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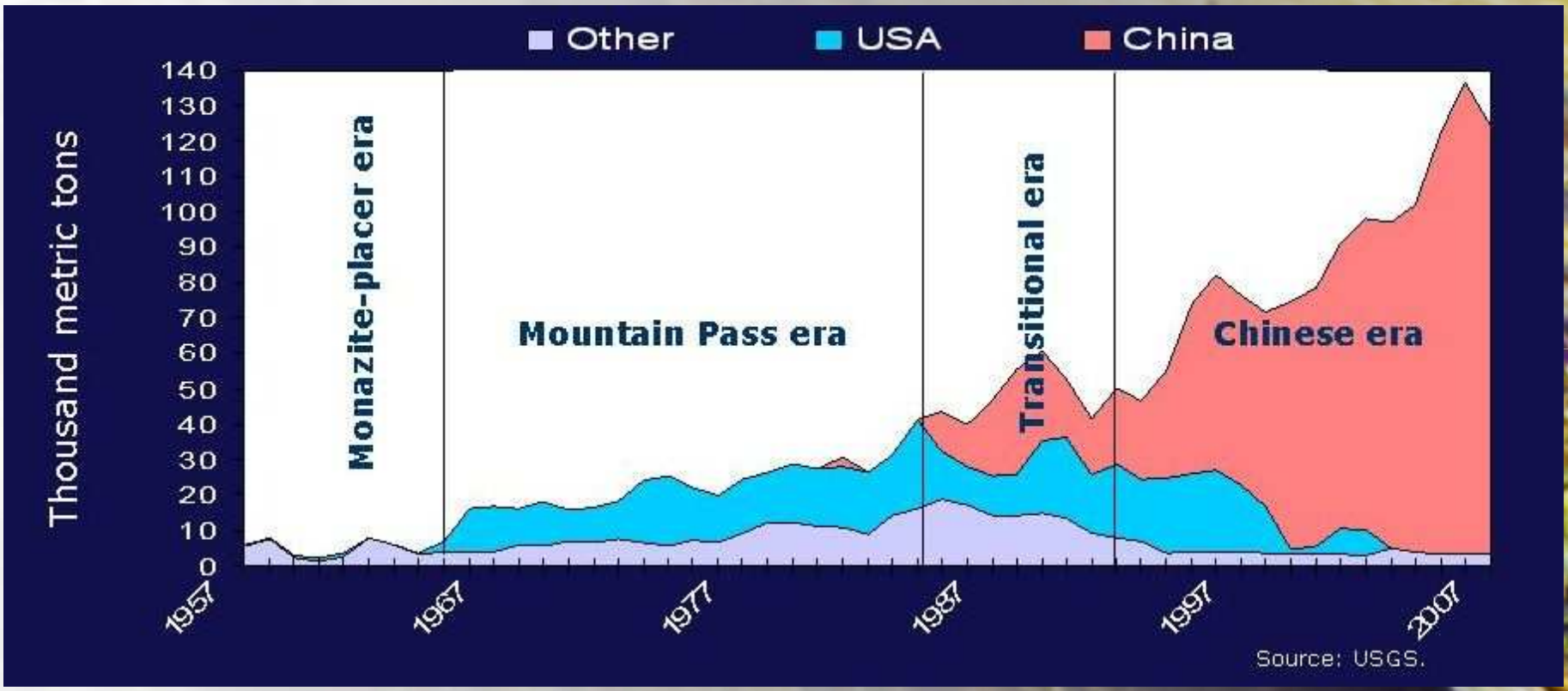
science for a changing world

Science Supporting Mineral Resource Stewardship

Dr. Marcia McNutt
Director, U.S. Geological Survey
March 18, 2010

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

Global rare earth element production 1957-2009



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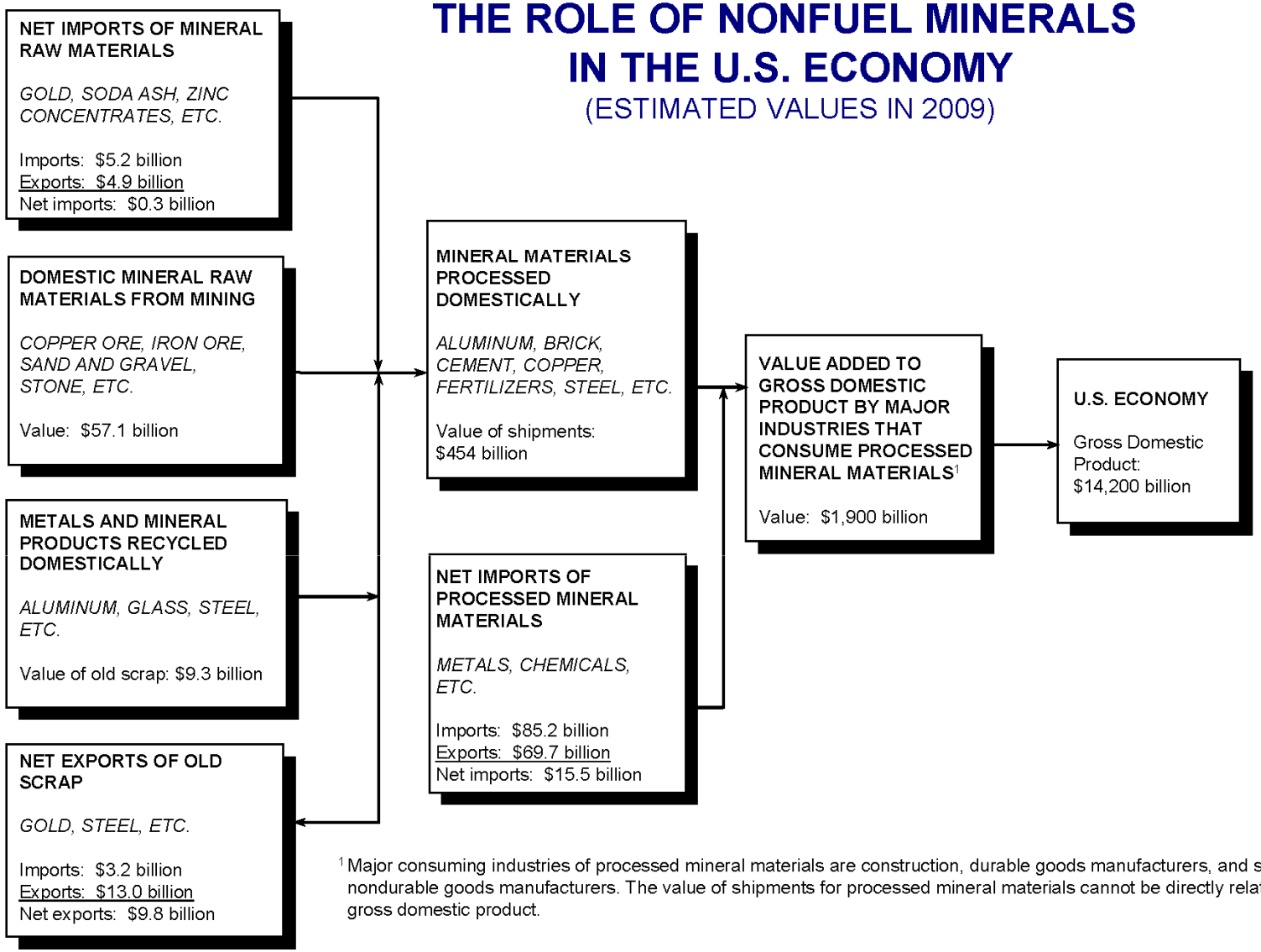
THE ROLE OF NONFUEL MINERALS IN THE U.S. ECONOMY

(ESTIMATED VALUES IN 2009)



[1] Major consuming industries of processed mineral materials are construction, durable goods manufacturers, and some nondurable goods manufacturers. The value of shipments for processed mineral materials cannot be directly related to gross domestic product.

