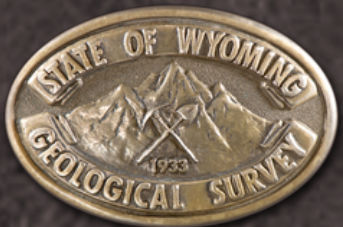




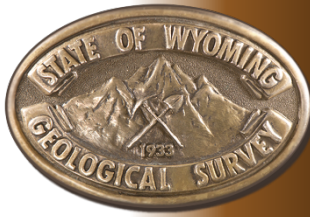
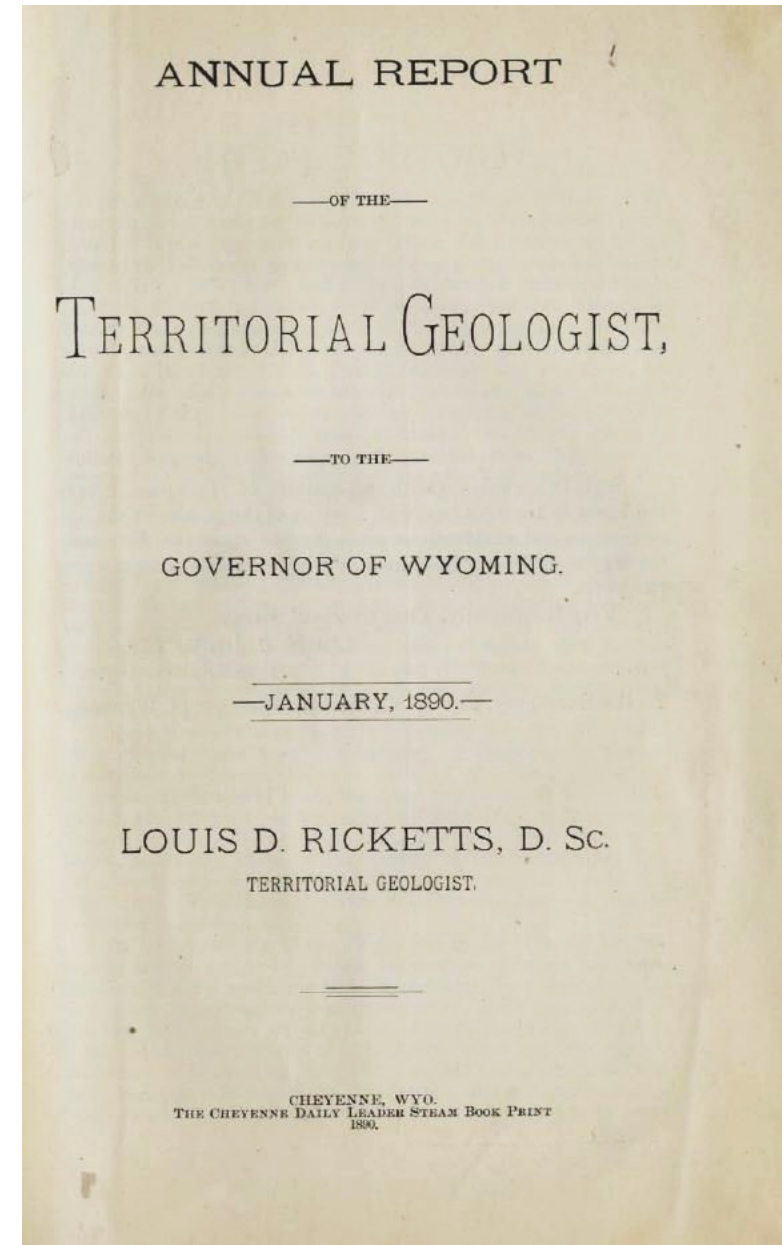
EXPLORATION OPPORTUNITY IN WYOMING

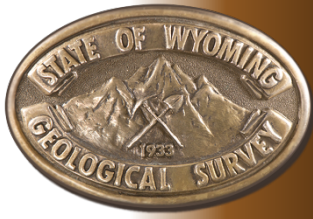
Erin Campbell, State Geologist
Wyoming State Geological Survey



History of the State Geologist and WSGS

- 1877—Territorial Assayer
- 1881—Territorial Geologist
- 1890—State Geologist
- 1901—Office of State Geologist
- 1933—Geological Survey of Wyoming



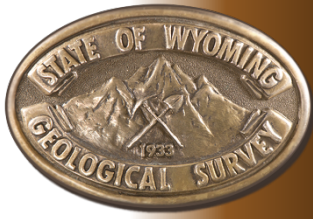


WSGS Statutes 1933 and Today

- Study geology of the state with emphasis on metallic and nonmetallic resources
- Examine topography and physical features
- Seek comprehensive understanding of geology and fossils
- Prepare and publish reports and maps of geology, fossils, mineral resources, topography, and physical features
- Furnish information, advice and services related to geology, mineral resources, and physical features of the state

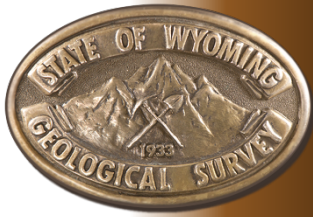


WMA 2021 Convention— Challenges and Changes: What Comes Next?



