CATALOG Undocumented Orphaned Wells R&D Program Overview

LANL-AE-2090-2115

Hari Viswanathan

Los Alamos National Laboratory

U.S. Department of Energy

National Energy Technology Laboratory
Resource Sustainability Project Review Meeting
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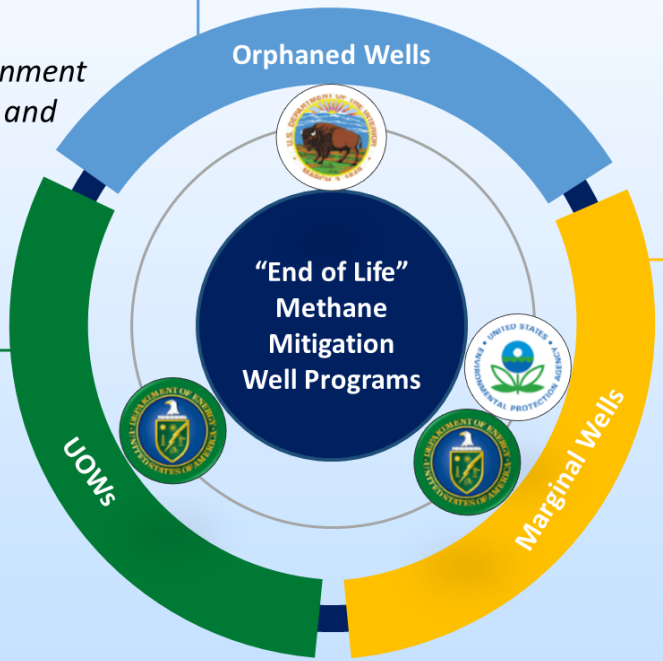
Federal Action for End of Life Wells

Orphaned Wells Program
Purpose: *Support plugging and abandonment operations across Federal, Tribal, State, and private lands.*
Budget: *$4.7 billion for 9 years*

Undocumented Orphaned Well (UOW) Program
Purpose: *Develop technologies and techniques to identify and characterize orphaned wells that are not currently in the regulatory inventory*
Budget: *$30 million for 5 years*



** A marginal well is defined as a well producing less than 15 barrels or oil or 90,000 cubic feet of natural gas per day.*

Methane Emissions Reduction Program (MERP)
Purpose: *Assess marginal well* methane emissions, prioritize methane mitigation opportunities, plugging wells and surface reclamation*
Budget: *$750 million for 5 years*

Project Overview

- 5 Years $30M BIL funding, FY 2023, 2024 Appropriations $10M/yr
- October 1, 2023 – February 28, 2027

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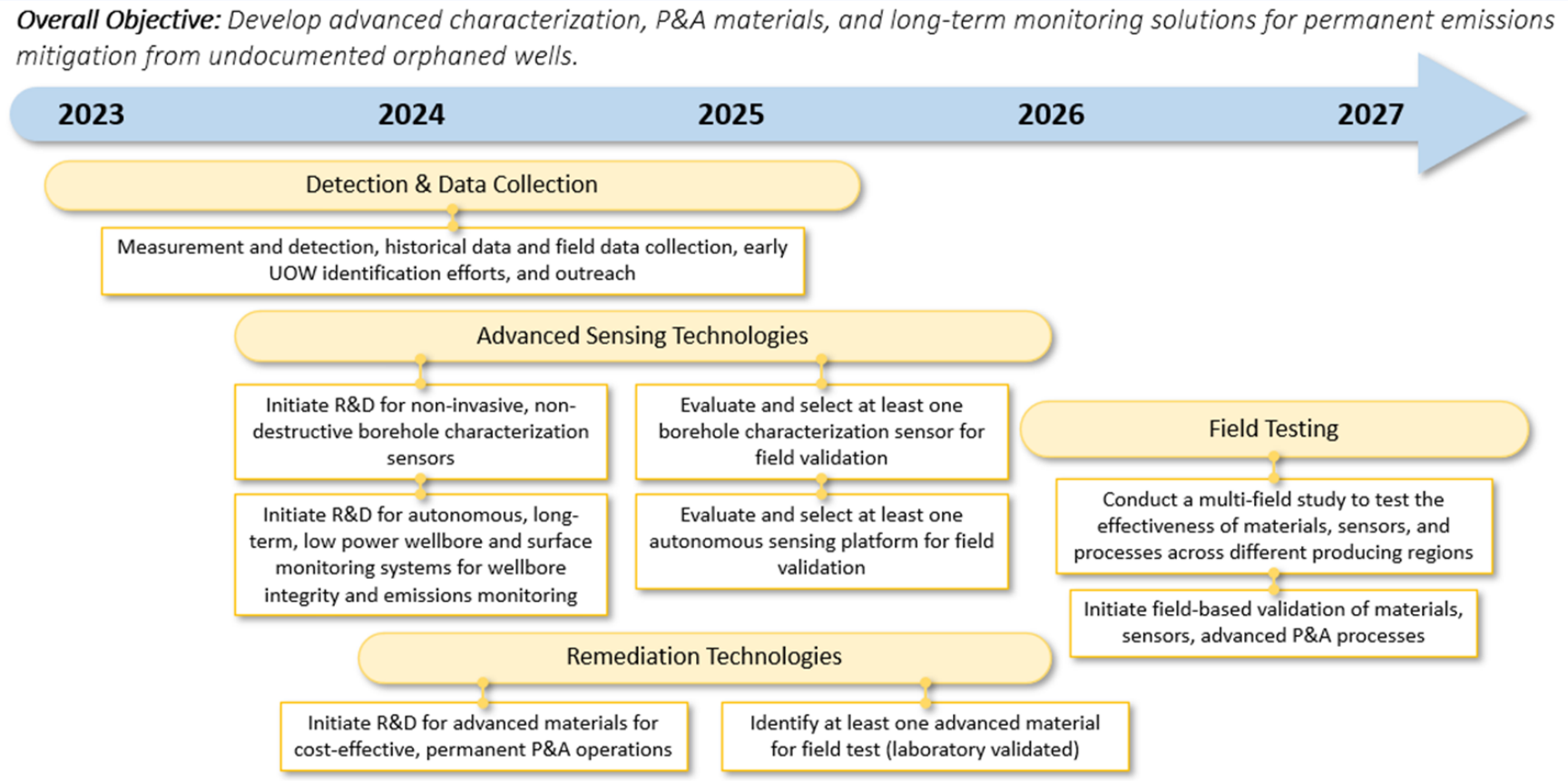
Milestones for UOWP



Project Overview

Relevant Appropriations Language

Section H2 (a, b)
Conduct research and development activities in cooperation with the Interstate Oil and Gas Compact Commission to assist the Federal land management agencies, States, and **Indian Tribes** in--

(A) identifying and characterizing undocumented orphaned wells; and

(B) mitigating the environmental risks of undocumented orphaned wells;

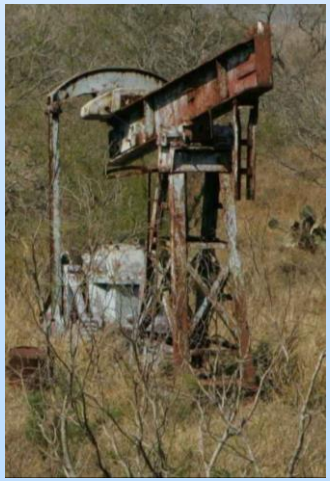
IOGCC 2021 estimate of undocumented orphaned wells is between **310,000** and **800,000**.

Program Budget

DOE's Undocumented Orphaned Well Program will be executed over **5 years with $30M** in appropriated budget.

FY2023 Appropriations

Up to **$10 million** to be spend on identification and characterization of undocumented orphaned wells.



