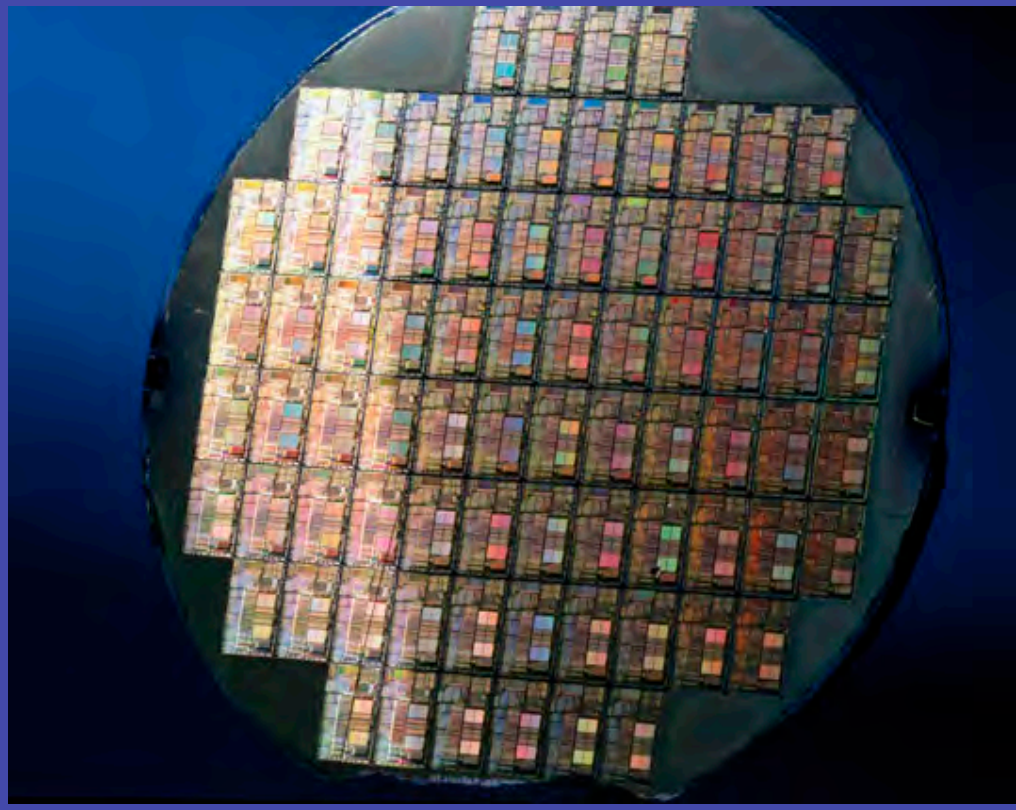
Consuming The Earth: The Past

Changing Patterns of Resource Use



2.6-2.5 MY Kada Gona River Ethiopia

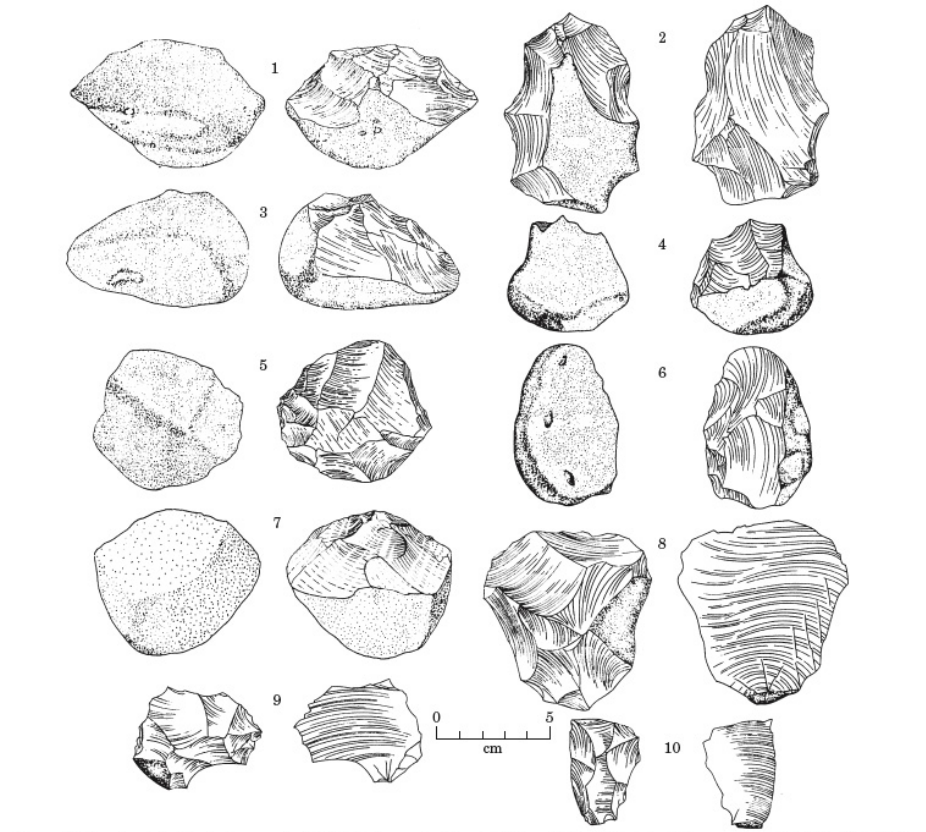
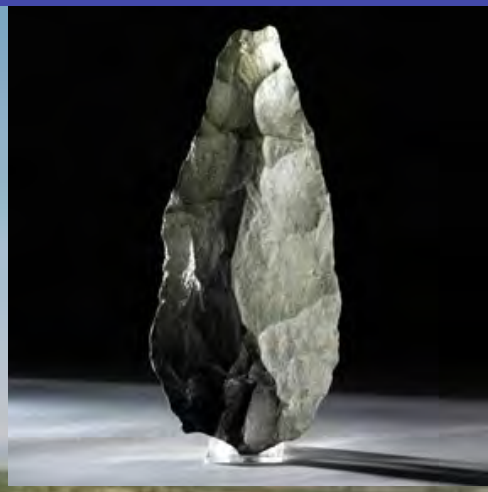


Figure 6. Drawings of artefacts (cores and whole flakes), excavated from EG10 and EG12. (1) unifacial chopper, EG10, (2) discoid, EG10, (3) unifacial side chopper, EG12, (4) unifacial end chopper, EG12, (5) partial (irregular discoid), EG12, (6) unifacial side chopper, EG10, (7) unifacial side chopper, EG12, (8–10) whole flakes, EG10.

Semwa (2000)

Olduvai Gorge, Tanzania



http://www.historyofscience.com/G2I/timeline/images/olduvai_Gorge.jpg

http://www.britishmuseum.org/images/Olduvai_285x285.jpg

Olduvai Gorge, Tanzania 0.7 to 1.4 M

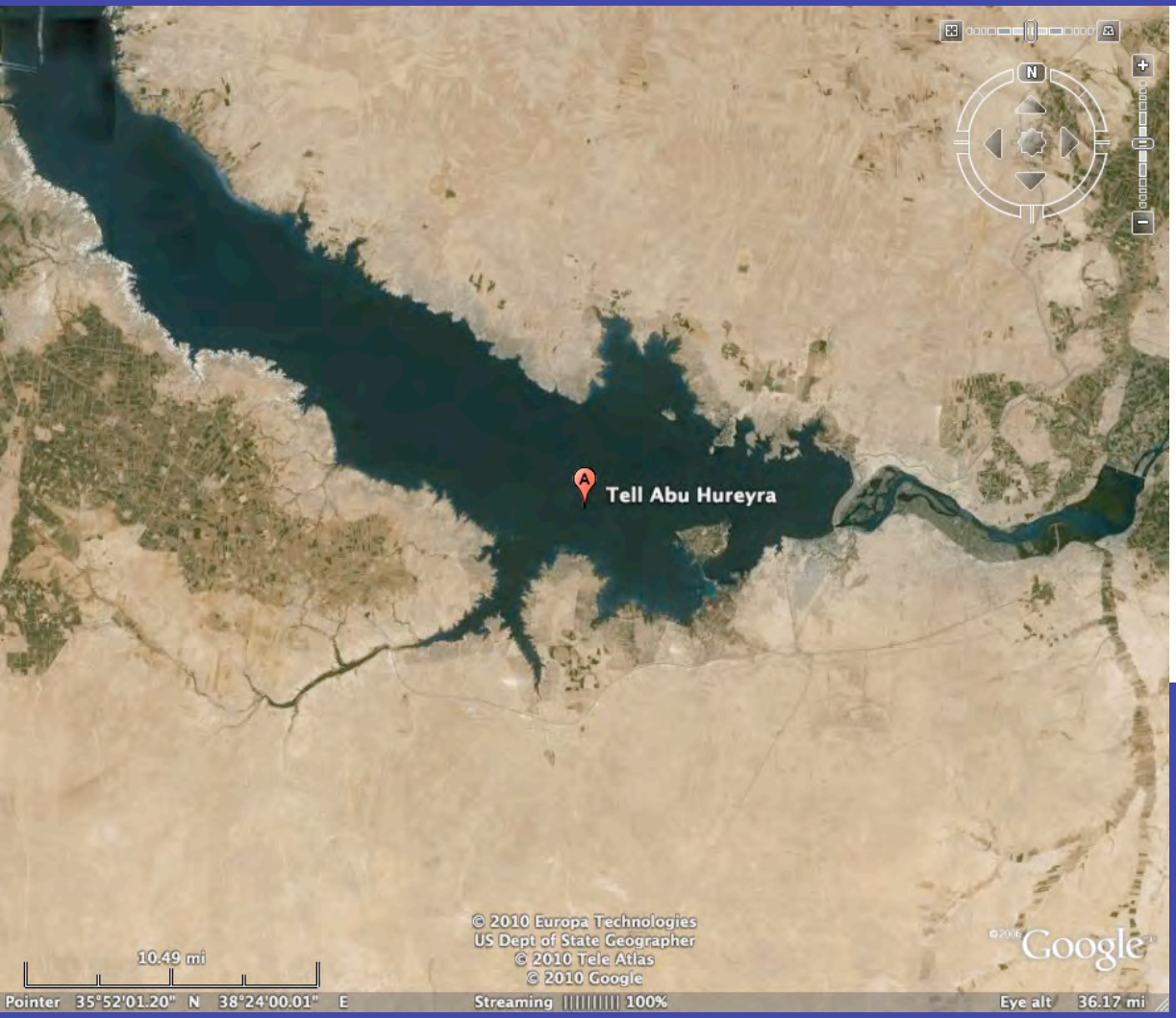
Clacton Spear, Clacton-on-Sea, UK

Oldest wooden implement in the world 420,000 years

http://www.britishmuseum.org/images/an21048_m.jpg

http://www.britishmuseum.org/images/Olduvai_285x285.jpg

Neolithic: Abu Hureyra, Syria

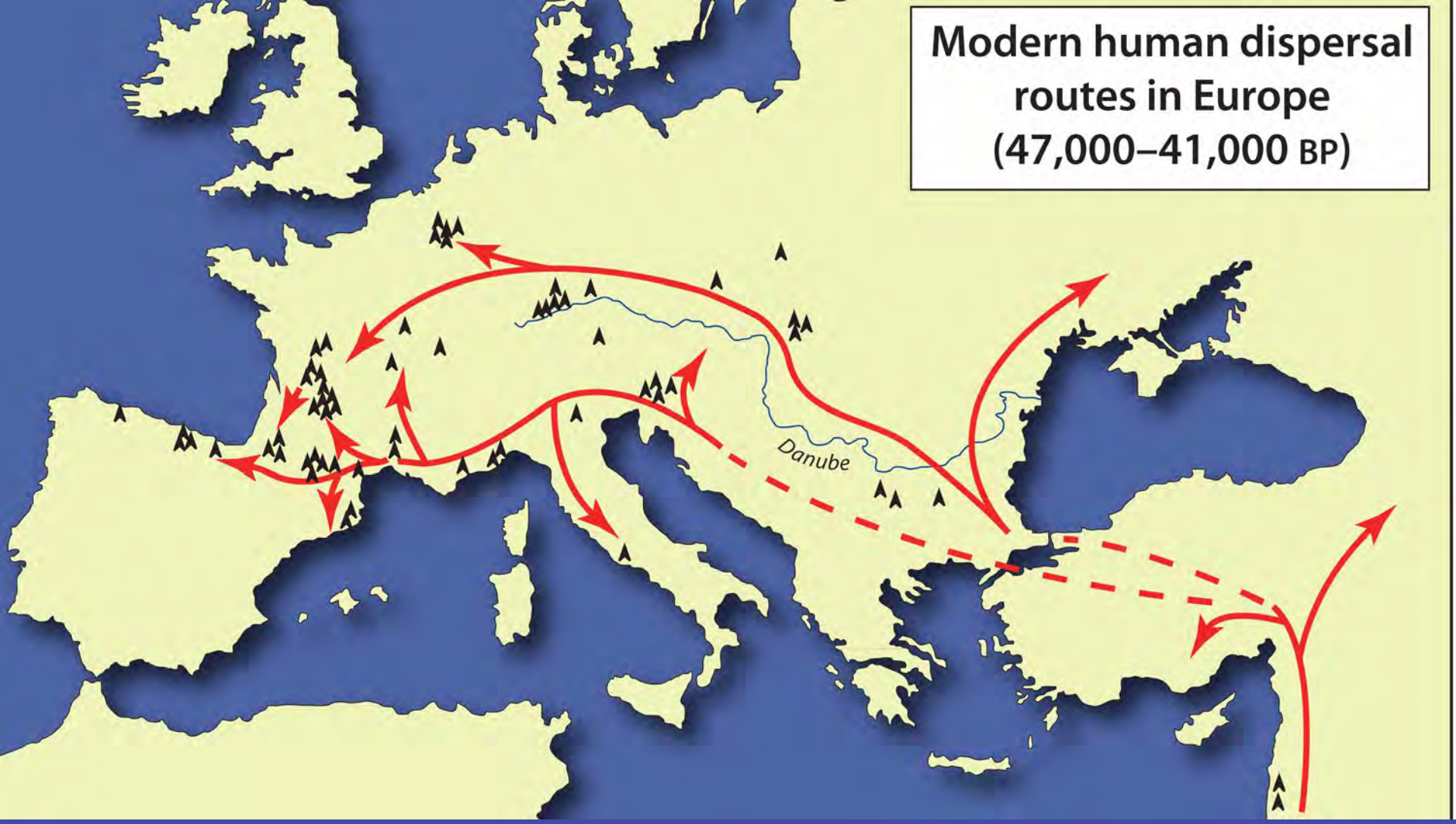


flour (9500-9000 BC

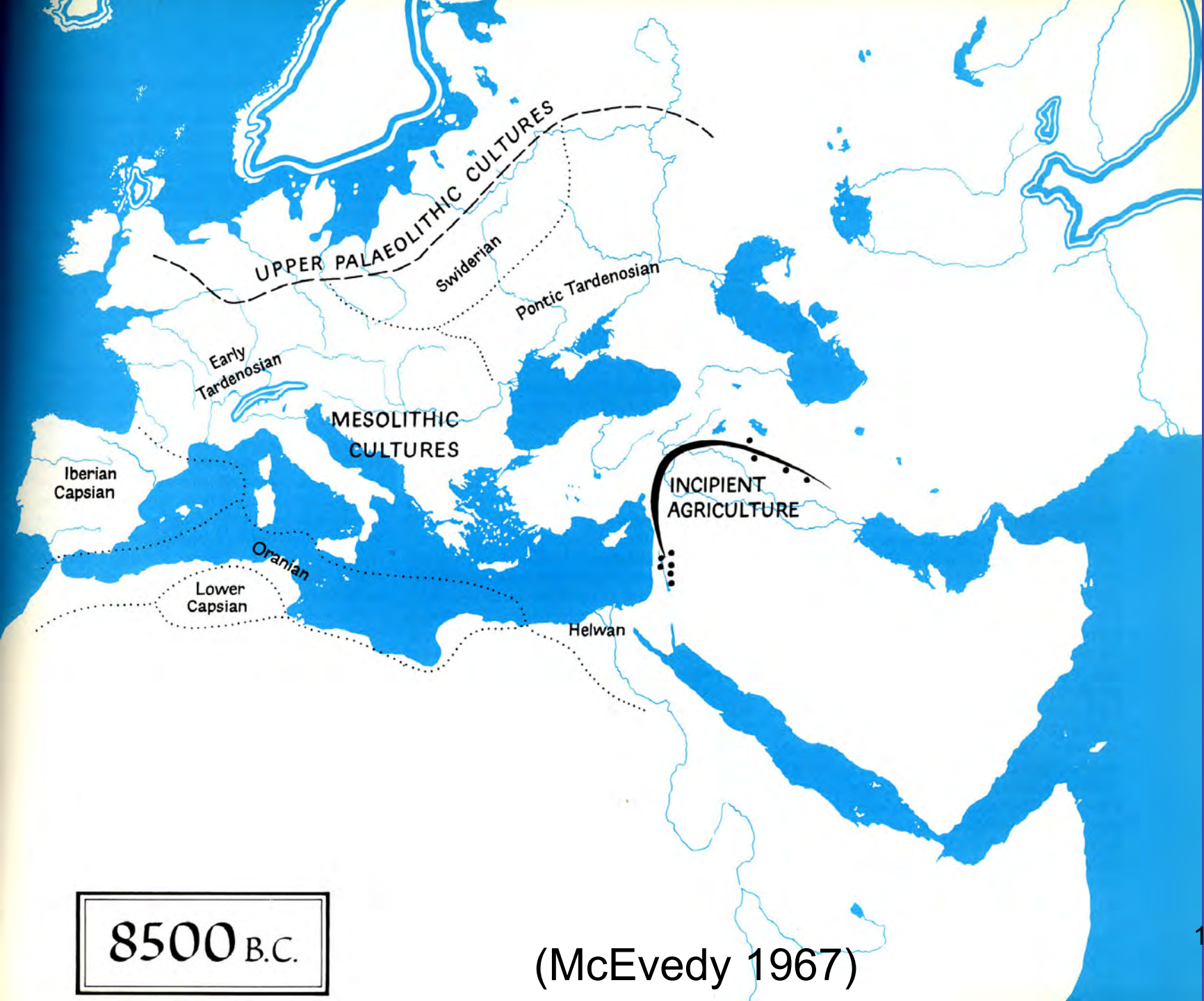
http://www.britishmuseum.org/explore/highlights/highlight_objects/pe/q/quern_stone_for_making_flour.aspx

