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

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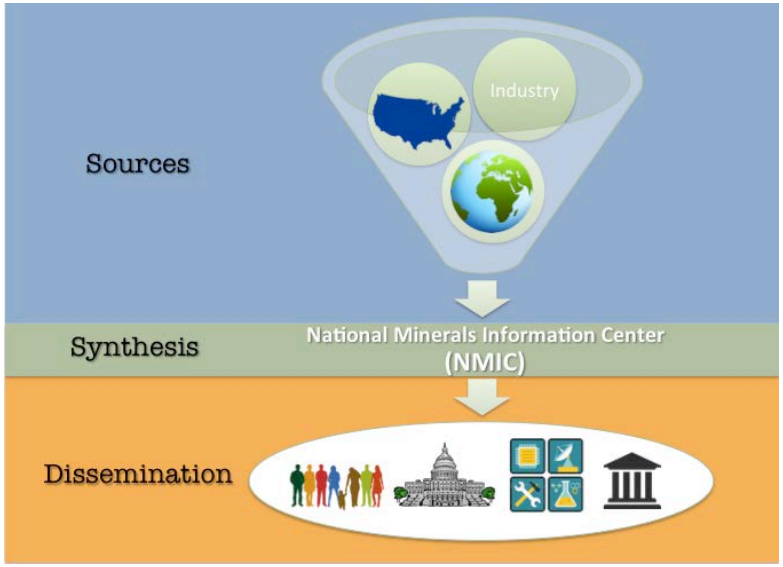
National Minerals Information Center
U.S. Geological Survey

5th Annual Continuing Education Conference
Alabama Board of Licensure for Professional Geologists
Birmingham, AL
May 26, 2016

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

USGS

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.

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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

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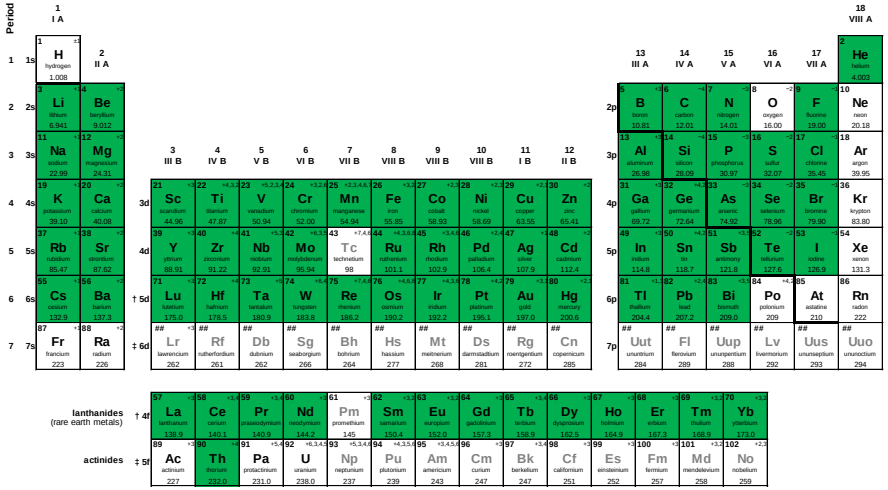
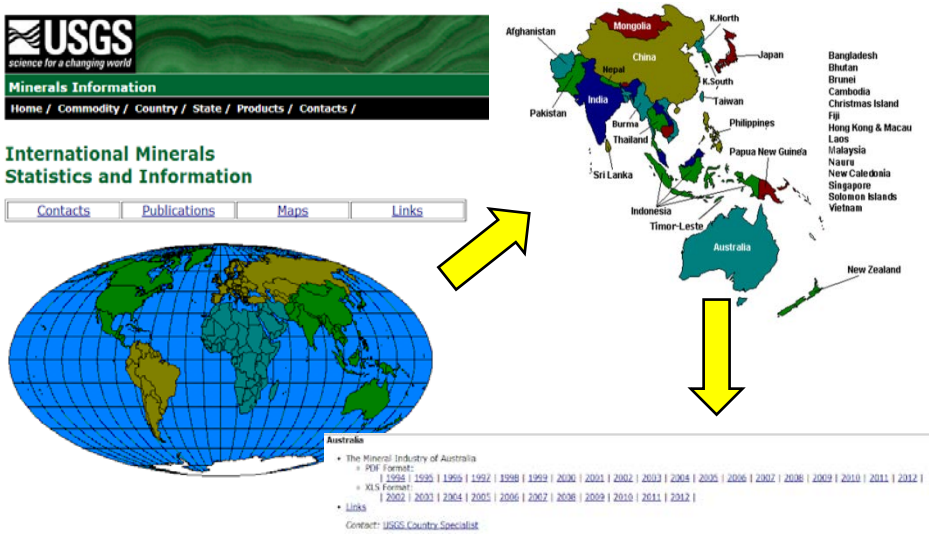
Scope & Product Portfolio

Broad Mineral Commodity Coverage (>85 Commodities)



Broad Global Coverage: >180 Countries



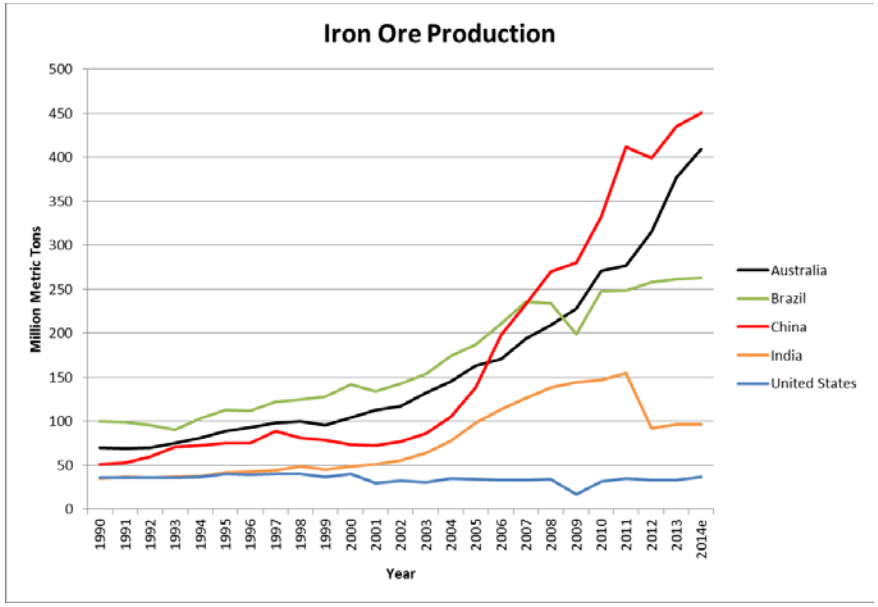
- Mineral Commodity Summaries
- Minerals Yearbook
- Mineral Industry Surveys
- Metal Industry Indicators
- Nonmetallic Mineral Industry Indexes
- Special publications
- Data Series
- Fact Sheets

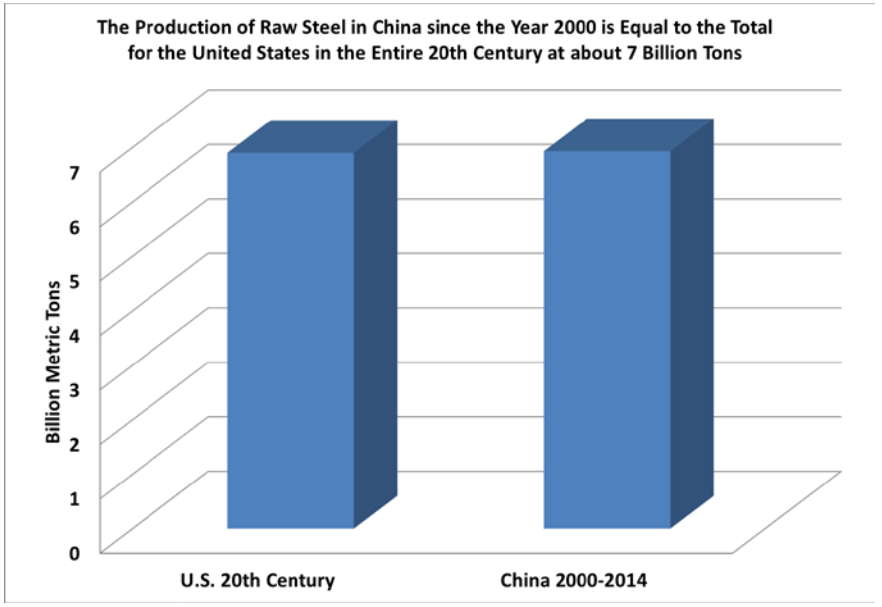
- **> 700 Publications Annually**
- **Monthly, quarterly, annual work product cycles**

http://minerals.usgs.gov/minerals/

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

USGS

“Middle Class” Population Growth

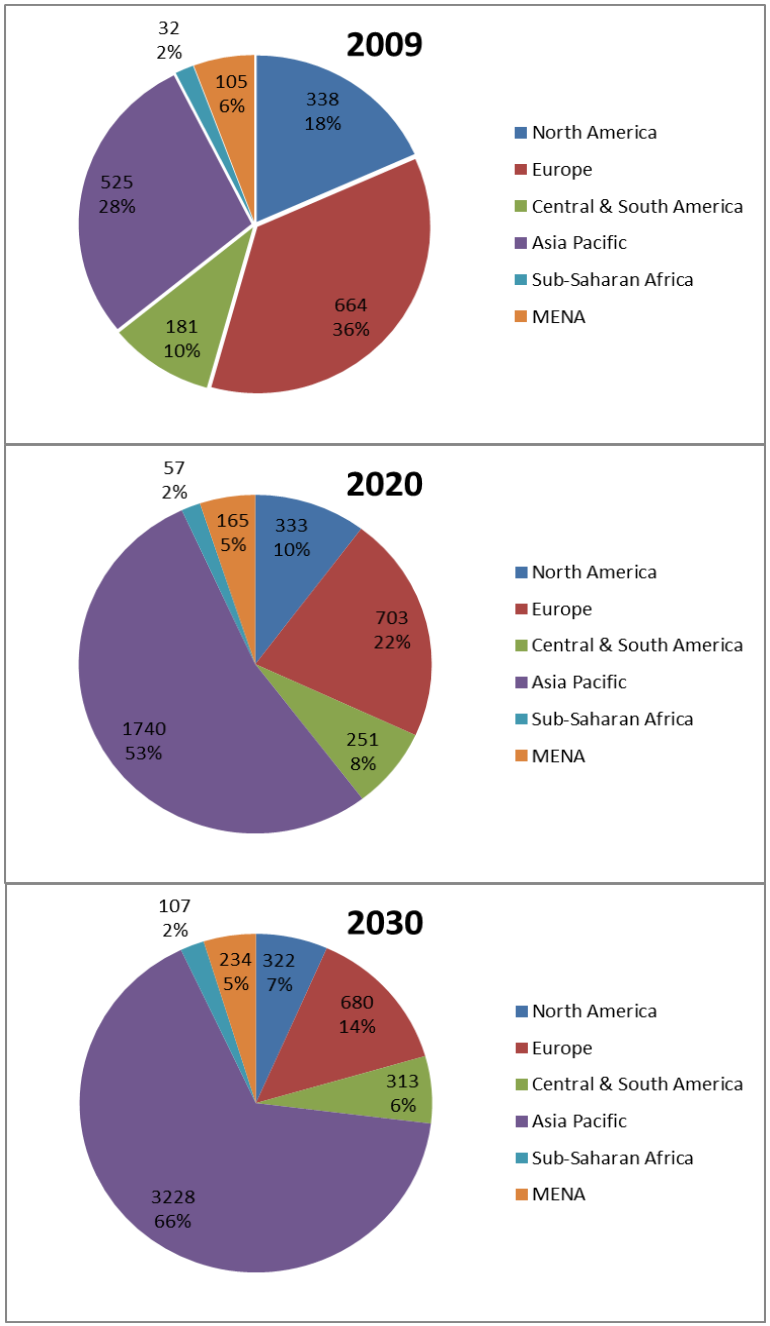
1.8 billion

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

3.2 Billion

4.9 billion



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

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	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cp		Fl		Lv		

