

# Gulf of Mexico Depleted Field Example

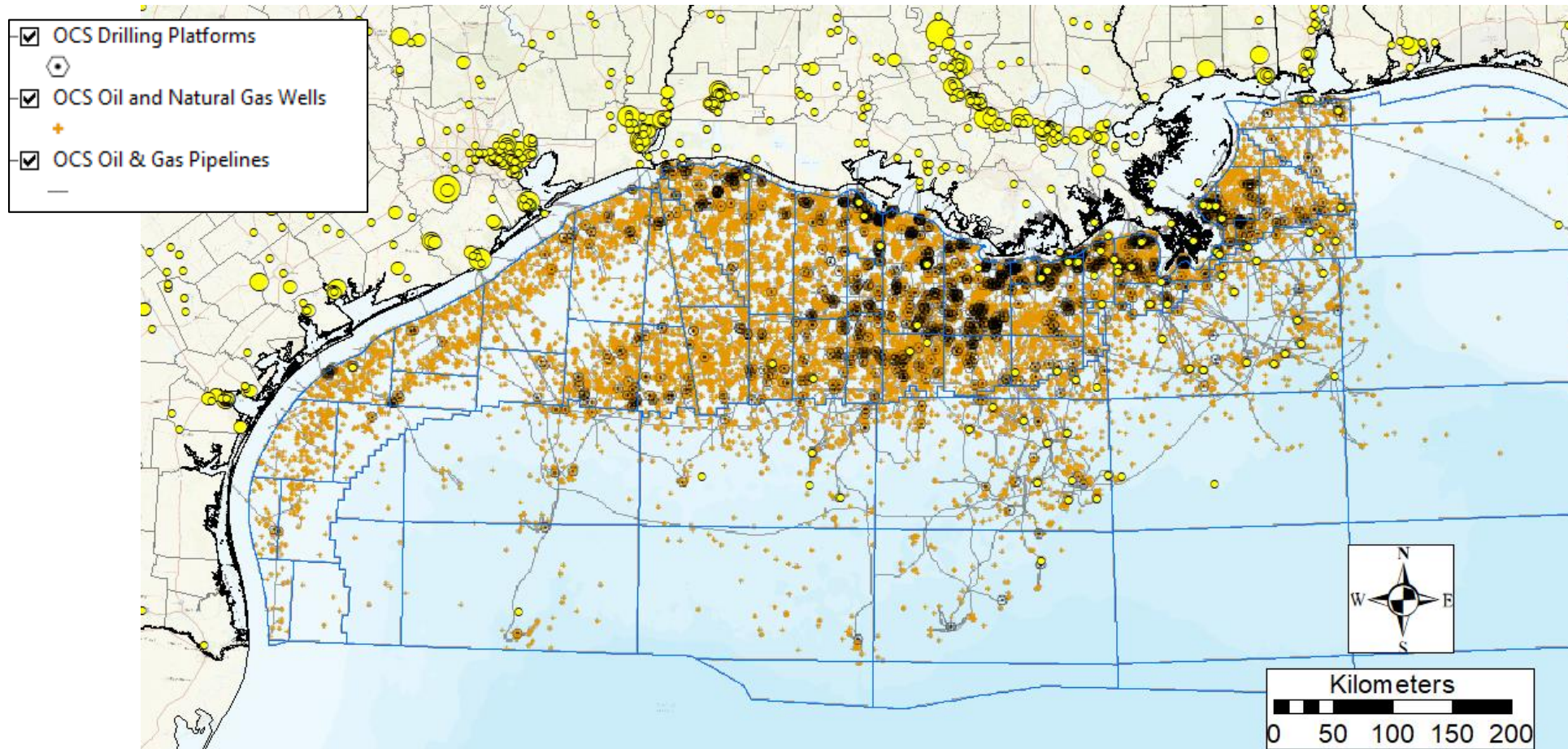
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BUREAU OF  
ECONOMIC  
GEOLOGY

