



AMERICAN  
RESOURCES  
— ★ —  
POLICY NETWORK

# AMERICAN RESOURCES POLICY NETWORK REPORT

REVIEWING RISK:

## Critical Metals & National Security

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# Table of Contents

<b>INTRODUCTION .....</b>	<b>3</b>
 <b>1.1 DEFINING “CRITICAL AND STRATEGIC METALS AND MINERALS”</b>	
A. United States of Confusion – The Lack of a “Definitional” Consensus .....	<b>6</b>
B. E Pluribus Unum? Reconciling Definition Attempts .....	<b>9</b>
 <b>1.2 AMERICAN RESOURCES RISK PYRAMID</b>	
American Resouces Risk Pyramid .....	<b>11</b>
Comparison of National Defense Stockpile Content FY 2000 / FY 2010 .....	<b>14</b>
 <b>2 SHADES OF DEPENDENCY</b>	
A. USGS’s Supply and Dependency Snapshot .....	<b>17</b>
Table 2.1 - USGS Data on Mineral Reserves and U.S. Dependencies .....	<b>18</b>
B. Visualizing Shades of Dependency .....	<b>24</b>
C. Analysis: Dependency, Intensity – and Opportunity .....	<b>26</b>
 <b>3 CONCLUSIONS</b>	
Findings .....	<b>33</b>

# Introduction

A broad range of non-fuel metals and minerals are critical to our commercial manufacturing base, our hopes for a transition to a green-energy economy, sustained innovations in the high-tech sector, and advanced weapons systems to allow our military to effectively fulfill its mission to protect the homeland and project American power around the globe.

As a result, access to critical and minerals and metals becomes a matter of national security. Given that, one would expect that formulating a coherent national mineral strategy to ensure such access would be a public policy imperative.

However, that is not the case.

To consult official U.S. Government statements on the issue of strategic materials is to discover immediately that the federal government does not speak with a single voice. In recent years, no less than seven departments or agencies – the Government Accountability Office (GAO), the Defense Logistics Agency (DLA), the Department of Defense (DoD), the Congressional Research Service (CRS), The Institute for Defense Analyses (IDA)<sup>1</sup>, the National Research Council (NRC), and the Department of Energy (DoE) - have all considered the critical metals issue in some form or another, and have released their findings in report form.

This study by the American Resources Policy Network -- the first in a series of quarterly reports on a variety of issues relating to critical and strategic minerals -- consults these various government reports and attempts to reconcile findings that overlap and diverge, with a particular view to critical and strategic metals and minerals in the realm of national security.<sup>2</sup>

<sup>1</sup> The Institute for Defense Analyses is a non-profit corporation that operates three federally funded research and development centers to provide objective analyses of national security issues, particularly those requiring scientific and technical expertise, and conduct related research on other national challenges. [www.ida.org](http://www.ida.org).

<sup>2</sup> Due to its mandated scope, the Department of Energy's 2011 Critical Minerals Strategy, which focuses on critical metals as they relate to green energy applications, is not included in our analysis.

# Introduction

For the purpose of this study, we reviewed the following eleven reports, all of which – with the sole exception of the National Research Council’s comprehensive 1999 report – were completed in the past four years:

1. U.S. Government Accountability Office (GAO). Rare Earth Materials in the Defense Supply Chain, GAO-10-617R, April 14, 2010. Accessed online at <http://www.gao.gov/new.items/d10617r.pdf>.
2. U.S. Department of Defense, 2009, Reconfiguration of the National Defense Stockpile Report to Congress: Washington, DC, U.S. Department of Defense. Accessed online at [http://www.acq.osd.mil/mibp/docs/nds\\_reconfiguration\\_report\\_to\\_congress.pdf](http://www.acq.osd.mil/mibp/docs/nds_reconfiguration_report_to_congress.pdf).
3. Executive Summary, Key Materials for High-Priority Weapon Systems, and Assessing Risks to their supply, A Report for the U.S. Defense National Stockpile Center, 31 July 2008, Appendix B in: U.S. Department of Defense, 2009, Reconfiguration of the National Defense Stockpile Report to Congress: Washington, DC, U.S. Department of Defense. Accessed online at [http://www.acq.osd.mil/mibp/docs/nds\\_reconfiguration\\_report\\_to\\_congress.pdf](http://www.acq.osd.mil/mibp/docs/nds_reconfiguration_report_to_congress.pdf).
4. Supplementary Risk Assessments, A Report for the U.S. Defense National Stockpile Center, 3 September 2008, Appendix C in: U.S. Department of Defense, 2009, Reconfiguration of the National Defense Stockpile Report to Congress: Washington, DC, U.S. Department of Defense. Accessed online at [http://www.acq.osd.mil/mibp/docs/nds\\_reconfiguration\\_report\\_to\\_congress.pdf](http://www.acq.osd.mil/mibp/docs/nds_reconfiguration_report_to_congress.pdf).
5. Defense Manufacturing in 2010 and Beyond: Meeting the Changing Needs of National Defense, Committee on Defense Manufacturing in 2010 and Beyond, Commission on Engineering and Technical Systems, National Research Council, 1999, accessed online at <http://www.nap.edu/catalog/6373.html>.
6. Managing Materials for a Twenty-first Century Military, Committee on Assessing the Need for a Defense Stockpile, National Research Council, 2008, accessed online at: <http://www.nap.edu/catalog/12028.html>.
7. Congressional Research Service, Report to Congress, Rare Earths Elements, the Global Supply Chain, by Mark Humphries, Sept. 6, 2011, accessed online at: <http://www.fas.org/sgp/crs/natsec/R41347.pdf>.
8. U.S. Department of Defense, 2001, Strategic and critical materials report to the Congress—Operations under the Strategic and Critical Materials Stock Piling Act during the period October 1999 through September 2000: Washington, DC, U.S. Department of Defense, accessed online at: [https://www.dnsc.dla.mil/Uploads/Materials/dladnsc2\\_9-13-2011\\_15-9-40\\_FY10%20Ops%20Report%20-%202005-06-2011.pdf](https://www.dnsc.dla.mil/Uploads/Materials/dladnsc2_9-13-2011_15-9-40_FY10%20Ops%20Report%20-%202005-06-2011.pdf).
9. U.S. Department of Defense Under Secretary of Defense for Acquisition, Technology and Logistics, August 2011, Interim Report - Assessment and Plan for Critical Rare Earth Materials in Defense Applications, Washington, DC, U.S. Department of Defense.
10. Congressional Research Service, Report to Congress, Rare Earth Elements in National Defense: Background, Oversight Issues, and Options for Congress, by Valerie Bailey Grasso, April 11, 2012, accessed online at: <http://www.fas.org/sgp/crs/natsec/R41744.pdf>.
11. Department of Defense, Office of the Under Secretary of Defense (Acquisition, Technology & Logistics) Deputy Under Secretary of Defense (Industrial Policy) Executive Secretary to the Strategic Materials Protection Board, Report of Meeting Department of Defense Strategic Materials Protection Board, Held on December 12, 2008, accessed online at: [http://www.acq.osd.mil/mibp/docs/report\\_from\\_2nd\\_mtg\\_of\\_smpb\\_12-2008.pdf](http://www.acq.osd.mil/mibp/docs/report_from_2nd_mtg_of_smpb_12-2008.pdf).

# Introduction

In our attempt to reconcile this snapshot of the federal government's approach to the United States' mineral supply issues we focus in the following pages on three key questions:

1. Is there a consensus on which metals or minerals are “critical and/or strategic?”
2. What is our supply risk or import exposure (drawing on USGS data)?
3. How do we square private market activity with public policy to reduce resource dependency where possible and ensure surety of supply?

Ultimately, while we attempt to draw our conclusions as objectively as possible, the reports we examine have divergent assumptions and methods of categorization and measurement. As a result, some of our characterizations are inherently subjective. Our policy is to identify, in the main text or footnotes, the basis on which we have made our judgments.

## “CRITICAL” OR “STRATEGIC” – THAT IS THE QUESTION

Are the metals and minerals under review here properly called Critical or Strategic? U.S. Government reports use both terms with little distinction. For our part, we offer this comment on nomenclature: When the context is applications or utilities -- for instance, what metals are essential to high-performance jet fighter turbines -- critical and strategic may well be used interchangeably: critical to the function in question; strategic as regards the importance of the system.

When the context is supply, however, there seems to be a distinction. All metals that are strategic may not be critical, in terms of supply adequacy. Here, critical connotes supply risk, and the larger assumption is that the metal or mineral in question -- to merit concern -- must be strategic.

# 1.1 Defining “Critical and Strategic Metals and Minerals”

## A. UNITED STATES OF CONFUSION – THE LACK OF A “DEFINITIONAL” CONSENSUS

One of Albert Einstein’s mottos was to first define the problem.

