



Critical Minerals: The USGS – National Minerals Information Center Perspective

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March 30, 2016**

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.

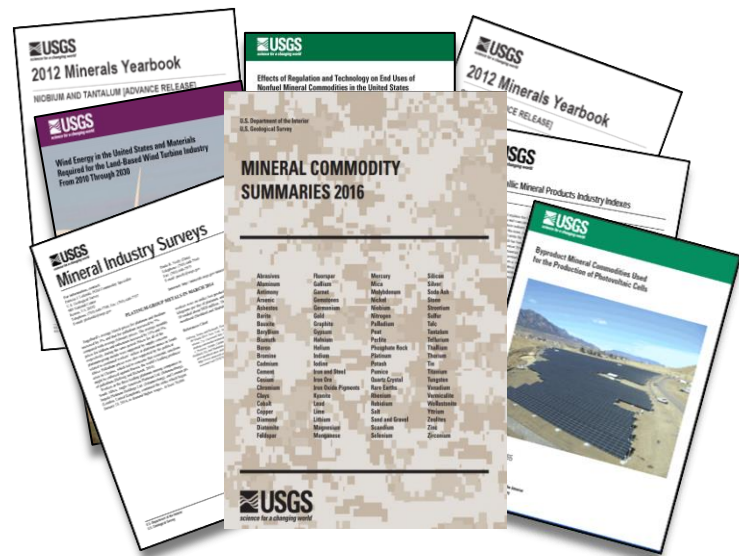
■ Objective

- 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.



Mineral Criticality Studies Are Impossible Without Data

Broad Mineral Commodity Coverage (>85 Commodities)

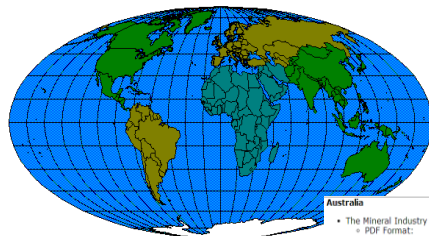


Broad Global Coverage: >180 Countries



International Minerals Statistics and Information

[Contacts](#)
[Publications](#)
[Maps](#)
[Links](#)



• The Mineral Industry of Australia
 • PDF Format:
 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
 • XLS Format:
 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
 • Links
 Contact: USGS Country Specialist

- 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



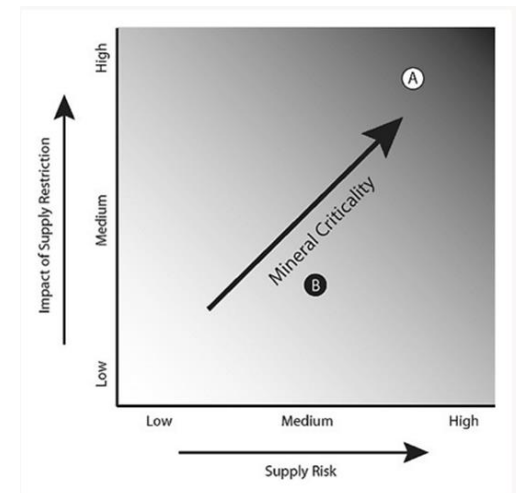
<http://minerals.usgs.gov/minerals/>

Critical Minerals – Some Observations

- Numerous evaluations of mineral criticality have been conducted, resulting in a variety of lists, indexes, and methodological refinements
- Criticality really depends on who is asking the question; an industry analysis is likely to come to a different conclusion and “list” depending on the application and market sector; an analysis by a government agency will likewise reach a different conclusion depending on mission and application:
 - Example: USGS Shakeout Scenario analysis of magnitude 7.8 earthquake in Southern California....critical minerals = aggregates (construction sand & gravel, concrete, asphalt)
 - Example: Oil & gas exploration and production....critical minerals = barite or frac sand
 - None of these fit the “classical” definition of a critical mineral
 - Department of Energy focus is on green energy
 - Department of Defense (Defense Logistics Agency) focus is on minerals for the strategic stockpile
- Criticality is not static but changes over time as the availability of mineral commodities changes and as new technologies result in increased consumption and new applications
- Mineral criticality studies require reliable, regularly updated, mineral production and consumption data for a broad spectrum of applications and stakeholder needs

Critical Minerals – Working Definition

- **Minerals, Critical Minerals, and the U.S. Economy (2008), National Academy of Sciences**
 - A mineral can be considered critical if:
 - Performs an essential function for which few if any substitutes exist
 - An assessment indicates a high probability of supply being disrupted resulting in physical unavailability or significantly higher price
 - Defined two axes:
 - Impact of supply disruption
 - Supply risk
 - Questions
 - How to measure these?
 - What data are required?
 - What are important attributes of the data?





