

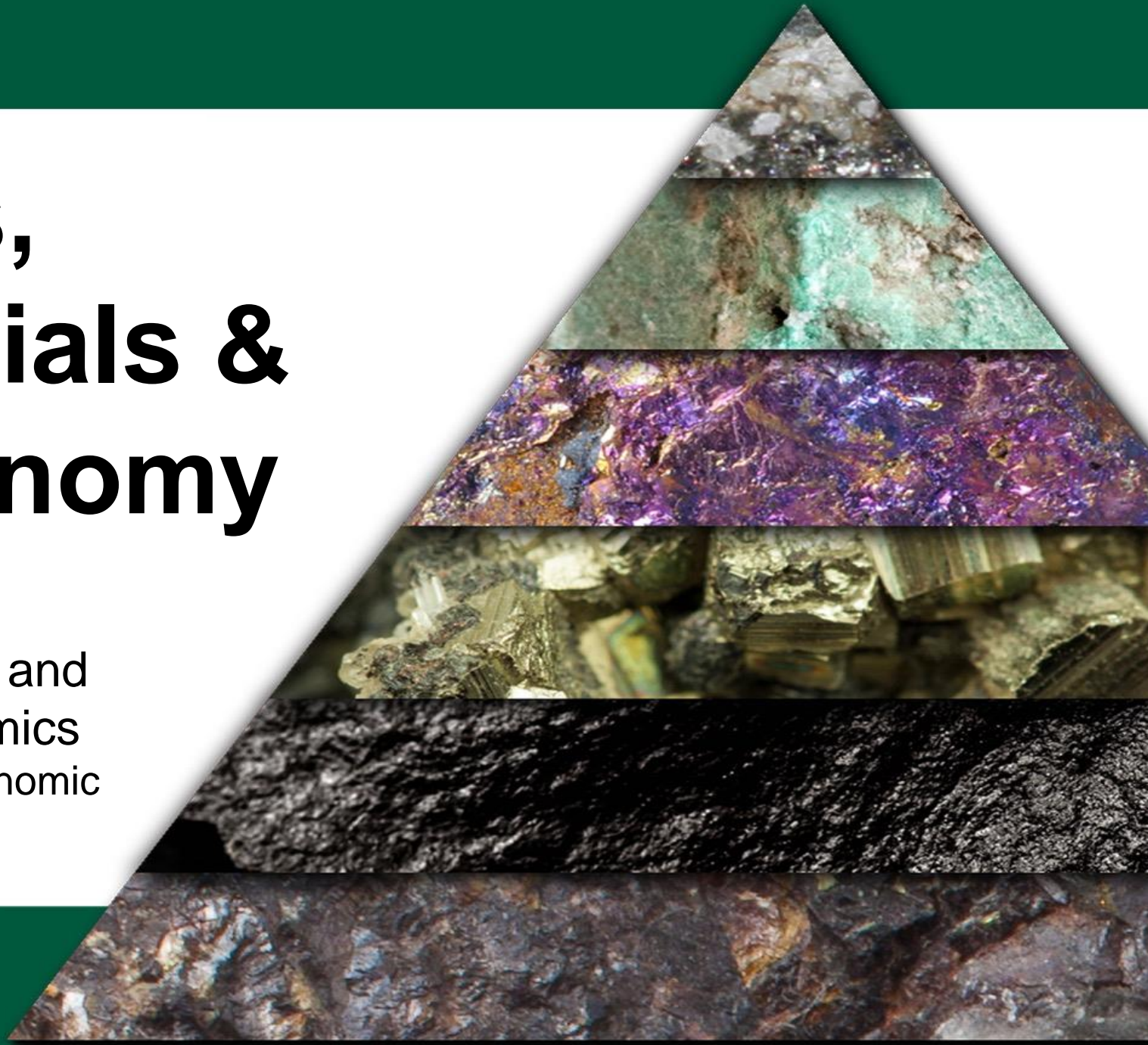
# Minerals, Critical Materials & Alaska's Economy

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UAA Institute of Social  
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UNIVERSITY of ALASKA ANCHORAGE

