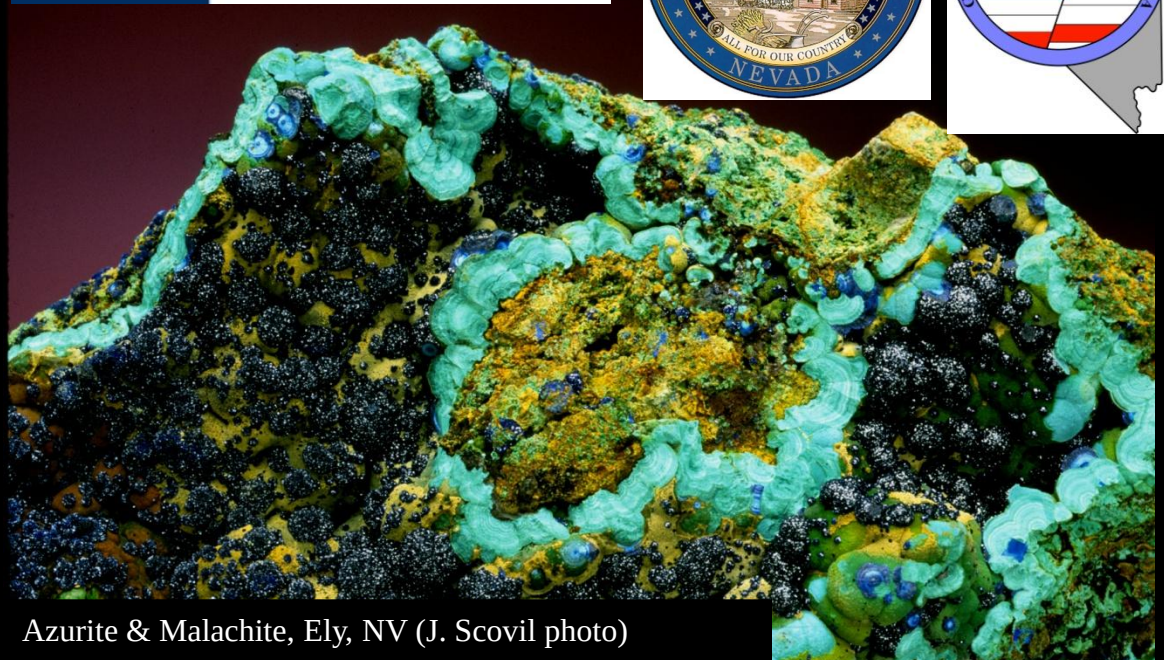
The Bright Future of Global Mineral Resources

Jon Price

Nevada Bureau of Mines and Geology



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

Round Mountain, NV (2007)

The Bright Future of Global Mineral Resources

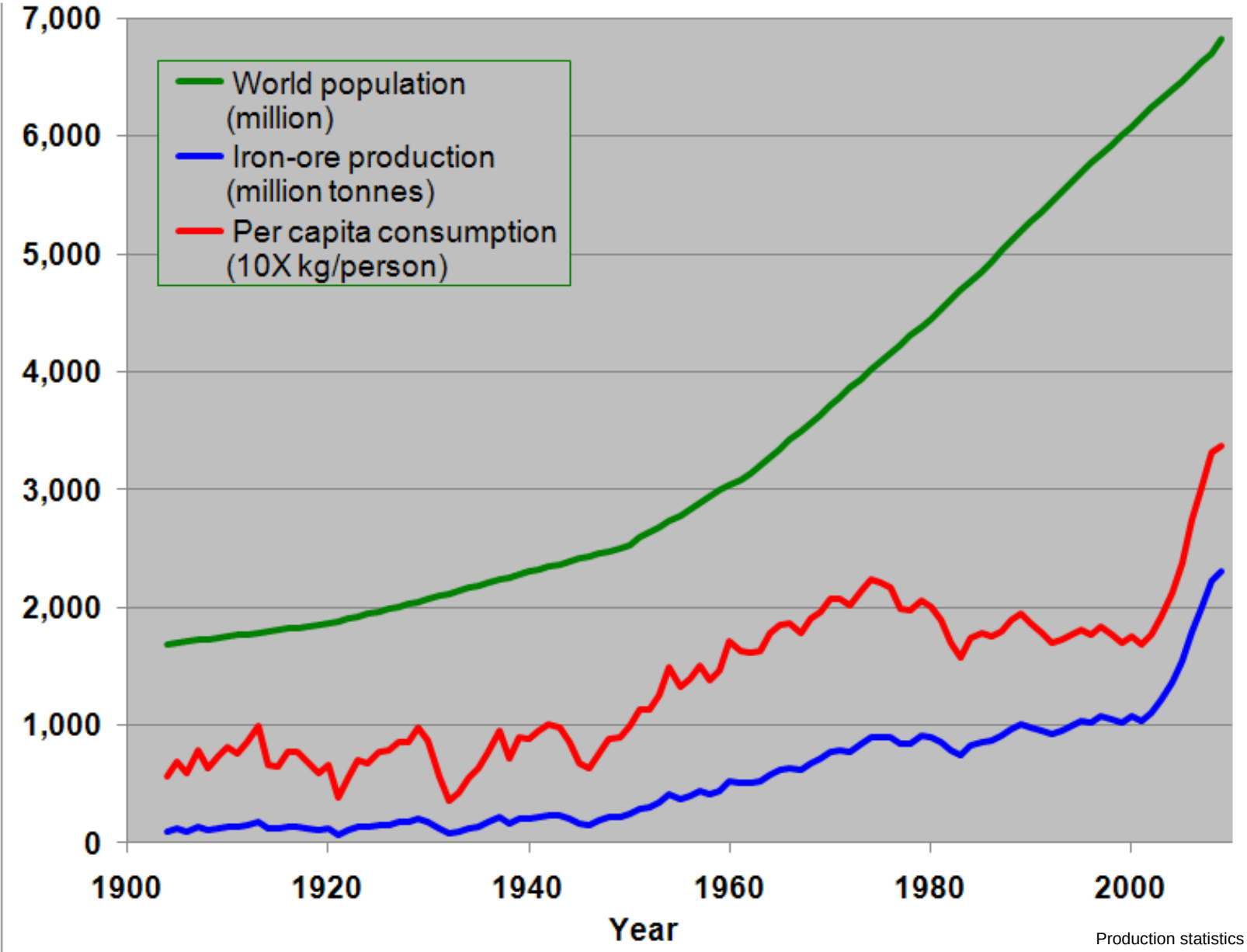
Demand is high.

China is #1.

The trends will help guide exploration.

Round Mountain, NV (2007)

Demand is high for nearly every mineral resource.



Iron

Production statistics mostly from USGS/USBM

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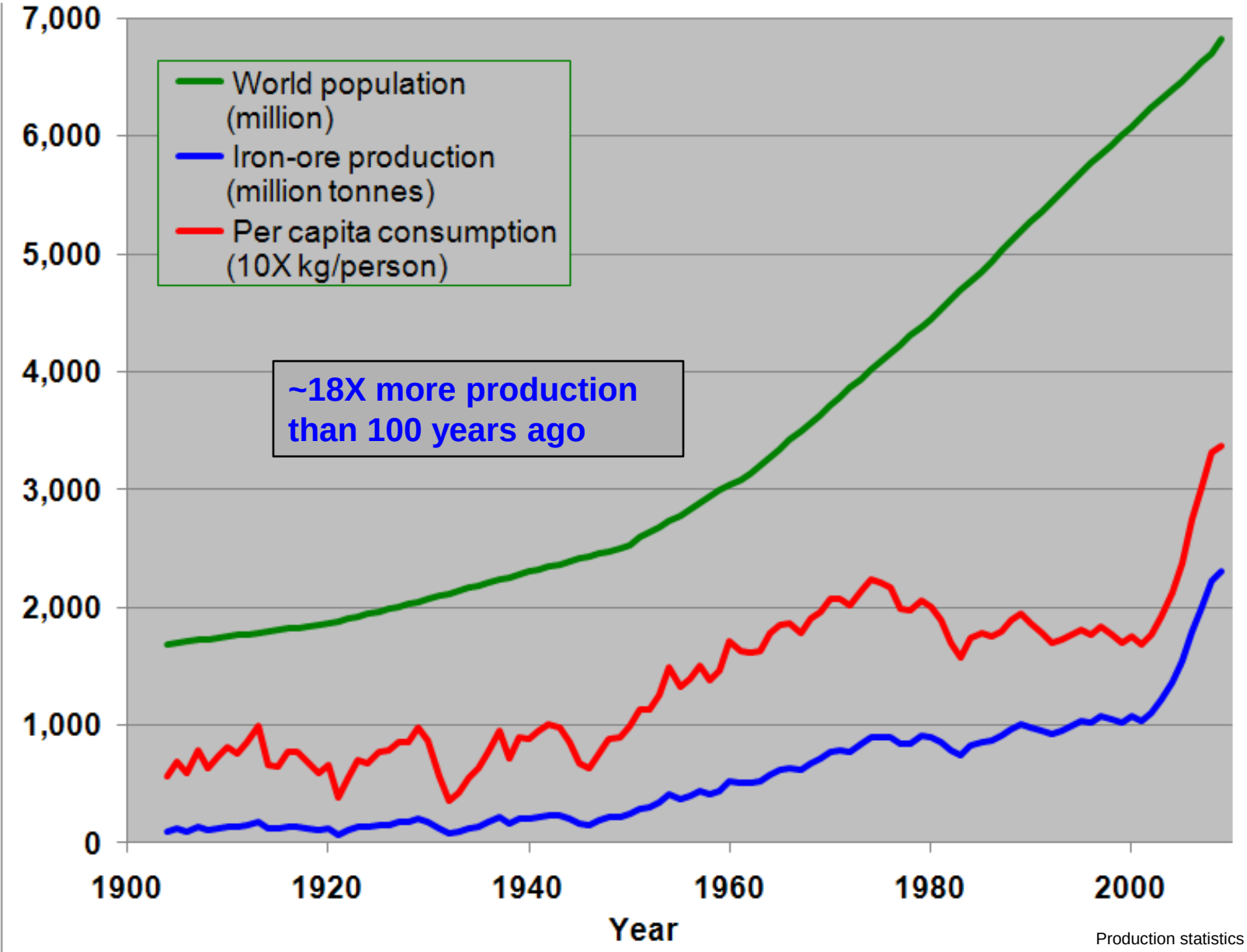