Sources: U.S. Geological Survey and U.S. Department of Commerce.

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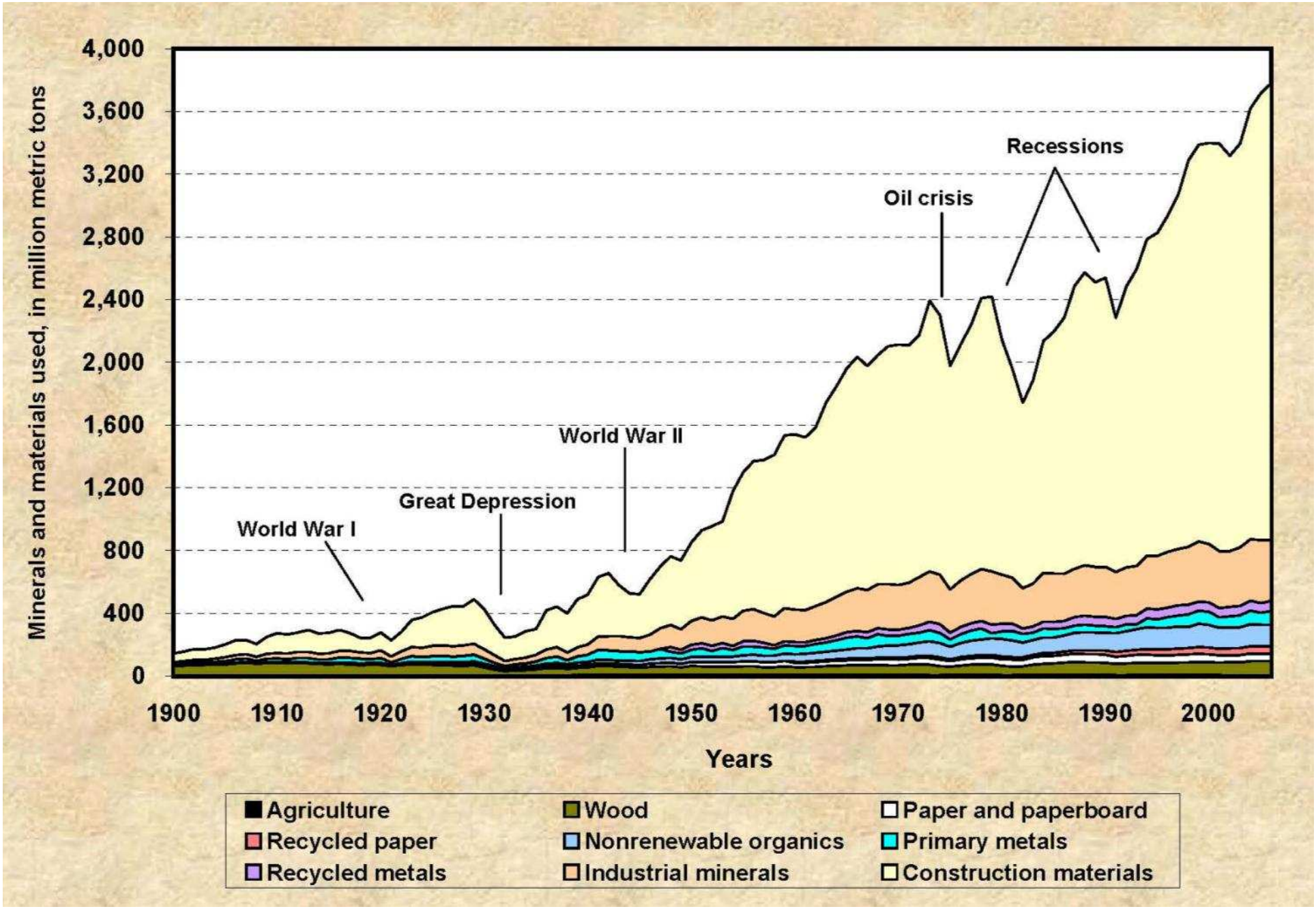
Minerals and materials used, in million metric tons
4,000
3,600
3,200
2,800
2,400
2,000
1,600
1,200
800
400
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
Years
World War I
Great Depression
World War II
Oil crisis
Recessions
Agriculture
Wood
Paper and paperboard
Recycled paper
Nonrenewable organics
Primary metals
Recycled metals
Industrial minerals
Construction materials