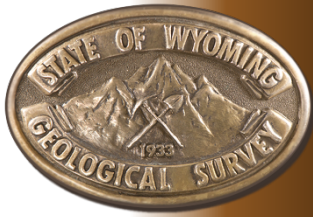
- Change brings opportunity
- Opportunities
 - Federal Funding
 - Supply Chain *aka* Critical Minerals
 - Infrastructure Raw Materials
 - Energy Minerals





Federal Issues/Funding Relevant to Wyoming

- Trump 2018 Executive Order - Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals
- Critical Minerals List – 2018: Federal Register 83 FR 7065
- USGS Earth MRi Critical Minerals Funding
- DOE Critical Minerals Funding
- Trump's 2020 Executive Order - Addressing the Threat to the Domestic Supply Chain from Reliance on Critical Minerals from Foreign Adversaries
- Biden 2021 Executive Order - America's Supply Chains
- Updates to Critical Minerals List - 2021
- Energy and Infrastructure Bills?



Critical Minerals- Federal Register 83 FR 7065

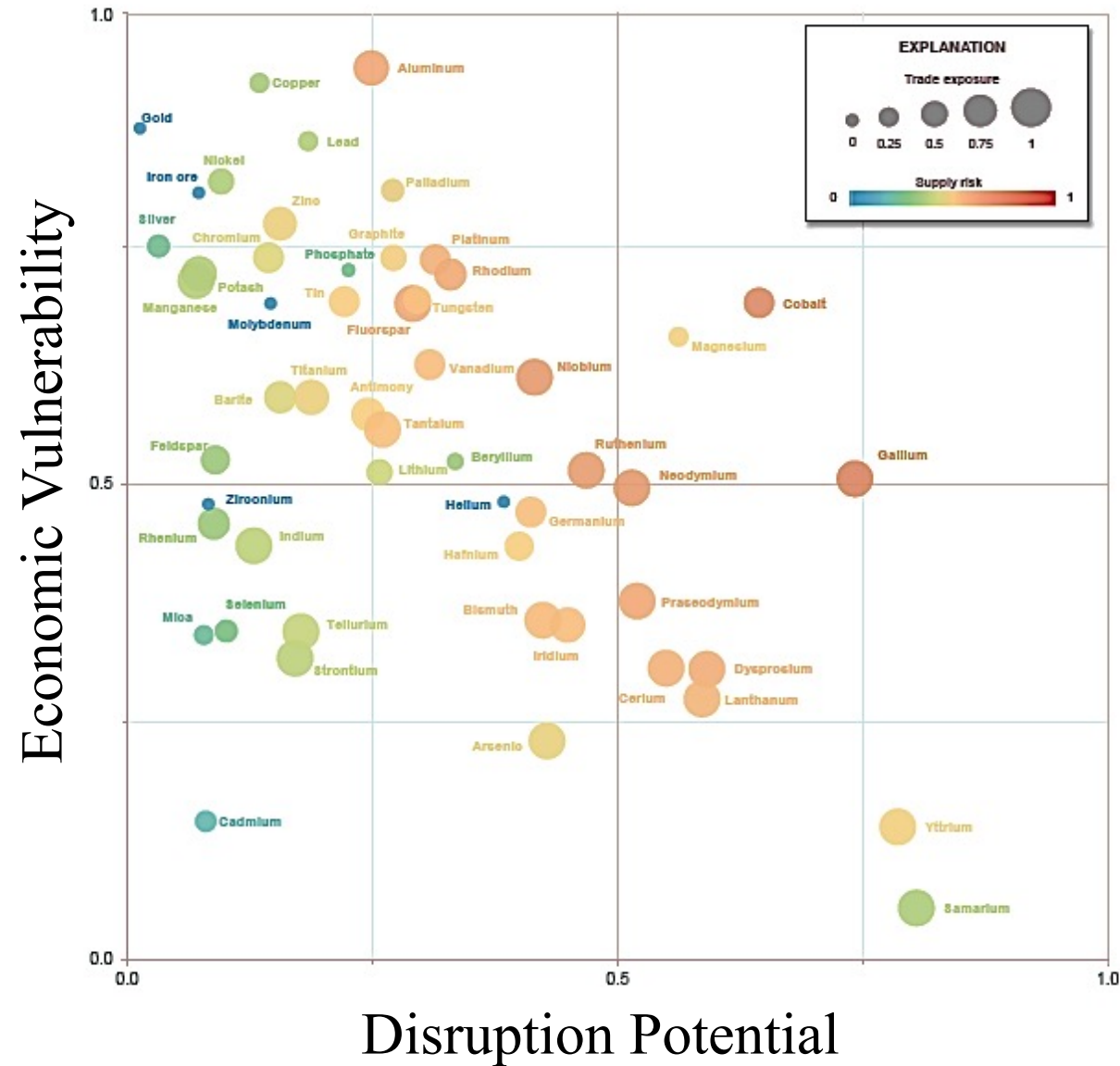
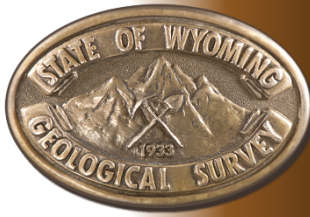
35 Critical Minerals or Material Groups, Federal Register 83 FR 7065:

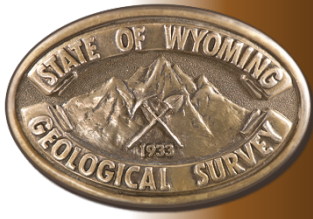
aluminum (bauxite), antimony, arsenic, barite, beryllium, bismuth, cesium, chromium, cobalt, fluorspar, gallium, germanium, graphite (natural), hafnium, helium, indium, lithium, magnesium, manganese, niobium, platinum group metals, potash, the rare earth elements group, rhenium, rubidium, scandium, strontium, tantalum, tellurium, tin, titanium, tungsten, uranium, vanadium, zirconium

