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science for a changing world
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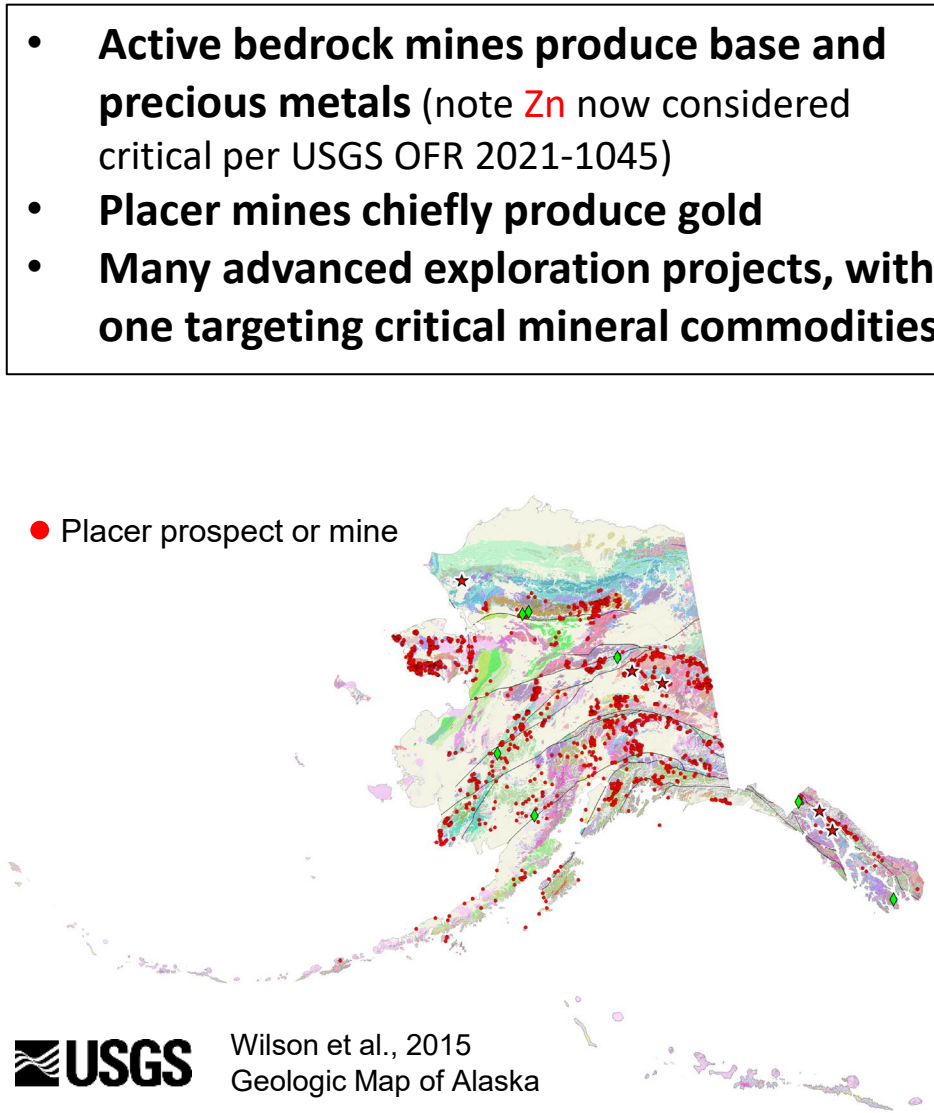
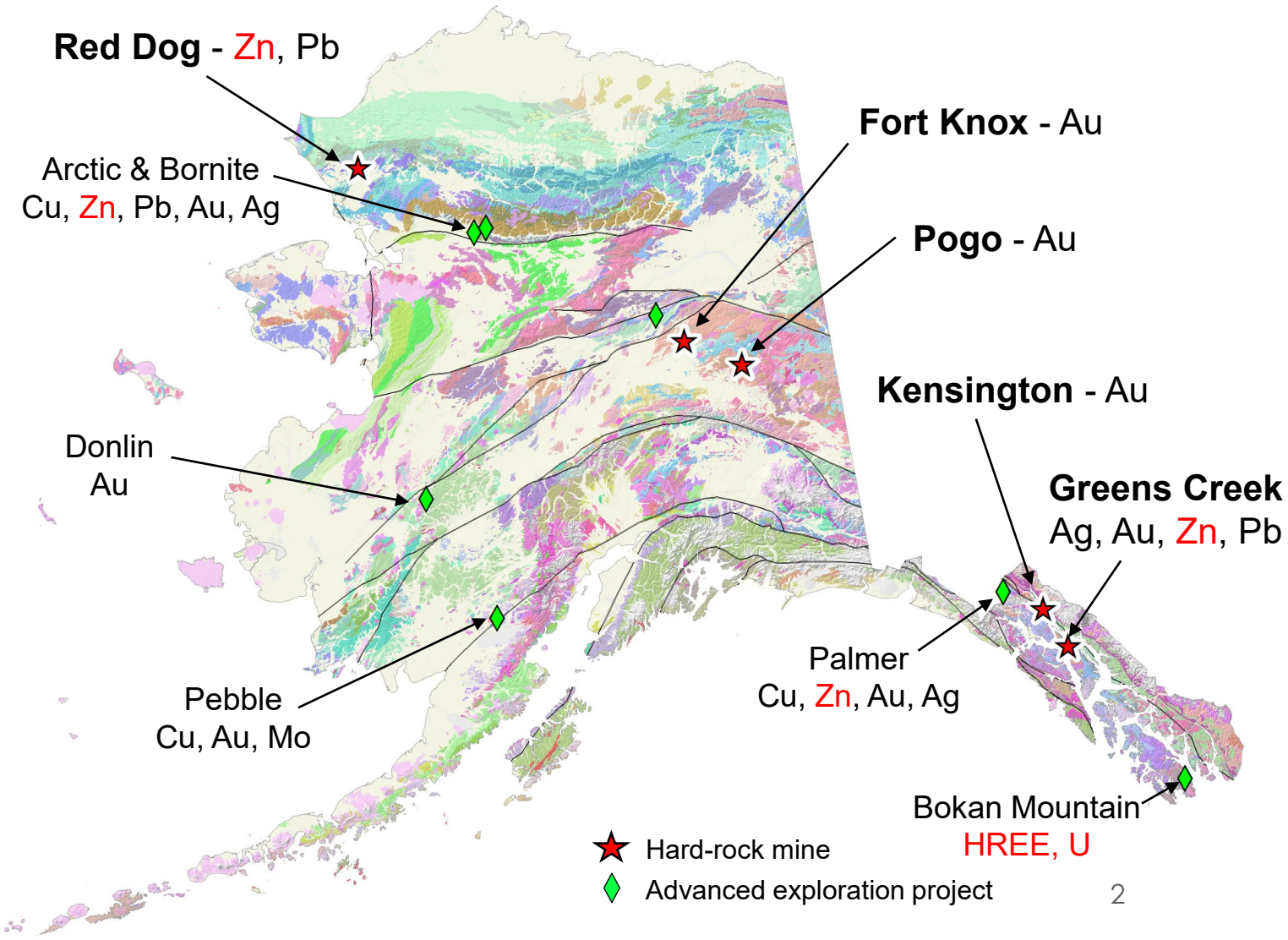
Alaska Critical Mineral Resources
JAMEY JONES, USGS ALASKA SCIENCE CENTER

Alaska hosts world class mines and undeveloped mineral deposits

- **Active bedrock mines produce base and precious metals** (note Zn now considered critical per USGS OFR 2021-1045)
- **Placer mines chiefly produce gold**
- **Many advanced exploration projects, with one targeting critical mineral commodities**



