Lead -- A Brief History: Occurrence and Use

Presented by

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Lead -- A Brief History: Occurrence and Use

We have lead because we had a lot more heavy, radioactive elements present in the early solar system.

When elements such as Uranium (elt 92) and Thorium (elt 90) decay by emission of alpha particles (elt 2) , they lead to lead (elt 82).

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Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Period 1	1 H																	2 He
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	57-71	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra	89-103	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Uut	114 Fl	115 Uup	116 Lv	117 Uus	118 Uuo

82 Pb

57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

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Lead has four stable isotopes:

204, 206, 207, and 208.

But it has 38 isotopes (atomic mass types), more than any other element.

http://www.periodictable.com/Properties/A/KnownIsotopes.html

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Lead-208 is the heaviest stable isotope of any element.

(But both thorium and bismuth have isotopes with a half-life longer than the age of the known universe.)

http://www.periodictable.com/Properties/A/KnownIsotopes.html

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Lead mineral deposits apparently all come from lead sulfide compounds reaching the crust by volcanic flows from the earth's mantle.

But many of these original igneous deposits are so old and reworked that lead is also found in sedimentary deposits and incorporated by ion exchange into calcium minerals.

(Environmental Pb^{2+} behaves like Fe^{2+} and Ca^{2+}just like Pb^{2+}in the body does, but our oxygen atmosphere means that there are virtually no naturally occurring Fe^{2+} minerals.)

http://geology.com/usgs/lead/

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Location	ppb by weight
Universe	10
Sun	10
Meteorite (carbonaceous)	1400
Crustal rocks	10000
Sea water	0.03
Stream	3
Human	1700

https://www.webelements.com/lead/geology.html

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Lead was known to many ancient peoples.

Pearls of metallic Lead and Copper were found at archaeological stratum X at Catal Hüyük, Konya, Anatolia, Turkey, dated at around 6500 BC.

http://elements.vanderkrogt.net/element.php?sym=Pb

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Plumbum *Lead*

Lood – Blei – Plomb – Plomo – 鉛 – Свинец – 鉛

Dense, dark blue-gray metal. Fairly soft
melting point 328 °C; 622 °F
boiling point 1740 °C; 3164 °F
density 11.35 g/cc; 708.56 pounds/cubic foot

http://elements.vanderkrogt.net/element.php?sym=Pb

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Perhaps the first written mention as "*abaru*" is on Babylonian tablets found in the library of the Assyrian king Ashurbanipal (668-626 BC). One of them includes a hymn to Gibil, the god of fire:

"You melt Copper and Lead, you clean Gold and Silver".

http://elements.vanderkrogt.net/element.php?sym=Pb

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During the excavations of the city of Ashur*a Lead chunk weighing 400 kilograms and dating from 1300 BC was discovered.

An important city of ancient Assyria, the nation that carried off the Ten Tribes of Israel from northern Palestine; the archeological site is in Iraq.

http://elements.vanderkrogt.net/element.php?sym=Pb

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"Only the gold, and the silver, the brass, the iron, the tin, and the lead, every thing that may abide the fire, ye shall make it go through the fire, and it shall be clean " (Numbers 31, 22-23, KJV).

http://elements.vanderkrogt.net/element.php?sym=Pb

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The alchemists believed Lead to be the oldest metal and associated it with the planet Saturn.

Sugar of lead (below) was a favorite poison of the Borgias and the Medicis in the middle ages; professional poisoners classified it as a saturnine poison.

http://elements.vanderkrogt.net/element.php?sym=Pb

Lead

A Brief History

http://www.deiwos.org/celestial-gods.html

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Because of its heavy weight it played a special role in the alchemic operations, they assigned to it the ability easily to be converted into Gold. They had many names for it, some secret, among others Plumbago (lead ore).

http://elements.vanderkrogt.net/element.php?sym=Pb

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But in England the term *plumbago* was also applied to galena (lead sulfide ore) and later for the naturally occurring graphite (found in the 14th C CE).

