

OKLAHOMA ENERGY: STATE OF THE STATE

Nicholas W. Hayman,

Oklahoma State Geologist & Director of the Oklahoma Geological Survey

Carl Symcox,

Research Affiliate, Oklahoma Geological Survey, & Diversified Well Logging



*OGS Workshop on
Oklahoma & the Energy
Transition, 11/16/22*

OKLAHOMA ENERGY: STATE OF THE STATE

1. **Welcome, Thanks, & OGS**
2. **Overview of Oklahoma's hydrocarbon production & produced-water legacy**
3. **Path to Carbon Capture & Sequestration**
4. **Oklahoma's Critical Mineral Resources**



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WELCOME!

THANK YOU TO ALL
REGISTRANTS!

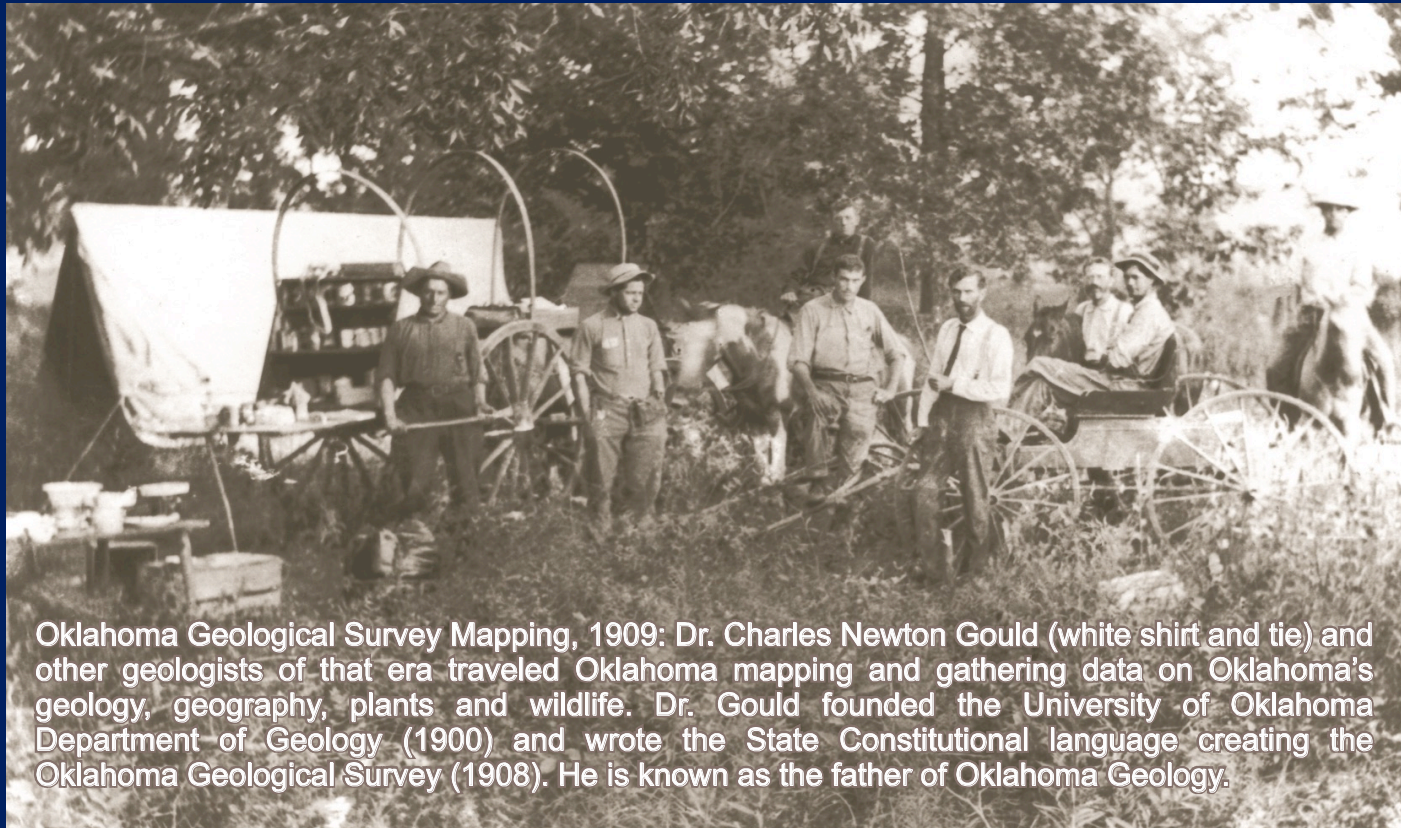
Funds our Workshop Account: this allows us to serve the K-12 and general public community of Oklahoma, put on these workshops, produce our publications, among many other wonderful activities!



We especially welcome:

- Talee Redcorn, councilman from the Osage Mineral Council,
- Mike Smith from AHS,
- John Antonio, incoming Dean of the OU Mewbourne College for Earth and Energy,
- Secretary of Energy and the Environment for Oklahoma Staff.

Oklahoma Geological Survey:
Research, information, & service state agency
within OU since 1908!



Oklahoma Geological Survey Mapping, 1909: Dr. Charles Newton Gould (white shirt and tie) and other geologists of that era traveled Oklahoma mapping and gathering data on Oklahoma's geology, geography, plants and wildlife. Dr. Gould founded the University of Oklahoma Department of Geology (1900) and wrote the State Constitutional language creating the Oklahoma Geological Survey (1908). He is known as the father of Oklahoma Geology.

TODAY'S OKLAHOMA GEOLOGICAL SURVEY

- Dr. Ben Allen (Postdoc, Physics),
- Dr. Carla Eichler (Sedimentology)
- Dr. Leah Jackson (Hydrogeology)
- Dr. Paul Ogwari (Seismology)
- Dr. Netra Regmi (Geomorphology)
- Dr. Tom Stanley (Field Geology)
- Dr. Ming Suriamin (Petroleum Geology)
- Dr. Carl Symcox (Affiliate, Petroleum Geology)
- Dr. Jake Walter (Seismology)
- **HIRING 2 MORE STAFF SCIENTISTS!**
- Dr. Molly Yunker (Education & Outreach)
- Fernando Ferrer (Seismic)
- Dr. Lindsey Hunt (Petrology)
- Russell Standridge (GIS)
- Cesalea Osborne (GIS)
- Andrew Thiel (Seismic)
- Isaac Woelfel (Seismic, field tech)
- Cari Pryor (HR)
- Joyce Stiehler (Manager)
- Chrishelle Drew (Support)



OPIC: Richie Tarver (Manager), Scott Bryant (Coordinator), Jeff Dillon (Customer support), Vy Jordan (Archive & Curation), Ryan Rosol (Coordinator), Mason Cullen (Tech)

OGS Community

State of Oklahoma

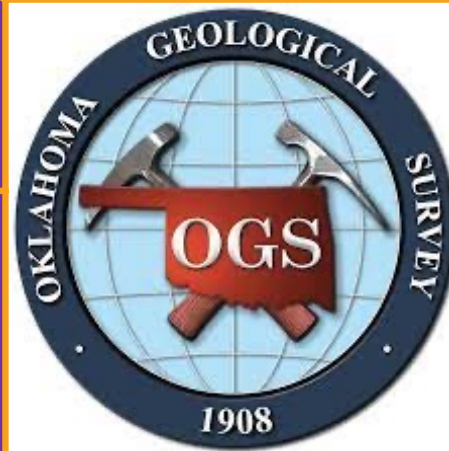
University Home

Energy
Industry

Regional
Higher
Education

Townships,
Tribal Nations,
Non-Profits

Federal Agencies



Educating the Public!



**GEOLOGIST
OFFICE
HOURS**

METEORITE?
FOSSIL?
MYSTERY MINERAL?
STRANGE ROCK?

BRING IT IN AND
WE'LL TAKE A LOOK...

OPEN TO THE
PUBLIC

FRIDAY, DECEMBER 3, 2021
9:00AM - 12:00PM

**Sarkeys Energy Center,
100 E. Boyd Street, Norman, OK 73019
Room P130 (basement)
free parking in the lot at
Boyd and Trout**

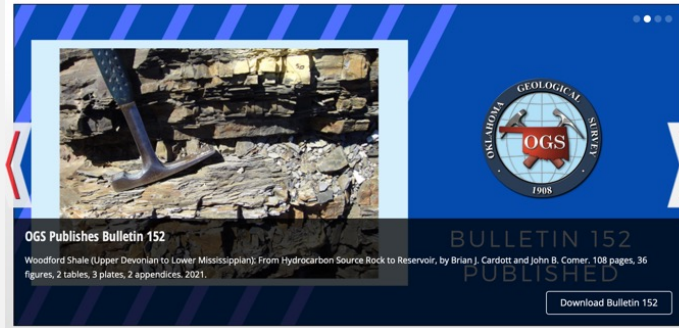
QUESTIONS?
yunker@ou.edu
405-325-1211



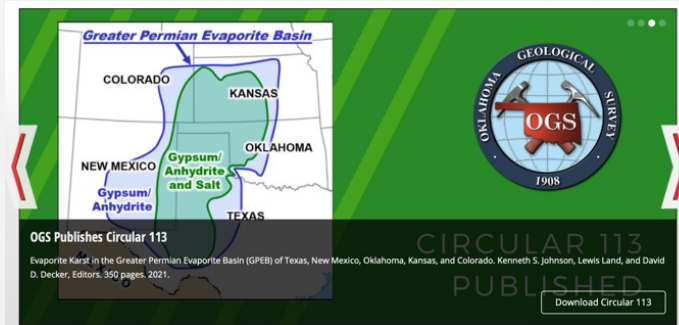
**Future workforce & public perception
depends on Education & Outreach**

NEW
PUBLICATIONS
(& NEW WEBSITE
COMING)!!

<https://www.ou.edu/ogs/publications>



Cardott et al., Bulletin 152 on the Woodford Shale



Johnson et al., Circular 113 on Oklahoma Evaporites



**Ken Johnson OGS Award,
to recognize service to
Oklahoma's Public with
Geologic Excellence!**

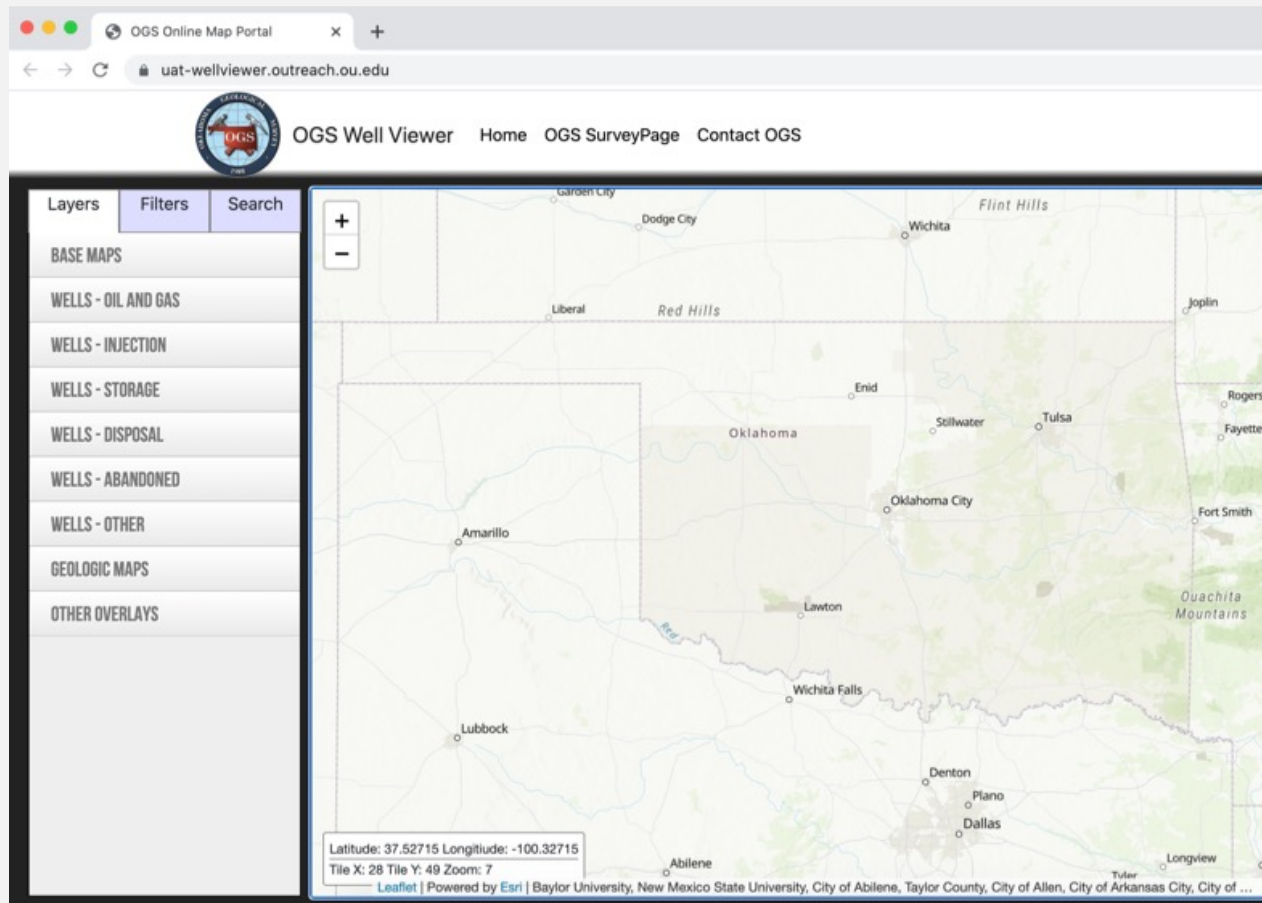
More to come: publications, field trips, awards, workshops, etc...