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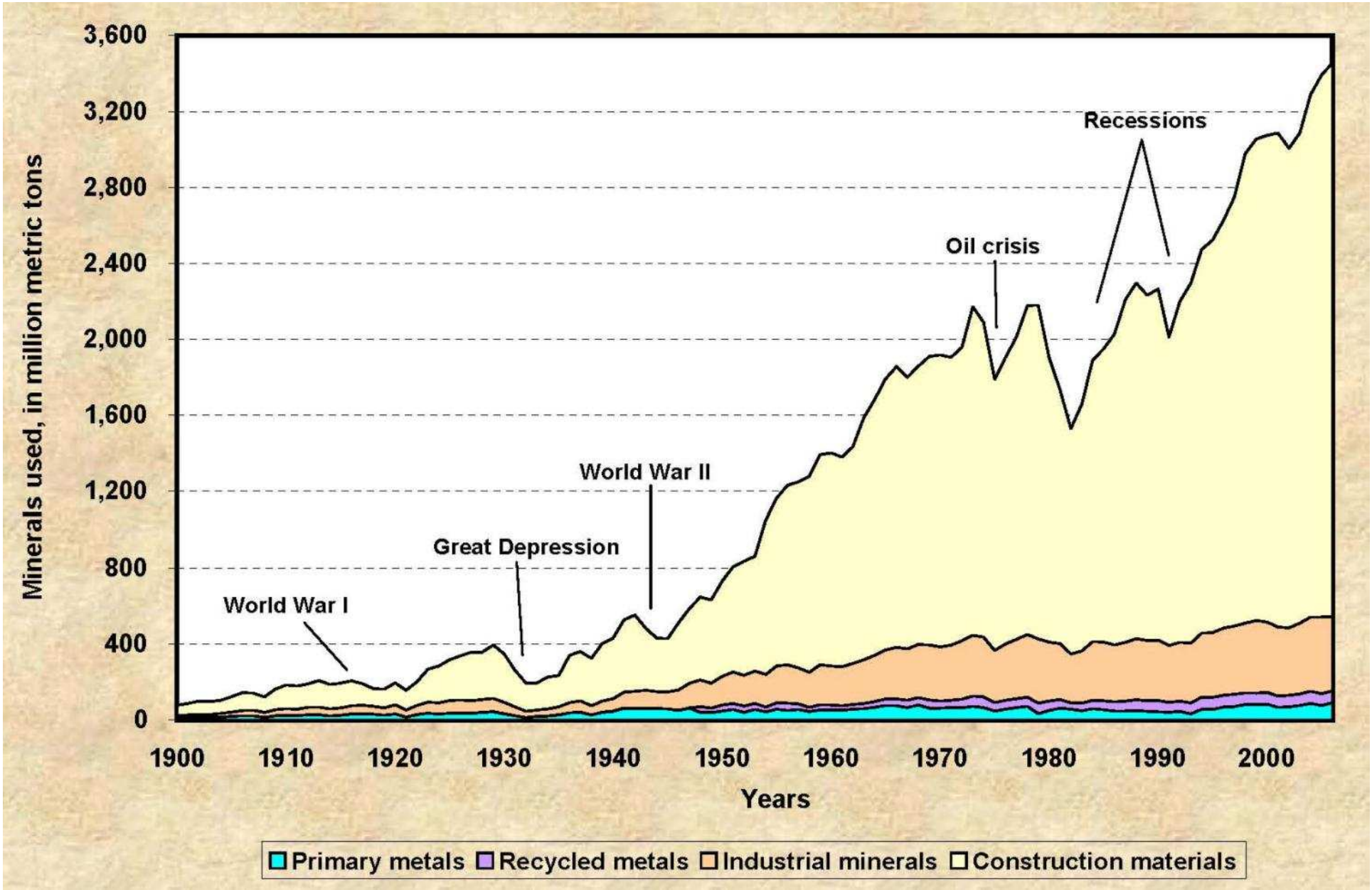
Minerals used, in million metric tons
3,600
3,200
2,800
2,400
2,000
1,600
1,200
800
400
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
Years
Recessions
Oil crisis
World War II
Great Depression
World War I
Primary metals
Recycled metals
Industrial minerals
Construction materials

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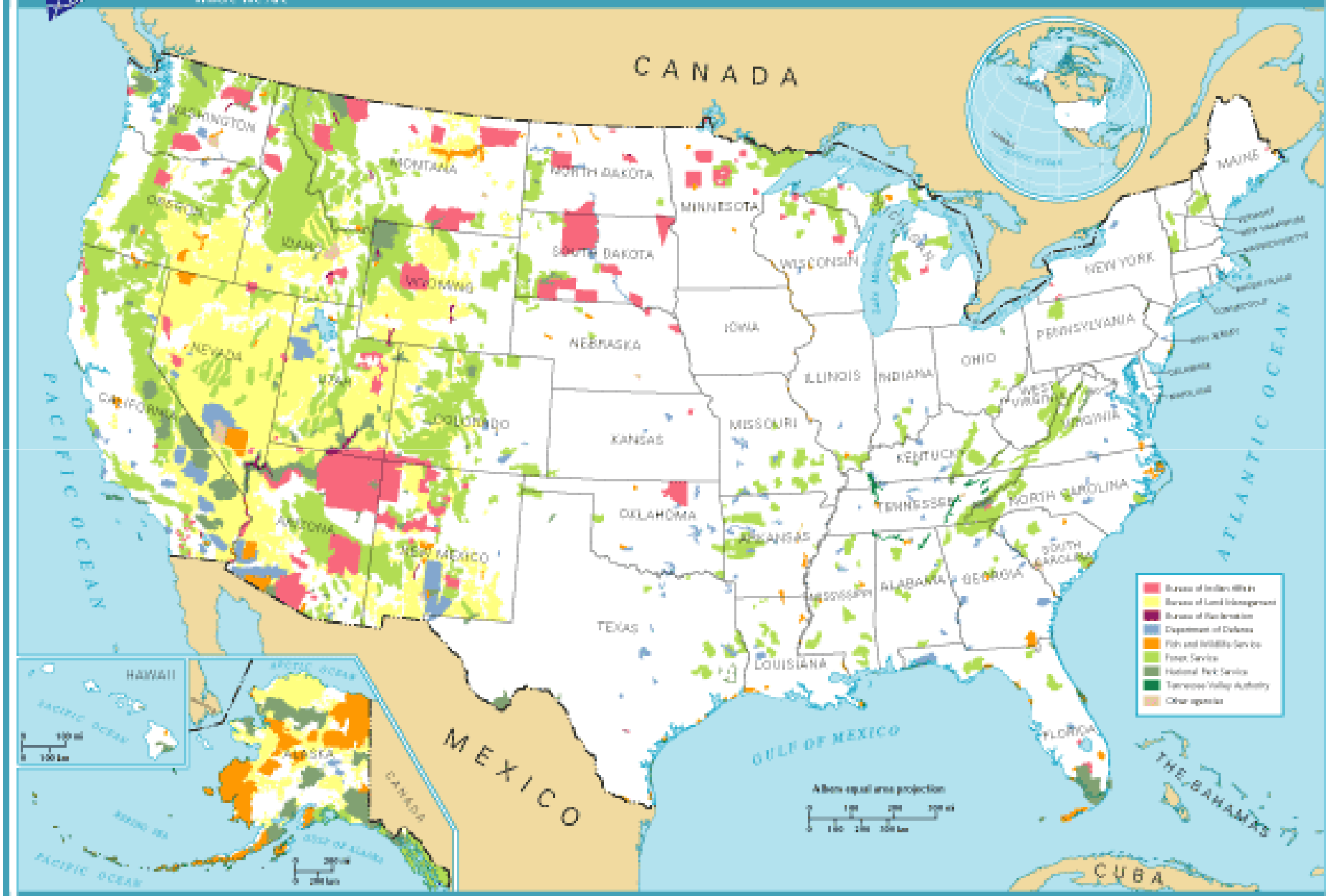
Where We Are

FEDERAL LANDS AND INDIAN RESERVATIONS



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

The **National Atlas** of the United States of America®

DOI Strategic Plan Framework

Protecting Natural, Cultural and Heritage Resources

Providing the Scientific Foundation for Decision Making

Sustainably Using Energy, Water and Natural Resources

Creating Opportunities for Young People in the Outdoors

Empowering People and Communities

Building a 21st Century Interior

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Providing the scientific foundation for decision making

Science for Sustainable Resource Use, Protection, and Adaptive Management

- Identify and Predict Ecosystem Change to Protect and Sustain Environmental Resources
- Identify and Model the Causes and Impacts of Changes to the Earth and Ocean System to Inform Management Strategies
- Assess and Forecast Climate Change and its Effects to Develop Mitigation and Adaptation Strategies
- Monitor and Assess Water Availability and Quality to Meet Water Resource Needs
- **Assess the National and Global Energy and Mineral Resource Endowment to Enhance Economic Vitality**