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

~30 elements

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	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cp		Fl		Lv		

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

~75 elements

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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.).*

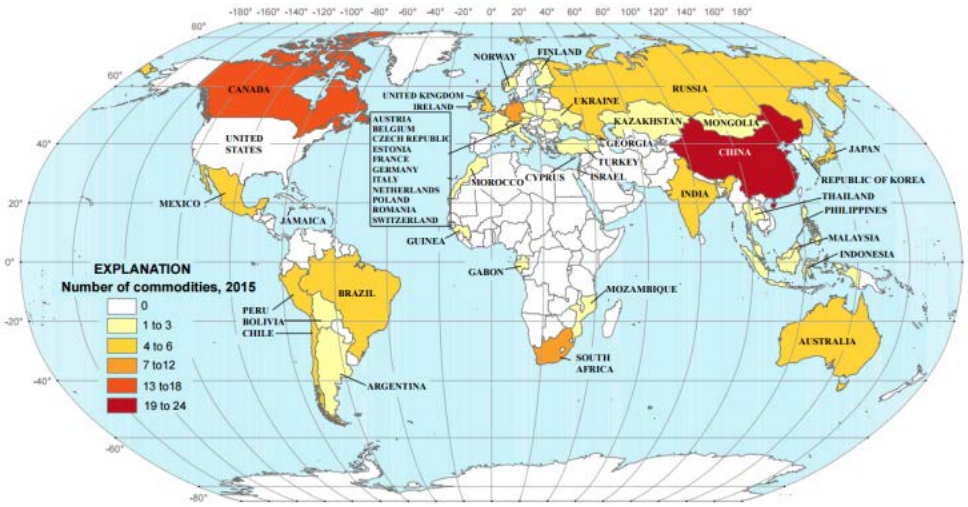
- **The term ‘‘strategic and critical” (S&C) materials is defined by this Act*:***

“…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

Net Import Reliance

- **Country Specific**
- **Updated Annually**
- **Broad coverage**
- **Timely**

2015 U.S. NET IMPORT RELIANCE[1]

Commodity	Percent	Major import sources (2011–14)[2]
ARSENIC	100	Morocco, China, Belgium
ASBESTOS	100	Brazil, Canada
BAUXITE	100	Jamaica, Guinea, Brazil, Guyana
CESIUM	100	Canada
FLUORSPAR	100	Mexico, China, South Africa, Mongolia
GALLIUM	100	Germany, China, United Kingdom, Ukraine
GRAPHITE (natural)	100	China, Mexico, Canada, Brazil
INDIUM	100	Canada, China, Belgium, Republic of Korea
MANGANESE	100	South Africa, Gabon, Australia, Georgia
MICA, sheet (natural)	100	India, Brazil, China, Belgium
NIOBIUM (columbium)	100	Brazil, Canada
QUARTZ CRYSTAL (industrial)	100	China, Japan, Romania, United Kingdom
RUBIDIUM	100	Canada
SCANDIUM	100	China
STRONTIUM	100	Mexico, Germany, China
TANTALUM	100	China, Germany, Indonesia, Kazakhstan
THALLIUM	100	Germany, Russia
THORIUM	100	India, France
VANADIUM	100	Czech Republic, Canada, Republic of Korea, Austria
GEMSTONES	99	Israel, India, Belgium, South Africa
BISMUTH	95	China, Belgium, Peru, United Kingdom
TITANIUM MINERAL CONCENTRATES	91	South Africa, Australia, Canada, Mozambique
PLATINUM	90	South Africa, Germany, United Kingdom, Canada
GARNET (industrial)	88	Australia, India, China
GERMANIUM	85	China, Belgium, Russia, Canada
ANTIMONY	84	China, Bolivia, Belgium, Thailand
DIAMOND (dust grit, and powder)	84	China, Ireland, Romania, Republic of Korea
POTASH	84	Canada, Russia, Israel, Chile
STONE (dimension)	83	China, Brazil, Italy,Turkey
ZINC	82	Canada, Mexico, Peru, Australia
RHENIUM	79	Chile, Poland, Germany
SILICON CARBIDE (crude)	77	China, South Africa, Netherlands, Romania
RARE EARTHS[3]	76	China, Estonia, France, Japan
COBALT	75	China, Norway, Finland, Russia
TIN	75	Peru, Indonesia, Bolivia, Malaysia
SILVER	72	Mexico, Canada, Poland, Peru
BARITE	70	China, India, Morocco, Mexico
PEAT	69	Canada
TITANIUM (sponge)	68	Japan, Kazakhstan, China
CHROMIUM	66	South Africa, Kazakhstan, Russia
PALLADIUM	58	Russia, South Africa, United Kingdom, Switzerland
TUNGSTEN	49	China, Bolivia, Canada, Germany
MAGNESIUM COMPOUNDS	43	China, Brazil, Canada, Australia
ALUMINUM	40	Canada, Russia, United Arab Emirates
MICA, scrap and flake (natural)	39	Canada, China, Finland, India
SILICON	38	Russia, Brazil, China, Canada
NICKEL	37	Canada, Australia, Russia, Norway
COPPER	36	Chile, Canada, Mexico
SALT	32	Chile, Canada, Mexico, The Bahamas
LEAD	31	Canada, Mexico, Peru, Australia, Kazakhstan
NITROGEN (fixed)—AMMONIA	29	Trinidad and Tobago, Canada, Russia, Ukraine
MAGNESIUM METAL	26	Israel, Canada, China, Mexico
IRON and STEEL	25	Canada, Republic of Korea, Brazil, Russia
PERLITE	21	Greece, Turkey
PUMICE	21	Greece, Iceland, Mexico
VERMICULITE	20	South Africa, Brazil, China
SULFUR	16	Canada, Mexico, Venezuela
GYPSUM	14	Mexico, Canada, Spain
TALC	13	Pakistan, Canada, China, Japan
FELDSPAR	12	Turkey, Mexico, Germany, India
BERYLLIUM	11	Kazakhstan, China, Nigeria, United Kingdom
IRON and STEEL SLAG	11	Canada, Japan, Spain, Italy
CEMENT	10	Canada, Republic of Korea, China, Greece

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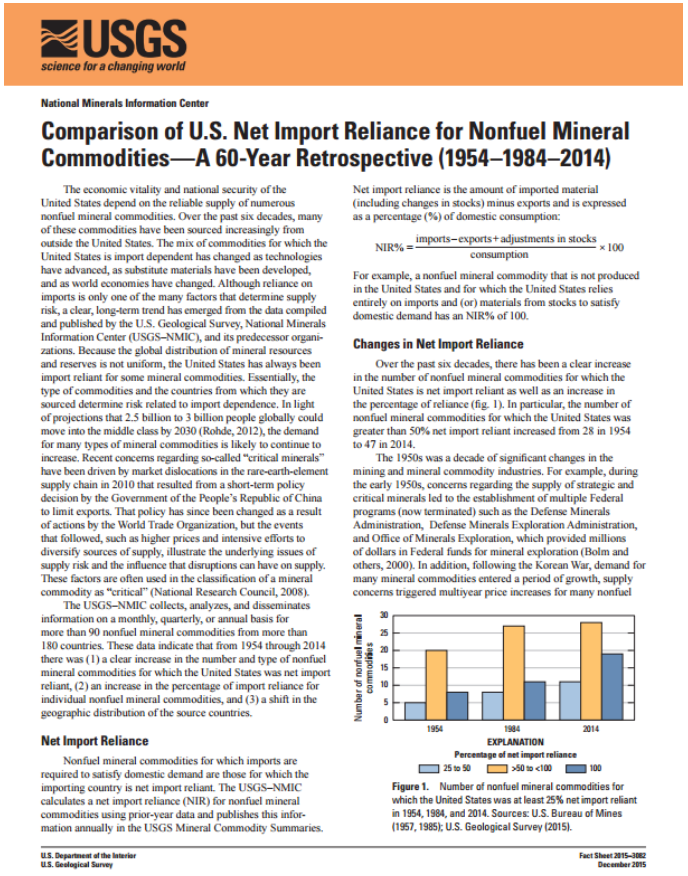
http://minerals.usgs.gov/minerals/pubs/mcs/2016/mcs2016.pdf

Recent Key Publications



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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 reliant, (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 country 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.

