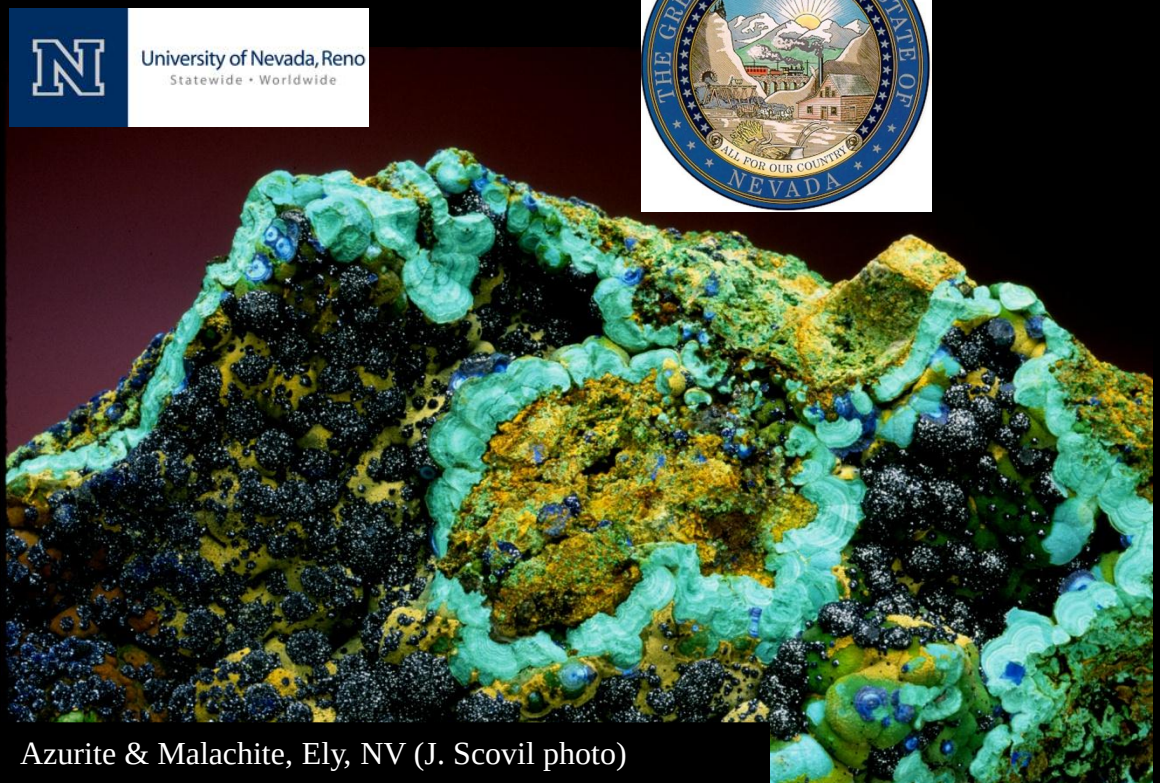
“Update on the Future of Mineral Resources”

18 November 2011

Jon Price

Nevada Bureau of Mines and Geology



Azurite & Malachite, Ely, NV (J. Scovil photo)

Round Mountain, NV (2007)

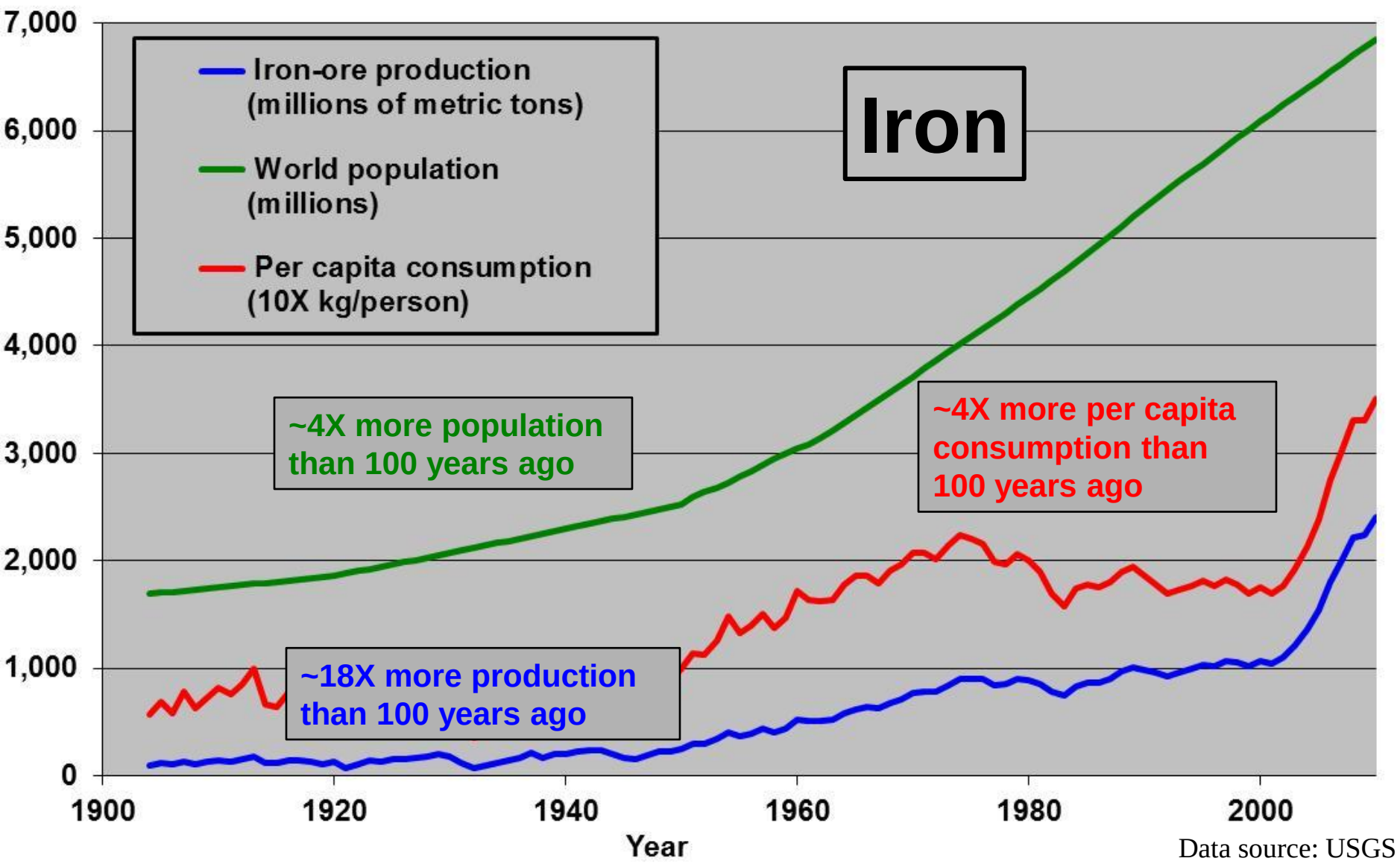
"Update on the Future of Mineral Resources"

Demand is high.

China is #1.

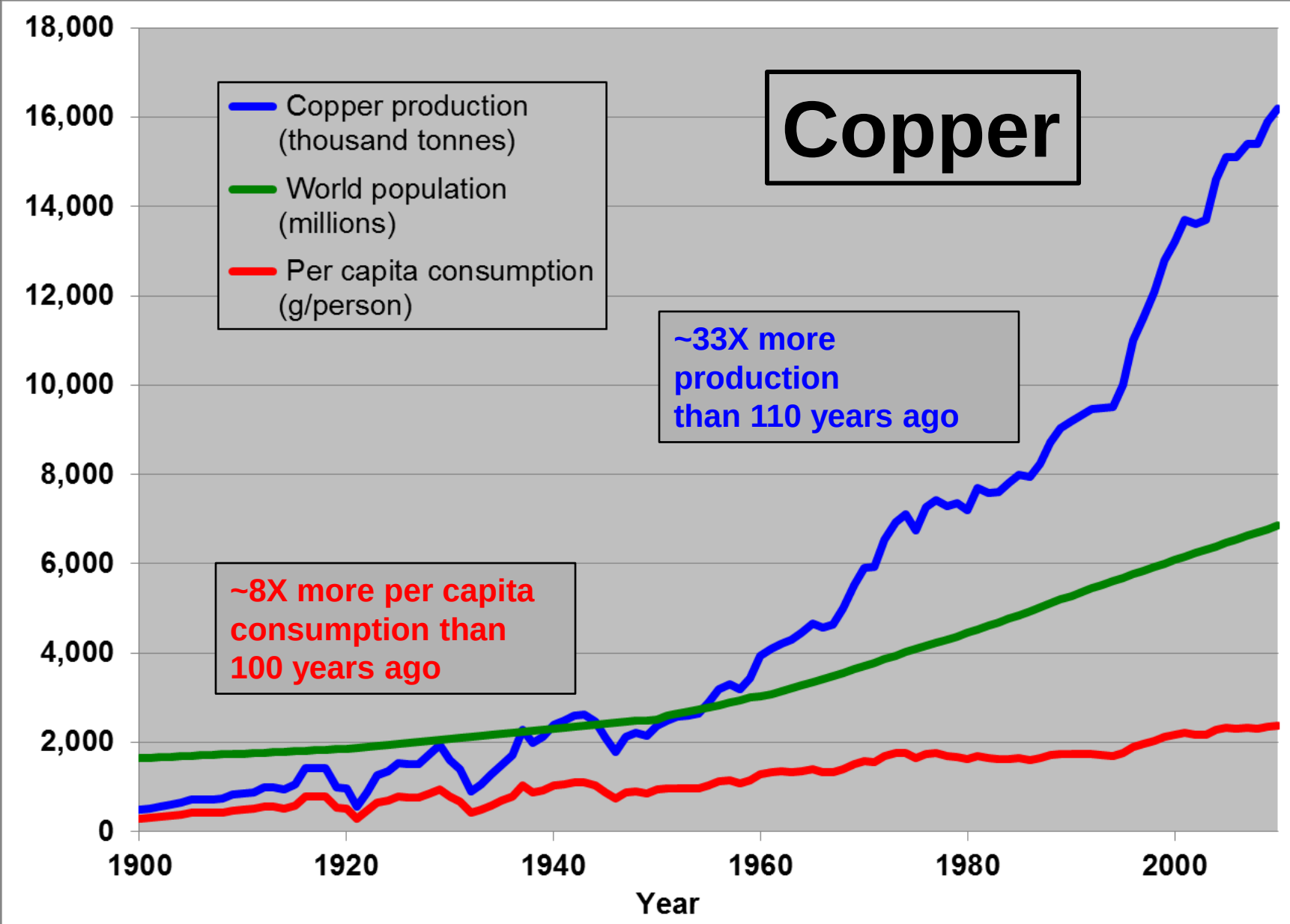
The trends will help guide exploration.

Round Mountain, NV (2007)



Data source: USGS

Demand is high for nearly every mineral resource, due to rising population and average standard of living.

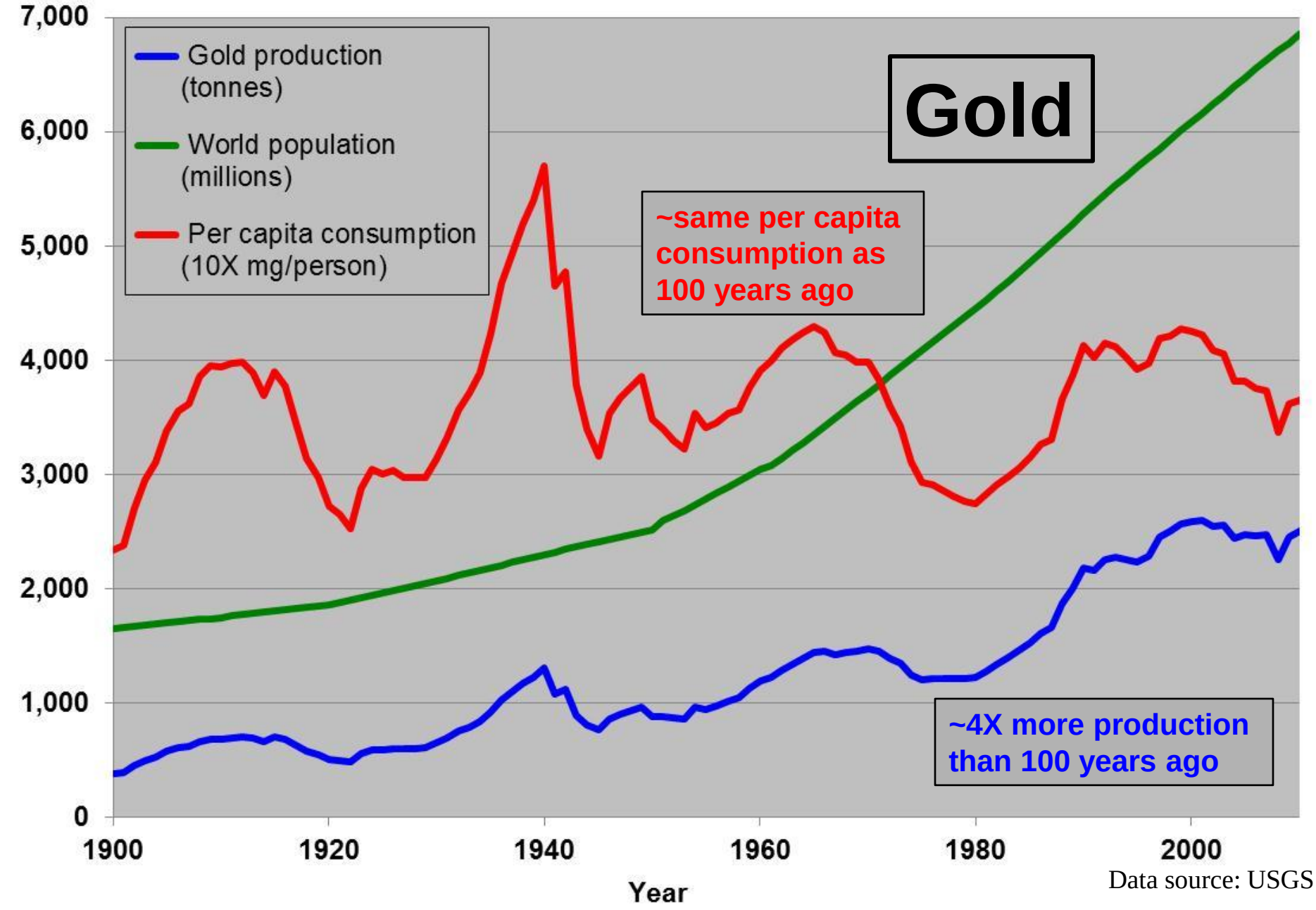


Data source: USGS

Demand is high for nearly every mineral resource.

Photo copyrighted by Michael Collier, from the AGI website, Rio Tinto/Kennecott Utah Copper mine; the remaining resource as of 16 May 2008 = 3.06 million metric tons of Cu

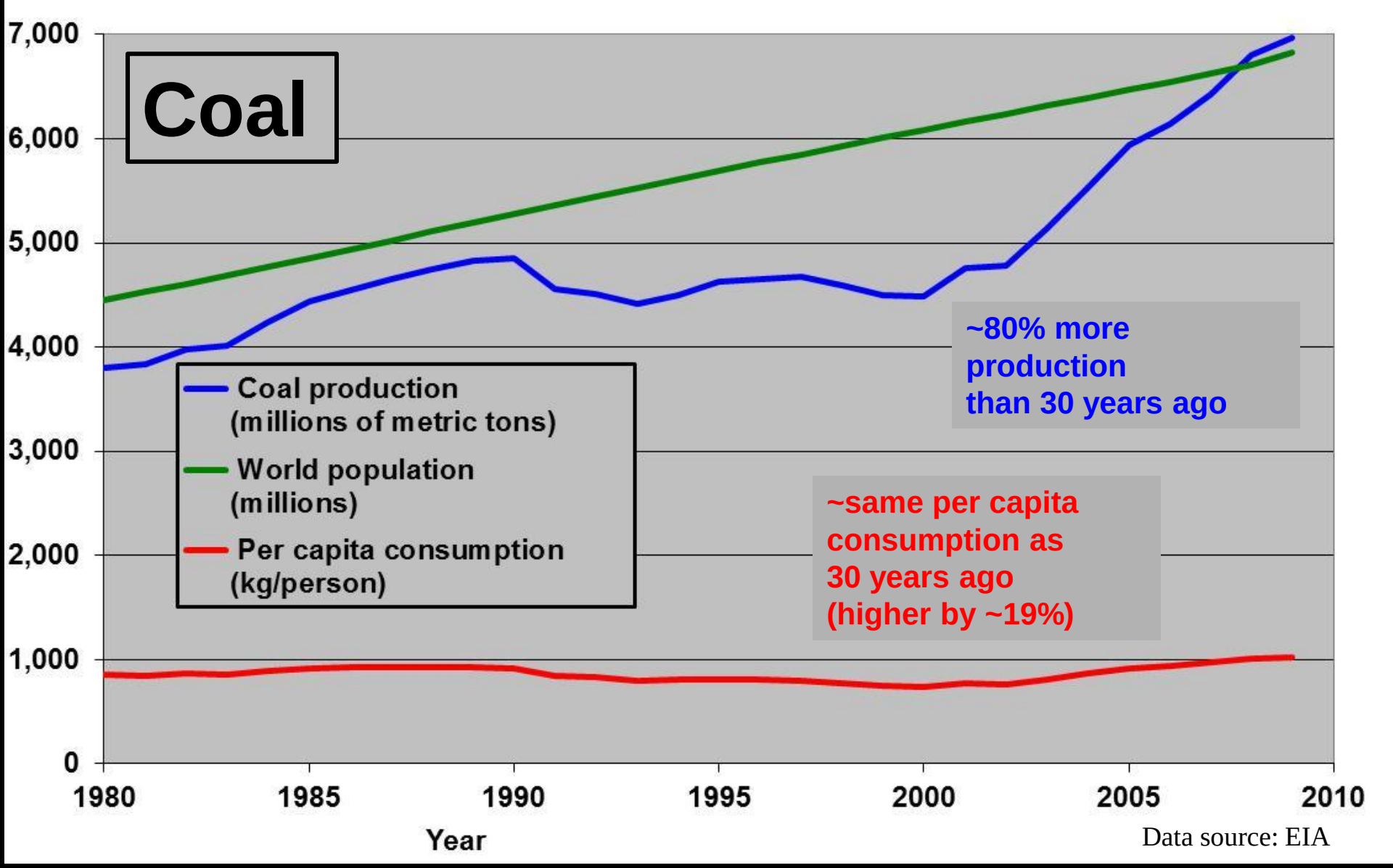
Global copper production in 2010 (16.2 million metric tons) nearly equaled over 100 years of production from the Bingham Canyon mine (17.0 million metric tons).



Data source: USGS

Demand is high for nearly every mineral resource.

Global gold production in 2010 (2,500 metric tons) approximately equaled the cumulative production from the Carlin trend (2,400 tons), one of world's top regions.



Demand is high for nearly every mineral resource.

Coal seams near Healy, Alaska

Annual global coal production (~7.0 billion metric tons) equals approximately 4.9 km^3 of coal, or ~1,600 km^2 of land with an average coal thickness of 3 m.