Oklahoma Petroleum Information Center (OPIC):

- Core Repository for the State (with a growing out-of-state collection)
- Official Archive for OCC (corporation commission) logs and records
- Industry contracts for special space and resources
- At-cost model for all use
- Research & Outreach vehicle
- Coordination with other OK regional libraries
- Seeking parties interested in giving (potentially with naming re-naming rights)

Well Viewer (Beta): toward the OGS APP that will link all OGS and other agency (OCC, DEQ, etc..) data: *Rolling Out Now!*



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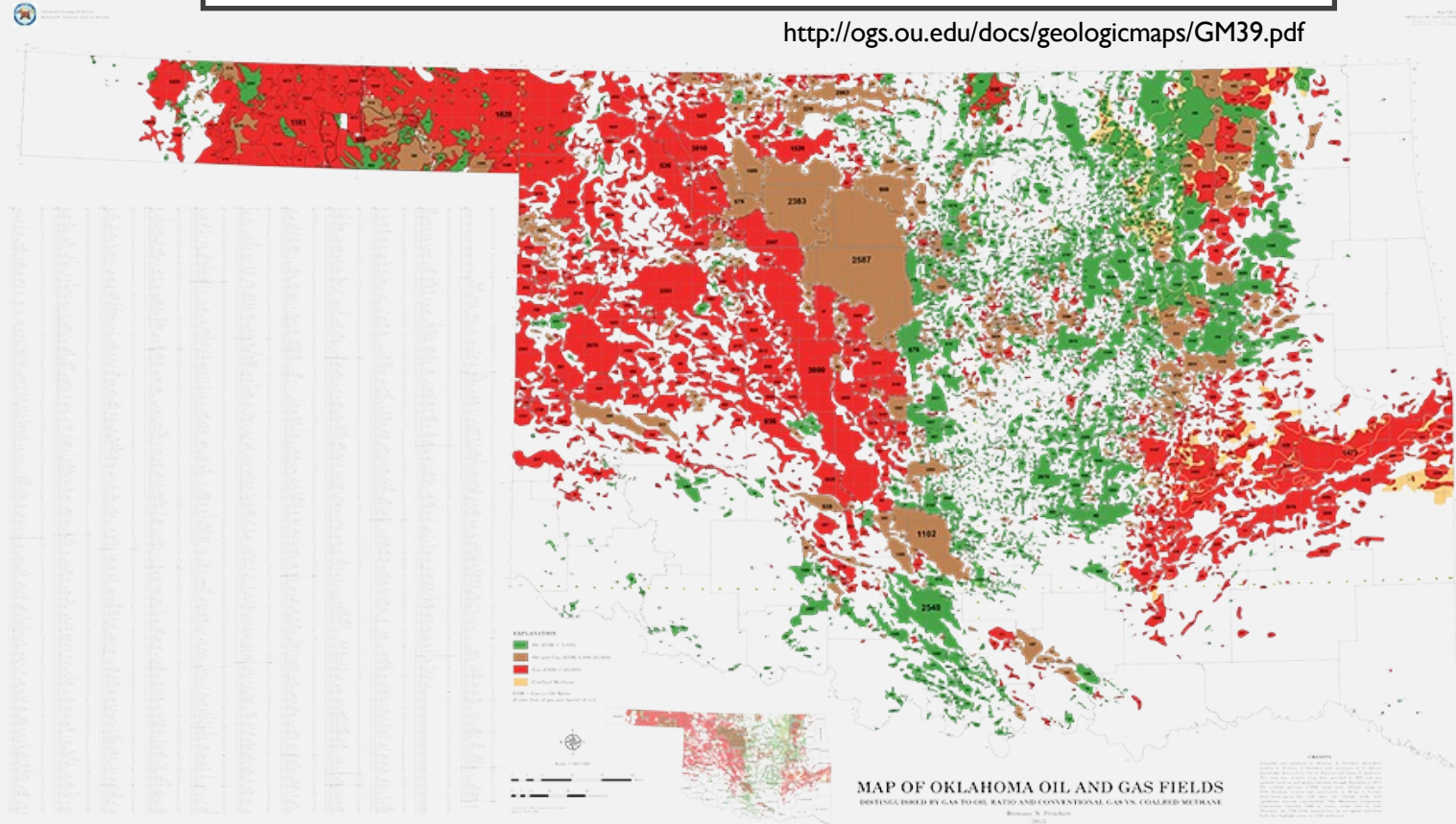
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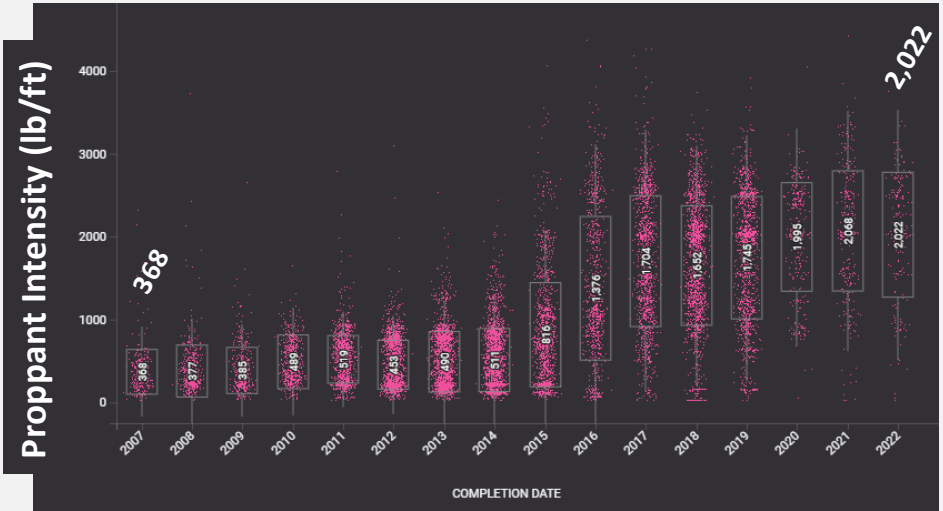
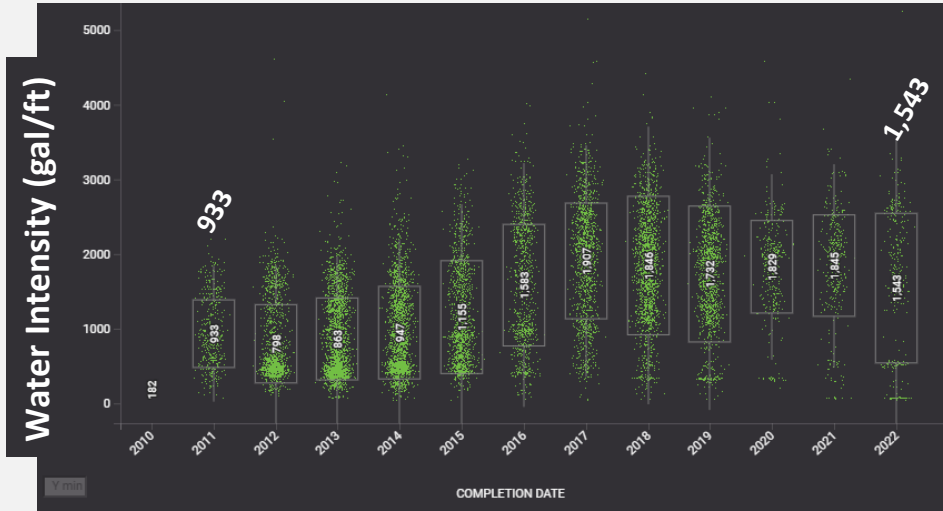
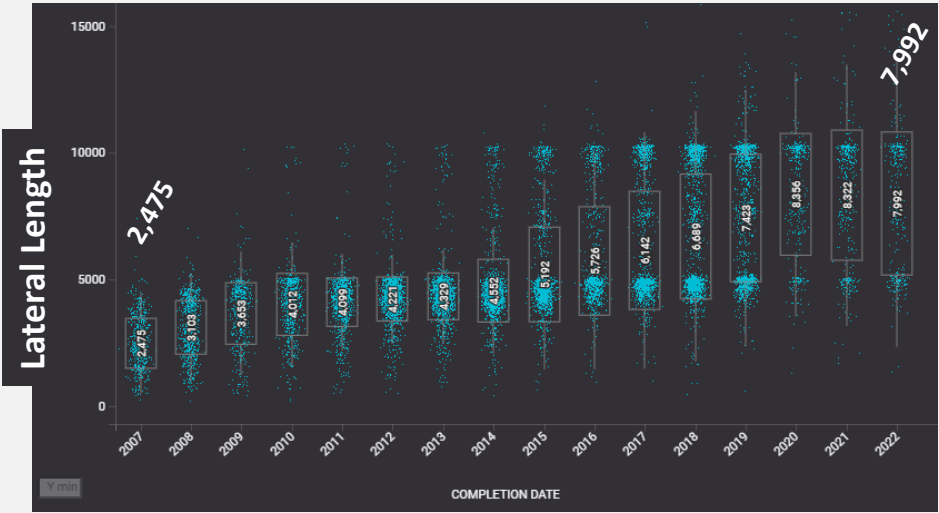
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OKLAHOMA'S HYDROCARBON HISTORY