17 Rare Earth Elements:

cerium, dysprosium, erbium, europium, gadolinium, holmium, lanthanum, lutetium, neodymium, praseodymium, promethium, samarium, scandium, terbium, thulium, ytterbium, yttrium

USGS Supply Chain Assessment





Critical Minerals—2021 Recommended Update

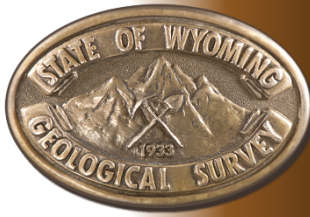
35 Critical Minerals or Material Groups, Federal Register 83 FR 7065:

aluminum (bauxite), antimony, arsenic, barite, beryllium, bismuth, cesium, chromium, cobalt, fluorspar, gallium, germanium, graphite (natural), hafnium, ~~helium~~, indium, lithium, magnesium, manganese, nickel, niobium, platinum group metals, ~~potash~~, the rare earth elements group, ~~rhodium~~, rubidium, scandium, ~~strontium~~, tantalum, tellurium, tin, titanium, tungsten, ~~uranium~~, vanadium, zinc, zirconium

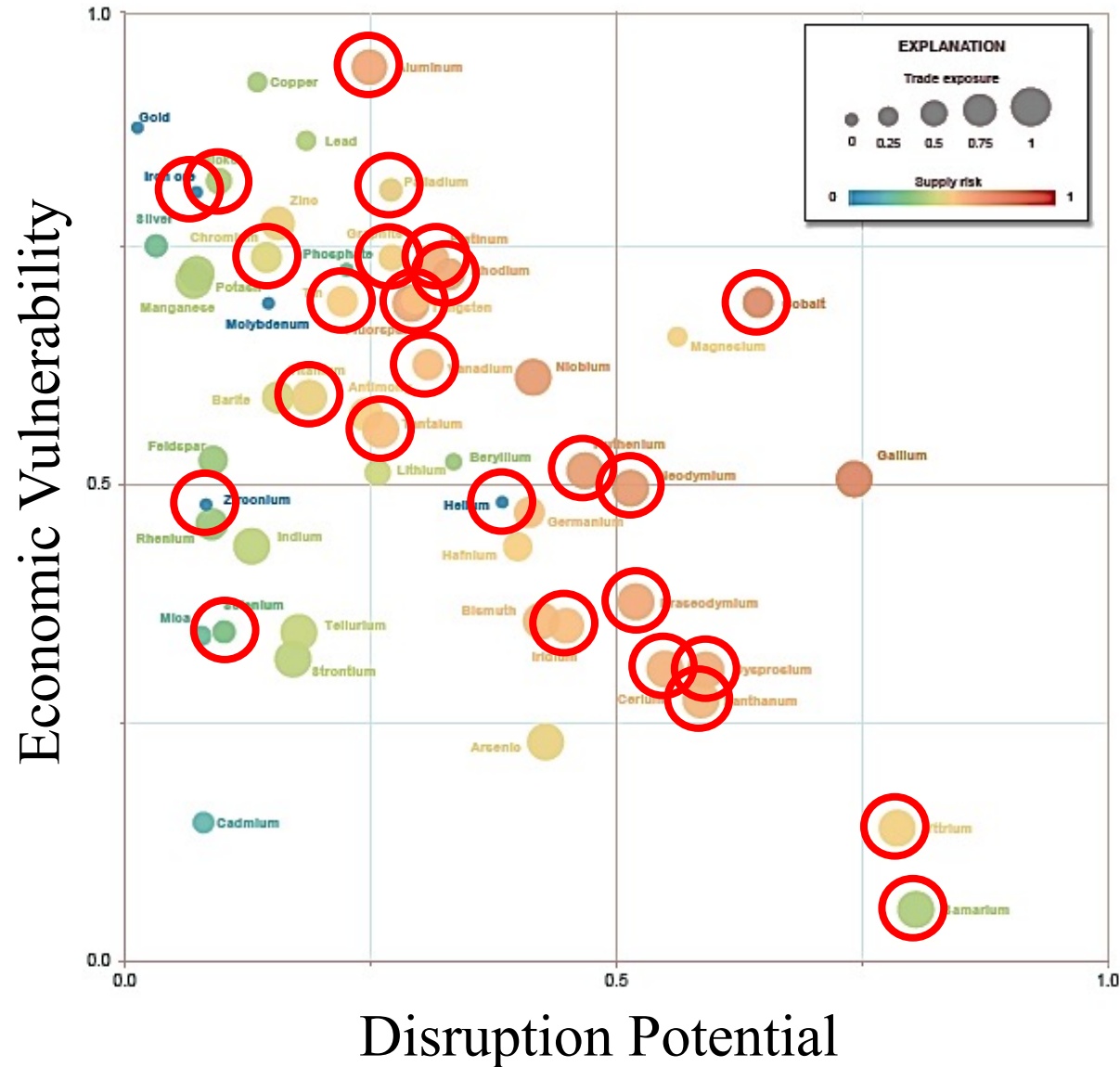
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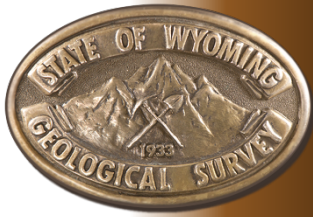
USGS Supply Chain Assessment