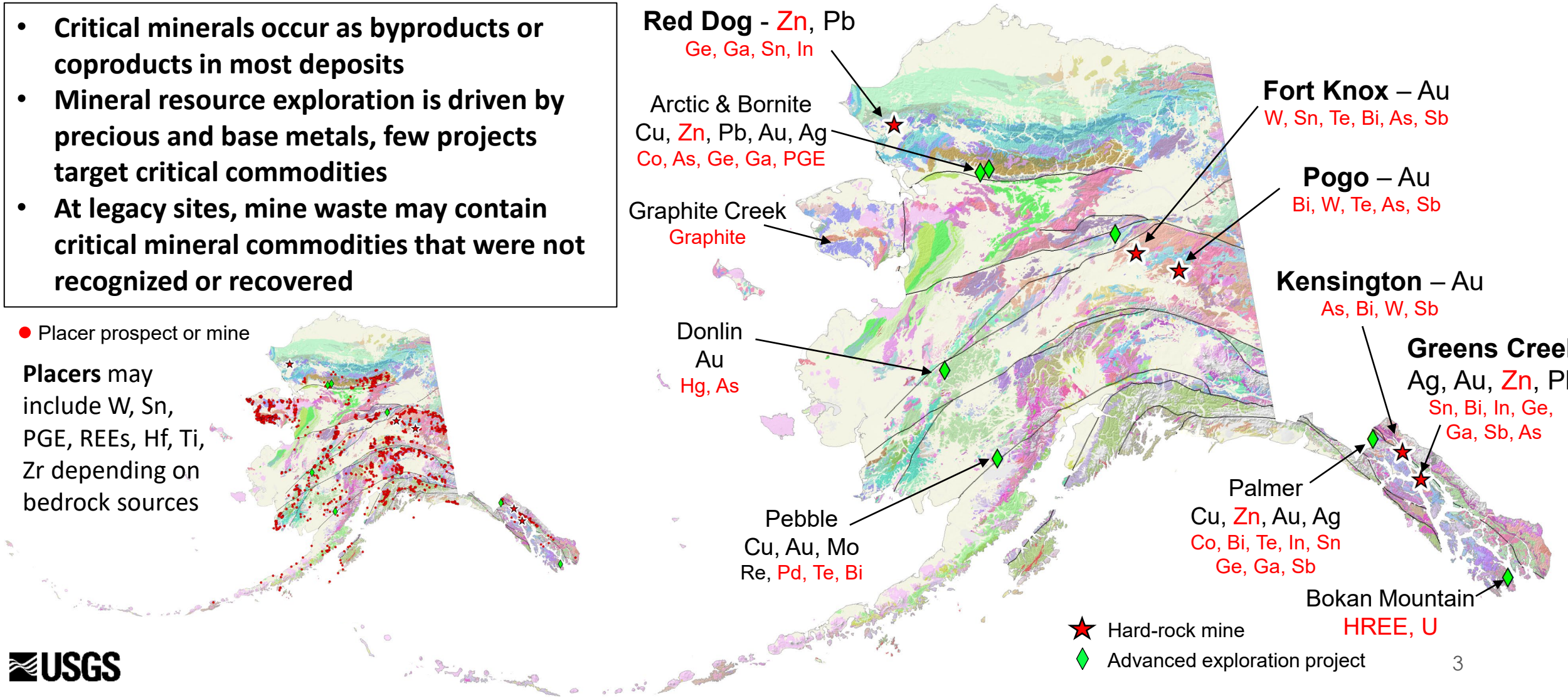


USGS

Wilson et al., 2015
Geologic Map of Alaska

Alaska has known or suspected critical mineral resource potential

- **Critical minerals occur as byproducts or coproducts in most deposits**
- **Mineral resource exploration is driven by precious and base metals, few projects target critical commodities**
- **At legacy sites, mine waste may contain critical mineral commodities that were not recognized or recovered**



USGS

Alaska datasets are extensive but also limited for critical commodities

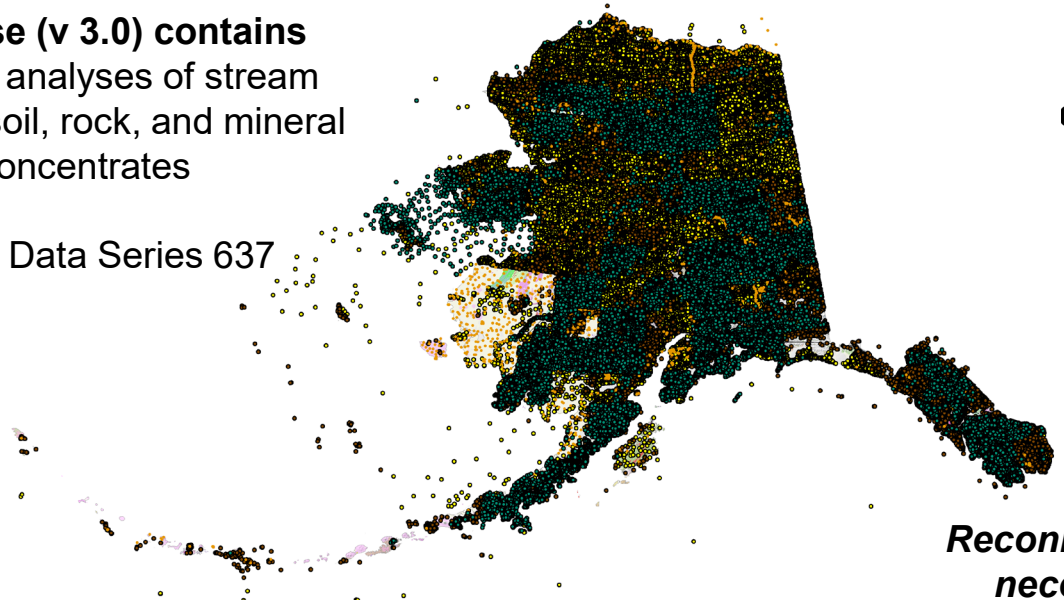
- **Alaska is highly prospective for hosting additional undiscovered deposits that include many critical mineral commodities**
- **USGS uses data-driven approach to mapping mineral resource prospectivity**
- **Mineral resource assessments are hindered by issues with data coverage and vintage**

Digital geologic map of Alaska
Complete and seamless at 1:250,000 scale

USGS SIM 3340

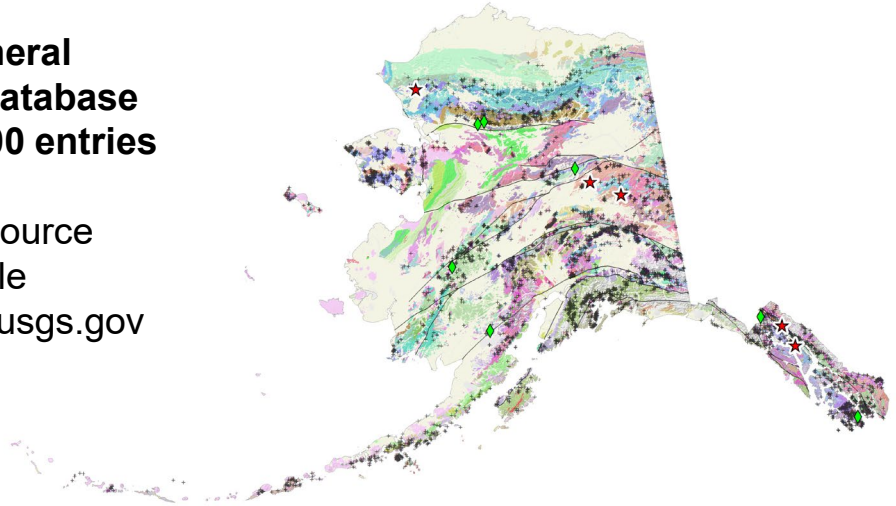
USGS Alaska Geochemical Database (v 3.0) contains
>396,000 analyses of stream sediment, soil, rock, and mineral concentrates

USGS Data Series 637



USGS Mineral occurrence database contains >7,000 entries

Alaska Resource Data File
https://ardf.wr.usgs.gov



Reconnaissance geological and geochemical data do not necessarily target elements now considered critical