A number of countries have begun to overhaul their mineral strategies to reflect changing supply and demand scenarios as well as shifting geopolitical realities; China is stockpiling Copper;<sup>3</sup> Japan has partnered with Kazakhstan to develop Rare Earths. Meanwhile, the United States remains inert. With issue awareness slowly but surely increasing, the Department of Defense’s assessment of the role of rare earths in the defense supply chain, in which the agency has shrugged off concerns, seems surprising, and, according to some experts, even naïve.<sup>4</sup>

A review of the above-listed U.S. government studies shows that the federal government’s failure to speak with one voice – a prerequisite to formulating a coherent mineral strategy that will allow us to remain competitive and allow our military to effectively perform its missions – begins with the inability to “define the problem.” Indeed, the lack of a commonly agreed-upon definition of what constitutes a “critical/strategic” metal or mineral – or what we call “definitional dissonance” - may be one of the underlying reasons why the United States runs the risk of falling behind in the global race for resources.

Consider the Rare Earths – the generic name for 17 elements in the periodic table, including Yttrium, Scandium and the 15 Lanthanides. Even in dealing with a small subset of 17 elements, three of the reviewed studies focusing exclusively on Rare Earths and related national security issues make no attempt to define the terms “critical/strategic metals or mineral.”<sup>5</sup> As defense specialist Valerie Bailey Grasso points out in the fourth Rare Earths-focused study considered for the purpose of this report, a 2012 CRS Report to Congress:

*There are several definitions of what constitutes a strategic or critical material; however, there is disagreement over which rare earth elements fall within these categories.*<sup>6</sup>

<sup>3</sup> China’s 1.9 million ton stockpile is more Copper than the U.S. consumes in one year. Linette Lopez, *China Reveals Its Copper Stockpile* [http://articles.businessinsider.com/2011-10-13/markets/30274392\\_1\\_international-copper-study-group-copper-inventories-copper-demand](http://articles.businessinsider.com/2011-10-13/markets/30274392_1_international-copper-study-group-copper-inventories-copper-demand)

<sup>4</sup> Adam Currie, *Pentagon Says US Rare Earth Supplies Will Meet Defense Needs*, exclusive to Rare Earth Investing News, accessed online on 05/01/12 at: <http://rareearthinvestingnews.com/6730/pentagon-says-us-rare-earth-supplies-meet-defense-department-needs-congress-export-restrictions-china-world-trade-organization/>.

<sup>5</sup> The respective studies are reports 1, 7, 9 and 10 from our list on page 4.

<sup>6</sup> Grasso, CRS Report to Congress, pg. 13.



## 1.1 Defining “Critical and Strategic Metals and Minerals”

According to Bailey Grasso, the Department of Defense’s current position on strategic materials, reflected in its assessment of Rare Earths in the defense supply chain, was largely determined by the findings of the Strategic Materials Protection Board (SMPB), a panel tasked with determining

*“the need to provide a long-term domestic supply of strategic materials designated as critical to national security, and to analyze the risk associated with each material and the effect on national defense that not having a domestic supply source might pose.”*

The panel’s definition, as put forth in its 2008 study (included in this report’s overall analysis), is as follows:

*“the “criticality” of a material is a function of its importance in DOD applications, the extent to which DOD actions are required to shape and sustain the market, and the impact and likelihood of supply disruption.”<sup>7</sup>*

While this sounds reasonable, further criteria are specified in the report,<sup>8</sup> which ultimately draws the net so tightly that only one material – high-purity Beryllium - meets the standard set by the SMPB.

For good reasons, the House Armed Services Committee has levied criticism against this definition, arguing that it

*“limits the ability of the Board to consider any course of action, however minor, in relation to a material until the point at which potential damage to national security is imminent and severe,”*

and further:

*“creates the perverse situation that a material could be critical to every element of the industrial base upon which the Department depends, but not considered critical to the Department itself if the material is also used significantly in commercial items.”<sup>9</sup>*

<sup>7</sup>DoD, SMPB report, pg. 5

<sup>8</sup>From pg. 7 of DoD SMBP report: “Critical materials are a subset of strategic materials. The Department of Defense should designate a material as “critical to national security” only if it meets the “technical” criterion of a “strategic” material; and also meets two additional criteria:

- “Business” criterion: The Department of Defense dominates the market for the material, and its active and full involvement and support is necessary to sustain and shape the strategic direction of the market; and
- “Security of Supply” criterion: There is significant and unacceptable risk of supply disruption due to vulnerable U.S. or qualified non-U.S. suppliers.”

<sup>9</sup>The FY2011 National Defense Authorization Act (H.R.6523) has addressed this issue by defining strategic materials as follows: “material essential for military equipment, unique in the function it performs, and for which there are no viable alternatives.” We note that Grasso’s 2012 CRS Report cites this definition.

## 1.1 Defining “Critical and Strategic Metals and Minerals”

Other studies included in our analysis use different definitions:

The 2011 Strategic and Critical Materials Report to the Congress appears to draw from definition in the Strategic and Critical Materials Stockpiling Act, 50 U.S.C. 98 et seq.:

*“(1) The term “strategic and critical materials” 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.”<sup>10</sup>*

On the other hand, the DoD’s 2009 Reconfiguration of the National Defense Stockpile Report to Congress uses the following terms to describe “critical or strategic minerals”:

*“materials required for defense and national security needs.”<sup>11</sup>*

and:

*“those materials for which the U.S. is largely import dependent, for which no viable economic substitute exists, or for which there is concern over the source (for geopolitical reasons) or the supply (for market reasons).”<sup>12</sup>*

Meanwhile, without explicitly defining “critical or strategic minerals”<sup>13</sup>, the Committee on Assessing the Need for a Defense Stockpile evaluated current national defense material needs by applying the following two criteria:

*“the recent evolution of the domestic and global materials supply chains and the impact of growing international materials needs on materials availability.”<sup>14</sup>*

<sup>10</sup>DoD, 2011 Strategic and critical materials report to the Congress, Appendix A, pg. 17.

<sup>11</sup>DoD, Reconfiguration of the National Defense Stockpile Report to Congress, pg.1.

<sup>12</sup>Ibid., pg. 6.

<sup>13</sup>Considered outside the scope of the study, see pg. 65 of Managing Materials for a Twenty-first Century Military, Committee on Assessing the Need for a Defense Stockpile.

<sup>14</sup>Ibid., pg. vii.



# 1.1 Defining “Critical and Strategic Metals and Minerals”

## ***B. E PLURIBUS UNUM?***

### **RECONCILING DEFINITION ATTEMPTS**

There are several recurring themes appearing in most reports, the most important of which cohere around the following five criteria:

- Unique properties necessary for key defense applications
- Substitution difficulties
- Supply chain vulnerabilities
- Import dependency (factoring for geo-political risk)<sup>15</sup>
- Over-concentration of supply from a single country (factoring for geo-political risk)

Nevertheless, common agreement on a single definition has yet to be found. This becomes a problem insofar as the cacophony of definitional approaches gets in the way of policy makers making sound policy choices. Different definitions lead to different results, and the challenges associated with this become apparent with the SMPB definition: We agree with the House Armed Services Committee that it is over-restrictive, especially insofar as it blunts the ability to forestall critical metal shortages by creating a definitional need for demonstrated market failure. Sound policy must move the “action continuum” to a place where U.S. policy can prevent material shortages – not simply react to shortages after they occur.

At the same time, we find definitions like the one used in the 2011 National Defense Authorization Act to be so loose as to fail to allow any relative risk assessment – in the manner of our Risk Pyramid (see Section 1.2 below) – to guide policymakers in prioritizing which metals and minerals require urgent action, and which ought simply to be monitored or placed on a “watch list.”

<sup>15</sup>Factoring for geo-political risk is easily the subject of its own report. Suffice to say that any policy screen must account for import dependency on allied nations and/or significant trade partners judged to be politically stable, and nations outside of the U.S. alliance structure and/or less stable.

## 1.1 Defining “Critical and Strategic Metals and Minerals”

Of all the definitions offered in the various government studies, we find the one used in the DoD’s 2009 Reconfiguration of the National Defense Stockpile Report comes closest to capturing the most-frequently-noted attributes across the various studies:

*“materials required for defense and national security needs.”*<sup>16</sup>

and:

*“those materials for which the U.S. is largely import dependent, for which no viable economic substitute exists, or for which there is concern over the source (for geopolitical reasons) or the supply (for market reasons).”*<sup>17</sup>

Though the latter seemingly precludes minerals for which the U.S. has significant domestic production and reserves, it’s vital that we take this with a grain of salt. Copper, for example, is abundant domestically, yet remains an invaluable resource due to its extensive security, technology and energy applications.<sup>18</sup>

<sup>16</sup> DoD, Reconfiguration of the National Defense Stockpile Report to Congress, pg.1.

<sup>17</sup> Ibid., pg. 6.