Because of this mistaken association, we still refer to the graphite-clay mineral in pencils by the name of pencil lead (English only!).

http://www.todayifoundout.com/index.php/2010/11/why-pencil-lead-is-called-lead/

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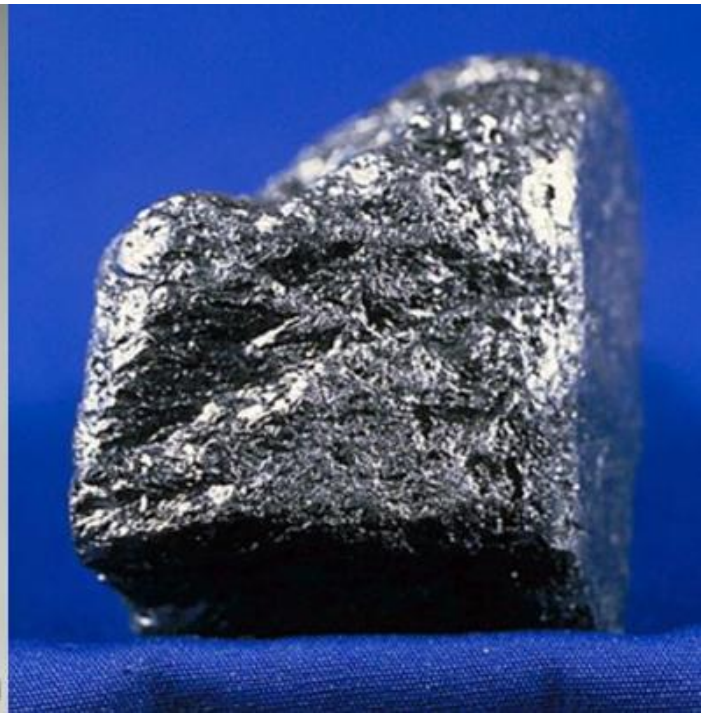

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Besides its awe-inspiring density, the earliest uses of lead and lead minerals appear to have been

- cosmetics and
- the manufacture of bronze.

Lead -- A Brief History: Occurrence and Use

Crushed dark powders ("kohl") have been used on the skin by African and Asian peoples

- to protect against the sun,
- to promote eye health ("strengthen the eyes,")
- and for cosmetic purposes.

Their use in Egypt dates to at least 3100 BCE.

https://en.wikipedia.org/wiki/Kohl_%28cosmetics%29

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They are still used today under various names.

https://en.wikipedia.org/wiki/Kohl_%28cosmetics%29

Lead -- A Brief History: Occurrence and Use

Bronze is usually described as an alloy of copper and tin.

But copper ores often contain lead (and zinc) as well. While zinc is hard to smelt (so brass develops centuries after bronze), lead smelts very easily and gets incorporated into the bronze alloy product.

Lead -- A Brief History: Occurrence and Use

The manufacture and use of bronze was pivotal in the history of civilization. Its introduction in the Tigris-Euphrates valley and its spread through Asia, North Africa, and Europe marks a turning point in the political, social, and economic history of the world.

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Bronze supplanted stone implements for hunting, agriculture, and warfare about 5000 years ago, just as it would itself be supplanted about two millenia later by iron.

Bronze technology spread from western Asia into the rest of the Eurasian landmass and into northern Africa. It was never important in Australia or the Americas.

Lead -- A Brief History: Occurrence and Use

Lead -- A Brief History: Occurrence and Use

By Roman times metallurgy progressed far beyond the Bronze Age capabilities, but the easily smelted silver and copper still predominated.

After conquering Transalpine Gaul, the Romans settle in to operating the German silver mines, leading to a massive explosion in the production of a significant by-product: ***lead***.

