



State of Alaska Department of Natural Resources

Rare Earth Elements, Why we Need Them and Why Alaska Matters to the U.S.

October 5, 2017



RARE EARTH ELEMENTS (REE)

Rare Earth Elements

La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
57	58	59	60	61	62	63	64	65	66	67	68	69	70	71



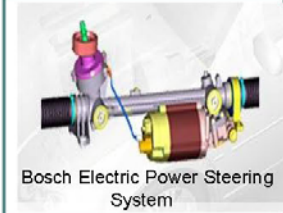
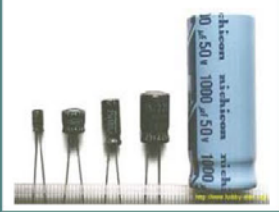




Lanthanides

Y
39





H																	He	
Li	Be											B	C	N	O	F	Ne	
Na	Mg											Al	Si	P	S	Cl	Ar	
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr	
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	
Cs	Ba		Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	An	Lr															




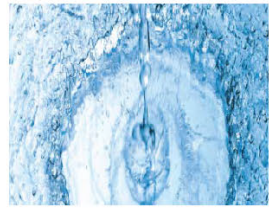


REE IN CIVILIAN APPLICATIONS

	Application	Rare Earth (RE) Technology		Application	Rare Earth (RE) Technology
	Hybrids, Plug-In, and Electric Vehicles	RE Permanent Magnets		Ni Metal Hydride Batteries	Energy Storage
	Electric assist motors in conventional and advanced vehicles	RE Permanent Magnets		Capacitors with High Energy Density	Rare Earth-doped ceramic, tantalum and other types of capacitors
	Wind and Hydro Power Generation	RE Permanent Magnets		Cordless Power Tools	RE Permanent Magnets
	Compact and Linear Fluorescent Lamps, LEDs, etc.	RE Phosphors		Integrated Starter / Generator for Improved MPG	RE Permanent Magnets

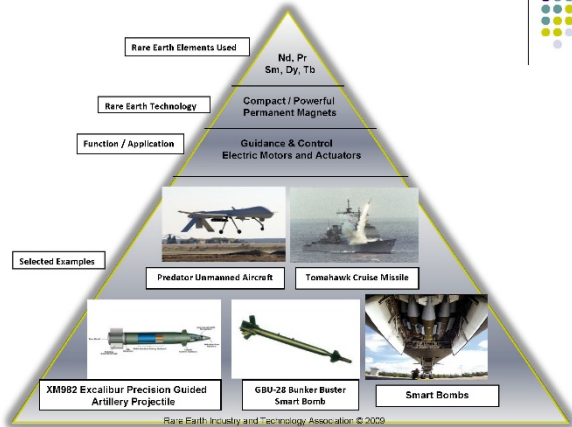
REE IN CIVILIAN APPLICATIONS

	Application	Rare Earth (RE) Technology
	Computer Disc Drives	RE Permanent Magnets
	Handheld Wireless Devices	RE Permanent Magnets RE Phosphors
	Fiber Optics	Signal Amplification
	Flat Screen Displays	Low Pressure UV Excitation of RE Phosphors

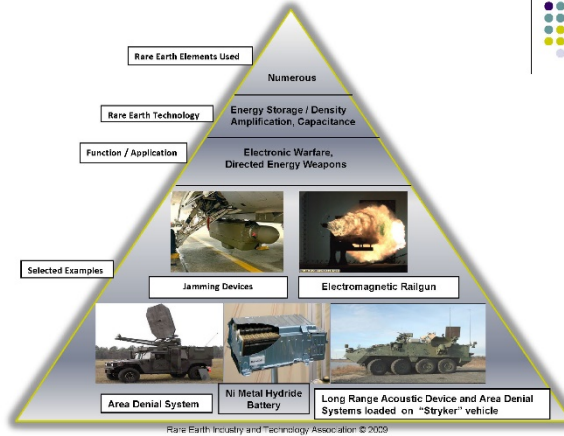
	Application	Rare Earth (RE) Technology
	Fluid Catalytic Cracking (FFC) for making gasoline	Provides Brønsted acid sites to the catalyst matrix
	Catalytic Converters and other emission reduction technologies	Ability to oxidize CO and ozone to CO ₂ and O ₂
	Medical Imaging – MRI	RE Permanent Magnets
	X-ray Imaging	Wavelength shift
	Water Treatment	Selective adsorption

REE IN MILITARY APPLICATIONS

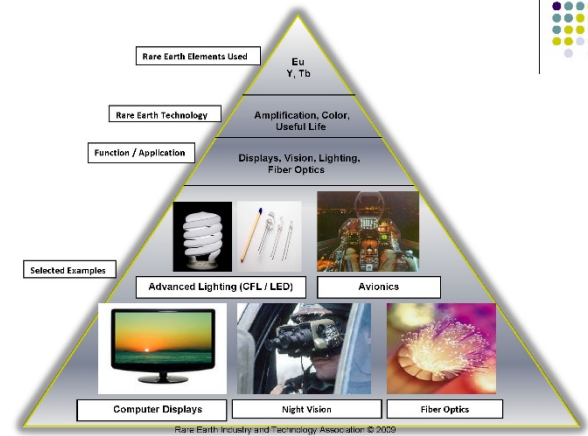
Rare Earth Technology Applied to Guidance & Control



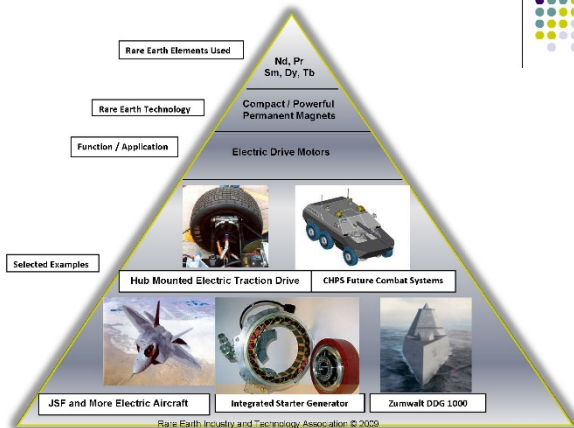
Rare Earth Technology Applied to Electronics



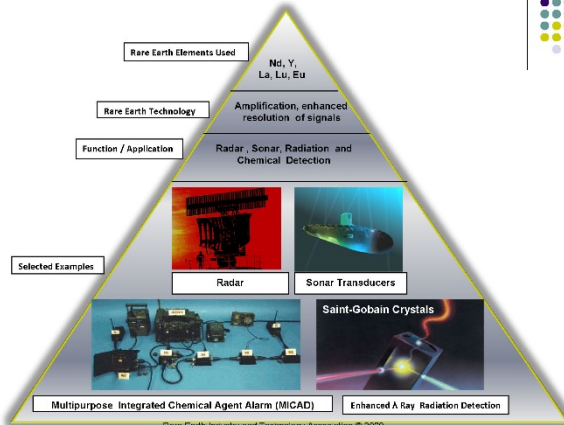
Rare Earth Technology Applied to Optics



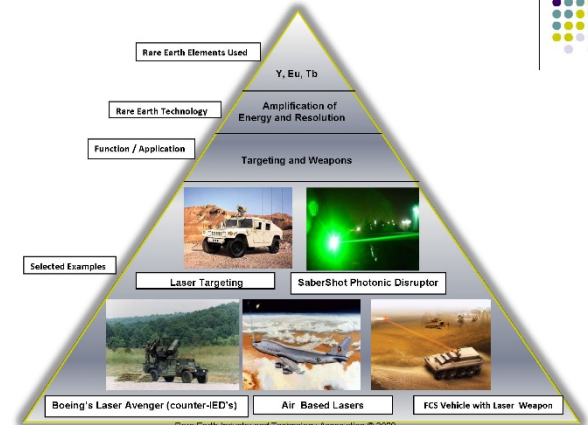
Rare Earth Technology Applied to Power, Stealth, Fuel Efficiency



