

Global Trends in Mineral Commodity Supplies: Implications for U.S. Economic and National Security Interests

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U.S. Department of the Interior U.S. Geological Survey

National Minerals Information Center: Business Model

- Well defined mission
- Well defined product portfolio
- Well defined customer base
- Operational focus
- Production shop, monthly, quarterly, and annual cycles
- Consistently deliver results





National Minerals Information Center (NMIC)

Mission

- To collect, analyze, and disseminate information on the domestic and international supply of and demand for non-fuel minerals and materials essential to the U.S. economy and national security.
- Objective
 - Provide decision makers with the information required to ensure that the U.S. has an adequate supply of minerals and materials to meet U.S. needs, at an acceptable cost with regard to environmental, energy, and economic factors.





Customers – Professional Associations

Minerals Science and Information Coalition

- Aluminum Association
- Association of American State Geologists
- American Chemical Society
- American Exploration & Mining Association
- American Geosciences Institute
- American Physical Society
- Associated Equipment Distributors
- Geological Society of America
- Industrial Minerals Association North America

- Interstate Mining Compact
 Commission
- Minerals Research Society
- National Electric Manufacturers Association
- National Mining Association
- National Stone, Sand and Gravel Association
- Portland Cement Association
- Society of Economic Geologists
- Society for Mining, Metallurgy and Exploration



Scope & Product Portfolio

Broad Mineral Commodity Coverage (>85 Commodities)



Broad Global Coverage: >180 Countries





- Mineral Commodity Summaries
- Minerals Yearbook
- Mineral Industry Surveys
- Metal Industry Indicators
- Nonmetallic Mineral Industry Indexes
- Special publications
- Data Series
- Fact Sheets
- > 700 Publications Annually
- Monthly, quarterly, annual work product cycles

Global Demand for Mineral Commodities

- Historically Unprecedented
- Growing Rapidly
- Dominated by Development in China
- Continued Demand Growth Anticipated for ROW



Source: USGS Historical Data Series



"Middle Class" Population Growth

Regional View

- Net + 3 billion people in the middle class by 2030
- Largest increase in the Asia Pacific region (6x)
- MENA (2x) from a relatively low base

≈USGS

 NA and Europe flat to declining (absolute numbers) with a shrinking global share



http://www.brookings.edu/~/media/research/files/papers/2010/3/china%20middle%20class%20kharas/03_china_middle_class_kharas.pdf

Technology is becoming more complex

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Cs	Ва	La	Hf	Та	w	Re	Os	Ir	Pt	Au	Hg	ті	Pb	Bi	Ро	At	Rn
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Ср		FI		Lv		

Се	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Но	Er	Tm	Yb	Lu
Th	Ра	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

~30 elements

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Li	Be		B C N O F												Ne		
Na	Mg			_	_	_						AI	Si	Р	S	CI	Ar
κ	Са	Sc	Ti	۷	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Мо	Тс	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Те	T	Xe
Cs	Ва	La	Hf	Та	w	Re	Os	Ir	Pt	Au	Hg	ТІ	Pb	Bi	Ро	At	Rn
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Ср		FI		Lv		

Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Но	Er	Tm	Yb	Lu
Th	Ра	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

~75 elements





DLA-SM Definition of Strategic & Critical Materials

DLA Strategic Materials is the operational arm of *The Strategic* and *Critical Materials Stockpiling Act (50 U.S.C. 98 et seq.).*

The term "strategic and critical" (S&C) materials is defined by this Act:

"...means materials that

- (A) would be needed to supply the military, industrial, and essential civilian needs of the United States during a national emergency, and
- (B) are not found or produced in the United States in sufficient quantities to meet such need."