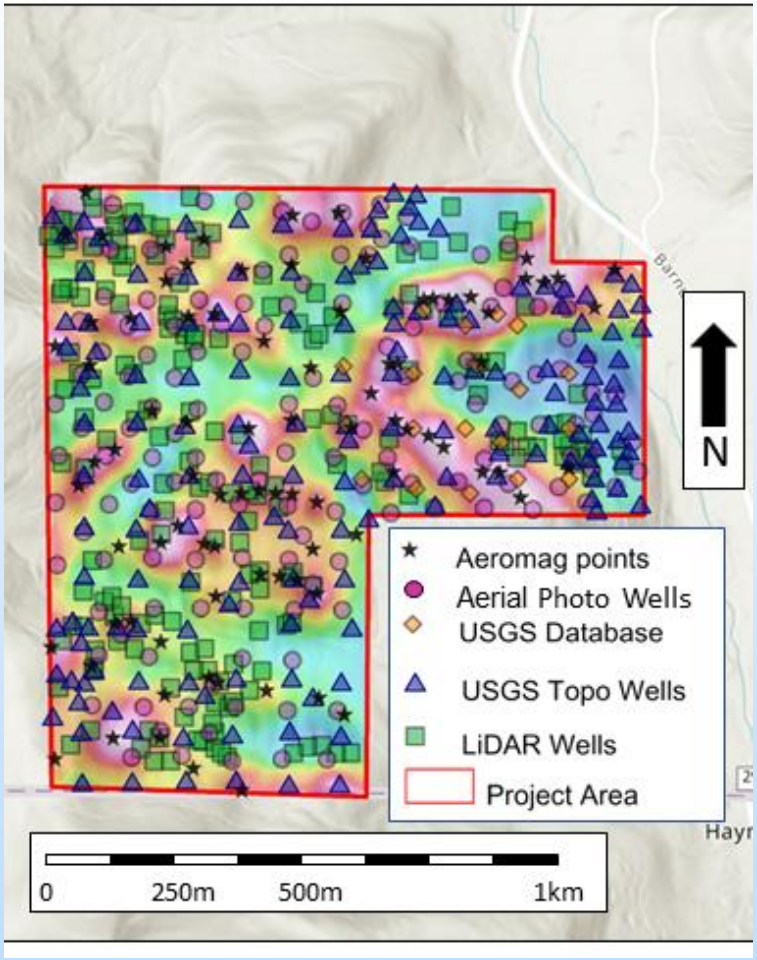
Key Partnerships and Stakeholders

National Laboratories	IOGCC (States)	DOI OWPO
• Data Analytics/Machine Learning (critical to disparate datasets) • Well characterization (subsurface and surface) • Experience with detecting and characterizing undocumented wells • ***NLs*** will be critical in identifying existing and new technology pathways	• The ***IOGCC*** will collaborate with individual State Environmental Agencies to gain critical insight into best practices and technology development needs. • The ***IOGCC*** will develop and maintain a list of critical points of contact within the ***States*** and assist in maintaining effective communications.	• Understanding the technology needs and estimation of undocumented orphaned wells. • Collaborate to ensure effective communications and project engagement. • Conduct critical identification and characterization of undocumented orphaned wells.

Sandia National Laboratories · Lawrence Livermore National Laboratory · Berkeley Lab · Los Alamos National Laboratory · National Energy Technology Laboratory · Interstate Oil & Gas Compact Commission · U.S. Department of the Interior · U.S. Department of Energy, Fossil Energy and Carbon Management

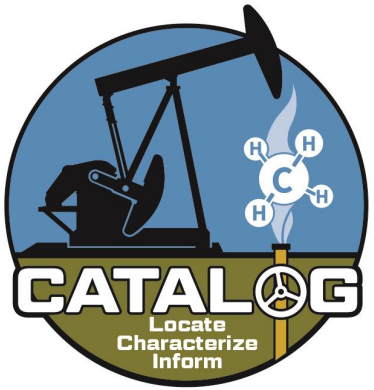
No Silver Bullet for Finding Wells

- Various methods could be used to locate wells
  - magnetic survey, aerial or satellite photography, LiDAR, methane measurements, historical records
- No method works in all cases
  - Magnetics fail when the well casing is removed (~15,000 wells had casings salvaged during WW2 for the metal) and is challenging in steep terrain or tall vegetation
  - Methane measurements fail when the well is not emitting (emissions are highly transient)
  - Aerial/satellite photos could be obstructed by vegetation or construction



Priorities and Work Packages

1. Methane Detection and Quantification (Biraud talk)
2. Well Identification
3. Sensor Fusion and Data Integration with Machine Learning (Trueblood talk)
4. Well Characterization
5. Integration and Best Practices (Viswanathan talk)
6. Data Management
7. Records Data Extraction (Lackey talk)
8. Wells Database
9. Field Teams (Guiltinan talk)



Consortium Advancing Technology for Assessment of Lost Oil & Gas Wells.

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WP1: Methane Measurements

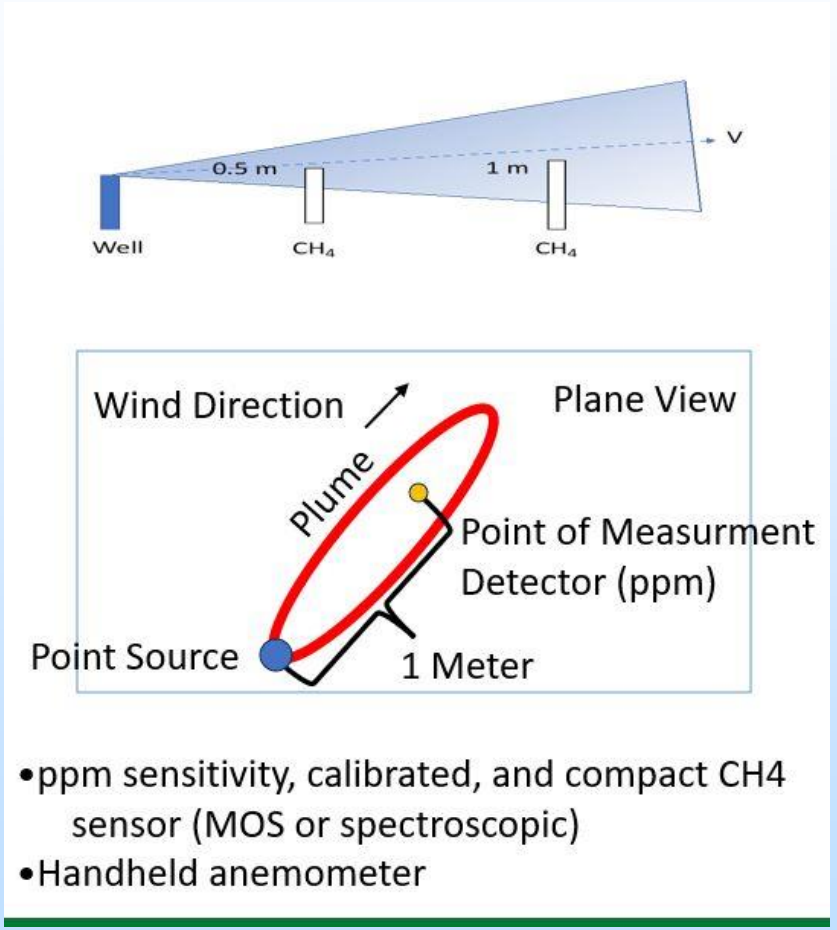
- Gas concentration and composition (ppm) measurements from orphan wells prioritized for plugging in Hillman Park, PA and Hobbs, NM
- Observed WellDone's protocols in NM
- Picarro backpack and RMLD deployed to detect CH4 leaks.
- Deployed FLIR (NETL) used to find leakage point.
- Xplorobot LIDAR and SEMTEC HI-FLOW2 to quantify CH4 leak rate at the well head.
- Leak rates range between 10 and 100 g/hr (relatively small)