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.)*.

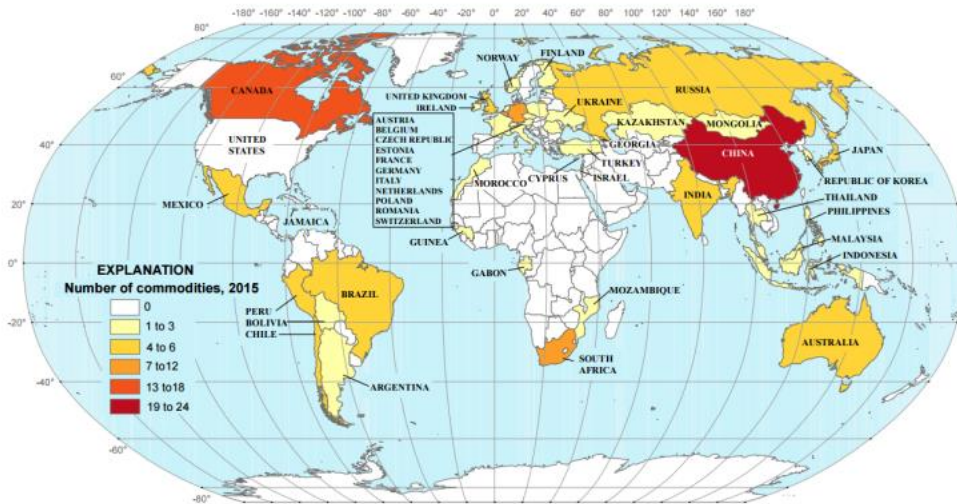
- The term “strategic and critical” (S&C) materials is defined by this Act:

“...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

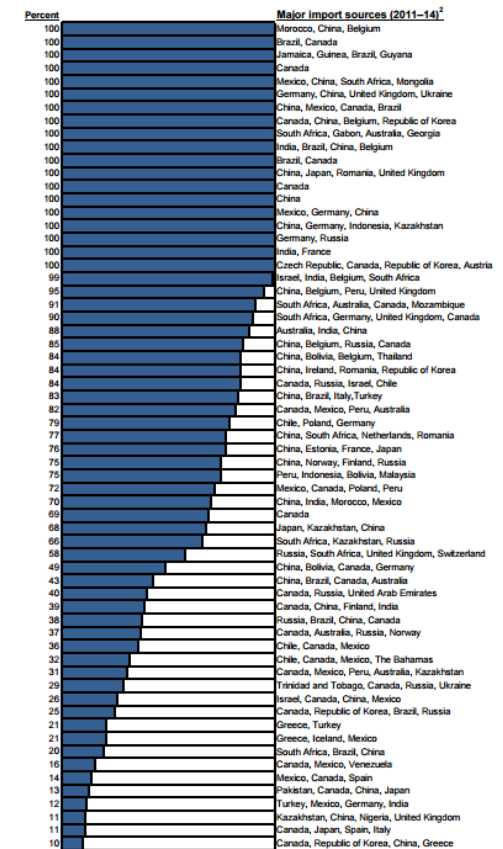


<http://minerals.usgs.gov/minerals/pubs/mcs/2016/mcs2016.pdf>

Net Import Reliance

- Country Specific
- Updated Annually
- Broad coverage
- Timely

2015 U.S. NET IMPORT RELIANCE¹



Supply Risk: Production – Country Concentration

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

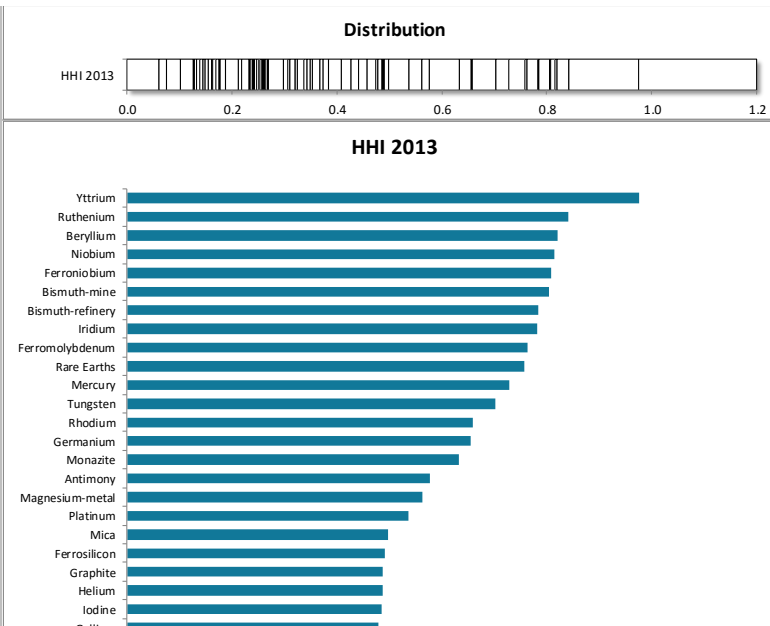


March 2016

World Production Tables

- Quantitative
- Country Specific
- Updated Annually
- Timely (MCS)
- Authoritative (MYB)
- Time Series

