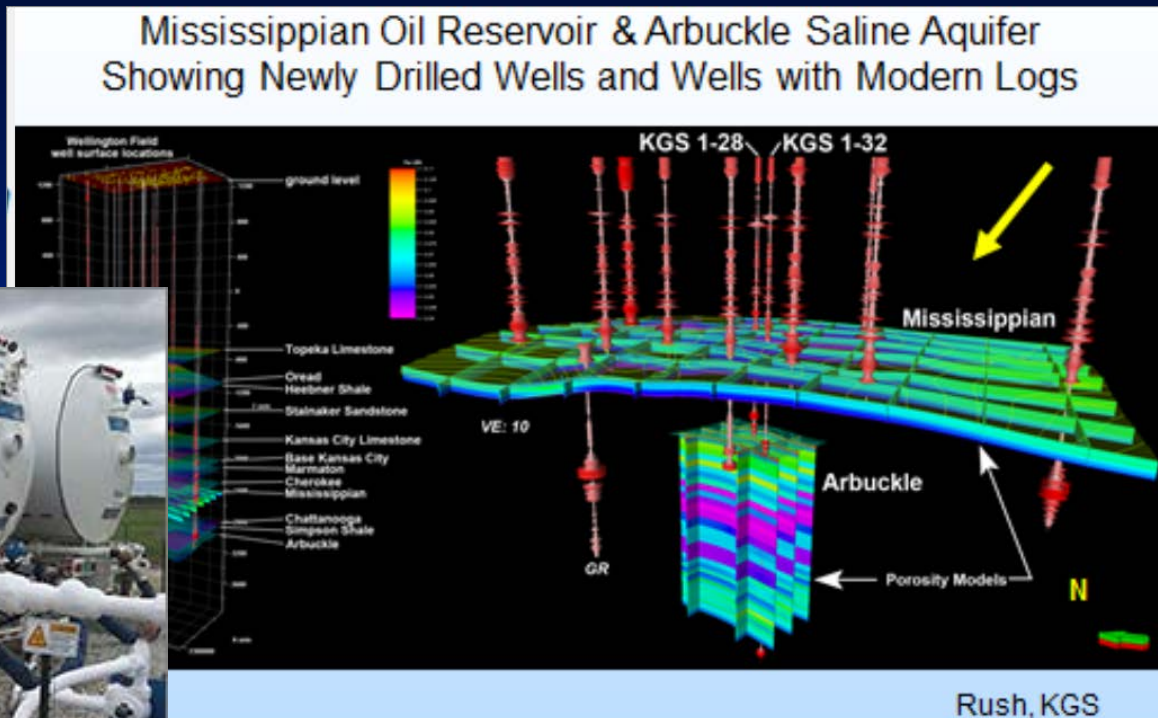


C12 Energy (2015)

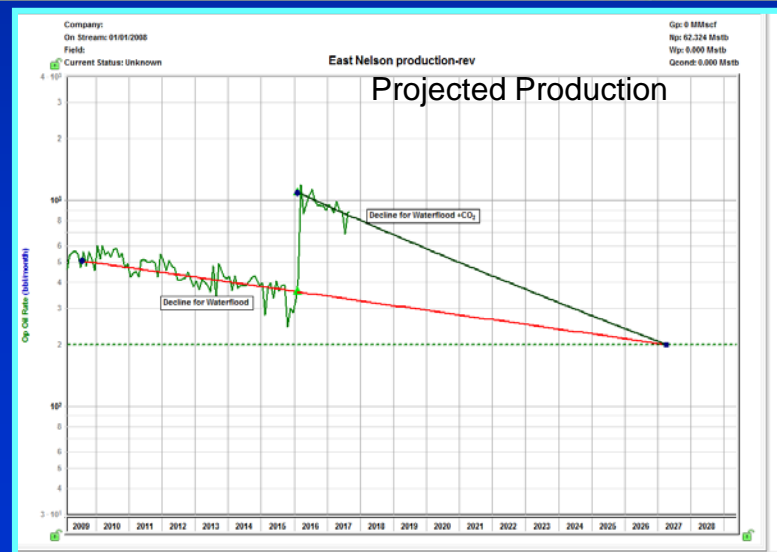
- Projected 10.7 MBO recovery from proposed Unit
- KCC denied pooling application