Hillman Park, PA

Hobbs, NM

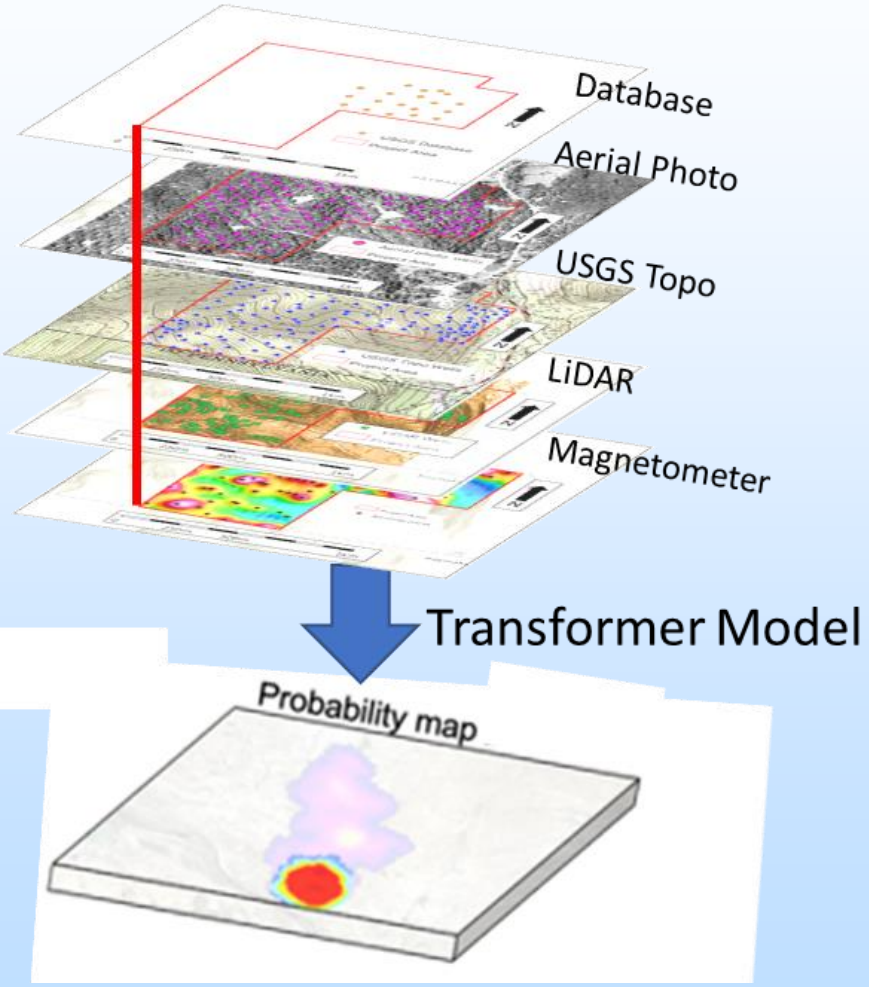
Cost-effective estimation of CH4 emission rates from UOWS

- The state-of-the-art uses a flux tower to estimate the emissions rate and costs about $2500+ per well
  - Measuring methane emission rates before and after plugging and abandonment is a top priority for the White House – “How much methane did we keep out of the atmosphere?”
- We need to drive this cost down dramatically to efficiently use DOI’s $4.7B budget
- White house asked CATALOG to develop a screening methodology to estimate flow rate from cheap concentration measurements: **defensible, simple procedure and cost effective**

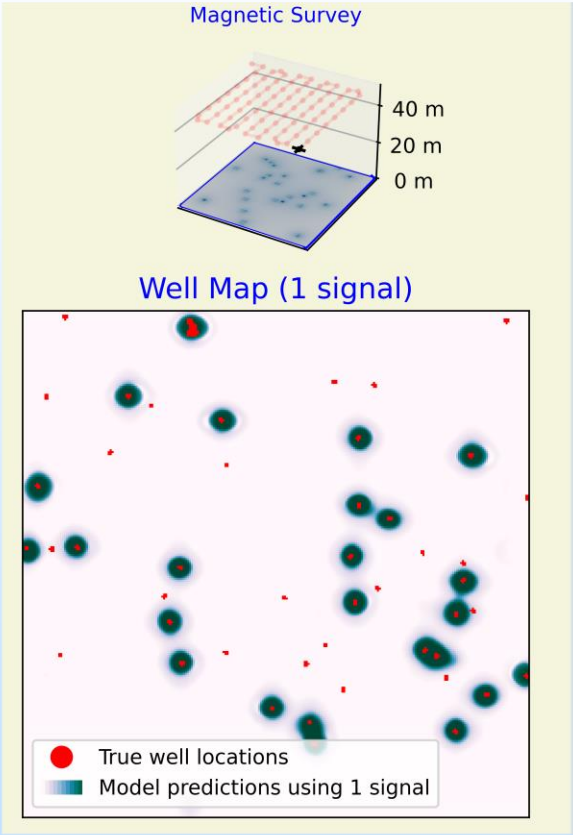


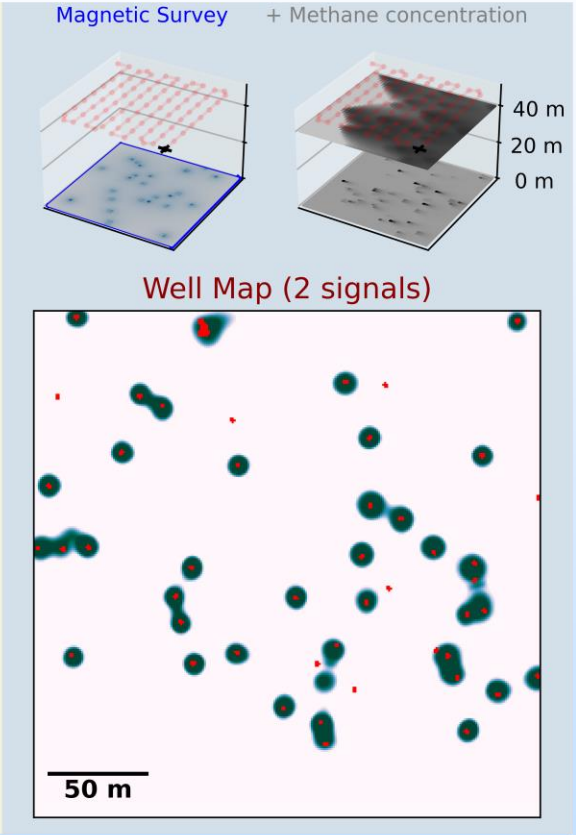
WP3: Data Fusion

- Machine Learning models have shown impressive results in fusing data from different sources (e.g., text and images).
- Our approach suggests that having two data sources (compared to just a methane sensor) increases the accuracy of the model by a wide margin.
- Sensevier Transformer model is efficient and useful for edge computing
- Sensevier can be deployed on drones and other field deployable devices
- Can we train drones to collect the best data? **(autonomous discovery)**



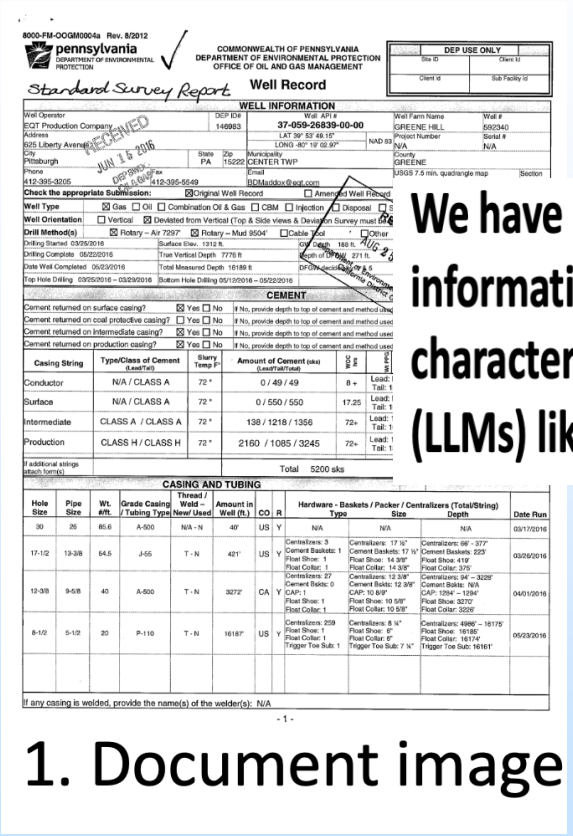
Data Fusion





Santos, J. E., …, Viswanathan, H. (2023). Development of the Senseiver for efficient field reconstruction from sparse observations. *Nature Machine Intelligence*, 1-9.