Science to Protect and Empower Communities

Multi-Dimensional Science and Information Framework for Understanding the Earth

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science for a changing world

Facing Tomorrow's Challenges—

U.S. Geological Survey Science in the Decade 2007–2017

Circular 1309

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One of the six USGS Strategic Science Directions concerns Energy and Minerals for America's Future

Providing a Scientific Foundation for Resource Security, Environmental Health, Economic Vitality, and Land Management

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USGS Mineral Resources Program

- Minerals information
  - Domestic and international supply and use of minerals and mineral materials
  - Material flow studies
- Mineral resource and mineral environmental assessments
- Basic and applied mineral research
  - How and where nonfuel mineral deposits form
  - Methods for estimating undiscovered deposits
  - Baseline data for the US

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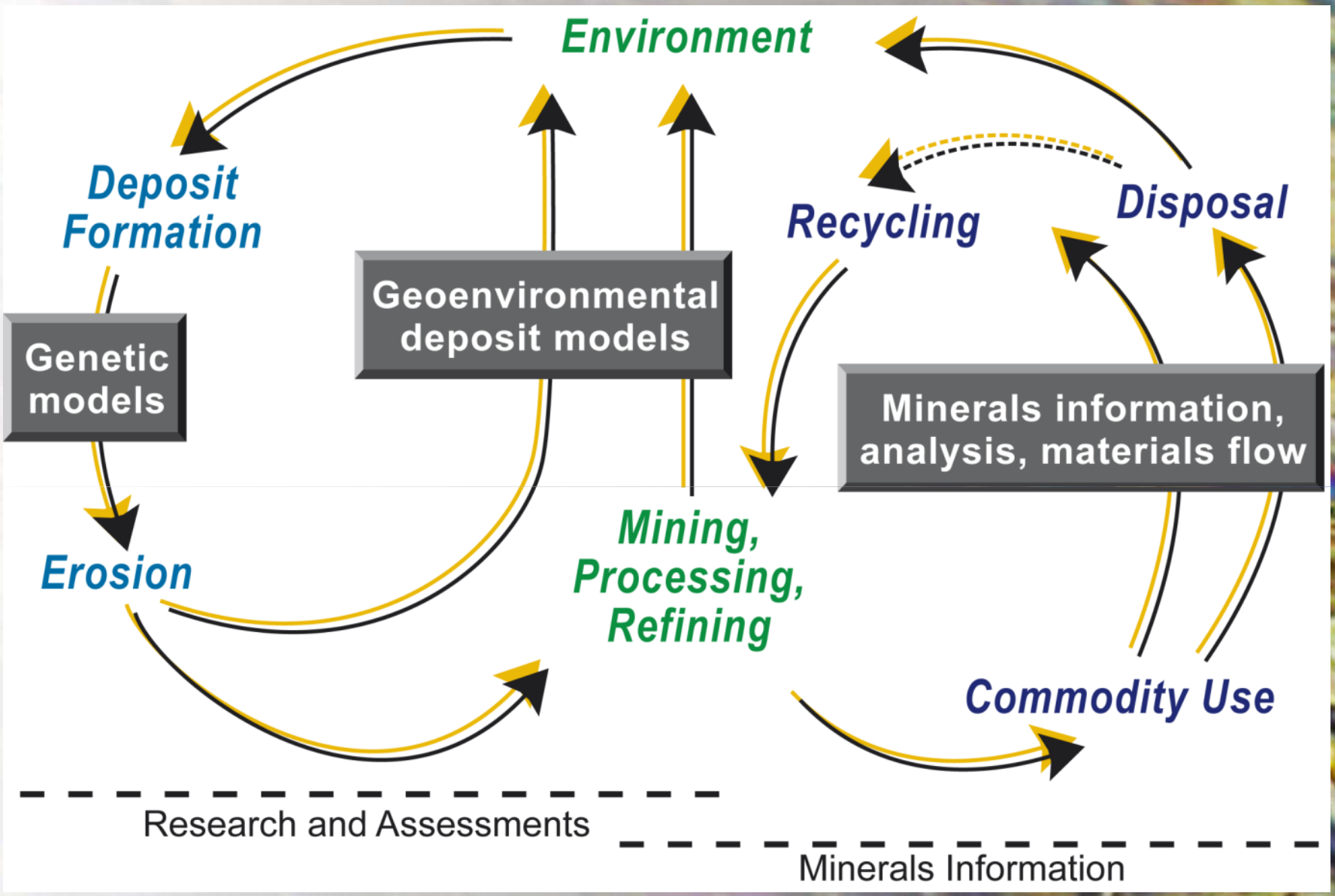
Environment
Deposit Formation
Genetic models
Geoenvironmental deposit models
Recycling
Disposal
Minerals information, analysis, materials flow
Erosion
Mining, Processing, Refining
Commodity Use
Research and Assessments
Minerals Information

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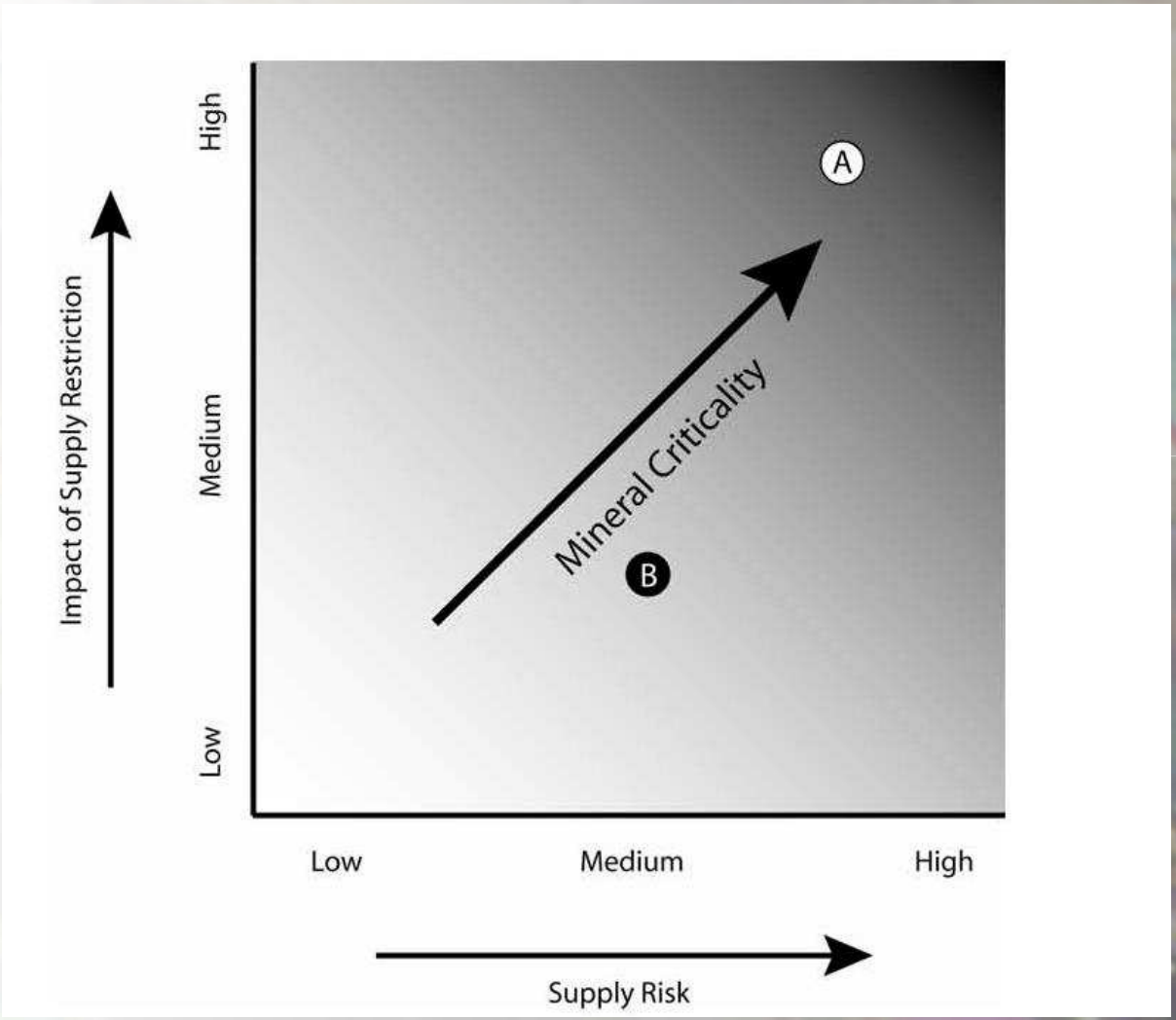
Criticality matrix