MAJOR IMPORT SOURCES OF NONFUEL MINERAL COMMODITIES FOR WHICH THE UNITED STATES WAS GREATER THAN 50% NET IMPORT RELIANT IN 2015



Source: U.S. Geological Survey



http://minerals.usgs.gov/minerals/pubs/mcs/2016/mcs2016.pdf

Net Import Reliance

- Country Specific
- Updated Annually
- Broad coverage
- Timely

ASBESTOS BAUXITE CESIUM FLUORSPAF GALLIUM

GRAPHITE (natural INDIUM

MANGANESE MICA, sheet (natural) NIOBIUM (columbium) QUARTZ CRYSTAL (indus RUBIDIUM SCANDIUM

STRONTIUM TANTALUM THALLIUM THORIUM

VANADIUM GEMSTONES BISMUTH

PLATINUM

GERMANILIM

ANTIMONY

STONE (din

RHENIUM SILICON CARBIDE (crude)

COBALT

SILVER

BARITE

PEAT

TIN

RARE EARTHS¹

TITANIUM (spor

CHROMIUM

PALLADIUN

TUNGSTEN MAGNESIUM COMPOUND

ALUMINUM

SULFUR GYPSUM TALC FELDSPAR

BERYLLIUM IRON and STEEL SLAG

CEMENT

MCA, scrap and flake (nat SILICON NICKEL COPPER SALT LEAD NITROGEN (fixed)—AMM MAGNESIUM METAL IRON and STEEL PERLITE PUMICE VERMICULITE

POTASH

ZINC

GARNET (industria

TITANIUM MINERAL CONC

DIAMOND (dust grit, and po

2015 U.S. NET IMPORT RELIANCE¹

	Percent	Major import sources (2011–14) ²
	100	Morocco, China, Beigium
	100	Brazil, Canada
	100	Canada
	100	Maxico China South Africa Monodia
	100	Germany, China, Joddin Vanca, Mongolia
	100	China, Mexico, Canada, Brazil
	100	Canada, China, Belgium, Begublic of Korea
	100	South Africa, Gabon, Australia, Georgia
	100	India, Brazil, China, Belgium
	100	Brazil, Canada
rial)	100	China, Japan, Romania, United Kingdom
	100	Canada
	100	China
	100	Mexico, Germany, China
	100	China, Germany, Indonesia, Kazakhstan
	100	Germany, Russia
	100	India, France
	100	Czech Republic, Canada, Republic of Korea, Austria
	99	Israel, India, Belgium, South Africa
	95	China, Belgium, Peru, United Kingdom
ENTRATES	91	South Africa, Australia, Canada, Mozambique
	90	South Africa, Germany, United Kingdom, Canada
	88	Australia, India, China
	85	China, Belgium, Russia, Canada
	84	China, Bolivia, Belgium, Thailand
wder)	84	China, Ireland, Romania, Republic of Korea
	84	Canada, Russia, Israel, Chie
	83	Crima, Brazil, Italy, Turkey
	82	Canada, Mexico, Peru, Australia Chila, Daland, Comman
	79	Chile, Poland, Germany Chile, South Africa, Natherlands, Domania
	76	China, Sobir Alica, Nertenanus, Romana China, Estoria, Erange, Japan
	76	China, Estoria, France, Japan
	75	Peru Indonesia Bolivia Malavsia
	72	Maxico Canada Boland Ban
	70	China India Moracco Mexico
	69	Canada
	68	Japan, Kazakhstan, China
	66	South Africa, Kazakhstan, Russia
	58	Russia, South Africa, United Kingdom, Switzerland
	49	China, Bolivia, Canada, Germany
s	43	China, Brazil, Canada, Australia
	40	Canada, Russia, United Arab Emirates
ral)	39	Canada, China, Finland, India
	38	Russia, Brazil, China, Canada
	37	Canada, Australia, Russia, Norway
	36	Chile, Canada, Mexico
	32	Chile, Canada, Mexico, The Bahamas
	31	Canada, Mexico, Peru, Australia, Kazakhstan
NIA	29	Trinidad and Tobago, Canada, Russia, Ukraine
	26	Israel, Canada, China, Mexico
	25	Canada, Republic of Korea, Brazil, Russia
	21	Greece, Turkey
	21	Greece, Iceland, Mexico
	20	South Africa, Brazil, China
	16	Canada, Mexico, Venezuela
	14	Mexico, Canada, Spain
	13	Pakistan, Canada, China, Japan
	12	Turkey, Mexico, Germany, India
	11	Kazakhstan, China, Nigeria, United Kingdom
	11	Canada, Japan, Spain, Italy
	10	Ganada, Republic of Korea, China, Greece