WP7: Automating Historical Records Extraction



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DEPARTMENT OF ENVIRONMENTAL PROTECTION
OFFICE OF OIL AND GAS MANAGEMENT

DEP USE ONLY

Standard Survey Report

Well Record

RECEIVED
JUN 16 2016

WELL INFORMATION

Well Operator	DEP ID#	Well API #	Well Farm Name	Well #
EQT Production Company	146983	37-059-26839-00-00	GREENE HILL	592340
Address		LAT 39° 53' 48.15"	Project Number	Serial #
625 Liberty Avenue		LONG -80° 19' 02.97" NAD 83	N/A	N/A
City	State	Zip	Municipality	County
Pittsburgh	PA	15222	CENTER TWP	GREENE
Phone	Fax	Email	USGS 7.5 min. quadrangle map	Section
412-395-9205	412-395-5549	BDMaddox@eqt.com		

Check the appropriate Submission: ☒ Original Well Record ☐ Amended Well Record

Well Type: ☒ Gas ☐ Oil ☐ Combination Oil & Gas ☐ CBM ☐ Injection ☐ Disposal

Well Orientation: ☐ Vertical ☒ Deviated from Vertical (Top & Side views & Deviation Survey must be

Drill Method(s): ☒ Rotary – Air 7297' ☒ Rotary – Mud 9504' ☐ Cable Tool ☐ Other

Drilling Started 03/25/2016 | Surface Elev. 1312 ft. | DW Depth 166 ft.
Drilling Complete 05/22/2016 | True Vertical Depth 7776 ft | Depth of DFOW 271 ft.
Date Well Completed 05/23/2016 | Total Measured Depth 16189 ft | DFOW deepest fresh water
Top Hole Drilling 03/25/2016 – 03/29/2016 | Bottom Hole Drilling 05/12/2016 – 05/22/2016

CEMENT

Cement returned on surface casing? ☒ Yes ☐ No
Cement returned on coal protective casing? ☐ Yes ☐ No
Cement returned on intermediate casing? ☒ Yes ☐ No
Cement returned on production casing? ☒ Yes ☐ No

Casing String	Type/Class of Cement (Lead/Tail)	Sacks Used	Amount of Cement (cu) (Lead/Tail/Total)	WOC	Slurry Wt.
Conductor	N/A / CLASS A	72 *	0 / 49 / 49	8 +	Lead: Tail: 1
Surface	N/A / CLASS A	72 *	0 / 550 / 550	17.25	Lead: Tail: 1
Intermediate	CLASS A / CLASS A	72 *	138 / 1218 / 1356	72+	Lead: Tail: 1
Production	CLASS H / CLASS H	72 *	2160 / 1085 / 3245	72+	Lead: Tail: 1
If additional strings attach form(s)			Total 5200 sks		

CASING AND TUBING

Hole Size	Pipe Size	Wt. #/ft.	Grade Casing / Tubing Type	Thread / Weld – New/ Used	Amount in Well (ft.)	CO	R	Hardware - Baskets / Packer / Centralizers (Total/String) Type	Size	Depth	Date Run
30	26	65.6	A-500	N/A - N	40'	US	Y	N/A	N/A	N/A	03/17/2016
17-1/2	13-3/8	54.5	J-55	T - N	421'	US	Y	Centralizers: 3 Cement Baskets: 1 Float Shoe: 1 Float Collar: 1	Centralizers: 17 ½" Cement Baskets: 17 ½" Float Shoe: 14 3/8" Float Collar: 14 3/8"	Centralizers: 66' - 377' Cement Baskets: 223' Float Shoe: 419' Float Collar: 375'	03/26/2016
12-3/8	9-5/8	40	A-500	T - N	3272'	CA	Y	Centralizers: 27 Cement Baksk: 0 CAP: 1 Float Shoe: 1 Float Collar: 1	Centralizers: 12 3/8" Cement Baksk: 12 3/8" CAP: 10 8/8" Float Shoe: 10 5/8" Float Collar: 10 5/8"	Centralizers: 94' – 3228' Cement Baksk: N/A CAP: 1294' – 1294' Float Shoe: 3270' Float Collar: 3226'	04/01/2016
8-1/2	5-1/2	20	P-110	T - N	16187'	US	Y	Centralizers: 259 Float Shoe: 1 Float Collar: 1 Trigger Toe Sub: 1	Centralizers: 8 ¼" Float Shoe: 6" Float Collar: 6" Trigger Toe Sub: 7 ¼"	Centralizers: 4986' – 16175' Float Shoe: 16185' Float Collar: 16174' Trigger Toe Sub: 16161'	05/23/2016

If any casing is welded, provide the name(s) of the welder(s): N/A

- 1 -

1. Document image

2. Semi-structured text

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We have had early success extracting well characterization information from image-based documents using optical character recognition (OCR) and large language models (LLMs) like ChatGPT

red Well
on

e": 39.896986
de": -80.3174
7776}

We have developed a tool that has had early success extracting well characterization information from image-based documents using optical character recognition (OCR) and large language models (LLMs) like ChatGPT

WP8: UOW Database

Updatable, Relational Database

Purpose

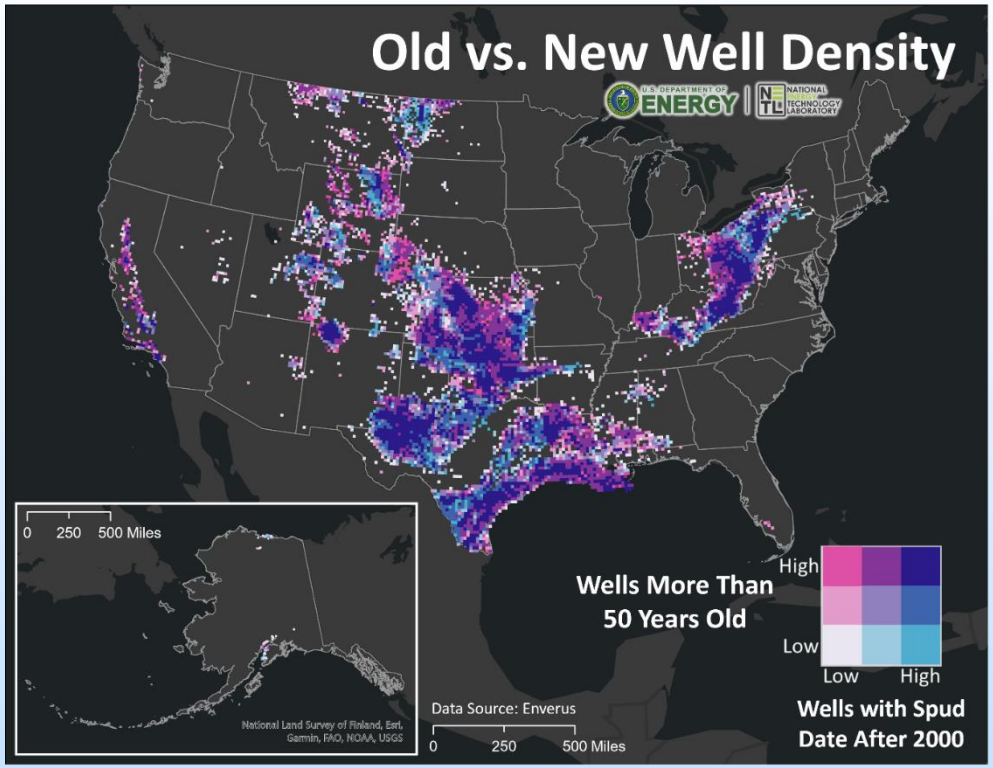
- Limit identifying known wells
- Framework for ML