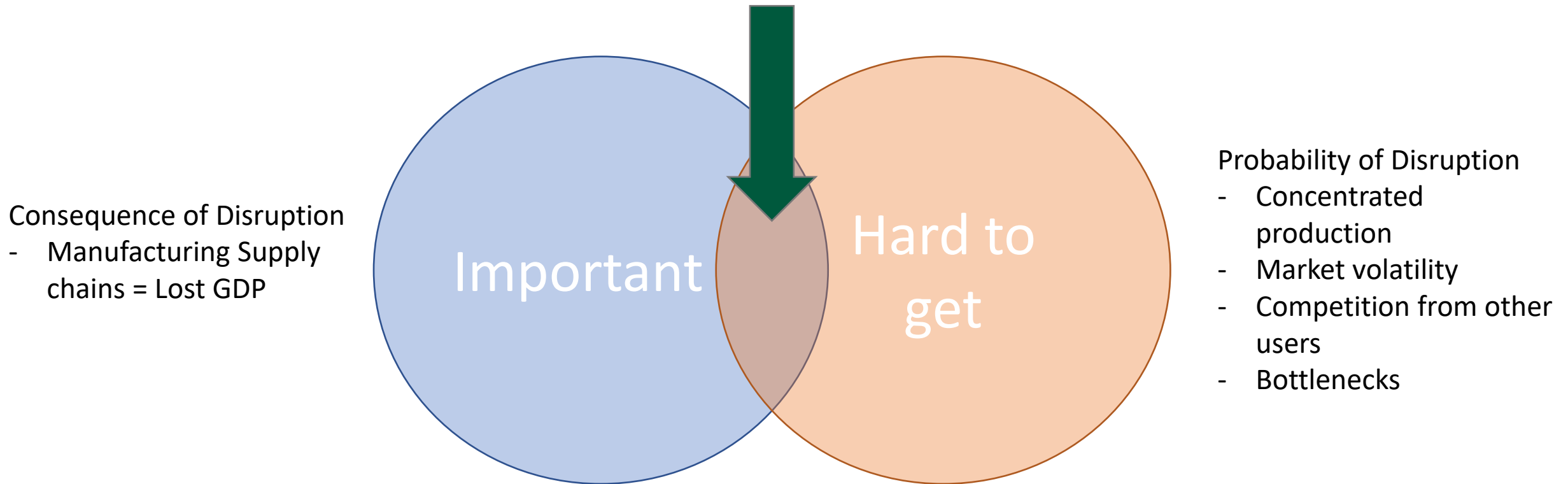


# Defining “Critical Minerals”

Periodic Table of the Elements																		18 VIII A 8A					
1 IA 1A																	2						
1 H Hydrogen 1.008	2 IIA 2A																	13 IIIA 3A	14 IVA 4A	15 VA 5A	16 VIA 6A	17 VIIA 7A	18 VIII A 8A
3 Li Lithium 6.941	4 Be Beryllium 9.012																	5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180
11 Na Sodium 22.990	12 Mg Magnesium 24.305	3 IIIB 3B	4 IVB 4B	5 VB 5B	6 VIB 6B	7 VIIB 7B	8 VIII 8	9 VIII 8	10 VIII 8	11 IB 1B	12 IIB 2B	13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.066	17 Cl Chlorine 35.453	18 Ar Argon 39.948						
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.88	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.933	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.39	31 Ga Gallium 69.732	32 Ge Germanium 72.61	33 As Arsenic 74.922	34 Se Selenium 78.09	35 Br Bromine 79.904	36 Kr Krypton 84.80						
37 Rb Rubidium 84.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.94	43 Tc Technetium 98.907	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.906	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.71	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.904	54 Xe Xenon 131.29						
55 Cs Cesium 132.905	56 Ba Barium 137.327	57-71	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.85	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.967	80 Hg Mercury 200.59	81 Tl Thallium 204.383	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium [208.982]	85 At Astatine 209.987	86 Rn Radon 222.018						
87 Fr Francium 223.020	88 Ra Radium 226.025	89-103	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [269]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [269]	111 Rg Roentgenium [272]	112 Cn Copernicium [277]	113 Uut Ununtrium unknown	114 Fl Flerovium [289]	115 Uup Ununpentium unknown	116 Lv Livermorium [298]	117 Uus Ununseptium unknown	118 Uuo Ununoctium unknown						
Lanthanide Series		57 La Lanthanum 138.906	58 Ce Cerium 140.115	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.24	61 Pm Promethium 144.913	62 Sm Samarium 150.36	63 Eu Europium 151.966	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.50	67 Ho Holmium 164.930	68 Er Erbium 167.26	69 Tm Thulium 168.934	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967							
Actinide Series		89 Ac Actinium 227.028	90 Th Thorium 232.038	91 Pa Protactinium 231.036	92 U Uranium 238.029	93 Np Neptunium 237.048	94 Pu Plutonium 244.064	95 Am Americium 243.061	96 Cm Curium 247.070	97 Bk Berkelium 247.070	98 Cf Californium 251.080	99 Es Einsteinium [254]	100 Fm Fermium 257.095	101 Md Mendelevium 258.1	102 No Nobelium 259.101	103 Lr Lawrencium [262]							

