STARR

State of Texas Advanced Resource Recovery

2022–2024 BIENNIUM REPORT

MARCH 2025

PRINCIPAL INVESTIGATOR
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PROGRAM DIRECTOR
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Bureau of Economic Geology

State Geological Survey of Texas
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Cover image:
Santa Rita No. 1 oil well, circa 1923, Reagan County, West Texas.

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EXECUTIVE SUMMARY

The mission of the State of Texas Advanced Resource Recovery (STARR) program is to conduct geoscience and engineering research to increase the production and profitability of earth resources, including oil, natural gas, hydrogen, geothermal and minerals, within the State of Texas while encouraging responsible economic development and supporting education and environmental stewardship. As part of this mission, one of our main objectives is to help increase severance tax income for the State of Texas through research projects that promote the drilling of profitable oil and gas wells in the state. Most recently, our team has also initiated research activities to better understand the potential of developing emerging energy solutions within the State. These novel solutions include hydrogen, geothermal, and mineral resources. In addition, members of our team look closely at the land, energy, and water nexus incorporating projects that range from wildfire detection and monitoring to produced water management research.

The Bureau of Economic Geology receives funds from the State to conduct research that assists energy operators, particularly small oil and gas operators, in adding new or increasing existing production throughout Texas. Revenue associated with STARR projects must equal or exceed the amount appropriated to the program by the Legislature. This report summarizes accomplishments of the STARR program from September 1, 2022, to August 31, 2024.

Credit to the STARR program for the 2022–2024 biennium, in accordance with methodology approved by the State of Texas Comptroller's office, is approximately $144,426,413 (table 1). ***Relative to total funding of $9.9 million over the current biennium, STARR is revenue positive by a factor of 14.6.***

Table 1. Summary of the field and regional studies that were active during the 2022–2024 biennium

Field Study Name	Years	Condensate (BBL)	Oil Well Head Value ($)	Oil Severance Tax (4.6%)	Gas (MCF)	Gas Well Head Value ($)	Gas Severance Tax (7.5%)	Oil Severance (100 %)	Gas Severance (100%)	Total Oil ($)	Total Gas ($)
Strawn Group (Fisher County): Darrell Mauldin (Travcon Energy)	2021–2023	357,283	29,391,969.66	1,322,638.63	958,780.00	5,201,374.84	390,103.11	1,322,638.63	390,103.11	1,322,638.63	390,103.11
Cisco Group (Motley, Floyd, Briscoe, and Hall Counties): Dan Earl Duggans (Independent)	2021–2023	3,868	307,376.58	13,831.95	0.00	0.00	0.00	13,831.95	0.00	13,831.95	0.00
Barnett Shale (Denton and Wise Counties) (in conjunction with MSRL and FRAC), Rebecca Harrington (BKV corporation)	2021–2024	1,691,433	99,284,164.76	4,467,787.41	60,846,335.00	162,533,954.81	12,190,046.61	4,467,787.41	12,190,046.61	4,467,787.41	12,190,046.61
Barnett Shale Wise County in conjunction with MSRL Devon	2021–2023	250,004	19,159,476.54	862,176.44	14,338,850.00	47,762,712.71	3,582,203.45	862,176.44	3,582,203.45	862,176.44	3,582,203.45
Tannehill sandstones (King County): Jack Deans and Trey Cortez (Burnett Oil Company)	2021–2023	3,767	288,977.99	13,004.01	119.00	465.01	34.88	13,004.01	34.88	13,004.01	34.88
San Andres Seminole and Handford fields (Gaines County): (Fasken Oil/Hess)	2021–2023	11,331	861,862.48	38,783.81	18.00	39.12	2.93	38,783.81	2.93	38,783.81	2.93
Austin Chalk (Tyler, Jasper, Newton, Sabine, Vernon, Beauregard Co.) (in conjunction with RCRL): Adam Haecker and Chrystiano Mardi (Continental Resources, BPX Energy Inc and RKI Energy Resources)	2022–2024	769,419	60,878,178.06	2,739,518.01	6,405,878.00	19,930,781.66	1,494,808.62	2,739,518.01	1,494,808.62	2,739,518.01	1,494,808.62
Wolfcamp A, Dean, Middle Leonard, Spraberry, Upper Leonard core (Martin Co, TX): Collab with TORA (Exxon core)	2022–2024	296,072.00	23,077,025.39	1,038,466.14	546,690.00	1,258,949.66	94,421.22	1,038,466.14	94,421.22	1,038,466.14	94,421.22
Yegua Formation (Jackson County) (Emerald Exploration)	2022–2024	38,885.00	3,055,181.37	137,483.16	1,297,493.00	3,633,416.53	272,506.24	137,483.16	272,506.24	137,483.16	272,506.24
Totals										**10,633,689.58**	**18,024,127.08**
								Field Study Revenue ($)		**28,657,816.65**	

Table 1. Summary of the field and regional studies that were active during the 2022–2024 biennium (cont.)

Regional Study Name	Years	Condensate (BBL)	Oil Well Head Value ($)	Oil Severance Tax (4.6%)	Gas (MCF)	Gas Well Head Value ($)	Gas Severance Tax (7.5%)	Oil Severance (25 %)	Gas Severance (25%)	Total Oil ($)	Total Gas ($)
Pettet and Sligo Rusk Cherokee Smith Gregg Panola Nacogdoches Wood Counties	2021–2023	5,288.00	425,040.39	19,126.82	290,377.00	930,238.46	69,767.88	4,781.70	17,441.97	4,781.70	17,441.97
Strawn Group (King, Stonewall, Dickens and Kent Counties)	2021–2023	68,868.00	5,479,516.01	246,578.22	39,824.00	164,790.67	12,359.30	61,644.56	3,089.83	61,644.56	3,089.83
Austin Chalk Group (La Salle, Wilson, Gonzales, Dewitt, Fayette, Lee, Burleson, Roberson, Walker, Polk, Tyler, Sabine, Vernon counties)	2021–2023	2,824,696.00	221,384,231.60	9,962,290.42	20,729,775.00	73,327,341.61	5,499,550.62	2,490,572.61	1,374,887.66	2,490,572.61	1,374,887.66
Cisco Group (Concho, Menard, Coke, Runnels, Tom Green, Nolan, Taylor and Schleicher counties)	2021–2023	19,760.00	1,522,369.34	68,506.62	1,170.00	2,979.50	223.46	17,126.66	55.87	17,126.66	55.87
San Andres Fm. Permian Basin (12 counties)	2021–2023	4,038,691.00	331,324,306.02	14,909,593.77	5,550,235.00	30,285,875.06	2,271,440.63	3,727,398.44	567,860.16	3,727,398.44	567,860.16
Bell Canyon and Cherry Canyon (Loving and Reeves Counties) (in conjunction with the QCL Group)	2021–2023	0.00	0.00	0.00	1,042.00	4,840.08	363.01	0.00	90.75	0.00	90.75
Wolfcamp Formation (Reagan and Hockley Counties) (in conjunction with the TORA Group)	2021–2023	1,765,310.00	142,407,853.19	6,408,353.39	5,426,423.00	24,400,152.31	1,830,011.42	1,602,088.35	457,502.86	1,602,088.35	457,502.86
Serbin Field Taylor Sandstone Formation (Lee, Bastrop, and Fayette Counties) (Riley Exploration Group)	2021–2023	109.00	8,565.18	385.43	553.00	1,868.66	140.15	96.36	35.04	96.36	35.04
Eagle Ford (Karnes)	2021–2023	41,461,762.00	3,237,916,764.57	145,706,254.41	125,131,529.00	470,856,285.88	35,314,221.44	36,426,563.60	8,828,555.36	36,426,563.60	8,828,555.36
Wolfcamp and Eagle Ford (Reagan and Karnes Counties) (in conjunction with MSRL)	2021–2023	54,414,626.00	4,328,339,643.92	194,775,283.98	173,691,104.00	586,792,458.86	44,009,434.41	48,693,820.99	11,002,358.60	48,693,820.99	11,002,358.60
Wilcox Core Workshop Karnes, DeWitt, Bastrop, Colorado, Lavaca, Anderson, Leon, Freestone collaboration with Ellington Resources and Petrostrat	2023–2025	333,124.00	26,602,019.48	1,197,090.88	3,369,515.00	7,413,640.64	556,023.05	299,272.72	139,005.76	299,272.72	139,005.76
Biostratigraphic Analysis of Wilcox Group (Karnes and DeWitt counties) Ellington	2024–2026	23,149.00	1,846,811.13	83,106.50	195,890.00	427,700.64	32,077.55	20,776.63	8,019.39	20,776.63	8,019.39
Lithologic controls on reservoir quality and production trends in the carbonate Pettet Formation (Rusk Co)	2024–2026	5,708.00	450,553.52	20,274.91	32,069.00	72,612.31	5,445.92	5,068.73	1,361.48	5,068.73	1,361.48
Sedimentology/Stratigraphy and Provenance of the mixed siliciclastic-carbonate Cisco Group in the Eastern Shelf (Menard, McCulloch, Concho, Tom Green, Coleman, Runnels, Coke, Callahan, Taylor, Shackelford, Stephens, Throckmorton, Archer, Wichita, Haskell, Stonewall, Kent, King)	2024–2026	236.00	18,749.79	843.74	0.00	0.00	0.00	210.94	0.00	210.94	0.00
Upper Pennsylvanian-Lower Permian Cline to Lower Leonard (Canyon-Wichita) mixed carbonate-siliciclastic sequences (Mitchell, Nolan, Howard, Coke, Sterling counties)	2023–2025	0.00	0.00	0.00	215.00	462.48	34.69	0.00	8.67	0.00	8.67
Cisco Group and Strawn Group, Northern Eastern Shelf (King Co.)	2023–2025	21,209.00	1,680,088.68	75,603.99	0.00	0.00	0.00	18,901.00	0.00	18,901.00	0.00
Totals										**93,368,323.27**	**22,400,273.38**
								Regional Study Revenue ($)		**115,768,596.65**	
								Total Revenue ($)		**144,426,413.31**	

STARR MISSION AND PROGRAM

The STARR mission is to conduct geoscience and engineering research to increase the production and profitability of earth resources, including oil, natural gas, hydrogen, geothermal and minerals, within the State of Texas while encouraging responsible economic development and supporting education and environmental stewardship (fig. 1).

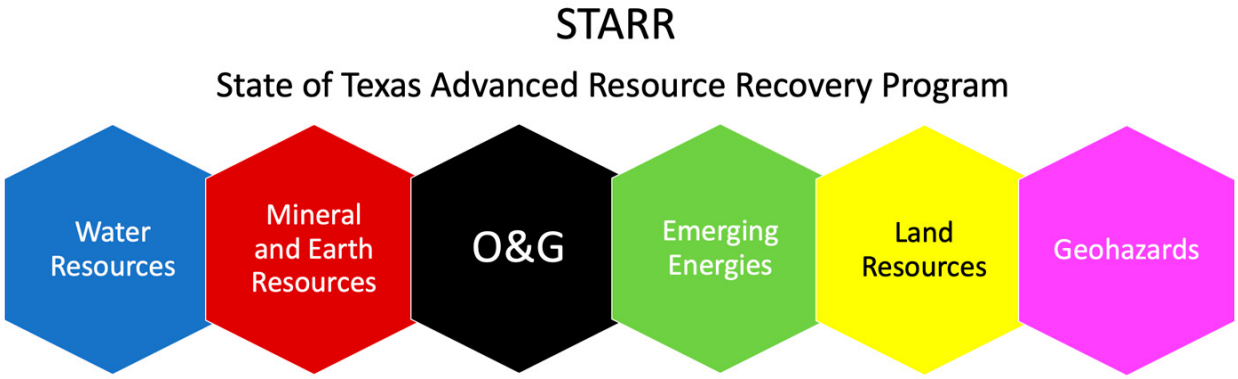

Figure 1. STARR organizational structure. The oil and gas division is our largest with researchers engaging in research and exploration related activities in collaboration with small Texas operators.

Texas leads the nation in oil and gas production from a combination of unconventional shale resources and continued development of conventional resources. The STARR program provides geological and engineering support to smaller operators who have limited staffing so that they can access state of the art tools and expertise to support their efforts to maintain and increase energy production within the state. STARR also engages in research to identify emerging energy opportunities within the State of Texas; this research is strategic for the future of the State and our Nation, and it includes assessments for hydrogen production and storage, improvement of techniques associated with CO_2 enhanced oil recovery (EOR) for older oil fields, critical mineral and natural H_2 exploration, and evaluation of geothermal potential, among others. In addition, STARR personnel and collaborators conduct important research associated with water management and environmental stewardship. The results from STARR are published in journals and Bureau Reports of Investigation and are presented at conferences in Texas and more broadly (see appendices B and C). As the energy economy grows and evolves, the work of STARR will continue to help shape energy exploration and resource assessment within the great State of Texas.

STARR Revenue-Neutrality Metrics

STARR Energy

An important goal of the STARR program is to demonstrate revenue neutrality. STARR's revenue neutrality is calculated over a period of two years. Royalties and severance taxes for the State are the basis for revenue-neutrality calculations (table 2). This metrics table was developed in conjunction with the State of Texas Comptroller's office in 2004.

Revenue values summarized in table 1 are derived from total production in areas defined by field and regional studies during the 2022–2024 biennium. Total revenue value is defined as all new

production multiplied by the price of oil and gas for a given month and totaled from oil and gas well head value. STARR involvement in regional plays allows the Bureau of Economic Geology to sum up 25% of the severance tax, whereas severance-tax credit for STARR field studies is at a 100% value (table 2). The total revenue in table 1 is the summation of this process for every regional and field study in the current biennium.

STARR Land, Fire, Water, and Energy Nexus

STARR funds continue to leverage and match external grants in at least four different programs. For the environmental side of the program, NASA sponsored the FireSense Technology project at $1,330,944.42 for three years to develop novel remote sensing and geospatial techniques to understand the potential for wildfires and impact on land and communities. In 2024, STARR also leveraged a $1 million grant from the National Science Foundation, which was awarded to UT Austin Energy Institute and distributed to the Permian Development Lab (PEDL) partners including STARR. The Bureau and STARR provided technical support for PEDL's research by developing geospatial frameworks and databases of surface and subsurface assets. STARR also leveraged funding to obtain support from the STATEMAP program with USGS providing $642,268 from federal sources in FY24. Finally, the STARR/University Lands (UL) project in emerging energies was executed with a total budget of $750,000 with UL providing $400,000 in funding.

Table 2. STARR revenue-neutrality metrics

Type of STARR recommendation	Expiration period following recommendation (Initial/ incremental production must begin before recommendation expires)	Time period for credit following initial production	Royalty credit	Severance tax credit
1. Drilling new infill or step-out well in established field	4 years	2 years	100%	100%
2. Drilling new infill or step-out well in established field with multiple reservoir intervals	4 years	2 years following completion of each additional reservoir interval	100%	100%
3. Recompletion—missed pay well in established field	4 years	2 years	100%	100%
4. Enhanced oil recovery (EOR) field project	4 years	2 years following date selected by STARR within a 5-year period from initial operator action	100% of incremental production	100% of incremental production
5. Exploration well	4 years	2 years	100%	100%
5a. Subsequent development wells following discovery of new field	2 years following initial production from exploration well	2 years	100%	100%
5b. Copycat wells following discovery of new field	2 years following initial production from exploration well	2 years	25%	25%
6. Wells drilled on basis of influence of regional trend studies	4 years starting 6 months after releasing study	2 years	25%	25%

Energy Division: Oil and Gas Research

Texas continues to produce more oil and natural gas than any other state (fig. 2). In 2022, Texas and New Mexico contributed the most growth to U.S. crude oil production. In 2023, oil production hit a record 1.92 billion barrels and operators produced 12.01 trillion cubic feet of natural gas. In May 2024, approximately 160,233 active oil wells and 83,415 active gas wells were producing oil and natural gas in the state (Railroad Commission of Texas) (fig. 3). The vast majority of this production comes from the Permian Basin in West Texas. No other state, or other region worldwide, has been as heavily explored or drilled for oil and natural gas as the Permian Basin.

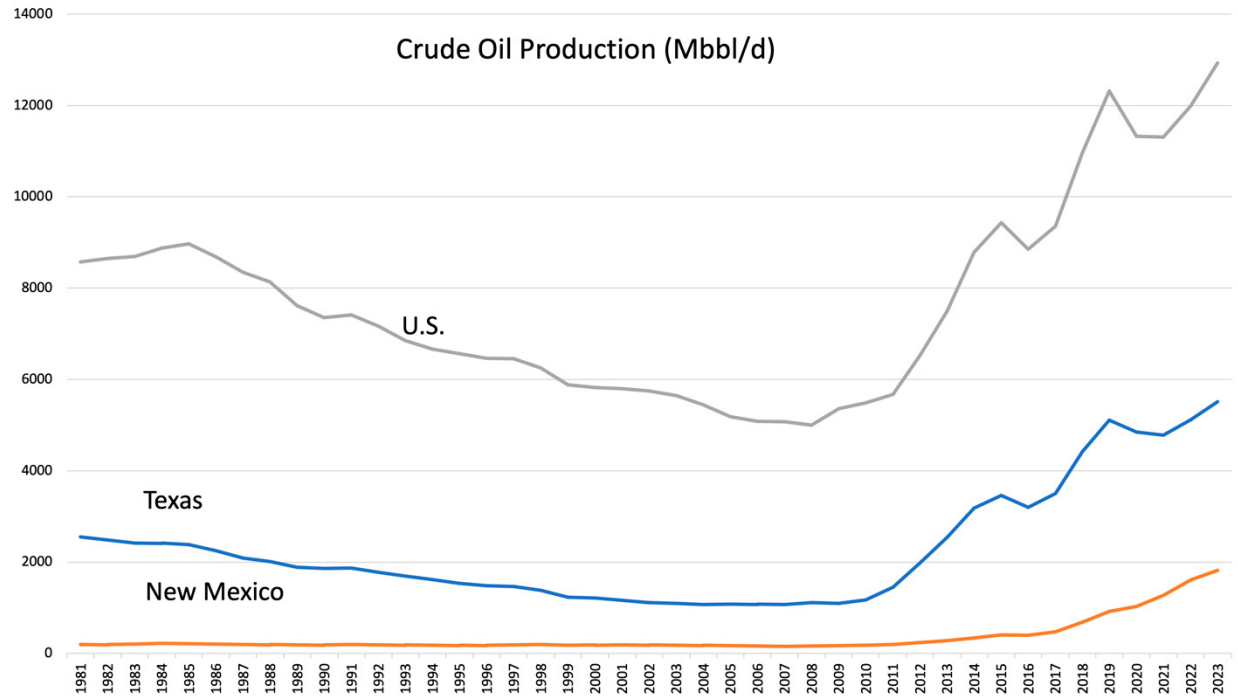

Figure 2. Crude oil production in thousand barrels per day for the United States compared to Texas and New Mexico. Source: U.S. Energy Information Administration.

Despite decades of heavy exploration and drilling within the state, the data clearly points to the untapped potential of the Texas subsurface with oil and gas production steadily increasing since 2009. As production continued to increase (fig. 2), the 2022–2024 biennium saw more stable prices in contrast to the previous two years (fig. 4). This behavior was influenced by post-pandemic economic adjustments and by geopolitical factors including the Russia-Ukraine conflict. Within this context, the STARR program provides geological and engineering support to smaller operators in Texas who have limited staffing and technical resources to enable access to state-of-the-art tools and expertise. Many oil and gas companies benefited from STARR field and regional studies during the 2022–2024 biennium (see Letters of Cooperation [see appendix A]).