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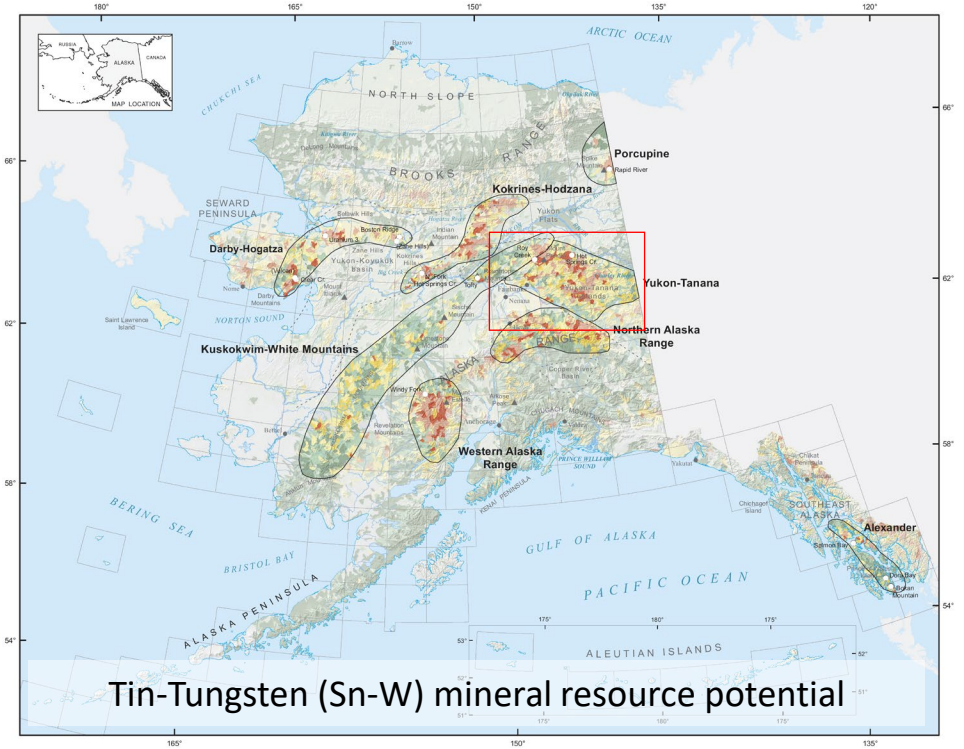
USGS conducts quantitative critical mineral resource assessments in Alaska

Results are promising for new discoveries but hindered by lack of modern mapping and data



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Tungsten skarn potential of the Yukon-Tanana Upland, eastern Alaska, USA—A mineral resource assessment

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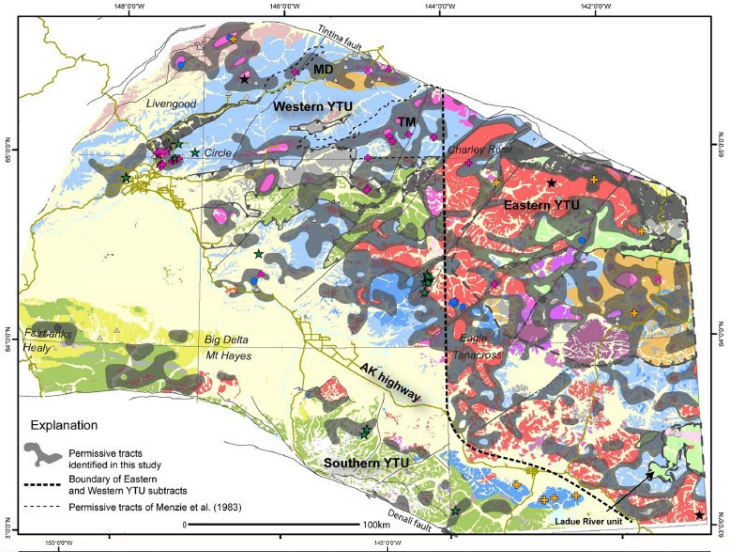
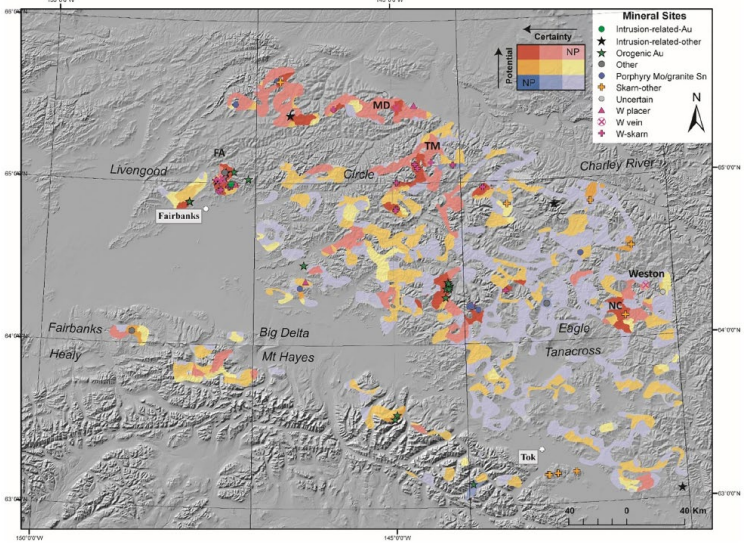
ABSTRACT

Tungsten (W) is used in a variety of industrial and technological applications and has been identified as a critical mineral for the United States, India, the European Union, and other countries. These countries rely on W imports mostly from China, which leaves them vulnerable to supply disruption. Consequently, the U.S. government has a current initiative to understand domestic resource potential. The eastern Alaska portion of the Yukon-Tanana Upland (YTU), is prospective for W skarn deposits, the major source of global W supply. The regional geology consists of juxtaposed Paleozoic lithotectonic packages that were reaccreted to North America in the Mesozoic. Multiple subsequent episodes of arc-related magmatism intruded the lithotectonic packages, accompanied by W skarn formation mostly associated with 100–90 Ma intrusions; major W skarn deposits in Canada are part of the same metallogenic event (e.g., Mactung, Cantung). In this paper, we present an assessment for undiscovered W skarn resources for parts of the lesser-explored western (Alaskan) portion of the YTU.

We used GIS proximity analysis to map the intersection of pluton and carbonate-bearing rocks to define three permissive tracts for W skarn deposits. The permissive tracts were qualitatively assessed by mineral potential mapping using region-wide sediment geochemistry and mineral concentrate datasets. This analysis showed that much of the western YTU has high potential for undiscovered W skarn deposits, whereas the eastern and southern YTU had only isolated areas of medium to high potential. Historical production and the quality of the geochemistry data of the western YTU tract (ca. 9200 km^2) permitted a quantitative assessment of undiscovered W resources. Probabilistic estimates by a panel of 20 experts predicted a 70% chance of one to three undiscovered W skarn deposits in the western YTU tract. The rationale for favorability employed by the expert panel included favorable lithology, previous production, clustering of previously mined deposits, W placers in the area, lack of recent exploration, pan concentrates containing W minerals, and W geochemical anomalies. Estimates were combined with a global grade and tonnage model for W skarns in a Monte Carlo simulation and provided a median estimate of undiscovered resources of 94 kt WO_3. If the undiscovered W skarn deposits are located close to infrastructure (e.g., near Fairbanks, or close to roads and/or power grid), application of an economic filter indicates that the median total economically recoverable WO_3 is 63 kt with a net present value (NPV) of $330 million USD (2008 dollars). Whereas if deposits are far from infrastructure, median recoverable WO_3 is only 30 kt and the NPV is $44 million.