○
Wyoming
Potential

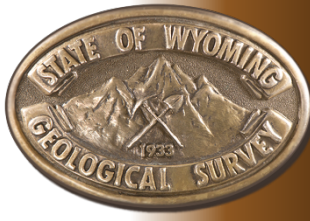


Modified from
Nassar and Fortier, 2021



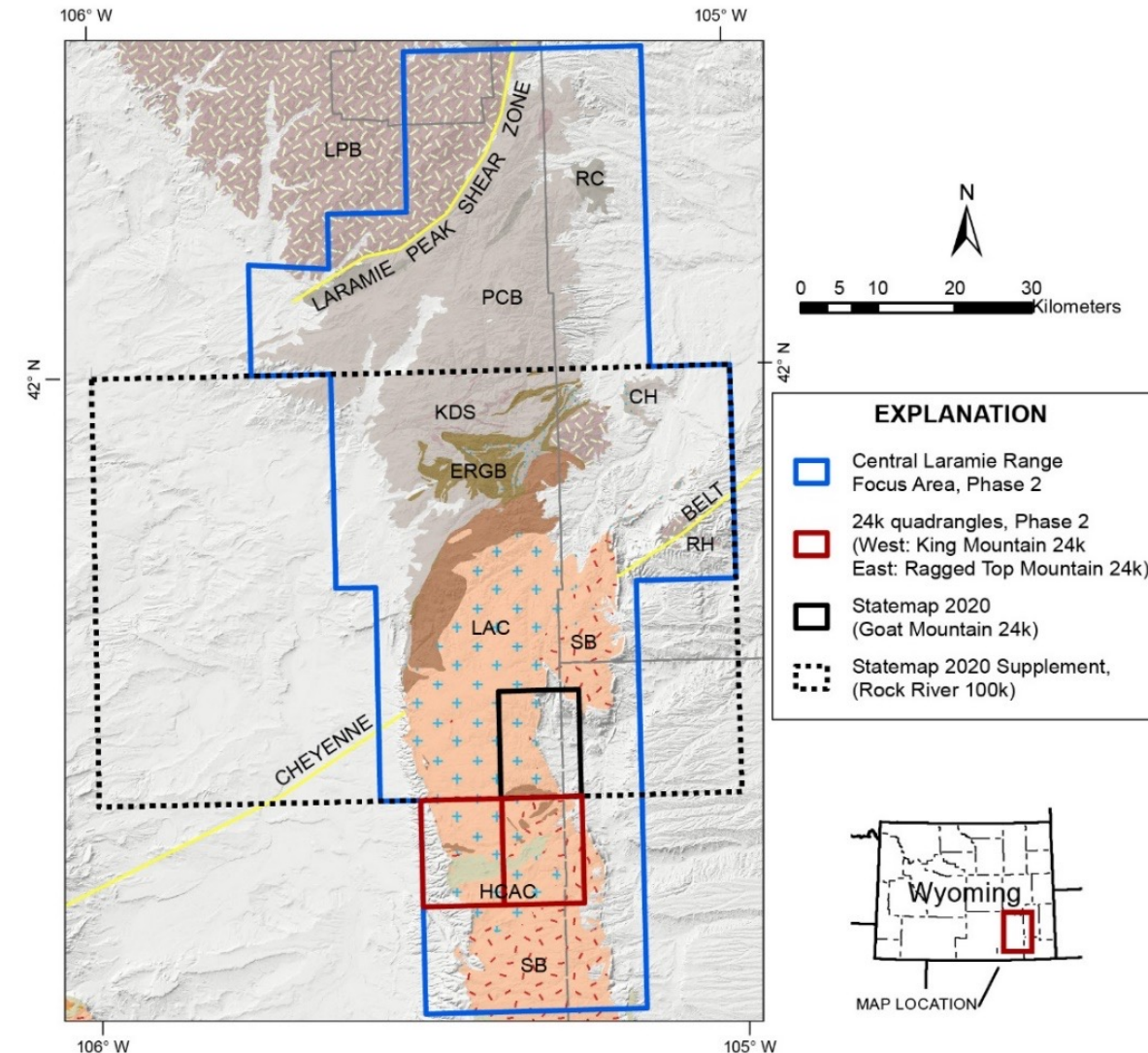
Wyoming Opportunities for Exploration

- Absaroka volcanics supergroup
- Aspen Mountain
- Bear Lodge district and broader Region
- **Central Laramie Range**
- Copper Mountain
- **Cretaceous heavy-mineral placer sandstones (black sandstones)**
- **Bates Hole area fluvial paleoplacers**
- **Kemmerer coals, underclays, and interbeds**
- Leucite Hills volcanics
- **Medicine Bow Mountains**
- Phosphoria Formation
- GGRB and PRB coals, underclays, and interbeds
- Rattlesnake Hills alkali intrusive complex
- Sierra Madre Mountains
- **Statewide paleoplacers**
- **Wyoming metasedimentary and metavolcanic belts (general)**