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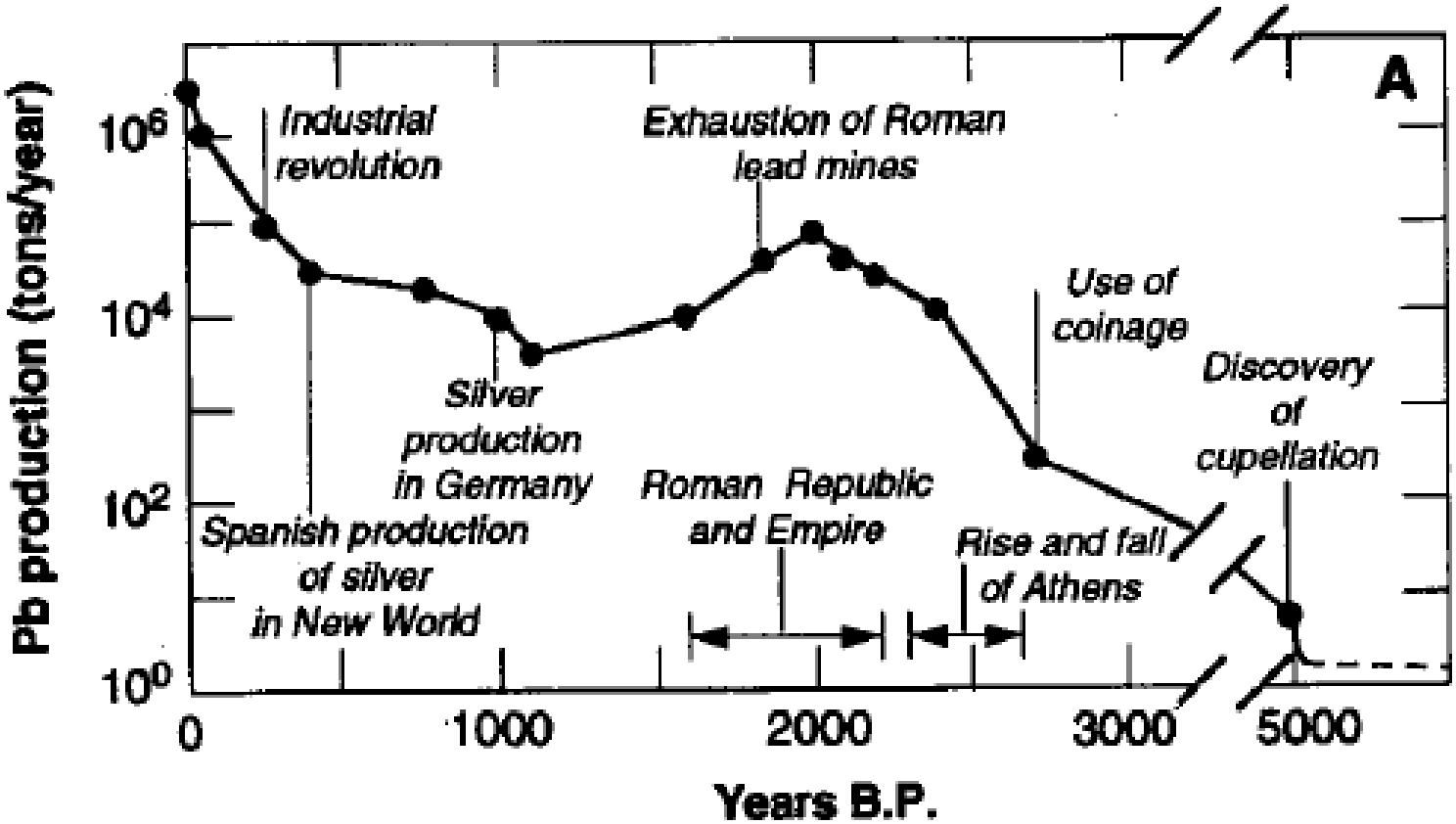

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Once so much lead is available, innovative Roman engineers find many uses for it, specifically including

- Water pipes
- Aqueduct liners and siphons
- Weights
- Liquid containers/liners

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Roman water pipes (France)

http://www.romanaqueducts.info/picturedictionary/pd_onderwerpen/pipe.htm

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By Emanuele - Flickr: Pont du Gard, CC BY-SA 2.0, https://commons.wikimedia.org/w/index.php?curid=18375492

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Roman lead commercial weight – Buckinghamshire England

https://finds.org.uk/database/images/image/id/502674

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Roman Cu/Pb cooking vessels: London 1st – 4th C CE
http://www.thehistoryblog.com/archives/5113

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A 30-year-old woman was laid to rest in a wood coffin at Juellinge, Denmark around 200 BC, shown. Together with cosmetic items and jewelry, the woman held a long-handled bronze strainer-cup in her right hand, part of an imported Roman wine-set, including a bucket, ladle and incised glass beaker behind her head

http://www.dailymail.co.uk/sciencetech/article-2930150/Travel-time-bottle-BEER-Alcohol-archaeologist-creates-authentic-ales-wines-using-2-000-year-old-residues-pots.html

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As a result of the secondary uses of lead, the Romans began to mine for lead directly, especially in Britain.

It was probably the liquid containers that were the biggest problem for the Roman elites.

(It was known that the lead/silver mines were a good place to kill off the enemies of the Roman state as well: see *Silver Pigs: A Marcus Didius Falco Mystery* by Lindsey Davis)

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When exposed to air, wine turns to vinegar.