Map of Neadanderthal Sites

https://upload.wikimedia.org/wikipedia/commons/1/1d/Carte_Neandertaliens.jpg



http://www.cam.ac.uk/sites/www.cam.ac.uk/files/news/research/news/110728-mellars-map1.jpg



(McEvedy 1967)

Chalcolithic: Wadi Feinan, Jordan (4500 - 3500 BC)

http://www.flickr.com/photos/84963342@N00/385336739

http://www.metmuseum.org/toah/images/h2/h2_L.1994.74.6.jpg

Bronze Age: Copper + Tin (+ Arsenic):

Timna, Isreal Copper Mines

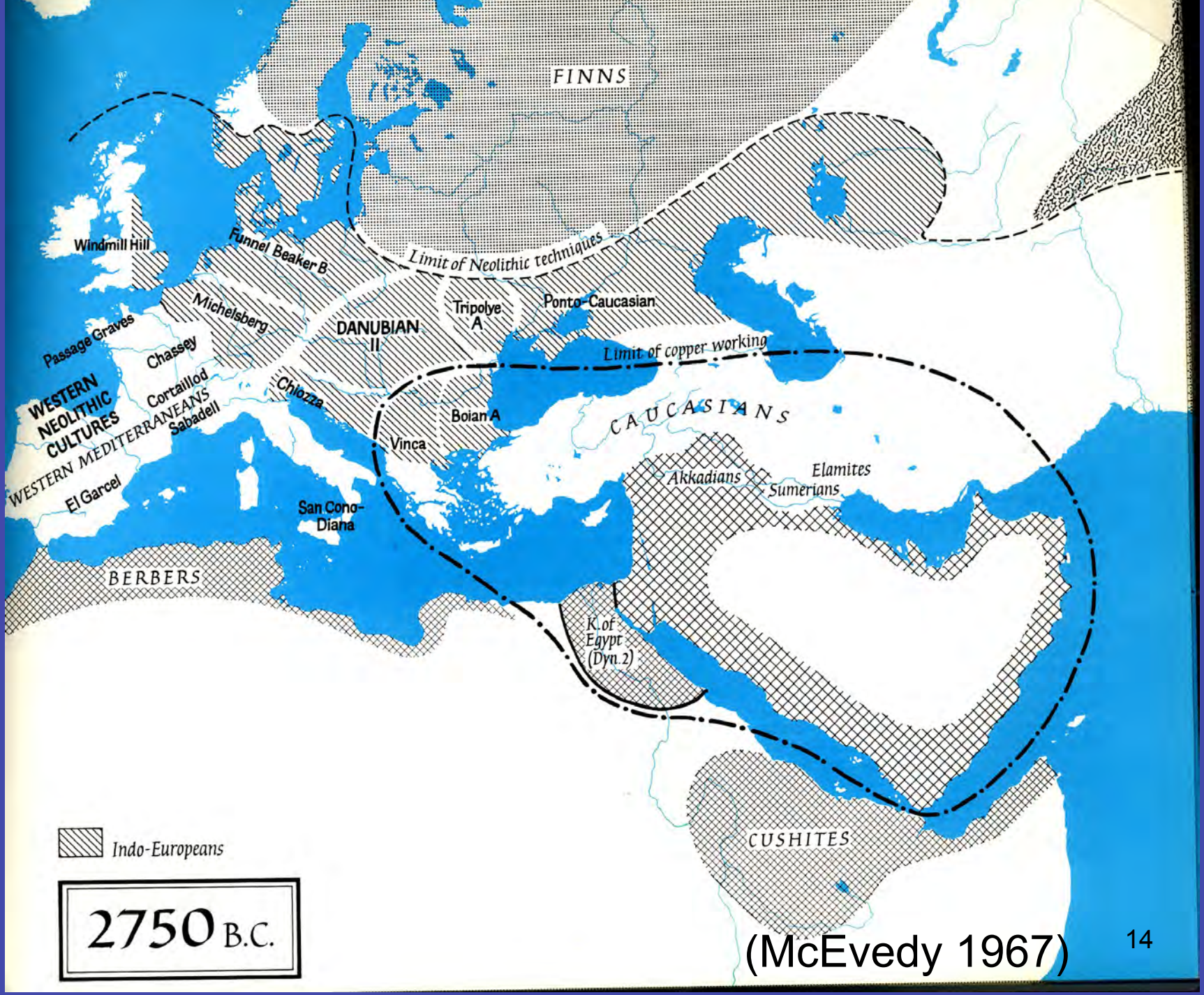
Group of arsenical copper tools from The Cyclades

http://www.flickr.com/photos/larbear/2743798004/

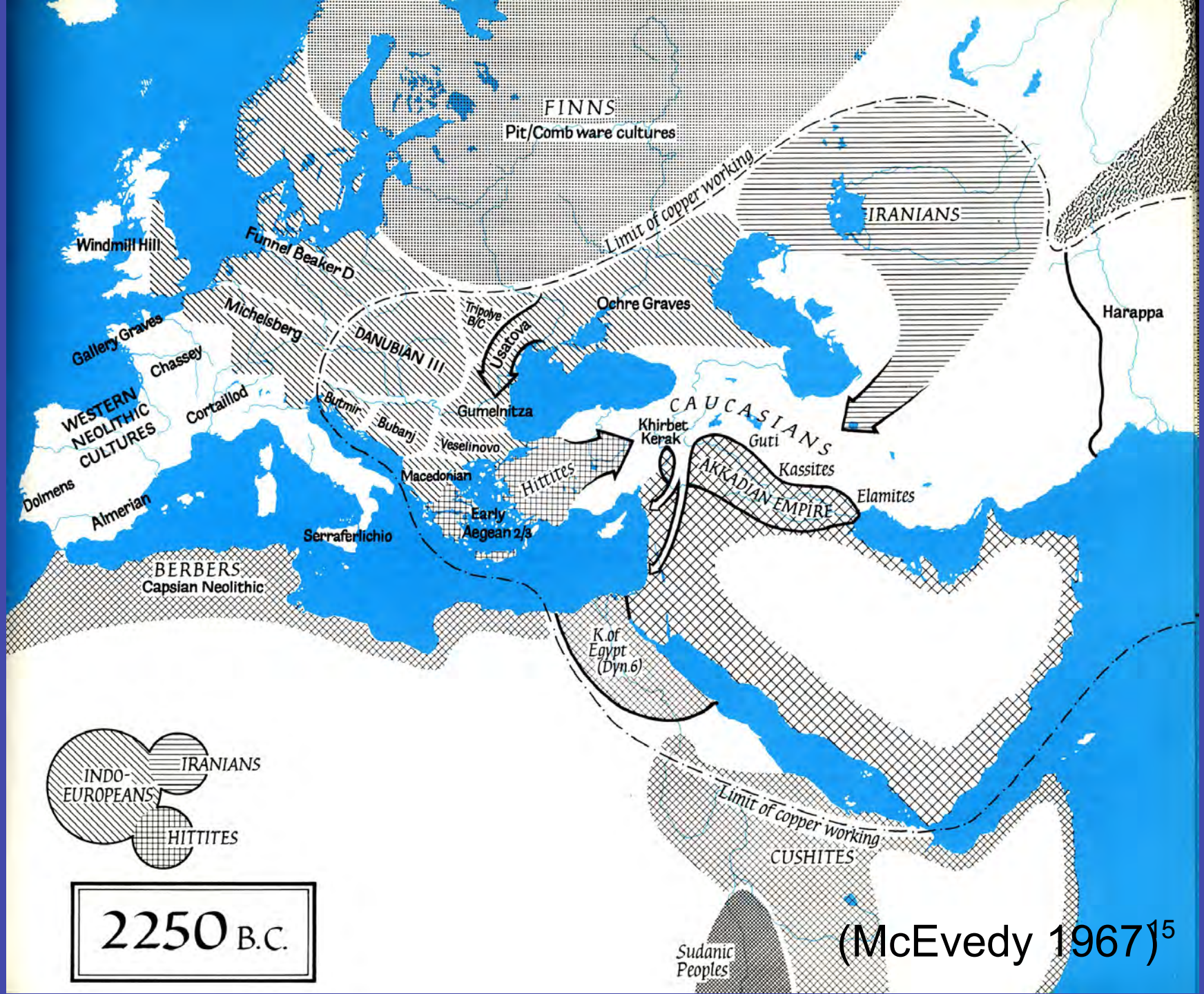
http://www.britishmuseum.org/images/ps340118_l.jpg

Bronze Age: The Mold gold cape: Bryn yr Ellyllon, Wale (1900 - 1600 BC

http://www.flickr.com/photos/awv/3759274280/



(McEvedy 1967)



(McEvedy 1967)[15]

Phrygian City Gordion: King Midas (Iron Age 1250 - 700 BC)

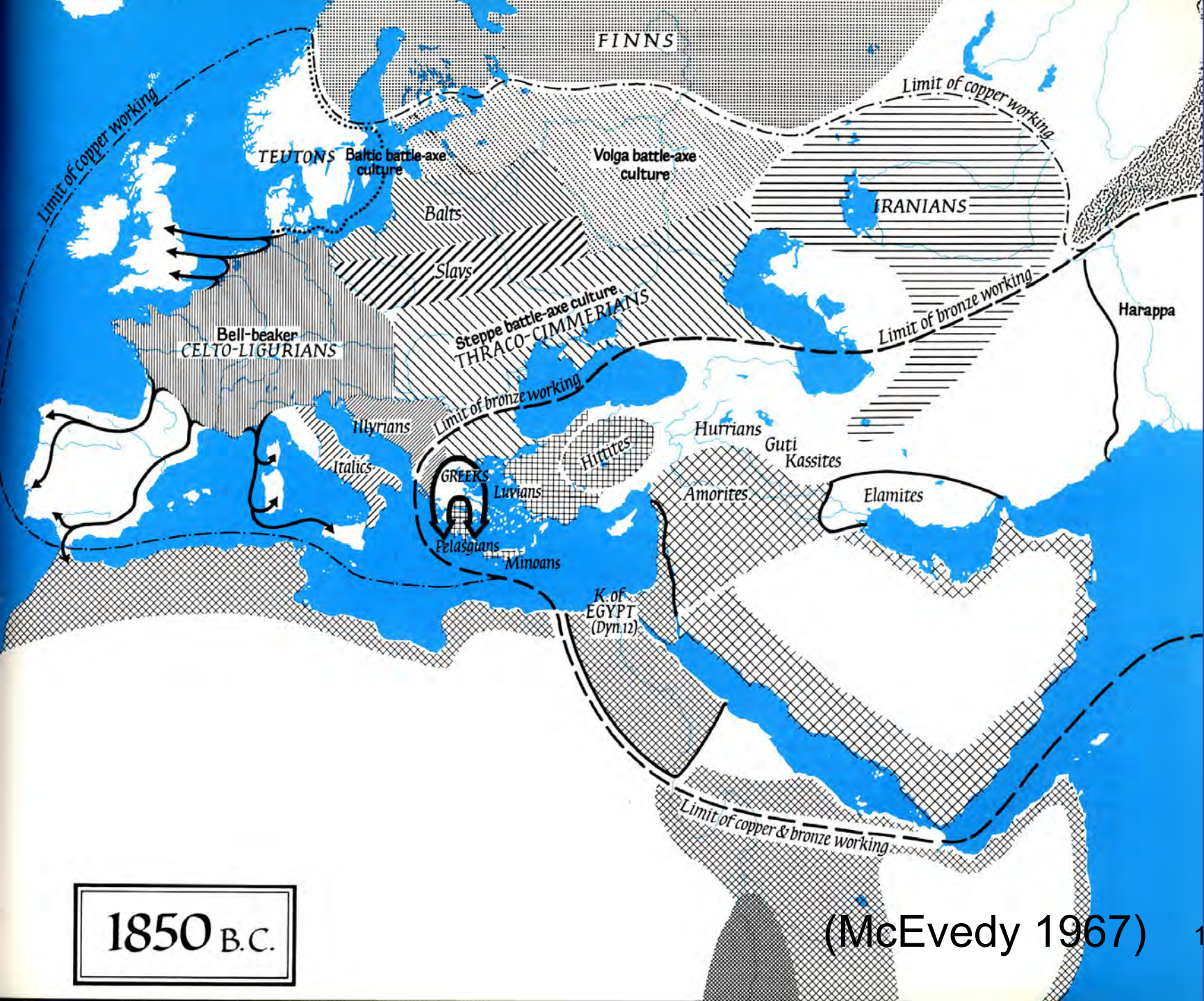
http://sites.museum.upenn.edu/gordion/history/ironage?showall=1

