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before the
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Good morning Chairman Murkowski, Ranking Member Cantwell, and Members of the Committee, and thank you for the opportunity to discuss the U.S. Geological Survey's efforts related to critical minerals.

Background

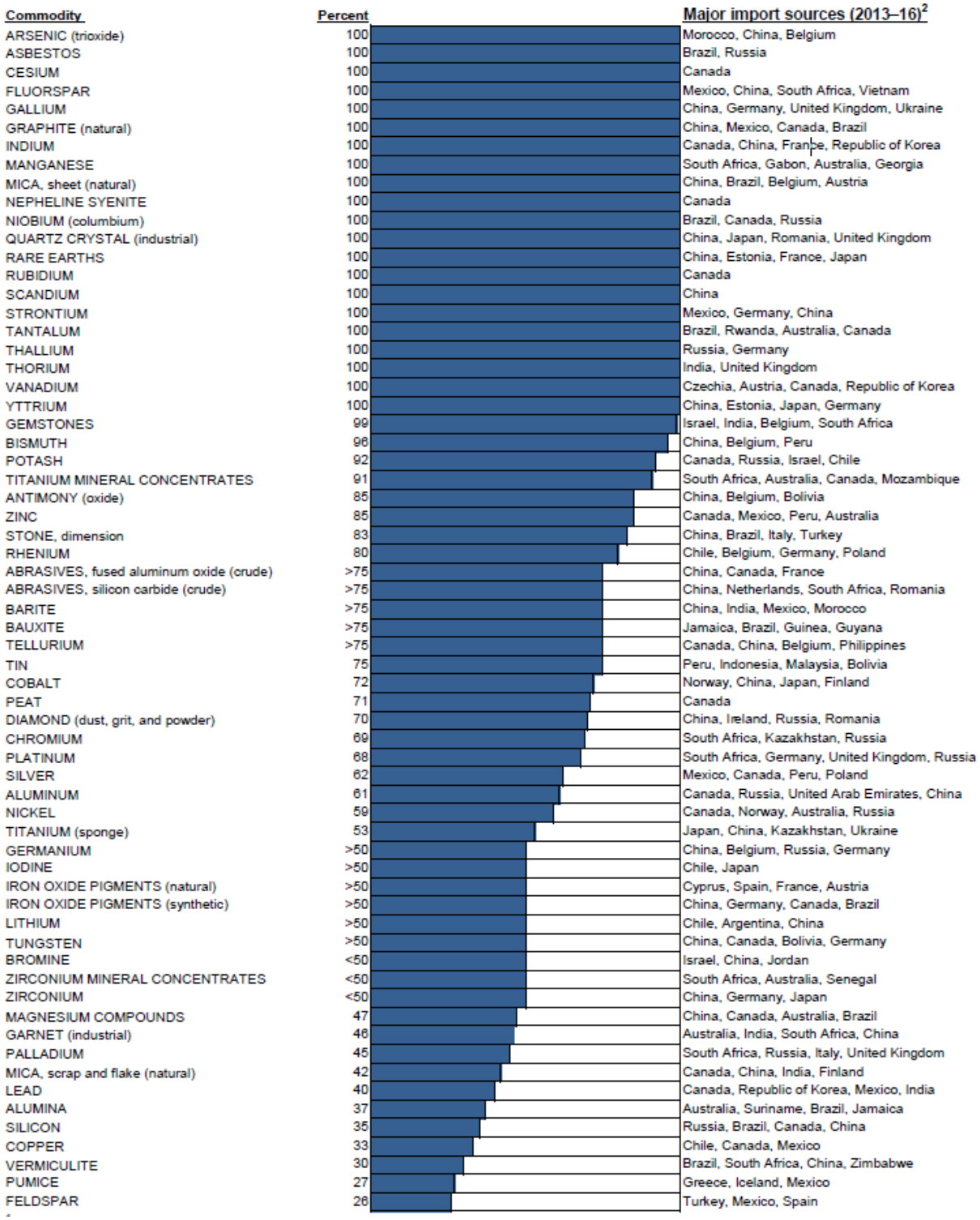
The Department of the Interior manages one-fifth of the Nation's lands, as well as the Nation's offshore energy. These responsibilities include leasing and permitting activities for both onshore and offshore access to and development of the Nation's mineral resources, through the Bureau of Land Management (BLM) and the Bureau of Ocean Energy Management. The U.S. Geological Survey (USGS) conducts scientific research on how mineral resources form geologically, provides earth-science based assessments on the geologic potential for mineral commodity occurrences across the Nation and globe, and provides statistics on the worldwide supply, demand, consumption, and flow of mineral commodities essential to the Nation's economy and national security.

