

The Arbuckle Group as a Resource

David Newell, Shelby Peterie, Richard Miller, and Rolfe Mandel
Kansas Geological Survey

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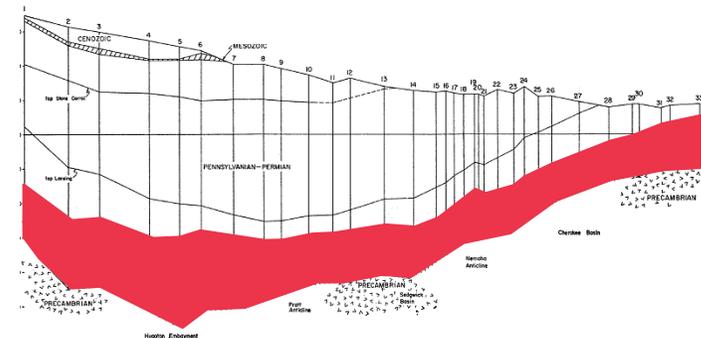
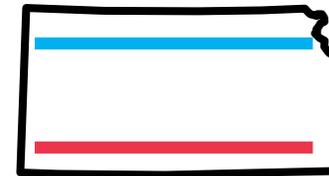
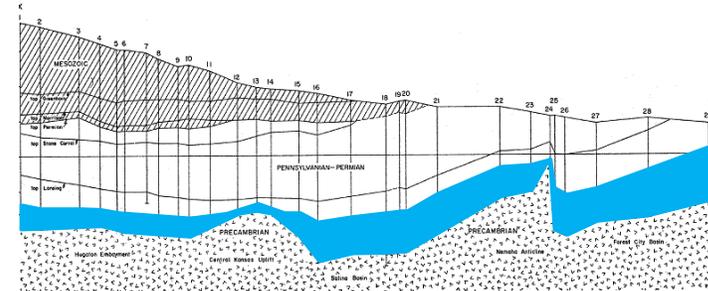


Why are we concerned? Why now?

- 30 years ago Arbuckle seemed like the perfect geologic interval
 - prolific producer of oil
 - seemingly infinite pore space for disposal, underpressured
 - deep below ground surface with multiple sealing intervals above
 - endless fresh water supply
- Today the Arbuckle shows multiple symptoms of possible environmental impact
 - origin of unprecedented seismicity trigger
 - increasing potential source of contamination of fresh water aquifers
 - potential for artesian flow in the near future
- Could have significant economic impact
 - over a billion \$ annually related to use of Arbuckle
 - Industry taxes, jobs, local economic impact, support community, future expansion

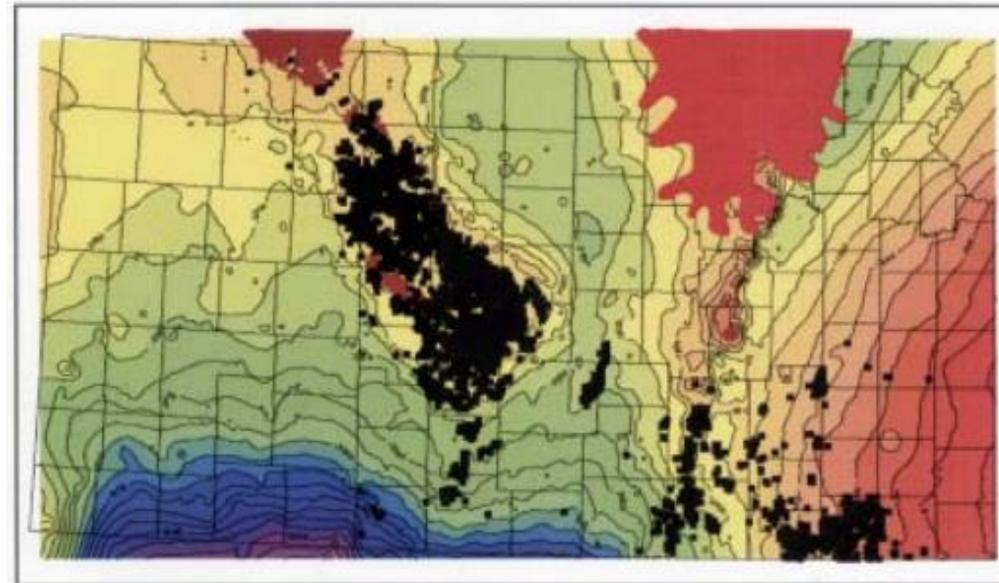
What is the Arbuckle Group?