Sources

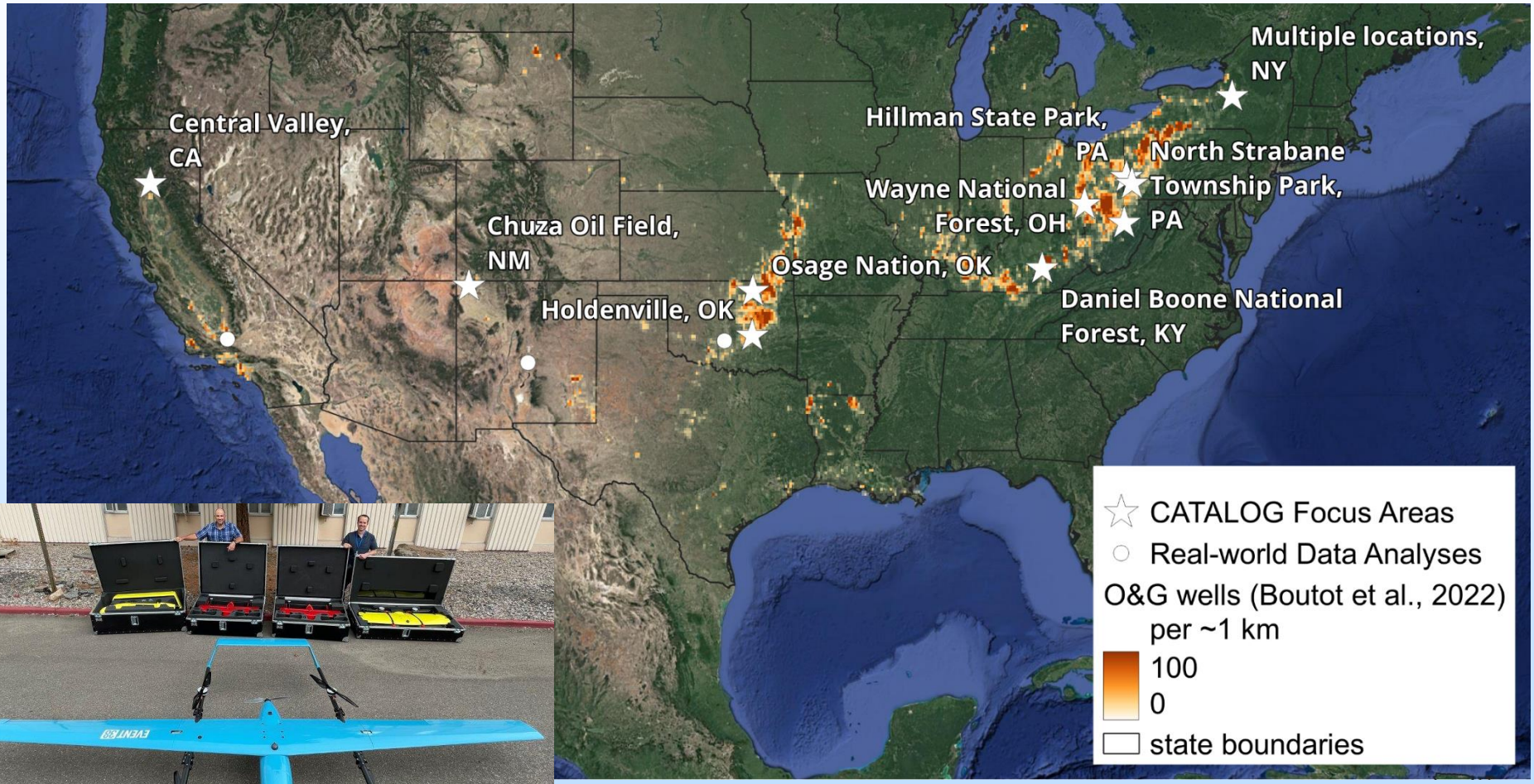
- States, Tribes, Private, DOI, GWPC, NGOs

Attributes

- Comparison and ranking via sources etc.
- Evergreen
- Tag back to managing agency.
- Framework for additional well data