Iron Age of India: Uttar Pradesh 1800 - 900 BC

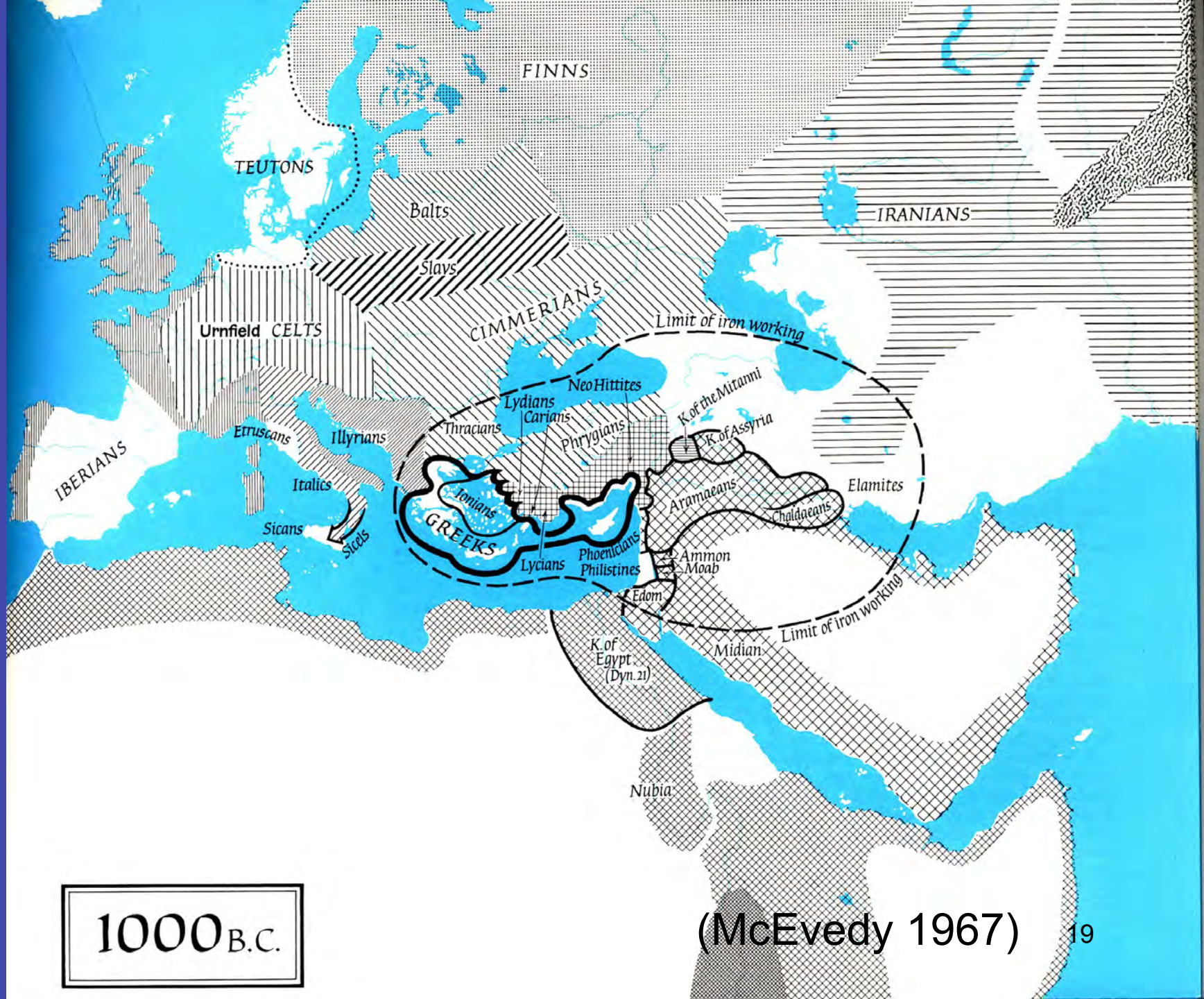
Figure 6. Damaged circular clay furnace, comprising iron slag and tuyeres and other waste materials stuck with its body exposed at lohsanwa mound, Period II, Malhar, Dist. Chandauli.

http://antiquity.ac.uk/projgall/tewari/tewari.pdf

Figure 7. Highly corroded iron arrowhead, Period I, Dadupur, Dist. Lucknow.



(McEvedy 1967)



(McEvedy 1967)

Building Stone: Acropolis, Gela, Sicily 6th C BC

Plato and Aristole
Dialectics

Della Robbia
Il Duomo
Firenze

Roman Empire: Cement and Hydraulic Engineering

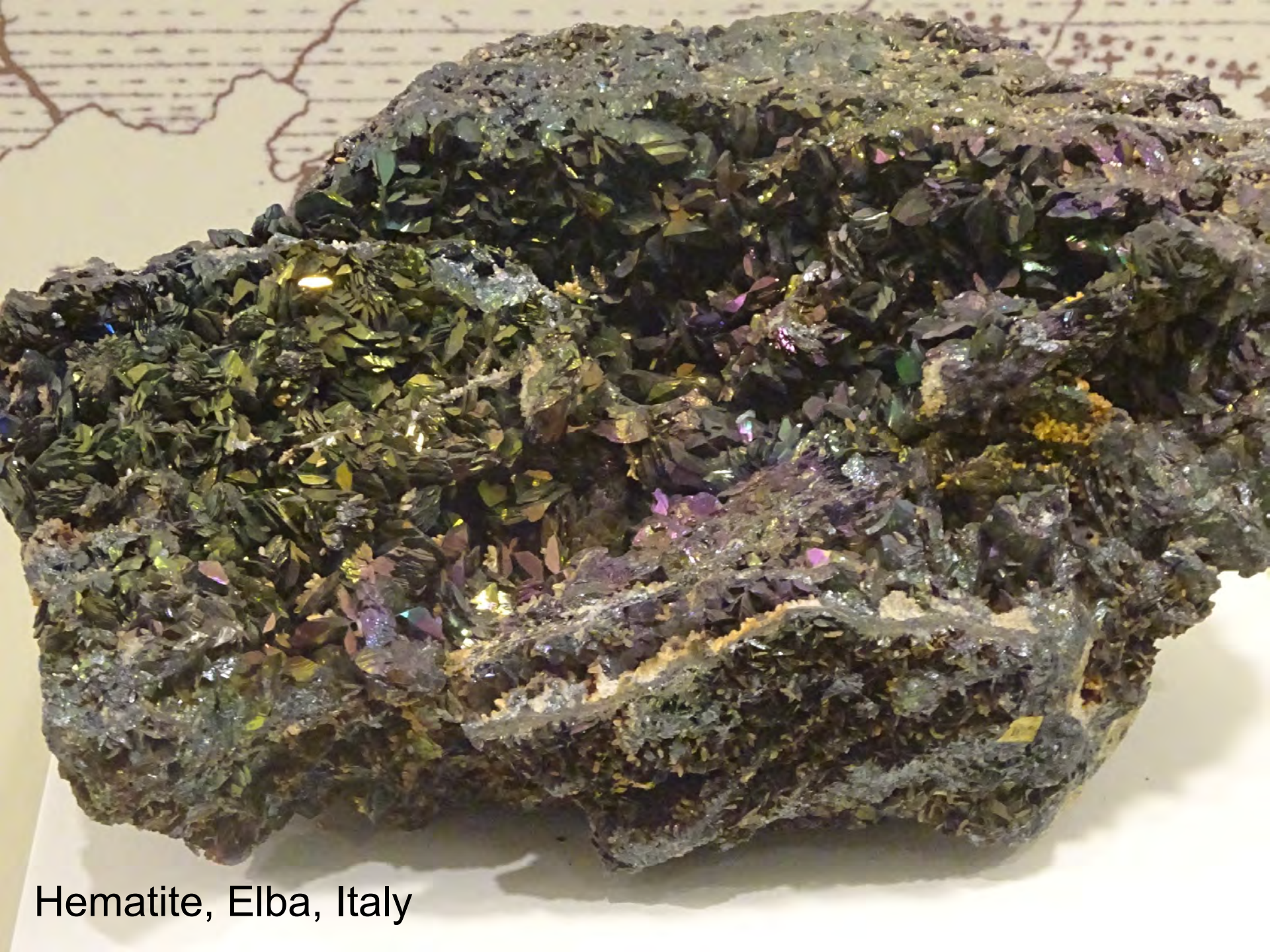
Segovia Aquaduct (~100 AD)

http://www.flickr.com/photos/armk/1241562208/

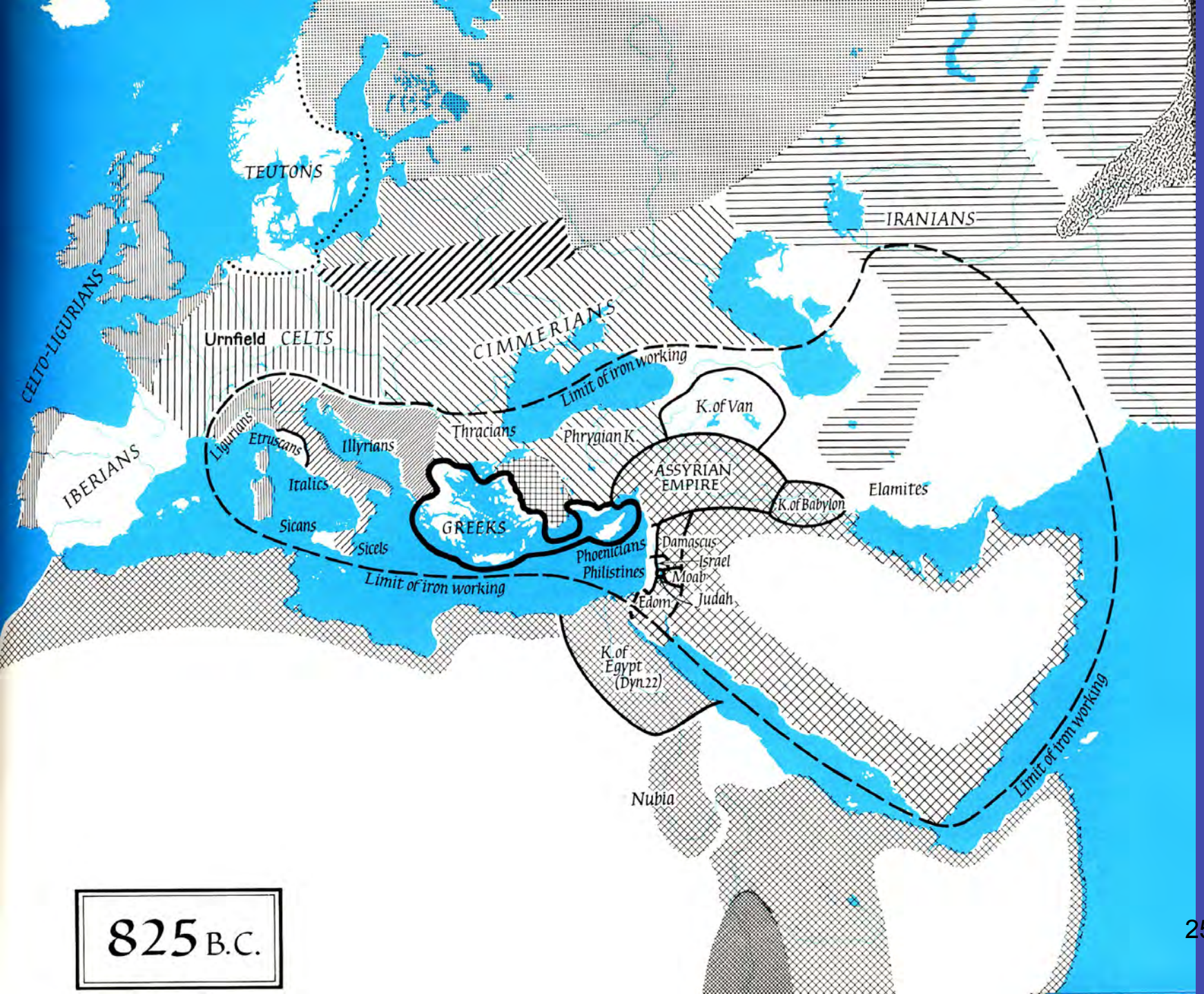
Pont du Gard (~50 AD)

http://www.flickr.com/photos/lesec/44052812/

The Pantheon, Rome, built ca 110 AD. Note cement roof



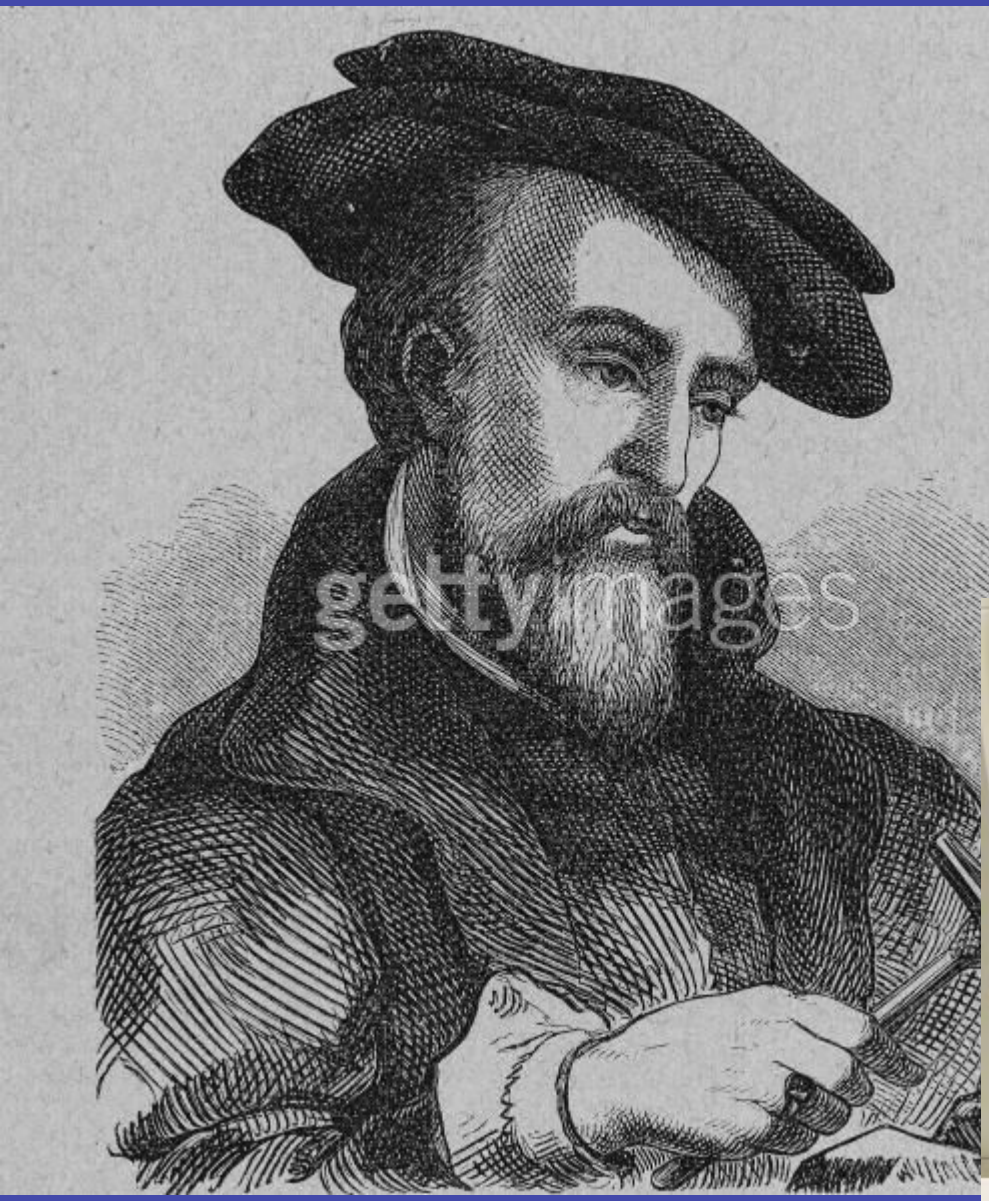
Hematite, Elba, Italy


TEUTONS
IRANIANS
CELTO-LIGURIANS
Urnfield CELTS
CIMMERIANS
Limit of iron working
K. of Van
Thracians
Phrygian K.
Ligurians
Etruscans
Illyrians
IBERIANS
Italics
ASSYRIAN EMPIRE
Elamites
K. of Babylon
Sicans
GREEKS
Damascus
Israel
Sicels
Phoenicians
Philistines
Moab
Limit of iron working
Edom
Judah
K. of Egypt (Dyn.22)
Nubia
Limit of iron working
825 B.C.