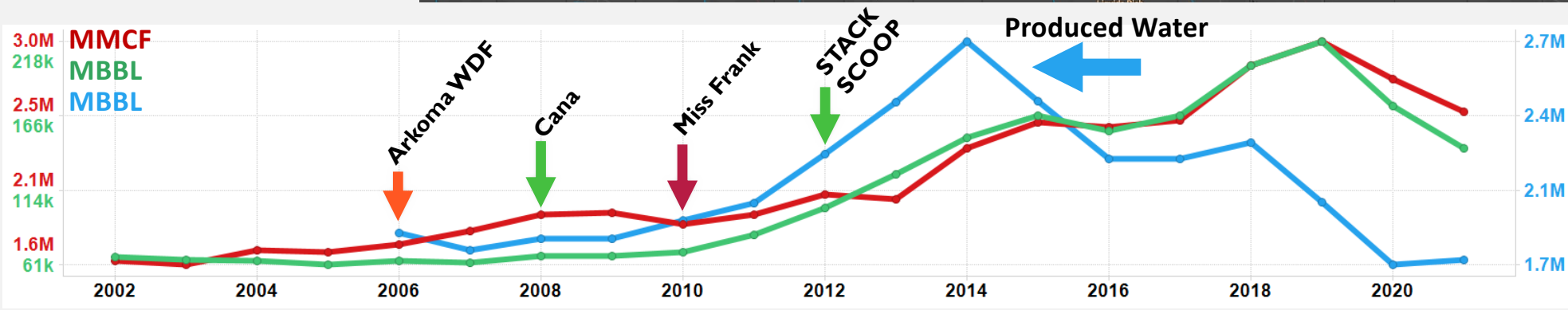
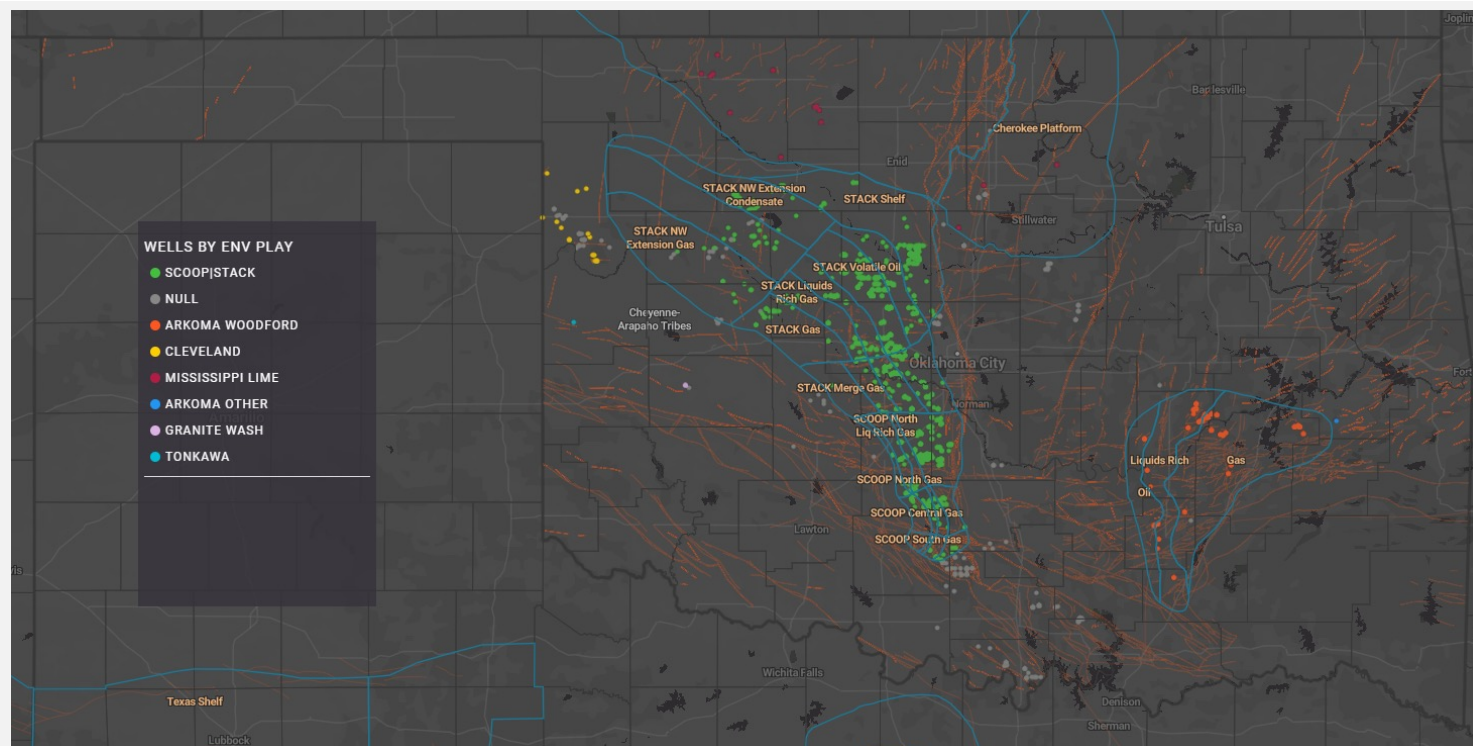
<http://ogs.ou.edu/docs/geologicmaps/GM39.pdf>



Drilling and Completion Practices have Matured

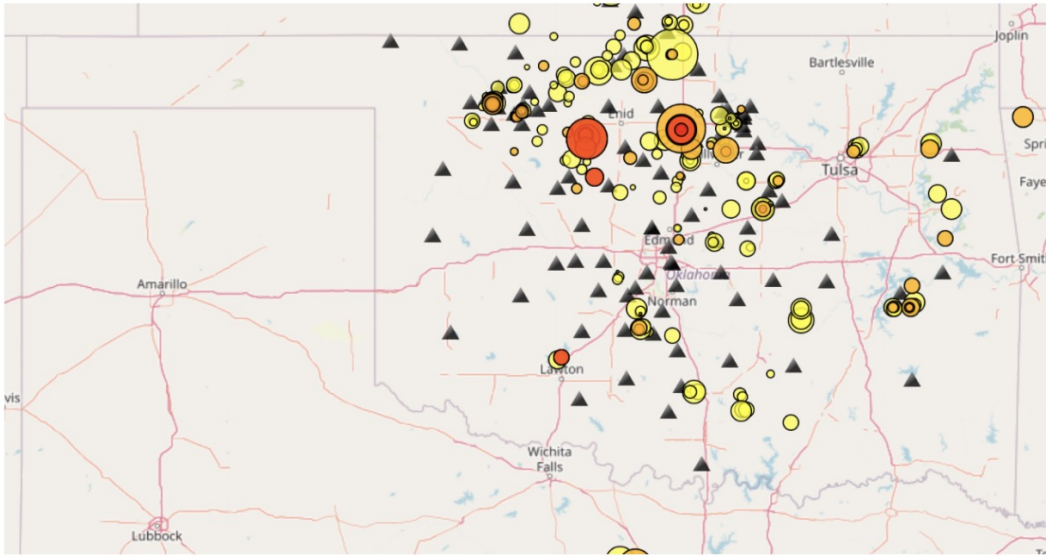


Years	Wells
'02-'04	248
'04-'06	760
'06-'08	1,083
'08-'10	1,350
'10-'12	2,013
'12-'14	3,891
'12-'16	3,507
'16-'18	2,284
'18-'20	2,935
'20-present	1,157

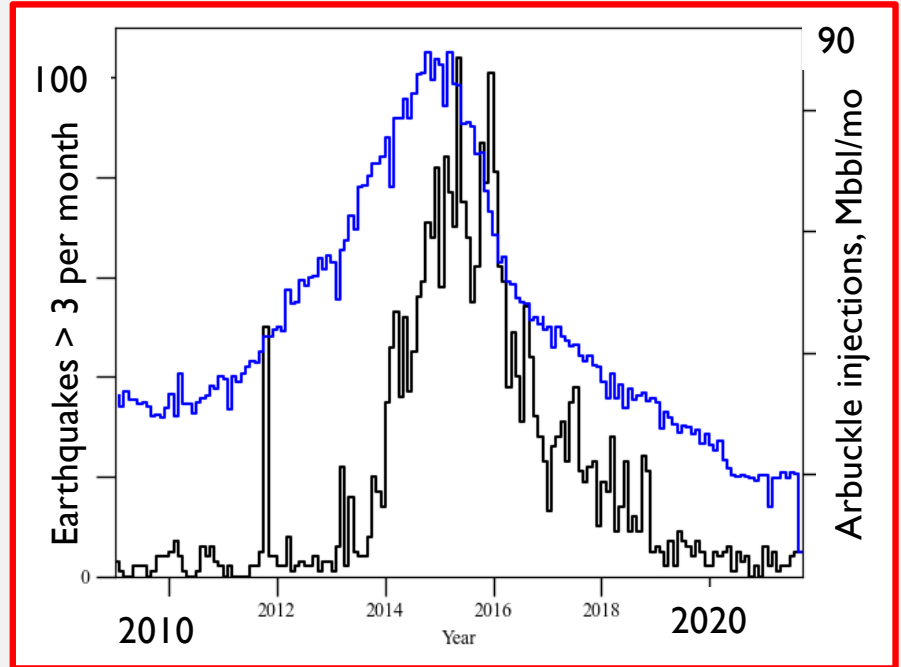


Salt Water Disposal (SWD) is associated with earthquakes. OGS seismic network portal allows real-time monitoring for the public & coordination with both industry and regulators

Recent Earthquakes-



<https://www.ou.edu/ogs/research/earthquakes/recentearthquakes>

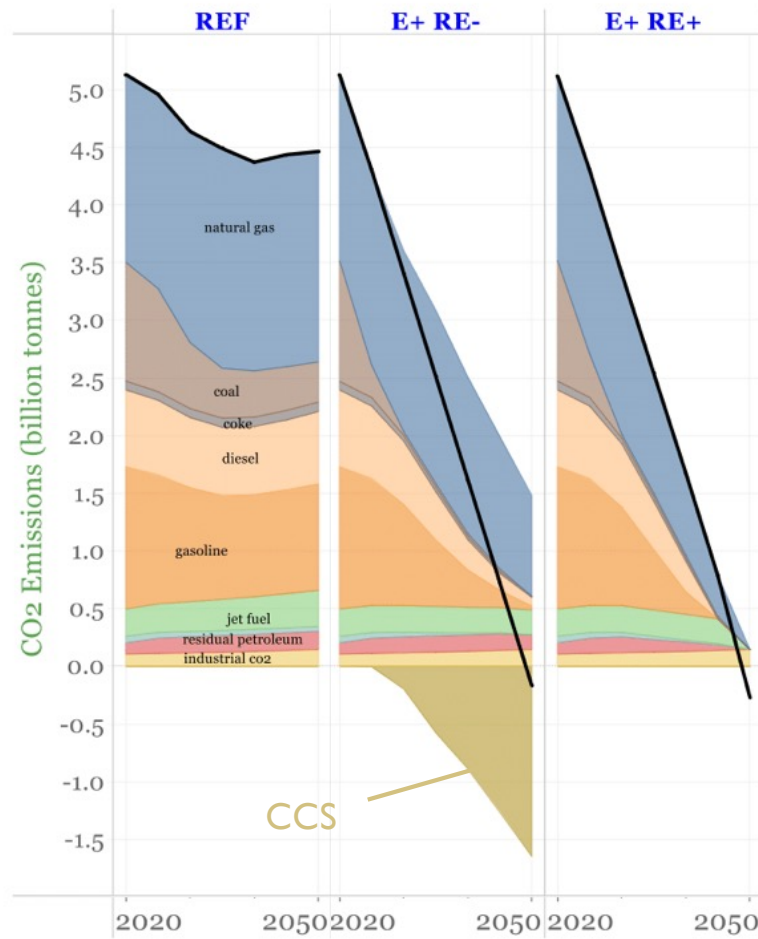


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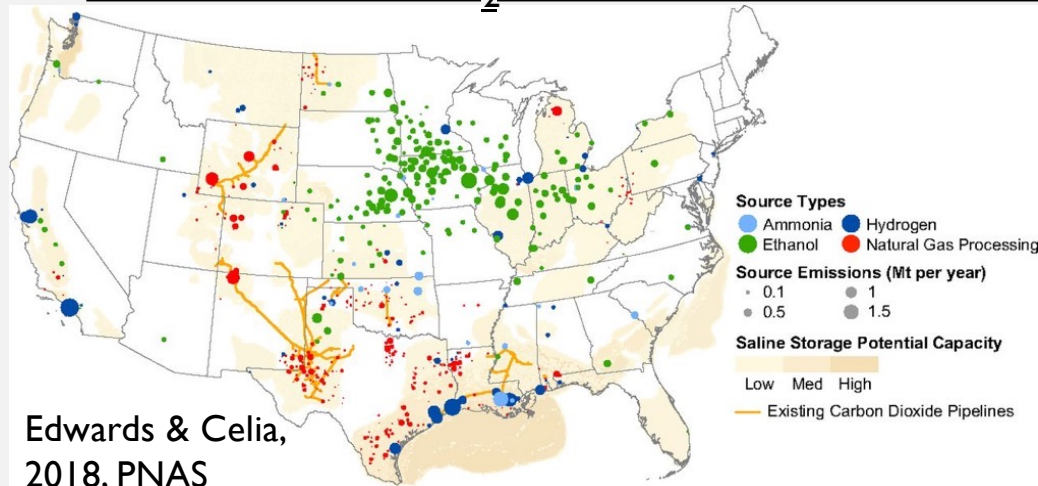
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Princeton “Rapid Switch” group: “Net-Zero half-century” report:

- Consistent with other ‘wedge models’ such as Shell’s annual report that a persistent hydrocarbon wedge is the reference model.
- Only realistic ‘aggressive’ model to a 2050 net-zero has a carbon capture and storage component.