When exposed to air and vinegar, lead dissolves to form a very soluble – and sweet-tasting -- compound:

lead acetate (sugar of lead).

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According to the CDC, the oral median lethal dose for lead acetate is about ¾ of an ounce for the average adult human being.

And the Roman elites developed a real fondness for slightly vinegared wine stored in lead-lined vessels.

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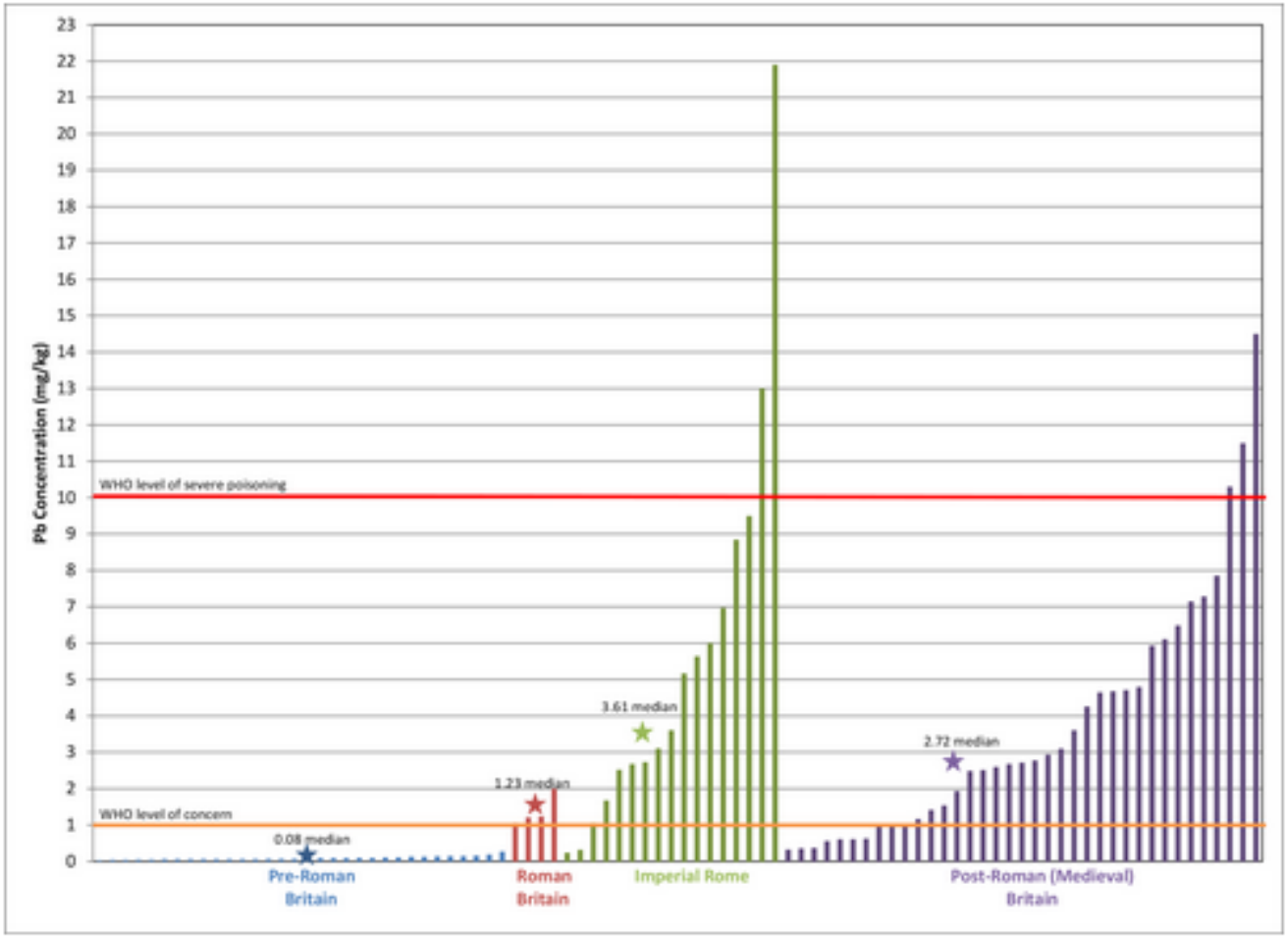

Lead concentration from skeletons from Britain and Rome.