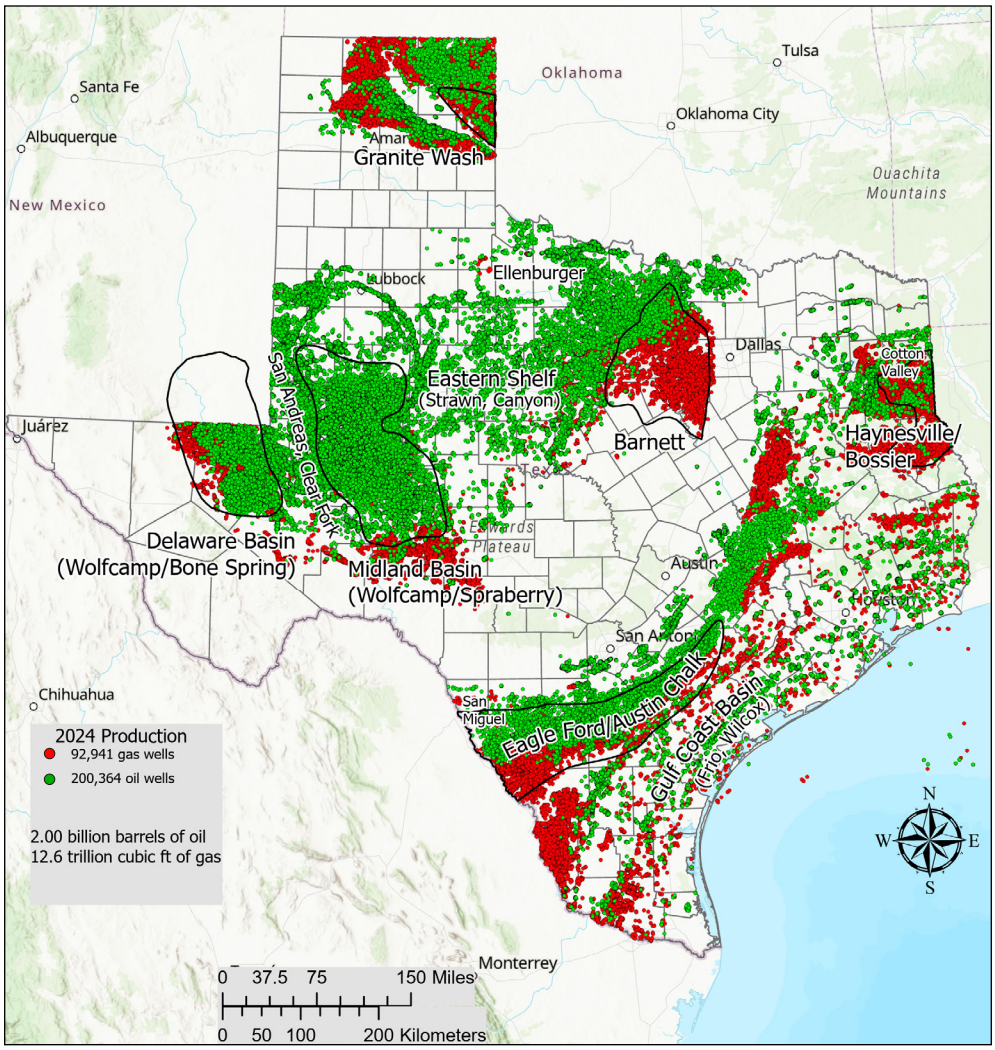

Figure 3. Map with active oil and gas wells. Data source: Railroad Commission of Texas.

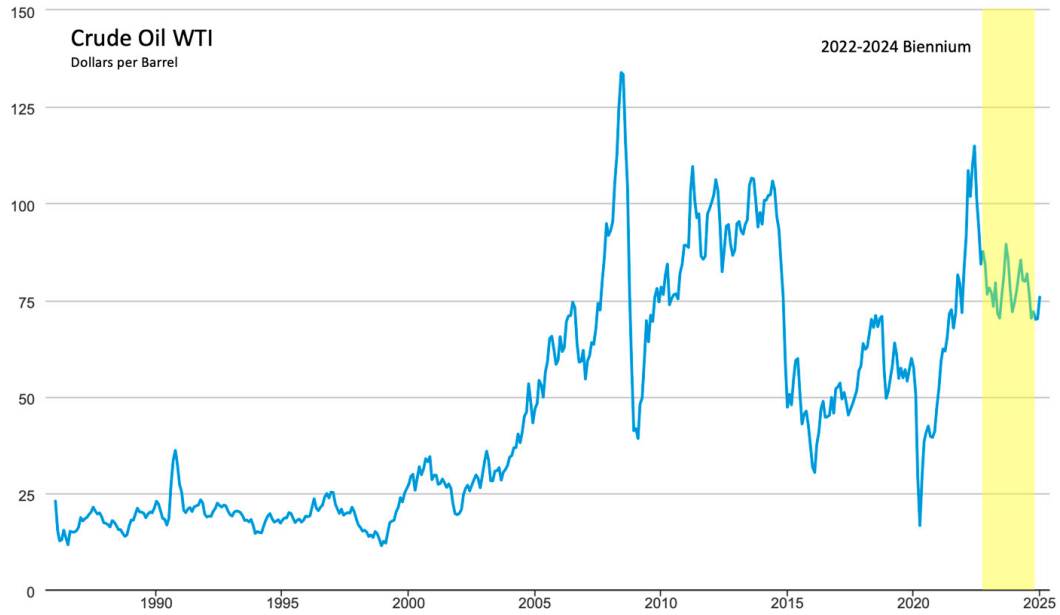

Figure 4. Oil and gas prices during the 2022–2024 biennium. Source: U.S. Energy Information Administration.

STARR researchers provide technical support that leads to drilling opportunities for increased oil and gas exploration and production. The STARR program provides a variety of research products that include core descriptions and interpretations, as well as subsurface lithology and structure maps from wireline-log data. These interactions with Texas operators take place across the state and by using a multitude of formats, from one-on-one interactions to the offering of workshops and the publishing of technical reports and articles (fig. 5). STARR researchers also produce a host of research products from seismic data such as cross sections, inversion analyses, stratal-slice maps, and attribute maps. These research products help oil and gas operators to define new exploration and production targets from infill wells, recompletions, field extensions, redesigned waterfloods, EOR, and exploration wells in sparsely drilled areas outside of existing fields.

Figure 5. STARR researchers delivering a core workshop on the Wilcox Group for Texas operators at the Bureau's Core Research Center in Austin, Texas in 2023.

STARR has a technology-transfer approach. During the current 2022–2024 biennium, STARR researchers produced a variety of publications, presentations, and workshops. These are summarized in appendices B to D.

During the 2022–2024 biennium, STARR researchers gave several presentations and conducted reviews of core, wireline-log, and seismic data for industry partners (fig. 5). A partial list of recent and current STARR partners includes TGN Natural Resources, Surge Energy, Portentum Energy, Dan Earl Duggan (independent), Cartodyne, Sabinal Energy Operating LLC, Ovintiv, TotalEnergies, Terra Volta, and WD3 Oil & Gas. A comprehensive list of oil and gas operators who have worked with STARR since 1995 is presented in table 2. In addition, STARR researchers frequently support the efforts of local and regional professional societies that seek our support to organize technical events. During the 2022–2024 biennium, STARR provided significant support organizing technical events to the Southwest Section of the American Association of Petroleum Geologists and the Abilene Geological Society. The involvement with professional associations magnifies the impact of the STARR program by widening exposure to oil and gas operators across Texas.

Table 3. STARR Oil & Gas field studies, 1995 to present

Field	Operator	Period of Project STARR Interaction
Keystone East field	Bass Enterprises, Hallwood Energy, Pioneer Natural Resources, Vista Resources	1995–1999
Geraldine Ford and Ford West fields (primary funding by U.S. Department of Energy)	Conoco, Incorporated	1995–1997
Lockridge, Waha, and Waha West fields (primary funding by U.S. Department of Energy and Gas Research Institute)	Shell Oil and Mobil Oil (now ExxonMobil)	1996–1998
Bar Mar field	Hanson Corporation	1997–1998
Ozona field	Union Pacific Resources, Cross Timbers Oil Co.	1996–1999
Duval County Ranch field	Killam Oil	1998–1999
Umbrella Point field	Panaco, Incorporated	1995–1999
Red Fish Bay field (shallow Frio)	Pi Energy	1996–1997
Corpus Christi East field (Frio)	Sabco Oil and Gas, Royal Exploration	1998–2000
Corpus Christi NW field (Frio)	Sabco Oil and Gas, Royal Exploration	1998–2000
Encinal Channel field (Frio)	Sabco Oil and Gas, Royal Exploration	1999–2000
Mustang Island 889 field (Frio)	Sabco Oil and Gas	2000–2001
Red Fish Bay field (Middle Frio)	IBC Petroleum, Cinco	2001–2008
Red Fish Bay field (Deep Frio)	Boss Exploration, Cinco	2003–2008
Mustang Island offshore (Frio)	Cabot Oil and Gas	2003
Northeast Red Fish Bay project (Frio)	Cabot Oil and Gas	2003
Laguna Madre (Frio)	Novus	2004–2005
Yates field EOR (Permian)	Kinder Morgan	2004–2006
Galveston Bay Shelf area study (Frio)	Santos USA Corp	2004–2006
Carancahua and Matagorda Bay projects (Frio, Miocene)	Brigham Exploration Company	2004–2008
West Bay area study (Alligator Point field; Frio, Miocene)	Gulf Energy Exploration	2005–2007
LaSalle, Calhoun offshore (Frio)	Gulf Energy Exploration	2005–2007
Gold River North field (Olmos)	Huber	2006
Gold River North field (Olmos)	St. Mary's Land and Exploration	2007–2009
East Texas field (Woodbine)	Various operators	2006–2008
North Newark field (Barnett)	Various operators	2007–2009
Spur Lake and Broken Bone fields	Gunn Oil Co.	2007–2009
Mustang Island (Frio)	Sabco Operating Co.	2006–2008
Copano Bay	MPG Petroleum	2007–2009
East Texas field (Moncrief lease)	Danmark Energy	2007–2009
Sugarkane field	Texas Crude	2006–2008
Cleveland/Marmaton/Atoka field	Jones Energy, Ltd.	2008–2010
Lavaca Bay field	Neumin Production Co.	2008–2010
Alabama Ferry field	Antioch Energy LLC	2009–2011
Haynesville	Petrohawk, Common Resources, BP	2009–2011
Spraberry/Wolfcamp (Midland County)	Pioneer Natural Resources	2010–2012
Lavaca Bay field (Frio)	Neumin Production Co.	2010–2012
Eliasville and Breckinridge fields (Caddo Limestone)	BASA Resources	2011–2013
Dismukes field (Dimmit County: Austin Chalk/Eagle Ford Shale)	CML Exploration	2011–2013
Sugar Creek field (Austin Chalk/Woodbine)	BBX Operating	2011–2013
Double A Wells field (Woodbine)	Vision Resources	2011–2013
K-R-S field (Marble Falls Limestone)	Cobra Oil & Gas, Stalker Energy	2011–2013

Table 3. STARR Oil & Gas field studies, 1995 to present (cont.)

Field	Operator	Period of Project STARR Interaction
Bend Conglomerate (Wise County)	Devon Energy	2011–2013
La Sara field (Frio)	Risco La Sara Operations	2011–2013
Ranger Limestone (Eastland County)	Stalker Energy	2011–2013
Austin Chalk (Dimmit County)	Newfield Exploration Company	2011–2013
Frio Formation (Refugio County)	T-C Oil Company	2012–2014
Cleveland/Marmaton/Granite Wash (Hemphill County)	Devon Resources, Arête Resources	2012–2014
Woodbine Group (Leon County)	Risco La Sara Operations, Chesapeake Energy	2012–2014
Woodbine Group (Walker County)	Chesapeake Energy	2012–2014
Cisco limestone (Tom Green County)	AEATX	2012–2014
Pearsall Formation (McMullen, Dimmit County)	Valence, Devon	2012–2014
San Angelo Sandstone (Irion County)	Renda Energy	2012–2014
Atoka/Cherokee Group (Ochiltree, Lipscomb, Hemphill Counties)	Arête Resources	2012–2014
Mississippian Lime (Shackelford, Stephens, Throckmorton, Young Counties)	Tracker Resources	2012–2014
Glorieta group (Ward County)	Whiting Resources	2012–2014
Harkey, Swastika, Cline Woodbine/Eagle Ford (Polk County)	BP	2012–2014
Woodbine Group (Tyler County)	BP	2012–2014
ClearFork formation (Iatan field)	BASA Resources	2013–2015
Buda Limestone (Dimmit County)	US Enercorp	2013–2015
Tonkawa, Douglas formations (Hemphill County)	Chesapeake Energy	2013–2015
Woodbine Group (AA Wells, Hortense fields)	Apache Corporation	2013–2015
Pettet Limestone (Anderson County)	Arête Resources	2013–2015
Woodbine Group (East Texas field)	Zone Energy	2013–2015
Woodbine Group (Kerens, South field)	Five Star Energy	2013–2015
Wilcox Group (Bee, Goliad Counties)	Excellong	2013–2015
Wolfcamp Formation (Howard County)	Excellong	2013–2015
Eaglebine trend (Fayette County)	Devon Resources	2014–2016
Marble Falls Formation (Jack County)	Atlas Resource Partners	2014–2016
ClearFork/Spraberry/Wolfcamp (Howard, Borden, Scurry Counties)	Harmonia, Inc.	2014–2016
Wilcox Group (Bee County)	Formosa Petrochemical	2014–2016
Douglas/Tonkawa formations (Lipscomb County)	Jones Energy, Ltd.	2014–2016
Wilcox Group (Lavaca County)	Imagine Resources LLC	2014–2016
Spraberry/Dean/Wolfcamp (Howard County)	Haimo America, Inc.	2015–2017
Nowack/Thrall (Williamson County)	Trinity Brothers	2015–2017
Serbin (Bastrop/Lee Counties)	Riley Exploration	2015–2017
Wolfcamp Formation (Howard County)	Anadarko Petroleum	2016–2018
Thrall (Williamson County)	Patriot Operating Co.	2016–2018
Ellenburger (Nolan County)	Winchester Energy Limited	2016–2018
San Miguel/Olmos (Maverick County)	Endeavor Natural Gas LP	2016–2018
Smackover Formation (Rains County)	Dyersdale Energy	2016–2018
Reinecke Horseshoe Atoll (Borden County)	Harmonia, Inc.	2016–2018
Cleveland formation (Hansford County)	Latigo Producing	2016–2018
Austin Chalk/Eagleford (Fayette County)	Oak Spring Energy	2016–2018
Wilcox/Carrizo (Grimes County)	Prolifico Exploration	2016–2018

Table 3. STARR Oil & Gas field studies, 1995 to present (cont.)

Field	Operator	Period of Project STARR Interaction
Austin Chalk (Jasper County)	Fourhorses LLC	2016–2018
Tannehill sandstone (Nolan/Taylor County)	TrayCon Exploration	2016–2018
Spraberry Formation (Reagan/Martin Counties)	De la Terra Exploration	2016–2018
Wilcox/Reklaw (Duval County)	Stalker Energy	2016–2018
Bend Conglomerate (Jack County)	TECCorp International	2017–2019
Wilcox Group (Dewitt County)	Copeland Resources	2017–2019
Tannehill formation (Nolan/Taylor/Coke County)	Teal Exploration	2018–2020
Woodbine Group (Polk County)	Petrotex	2018–2020
Strawn Group (Knox County)	Tri-Star Petroleum Company	2018–2020
Cleveland formation (Lipscomb County)	Tecolote, Inc.	2019–2020
Taylor Group (Williamson County)	Boardman Industries	2019–2020
Ellenburger Group (Kendall County)	Starcreek Energy	2019–2020
Wilcox Group (Zapata County)	Hilcorp	2019–2020
Frio Formation (Nueces/San Patricio Counties)	Durango Resources	2019–2020
Yegua Formation (Jackson County)	Emerald Bay Exploration	2019–2020
Caddo/Canyon/Tannehill (Knox County)	Daylight Petroleum	2019–2020
Strawn Group (Coke/Nolan Counties)	Affirmed Resources	2020–2022
Clearfork formation (Crosby County)	Surge Energy	2020–2022
Cisco and Strawn Groups (Nolan County)	Winchester Energy Limited	2020–2022
Woodbine Group (Polk County)	Pantheon Oil and Gas	2020–2022
Hope Sandstone (Concho County)	SCAL, Inc.	2020–2022
Pearsall Formation (Maverick County)	Tony Ortiz Production Services	2020–2022
Barnett Shale (Wise County)	Devon	2020–2021
Austin Chalk (Tyler, Jasper, Newton, Sabine, Vernon, Beauregard Counties)	Continental Resources	2020–2022
Austin Chalk (Tyler, Jasper, Newton, Sabine, Vernon, Beauregard Counties)	BPX Energy, Inc.	2020–2022
Austin Chalk (Tyler, Jasper, Newton, Sabine, Vernon, Beauregard Counties)	RKI Energy Resources	2020–2022
Strawn Group (Fisher County)	TravCon Geology	2020–2022
Serpentine Thrall field (Williamson County)	P&F Operations	2020–2022
Caballos Novaculite, Maravillas Chert, Thistle field (Pecos County)	Jim Levy (Independent)	2020–2022
Cisco Group (Motley, Floyd, Briscoe, and Hall Counties)	Dan Earl Duggans (Independent)	2020–2022
Frio Formation, Aransas Pass field (Aransas and Refugio Counties)	Claude Joseph and Nathaniel Mayfield (Independents)	2020–2022
San Andres Seminole unit (Gaines County)	Fasken Oil	2020–2022
Pettet Play (East Texas)	TG Natural Resources	2023–2024
Wilcox Group (Gulf Coast)	Portentum Energy	2023–2024
Ellenburger (Eastern Shelf)	Cartodyne	2024
San Andres/Grayburg Fms (UL Block 10)	Sabinal Energy Operating, LLC	2024
Two Finger Sand/Upper Barnett/Atoka (Midland/Andrews Counties)	Ovintiv	2024
Wilcox Group (Gulf Coast)	TotalEnergies	2024
Vicksburg Formation (South Texas)	WD3 Oil & Gas, LP	2024
Strawn/Tannehill (King County)	Burnett Oil	2019–
Strawn Group (Scurry County)	Carr Resources	2020–
Barnett Shale (Denton and Wise Counties)	BKV Corporation	2021–
Wolcamp D and Ellenburger (Eastern Shelf)	Surge Energy	2024–
Smackover (East Texas)	TerraVolta	2024–

Synopsis STARR Oil and Gas Energy Projects

Comprehensive Strawn Eastern Shelf Study Continues

The Pennsylvanian Strawn Group of the Eastern Shelf of the Permian Basin remains a hot topic, with intense interest from academic geologists and operators alike. The Strawn has been a hydrocarbon target for over 80 years, but is relatively poorly known from a geologic perspective as it is highly heterogeneous with a complex stratigraphic and tectonic evolution, reservoir development, and petroleum fill history. STARR researchers have been working diligently to fill these knowledge gaps through a multidisciplinary regional-scale study.

Figure 6. STARR researcher Peter Flaig and graduate student Isabel Johnson image an outcrop in the Sacramento Mountains.

Stratigraphers Dr. Peter Flaig and Kelly Hattori have analyzed many Strawn cores in King and Stonewall Counties, defining facies, determining depositional systems, and developing new models for the stratigraphic evolution of the system. Hattori and Flaig have also identified an outcrop analog of equivalent age and similar depositional setting in the Sacramento Mountains, NM, and are conducting fieldwork seeking to characterize carbonate, mixed carbonate-clastic, and clastic stratigraphy observed there at a seismic scale. They have recruited a new graduate student, Isabel Johnson, to assist with these efforts; Johnson will be characterizing mixed carbonate-siliciclastic Strawn systems in Haskell/Stonewall Counties and will be comparing these to the Sacramento Mountains outcrop analog.

Petroleum engineer Jerry Jensen worked to gain a better understanding of Strawn production characteristics through detailed permeability measurements and interpretation for a core retrieved from a well in Katz field (King/Stonewall Counties). Results of the initial study highlighted the effect of bioturbation on permeability, and also revealed that traditional core plug-derived analyses overestimate permeability by a factor of three compared to more high-resolution continuous probe permeameter measurements. The work was published in *Geosciences,* and will be expanded to include more cores in the upcoming year. Additionally, Jensen has recruited a new graduate student in petroleum engineering, David Dadzie, to study reservoir connectivity of the Katz field using a dataset acquired from operators Atlas and KinderMorgan. This work is expected to illuminate factors controlling production efficacy in the field.

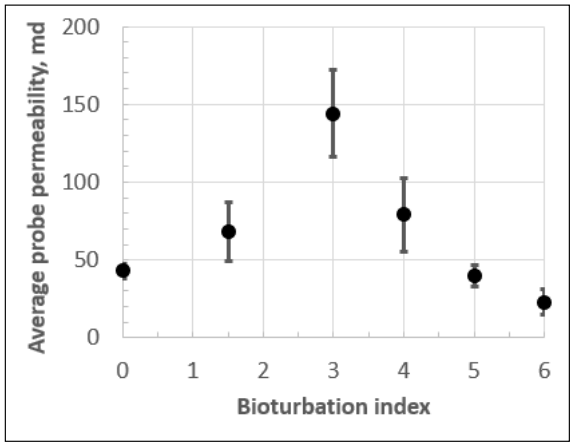

Figure 7. Permeability versus bioturbation index demonstrating positive effect of moderate bioturbation intensity on permeability.

Geophysicist Chris Ogiesoba worked closely with Burnett Oil to perform seismic reservoir characterization of part of the northern end of the Eastern Shelf. As part of his work, he performed seismic inversion, multiattribute analysis, and Bayesian classification on a 3D seismic volume and generated porosity, acoustic impedance, and lithology cubes to increase understanding of the lithology distribution and prospectivity of the formation.