Silk route to China
GOLD
FURS
AMBER
LEAD TIN
London
Trier
TIN
WHEAT
GOLD
IRON
FISH
FISH
LEAD COPPER SILVER TIN
Merv
Balkh
Hecatompylus (Damghan)
IVORY SPICE
Autun
Lyons
Nimes
Milan
Verona
Padua
OIL WINE
TIMBER
Ecbatana (Hamadan)
Rayy
Isfahan
GOLD COPPER MERCURY TIN SILVER LEAD WHEAT OIL
Narbonne
Rome
Capua
Beneventum
Ostia
Salonika
Byzantium
Cyzicus
Nicaea
Pergamum
Sardes
Apamea
Iconium
Edessa
Tarsus
Hatra
Istakhr
Darabjird
Puteoli
Naples
Corinth
Smyrna
Antioch
Cyrrhus
Apamea
Seleucia
Laodicea
Ephesus
Athens
Rhodes
Palmyra
Damascus
Jerash
Erech
Cadiz
New Carthage
Utica
WHEAT OIL
Syracuse
Carthage
COPPER
Laodicea
Sidon
Tyre
GLASS
TEXTILES
Caesarea
Autumn
Spring
Petra
Cyrene
Tanis
Alexandria
Memphis
Antinoopolis
Leptis Magna
WHEAT PAPYRUS GLASS LINEN
Ptolemais
GOLD
To India Summer
Winter
IVORY RESINS
RESINS
GOLD IVORY
A.D. 230

The School of St Thomas Aquinas, Strozzi 1450
San Marco, Firenze

Early Rennaissance



http://www.gettyimages.com/detail/3450050/Hulton-Archive

Georg Agricola
(1490-1555)

Bermannus, sive de re metallica dialogus (1530)

De Natura Fossilium (1546)

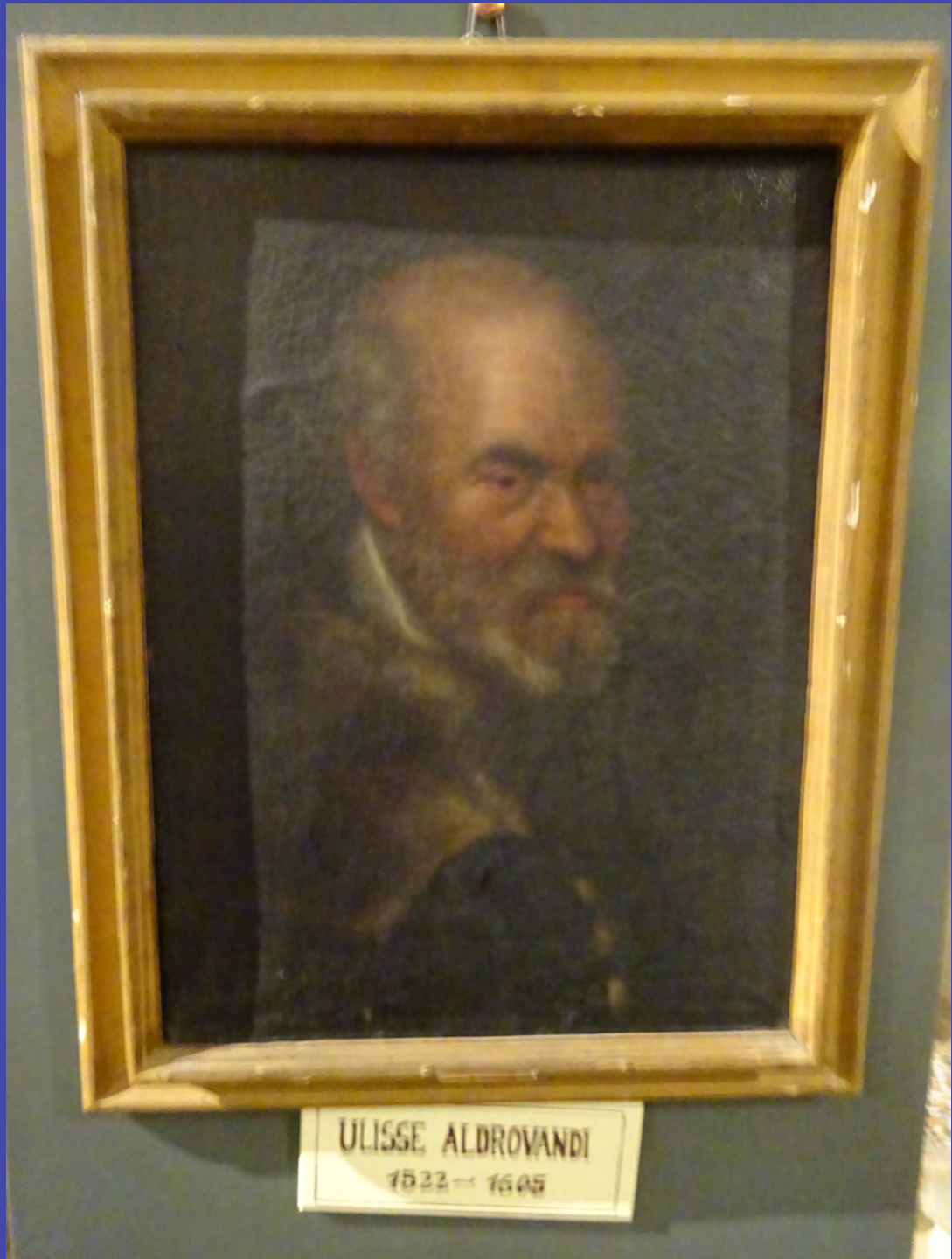
De Re Metallica (1556)

Lead-Zinc ore, Pomorzani Mine, Poland


Poggi Palace, University of Bologna

Ulisse Aldrovandi
1522-1605 AD
Bologna

“Father of Natural History”




Aldrovandi Collection, Poggi Palace, Bologna

Metals in common Use in 1800:
Gold
Silver
Copper
Lead
Mercury
Iron
Tin
Platinum
Antimony
Bismuth
Zinc
Arsenic

Platinum Chalice
1788

The platinum was refined from silver ore recovered in placer deposits in Venezuela and Colombia

http://danielmitsui.tripod.com/sitebuildercontent/sitebuilderpictures/platinum.jpg

Industrial Age:
Titanium
Magnesium
Cobalt
Nickel
Manganese
Aluminum
Chromium
Industrial diamonds
Flourite
Phosphate]
Potash
Asbestos

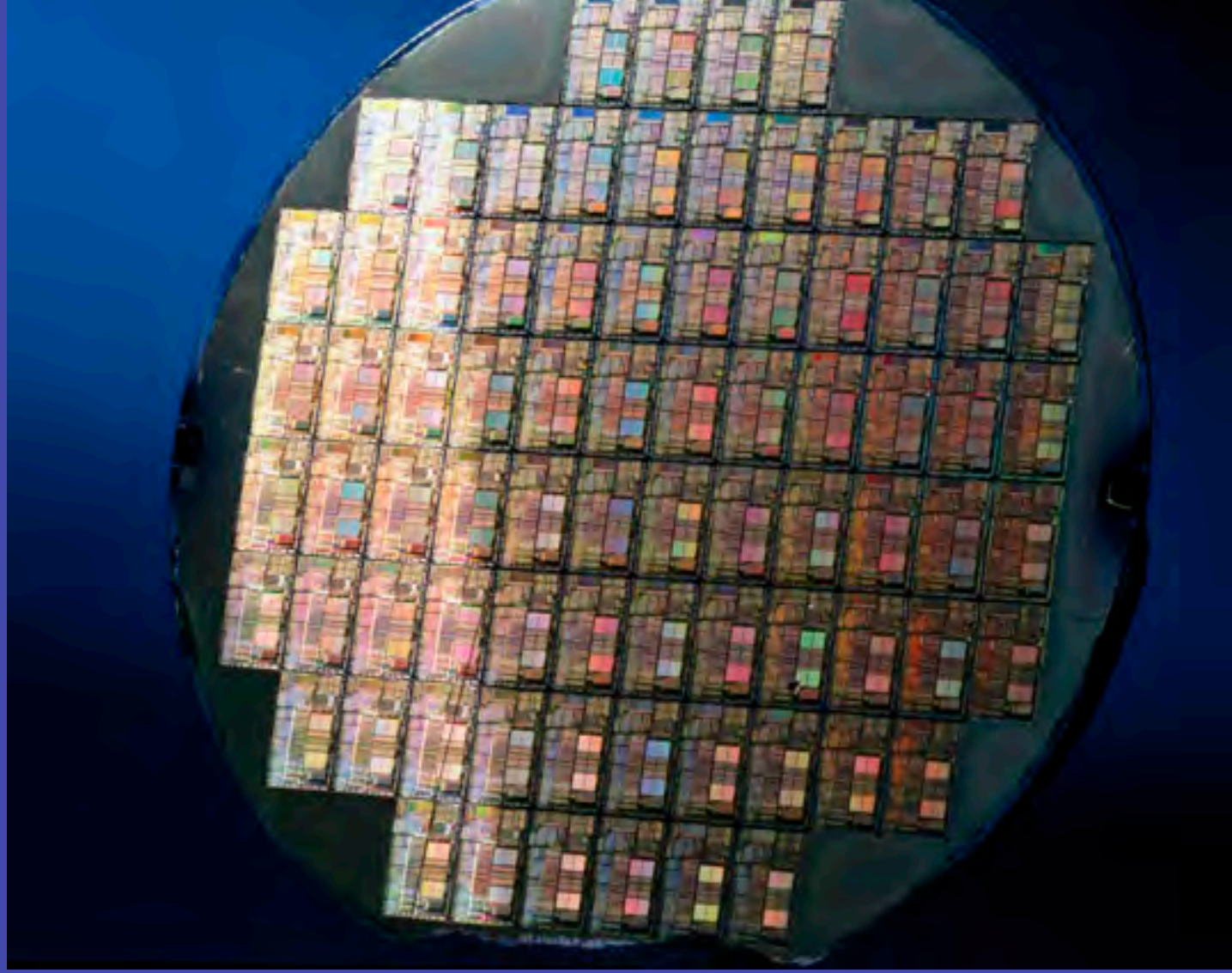
Napoleon III's aluminum baby rattle

Aluminum Hortop on Washington Monument

Moka Express
1933
Alfonso Bialetti inventor

Made of Aluminum because Mussolini embargoed steel in favor the national metal.
NY Times 21 Feb 2016

Modern Age:
Plutonium
Cadmium
Uranium
Zirconium
Silicon
Lithium . . . .



Silicon disk (1996)

http://www.sciencemuseum.org.uk/images/object_images/535x535/10305851.jpg

1907: The First Man-Made Material: Bakelite

THE BAKELITE MOMENT

'I know this will be an important invention.' Baekeland's diary, 11 July 1907

After five years of intensive research, the breakthrough came on 11 July 1907. It was all about finding the right conditions.

As he came closer to his goal, Baekeland worked solidly for five days in his laboratory next to his home in Yonkers, New York.

He was experimenting with two chemicals, formaldehyde and phenol. It was only when he combined them at over 150°C, under pressure and with an alkaline catalyst, that his dream became a reality.

Baekeland worked quickly, improving his material and designing the Bakelizer, a machine that would control the violence of the reaction.

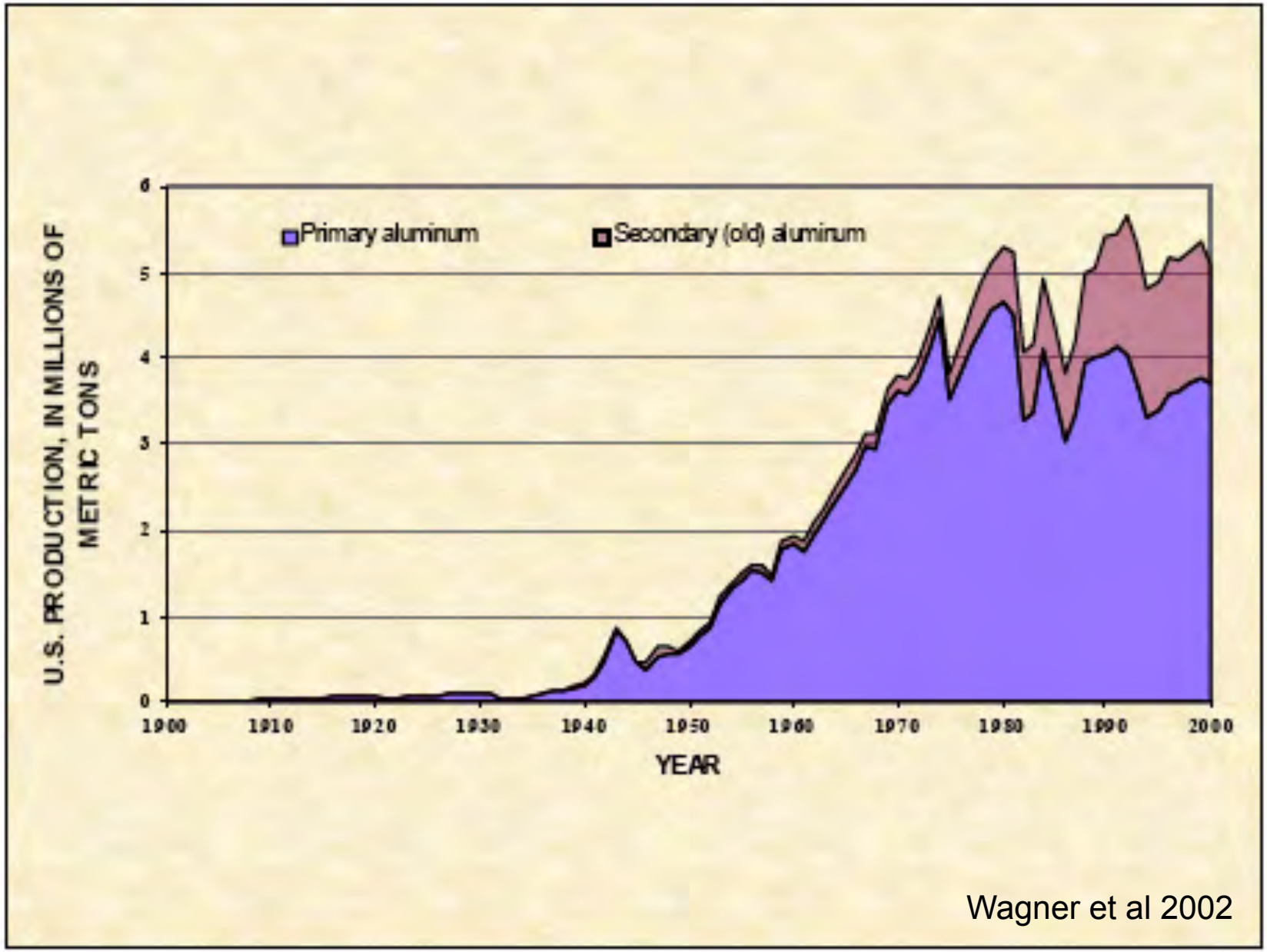
Patterns of Production: Aluminum

Wagner et al 2002

Figure D3. U.S. Bauxite price, in constant 2000 dollars, and world production, 1900-2000 (

Wagner et al 2002

Figure D4. U.S. production of alumina, bauxite, and primary aluminum, 1900-2000 (data from