(Raw data from Montgomery et al. 2010, Tables 11.2, 11.3, 11.4.)

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Some historians believe that it was this proclivity that did them in.

Levels in the skeletons of provincial Roman elites are the highest ever measured in any population on the planet.

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The industrial era greatly expanded the uses of lead and lead compounds beyond anything seen in pre-Roman times.

Our best record of Northern Hemisphere lead production is from looking at biennial air emissions of lead – deposits into the Greenland ice sheet.

It only bring us up to about 500 years BP (roughly the arrival of Columbus in the Americas).

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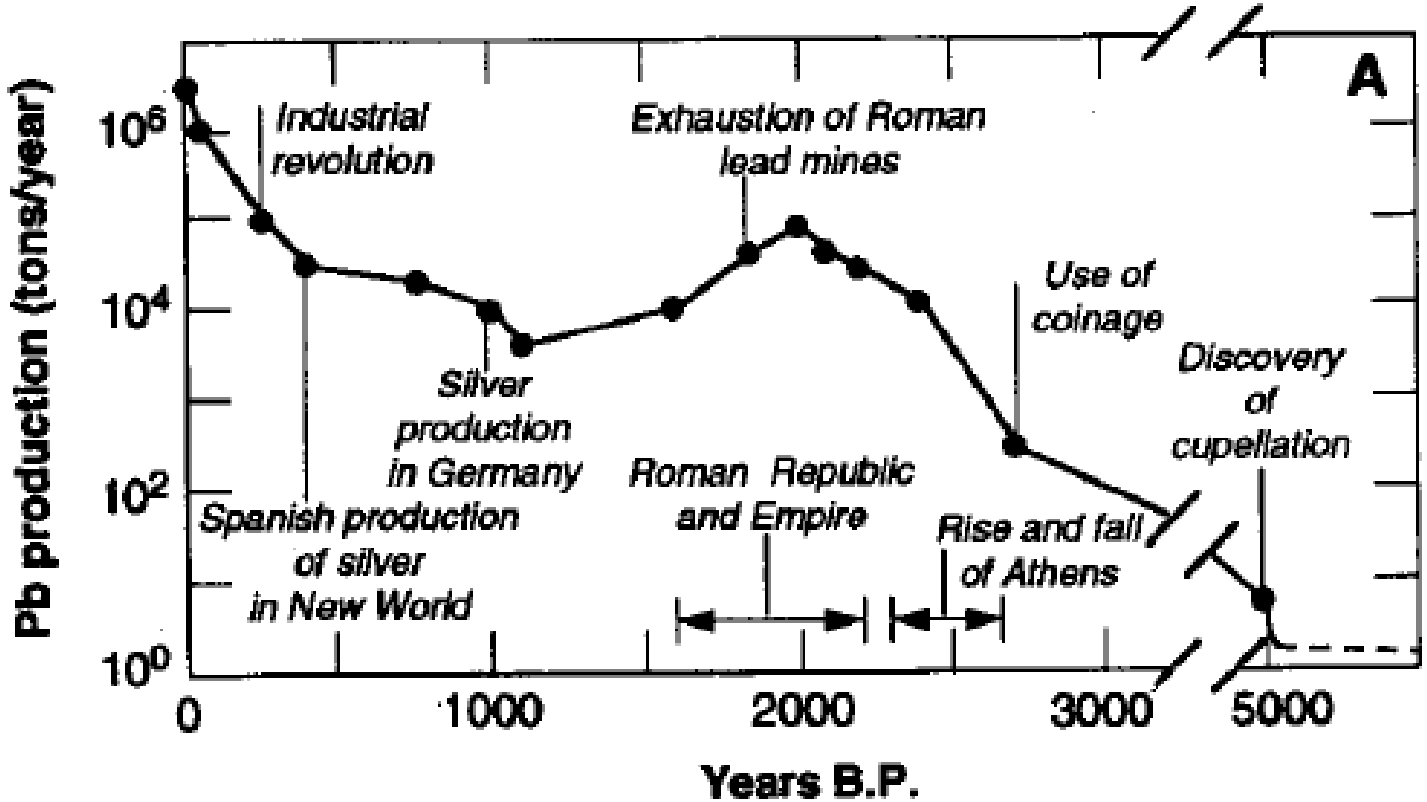

Hong. Sungmin; Candelone, Jean-Pierre, Patterson, Clair C.; Boutron, Claude F., *Science;* Sep 23, 1994; 265, 5180 pgs. 1841-1843.