Iron

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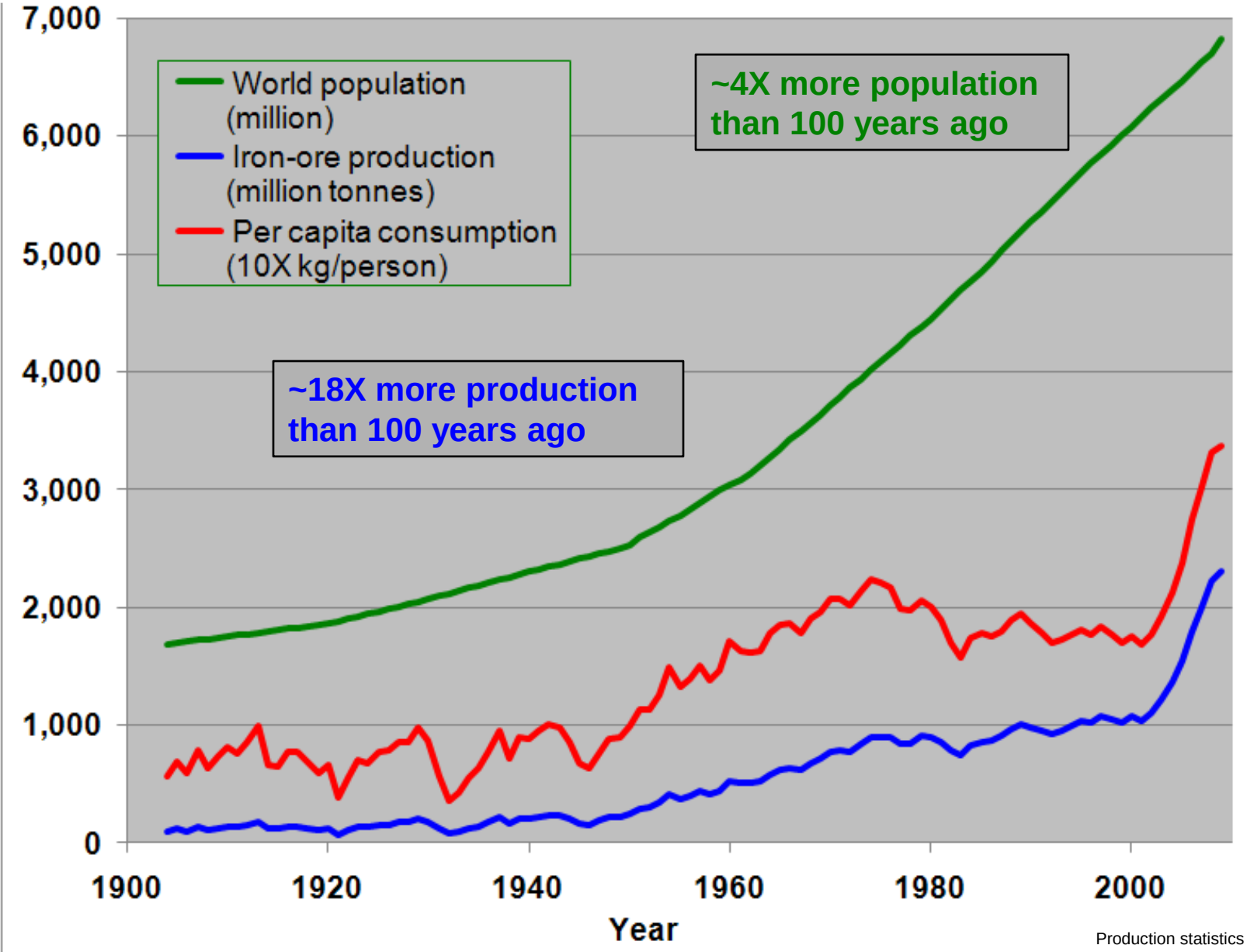
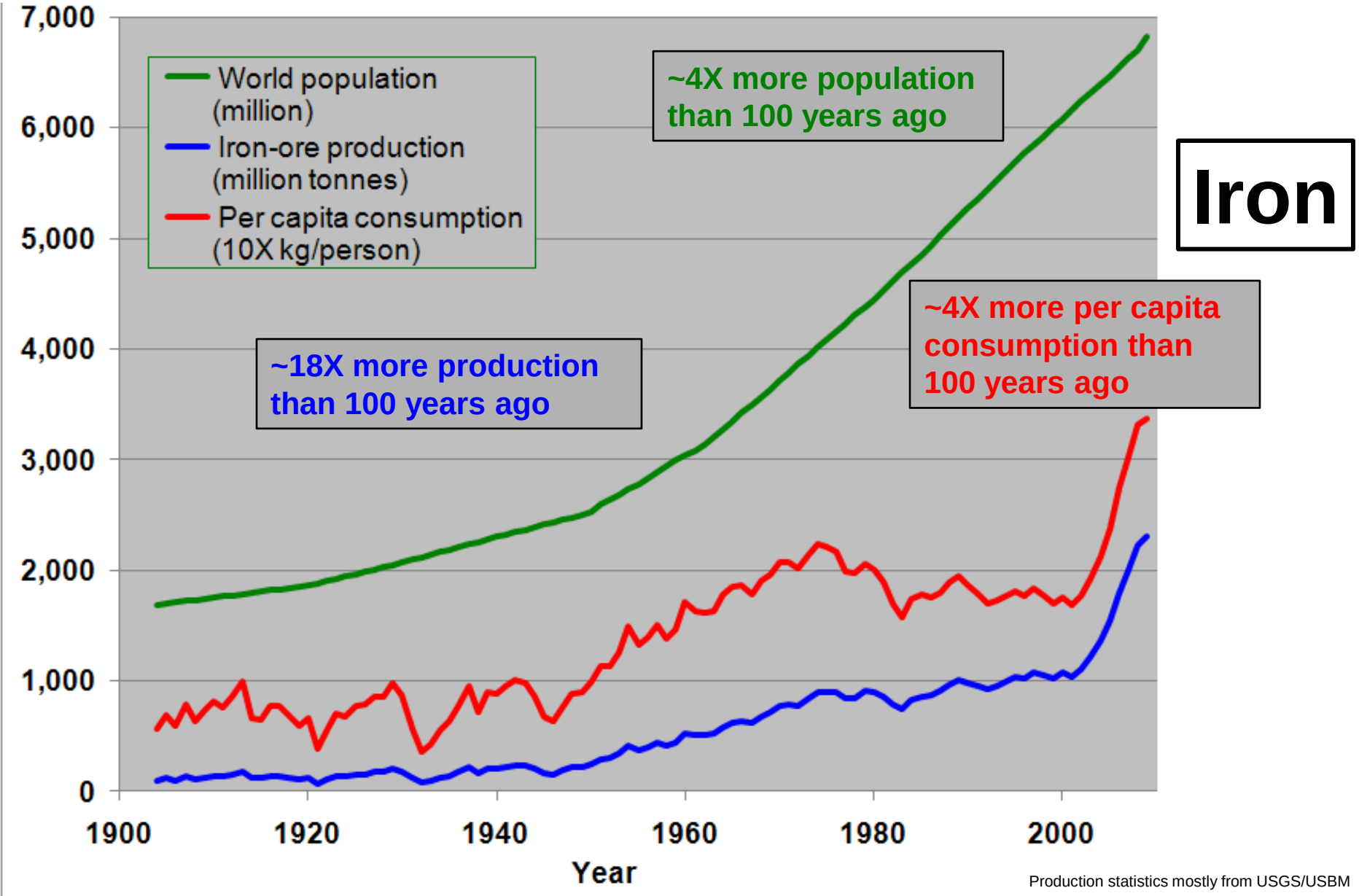
Demand is high partly because population is increasing.



Iron

Production statistics mostly from USGS/USBM

Demand is also high partly because standard of living is increasing.



Annual global iron-ore production reached an all-time high of 2.3 billion metric tons in 2009. That equals approximately 0.4 km^3 of ore, or at least 1 km^3 of ore plus overburden and waste rock – one huge mine, per year.

Demand is high for nearly every mineral resource.