Distribution of CO₂ favors distributed CCS in mid-continent



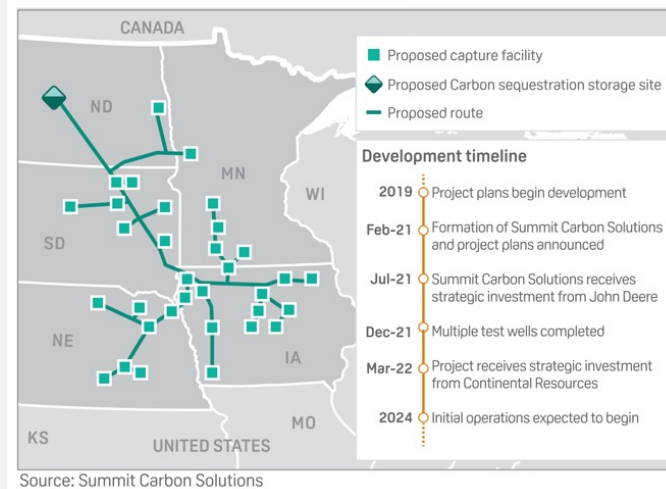
Patchy CO₂ pipeline networks, ethanol, ammonia, and H₂ production typify US; largest storage along Gulf of Mexico

Continental Resources & Summit Carbon Solutions approach as ethanol-to-pipeline-to site; EOR site in North Dakota

Smaller-scale similar examples in northeast OK

All futuristic, only ND has Class-VI primacy

SUMMIT CARBON SOLUTIONS TO CAPTURE CARBON FROM 31 MIDWEST ETHANOL PLANTS

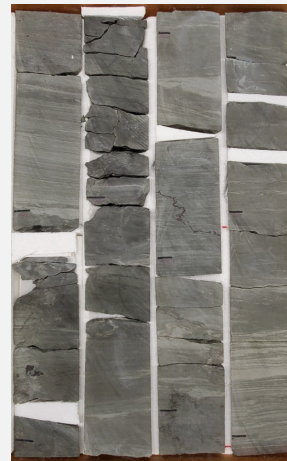


Check Out the Geostorage Core Display

Virgil



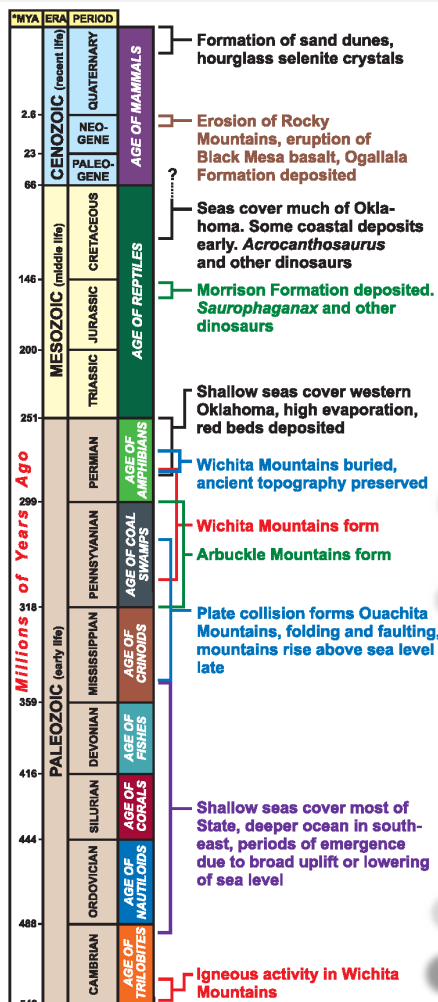
Red Fork



Arbuckle



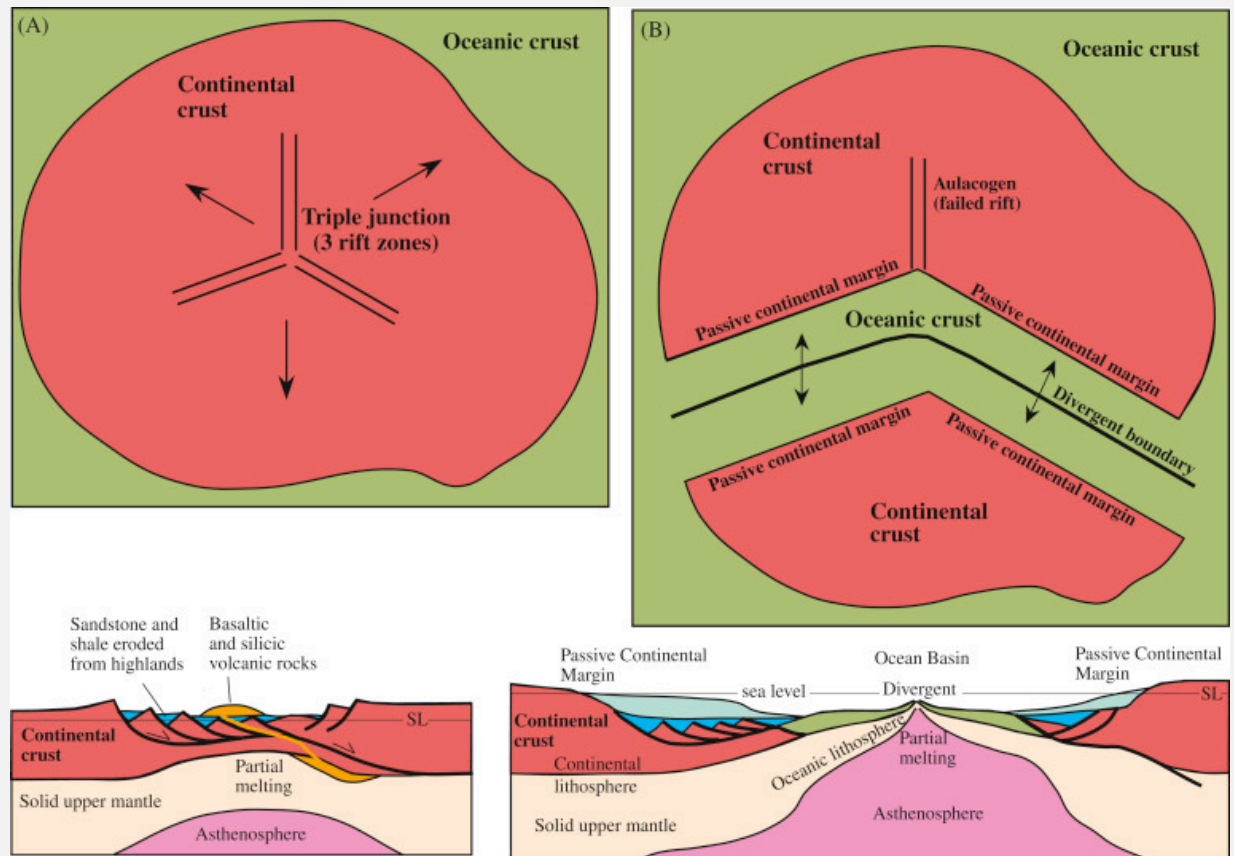
SOIP



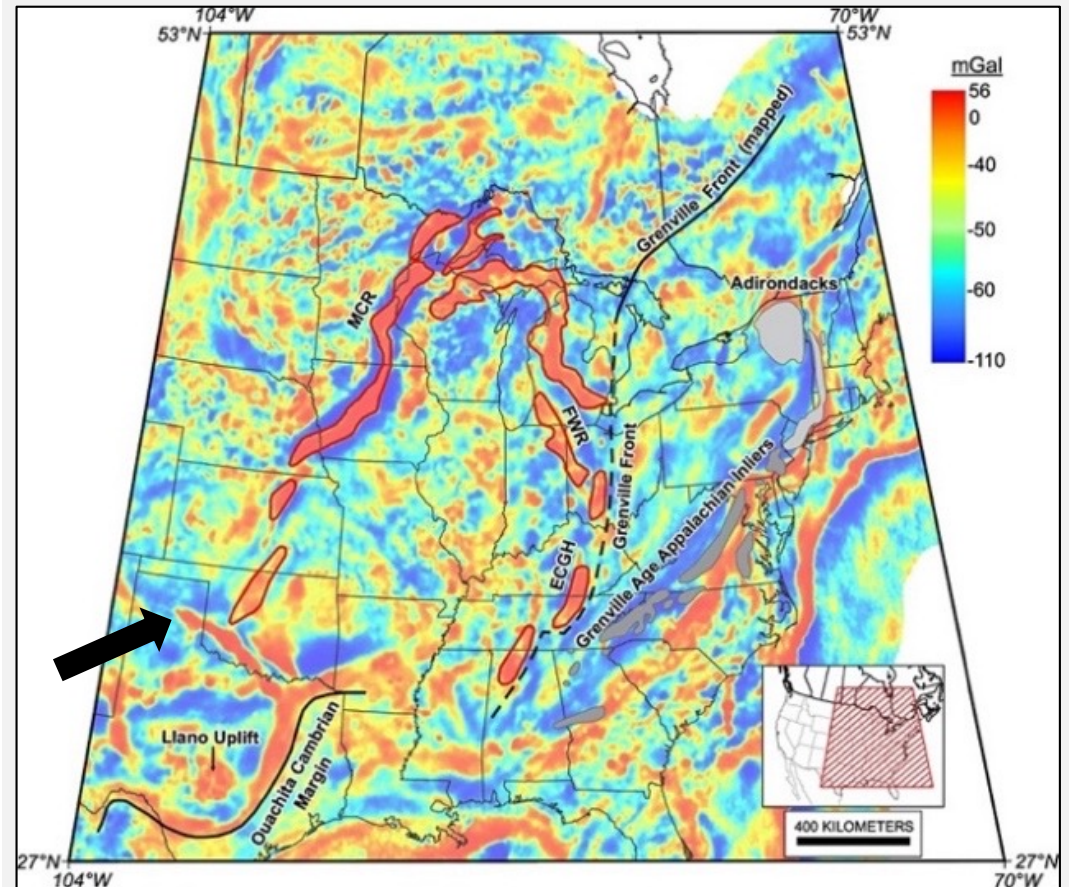
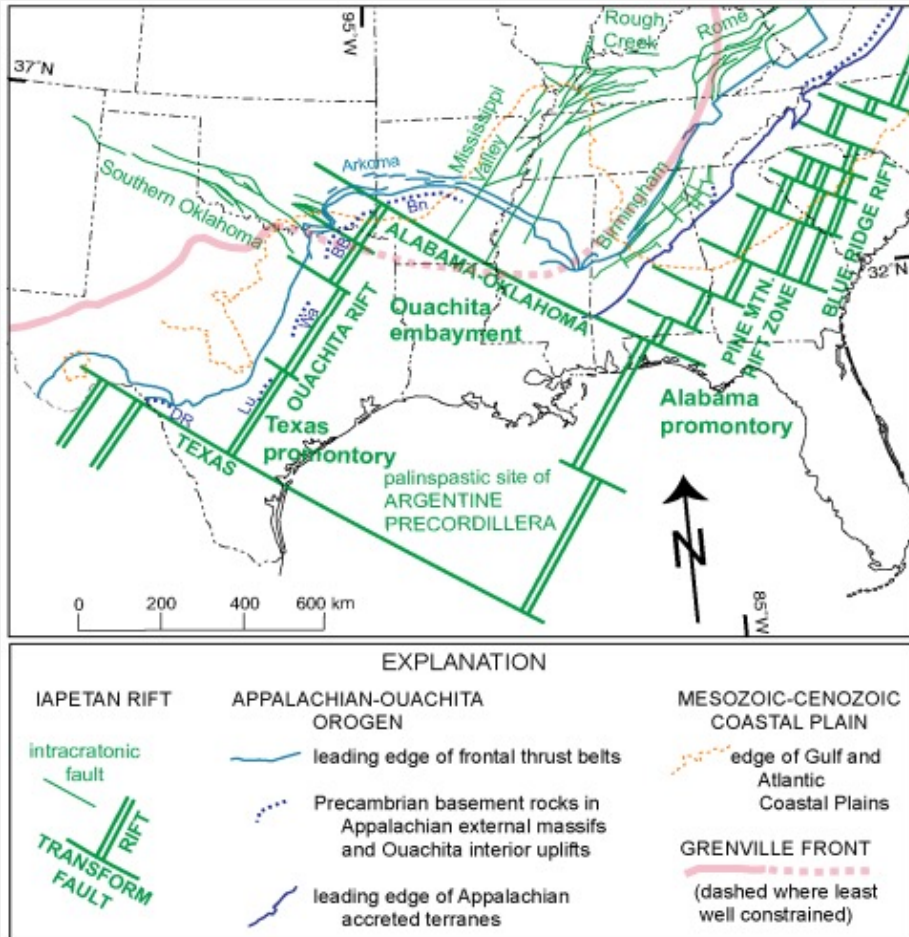
The Origin of the Southern Oklahoma Igneous Province