# GoM CO<sub>2</sub> Sources and Offshore Infrastructure



# GoM Shelf Platform Stock

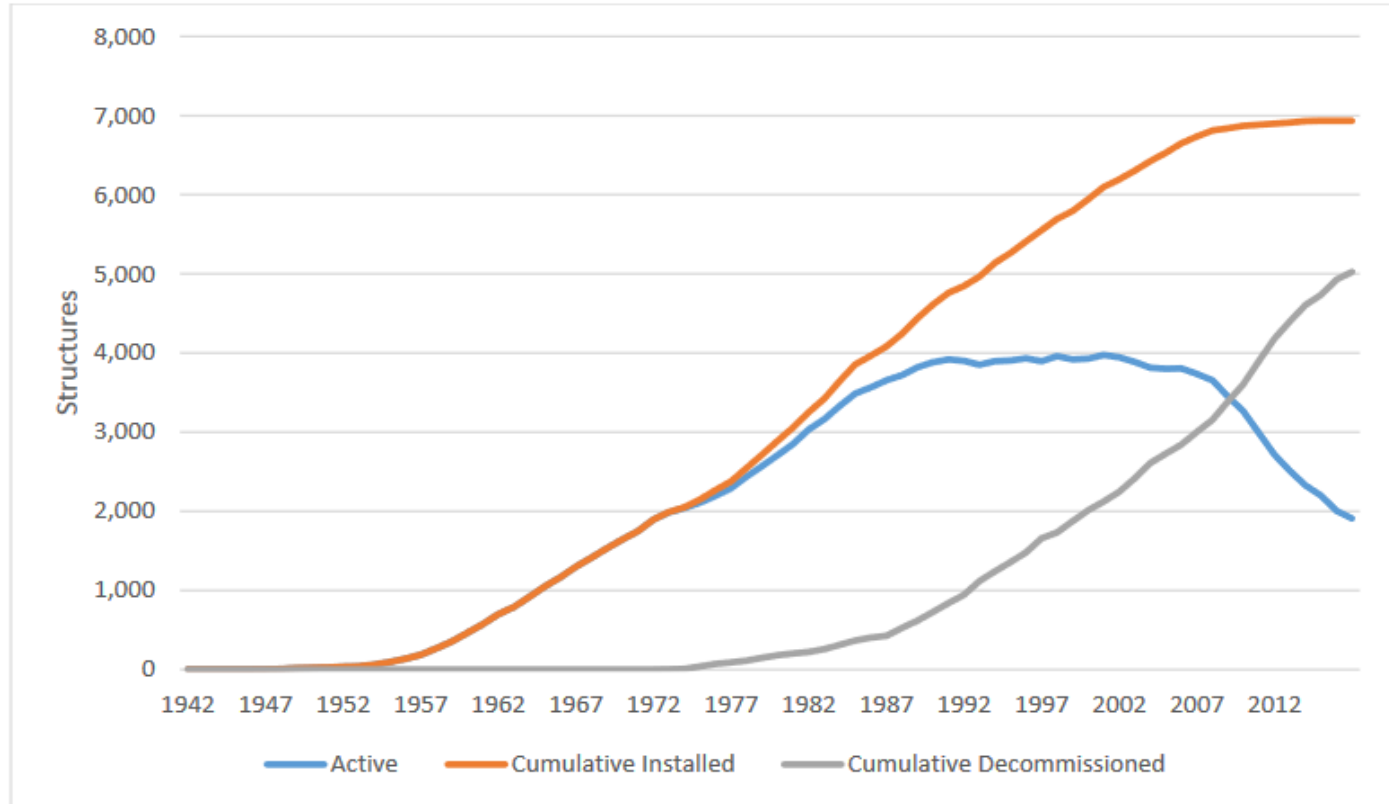


Figure A.8. Active structures in water depth less than 400 ft, 1942-2017

Source: BOEM, February 2018

# Anonymous Depleted Field



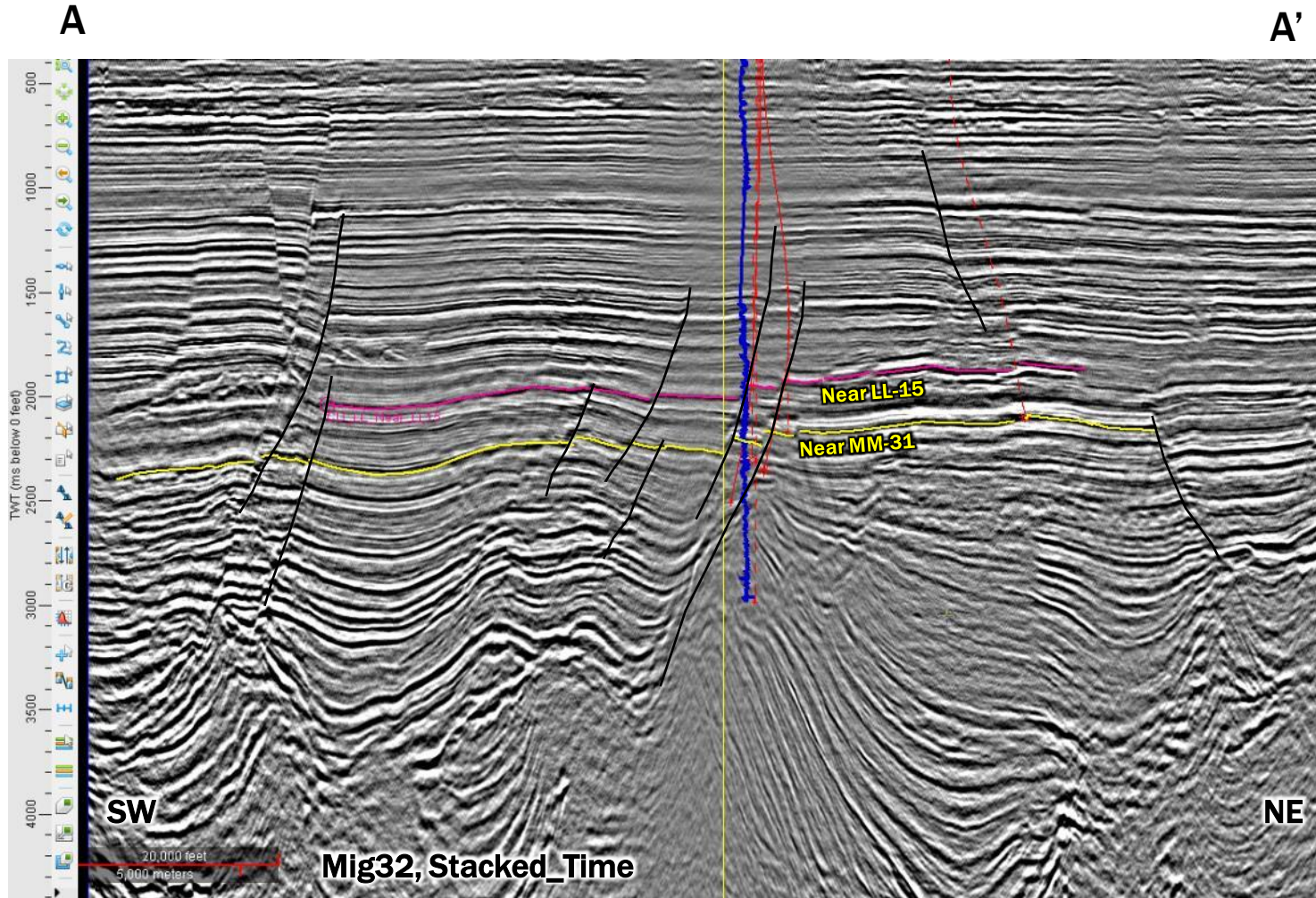
- Discovered in the early 1980s by a Major
- Produced both gas and oil
- 56 mmbbl liquids (oil and water)
- 315Bcf gas
- Fluid replacement would suggest ~30Mt CO<sub>2</sub> storage capacity