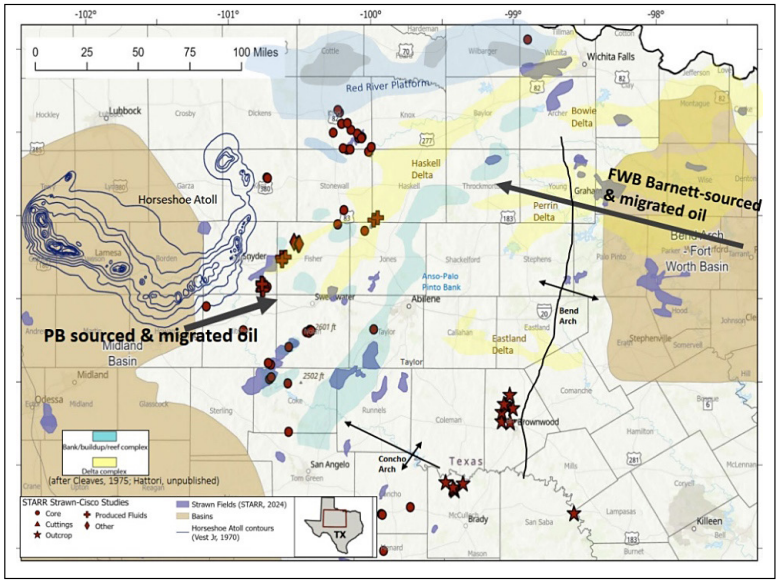

Figure 8. Paleogeographic reconstruction of the Pennsylvanian Strawn petroleum system. Reservoir distribution is overlain on major deltaic complexes and carbonate reef buildups, while arrows trace hydrocarbon migration pathways from source rocks in the Fort Worth Basin (east) and Midland Basin (west). Key structural features–the Horseshoe Atoll, Bend Arch, and Concho Arch–are labeled. Locations of core, cutting, and produced oil samples are also indicated.

Geochemists Drs. Lucy Ko and Xun Sun have been working on understanding the migration and charging history of the oils in the mixed siliciclastic and carbonate Strawn reservoirs from the Fort Worth Basin on the east and the Midland Basin on the west. They gathered data from literature for the chemical and physical oil properties and conducted compositional and biomarker analyses of oil samples retrieved from Strawn reservoirs around the Eastern Shelf to fingerprint the oil's origin. They have also incorporated oil samples retrieved from source rocks in the surrounding area, including the Wolfcamp D/Cline Shale.

Figure 9. STARR researchers present at a sold-out core workshop on the Strawn Group to a large group of very attentive geologists.

The research group has presented the results of their work at numerous meetings over the past two years, including Southwest Section AAPG Annual Meeting, Geological Society of America Annual Meeting, and AAPG IMAGE. They have also given presentations at local geological societies, including Abilene Geological Society and Fort Worth Geological Society. Most recently, they led a very successful core workshop for the Fort Worth Oil Information Library. The team will continue working on this project through 2025-2026 by expanding the scope of the project, adding new data and understanding, and interfacing with stakeholders frequently.

Pettet Formation Depositional Systems, East Texas Basin

STARR researcher Kelly Hattori has been spearheading an effort to characterize the geology of the Early Cretaceous Pettet Formation, an active play in the East Texas region. The formation produces hydrocarbons from skeletal-oolitic grainstones interpreted to be ancient shoal belts

similar to that observed in modern sand flats off the coast of Florida. Very little literature is published on this formation; Hattori and co-workers Dr. Bob Loucks and Eric Radjef have thus spent the past few years working it in detail.

The initial study by Hattori and Loucks (published in *Gulf Coast Association of Geological Societies Journal*) sought to characterize the lithofacies, depositional environments, and timing of deposition for the Pettet Formation in Rusk County, East Texas. Hattori conducted extensive mapping of four identifiable subunits of the Pettet Formation, then developed cross sections and isopachs that visualize the migration of shoals through these units across the study area through time. These shoals have never been mapped as individual units before; the effort provided new insight into potential reservoir distribution and partitioning.

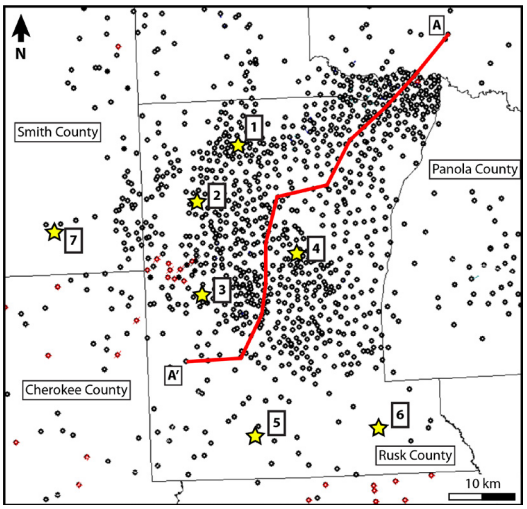

Figure 10. Map of correlated wells (black dots) and described Pettet cores (stars) in the study area. Red line shows line of cross section. Further work published in Hattori and Loucks (2021), GCAGS Journal.

A follow-up study by Hattori and Radjef (published in the *American Association of Petroleum Geologists Bulletin*) expanded on the initial work and incorporated hydrocarbon production figures, contextualizing the impact of lithologies and timing of deposition on real-world reservoir production. The study found that shoal deposits from Pettet subunit B have higher porosity and permeability than those of other units, and have accordingly higher oil and gas production.

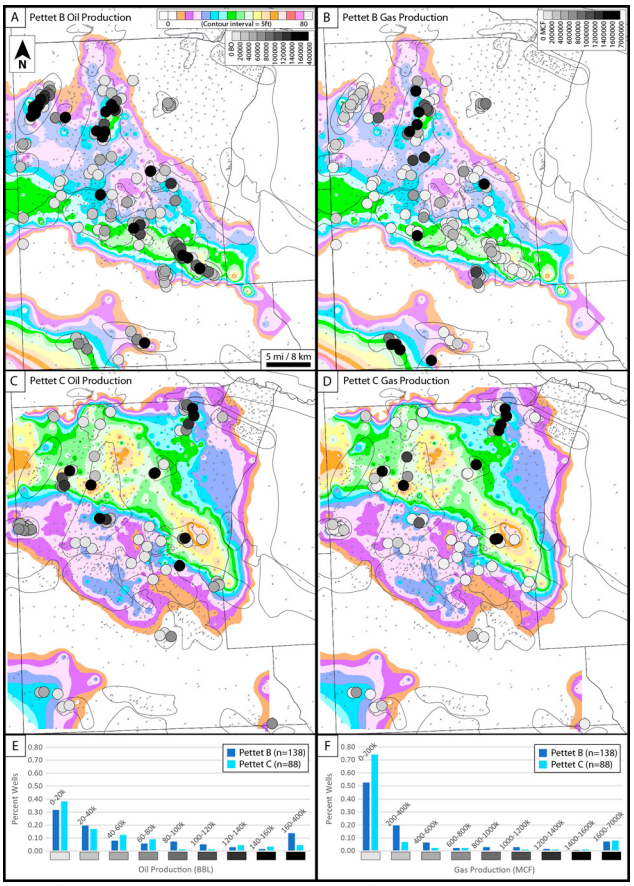

Figure 11. Pettet shoals have been shown to produce different amounts of hydrocarbons based on subunit (time of deposition) and position in the region relative to the thickest portions of the shoals. For more detail, see Hattori and Radjef (2024), AAPG Bulletin.

Additional work has been conducted to expand the Pettet study area to the broader East Texas region: Loucks and Hattori published a manuscript (*Marine and Petroleum Geology*) detailing the facies and depositional environments in the Wright Mountain field, Smith County; a manuscript is in progress, detailing the facies and depositional environments of the Pettet in Van Zandt County; and further work involving well-log correlation has been conducted to provide a framework for the larger region. Study results have been presented at several conferences (AAPG IMAGE, Southwest Section AAPG Annual Meeting, GCAGS GeoGulf, and Mountjoy Carbonate Research Conference) and to many local geological societies (South Texas Geological Society, East Texas Geological Society, Fort Worth branch of SIPES, Dallas branch of SIPES).

San Andres and Grayburg Formations in University Lands

The Fuhrman-Mascho field is located on the eastern side of the Central Basin Platform within University Lands. The field was discovered in 1930 producing from the carbonates and sandstones of the Andres and Grayburg Formations. Oil production has been active for the last 90 years and water injection is ubiquitous across the field. In order to predict fluid interactions within the reservoir and to identify frac'ing targets, it is necessary to understand reservoir characteristics of the sandstone and carbonate intervals in order to maximize oil production while minimizing produced water (fig. 12).

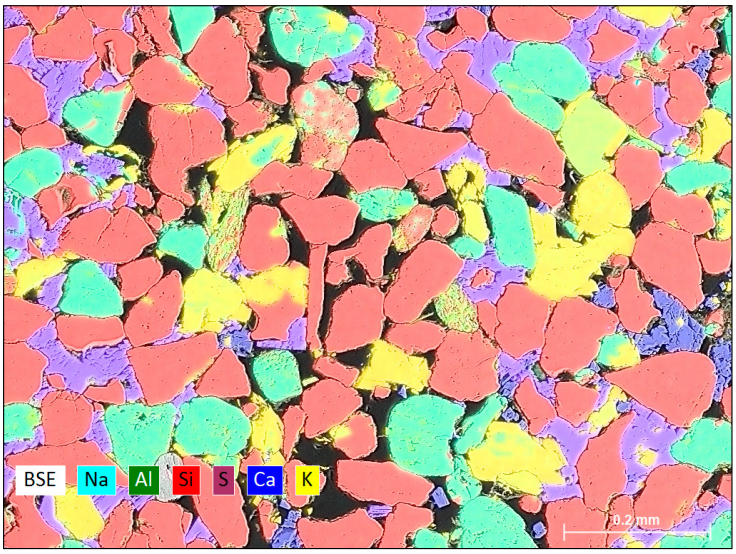

Figure 12. Union of California No. 12-A Fuhrman-Mascho 4285.3 ft. SEM-EDS images. Image shows a porous sandstone with abundant grains of quartz, albite, K-spar, and silicified volcanic rock fragments. Interparticle pore space (black) is common; however, anhydrite cement fills some of the interparticle pores space. The anhydrite cement displays dissolution. Good permeability should be associated with this sandstone.

In this project, the STARR team engaged in a study to identify sandstone reservoir distribution, mineralogy, and reservoir quality. The research project included petrographic work to help calibrate the gamma-ray logs across the field in order to understand vertical and horizontal heterogeneities. Also, it documented the pore types and how they formed. Results of the study indicated that sand-silt-rich intervals have good intergranular porosity while silty and dolomite-rich units present poor reservoir characteristics. In addition, the STARR team engaged in core descriptions and mapping of depositional systems so that the distribution of the good reservoir intervals could be better understood. This work is relevant for operators since the integration of these results with production data helps inform strategies for future oil and water flows. Also, this is one of the first studies to map out the sandstone reservoir lithofacies, which will help locate infill wells and provide data for field extension (fig. 13).

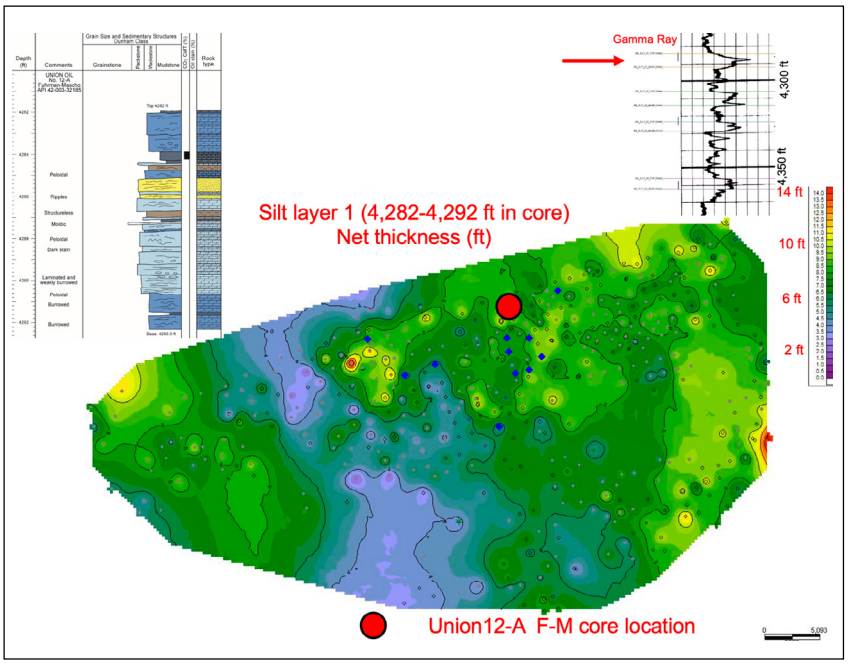

Figure 13. Integration of core description, well logs, and mapping of net thickness of key intervals. This approach will help operators place infill wells and provide data for field extension.

Reservoir Characterization Wolfcamp Formation

The upper Pennsylvanian Cline Shale (Wolfcamp D) is a prolific source of oil and shale gas. This unit is one of the largest hydrocarbon plays in the United States; however, the lithology, total organic matter content (TOC), and its thermal maturity is highly variable across the Permian Basin of West Texas (fig. 14). STARR researchers have ample experience studying and documenting the heterogeneities of the Cline Shale. Texas operators across the state frequently seek our advice to help in the characterization of this important oil and gas exploration target. In this project, our team provided a regional overview of the Cline Shale allowing the operator to obtain a better understanding of subsurface conditions in their region of interest in Howard and Martin Counties (Midland Basin). The team provided information relevant to better understand the regional distribution of sedimentary facies, mineralogical trends, source rock quality, and paleodepositional environments. This information was of value to the operator providing new insights to improve reservoir quality predictions and to inform new drilling efforts.

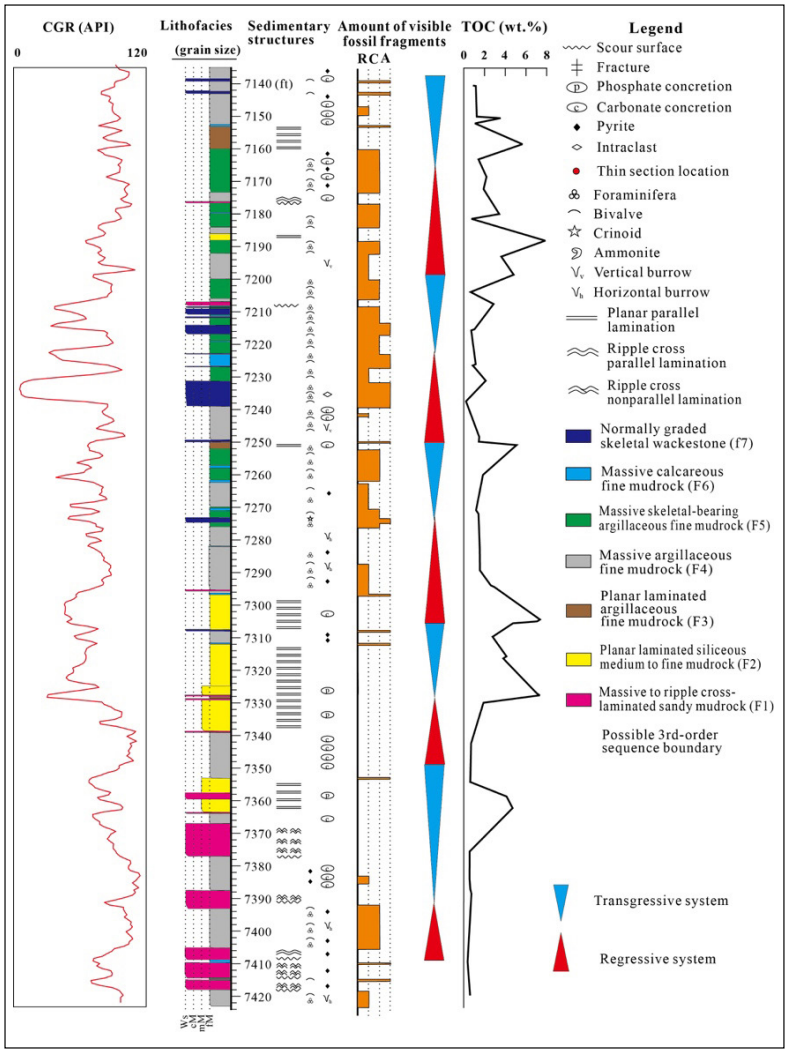

Figure 14. Column section of the Cline Shale in the Adoue #1-H well showing stratigraphic cycles (3rd-order), lithofacies, and variation in TOC.

The STARR team also performed work on the lower Permian Wolfcamp (B and C1) section of the eastern Midland Basin. This interval is >1,000 ft thick, characterized by a mixed succession of shale (mudrock) and sandstone lithofacies (fig. 15). Both mudrocks and sandstones are prolific reservoirs and active

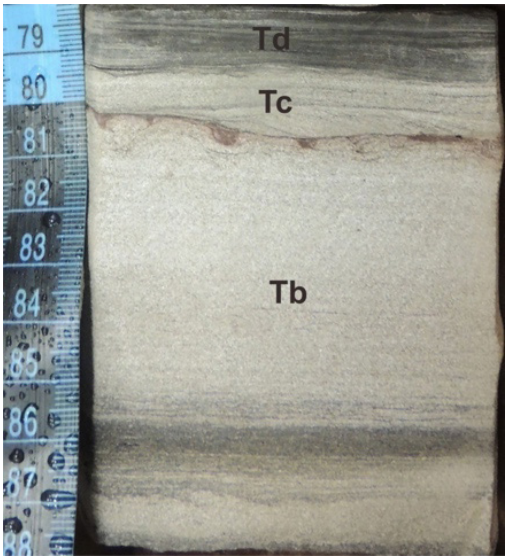

Figure 15. Core photo of the Wolfcamp sandstone in the F. Stubblefield #1-A well, showing Bouma sequence Tb, Tc, and Td interpreted to be turbidity-flow deposits. Depth: 6197.5 ft.

exploration/production targets. Because the succession is highly heterolithic, it is critical to understand and predict the stratigraphic and lateral variability in lithologic change and assess its impacts on reservoir properties.

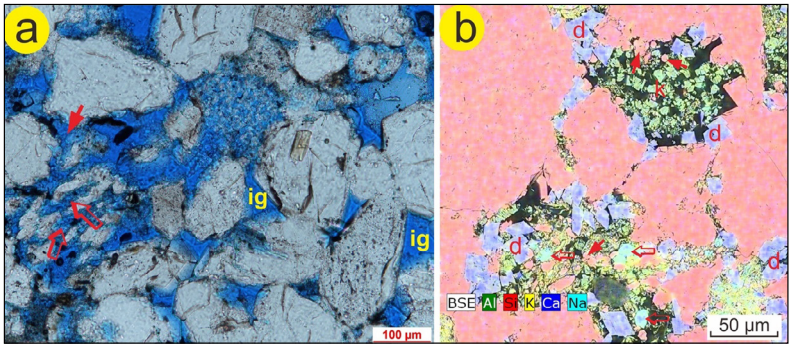

Figure 16. (a) Photomicrograph showing dissolution created secondary intraparticle pores in feldspar (examples by hollow arrows) and enhanced intergranular pores (solid arrow). Well: V.T. McCabe #18-D. Depth: 6036.0 ft. (b) SEM-EDS image showing pores are filled/cemented by kaolinite/dickite (k), ferroan dolomite (d), and sparse, euhedral to subhedral, microcrystalline quartz (solid arrows) and albite (hollow arrows). Well: V.T. MaCabe #18-D. Depth: 6,066.2 ft.

Diagenesis is a major factor that substantially affects the sandstone reservoir property within the lower Wolfcamp (B and C1) (fig. 16). In this project, the core samples were analyzed using petrographic and SEM techniques to characterize diagenetic processes that impact reservoir characteristics, such as porosity types, porosity distribution, and permeability pathways. Petrographic observations provided key constraints for reservoir-quality predictive models.

Woodbine Group Depositional Model and Age

STARR research on the Woodbine Group focuses on outcrops in the Arlington area near Grapevine Lake, Texas. Dr. Peter Flaig is collaborating with paleontologists and paleobotanists at the University of Wisconsin-Parkside and Perot Museum of Nature and Science along with palynologists with Ellington Geological Services. The goal is to refine the depositional model for Woodbine deposits as well as the depositional age. Deposits of the Woodbine in outcrop are interpreted as those of tidal deltas, tidal flats, tidal channels, and fluvial channels emplaced along a Cretaceous coastline. Deposits are unique because they represent rarely exposed paralic systems along the southern coast of Appalachia separated from Laramidia by the Cretaceous Western Interior Seaway. They also include well-preserved plant material, pollen, and vertebrates including turtles, crocodiles, fish, amphibians, and dinosaurs.