Net import reliance is the amount of imported material (including changes in stocks) minus exports and is expressed as a percentage (%) of domestic consumption:

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

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

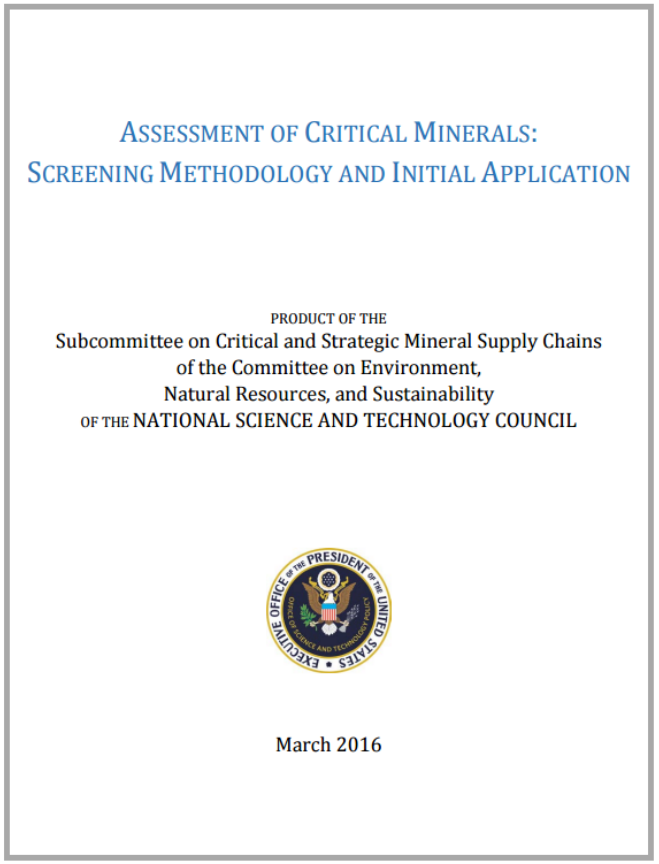
Over the past six decades, there has been a clear increase in the number of nonfuel mineral commodities for which the United States is net import reliant as well as an increase in the percentage of reliance (fig. 1). In particular, the number of nonfuel mineral commodities for which the United States 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 critical minerals led to the establishment of multiple Federal programs (now terminated) such as the Defense Minerals Administration, Defense Minerals Exploration Administration, and Office of Minerals Exploration, which provided millions of dollars in Federal funds for mineral exploration (Bolm and others, 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 nonfuel

Figure 1. Number of nonfuel mineral commodities 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).

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

Fact Sheet 2015–3082
December 2015



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March 2016

http://minerals.usgs.gov/minerals/

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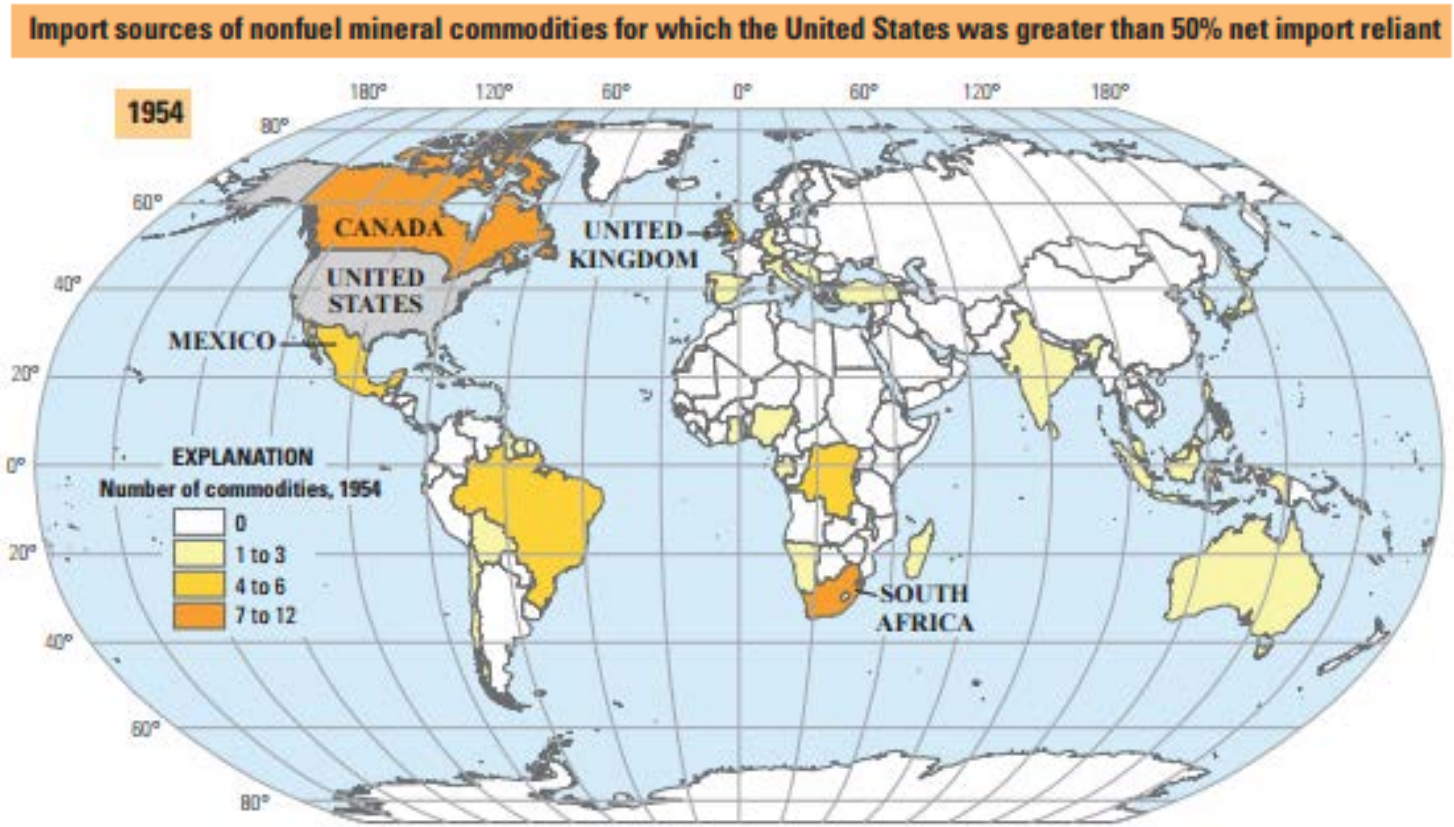
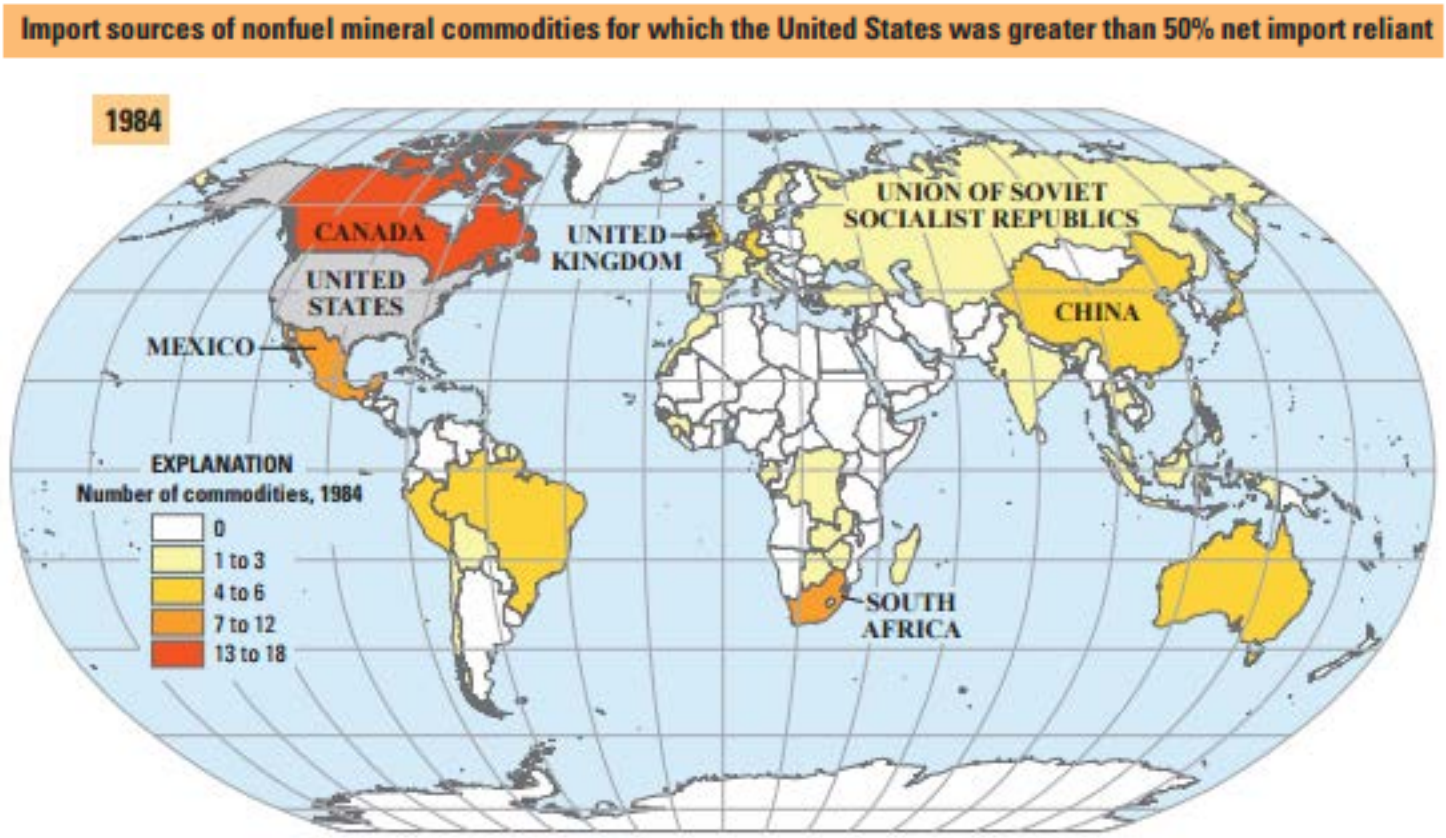
Geographic Distribution of Import Sources – 1954