WP9: Field Activities

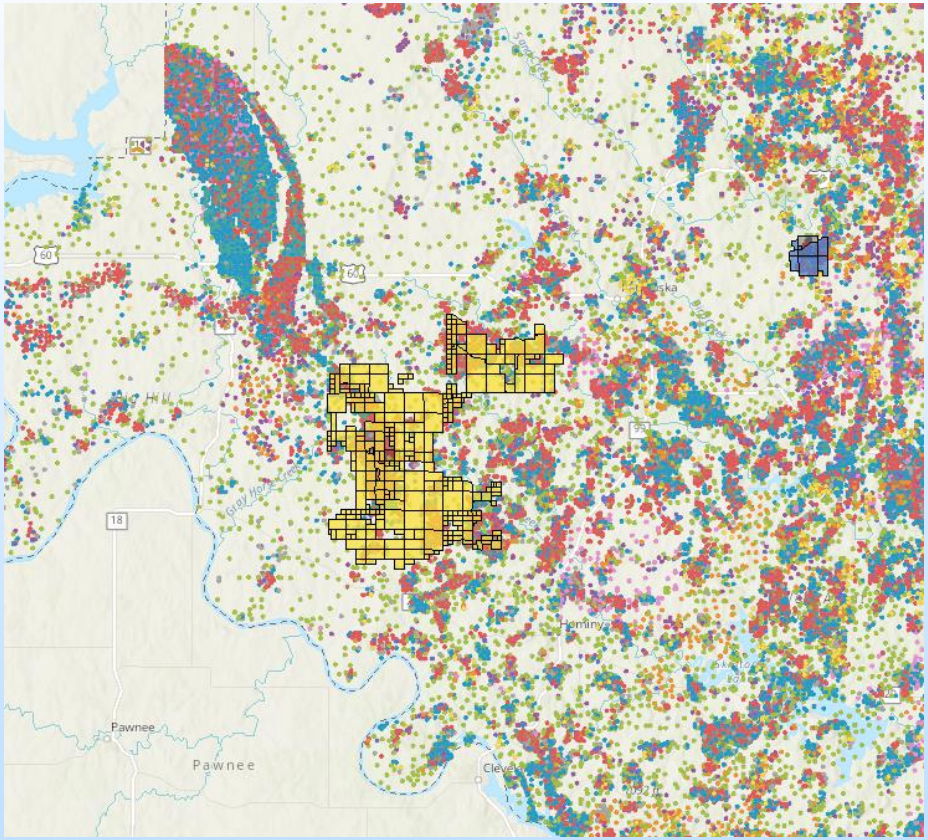


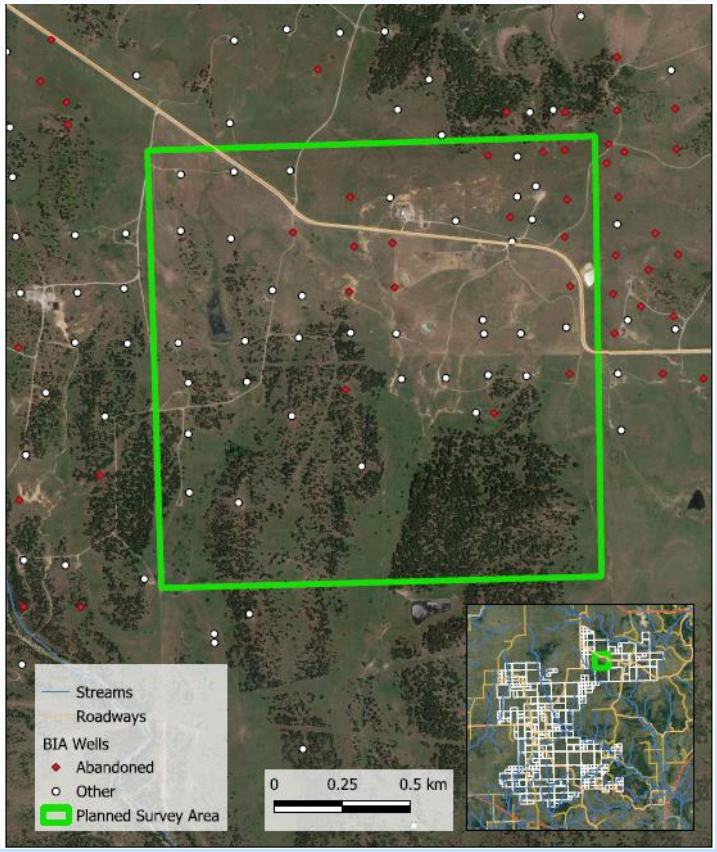
Osage County Field Study

- August of 2023 DOE and the Osage Nation signed a Memorandum of Understanding
- Support Osage DOI Orphan Well Program Office Grant
- Advances CATALOG goals
- First field visit in late October 2023

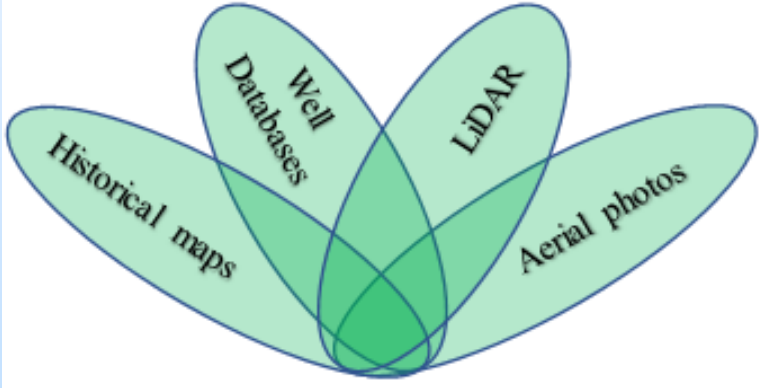
Engagement of the Osage is the key to making this successful