9

Recent Key Publications

Science for a changing world

National Minerals Information Center

Comparison of U.S. Net Import Reliance for Nonfuel Mineral Commodities—A 60-Year Retrospective (1954–1984–2014)

The economic vitality and national security of the United States depend on the reliable supply of numerous nonfuel mineral commodities. Over the past six decades, many of these commodities have been sourced increasingly from outside the United States. The mix of commodities for which the United States is import dependent has changed as technologies have advanced, as substitute materials have been developed, and as world economies have changed. Although reliance on imports is only one of the many factors that determine supply risk, a clear, long-term trend has emerged from the data compiled and published by the U.S. Geological Survey, National Minerals Information Center (USGS-NMIC), and its predecessor organizations. Because the global distribution of mineral resources and reserves is not uniform, the United States has always been import reliant for some mineral commodities. Essentially, the type of commodities and the countries from which they are sourced determine risk related to import dependence. In light of projections that 2.5 billion to 3 billion people globally could move into the middle class by 2030 (Rohde, 2012), the demand for many types of mineral commodities is likely to continue to increase. Recent concerns regarding so-called "critical minerals" have been driven by market dislocations in the rare-earth-element supply chain in 2010 that resulted from a short-term policy decision by the Government of the People's Republic of China to limit exports. That policy has since been changed as a result of actions by the World Trade Organization, but the events that followed, such as higher prices and intensive efforts to diversify sources of supply, illustrate the underlying issues of supply risk and the influence that disruptions can have on supply. These factors are often used in the classification of a mineral commodity as "critical" (National Research Council, 2008).

The USGS--NMIC collects, analyzes, and disseminates information on a monthly, quarterly, or annual basis for more than 90 nonfuel mineral commodities from more than 180 countries. These data indicate that from 1954 through 2014 there was (1) a clear increase in the number and type of nonfuel mineral commodities for which the United States was net import relatint, (2) an increase in the percentage of import reliance for individual nonfuel mineral commodities, and (3) a shift in the geographic distribution of the source countries.

Net Import Reliance

Nonfuel mineral commodities for which imports are required to satisfy domestic demand are those for which the importing courty is net import reliant. The USGS-NMIC calculates a net import reliance (NIR) for nonfuel mineral commodities using prior-year data and publishes this information annually in the USGS Mineral Commodity Summaries.

U.S. Department of the Interior U.S. Geological Survey Net import reliance is the amount of imported material (including changes in stocks) minus exports and is expressed as a percentage (%) of domestic consumption:

 $NIR\% = \frac{imports - exports + adjustments in stocks}{consumption} \times 100$

For example, a nonfuel mineral commodity that is not produced in the United States and for which the United States relies entirely on imports and (or) materials from stocks to satisfy domestic demand has an NIR% of 100.

Changes in Net Import Reliance

Over the past six decades, there has been a clear increase in the number of nonfuel mineral commodities for which the United States is net import reliant as well as an increase in the percentage of reliance (fig. 1). In particular, the number of nonfuel mineral commodities for which the United States was greater than 50% net import reliant increased from 28 in 1954 to 47 in 2014.