Geographic Distribution of Import Sources – 1984



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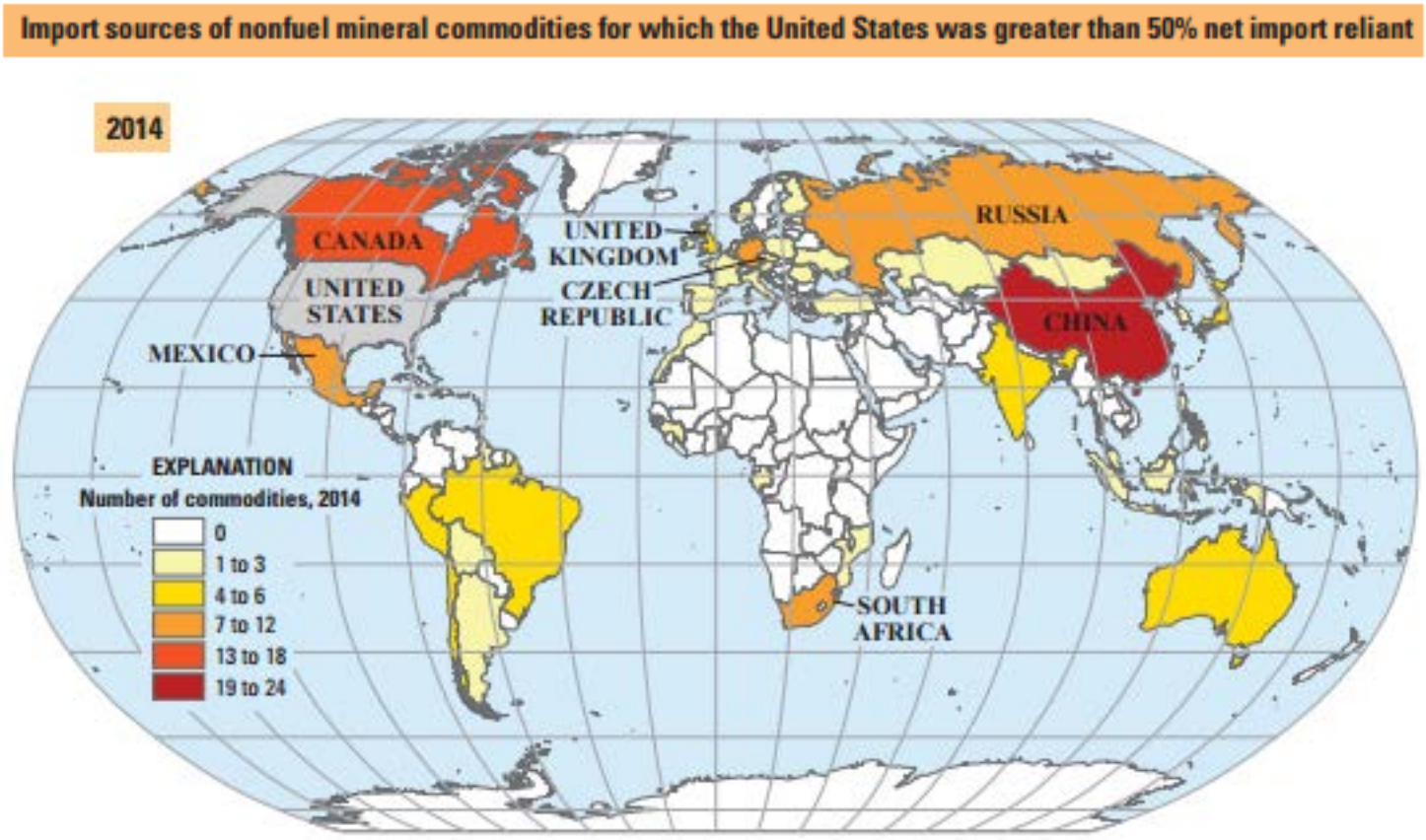
Geographic Distribution of Import Sources – 2014



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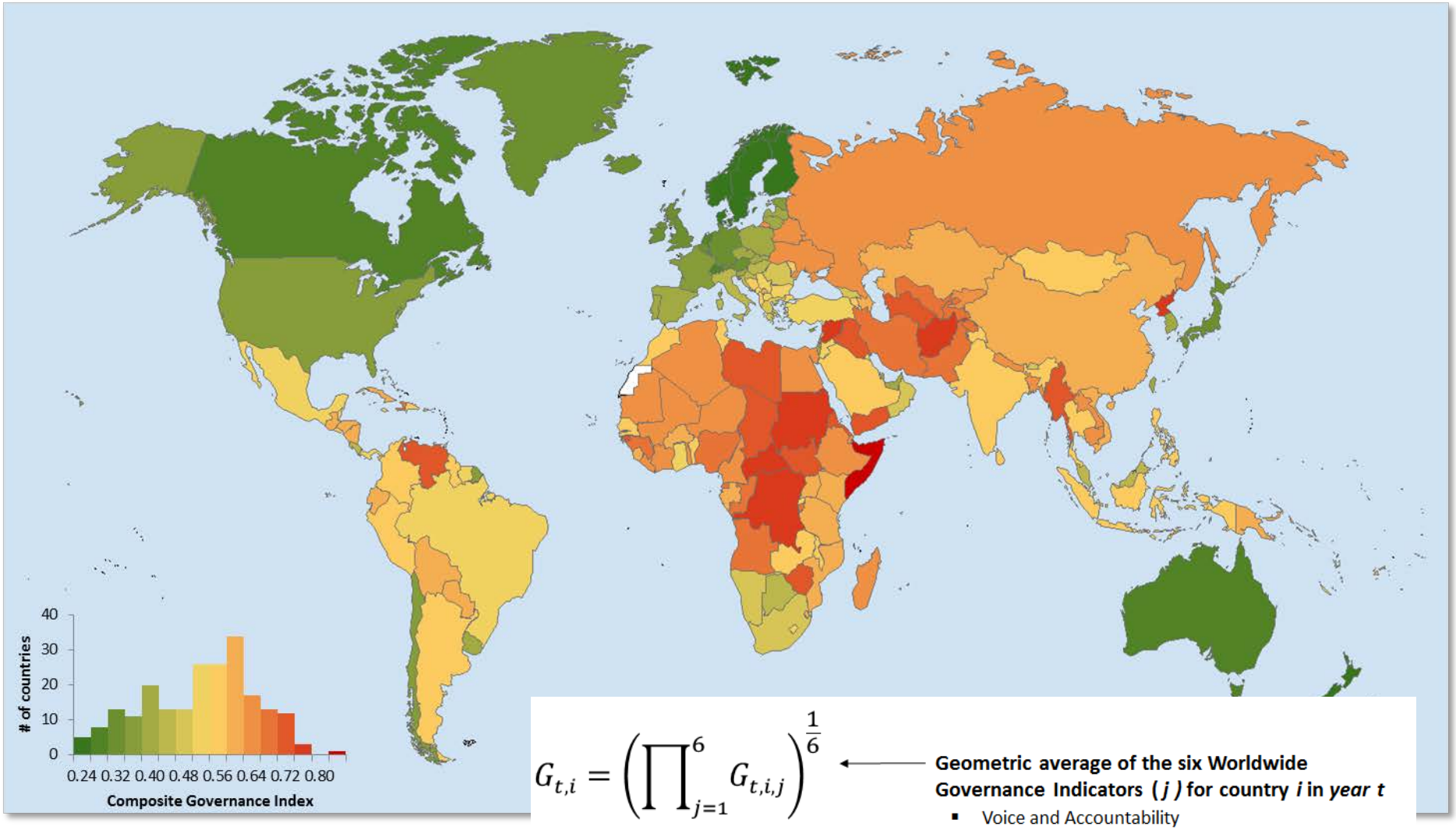
Governance Risk



$$G_{t,i} = \left(\prod_{j=1}^{6} G_{t,i,j} \right)^{\frac{1}{6}}$$

Geometric average of the six Worldwide Governance Indicators (*j*) for country *i* in *year t*

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

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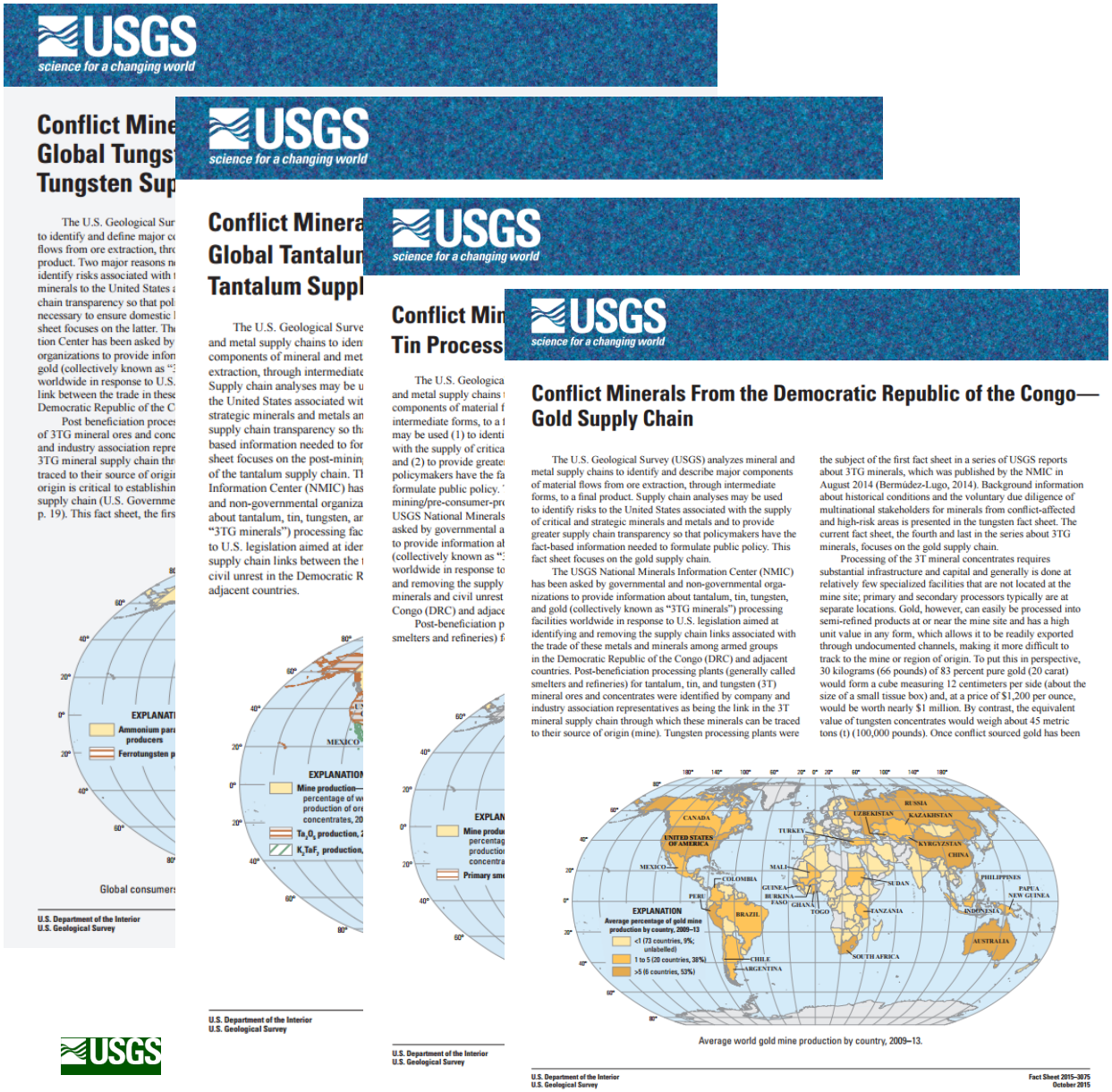
Conflict Minerals Fact Sheet Series