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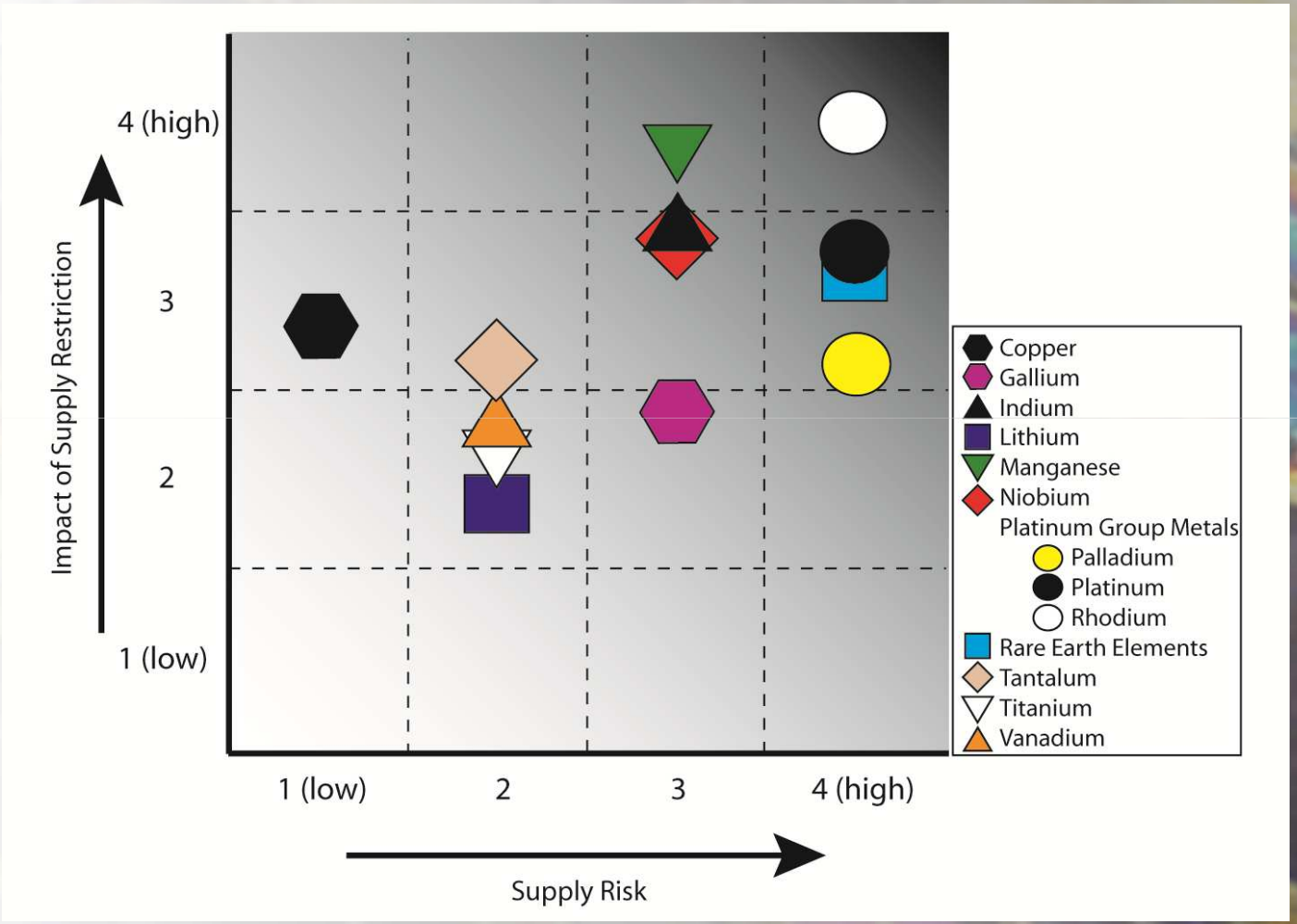
Criticality matrix: REE



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Critical minerals

- “All minerals and mineral products could be or could become critical to some degree, depending on their importance and availability.”
- “Decision makers in both the public and the private sectors need continuous, unbiased, and thorough mineral information provided through a federally funded system of information collection and dissemination.”

Minerals, Critical Minerals, and the U.S. Economy, 2008,
The National Academies Press