Reliance on Foreign Sources of Minerals

USGS data show that domestic and global demand for mineral commodities continues to increase.[1] An increasingly broad range of mineral commodities are used in consumer and national security applications , especially those involving advanced technologies. The United States remains a major mineral producer with an estimated total value of non-fuel mineral resources of $75.2 billion in 2017, and is a net exporter of 16 non-fuel mineral commodities. However, our country continues to rely on foreign sources for some raw and processed mineral materials. In 2017, the country was 100 percent import-reliant for 21 mineral commodities. For comparison, in 1984, the country was 100 percent import-reliant for just 11 mineral commodities. Furthermore, the country was at least 50 percent import-reliant for 50 mineral commodities in 2017. Figures 1 and 2 provide an overview of these import sources, and show that China, followed by Canada, supplied the largest number of nonfuel mineral commodities for which the U.S. is more than 50 percent import reliant.

This dependency of the United States on foreign sources creates the potential for strategic vulnerabilities for the Nation's economic and national security interests, to adverse foreign government actions, natural disasters, or other events that can disrupt supply of important minerals.

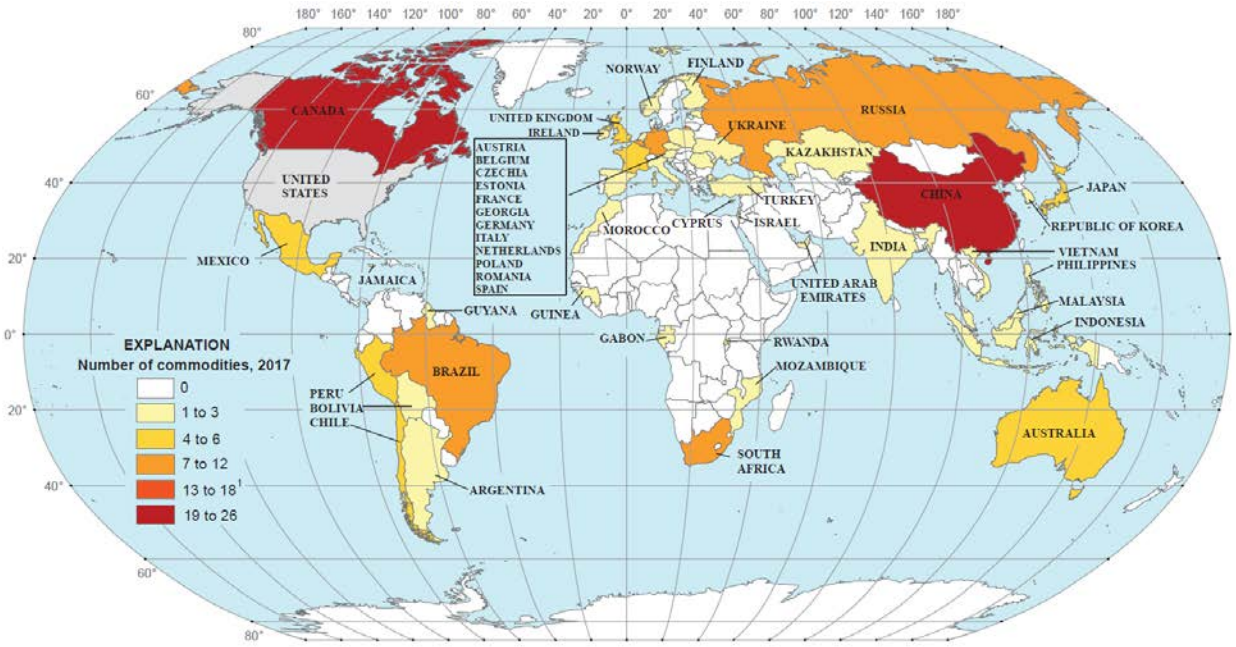
[1] U.S. Geological Survey, 2018, Mineral Commodity Summaries 2018, 200 pp, https://minerals.usgs.gov/minerals/pubs/mcs/