August 2014

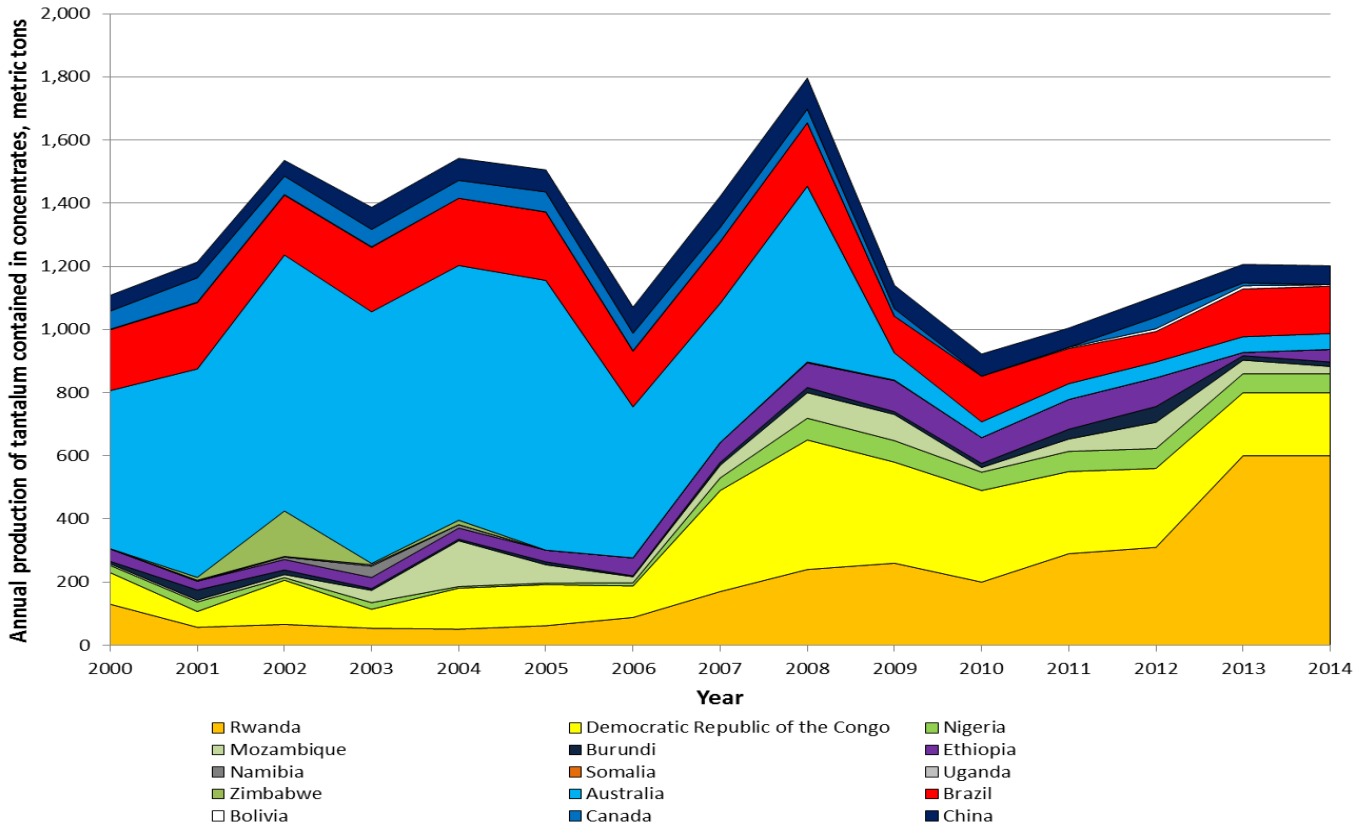
December 2014

July 2015

November 2015



Tantalum Task Force – The Conflict – Critical Mineral Nexus



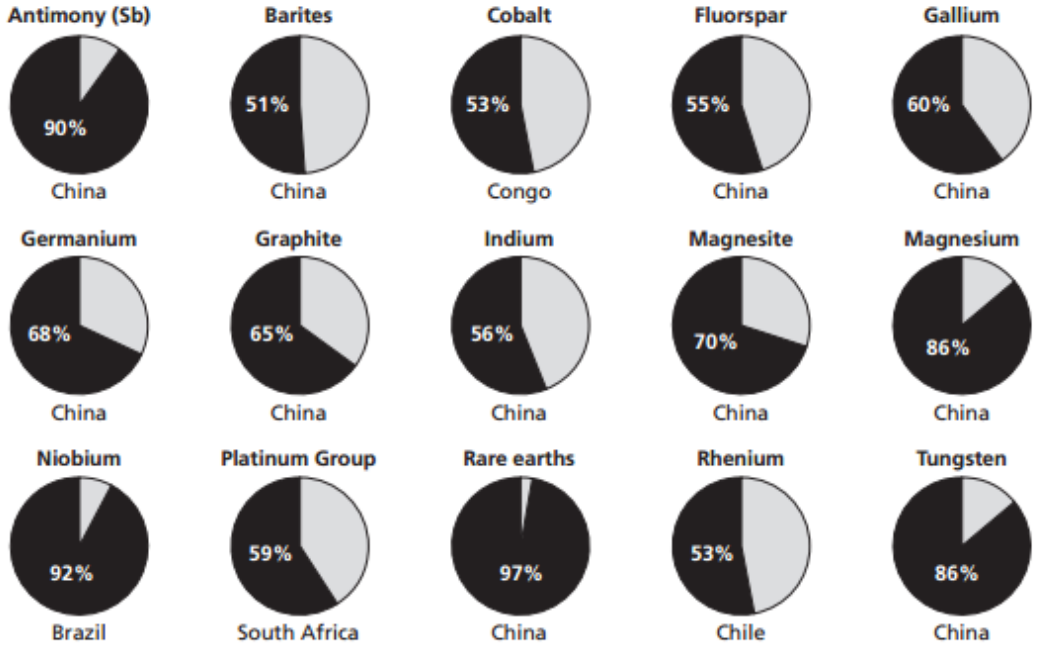
- **2000-2006 production dominated by Australia and Brazil**
- **2009-2014 production dominated by DRC+ and other African countries**
- **Shift from industrial to artisanal mining**
- **Shift to countries with higher governance risk**
- **Tantalum material flow analysis project (Dodd-Frank, DLA, HASC)**

USGS

https://pubs.er.usgs.gov/publication/fs20153079

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-S.1

Source: Rand National Defense Research Institute

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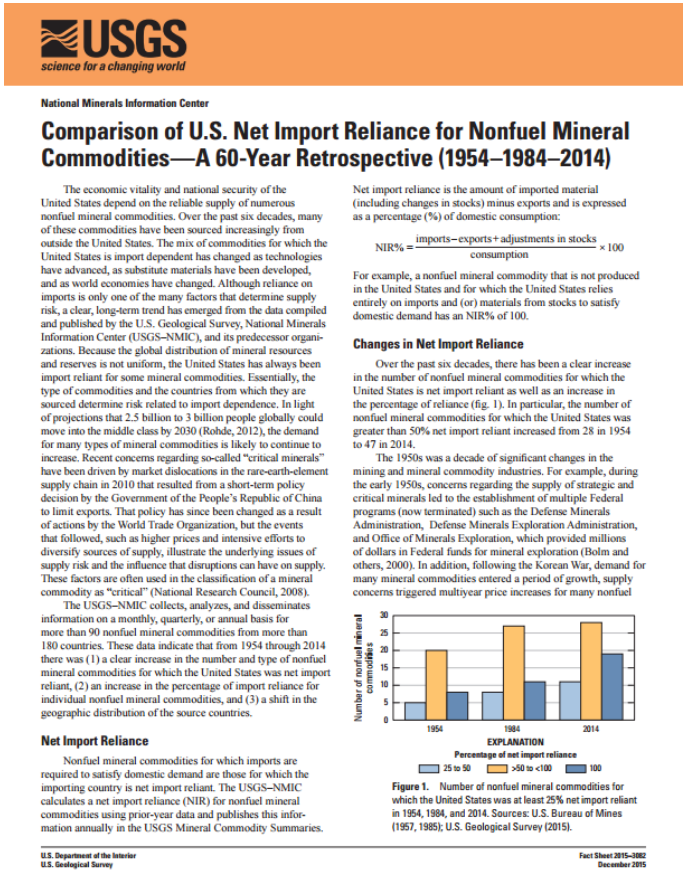
Recent Key Publications



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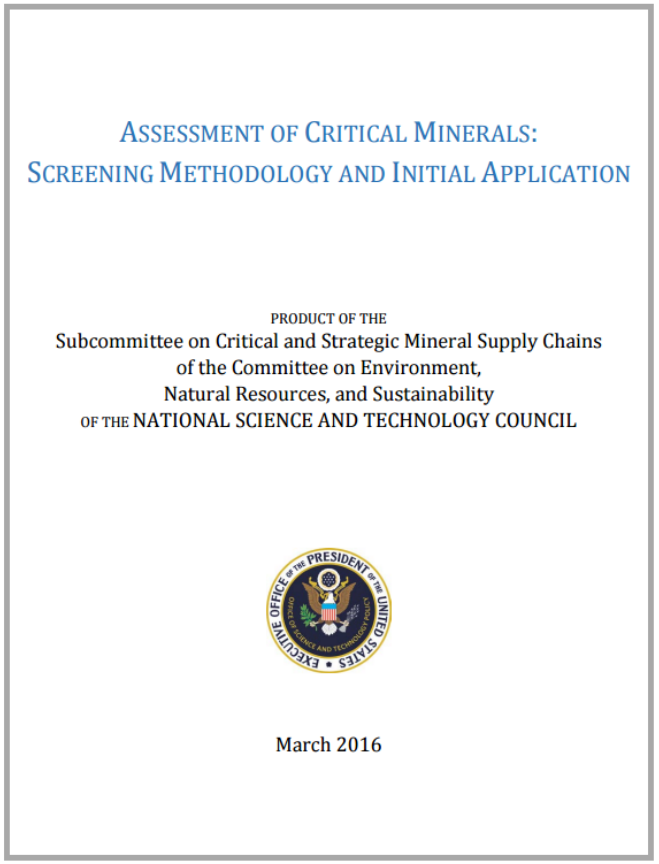