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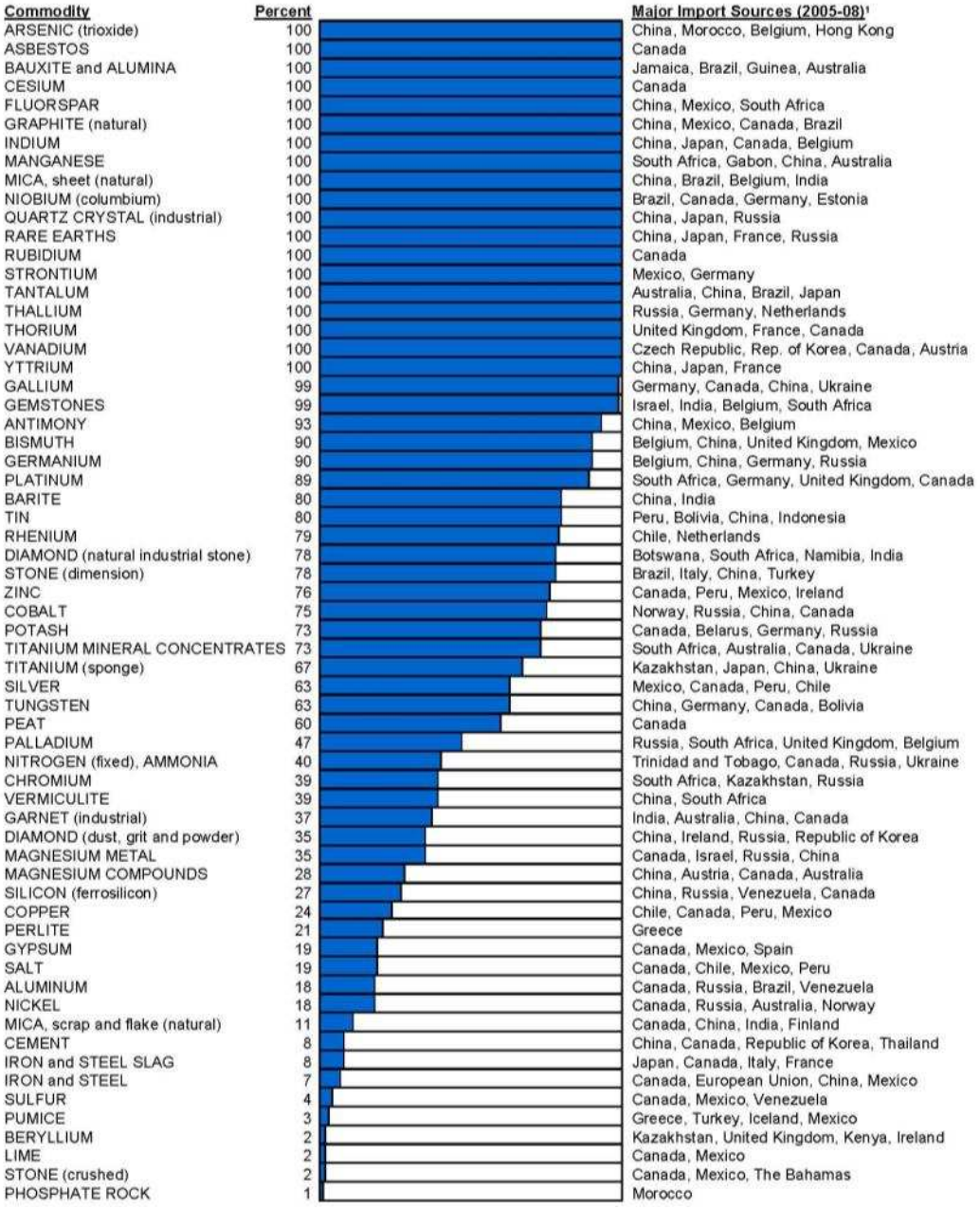
2009 U.S. NET IMPORT RELIANCE FOR SELECTED NONFUEL MINERAL MATERIALS



Commodity	Percent	Major Import Sources (2005-08)[1]
ARSENIC (trioxide)	100	China, Morocco, Belgium, Hong Kong
ASBESTOS	100	Canada
BAUXITE and ALUMINA	100	Jamaica, Brazil, Guinea, Australia
CESIUM	100	Canada
FLUORSPAR	100	China, Mexico, South Africa
GRAPHITE (natural)	100	China, Mexico, Canada, Brazil
INDIUM	100	China, Japan, Canada, Belgium
MANGANESE	100	South Africa, Gabon, China, Australia
MICA, sheet (natural)	100	China, Brazil, Belgium, India
NIOBIUM (columbium)	100	Brazil, Canada, Germany, Estonia
QUARTZ CRYSTAL (industrial)	100	China, Japan, Russia
RARE EARTHS	100	China, Japan, France, Russia
RUBIDIUM	100	Canada
STRONTIUM	100	Mexico, Germany
TANTALUM	100	Australia, China, Brazil, Japan
THALLIUM	100	Russia, Germany, Netherlands
THORIUM	100	United Kingdom, France, Canada
VANADIUM	100	Czech Republic, Rep. of Korea, Canada, Austria
YTTRIUM	100	China, Japan, France
GALLIUM	99	Germany, Canada, China, Ukraine
GEMSTONES	99	Israel, India, Belgium, South Africa
ANTIMONY	93	China, Mexico, Belgium
BISMUTH	90	Belgium, China, United Kingdom, Mexico
GERMANIUM	90	Belgium, China, Germany, Russia
PLATINUM	89	South Africa, Germany, United Kingdom, Canada
BARITE	80	China, India
TIN	80	Peru, Bolivia, China, Indonesia
RHENIUM	79	Chile, Netherlands
DIAMOND (natural industrial stone)	78	Botswana, South Africa, Namibia, India
STONE (dimension)	78	Brazil, Italy, China, Turkey
ZINC	76	Canada, Peru, Mexico, Ireland
COBALT	75	Norway, Russia, China, Canada
POTASH	73	Canada, Belarus, Germany, Russia
TITANIUM MINERAL CONCENTRATES	73	South Africa, Australia, Canada, Ukraine
TITANIUM (sponge)	67	Kazakhstan, Japan, China, Ukraine
SILVER	63	Mexico, Canada, Peru, Chile
TUNGSTEN	63	China, Germany, Canada, Bolivia
PEAT	60	Canada
PALLADIUM	47	Russia, South Africa, United Kingdom, Belgium
NITROGEN (fixed), AMMONIA	40	Trinidad and Tobago, Canada, Russia, Ukraine
CHROMIUM	39	South Africa, Kazakhstan, Russia
VERMICULITE	39	China, South Africa
GARNET (industrial)	37	India, Australia, China, Canada
DIAMOND (dust, grit and powder)	35	China, Ireland, Russia, Republic of Korea
MAGNESIUM METAL	35	Canada, Israel, Russia, China
MAGNESIUM COMPOUNDS	28	China, Austria, Canada, Australia
SILICON (ferrosilicon)	27	China, Russia, Venezuela, Canada
COPPER	24	Chile, Canada, Peru, Mexico
PERLITE	21	Greece
GYPSUM	19	Canada, Mexico, Spain
SALT	19	Canada, Chile, Mexico, Peru
ALUMINUM	18	Canada, Russia, Brazil, Venezuela
NICKEL	18	Canada, Russia, Australia, Norway
MICA, scrap and flake (natural)	11	Canada, China, India, Finland
CEMENT	8	China, Canada, Republic of Korea, Thailand
IRON and STEEL SLAG	8	Japan, Canada, Italy, France
IRON and STEEL	7	Canada, European Union, China, Mexico
SULFUR	4	Canada, Mexico, Venezuela
PUMICE	3	Greece, Turkey, Iceland, Mexico
BERYLLIUM	2	Kazakhstan, United Kingdom, Kenya, Ireland
LIME	2	Canada, Mexico
STONE (crushed)	2	Canada, Mexico, The Bahamas
PHOSPHATE ROCK	1	Morocco