Berexco's (and KGS) Wellington Pilot (2016)

DOE-FE-006821

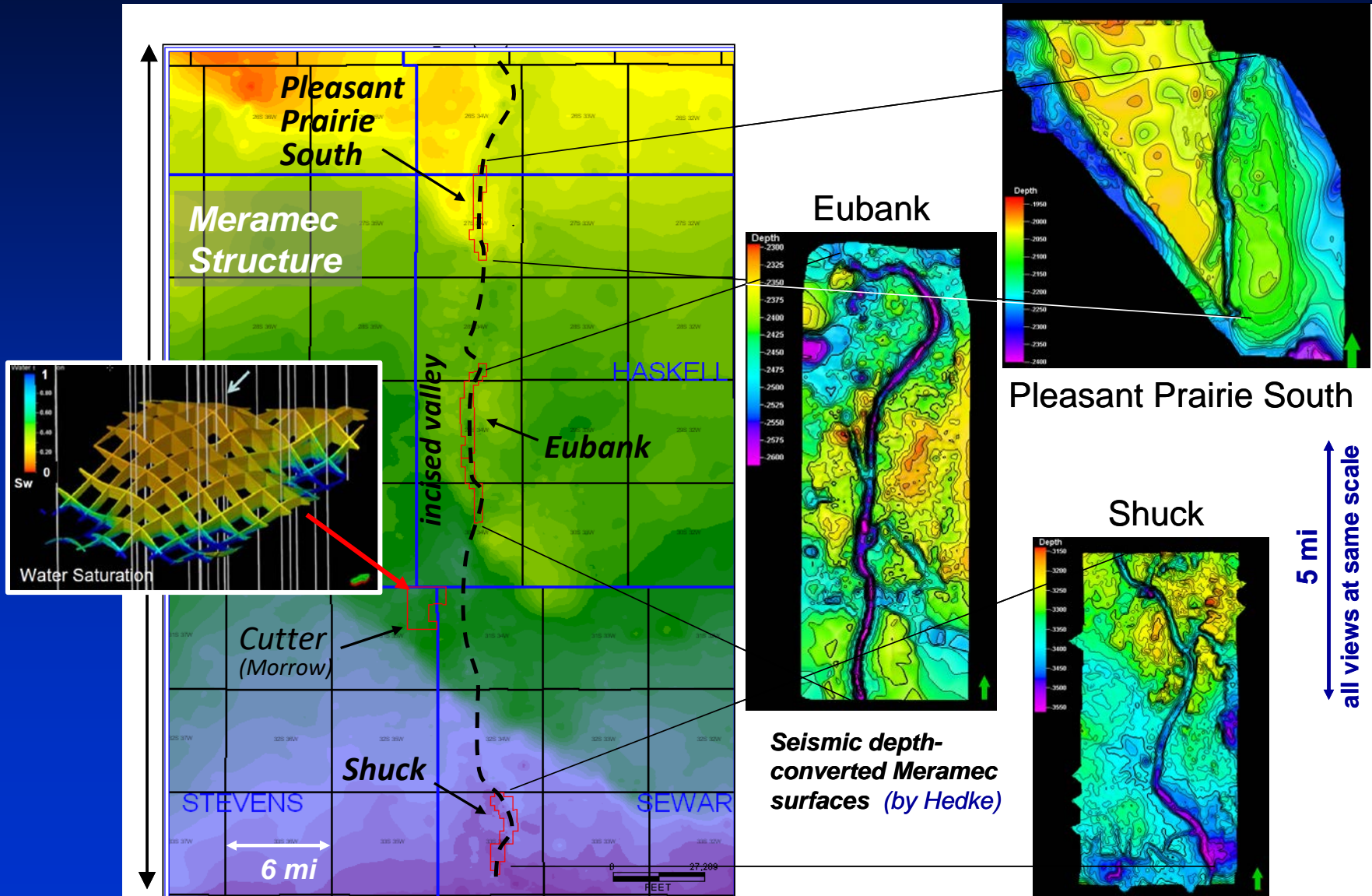


- Injected 374 mmcf CO₂ (19,800 tonnes) over 165 days through June 2016
- Projected Incremental oil - 32.4 mbo
- Projected Gross utilization: 11.5 mcf/BO