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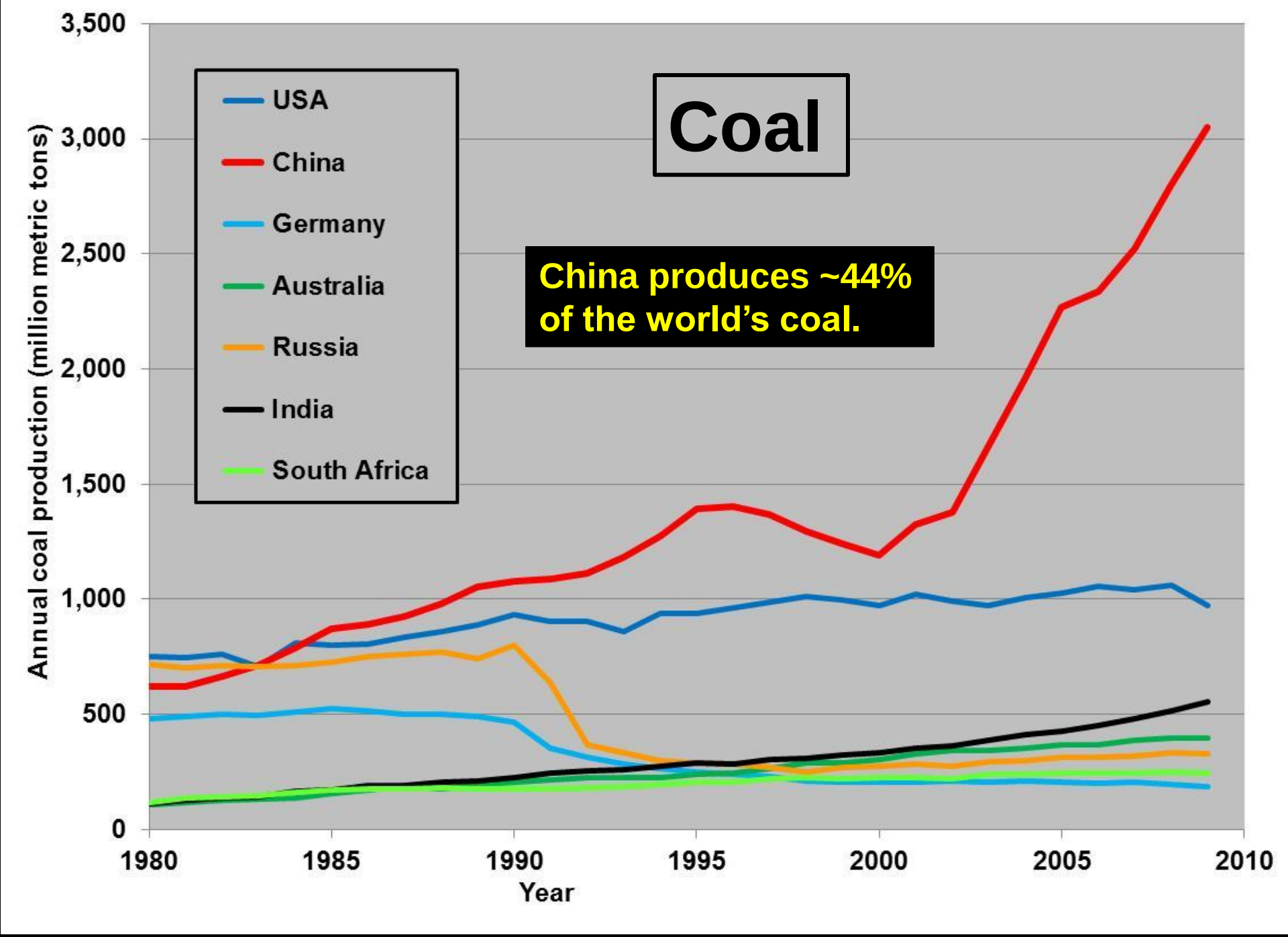
China is #1.

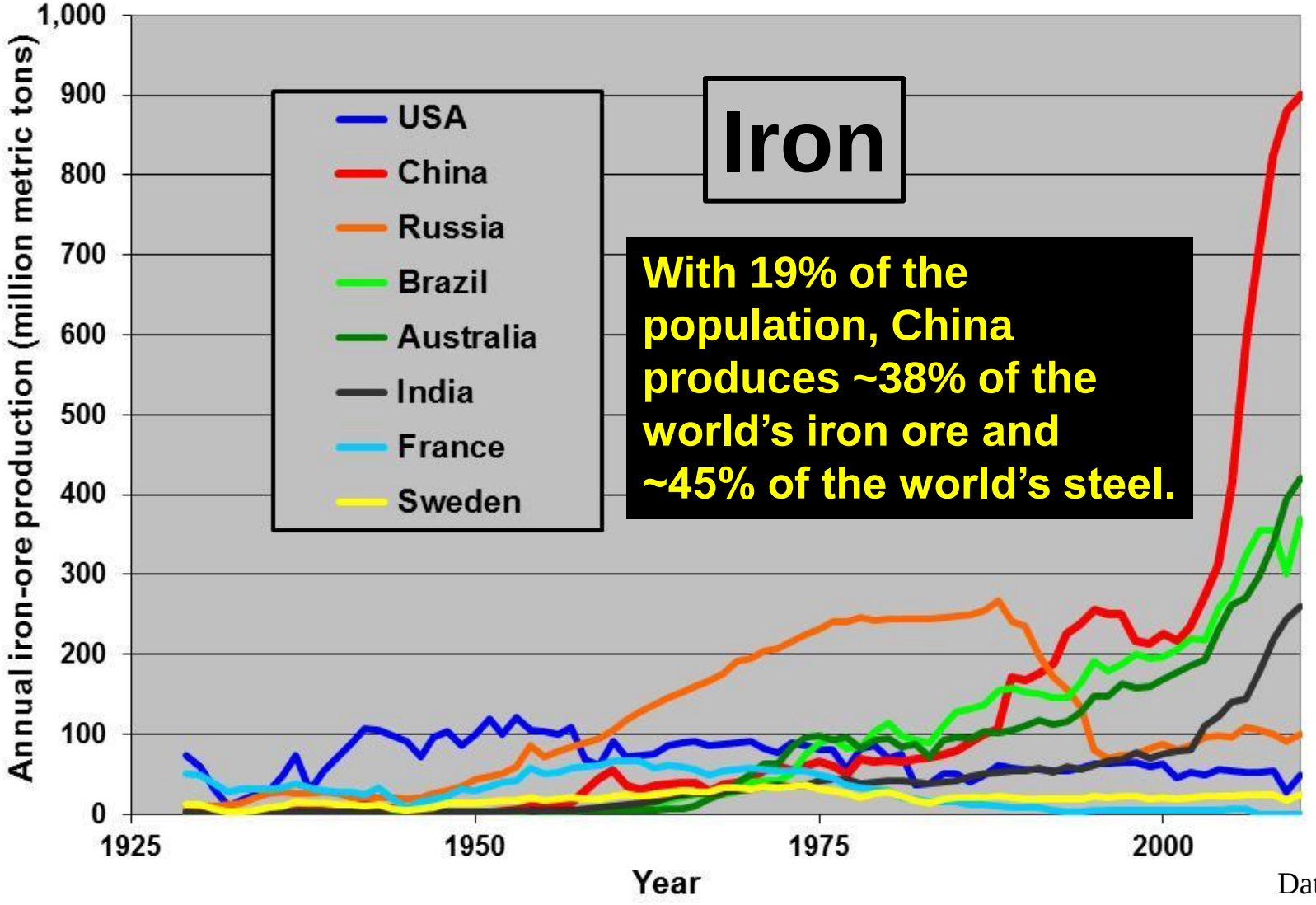
The trends will help guide exploration.

Round Mountain, NV (2007)


Coal
China produces ~44% of the world's coal.
USA
China
Germany
Australia
Russia
India
South Africa
Annual coal production (million metric tons)
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1980
1985
1990
1995
2000
2005
2010
Year

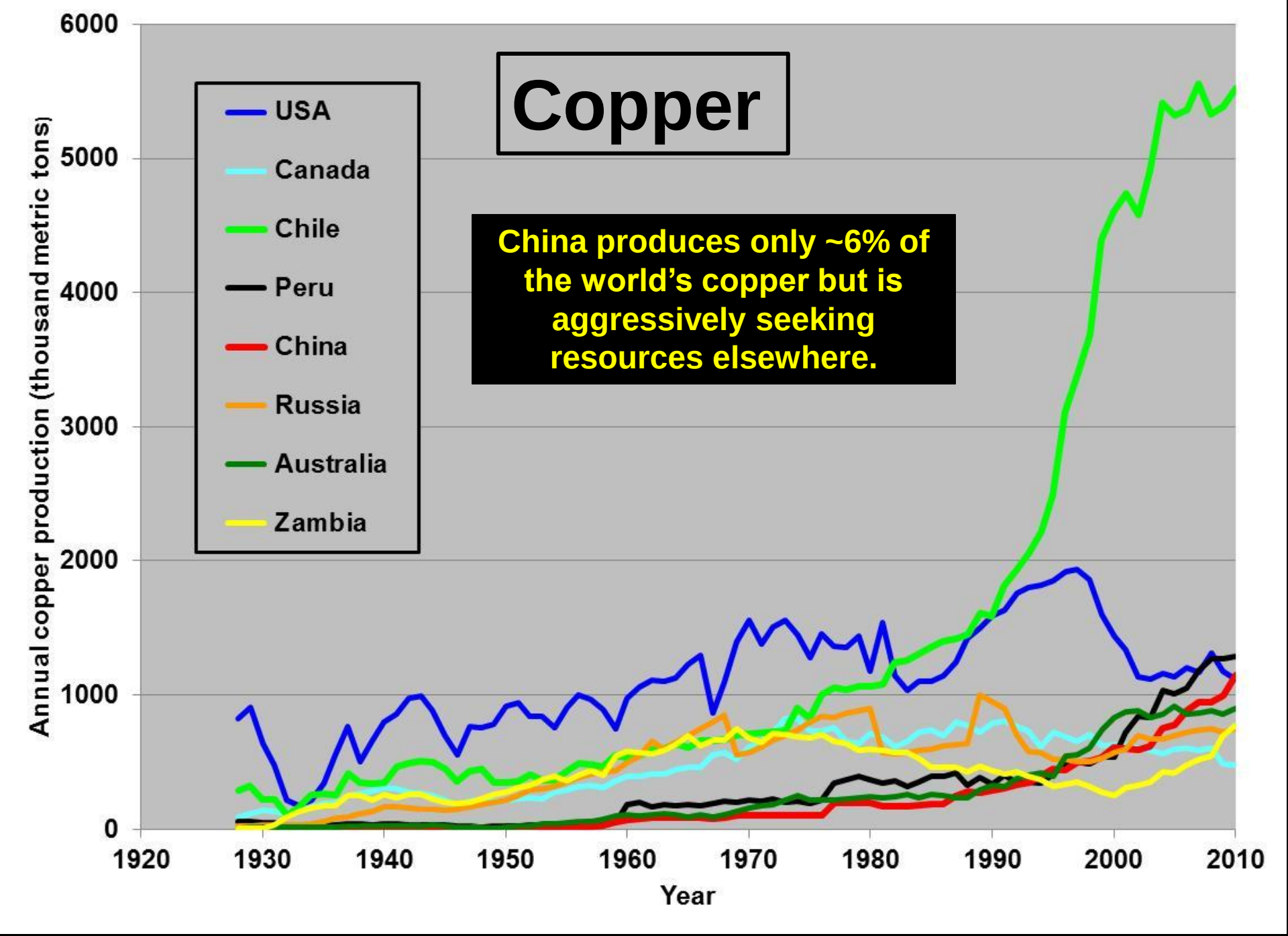
The amount of CO_2 released from burning of coal in 2009 would have been enough, without natural reduction from plant growth, rain, and other processes, to raise the concentration of CO_2 in the atmosphere by ~2.6 ppmv, a bit more than the recent global trend of CO_2 increasing ~1.8 ppmv per year.

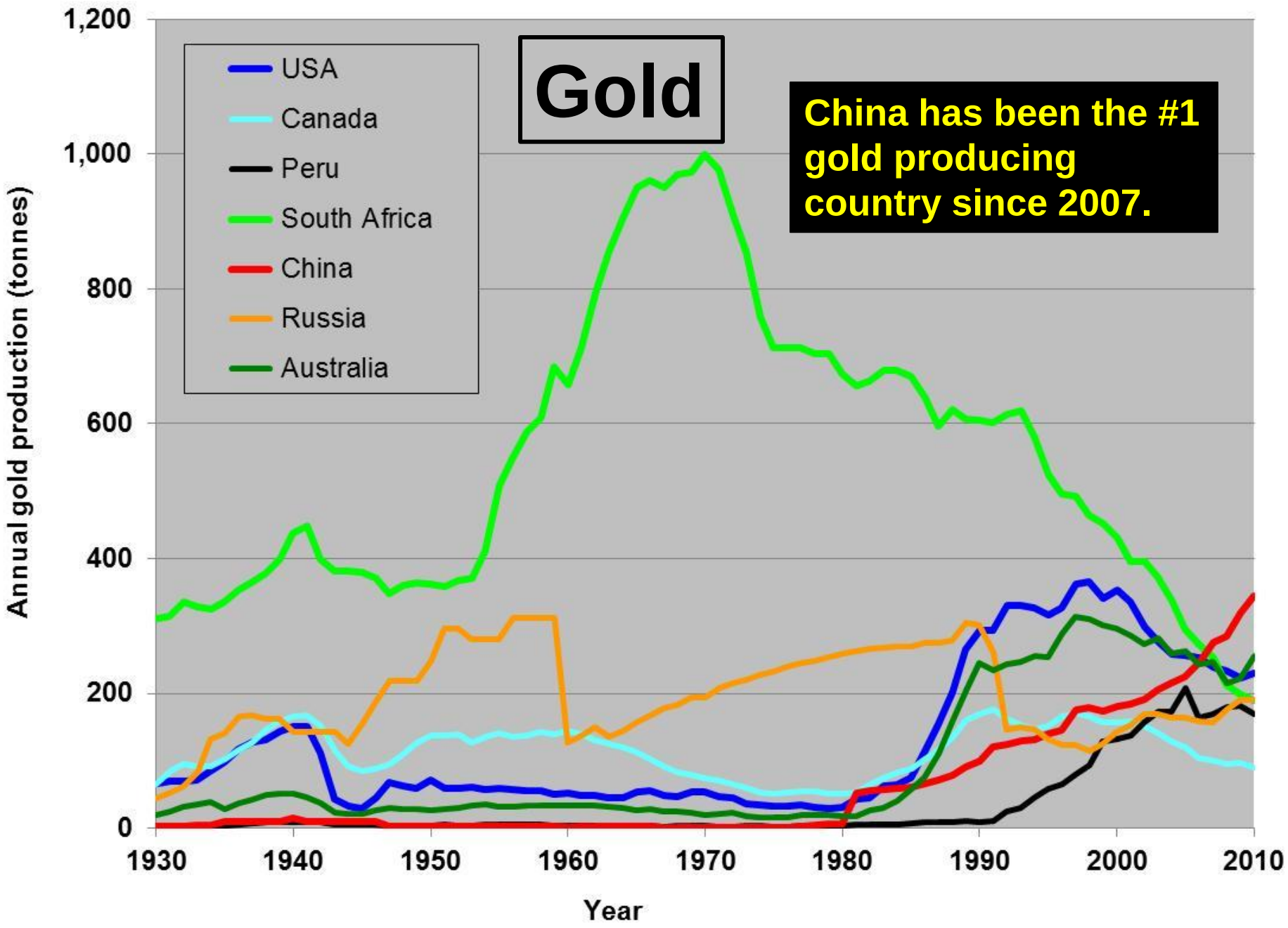
Valmy coal-fired power plant, Humboldt County, Nevada