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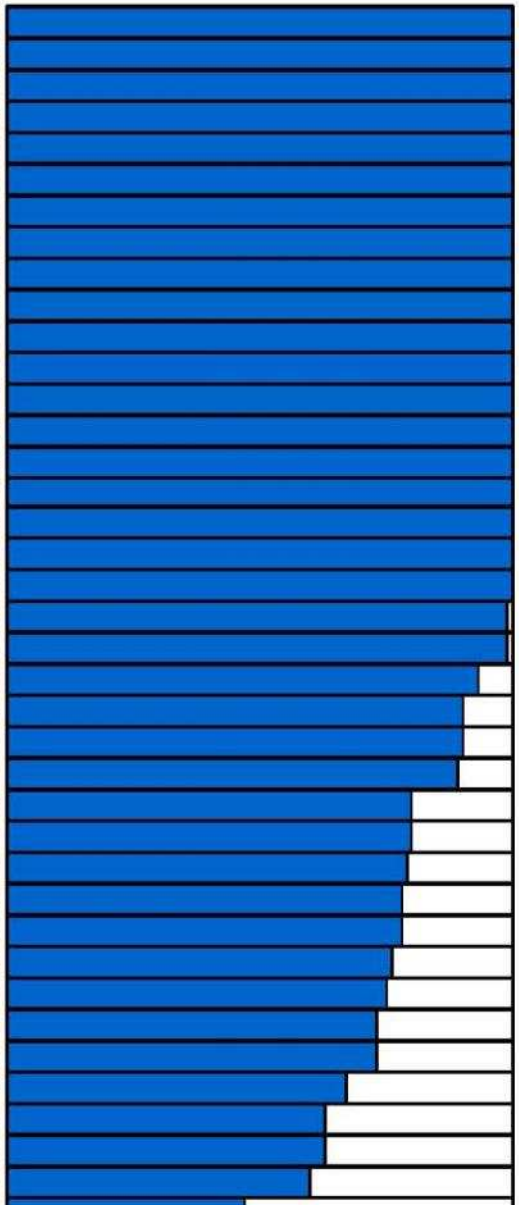

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Targeted Commodities (2008-2013)

FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Copper	Lead	Nickel	Platinum-Group Metals	Phosphate Rock	Gold
	Zinc	Cobalt	Potash	Titanium and TiO_2	
	Molybdenum	Chromium	Rare Earth Elements	Iron ore	
		Beryllium			

Also uranium and lithium

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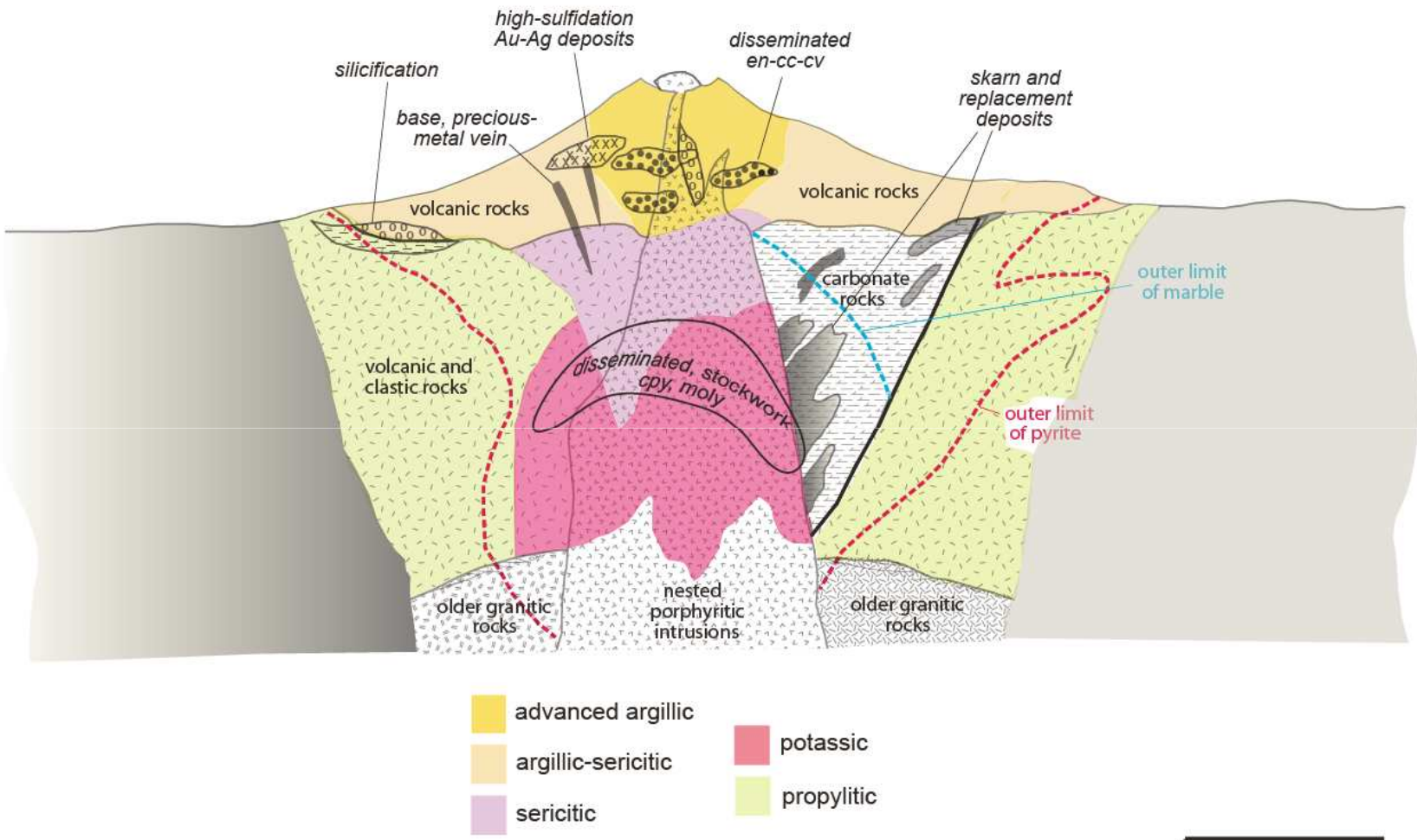