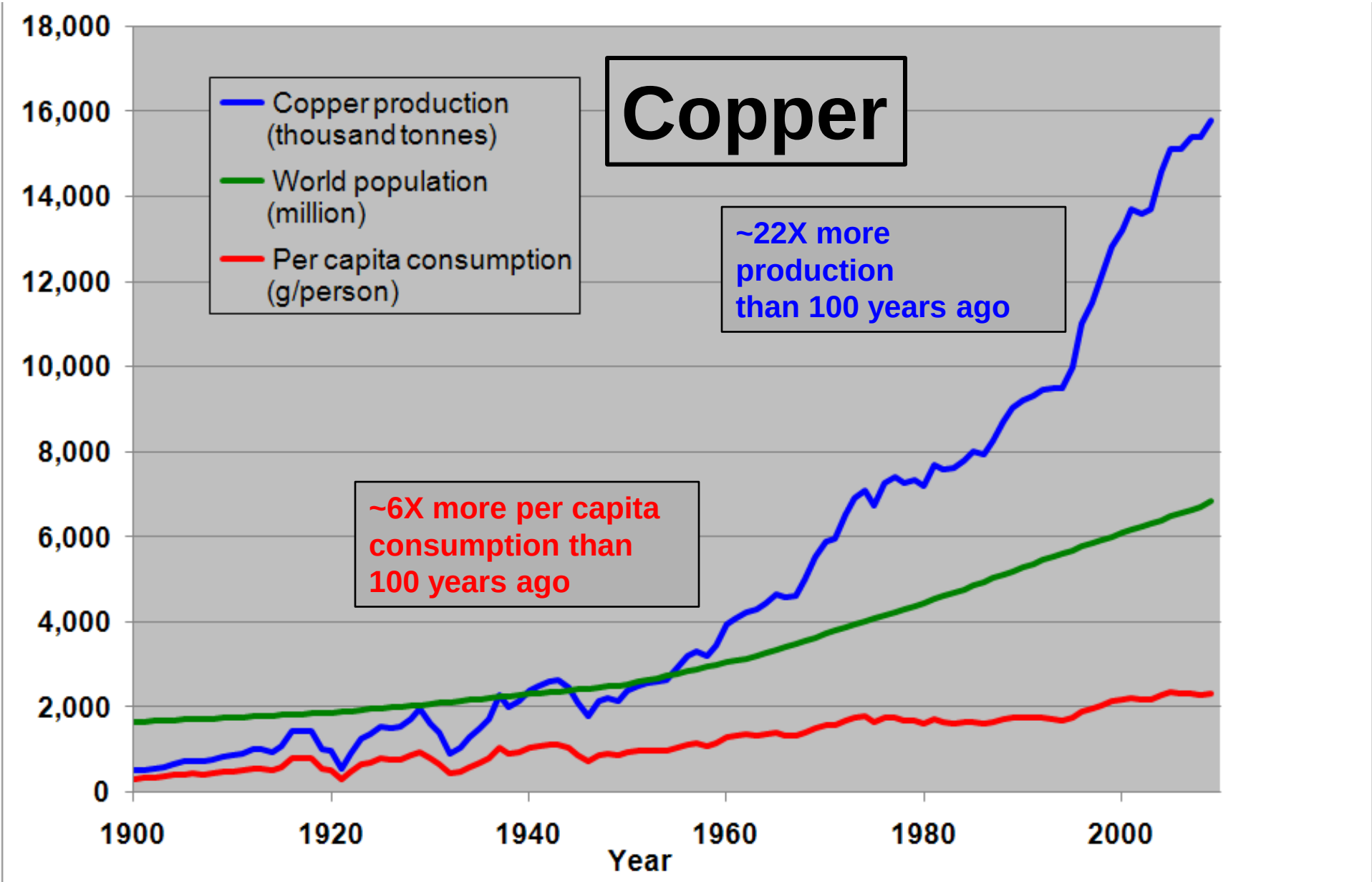
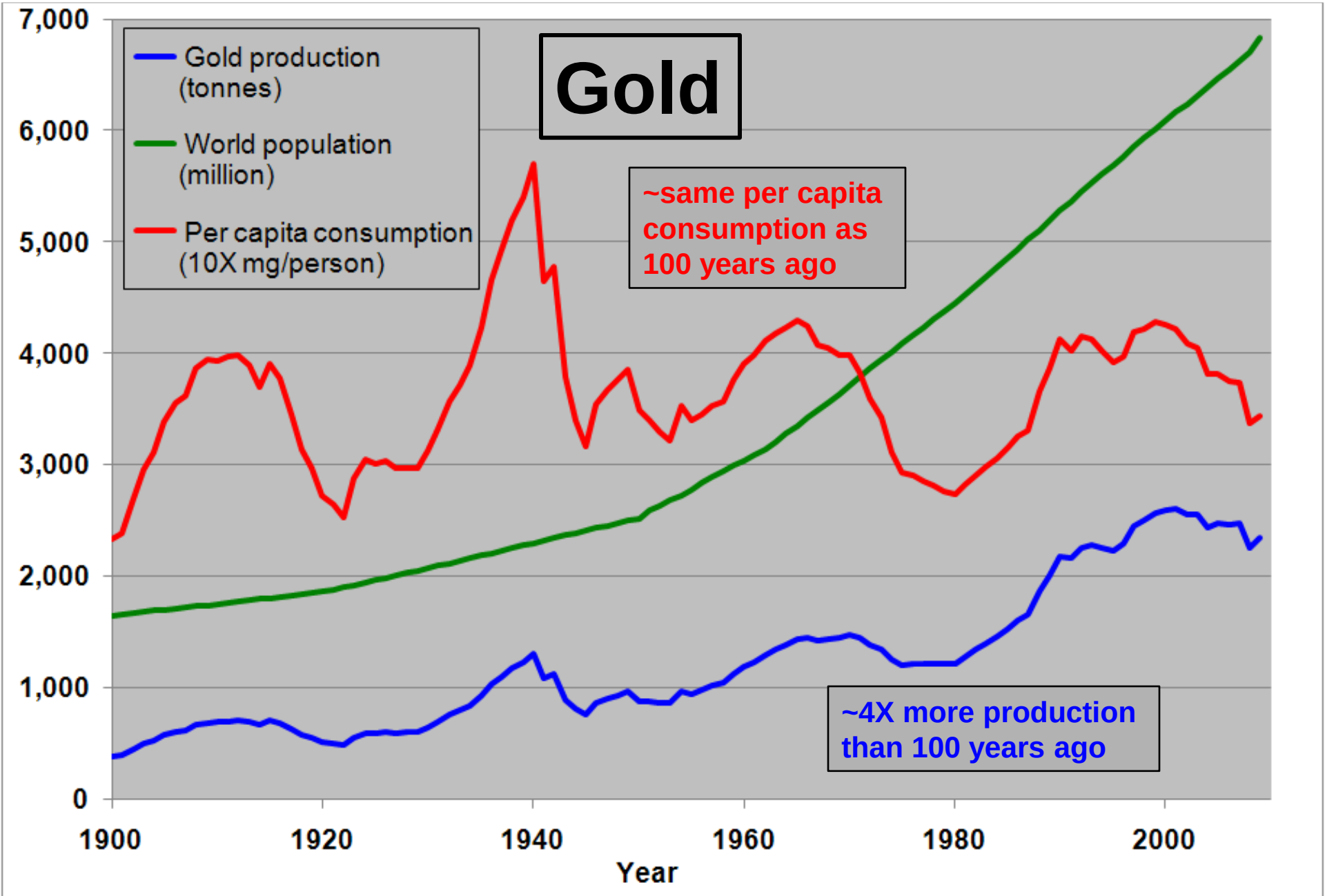


Photo copyrighted by Michael Collier, from the AGI website, Rio Tinto/Kennecott Utah Copper mine; the remaining resource as of 16 May 2008 = 3.06 million metric tons of Cu

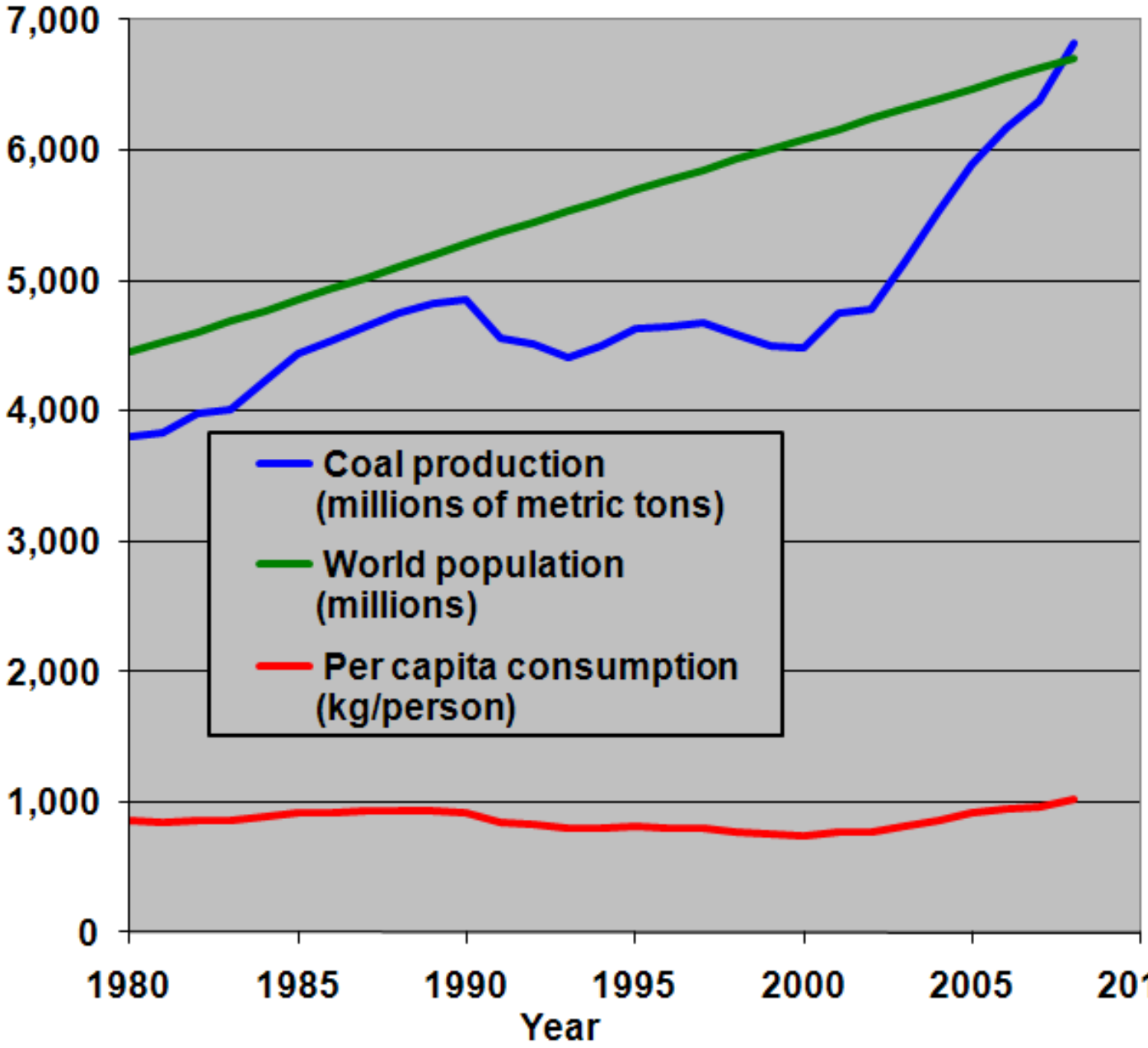
Global copper production in 2009 (15.8 million metric tons) nearly equaled over 100 years of production from the Bingham Canyon mine (16.4 million metric tons).

Demand is high for nearly every mineral resource.



Global gold production in 2009 (2,350 metric tons) approximately equaled the cumulative production from the Carlin trend (2,230 tons), one of world's top regions.

Demand is high for nearly every mineral resource.



~80% more production than 30 years ago

~51% more population than 30 years ago

Coal

~same per capita consumption as 30 years ago (higher by ~19%)