## Not so easy!

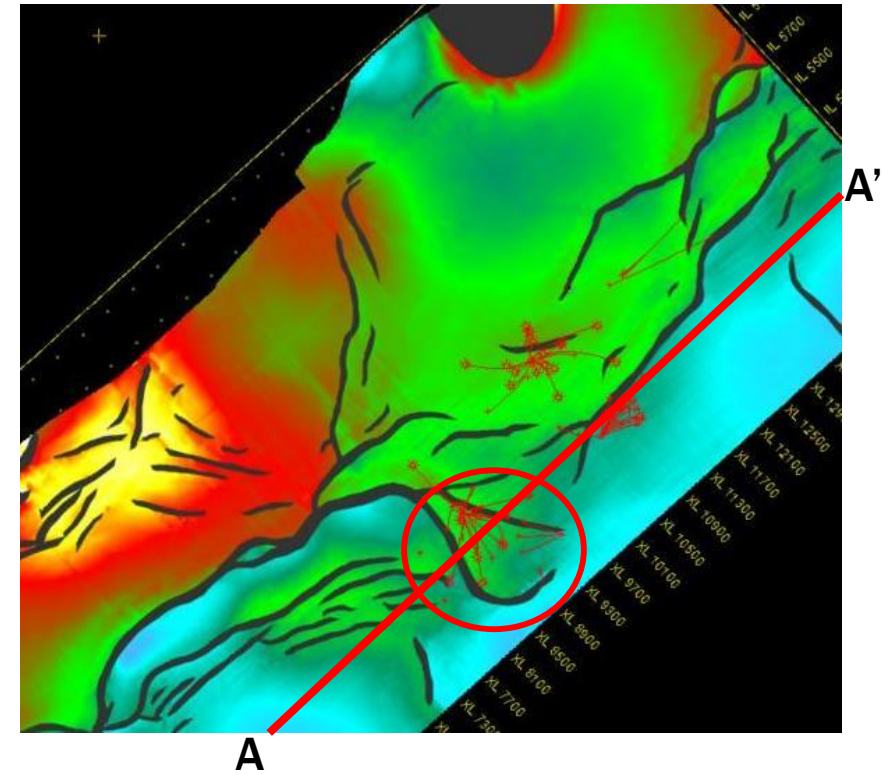
- Records mention half a dozen operators
- 20 wells and 61(?) bottom hole locations
  - All(?) wells sidetracked and/or recompleted, often multiple times
- Produced from 19 reservoirs



# Structure Map, Mid Miocene, Near MM31



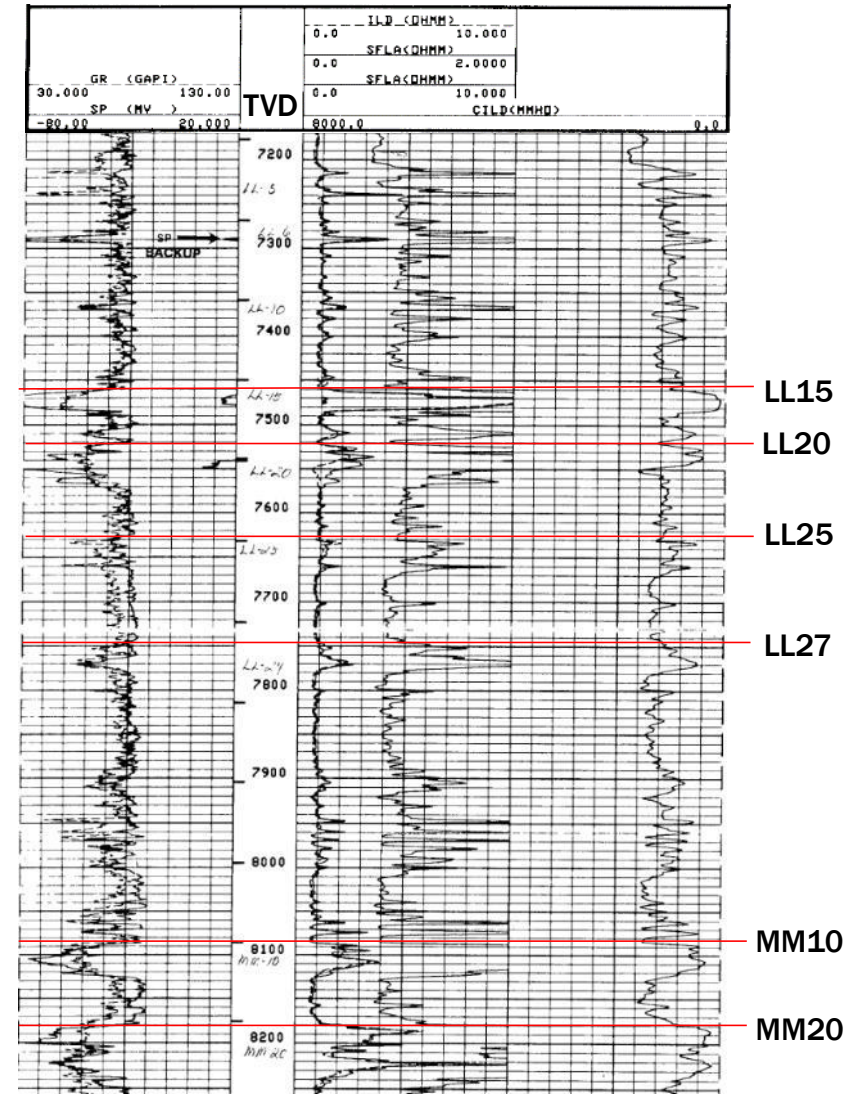
NAMSS data



# Reservoir Parameters

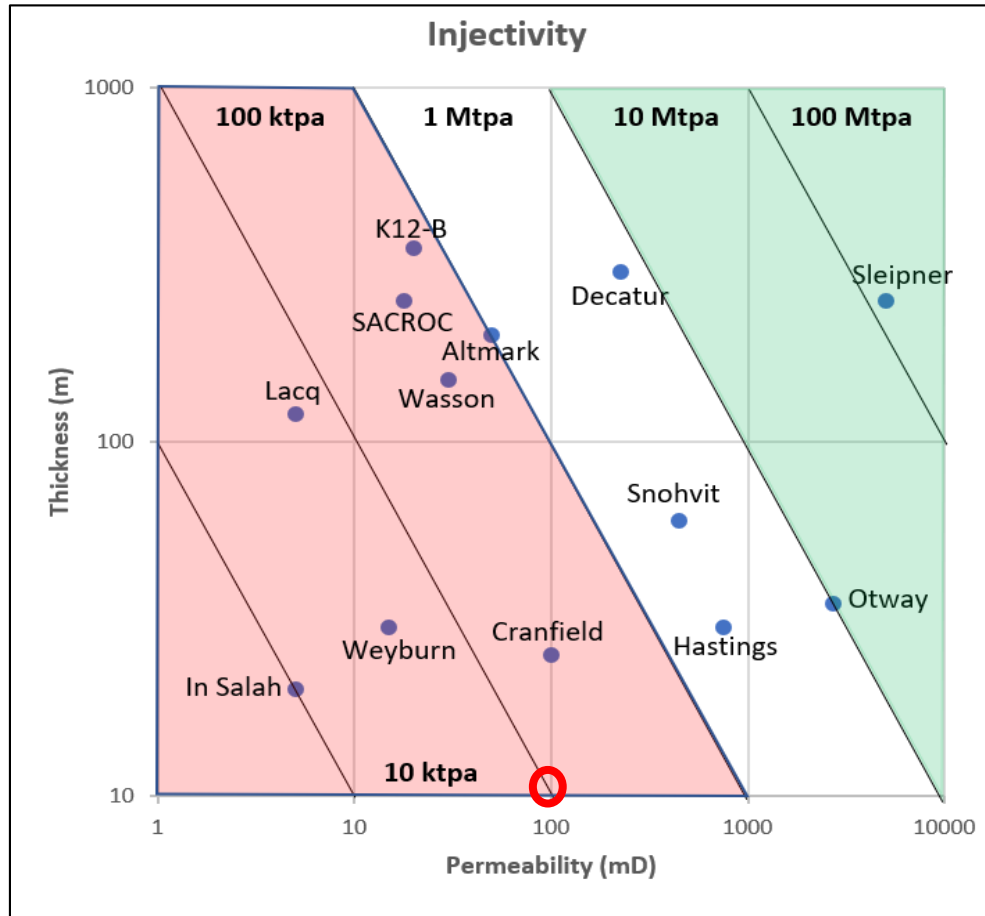
- Middle Miocene reservoirs
- Paralic depositional systems
  - Thin, channelized reservoirs
  - Moderate connectivity