Rare Earth Technology Applied to Surveillance & Detection



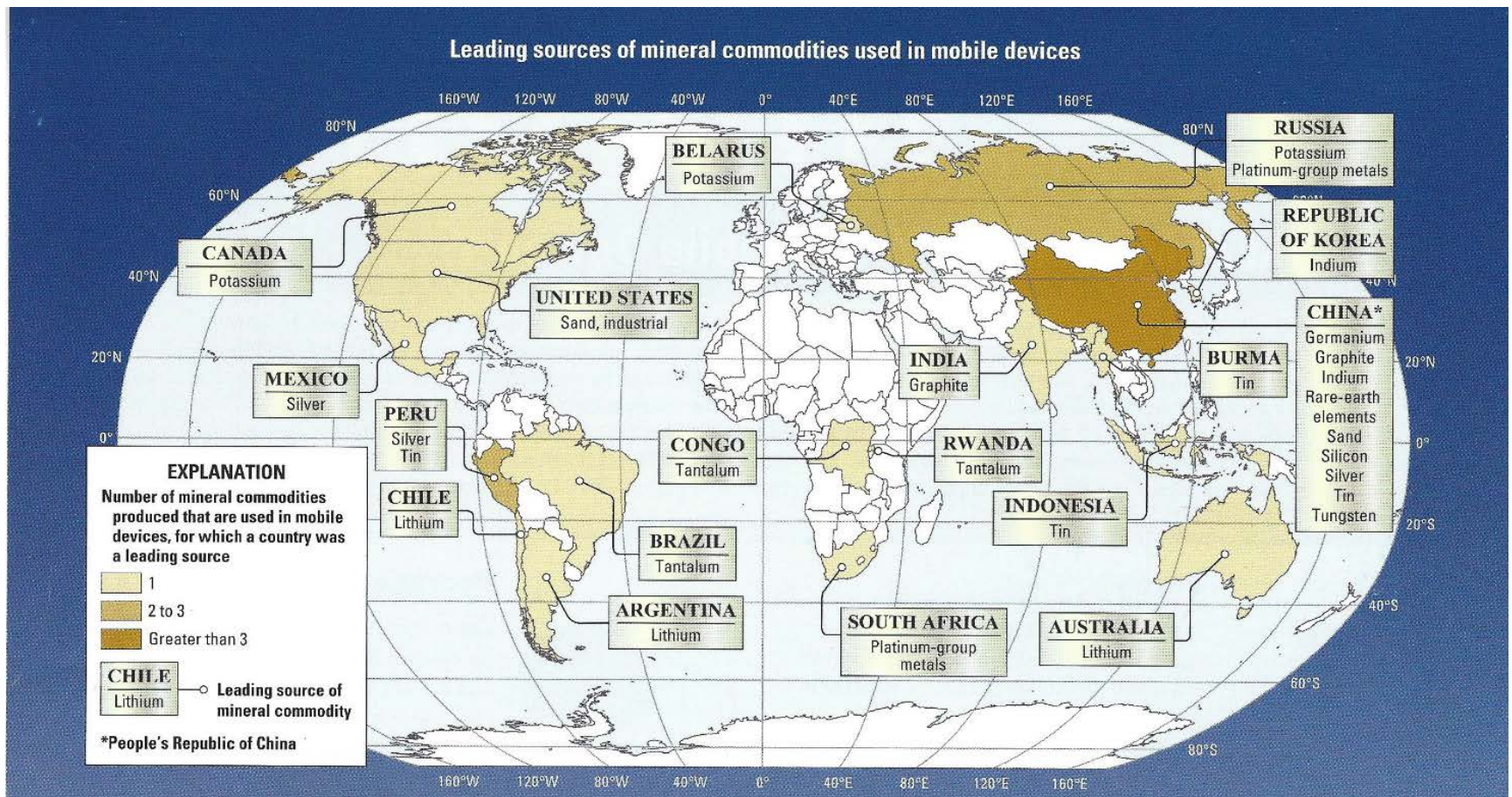
Rare Earth Technology Applied to Lasers



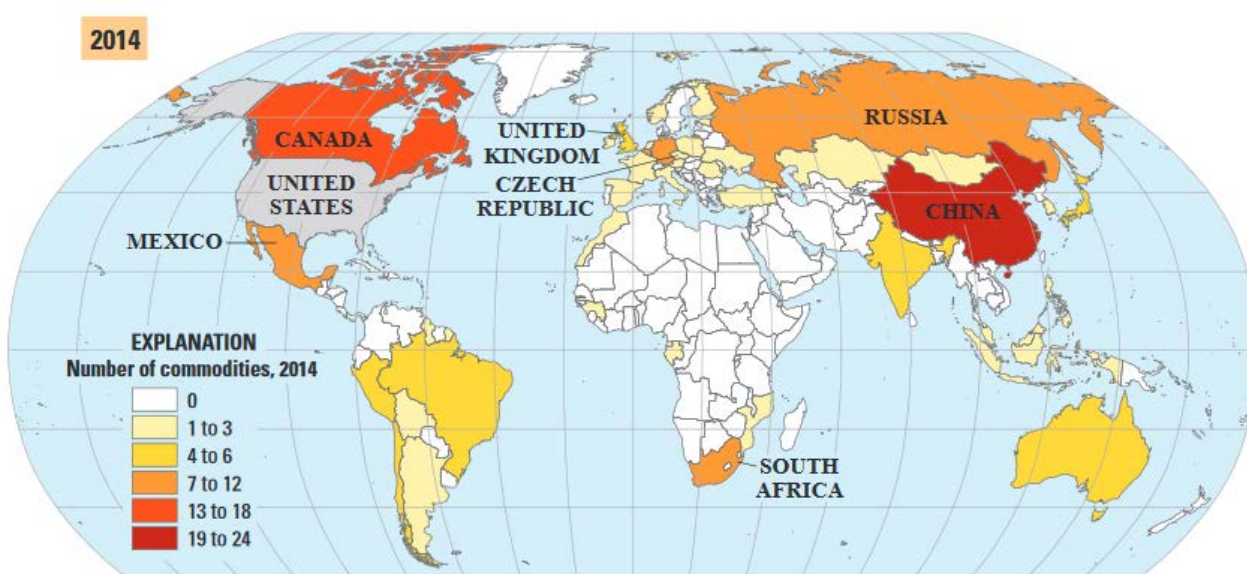
STRATEGIC & CRITICAL MINERALS

Strategic means you don't produce it

Critical means you need it

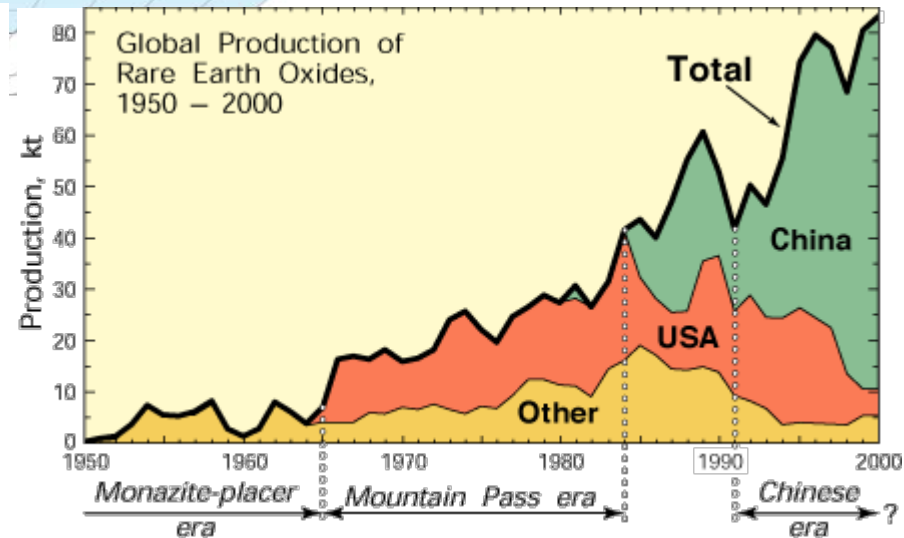
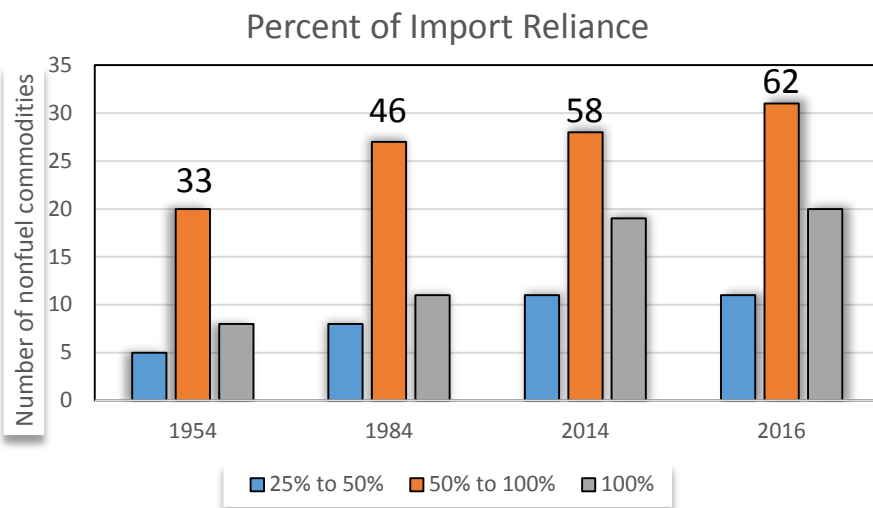


IMPORT RELIANCE



2014

Arsenic
Asbestos
Bauxite
Cesium
Fluorspar
Graphite, natural
Indium
Iodine
Manganese
Mica, sheet
Niobium (Columbium)
Quartz crystal, industrial
Rubidium
Scandium
Strontium
Tantalum
Thallium
Thorium
Vanadium

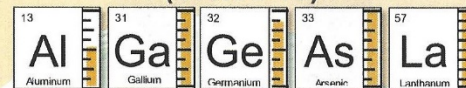


SCM MILITARY APPLICATIONS

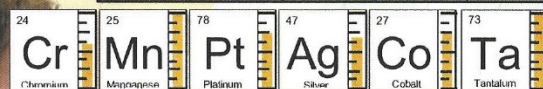
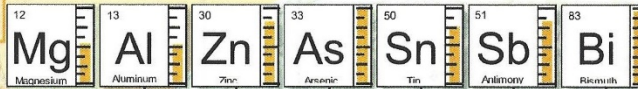
CRITICAL METALS IN SPECIAL FORCES GEAR



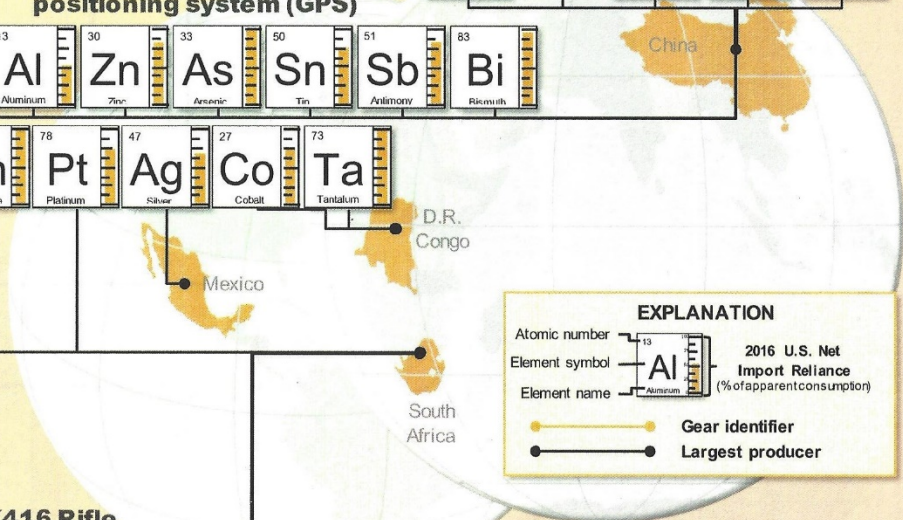
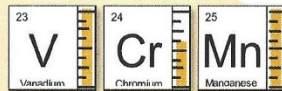
Ground Panoramic Night Vision Goggles (GPNVG-18)