# Defining “Critical Minerals”

- Critical minerals are *IMPORTANT* and also *HARD TO GET*

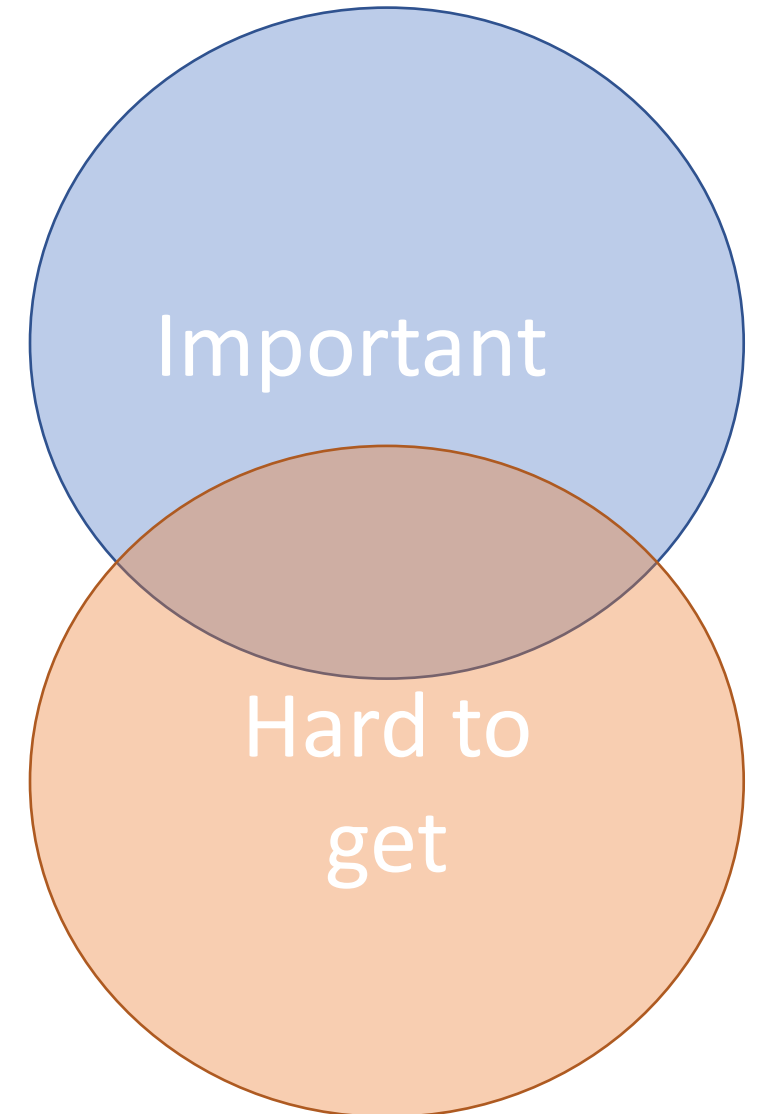


# What's “Critical” Depends on Your Perspective

- At a country level: The *US's* manufacturing industry has a different perspective than *Germany's*
  - We make different things
  - We have different supply chains
- At a company level: *Tesla* different than *Toyota*
  - Tesla only makes EVs
  - Toyota makes ICE, hybrid, and EVs
- *China's* supply risk is different than the *UK's*
  - China dominates secondary processing
  - BUT still faces risks