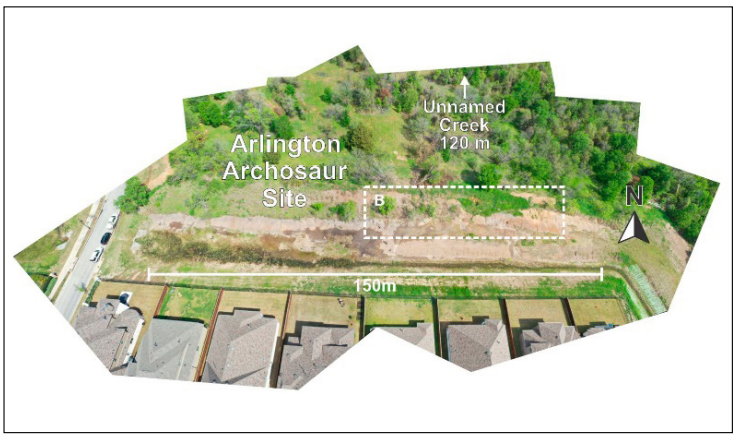

Figure 17. Drone image of the Woodbine Group outcrops at the Arlington Archosaur Site near Arlington, Texas. From Noto et al., 2025 (Sedimentologika).

Refining the Woodbine Group depositional model and age is important because the Woodbine dips into the subsurface and becomes an important oil and gas reservoir in the nearby East Texas Basin and East Texas Oil Field. A new depositional model and age constraints will allow us to correlate age-equivalent deposits from the outcrop into the subsurface at locations where core is available. Continuing and future work includes the addition of several core-based investigations near the outcrop belt in the Dallas area and

in the East Texas Field. Wireline well-log correlations will place the core analysis within a regional stratigraphic framework.

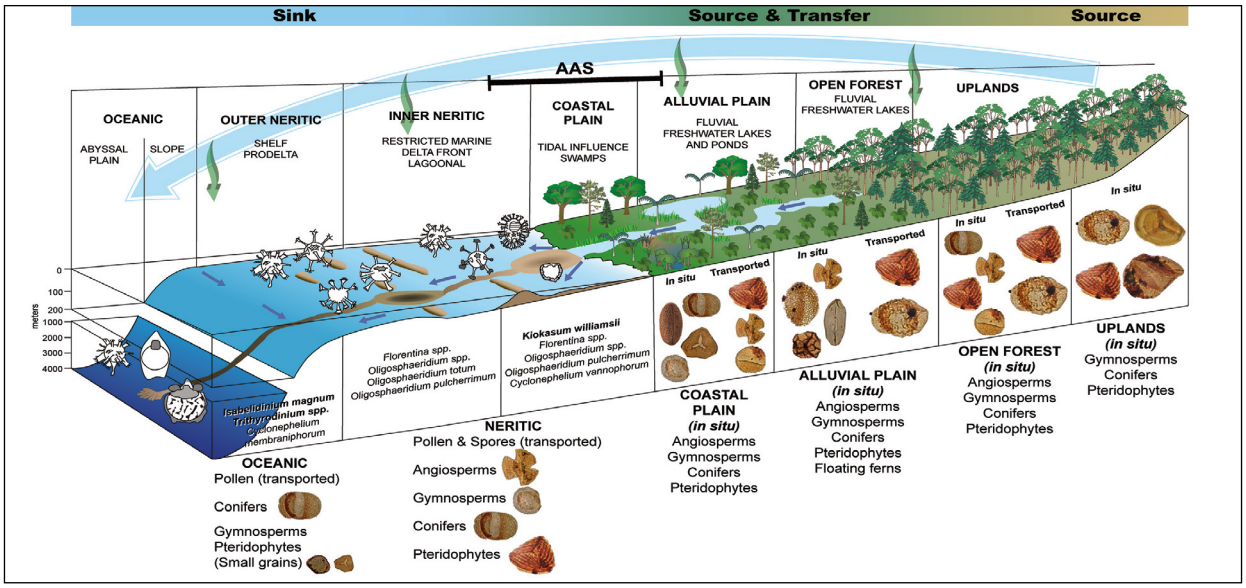

Figure 18. Idealized depositional model of paleoenvironments in the Woodbine Group at the Arlington Archosaur Site, Arlington, Texas. The model combines data from sedimentology, palynology, and vertebrate paleontology. From Noto et al., 2025 (Sedimentologika).

Wilcox Group Depositional Systems, Paleogeography, Climate, and Correlations

STARR research on the Lower Wilcox Group is based on subsurface data (well logs, seismic, and cores) in south-central Texas. Detailed stratigraphic and sedimentologic interpretations are integrated with geochemistry and palynology with help from our collaborators at Ellington Geological Services. The goal is to refine the depositional model for Wilcox deposits in a source-to-sink framework, from the outcrop to the deep-water basin through refined stratigraphic correlations across challenging shelf-margin structures. The onshore Wilcox Group has been targeted for hydrocarbon exploration and production for many decades. These depleted reservoirs can be used today for carbon sequestration, energy storage, and geothermal energy. In addition, the comprehensive characterization of the Lower Wilcox deposits helps detect patterns related to paleogeography and climate. Fine-scale geochemical fingerprinting of the Lower Wilcox (fig. 19) reveals relative humid–arid cycles occurring over 4th order timeframes that generally follow the shoreline movement described by independent stratigraphic analysis. These observations are valuable as they can help improve predictions for reservoir presence and quality.

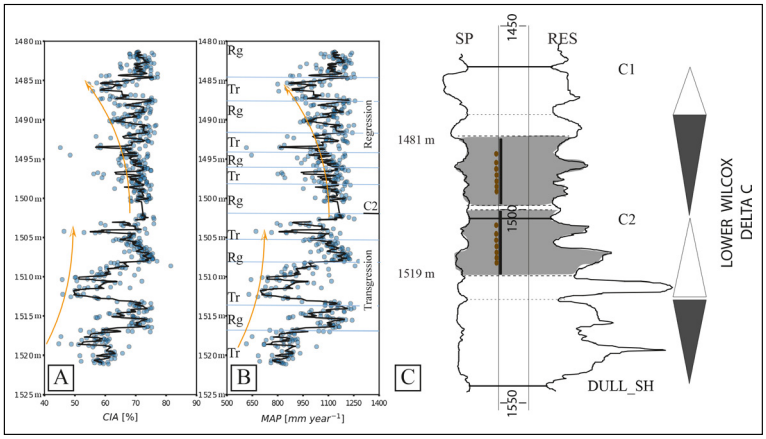

Figure 19. Geochemistry analysis for a 4th order Lower Wilcox cored interval in Moczygemba #11 well A. Weathering (CIA) B. Mean Annual Precipitation (MAP). C. Wire-line log From Olariu et al., 2025.

Research on the Middle to Upper Wilcox Group provides stratigraphic, isotopic, biostratigraphic, and geochemical evidence from outcrops near Bastrop, Texas and contemporaneous core that include the Paleocene-Eocene Thermal Maximum (PETM). This multidisciplinary data set identified key characteristics that place the outcrops within a regional framework, and ultimately enables us to correlate deposits with down-dip onshore shelf and deepwater Wilcox wells. Research includes one master's thesis and collaborations with the University of Geneva (Isotopes), PetroStrat (Palynology), and Rohmtek (Geochemistry).

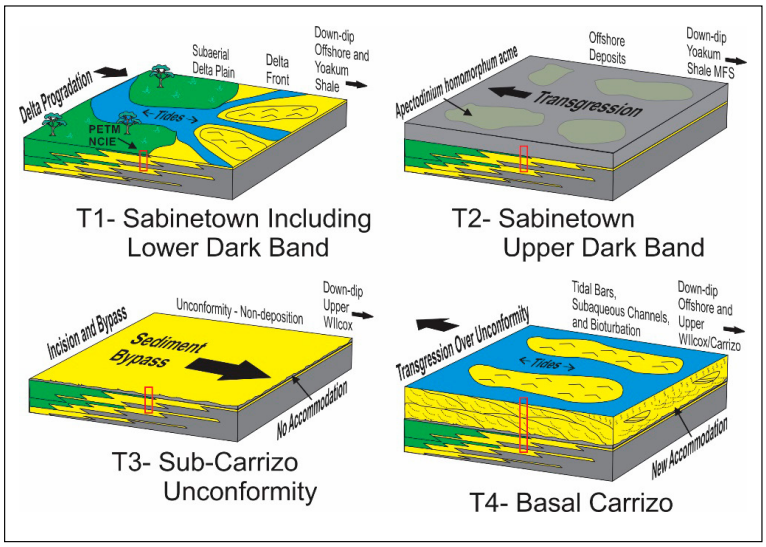

Figure 20. Paleoenvironmental models developed from Bastrop outcrops and probable correlations with down-dip datasets including A) Time 1: Sabinetown and lower Dark Band, B) Time 2: upper Dark Band, C) Time 3: sub-Carrizo unconformity, and D) Time 4: basal Carrizo.

Emerging Energy Opportunities in Texas

University Lands Project in Emerging Energy Opportunities

In 2022, the STARR program entered into a partnership with University Lands (UL), which is the fiduciary steward of 2.1 million acres of land across 19 counties in West Texas. UL manages surface and mineral interests of this land for the benefit of the Permanent University Fund (PUF). The PUF is a university endowment that benefits more than 20 educational and health institutions across The University of Texas System and Texas A&M University System. UL wanted to evaluate emerging energy and resource opportunities within their acreage. Within this context, STARR conducted research to assess emerging energy and resource opportunities and their fiscal and environmental impacts on UL acreage in West Texas.

Deliverables included value-based, geospatial assessments of UL surface and subsurface resources. The first phase of the project consisted in assembling a GIS database with layers that take into consideration the entire value chain for different emerging energy opportunities (fig. 21). This approach allows the user to customize maps using a versatile and reliable geospatial framework.

In addition, our researchers examined opportunities associated with a broad set of emerging energies including hydrogen, carbon management (enhanced oil recovery and carbon capture and sequestration), critical minerals, and geothermal. One of the conclusions of the study was that the Permian Basin of West Texas offers a wide range of opportunities to develop emerging energies; however, high development cost (technology and infrastructure), lack of access to markets, and regulation uncertainties pose significant challenges to these technologies. Our study also revealed that there is a great deal of complex interdependence that links emerging energies and hydrocarbon production (fig. 22). The true nature of these relationships needs deeper consideration to avoid unwanted and potentially harmful activity interference that can harm energy

production. The main take away was that hydrocarbon exploration and production in the Permian Basin will continue to play a significant role for decades to come in order to ensure energy reliability, affordability, and security in Texas and beyond.

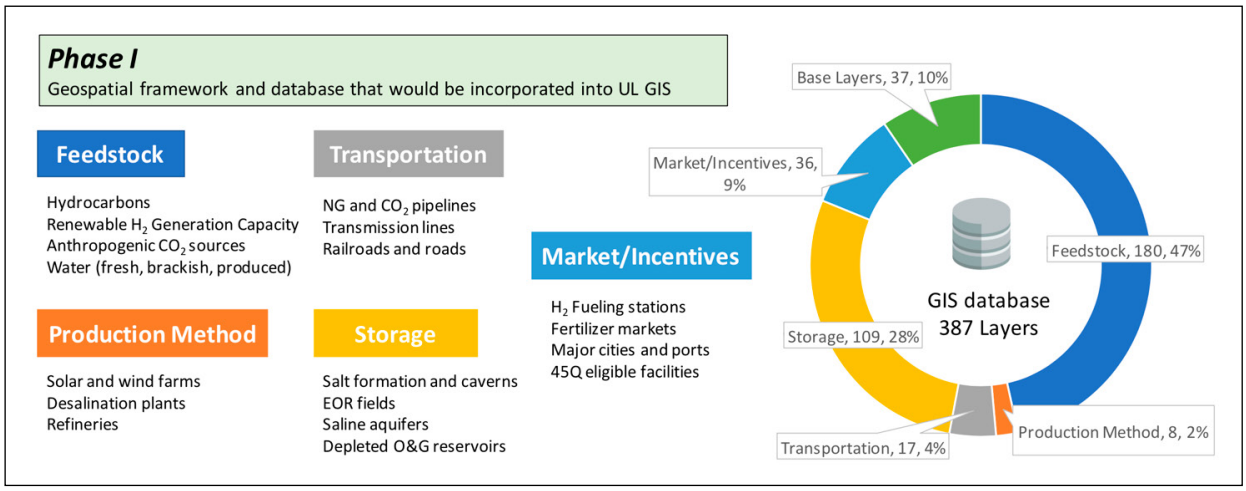

Figure 21. The GIS database delivered to UL contained more than 387 layers that were organized taking into consideration the role of the information obtained or generated as part of broader value chains.

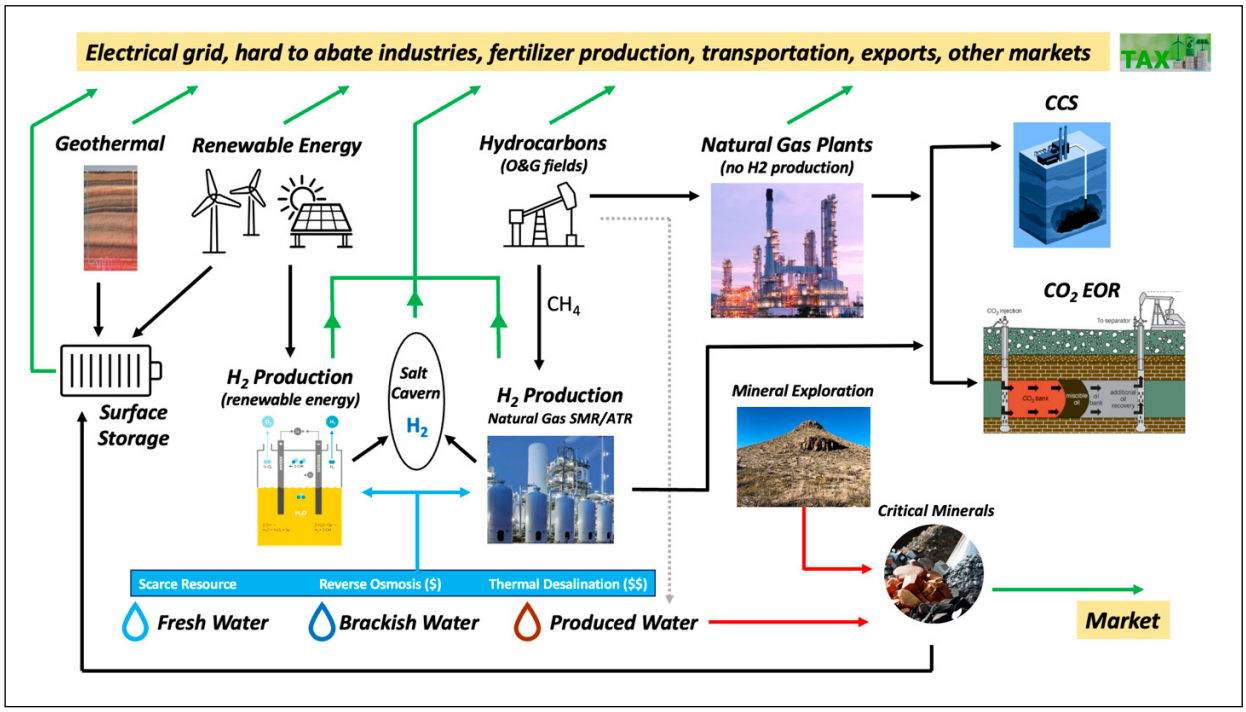

Figure 22. The development of emerging energies poses many challenges. Some of them relate to the intricacy of relationships between different opportunities, the competition for resources, and the risk of interference with proven energy sources.

Permian Energy Development Lab Geospatial and Socio-Economic Modeling

Permian Energy Development Lab (PEDL) is a consortium founded by the University of Texas at Austin and the Cynthia and George Mitchell Foundation, primarily, with significant collaboration from several universities, colleges, and DOE National Laboratories. PEDL was founded to facilitate and conduct advanced research on integrated energy systems in the Permian Basin, leveraging the significant energy-related infrastructure and geologic resources that has been created by STARR, and other funding sources for many years, even decades. Figure 23 shows the 66 county footprint of the PEDL area.

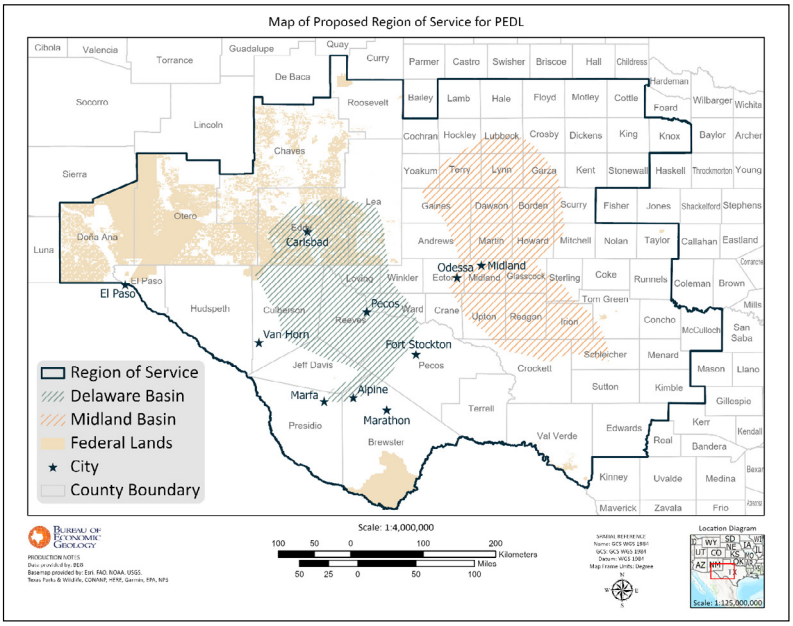

Figure 23. Map of proposed region of service for PEDL.

Leveraging STARR's energy research expertise and a robust geospatial database, a suite of geospatial frameworks and databases was created to model the Permian Basin's infrastructure, natural and energy resources, and socioeconomic structure. STARR researcher Mert Ugurhan created interactive GIS platforms for visualizing and analyzing the region's resources and socioeconomic indicators. These platforms were integrated into PEDL's webpage (https://pedl.tech/geospatial-maps) and are currently being used by PEDL's research teams to support ongoing research and decision-making processes. All the information is available to the public, and thus is an excellent resource for anyone seeking information on regional characteristics. STARR's expertise in geoscience and engineering research has the potential to further expand the STARR-PEDL collaboration and contribute to PEDL's research goals of integrating current, emerging, and new energy technologies.

The Role of Evaporitic Sequences in the Permian Basin of West Texas – Energy Storage and Produced Water Disposal

Emerging energies and oil and gas activities are becoming increasingly intertwined. The shallow evaporitic sequences of the Permian Basin in West Texas, specifically the Castile and Salado formations (fig. 24), exemplify the importance of the subsurface for various applications. The STARR team has conducted extensive research characterizing these units, as their utility spans a wide range of applications, including energy storage in salt caverns and their role as seals for shallow water disposal zones. Additionally, dissolution fronts affecting evaporitic sequences can pose drilling hazards in the wider Permian Basin region. STARR researchers will increase their collaboration with the Center for Injection and Seismicity Research (CISR) during the upcoming biennium to leverage our recently acquired knowledge regarding the shallow evaporitic sequences of West Texas. The main aim for this upcoming collaboration will be to characterize the physical

geomechanical characteristics of the Castile Formation to evaluate its sealing capacity and use this information to generate a risk map for produced water (PW) disposal in the Permian Basin of West Texas.

In addition, during the 2022–2024 biennium we integrated key geoscience input and engineering tools to estimate energy storage capacities using salt caverns in the Permian Basin. These tools allow us to estimate subsurface storage capacities for a variety of energy vectors including hydrogen and natural gas (fig. 25). We have also included information associated with infrastructure (e.g., pipelines, natural gas plants, etc.) to obtain a comprehensive view of the interconnection between subsurface and surface conditions, resource colocation opportunities, and proximity to markets.