Well	Section	Gross Thickness (ft)	Net Thickness (ft)	N:G ratio	Porosity
1	LL15	58	25	0.43	0.26
	MM10	194	43	0.22	0.22
2	LL15	48	18	0.38	0.28
3	LL15	46	17	0.37	0.26
	MM 20	96	62	0.65	0.24
	Shallow Section (5700'-6400') *more uncertainties	700	386	0.55	0.27





# Injectivity

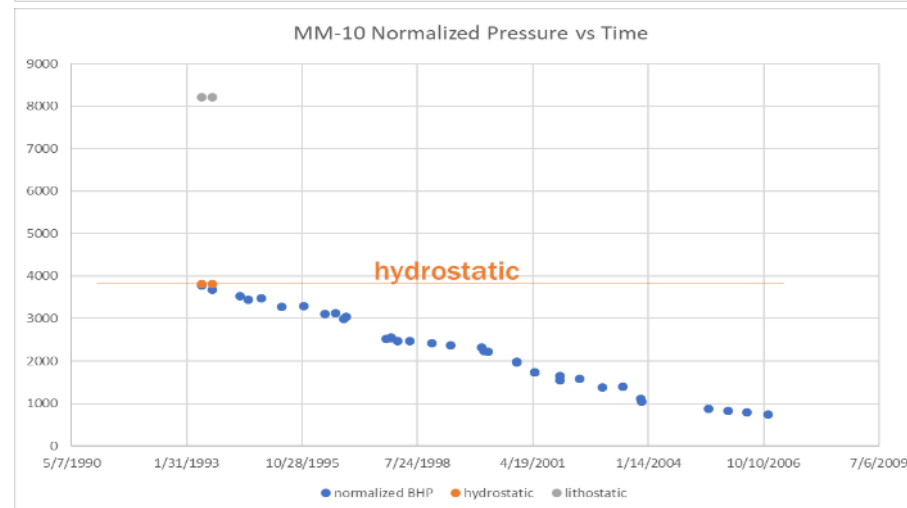
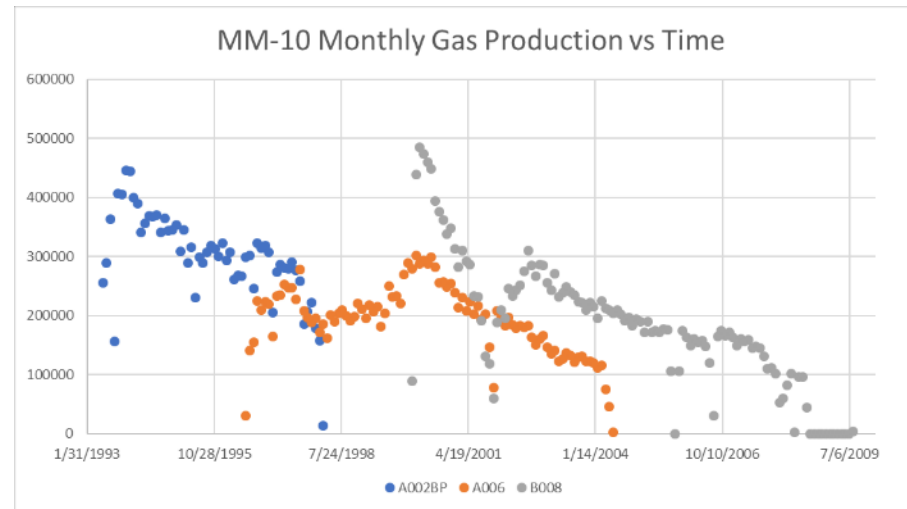


- Typical reservoir sand
  - ~100mD average permeability
  - 10m thickness
- Expect injection rates of ~100kt (kilotons)/well/year.
- Deviated wells or multi-zone completions could improve rates