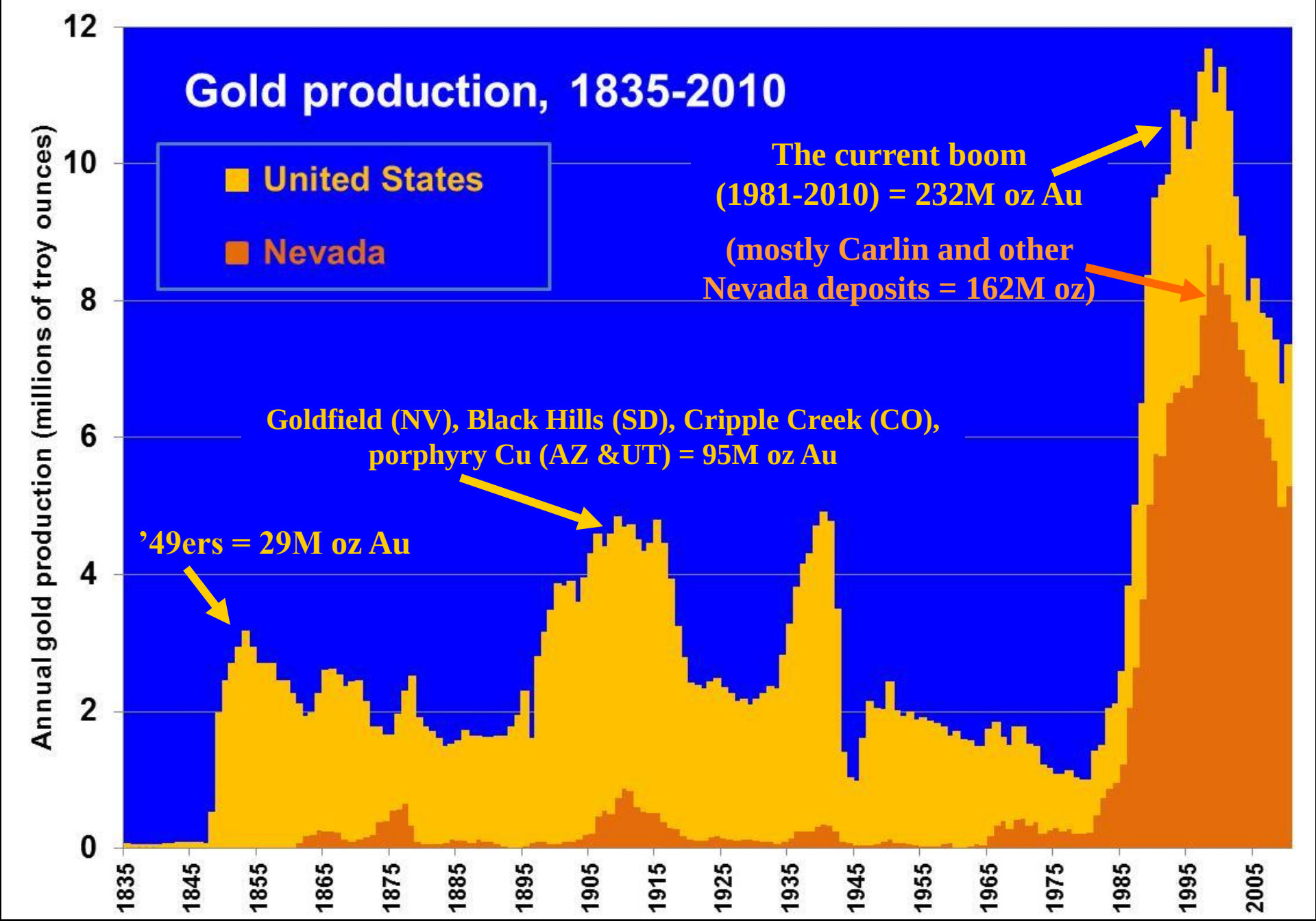


Data source: USGS

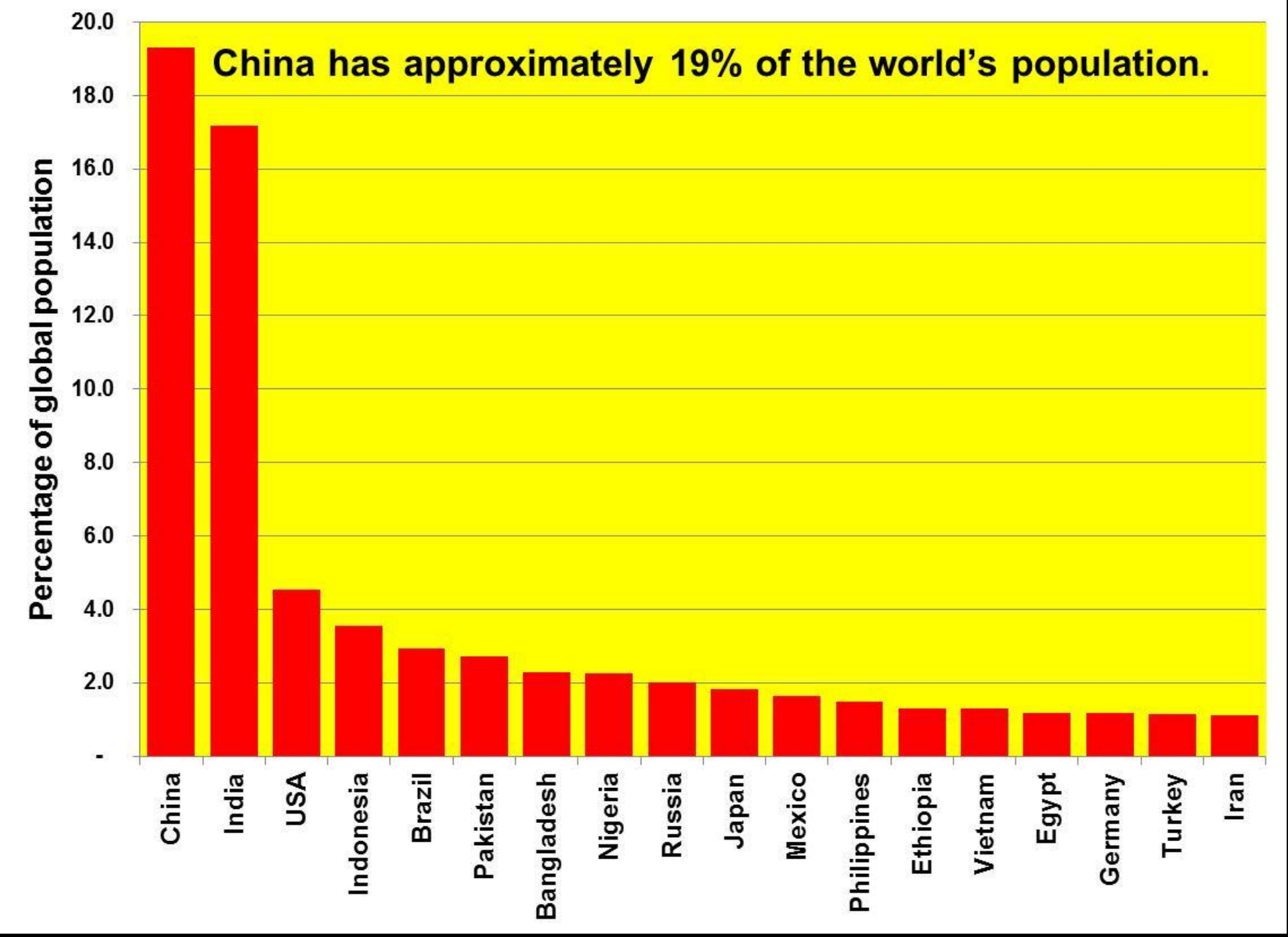
There has been a great recession in the USA, but not significantly in China, Australia, or India (by this measure – iron ore).

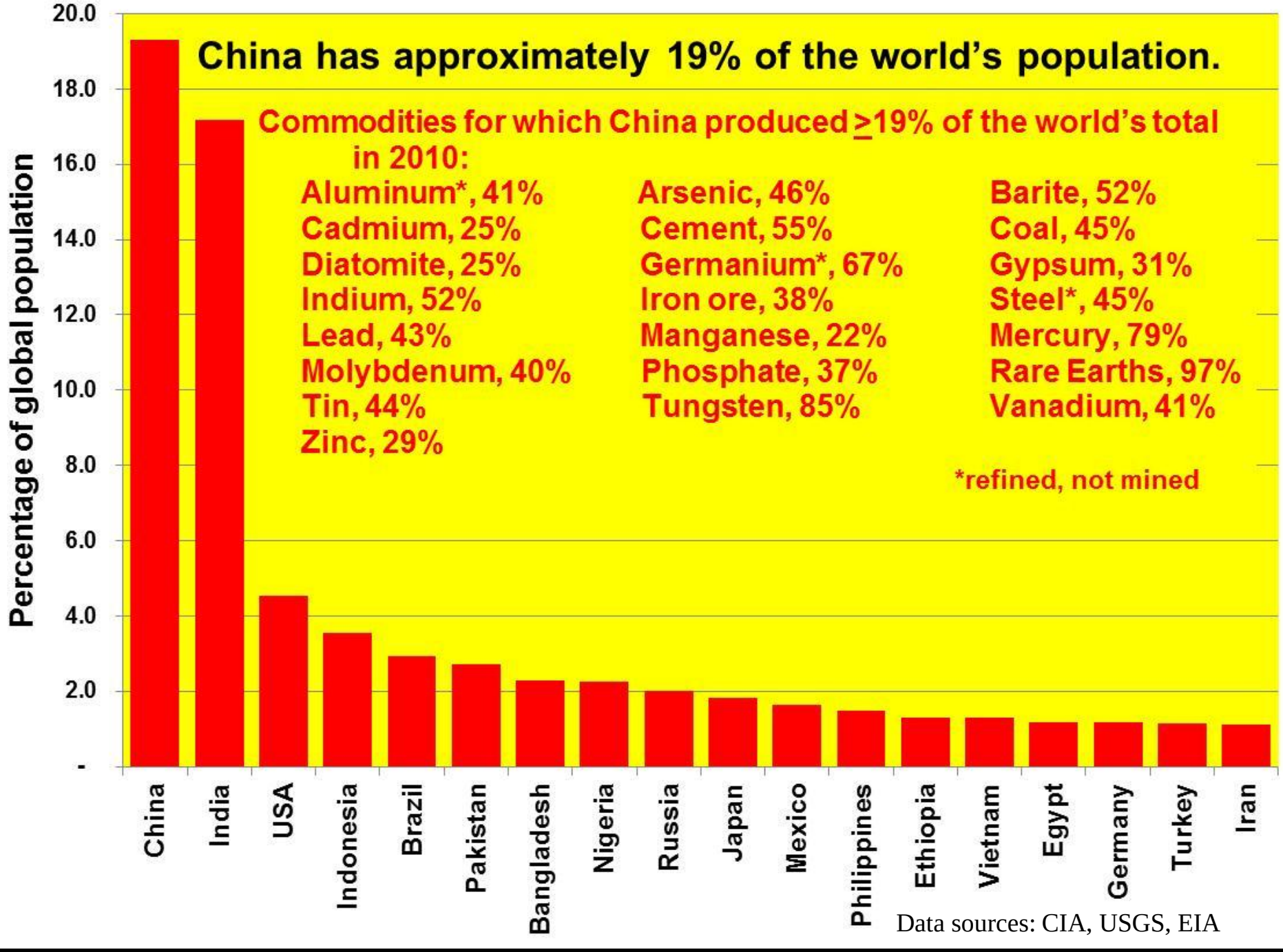

Copper
USA
Canada
Chile
Peru
China
Russia
Australia
Zambia
China produces only ~6% of the world's copper but is aggressively seeking resources elsewhere.
Annual copper production (thousand metric tons)
6000
5000
4000
3000
2000
1000
0
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
Year


Gold
China has been the #1 gold producing country since 2007.
USA
Canada
Peru
South Africa
China
Russia
Australia
Annual gold production (tonnes)
1,200
1,000
800
600
400
200
0
1930
1940
1950
1960
1970
1980
1990
2000
2010
Year



We are in the midst of the biggest gold-mining boom in American history.


China has approximately 19% of the world's population.
Percentage of global population
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
-
China
India
USA
Indonesia
Brazil
Pakistan
Bangladesh
Nigeria
Russia
Japan
Mexico
Philippines
Ethiopia
Vietnam
Egypt
Germany
Turkey
Iran

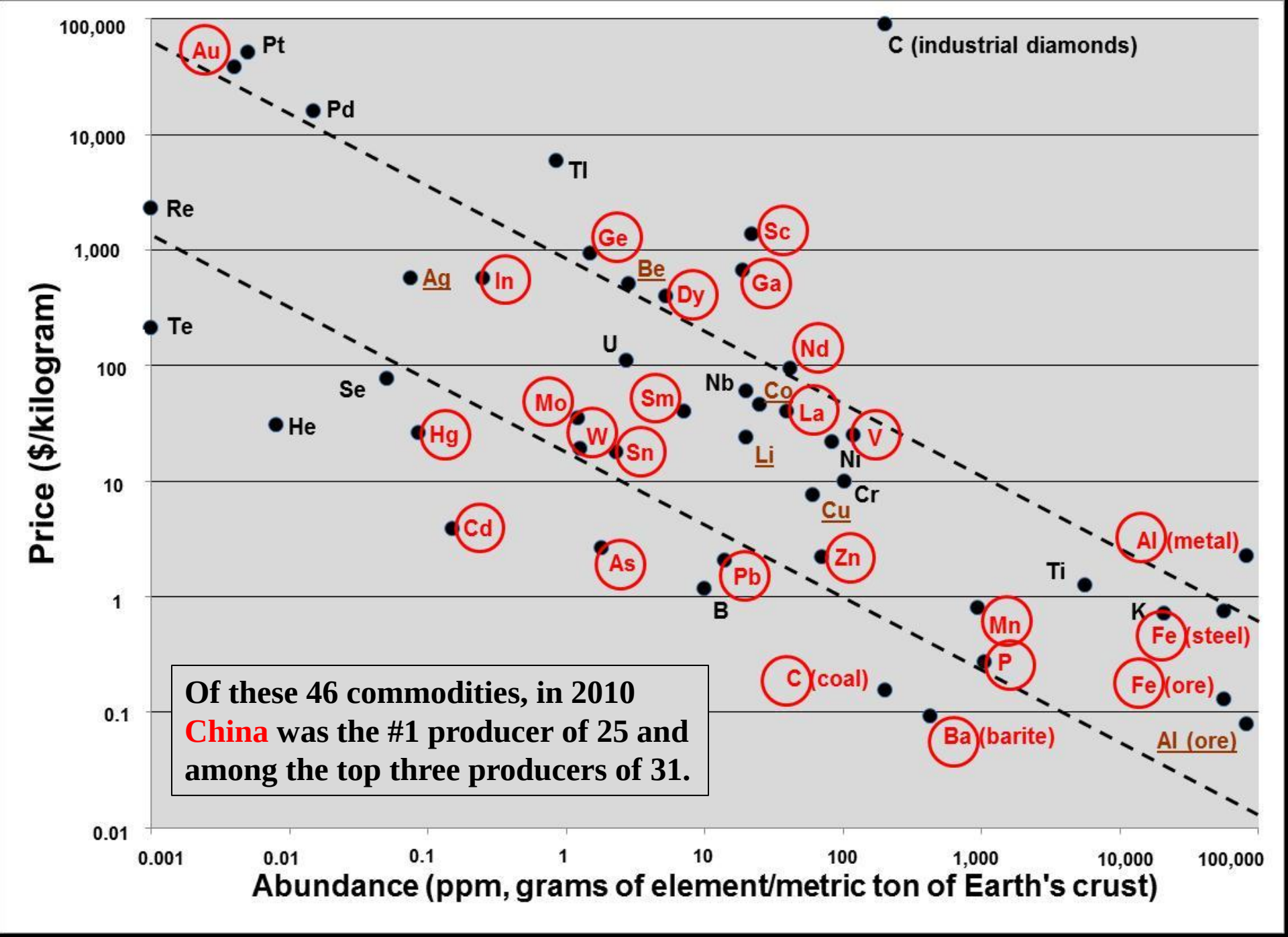


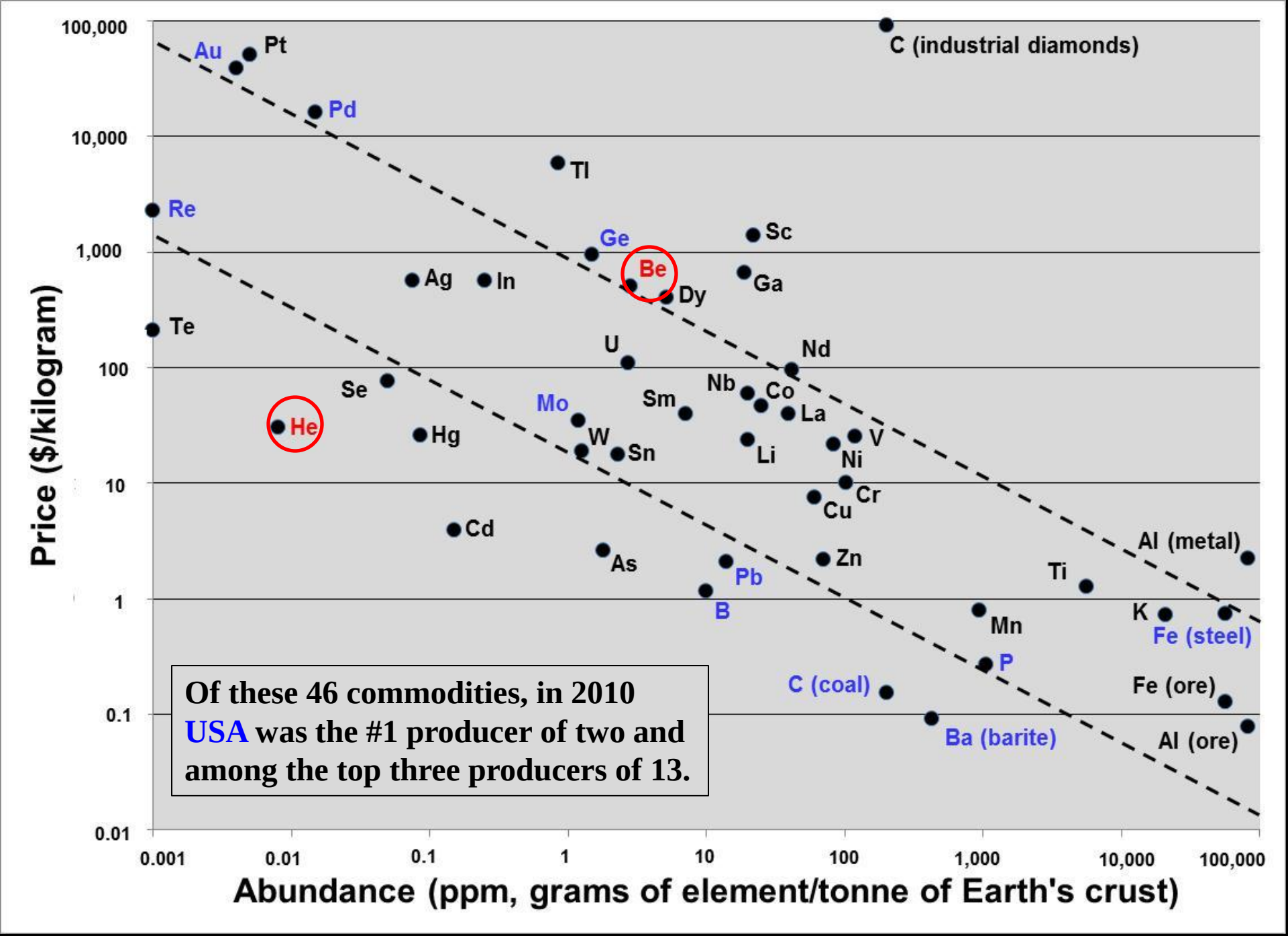
Data sources: CIA, USGS, EIA

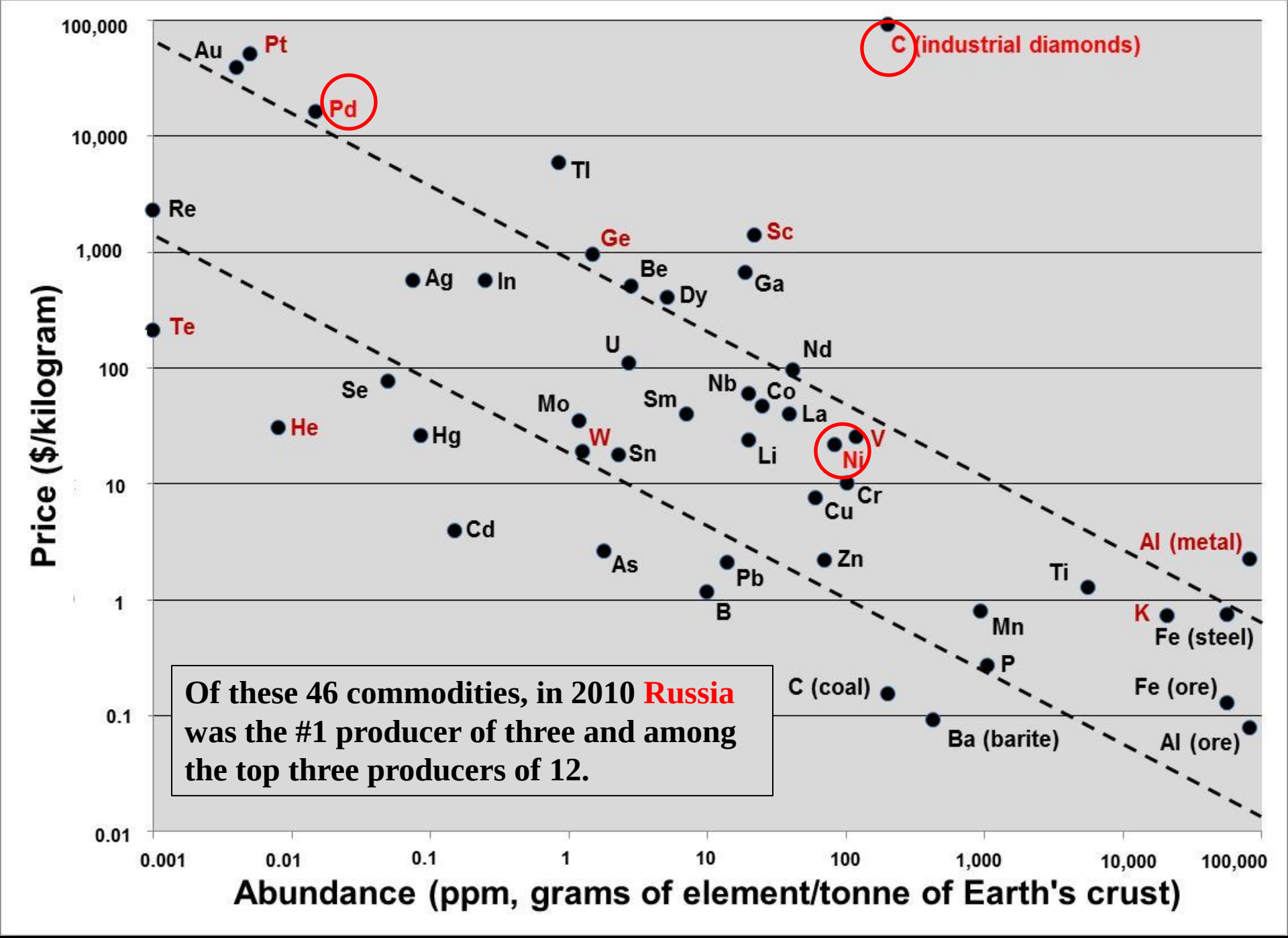
In production of 46 mineral commodities, China ranks well above all others.