Commodity	Percent	Major import sources (2013–16)[2]
ARSENIC (trioxide)	100	Morocco, China, Belgium
ASBESTOS	100	Brazil, Russia
CESIUM	100	Canada
FLUORSPAR	100	Mexico, China, South Africa, Vietnam
GALLIUM	100	China, Germany, United Kingdom, Ukraine
GRAPHITE (natural)	100	China, Mexico, Canada, Brazil
INDIUM	100	Canada, China, France, Republic of Korea
MANGANESE	100	South Africa, Gabon, Australia, Georgia
MICA, sheet (natural)	100	China, Brazil, Belgium, Austria
NEPHELINE SYENITE	100	Canada
NIOBIUM (columbium)	100	Brazil, Canada, Russia
QUARTZ CRYSTAL (industrial)	100	China, Japan, Romania, United Kingdom
RARE EARTHS	100	China, Estonia, France, Japan
RUBIDIUM	100	Canada
SCANDIUM	100	China
STRONTIUM	100	Mexico, Germany, China
TANTALUM	100	Brazil, Rwanda, Australia, Canada
THALLIUM	100	Russia, Germany
THORIUM	100	India, United Kingdom
VANADIUM	100	Czechia, Austria, Canada, Republic of Korea
YTTRIUM	100	China, Estonia, Japan, Germany
GEMSTONES	99	Israel, India, Belgium, South Africa
BISMUTH	96	China, Belgium, Peru
POTASH	92	Canada, Russia, Israel, Chile
TITANIUM MINERAL CONCENTRATES	91	South Africa, Australia, Canada, Mozambique
ANTIMONY (oxide)	85	China, Belgium, Bolivia
ZINC	85	Canada, Mexico, Peru, Australia
STONE, dimension	83	China, Brazil, Italy, Turkey
RHENIUM	80	Chile, Belgium, Germany, Poland
ABRASIVES, fused aluminum oxide (crude)	>75	China, Canada, France
ABRASIVES, silicon carbide (crude)	>75	China, Netherlands, South Africa, Romania
BARITE	>75	China, India, Mexico, Morocco
BAUXITE	>75	Jamaica, Brazil, Guinea, Guyana
TELLURIUM	>75	Canada, China, Belgium, Philippines
TIN	75	Peru, Indonesia, Malaysia, Bolivia
COBALT	72	Norway, China, Japan, Finland
PEAT	71	Canada
DIAMOND (dust, grit, and powder)	70	China, Ireland, Russia, Romania
CHROMIUM	69	South Africa, Kazakhstan, Russia
PLATINUM	68	South Africa, Germany, United Kingdom, Russia
SILVER	62	Mexico, Canada, Peru, Poland
ALUMINUM	61	Canada, Russia, United Arab Emirates, China
NICKEL	59	Canada, Norway, Australia, Russia
TITANIUM (sponge)	53	Japan, China, Kazakhstan, Ukraine
GERMANIUM	>50	China, Belgium, Russia, Germany
IODINE	>50	Chile, Japan
IRON OXIDE PIGMENTS (natural)	>50	Cyprus, Spain, France, Austria
IRON OXIDE PIGMENTS (synthetic)	>50	China, Germany, Canada, Brazil
LITHIUM	>50	Chile, Argentina, China
TUNGSTEN	>50	China, Canada, Bolivia, Germany
BROMINE	<50	Israel, China, Jordan
ZIRCONIUM MINERAL CONCENTRATES	<50	South Africa, Australia, Senegal
ZIRCONIUM	<50	China, Germany, Japan
MAGNESIUM COMPOUNDS	47	China, Canada, Australia, Brazil
GARNET (industrial)	46	Australia, India, South Africa, China
PALLADIUM	45	South Africa, Russia, Italy, United Kingdom
MICA, scrap and flake (natural)	42	Canada, China, India, Finland
LEAD	40	Canada, Republic of Korea, Mexico, India
ALUMINA	37	Australia, Suriname, Brazil, Jamaica
SILICON	35	Russia, Brazil, Canada, China
COPPER	33	Chile, Canada, Mexico
VERMICULITE	30	Brazil, South Africa, China, Zimbabwe
PUMICE	27	Greece, Iceland, Mexico
FELDSPAR	26	Turkey, Mexico, Spain