# A look at one perspective: USGS

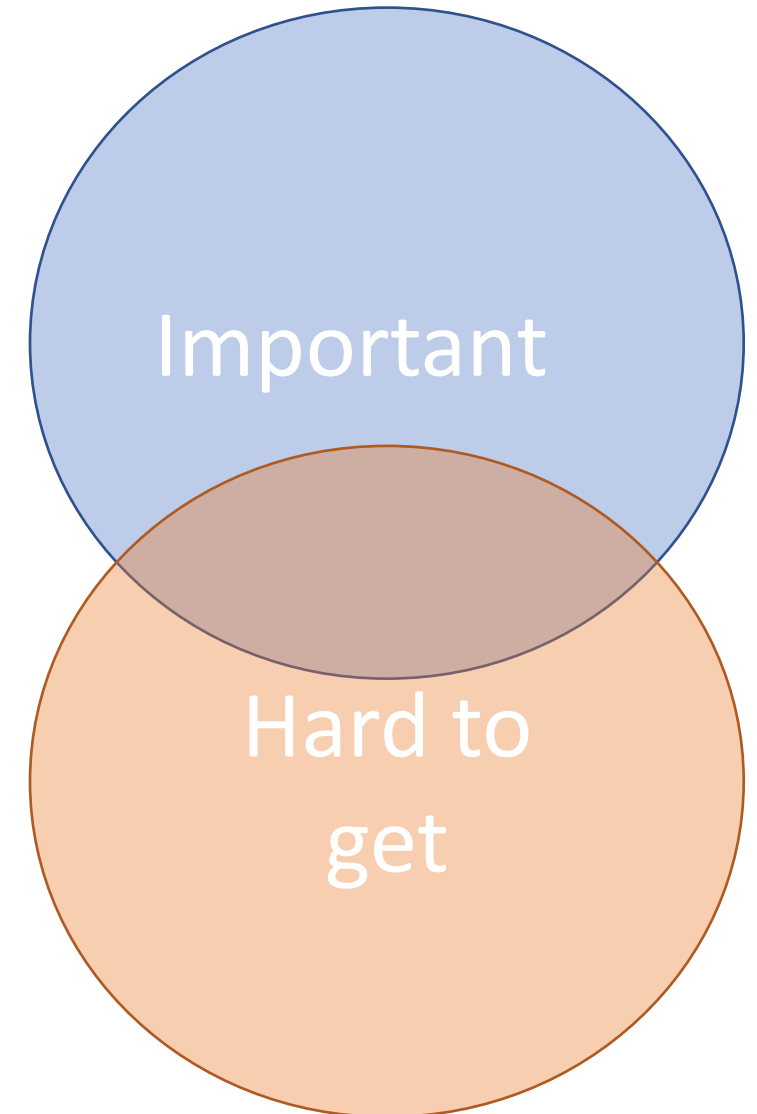
- USGS in 2018 released list of “critical” minerals in response to Executive Order No. 13817
- The Energy Act of 2020 now requires USGS to update method and list every 3 years.
  - Critical minerals defined as minerals which:
    - (i) are essential to the economic or national security of the United States;
    - (ii) the supply chain of which is vulnerable to disruptions (including restrictions associated with foreign political risk, abrupt demand growth, military conflict, violent unrest, anti-competitive or protectionist behaviors, and other risks throughout the supply chain); **and**
    - (iii) serve an essential function in the manufacturing of a product (including energy technology-, defense-, currency-, agriculture-, consumer electronics-, and healthcare-related applications), the absence of which would have significant consequences for the economic or national security of the United States”