Coal seams near Healy, Alaska

Annual global coal production (~6.8 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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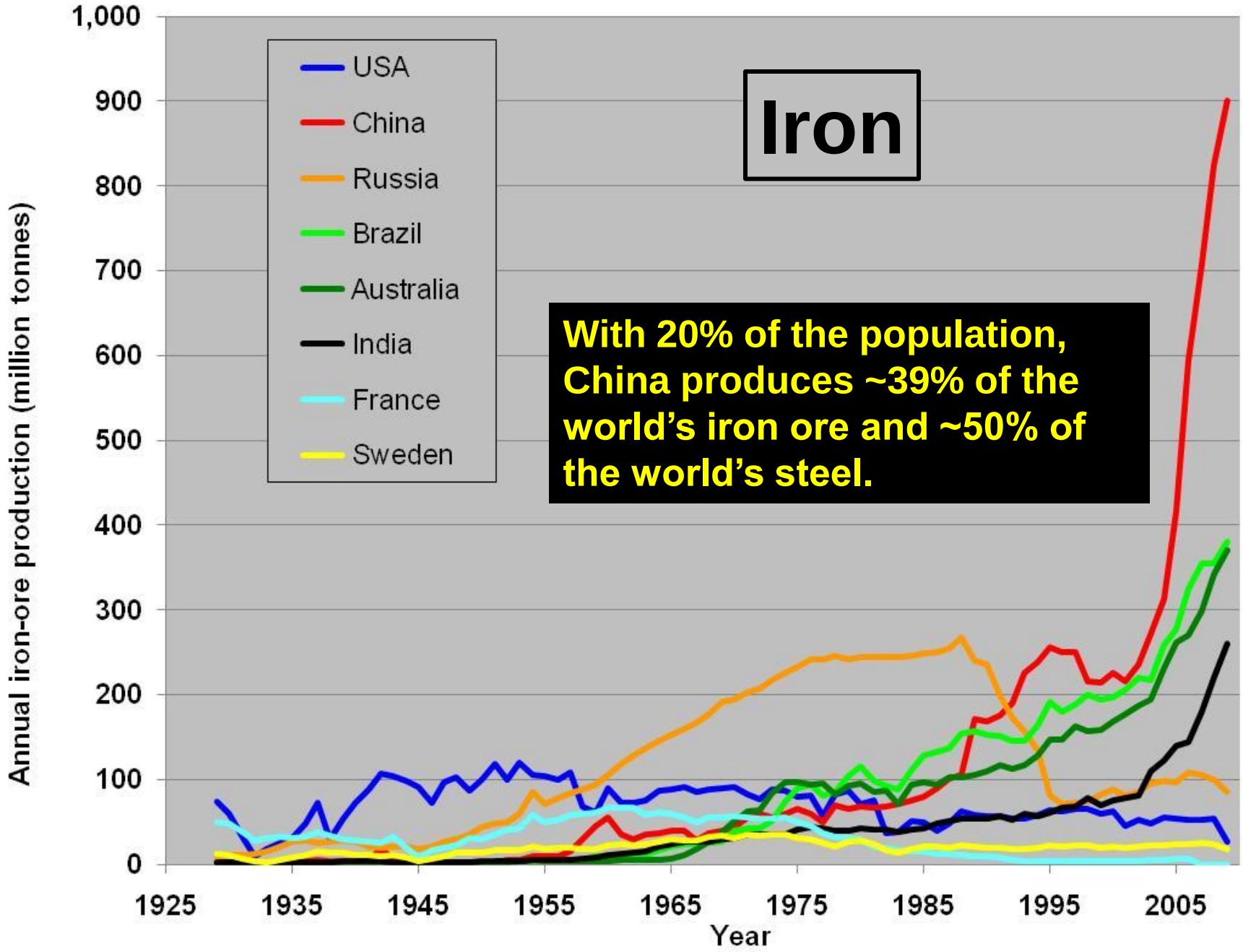
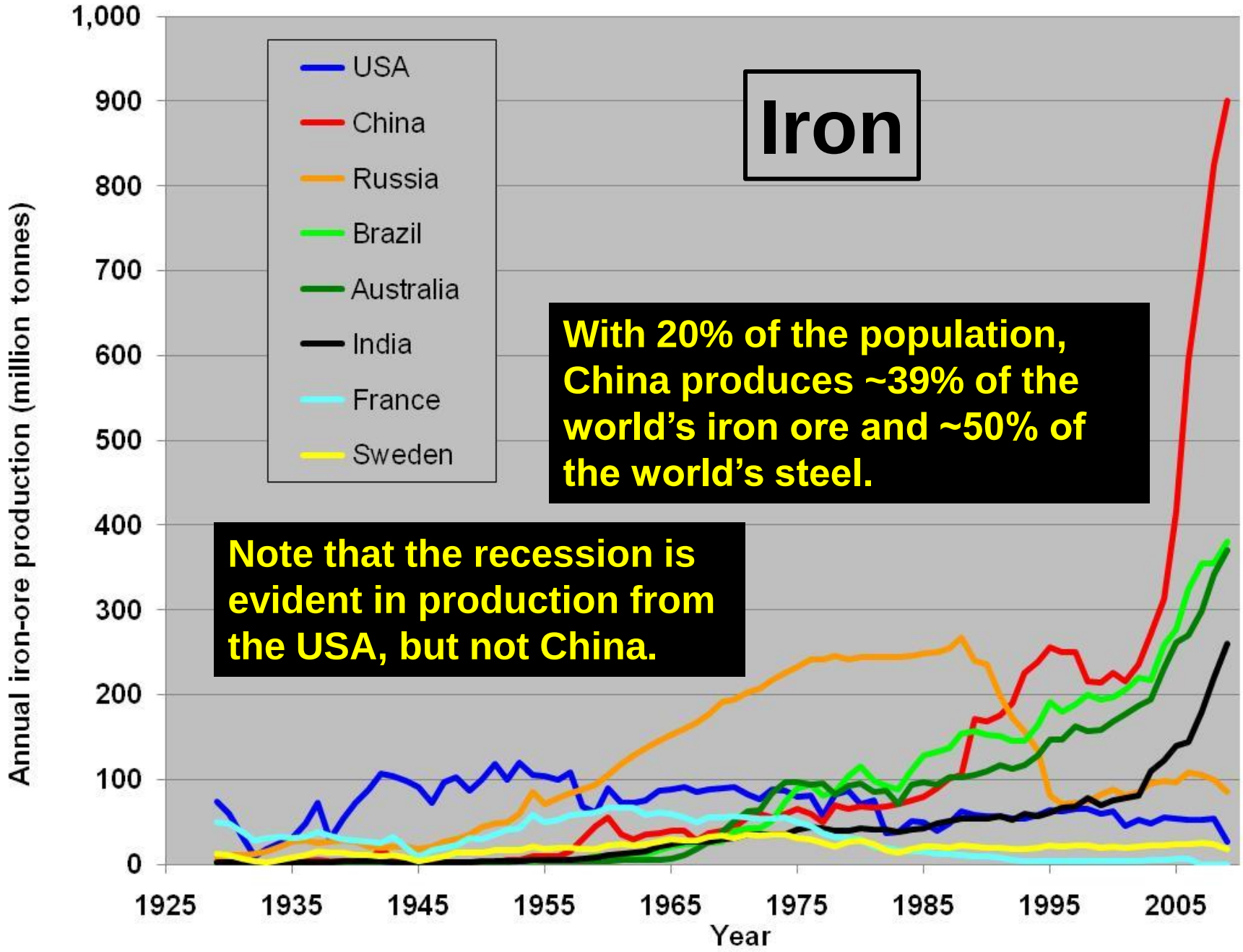
Round Mountain, NV (2007)


Iron
USA
China
Russia
Brazil
Australia
India
France
Sweden
With 20% of the population, China produces ~39% of the world's iron ore and ~50% of the world's steel.
Annual iron-ore production (million tonnes)
1,000
900
800
700
600
500
400
300
200
100
0
1925
1935
1945
1955
1965
1975
1985
1995
2005
Year


Iron
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With 20% of the population, China produces ~39% of the world's iron ore and ~50% of the world's steel.
Note that the recession is evident in production from the USA, but not China.
Annual iron-ore production (million tonnes)
1,000
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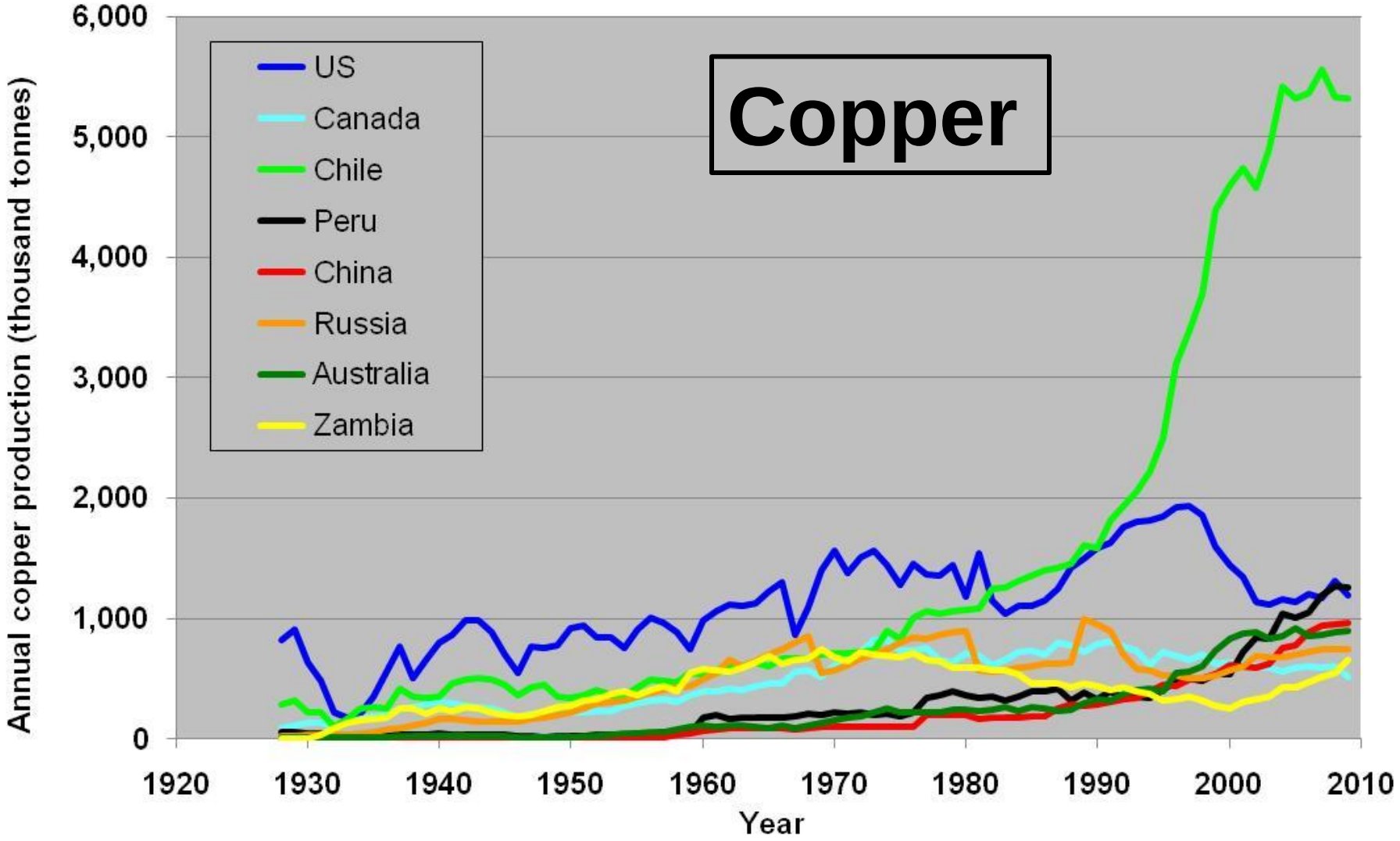
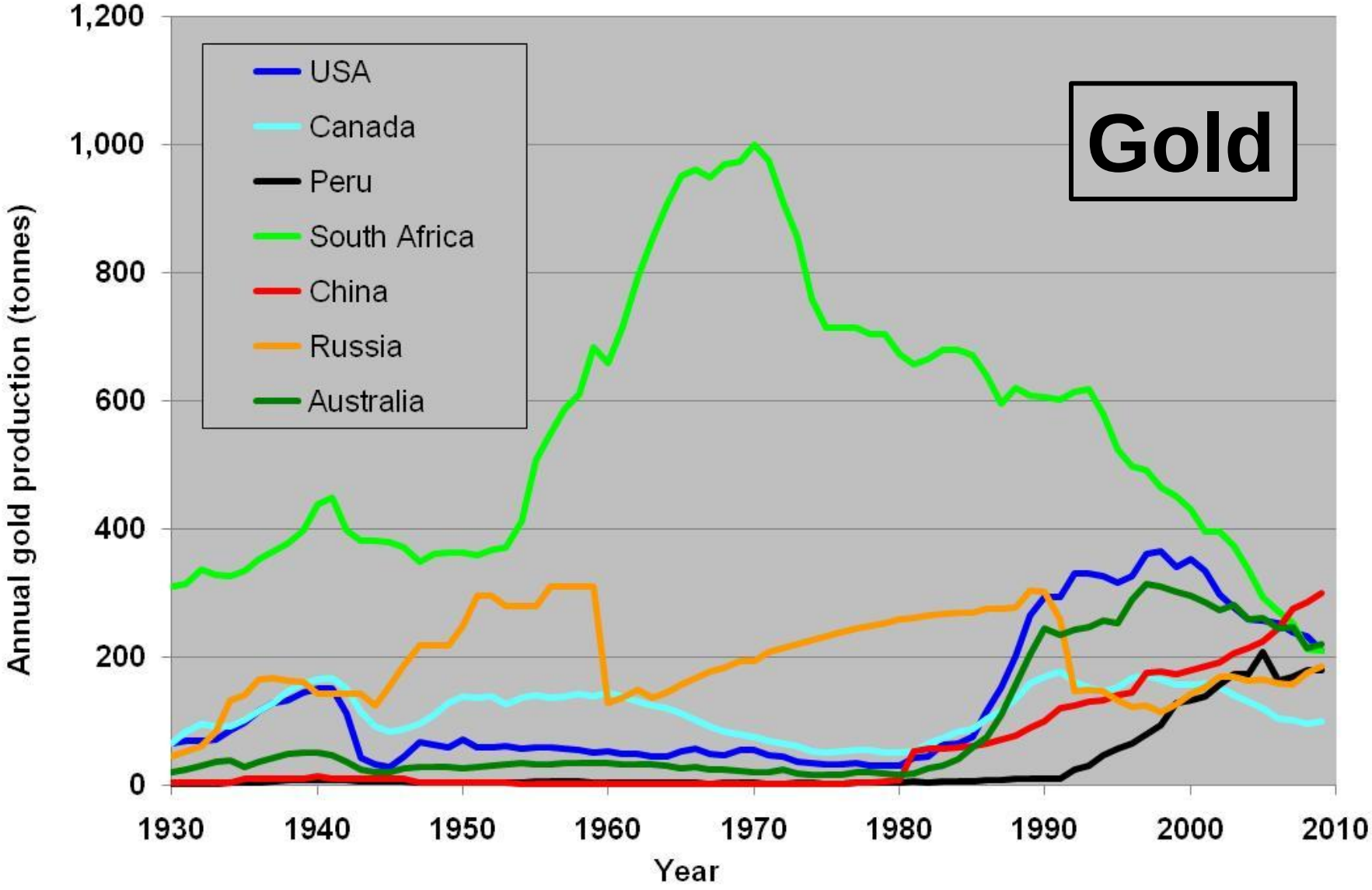
Year