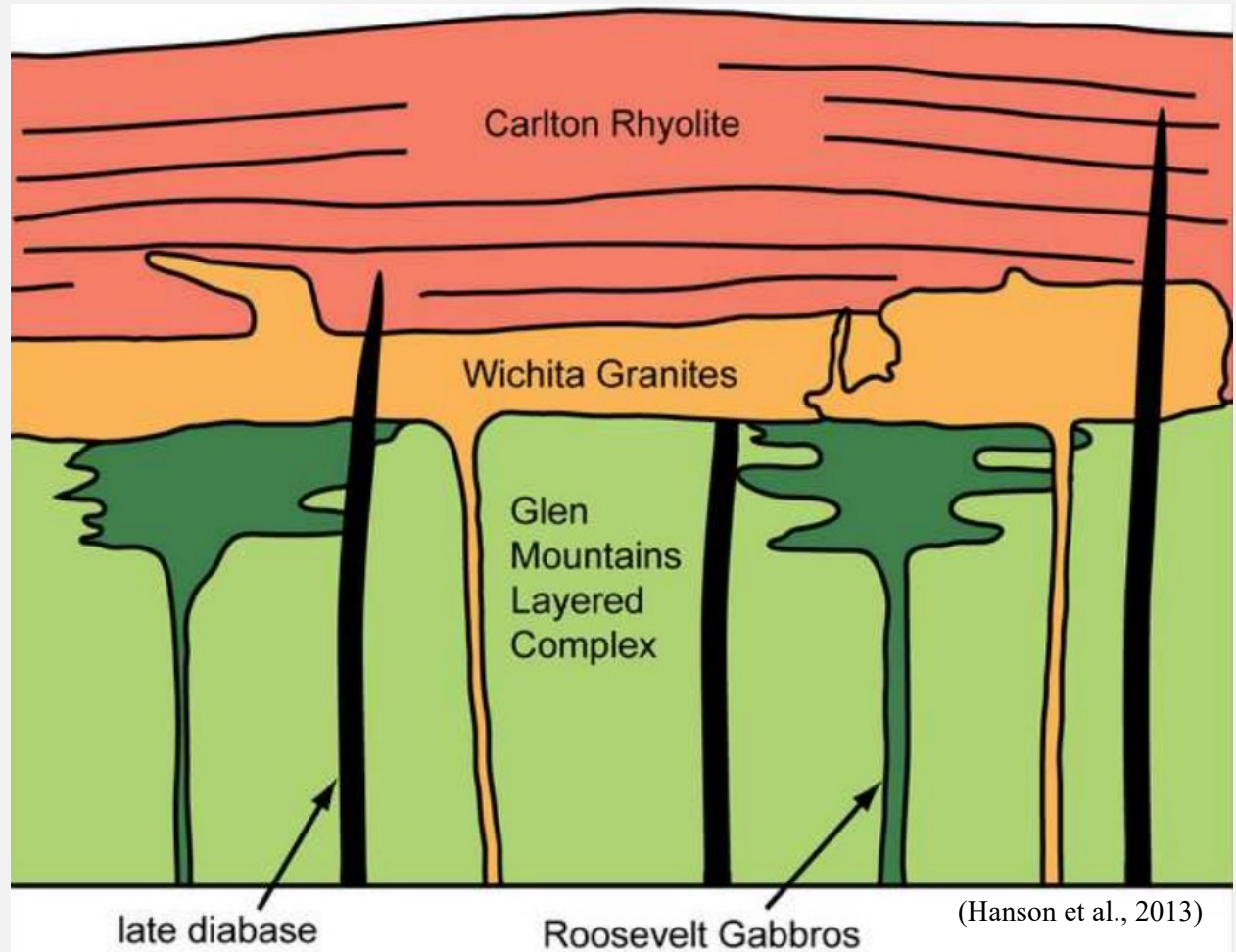
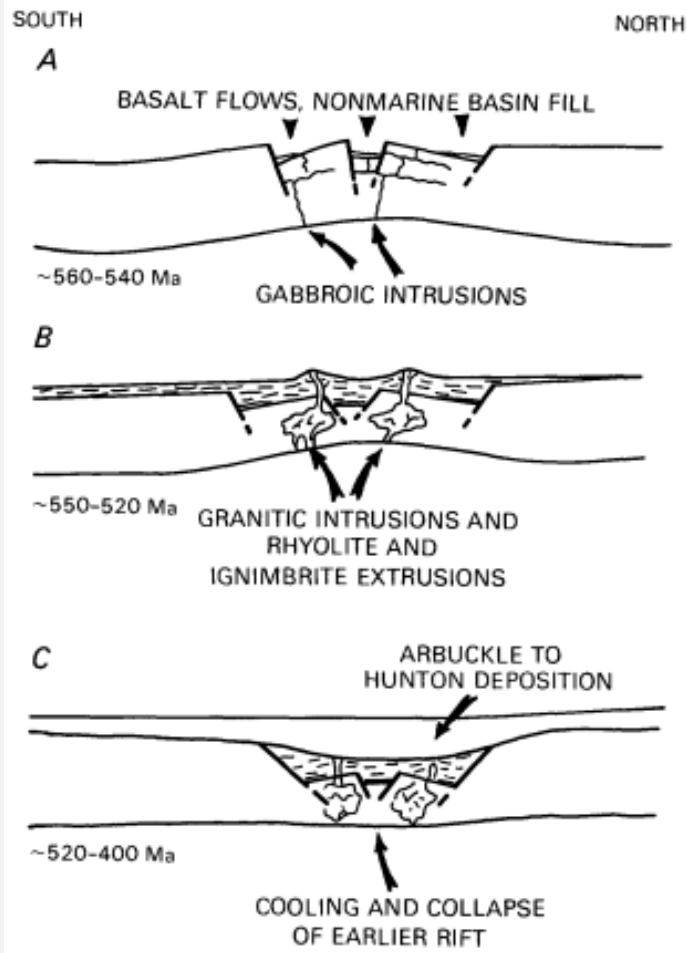
How does a Cookie Break?



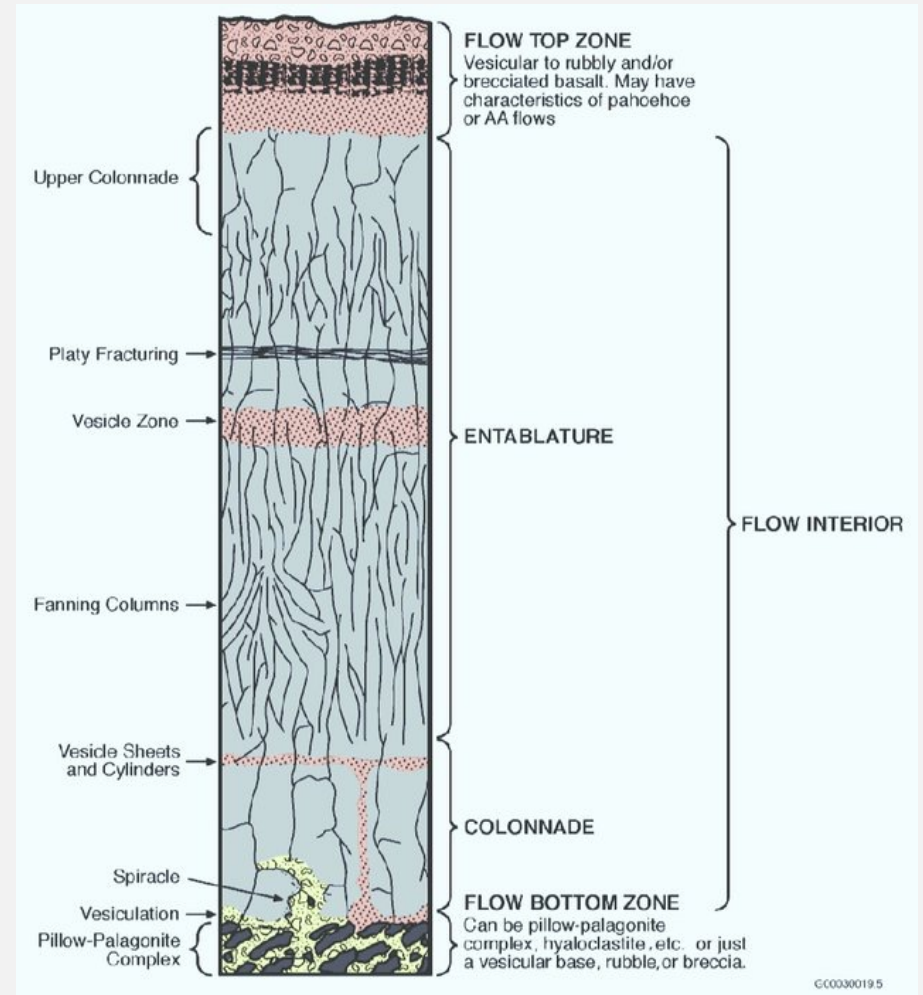
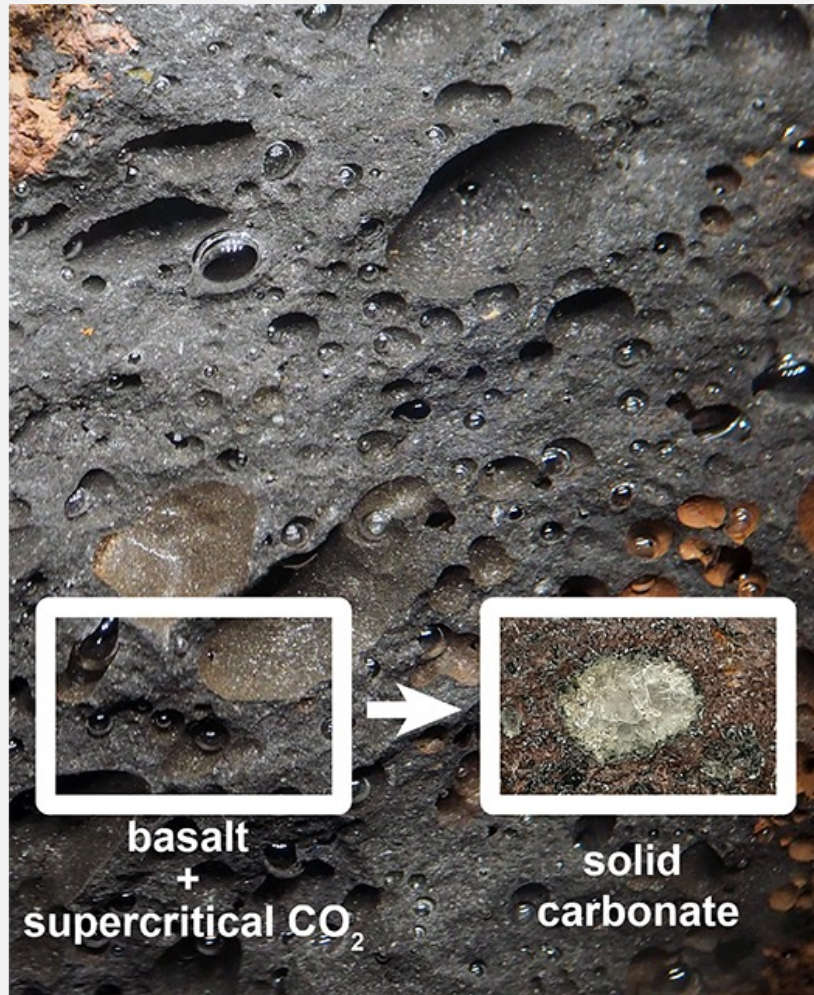
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The Origin of the Southern Oklahoma Igneous Province