Communications gear & global positioning system (GPS)



HK416 Rifle



EXPLANATION

Atomic number — 13
Element symbol — Al
Element name — Aluminum

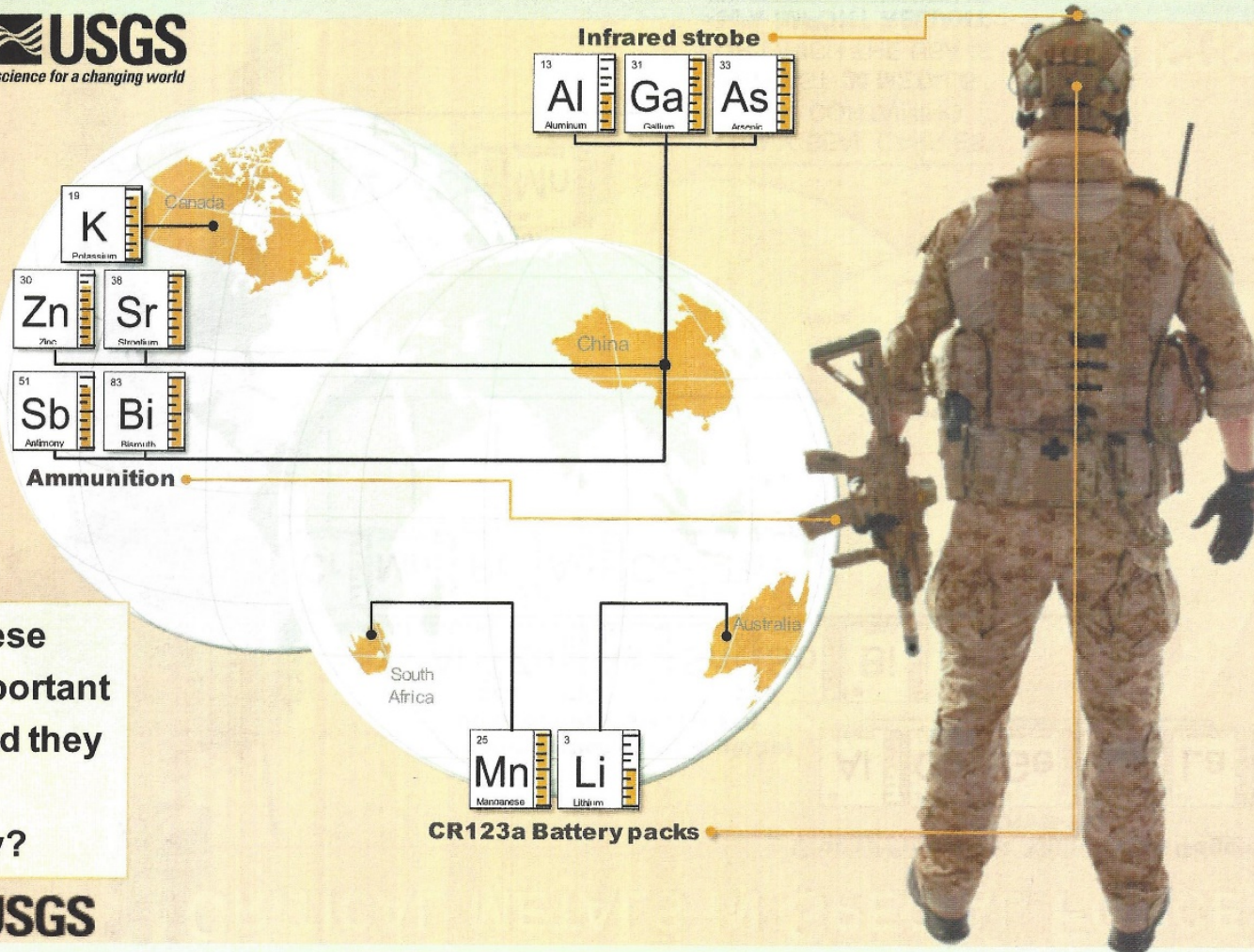
2016 U.S. Net Import Reliance (% of apparent consumption)

● Gear identifier
● Largest producer

A NAVY SEAL CARRIES GEAR CONTAINING AT LEAST 20 METALS FOR WHICH THE USA IS >50% IMPORT RELIANT



MINERAL RESOURCES



For all of these critically important metals, could they be sourced domestically?

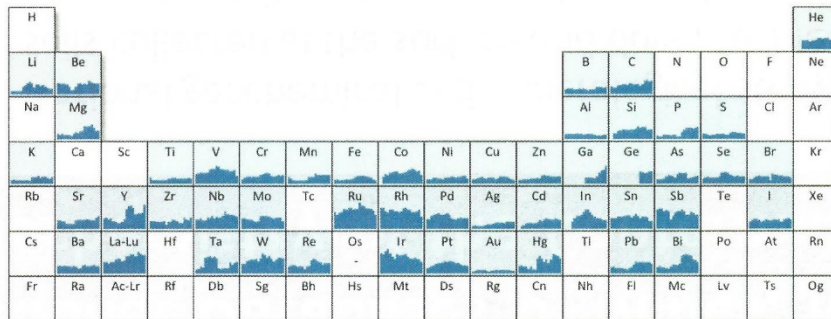


NATIONAL MINERAL SECURITY

Mineral Resources Program – Critical Minerals Screening Tool

Criticality (C) is based on three fundamental indicators: $C = \sqrt[3]{R \cdot G \cdot M}$

- 1) Supply risk (R)
- 2) Production growth (G)
- 3) Market dynamics (M)

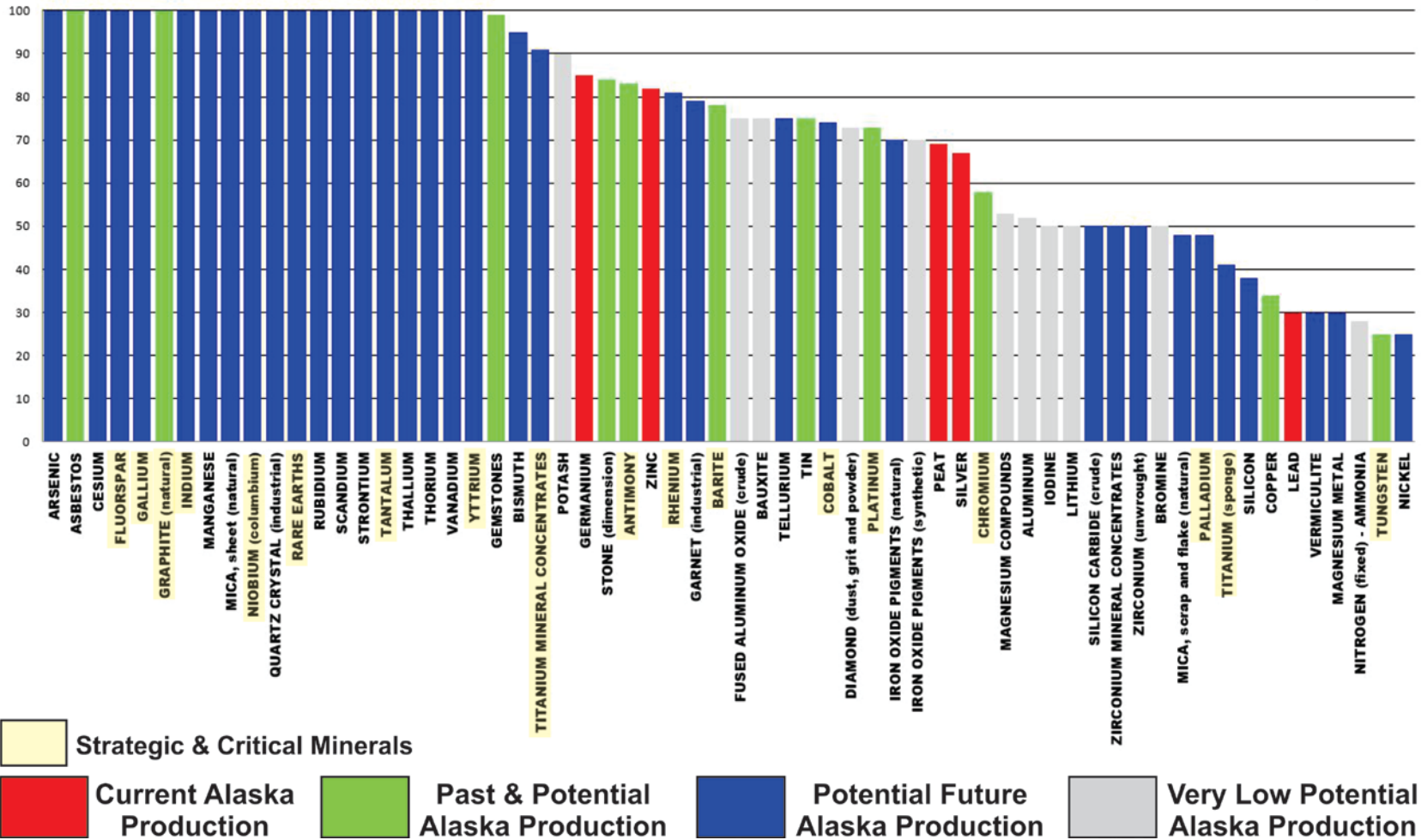


This early-warning screening tool is now used by the Defense Logistics Agency to help determine if a mineral commodity should be on the National Stockpile.