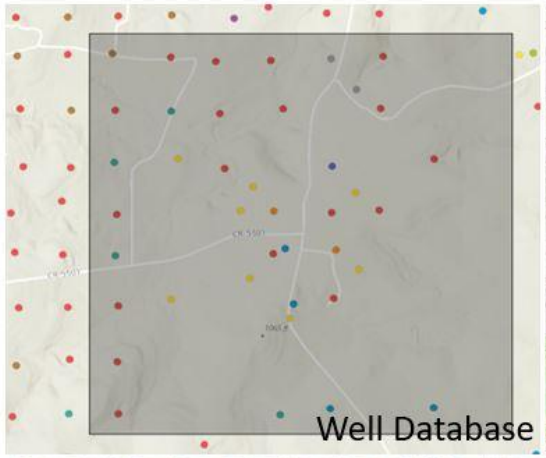
First Site: Osage Nation Ranch

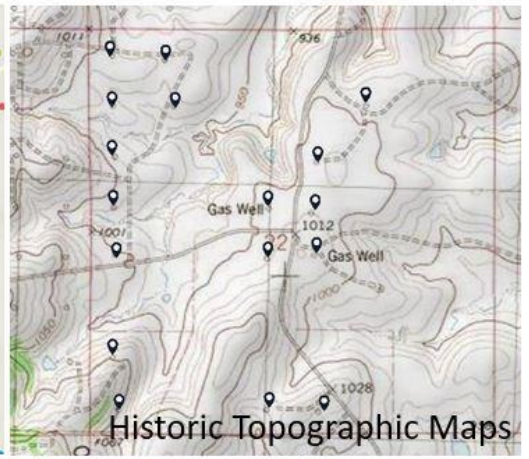


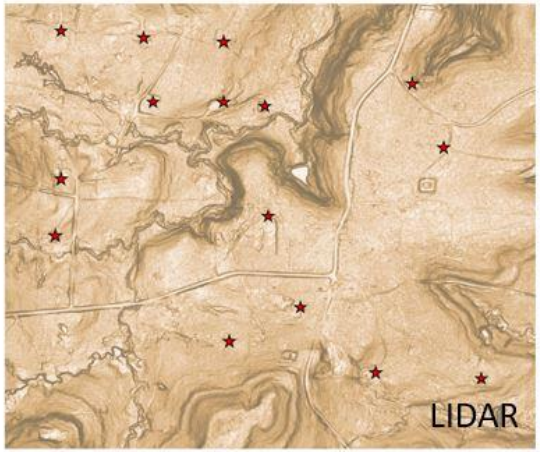


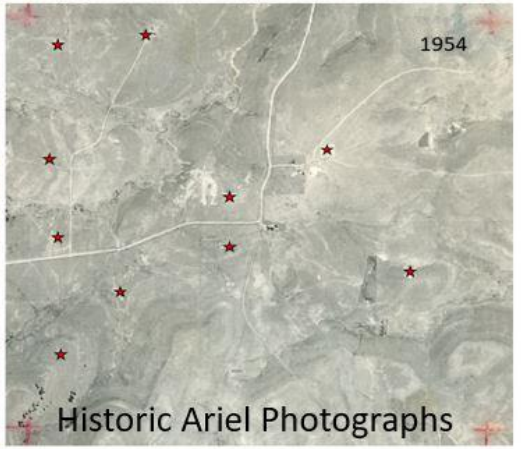
GIS Layer Data to Find Wells



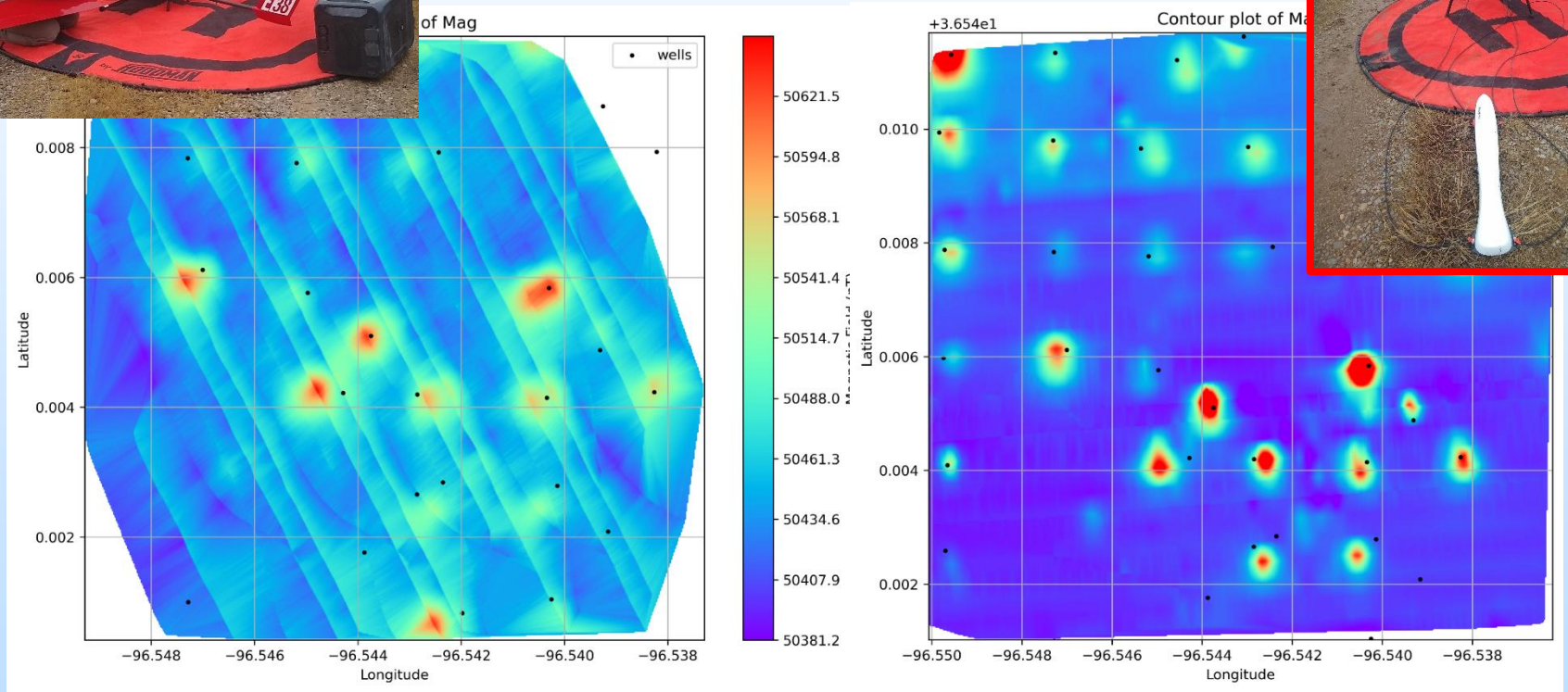




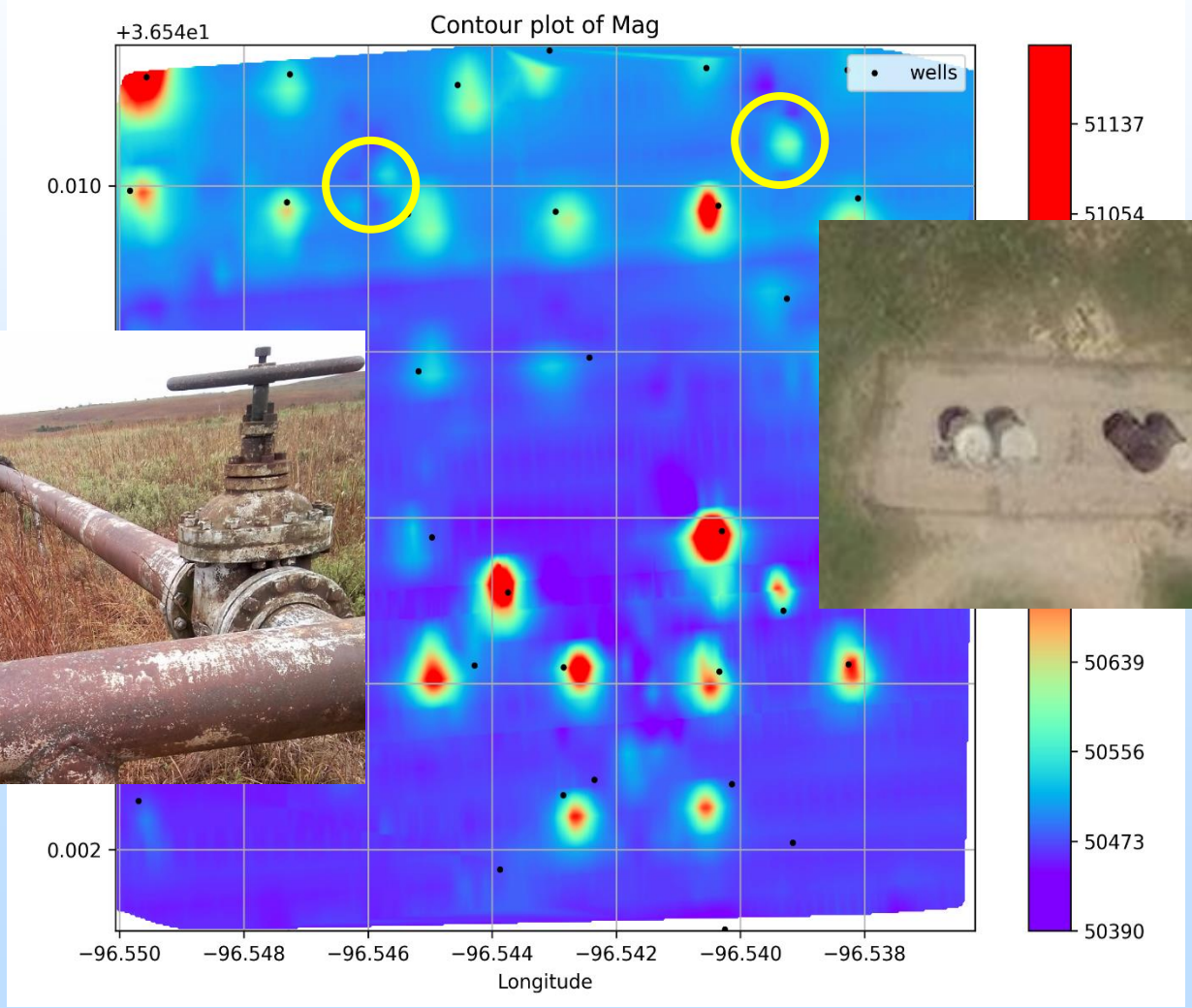




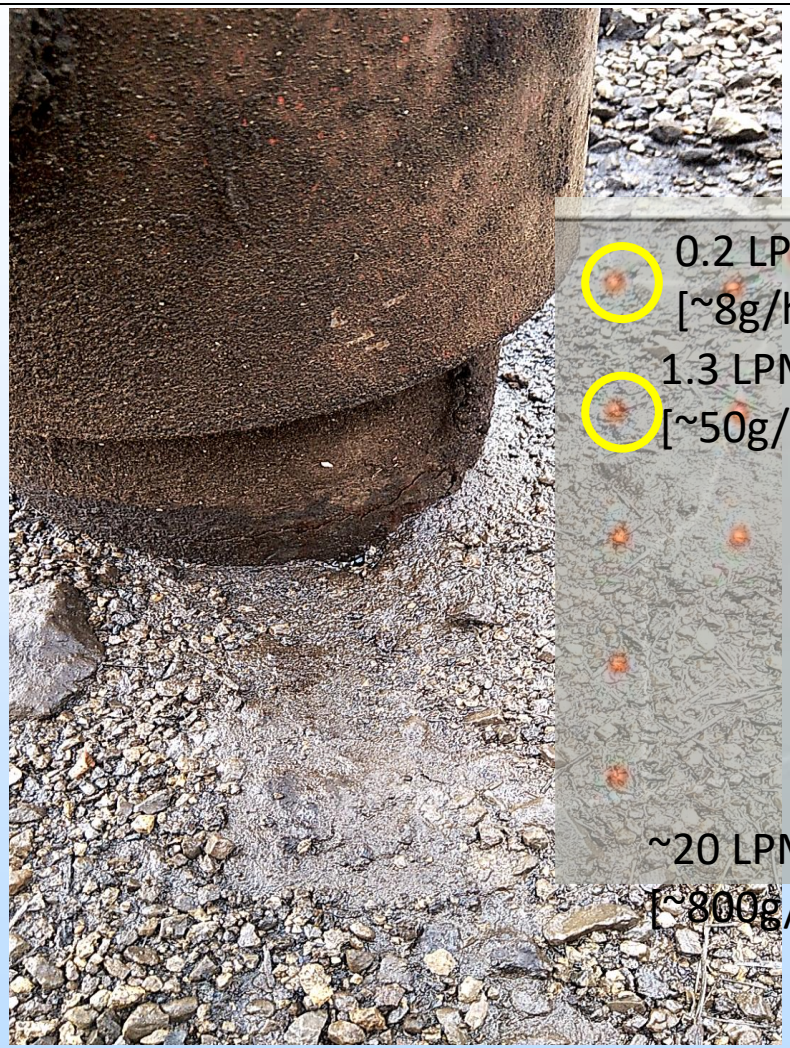
Magnetic Data UAVs



Magnetic Data Infrastructure



Leaky Well Examples



Outreach and Workforce Development Efforts or Achievements

- Outreach
  - Interstate Oil and Gas Compact Commission to interface with states
  - Osage Nation field study
  - Navajo Nation field study
  - Forest Service and Texas Railroad Commission
  - Interagency meetings with DOI for methane mitigation protocols
  - Presented at AGU, AAPG, SEG
- Workforce Development
  - Numerous students and postdocs at each of the 5 national labs
  - Collaborating with academics such as Mary Kang and exchanging students

Summary

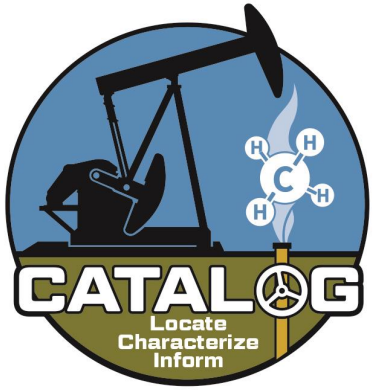
We are developing best practices for the states to employ to locate and characterize undocumented orphan wells

- Different areas in the US have different challenges: topography, vegetation, city vs unpopulated areas
- With 300,000 – 1,000,000 wells at least, we must prioritize wells to plug and abandon based emissions and other environmental risks
- Next you will see more details on our activities

Organization Chart

Program Leads

Tim Reinhart (DOE Division Director)
Andrew Govert (DOE Sr. Program Manager)
Liz McNamara (DOE Program Manager)
Hari Viswanathan (LANL, Technical Lead)



Consortium Advancing Technology for Assessment of Lost Oil & Gas Wells.