PCD - HYPOGENE CONFIGURATION

1 km

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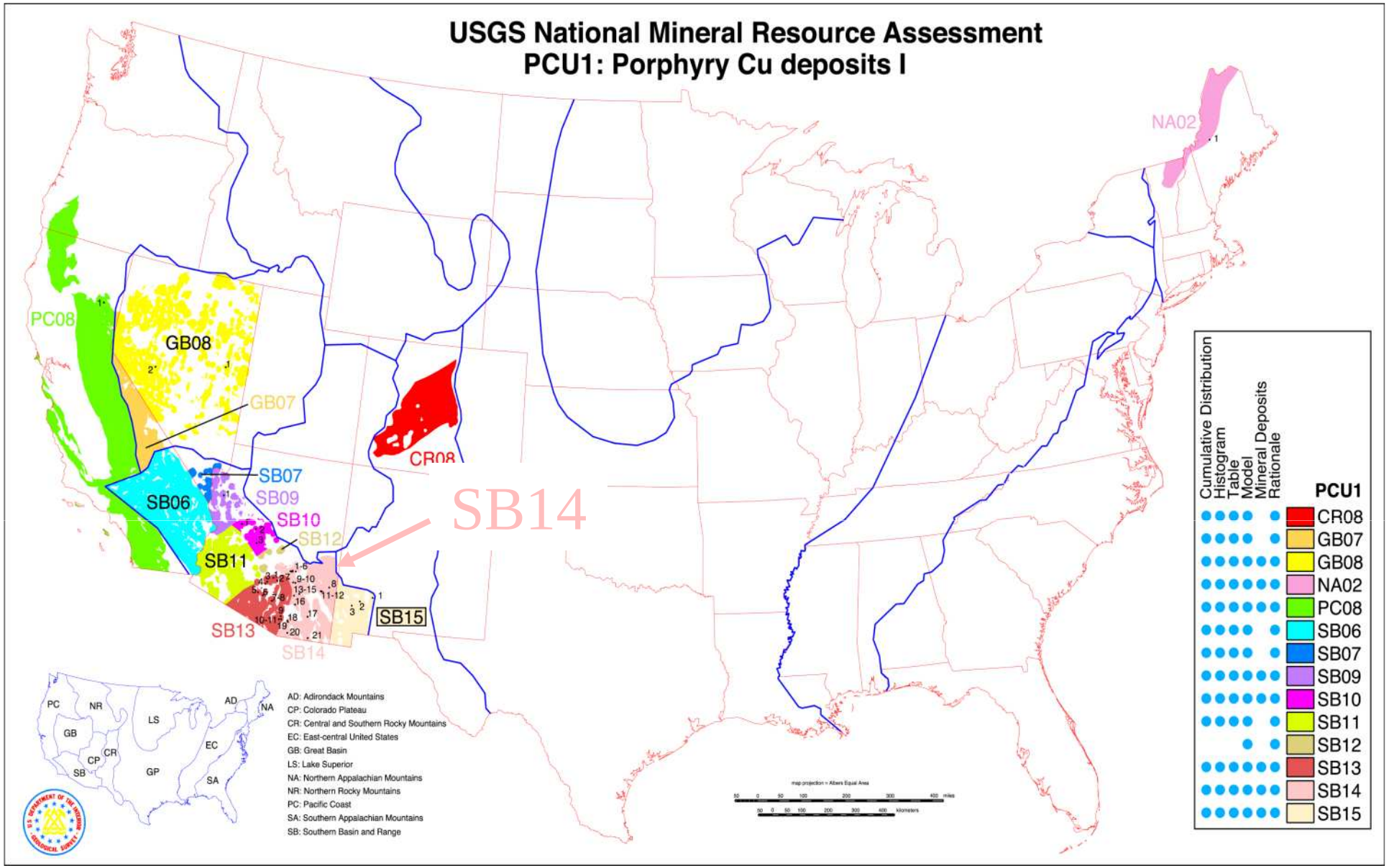
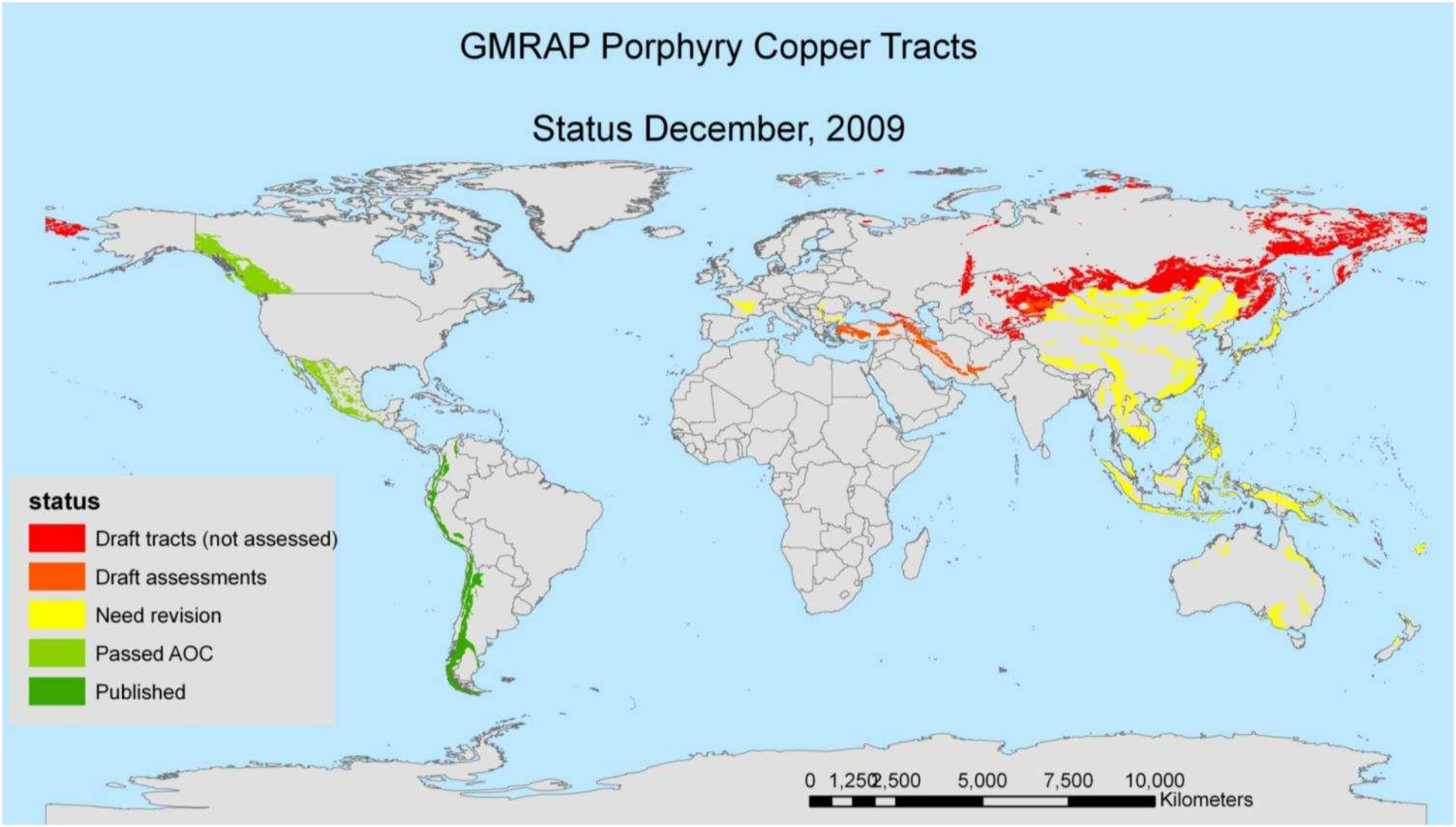


U.S. Geological Survey National Assessment Team, 1996

http://pubs.er.usgs.gov/usgspubs/ofr/of2002198/


GMRAP Porphyry Copper Tracts
Status December, 2009
status
Draft tracts (not assessed)
Draft assessments
Need revision
Passed AOC
Published
0 1,250 2,500 5,000 7,500 10,000
Kilometers

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