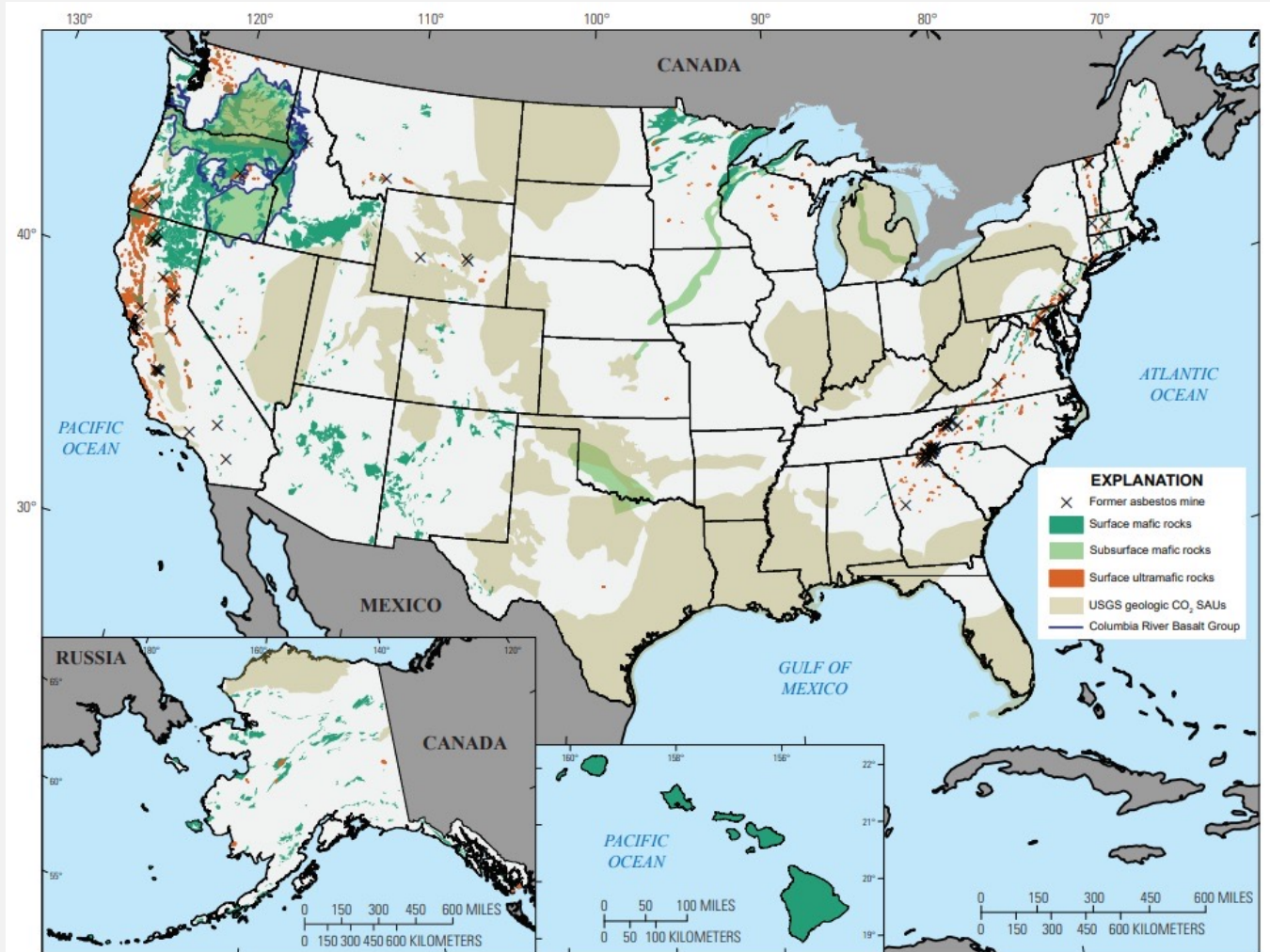


Mafic Rocks as a Carbon Sink



Mafic Rocks as a Carbon Sink

The Southern Oklahoma Igneous Province may represent one of the largest subsurface mafic rock deposits in the country



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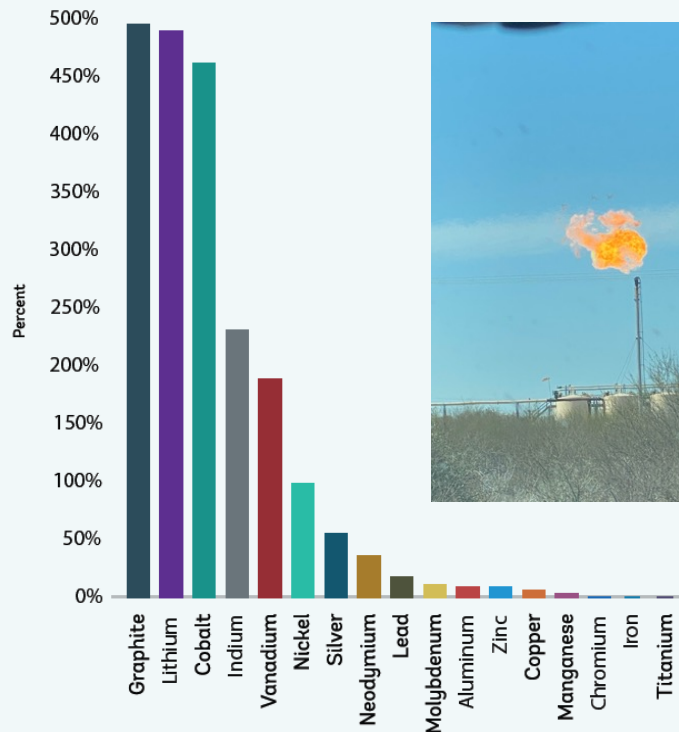
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Critical Minerals & the Energy Transition

a. 2050 annual demand from energy technologies as percentage of 2018 production



>400% needed Graphite, Lithium, and Cobalt to power the EV revolution



Taken from I83 near Austin w/in 30 mi of one another

AASG Critical Minerals Report
(in prep).

Oklahoma in the News



EMISSIONS & EFFICIENCY

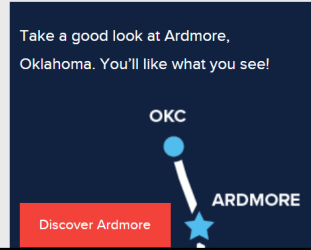
Canoo acquires new EV production facility in Oklahoma City

Nov. 14, 2022

The electric delivery van manufacturer has purchased a facility that is expected to employ over 500 and produce 20,000 EVs per year.

FleetOwner Staff

Take a good look at Ardmore, Oklahoma. You'll like what you see!



Discover Ardmore

WOODSIDE ENERGY, LTD ANNOUNCES PLANS FOR GREEN HYDROGEN FACILITY IN ARDMORE

Posted by Andrea Anderson on 12/07/2021

\$100M rare earth metals manufacturing facility announced for Stillwater

Gov. Kevin Stitt says the facility can lessen America's dependence on China for rare earth metals

Share





Updated: 8:34 PM CDT Jun 9, 2022



OKLAHOMA Governor J. Kevin Stitt

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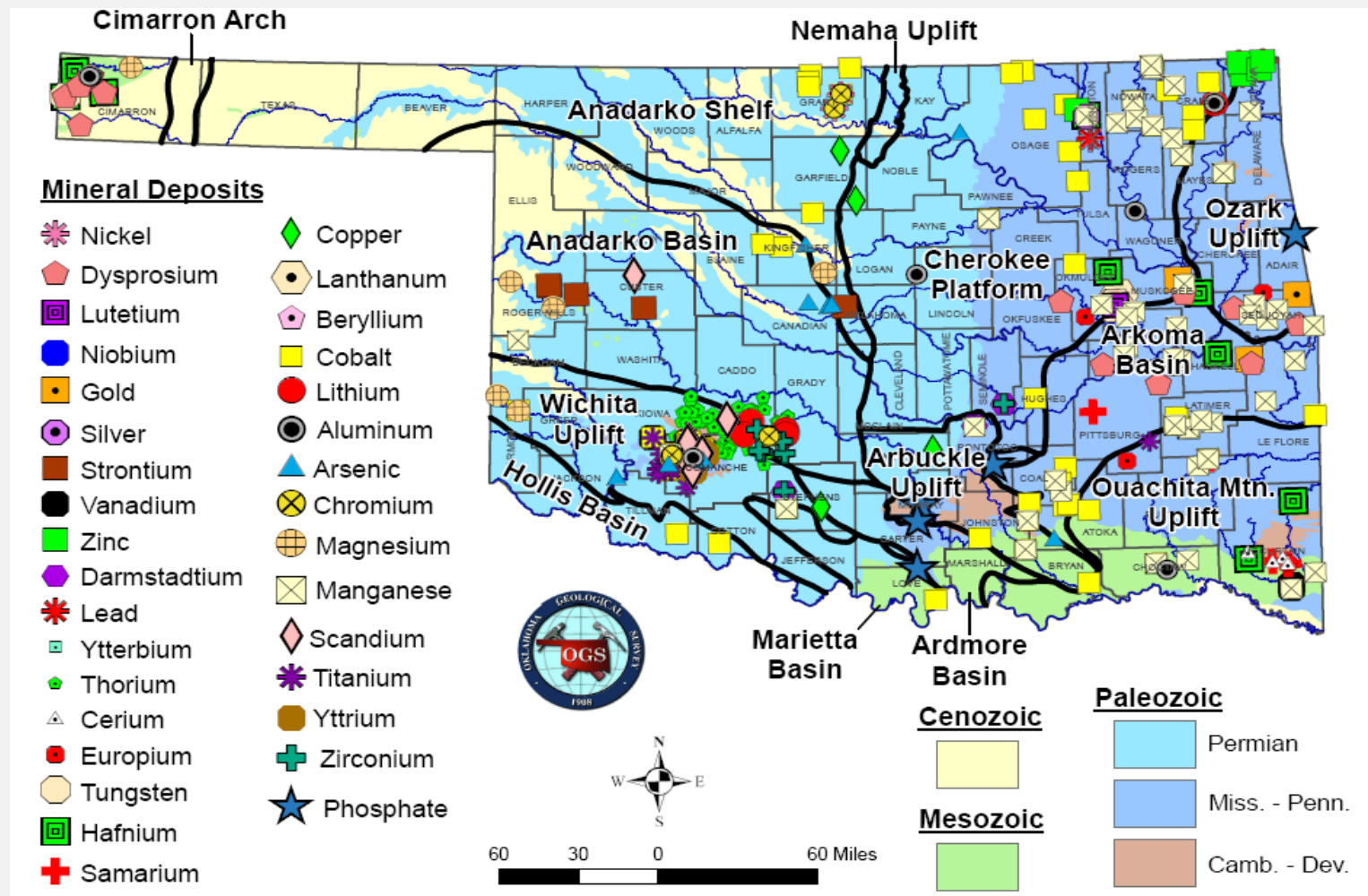
Newsroom > Oklahoma.gov Home > Oklahoma.gov Home > Oklahoma, Louisiana, Arkansas Announce Hydrogen Partnership