US IMPORT RELIANCE

2016 U.S. Import Reliance For Minerals and Mineral Materials

USGS, 2017, Mineral Commodity Summaries



ALASKA'S RESOURCES

Alaska Potential

Arsenic

Asbestos

Cesium

Fluorspar

Gallium

Graphite

Indium

Manganese

Niobium

Rare Earths

Rubidium

Strontium

Tantalum

Thallium

Thorium

Vanadium

Yttrium

Bismuth

Titanium

Germanium

Rhenium

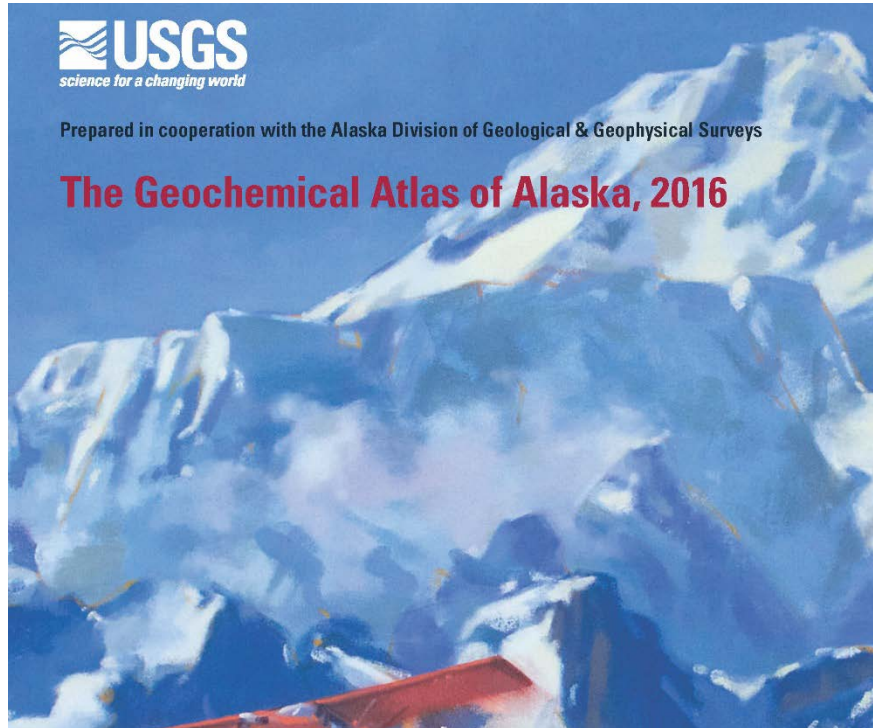
Antimony

Barite

Tellurium

Tin

Cobalt



USGS
science for a changing world

Prepared in cooperation with the Alaska Division of Geological & Geophysical Surveys

The Geochemical Atlas of Alaska, 2016

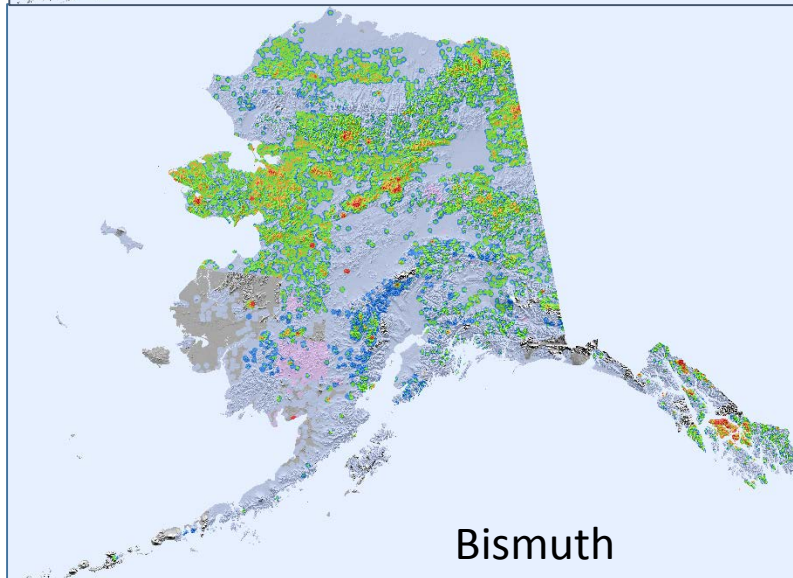
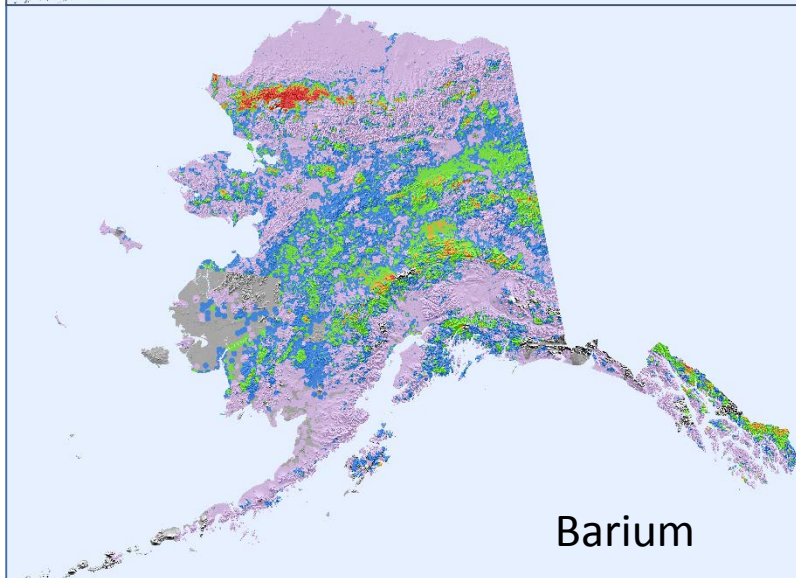
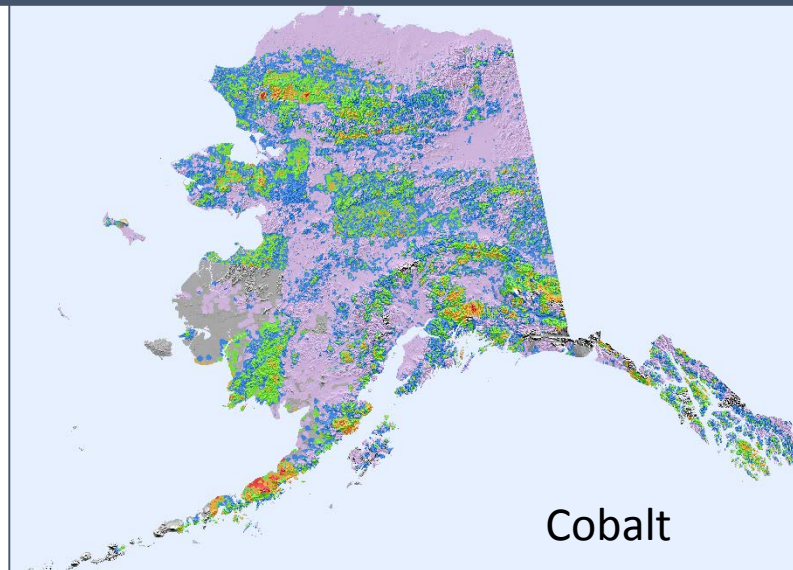
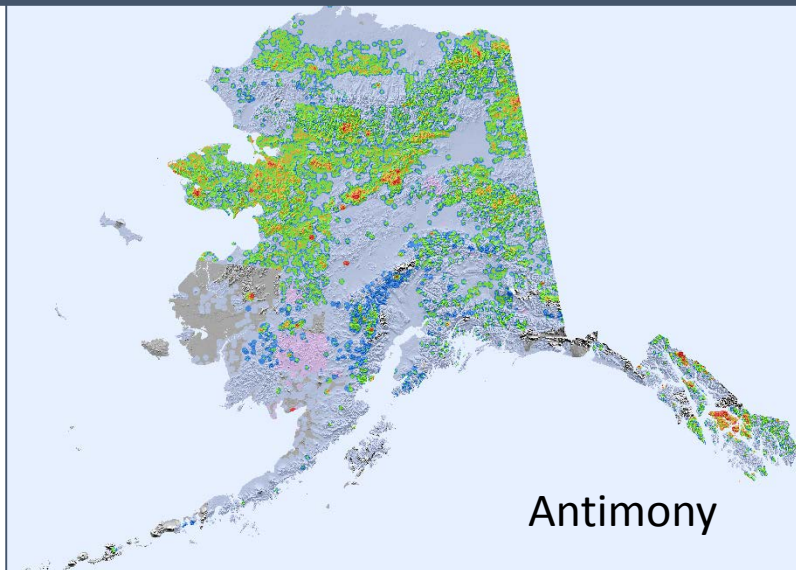
THE GREAT STATE OF ALASKA DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS
State of Alaska | Natural Resources | Geological & Geophysical Surveys | Geochemistry

species_co [500 TO 999999] Search Previous Displaying 1 - 99 of 99 Next Showing 100 Sort by Score Download All Results