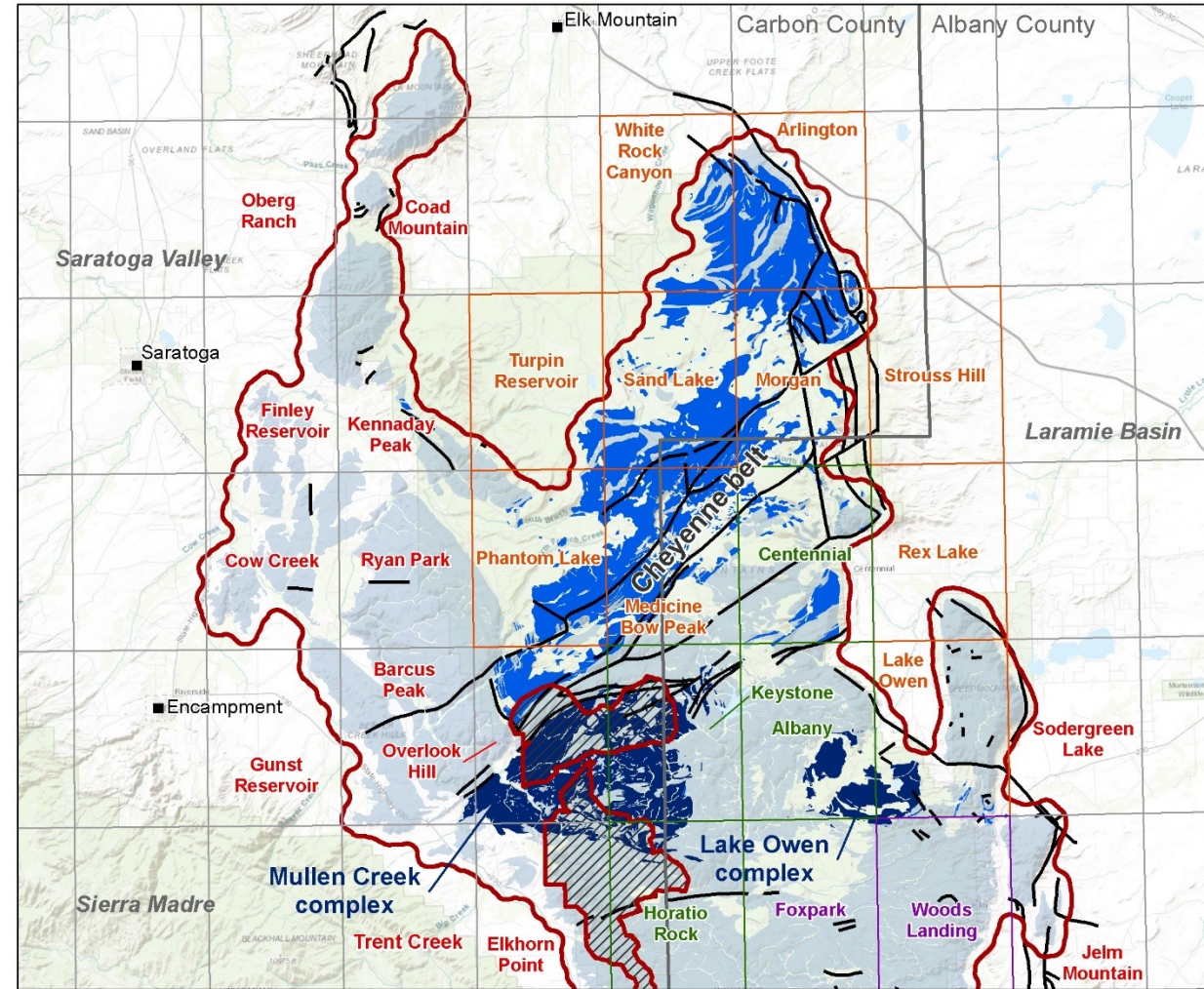
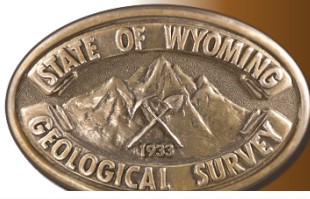
Critical Minerals in the Central Laramie Range

- Mafic magmatic, Fe-Ti-V oxides, associated Cr, Ni:
 - LAC, ERGB, HCAC
- Conduit-type Cu-Ni-PGE and komatiitic Ni, Cr:
 - Kennedy Dike Swarm, ERGB
- Graphite:
 - supracrustal belts
- Unidentified mineral system: Cu, Ag, Au, W, REEs, Mo, Ni:
 - HCAC, Sherman Batholith
- REEs, U, Al:
 - LAC, HCAC, Sherman Batholith



Critical Minerals in the Medicine Bow Mountains

- Mineralization
 - 1.78-1.74 Ga suture between Archean Wyoming Province and Proterozoic Colorado Province
- Critical minerals
 - Documented production: **PGE, REE, U**
 - Elevated: **As, Co, Cr, Mg, Mn, Nb, Sb, Sn, Ta, Ti, V, and W**
 - Co- and by-product commodities: Au, Ag, Cu, Mo, **Ni**, Pb, Th, and **Zn**