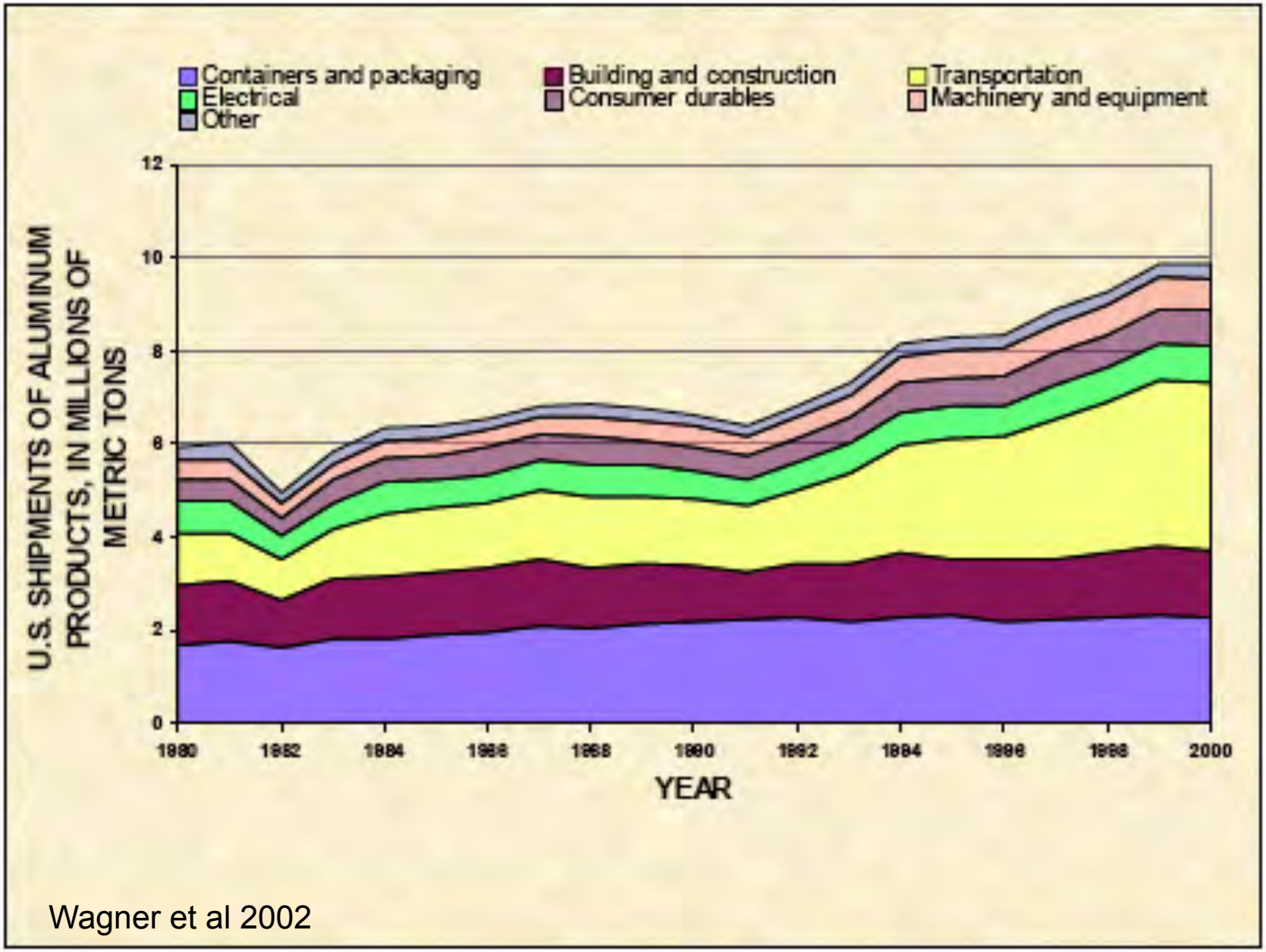


Wagner et al 2002

Figure D5. U.S. primary and secondary (old) aluminum production, 1900-2000 (data from

Wagner et al 2002

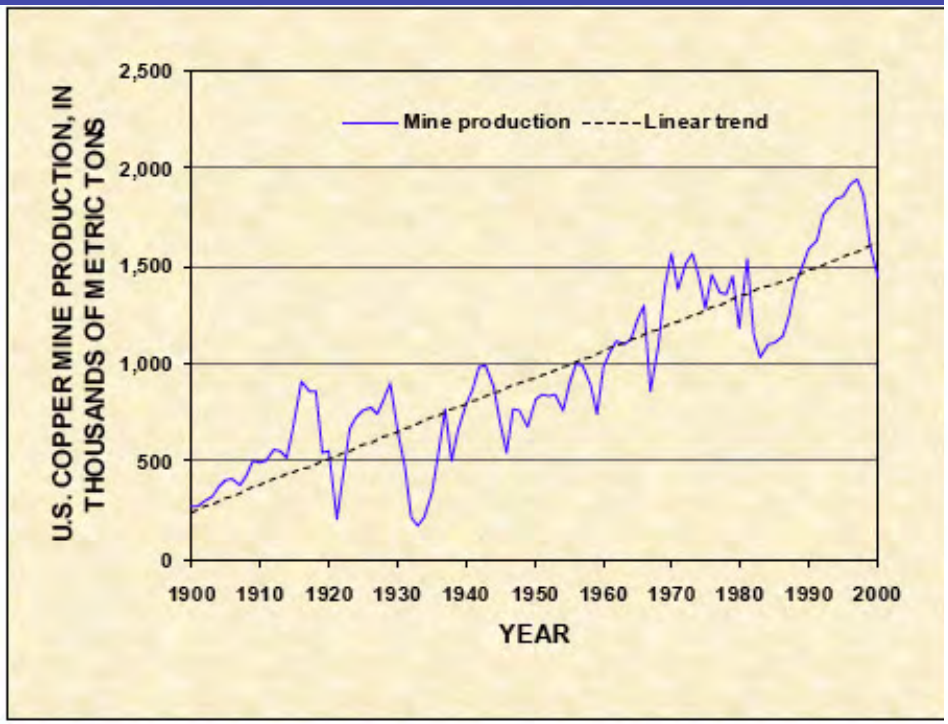
Figure D7. U.S. primary aluminum production as a percent of world production, 1900-2000



Wagner et al 2002

Figure D9. U.S. distribution of end-use shipments of aluminum products, 1980-2000 (data fro

Patterns of Production: Copper



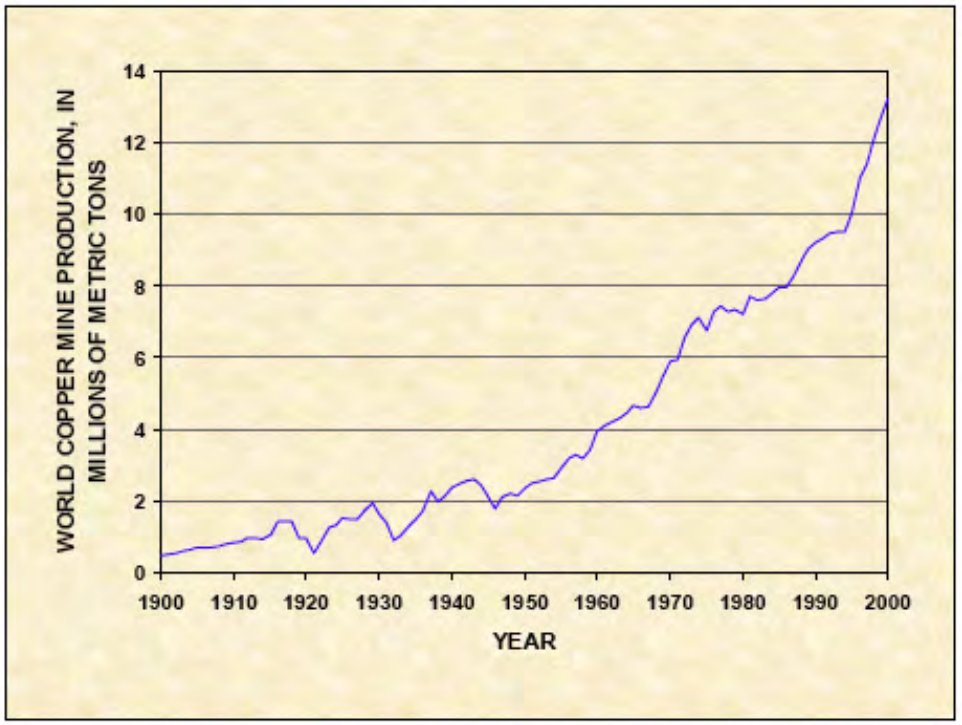
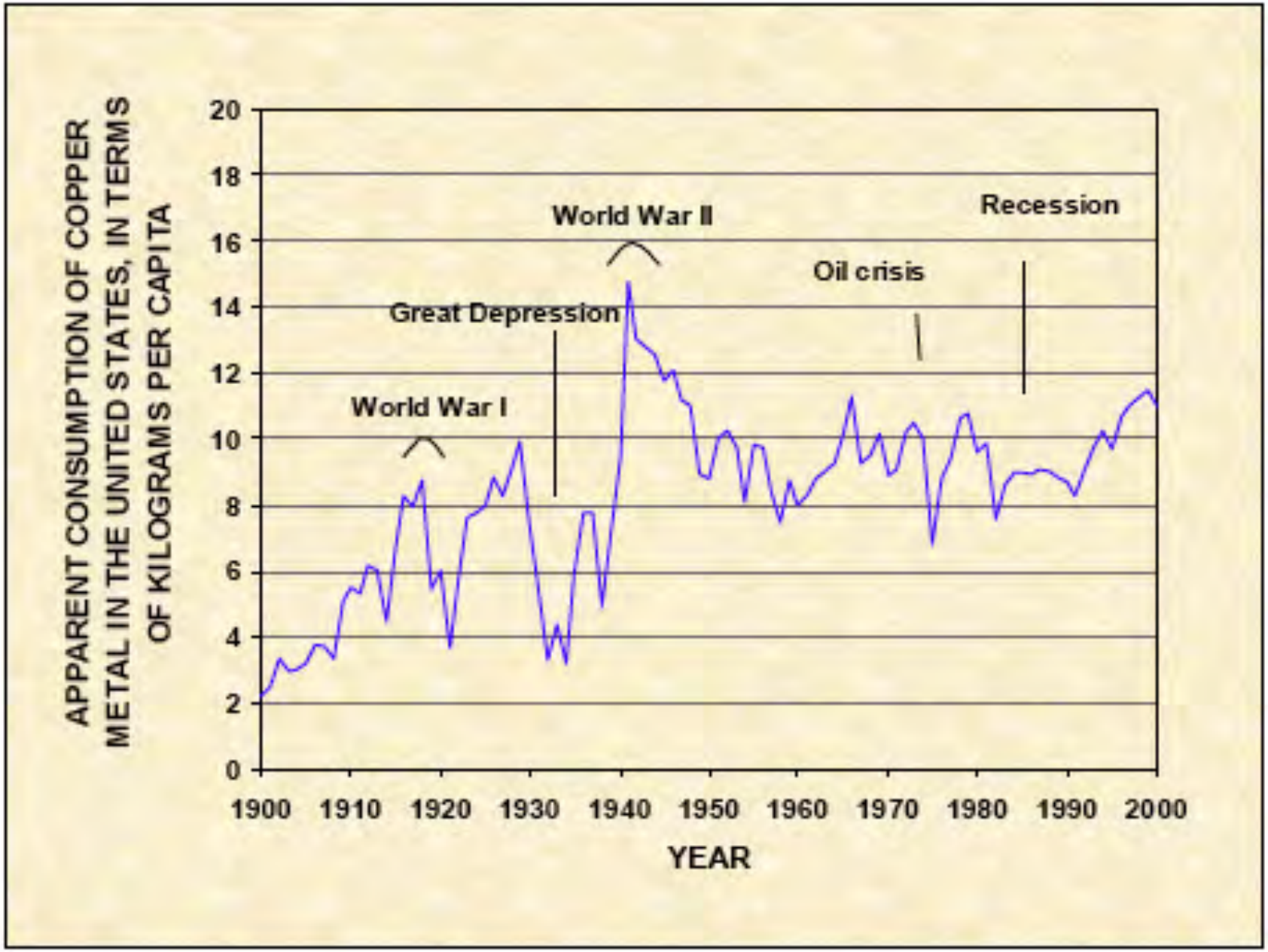


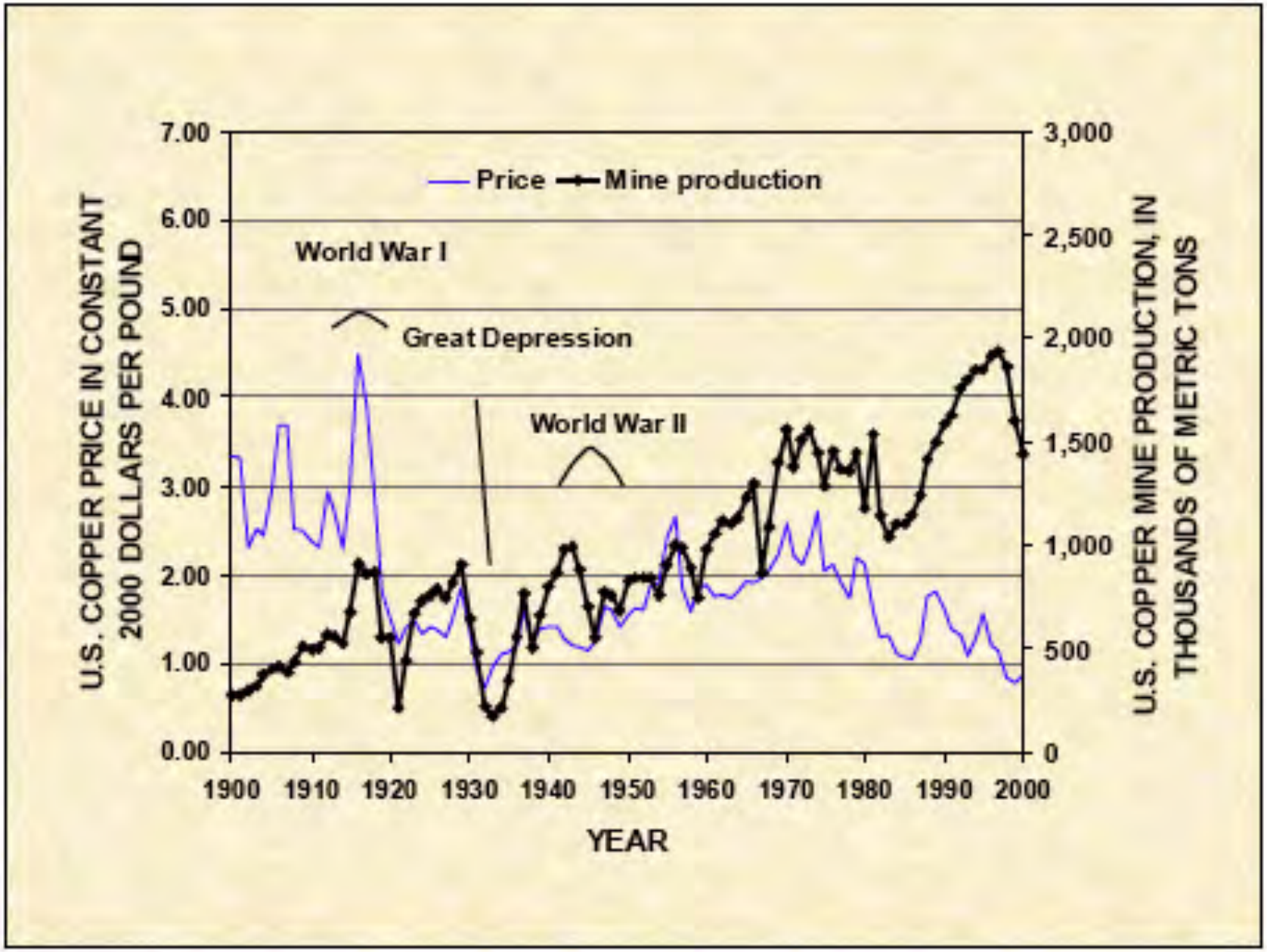
Figure E6. World copper mine production, copper content, 1900-2000 (data from Porter and