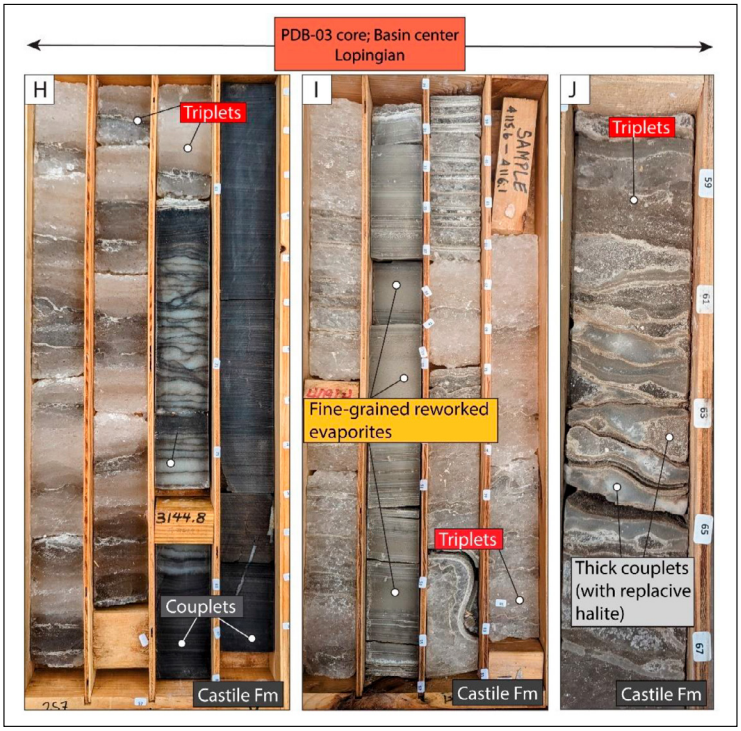

Figure 24. Core samples illustrating the complexities and heterogeneities that are present in the Castile Formation. This unit represents the main seal for the shallow water injection zone in the Delaware Basin. STARR and CISR teams at the Bureau are currently evaluating the regional sealing capacity of this unit to better inform PW injection strategies at a regional scale.

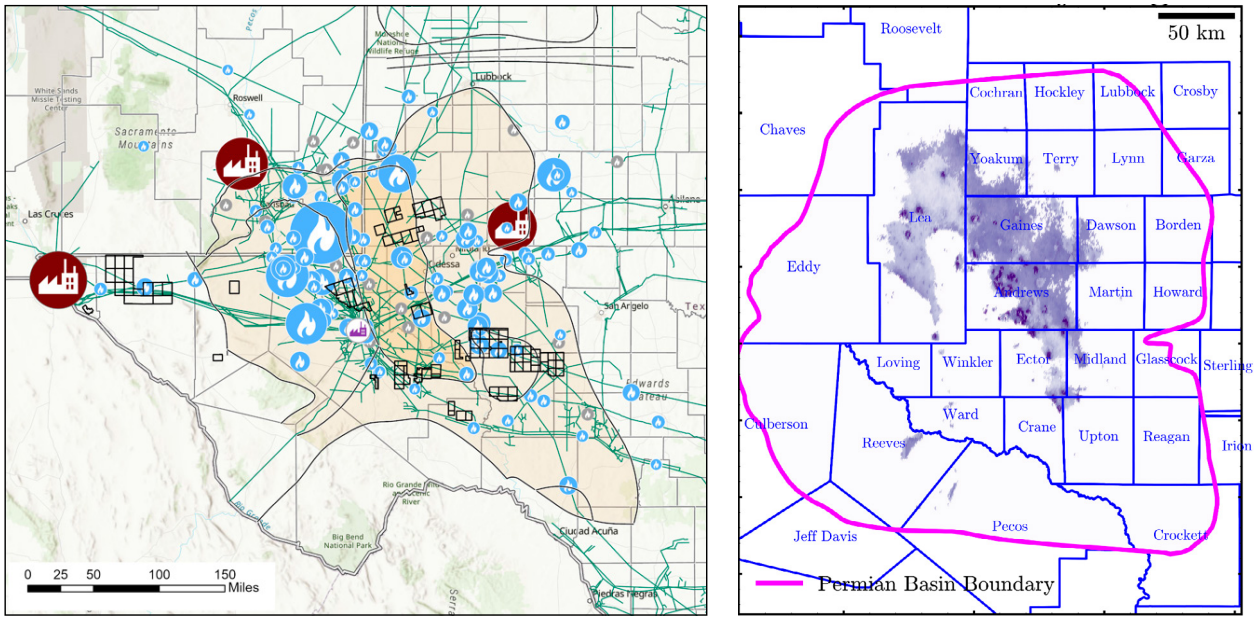

Figure 25. The map on the left showcases several layers of infrastructure in the Permian Basin of West Texas including natural gas pipelines in green, refineries (brown circles), and natural gas plants (blue circles – sizes reflect CO_2 emission intensity per facility). The map on the right illustrates the location of high potential and low uncertainty (darker shades of blue) regions in the Permian Basin for salt cavern development. This information is then used as input to calculate energy storage capacity for a variety of energy vectors including but not limited to hydrogen and natural gas (right).

Exploration for Lithium-rich Brines in Northeast Texas

In recent years the Jurassic Smackover Formation in northeast Texas has become a major exploration target for the production of lithium-rich brines. STARR is working with several companies to understand and locate the highest quality reservoir strata to explore for these brines. The investigation, based on numerous cores, have defined the best reservoirs as those that are in the upper Smackover grainstones that have been dolomitized. In the dolomitized reservoirs permeabilities can range from hundreds into several thousand millidarcys. Because exploration of brines is not dependent on trapping, as is oil and gas, brine reservoirs are considered to be continuous, making reservoir quality the major risk factor for economic production (fig. 26). This STARR project provides major support to companies in their exploration effort for lithium-rich brines in northeast Texas.

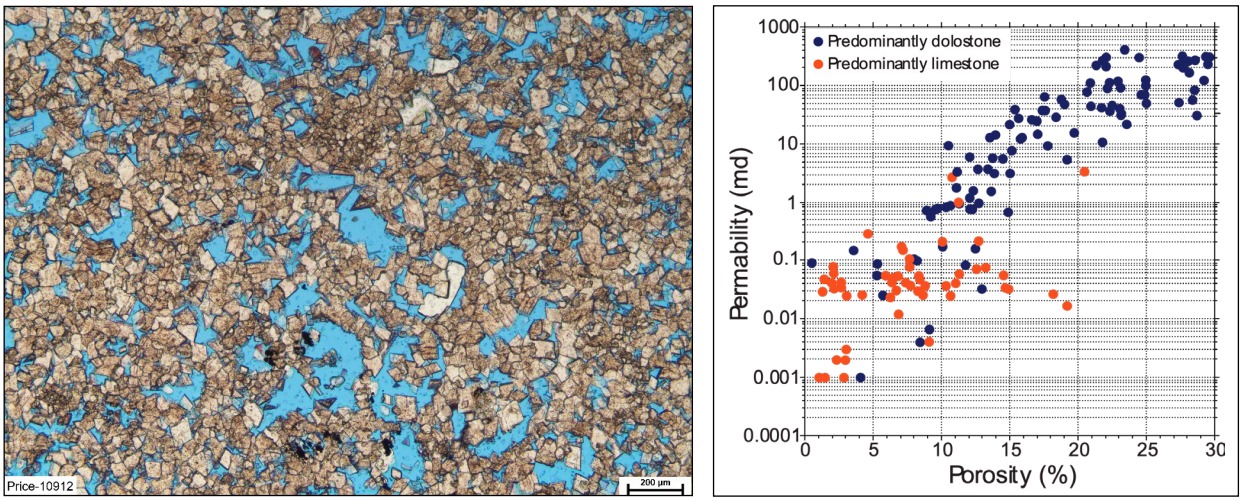

Figure 26. Highly dolomitized ooid grainstone reservoir with intercrystalline and oomoldic pores. Porosity = 22.1%; permeability = 309 md (left). Smackover porosity versus permeability plot where samples are differentiated by mineralogy. Dolomitized samples have better reservoir quality (right).

Conventional and Emerging Energies in the Ellenburger Group

The Ellenburger Group in West Texas exemplifies the potential for multipurpose uses of the subsurface for both traditional oil and gas activities, as well as for emerging energy applications. The Ellenburger has been a target for hydrocarbon exploration and production for many years. Recently, this unit has also been used for CO_2 injection and wastewater disposal. In November 2023, BKV Corporation began injecting CO_2 into the Ellenburger Group near Bridgeport, Texas (https://www.bkv.com/news/bkv-enlink-first-carbon-sequestration-project-barnett-zero). For each of these undertakings to be economically successful, reservoir quality and heterogeneity are important risk factors. Within the Ellenburger, these factors are complex due to diagenetic processes of dolomitization and karstification, which have significantly affected the original limestone. The STARR team has many years of experience studying the Ellenburger Group. In the fall of 2024, the team hosted a workshop for industry partners to take a closer look at this important geologic formation in Texas (fig. 27).

Figure 27. Dr. Bob Loucks delivers a lecture to participants of the STARR Ellenburger workshop showcasing the complexity of karst depositional models.

Thousands of feet of Ellenburger core have been described by STARR researchers to provide operators with comprehensive depositional models, maps with lithofacies distributions, and diagenetic studies that helped progress their understanding of reservoir quality and heterogeneity. In addition, our seismic interpreters have performed seismic characterization analysis that shows the three-dimensional architecture of karst systems within the Ellenburger.

STARR Mapping, Hazards, and Minerals

During the current biennium, STARR matching funds have enabled increases in U.S. Geological Survey funding through the STATEMAP Program to expand coastal-, groundwater-, geohazards, and minerals-related geologic mapping in Texas. These funds supported hiring of geologists for the mapping program, new detailed mapping in six project areas (fig. 28), preparing maps in the distributable USGS/AASG Geologic Map Schema (GeMS) for public use, and compiling statewide salt distribution and geothermal attribute maps. In addition, multiple cooperative Earth MRI projects are supplementing the STARR and STATEMAP geologic mapping efforts related to critical minerals in the Trans-Pecos region.

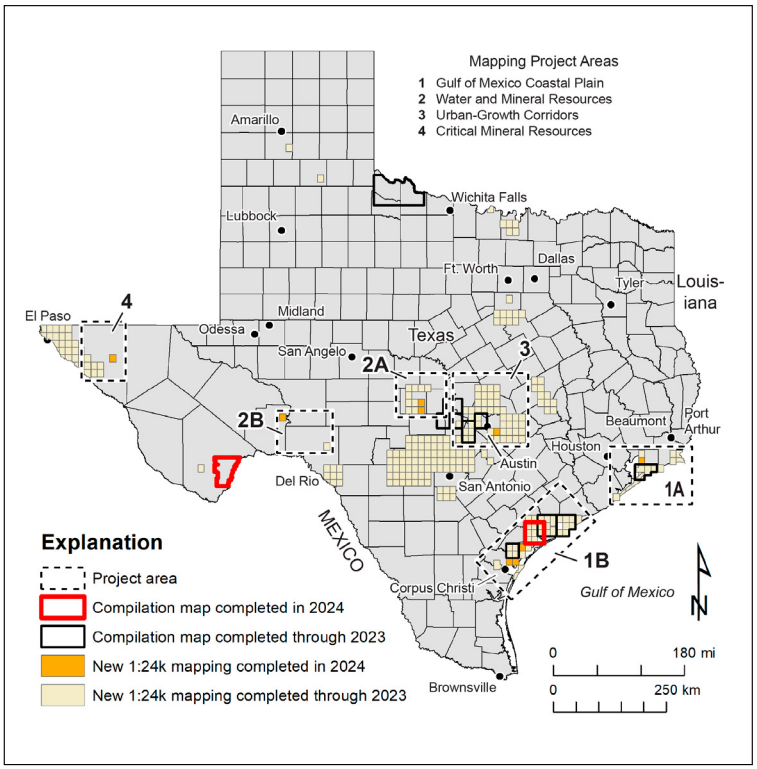

Figure 28. Location of geologic mapping project areas on the Texas Coastal Plain (1A and 1B), in the central (2A) and western (2B) Texas groundwater- and mineral-resource areas, in the central Texas urban-growth corridor (3), and in the Trans-Pecos critical minerals resource area (4).

During FY2024 and FY2025, Bureau researchers completed 18 new quadrangle-scale Open-File Maps, six multi-quadrangle compilation maps, a statewide subsurface salt distribution map, and a regional geothermal attributes map as part of the cooperative STARR and STATEMAP programs. Beyond mapping, STARR Hazards funds have enabled Bureau researchers to respond quickly to requests for emergency assistance from state and regional officials when geologic hazards threaten public safety, critical infrastructure, or environmental health. One example from the current biennium is the Southwest Mesa sinkhole in Crockett County, where RRC officials requested Bureau assistance to assess the collapse potential of a large fissured area near Fort Stockton before re-entering a well.

Wildfires in Texas

Globally, the quantity, size, and severity of wildland fires have increased by approximately 5% annually over the past two decades. These fires evolve rapidly, injecting heat, gases, and particulate matter into the environment. High-resolution multispectral thermal infrared data of an entire wildfire can aid in active fire detection, behavior evaluation, and emission assessment—important metrics for fire managers (fig. 29). This line of research is particularly relevant for Texas, where the

frequency and intensity of fires appear to be increasing, threatening human life and infrastructure within the state.

The 2024 Smokehouse Creek Fire in the Texas Panhandle developed into the largest wildfire recorded in the state's history (and second largest ever in the U.S.), burning more than one million acres. Although human casualties were limited to two fatalities and material damages were

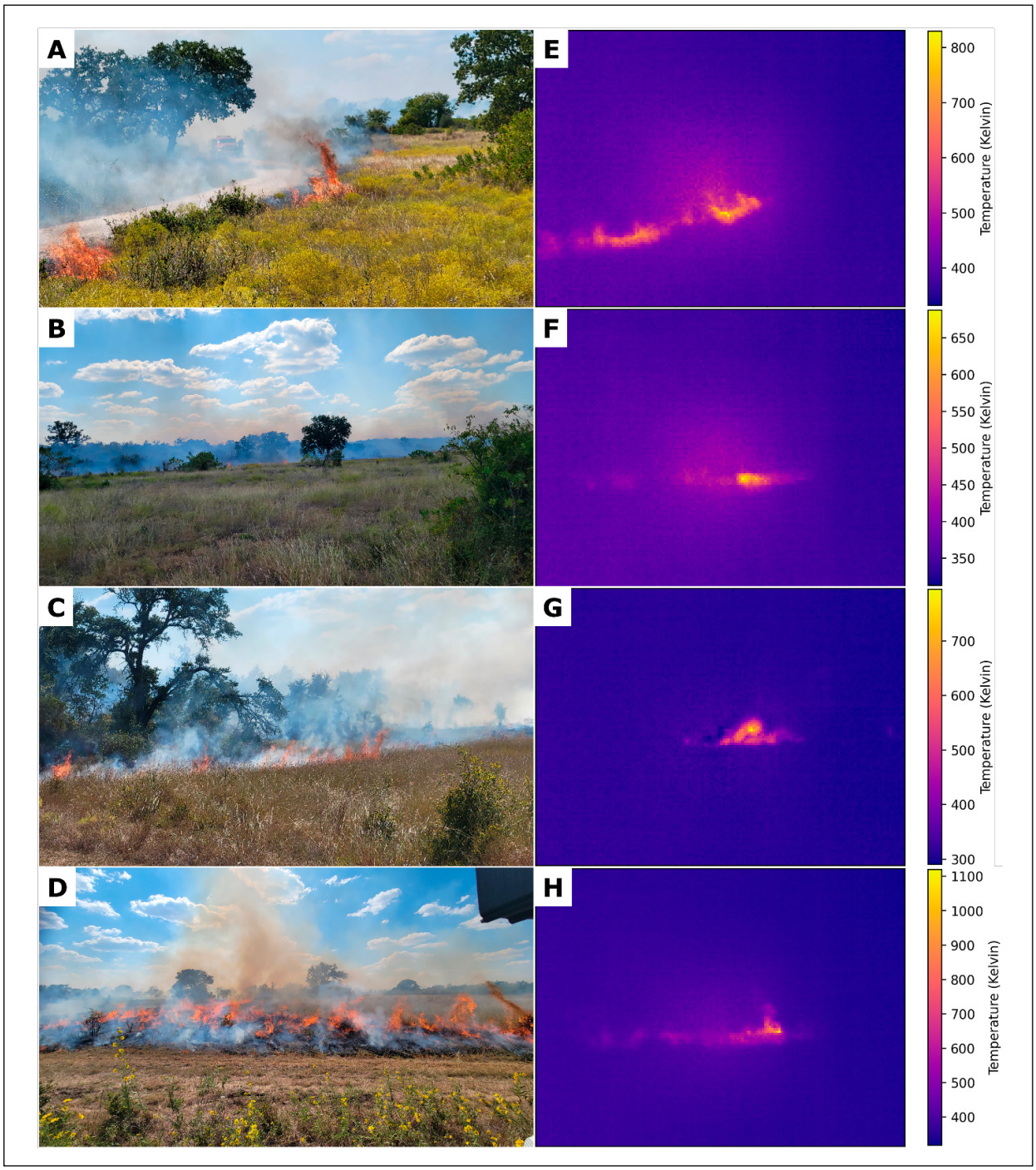

Figure 29. Initial ground deployment at a prescribed burn of the thermal infrared instruments at Balcones Canyonlands National Wildlife Refuge. (A-D) Visible photographs and (E-H) surface temperature data of the burn. Flexibility in uncrewed aerial system observations enables 3D representations of dynamics and fluxes, which will help inform incident commanders in decision making. 1,000 K is equivalent to approximately 1,340.33°F.

relatively minor due to the sparse population in the region, future events in West Texas could seriously compromise infrastructure (e.g., transmission lines, oil and gas infrastructure) and larger communities. Therefore, it is crucial to advance research in order to accurately evaluate wildland fire risks and help rapidly mitigate these risks.

This project contains three primary wildland fire science and technology tasks focusing on the active-fire stage of wildland fire management across Texas and the U.S. The technological aspects of the project involve the development of novel small uncrewed aerial systems with multispectral thermal infrared spectral imaging instruments to investigate the thermodynamics and gas emissions from wildfires, as well as constraining the ecological (vegetation and soils) and societal impacts (infrastructure and air quality). These systems will characterize active fires from previously unattainable perspectives, as well as high temporal resolutions, and improve our ability to evaluate risk both to fire fighters and society.

The project also involves participation and training of undergraduate and graduate students in fire-related projects (fig. 30). Students are engaging through undergraduate fellowships, the JSG graduate program, and the JSG Research Traineeship Experience (RTX) program. These student-lead research projects include (1) the development of autonomous fire detection instrumentation; (2) ecological investigations at Indiangrass Wildlife Sanctuary in east Austin; and (3) understanding of the immediate and long-term effects of the application of fire on soil hydraulic properties, key chemical components, and ecological recovery in the Texas Hill Country. The participation of students in this overall project is vital to develop a skilled workforce to help reduce the risks of wildland fires across Texas and the U.S. into the future.

The goals of this project will be achieved via STARR collaborations with partners at NASA FireSense, U.S. Fish & Wildlife Service, Balcones Canyonlands National Wildlife Refuge (BCNWR), UT Austin Wildflower Center, TAMU Forest Service, and the city of Austin. Partners have provided insights into improving wildfire characterization, reducing the impact and likelihood of catastrophic wildfires in Texas; and provided access to natural experiments through prescribed burning. Further, the improvements in fire characterization through advances in instrumentation and data products with near real-time data distribution is highly beneficial to fire managers and models.

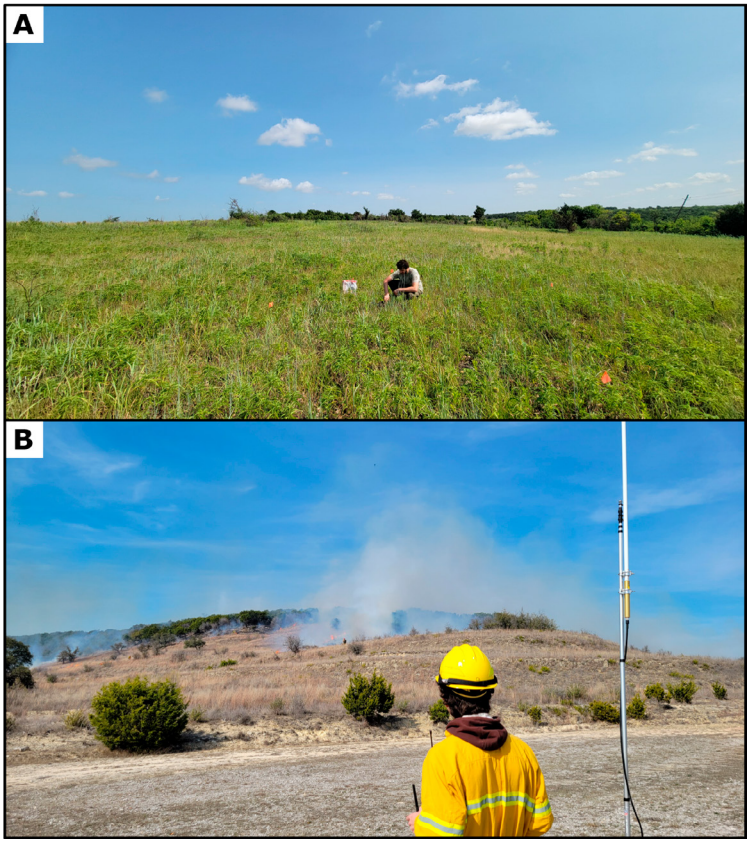

Figure 30. (A) RTX student conducting site surveys for ecological investigations across both burned and unburned sites at Indiangrass Wildlife Sanctuary in east Austin. (B) Graduate student acquiring multispectral thermal infrared data from an uncrewed aerial system over a prescribed burn at Balcones Canyonlands National Wildlife Refuge.