- Thick sequence of sedimentary rocks
 - directly above basement (granite) rocks
 - highly permeable intervals
 - vital to many industries in Kansas
- There is a lot we don't know
 - large number of unmapped faults
 - highly variable zones/areas
 - water chemistry (in situ and disposal fluids)
 - fluid levels/pressure
 - fluid flow
- Why so much variability in characteristics and properties of the Arbuckle across the State?
- Clear need for regional framework for building localized understanding to optimally use

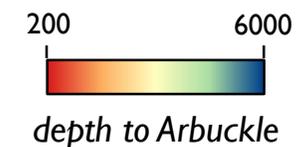


Uses of the Arbuckle

- Oil and gas (KCC)
 - *production*
 - oilfield brine disposal
- Industrial waste disposal (KDHE)
 - hazardous and non-hazardous
 - oil refining
 - product storage
 - chemical manufacturing
 - food production
- Drinking water (KDHE)
 - municipal water treatment
 - freshwater source
- CO₂ sequestration (EPA)

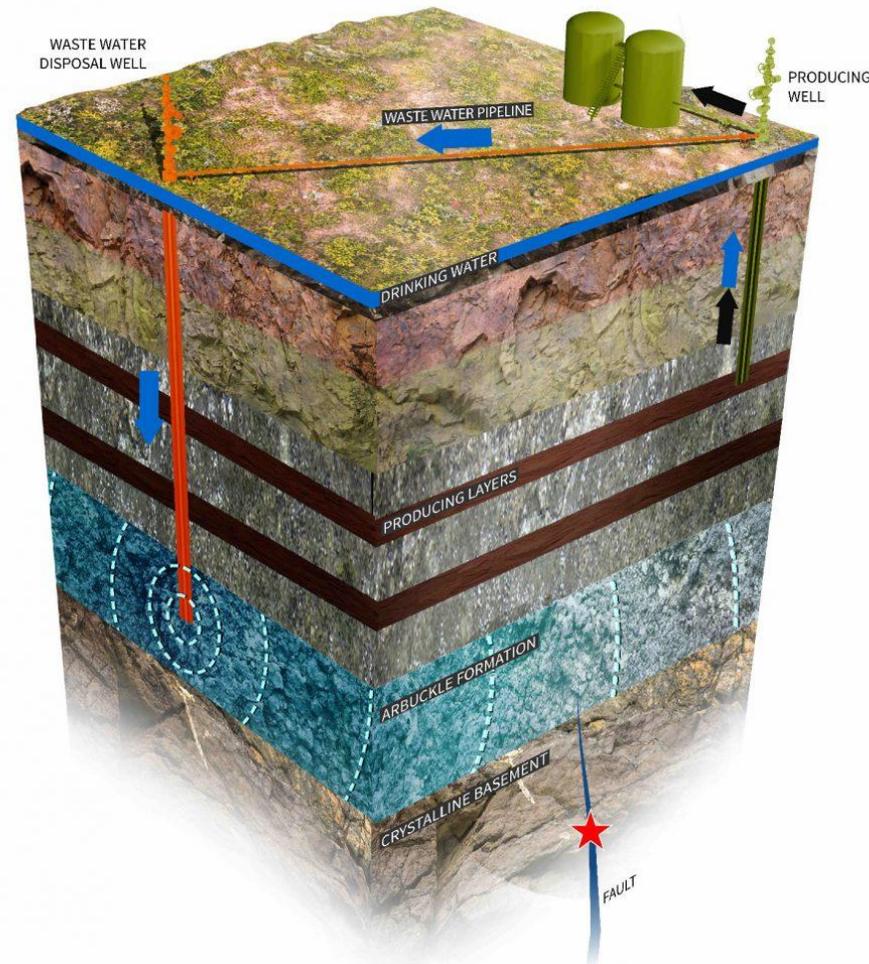


● = Arbuckle production well



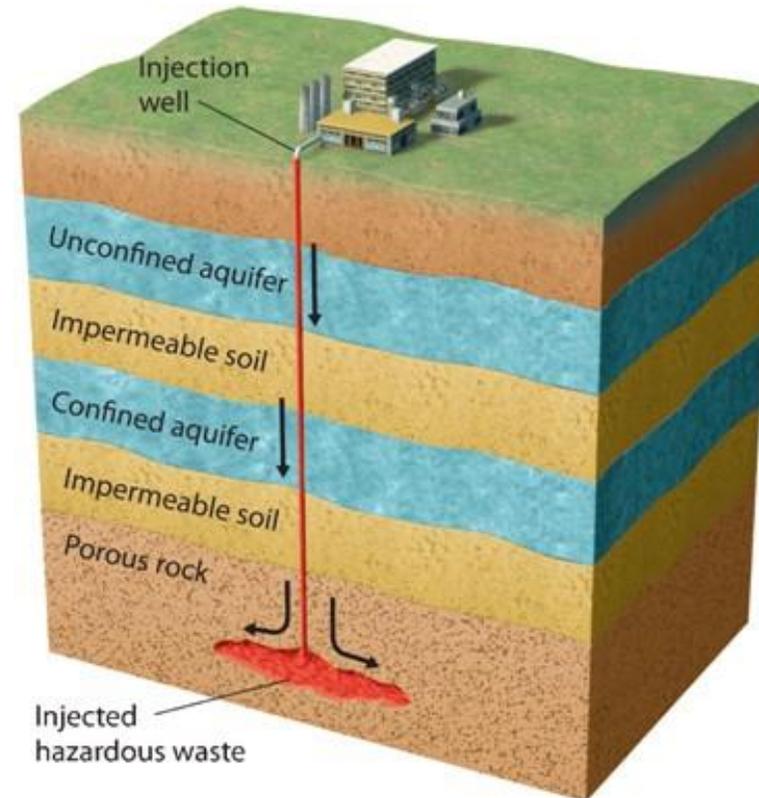