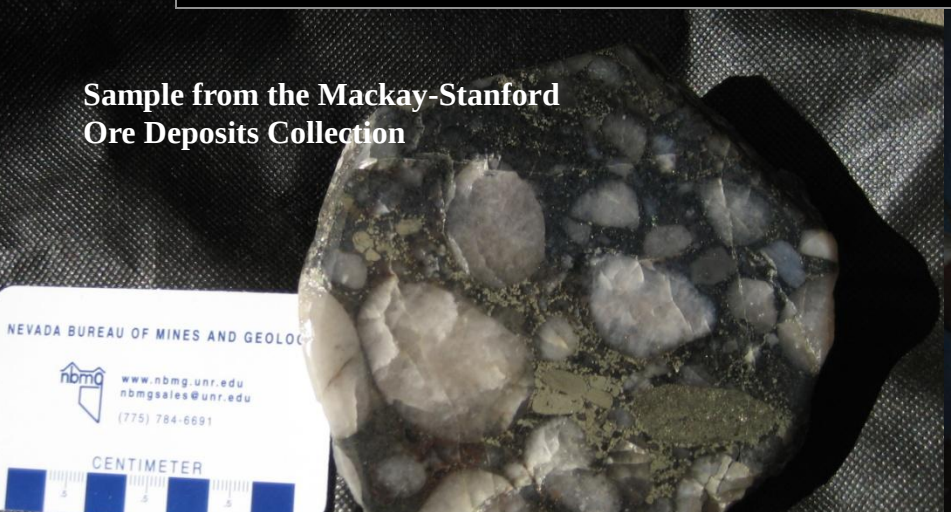
China produces only ~6% of the world's copper but is aggressively seeking resources elsewhere.



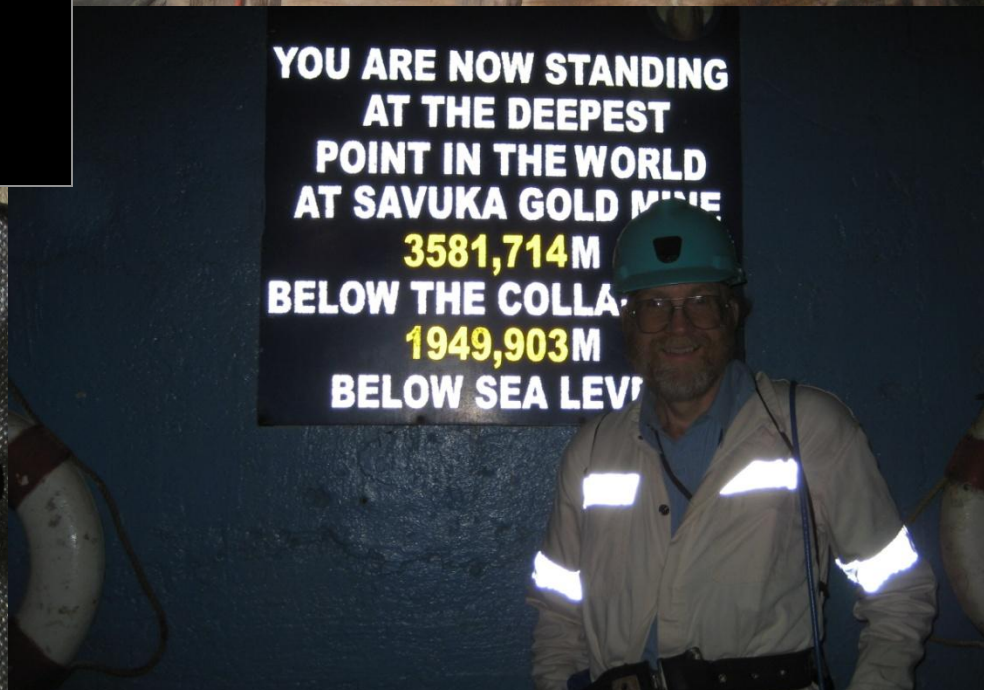
China has been the #1 gold producing country since 2007.



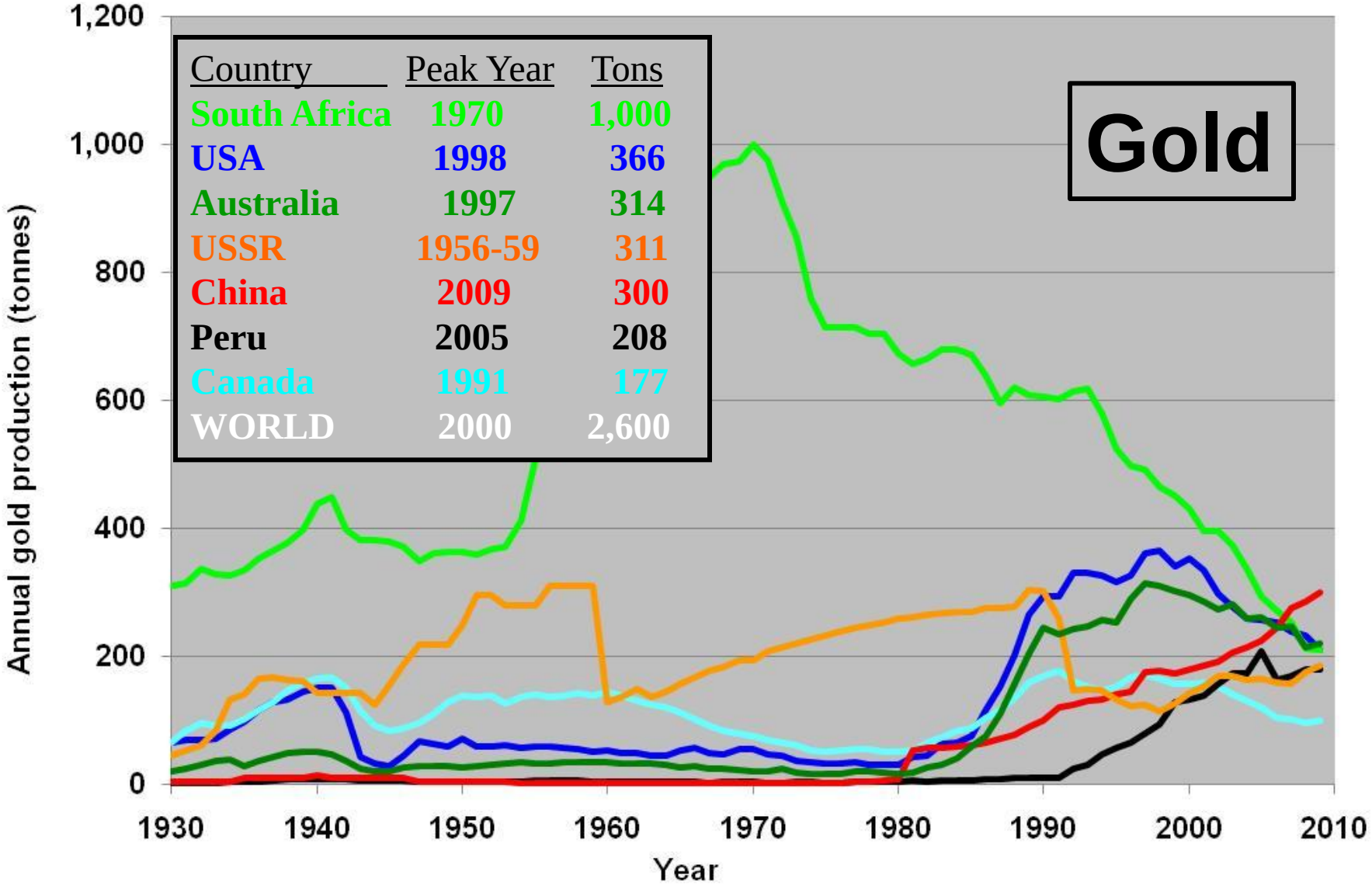
The South African mines on the Witwatersrand are getting deeper and more costly than before.