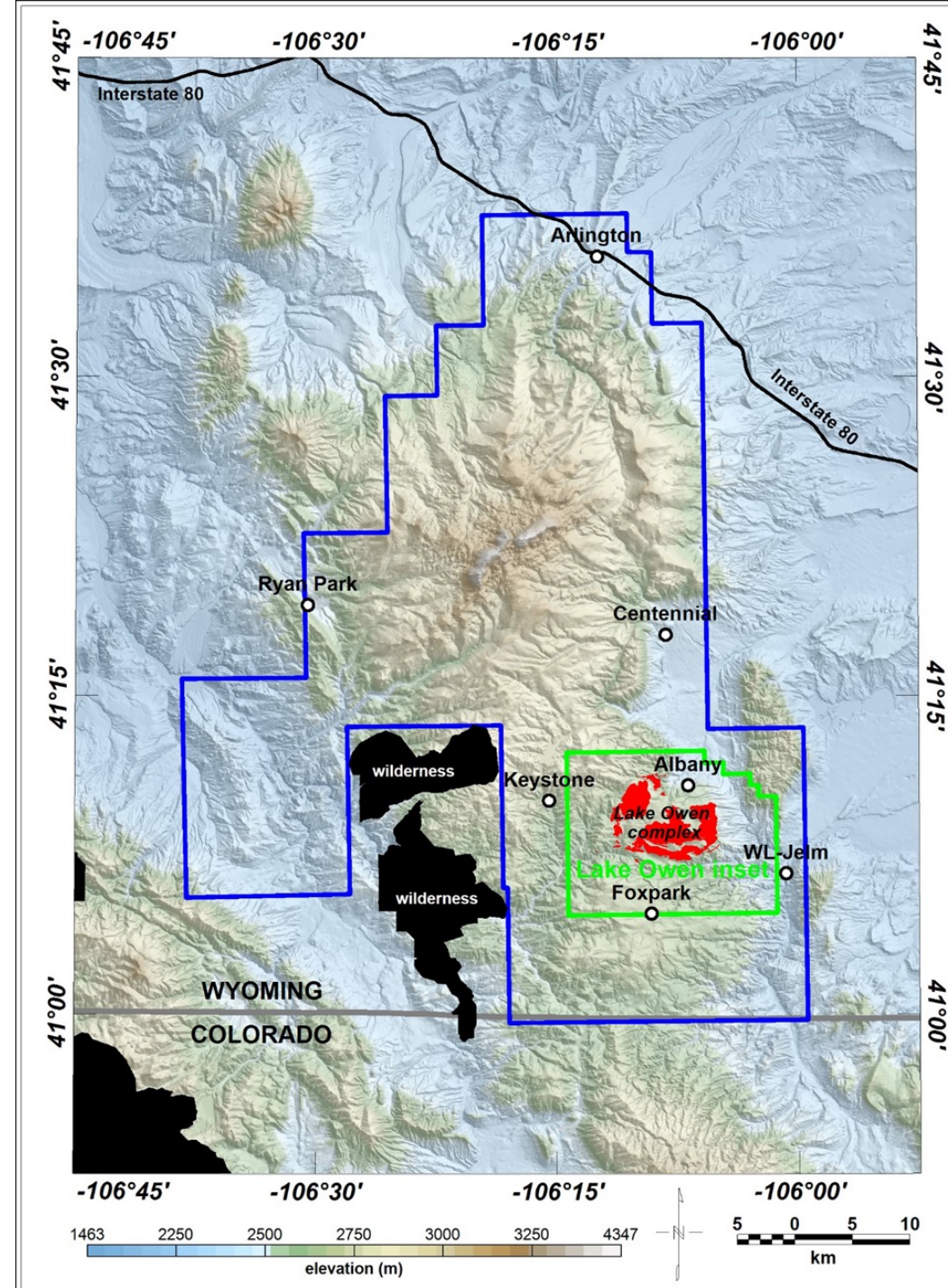


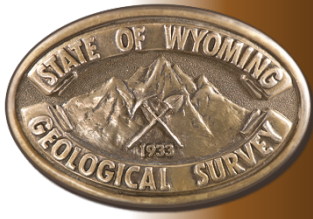
Explanation



Earth MRI: Medicine Bow Mtns. Geophysical Survey

- Summer 2022--WSGS will collaborate with USGS to acquire high-resolution magnetic and radiometric data in the Medicine Bow Mountains.
- Geophysical survey boundary in blue, with Lake Owen inset (tighter flights lines = higher resolution data) in green.
- \$457,800 from USGS; \$50,000 from State of WY per legislation