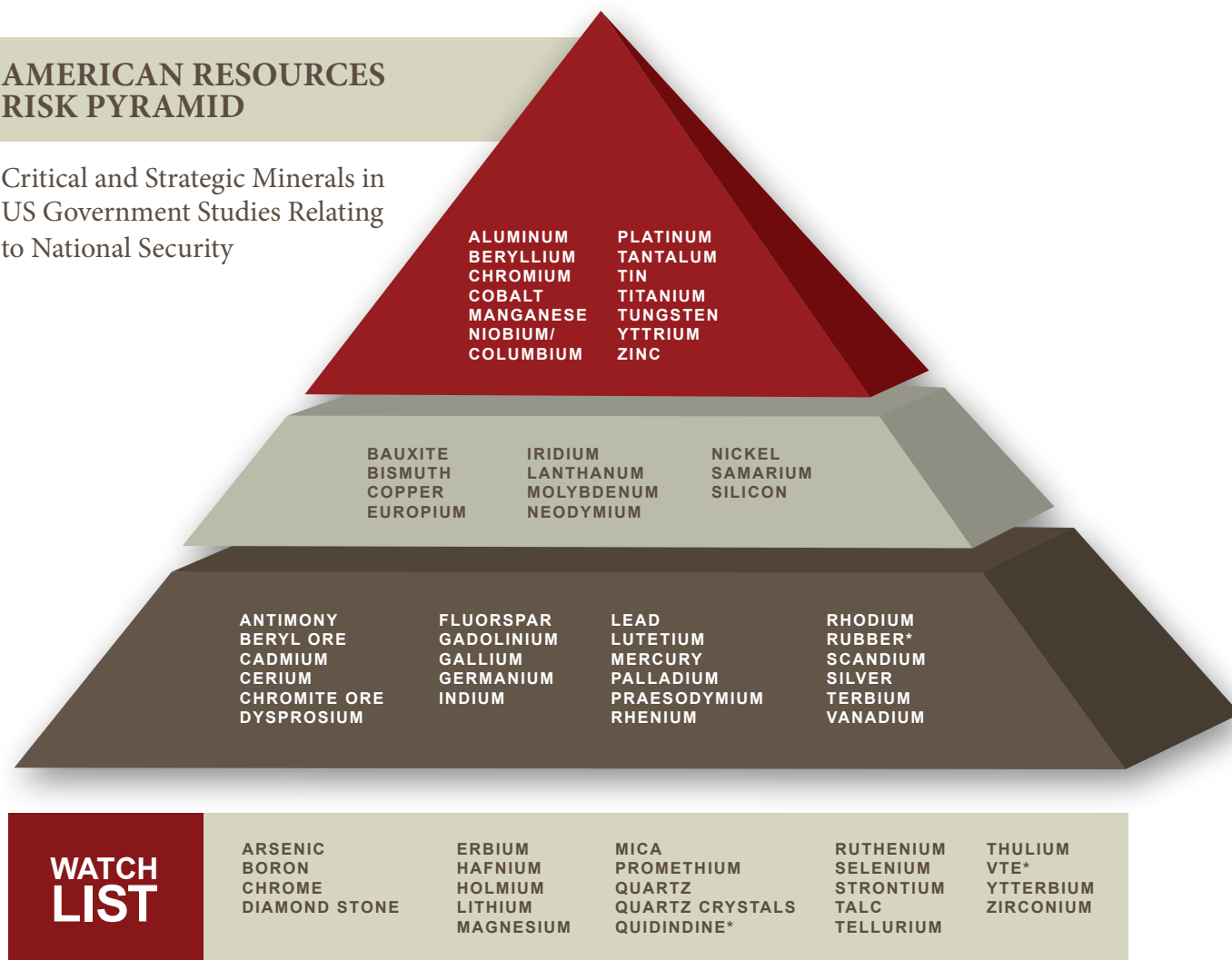
<sup>18</sup> New Copper utilities emerge regularly. As this report goes to print, researchers have discovered superior performance in Copper switches for cloud computing data storage: <http://www.marketwatch.com/story/extreme-networks-tackles-growing-demand-for-10-gigabit-ethernet-copper-switches-in-data-centers-2012-05-07>

## 1.2 American Resources Risk Pyramid

Surveying the above-referenced government reports, we attempted to not only reconcile definitional frameworks, but also the various list of minerals and metals appearing in those studies. We believe the American Resources “Risk Pyramid” provides a reasonable window into the federal government’s approach to the United States’ mineral supply issues.<sup>19</sup>

### AMERICAN RESOURCES RISK PYRAMID

Critical and Strategic Minerals in  
US Government Studies Relating  
to National Security



\* NOT TECHNICALLY MINERALS, THEREFORE OMITTED IN FURTHER CALCULATIONS

<sup>19</sup>Note that we do not consider this pyramid to display a finite universe of “critical and/or strategic metals or minerals,” but merely a way to capture what comes closest to a consensus among federal agencies on which elements may be deemed as such.

## 1.2 American Resources Risk Pyramid

To arrive at our Risk Pyramid, we first tallied the appearance of minerals and metals on select lists or in select tables<sup>20</sup> contained in (or appearing throughout) the reviewed studies, assigning one point per appearance.

As all 17 Rare Earth elements appear in all four reports, they were only given one cumulative point for the overall calculations so as not to skew the result. On top of that, and in contrast to a comparatively “generic” treatment in the other reports, Valerie Bailey Grasso’s CRS Report to Congress singles out nine Rare Earths for their importance in specific defense applications – these nine were awarded an additional bonus point.

Minerals and metals that were given four or more points in our calculations make up the tip of our pyramid. The second tier is formed by elements garnering three points, while the pyramid’s base consists of minerals and metals that have been assigned two points.

In addition, we added the remaining minerals that received one point in our calculations to a “Watch List.”

### DoD’s Top Ten Standard Materials By Usage <sup>21</sup>

STANDARD MATERIAL	DOD DEMAND IN STONS PER YEAR
Aluminum	275,219.8
Copper	105,625.8
Lead	88,464.8
Fluorspar acid grade	56,544.5
Zinc	51,085.5
Rubber (natural)	29,490.3
Manganese Ore (chem/ metal grade)	25,041.8
Nickel	17,311.75
Chromium Ferro	9,667.8
Chromite Ore	9,630.5

The report is available for download at  
[www.americanresources.org/criticalmetalsreport](http://www.americanresources.org/criticalmetalsreport)

<sup>20</sup> The following lists and tables were used: Table ES-1 in Appendix B, and Table 1 in Appendix C, DoD, 2009 Reconfiguration of the National Defense Stockpile Report to Congress; Table 4-3 in Managing Materials for a Twenty-first Century Military Committee on Assessing the Need for a Defense Stockpile, National Research Council, 2008; Table 1 in U.S. Department of Defense, 2001, Strategic and critical materials report to the Congress. The National Research Council Study Defense Manufacturing in 2010 and Beyond focused on processes rather than materials and only specifically references Titanium processing, while the DoD’s Report of Meeting Department of Defense Strategic Materials Protection Board Held on December 12, 2008 concluded that only Beryllium was a “strategic and critical” mineral.

<sup>21</sup> This chart is derived from data in Appendix B in DoD 2009, Reconfiguration of the National Defense Stockpile Report to Congress. We provide it here to give an indicator of the volume of materials used for defense purposes on an annual basis.

## 1.2 American Resources Risk Pyramid

### A SNAPSHOT OF THE POST-COLD WAR NATIONAL DEFENSE STOCKPILE (NDS)

Until the U.S. Government issues a single and definitive study of critical metals issues in the context of defense and national security, the American Resource Risk Pyramid allows a composite view of the various studies that have been done, and a relative ranking of metals and minerals identified as critical and strategic.



Post-Cold War National Defense Stockpile (NDS)

The National Defense Stockpile was created as a result of the 1939 Strategic Materials Act, which authorized federal funds for the purchase of strategic raw materials for a stockpile.

The original stockpile identified 42 metals and minerals, at the direction of the Army and Navy Munitions Boards. During the early years of the Cold War, the number of materials rose to 75 and to a low of 12, in response to changing national security concepts.<sup>22</sup>

In key respects, the concept of a National Defense Stockpile was a casualty of the end of the Cold War. In 1992, the Department of Defense determined that 99% of the stockpile inventory was “excess to (post-Cold War) defense needs,” and directed the Defense National Stockpile Center to sell off much of the NDS inventories.

Faced with changing mineral needs and domestic production capabilities -- against the backdrop of increasingly fragmented globalized supply chains and concerns regarding possible supply disruptions due to new geopolitical realities -- there has been a rethinking of stockpiling policy in recent years, as reflected by several of the studies referenced in this report.

After years of gradually depleting the NDS, Congress mandated a re-examination of the need for a stockpile, the results of which were captured in the 2009 Reconfiguration of the National Defense Stockpile Report to Congress, one of the 11 reports assessed in our study.

<sup>22</sup> The Role of the National Defense Stockpile in the Supply of Strategic and Critical Materials, by Colonel Scott F. Romans, United States Army Reserve, U.S. Army War College, Carlisle Barracks, PA, 2008.

## 1.2 American Resources Risk Pyramid

### COMPARISON OF NATIONAL DEFENSE STOCKPILE CONTENT FY 2000 / FY 2010

While the FY 2000 revised Annual Materials Plan lists 62 materials listed to be stockpiled, the gradual sell-off depleted the NDS to only contain inventories of 28 minerals according to the FY 2010 Annual Materials Plan.

23 of those 28 metals and minerals appear on the American Resources Risk Pyramid – marked here with an asterisk.