Four fields in KGS/DOE study “CO2 Ready”

Could take **2 Mt/yr** + **13.2 mmbo** from EOR



Pleasant Prairie So. Chester IVF

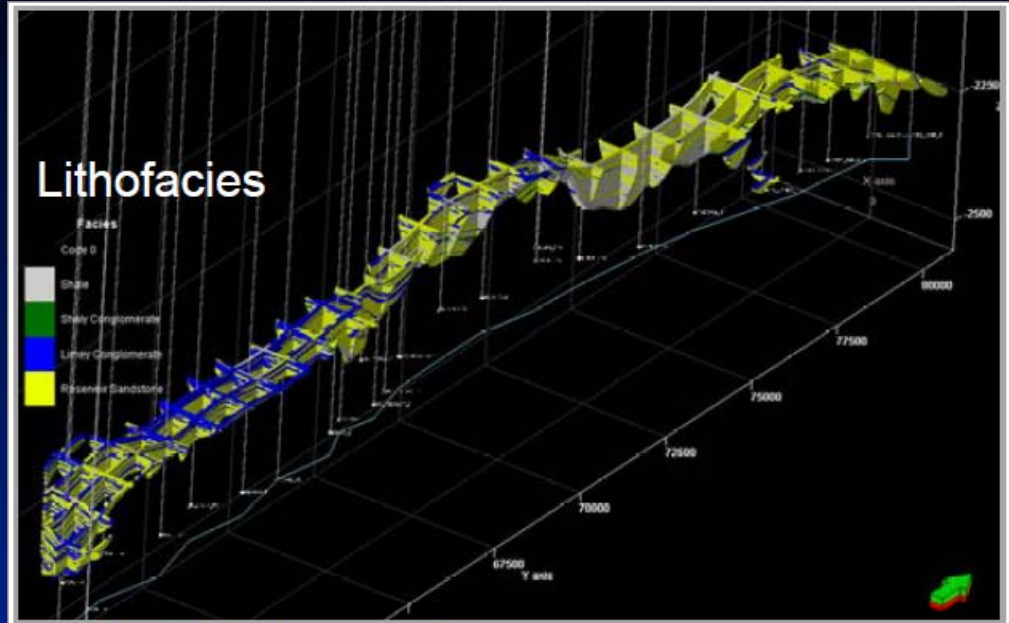
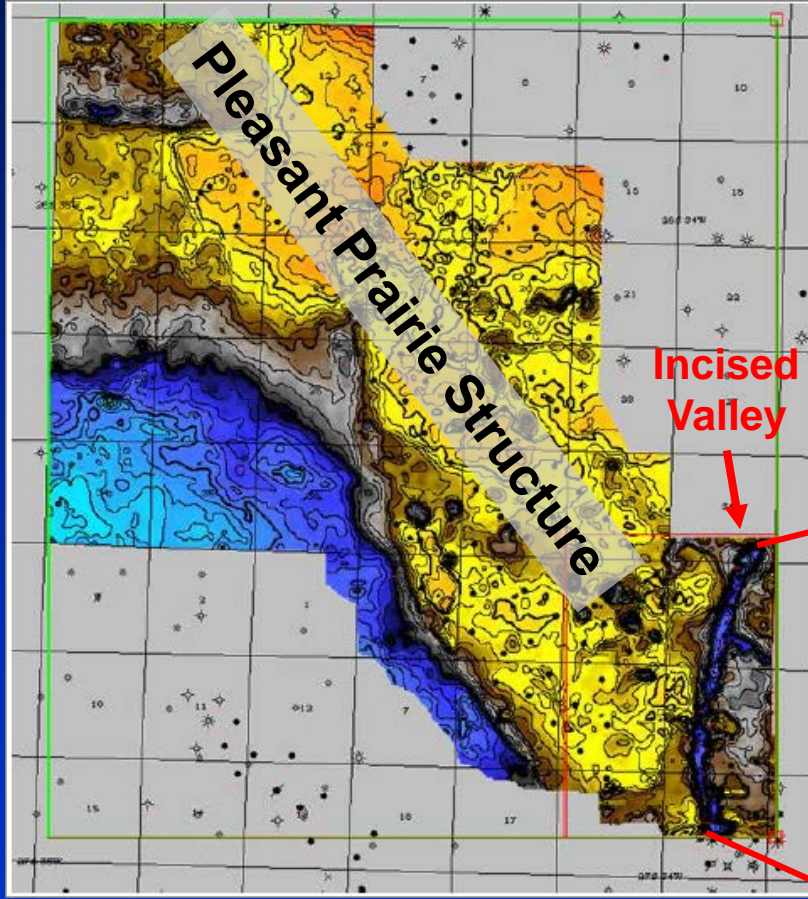