After Hoffman et al, 2015

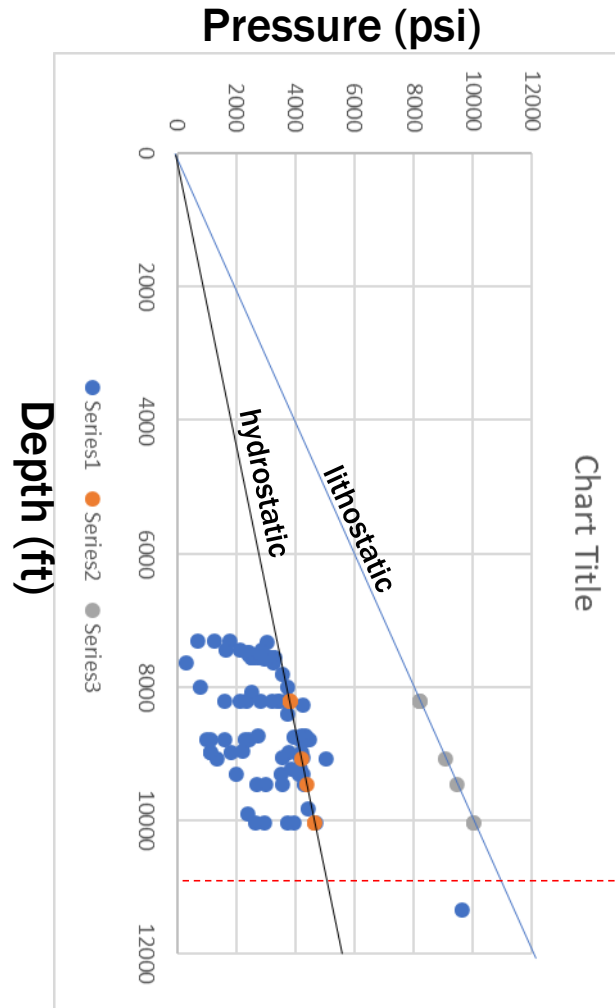
# Production by Reservoir

reservoir	Cumulative production		
	oil (mmbbl)	gas (Bcf)	water (bbl)
00-10	0.13	41.47	0.06
00-10L	3.16	4.55	1.17
LL-10	0.60	17.66	0.69
LL-15	20.20	14.14	24.48
LL-20	0.10	1.01	1.25
LL-25	0.06	12.78	0.15
LL-27	0.06	12.75	0.15
LL-6	0.05	12.81	0.09
MM-10	0.41	56.91	0.13
MM-20	0.39	50.50	0.20
MM-31	0.11	11.44	0.13
MM-40	0.07	9.88	0.01
MM-41	0.03	1.41	0.02
MM5/MM6	0.11	21.90	0.68
MM50	0.24	17.89	0.12
MM60	0.38	16.73	0.56
MM7/MM5/6	0.04	3.17	0.59
OO-10	0.02	8.32	0.14
OO-20	0.00	0.03	0.00
total	26.17	315.36	30.61





# All pressures vs depth



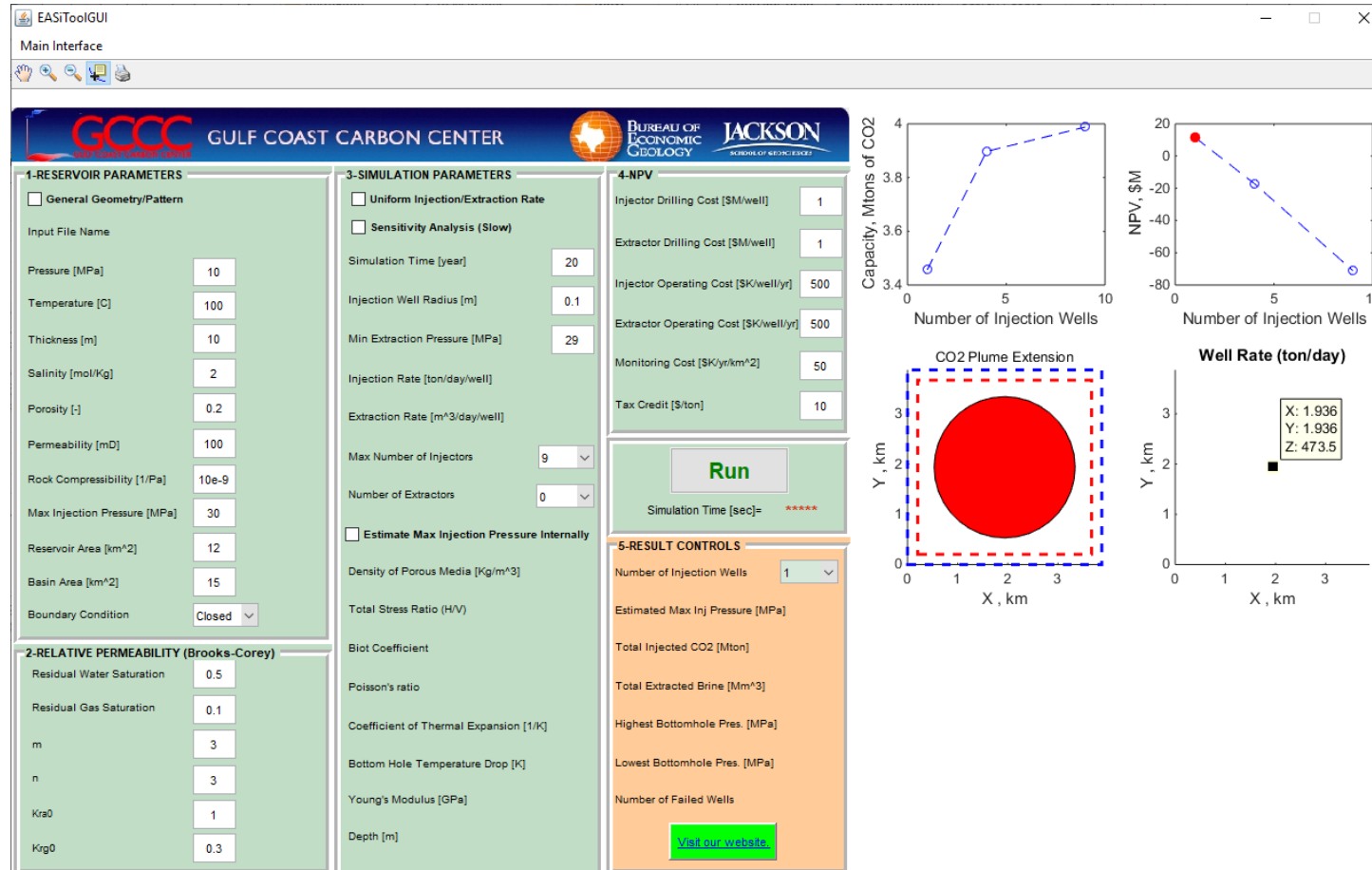
Top of overpressure ~11000 ft  
(Burke et al map top OP at ~8500ft)

Blue dots=all observed pressures

# Fluid Replacement Calculation Results

reservoir	Cumulative production			Replacement volume CO2 (Mt)		
	oil (mmbbl)	gas (Bcf)	water (bbl)	50% SE	75% SE	100% SE
00-10	0.13	41.47	0.06	1.66	2.5	3.33
00-10L	3.16	4.55	1.17			
LL-10	0.60	17.66	0.69			
LL-15	20.20	14.14	24.48	3.86	5.79	7.72
LL-20	0.10	1.01	1.25			
LL-25	0.06	12.78	0.15			
LL-27	0.06	12.75	0.15			
LL-6	0.05	12.81	0.09			
MM-10	0.41	56.91	0.13	2.84	4.27	5.69
MM-20	0.39	50.50	0.20	2.54	3.81	5.08
MM-31	0.11	11.44	0.13			
MM-40	0.07	9.88	0.01			
MM-41	0.03	1.41	0.02			
MM5/MM	0.11	21.90	0.68			
MM50	0.24	17.89	0.12			
MM60	0.38	16.73	0.56			
MM7/MM	0.04	3.17	0.59			
OO-10	0.02	8.32	0.14			
OO-20	0.00	0.03	0.00			
total	22.854	260.980	29.243			