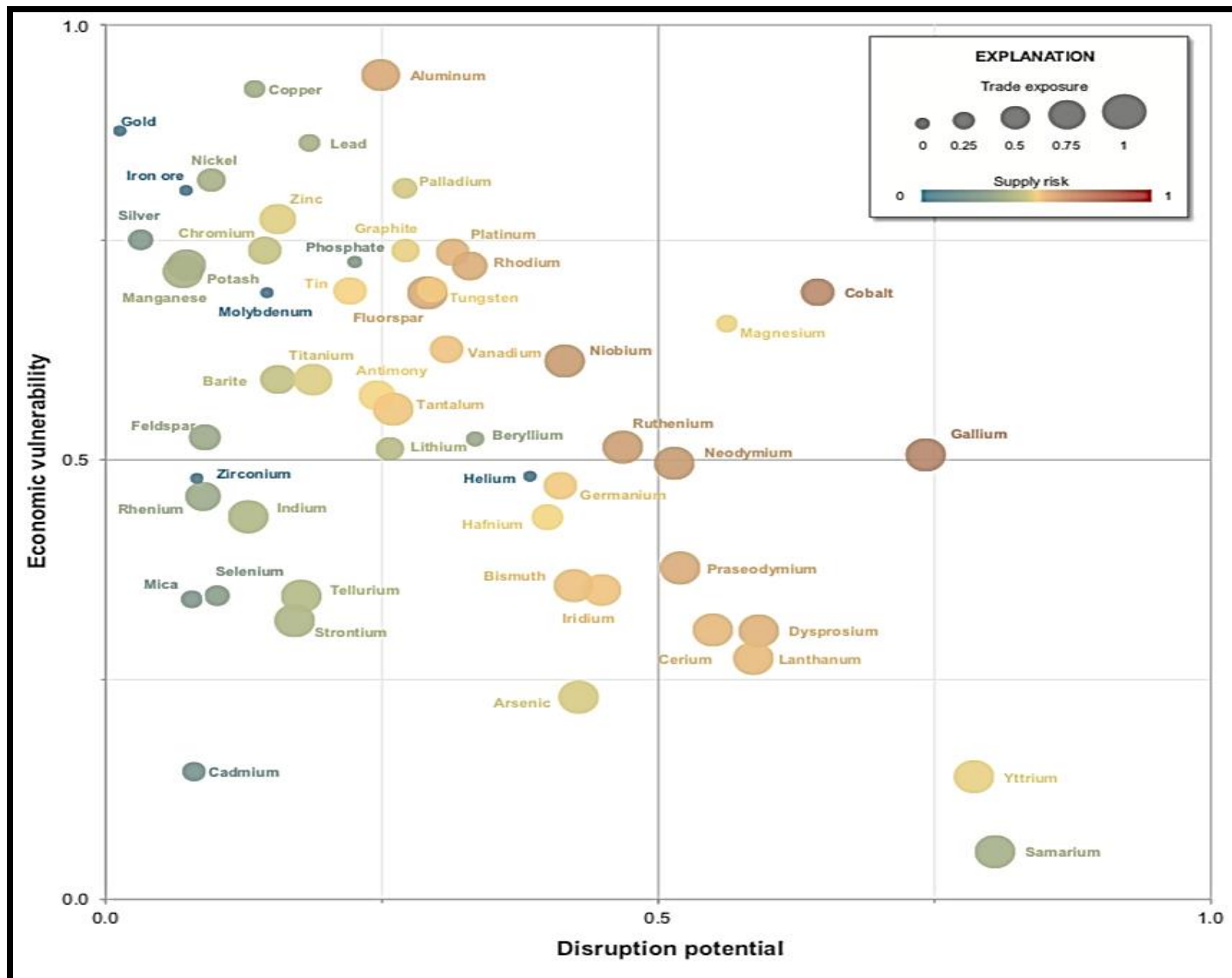


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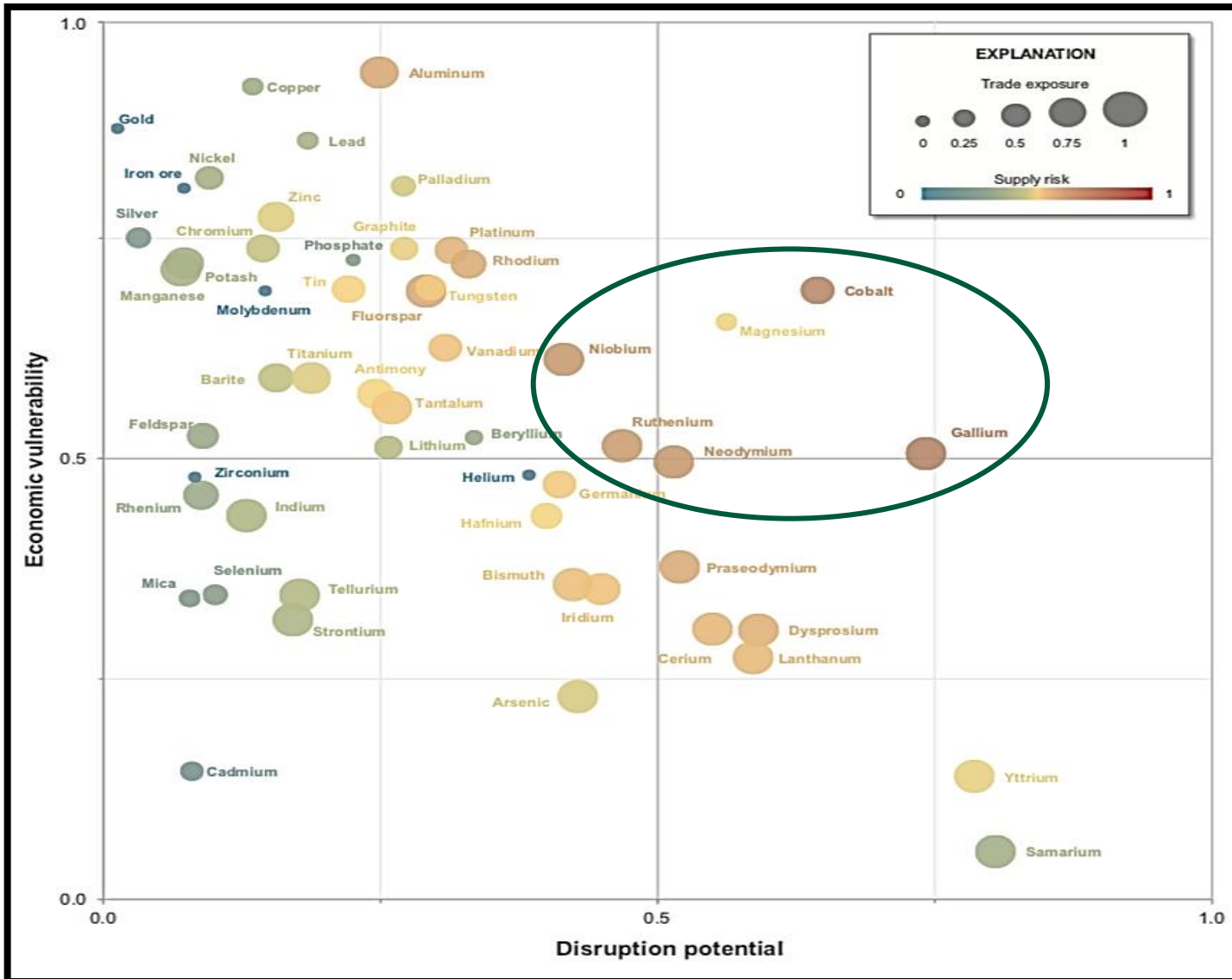
Important



Hard to get

Commodity	2018	Recency-weighted mean	Leading producing countries
			Names and process stages
Gallium		0.67	China
Niobium		0.66	Brazil
Cobalt		0.65	DRC (mining), China (refining)
Neodymium		0.65	China (mining and refining)
Ruthenium		0.63	South Africa
Rhodium		0.62	South Africa
Dysprosium		0.61	China (mining and refining)
Aluminum		0.60	China (alumina and aluminum); Australia (bauxite)
Fluorspar		0.60	China
Platinum		0.60	South Africa
Iridium		0.59	South Africa
Praseodymium		0.58	China (mining and refining)
Cerium		0.58	China (mining and refining)
Lanthanum		0.58	China (mining and refining)
Bismuth		0.55	China
Yttrium		0.54	China (mining and refining)
Antimony		0.53	China
Tantalum		0.53	DRC
Hafnium		0.51	France
Tungsten		0.51	China
Vanadium		0.51	China
Tin		0.50	China (mining and smelting)
Magnesium		0.49	China
Germanium		0.49	China
Palladium		0.48	Russia
Titanium		0.48	Australia (mineral concentrate), China (sponge)
Zinc		0.48	China (mining and smelting)
Graphite		0.47	China
Chromium		0.47	South Africa
Arsenic		0.45	China
Barite		0.44	China
Indium		0.41	China
Samarium		0.40	China (mining and refining)
Manganese		0.40	South Africa
Lithium		0.40	Australia (mining), China (refining)
Tellurium		0.40	China
Lead		0.39	China (mining and refining)
Potash		0.38	Canada
Strontium		0.36	China
Rhenium		0.36	Chile
Nickel		0.36	Indonesia (mining), China (refining)
Copper		0.34	Chile (mining), China (smelting and refining)
Beryllium		0.33	United States
Feldspar		0.32	Turkey
Phosphate		0.25	China
Silver		0.25	Mexico
Mica		0.22	China
Selenium		0.23	Japan
Cadmium		0.11	China
Zirconium		0.09	Australia
Molybdenum		0.07	China
Gold		0.00	China
Helium		0.00	United States
Iron ore		0.00	Australia