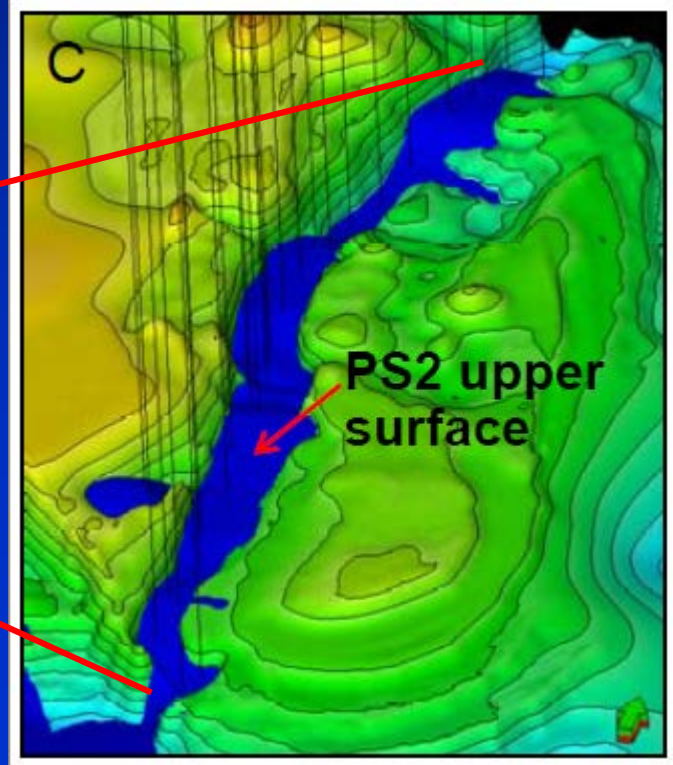
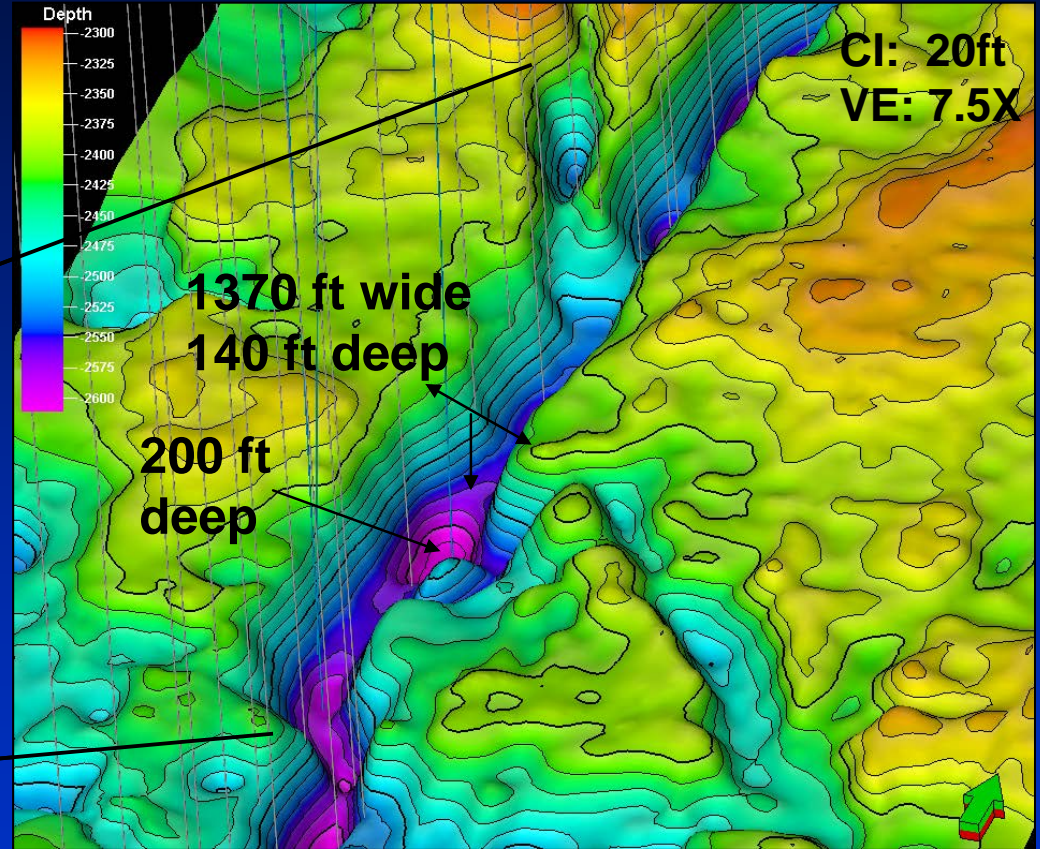
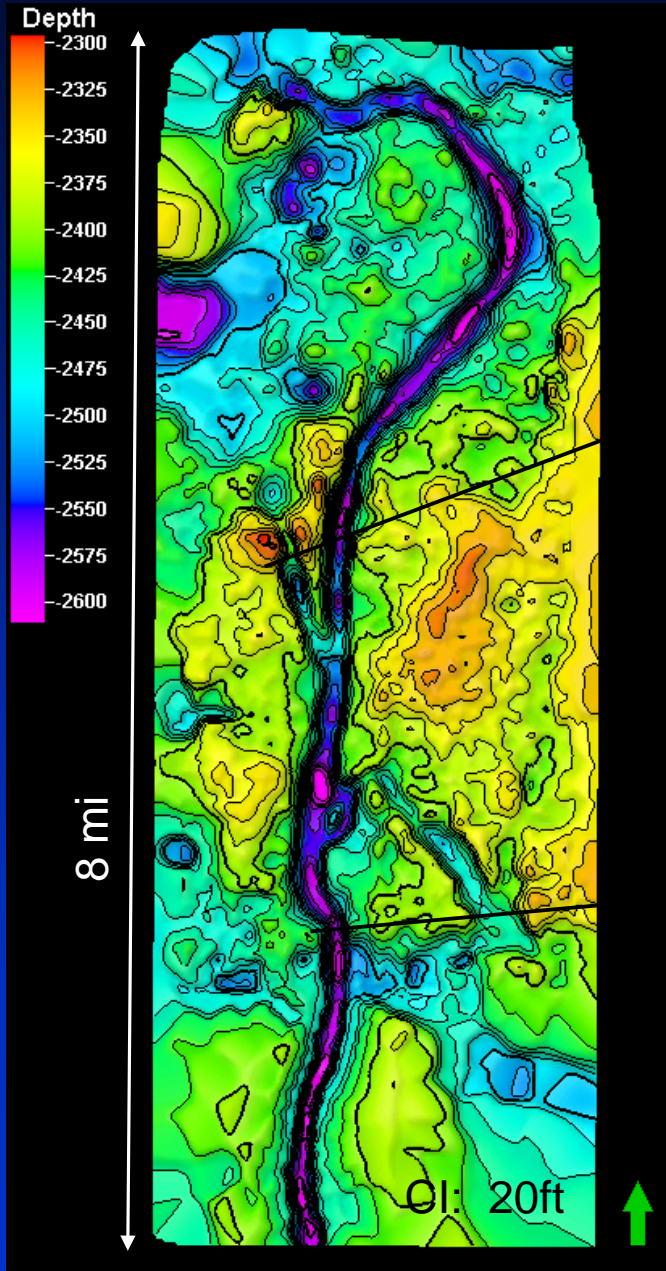