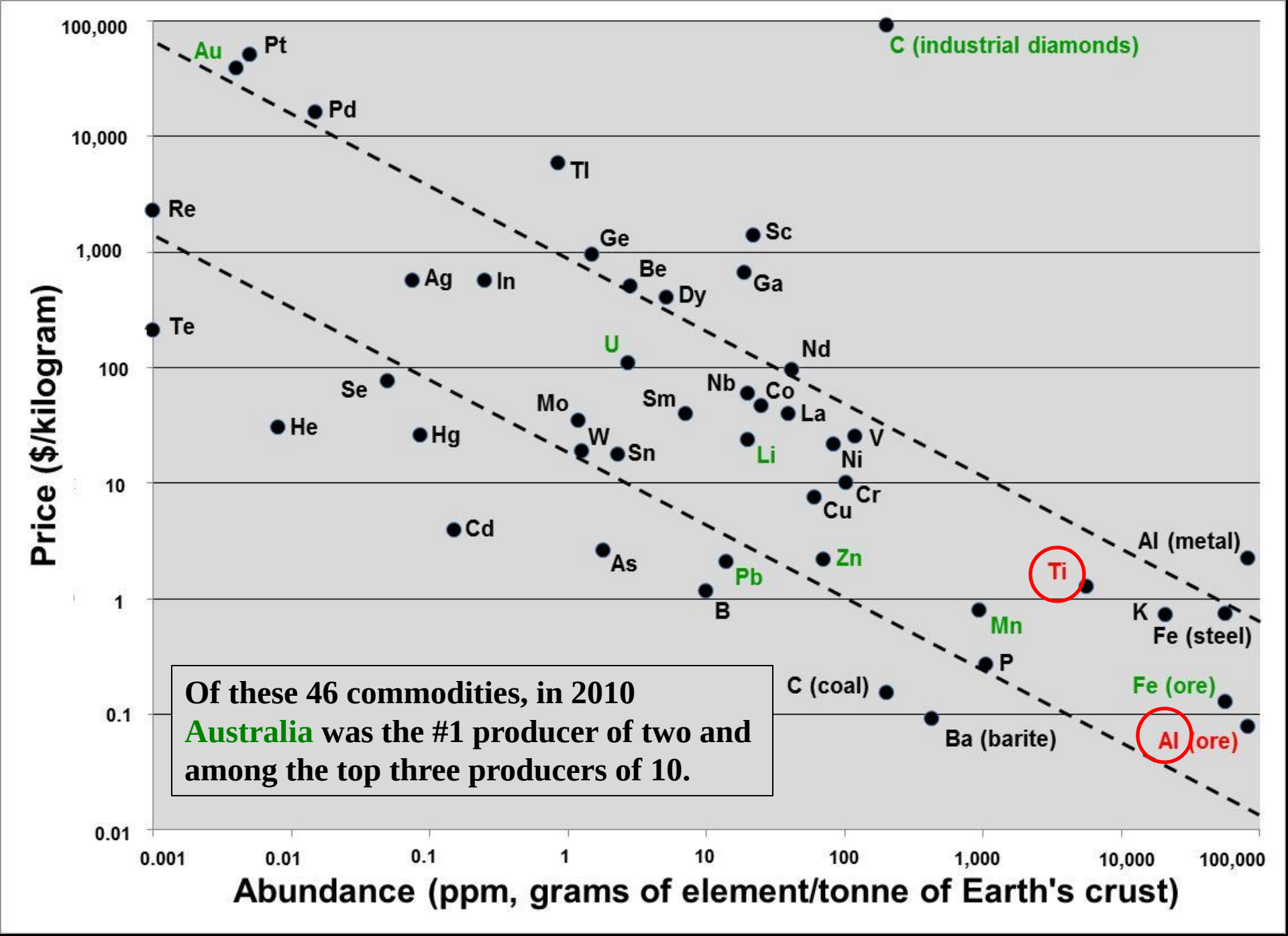
Country	Number of commodities for which this country is the #1 producer	Number of commodities for which this country is among the top 3 producers
China	25	31
Russia	3	12
USA	2	13
Australia	2	10

2010 production statistics from USGS


Price ($/kilogram)
100,000
10,000
1,000
100
10
1
0.1
0.01
0.001
0.01
0.1
1
10
100
1,000
10,000
100,000
Abundance (ppm, grams of element/metric ton of Earth's crust)
Au
Pt
Pd
Re
Te
Se
He
Ag
In
Tl
Ge
Be
Dy
Sc
Ga
U
Nd
Nb
Co
La
Mo
Sm
W
Sn
Hg
Li
V
Ni
Cr
Cu
Cd
As
Zn
Pb
B
Ti
Al (metal)
K
Mn
Fe (steel)
P
C (coal)
Fe (ore)
Ba (barite)
Al (ore)
C (industrial diamonds)
Of these 46 commodities, in 2010
China was the #1 producer of 25 and
among the top three producers of 31.


Price ($/kilogram)
100,000
10,000
1,000
100
10
1
0.1
0.01
Au
Pt
Pd
Re
Te
He
Tl
Ge
Ag
In
Be
Dy
Sc
Ga
U
Nd
Se
Nb
Co
Mo
Sm
La
Hg
W
Sn
Li
V
Ni
Cr
Cu
Cd
As
Zn
Pb
B
Al (metal)
Ti
Mn
K
Fe (steel)
P
C (coal)
Fe (ore)
Ba (barite)
Al (ore)
C (industrial diamonds)
Of these 46 commodities, in 2010 USA was the #1 producer of two and among the top three producers of 13.
0.001
0.01
0.1
1
10
100
1,000
10,000
100,000
Abundance (ppm, grams of element/tonne of Earth's crust)


Price ($/kilogram)
100,000
10,000
1,000
100
10
1
0.1
0.01
Au
Pt
Pd
C (industrial diamonds)
Tl
Re
Ge
Sc
Ag
In
Be
Dy
Ga
Te
U
Nd
Se
Nb
Co
Mo
Sm
La
He
Hg
W
Sn
Li
V
Ni
Cr
Cu
Cd
Al (metal)
As
Zn
Ti
Pb
B
Mn
K
Fe (steel)
P
C (coal)
Fe (ore)
Ba (barite)
Al (ore)
0.001
0.01
0.1
1
10
100
1,000
10,000
100,000
Abundance (ppm, grams of element/tonne of Earth's crust)
Of these 46 commodities, in 2010 Russia was the #1 producer of three and among the top three producers of 12.


Price ($/kilogram)
100,000
10,000
1,000
100
10
1
0.1
0.01
Au
Pt
Pd
Re
Tl
Ge
Sc
Ag
In
Be
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Dy
Te
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C (industrial diamonds)
Al (metal)
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Fe (steel)
C (coal)
Fe (ore)
Ba (barite)
Al (ore)
0.001
0.01
0.1
1
10
100
1,000
10,000
100,000
Abundance (ppm, grams of element/tonne of Earth's crust)
Of these 46 commodities, in 2010 Australia was the #1 producer of two and among the top three producers of 10.

So what?

And who cares?

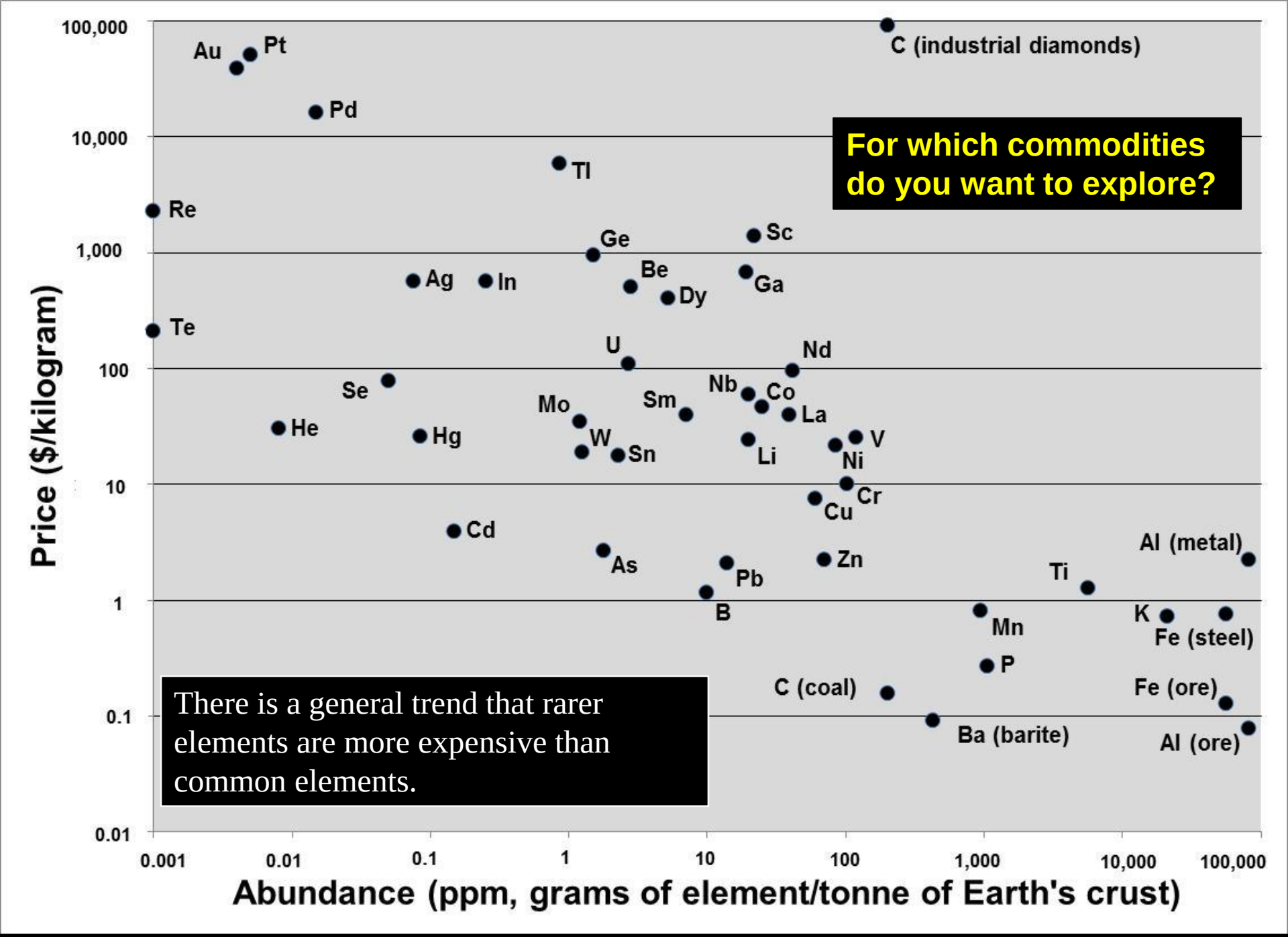
"Update on the Future of Mineral Resources"

Demand is high.

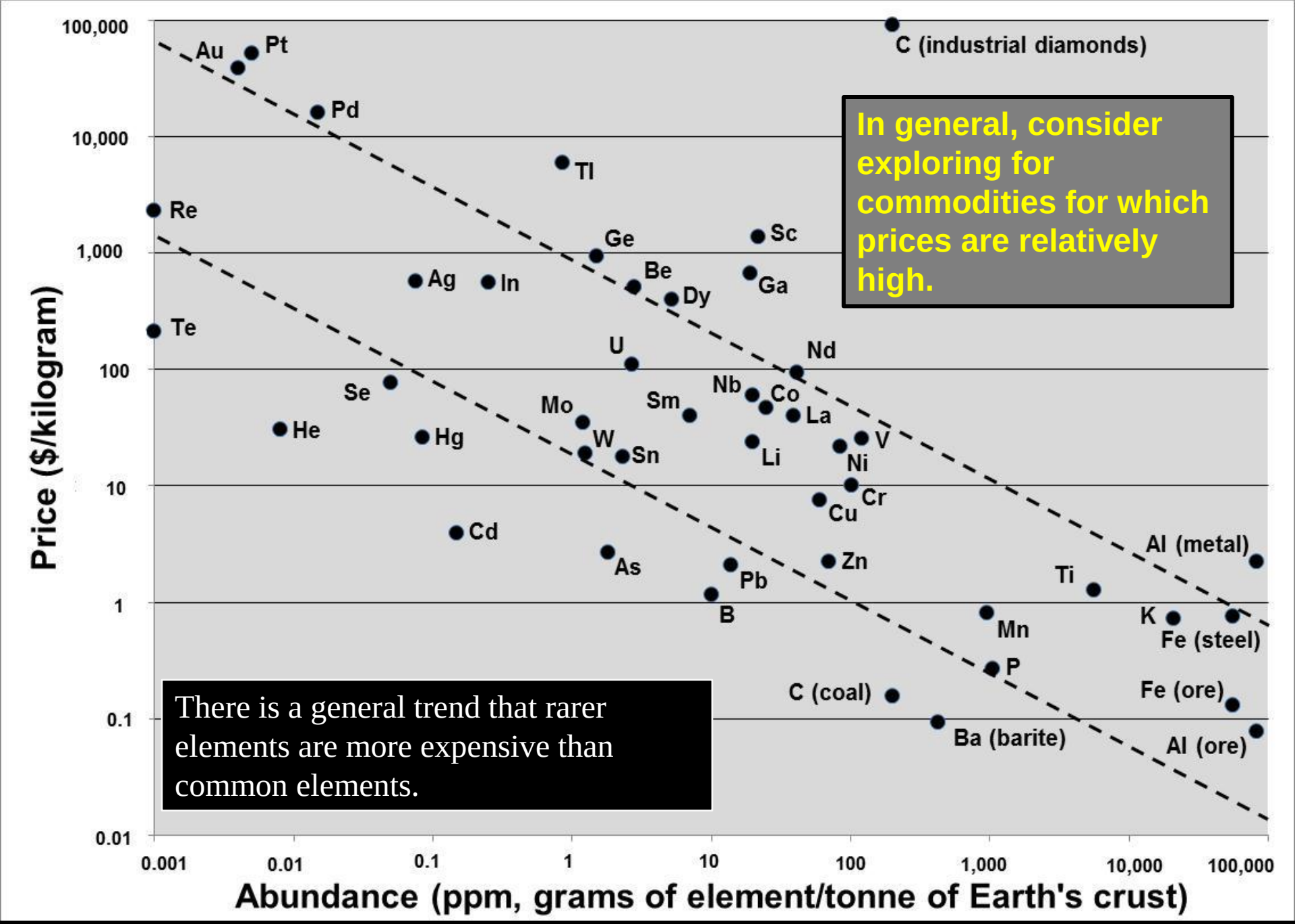
China is #1.

The trends will help guide exploration.

Round Mountain, NV (2007)