Wagner et al 2002



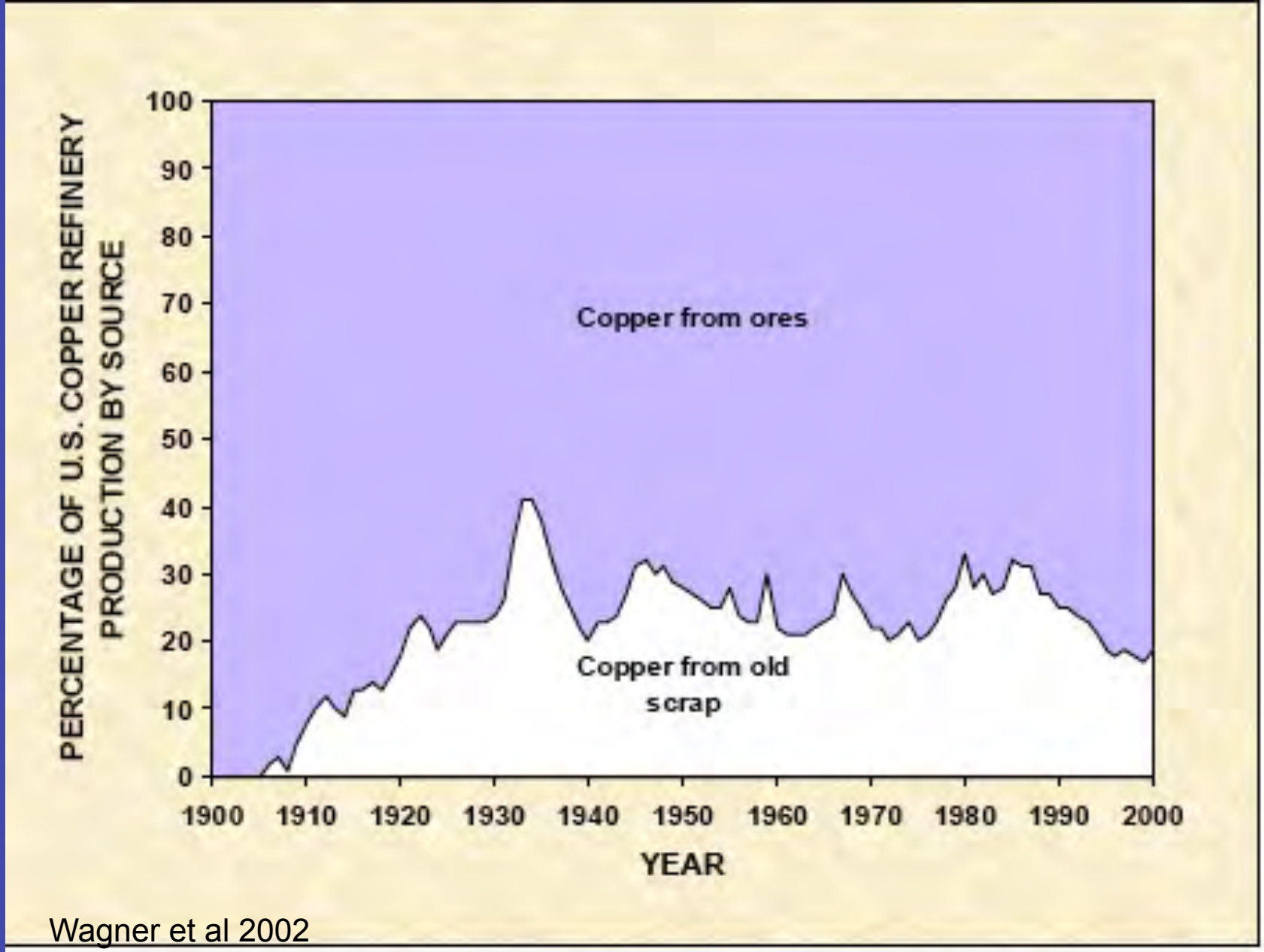
Wagner et al 2002

Figure E9. U.S. apparent consumption of copper, in metric tons per capita, 1900-2000 (data



Wagner et al 2002

Figure E3. U.S. copper price, in constant 2000 dollars, compared to mine production, 1900-



Wagner et al 2002

Figure E5. U.S. copper refinery production by source, by percent, 1900-2000 (data from Porter

Patterns of Production: Potash

Wagner et al 2002

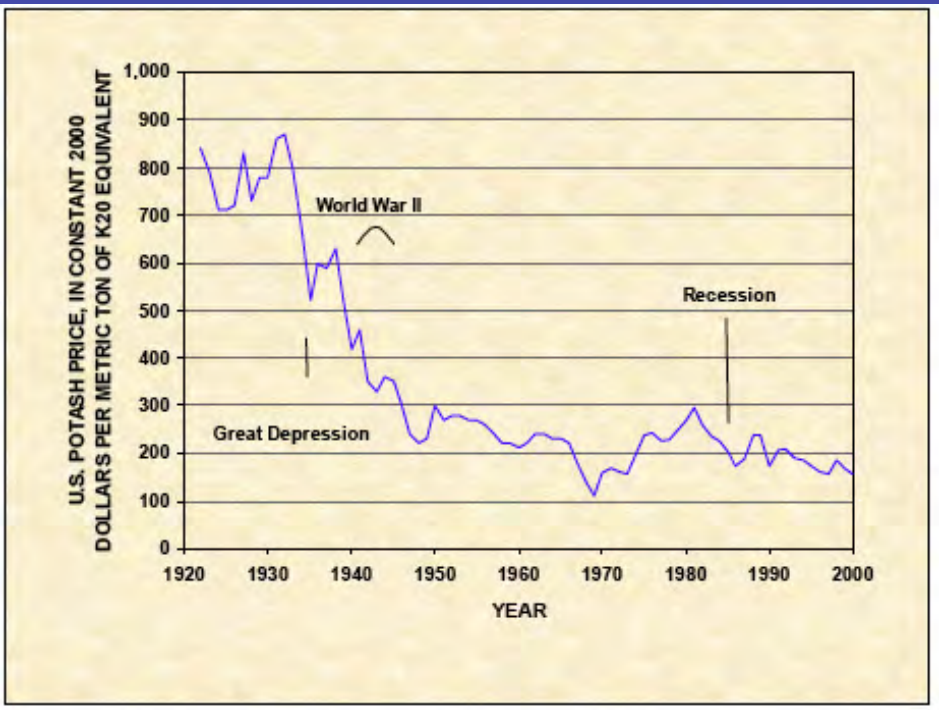
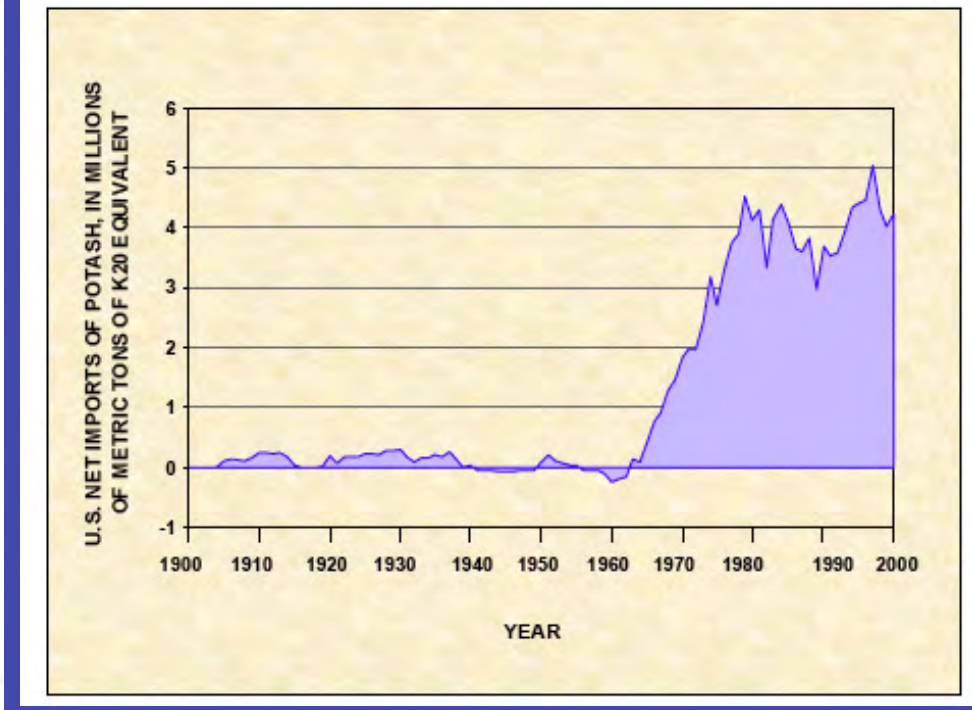


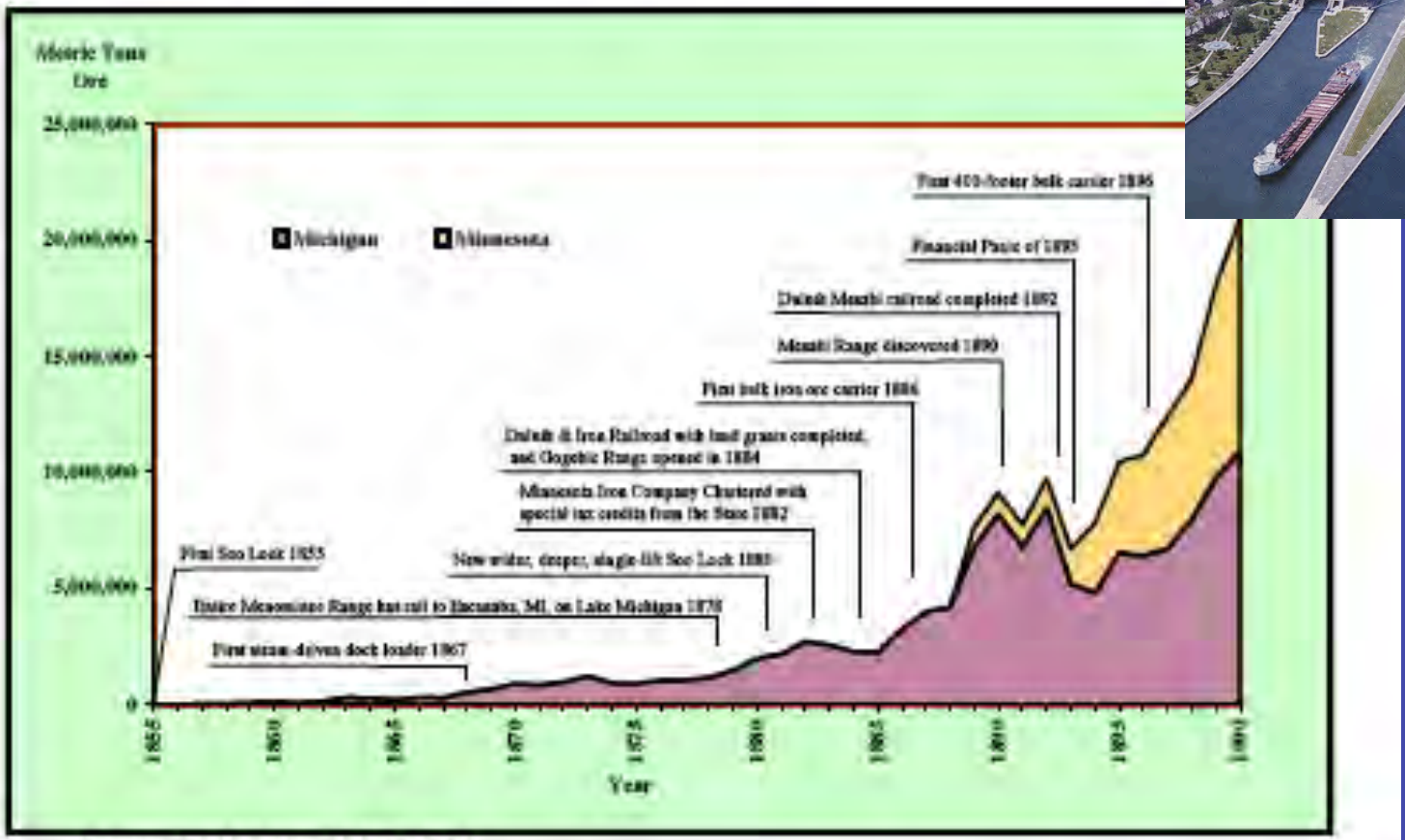
Figure F1. U.S. potash average price, in constant 2000 dollars, 1922-2000 (data from



Wagner et al 2002

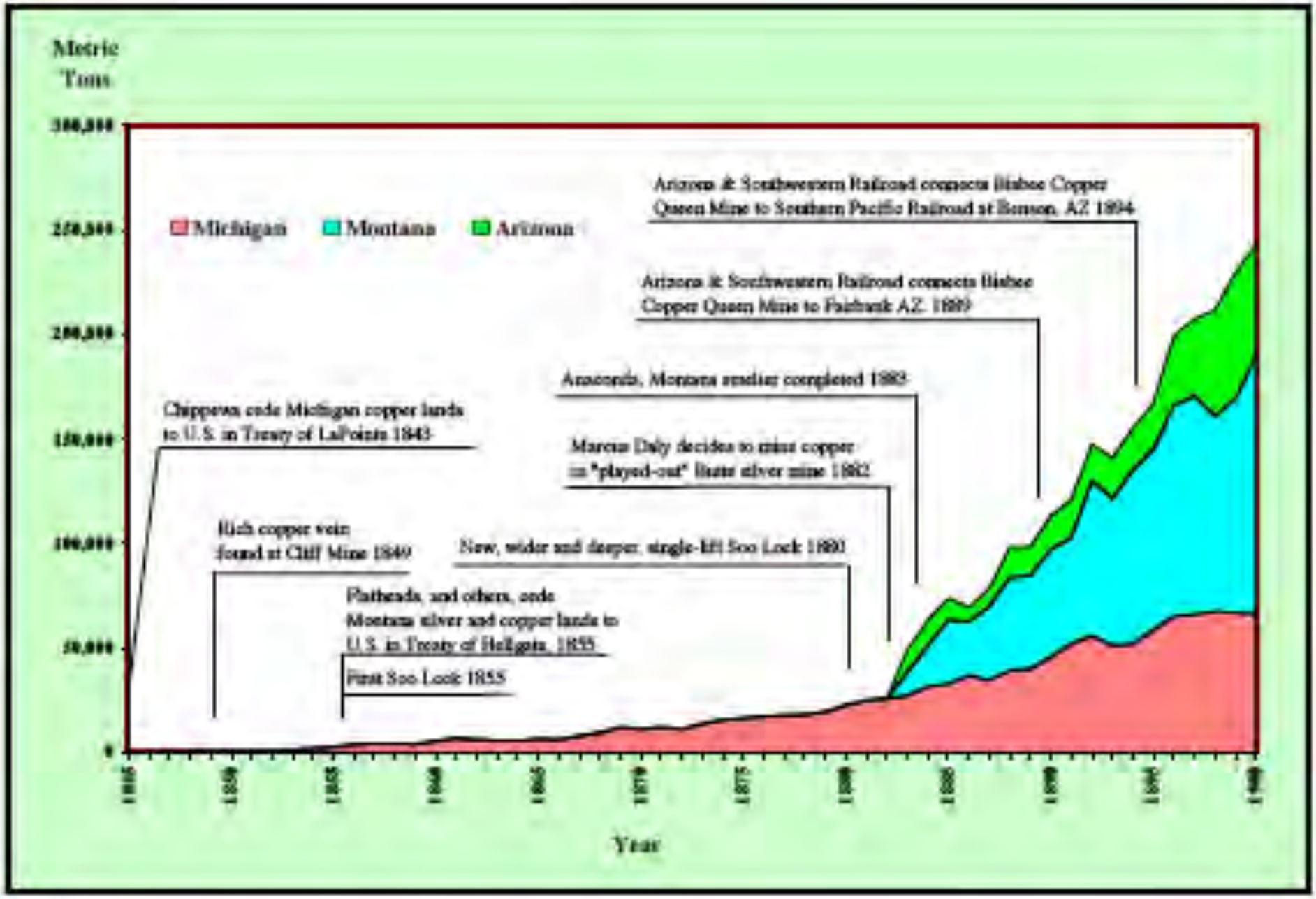
Policy and Production

Figure 5. Nineteenth century Lake Superior iron ore production.