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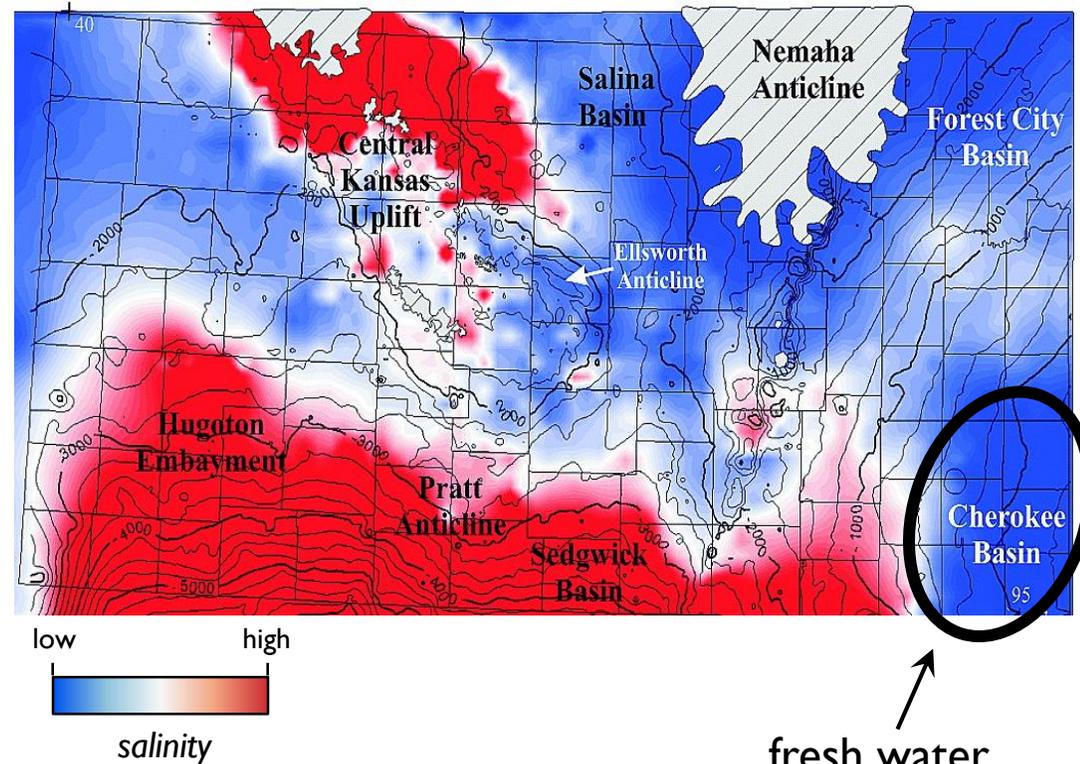
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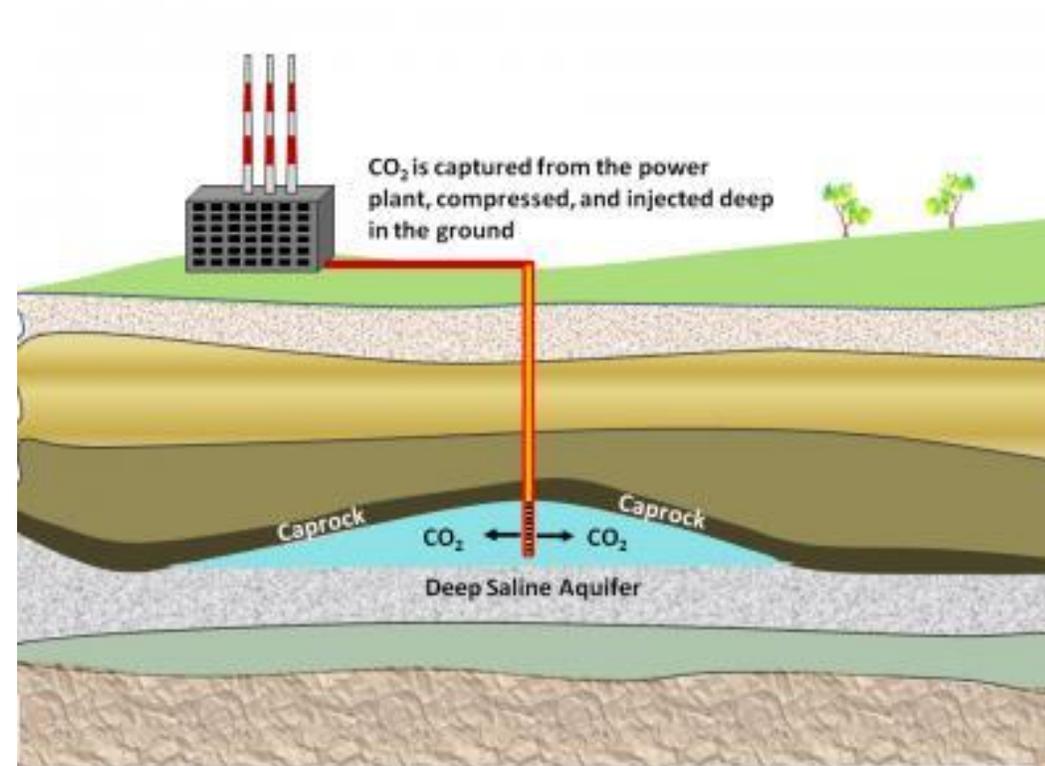
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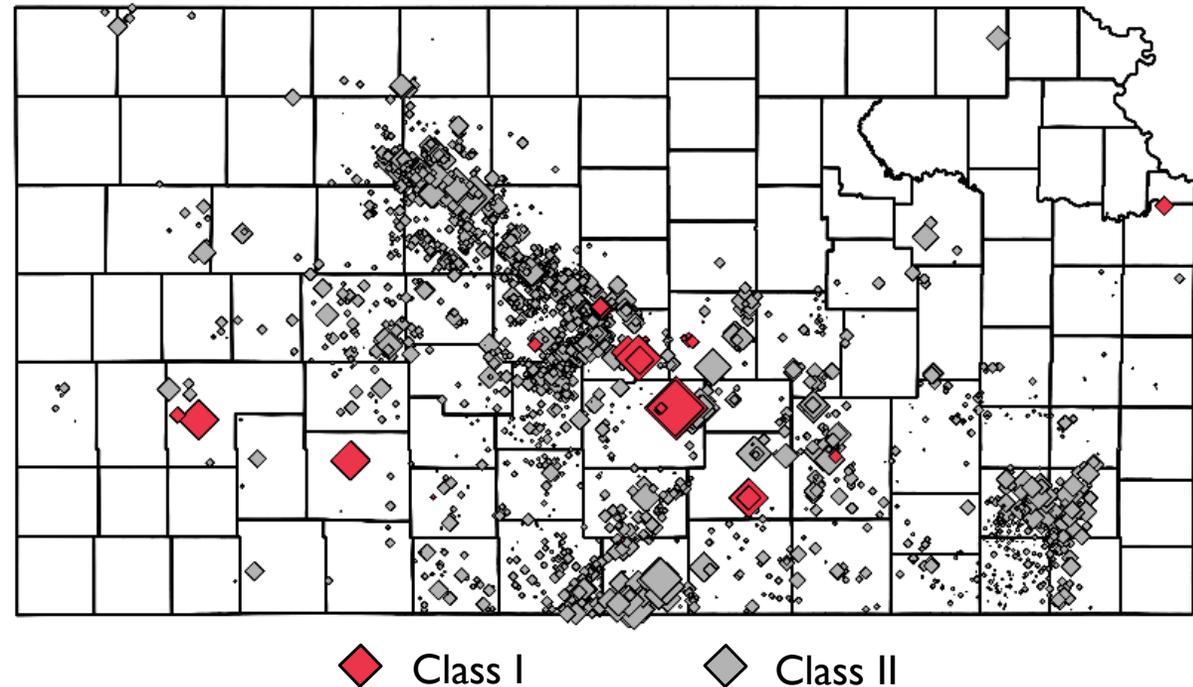
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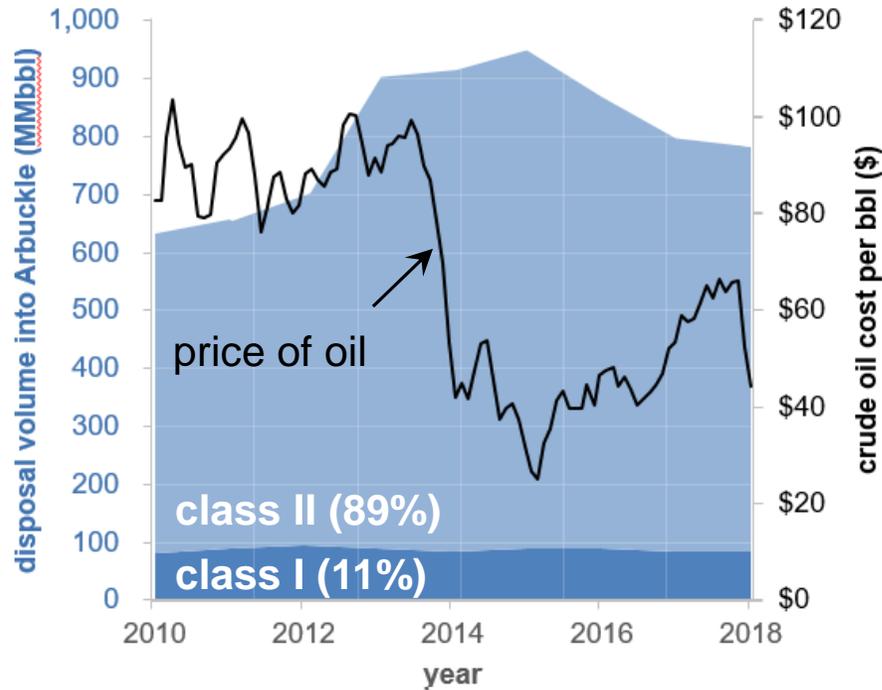
Arbuckle Disposal