Our models for contained WO_3 resources and NPV estimates for the western YTU tract are considerably lower than the known resources in skarns in adjacent areas in Canada. Estimates for the western YTU are also lower than preliminary estimates for undiscovered W skarn deposits in areas of the western conterminous United States. We speculate that lower permeability and continuity of favorable carbonate rock horizons in the relatively higher-grade metamorphic country rocks in the Alaska portion of the YTU may explain some of the differences in prospectivity. More detailed geologic mapping, modern geochemistry, and geophysical surveys are needed to refine the resource potential of the whole YTU. Regardless, quantitative mineral resource assessment provides a useful tool for making first-order regional estimates of undiscovered resources, identifying target areas for new data acquisition, and guiding research on the fundamental controls of district-scale metallogenic endowments.



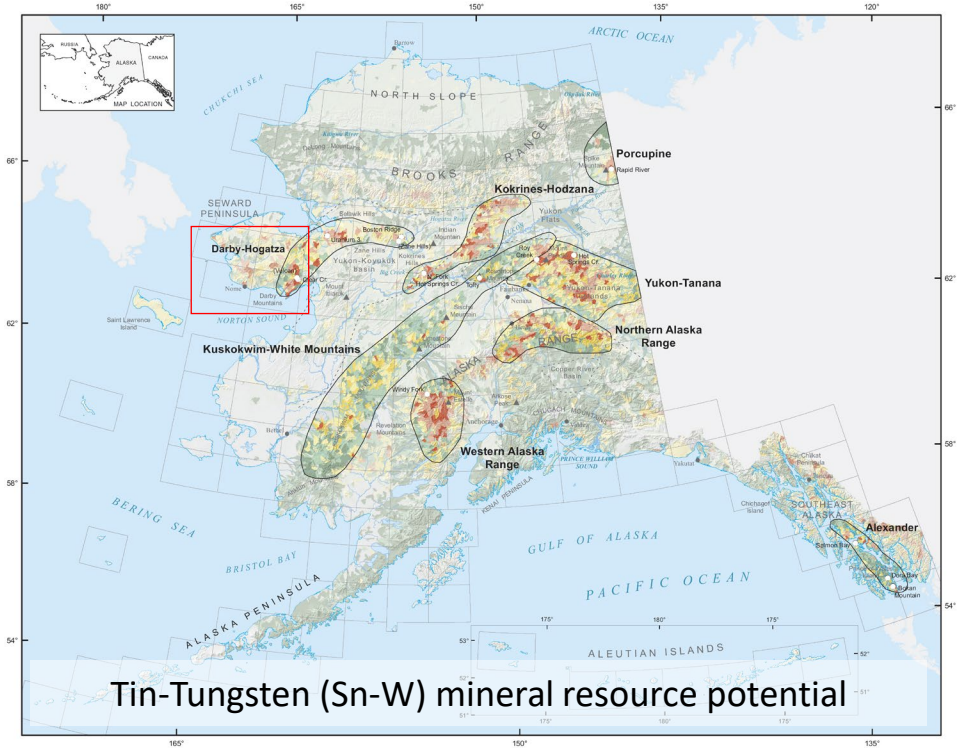


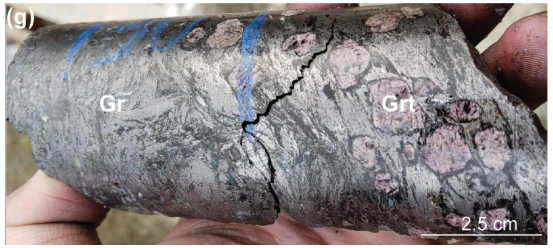
Alaska has undiscovered critical mineral potential, but modern systematic mapping and geophysical data are needed

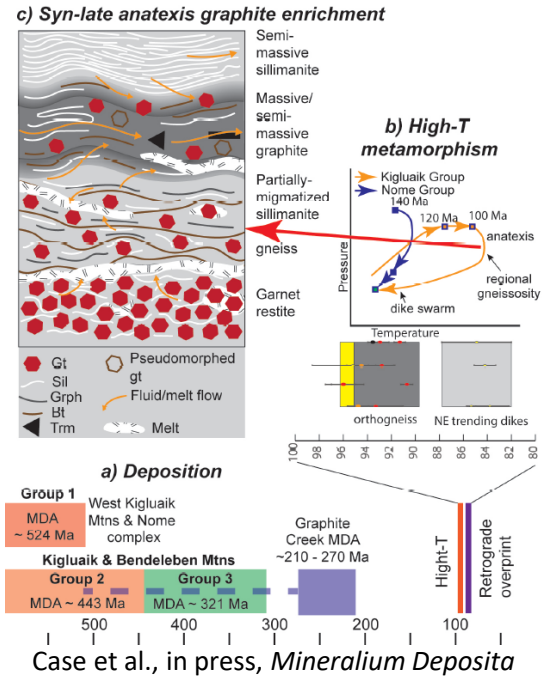
USGS

USGS conducts quantitative critical mineral resource assessments in Alaska

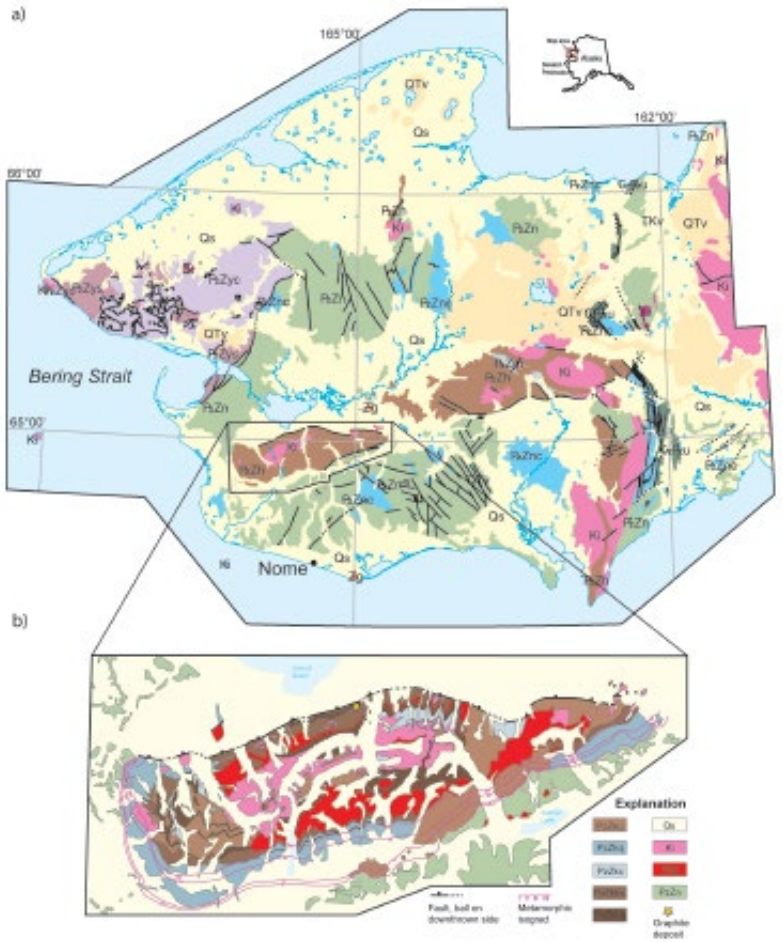
Graphite resources are the focus the next quantitative assessment, and Alaska has the largest known flake graphite resource in the world