APPENDIX A: LETTERS OF COOPERATION

The following selected letters are from partner companies with whom the STARR program has recently collaborated. These letters document the strong interaction between STARR and the oil and gas industry.

7/31/2023

STARR Program
Bureau of Economic Geology
Jackson School of Geosciences
Austin, Texas

Dr. Moscardelli:

On behalf of TG Natural Resources, I would like to express our sincere gratitude to the Bureau of Economic Geology and especially Kelly Hattori for slabbing and showing us several Pettet cores that she has used in her research.

Kelly's in depth understanding of carbonate development as well as here high-level ability to differentiate different core facies was very helpful in my understanding of carbonate rocks in East Texas. Mapping different carbonate facies can be a challenge and I have found it to be very helpful seeing the different facies in person and thanks to Kelly we were able to do just that.

Once again, thank you to Kelly, and the BEG for letting us come visit and take a tour around the facility. We look forward to developing a relationship with Kelly and the BEG moving forward.

Sincerely,

Will Pollard
Staff Geologist
TG Natural Resources

11330 Clay Rd, Suite 200, Houston, Texas 77041

Lorena G. Moscardelli, Ph.D.
Research Associate Professor and Principal Investigator
State of Texas Advanced Resource Recovery (STARR) Program Bureau of Economic Geology, Jackson School of Geosciences, The University of Texas at Austin
P.O. Box X
University Station
Austin, TX 78713-8924

September 11, 2024

Dear Dr. Moscardelli:

I would like to acknowledge the significant contributions that the State of Texas Advanced Resource Recovery (STARR) Program at the Texas Bureau of Economic Geology have made to Surge Energy's understanding of Strawn, Cline Shale (Wolfcamp D formation), Wolfcamp C sandstone reservoir, and Ellenburger carbonate caves on the Eastern Shelf of the Midland basin.

The core workshop conducted at the Bureau in July 2024 provided us an excellent opportunity to observe the lithofacies and vertical variation of the different reservoirs, which we believe will help us find more oil in this part of the basin.

As in the past, your professional staff always work hard to meet our need and provided us very important information for the plays and our areas of interest, which are very critical for our future effort in finding more oil and gas in the Permian basin.

Surge Energy looks forward to a long and fruitful relationship with the STARR program as we continue to explore and develop oil and gas resources in Texas.

Sincerely,

Xijin Liu

Dr. Xijin (CJ) Liu
Chief Geologist
Surge Energy America

THE SOUTHWEST SECTION
of the
AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
2023 CONVENTION

www.swsaapg.org * P.O. Box 1671 * Wichita Falls, Texas 76307

Dr. Lorena G. Moscardelli
STARR Program
Bureau of Economic Geology
The University of Texas at Austin
P.O. Box X
University Station
Austin, Texas 78713-8924

June 12, 2023

Dear Dr. Moscardelli,

The Southwest Section of the American Association of Petroleum Geologists (SWS-AAPG) held a very successful convention in Wichita Falls, Texas, May 6-9, 2023. The technical session was outstanding and bolstered by the strong commitment from the geologists working within the State of Texas Advanced Resource Recovery (STARR) Program at the Bureau of Economic Geology (BEG). The range of formations the Program's geologists covered, including the Tannehill, Wolfcamp, and Strawn on the Eastern Shelf, generated much excitement and provoked stimulating discussions among the attendees.

Those presentations, along with the STARR Program's Cisco study in the Palo Duro Basin, could not have been presented in a more favorable geographical location than Wichita Falls. The North Texas Geological Society (NTGS) was honored with the STARR Program's participation helping us celebrate our 100th Anniversary.

Geologists exploring for oil and gas in Texas depend on the science and research provided by the STARR Program to guide and direct our exploration. Without this research, geologists would struggle understanding the technical processes of the petroleum systems sourcing the reservoirs we seek to discover and develop. The NTGS and SWS-AAPG certainly hope the State of Texas continues supporting this extremely important and valuable program that develops the mineral interests of our private citizens and State.

Thank you for the STARR Program's participation.

Best regards,

Craig Reynolds
General Chair
2023 SWS-AAPG Convention

PORTENTUM ENERGY
PRODIGY • TECHNOLOGY • SYNERGY

4/13/2023

STARR Program
Bureau of Economic Geology
The University of Texas
Austin, Texas

Howdy Dr. Moscardelli:

On behalf of the Portentum Energy Co., I would like to express our sincere gratitude to the Bureau of Economic Geology and especially to Dr. Lulia Olariu, her esteemed colleagues, and students for setting up the Wilcox Formation Workshop on March 22, 2023.

The displayed Wilcox Formation cores along with the regional geological interpretations, and discussions were of tremendous value to our company and our operations.

As a newly minted O&G Operator in the State of Texas, we rely heavily on the publications of well, and geological records from all sources. The Wilcox Formation Workshop supplements our regional geological understanding and production characteristics, all of which will enable us to conduct our operations more effectively.

Once again, thank you, your colleagues, and all the contributors for their great work with the Bureau of Economic Geology at the University of Texas.

Sincerely,

Bob Tu
President and COO

Abilene Geological Society

P.O. Box 974
Abilene, Texas 79604-0974

https://abilenegeo.org/

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brittnee@deltaoandg.com

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Darrell Mauldin
(325) 370-4480
Darrellm@travconexp.com

10/23/2023

STARR Program
Bureau of Economic Geology
The University of Texas at Austin
Austin, Texas

Dear Dr. Moscardelli,

The Abilene Geological Society would like to offer our sincere thanks to Kelly Hattori for her presentation, "Carbonate and mixed carbonate-clastic facies variability across the Upper Strawn Formation on the Eastern Shelf, King County, TX" given at our October 19th luncheon.

Her and the other researchers work on regional studies on the Strawn formation of the Eastern Shelf is extremely valuable to our members and we greatly appreciate the significant contributions the State of Texas Advanced Resource Recovery Program has made to the understanding of technical processes of depositional systems in the area and greater understanding on the petroleum systems associated to them. The insights gained by many of us from these studies, contribute to our exploration efforts in the area. Our members greatly appreciate these studies and look forward to collaborating with more in the future as the program continues its efforts in local counties.

As always, we greatly appreciate the STARR Program's willingness to participate and lead in our technical programs, workshops and luncheons. The research and science provided is extremely important to our professional understanding of the reservoirs we seek and we hope the State of Texas continues to support the program in coming years.

Sincerely,
Brittnee Brannan
AGS President

1200 17th Street, Suite 2100
Denver, CO 80202
bkvcorp.com

March 11, 2025

Lorena G. Moscardelli, Ph.D.
Research Scientist and Principal Investigator
State of Texas Advanced Resource Recovery (STARR) Program
Bureau of Economic Geology, Jackson School of Geosciences
The University of Texas at Austin
P.O. Box X
University Station
Austin, TX 78713-8924

Dear Ms. Moscardelli:

On behalf of BKV Corporation, I would like to express our sincere appreciation for the significant contributions that the State of Texas Advanced Resource Recovery (STARR) Program at the Texas Bureau of Economic Geology has made to our understanding of the Ellenburger and Woodbine Groups in Texas.

Over the past year, the STARR Program has shared numerous insights and research results on the Ellenburger, most notably an Ellenburger pressure model in the Fort Worth Basin. Additionally, we greatly benefited from the all-day lecture and core workshop that you and your team hosted for the BKV subsurface team and other Texas operators on November 18, 2024.

Your team's presentations on Ellenburger research, followed by the presentation of relevant cores, provided invaluable insights. The BKV subsurface team gained important knowledge of reservoir quality and regional stratigraphy, which will be instrumental in assessing Ellenburger water hazards for our Barnett new drilling and refracturing operations, as well as in evaluating saltwater disposal and carbon capture and sequestration (CCS) opportunities in the Fort Worth Basin.

Furthermore, BKV has benefitted from STARR-supported research on the Woodbine of East Texas, which is emerging as a potential CCS target. Your team's work in sharing a regional stratigraphic framework, core descriptions, and core analysis has significantly enhanced our understanding of this reservoir.

The STARR Program's continued efforts in providing valuable geologic interpretations and analyses are greatly appreciated as we develop our gas resources and pursue carbon sequestration initiatives in Texas. We look forward to continued collaboration with you and your team.

Thank you again for your dedication and contributions.

Sincerely,

Rebecca R. Harrington
Geoscience Manager
BKV Corporation

Matt Williams
Geologist/ New Venture Advisor Cartodyne
Houston, TX

LORENA G MOSCARDELLI, Ph.D., Research Associate Professor and Principal Investigator
State of Texas Advanced Resource Recovery (STARR) Program
Bureau of Economic Geology
Jackson School of Geosciences | The University of Texas at Austin

Dr. Moscardelli,

I wanted to take the opportunity to let you know of the value of the STARR/ BEG Ordovician Core workshop in November of 2024. I am now working as an advisor to a Cartodyne, a small private GIS-focused enterprise providing high-quality GIS and geoscience technology to clients predominantly in Texas who are pursuing development in oil and gas, CCS, as well as supporting cities and other agencies complying with RRC and other regulatory bodies.

The STARR workshop allowed me to remain current on research and its applications to resource exploration and carbon storage, replenish knowledge, and expand it with industry colleagues.

I hope to participate in future STARR events, and apply to the ongoing and dynamic Texas energy endeavors

Best,

MATT WILLIAMS
Geologist / New Ventures Advisor
Licensed Texas Professional Geologist #4372

Matt Williams
Geologist/ New Venture Advisor Cartodyne
Houston, TX

LORENA G MOSCARDELLI, Ph.D., Research Associate Professor and Principal Investigator
State of Texas Advanced Resource Recovery (STARR) Program
Bureau of Economic Geology
Jackson School of Geosciences | The University of Texas at Austin

Dr. Moscardelli,

I wanted to update you on my recent work on the Ordovician Simpson Shale in the Permian Basin and the assistance that the STARR program has provided to evaluate this potential new Unconventional Source Rock Resource Play. It is notable that minimal published data exists on the Simpson, especially specific to the Texas Permian Basin.

The STARR/ BEG data and technical expertise can assess organic content, lithology and depositional environments which are critical first steps before targeting areas for significant capital investments and potential production. I connected with Dr. Loucks after a previous STARR workshop, regarding the Simpson formation. He had identified a long (several hundred feet) core obtained decades ago in Upton County of interest. I had the opportunity to review the core at the BEG Lab and benefit from his observations and ideas, drawing from his extensive experience. The physical observations integrated with current thinking in sedimentology and unconventional resource development will significantly advance these assessments. Dr Loucks also highlighted possible additional data evaluations, such as Organic content assessment and SEM level mineralogy determinations, which would significantly quantify the possible resource available.

Prior to my current work as a consultant and advisor to a Cartodyne, a small private GIS-focused enterprise, I have extensive experience in assessing and developing unconventional resource plays. I have worked over 40 years in subsurface geoscience technical evaluations and management. In the last 25 years, I have been involved in originating and developing many projects with extensive development of unconventional resources for major companies, most recently as VP Geoscience for an LNG and Upstream development company. I understand the technical and commercial aspects of modern unconventional resources assessment and development, and the data and expertise at STARR are excellent resources to further identify and evaluate future targets such as the Simpson.

I look forward to continuing these evaluations with assistance of STARR and the BEG which hopefully with advance the development of critical additional energy resources.

Best,

MATT WILLIAMS
Geologist / New Ventures Advisor
Licensed Texas Professional Geologist #4372

Sabinal Energy Operating, LLC

December 19, 2024

Dr. Lorena Moscardelli, Primary Investigator
State of Texas Advanced Oil and Gas Resource Recovery (STARR) Program
Texas Bureau of Economic Geology

Dear Dr. Moscardelli

We (Sabinal Energy) would like to thank you for the help provided by Mr. Ambose and Mr. Loucks, and the State of Texas Advanced Oil and Gas Resource Recovery (STARR) program at the Texas Bureau of Economic Geology. Sabinal Energy operates 147,500 acres with >3,300 producing oil wells in mature fields scattered across the Permian Basin. In addition to efficiently producing oil from existing fields, we are always trying to maintain and increase production from those assets. One way we are doing that is drilling and frac'ing horizontal wells in and at the edges of our fields.

Sabinal is a relatively small company with approximately 160 employees and production of ~14,000 BOPD, and hence do not have a research staff and appreciate the help that Bill Ambrose and Bob Loucks gave us.

One of the fields that we operate is Fuhrman-Mascho on University Lands on the eastern side of the Central Basin Platform. It was discovered in 1930 with production from carbonates and sands in the San Andres and Grayburg Formations. Sabinal is interested in drilling and frac'ing horizontal wells on our acreage which includes University Lands and Block 10. During the last 90 years, much oil has been produced and water injected. For successful wells, we need to understand where oil is still remaining and where water is, especially water that might be under pressure from injection or aquifers. As you know, frac'ing allows contact with much rock away from the original well bore, hence understanding the reservoir characteristics of sands, silts and carbonates are important to maximize oil and minimize produced water.

We recently drilled and frac'ed two horizontal wells in the southern margin of Fuhrman-Mascho field. This in an area that LimeRock has gotten some nice, sustained oil production recently from horizontal frac'ed wells. Our two wells are FUHRMAN-MASCHO UNIT 2610H and FUHRMAN-MASCHO UNIT 2101H. FUHRMAN-MASCHO UNIT 2610H started producing approximately 450 BOPD and is still at approximately 270 BOPD of oil along with water. FUHRMAN-MASCHO UNIT 2101H started producing approximately 250 BOPD and is at approximately 200 BOPD of oil along with water.

1780 Hughes Landing Blvd., Suite 1200, The Woodlands, TX 77380
346-224-9300

Ovintiv USA Inc.
Republic Plaza
370 17th Street, Suite 1700
Denver, CO, USA 80202
T 303 623 2300

Dr. Lorena Moscardelli
State of Texas Advanced Resource Recovery (STARR) Program
Bureau of Economic Geology
The University of Texas at Austin
P.O. Box X, University Station
Austin, TX 78713-8924

Dear Dr. Moscardelli,

Ovintiv would like to acknowledge and thank your team for providing us with data through the State of Texas Advanced Resource Recovery (STARR) program, in support of a reservoir characterization project in the Midland Basin of Texas,

We requested information on several cores that had been studied and published on by researchers at the Bureau of Economic Geology. Your colleagues Kelly Hattori and Dr. Robert Loucks provided the data quickly and completely. Not only were core analyses provided, but a supporting presentation and thesis were also shared that provided us with greater context and detail. We greatly appreciate the time, efforts and support from you and your team on this request, and the STARR program in general to support Texas operators in the study and development of hydrocarbon resources.

We are grateful that the research and data compiled, archived, and shared by the STARR team and the Bureau of Economic Geology is available to assist Ovintiv's technical and operational capabilities. We have benefitted from many publications, presentations and collaborations with the Bureau's staff and consortia for many years. Continued economic support of STARR is a valuable knowledge resource and is in the best interest of all Texas operators and researchers.

Kind regards,

Dr. Brian Ruskin
Advisor, Geology
Texas Operating Area – Reservoir Characterization Team
Ovintiv USA Inc.

TotalEnergies

TotalEnergies E&P Americas, LLC
1201 Louisiana Street, Suite 1800
Houston, TX 77002, USA

August 21st, 2023

Dr. Lorena G. Moscardelli
Project Director
STARR Program
Bureau of Economic Geology
The University of Texas at Austin
P. O. Box X
University Station
Austin, Texas 78713-8924

Dear Dr. Moscardelli:

We would like to express our gratitude for hosting TotalEnergies at the STARR/ BEG Wilcox Group Core Workshop on March 22, 2023. Many thanks to Iulia Olarui for organizing day as well as the contributions from Peter Flaig, Katherine Garcia, Cornel Olarui, Angela Hessler, Evan Sivil, Vann Smith, Maria Lorente, Chris Denison, and Thomas Demchuk.

The geoscientists at TotalEnergies find the research carried out by the State of Texas Advanced Resource Recovery project (STARR) at the Bureau of Economic Geology (BEG) to be highly valuable for our exploration and production activities. The Wilcox Group research and publications done by the STARR and the BEG provide unparalleled analogues and examples of methodology for our understanding of the offshore geology, thus positively impacting our oil and gas production and exploration potential.

The continued funding of the STARR and the BEG is essential to maintain a high level of detailed and relevant knowledge to the overall oil and gas industry as well as TotalEnergies geoscientists. The long history of distinguished research provides a powerful resource for the industry.
Sincerely,

Richard van den Brand, Exploration Manager Argentina and US GOM,
TotalEnergies E&P Americas, LLC

February 28, 2024

Nick Soto-Kerans
TerraVolta Resources
3355 W Alabama St
Suite 900
Houston, TX 77098
512-968-6728
sk@tvopco.com

Dr. Robert Loucks
Principal Investigator
Bureau of Economic Geology
STARR Program

Dear Bob,

Attached is a brief summary highlighting some of the outstanding work you have been doing in conjunction with us over here at TerraVolta Resources. We hope to continue this work with you all at the STARR program, as it is very vital to us as well as many other parties looking to explore for alternative resources such as lithium within the State of Texas.

Thanks for your help.

All the best,
Nick

11330 Clay Rd, Suite 200, Houston, Texas 77041

Lorena G. Moscardelli, Ph.D.
Research Scientist and Principal Investigator
State of Texas Advanced Resource Recovery (STARR) Program Bureau of Economic Geology, Jackson School of Geosciences The University of Texas at Austin
P.O. Box X
University Station
Austin, TX 78713-8924

April 24, 2023

Dear Dr. Moscardelli:
I would like to acknowledge the significant contributions that the State of Texas Advanced Resource Recovery (STARR) Program at the Texas Bureau of Economic Geology have made to Surge Energy's understanding of Cline Shale (Wolfcamp D formation) in central Midland basin around Howard and Martin Counties, Texas.

The Bureau has quickly and effective shared with us the regional study of the Cline shale, which helped enhance our understanding of the Cline shale such as regional distribution, sedimentary facies, mineralogy, source rock (e.g., TOC) property, as well as depositional environment. We gained important insights into the reservoir quality and regional stratigraphy that will help us better define the area of interest and new drilling efforts.

We are thinking about initiate a new study with STARR researchers that will aid in the understanding of the depositional fairways, petrophysical properties, and petroleum systems in the Dean Sand for development opportunities in the northern Midland basin, Texas.

Surge Energy looks forward to a long and fruitful relationship with the STARR program as we continue to explore and develop oil and gas resources in Texas.

Sincerely,

Dr. Xijin (CJ) Liu
Chief Geologist
Surge Energy America

UNIVERSITY LANDS

July 1, 2024

Lorena G Moscardelli, Ph.D.
Project Director, STARR Program
Bureau of Economic Geology – The University of Texas Austin
P.O. Box X
University Station
Austin, TX 78713-8924

Dear Dr. Moscardelli:

I am writing to acknowledge and express our gratitude for the contributions and work the STARR team has conducted over the past years to aid University Lands in the stewardship of the 2.1 million acres in West Texas that directly impact The University of Texas and Texas A&M Systems' Permanent University Fund (PUF) and Available University Fund (AUF).

This collaborative work has been a tremendous benefit in many aspects around natural resources in oil & gas, water, minerals, and additionally emerging energy and low-carbon initiatives, and has paved a way for current and future understandings. This is work that directly benefits the State of Texas and the more than 400,000 students attending institutions within both University Systems.

We look forward to our ongoing work with the team and the resulting benefits provided to the State of Texas as well as encouraging the consideration for continued funding from the State of Texas.