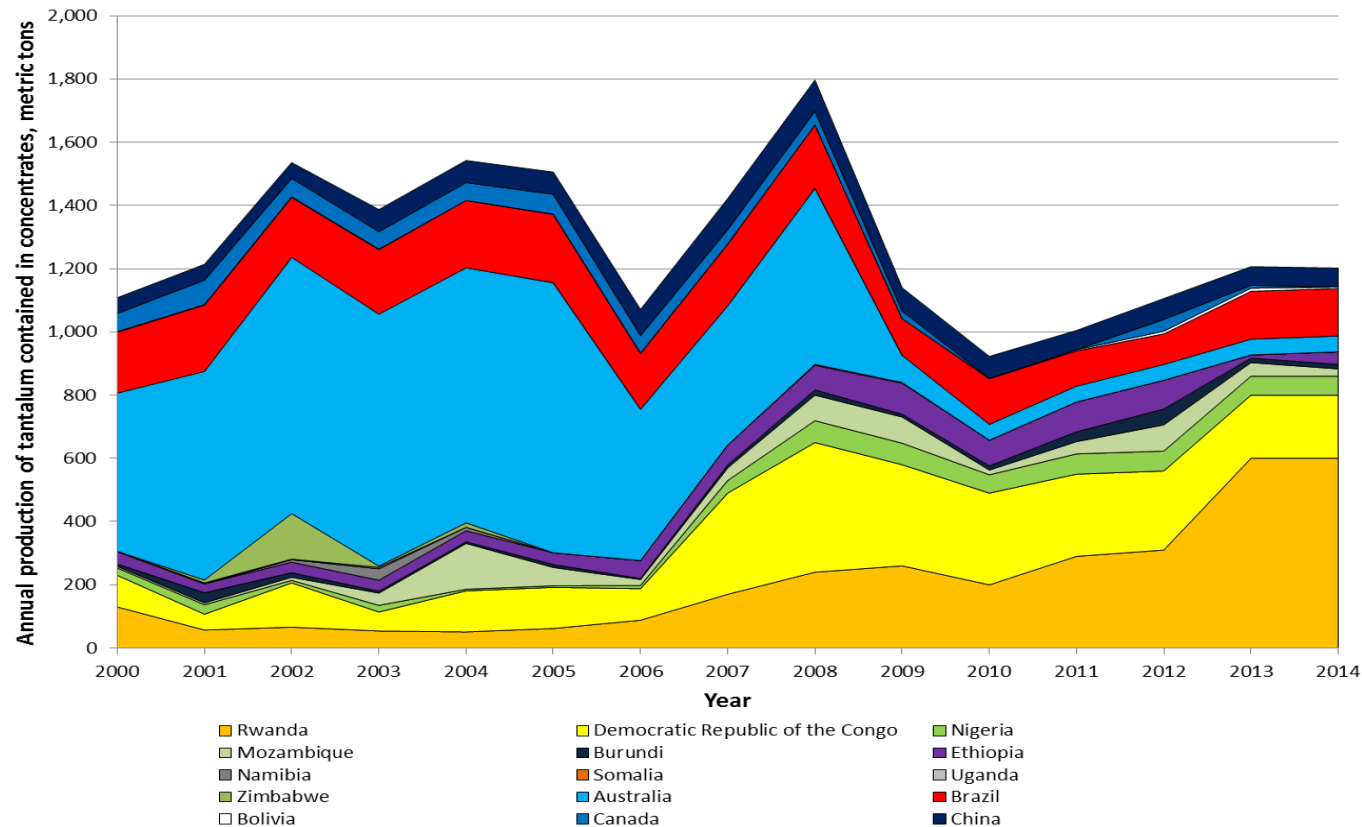
Rank	Commodity	2013
1	Yttrium	0.98
2	Ruthenium	0.84
3	Beryllium	0.82
4	Niobium	0.82
5	Ferriobium	0.81
6	Bismuth-mine	0.81
7	Bismuth-refinery	0.78
8	Iridium	0.78
9	Ferromolybdenum	0.76
10	Rare Earths	0.76
11	Mercury	0.73
12	Tungsten	0.70
13	Rhodium	0.66
14	Germanium	0.66
15	Monazite	0.63
16	Antimony	0.58
17	Magnesium-metal	0.56
18	Platinum	0.54
19	Mica	0.50
20	Ferrosilicon	0.49
21	Graphite	0.49
22	Helium	0.49
23	Iodine	0.49
24	Gallium	0.48
25	Magnesite	0.47
26	Fluorspar	0.46
27	Boron	0.44
28	Silicomanganese	0.43