Source of data: USGS, EIA, CRC Handbook of Chemistry and Physics, others



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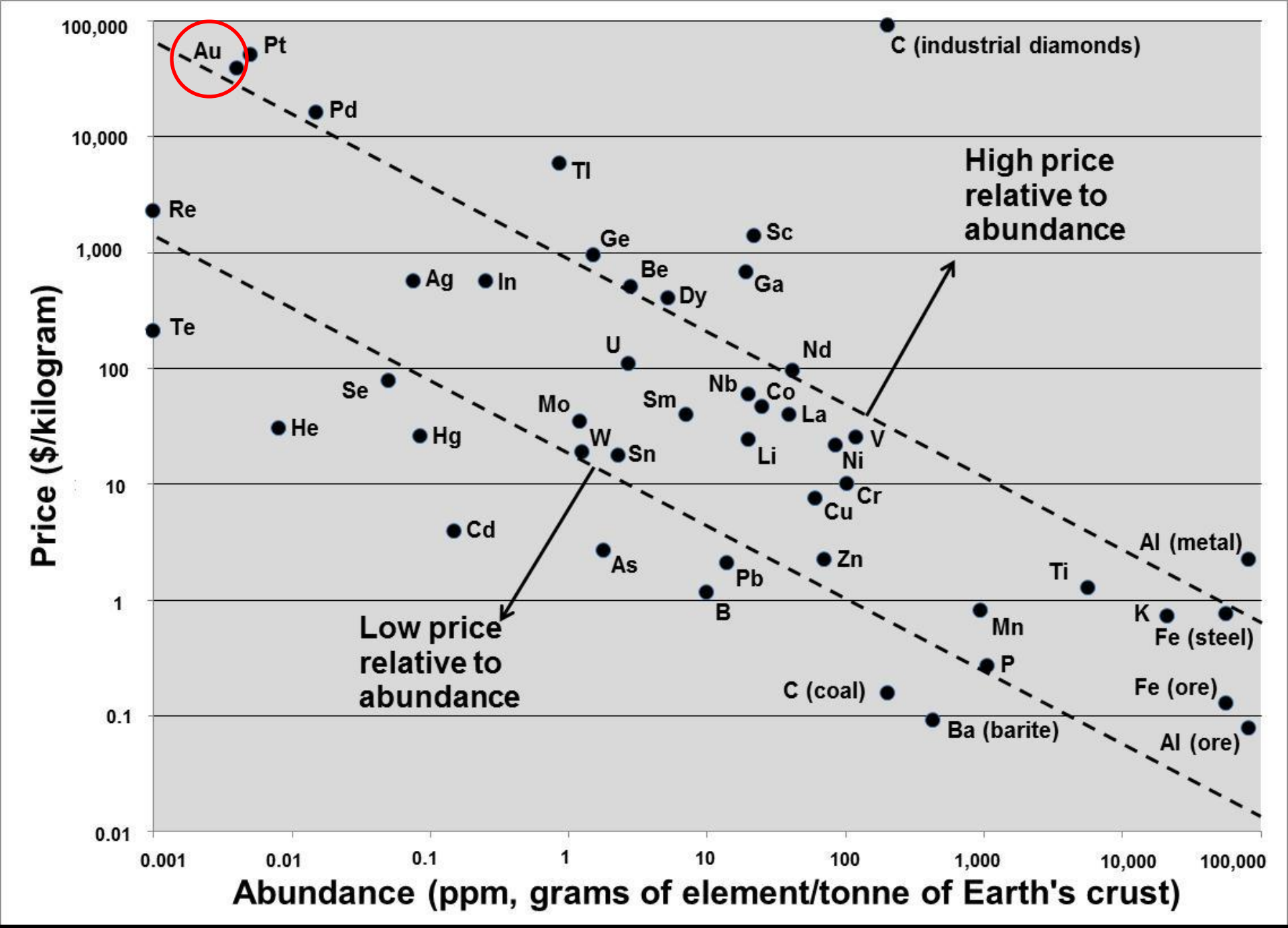
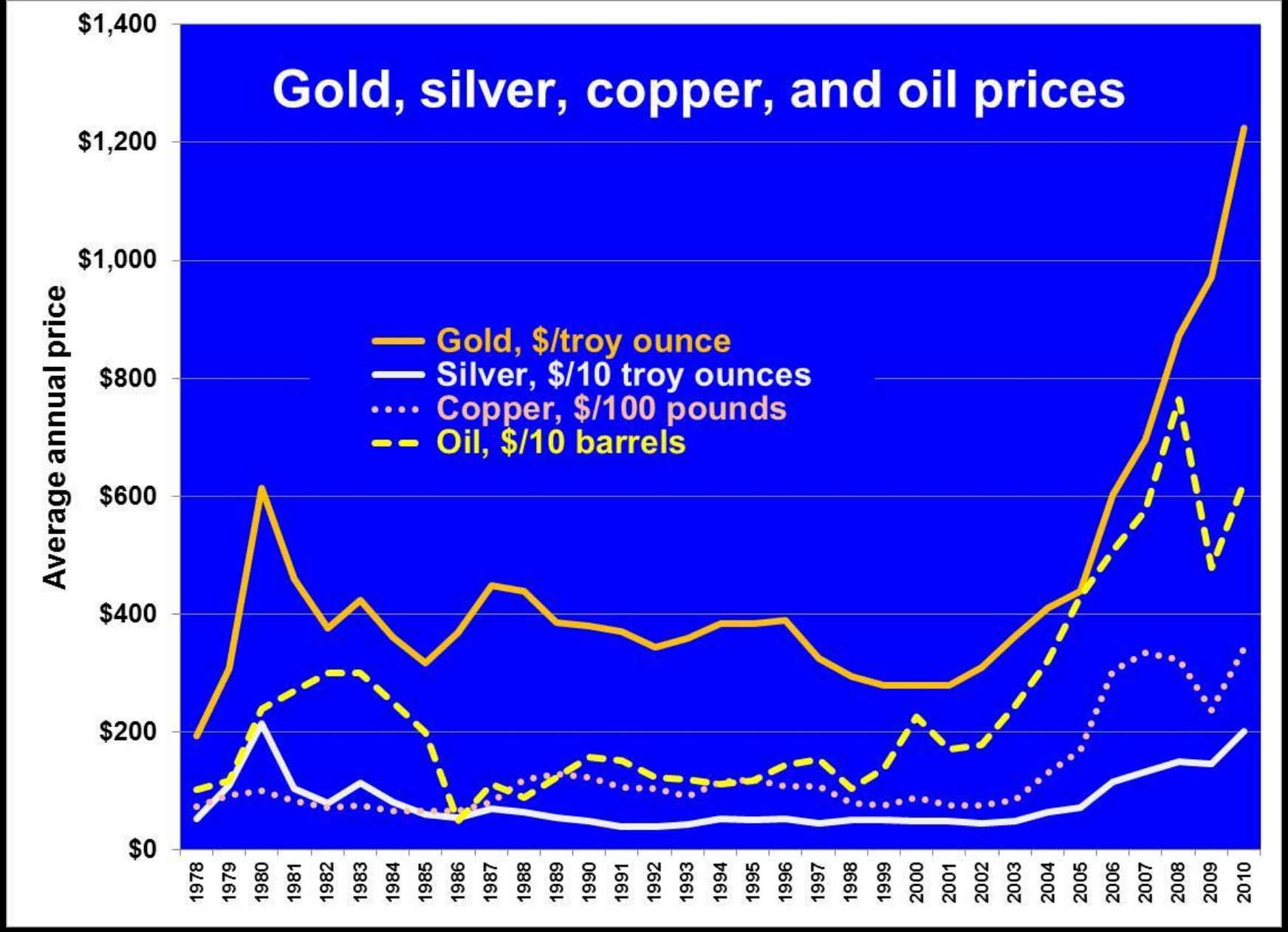
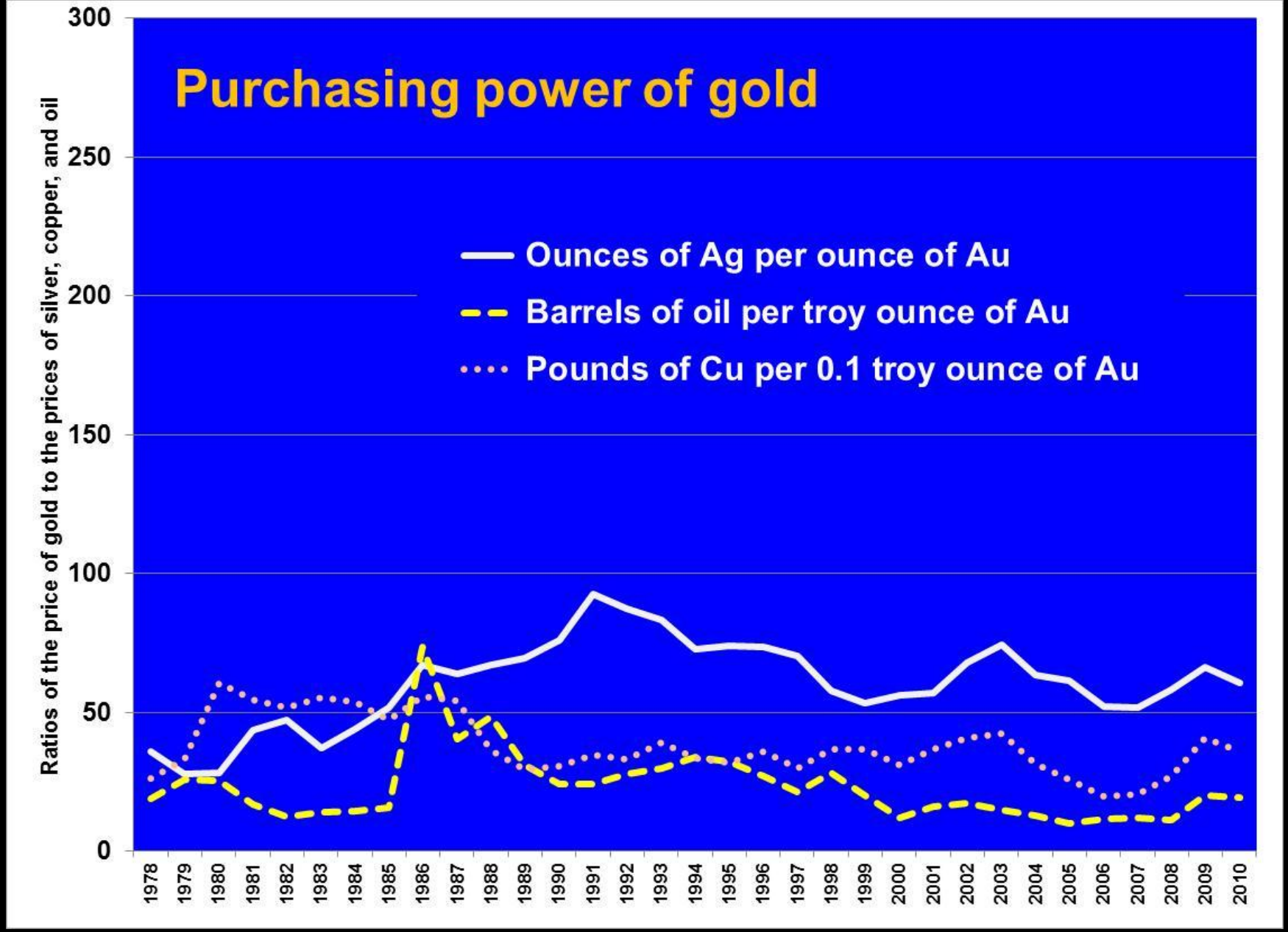


Source of data: USGS, EIA, CRC Handbook of Chemistry and Physics, others

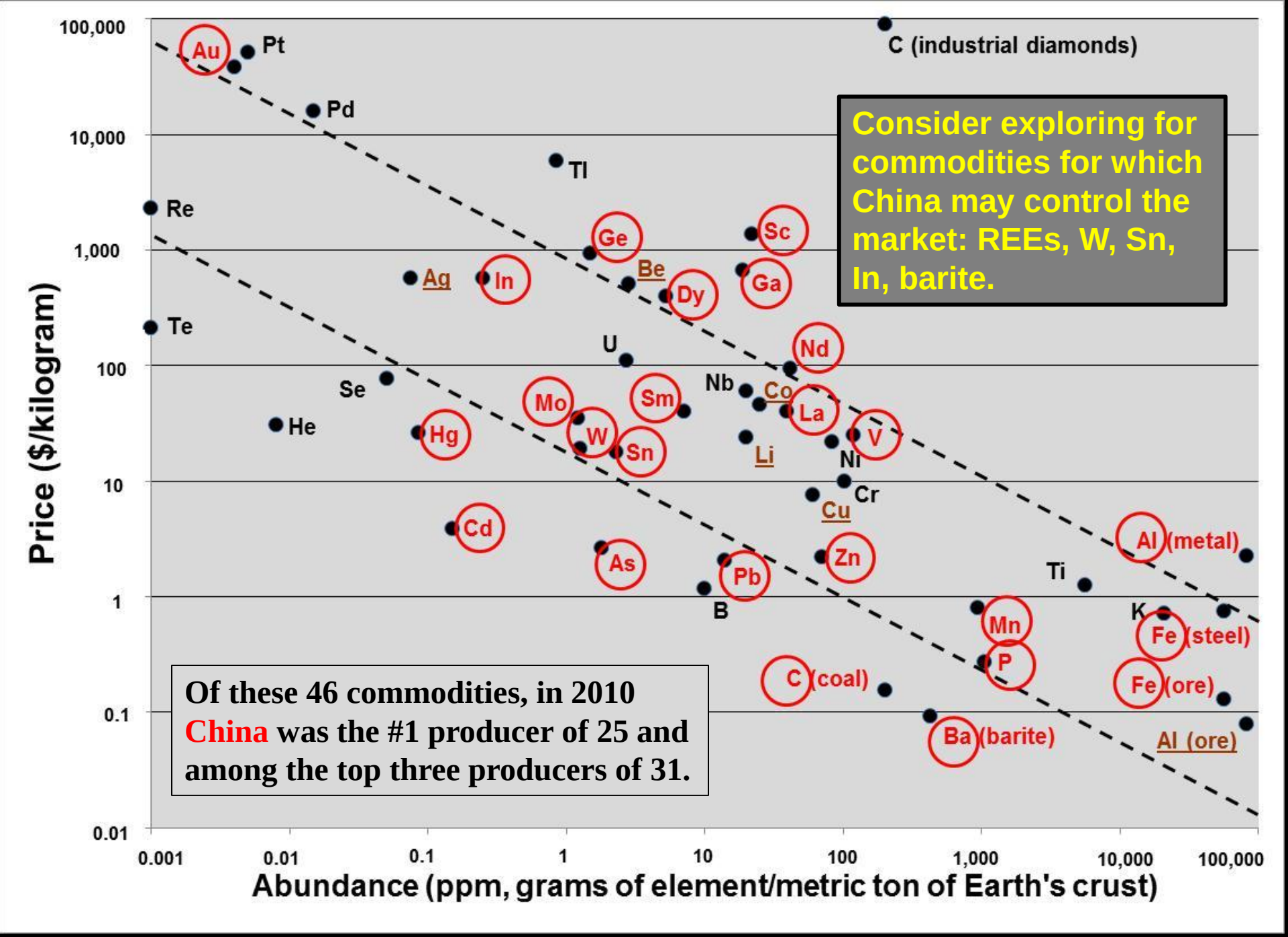
The average annual price of gold is reaching the inflation-adjusted historical high; $613/ounce in 1980 = $1,689/ounce in 2011, when adjusted for inflation.



In general, the prices of commodity prices have risen in recent years.



In general, gold has kept its purchasing power over the years. Gold is money.


Price ($/kilogram)
100,000
10,000
1,000
100
10
1
0.1
0.01
0.001
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1
10
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1,000
10,000
100,000
Abundance (ppm, grams of element/metric ton of Earth's crust)
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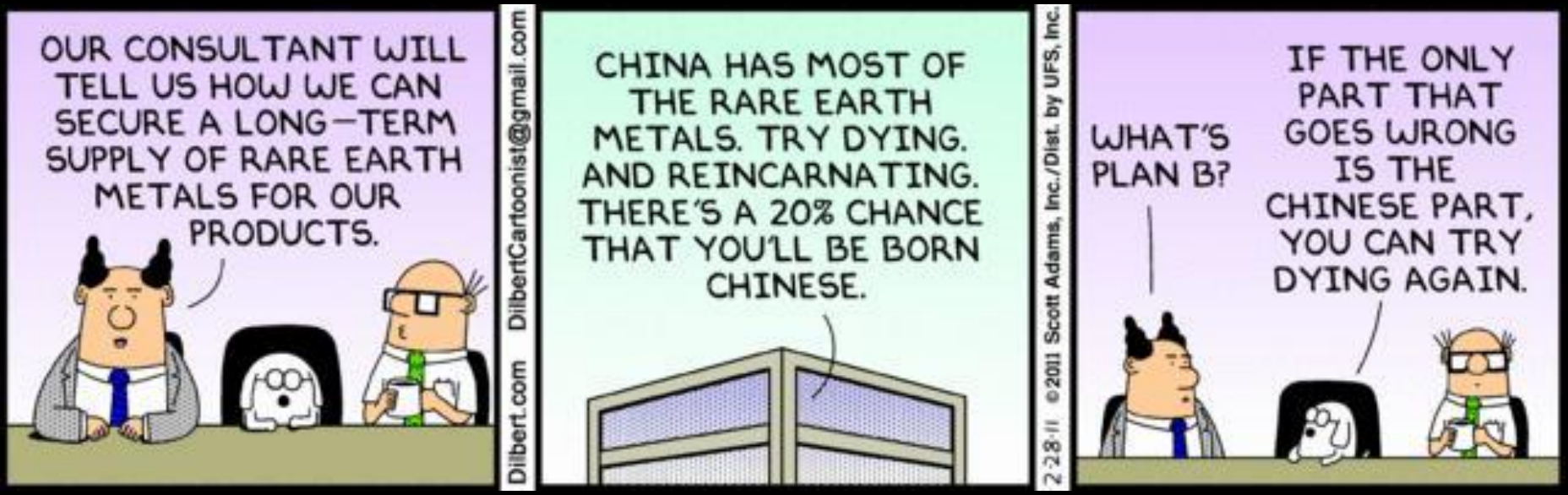
U
Nd
Nb
Co
La
Mo
Sm
W
Sn
Hg
Li
V
Ni
Cr
Cu
Cd
As
Zn
Pb
B
Ti
Al (metal)
K
Fe (steel)
Mn
P
C (coal)
Fe (ore)
Ba (barite)
Al (ore)
C (industrial diamonds)
Consider exploring for commodities for which China may control the market: REEs, W, Sn, In, barite.
Of these 46 commodities, in 2010 China was the #1 producer of 25 and among the top three producers of 31.

"Forget gold. Strategic metals are where it's at."


OUR CONSULTANT WILL TELL US HOW WE CAN SECURE A LONG-TERM SUPPLY OF RARE EARTH METALS FOR OUR PRODUCTS.
Dilbert.com DilbertCartoonist@gmail.com
CHINA HAS MOST OF THE RARE EARTH METALS. TRY DYING. AND REINCARNATING. THERE'S A 20% CHANCE THAT YOU'LL BE BORN CHINESE.
2-28-11 ©2011 Scott Adams, Inc./Dist. by UFS, Inc.
WHAT'S PLAN B?
IF THE ONLY PART THAT GOES WRONG IS THE CHINESE PART, YOU CAN TRY DYING AGAIN.

Energy Critical Elements:

								2 **He** Helium 4.003
			5 **B** Boron 10.811	6 **C** Carbon 12.0107	7 **N** Nitrogen 14.00674	8 **O** Oxygen 15.9994	9 **F** Fluorine 18.9984032	10 **Ne** Neon 20.1797
			13 **Al** Aluminum 26.981538	14 **Si** Silicon 28.0855	15 **P** Phosphorus 30.973761	16 **S** Sulfur 32.066		
28 **Ni** Nickel 58.6934	29 **Cu** Copper 63.546	30 **Zn** Zinc 65.39	31 **Ga** Gallium 69.723	32 **Ge** Germanium 72.61	33 **As** Arsenic 74.92160	34 **Se** Selenium 78.96		
46 **Pd** Palladium 106.42	47 **Ag** Silver 107.8682	48 **Cd** Cadmium 112.411	49 **In** Indium 114.818	50 **Sn** Tin 118.710	51 **Sb** Antimony 121.760	52 **Te** Tellurium 127.60		
78 **Pt** Platinum 195.078	79 **Au** Gold 196.96655	80 **Hg** Mercury 200.59	81 **Tl** Thallium 204.3833	82 **Pb** Lead 207.2	83 **Bi** Bismuth 208.98038	84 **Po** Polonium (209)	85 **At** Astatine (210)	86 **Rn** Radon (222)
65 **Tb** Terbium 158.92534	66 **Dy** Dysprosium 162.50	67 **Ho** Holmium 164.93032	68 **Er** Erbium 167.26	69 **Tm** Thulium 168.93421	70 **Yb** Ytterbium 173.04	71 **Lu** Lutetium 174.967		

Securing Materials for Emerging Technologies

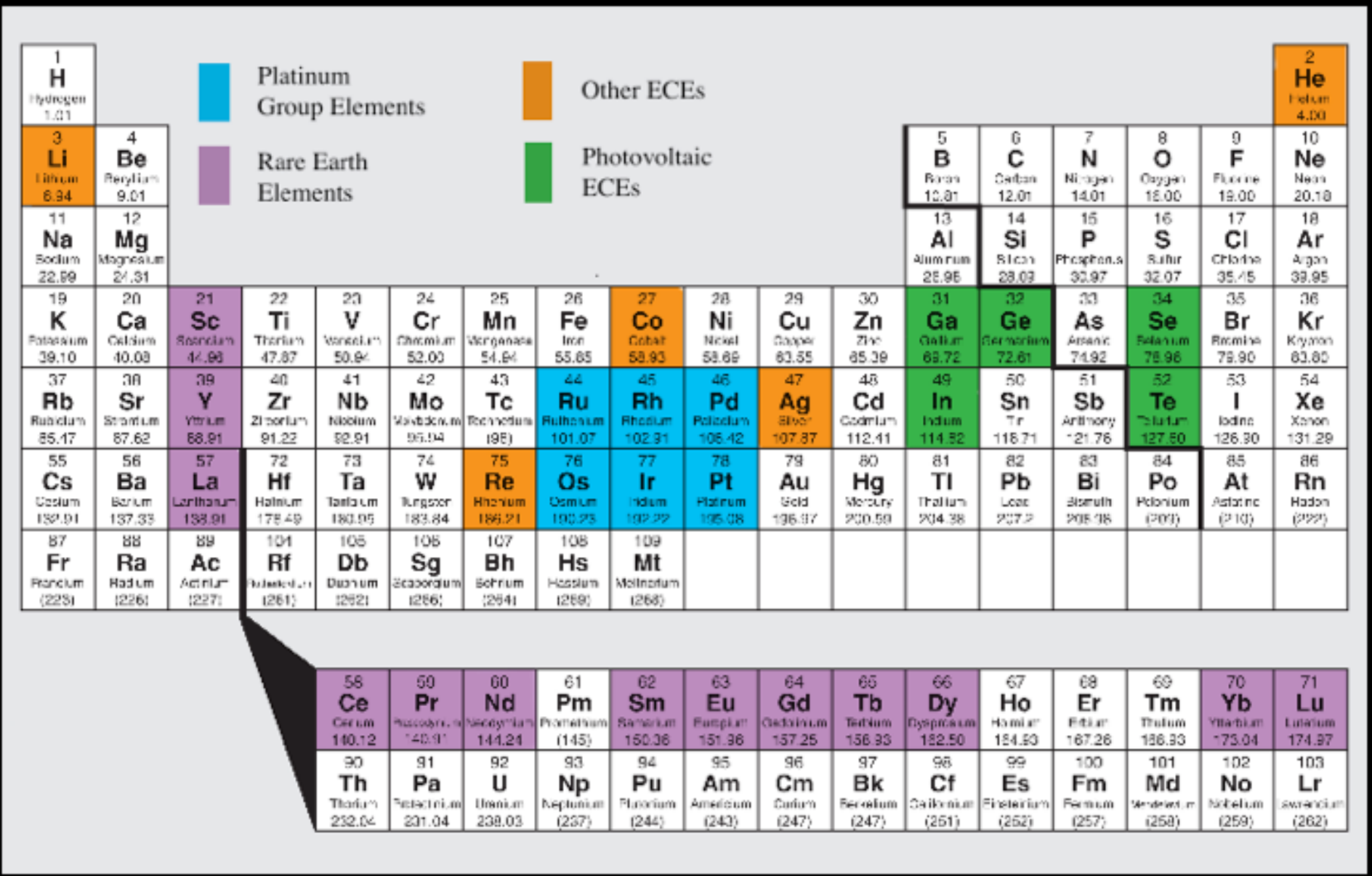
A REPORT BY THE APS PANEL ON PUBLIC AFFAIRS & THE MATERIALS RESEARCH SOCIETY

MRS APS physics

Consider exploring for mineral resources that will likely be in higher demand in the future.