Figure 1. 2017 U.S. net import reliance[2], expressed as a percentage of apparent consumption. (Source: USGS Mineral Commodity Summaries 2018.)

[2] In descending order of import share.



[1]In 2017, no countries qualified for the "13 to 18 commodities" category.

Figure 2. Major import sources of non-fuel mineral commodities, shaded to indicate the number of commodities for which the United States was more than 50 percent net import reliant in 2017. (Source: USGS Mineral Commodity Summaries 2018.)

A New Whole-of-Government Strategy

On December 20, 2017, President Trump issued Executive Order 13817, "A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals". The Executive Order directed the Federal Government to develop an interagency report, to include:

> (i) a strategy to reduce the Nation's reliance on critical minerals;
>
> (ii) an assessment of progress toward developing critical minerals recycling and reprocessing technologies, and technological alternatives to critical minerals;
>
> (iii) options for accessing and developing critical minerals through investment and trade with our allies and partners;
>
> (iv) a plan to improve the topographic, geologic, and geophysical mapping of the United States and make the resulting data and metadata electronically accessible; and
>
> (v) recommendations to streamline permitting and review processes related to developing leases; enhancing access to critical mineral resources; and increasing discovery, production, and domestic refining of critical minerals.

The Department of the Interior is contributing to several aspects of the report, with the Department of Commerce responsible for the overall report. Additional interagency contributions are being coordinated through the White House Office of Science and Technology Policy's National Science and Technology Council (NSTC) Subcommittee on Critical and Strategic Mineral Supply Chains. I'll describe some of the steps that USGS has taken in response to the Executive Order, and then discuss our approach to identifying critical minerals.

The Executive Order directed the Secretary of the Interior, in coordination with the Department of Defense and in consultation with other executive branch agencies, to publish a list of critical minerals. Under Department of the Interior Secretarial Order 3359, the USGS, in coordination with the BLM and with broad Federal interagency input, led development of the critical minerals list; this list will guide the focus of the Commerce-led report.

The USGS is also leading development of a plan to improve the Nation's mapping and understanding of subsurface mineral resources (item iv above), with input from agencies with both onshore and offshore mapping responsibilities (including USGS science and mapping programs, the Bureau of Ocean Energy Management, the National Oceanic and Atmospheric Administration, and the Department of Energy), and anticipated partnerships with states. The plan aims to improve the Nation's geophysical, geological and topographic mapping, building on existing national maps to create modern maps based on the newest technologies and science. USGS data collection, analysis and interpretation greatly enhances our understanding of the Nation's geological endowment of critical minerals, and directly benefits our understanding of other economically valuable mineral resources, energy resources, groundwater resources, geologic hazards, infrastructure dependencies on subsurface geology, and other societal needs.

In addition, the USGS is contributing technical input to the report in response to the Executive Order on the geologic composition of above-ground sources of minerals such as mine wastes and other waste streams; and on global production and trade statistics for mineral commodities.

Identifying Minerals as "Critical"

Federal agencies and other organizations use a number of existing definitions and criteria to identify a material or mineral as "critical", "strategic", or otherwise important. The Executive Order defined a critical mineral as (i) a non-fuel mineral or mineral material essential to the economic and national security of the United States, (ii) the supply chain of which is vulnerable to disruption, and (iii) that serves an essential function in the manufacturing of a product, the absence of which would have significant consequences for the U.S. economy or national security.