Sincerely,

John Tackett

Chief Geologist

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March 26, 2024

Lorena G. Moscardelli
Project Director
STARR Program
Bureau of Economic Geology
The University of Texas at Austin
P.O. Box X
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Dear Dr. Moscardelli:

WD3 Oil & Gas, LP (WD3) and partners would like to thank the Texas Bureau of Economic Geology (BEG) for the ongoing work you are providing through the State of Texas Advance Research Resource Recovery project (STARR). Currently, your team is helping us evaluate the Vicksburg formation in an area of southern Texas that has historically produced at sub-economic rates due to complicated rock properties. This research has already provided a better understanding of the depositional setting and rock fabric. We are currently using this insight to develop better drilling and completion strategies and believe this will lead to more cost-effective exploitation and production.

Using the BEG's online data continuum search engine, WD3 found a whole core in well of interest that is stored in BEG core facility in Houston, TX. WD3 contacted the BEG and your staff quickly located the core then did a detail core description which provided a better understand of the depositional environment and lithology. The description suggested further evaluation was warranted to better understand the porosity and permeability distribution of the rock. Working jointly, we have defined a program to assess these concerns.

As a small independent, WD3 values the expertise and knowledge that has been provided by BEG through the STARR program. Hopefully the STARR program will continue to receive funding from the State of Texas.

Sincerely,

Walter M. Denny, III
President of General Parnter

APPENDIX B: STARR PUBLICATIONS

One of the main goals of the STARR project is to disseminate results and new concepts developed by the program. During current reporting biennium (September 1, 2022 to August 31, 2024), STARR researchers generated 60 peer-reviewed publications, including two Bureau Reports of Investigation.

STARR Peer-Reviewed Publications:

1. Ambrose, W. A., Shelf and lower-shoreface deposits in the Upper Midway Group and the transition into fluvial-dominated deltaic deposits in the Hooper Formation (Lower Wilcox Group) in the southeastern Texas Gulf Coast: GCAGS Journal, v. 13, p. 34-52, https://doi.org/10.62371/KCUK6360.

2. Bhattacharya, S., Ambrose, W. A., Ko, L. T., and Casey, B., 2022, Integrated detection and investigation of bad borehole section in the Wolfcamp Formation in the Midland Basin using time machine learning, petrophysics, and core characterization, Interpretation, v. 10, C19–C27. http://dx.doi.org/10.1190/INT-2021-0165.1.

3. Bump, A. P., Bakhshian, S., Ni, H., Hovorka, S. D., Olariu, M. I., Dunlap, D., Hosseini, S. A., and Meckel, T. A., 2023, Composite confining systems: Rethinking geologic seals for permanent CO2 sequestration: International Journal of Greenhouse Gas Control, v. 126, no. 103908, 12 p., http://doi.org/10.1016/j.ijggc.2023.103908.

4. Duffy, O. B., Hudec, M. R., Peel, F., Apps, G., Bump, A., Moscardelli, L., Dooley, T. P., Fernandez, N., Bhattacharya, S., Wisian, K., and Shuster, M. W., 2023, The role of salt tectonics in the energy transition: an overview and future challenges: Tektonika, v. 1, no. 1, p. 18–48, http://doi.org/10.55575/tektonika2023.1.1.11.

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9. Hattori, K. E., Loucks, R. G., and Zeng, H., 2023, Back-reef depositional environments in a Lower Cretaceous (Sligo) shelf-margin complex: insights into ultradeep reservoir preservation and controls on stacking patterns in an outer platform setting: GCAGS Journal, v. 12, p. 17-32, http://doi.org/10.62371/HGLG8668.

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11. Jensen, J. L., Flaig, P. P., and Hattori, K. E., 2024, The effects of facies variability and bioturbation intensity on permeability in a mixed siliciclastic-carbonate core from the Upper Strawn Group, Katz Field, Stonewall County, Texas: Geosciences, v. 14, no.12, 339, https://doi.org/10.3390/geosciences14120339.

12. Karakaya, S., Ogiesoba, O. C., Olariu, C., and Bhattacharya, S., 2024, Generating 3D lithology probability volumes using poststack inversion, probabilistic neural networks, and Bayesian classification — a case study from the mixed carbonate and siliciclastic deposits of the Cisco Group of the Eastern Shelf of the Permian Basin, north-central Texas: Geophysics, v. 89, no. 2, p. B131–B146, http://doi.org/10.1190/GEO2023-0157.1.

13. Karakaya, S., Olariu, C., Kerans, C., Ogiesoba, O. C., Steel, R., and Palacios, F., 2024, Icehouse mixed carbonate and siliciclastic sequence evolution based on 3D seismic analysis: Insights from the Eastern Shelf of the Permian Basin, Texas: Marine and Petroleum Geology, v. 170, p. 107094, https://doi.org/10.1016/j.marpetgeo.2024.107094.

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23. Loucks, R. G., Reed, R. M., Zeng, H., and Periwal, P., 2023, Carbonate sedimentation and reservoirs associated with a volcanic mound in an open-marine, deep-water, drowned platform setting, Elaine field area, Upper Cretaceous Anacacho Formation, South Texas U.S.A.: Marine and Petroleum Geology, v. 154, no. 106314, 17 p., http://doi.org/10.1016/j.marpetgeo.2023.106314.

24. Loucks, R. G., Alnahwi, A., and Periwal, P., 2023, Characterization of the Upper Cretaceous Del Rio-Buda Section on the Drowned, Outer Comanche Platform in South Texas and Implications for Reservoir Development and Exploration: GCAGS Transactions, v. 72, p. 141–147.

25. Loucks, R. G., and Reed, R. M., 2023, Alteration of Volcanic Grains to Glauconite in the Upper Cretaceous Austin Chalk Formation in the Balcones Igneous Province, South and Central Texas; Implications for Depositional History: GCAGS Transactions, v. 72, p. 149–154.

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33. Ogiesoba, O., Karakaya, S., and Cortez, T., 2023, Simultaneous seismic inversion study for channel sandstone identification, northern part of the Eastern Shelf, King County, North-Central Texas: Interpretation, v. 11, no. 3, p. T593–T610, http://doi.org/10.1190/INT-2022-0096.1.

34. Olariu, M. I., 2023, Sedimentology and stratigraphy of the earliest deltaic shorelines of the Paleocene Lower Wilcox Group in the Gulf of Mexico: Journal of Sedimentary Reasearch, v. 93, no. 8, p. 522–540, http://doi.org/10.2110/jsr.2021.084.

35. Olariu, M. I., and Zeng, H., 2023, Depositional processes at the Lower Wilcox shelf–slope transition zone: GCAGS Journal, v. 12, p. 33–44, http://doi.org/10.62371/EUGP1650.

36. Palacios, F. C., Steel, R. J., and Ambrose, W. A., 2024, Compound-clinoform model for tide-influenced deltas in the mixed siliciclastic–carbonate Cisco Group, Upper Pennsylvanian (Virgilian), Eastern Shelf of the Permian Basin, U.S.A.: Journal of Sedimentary Research, v. 94, p. 686–713, https://doi.org/10.2110/jsr.2023.064.

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APPENDIX C: STARR PRESENTATIONS & ABSTRACTS

One of the main goals of the STARR program is to disseminate results and new concepts in oil and gas research. During current reporting biennium (September 1, 2022 to August 31, 2024), STARR researchers gave a variety of presentations to oil and gas operators, as well as to the broader energy industry within the State of Texas; this is a vital outreach activity impacting new oil and gas production in Texas, as well as the development of new energy sources.

1. Ambrose, W. A., Hentz, T. F., and Rogers, H., III, 2023, Regional and local variability in lowstand valley-fill and deltaic deposits in the Tannehill Sandstone (Cisco Group), Eastern Shelf of the Permian Basin (abs.): Annual Southwest Section AAPG Meeting, Wichita Falls, Texas.

2. Ambrose, W. A., 2024, The shelf-to-lower-shoreface transition in the Upper Midway Group in southeastern Texas (abs.): Annual GeoGulf Meeting, San Antonio, Texas.

3. Ambrose, W. A., and Hentz, T. F., 2024, Facies variability and sandstone-body architecture of slope and basin floor systems, Wolfcampian Cisco Group in the Eastern Shelf of the Permian Basin (abs.): Annual Southwest Section AAPG Meeting, Abilene, Texas.

4. Berdysheva, S., McMahon, T., Hoffman, D., and Ikonnikova, S., 2024, Influence of Geological, Completion, and Well-Spacing Parameters on First-Year Productivity in the Delaware Basin: URTeC: 4044740, https://doi.org/10.15530/urtec-2024-4044710.

5. Bhattacharya, S., Melani, L., Martínez-Doñate, A., Schuba, N., and Moscardelli, L., 2023, Petrophysical challenges in salt characterization and their implications on hydrogen storage: A case study from the Castile-Salado bedded salt interval in the Permian Basin, United States (abs.): Solution Mining Research Institute Fall Meeting, San Antonio, Texas.

6. Bhattacharya, S., Bachshian, S., Hovorka, S., Uroza, C., Hosseini, S., Bump, A., Trevino, R., Olariu, M. I., and Haagsma, A., 2023, Integrated Petrophysical Studies for Subsurface Carbon Sequestration: Society of Petrophysicists and Well Log Analysts SPWLA 64th Annual Logging Symposium, p. 1-9.

7. Bhattacharya, S., Uroza, C., Hosseini, S., Bump, A., Trevino, R., Hovorka, S., Olariu, M. I., and Haagsma, A., 2023, The role of petrophysics in subsurface characterization for geologic carbon sequestration projects: Society of Petrophysicists and Well Log Analysts (SPWLA) Annual Meeting.

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9. Bhattacharya, S., Moonesan, S., and Casey, S., 2024, Regional pore pressure variations of the Wolfcamp, Dean, and Spraberry formations of the Midland Basin, integrating petrophysical, reservoir, and completions data (abs.): Southwest Section AAPG Program with Abstracts.

10. Bhattacharya, S., and Sabbagh, R., 2023, Basin-wide mapping of Poisson's ratio of the Wolfcamp and Spraberry formations in the Midland Basin, integrating petrophysical modeling, class-based machine learning, and core measurements (abs.): International Meeting for Applied Geoscience & Energy (IMAGE) 2023 Program with Abstracts.

11. Bump, A. P., Bakhshian, S., Dunlap, D., Hosseini, S., Hovorka, S. D., Meckel, T. A., Ni, H., and Olariu, M. I., 2022, Baffled confinement systems: Characterizing, de-risking and permitting unconventional seals for CO2 Storage: 16th International Conference on Greenhouse Gas Control Technologies GHGT-16.

12. Calle, A. Z., Palacios, F., Carr, D. L., Eastwood, R. L., Bhattacharya, S., and McMahon, T., 2024, Basinwide Haynesville-Bossier lithofacies distribution north-central Gulf of Mexico Basin (abs.): GeoGulf 2024.

13. Calle, A. Z., Smye, K., Eastwood, R., Horne, L., Hennings, P., and McMahon, T., 2024, Preliminary evaluation of Ordovician to Mississippian rocks as unconventional shale prospects in the Midland Basin, West Texas (abs.): Southwest Section AAPG Program with Abstracts.

14. Carr, D. L., Ambrose, W. A., and Hamlin, H. S., 2024, Basinwide subsurface stratigraphic architecture and wireline facies distribution of Leonardian strata, Midland Basin, West Texas (abs.): Southwest Section AAPG Program with Abstracts.

15. Carr, D. L., Ambrose, W. A., and Hamlin, H. S., 2023, Basinwide subsurface stratigraphic architecture and wireline facies distribution of Leonardian strata, Midland Basin, West Texas (abs.): International Meeting for Applied Geoscience & Energy (IMAGE) 2023 Program with Abstracts.

16. Carr, D. L., and Hamlin H. S., 2023, Understanding the stratigraphic 'big picture' by utilizing core-calibrated wireline facies: An example from the Middle Leonard interval, Midland Basin, West Texas: URTeC 3859717. https://doi.org/10.15530/urtec-2023-3860644.

17. Casey, B. J., Hoffman, D., Carr, D. L., Bhattacharya, S., and Horne, E. A., 2023, How well do you know your Midland Basin: Expanded mapping and 3D modeling of the Midland Basin, Southeast New Mexico and West Texas (abs.): International Meeting for Applied Geoscience & Energy (IMAGE) 2023 Program with Abstracts.

18. Contreras, D., Zippi, P., Jacobs, B., Flaig, P., and Henk, B., 2024, Reconstructing the coastal vegetation of Cenomanian southwestern Appalachia: An integrated study of plant fossils and sediments of the Lewisville Formation (Woodbine Group), Dallas-Fort Worth Texas, USA: XI International Organisation of Palaeobotany Conference (IOPC), Prague, Czech Republic.

19. Contreras, D., Zippi, P., Jacobs, B., Flaig, P., and Henk, B., 2024, Reconstructing the coastal vegetation of Cenomanian southwestern Appalachia: An integrated study of plant fossils and sediments of the Lewisville Formation (Woodbine Group), Dallas-Fort Worth Texas, USA: North American Paleontological Convention, Ann Arbor, Michigan.

20. Contreras, D., Noto, C., Flaig, P. P., Zippi, P., Lorente, A. A., Andrzejewski, K., Tykoski, R., and Englehart, N. L., 2023, Deciphering the Woodbine Group (Late Cretaceous); Cenomanian) outcrops of the Dallas – Fort Worth metroplex: New data and new horizons: Mesozoic Terrestrial Ecosystems, Salt Lake City, Utah.

21. Flaig, P. P., Garcia, K., Denison, C., Demchuk, T., Spangenberg, J., Campion, N., Adatte, T., Castletort, S., and Moscardelli, L., 2024, Evidence for the Paleocene–Eocene Thermal Maximum in outcrops, Bastrop County, Central Texas: GeoGulf, San Antonio, Texas.

22. Flaig, P. P., Garcia, K., Denison, C., Demchuk, T., Spangenberg, J., Campion, N., Adatte, T., Castletort, S., and Moscardelli, L., 2024, Evidence for the Paleocene–Eocene Thermal Maximum in outcrops, onshore Texas: SEPM International Sedimentary Geosciences Congress, Flagstaff, Arizona.

23. Flaig, P. P., Hattori, K. E., Hasiotis, S. T., Boucher, L., Buntin, C., Roberts, A., Lorente, M. A., and Moscardelli, L., 2023, Complex clastics and associated carbonates of the Strawn Formation: Re-evaluation of deposystem interpretations from core and outcrop-based investigations: American Association of Petroleum Geologists SW Section meeting, Wichita Falls, Texas.

24. Flaig, P. P., Denison, C. N., Ambrose, W. A., and Demchuk, T. D., 2023, Outcrop evidence for variable channel-floodplain facies and stratal architectures across the Simsboro to Calvert Bluff transition, Wilcox Group, Butler, Texas: GeoGulf 2023, Houston, Texas.

25. Fu, Q., 2023, Lithofacies, Cyclicity, and Reservoir Heterogeneity of Peritidal Carbonates, Clear Fork Formation, in the Northern Eastern Shelf of the Permian Basin, Texas (abs.): GeoGulf 2023, Houston, Texas.

26. Fu, Q., and Periwal, P., 2004, Diagenesis and pore network of the Wolfcamp sandstones in Mitchell County (Texas), Midland Basin (abs.): The International Meeting for Applied Geoscience & Energy (IMAGE), Houston, Texas.

27. Garcia, K., Flaig, P., Denison, C., Demchuk, T., Adatte, T., Spangenberg, J., Castelltort, S., and Moscardelli, L., 2023, A multidisciplinary study of the Paleocene-Eocene thermal maximum (PETM) at the Sabinetown-Carrizo transition near Bastrop, Texas (abs.): The International Meeting for Applied Geoscience & Energy (IMAGE), Houston, Texas.

28. Garcia, K., Flaig, P. P., Denison, C. N., and Demchuk, T. D., 2023, The Paleocene-Eocene Thermal Maximum in outcrops near Bastrop, Texas: Sedimentology, ichnology, biostratigraphy, and δC13 isotopes: GeoGulf 2023, Houston, Texas.

29. Hattori, K. E., 2022, The importance of evaluating the overprint of local-scale controls on eustatically-driven sequence stratigraphic frameworks: An example from the Early Cretaceous Pettet Formation, East Texas, USA: Mountjoy Carbonate Research Conference III, Banff, Alberta, Canada.

30. Hattori, K. E., 2022, Depositional systems of the James Limestone in East Texas: Global, regional, and local context for a complex formation: East Texas Geological Society, Tyler, Texas.

31. Hattori, K. E., 2022, The road less traveled: An unusual path into geological research, and insight into ways forward into a great geological career: Stephen F. Austin University AAPG Student Chapter, Nacogdoches, Texas.

32. Hattori, K. E., 2022, Paleogeographic controls on post-OAE 1a carbonate factory recovery: An example from the Fairway Field, East Texas Basin: Reservoir Characterization Research Laboratory Annual Meeting, Austin, Texas.

33. Hattori, K. E., and Loucks, R. G., 2022, Facies and interpretations of depositional conditions at the Lower Cretaceous Sligo shelf margin in East Texas: Insights from a rare long core in Tyler County, Texas: Reservoir Characterization Research Laboratory Annual Meeting, Austin, Texas.

34. Hattori, K. E., Radjef, E., and Loucks, R. G., 2023, Lithologic controls on reservoir quality and production trends in the carbonate Pettet Formation, Rusk County, East Texas: GeoGulf Annual Meeting, Houston, Texas.

35. Hattori, K. E., and Flaig, P. P., 2023, Carbonate and mixed carbonate-clastic facies variability across the Upper Strawn Formation on the Eastern Shelf: Preliminary core-based observations: AAPG Southwest Section Annual Meeting, Wichita Falls, Texas.

36. Hattori, K. E., Flaig, P. P., and Wahlman, G. P., 2023, Carbonate and mixed carbonate-clastic facies variability across the upper Strawn Formation on the Eastern Shelf, King County, TX: Reservoir Characterization Research Laboratory Annual Meeting, Austin, Texas.

37. Hattori, K. E., Flaig, P. P., and Wahlman, G. P., 2023, Carbonate and mixed carbonate-clastic facies variability across the Upper Strawn Formation on the Eastern Shelf, King County, TX: Abilene Geological Society, Abilene, Texas.

38. Hattori, K. E., Loucks, R. G., and Zeng, H., 2024, The Early Cretaceous Sligo Shelf Margin of East Texas: Facies and depositional settings: GeoGulf Annual Meeting, San Antonio, Texas.

39. Hattori, K. E., Flaig, P. P., and Wahlman, G. P., 2024, The Strawn Formation of the Eastern Shelf: New insights into autocyclic and allocyclic drivers and depositional system heterogeneity: AAPG Southwest Section Annual Meeting, Abilene, Texas.

40. Hattori, K. E., 2024, Paleogeographic controls on post-OAE 1a carbonate factory recovery: A Texas-sized window into patterns of reestablishment: SEPM International Sedimentary Geosciences Congress, Flagstaff, Arizona.

41. Hattori, K. E., 2024, The Pettet Formation of East Texas: Key facies, stacking patterns, sequence stratigraphy, and reservoir facies distribution: Reservoir Characterization Research Laboratory Annual Meeting, Houston, Texas.

42. Hattori, K. E., Loucks, R. G., and Kerans, C., 2024, Halokinetic influence on carbonate depositional environments: An example from the Fairway field, East Texas Salt Basin: Reservoir Characterization Research Laboratory Annual Meeting, Houston, Texas.

43. Hessler, A., Sivil, E., Olariu, I., Liu, X., Smith, V., Lorente, M. A., and Moscardelli, L., 2023, Geochemical fingerprinting of facies and environments across 106-year delta cycle in the Paleocene Lower Wilcox Group (abs.): The International Meeting for Applied Geoscience & Energy (IMAGE), Houston, Texas.

44. Hoffman, D., Bhattacharya, S., Carr, D. L., Casey, B. J., Eastwood, R., Horne, E. A., and Smye, K., Integrated 3D geocellular model of the Wolfcamp-Bone Spring interval in the Delaware Basin, United States (abs.): Challenges, expectations, and utilization for regional evaluations: International Meeting for Applied Geoscience & Energy (IMAGE) 2023 Program with Abstracts.

45. Jensen, J. L., Flaig, P. P., and Hattori, K. E., 2024, Bioturbation effects on permeability in tidally-modified Strawn Group deposits, Texas: AAPG IMAGE, Houston, Texas.

46. Ko, L. T., Moscardelli, L., Lin, N., Radjef, E., Shuster, M., and Ugurhan, M., 2023, Envisioning the development of the hydrogen economy and CCUS in the Permian Basin, West Texas, USA (abs.): The Fourth EAGE Global Energy Transition Conference and Exhibition, Paris, France.

47. Ko, L. T., Peng, S., Fu, Q., Periwal, P., and Sivil J. E., 2023, Revisiting Mississippian Barnett Shale: lithological and geochemical control on varied reservoir heterogeneity and fluid saturation from late oil to dry gas window, Fort Worth Basin, Texas (abs.): American Association of Petroleum Geologists Southwest Section (AAPG SWS), Wichita Falls, Texas.