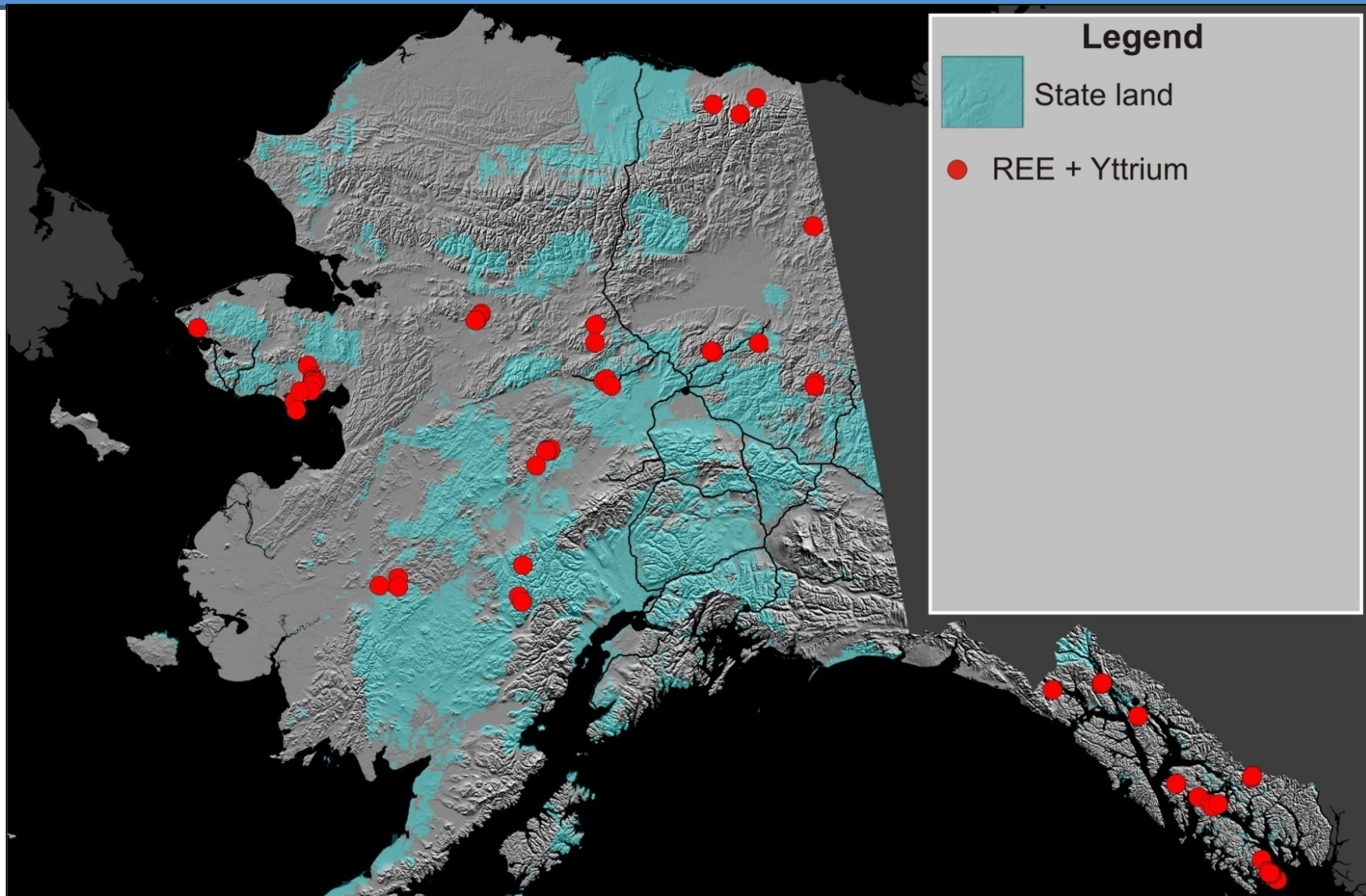
Sample No	Sample Type	Citation	SrO2	SrO	ThO2	Al2O3	Al2O3	Fe2O3	Fe	MnO	MgO	MgO	CaO	CaO	Na2O	Na2O	K2O	P2O5	SrO	Cr2O3	BaO	LOI	Total	Ag	Ag	Ag	Ag	Ag	Ag	Ag	Ag	Ag			
			OES	XRF	XRF	OES	XRF	XRF	XRF	OES	XRF	OES	XRF	OES	XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF	AAS	FA-ICP	AES-MS	MS	ICP	AES	ICP	AES-MS	NAA	OE		
1410781	soil	OPR 213-84																																	
801-48	rock	M.A. 119-52																																	
2665 (on OPR 14-00)	rock	OPR 14-00																																	
10483 (BLND)	rock	Beam, K.W. and others, 2004																																	
10381 (BLND)	rock	Beam, K.W. and others, 2004																																	
10203 (BLND)	rock	Beam, K.W. and others, 2004																																	
KV15459	rock	Bowdoin, T.K. and others, 1934																																	
KV15460	rock	Bowdoin, T.K. and others, 1934																																	
10104 (BLND)	rock	Beam, K.W. and others, 2004																																	
11271 (BLND)	rock	Beam, K.W. and others, 2002																																	
417 (BLND)	rock	Rittenbender, P.E. and others, 2000																																	
2000 (BLND)	rock	Rittenbender, P.E. and others, 2002																																	
2000 (BLND)	rock	Rittenbender, P.E. and others, 2002																																	
1162 (on US80M OPR 11-95)	rock	OPR 11-95																																	
87812-928	sediment	RPE 2015-4																																	
1531 (on US80M OPR 11-95)	rock	OPR 11-95																																	
1582 (on US80M OPR 11-95)	rock	OPR 11-95																																	
1583 (on US80M OPR 11-95)	rock	OPR 11-95																																	
1583 (on US80M OPR 11-95)	rock	OPR 11-95																																	
15315 (BLND)	rock	Meyer, M.P. and others, 2003																																	
2121 (BLND)	rock	Mass, K.M. and others, 1998																																	