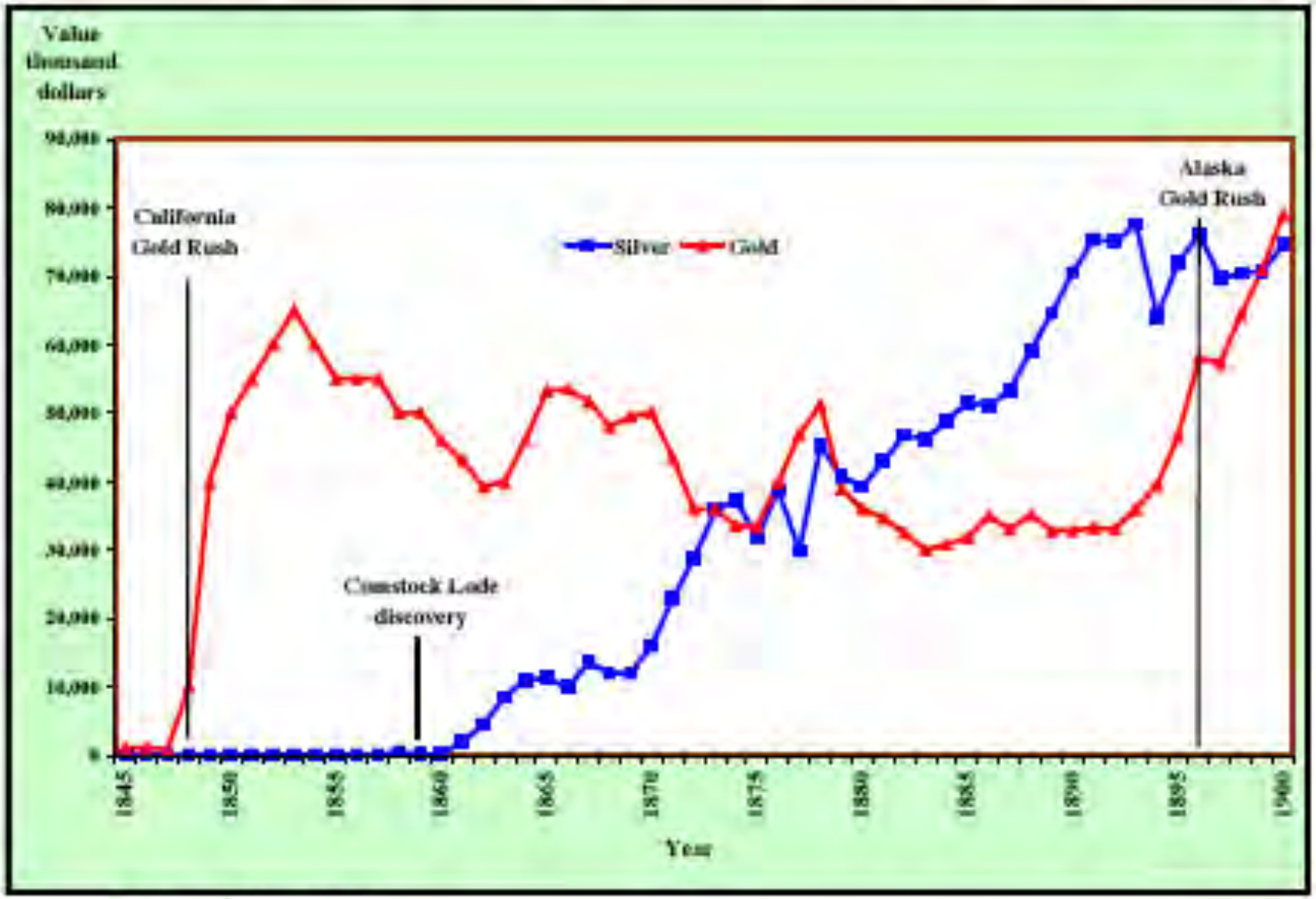
Source: Birkinbine, 1892, 1901.

Goonan 2002


Metric Tons
Michigan
Montana
Arizona
Arizona & Southwestern Railroad connects Bisbee Copper Queen Mine to Southern Pacific Railroad at Benson, AZ 1894
Arizona & Southwestern Railroad connects Bisbee Copper Queen Mine to Fairbank AZ 1889
Anaconda, Montana smelter completed 1883
Chippewa cede Michigan copper lands to U.S. in Treaty of LaPointe 1843
Marcus Daly decides to mine copper in "played-out" Butte silver mine 1882
Rich copper vein found at Cliff Mine 1849
New, wider and deeper, single-lift Soo Lock 1881
Flatheads, and others, cede Montana silver and copper lands to U.S. in Treaty of Hellgate, 1855
First Soo Lock 1855
Year

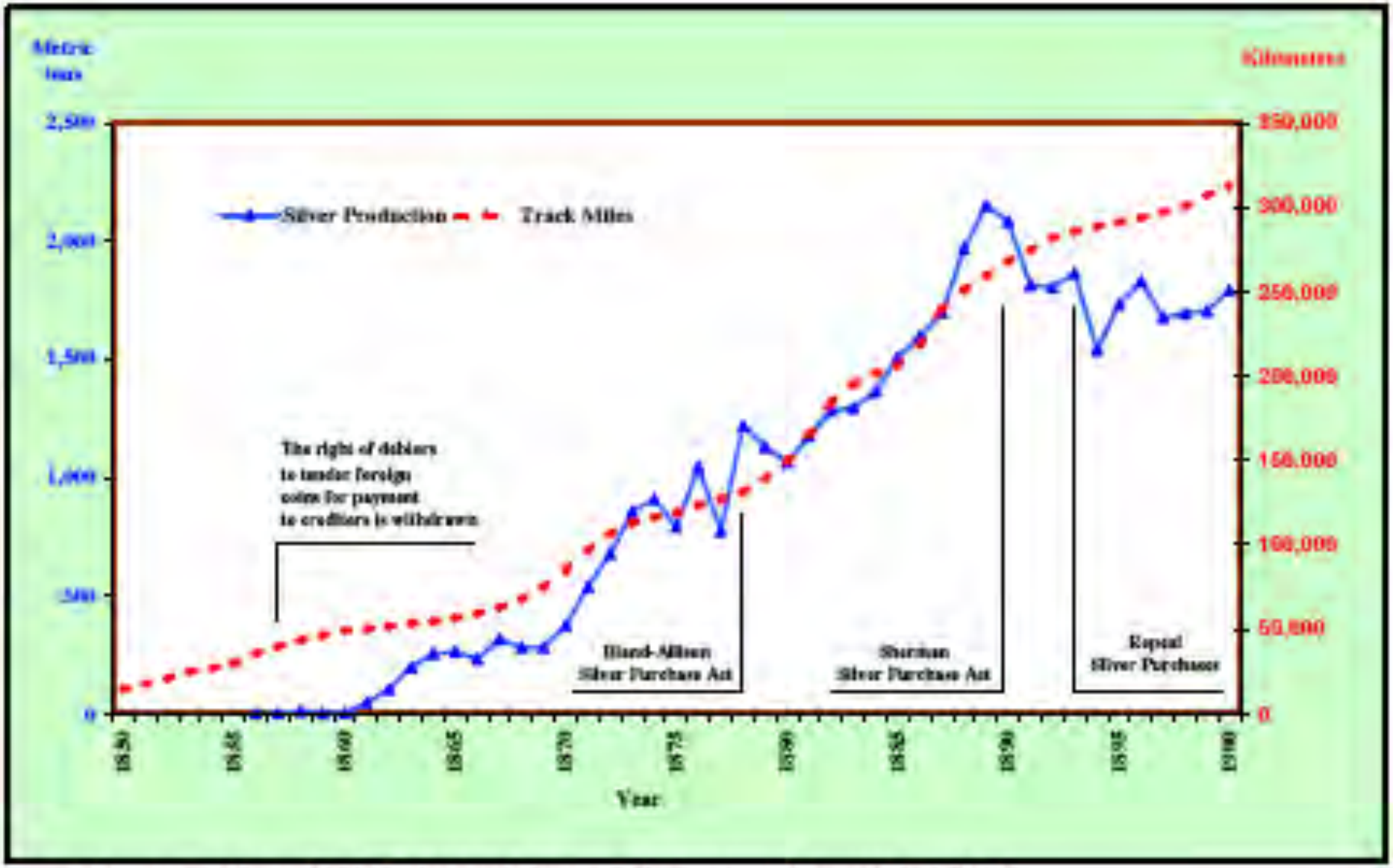
Goonan 2002

Figure 6. U.S. production of gold and silver in the 19th Century.



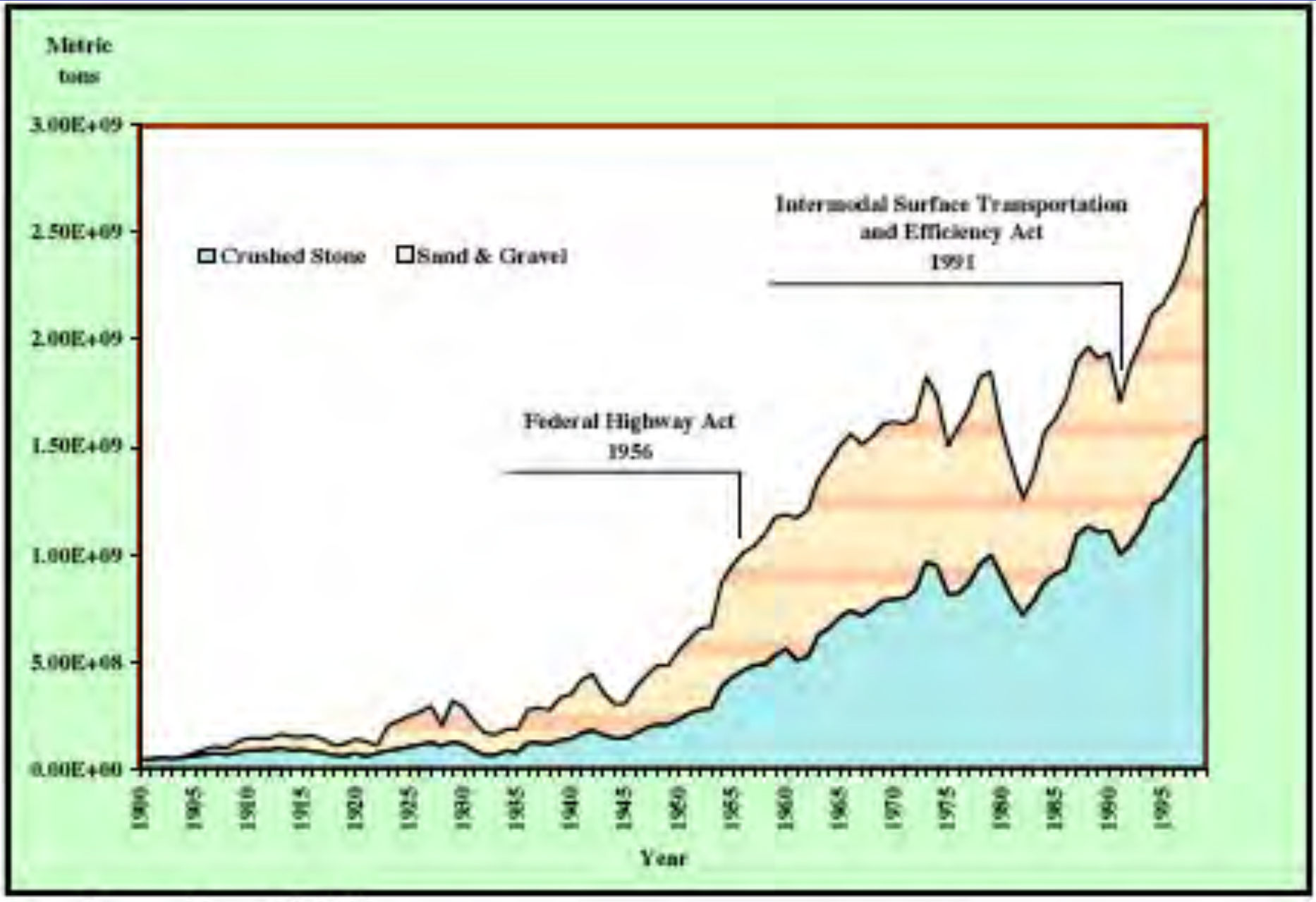
Source: Roberts, 1901.

Goonan 2002



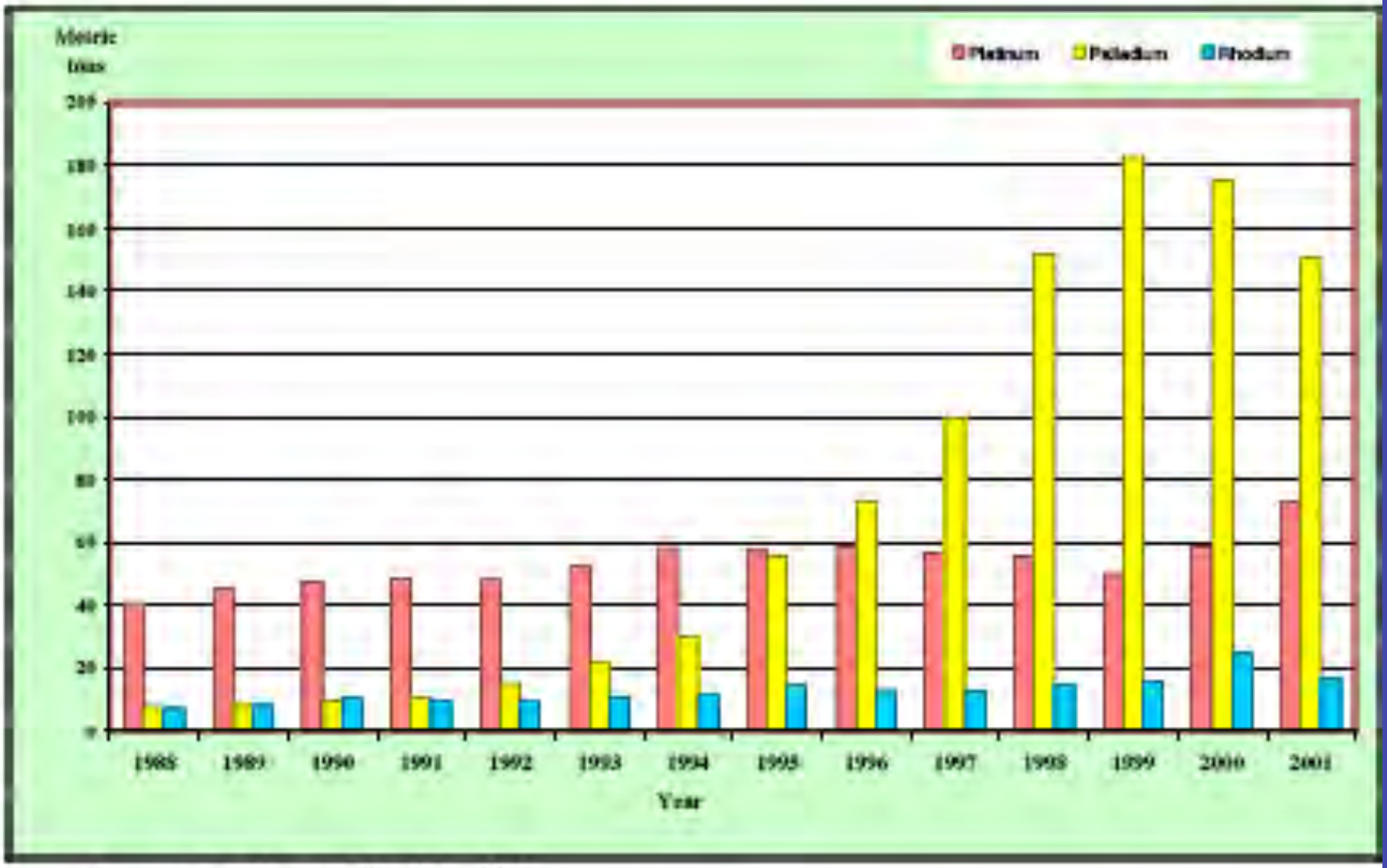
Source: Roberts, 1901; National Bureau of Economic Research, 1912§.

Goonan 2002


Metric tons
3.00E+09
2.50E+09
2.00E+09
1.50E+09
1.00E+09
5.00E+08
0.00E+00
Crushed Stone
Sand & Gravel
Intermodal Surface Transportation and Efficiency Act 1991
Federal Highway Act 1956
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
Year

Goonan 2002

Figure 12. World use of platinum, palladium, and rhodium for catalytic converters.



Source: Cowley and Hanlein, 2001

Goonan 2002

Table 1. Land acquisitions that grew 13 original United States to 50 United States.

Land Acquisition	Date Acquired	From	States derived from acquired land:
Treaty of Paris	1783	Great Britain	Alabama (95%), Illinois, Indiana, Kentucky, Maine, Michigan, Minnesota (33%), Mississippi (95%), Ohio, Tennessee, and Wisconsin
Louisiana Purchase	1803	France	Arkansas, Colorado (40%), Iowa, Kansas (80%), Louisiana, Minnesota (67%), Missouri, Montana (90%), Nebraska, North Dakota, Oklahoma (85%), South Dakota, and Wyoming (60%)
Florida Purchase	1819	Spain	Alabama (5%), Florida, and Mississippi (5%)
Texas Accession	1845	Republic of Texas (Mexico)	Colorado (30%), Kansas (20%), New Mexico (65%), Oklahoma (15%), Texas, and Wyoming (5%)
Webster-Ashburton Treaty	1846	Great Britain	Idaho, Montana (10%), Oregon, Washington, and Wyoming (15%)
Guadalupe-Hildago Treaty	1848	Mexico	Arizona (75%), California, Colorado (30%), Nevada, New Mexico (33%), Utah, and Wyoming (20%)
Gadsden Purchase	1853	Mexico	Arizona (25%), and New Mexico (2%)
Alaska Purchase	1867	Russia	Alaska
Hawaii Accession	1898	Republic of Hawaii	Hawaii

Compiled from Gannett, 1900.
The 13 original colonies, Vermont (from New York), and West Virginia (from Virginia) are excluded.
Numbers in parentheses represent the author's estimate of percent of the State's territory associated with the subject acquisition.