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March 2016

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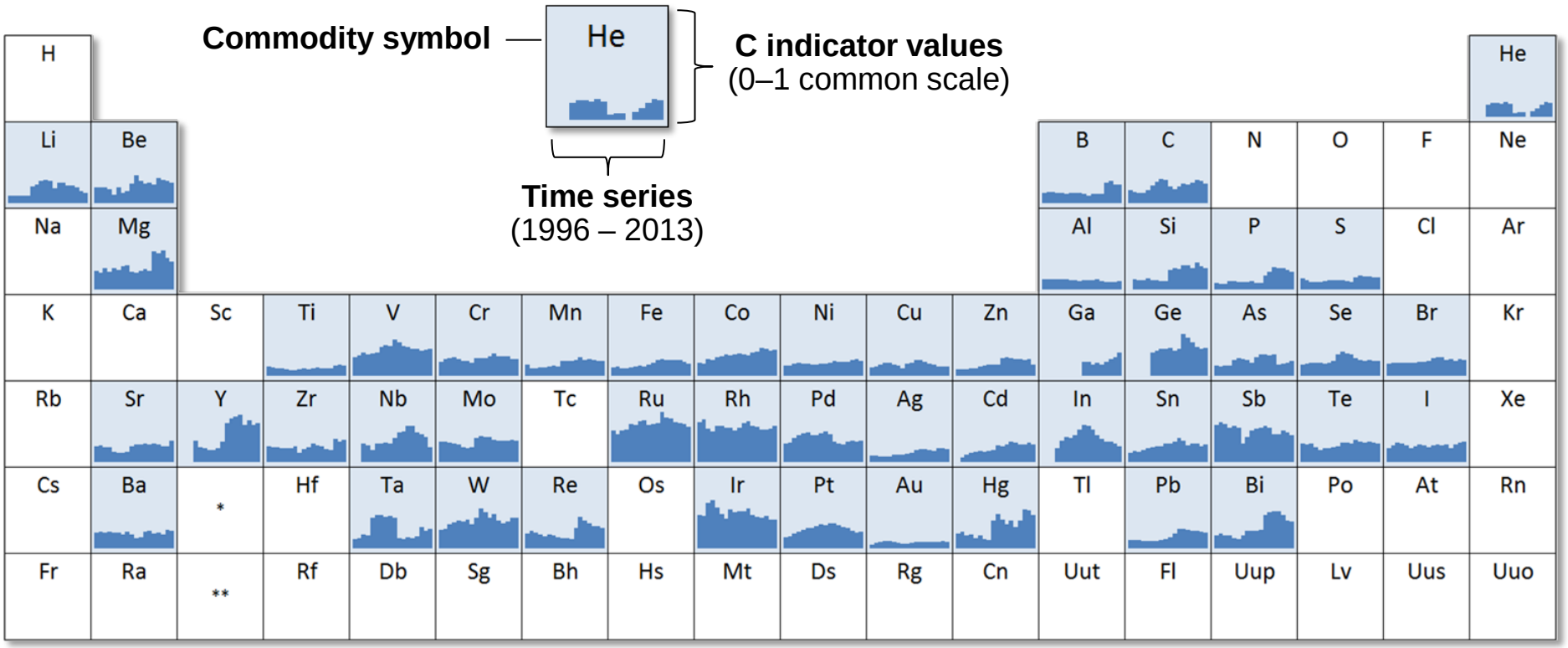
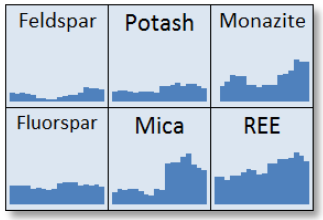
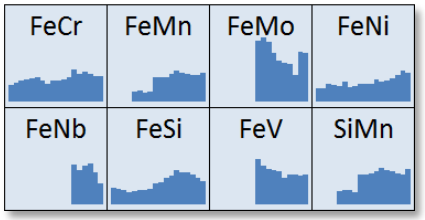
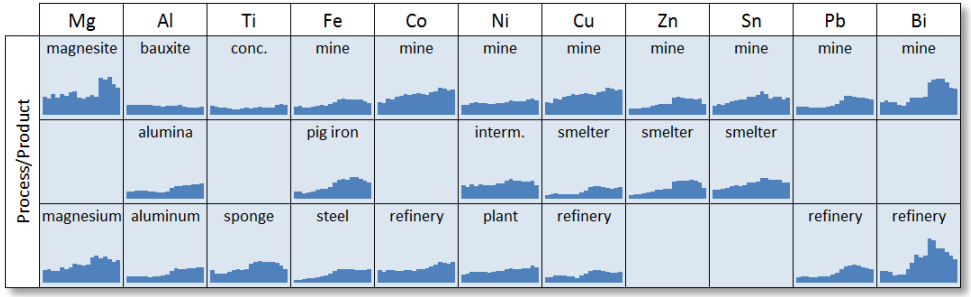
Criticality indicator