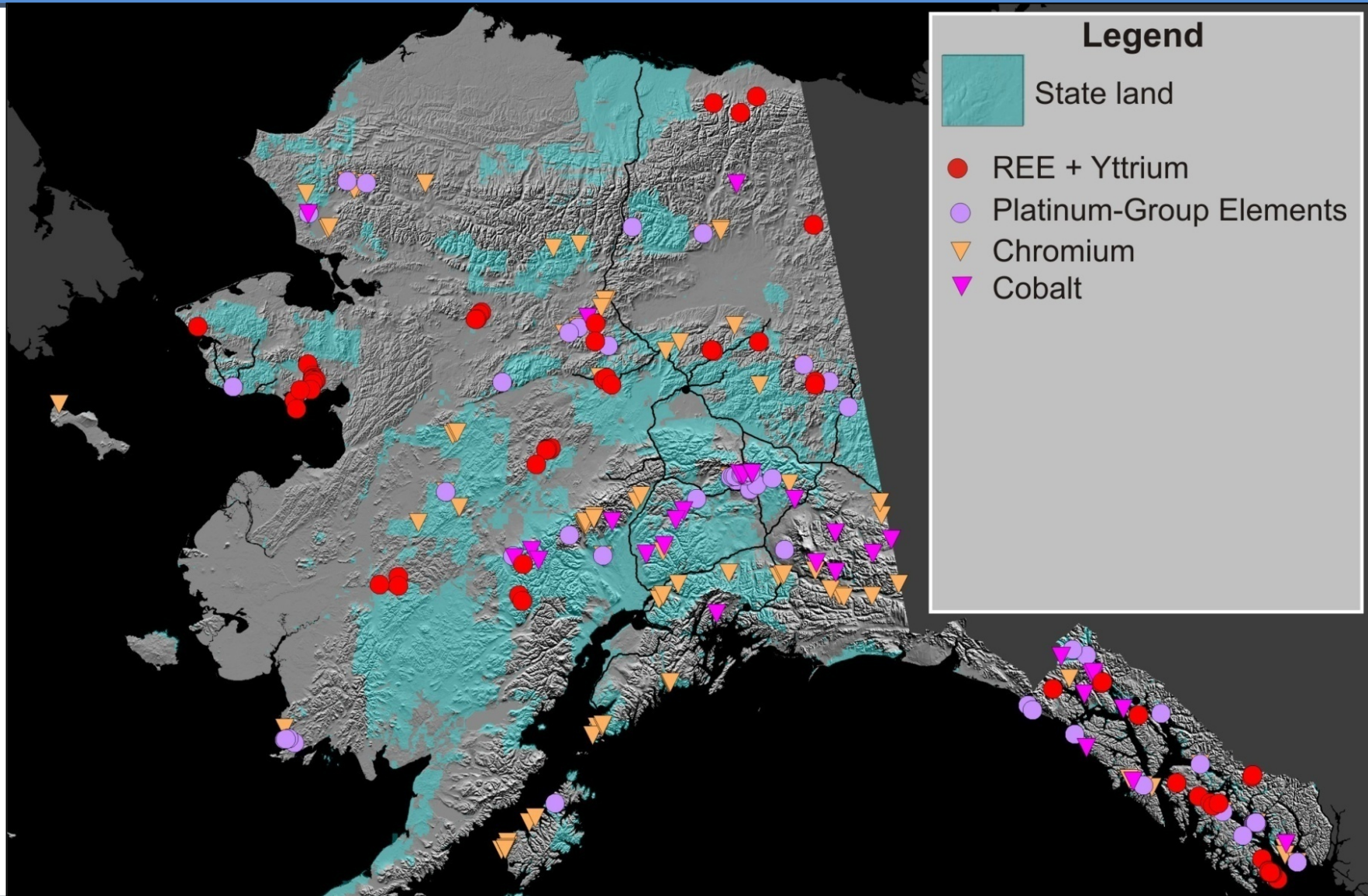
ALASKA'S POTENTIAL



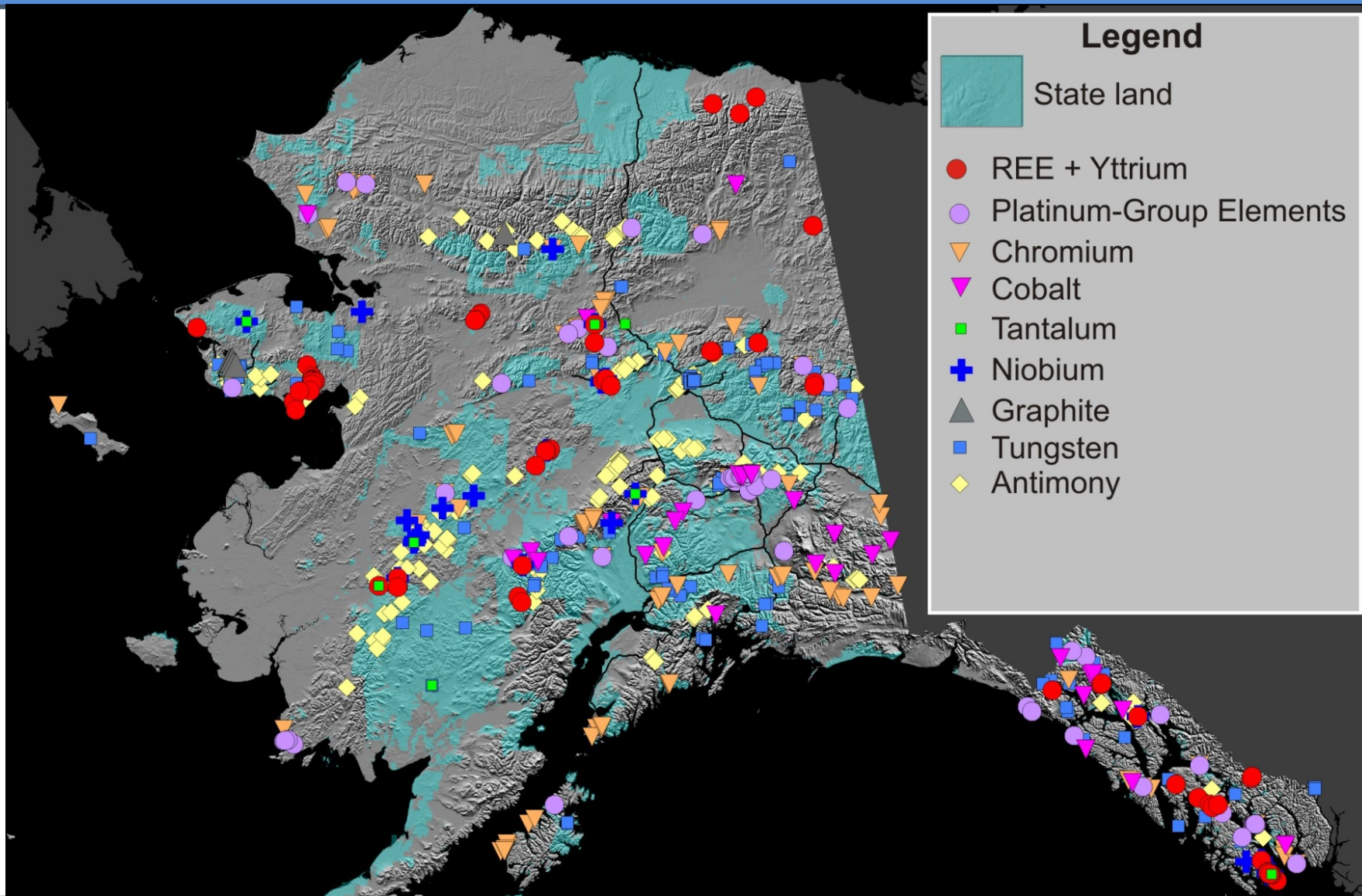
RARE EARTH PROSPECTS



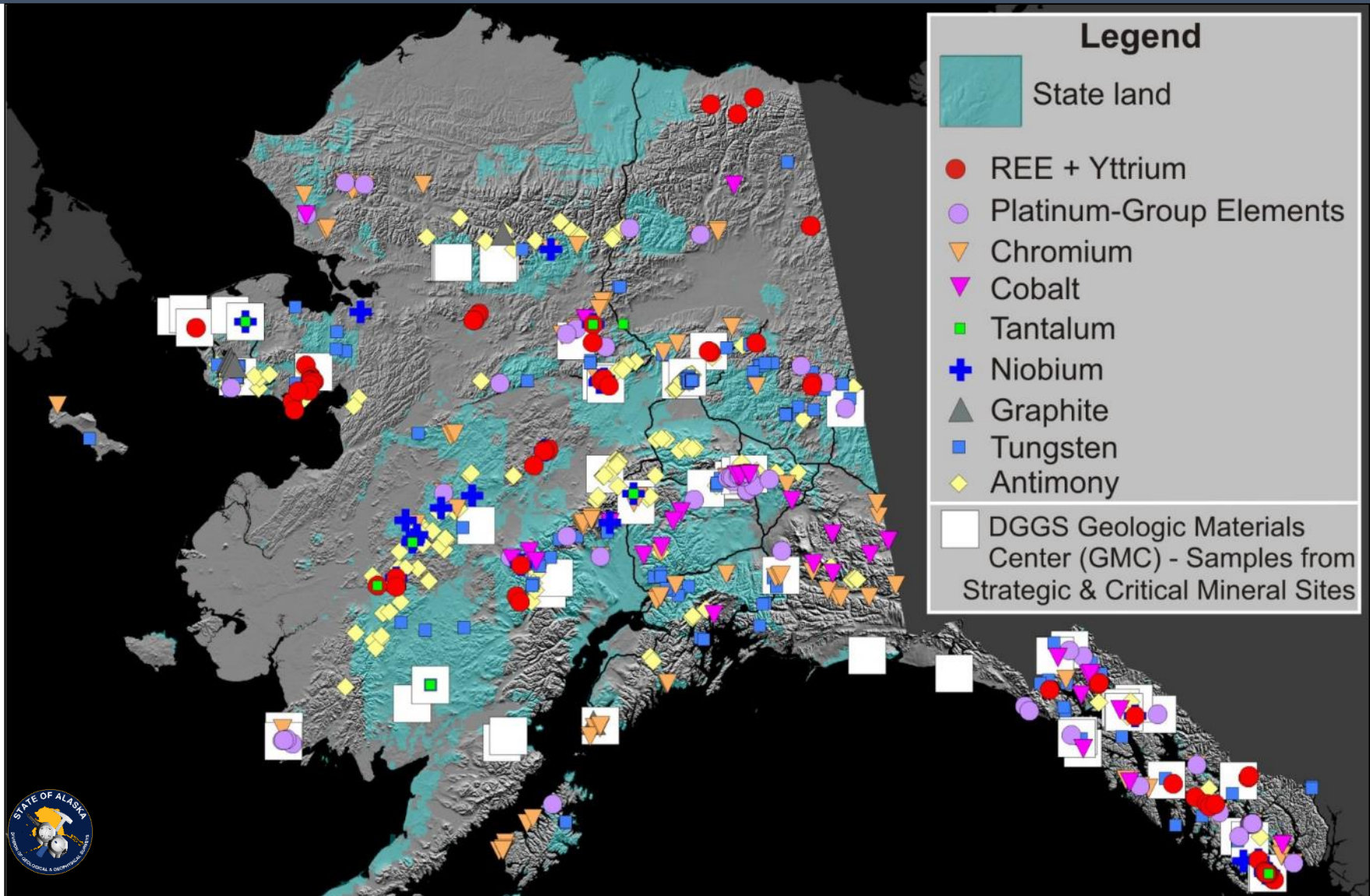
PLATINUM GROUP PROSPECTS



SCM PROSPECTS

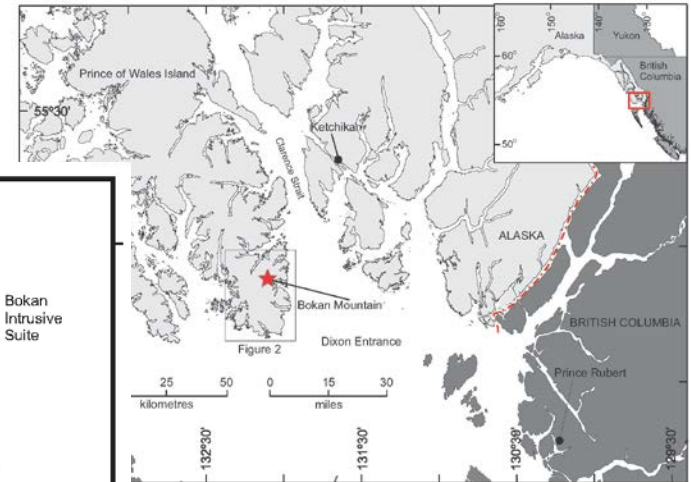
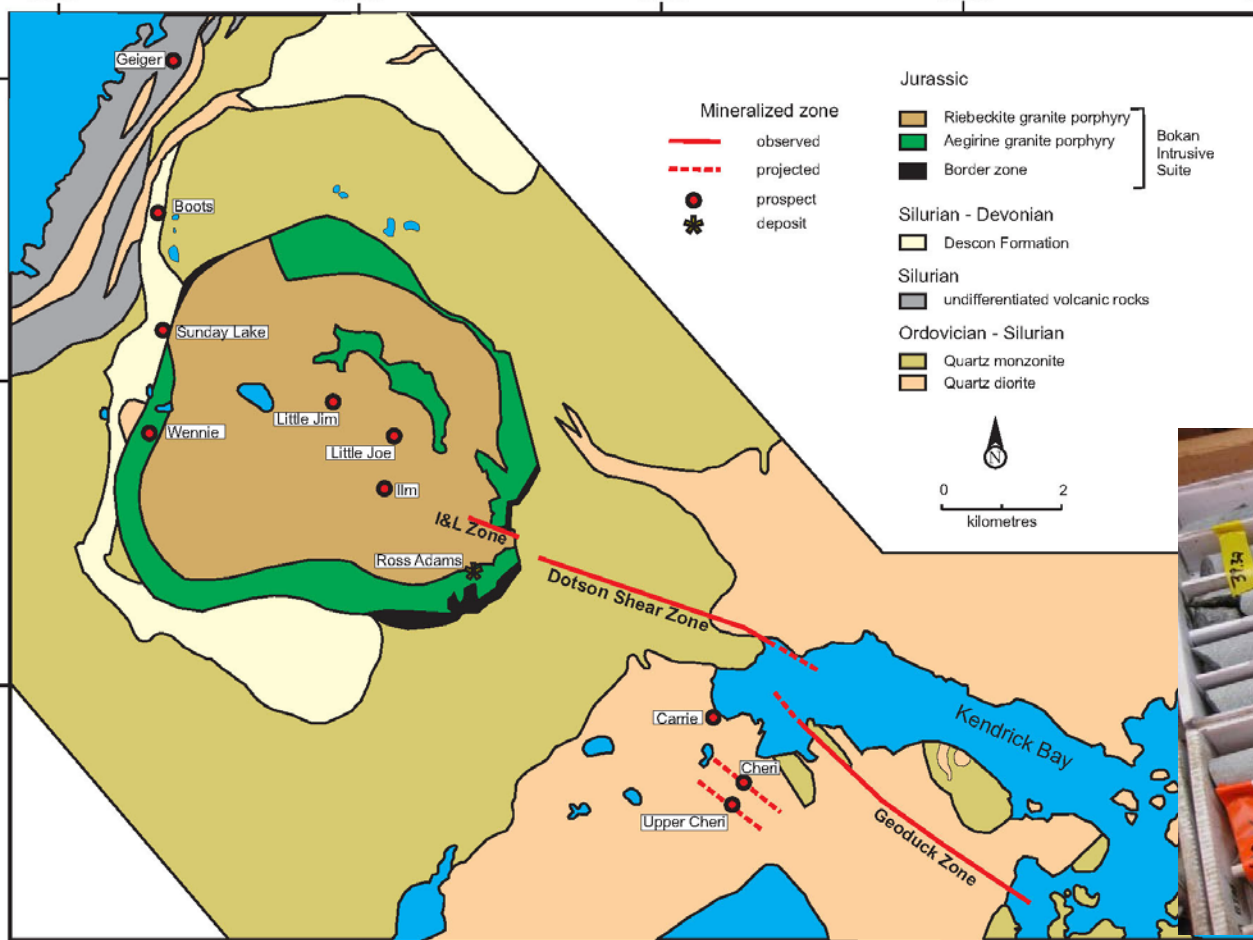