To identify minerals meeting the definition of criticality under the Executive Order, the USGS used as a starting point a screening tool developed in 2016 and updated in 2017[3,4] by the NSTC

[3] White House Office of Science and Technology Policy, National Science and Technology Council, 2016, "Assessment of critical minerals: screening methodology and initial application", https://www.whitehouse.gov/sites/whitehouse.gov/files/images/CSMSC%20Assessment%20of%20Critical%20Minerals%20Report%202016-03-16%20FINAL.pdf

[4] EA McCullough and N Nassar, 2017, "Assessment of critical minerals: Updated application of an early-warning screening methodology", in Mineral Economics 30(3), https://pubs.er.usgs.gov/publication/70191019

Subcommittee. The NSTC Subcommittee has representation from Federal Departments including, but not limited to, Defense, Interior, Energy, State, Commerce, and Homeland Security. This interagency engagement resulted in a tool that drew from the contributing agencies' existing prioritization processes, and represents a range of Federal agency missions and understanding of industries. The tool is a quantitative methodology for identifying and ranking mineral commodities based on widely accepted criteria published in the mineral commodity literature. Using that methodology, and several other sources of data, the USGS applied two principal quantitative criteria to evaluate minerals for inclusion on the draft list of critical minerals: the Herfindahl-Hirschman index, which measures country concentration of production, and the USGS net import reliance metric based on USGS's annual Mineral Commodities Summaries.[5]

The Secretary of the Interior published a draft list of critical minerals in the Federal Register on February 16, 2018[6], accepted public comment for 30 days ending March 19, 2018[7], and received more than 450 comments, which are available at regulations.gov (https://www.regulations.gov/document?D=DOI-2018-0001-0001). After reviewing the comments, the Department of the Interior finalized the list in a second Federal Register notice on May 18, 2018.[8] The list of critical minerals, while "final," is not a permanent list, but is dynamic and will be updated periodically to reflect current data on supply, demand, and concentration of production, as well as current policy priorities. The list consists of 35 minerals or mineral groups: 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, and zirconium. Figure 3 provides an overview of these critical minerals' major uses at the sector level and trade dependencies at the country level.

This list of critical minerals does not include a number of economically significant minerals, such as copper, zinc, molybdenum, gold, silver; and industrial minerals such as phosphate rock, sand, gravel, and aggregates that are produced domestically in large quantities. Given current levels of domestic production, the U.S. is not highly reliant on imports for these minerals and typically has a combination of domestic reserves and reliable foreign sources adequate to meet foreseeable domestic consumption requirements. While these minerals do not currently meet the definition of critical, they are important to a modern society for the purposes of national security, technology, infrastructure, and energy production from both fossil fuels and renewable energy generation.

[5] The methodology used by the USGS is published in USGS Open-File Report 2018-1021, https://pubs.usgs.gov/of/2018/1021/ofr20181021.pdf

[6] Draft List of Critical Minerals, 83 FR 7065, https://www.federalregister.gov/documents/2018/02/16/2018-03219/draft-list-of-critical-minerals

[7] Comments received are available at https://www.regulations.gov under docket DOI-2018-0001.

[8] Final List of Critical Minerals 2018, 83 FR 23295, https://www.federalregister.gov/documents/2018/05/18/2018-10667/final-list-of-critical-minerals-2018