Energy-critical elements (ECEs) are a class of chemical elements that currently appear critical to one or more new energy-related technologies. A shortage of these elements would significantly inhibit large-scale deployment, which could otherwise be capable of transforming the way we produce, transmit, store, or conserve energy. We reserve the term ECE for chemical elements that have not been widely extracted, traded, or utilized in the past, and are therefore not the focus of well-established and relatively stable markets.

Some ECEs today



New Energy Technologies

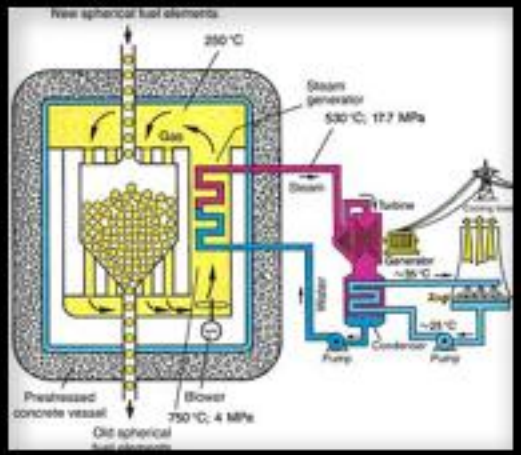
- **Renewable**
- CO_2 neutral

Tellurium
Indium
Gallium
Germanium

Neodymium
Dysprosium
Praseodymium
Samarium

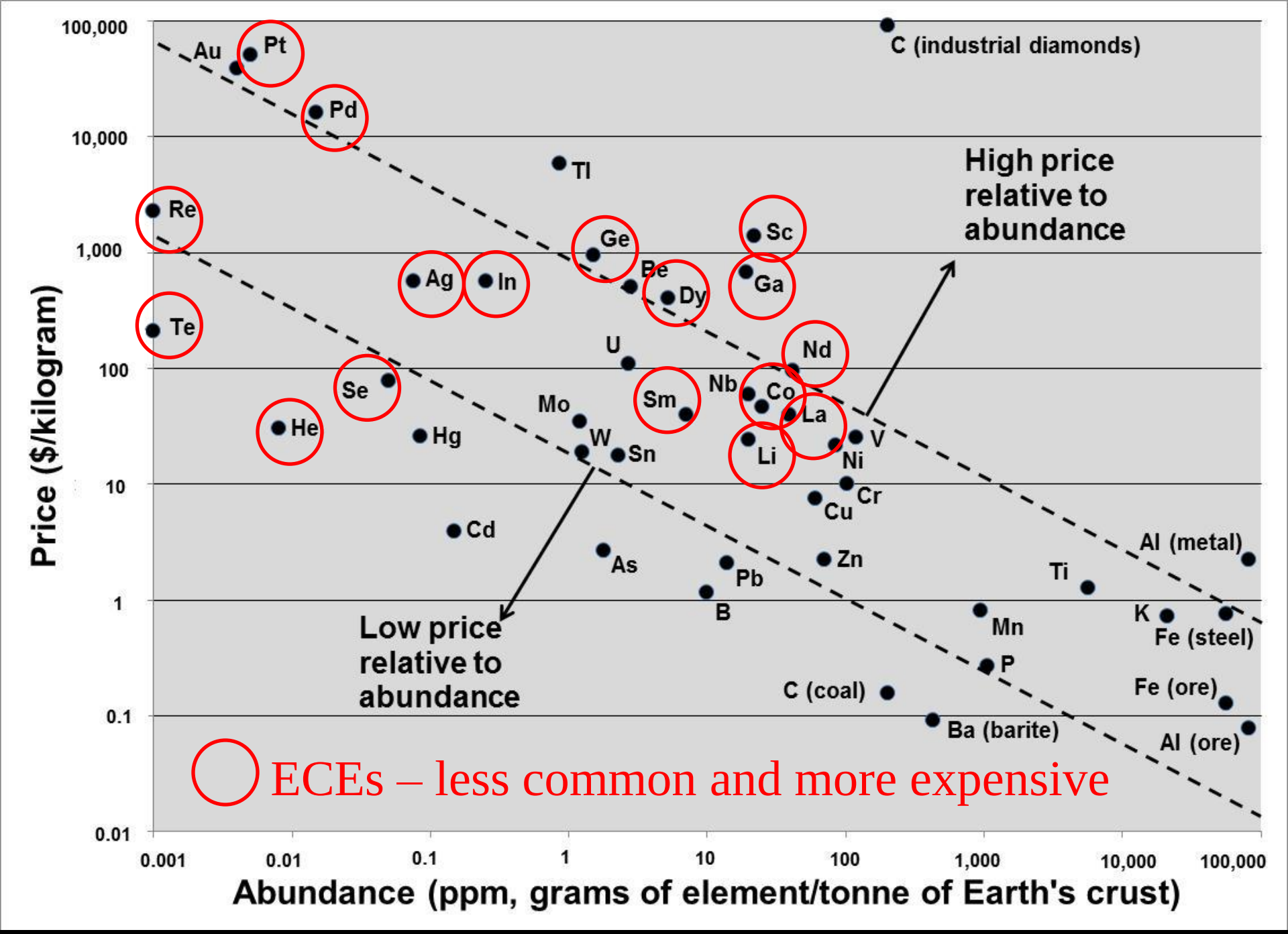
Terbium

Europium

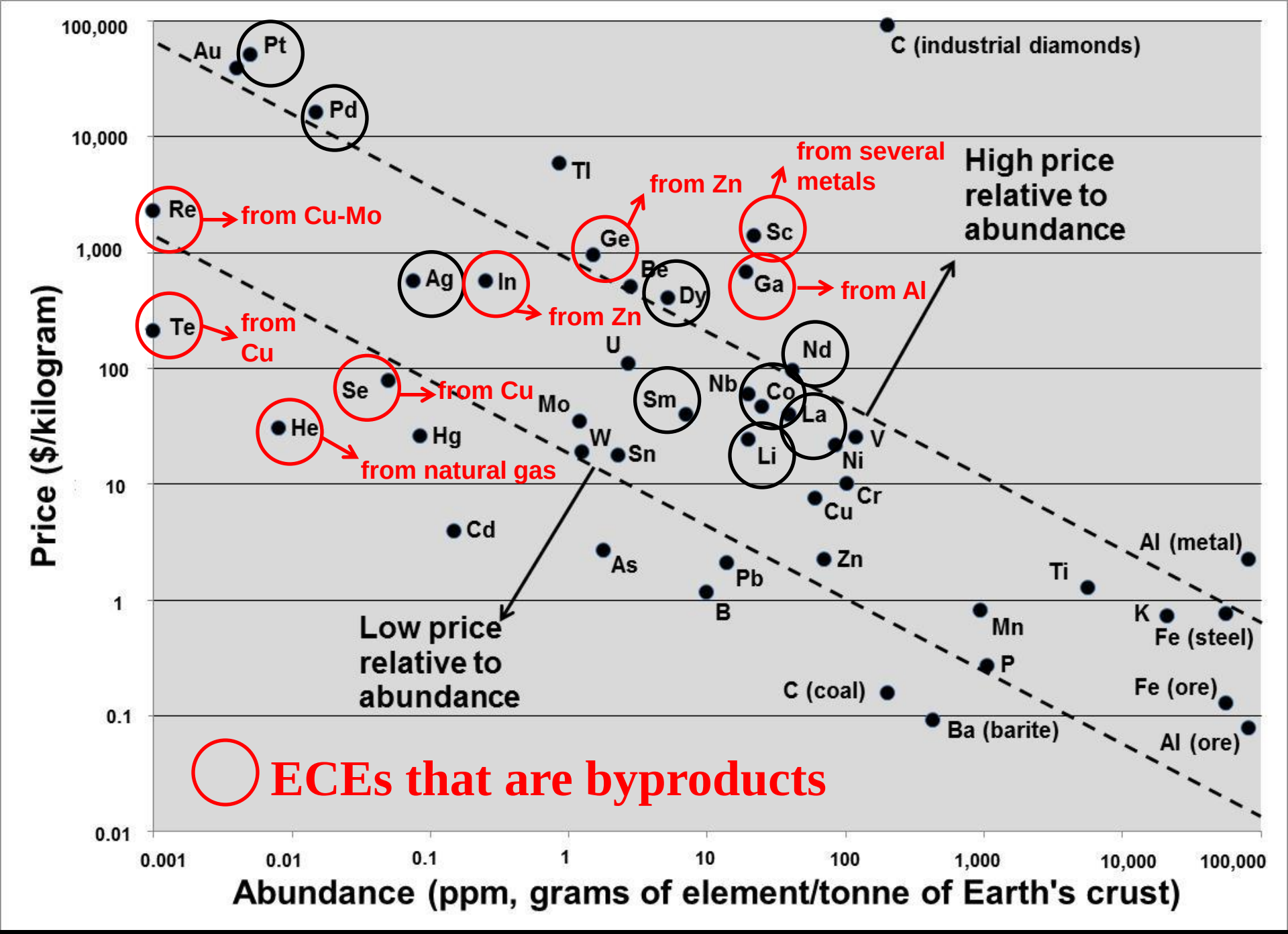


Helium

Lithium
Lanthanum



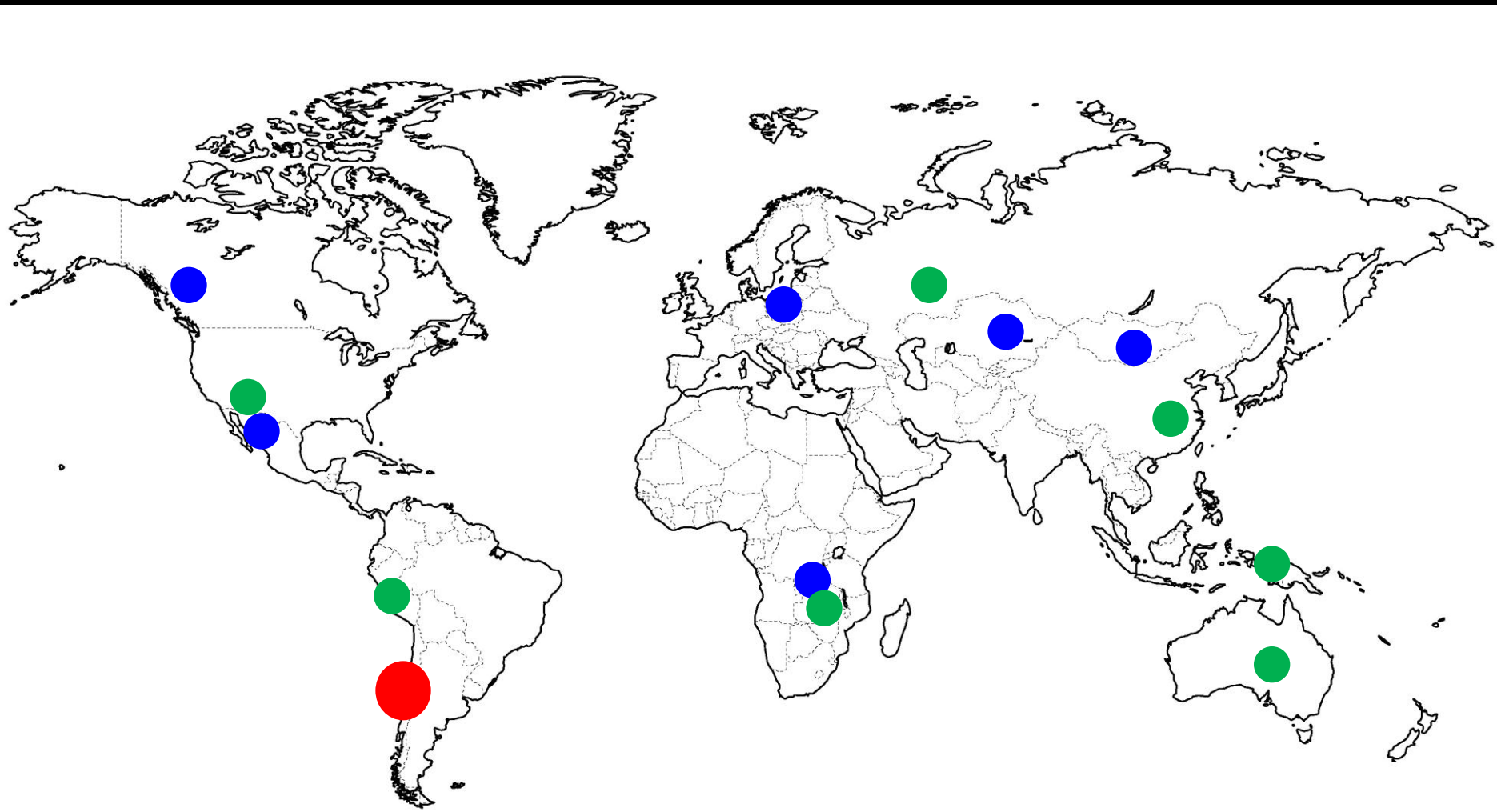
Source of data: USGS, EIA, CRC Handbook of Chemistry and Physics, others



Source of data: USGS, EIA, CRC Handbook of Chemistry and Physics, others

	Main product Cu	Byproduct Se	**Byproduct Te**
Global production (metric tons)	16,200,000	2,260	~500
Price ($/kg)	$7.54/kg	$77.16/kg	$210/kg
Value of global production ($)	$122 x 10^9	$174 x 10^6	$105 x 10^6
Ratio of values of global production		Cu:Se = 700:1	**Cu:Te = 1200:1**

Securing more mineral resources that are recovered as byproducts will require either exploration for new types of resources or research on metallurgical extraction.



World's leading copper producer (Chile, 34%)

Countries with 4% or more of global production

Other countries with production or major reserves

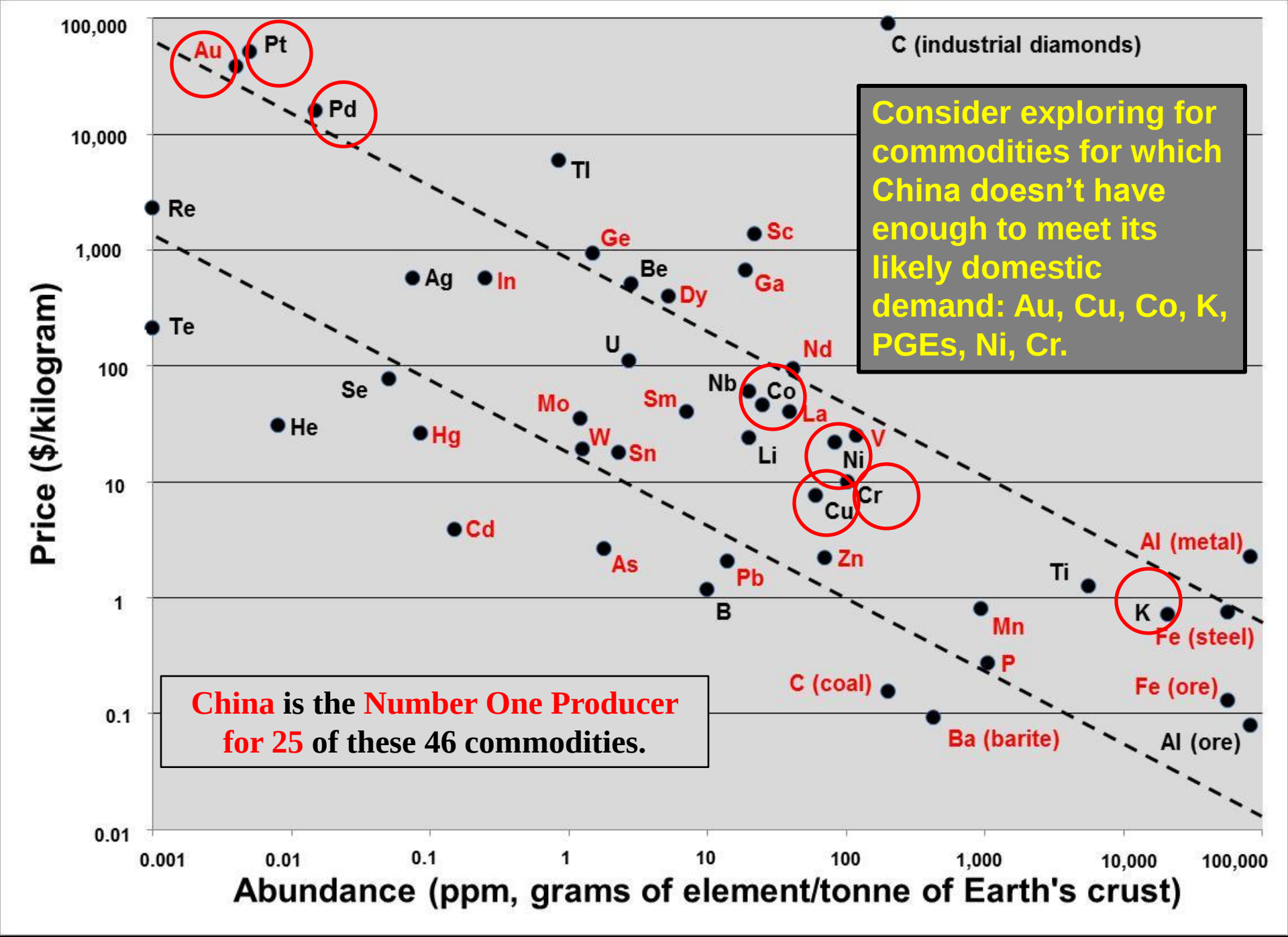
Copper resources are broadly distributed, but not much is known about the byproduct-element concentrations in many copper ores.