Case et al., in press, *Mineralium Deposita*

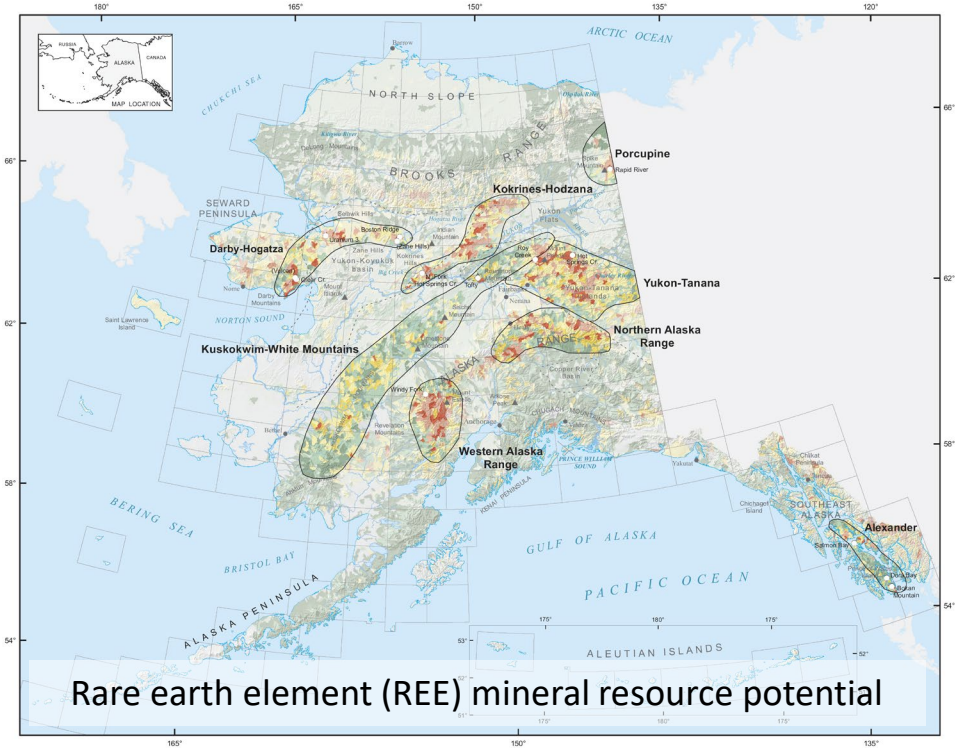


Alaska has known graphite resources, and additional resource potential is being assessed

USGS

USGS maps critical mineral prospectivity across Alaska

Mineral resource prospectivity mapping leverages existing databases and covers entire state with watershed-based mapping and classification



Rare earth element (REE) mineral resource potential

USGS science for a changing world

Geospatial Analysis Identifies Critical Mineral-Resource Potential in Alaska

- This study devised a new geographic information system (GIS)-based method to identify areas that have mineral-resource potential.
- The method identified areas in Alaska that have the potential to contain concentrations of critical minerals.
- Our method provides a valuable template for evaluations of mineral-resource potential for large, under-explored regions.
- These results will inform land management decisions, and will also help to guide future mineral exploration activities and scientific investigations.

Alaska consists of more than 663,000 square miles (1,717,000 square kilometers) of land—more than a sixth of the total area of the United States—and large tracts of it have not been systematically studied or sampled for mineral-resource potential. Many regions of the State are known to have significant mineral-resource potential, and there are currently six operating mines in the State along with numerous active mineral exploration projects. The U.S. Geological Survey (USGS) and the Alaska Division of Geological & Geophysical Surveys (ADGGS) have developed a new geospatial tool that integrates and analyzes publicly available databases of geologic information and estimates the mineral-resource potential for critical minerals, which was recently used to evaluate Alaska. The results of the analyses highlight areas that have known mineral deposits and also reveal areas that were not previously considered to be prospective for these deposit types. These results will inform land management decisions by Federal, State, and private landholders, and will also help guide future exploration activities and scientific investigations in Alaska. For a detailed discussion of the datasets used in the analyses, explanations of the analytical process, and interpreted results of the study, see http://dx.doi.org/10.3133/ofr20161191.

What are Critical Minerals?

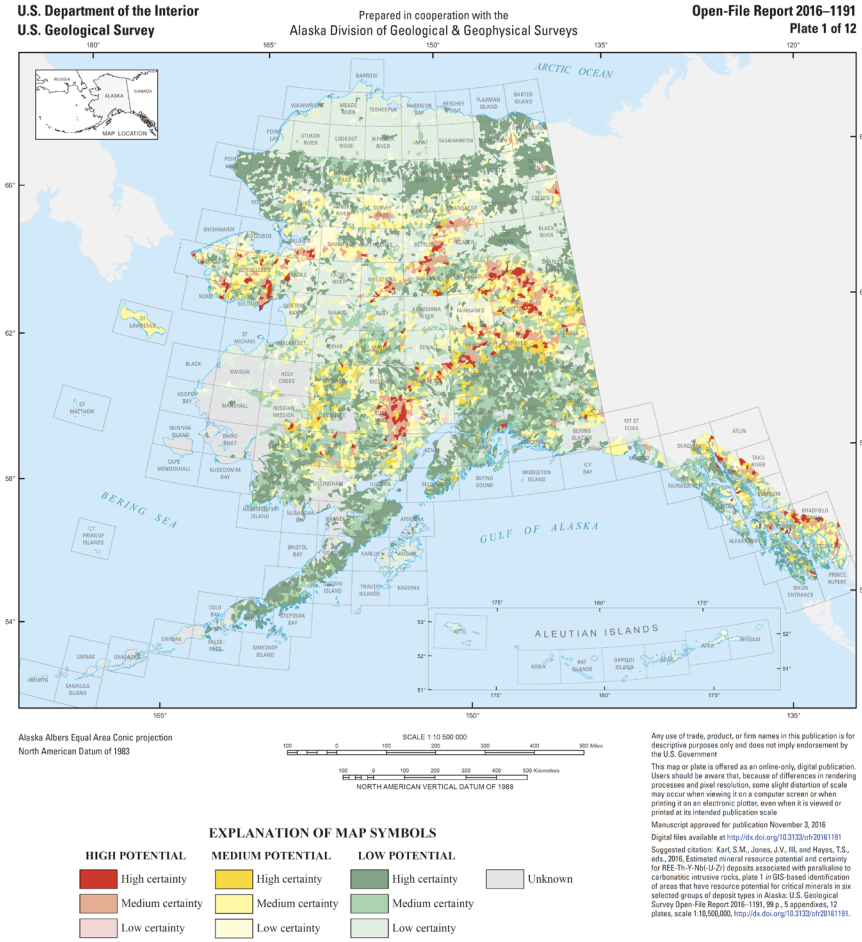
Critical minerals, sometimes referred to as strategic and critical minerals, are those for which the United States imports more than half of its total supply, and which are largely obtained from nations that cannot be considered reliable trading partners. They are integral to every part of our modern life.

The commodities and mineral deposit groups selected for this study (see table and maps) were identified in a collaborative process that included Federal, State, and academic scientists, as well as State and Federal administrators who have resource-management responsibilities. The deposit groups were selected because they are known or suspected to exist in Alaska and may contain one or more critical minerals.

Examples of Uses of Critical Minerals

- **Rare earth elements, yttrium:** recyclable batteries, oil refining, power generators, jet engines, semiconductors, computers, smartphones, night-vision goggles, and permanent magnets such as those used in magnetic resonance imaging (MRI) machines
- **Platinum group elements:** catalytic converters, toxic emissions scrubbers, electronics, dental applications
- **Germanium, gallium:** solar cells, infrared optics, light-emitting diodes (LEDs), semiconductors, smartphones
- **Uranium, thorium:** nuclear power, radio isotopes for medical diagnosis and research
- **Tin, indium:** architectural glass, flat screens, solar cells, semiconductors, smartphones, lead-free solders, tin-niobium alloys for superconductors
- **Tungsten, titanium:** high-strength metal alloys, and for tungsten, thermocouples, thermometers, light bulb filaments
- **Gold:** radiation protection films for spacecraft, dental applications, and jewelry
- **Molybdenum, chrome, cobalt, nickel, tantalum, vanadium:** superalloys for resistance to wear and corrosion in pipelines, seawater desalination plants, turbines, missiles, and spacecraft

Scientific instrument on the Meteorina pluton, Ruby batholith, Alaska. Photograph by Susan Karl, USGS.