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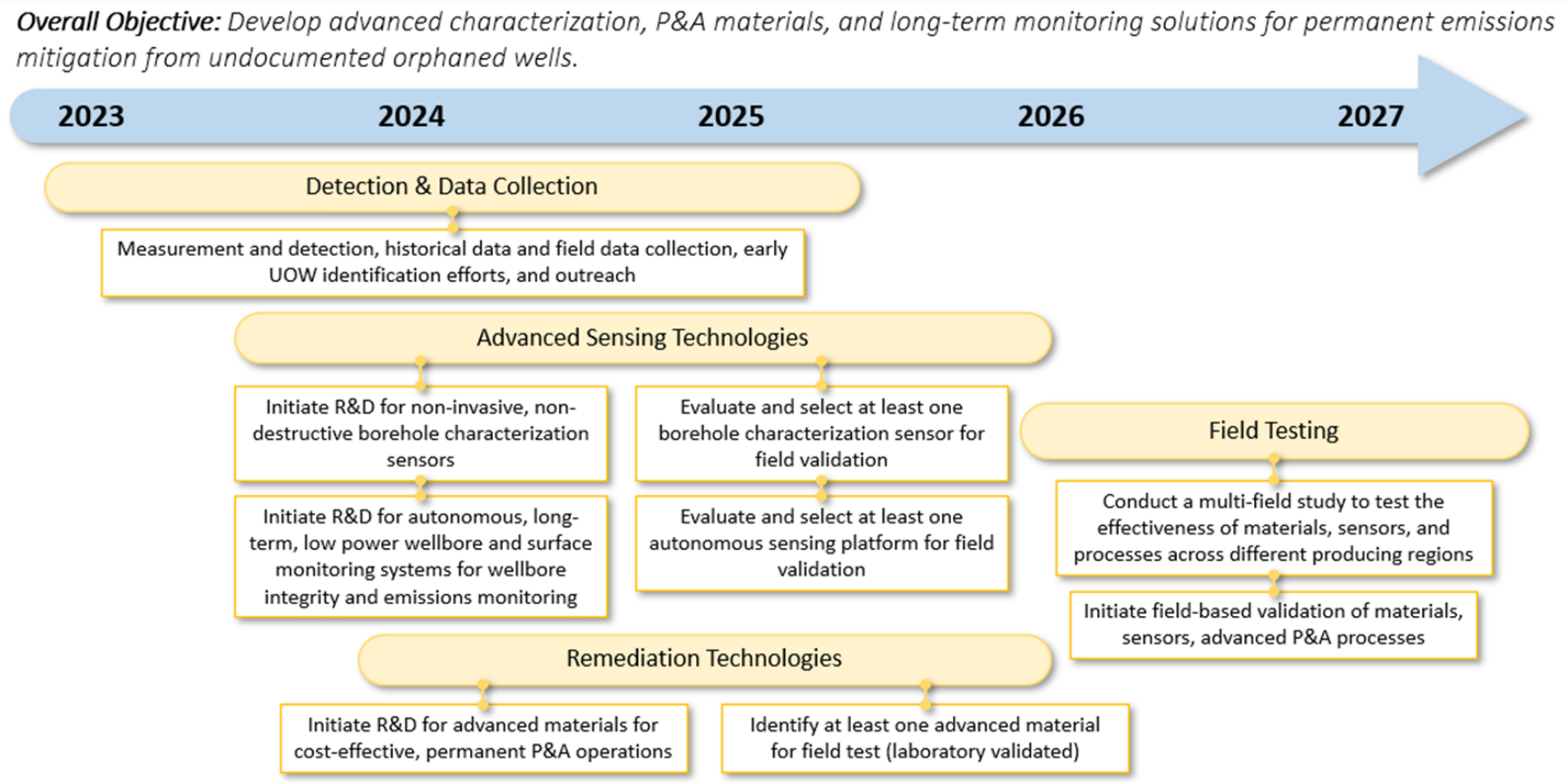
Work Package Leads

1. Methane Detection and Quantification (Biraud, LBNL)
2. Well Identification (Weiss, SNL)
3. Sensor Fusion and Data Integration with Machine Learning (Trueblood, LLNL)
4. Well Characterization (Delorey, LANL)
5. Integration and Best Practices (Pekney, NETL)
6. Data Management (Bauer, NETL)
7. Data Extraction (Lackey, NETL)
8. Wells Database (Bauer, NETL)
9. Field Teams (Downs, SNL)

Gantt Chart


Overall Objective: Develop advanced characterization, P&A materials, and long-term monitoring solutions for permanent emissions mitigation from undocumented orphaned wells.
2023
2024
2025
2026
2027
Detection & Data Collection
Measurement and detection, historical data and field data collection, early UOW identification efforts, and outreach
Advanced Sensing Technologies
Initiate R&D for non-invasive, non-destructive borehole characterization sensors
Evaluate and select at least one borehole characterization sensor for field validation
Initiate R&D for autonomous, long-term, low power wellbore and surface monitoring systems for wellbore integrity and emissions monitoring
Evaluate and select at least one autonomous sensing platform for field validation
Field Testing
Conduct a multi-field study to test the effectiveness of materials, sensors, and processes across different producing regions
Initiate field-based validation of materials, sensors, advanced P&A processes
Remediation Technologies
Initiate R&D for advanced materials for cost-effective, permanent P&A operations
Identify at least one advanced material for field test (laboratory validated)