

Overview of the Potential for Selected Critical Minerals in Oklahoma

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Presentation Outline



- <u>Critical Mineral Potential in Oklahoma Coals</u>
 - Coal potential of eastern Oklahoma: NE Shelf and Arkoma Basin
 - Northeast Oklahoma Metropolis Mine
- National Uranium Resource Evaluation (NURE) Database for Oklahoma
- Helium Potential in Northwest Oklahoma, Cimarron Co.
 - Keyes Formation
- <u>Copper Prospect. Black Mesa Mountains, Northwest Oklahoma</u>
- <u>Critical Minerals in Basement Mafic and Ultramafic Rocks & Sediments: Southwest OK</u>

Summary- Critical & Industrial Mineral Exploration in OK



• <u>Oklahoma: raw nonfuel minerals had a value of</u> • <u>\$507 million in 2004</u>

- 1st in U.S. production of gypsum and iodine (U.S. producer)
- 2nd in Tripoli production
- 7th in common clays produced
- 4th in feldspar
- 8th in industrial sand and gravel

• Lead-Zinc:

- Miami-Picher Ottawa Co. Historically made important contributions to the State's economy until 1970
- Center for lead-zinc production: Tri-State Mining district NE OK, SE KS, SW MO
- <u>Copper: SW Corner of OK. Near Altus, Jackson</u> <u>Co. Mined by open pit mines</u>
 - Produced 1.88 million tons of ore between 1964 and 1975

Wichita and Ouachita Mountains areas:

- Wichita, Arbuckle, and Ouachita Mountains in the south and in the Ozark Uplift in the northeast
 - Almost all were open pit mines except for salt and iodine produced from brine wells; helium from natural gas wells; one underground limestone mine
- <u>Deposits and resources that are not mined</u> now, or with no current mining permits:
 - Asphalt
 - Lead
 - Zinc
 - Copper
 - Iron
 - Manganese
 - Titanium
 - Lithium
 - Uranium

Minerals Associated with Coal Deposits

Even the waste piles have value!



Rank of All Coal Beds At or Near Surface in OK Coalfield





Explanation

hvb High volatile bituminous
 mvb Medium volatile bituminous
 Ivb Low volatile bituminous
 Arkoma Basin boundary
 Rank boundary
 Commercial coal belt
 Noncommercial coal-bearing region

Wells & Cross-Sectional Lines in Relation to Coal Bearing Belt in NE Oklahoma Shelf Area





Typical cross section (shown on next slide)

Modified from

Hemish, 2002

<u> </u>	lahoma coals are enriched
<u>in 1</u>	these elements:
•	La
•	Mn
•	Li
•	Zn
•	Sr
•	Со
•	Ni
•	V
•	As
•	Br
•	Ве
•	Zr
•	Ga
•	Ge
	Ph

Avg. Interval Distance of ~4mi



SP 2002-2 PLATE 1 OF 6 Cross section A-A' (west to east)

Harden Core

Cedar Bluff Coal

Coal, black, bright, moderately friable, includes pyrite and white calcite on cleat surfaces	Depth t unit to (ft)
(Cedar Bluff coal)	34.7
Shale, black, soft, flaky, very carbonaceous	35.0
Underclay, medium-gray, contains black carbonized	
plant material	35.1
Shale, medium-gray, silty, noncalcareous, contains	
abundant black carbonized plant compressions on	
stratification surfaces and widely spaced thin	
coal laminae; includes rare, dark-gray siltstone-	
filled burrows -1 in. long and 0.75 in. deep;	
grades into underlying unit	35.3
Coal, black, very friable, includes abundant pyrite	
and white calcite on cleat surfaces (Cedar Bluff	
coal)	36.2
40 -	



Underclay- Harden 135.4









Monazite. La rich critical mineral; is a rare phosphate mineral with a chemical composition of $(Ce,La,Nd,Th)(PO_4,SiO_4)$. It usually occurs in small isolated grains, as an accessory mineral

Harmon Close-up Photos Underclay



166.5 ft







Okmulgee County Coal Studies (Cardott, 1989, 1990)

Bed	Rank_Major	Rank_Minor
TEBO	BIT	hvA
TEBO	BIT	hvA
TEBO	BIT	hvA
TULSA	BIT	hvC
DAWSON	BIT	hvB
TULSA	BIT	

Vitrinite Reflectance Limits

TABLE III Oil Reflectance Limits of ASTM Coal Rank Classes

Rank	Maximum reflectance (%)	Maximum reflectance (%) ^a	Random reflectance (%) ⁶
Subbituminous	-0.47		
	C 0.47-0.57		
High volatile bituminous	B 0.57-0.71	<1.03	0.50-1.12
	A 0.71-1.10		
Medium volatile			100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100
bituminous	1.10-1.50	1.03-(1.35-1.40)	1.12-1.51
Low volatile bituminous	1.50-2.05	>(1.35-1.40)	1.51-1.92
Semianthracite	2.05-3.00 (approx.)		1.92-2.50
Anthracite	>3.00 (approx.)		>2.50

^a Procedure of Bethlehem Steel Corporation using "reactive vitrinite" reflectance.
^b From McCartney and Teichmüller (1972, 1974).