Oklahoma, Louisiana, Arkansas Announce Hydrogen Partnership

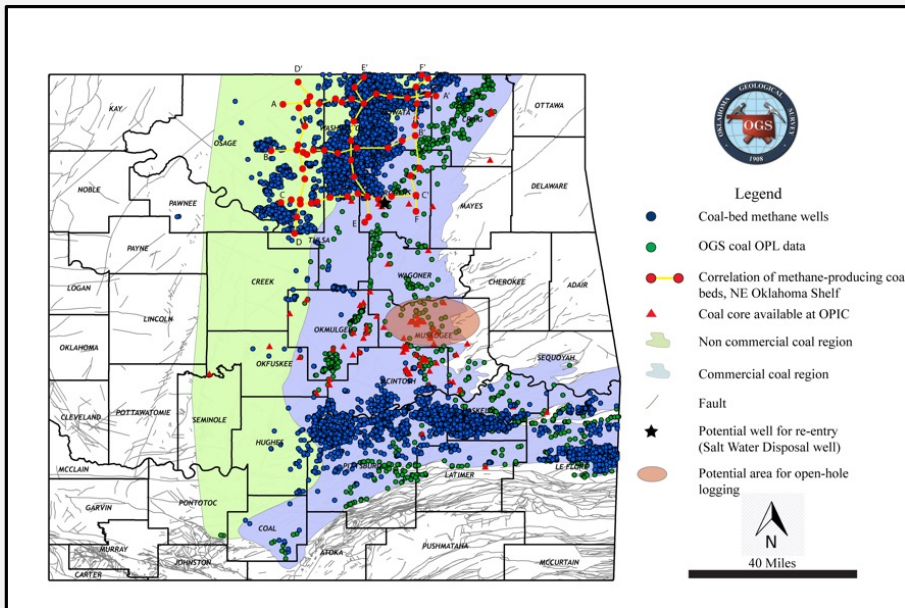
Spiers New Technologies Brings International Perspective to Oklahoma

September 21, 2016 | Filed Under: Business

Oklahoma has Other Materials for the Energy Transition



REE studies are involving USGS, DOE, and our neighbor state surveys



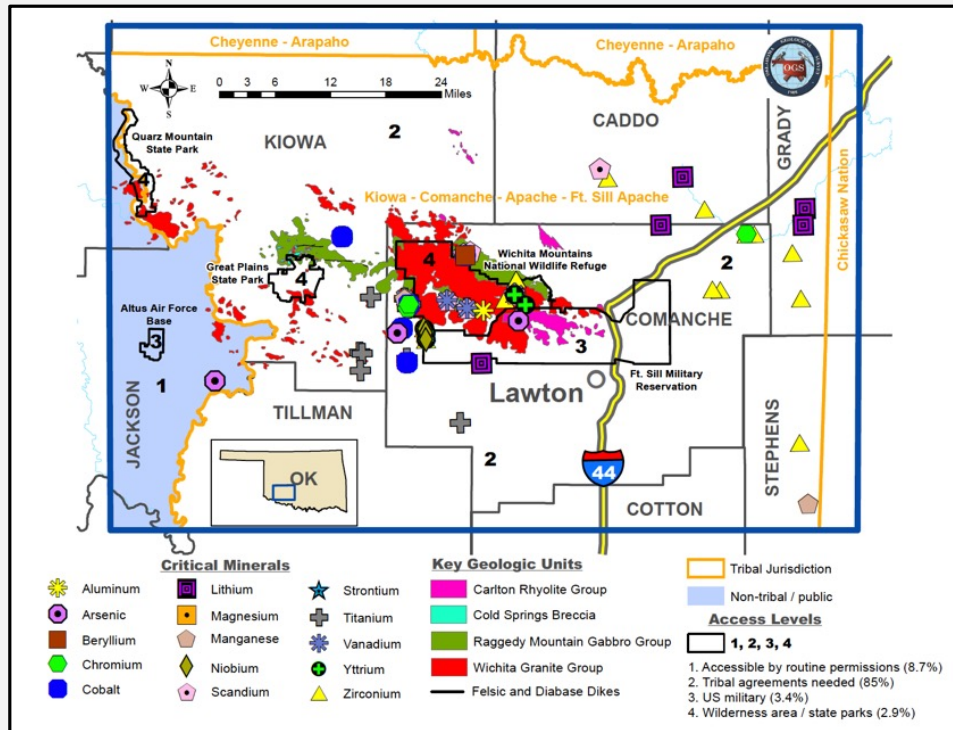
- Kansas Geological Survey & Osage Nation: looking at REEs in coal and associated deposits
- Woodford Shale in our collection and knowledge base of the field appear to have enriched REEs in Phosphate nodules



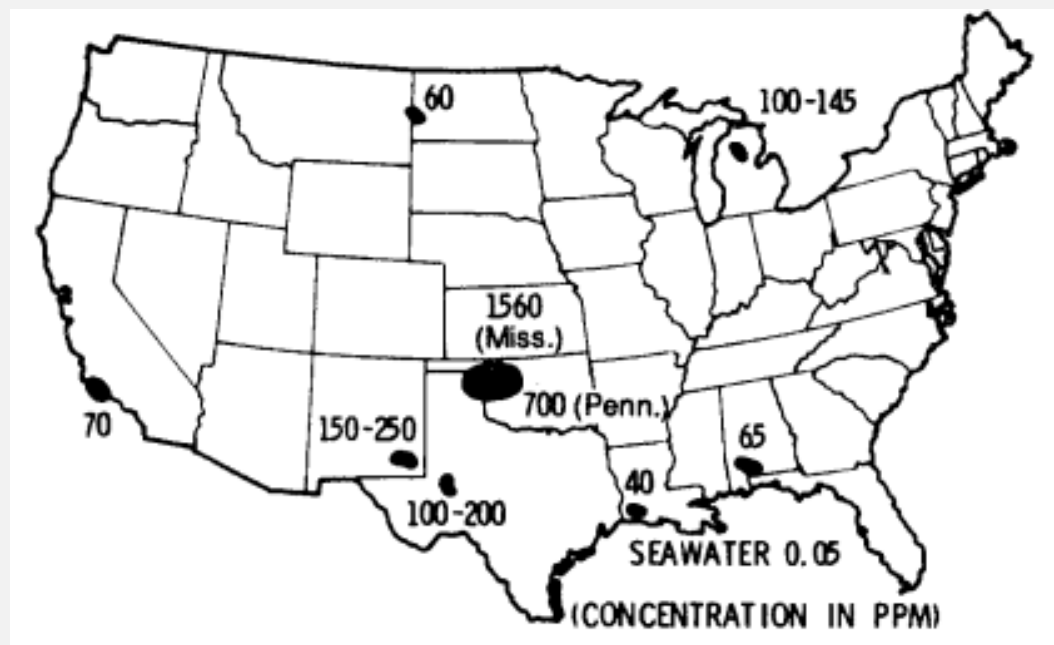
Earth-MRI (USGS) & CORE-CM (DOE):

USGS investment into detailed assessment of critical minerals

Area supported early 20th c. strategic needs, today working across USGS, tribes, and the state for the new era.