COMPARISON OF NATIONAL DEFENSE STOCKPILE CONTENT 2000 / 2010	REVISED ANNUAL MATERIAL PLAN (AMP) - FY 2000	FISCAL YEAR 2010 AMP FY 2010
Aluminum Oxide, Abrasive*	✓	✓
Aluminum Oxide, Fused Crude*	✓	
Analgesics	✓	
Antimony*	✓	
Asbestos (all types)	✓	
Bauxite, Metallurgical Jamaican*	✓	✓
Bauxite, Metallurgical Surinam*	✓	
Beryl Ore*	✓	✓
Beryllium Metal*	✓	✓
Beryllium Copper Master Alloy*	✓	✓
Cadmium*	✓	
Celestite	✓	
Chromite, Chemical	✓	
Chromite, Metallurgical	✓	
Chromite, Refractory	✓	
Chromium, Ferro*	✓	✓
Chromium, Metal*	✓	✓
Cobalt*	✓	✓
Columbium (Niobium)* Carbide Pwd.	✓	

<sup>23</sup> Note that while this comparison contains various grades of minerals and metals, these are pooled for simplicity on the Risk Pyramid graphic.



## 1.2 American Resources Risk Pyramid

COMPARISON OF NATIONAL DEFENSE STOCKPILE CONTENT 2000 / 2010	REVISED ANNUAL MATERIAL PLAN (AMP) - FY 2000	FISCAL YEAR 2010 AMP FY 2010
Columbium (Niobium)* Concentrates	✓	
Columbium (Niobium), Ferro*	✓	
Columbium (Niobium) Metal Ingots*	✓	✓
Diamond Stone	✓	✓
Fluorspar, Metallurgical Grade*	✓	
Germanium*	✓	✓
Graphite	✓	
Iodine	✓	
Jewel Bearings	✓	
Kyanite	✓	
Lead*	✓	
Manganese, Battery Grade, Natural*	✓	✓
Manganese, Battery Grade, Synth.*	✓	✓
Manganese, Chemical Grade*	✓	✓
Manganese, Ferro*	✓	✓
Manganese, Metal, Electrolytic*	✓	
Manganese, Metallurgical Grade*	✓	✓
Mica, All	✓	✓
Palladium*	✓	
Platinum*	✓	✓
Platinum – Iridium*		✓
Quidindine	✓	✓
Quinine	✓	
Sebacic Acid	✓	
Silver (Coins)*	✓	
Talc	✓	✓
Tantalum Carbide Powder*	✓	✓
Tantalum Metal Ingots*	✓	

## 1.2 American Resources Risk Pyramid

COMPARISON OF NATIONAL DEFENSE STOCKPILE CONTENT 2000 / 2010	REVISED ANNUAL MATERIAL PLAN (AMP) - FY 2000	FISCAL YEAR 2010 AMP FY 2010
Tantalum Metal Powder*	✓	
Tantalum Minerals*	✓	
Tantalum Oxide*	✓	
Thorium Nitrate	✓	
Tin*	✓	✓
Titanium Sponge*	✓	
Tungsten Carbide Powder*	✓	
Tungsten Ferro*	✓	
Tungsten Metal Powder*	✓	✓
Tungsten Ores & Concentrates*	✓	✓
VTE, Chestnut	✓	
VTE, Quebracho	✓	✓
VTE, Wattle	✓	✓
Zinc*	✓	✓
Zirconium (Baddeleyite)	✓	

## 2 Shades of Dependency

### A. USGS'S SUPPLY AND DEPENDENCY SNAPSHOT

The following table provides a snapshot of mineral resource availability and degrees of dependency from a U.S. perspective. Drawing from the United States Geological Survey's (USGS) 2012 Mineral Commodity Summaries report, the table depicts the amount of global reserves and the amount of U.S. reserves, both in numbers and as a percentage of global reserves. Following USGS methodology, we also list up to four of the main supplier nations, and provide the degree to which the United States relies on foreign imports to meet domestic needs for each respective mineral material.<sup>25</sup>

#### MORE ON RARE EARTHS SUPPLY

### The Critical Rare Earths Report

In its Mineral Commodity Summaries, USGS does not provide individual summaries for the group of 15 Lanthanides, which together with Yttrium and Scandium make up the Rare Earths Elements group.

American Resources Expert and cofounder of Technology Metals Research Gareth Hatch has written an instructive study which features detailed evaluations of the supply challenges and qualitative rankings for individual REEs. Built on a set of four global supply projections for rare earth oxides, the study is packed full of visual data from 2012 through 2017.

The report is available for download at  
[www.americanresources.org/criticalmetalsreport](http://www.americanresources.org/criticalmetalsreport)

### THE AMERICAN RESOURCES COLOR CODE

We conclude that for a dozen of the listed metals and minerals or respective groups (shaded in yellow in the table) - all of which also appear on the American Resources Risk Pyramid - U.S. import dependence is largely self-inflicted, and a remedy in the form of additional supply could be homemade. As we're fortunate to have significant reserves of these mineral resources beneath our own soil, prioritizing the exploration and development of these deposits could go far in reducing our reliance on foreign suppliers.

For an additional set of fifteen metals and minerals or respective groups (shaded in green)<sup>26</sup>, the data suggests that the United States could probably do more to reduce foreign resource dependencies. While domestic supplies are not necessarily ample for these elements, and the economics of extraction is a critical factor, exploring and developing U.S. deposits could lessen the intensity of U.S. resource dependence.

<sup>24</sup> U.S. Geological Survey, 2012 Mineral Commodity Summaries 2012: U.S. Geological Survey.

<sup>25</sup> Note that as USGS does not provide individual data sets for all of the Rare Earth elements and (with the exception of Yttrium and Scandium) treats them as a group, we also list them as a group for the purpose of this section.

<sup>26</sup> Note that Beryl Ore, Chrome, or Chromite, which were treated as separately-listed elements by various government reports, did not get their own sections in the USGS report, and appear under Beryllium and Chromium respectively.

## 2 Shades of Dependency

For an additional set of fifteen metals and minerals or respective groups (shaded in olive green), the data suggests that the United States could probably do more to reduce foreign resource dependencies. While domestic supplies are not necessarily ample for these elements, and the economics of extraction is a critical factor, exploring and developing U.S. deposits could lessen the intensity of U.S. resource dependence.

For eight of the listed metals and minerals (shaded in purple) USGS does not list any U.S. reserves,<sup>27</sup> meaning that in order to secure supplies, imports are our only option short of recycling and substitution, the possibilities for which are limited.

Lastly, we assigned a blue shading to minerals and metals for which the United States is presently a net exporter. Note, however, that even for certain forms of these metals and minerals, the United States still relies on imports from foreign countries.

**TABLE 2.1 – USGS DATA ON MINERAL RESERVES AND U.S. DEPENDENCIES**

	GLOBAL RESERVES	US RESERVES (TOTAL AND % OF GLOBAL RESERVES)	MAIN SUPPLIER NATIONS	DEPENDENCY DEGREE
ALUMINUM	55,900 (year-end capacity in thousand metric tons)	3,200 5.72%	Canada, Russia, China, Mexico	13%
ANTIMONY	1,800,000 (metric tons of antimony content)	No information given, though resources listed as primarily present in Alaska, Idaho, Montana, and Nevada	China, Mexico, Belgium	87%
ARSENIC	~1,040,000 (metric tons)	No information given, but since it is recovered from copper, gold and lead smelter dust, more could probably be done	China, Japan, Morocco, Belgium	100%
BAUXITE	29,000,000 (metric dry tons)	20,000 0.7%	Jamaica, Brazil, Guinea, Australia	100%

<sup>27</sup> However, while USGS lists zero reserves (saying that available deposits are low grade) for Manganese, we note that one U.S. company is seeking to re-develop a historic Manganese mine in Arizona. Furthermore, there is a Niobium (Columbium) development project underway in Nebraska, while USGS also lists zero Niobium (Columbium) reserves.

## 2 Shades of Dependency

	GLOBAL RESERVES	US RESERVES (TOTAL AND % OF GLOBAL RESERVES)	MAIN SUPPLIER NATIONS	DEPENDENCY DEGREE
BERYLLIUM (INFORMATION FOR BERYL ORE NOT SEPARATELY LISTED BY USGS)	Not sufficiently well delineated to report consistent figures for all countries	Very little Beryl that can be economically hand-sorted. Large Bertrandite reserves in Utah totaling about 15,000 metric tons	Russia, Kazakhstan, Japan	21%
BISMUTH	320,000 (metric tons)	Zero reserves	China, Belgium, United Kingdom	89%
BORON	210,000 (metric tons of boric oxide)	40,000	Turkey, Chile, Bolivia	Net exporter
CADMIUM	640,000 (metric tons)	19.05%	(Metal): Mexico, Australia, Canada, Germany	Net exporter
CHROMIUM (CHROME AND CHROMITE ORE INFORMATION NOT PROVIDED SEPARATELY BY USGS)	>480,000 (metric tons gross weight, shipping grade)	39,000	South Africa, Kazakhstan, Russia, China	60%
COBALT	7,500,000 (metric tons)	6.09%	China, Norway, Russia, Canada	75%
COLUMBIUM / NIOBIUM	3000000 (metric tons)	Zero reserves	Brazil, Canada, Germany, Russia	100%
COPPER <sup>28</sup>	690,000 (thousand metric tons)	35,000 5.07%	Chile, Canada, Peru, Mexico	35%