Data source: USGS

Chalcopyrite, pyrrhotite, and magnetite
DDH NC 08-20, 1213 feet,
North deposit, Pumpkin Hollow,
Lyon County, NV

Reid Yano, UNR M.S. student, in collaboration with the USGS, is investigating trace elements in copper ores related to porphyry systems, with samples collected by himself and from the **Mackay-Stanford Ore Deposit Collection.**

He's following up on various anomalies, including **high Te** at Cananea (Mexico), Bingham (UT), Chuquicamata and El Teniente (Chile), and Bisbee (AZ).


Price ($/kilogram)
100,000
10,000
1,000
100
10
1
0.1
0.01
0.001
0.01
0.1
1
10
100
1,000
10,000
100,000
Abundance (ppm, grams of element/tonne of Earth's crust)
Au
Pt
Pd
Re
Tl
Ge
Sc
Ag
In
Be
Ga
Dy
Te
U
Nd
Se
Nb
Co
Mo
Sm
La
He
Hg
W
Sn
V
Li
Ni
Cr
Cu
Cd
As
Zn
Al (metal)
Pb
Ti
B
K
Mn
Fe (steel)
P
C (coal)
Fe (ore)
Ba (barite)
Al (ore)
C (industrial diamonds)
Consider exploring for commodities for which China doesn't have enough to meet its likely domestic demand: Au, Cu, Co, K, PGEs, Ni, Cr.
China is the Number One Producer for 25 of these 46 commodities.

China's economy will likely drive up the demand for those commodities for which it can't mine enough domestically.

Commodity	% from China	% from Canada	% from US	Leading Producer
Platinum	0	3	2	South Africa (75%)
Potash	9	29	3	Canada (29%)
Chromium	~0	~0	~0	South Africa (39%)
Copper	6	3	7	Chile (34%)
Nickel	5	10	0	Russia (17%)

For example, the leading producers of nickel are Russia (17% of 2010 mine production), Indonesia (15%), Philippines (10%), Canada (10%), and Australia (9%).

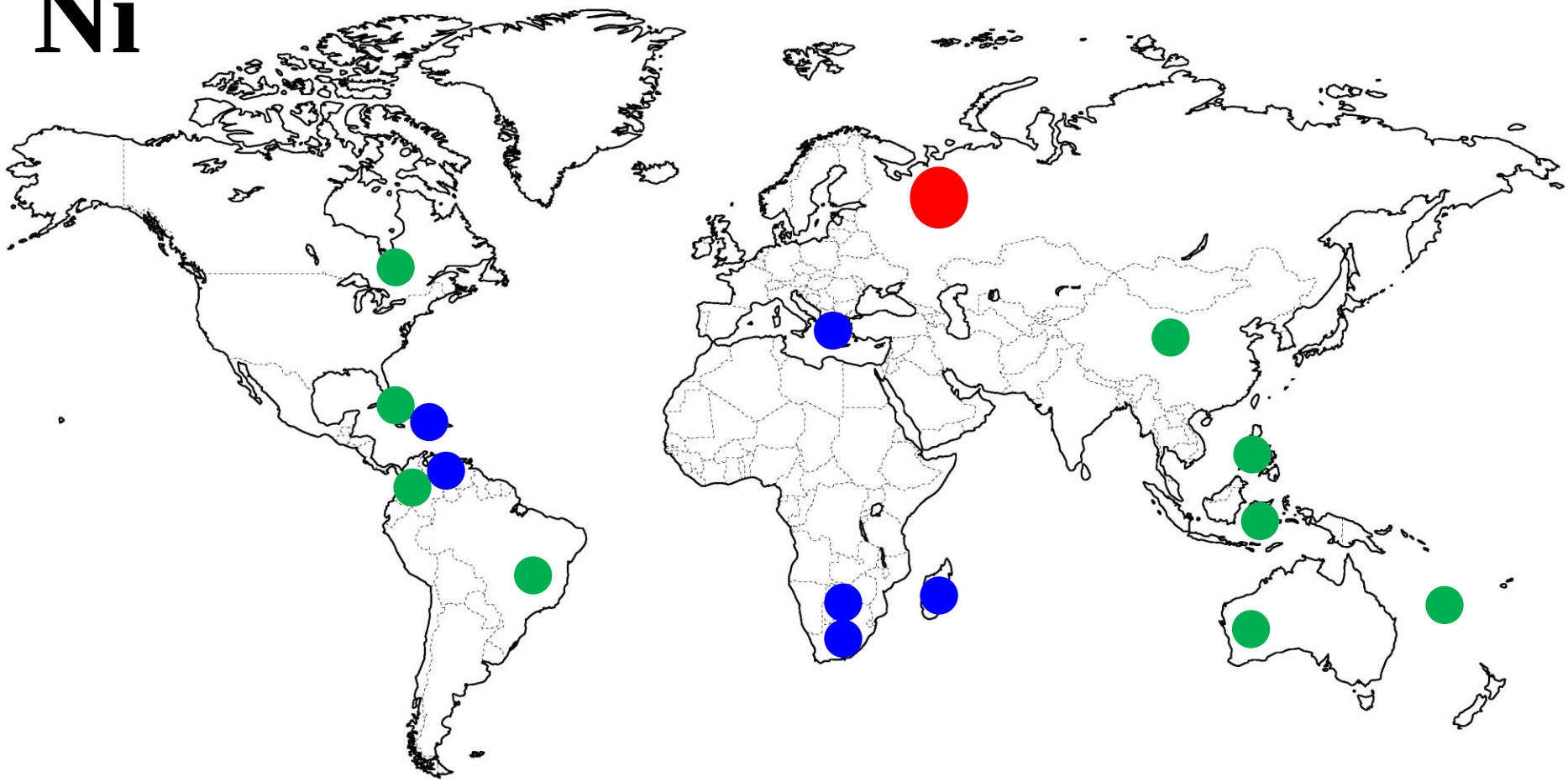
Mount Keith Ni mine, Western Australia: 323 million metric tons @ 0.56% Ni

Spinifex texture in serpentinite, Honeymoon Well nickel deposit, Western Australia - indicator of bladed crystals of olivine, from quenching of an ultramafic lava flow

Production statistics from USGS

Watch for competition in the regions of resource-rich Precambrian cratons, which are major sources of iron, manganese, nickel, chromium, titanium, copper, cobalt, zinc, gold, palladium, platinum, and uranium. This includes parts of Africa, Australia, South America (particularly Brazil and Venezuela), Russia, and Canada.

Ni



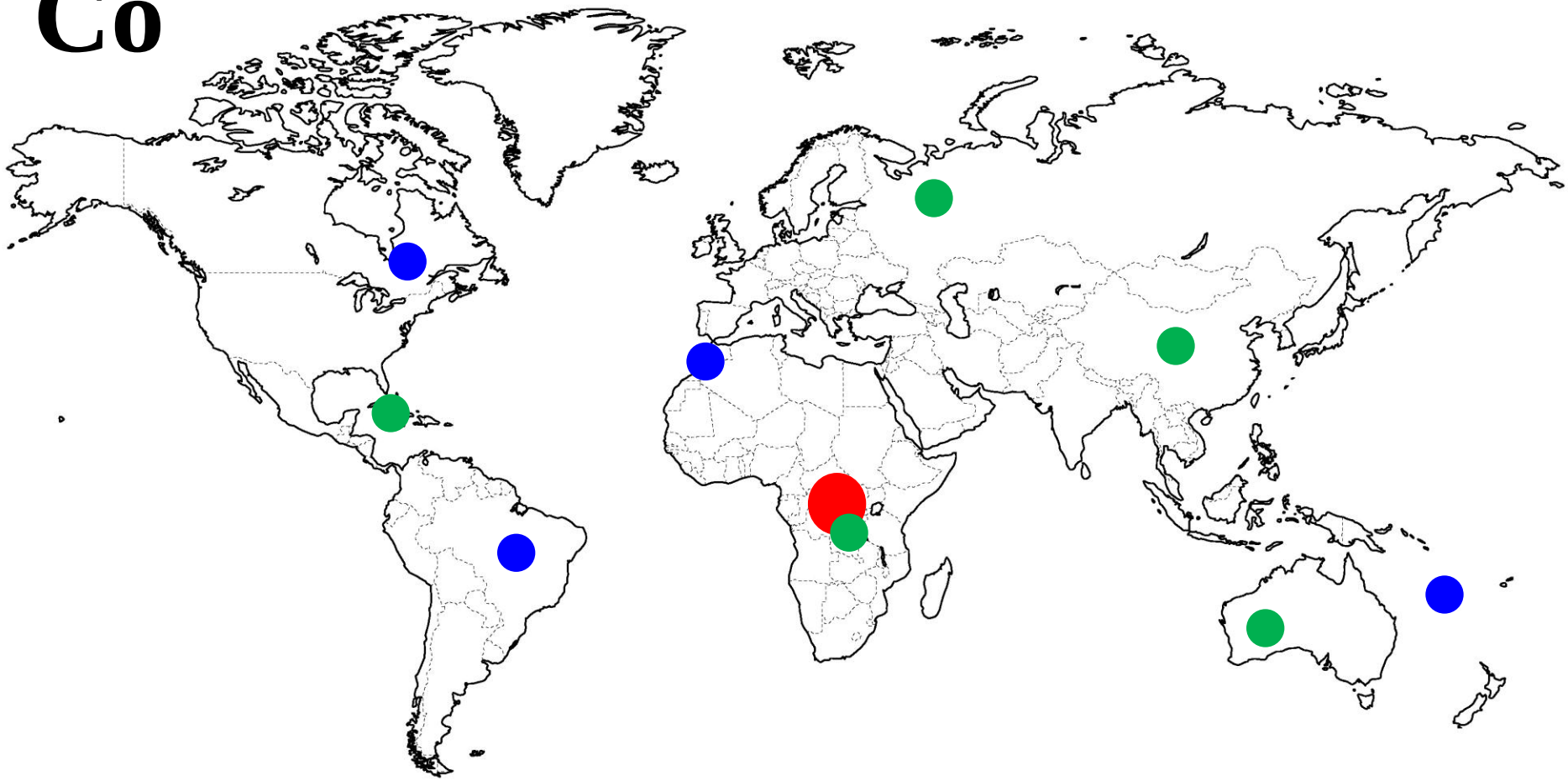
World's leading nickel producer (Russia, 17%)

Countries with 4% or more of global production

Other countries with production or major reserves

(China 5%)

Co



World's leading cobalt producer (Democratic Republic of Congo, 51%)

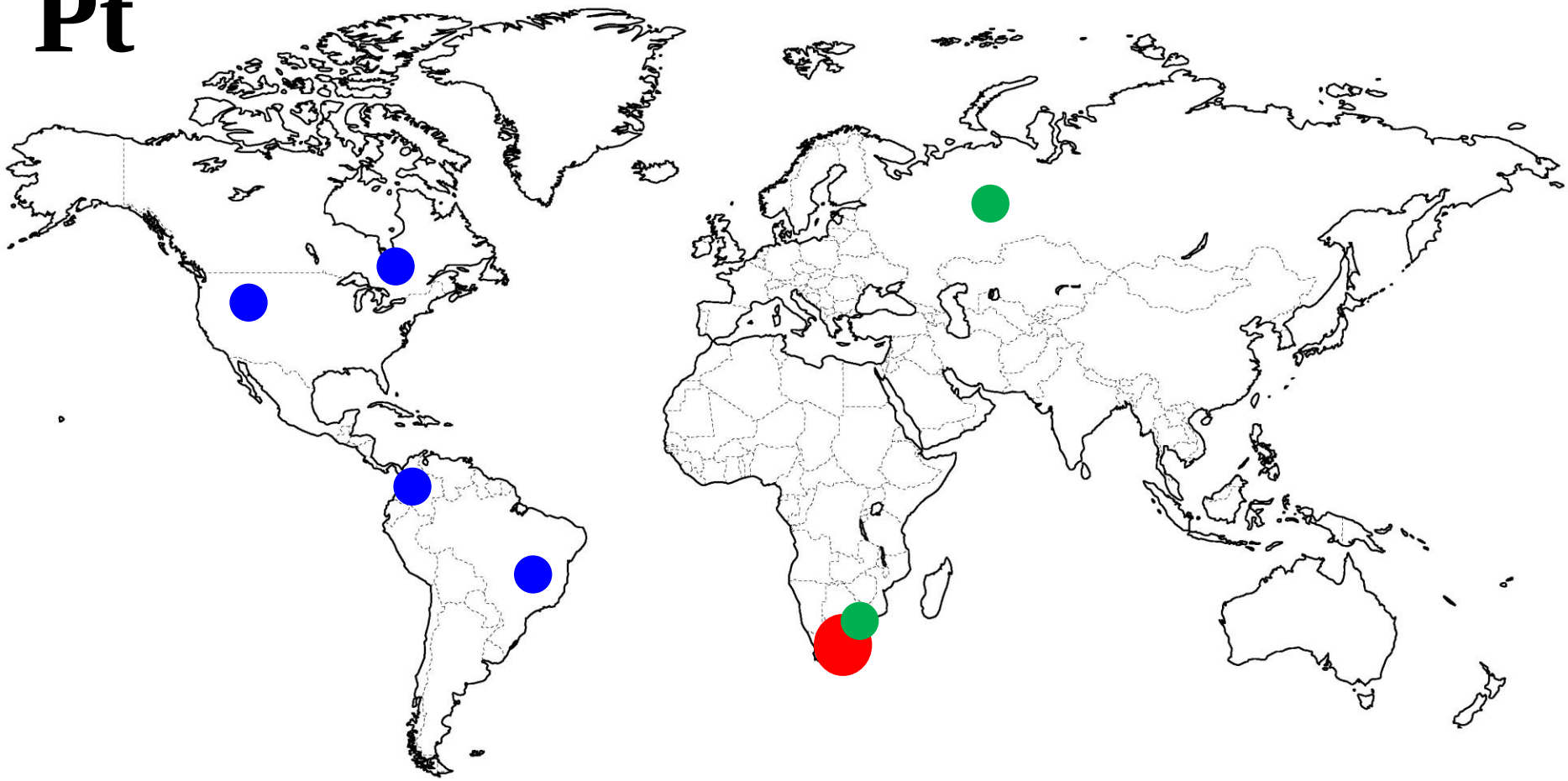
Countries with 4% or more of global production

Other countries with production or major reserves

(China = 7%)

Data source: USGS

Pt



World's leading platinum producer (South Africa, 75%)

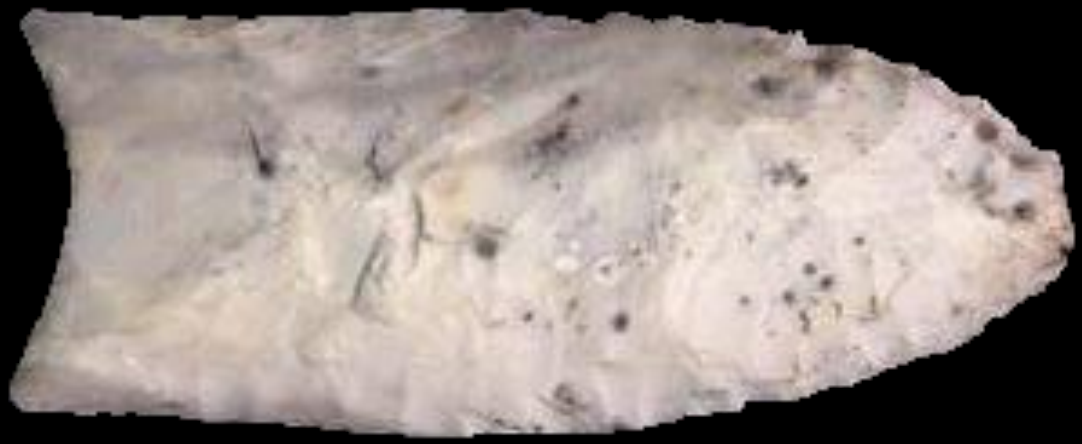
Countries with 4% or more of global production

Other countries with production or major reserves

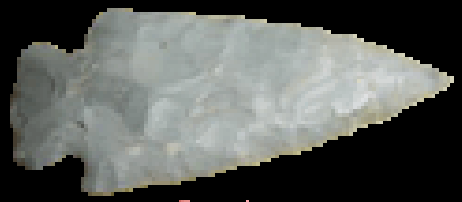
(China ~none)

Data source: USGS

Also watch for competition in the resource-rich current and past continental and island-arc settings that are major sources of copper, molybdenum, tungsten, gold, and silver. This includes the Pacific Rim of Fire, particularly the Cordillera of South and North America, Mongolia, and several other locations.

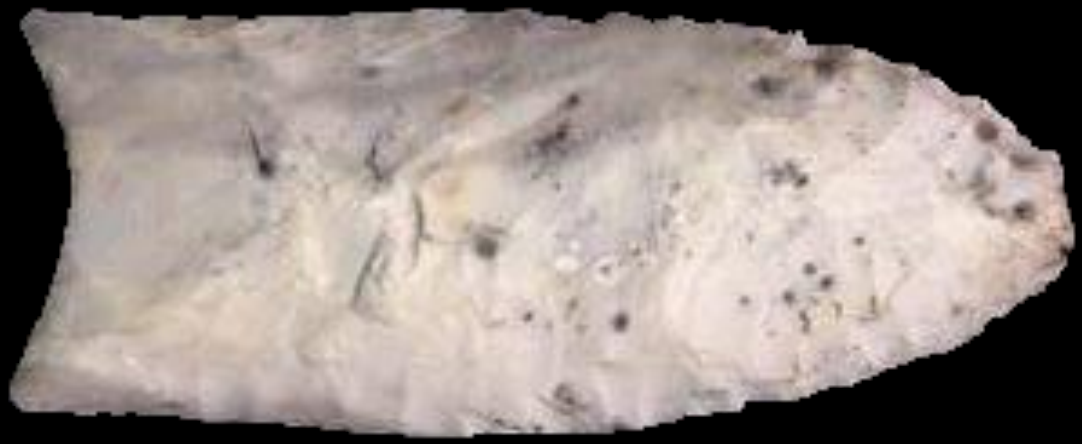


Arrowhead clipart from www.firstpeople.us

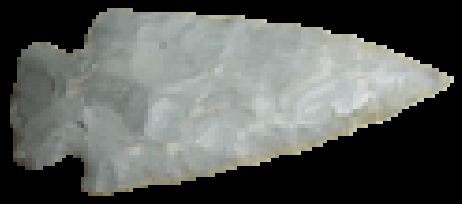


Critical and strategic minerals will change with time.