Mineral commodity	Sectors						Top Producer	Top Supplier	Notable example application
	Aerospace (non-defense)	Defense	Energy	Telecommunications & electronics	Transportation (non-aerospace)	Other			
Aluminum	■	■	■	■	■	■	China	Canada	Aircraft, power transmission lines, lightweight alloys
Antimony		■	■	■	■	■	China	China	Lead-acid batteries
Arsenic		■	■	■		■	China	China	Microwave communications (gallium arsenide)
Barite			■	■		■	China	China	Oil and gas drilling fluid
Beryllium	■	■	■	■		■	United States	Kazakhstan	Satellite communications, beryllium metal for aerospace
Bismuth		■	■	■		■	China	China	Pharmaceuticals, lead-free solders
Cesium and rubidium	■	■	■	■		■	Canada	Canada	Medical applications, global positioning satellites, night-vision devices
Chromium	■	■	■	■	■	■	South Africa	South Africa	Jet engines (superalloys), stainless steels
Cobalt	■	■	■	■	■	■	Congo (Kinshasa)	Norway	Jet engines (superalloys), rechargeable batteries
Fluorspar			■	■		■	China	Mexico	Aluminum and steel production, uranium processing
Gallium	■	■	■	■		■	China	China	Radar, light-emitting diodes (LEDs), cellular phones
Germanium	■	■	■	■		■	China	China	Infrared devices, fiber optics
Graphite (natural)	■	■	■	■	■	■	China	China	Rechargeable batteries, body armor
Helium				■		■	United States	Qatar	Cryogenic [magnetic resonance imaging (MRI)]
Indium	■	■	■	■		■	China	Canada	Flat-panel displays (indium-tin-oxide), specialty alloys
Lithium	■	■	■	■	■	■	Australia	Chile	Rechargeable batteries, aluminum-lithium alloys for aerospace
Magnesium	■	■	■	■	■	■	China	China	Incendiary countermeasures for aerospace
Manganese	■	■	■	■	■	■	China	South Africa	Aluminum and steel production, lightweight alloys
Niobium	■	■	■	■		■	Brazil	Brazil	High-strength steel for defense and infrastructure
Platinum group metals	■		■	■	■	■	South Africa	South Africa	Catalysts, superalloys for jet engines
Potash			■	■		■	Canada	Canada	Agricultural fertilizer
Rare earth elements	■	■	■	■	■	■	China	China	Aerospace guidance, lasers, fiber optics
Rhenium	■		■	■		■	Chile	Chile	Jet engines (superalloys), catalysts
Scandium	■		■	■		■	China	China	Lightweight alloys, fuel cells
Strontium	■	■	■	■	■	■	Spain	Mexico	Aluminum alloys, permanent magnets, flares
Tantalum	■	■	■	■		■	Rwanda	China	Capacitors in cellular phones, jet engines (superalloys)
Tellurium		■	■	■		■	China	Canada	Infrared devices (night-vision), solar cells
Tin		■		■		■	China	Peru	Solder, flat-panel displays (indium-tin-oxide)
Titanium	■	■	■	■		■	China	South Africa	Jet engines (superalloys) and airframes (titanium alloys), armor
Tungsten	■	■	■	■		■	China	China	Cutting and drilling tools, catalysts, jet engines (superalloys)
Uranium	■	■	■			■	Kazakhstan	Canada	Nuclear applications, medical applications
Vanadium	■	■	■	■		■	China	South Africa	Jet engines (superalloys) and airframes (titanium alloys), high-strength steel
Zirconium and hafnium	■	■	■	■		■	Australia	China	Thermal barrier coating in jet engines, nuclear applications

Figure 3. The 2018 list of critical minerals, as defined by Executive Order 13817.

Input from other agencies represented on the NSTC Subcommittee emphasized that uranium, while primarily used as a fuel mineral, also has important non-fuel uses related to national security, such as radiation shields, counterweights, and armor piercing kinetic energy penetrators. In addition, Energy Information Administration data indicate high production concentration and significant import reliance. Based on these factors, uranium meets the criteria for inclusion on the 2018 list.

Of the 35 minerals deemed critical, 12 are commodities recovered during the processing, smelting, or refining of a host material and are, therefore, deemed "byproducts." For example, rhenium is recovered as a byproduct of smelting copper-molybdenum ores. Similarly, helium is a byproduct of natural gas production.

Conclusion

The USGS is actively working to support the Executive Order through our minerals science and mineral information. We appreciate the strong engagement of Congress, other Federal agencies, and of the coordinating roles played by the White House Office of Science and Technology Policy, Council on Environmental Quality and the National Economic Council.

Thank you for the opportunity to present on behalf of the U.S. Geological Survey on the important subject of critical minerals. I will be happy to answer any questions.