SAMPLES AT THE GMC



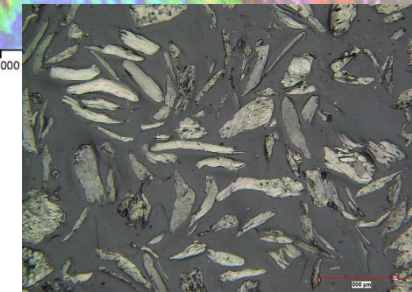
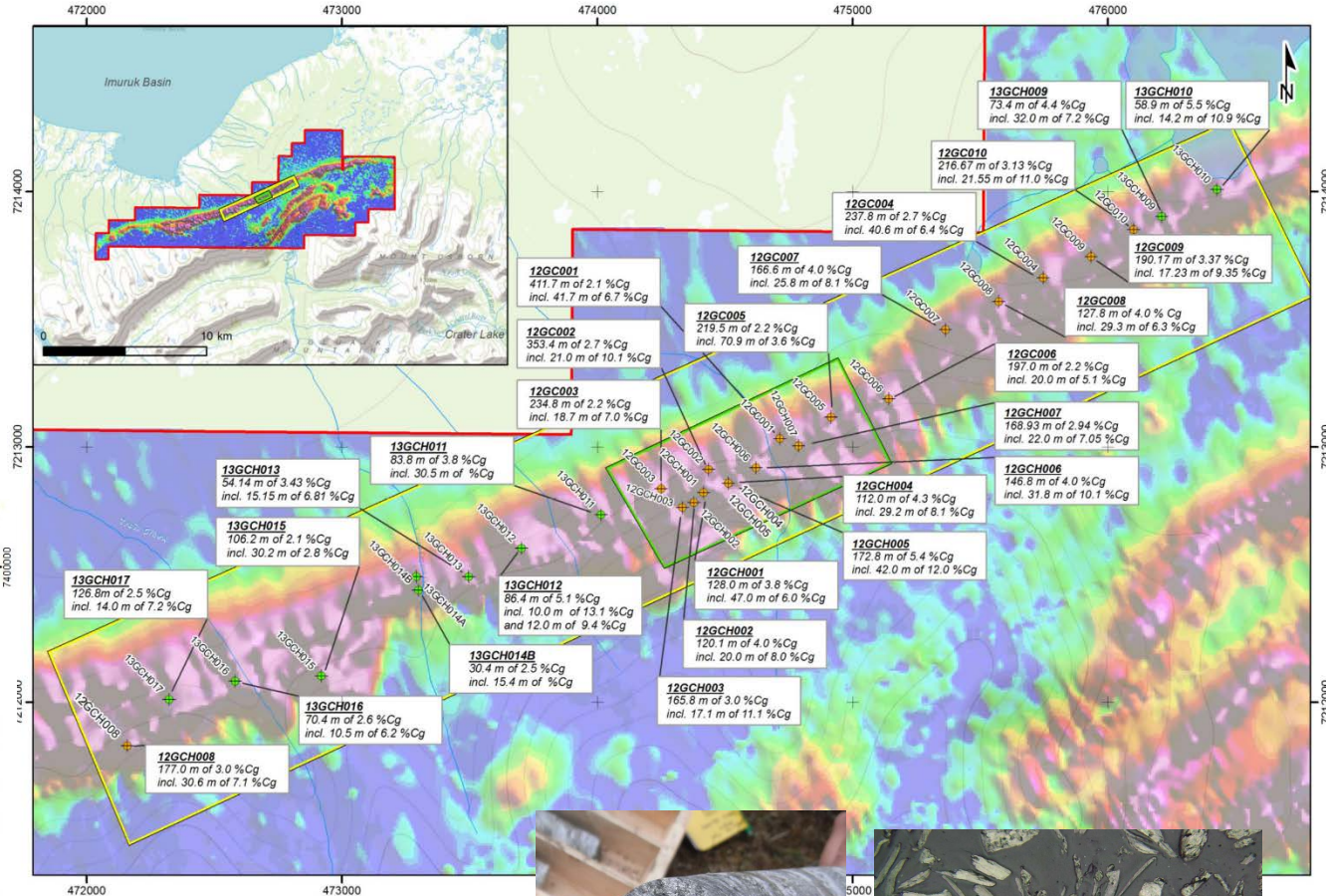
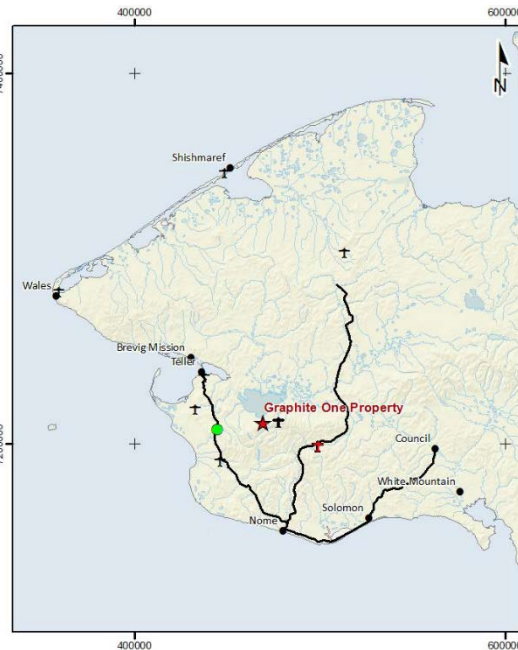
RARE EARTHS - BOKAN MT.

- 5.3 million tons grading 0.6% TREO+Y
- Largest U.S. heavy REE deposit



GRAPHITE – GRAPHITE ONE

- Largest graphite deposit in U.S.
- High quality for use in batteries
- Resource - 11.4 million tons @ 7.2 % Cg

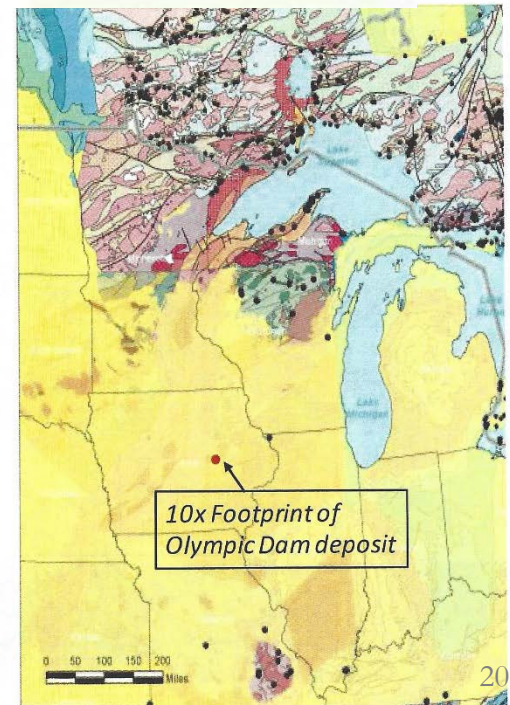


3DEEP - A NEW USGS INITIATIVE

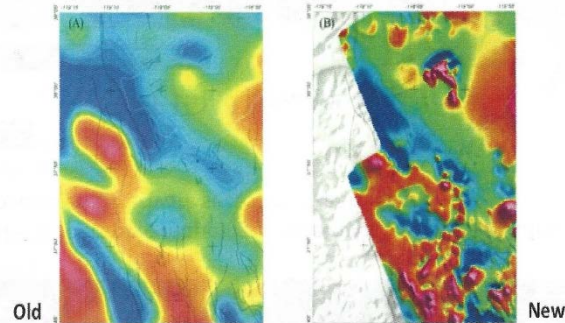
A Geological and Geophysical Mapping Program

For National Mineral Security

- Continue Lidar mapping in the US and **Alaska** prioritizing federal lands
- Expand geological mapping, prioritizing **Alaska** and the western states
- Conduct airborne geophysical surveys, prioritizing the Mid-Continent and **Alaska**