Avatar



Arrowhead clipart from www.firstpeople.us



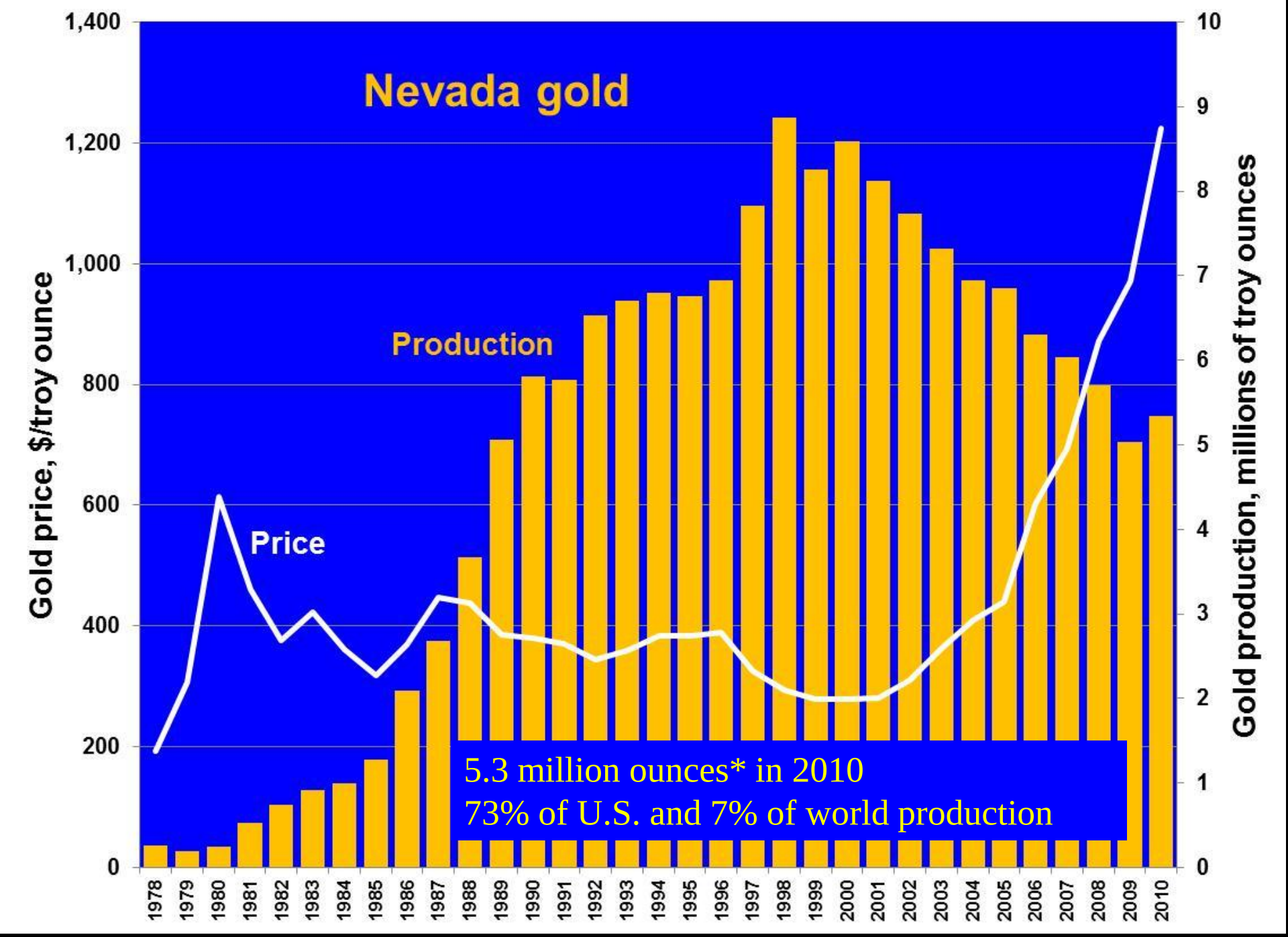
Critical and strategic minerals will change with time.

$CuIn_xGa_{(1-x)}Se_2$ or CIGS, for solar panels?
CdTe , GaAs, and Ge for solar panels?
Nd for magnets for wind and other electrical turbines?
Li and V for different types of batteries?

Why explore in Nevada?

Among many other reasons, Nevada is the US leader in gold, barite, and lithium; a significant historical producer of copper, silver, and zinc; and a key source of industrial minerals for construction (gypsum, cement resources, aggregate).

Lithium-brine evaporation pond, 2008,
Clayton Valley (Silver Peak), Nevada


Nevada gold
Production
Price
5.3 million ounces* in 2010
73% of U.S. and 7% of world production
Gold price, $/troy ounce
Gold production, millions of troy ounces
1,400
1,200
1,000
800
600
400
200
0
10
9
8
7
6
5
4
3
2
1
0
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
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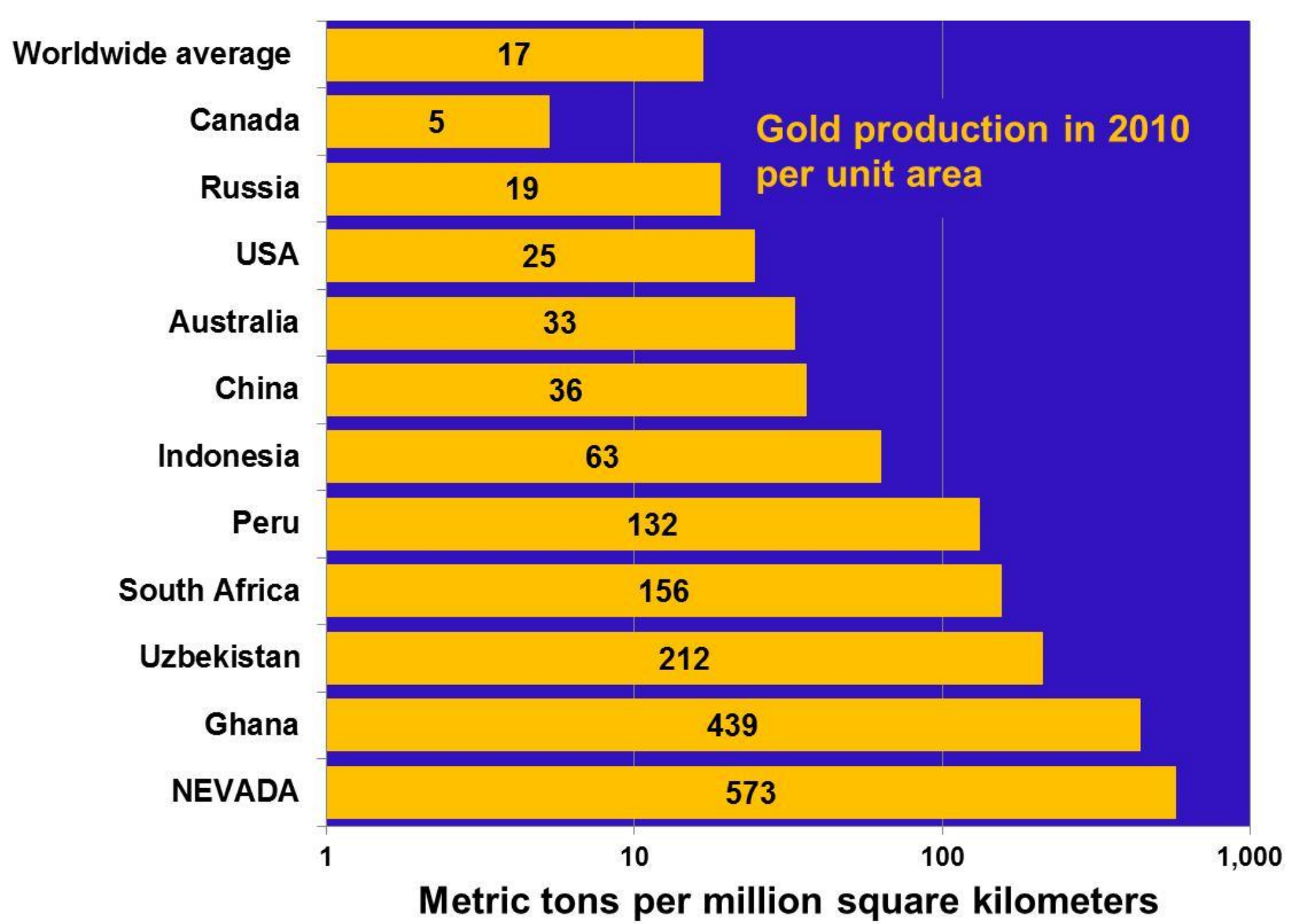
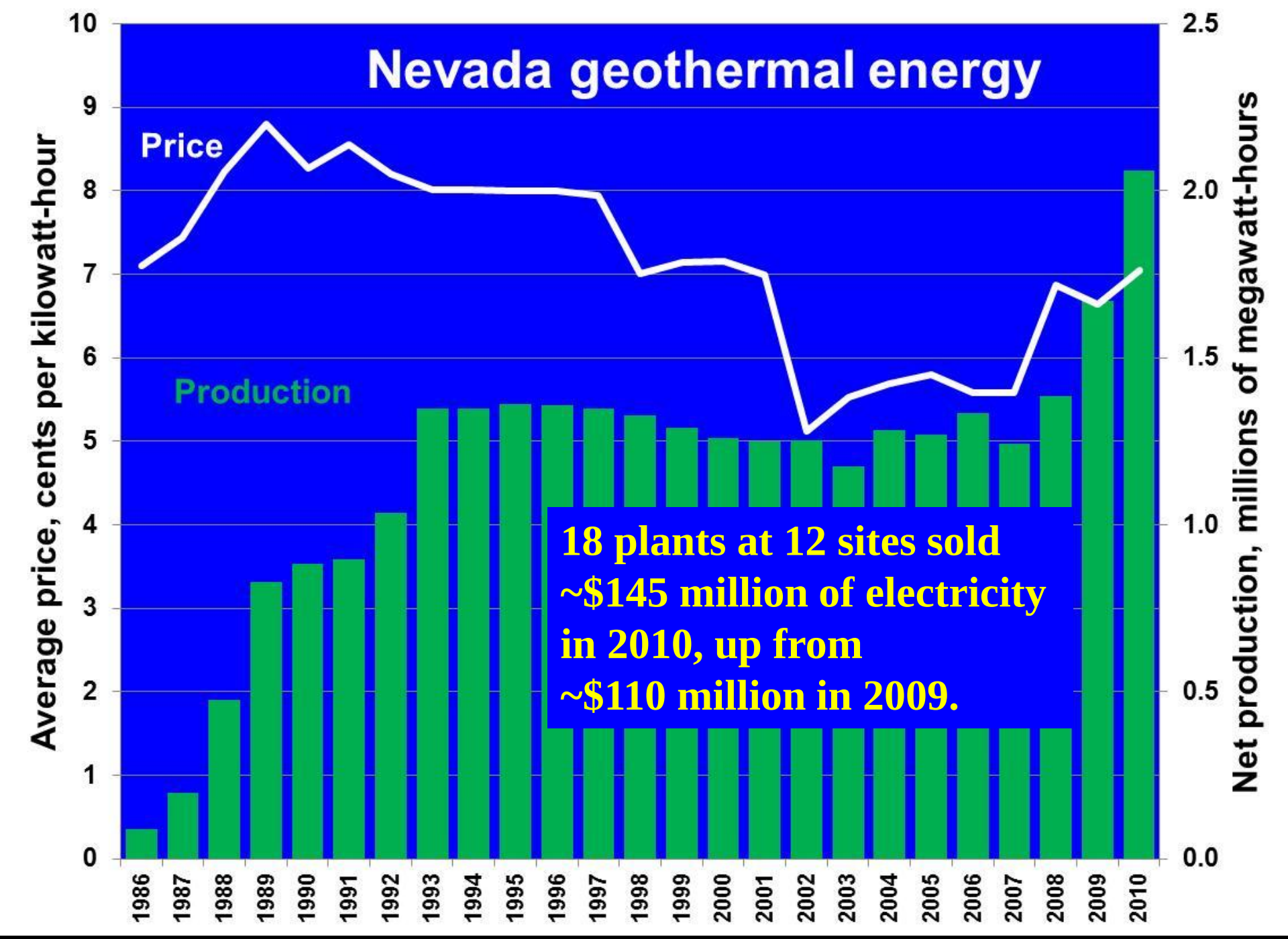
2004
2005
2006
2007
2008
2009
2010



Nevada is certainly one of the best places , if not the best, to explore for and mine gold.


Nevada geothermal energy
Price
Production
18 plants at 12 sites sold
~$145 million of electricity
in 2010, up from
~$110 million in 2009.
Average price, cents per kilowatt-hour
Net production, millions of megawatt-hours
0
1
2
3
4
5
6
7
8
9
10
0.0
0.5
1.0
1.5
2.0
2.5
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010

Nevada geothermal power

Megawatts

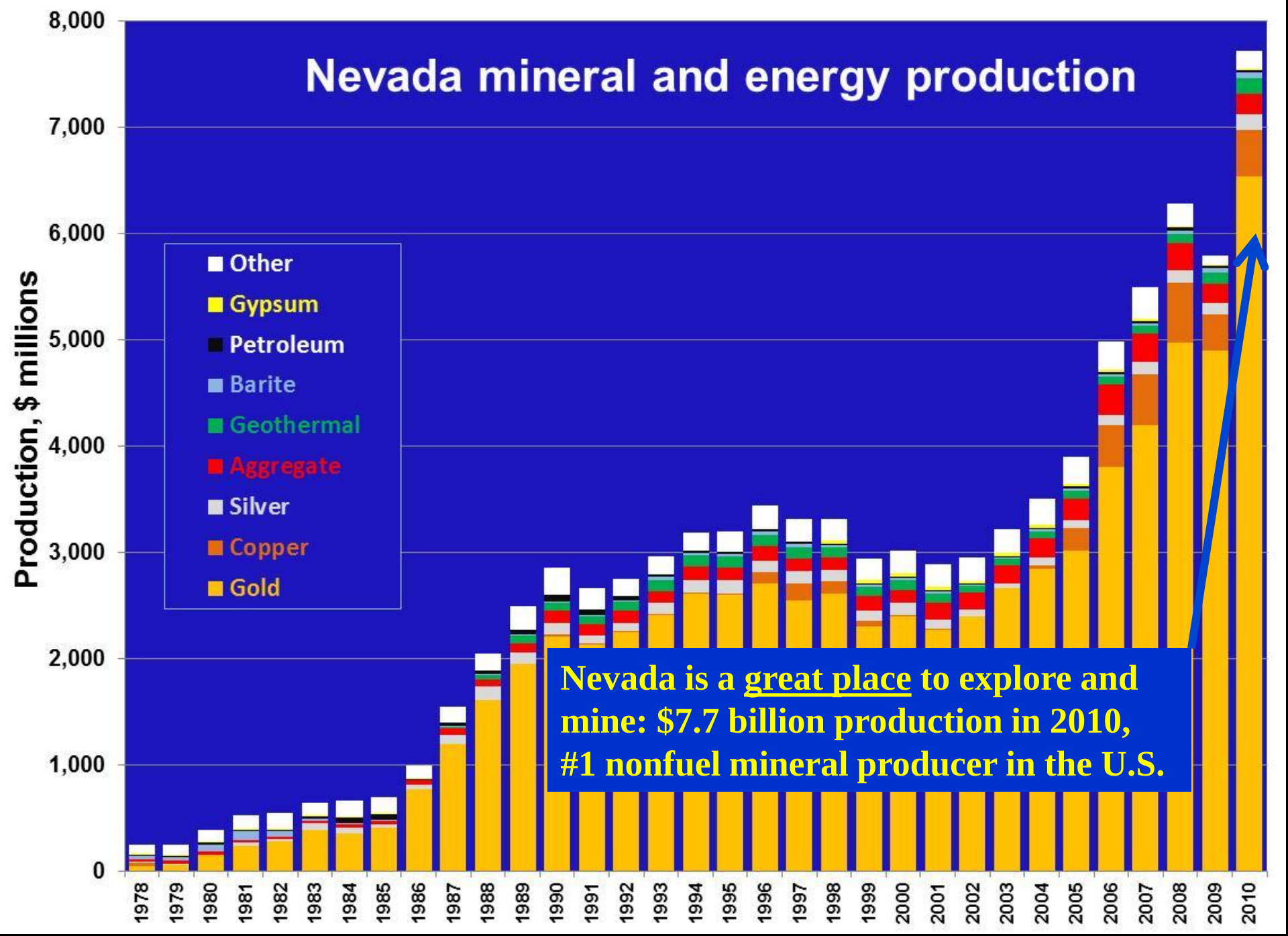
500
450
400
350
300
250
200
150
100
50
0

Nameplate capacity

Average net output

Net output lags behind capacity. Current projects should add 2,100 to 2,400 Mw of capacity within 10 years.

1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010


Nevada mineral and energy production
Production, $ millions
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Other
Gypsum
Petroleum
Barite
Geothermal
Aggregate
Silver
Copper
Gold
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Nevada is a great place to explore and mine: $7.7 billion production in 2010, #1 nonfuel mineral producer in the U.S.

"Update on the Future of Mineral Resources"

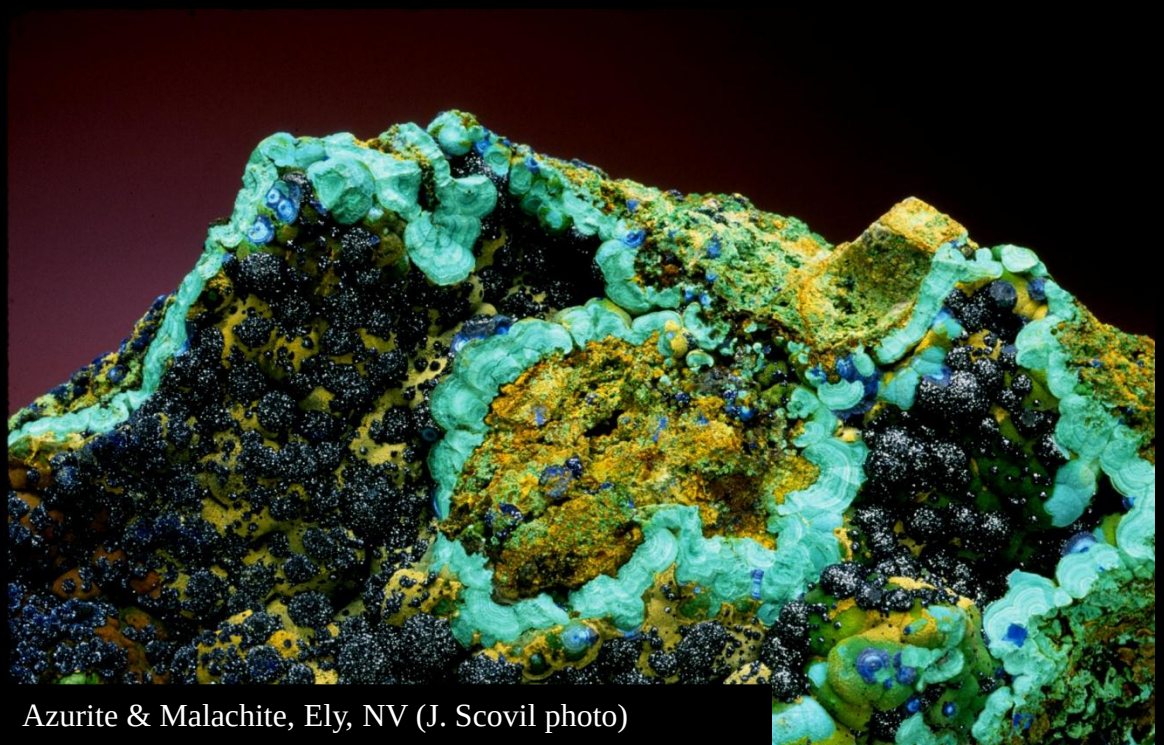
Demand is high.

China is #1.

The trends will help guide exploration.

Round Mountain, NV (2007)

Thank you!



Azurite & Malachite, Ely, NV (J. Scovil photo)

Round Mountain, NV (2007)