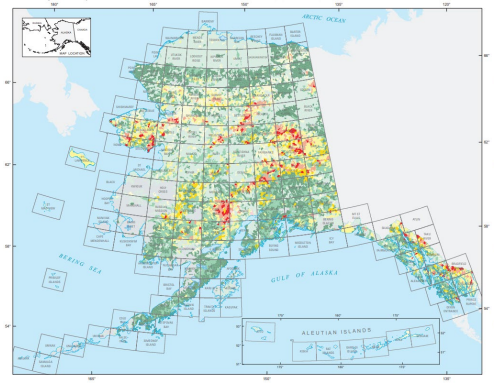
Estimated Mineral Resource Potential and Certainty for REE-Th-Y-Nb(-U-Zr) Deposits Associated with Peralkaline to Carbonatitic Intrusive Rocks

Prospectivity mapping provides a synoptic, data-driven view and aids in land-use planning

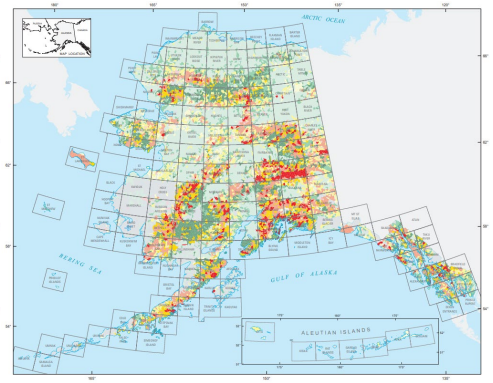
USGS

USGS maps critical mineral prospectivity across Alaska

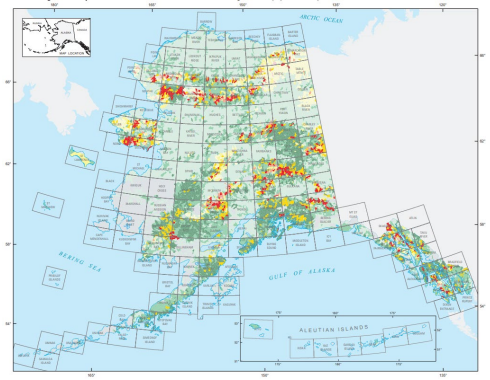
Mineral resource prospectivity maps are complete for most mineral systems, and models will be re-run and maps updated as new data emerge



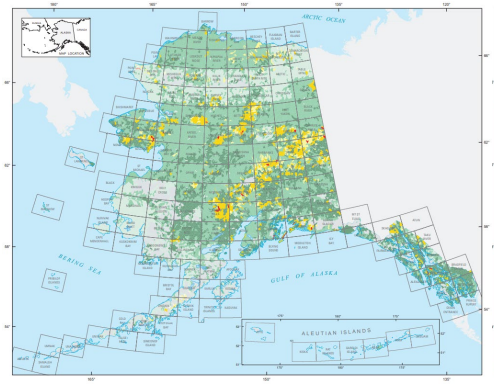
REE-Th-Y-Nb(-U-Zr) deposits



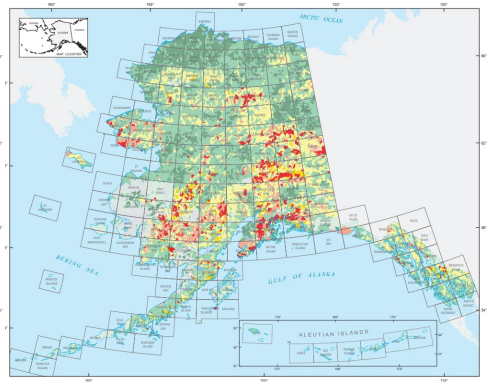
PGE(-Co-cr-Cu-Ni-Ti-V) deposits



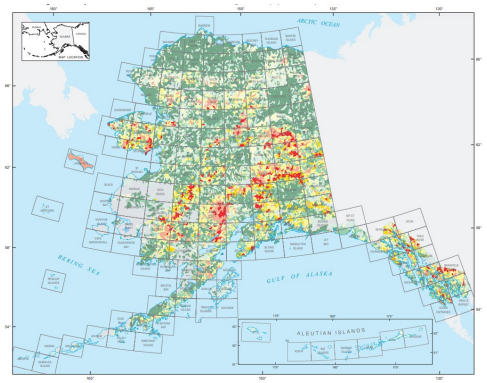
Carbonate-hosted Cu(-Co-Ag-Ge-Ga)

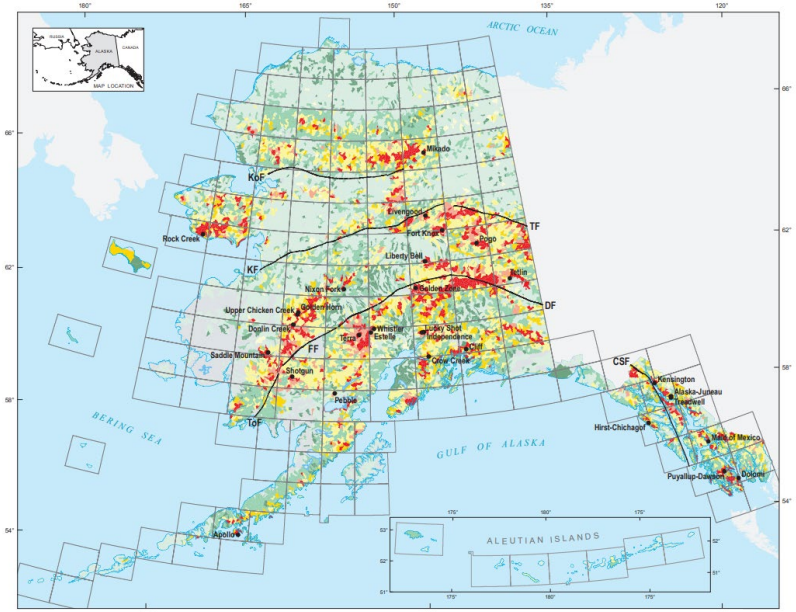


Sandstone-hosted U(-V-W)



Placer and paleoplacer Au





Lode gold potential, six deposit types
USGS OFR 2021-1041

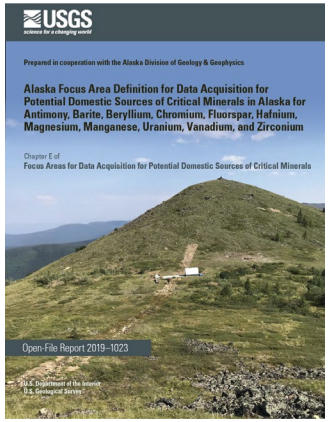
All data and codes are made publicly available with each report