National Uranium Resource Evaluation (NURE) Database for Oklahoma

Contains supplemental data for critical minerals analysis

National Geochemical Database—Reformatted Data from the National Uranium Resource (Figure 2) Evaluation (NURE) Hydrogeochemical and Stream Sediment Reconnaissance (HSSR) Program

LA JUNTA	Dodge City	Pratt	WICHITA	JOPLIN	
Dalhart	PERRYTON	Woodward	ENID	TULSA	
	Amarillo	CLINTON	Окіанома Сіту	Fort Smith	
	PLAINVIEW	LAWTON	ARDMORE	McAlest	ER
Quadrangle without NURE HSSR data Oklahoma Quadrangle Index Map		WICHITA Falls	SHERMAN	TEXARKA	NA



https://mrdata.usgs.gov/nure/sediment/map-us.html

nttps://pubs.usgs.gov/ot/1997/otr-97-0492/state/nure_ok.htm



Oklahoma NURE Data with the Highest Values (ppm)



Source: USGS NURE Data.

OGS 2021 Interpretation: Hf, Dy in Cimarron County; Th, Nb, V, Li, Ds, Co, Cu in Wichita Mts.; Co, Hf, Ce, V, Eu, Sm in Ouachita Mtn.; Lu, Au, Hf, Dy, Co, Eu in Eastern Oklahoma, Ozark Uplift/ W. Cherokee Platform areas; Zn, Li, Pb, Co, Ag, Hf in NE Oklahoma, and Co, Cu, NW Anadarko Shelf

Helium Potential in Northwest Oklahoma, Cimarron Co.

Other counties such as Osage County have historically reported high Helium content in wells producing gas

Location of Relatively High Helium Content in Keyes Sandstone







U.S. Bureau of Mines He in wells data in USGS: <u>https://www.sciencebase.gov/catalog/item/609e8fe1d34ea221ce3f39e6</u> He [mol/µL] measurements in Davolt, Purdy 1-B and Purdy 1-F Rock samples By Advance Hydrocarbon Stratigraphy



Copper Prospect. Black Mesa Mountains, Northwest Oklahoma

Extrusive Basalts are interesting for critical minerals!





Copper Prospect. Black Mesa Mountains, Cimarron County



The copper is in the Sheep Pen Sandstone (Late Triassic).

"The copper probably was carried under oxidizing conditions and deposited under reducing conditions", Fay (1983).

Modified from Robert Fay, 1983







Critical minerals in basement mafic and ultramafic rocks: Southwest OK

Let's not forget our hard rock geology!

Critical Minerals in Basement Mafic & Ultramafic Rocks, Southwest OK





Possible Sample location



Basement rocks- Glen Mountain 3609





ilmenite (IIm): iron and titanium oxide (FeTiO₃), that is used as the major source of titanium.





Kennemar 1-7 Core. USGS Geochemical results

Zn

Cu

Depth (ft.)

PPM

Ni

Cr







6,001



Wt %

Ti

V

Overall Conclusions



- The state of Oklahoma has a potential for coal and underclay strata, mafic and ultra mafic rocks, and close to surface formations (NURE) enriched in these critical mineral elements:
 - Mn, Li, Zn Sr, Co, Ni, V, As, Br, Be, Zr, Ga, Ge, Pb, La, Hf, Au, Ag
- Deposits and resources that are not mined now, or with no current mining permits, but still have a potential are:
 - Coal and Underclay beds, Asphalt, Lead, Zinc, Copper, Iron, Manganese, Titanium, Lithium, and Uranium (to name the major minerals/elements/compounds)
- Helium has historically been a component of natural gas deposits in several counties including Cimarron and Osage:
 - The Helium Content in the Keyes Formation In Northwestern Oklahoma still has a potential, and characterization suggest that there are intervals of these units that remain unexplored.

Contribute & Help to Provide Knowledge & Promote the Vast Oklahoma Resources!!!



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