- Class I wells: 49
 - industrial and municipal waste
 - gravity feed
 - monitored and tested
- Class II wells: > 2,000
 - oilfield brine (extracted during production)
 - pressurized
 - less monitoring/testing

active Arbuckle disposal wells (2018)



Arbuckle Usage Statistics

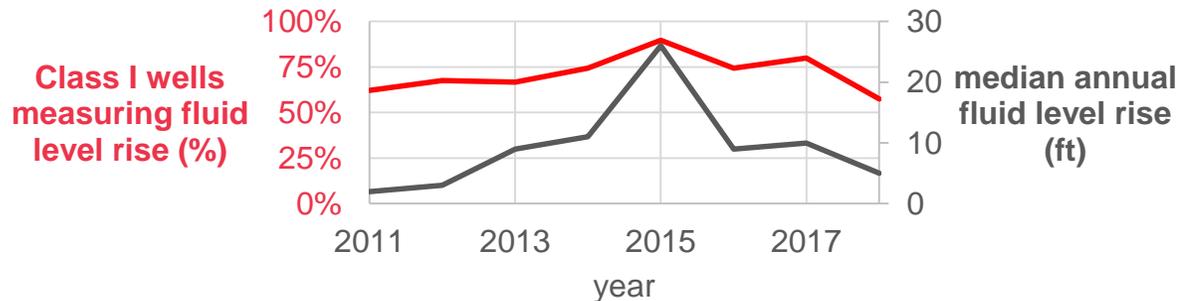


- Input–Output

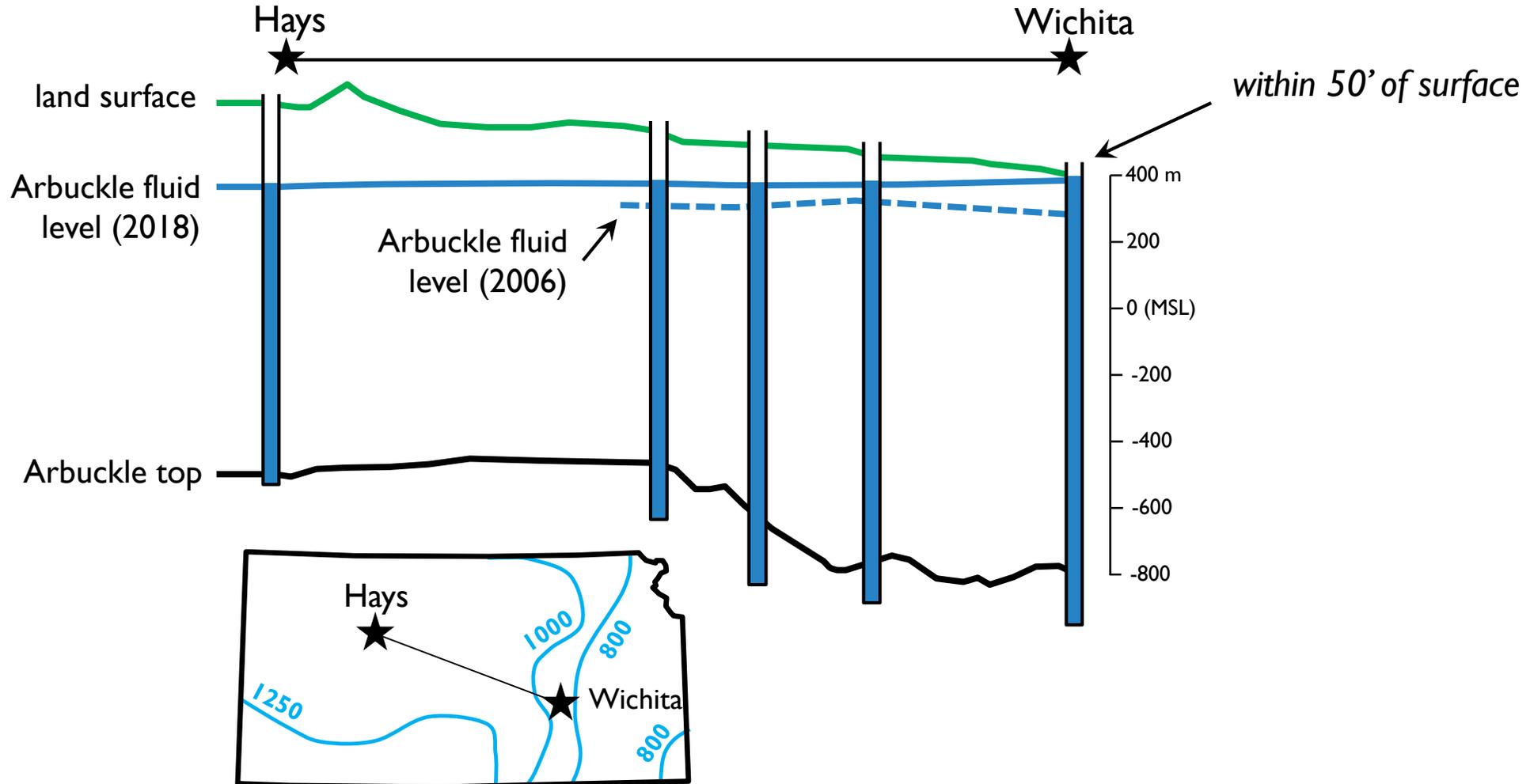
- Oil extracted since early 1900s: 2 billion barrels
- Fluid injected the past 10 years: 7 billion barrels (3.5x historic production)
- Fluid injected last year: 160 x volume of oil extracted