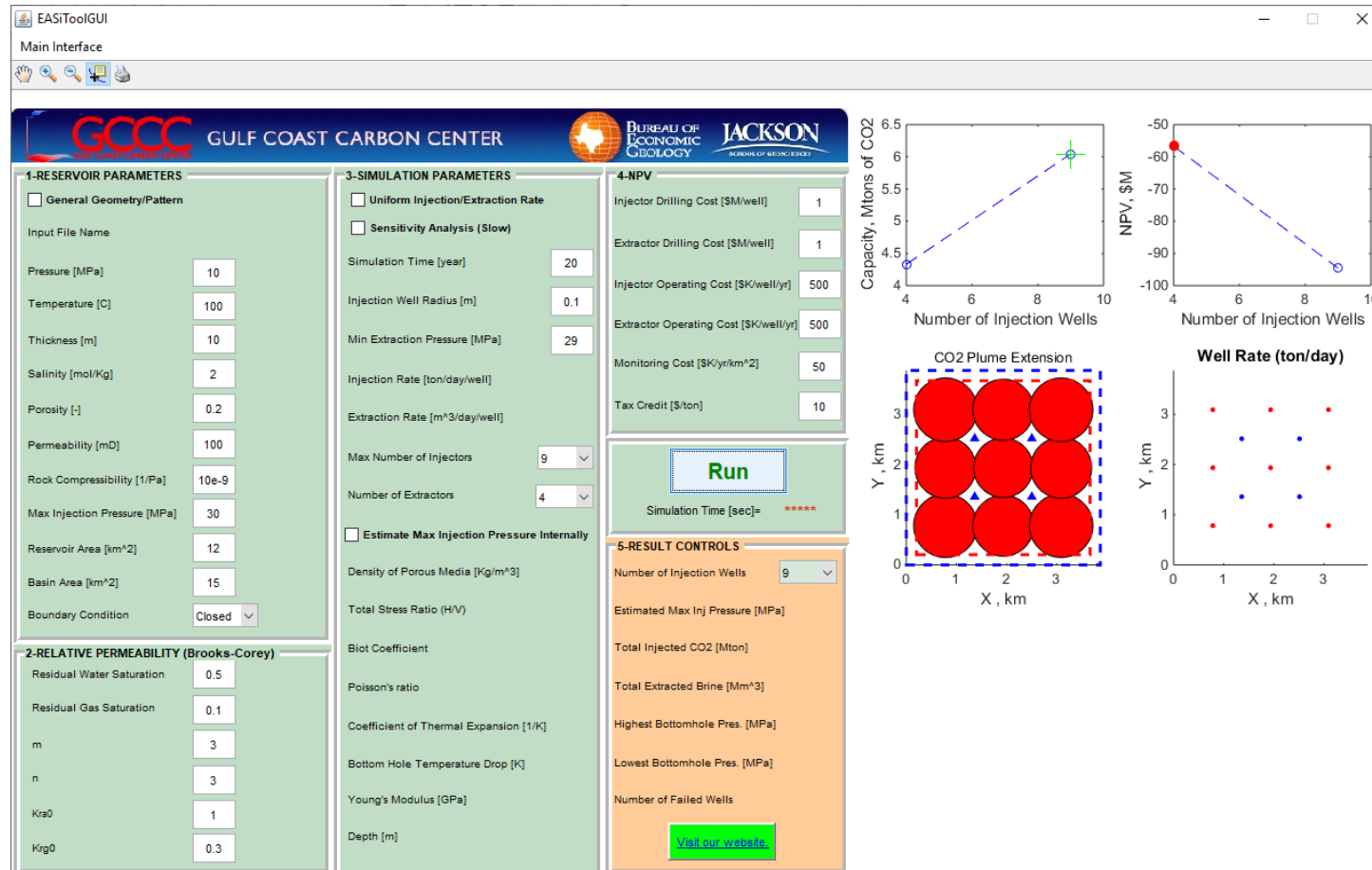
# Bottom-up Capacity: ~4Mt/reservoir



- Quick-look assessment based on reservoir properties and pressure build-up
- Indicates capacity of ~4Mt/reservoir
- Depends on number of wells and injection rate
- **Software can't completely honor the pressure space available—actual capacity is likely a bit higher (5-6Mt per reservoir?)**