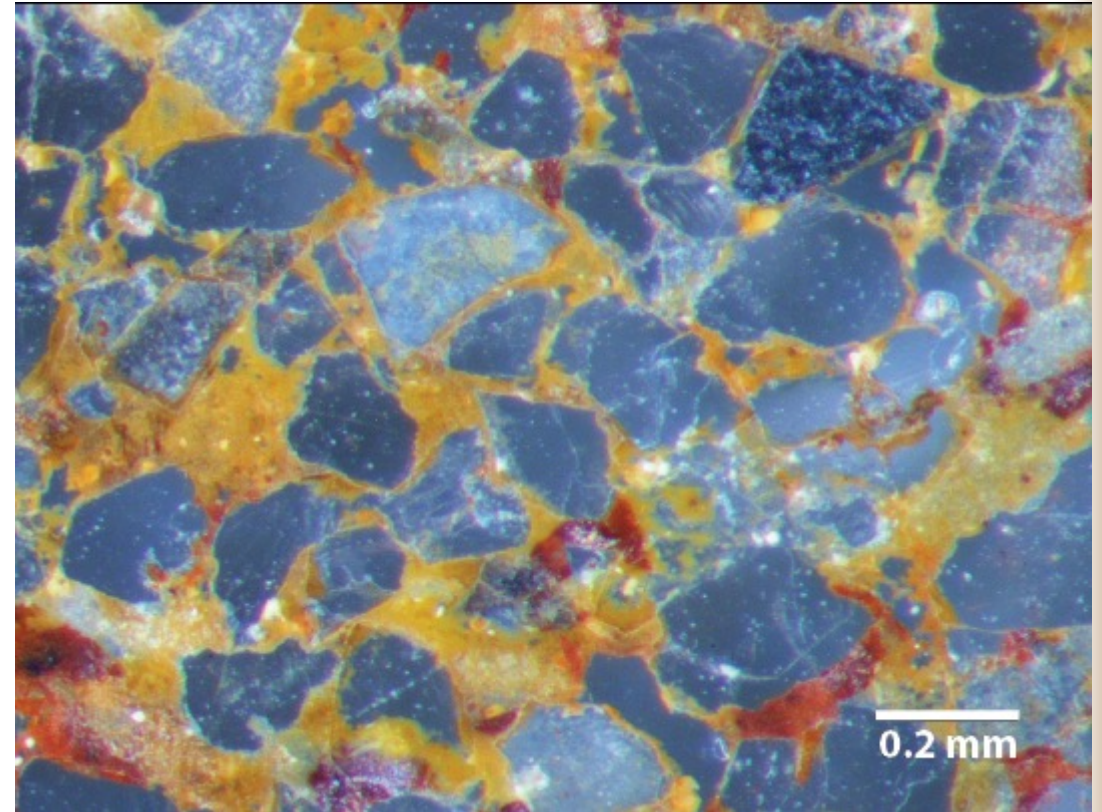
Heavy Mineral Sands/Paleoplacers

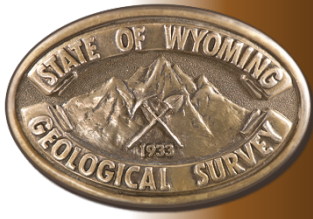
Titanium
Zirconium
Rare Earth Elements
Hafnium
Niobium
Vanadium



Heavy Mineral Sands/Paleoplacers

- Precambrian quartz-pebble conglomerates in the Medicine Bow and Sierra Madre Ranges
- Cambrian Flathead Sandstone in the Bighorn Mountains and other ranges
- Various Mesozoic sandstones throughout the state, primarily Mesaverde Formation/Group
- Fluvial paleoplacers of the Eocene Wind River Formation, Oligocene White River Formation, and associated strata in central Wyoming

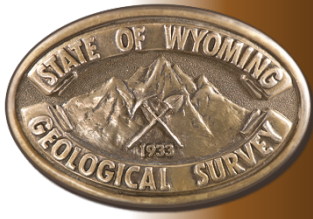




Kemmerer Coal Underclays and Interbeds

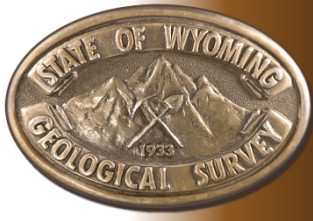
- Trace element data in WY coals are limited
- Data in associated rocks even more rare
- Work is complimentary to UW-SER CORE-CM projects in GGRB and PRB





Kemmerer Coal Study Transects



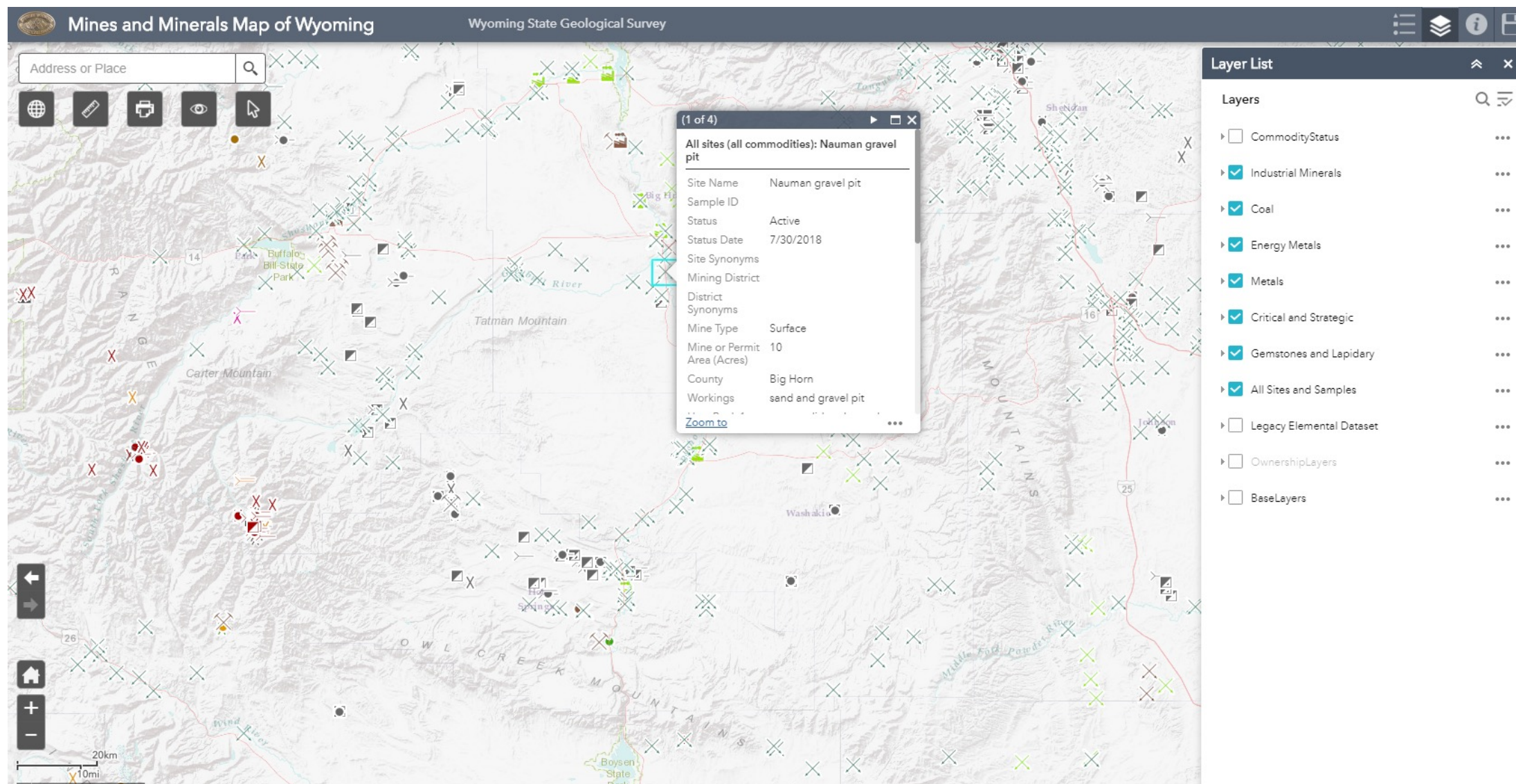


Uranium (U) and Helium (He) Priority Areas

- Gas Hills (U)
- Great Divide Basin (U)
- Hauber (U)
- Maybell - Poison Basin (U)
- Powder River Basin (U)
- Shirley Basin (U)
- Moxa Arch (He)