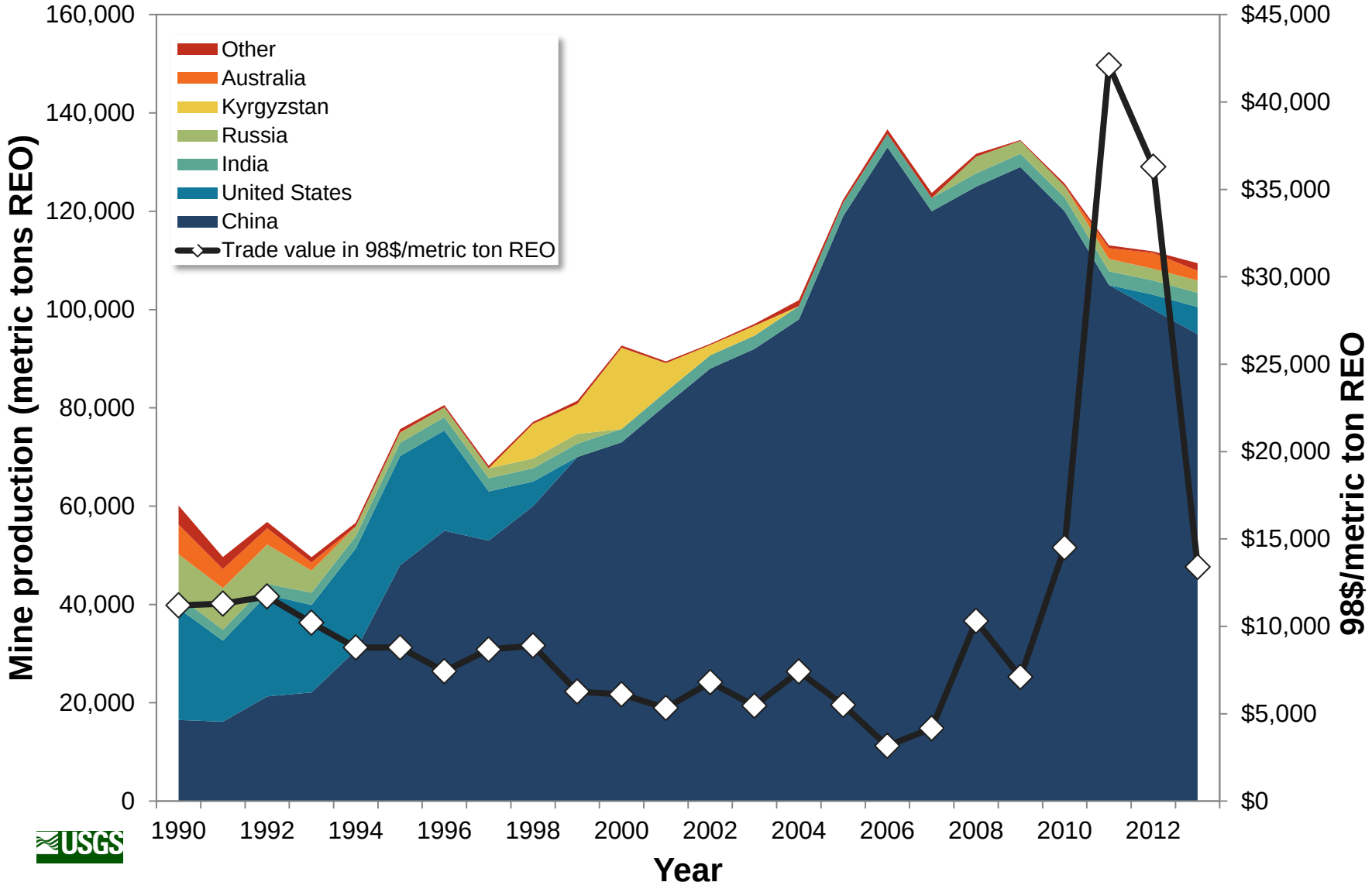




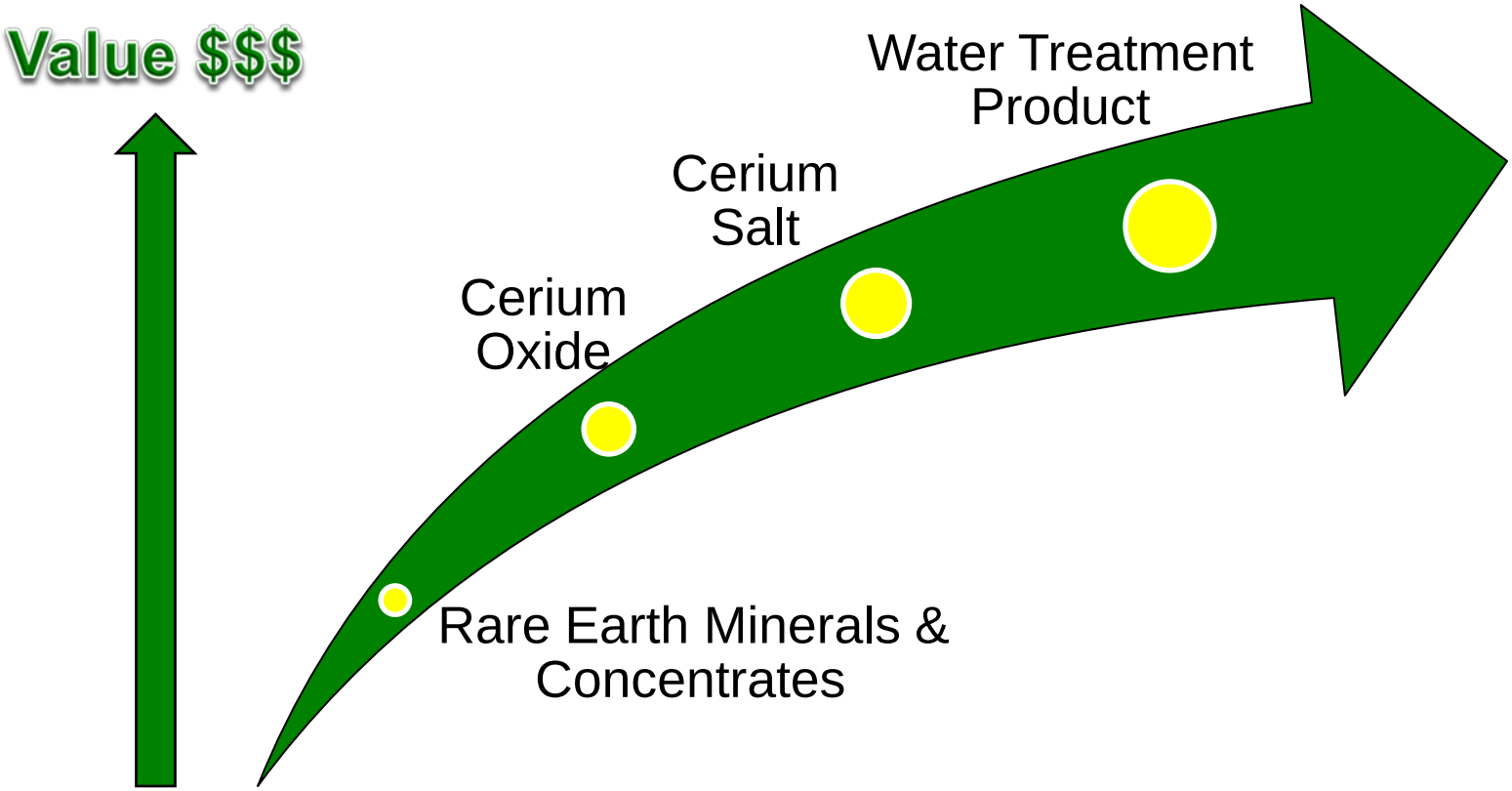


USGS

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

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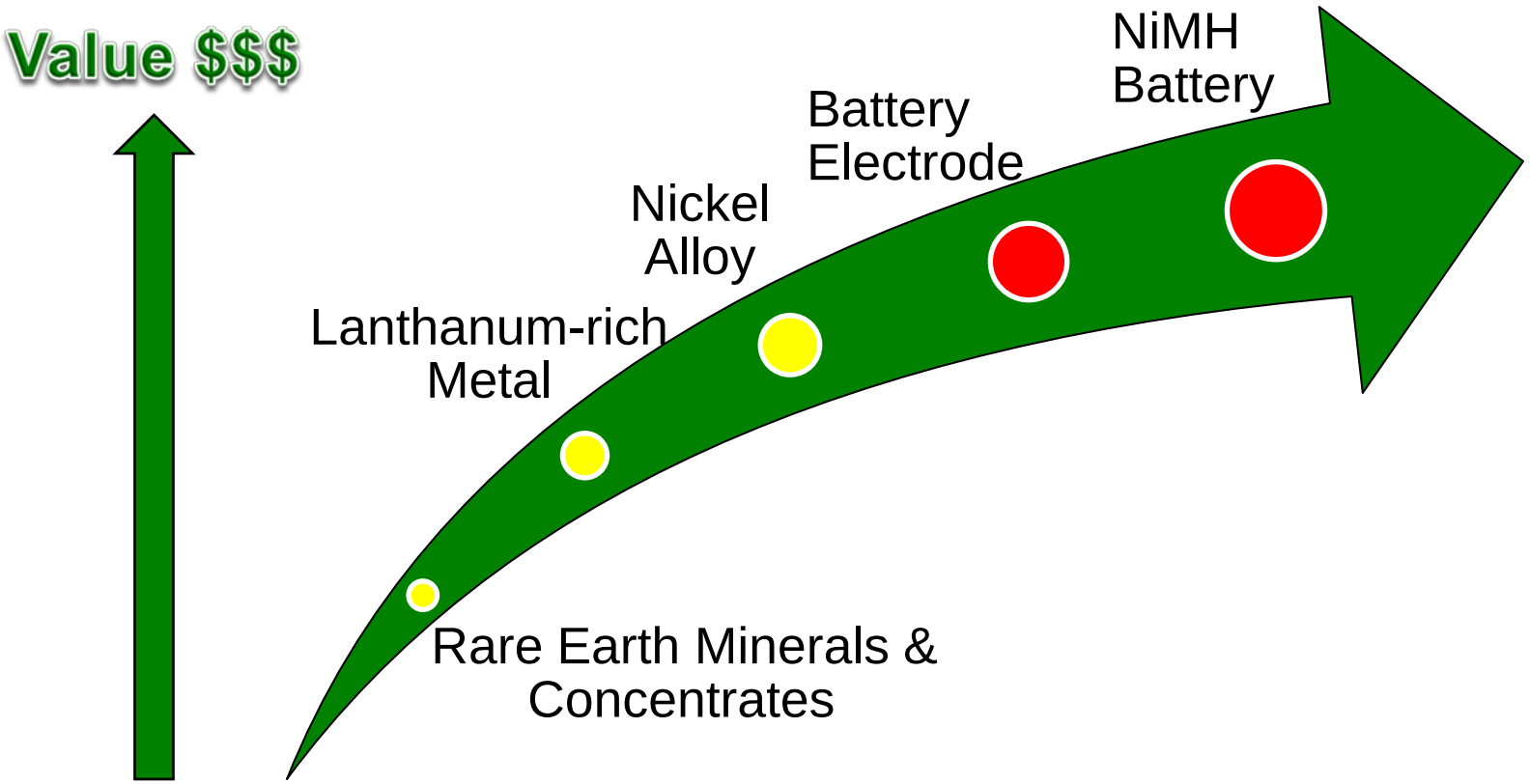
REE Value Chain - Lanthanum



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

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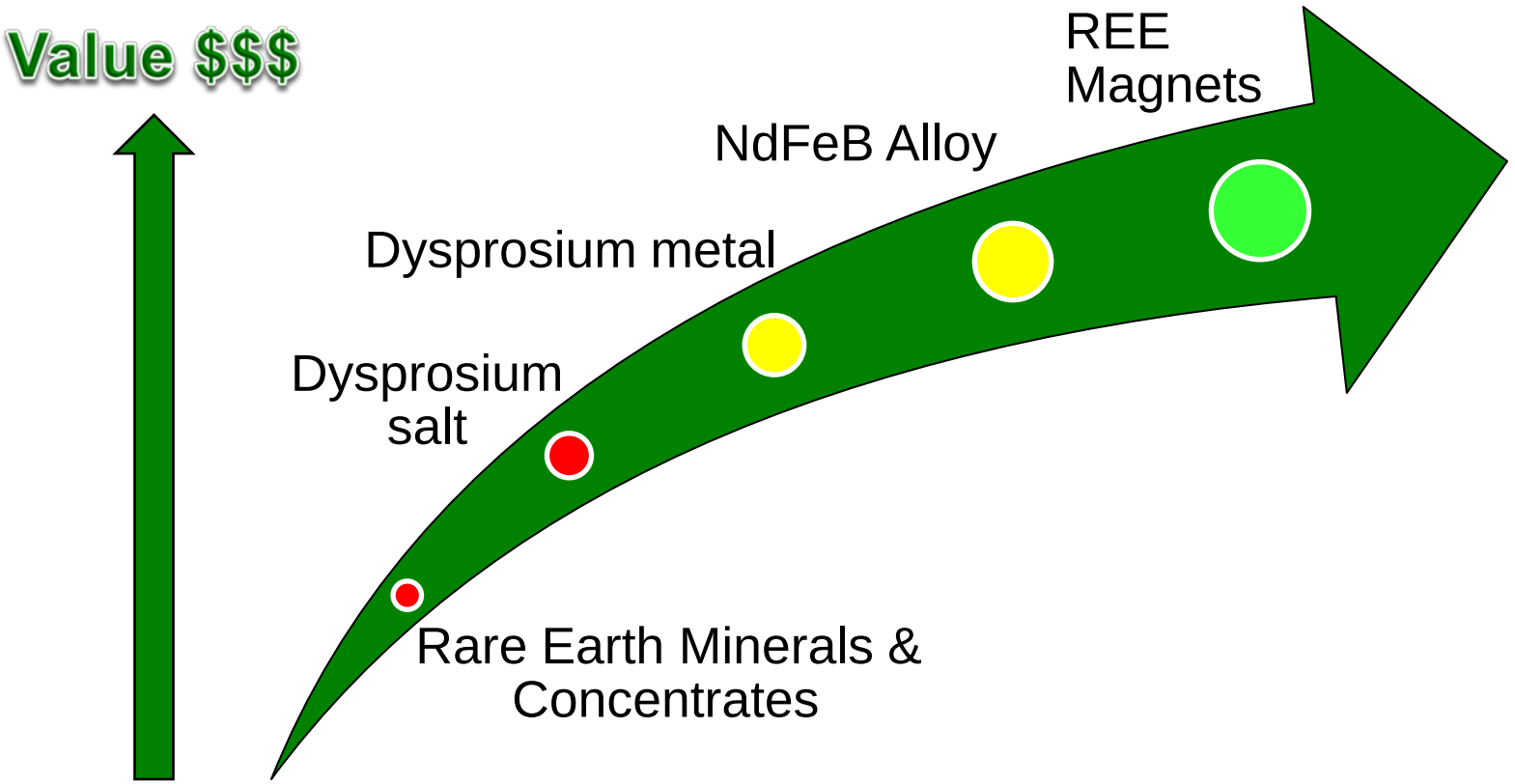
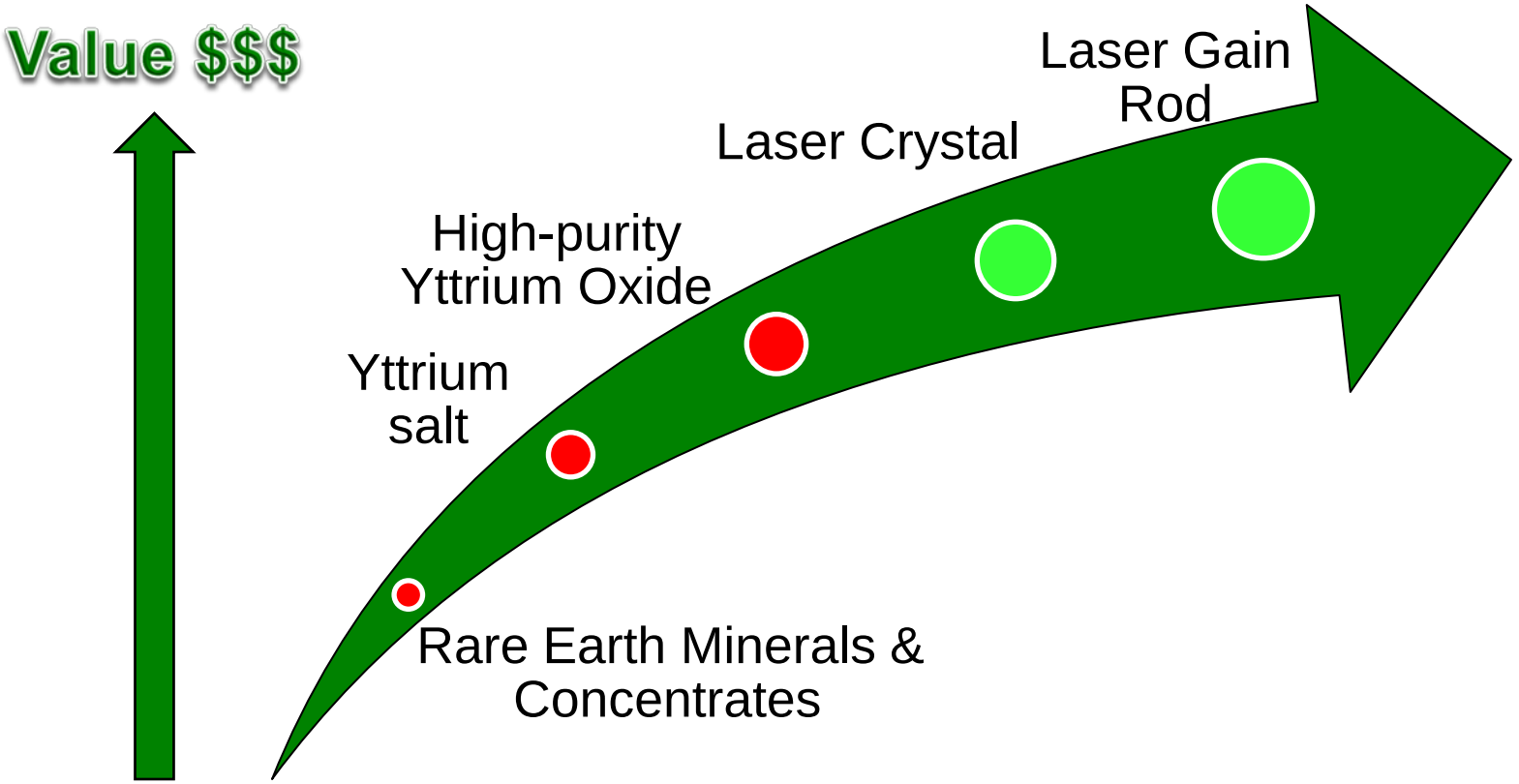
REE Value Chain - Dysprosium