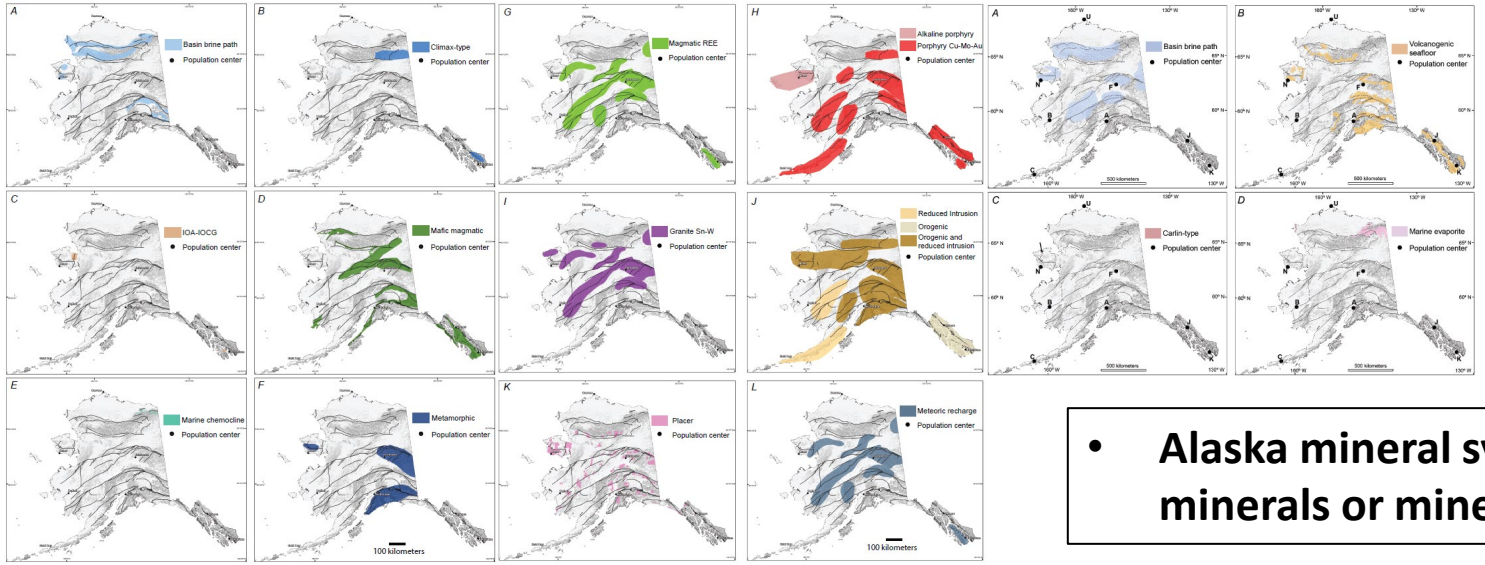
USGS

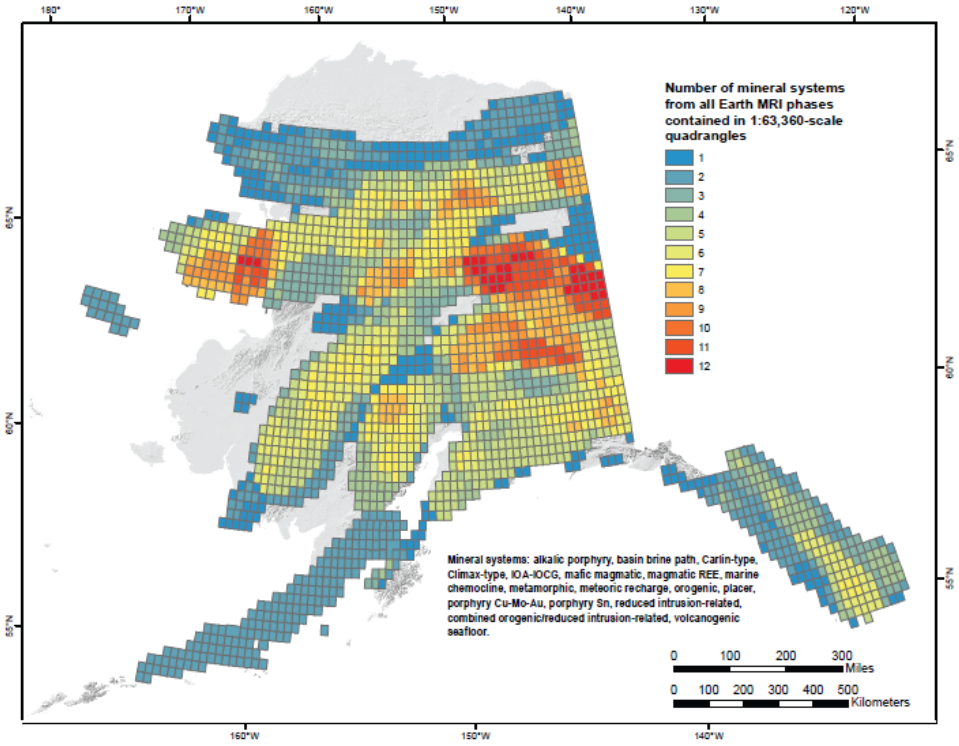
Prospectivity mapping identifies data gaps and research opportunities; helps prioritize new data collection

Filling in the critical mineral data gaps in Alaska – Earth MRI

- **USGS mapped 17 different mineral systems across Alaska that have critical mineral associations**
- **More than 100 focus area were defined for new data collection**
- **Areas with overlapping mineral systems or major prospects were prioritized for new geologic, geochemical, and geophysical data collection**





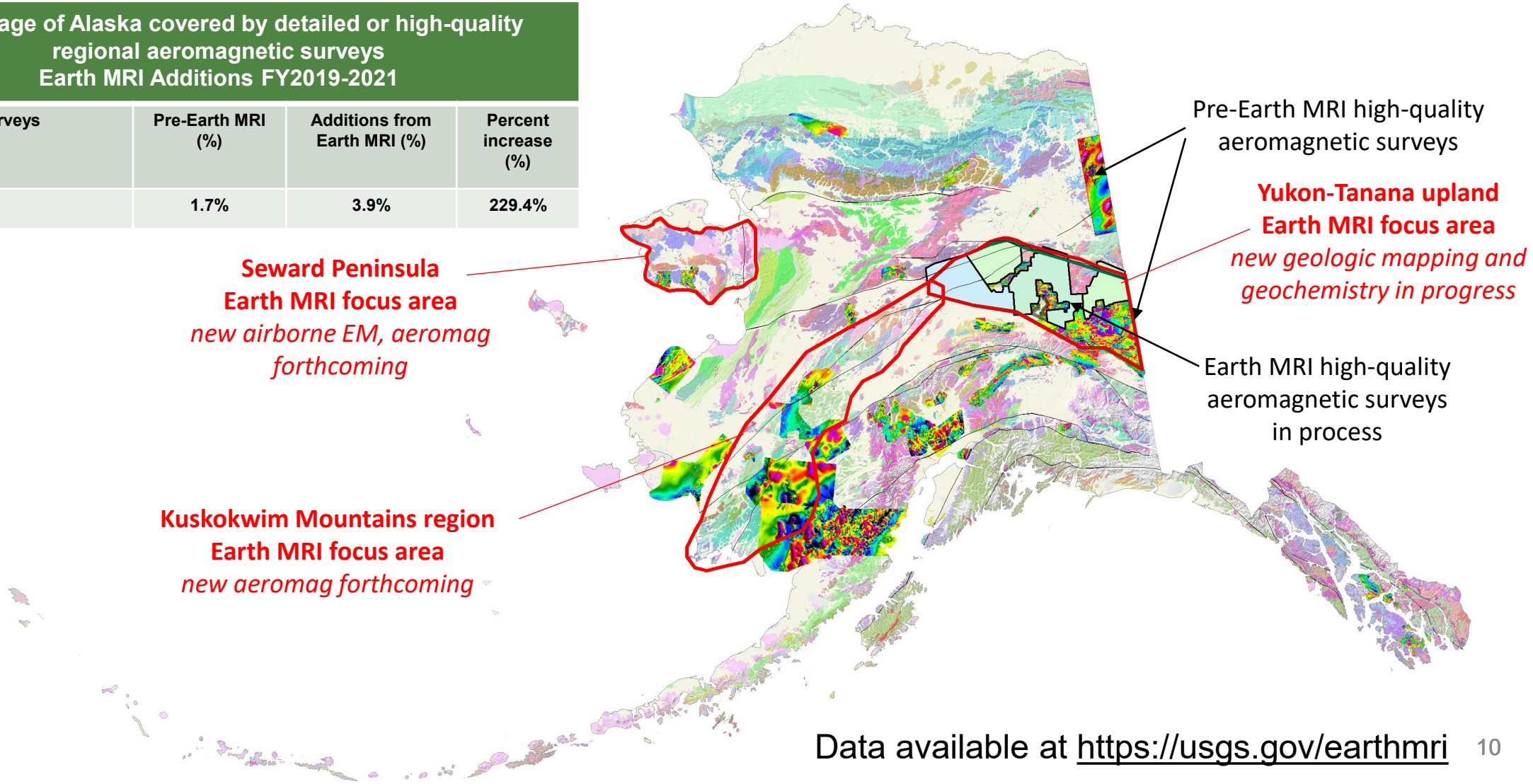


USGS OFR 2019-1023

- **Alaska mineral systems and focus areas address 22 of the 35 minerals or mineral material groups presently deemed critical**