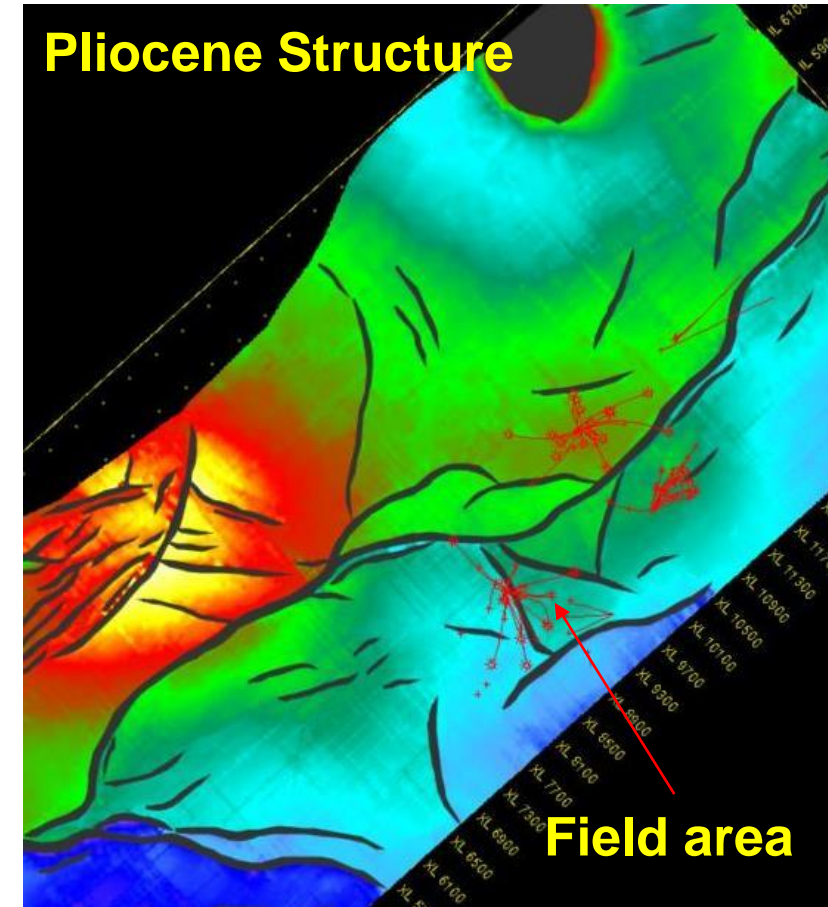
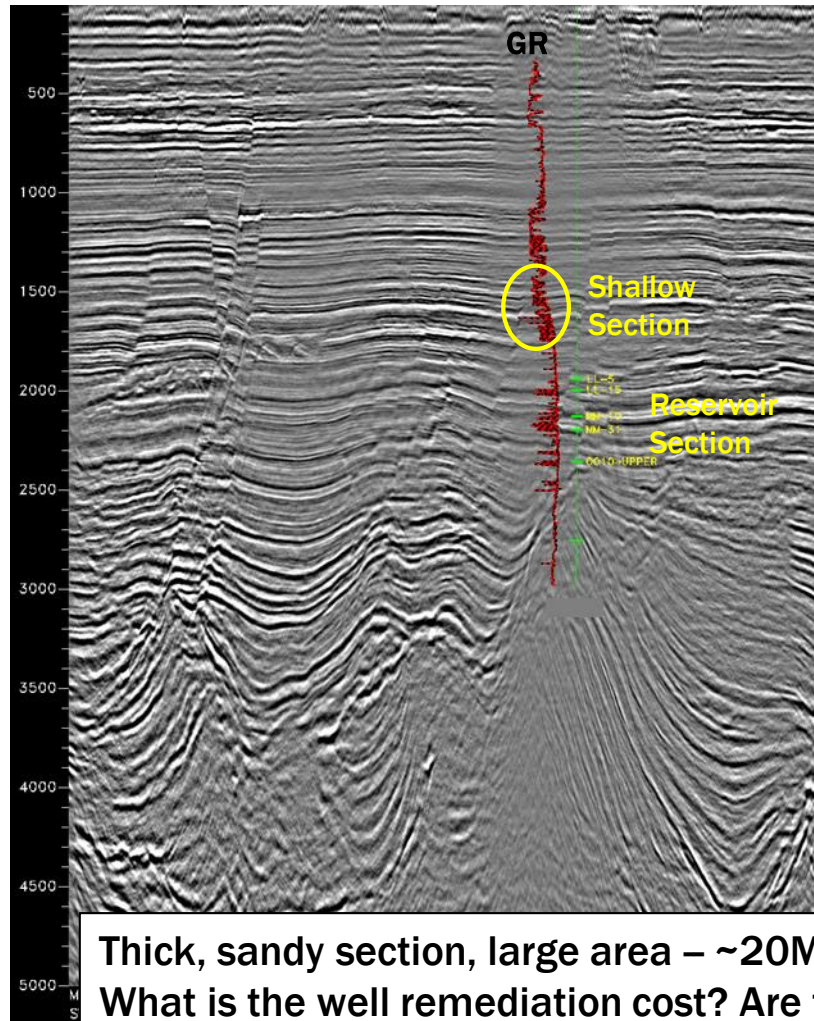
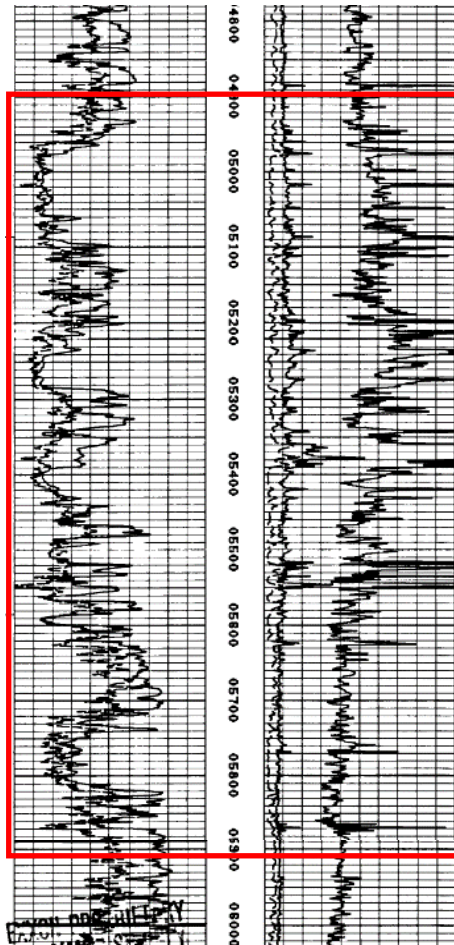