- Fluid level and formation pressure

- Likely higher now than ever before
- Elevated risk for seismicity
- Likely future groundwater contamination associated with fluid level rise

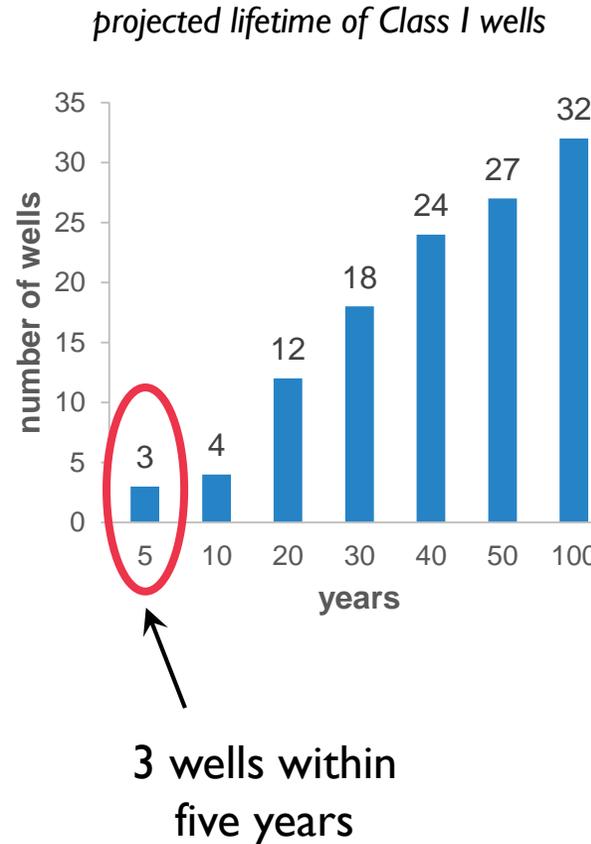


Rising Fluid Levels



Implications and Hypothetical Scenarios

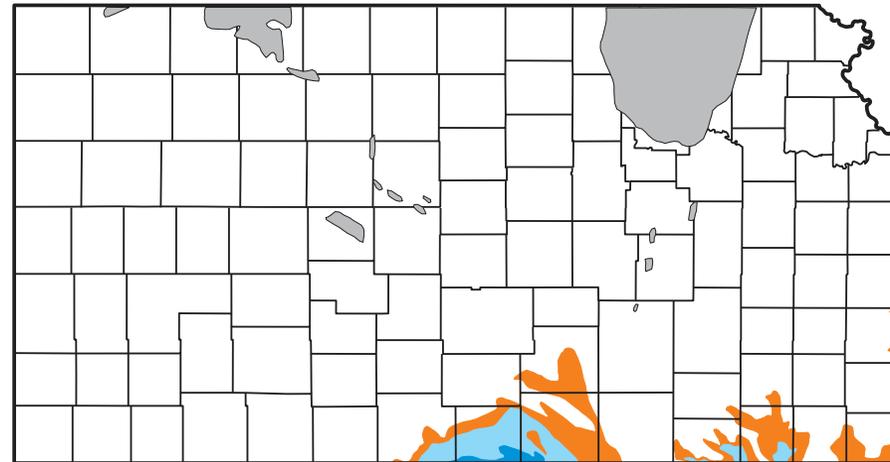
- Loss of gravity feed
 - required for Class I wells
 1. **Existing facilities**
 - could lose use of disposal wells
 - would require cost-prohibitive measures
 2. Hypothetical facility
 - freshwater can't enter Arbuckle
 - sits in wellbore
- Drinking water contamination
 - fluid level above water source
 - inadequately plugged wells
 - *reality of leaks*: sinkholes
- The possibility is real within 20 years or less