<sup>28</sup> Although Copper falls in the middle tier of our Risk Pyramid – largely due to existing domestic deposits – we believe the metal's placement belies its greater importance to national defense (see Fact Box: DoD's Top Ten Standard Materials By Usage) and energy technology (over three tons per wind turbine, hybrid cars, etc). There are also indications that Copper is at greater risk for supply disruption than other major metals. (see Elisa Alonso; Material Scarcity from the Perspective of Manufacturing Firms: Case Studies of Platinum and Cobalt [http://msl.mit.edu/theses/Alonso\\_E-thesis.pdf](http://msl.mit.edu/theses/Alonso_E-thesis.pdf), p. 168)

## 2 Shades of Dependency

	GLOBAL RESERVES	US RESERVES (TOTAL AND % OF GLOBAL RESERVES)	MAIN SUPPLIER NATIONS	DEPENDENCY DEGREE
FLUORSPAR	240,000 (thousand metric tons)	Information not available	Mexico, China, South Africa, Mongolia	100%
GALLIUM	216 metric tons	Information not available, but as it occurs as byproduct of primarily Bauxite, more could probably be done domestically	Germany, Canada, United Kingdom, China	99%
GERMANIUM	NA	450,000 (kilogram)	China, Belgium, Russia, Germany	90%
HAFNIUM	Quantitative estimates not available, occurs with zirconium	Quantitative estimates not available, occurs with zirconium	France, Germany, United Kingdom	NA
INDIUM	Quantitative estimates of reserves are not available	Quantitative estimates of reserves are not available	China, Canada, Japan, Belgium	100%
LEAD	85,000 (thousand metric tons)	6,100 7.18%	Canada, Mexico, Peru	Net exporter
LITHIUM	13,000,000 (metric tons)	38,000 0.29%	Argentina, Chile, China	> 80%
MAGNESIUM	Compounds: 2,500,000 (metric tons) Metal: not quantified	Compounds: 10,000 Compounds: 0.4% Metal: not quantified	Compounds: China, Canada, Brazil, Austria Metal: Israel, Canada, China	Compounds: 53% Metal: 35%



## 2 Shades of Dependency

	GLOBAL RESERVES	US RESERVES (TOTAL AND % OF GLOBAL RESERVES)	MAIN SUPPLIER NATIONS	DEPENDENCY DEGREE
MANGANESE	630,000 (thousand metric tons gross weight)	Zero reserves	South Africa, Gabon, China, Australia	100%
MERCURY	93,000 (metric tons)	Zero reserves	Peru, Chile, Germany, Canada	Net exporter
MICA	Natural: very large	Natural: very small		Sheet, natural: 100% Scrap and flake, natural: 20%
MOLYBDENUM	10,000 (thousand metric tons)	2,700 27%		Net Exporter
NICKEL	80,000,000	Zero reserves	Canada, Russia, Australia, Norway	47%
QUARTZ CRYSTALS (HIGH PURITY) (SEPARATE INFORMATION FOR QUARTZ NOT LISTED BY USGS)	Information unavailable, but reserves for lascas thought to be large		China, Japan, Russia	100%
PLATINUM METALS GROUP	66,000,000 (kilograms)	900,000	Platinum: Germany, South Africa, United Kingdom, Canada; Palladium: Russia, South Africa, United Kingdom, Norway	Platinum: 88% Palladium: 56% (> Averaged 72%)

## 2 Shades of Dependency

	GLOBAL RESERVES	US RESERVES (TOTAL AND % OF GLOBAL RESERVES)	MAIN SUPPLIER NATIONS	DEPENDENCY DEGREE
QUIDINDINE (NOT LISTED IN USGS REPORT)				
RARE EARTHS	110,000,000 (metric tons of rare earth oxide)	13,000,000 11.82%	China, France, Estonia, Japan	100%
RHENIUM	2,500,000 (kilograms)	390,000 15.6%	Chile, Netherlands, Germany	87%
SELENIUM	93,000 (metric tons)	10,000 9.3%	Peru, Chile, Germany, Canada	Net exporter
SILICON	Ample in relation to demand, no quantitative estimates available	Should be ample	China, Russia, Venezuela, Canada	42%
SILVER	530,000 (metric tons)	25,000 4.72%	Mexico, Canada, Peru, Chile	75%
STRONTIUM	6,800,000 (metric tons)	Zero	Mexico, Germany	100%
TANTALUM	120,000 (metric tons)	Zero	China, Germany, Australia, Kazakhstan	100%
TELLURIUM	24,000 (metric tons)	Zero	China, Canada, Philippines, Belgium	Withheld in USGS report.
TIN	4,800,000 (metric tons)	Zero	Peru, Bolivia, Indonesia, China	76%

## 2 Shades of Dependency

	GLOBAL RESERVES	US RESERVES (TOTAL AND % OF GLOBAL RESERVES)	MAIN SUPPLIER NATIONS	DEPENDENCY DEGREE
TITANIUM	Mineral concentrates, Ilmenite: 650,000 (thousand metric tons of contained TiO <sub>2</sub> ) mineral concentrates, Rutile: 690,000	Mineral concentrates, Ilmenite: 2,000 0.31% mineral concentrates, Rutile: data included in Ilmenite	Sponge: Kazakhstan, Japan, China, Russia Mineral concentrates: South Africa, Australia, Canada, Mozambique	Sponge: 69% Mineral concentrates: 58%
TUNGSTEN	3,100,000 (metric tons)	140,000 4.52%	China, Bolivia, Canada, Germany	36%
VANADIUM	14,000 (thousand metric tons)	45 0.32%	Rep. of Korea, Canada, Austria, Czech Republic	80%
YTTRIUM <sup>29</sup>	540,000 (metric tons of yttrium oxide)	120,000 22.22%	China, Japan, France, United Kingdom	100%
ZINC	250,000 (metric tons)	12,000 4.8%	Canada, Peru, Mexico, Ireland	73%
ZIRCONIUM	52,000 (thousand metric tons)	500 0.96%	Mineral concentrates: Australia, South Africa Unwrought, including powder: Germany, France, Japan, Kazakhstan	Net exporter

<sup>29</sup> Note that Yttrium is one of only two Rare Earths for which USGS lists reserves, import and dependency information separately. The Mineral Commodity Summaries report has a chapter on Scandium, but provides little to no data.

## 2 Shades of Dependency

### B. VISUALIZING SHADES OF DEPENDENCY

While Table 2.1 provides an overall snapshot on the United States' mineral resource potential and dependencies, the following charts focus on which countries domestic manufacturers rely on to meet production needs.

The following charts were derived using USGS data from Table 2.1, cross-referenced with Chart 1.2, our Risk Pyramid. We counted the numbers of times a metal or mineral is listed as one of the (up to) top four suppliers for metals and minerals appearing on the American Resources Risk Pyramid, while excluding metals and minerals from the Watch List.

To ensure comparability of data, a few adjustments and exclusions had to be made, which are explained below.

#### ALL CHARTS:

- For metals and minerals with various grades, we only used the top one listed. (Example: For Titanium, we only counted the countries listed for “sponge”)
- For REEs, we only counted China as top supplier country, as the other ones listed only refine material from China.
- For the Platinum Group Metals (PGM), we only counted supplier nations for palladium and platinum where applicable. For lack of data, we had to exclude PGM metals rhodium and iridium.
- For Beryl Ore, no separate information was provided. We used data provided for Beryllium here.

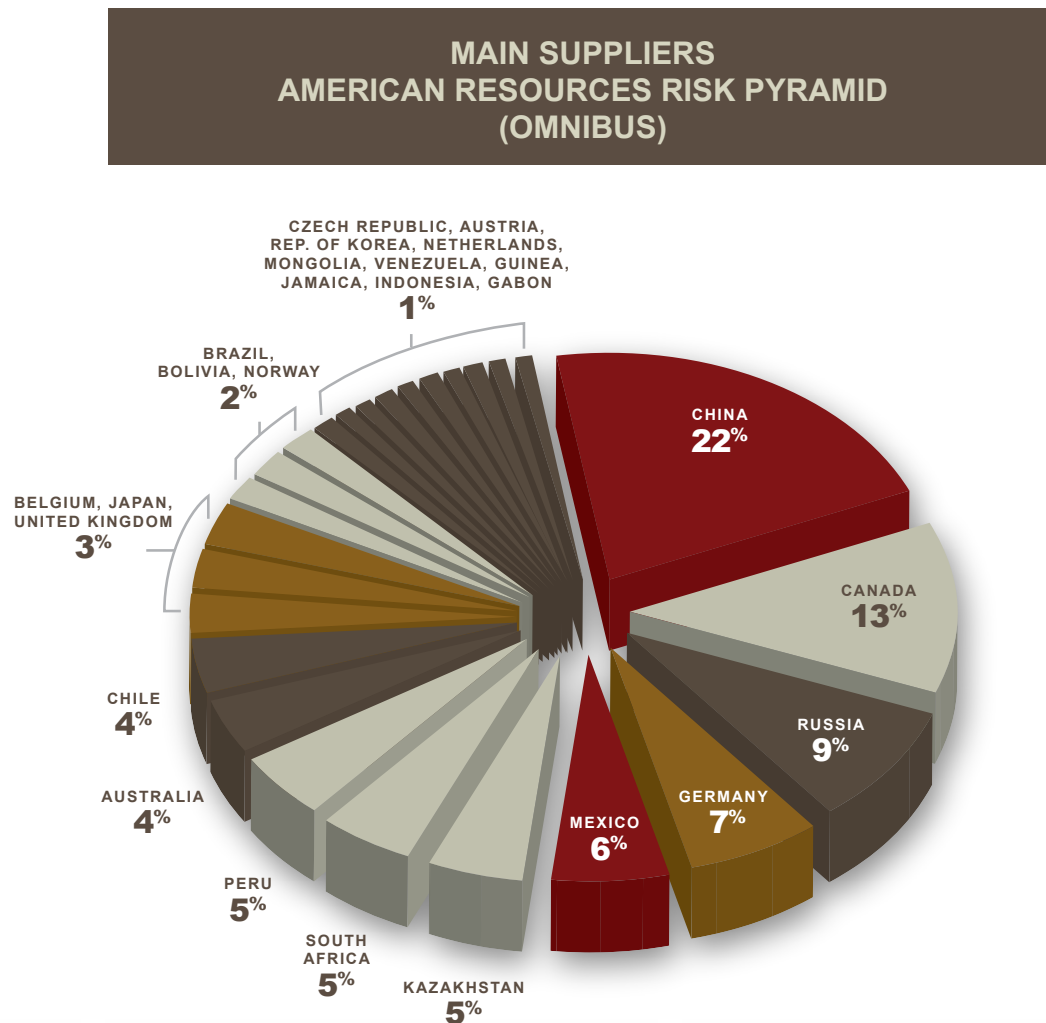
#### “MAIN SUPPLIERS PER PYRAMID TIER” CHARTS:

- While USGS provides separate data for Yttrium, all other REEs making our Risk Pyramid are lumped together as a group. Consequently, in our calculations, we applied the data provided for the group for all other individual REEs included.

## 2 Shades of Dependency

### “INTENSITY OF DEPENDENCY” CHARTS:

- Metals and minerals for which the U.S. is currently a net exporter were excluded, as no dependency degree information was provided.
- For the REEs, which appear as a group with an import dependency of 100%, we counted China twelve times (once for every REE that made our Risk Pyramid).
- For Platinum and Palladium we used a dependency number of 72%, the average for the two (Platinum at 88%; Palladium at 56%). This therefore understates Platinum and overstates Palladium, but provides at least a partial indicator of U.S. intensity of dependence.
- Tellurium was excluded from this section as information on the degree to which the U.S. relies on foreign Tellurium imports is withheld by USGS.



## 2 Shades of Dependency

### C. ANALYSIS DEPENDENCY, INTENSITY – AND OPPORTUNITY

#### FOREIGN DEPENDENCY: THE ELEPHANT IN THE ROOM

As our charts make clear, when the issue is resource dependency, the elephant in the room is China. Our first “omnibus” chart comprising supplier nations for all the metals and minerals that make our “Risk Pyramid” shows that the United States relies to a disproportionately high degree on mineral imports from China, accounting for 22% of mineral imports.

When we segment our Pyramid into High-, Medium- and Low-Risk categories, China takes the top slot in each, with a dependency percentage ranging from 19 to 27%.

The U.S.’s complex relationship with China suggests that policy-makers should closely monitor the degree of resource dependency, with an eye towards diversifying away from China to other resource suppliers – and to the development of domestic American alternatives.

#### FACTORING FOR GEO-POLITICAL RISK - U.S. Mineral Supply and Freedom

Cross-referencing our findings regarding the United States’ top supplier nations for critical and strategic metals and minerals with two of the leading freedom indices, Freedom House’s 2012 Freedom<sup>30</sup> in the World report, and the Heritage Foundation Wall Street Journal 2012 Index of Economic Freedom<sup>31</sup>, we found that a striking seven countries among the twenty listed as main importers for metals and minerals that make our Risk Pyramid are considered “mostly unfree” by the Heritage/WSJ Index, while the picture on the Freedom House report is more mixed.

China, appearing as one of the top suppliers for the largest share of materials on our pyramid, is not only ranked “mostly unfree” in terms of economic freedom by the Heritage/WSJ Index, it also scores as “not free” on the Freedom House report. The same applies for Russia, which accounts for the third largest share of materials. With political and economic stability in question, concerns regarding supply shortages loom large.

There may be less reason to be concerned about our reliance on mineral supplies from allied countries judged to be politically stable, such as Canada, Germany, or Australia. However, the situation is less clear-cut with other nations like Kazakhstan, which is ranked as “unfree” by Freedom House, but “moderately free” by the Heritage/WSJ Index. Its trade freedom score has also declined slightly, and recent media reports have raised questions about the country’s political stability.<sup>32</sup>

While this hasn’t stopped Japan (on which the U.S. also relies for refined rare earths materials) from partnering with Kazakhstan<sup>33</sup>, it underscores the volatility of geo-political realities. Consequently, accounting for geo-political risk in the effort to ensure secure and ongoing access to critical and strategic metals and minerals should be a policy imperative.

<sup>30</sup> Freedom House, Freedom in the World 2012, accessed online on 05/03/12 at: <http://www.freedomhouse.org/report/freedom-world/freedom-world-2012>

<sup>31</sup> Heritage Foundation Wall Street Journal 2012 Index of Economic Freedom, accessed online on 05/03/12 at: <http://www.heritage.org/index/default>.

<sup>32</sup> <http://www.economist.com/blogs/banyan/2012/02/jitters-kazakhstan>.

<sup>33</sup> <http://www.reuters.com/article/2012/04/29/us-japan-kazakhstan-idUSBRE83S01920120429>.



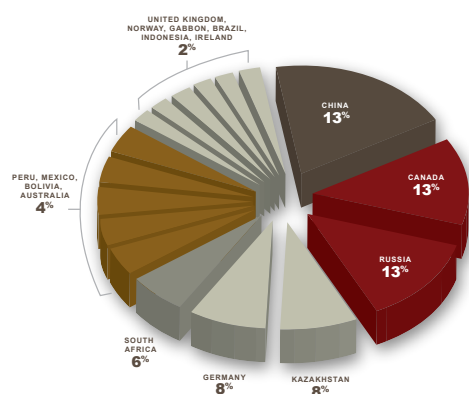
## 2 Shades of Dependency

Russia ranks third on our “omnibus” dependency index. With the rough road to a “Reset” of U.S.-Russian relations, here too the U.S. should be cognizant of dependency and steps to diminish it through diversification and domestic resource development

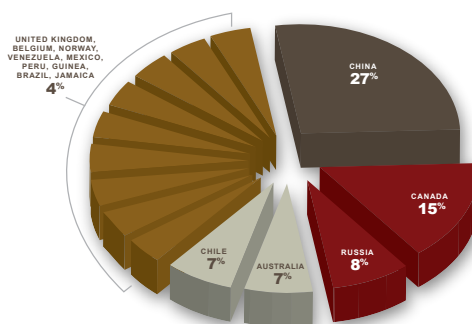
Russia is bracketed by Canada, Germany and Mexico – in the first two cases allies and major trade partners of the U.S., and in the third, a NAFTA partner with whom strong economic ties are a policy imperative. Dependency on these nations should carry a lower concern for risk, though even here, where the U.S. has domestic reserves for specific metals and minerals, surety of supply – and economic growth – should dictate a new look at ways to encourage domestic development.

Next come Kazakhstan, Peru and South Africa at 5% each, followed by Chile, and Australia at 4% each. As the U.S. has significant trade ties plus a security alliance with resource-rich Australia, the above comments pertaining to Canada and Germany largely apply here as well. Peru, Chile and South Africa are emerging trade relationships of value to the U.S., which suggest a diminished level of risk. Kazakhstan, which ranks low in surveys of political stability and respect for human rights (see box on Page 26) – and sits in a difficult geo-political position between China and Russia – could ultimately prove to be a reliable resource partner, or be pulled into directions antithetical to U.S. interests. As resource relationships often last decades, dependency on Kazakhstan deserves a higher level of risk monitoring.

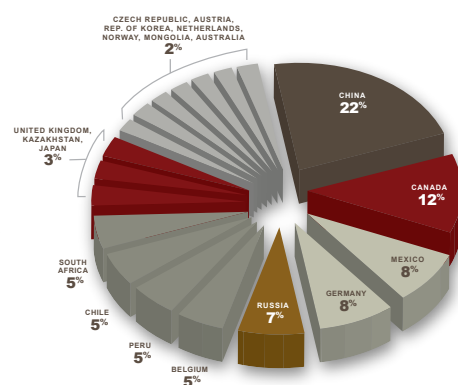
The picture of dependency does not change much when we break our omnibus chart up by the High-, Medium-, and Low Risk tiers of our Pyramid.



**MAIN SUPPLIERS FOR  
TOP TIER**  
OF THE AMERICAN RESOURCES  
RISK PYRAMID



**MAIN SUPPLIERS FOR  
MIDDLE TIER**  
OF THE AMERICAN RESOURCES  
RISK PYRAMID



**MAIN SUPPLIERS FOR  
BOTTOM TIER**  
OF THE AMERICAN RESOURCES  
RISK PYRAMID

## 2 Shades of Dependency

### INTENSITY OF DEPENDENCE HEIGHTENED RISK TO SUPPLY DISRUPTION

Our second screen – intensity of dependence – captures the extent to which the U.S. depends for significant (and in some cases 100%) metals and minerals supply on specific nations. As a rule, as the U.S. approaches high levels of dependence on specific countries for a metal or mineral, the risk of supply disruption becomes a factor – and economics can be displaced by considerations of geo-politics.