# 5-6Mt/reservoir with water extraction



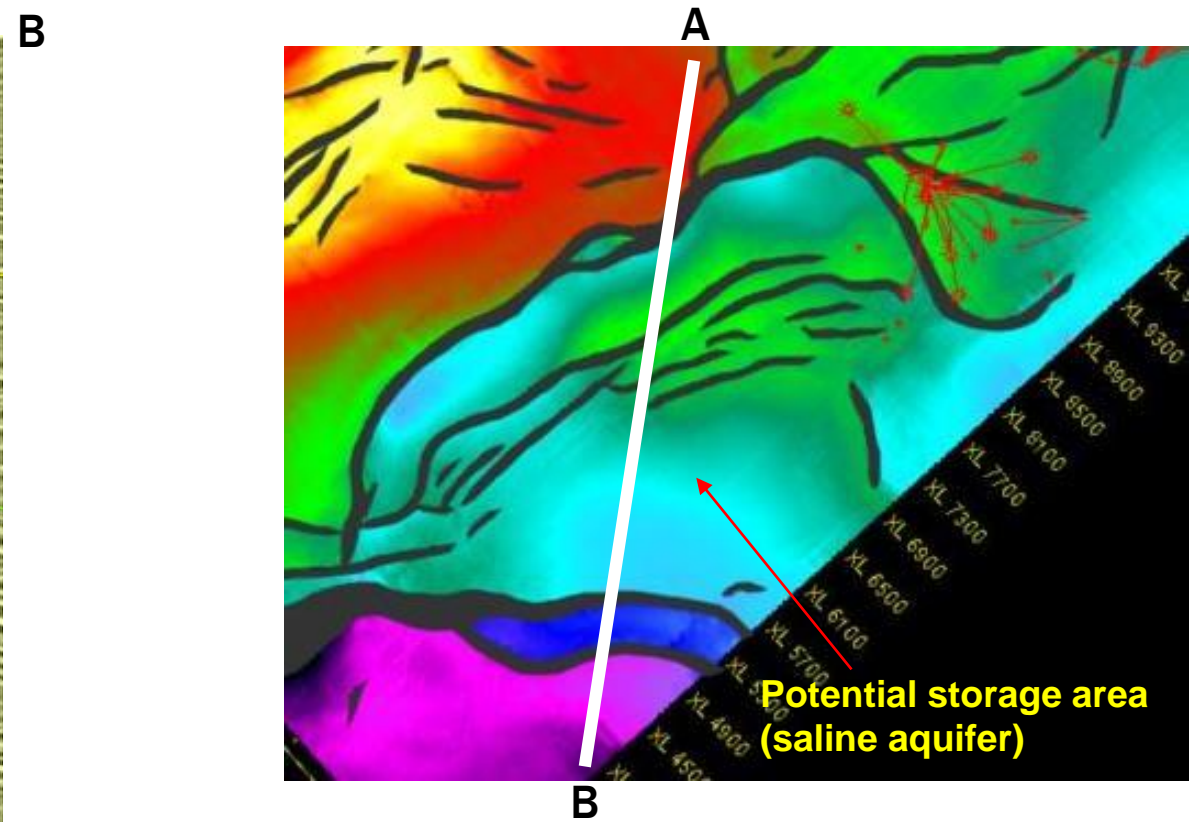
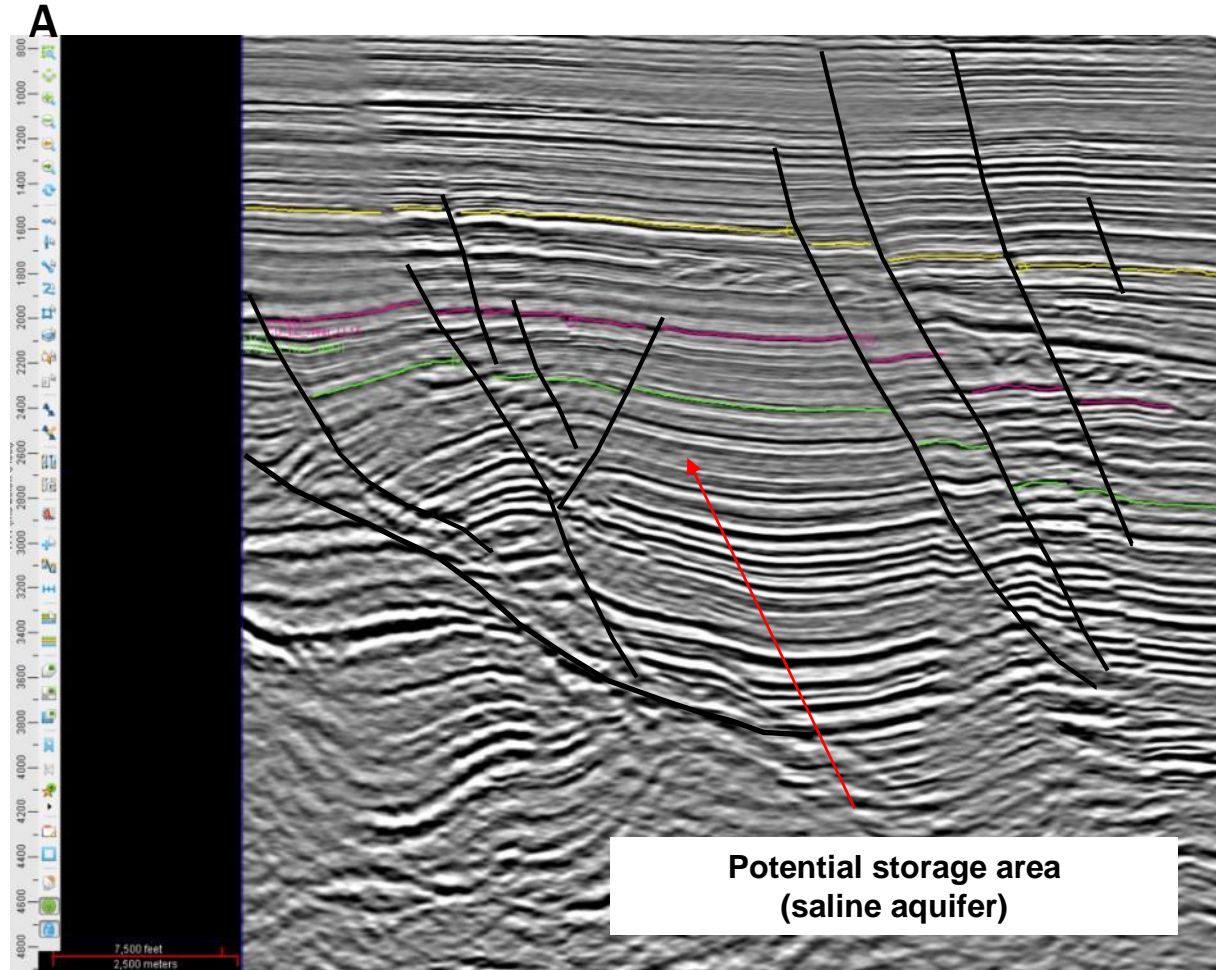
- Adding water extraction allows further pressure management
- Indicates capacity of ~5-6Mt/reservoir
- Depends on number of wells and injection rate
- **Can't completely honor the pressure space available—actual capacity is likely a bit higher (7Mt per reservoir?)**
- **Note that CO2 break-through and/or water disposal may limit this strategy**

# Alternative #1: Shallow Sandy Section





# Alternative #2: Injection in water leg



Lateral equivalent of proven reservoirs and seals and a much larger fault block (better pressure dissipation) but would require a long step-out and new leases. ~20Mt capacity



# Summary

- ~5Mt storage capacity in each of the 4 major reservoirs
- Capacity could be increased with
  - Addition of other reservoirs
  - Water extraction (subject to water disposal and managing CO<sub>2</sub> breakthrough)
- Low injectivity will limit injection rates, subject to well design
- Options for growth
  - Target the shallow section
    - Looks promising but needs characterization
    - What is the well remediation cost?
  - Target the water leg of the producing reservoirs in adjacent fault blocks
    - Lateral equivalent of proven reservoirs and seals
    - Long step-out—would require clever engineering and new acreage