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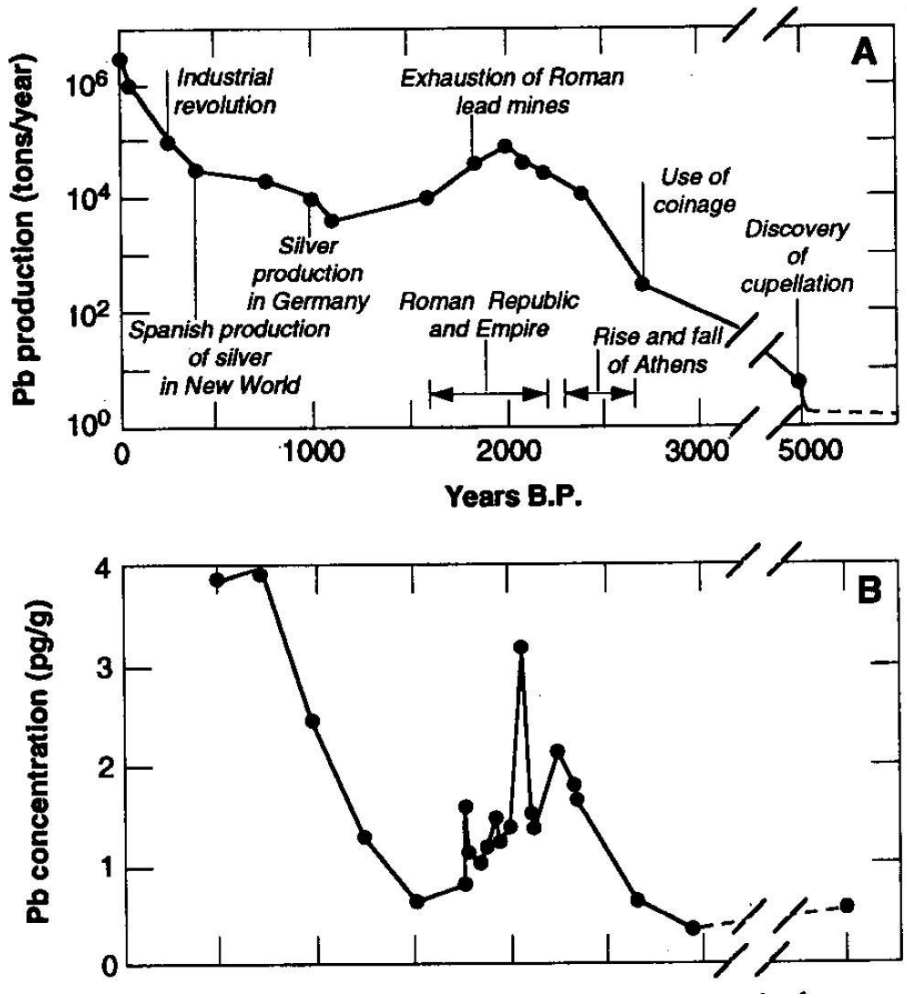

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The upshot is that the remarkable properties of lead metal and its ease of access to technological societies has not only contaminated our physical environment, but the environment's inhabitants as well.

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NEJM FULL TEXT

N Engl J Med. 1979 Apr 26;300(17):946-51.

Skeletal concentrations of lead in ancient Peruvians.

Ericson JE, Shirahata H, Patterson CC.

Abstract

The level of biologic lead (expressed as the ratio of atomic lead to atomic calcium) in bones of Peruvians buried 1600 years ago was found to be 3 x 10(-8), as compared to 2100 to 3500 x 10(-8) in the bones of present-day residents of England and the United States. The ratio of barium to calcium was 2 to 3 x 10(-6) in bones of ancient Peruvians and present-day Americans. Barium and lead have similar morphologic distributions in organisms, so this discrepancy for lead must result from overexposure of present-day people to industrial lead and not from natural variations. The magnitude of this discrepancy has been confirmed by two different lines of investigation not reported in this article. This new evidence suggests that natural interactions of lead in human cells have not yet been determined because reagents, nutrients and controls used in laboratory and field studies have been contaminated with lead far in excess of naturally occurring levels.

Subsequent speakers will help clarify the health consequences of this massive cultural and environmental change.