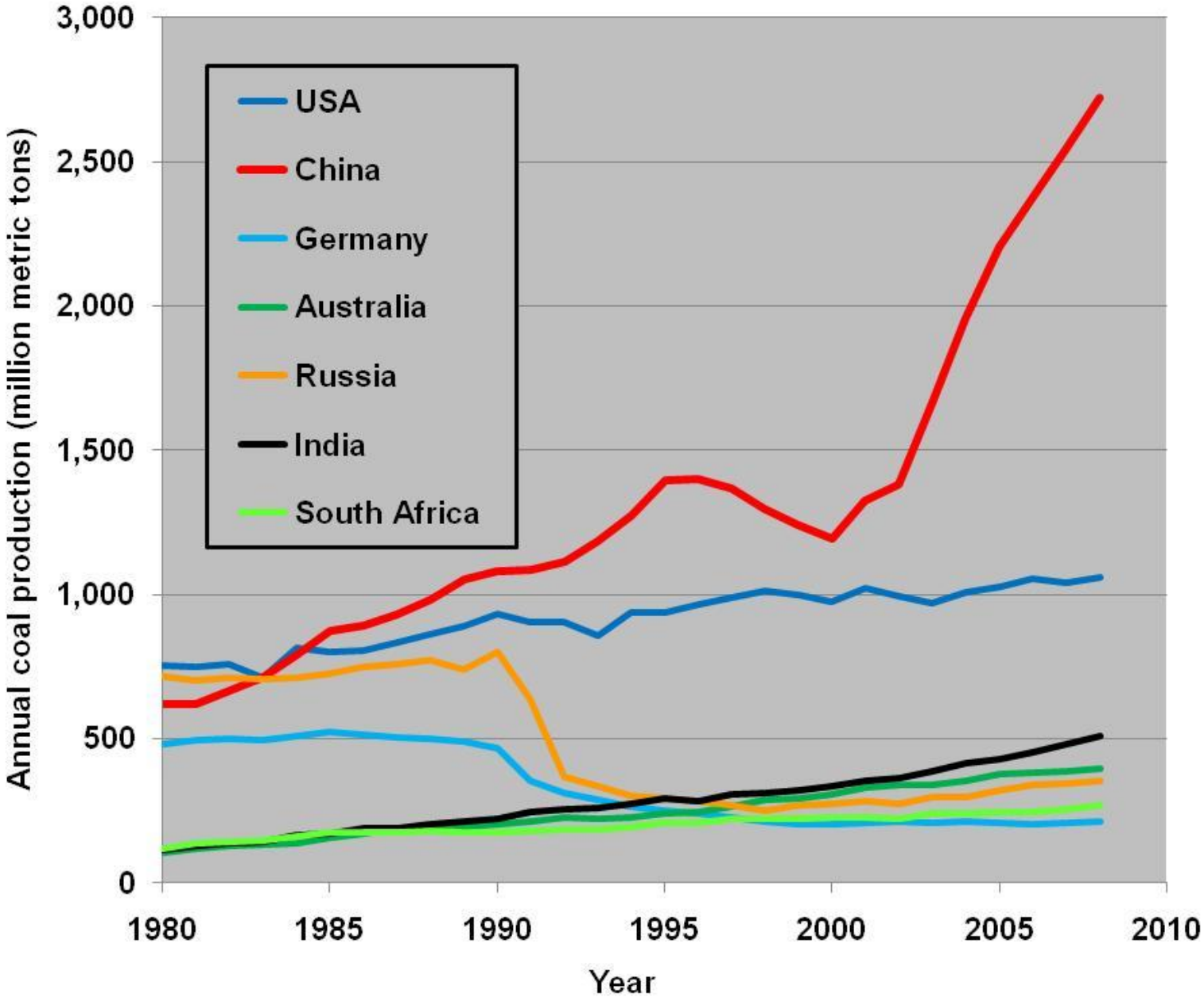
Sample from the Mackay-Stanford Ore Deposits Collection



South Africa's production peaked in 1970, but China is on the rise.



China produces ~40% of the world's coal.



Coal

The amount of CO_2 released from burning of coal in 2008 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

Leading Producer	Commodities with >100,000,000 tons of annual global production
China	Cement (50%) Coal (40%) Iron ore (39%) Phosphate rock (35%) Gypsum (28%)
Australia	Aluminum ore (31%)

Leading Producer	Commodities with >10,000,000 tons of annual global production
China	Zinc (25%)
South Africa	Chromium (42%)
Chile	Copper (34%)
Canada	Potash (26%)

Leading Producer	Commodities with >1,000,000 tons of annual global production
China	Barite (55%)
	Lead (43%)
	Manganese (25%)
US	Diatomite (36%)
Russia	Nickel (19%)
Australia	Titanium (27%)

Leading Producer	Commodities with >100,000 tons of annual global production
China	Rare earths (97%) Tin (45%) Molybdenum (39%)

Leading Producer	Commodities with >10,000 tons of annual global production
China	Tungsten (81%)
	Arsenic (47%)
	Vanadium (37%)
	Cadmium (23%)
US	Helium (63%)
Canada	Uranium (21%)
Congo	Cobalt (40%)
Brazil	Niobium (92%)
Chile	Lithium (41%)
Peru	Silver (18%)

Leading Producer	Commodities with >1,000 tons of annual global production
China	Gold (13%)
	Mercury (63%)
Japan	Selenium (50%) – from smelting

Leading Producer	Commodities with >100 tons of annual global production
China	Indium (50%)
	Germanium
USA	Beryllium (85%)
South Africa	Platinum (79%)
Russia	Palladium (41%)
Chile	Tellurium – byproduct of copper

In production of 41 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	21	28
USA	4	14
Chile	3	5
Australia	2	11
Russia	2	8
Canada	2	6
South Africa	2	6
Congo	2	2

2009 production statistics from USGS

So what?

And who cares?

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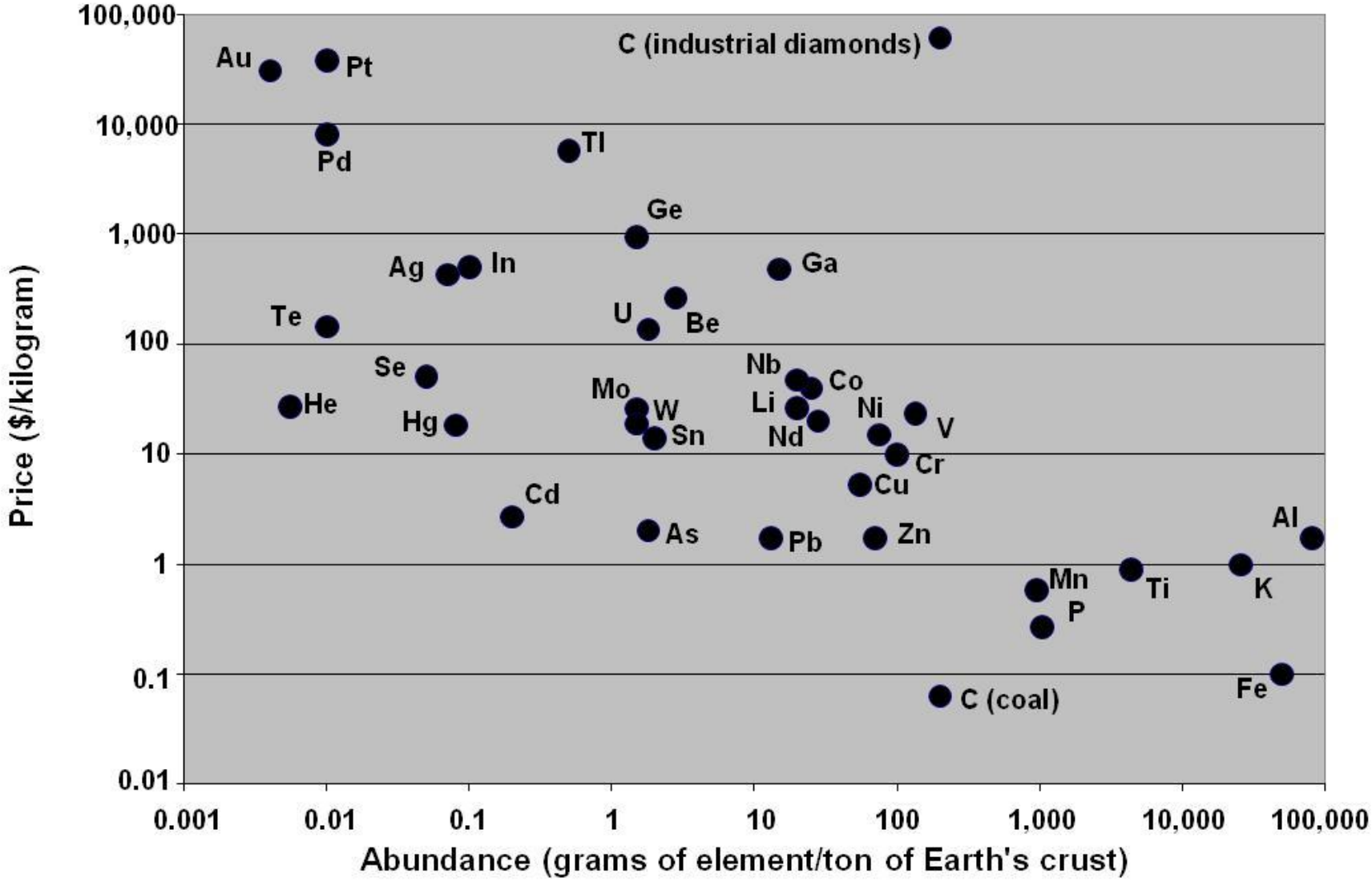
Round Mountain, NV (2007)

For which commodities do you want to explore?