- Dysprosium is a heavy rare earth element
- Only trace quantities of heavy REE in Mountain Pass resource
- One U.S. producer capable of producing REE magnets

USGS

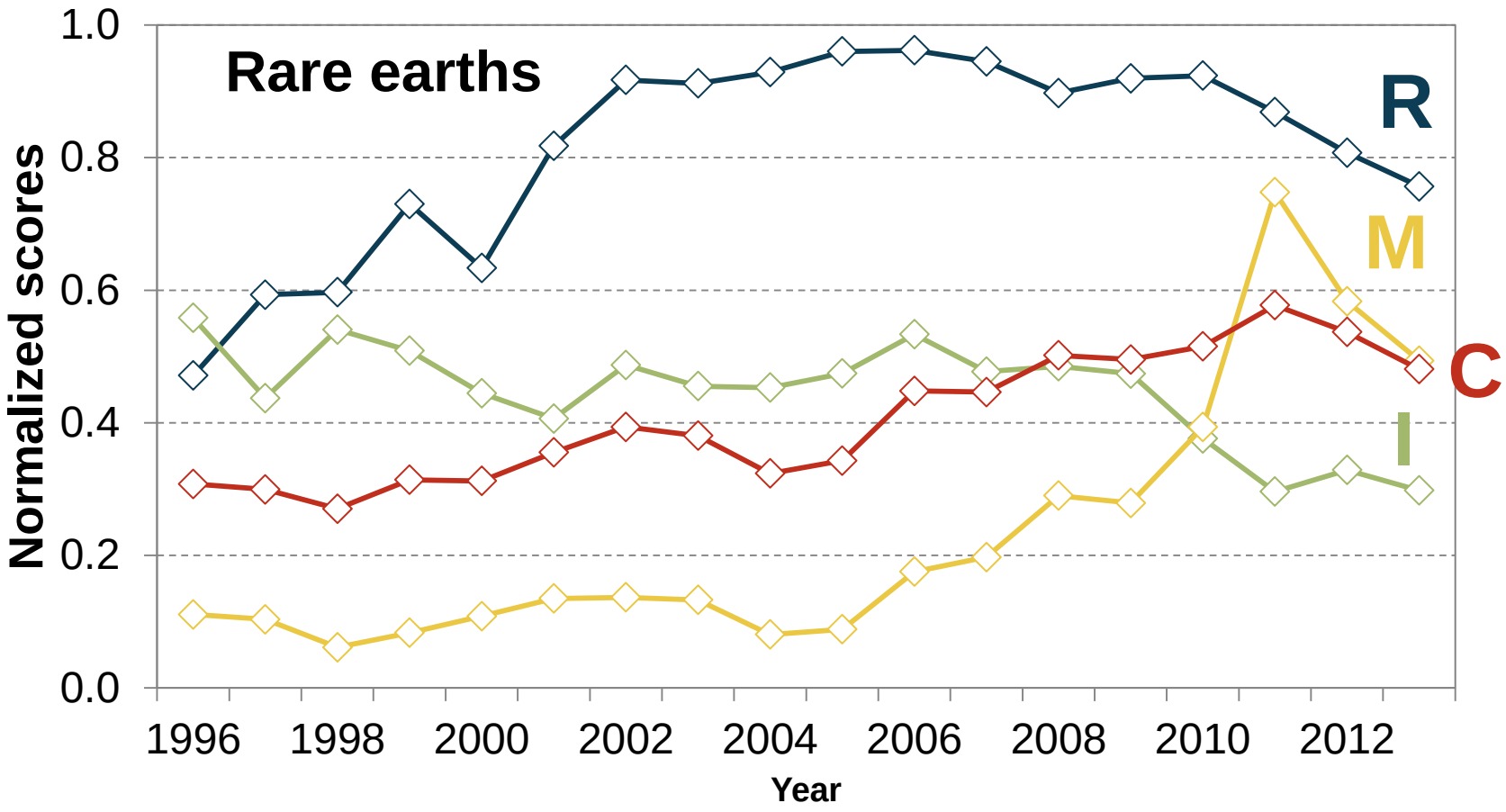
REE Value Chain - Yttrium



- 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

USGS

Early Warning Screening Tool Application - REE



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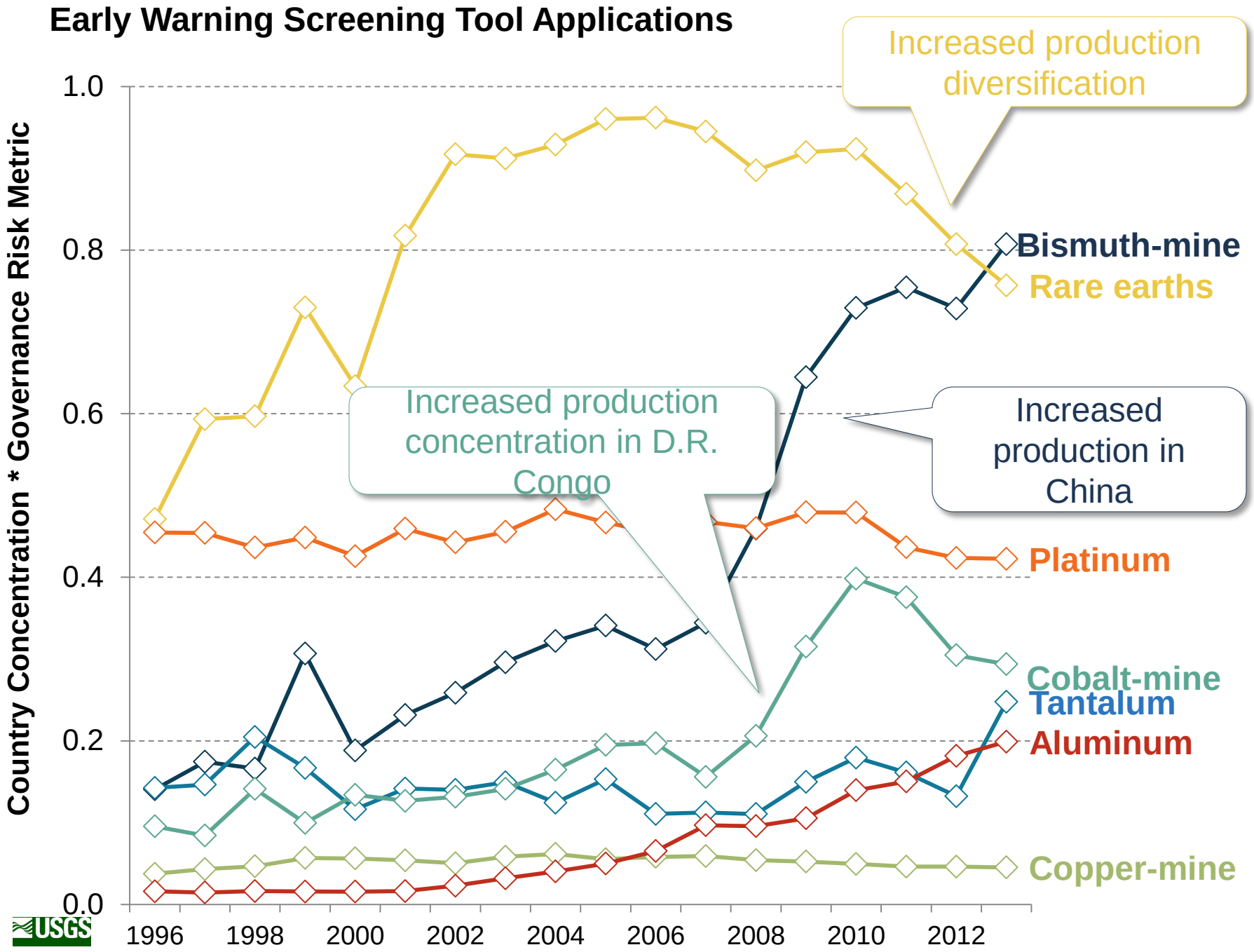
Early Warning Screening Tool Applications
Country Concentration * Governance Risk Metric
1.0
0.8
0.6
0.4
0.2
0.0
1996
1998
2000
2002
2004
2006
2008
2010
2012
Increased production diversification
Increased production concentration in D.R. Congo
Increased production in China
Bismuth-mine
Rare earths
Platinum
Cobalt-mine
Tantalum
Aluminum
Copper-mine
USGS

Pending Legislation

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Congress / Bills / S. 2012

S. 2012: Energy Policy Modernization Act of 2016

Introduced: **Sep 9, 2015**

Status: **Passed Senate** on **Apr 20, 2016**
This bill passed in the Senate on April 20, 2016 and goes to the House next for consideration.

TRACK THIS BILL

Call Congress

Sponsor: 

Lisa Murkowski
Senior Senator from Alaska
Republican

Text: 

Read Text »
Last Updated: Apr 20, 2016
Length: 798 pages

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

USGS