In terms of intensity, China's impact – China is a supplier-nation for 43% of the metals and minerals for which the U.S. is 91 to 100% dependent – is even more outsized than on our dependency index. This tracks with the USGS findings that show China as a supplier for 11 of the 19 metals for which the U.S. is 100% dependent,<sup>34</sup> and the findings of the British Geological Survey, which lists China as the leading global producer of 28 of the 52 elements and element groups on its 2011 Risk List – a whopping 54%.<sup>35</sup>

For American Resources, as in the case of dependency, intensity adds to the urgency that the U.S. diversify away from China and develop domestic resources as alternatives.

The 91-100% intensity exposure to the next tier of supplier-nations – Canada, Germany and Australia, each of which registers 8% – is, as in the case of dependency, a matter of diminished risk, as is the 5% score for significant trading partners Brazil and South Africa. Here, where import exposure is above 91% and in some cases 100%, American Resources believes an effort to diversify and encourage domestic resource development is warranted.

Crossing over from our intensity index to country dependency, China is a top provider of 18 metals and minerals for which the U.S. is 91 to 100% import-dependent. Three rank in the top tier of our Risk Pyramid (Manganese, Tantalum and Yttrium), four in the mid-tier (Europium, Lanthanum, Samarium and Neodymium), and eleven in the third tier (Fluorspar, Indium, Gallium, Germanium, Cerium, Dysprosium, Gadolinium, Lutetium, Praseodymium, Scandium and Terbium).

The U.S.'s mid-range intensity of exposure (between 71-90% dependent) is far more diversified. Here, China is tied with another country for first place – Canada, both at 12%. They are followed by a cluster of countries at 7%: Mexico, Peru, the UK, Russia, Germany, and Belgium. Chile, South Africa, and Norway follow at 5%. On our 51 to 70% intensity chart, five nations account for the whole, with China, Russia and Kazakhstan accounting for 25% each, and Japan and South Africa dividing the final quarter. This bloc of 75% should raise risk concerns, and spark diversification and domestic development efforts.

<sup>34</sup> U.S. Geological Survey, 2012 Mineral Commodity Summaries, pg. 6.

<sup>35</sup> British Geological Survey, 2011 Risk List, pg. 3, accessed online on 05/02/12 at <http://www.bgs.ac.uk/mineralsuk/statistics/riskList.html>.

## 2 Shades of Dependency

The 90-100% intensity exposure to the next tier of supplier-nations – Canada, Germany and Australia, each of which registers 8% – is, as in the case of dependency, a matter of diminished risk, as is the 5% score for significant trading partners Brazil and South Africa. Here, where import exposure is above 90% and in some cases 100%, American Resources believes an effort to diversify and encourage domestic resource development is warranted.

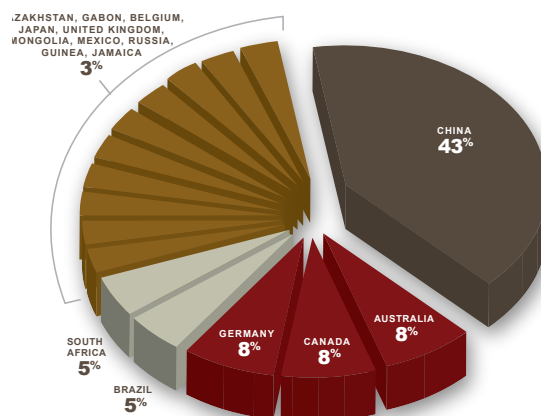
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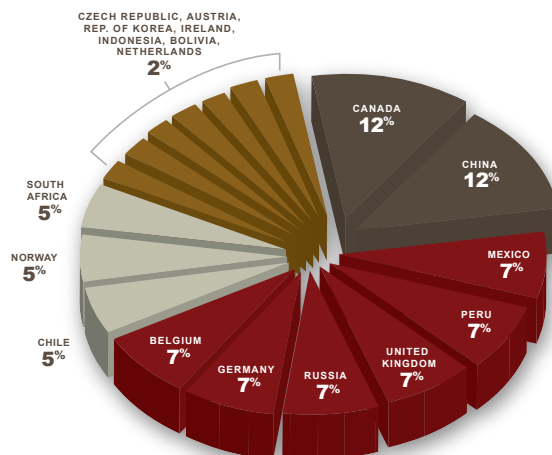
### INTENSITY OF DEPENDENCE

TOP SUPPLIERS FOR MINERALS FOR WHICH US IMPORT DEPENDENCE RANGES BETWEEN 91% AND 100%



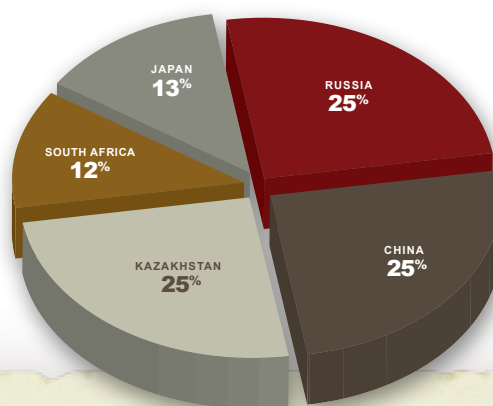
### INTENSITY OF DEPENDENCE

TOP SUPPLIERS FOR MINERALS FOR WHICH US IMPORT DEPENDENCE RANGES BETWEEN 71% AND 90%



### INTENSITY OF DEPENDENCE

TOP SUPPLIERS FOR MINERALS FOR WHICH US IMPORT DEPENDENCE RANGES BETWEEN 51% AND 70%

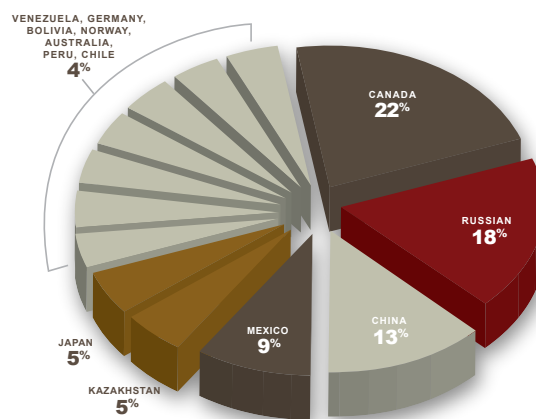


## 2 Shades of Dependency

For those who are inclined to treat this 51 to 70% segment as a lower-order concern, recall that U.S. dependency on foreign oil supply is only now coming below the 50% level. Considering the extent to which “oil politics” drives U.S. foreign and national security policy, the intensity of dependence for the range of metals in this category cannot be dismissed. In all, the U.S. is dependent for at least 50% of its supply for 43 metals and minerals.

To put it another way, if “foreign oil” appeared on the USGS dependency chart, it would appear in 44th place.

**INTENSITY OF DEPENDENCE**  
TOP SUPPLIERS FOR MINERALS FOR WHICH US IMPORT  
DEPENDENCE RANGES BETWEEN 1% AND 50%



### A SHORT NOTE ON COPPER DEPENDENCY

As we acknowledge in footnote 26, Copper presents a notable exception to the “foreign dependency = risk for supply disruption” axiom. The United States is the world’s third largest Copper producer, yet a 2010 MIT study by Elisa Alonso notes that the risk of Copper disruption is significantly greater than for other major metals, and is at or near an historical high. The Office of the Secretary of Defense lists Copper as a metal that has, “[Already] caused some kind of weapon production delay for the DoD.”

Copper is also the primary metal for other strategic and critical metals highlighted in this report. Significant amounts of Molybdenum, Rhenium (nearly 75% of world’s production), Tellurium and Selenium (95% of world’s production) come from Copper mining and refining.<sup>36</sup> Copper shortages will trigger companion shortages in these metals as well. We highlight this to further demonstrate the shortsightedness of targeting metals based entirely on stand-alone percentages. It’s critical that we take all aspects and applications of these resources into account as we assess their importance.

<sup>36</sup> [http://www.ctempo.org/studies/TECHNOLOGY%20METALS%20AND%20ENERGY%20CRITICAL%20ELEMENTS%20\(ECES\).pdf](http://www.ctempo.org/studies/TECHNOLOGY%20METALS%20AND%20ENERGY%20CRITICAL%20ELEMENTS%20(ECES).pdf)

## 2 Shades of Dependency

### OPPORTUNITY: REMEDYING FOREIGN DEPENDENCE WITH DOMESTIC SUPPLY

Our second screen – intensity of dependence – captures the extent to which the U.S. depends for significant Our final screen is titled “Opportunity” – as we identify critical metals and minerals on our Risk Pyramid for which there exists documented U.S. resources, which – if developed – could lessen our resource dependency.

Beginning with the 13 metals and minerals at the top of our Risk Pyramid, and drawing on our table derived from USGS reports for known reserves, we find 9 for which known U.S. reserves suggest increased domestic supply could be possible.