Herfindahl-Hirshmann Index: Sum of the squares of country share of production of a commodity:



Tantalum: 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 and less transparent trade flows
- Criticality is dynamic, need to use time series to analyze for emerging risks
- Combine with governance risk e.g. World Governance Indicators (World Bank)

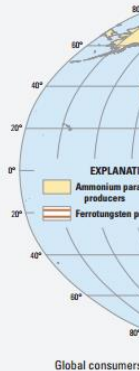
Conflict Minerals Fact Sheet Series



Conflict Minerals Global Tungsten Tungsten Supply

The U.S. Geological Survey (USGS) identifies and defines major components of material supply chains to identify risks associated with the United States associated with tungsten supply chain transparency so that pol sheet focuses on the latter. The tion Center has been asked by organizations to provide information (collectively known as "3TG" worldwide in response to U.S. link between the trade in these Democratic Republic of the C

Post-beneficiation process of 3TG mineral ores and concentrate and industry supply chain the traced to their source of origin origin is critical to establish supply chain (U.S. Government p. 19). This fact sheet, the first

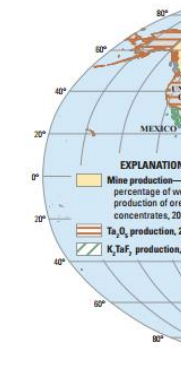


U.S. Department of the Interior
U.S. Geological Survey



Conflict Minerals Global Tantalum Tantalum Supply

The U.S. Geological Survey (USGS) identifies and defines major components of material supply chains to identify risks associated with the United States associated with tantalum supply chain transparency so that pol sheet focuses on the latter. The tion Center has been asked by organizations to provide information (collectively known as "3TG" worldwide in response to U.S. link between the trade in these Democratic Republic of the C



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



Conflict Minerals Tin Processing

The U.S. Geological Survey (USGS) identifies and defines major components of material supply chains to identify risks associated with the United States associated with tin processing. This fact sheet focuses on the gold supply chain.



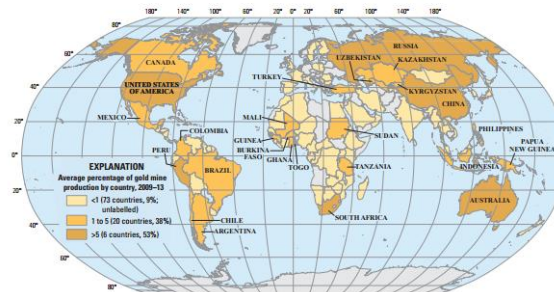
Conflict Minerals From the Democratic Republic of the Congo— Gold Supply Chain

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 transparency so that policymakers 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 tungsten (3T) mineral ores and concentrates were identified by company and 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 3TG minerals, which was published by the NMIC in August 2014 (Bermúdez-Lugo, 2014). Background information about historical conditions and the voluntary due diligence of multinational stakeholders for minerals from conflict-affected and high-risk areas is presented in the tungsten fact sheet. The current fact sheet, the fourth and last in the series about 3TG minerals, focuses on the gold supply chain.

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 83 percent pure gold (20 carat) would form a cube measuring 12 centimeters per side (about the 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 tons (1) (100,000 pounds). Once conflict sourced gold has been

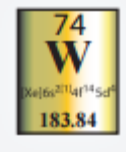


Average world gold mine production by country, 2009–13.

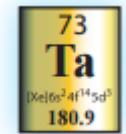
U.S. Department of the Interior
U.S. Geological Survey

Fact Sheet 2015-3075
October 2015

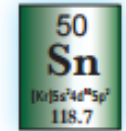
August 2014



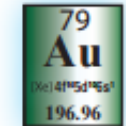
December 2014



July 2015



November 2015



Summary: Components & Characteristics of the USGS – National Minerals Information Center Approach to Mineral Criticality

- Broad coverage
- Global
- Country specific
- Flexibility
- Authoritative
- Dynamic
- Trends, not lists
- Metrics:
 - Rigor
 - Data availability
- Examples of data types used
 - Net import reliance
 - Production country concentration
 - Growth in world production
 - Price volatility
 - World governance indicators
- Ultimate Goal:
 - Practical, simple, early warning screening tool
 - Identify candidates for deep-dive analysis