Filling the Gaps: Earth MRI Data Acquisition

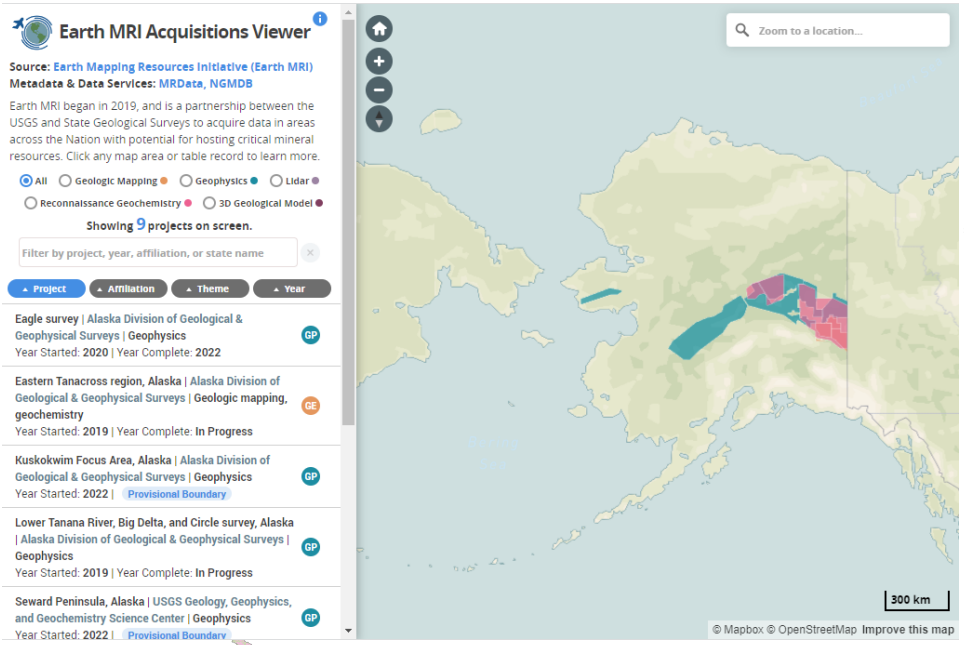
Percentage of Alaska covered by detailed or high-quality regional aeromagnetic surveys Earth MRI Additions FY2019-2021			
Geophysical Surveys	**Pre-Earth MRI (%)**	**Additions from Earth MRI (%)**	**Percent increase (%)**
Alaska	**1.7%**	**3.9%**	**229.4%**

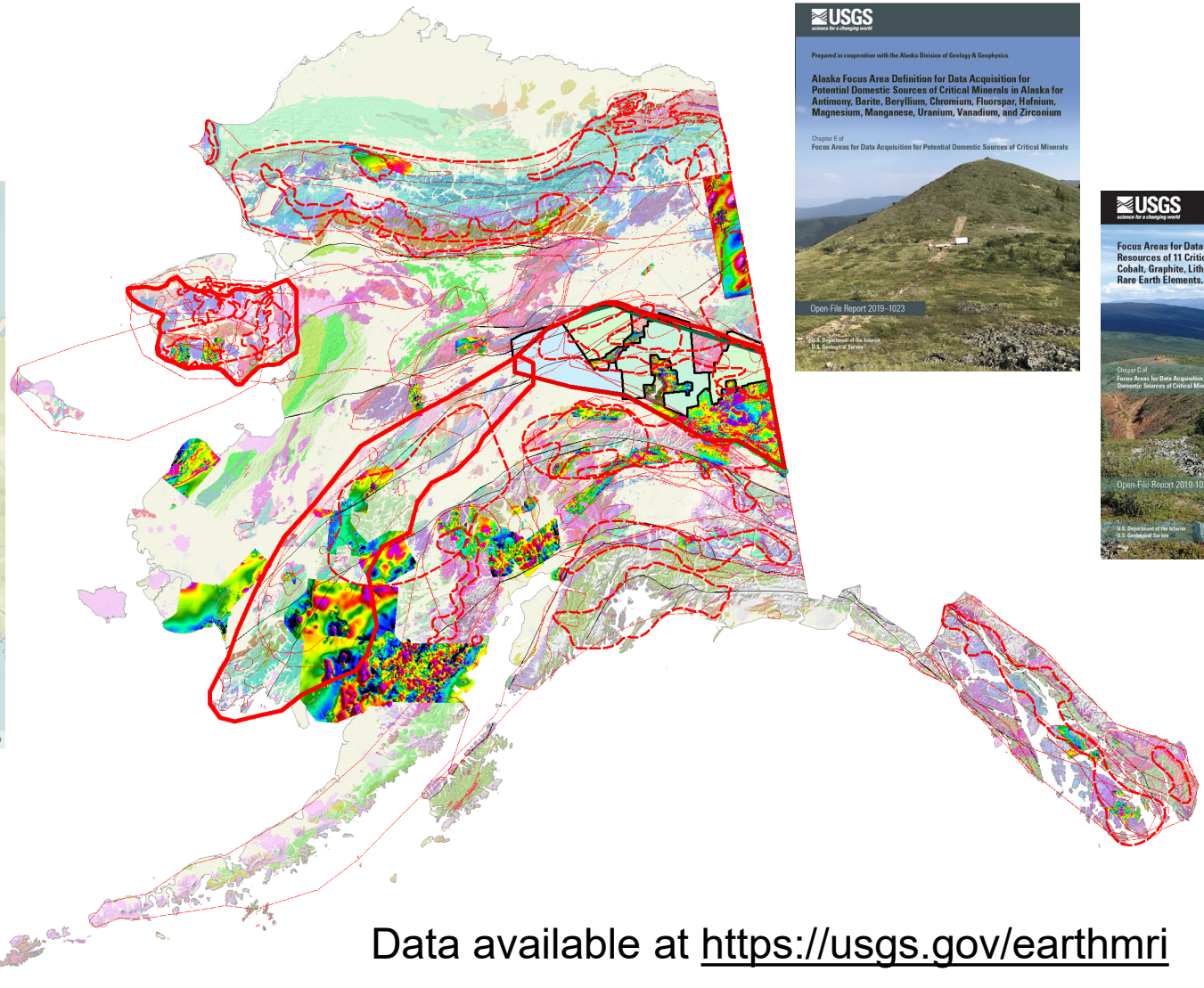


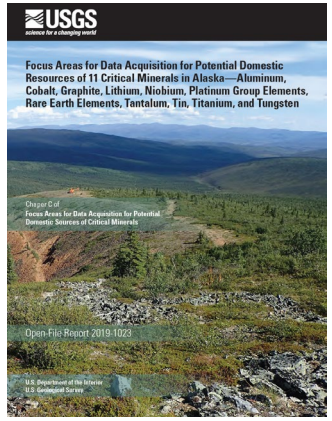
Data available at https://usgs.gov/earthmri

Filling the Gaps: Earth MRI Data Acquisition

Remaining Earth MRI focus areas (red dashed areas) cover most geologic belts of the state







Data available at https://usgs.gov/earthmri

Summary

- Alaska has significant resource potential for both critical and other essential mineral commodities
- A number of challenges limit mineral resource development in Alaska and the Arctic in general, including incomplete or imprecise geological and geophysical information
- USGS provides assessments of critical mineral resources and develops data-driven mineral prospectivity maps for all of Alaska
- USGS is working with the AK DGGS to fill key geoscience gaps with new data collection, mapping, and research

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