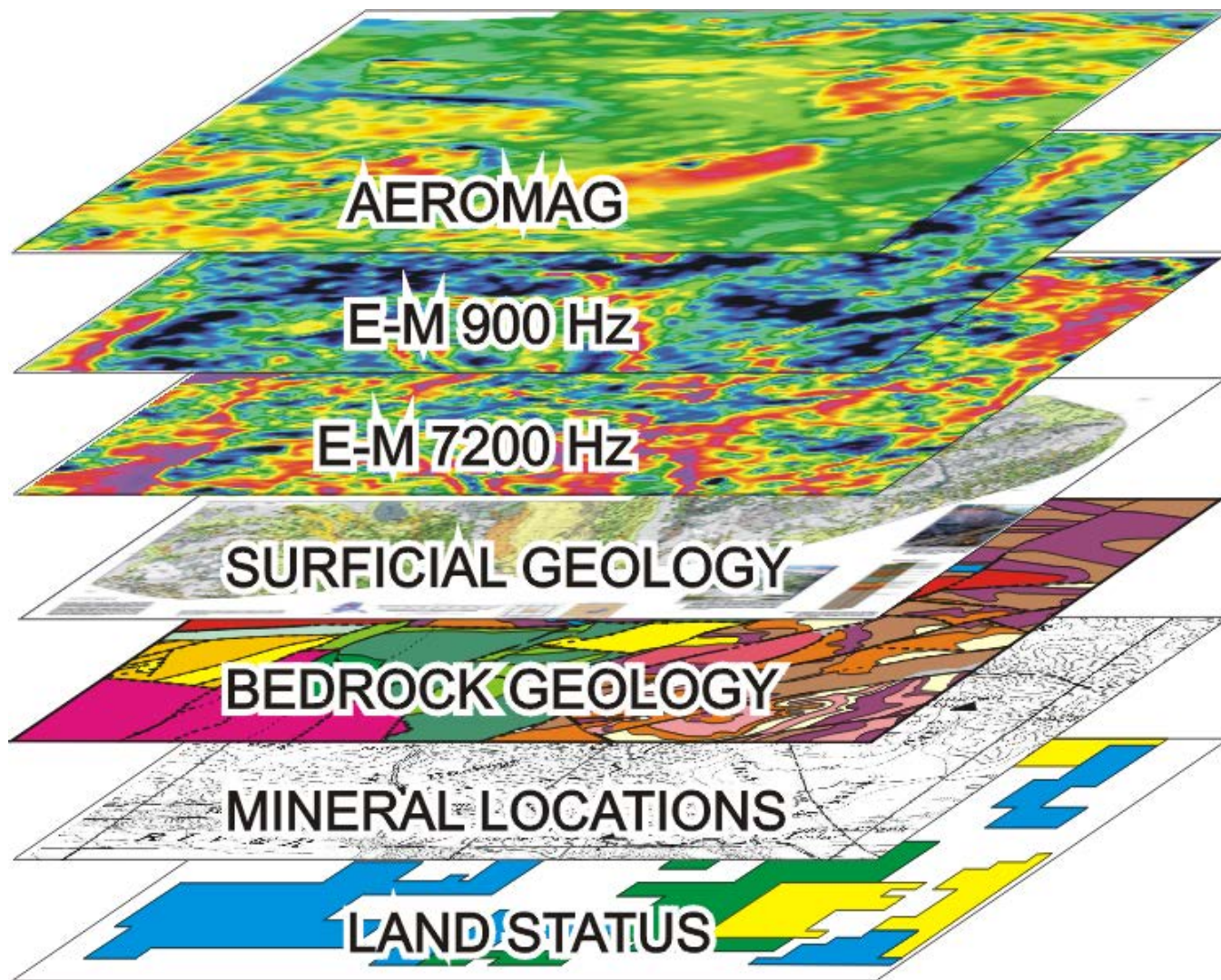


Aeromagnetic Geophysics —
Near Mountain Pass REE Deposit



- Present or past producing mines
- Sedimentary rocks covering Precambrian basement

DGGS INTEGRATED MAPPING



DGGS DATA DELIVERY

Public Library



Geologic Reports



Geologic Materials Center



Publications Search Web Page

A screenshot of the 'Advanced Publications Search' web page. The page title is 'Geological & Geophysical Surveys Alaska Department of Natural Resources'. It features a search form with fields for Title, Author, Publication Number, Keyword(s), and a dropdown menu for 'all these words'. There are also dropdown menus for 'Quadrangle' (listing AS, Adak, Alyok, Alaska General, Alaska Statewide), 'Publishing Agency' (listing All Publishers), 'Publication Year' (listing All Publication Years), and 'Range of Years' (From and To). There are checkboxes for 'Geospatial Data Only' and 'Exclude Geophysics Pubs', and buttons for 'Search Pubs' and 'Reset Fields'. The page footer includes contact information for the Division of Geological & Geophysical Surveys.

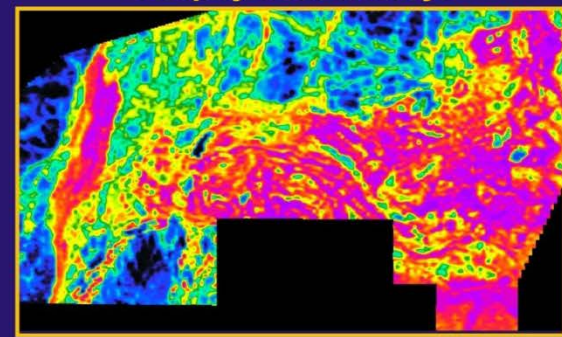
WebGeochem Search Page

A screenshot of the 'WebGeochem: DGGS Geochemical Sample Analysis Search' web page. It features a search form with a dropdown menu for 'Sample Type' (listing other rock, drill core) and a 'Submit' button. Below this, it says 'You have selected rock sample type'. There is another dropdown menu for 'Analysis Type' (listing trace element, rare earth element, major oxide, minor oxide, and trace element) and a 'Submit' button. Below this, it says 'You have selected major oxide, minor oxide, and trace element analysis type'. There is a dropdown menu for 'Project' (listing Salcha River-Pogo) and buttons for 'Re-Submit Request', 'Back One', and 'Start Over'. There are also links for 'User's Guide' and 'Data Loading Status'. An attention notice at the bottom states: 'ATTENTION! Pop-up blockers must be disabled in order to view this site properly. Click here to learn how.' The footer includes contact information for the Division of Geological & Geophysical Surveys.

Geochemistry

A screenshot of a data table showing geochemical analysis results. The table has multiple columns for various elements and isotopes, including major oxides, minor oxides, and trace elements. The data is organized into rows, likely representing different samples or analyses. The table is presented in a standard spreadsheet format with a header row and several data rows.

Geophysical Surveys



DGGS MINERAL RESOURCES PROGRAM

Mission: Determine the potential of Alaska land to produce metals and minerals

Geologic mapping

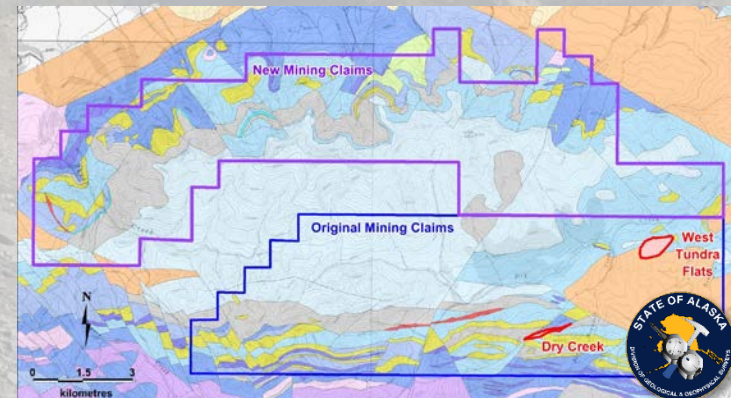
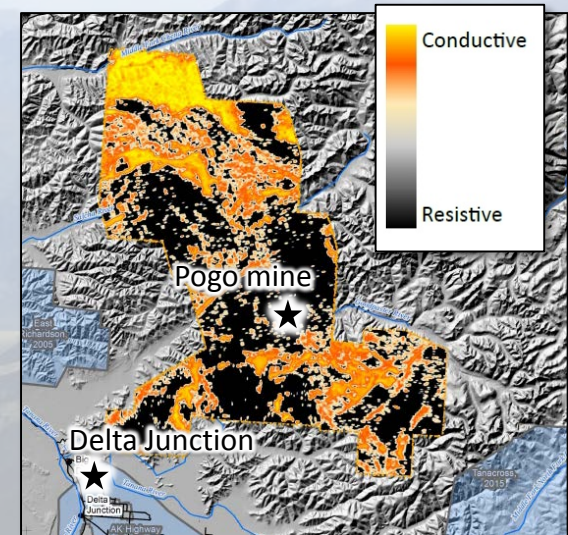
- Mapped 480 square-miles in the Tok River area
 - 20 new mineral occurrences described and sampled
 - 582 new geochemical analyses released stimulated claim staking
- Published geologic map and report to aid exploration at Livengood, an active Au-Cu-Ag-W exploration area

Airborne Geophysics

- Published merged digital datasets for seamless coverage of the Pogo Mine and Fortymile areas
- Flew a magnetometer survey over Icy Cape for Mental Health Trust Lands
- Preparing for a federally-funded survey of the Porcupine River area in early 2017

Other activities

- Published the 35th Alaska's Mineral Industry report
- Data provided in response to industry request resulted in 32,000 acre claim block being staked in Bonnifield area
- Published 15 maps, reports and datasets on Alaska's mineral potential





SUMMARY



- Alaska is richly endowed with mineral resource potential
- Alaska's diverse geology provides the potential for a wide variety of mineral deposit types, including REE and other Strategic Minerals
- DGGS is providing essential framework data on Alaska mineral resources for use in policy decisions and mineral exploration
- DNR is working with our Federal colleagues to ensure Alaska mineral resource potential is recognized, and developed in a prudent and responsible manner

STATE OF ALASKA

- RESOURCE POTENTIAL: MINERALS -



The State of Alaska ranks in the ***Top Ten in the World*** for important minerals including:

- **Coal:** 17% of the world's coal; *2nd most in the world*
- **Copper:** 4% of the world's copper; *8th most in the world*
- **Lead:** 4% of the world's lead; *6th most in the world*
- **Gold:** 8% of the world's gold; *5th most in the world*
- **Zinc:** 6% of the world's zinc; *6th most in the world*
- **Silver:** 4% of the world's silver; *9th most in the world*
(USGS 2015 estimates)

Alaska ranked **2nd for mineral potential** in the 2015 Fraser Institute Survey of Mining Companies.

With more than **7,400 documented prospects**, Alaska has the potential to lead the nation in mineral production.