- Significant <sup>37</sup> U.S. Reserves: Aluminum, Platinum, Tungsten, Yttrium and Zinc.
- Some <sup>38</sup> U.S. Reserves: Beryllium, Chromium, Cobalt and Titanium.

#### Legislative Efforts to promote domestic mineral resource development in the 112th Congress

There are a number of Congressional efforts relating to critical and strategic mineral issues underway. The three bills featured below are particularly comprehensive and explore ways to increase domestic mineral production:

##### **H.R. 4402, National Strategic and Critical Minerals Production Act of 2012** (Rep. Mark Amodei, R-NV 2nd District)

H.R. 4402 would, among other things, require a more efficient development of domestic sources of strategic and critical minerals and mineral materials; including Rare Earth elements, and facilitate a timely permitting process for mineral exploration and mine development.

##### **H.R. 2011, National Strategic and Critical Minerals Policy Act of 2011** (Rep. Doug Lamborn, R-CO 5th District)

H.R. 2011 would require assessments of U.S. capabilities to meet current and future demands for the minerals critical to domestic manufacturing competitiveness, economic, and national security, as well as of current mineral potential of federal lands. It would further require an inventory of Rare Earth elements and other minerals deemed critical based on potential for supply disruptions, and set certain policy goals for federal agencies aimed at facilitating domestic resource production.

##### **S. 1113, The Critical Minerals Policy Act of 2011** (Sen. Lisa Murkowski, R-AK)

S. 1113 would, among other things, require the development of a methodology to identify critical minerals in conjunction with a comprehensive assessment of critical mineral potential in the U.S., including on federal lands. It would further facilitate the streamlining of the U.S. mining permitting process, and require the production of an Annual Critical Minerals Outlook report providing forecasts of supply, demand and price developments.

For more information on these bills and other relevant pieces of legislation introduced in the 112th and 111th Congress visit [www.americanresources.org](http://www.americanresources.org).

<sup>37</sup> “Significant” = more than 1% where numbers were available, or extrapolation based on USGS description. Example: USGS notes that Indium is most commonly extracted from Zinc-Sulfide Ore. As U.S. has significant Zinc deposits, extraction of Indium should be possible.

<sup>38</sup> “Some”: Up to 1% where numbers were available, otherwise assumed extrapolation from USGS descriptions.



## 2 Shades of Dependency

Four metals in the top Risk tier – Manganese, Niobium, Tantalum and Tin – are reported by USGS as having little or no known U.S. resources. We note, however, that in the cases of Niobium and Manganese, two mining companies are currently pursuing development projects in the U.S. for these critical resources.

For the center tier of our Risk Pyramid – a total of 11 metals and minerals – eight show reported U.S. resources, while one is currently sourced to a degree that the U.S. is a net exporter (Molybdenum). Only Nickel (where the U.S. depends on imports from Canada, Russia, Australia and Norway, in addition to recycling purchased scrap), and Bismuth (where the U.S. relies on China, Belgium and the UK for imports) show no known U.S. resource.

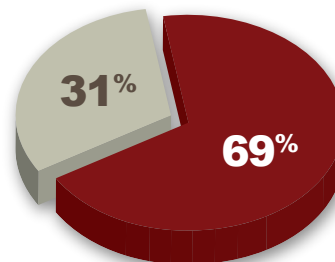
For the bottom tier of our Risk Pyramid – a total of 22 metals and minerals (not counting rubber) – 19 show reported U.S. resources, while three – Cadmium, Lead and Mercury – are in the net-export category.

The findings in this final screen are quite dramatic.<sup>39</sup>

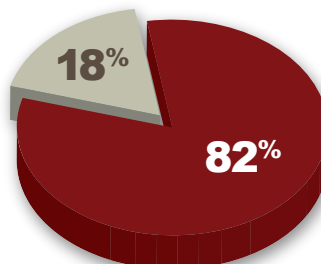
For our omnibus Risk Pyramid of 46 metals and minerals, known U.S. resources exist for 40.

In other words, for 87% of the metals and minerals on our Risk Pyramid, domestic resources exist – the development of which could lessen our import dependency.

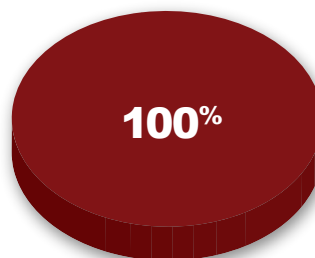
**TOP TIER OF PYRAMID- 69%**  
PERCENTAGE FOR WHICH KNOWN U.S. RESERVES EXIST



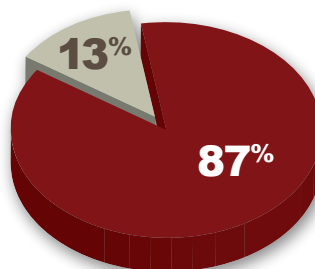
**MIDDLE TIER OF PYRAMID- 82%**  
PERCENTAGE FOR WHICH KNOWN U.S. RESERVES EXIST



**BOTTOM TIER OF PYRAMID- 100%**  
PERCENTAGE FOR WHICH KNOWN U.S. RESERVES EXIST



**RISK PYRAMID “OMNIBUS”- 87%**  
PERCENTAGE FOR WHICH KNOWN U.S. RESERVES EXIST



<sup>39</sup> Note that green/yellow shading in charts also includes minerals for which U.S. is shown as net exporter in our color-coded table.



## 3 Conclusions

### Findings

#### DEFINITIONAL DISSONANCE

“Definitional dissonance” impedes any attempt to assess critical metals and minerals vulnerabilities for U.S. national security implications. Different definitions produce different assessments of strategic and/or critical metals. The cacophony is not conducive to sound policy-making.

#### ASSESSING RISK: THE AMERICAN RESOURCES RISK PYRAMID

American Resources offers its Risk Pyramid as a way of comparing existing reports and studies to form a composite view of metals and minerals and their criticality to defense applications and national security.

#### U.S. IMPORT DEPENDENCY, SELF-INFLICTED

U.S. import dependence is largely self-inflicted, and a remedy in the form of additional supply could be homemade. As we’re fortunate to have significant reserves of these mineral resources beneath our own soil, making the exploration and development of these deposits a priority could go far in reducing our reliance on foreign suppliers.

#### DANGERS OF DEPENDENCY

When the issue is resource dependency, the elephant in the room is China. Our “Omnibus” Dependency Chart -- comprising supplier nations for all the metals and minerals making our “Risk Pyramid” -- shows that the United States relies to a disproportionately high degree on mineral imports from China, accounting for 22% of mineral imports.

We found that a striking seven countries among the twenty listed as main importers for metals and minerals that make our Risk Pyramid are considered “mostly unfree” by the 2012 Heritage Foundation Index of Economic Freedom.<sup>40</sup>

While some degree of foreign dependency may be both inevitable and benign – e.g., supplier-nations who are also allies or major trading partners – in cases where dependency is on nations with whom we encounter geo-political competition and the risk of conflict (e.g., China or Russia) or nations that are less stable or rank low on human rights/political freedom indices (e.g., Kazakhstan), the U.S. should consider a policy of diversifying supply and (when possible) encouraging domestic resource production.

<sup>40</sup> The seven countries are: Bolivia, Brazil, China, Gabon, Guinea, Indonesia, and Russia; Heritage Foundation, 2012 Index of Economic Freedom.

## 3 Conclusions

### INTENSITY AND DISRUPTION RISK

Intensity of dependence captures the extent to which the U.S. depends for significant (and in some cases 100%) metals and minerals supply on specific nations. As a rule, as the U.S. approaches high levels of not total dependence on specific countries for a metal or mineral, the risk of supply disruption becomes a factor – and economics can be displaced by considerations of geo-politics.

In terms of intensity, China's impact – China is a supplier-nation for 43% of the metals and minerals for which the U.S. is 91 to 100% dependent – is even more outsized than on our dependency index. For those who may be lulled by our intensity charting to treat this 51 to 70% segment as a lower-order concern, recall that U.S. dependency on foreign oil supply is only now coming below the 50% level. Considering the extent to which “oil politics” drives U.S. foreign and national security policy, the intensity of dependence for the range of metals in this category cannot be dismissed. In all, the U.S. is dependent for at least 50% of its supply for 43 metals and minerals.

To put it another way, if “foreign oil” appeared on the USGS dependency chart, it would appear in 44th place.

Dependency percentages should not be the final word on supply risk; the United States is the world's third-largest Copper producer, yet it is at a higher risk for Copper disruption than any other metal.

### OPPORTUNITY: REMEDYING FOREIGN DEPENDENCE WITH DOMESTIC SUPPLY

For our omnibus Risk Pyramid of 46 metals and minerals, known U.S. resources exist for 40.

*In other words, for 87% of the metals and minerals on our American Resources Risk Pyramid, domestic resources exist – the development of which could lessen the United States' import dependency.*

U.S. policy-makers routinely debate how best to encourage sustained economic growth, the next generation of technological progress, and the advanced weapons systems on which our national security depends. Each of these essential public policy goals presupposes reliable access to critical resources -- the metals and minerals assessed in this report – that constitute the raw material of modern development.

It is our hope at American Resources that this report and the reactions it engenders will contribute to a sound policy on U.S. resource development – and a decrease in our dangerous dependency on foreign sources of supply.