

# Characterization of Oil-Field Brines and Estimation of Gross Values for Elements of Interest in Produced Waters



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# What are Elements of Interest (EOI)?



*Elements of Interest (EOI)* are elements that <u>may be</u> economically recovered from wastewaters and brines (i.e., \$ value > \$ extraction cost).



*Major* constituents make up most of the total dissolved solids (TDS) concentrations in produced water.

IM

CM

Industrial Minerals (IMs) are principally found in rock or coal resources.

*Critical Minerals (CMs)* are elements that are critical to the 21<sup>st</sup> century economy because they have important uses, no viable substitutes, and limited global supply.



*CM-Rare Earth Elements (REE)* are a group of chemically similar metallic elements comprising the lanthanide series and (usually) scandium and yttrium.



*CM-Platinum Group Elements (PGE)* are metals that have similar physical and chemical properties and tend to occur together in nature.



# "Assessment of Produced Water Quality, Critical Minerals, and Rare Earth Elements in Oklahoma and Kansas"

- Part 1 Compile produced water quality (PWQ) data in Oklahoma
- Part 2 Perform comprehensive analyses of Elements of Interest (EOI) in produced water (PW) collected from 100 oil wells
- Part 3 Compute gross values of EOI
- Part 4 Conduct exploratory data analysis (EDA) for EOI



# Case Studies: OK Produced Water Quality Database







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**Funded By:** 



## Case Studies: Midcontinental USA PW





#### Characterize SW & PW EOI Concentrations





Sample seawater (SW) from shoreline surf



Best Case: Sample PW from storage tank after gravity separation





Worst Case: Sample PW from wellhead and allow for gravity separation in the field

H<sub>2</sub>O Sample for Analyses at Laboratory

## EOI analyzed in this project



## Case Studies: Iodine in OK & KS





## Case Studies: Lithium in east Texas vs. Smackover





Smackover map from *Moldovanyi and Walter, 1992* 

Condon and Dyman, 2006



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#### Compute EOI Gross Values in PW



#### Case Studies: 60+ EOI in OK & KS





Compute Gross Values for EOI in 49 Oklahoma and Kansas PW samples

	TDS (mg/L)
min	76,300
25 <sup>th</sup> %	155,250
median	235,500
75 <sup>th</sup> %	252,500
max	287,000

### Case Studies: 60+ EOI in Permian Basin





Compute Gross Values for EOI in 25 Permian Basin PW samples

	TDS (mg/L)
min	55,800
25 <sup>th</sup> %	156,000
median	178,000
75 <sup>th</sup> %	193,000
max	537,000

Case Study Permian Basin PW

*Murray (2023-in preparation)* 

#### Case Studies: 60+ EOI in east Texas





Compute Gross Values for EOI in 26 east Texas PW samples

	TDS (mg/L)
min	76,200
25 <sup>th</sup> %	204,000
median	227,500
75 <sup>th</sup> %	241,000
max	255,000

15



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#### Strong positive correlation

- 0.75

- 0.50

- -0.25

-0.50

200,000

Strong relationships b/w common water quality measurements (e.g., pH, TDS, Na, Cl) and EOI can be used to estimate concentrations of EOI where they were not measured

Strong negative correlation

Murray and Wu (2023-in preparation)

#### Case Studies: Midcontinental USA PW





#### Case Studies: Midcontinental USA PW





# Conclusions



- Numerous EOI can be detected in produced water
- Concentrations of 6–10 EOI are high enough to have a gross value of >\$1.00 per barrel
- EOI concentrations can be estimated from commonly analyzed elements after an exploratory data analysis (EDA)
- Mineral-enriched brine producing reservoirs can be targeted for economic recovery of EOI

#### Future directions:

- Evaluate extraction costs for target EOI
- Continue sampling, analysis, and characterization of produced water for EOI in other plays & US states

## Thank You! Questions?







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J 15

-0 02

-0.37

-0.11

-0.39

-0.11

-0.24

J 28

0.31

0 15

Matrix of correlation coefficients between each element or parameter detected in the OK & KS samples





Strong positive correlation

Strong relationships b/w common water quality measurements (e.g., pH, TDS, Na, CI) and EOI can be used to estimate concentrations of EOI where they were not measured

Strong negative correlation

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