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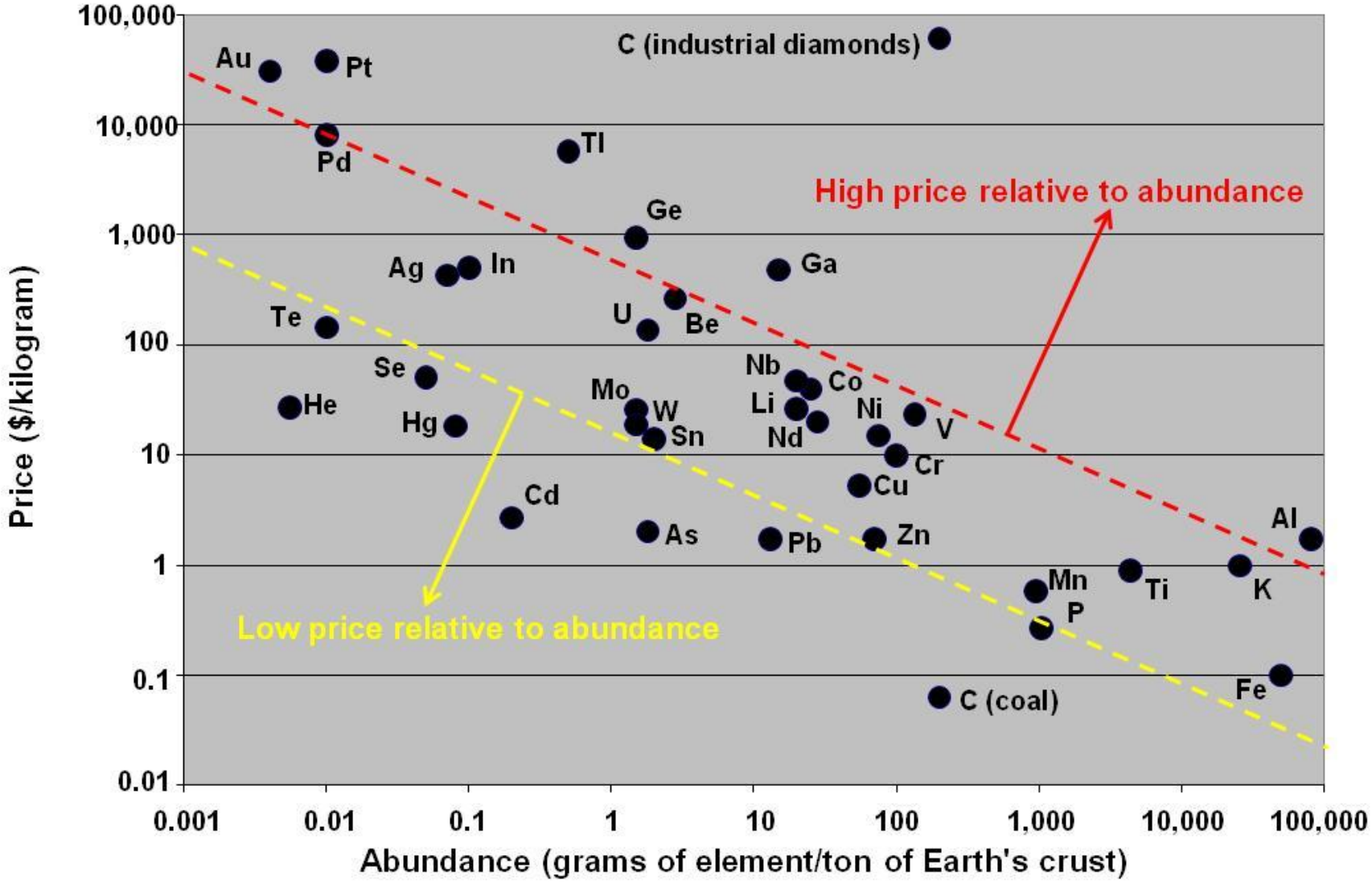
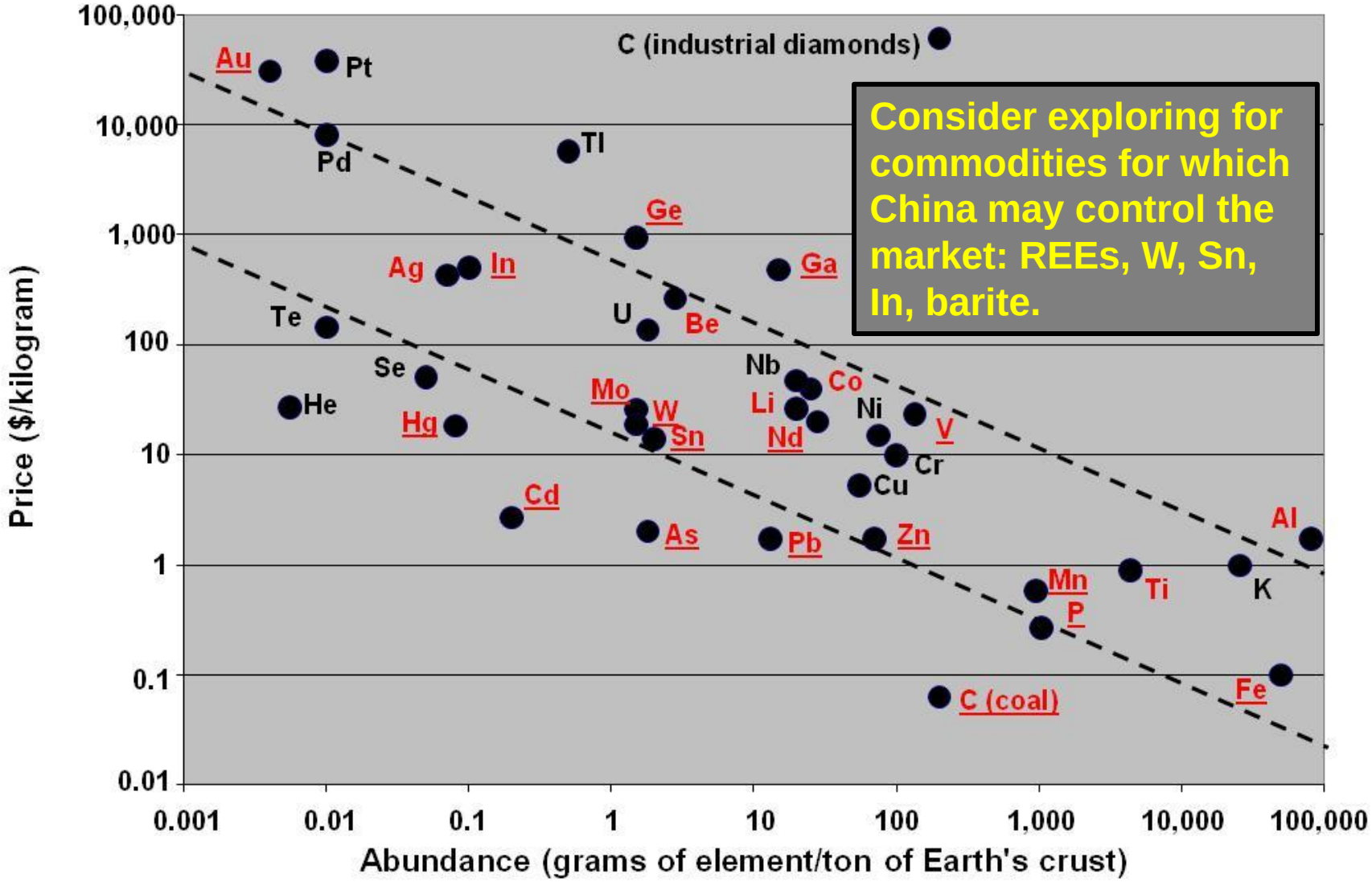
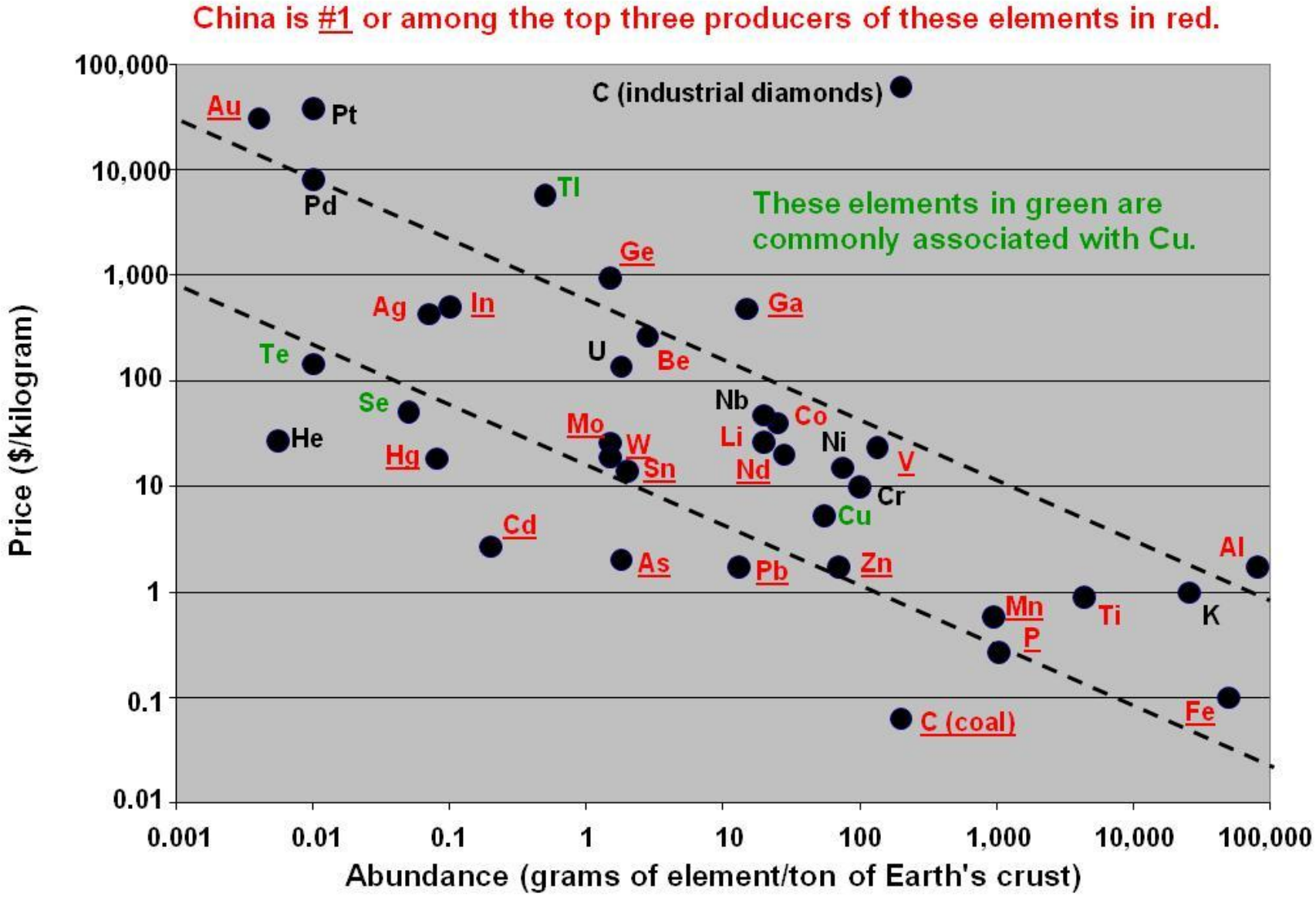