The 1950s was a decade of significant changes in the mining and mineral commodity industries. For example, during the early 1950s, concerns regarding the supply of strategic and programs (now terminated) such as the Defense Minerals Administration, Defense Minerals Exploration Administration, and Office of Minerals Exploration Administration, and Office of Minerals Exploration, which provided millions of dollars in Federal funds for mineral exploration (Bohm and offers, 2000). In addition, following the Korean War, demand for many mineral commodities entered a period of growth, supply concerns triggered multiyear price increases for many nonfiel



EXPLANATION

Percentage of act import reliance

25 to 50 50 to <100 100

Figure 1. Number of nonfuel mineral commodifies for

which the United States was at least 25% net import reliant in 1954, 1984, and 2014. Sources: U.S. Bureau of Mines (1957, 1985); U.S. Geological Survey (2015).

> Fact Sheet 2015–3082 December 2015

ASSESSMENT OF CRITICAL MINERALS: SCREENING METHODOLOGY AND INITIAL APPLICATION

PRODUCT OF THE Subcommittee on Critical and Strategic Mineral Supply Chains of the Committee on Environment, Natural Resources, and Sustainability OF THE NATIONAL SCIENCE AND TECHNOLOGY COUNCIL



March 2016





Geographic Distribution of Import Sources – 1954





Geographic Distribution of Import Sources – 1984





Geographic Distribution of Import Sources – 2014





Governance Risk



- Political Stability and Absence of Violence
- Government Effectiveness
- Regulatory Quality
- Rule of Law
- Control of Corruption



Conflict Minerals Fact Sheet Series

USGS science for a changing world

Conflict Mine Global Tungs Tungsten Sup

The U.S. Geological Sur to identify and define major co flows from ore extraction, three product. Two major reasons ne identify risks associated with t minerals to the United States a chain transparency so that poli necessary to ensure domestic l sheet focuses on the latter. The tion Center has been asked by organizations to provide infor gold (collectively known as "? worldwide in response to U.S. link between the trade in these Democratic Republic of the C Post beneficiation proces

of 3TG mineral ores and conc and industry association repre 3TG mineral supply chain thr traced to their source of origin origin is critical to establishin supply chain (U.S. Governme p. 19). This fact sheet, the first



Conflict Minera Global Tantalun Tantalum Suppl

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The U.S. Geological Surve and metal supply chains to iden components of mineral and met extraction, through intermediate Supply chain analyses may be u the United States associated wit strategic minerals and metals an supply chain transparency so the based information needed to for

sheet focuses on the post-minin; of the tantalum supply chain. TI Information Center (NMIC) has and non-governmental organiza about tantalum, tin, tungsten, ar "3TG mineral") processing fac to U.S. legislation aimed at ider supply chain links between the I civil unrest in the Democratic R adjacent countries.

> EXPLANATION Aine production percentage of w production of or

Ta₂O₅ production, 2 K₂TaF, production,



The U.S. Geologica and metal supply chains components of material f intermediate forms, to a 1 may be used (1) to identi with the supply of critica and (2) to provide greater policymakers have the fa formulate public policy. mining/pre-consumer-pro USGS National Minerals asked by governmental a to provide information at (collectively known as ": worldwide in response to and removing the supply minerals and civil unrest Congo (DRC) and adjace Post-beneficiation p smelters and refineries) f

Conflict Minerals From the Democratic Republic of the Congo— Gold Supply Chain

The U.S. Geological Survey (USGS) analyzes mineral and metal supply chains to identify and describe major components of material flows from ore extraction, through intermediate forms, to a final product. Supply chain analyses may be used to identify risks to the United States associated with the supply of critical and strategic minerals and metals and to provide greater supply chain transparence yo that policymaters have the fact-based information needed to formulate public policy. This fact sheet focuses on the gold supply chain.