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Government Land Surveys

Name/Authority	Year	Purpose
Amos Eaton/New York	1820	Albany County, NY, for agriculture
Amos Eaton/New York	1821	Rensselaer County, NY, for agriculture
Amos Eaton/New York	1823	Districts adjoining Erie Canal, for agriculture
D. Olmstead/North Carolina	1823	State, for agriculture and gold
Army Corps of Engineers	1824	Public canals and roads
Topographical Bureau, U.S. Army	1834	Geophysical structure, mineral resources and products of the public lands
U.S. Exploring Expedition	1836	Explore U.S. territory
Corps of Topographical Engineers	1838	Map the continent, a project that continues to date
Fremont Expeditions	1842–46	Three expeditions through the American northwest (English control), and the American west (Spanish control).
Railroad Exploration	1853	To find most practical rail route from Mississippi River to west coast.
Clarence King U.S. Corps of Engineers	1867	Survey the 40th Parallel for rail possibilities
John Wesley Powell	1869	Explore Green and Colorado rivers
George Wheeler	1869	North-South routes through Nevada
Ferdinand V. Hayden	1871	Survey Nebraska, Colorado, and Wyoming
U.S. Geological Survey	1879	Established as permanent agency for mineral, water, and survey work, including mapping

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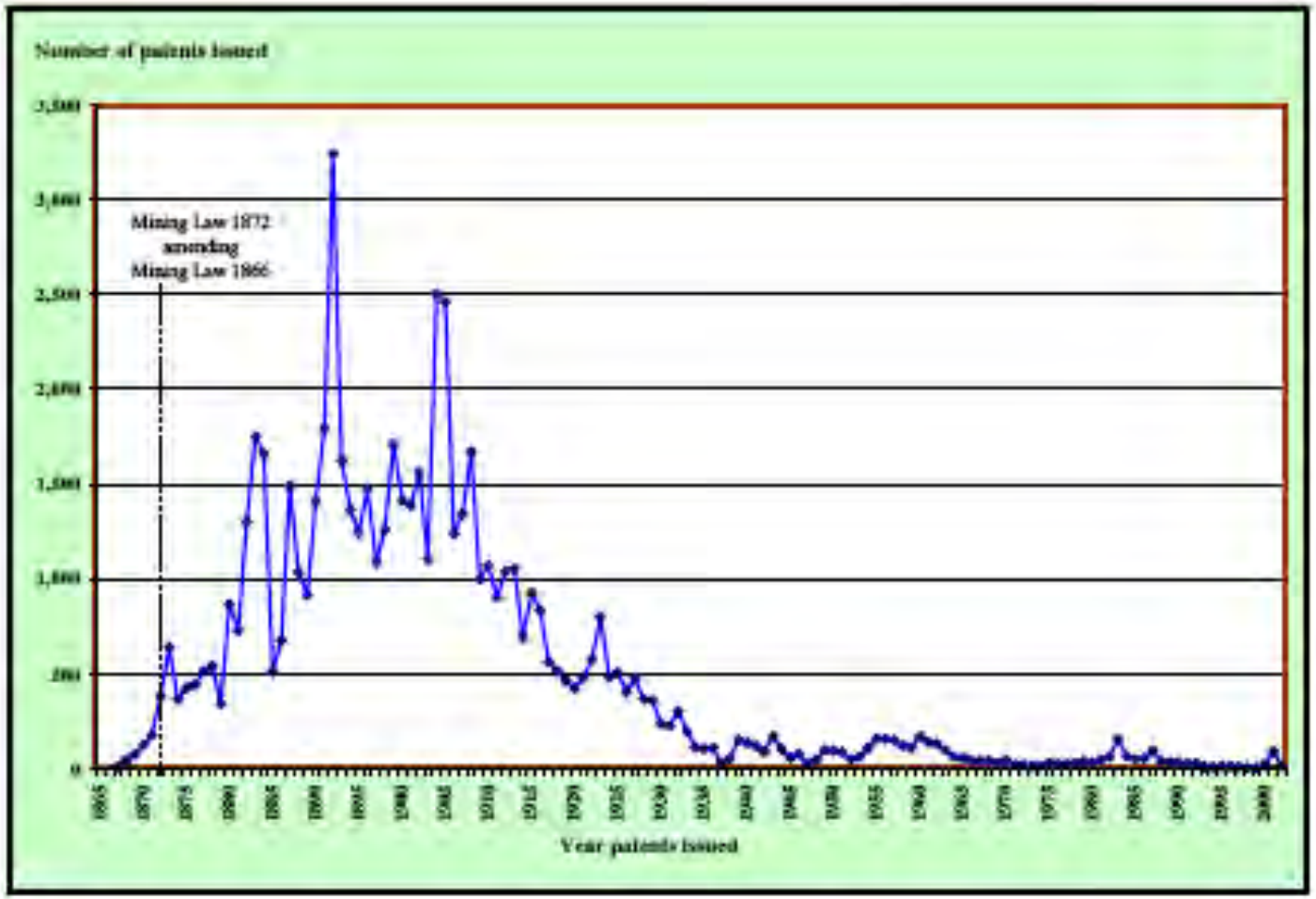
Figure 3. Patents issued under the General Mining Act of 1872.



Source: R.E. Deery, U.S. Bureau of Land Management, written commun., 2002.
Data for years 1867 through 1873 is claims patented, not patents.

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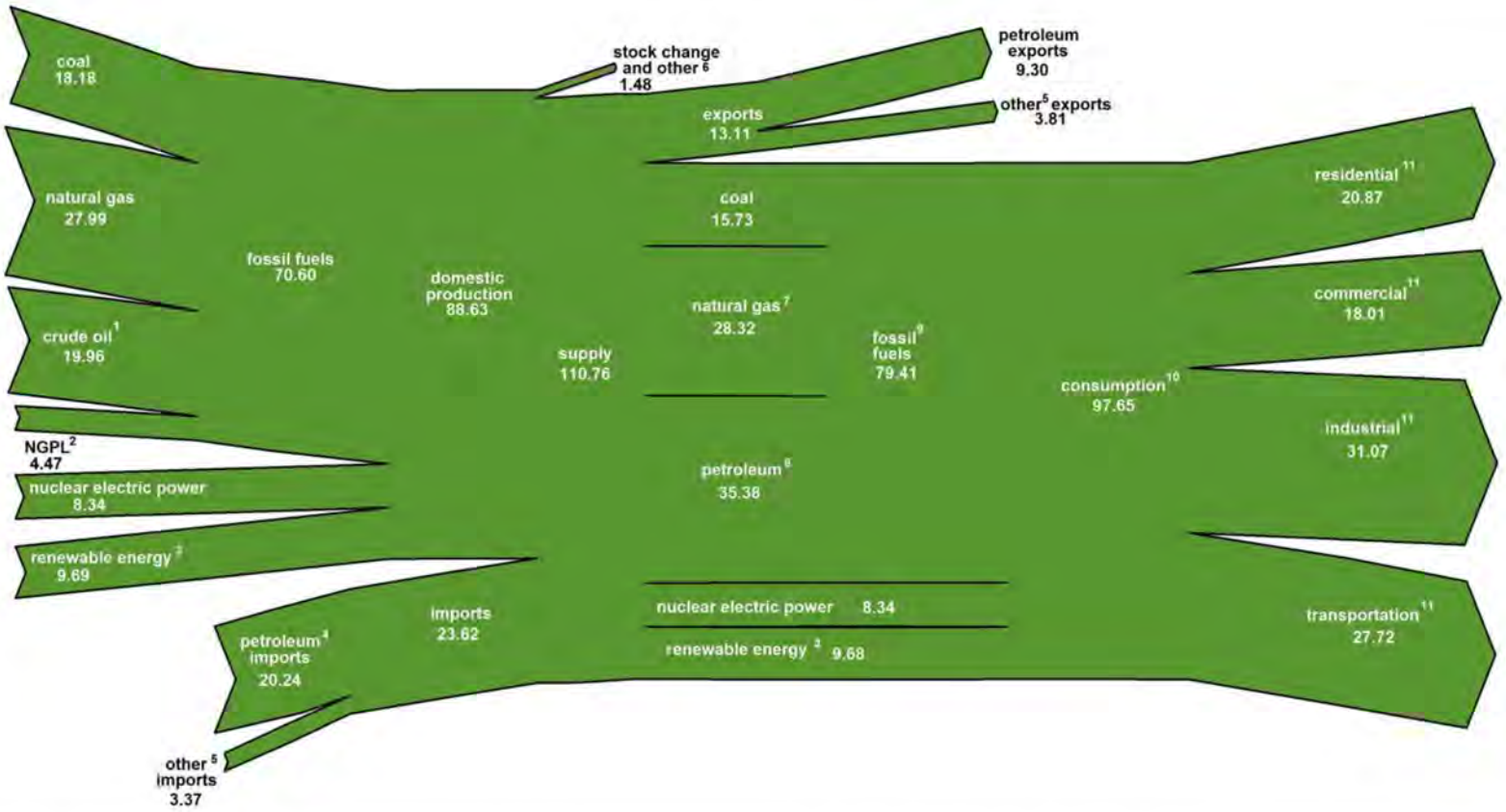
Legislation/Program	Year	Public Purpose
Indian Lands Leasing Act	1891	Authorized mineral leases on Indian land[1].
Stock Raising Homestead Act	1916	Authorized mineral location and claims on homestead claims[2].
Mineral Leasing Act	1920	Authorized and governs leasing of public lands for development of deposits of coal, oil, gas and other hydrocarbons, sulfur, phosphate, potassium, and sodium[3].
Various Acts to create Hydro-electric Dams	1933 to 1944	The "New Deal" featured the building of many high profile dams. These provided employment, river transportation, recreation, irrigation, and inexpensive electricity[4].
Mc Mahon Act	1946	Established the Atomic Energy Commission. Commission uranium purchases created an industry boom, until purchases ended in 1970[5].
Strategic and Critical Minerals Production Act	1950	Authorized government stockpiling of "strategic" minerals, effecting production subsidies for many[6].
Federal Aid Highway Act	1956	Authorized construction of the U.S. Interstate Highway System, increasing the demand for aggregates, cement and steel[7].
Intermodal Surface Transportation and Efficiency Act (ISTEA)	1991 to present	Continually funds transportation infrastructure expansion and repair, sustaining the construc-tion industry and its materials suppliers[8].

Goonan 2002

U.S. Energy Flow, 2015

quadrillion Btu



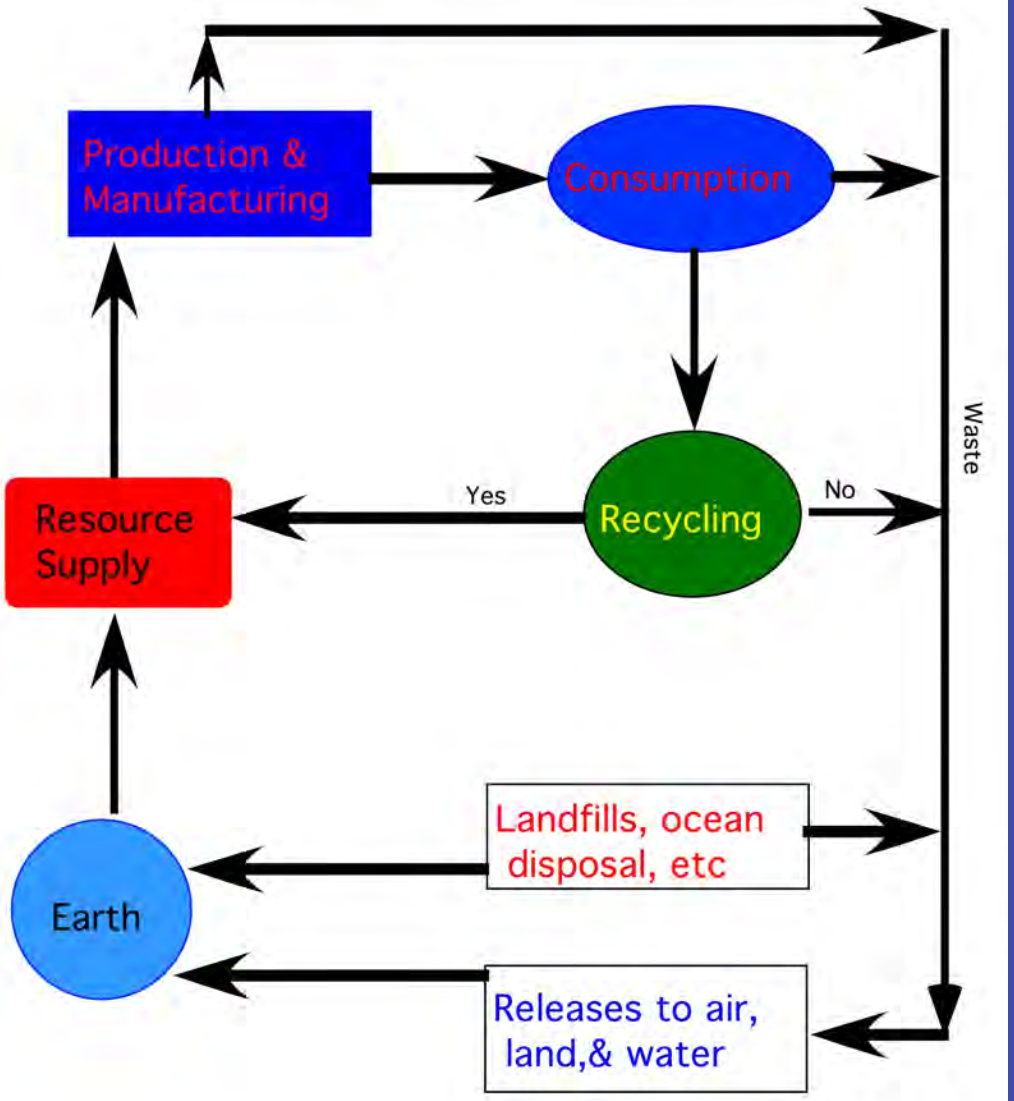
[1] Includes lease condensate.
[2] Natural gas plant liquids.
[3] Conventional hydroelectric power, biomass, geothermal, solar, and wind.
[4] Crude oil and petroleum products. Includes imports into the Strategic Petroleum Reserve.
[5] Natural gas, coal, coal coke, biofuels, and electricity.
[6] Adjustments, losses, and unaccounted for.
[7] Natural gas only; excludes supplemental gaseous fuels.
[8] Petroleum products, including natural gas plant liquids, and crude oil burned as fuel.
[9] Includes -0.02 quadrillion Btu of coal coke net imports.
[10] Includes 0.23 quadrillion Btu of electricity net imports.
[11] Total energy consumption, which is the sum of primary energy consumption, electricity retail sales, and electrical system energy losses. Losses are allocated to the end-use sectors in proportion to each sector's share of total electricity retail sales. See Note 1, "Electrical System Energy Losses," at the end of U.S. Energy Information Administration, *Monthly Energy Review* (April 2016), Section 2.

Notes: • Data are preliminary. • Values are derived from source data prior to rounding for publication. • Totals may not equal sum of components due to independent rounding.

Sources: U.S. Energy Information Administration, *Monthly Energy Review* (April 2016), Tables 1.1, 1.2, 1.3, 1.4a, 1.4b, and 2.1.

https://www.eia.gov/totalenergy/data/monthly/pdf/flow/total_energy.pdf

Materials Flow Cycle



Modified from USGS(1998)

El Bourj el Arab, Dubai

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