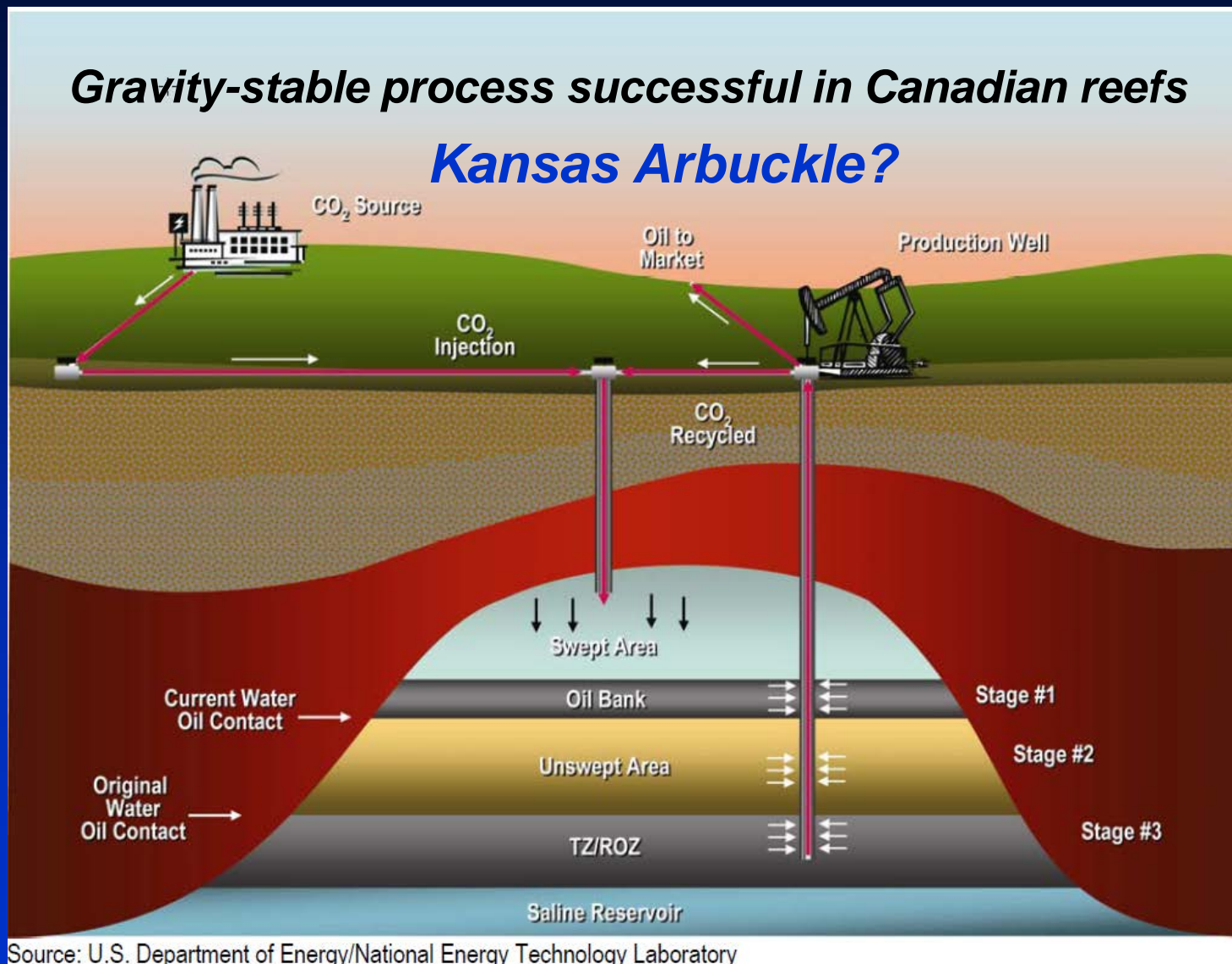
Fig. 6.14 Lithofacies model



Eubank North Unit Chester IVF



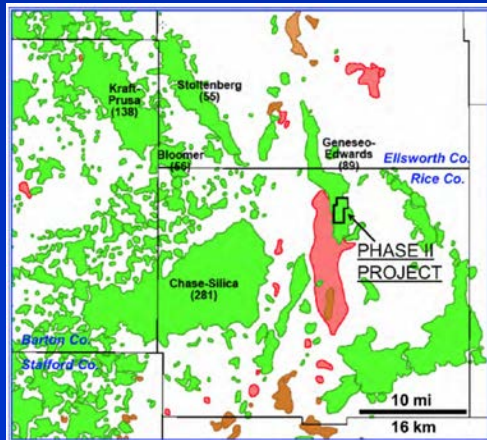
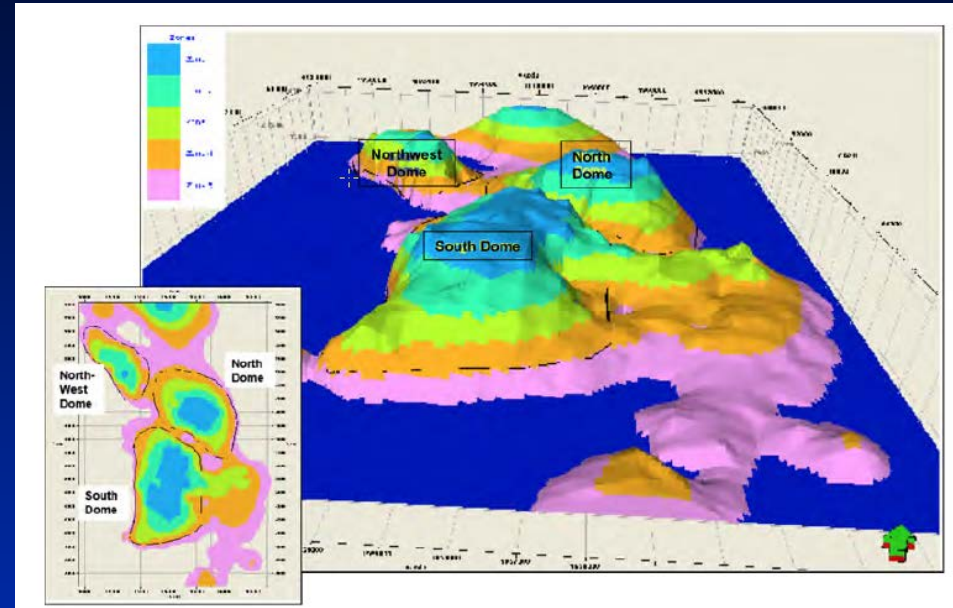
Here's the upside potential: Arbuckle



Geneseo-Edwards study

Kansas Ethanol, LLC (Lyons, KS) and CAP CO2, LLC, 2010

- 55 MGY plant 15 miles to Geneseo-Edwards oilfield
- Did not go forward
 1. Not funded in DOE Phase II
 2. Drop in oil prices
 3. Geologic risk



	Cumulative Oil (mmbo)			CO2 stored		Ethanol plant years
	Gross	Arbuckle	CO2 EOR	mmcf	Million Tonnes	
DOE Project	30.2	26.3	6.1	9,613	0.50	3.5
Balance Geneseo-Edwards	59.2	47.4	11.0	17,311	0.90	6.3
Stoltenberg	55.1	44.1	10.2	16,112	0.84	5.9
Bloomer	55.8	44.6	10.4	16,316	0.85	6.0
Kraft-Prusa	137.8	110.2	25.6	40,294	2.09	14.7
Chase-Silica	280.6	224.5	52.1	82,050	4.26	30.0
	618.7	497.1	115.3	181,695	9.4	66.4

Summary

- Kansas' resource base supports large scale CO2 EOR
- **4.3 Mt/yr** for 25 yrs and **250 mmbbo** (conservative) is a very big deal
- **\$12.5 Billion** in oil at \$50/BO

Discussion

- We need 5X the resource base identified today for a 25-yr project
- Question for you: Where is it?

Later today in open discussion

- Sometime, we (you) will need to work together (COOP model??) to justify pipeline and ethanol plant infrastructure.
- Can this happen?