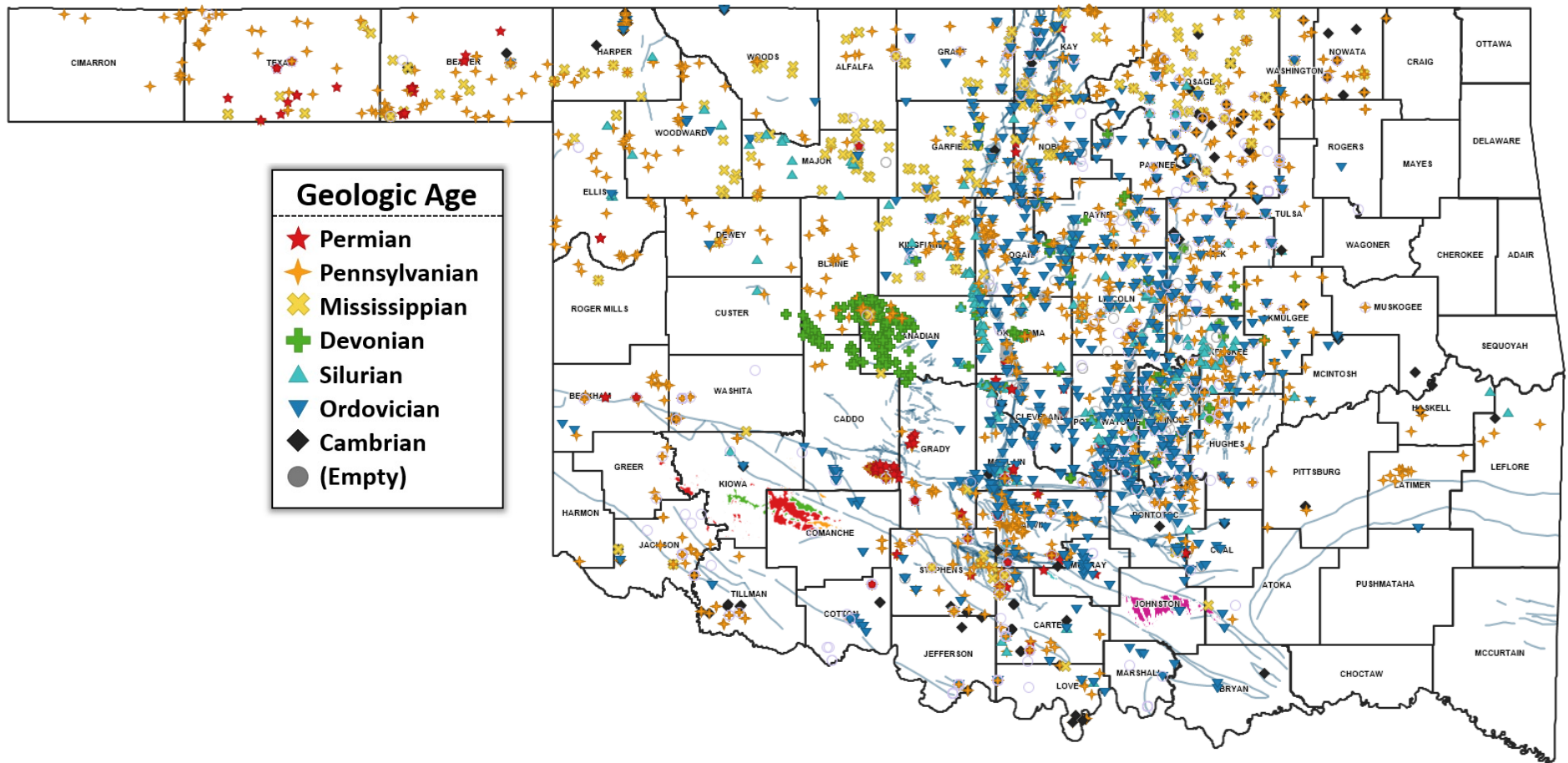


Oklahoma's Brine Mining—Iodine



All iodine production in USA comes from Woodward, Oklahoma

Produced Water Management—Using UIC Reg. to Supplement USGS Database



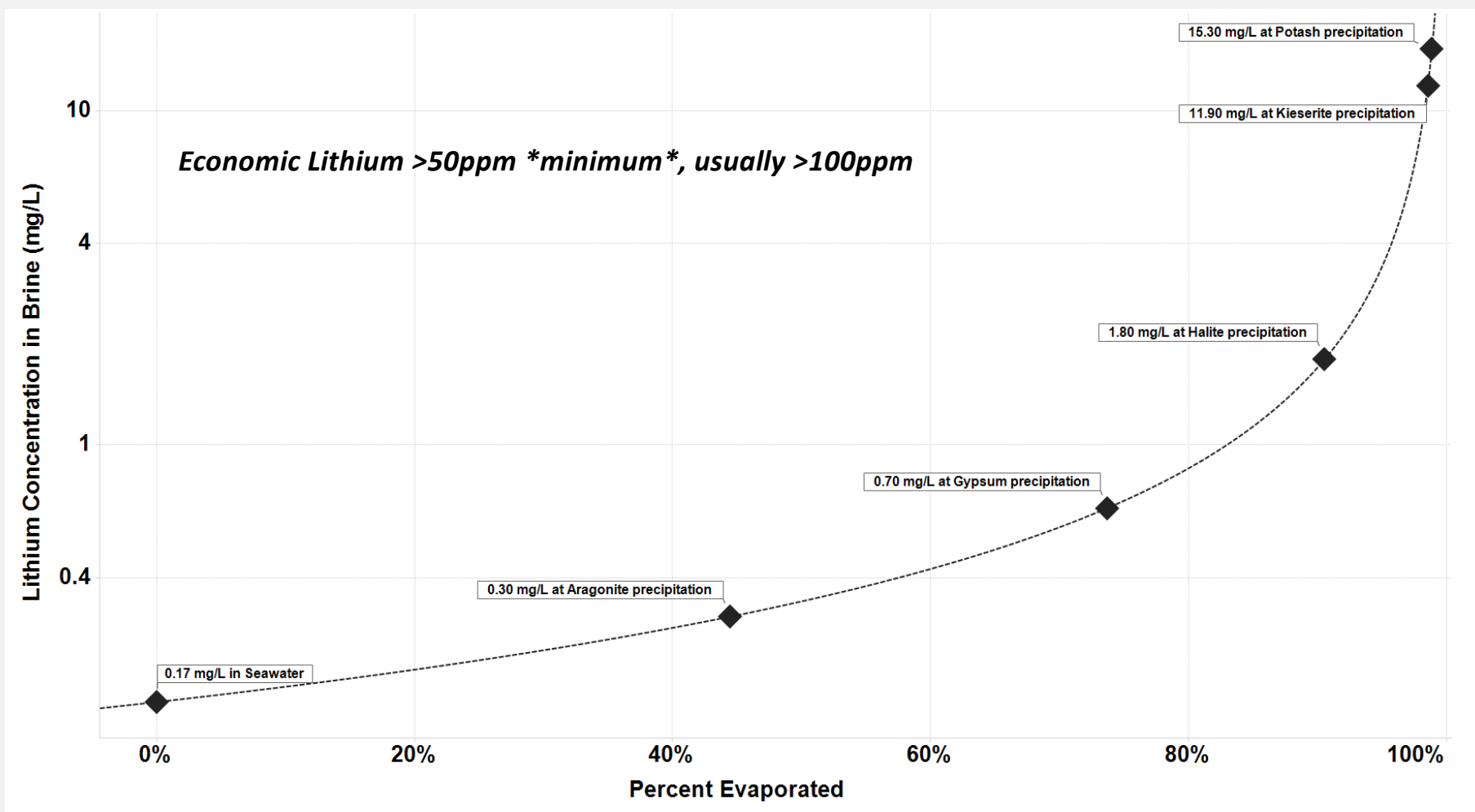
Produced Water Management—Using UIC Reg. to Supplement USGS Database

Value extraction from waste streams will require more complete water quality analyses and reporting requirements

Geologic Age	Total	Ph	TDS	Ag	Al	As	B	Ba	Br	Ca	Cd	Cl	Co	Cr	Cu	F	Fe	Hg
Zone 1	22	100%	100%	0%	0%	0%	9%	91%	0%	100%	0%	100%	0%	0%	0%	0%	86%	0%
Zone 2	12	92%	100%	0%	0%	0%	33%	58%	0%	92%	0%	100%	0%	0%	0%	0%	83%	0%
Zone 3	82	82%	99%	0%	1%	0%	0%	61%	0%	80%	0%	100%	0%	0%	0%	0%	72%	0%
Zone 4	123	88%	94%	0%	0%	0%	5%	57%	2%	87%	0%	100%	0%	0%	2%	0%	77%	0%
Zone 5	74	76%	78%	0%	1%	0%	8%	47%	1%	77%	0%	84%	0%	0%	0%	0%	70%	0%
Zone 6	377	84%	94%	0%	12%	0%	16%	58%	8%	81%	1%	99%	1%	1%	4%	1%	68%	2%
Zone 7	64	61%	100%	0%	6%	0%	6%	41%	0%	59%	0%	100%	0%	0%	0%	0%	59%	0%
Zone 8	115	90%	98%	0%	1%	0%	5%	52%	1%	90%	0%	100%	0%	1%	1%	0%	84%	0%
Zone 9	9	89%	100%	0%	56%	0%	56%	56%	56%	89%	0%	100%	0%	0%	0%	0%	89%	11%
Zone 10	17	71%	82%	0%	0%	0%	0%	6%	0%	100%	0%	12%	0%	0%	0%	0%	12%	0%
Zone -1	640	75%	99%	0%	2%	0%	11%	45%	0%	74%	0%	100%	0%	0%	1%	0%	63%	0%
Zone -2	142	82%	99%	0%	2%	0%	4%	51%	1%	82%	0%	100%	0%	0%	0%	1%	76%	0%

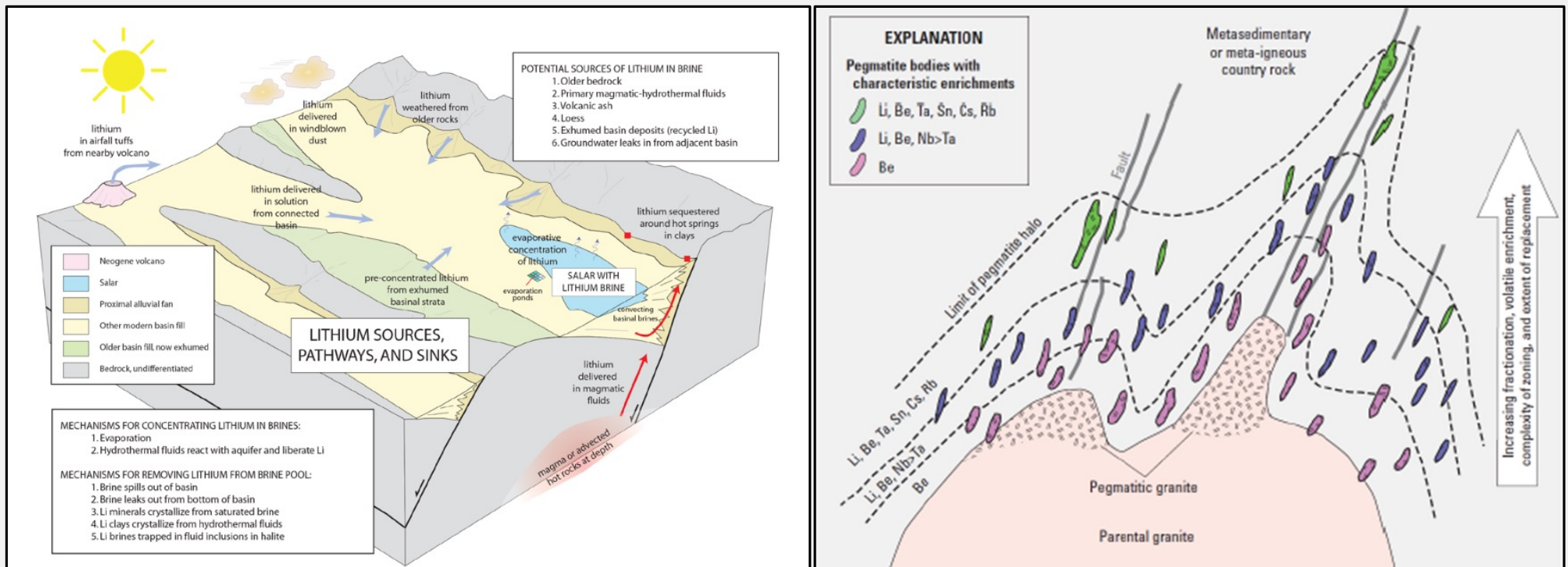
Geologic Age	Total	I	K	Li	Mg	Mn	Na	Ni	Pb	Se	Sr	Ti	Zn	BO3	CO2	H2S	HCO3	SO4
Zone 1	22	0%	9%	0%	95%	14%	100%	0%	0%	0%	9%	0%	0%	0%	91%	18%	100%	64%
Zone 2	12	0%	42%	33%	83%	33%	92%	0%	0%	0%	42%	0%	33%	0%	50%	50%	83%	67%
Zone 3	82	0%	21%	0%	62%	34%	99%	0%	4%	0%	21%	0%	4%	6%	49%	26%	76%	65%
Zone 4	123	2%	18%	1%	81%	18%	97%	0%	3%	0%	14%	0%	5%	1%	41%	17%	77%	63%
Zone 5	74	18%	23%	3%	76%	20%	81%	0%	0%	0%	18%	0%	3%	0%	38%	11%	70%	61%
Zone 6	377	2%	38%	14%	71%	42%	93%	1%	3%	0%	41%	1%	12%	1%	45%	30%	67%	77%
Zone 7	64	0%	16%	3%	59%	25%	97%	0%	0%	0%	23%	0%	2%	0%	42%	30%	59%	52%
Zone 8	115	0%	15%	3%	84%	16%	98%	0%	0%	0%	14%	1%	3%	0%	52%	23%	82%	77%
Zone 9	9	0%	56%	56%	89%	56%	100%	0%	0%	0%	67%	11%	0%	0%	33%	67%	89%	89%
Zone 10	17	0%	0%	0%	100%	0%	41%	0%	0%	0%	0%	0%	0%	0%	12%	12%	71%	94%
Zone -1	640	0%	19%	3%	67%	14%	98%	0%	0%	0%	12%	0%	4%	0%	41%	19%	69%	52%
Zone -2	142	0%	15%	1%	70%	19%	97%	0%	2%	0%	11%	0%	4%	1%	45%	20%	77%	65%

Evaporated Seawater is Insufficient for Economic Lithium



Future of Lithium Exploration Models

While near surface lithium exploration is now better understood, there is still no unified lithium exploration model for deep brines



OKLAHOMA & THE ENERGY TRANSITION

Morning Sessions (8:45AM to 12:00PM)

8:00-8:45 **Doors Open – Core Layout Available All Day**

8:45-9:30 "Oklahoma Energy: The State of the State" [Nick Hayman, OGS & Carl Symcox]

9:30-10:00 "Use of Hydrocarbon Wells System to Harness the Geothermal Potential of Oklahoma Sedimentary Basins: Opportunities for Energy Transition and Workforce Development" [Saeed Salehi, OU]

10:00-10:30 **Coffee Break and Poster Session**

10:30-11:00 "Navigating earthquake hazards in the intraplate: the last decade as a guide for the next decade" [Jake Walter, OGS]

11:00-11:30 "Planning for the Water / Energy Nexus in Oklahoma" [Owen Mills, OWRB]

11:30-12:00 **Morning Panel Discussion**

12:00 – 1:00 **Lunch**

Afternoon Session (1:00PM to 5:00PM)

1:00-1:30 "Integrating Induced Seismicity with Fault Interpretation at the Decatur, IL CCS Projects" [Sherilyn Williams-Stroud, UIUC]

1:30-2:00 "H2 Storage in Salt Formations: A Texas Perspective" [Lorena Moscardelli, BEG]

2:00-2:30 "Geological Carbon Sequestration in Oklahoma: From Source to Sink" [Fnu "Ming" Suriamin, OGS]

2:30–3:00 **Coffee Break and Poster Session**

3:00-3:30 "Lessons Learned from Galvanic Energy's Smackover Lithium Brine Prospect" [Garrett Powell, Galvanic Energy]

3:30-4:00 "Rare Earth Elements in Sedimentary Phosphate: Solution to the Global REE Crisis?" [Pat McLaughlin, IGS]

4:00-4:30 "Overview of Cobalt Potential in Western Oklahoma's Strataform Copper Deposits and an Assessment of the REE Potential in the Woodford Shale" [Andrew Cullen, Big Hill Adventures]

4:30-5:00 **Afternoon Panel Discussion**