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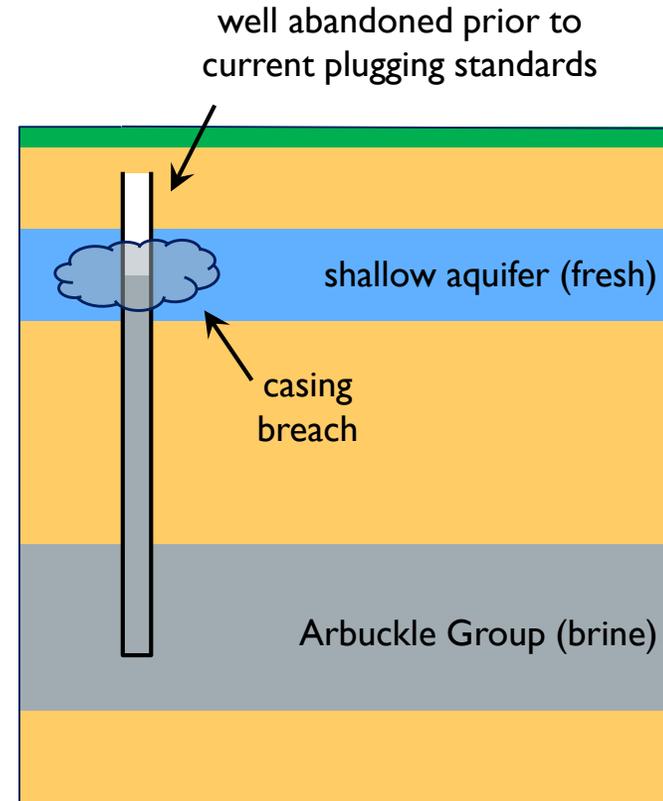
map represents ability to dispose of freshwater-density fluid



-  Loss of gravity feed
-  At risk for losing gravity feed

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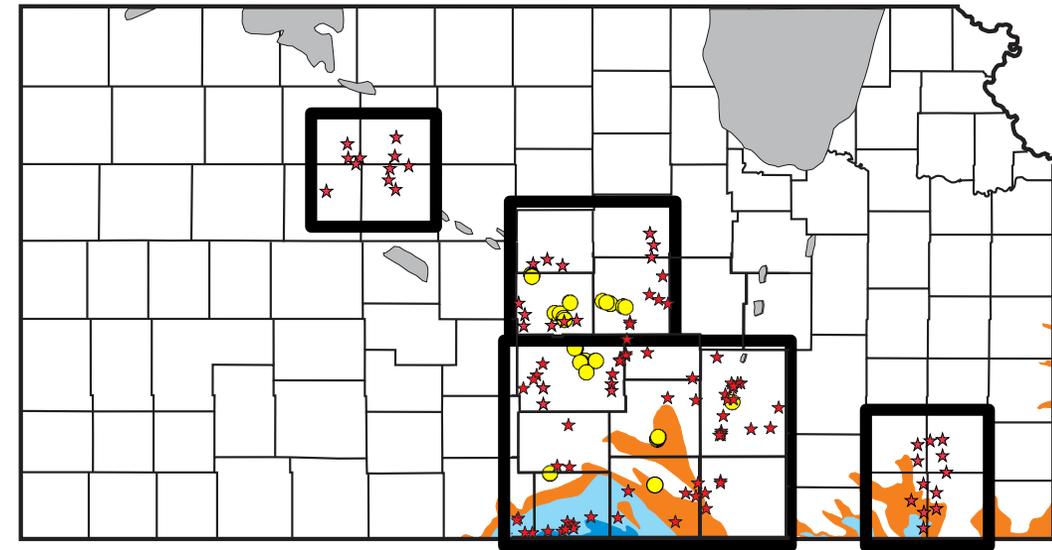
sinkholes attributed to Arbuckle Class II SWD



Panning (Barton Co.)

Focus Areas and Resulting Products

- **Objective:** informed disposal for sustainable use of the Arbuckle
 1. Fault mapping and rock property variability
 - *Product:* High-resolution fault maps, relative permeability of Arbuckle zones (karsting, fractures, etc.)
 2. Determine sustainable injection rates/volumes
 - *Product:* establish better link between formation pressure, measured injection volumes/rates, fluid level rise, and percolation rates
 3. Potentiometric surface mapping (new measurements in 120 wells)
 - *Product:* more detailed piezometric surface to identify problem areas for disposal, and shallow aquifers at risk for contamination
- **Product users:** policy makers, regulators, commercial users, industrial producers, municipalities



- current Arbuckle well measurements
- ★ Arbuckle wells proposed for new measurements

Sustainability of the Arbuckle Group as a Resource

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