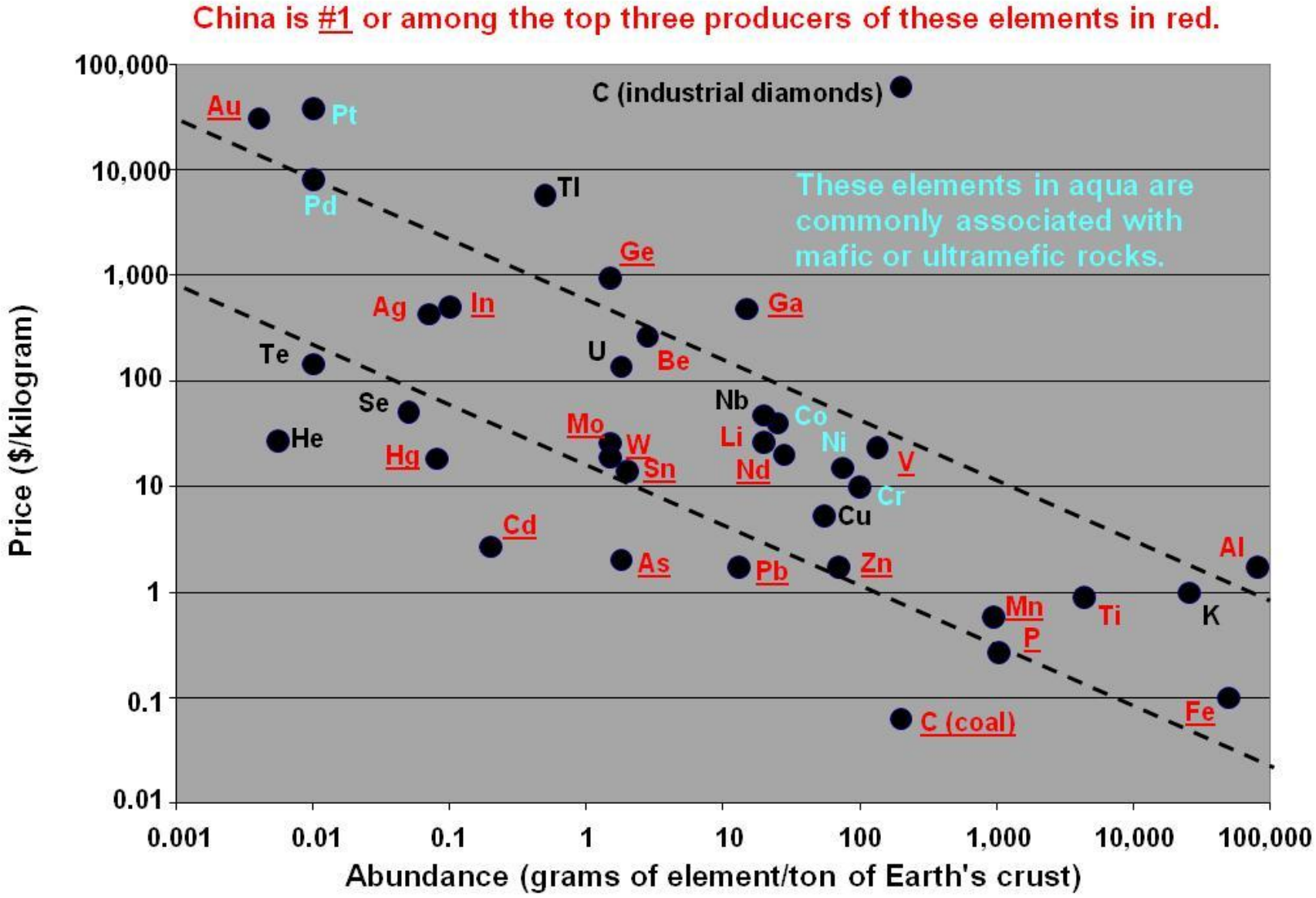
China is #1 or among the top three producers of these elements in red.



Consider exploring for commodities for which China doesn't have enough to meet its likely domestic demand: Au, Cu, Co, K.



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'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 (77%)
Potash	11	26	3	Canada (31%)
Chromium	0	~0	~2	South Africa (45%)
Copper	6	3	8	Chile (36%)
Nickel	6	13	0	Russia (19%)

For example, the leading producers of nickel are Russia (19% of 2009 mine production), Indonesia (13%), Canada (13%), and Australia (12%).

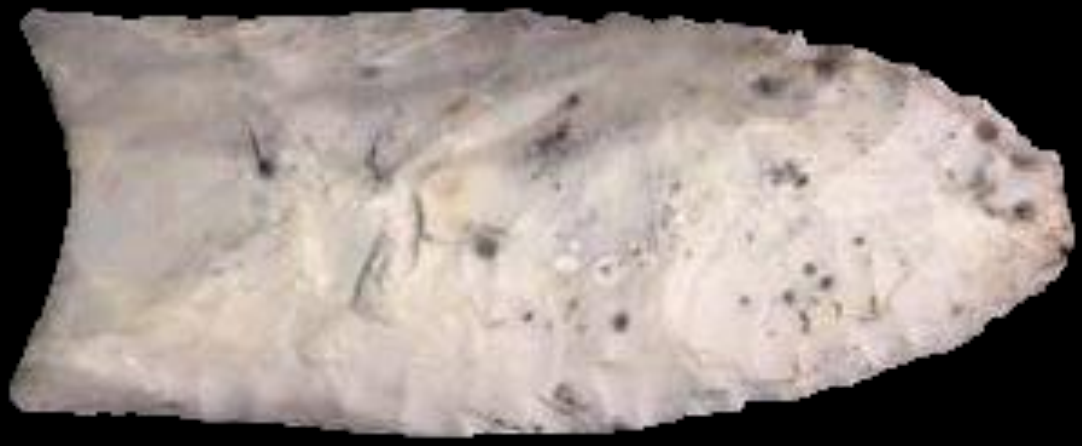
Mount Keith Ni mine, Western Australia: 323 million metric tons @ 0.56% Ni

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

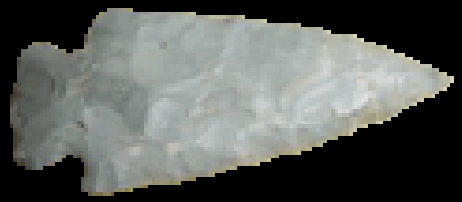
2009 production statistics from USGS

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, and uranium. This includes parts of Africa, Australia, South America (particularly Brazil and Venezuela), Russia, and Canada.

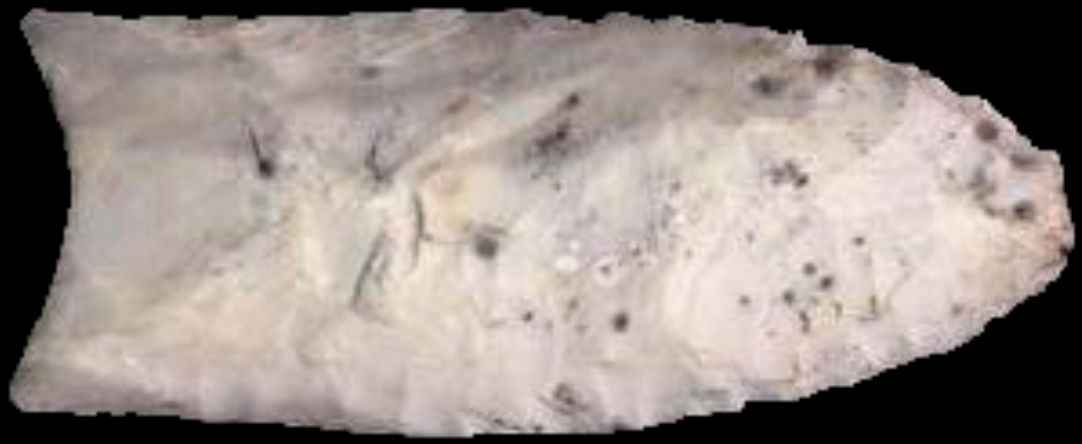
Also watch for competition in the resource-rich current and past continental and island-arc settings that are major sources of copper, molybdenum, tungsten, gold, and silver. This includes the Pacific Rim of Fire, particularly the Cordillera of South and North America, Mongolia, and several other locations.



Arrowhead clipart from www.firstpeople.us



Critical and strategic minerals will change with time.



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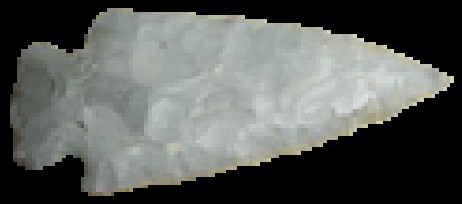

Critical and strategic minerals will change with time.

$CuIn_xGa_{(1-x)}Se_2$ 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?

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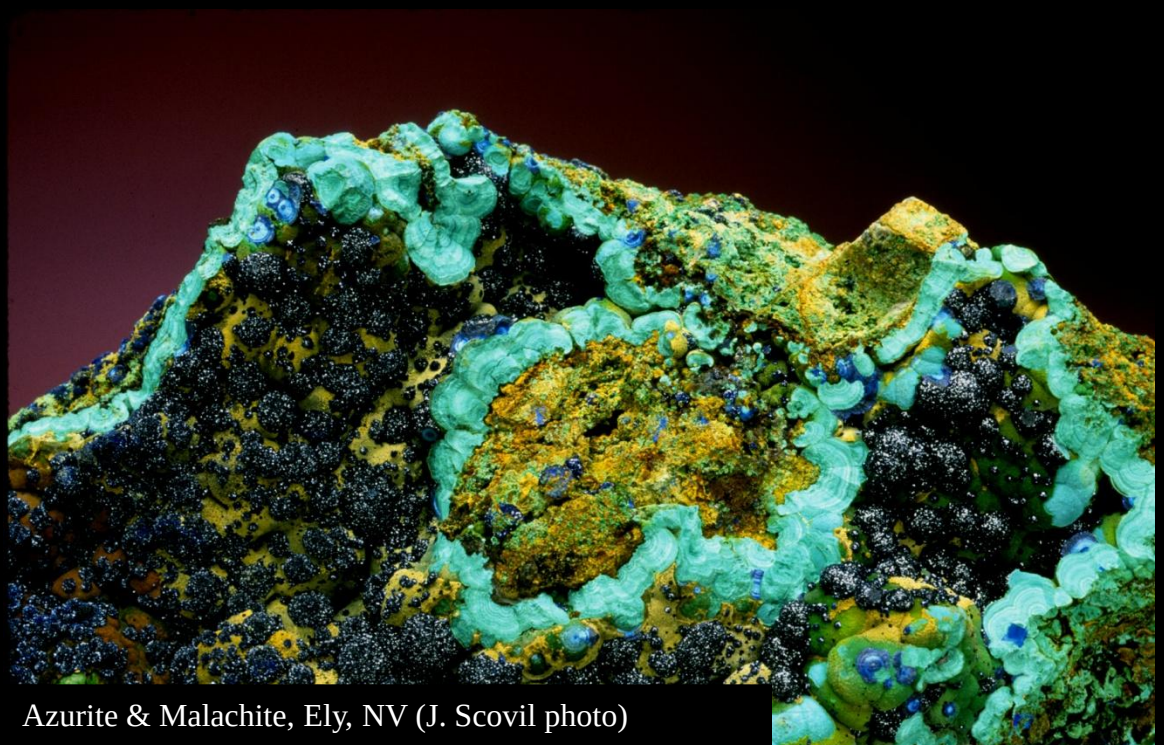
Why explore in Nevada?

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 – temporarily shut down wells in 2009, but continuing to produce, Clayton Valley (Silver Peak), Nevada

Thank you!



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

Round Mountain, NV (2007)