48. Ko, L. T., Adriaens, R., Mertens, G., and Loucks, R. G., 2023, Clay mineral assemblages and diagenesis in Upper Cretaceous Eagle Ford Group (mudrocks) in south Texas (abs.): Clay Mineral Society Annual Meeting, Austin, Texas.

49. Ko, L. T., Larson, T., Periwal, P., and Sivil, E., 2023, Facies and Associated Reservoir Characteristics of Second Bone Spring Carbonate, Third Bone Spring Siliciclastics (Sand), and Wolfcamp A and B in southern Delaware Basin (abs.): International Meeting for Applied Geoscience & Energy (IMAGE), Houston, Texas.

50. Loucks, R. G., Hattori, K., and Spears, C. S., 2024, Stratigraphic and Lithofacies Framework of the Lower Cretaceous Pettet Formation in the Wright Mountain Field on the Northeastern Flank of the East Texas Basin: GeoGulf Transactions, v. 73, p. 79–87.

51. Loucks, R. G., Reed, R. M., and Periwal, P., 2024, Interpretation of the Upper Cretaceous Pilot Knob Volcano associated McKown Limestone at McKinney Falls State Park; Shallow-Water High-Energy Beach System or Deeper Water Gravity Flow Deposits?: GeoGulf Transactions, v. 73, p. 89–98.

52. Loucks, R. G., 2024, Carbonate Sedimentation and Reservoirs Associated with a Volcanic Mound in an Open-Marine, Deep-Water, Drowned Platform Setting: Elaine Field Area, Upper Cretaceous Anacacho Formation, South Texas (abs.): South Texas Geological Society, San Antonio, Texas.

53. Loucks, R. G., and Reed, R., 2023, Alteration of Volcanic Grains to Glauconite in the Upper Cretaceous Austin Chalk Formation in the Balcones Igneous Province, South and Central Texas; Implication for Depositional History (abs.): presented to GCAGS, presented at GCAGS Annual Meeting, Houston, Texas.

54. Loucks, R. G., Sivil, J. E., and Hattori, K., 2024, Carbon isotope secular curve for the Upper Cretaceous Chalks in the South Texas Maverick Basin showing the expression of the OAE-2 and OAE-3 and associated lithofacies and chemostratigraphy (abs.): ISGC/SEPM Flagstaff, Arizona.

55. Loucks, R. G., Zeng, H., and Reed, R. M., 2024, Three-Dimensional Anatomy of Upper Cretaceous Carbonate Systems Associated with Volcanic Mounds on an Open-Marine, Deepwater Platform: Texas Maverick Basin and San Marcos Arch, USA (abs.): ISGC/SEPM 2024 Flagstaff, Arizona.

56. McMahon, T. P., 2024, Basin-scale resource assessment of unconventional reservoirs: An integrated approach (abs.): Southwest Section AAPG Program with Abstracts.

57. McMahon, T. P., Bhattacharya, S., Wang, Q., and Yut, K., 2024, Potential for Carbon Sequestration in Depleted Eagle Ford Shale Reservoirs (abs.): GeoGulf 2024.

58. McMahon, T. P., Wang, Q., and Berdysheva, S., 2024, Well Azimuth, Shmin Direction, and First Year's Production in the Permian Basin: URTeC: 40929236, 11 p. https://doi.org/10.15530/urtec-2024-4029236.

59. McMahon, T. P., Bhattacharya, S., Smye, K. M., Casey, B. J., Carr, D. L., Calle, A., Eastwood, R., Hoffman, D., Ikonnikova, S., Moonesan, S., Rogers, H., Sabbagh, R., Saheli, A., and Yut, K., 2023, An integrated approach to basin-scale resource assessment of unconventional reservoirs (abs.): International Meeting for Applied Geoscience & Energy (IMAGE) 2023 Program with Abstracts.

60. Martínez-Doñate, A., Moscardelli, L., Ko, L., Melani, L., Schuba, N., Bhattacharya, S., Ruiz Maraggi, L., and Blancone, D., 2024. Halite precipitation dynamics driven by refluxing deep hypersaline brines: Insights from the Permian Castile Formation (Delaware Basin, USA) (abs.): SEPM International Sedimentary Geosciences Congress, Flagstaff, Arizona.

61. Martinez-Doñate, A., Moscardelli, L., Schuba, N., Ko, L., Bhattacharya, S., and Melani, L., 2023, The stratigraphic record of the Castile Formation in the northern Delaware Basin (Texas and New Mexico): Updating sedimentary processes governing deep-water evaporite sequences (abs.): The International Meeting for Applied Geoscience & Energy (IMAGE), Houston, Texas.

62. Martínez-Doñate, A., Moscardelli, L., Ko, L., Melani, L., Schuba, N., Bhattacharya, S., and Ruiz Maraggi, L., 2023, Geological and geochemical characterization of salt-bearing sequences for hydrogen storage in the Delaware Basin (West Texas) (abs.): The Fourth EAGE Global Energy Transition Conference and Exhibition, Paris, France.

63. Martínez-Doñate, A., Moscardelli, L., Melani, L., Schuba, N., Ko, L., Bhattacharya, S., and Ruiz Maraggi, L., 2024, Characterization of shallow- and deep- water evaporitic sequences in the Permian Basin of West Texas (abs.): 85th EAGE Annual Conference and Exhibition, Oslo, Norway.

64. Melani, L., Martínez-Doñate, A., Bhattacharya, S., Moscardelli, L., and Schuba, C. N., 2024, Electrofacies characterization and core-log calibrations in heterogeneous bedded salt formations of the Delaware Basin: significance for hydrogen storage (abs.): 2024 SEPM International Sedimentary Geosciences Congress, Flagstaff, Arizona.

65. Melani, L., Martínez-Doñate, A., Bhattacharya, S., Moscardelli, L., and Schuba, C. N., 2024, Machine learning-based electrofacies classification for layered evaporitic sequences of the Delaware Basin: implications for hydrogen storage (abs.): SPWLA PDDA SIG 2024 Fall Topical Conference, Houston, Texas.

66. Moonesan, S., 2024, PVT Correlations for Initial Formation Volume Factor Estimation: A Case Study in Midland Basin: URTeC: 4034724, 14 p. https://doi.org/10.15530/urtec-2024-4034724.

67. Moscardelli, L., Smith, V., Hessler, A., Olariu, I., Lorente, M. A., Sivil, E., and Liu, X., 2023, Revisiting the onshore Lower Wilcox Group: Implications for the development of subsurface low carbon energy solutions in the Gulf Coast Region (abs.): The International Meeting for Applied Geoscience & Energy (IMAGE), Houston, Texas.

68. Moscardelli, L., Martínez-Doñate, A., Schuba, C. N., Ruiz Maraggi, L., Melani, L., Ko, L., Lin, N., and Bhattacharya, S., 2024, Subsurface hydrogen storage in salt formations: Geological, engineering, and economic assessments (abs.): 85th EAGE Annual Conference and Exhibition, Oslo, Norway.

69. Ogiesoba, O. C., Palacios, C. F., and Karakaya, S., 2024, Multiattribute and Bayesian characterization of Salt Creek Field, Kent County, Texas (abs.): The 4th International Meeting for Applied Geoscience & Energy (IMAGE), Houston, Texas, August 26-29, 2024.

70. Ogiesoba, O. C., 2023, Seismic reservoir characterization of the Strawn Group, Northern part of the Eastern Shelf, King County, North-Central Texas (abs.): The 3rd International Meeting for Applied Geosciences and Energy (IMAGE), Houston, Texas, August 28-31, 2023.

71. Olariu, M. I., Smith, V., Moscardelli, L., and Lorente, M. A., 2024, Low-amplitude, high-frequency climatically-driven eustatic sea-level changes in the Lower Wilcox: AAPG Gulf Coast Section (GeoGulf Conference), Houston, Texas.

72. Olariu, M. I., 2024, Depositional history and architectural variability of Wilcox Group in Texas: Potential for CO2 sequestration: Austin Geological Society.

73. Olariu, I., Moscardelli, L., Lorente, M. A., Hessler, A., Smith, V., and Liu, X., 2023, High-resolution stratigraphy of Lower Wilcox Guadalupe C Delta: Implications for CO2 sequestration (abs.): The International Meeting for Applied Geoscience & Energy (IMAGE), Houston, Texas.

74. Olariu, M. I., Trevino, R., Dunlap, D., DeAngelo, M., Bump, A., and Nunez-Lopez, V., 2022, Onshore/Offshore CO2 storage assessment: UTCCS-6 Conference on carbon capture and storage.

75. Olariu, M. I., 2022, Architecture and variability of Lower Wilcox sand prone slope deposits, South Central Texas: The International Meeting for Applied Geoscience & Energy (IMAGE), Houston, Texas.

76. Palacios, F. C., and Ogiesoba, O. C., 2024, Depositional characterization of the Tannehill, Kent County, Texas, by integrating well-log and seismic facies analysis (abs.): 2024 AAPG Southwest Section Annual Convention, Abilene, Texas.

77. Palacios, F. C., Steel, R. J., and Ambrose, W. A., 2024, Compound clinoform model for tidal-influenced deltas in the mixed siliciclastic-carbonate Cisco Group, Virgilian (Gzhelian), Eastern Shelf of the Permian Basin, USA (abs.): SEPM International Sedimentary Geosciences Congress, Flagstaff, Arizona.

78. Palacios, F. C., and Steel, R. J., 2024, Shelf architecture evolution of the Virgilian mixed siliciclastic-carbonate Cisco Group, Eastern Shelf of the Permian Basin, North-Central Texas (abs.): The international Meeting for Applied Geoscience & Energy (IMAGE), Houston, Texas.

79. Peng, S., Ruiz Maraggi, L. M., Bhattacharya, S., Yut, K., McMahon, T., and Haddad, M., 2023, Feasibility of CO2 storage in depleted unconventional oil and gas reservoirs: Capacity, microscale mechanism, injectivity, fault stability, and monitoring: URTeC: 3866067, https://doi.org/10.15530/urtec-2023-3866067.

80. Shevchenko, P., and Periwal, P., 2024. The impact of pore wettability and heterogeneity on CO2 sweeping efficiency in enhanced oil recovery in unconventional reservoir rocks: Unconventional Resources Technology Conference, 17–19 June 2024, Houston, Texas.

81. Peng, S., Ruiz Maraggi, L., Bhattacharya, S., Yut, K., McMahon, T., and Haddad, M., 2023. Feasibility of CO2 storage in depleted unconventional oil and gas reservoirs: Capacity, microscale mechanism, injectivity, fault stability, and monitoring: Unconventional Resources Technology Conference, 13–15 June 2023, Denver, Colorado.

82. Peng, S., 2023. Does liquid slip flow occur in unconventional reservoir rocks? A laboratory study of liquid permeability: Unconventional Resources Technology Conference, 13–15 June 2023, Denver, Colorado.

83. Peng, S., LaManna, J., Periwal, P., and Shevchenko, P., 2022. Water imbibition and oil recovery in shale: Dynamics and mechanisms using integrated Cm-to-Nm-Scale imaging: Unconventional Resources Technology Conference, June 2022, Houston, Texas.

84. Radjef, E. M., 2023, An Underexplored Cisco Carbonate Oil Play in the Palo Duro Basin, Texas (abs.): Southwest Section of the American Association of Petroleum Geologists Convention Program, Wichita Falls, Texas.

85. Reed, R. M., and Adriaens, R., 2024, Compositional variations of tuffs of the Late Cretaceous volcanic play of the Balcones Igneous Province, Texas, and their effect on volcanic-hosted reservoirs (abs.): GeoGulf 2024, San Antonio, Texas.

86. Reed, R. M., and Adriaens, R., 2023, Understanding clay-mineral alteration of silica-undersaturated mafic volcanic tuff through integration of XRD and SEM analyses (abs.): 60th Annual Meeting of the Clay Minerals Society, Austin, Texas.

87. Reed, R. M., and Loucks, R. G., 2023, Conversion of silica-undersaturated mafic volcanic grains to glauconite: Examples from the Late Cretaceous Balcones Igneous Province, Texas (abs.): Geological Society of America Annual Meeting, Pittsburgh, Pennsylvania.

88. Reed, R. M., and Loucks, R. G., 2023, Textures, mineralogy, and reservoir properties of an altered mafic tuff core from the Upper Cretaceous (lower Campanian) of Central Texas (abs.): GeoGulf 2023, Houston, Texas.

89. Reed, R. M., Loucks, R. G., and Adriaens, R., 2022, Mineralogy, alteration, fabric, and texture of silica-undersaturated mafic lapilli tuffs from the Late Cretaceous Balcones Igneous Province, Central Texas, USA (abs.): Geological Society of America Annual Meeting, Denver, Colorado.

90. Rogers, H., and Ambrose, W. A., 2024, Reflections of the Lower and Middle Frio Formation Along the South Texas Gulf Coast (abs.): Gulf Coast Association of Geological Societies GeoGulf, San Antonio, Texas.

91. Rogers, H., 2023, Salt Cavern Storage Potential in the Gulf Coast of Texas (abs.): Gulf Coast Association of Geological Societies GeoGulf, Houston, Texas.

92. Rogers, H., 2023, Potential Utilization of Salt Caverns for Brine Production Liquified Petroleum Gas (LPG) and Natural Gas Storage in the Permian Basin (abs.): Austin Geological Society, Austin, Texas.

93. Ruiz Maraggi, L. M., Walsh, M. P., Lake, L. W., and Male, F. R., 2024, Fast optimization of the net present value of unconventional wells using rapid rate-transient analysis: Unconventional Resources Technology Conference (URTeC), Houston, Texas.

94. Ruiz Maraggi, L., and Moscardelli, L., 2023, Hydrogen storage potential of U.S. salt domes in Texas, Louisiana, and Mississippi (abs.): The International Meeting for Applied Geoscience & Energy (IMAGE), Houston, Texas.

95. Ruiz Maraggi, L., and Moscardelli, L., 2023, The GeoH2 Web App: An Integrated Engineering and Geoscience Tool for Modeling Hydrogen Storage Within Salt Formations (abs.): Solution Mining Research Institute Fall Meeting, San Antonio, Texas.

96. Ruiz Maraggi, L., and Moscardelli, L., 2023, Hydrogen storage potential of U.S. salt domes in Texas, Louisiana, and Mississippi (abs.): The Fourth EAGE Global Energy Transition Conference and Exhibition, Paris, France.

97. Ruiz Maraggi, L. M., Walsh, M. P., and Lake, L. W., 2023, A new approach to apply decline-curve analysis for tight-oil reservoirs producing under variable pressure conditions: Unconventional Resources Technology Conference (URTeC), Denver, Colorado.

98. Ruiz Maraggi, L. M., Walsh, M. P., Lake, L. W., and Male, F. R., 2023, Bayesian variable pressure decline-curve analysis for shale gas wells: Unconventional Resources Technology Conference (URTeC), Denver, Colorado.

99. Schuba, N., Moscardelli, L., Dooley, T., and Hattori, K., 2023, Bedded salt formations of the Delaware Basin and their significance for salt cavern placement (abs.): The International Meeting for Applied Geoscience & Energy (IMAGE), Houston, Texas.

100. Schuba, N., Ruiz Maraggi, L., and Moscardelli, L., 2024, Subsurface hydrogen storage exploration methods: From play-scale screening to prospect-scale refinement in salt basins (abs.): 85th EAGE Annual Conference and Exhibition, Oslo, Norway.

101. Smith, V., Olariu M. I., Bord, D., Moscardelli, L., Sivil E., Hessler, A., Liu, X., and Lorente, M. A., 2023, Palynostratigraphy of the Lower Wilcox Group, onshore Texas: The International Meeting for Applied Geoscience & Energy (IMAGE), Houston, Texas.

102. Zeng, H., 2022, Recent progresses in seismic sedimentology: improving thin bed prediction in lacustrine basins (abs.): 21st sedimentological conference, a new journey of sedimentology: from the Pacific to the Himalaya, August 22-26, 2022, Beijing, China (virtual).

103. Zeng, H., Zhang, B., and Olariu, M. I., 2022, Facies-induced bias in machine learning-enhanced seismic lithology (inversion) (ext. abs.): SEG/AAPG International Meetings ; IMAGE 2022 · 28 August-1 September 2022.

104. Zeng H., Loucks, R. G., and Reed, R. M., 2023, Architecture of an Upper Cretaceous volcanic mound and associated carbonate systems: Elaine field, South Texas (abs.): The International Meeting for Applied Geoscience & Energy (IMAGE), Houston, Texas.

105. Zeng, H., and Olariu, M. I., 2024, Massive (up to 500 m) sands in Lower Wilcox intraslope Basins, South-central Texas, USA: Another major sand accumulation mechanism in Wilcox time (abs.): The International Meeting for Applied Geoscience & Energy (IMAGE), Houston, Texas.

APPENDIX D: STARR WORKSHOPS & GUIDEBOOKS

STARR researchers have prepared and delivered the following thematic workshops and guidebooks to oil and gas operators during the current reporting biennium (September 1, 2022 to August 31, 2024).

1. Ambrose, W. A., Loucks, B., Ogiesoba, O., Radjef, E., Reed, R., Sun, X., Zeng, H., Zhang, T., and Moscardelli, L., 2023, Cretaceous volcanic reservoirs of Texas: Interactive workshop on the Cretaceous volcanic oil-and-gas province of south-central Texas: Bureau of Economic Geology, Jackson School of Geosciences, Core Workshop, 95 p.

2. Flaig, P. P., and Denison, C., 2024, The Sabinetown-Carrizo Wilcox succession in Bastrop, TX: Facies, stratal architectures, palynology, isotopes, paleoenvironmental evolution, and regional correlations, BEG-STARR Field Guidebook, 61 p.

3. Loucks, R. G., Zeng, H., Radjef, E., and Hennings, P. H., 2024, Lower Ordovician Ellenburger Group Workshop: Bureau of Economic Geology, Jackson School of Geosciences, Core Workshop, 110 p.

4. Olariu, M. I., Flaig, P., Ambrose, W., Sharma, N., Smith, V., Lorente, M. A., Jensen, J., Moscardelli, L., Denison, C., and Demchuk, T., 2024, Sedimentology, palynology, and geochemistry of the Wilcox Group: Insights into depositional system evolution, biostratigraphy, paleoclimate, and reservoir characterization: Bureau of Economic Geology, Core Workshop Guidebook, 88 p.

5. Olariu, I., Flaig, P., Garcia, K., Olariu, C., Hessler, A., Sivil, E., Vann, S., Lorente, M. A., Moscardelli, L., Denison, C., and Demchuk, T., 2023, Wilcox group recent sedimentologic, biostratigraphic, and chemostratigraphoc insights: Implications for stratigraphic correlations, depositional trends, paleoclimate, and exploitation of energy resources in Texas: Bureau of Economic Geology, Jackson School of Geosciences, Core Workshop, 154 p.

APPENDIX E: STARR MEDIA COVERAGE

1. Henrikson, E. (2023, March 15). Salt could be key ingredient for clean energy transition, UT Austin researchers say. Kxan. https://www.kxan.com/news/science/salt-could-be-key-ingredient-for-clean-energy-transition-ut-austin-researchers-say/.

2. Tincher, R. (2023, March 7). UT researchers' study highlights salt's future in production of hydrogen, geothermal energy. The Daily Texan. https://thedailytexan.com/2023/03/07/ut-researchers-study-highlights-salts-future-in-production-of-hydrogen-geothermal-energy/.

3. Tittlemier, T. (September 06, 2024) Strawn Core Workshop Luncheon. PBE Podcast. https://www.youtube.com/watch?v=Mlmx5Xl5cbU.

4. Max, J. (2023, March 9). New study finds salt deposits could serve as a hydrogen storage tank. Hydrogen Fuel News. https://www.hydrogenfuelnews.com/hydrogen-storage-research-salt/8557599/.

5. Jacobs, T. (2023, March 30). Digging Into the US Gulf Coast's 'Salt Real Estate' for Hydrogen Storage. Journal of Petroleum Technology. https://jpt.spe.org/digging-into-the-us-gulf-coasts-salt-real-estate-for-hydrogen-storage.

6. Yonick, K. (2023, February 21). UT researching the role salt has in lower carbon, geothermal energy. Kvue. https://www.kvue.com/article/news/education/university-of-texas/university-of-texas-salt-study-energy/269-deae3483-cb0e-4e82-bdab-812ba8a38714.

7. Flaig, P. (2023, May). Hidden treasure beneath our feet: Exploring the Willcox Group, Palo Alto College Media. https://pacpulse.com/2024/05/13/hidden-treasure-beneath-our-feet-exploring-the-willcox-group/.