WSGS Mines and Minerals Map





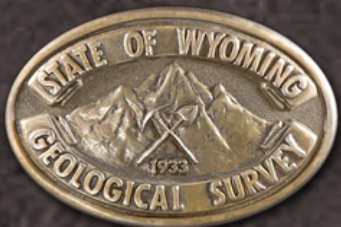
If it didn't grow, it was mined.

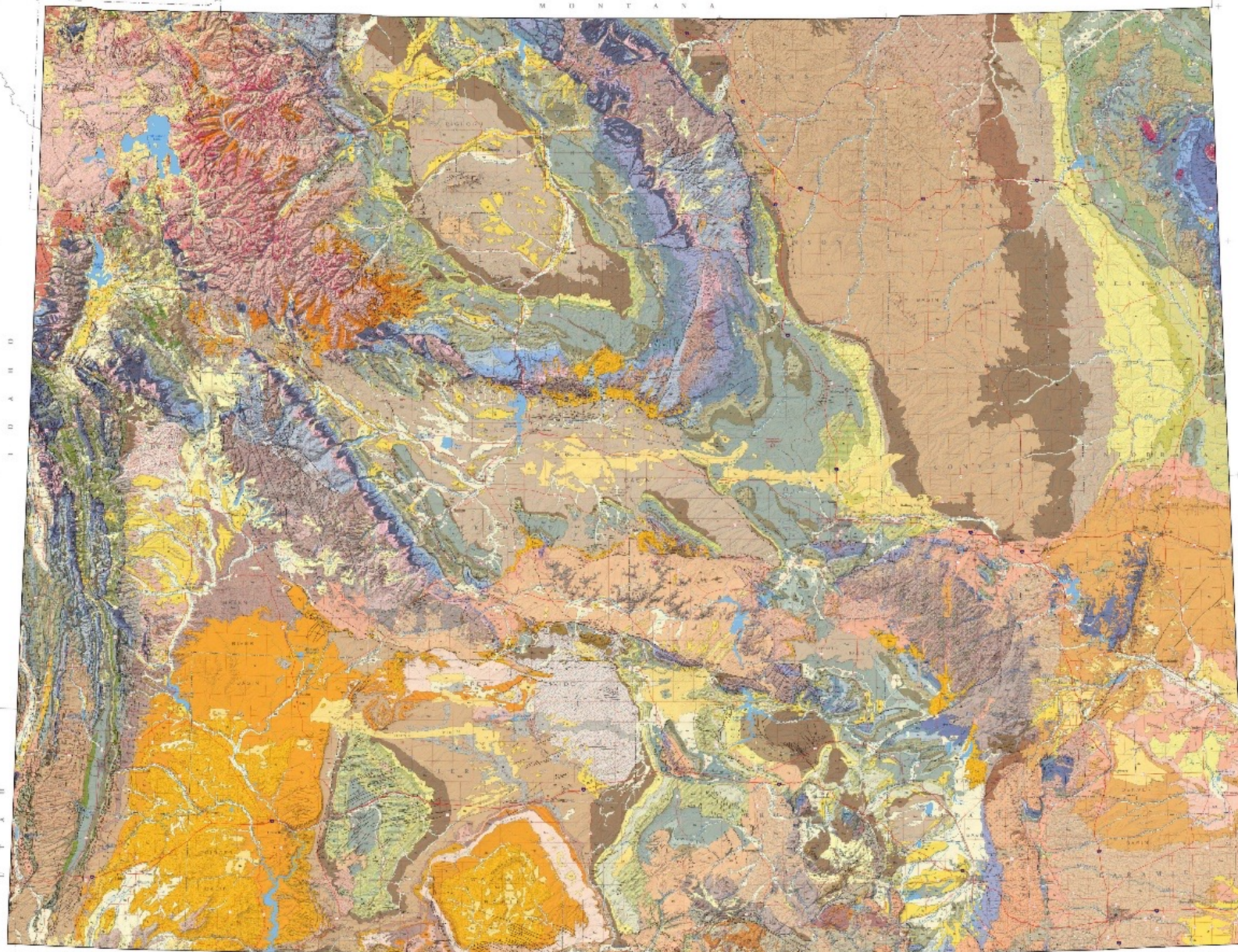
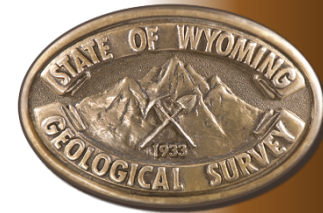
ERIN.CAMPBELL@WYO.GOV

307-703-0762 CELL

WSGS-INFO@WYO.GOV

307-766-2286 OFFICE





GEOLOGIC MAP OF WYOMING

Map by
J. B. Love and Ann Cox Christiansen
U.S. Geological Survey, 1962
Wyoming State Geological Survey, 2011



Geologic Map of Wyoming
Scale 1:625,000
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