The USGS National Minerals Information Center (NMIC) has been asked by governmental and non-governmental organizations to provide information about tantalum, tin, tungsten, and gold (collectively known as "3TG minerals") processing facilities worldwide in response to U.S. legislation aimed at identifying and removing the supply chain links associated with the trade of these metals and minerals among armed groups in the Democratic Republic of the Congo (DRC) and adjacent countries. Post-beneficiation processing plants (generally called smelters and refineries) for tantalum, tin, and ungsten (3T) mineral ores and concentrates were identified by company and industry association representatives as being the link in the 3T

industry association representatives as being the link in the 3T mineral supply chain through which these minerals can be traced to their source of origin (mine). Tungsten processing plants were the subject of the first fact sheet in a series of USGS reports about 37G minerals, which was published by the NMIC in August 2014 (Bermidez-Lugo, 2014). Background informatio about historical conditions and the voluntary due diligence of multinational stakeholders for minerals from confilt-caffected and high-risk areas is presented in the tungsten fact sheet. The current fact sheet, the fourth and last in the series about 37G minerals, focuses on the 30d supply chain. Processing of the 31 mineral concentrates remuires

Processing of the 3T mineral concentrates requires substantial infrastructure and capital and generally is done at relatively few specialized facilities that are not located at the mine site, primary and secondary processors typically are at separate locations. Gold, however, can easily be processed into semi-refined products at or near the mine site and has a high unit value in any form, which allows it to be readily exported through undocumented channels, making it more difficult to track to the mine or region of origin. To put this in perspective, 30 kilograms (66 pounds) of 85 percent pure gold (20 caral) would form act be measuring 12 centimeters per side (about th size of a small tissue box) and, at a price of \$1,200 per ounce, would be worth nearly \$1 million By contrast, the equivalent value of tungsten concentrates would weigh about 45 metric ness (1010,000 pounds). Once conflic sourced gold has been

Fact Sheet 2015-307

CLASHS CLASHS

Average world gold mine production by country, 2009-13

July 2015



Kelfos² 4f¹⁴ Sd

180.9

November 2015





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U.S. Department of the Interio U.S. Geological Survey

U.S. Department of the Interio U.S. Geological Survey

EXPLA



August 2014

December 2014



Tantalum Task Force – The Conflict – Critical Mineral Nexus







VERO

- 2000-2006 production dominated by Australia and Brazil
- 2009-2014 production dominated by DRC+ and other African countries
- Shift from industrial to artisanal mining

≈USGS

- Shift to countries with higher governance risk
- Tantalum material flow analysis project (Dodd-Frank, DLA, HASC)



Production – Country Concentration



Figure S.1 Percentage of Global Production (Mining) of Key Materials Within a Single Country

SOURCE: U.S. Geological Survey, Minerals Commodity Summaries, Pittsburgh, Penn.: U.S. Government Printing Office, 2012; International Organizing Committee for the World Mining Congresses, World Mining Data, Vol. 26, 2011.

RAND RR133-5.1

Source: Rand National Defense Research Institute



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March 2016





Criticality indicator









China has dominated rare earth oxide mine production since the late-1990s



REE Value Chain - Cerium



- Cerium is a light rare earth element
- Accounts for 49% of total REE resource at Mountain Pass
- Molycorp capable of producing intermediate and final cerium products



REE Value Chain - Lanthanum



- Lanthanum is a light rare earth element
- Accounts for 33% of total REE resource at Mountain Pass
- No U.S. producers of NiMH batteries



REE Value Chain - Dysprosium



- Dysprosium is a heavy rare earth element
- Only trace quantities of heavy REE in Mountain Pass resource





REE Value Chain - Yttrium



- Yttrium is a heavy rare earth element
- Only trace quantities of heavy REE in Mountain Pass resource
- Several U.S. producers make laser crystals and components



Early Warning Screening Tool Application - REE







Pending Legislation

Ovtrack.us Home browse track about open data

Congress / Bills / S. 2012

S. 2012: Energy Policy Modernization Act of 2016



- Language from American Mineral Security Act incorporated
- Critical and Strategic Minerals
- Specific Tasks Identified for USGS NMIC
- ✓USGS Passed Senate 85-12