# A look at one perspective: USGS





# Different Perspectives + Different Timing = Different Lists

Mineral	US 2018	US 2022	EU 2023	Japan 2023	Strategic Defense
Current Production in Alaska					
Zinc		✓		✓	
Gold					
Silver					
Lead					

Mineral	US 2018 (35)	US 2022 (50)	EU 2023 (34)	Japan 2023 (35)	Strategic Defense (12)
Historical Production in Alaska					
Antimony	✓	✓	✓	✓	✓
Tin	✓	✓		✓	
Tungsten	✓	✓	✓	✓	✓
Chromium	✓	✓		✓	
Platinum		✓			
Palladium		✓			
Platinum Group Metals	✓		✓	✓	
Uranium	✓				
Mercury (not on current lists)					

# Different Perspectives – Different Lists

Mineral	US 2018 (35)	US 2022 (50)	EU 2023 (34)	Japan 2023 (35)	Strategic Defense (12)
Confirmed Resources in Alaska					
Rare Earth Elements (REE)	✓		✓	✓	✓
Cerium		✓		✓	
Neodymium		✓		✓	
Praseodymium		✓		✓	
Dysprosium		✓		✓	
Erbium		✓		✓	
Europium		✓		✓	
Gadolinium		✓		✓	
Holmium		✓		✓	
Lanthanum		✓		✓	
Lutetium		✓		✓	
Samarium		✓		✓	
Terbium		✓		✓	
Thulium		✓		✓	
Ytterbium		✓		✓	
Yttrium		✓		✓	✓
Copper			✓*		
Molybdenum	✓	✓		✓	
Cobalt	✓	✓	✓	✓	
Nickel		✓	✓*	✓	
Graphite (Natural)	✓	✓	✓	✓	✓
Lithium	✓	✓	✓	✓	

Mineral	US 2018 (35)	US 2022 (50)	EU 2023 (34)	Japan 2023 (35)	Strategic Defense (12)
Speculative Potential in Alaska					
Aluminum/Bauxite	✓	✓	✓	✓	
Arsenic	✓	✓	✓	✓	✓
Barite	✓	✓	✓	✓	
Beryllium	✓	✓	✓	✓	
Bismuth	✓	✓	✓	✓	✓
Boron/Borate			✓	✓	
Cesium	✓	✓		✓	
Coking Coal			✓		
Feldspar			✓		
Fluorspar	✓	✓	✓	✓	
Gallium	✓	✓	✓	✓	✓
Germanium****	✓	✓	✓	✓	✓
Hafnium	✓	✓	✓	✓	
Helium	✓		✓	✓	
Indium	✓	✓		✓	✓
Iridium		✓			
Magnesium	✓	✓	✓	✓	
Manganese	✓	✓	✓	✓	
Niobium	✓	✓	✓	✓	
Phosphate Rock			✓		
Phosphorus			✓	✓	
Potash	✓				
Rhenium	✓			✓	
Rhodium		✓			
Rubidium	✓	✓		✓	
Ruthenium		✓			
Scandium	✓	✓	✓	✓	✓
Silicon Metal			✓		
Strontium	✓		✓	✓	
Tantalum	✓	✓	✓	✓	✓
Tellurium	✓	✓		✓	
Titanium	✓	✓	✓	✓	
Vanadium	✓	✓	✓	✓	
Zirconium	✓	✓		✓	

# Why create lists?

- Method for prioritization of R&D research spend:
- Diversify production: *Increase primary supply*
  - Reduce mining & milling private and external cost
  - Increase mill/refinery recovery efficiency
- Develop substitutes: *Reduce demand*
  - Improve manufacturing processes
  - Use less to achieve same properties
  - Substitute metals
  - Substitute technology
- Promote circular economies: *Enhance End of Life Recycling*

# Why create lists?

- Primary CM policy: R&D funding allocation (see previous slide)
- However, other policy includes:
- Permitting & Facilitating IBA/FPI Consent
- Stockpiles, Take/Pay contracts, Grants, Subsidies, etc
- Identify workforce needs
- Trade policy
- Information

# What are jurisdictions trying to achieve?

- Supply chain disruptions can impact manufacturing activity
  - For strategic minerals – national defense implications
  - For critical minerals – impacts to economy via manufacturing disruption
- Other goals (eg decarbonization) require deployment of significant manufactured capital
  - High external cost of delayed deployment



# Alaska's Investment Landscape



# Thank you

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