

LEAD INDUSTRIES ASSOCIATION

430 LIDINGTON AVENUE

NEW YORK 17, N. Y.

February 28, 1956

SUBJECT: LEAD CHAPTER
"ECONOMIC GEOGRAPHY OF
INDUSTRIAL MATERIALS"

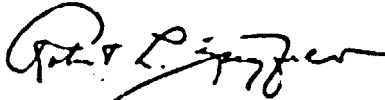
To Members of the Lead Industries Association:

Attached please find a reprint of the chapter on lead that appears in the just published book entitled "Economic Geography of Industrial Materials" edited by Prof. Albert S. Carlson, Department of Geography, Dartmouth College, Hanover, N.H.

The book was published by the Reinhold Publishing Corporation, 430 Park Avenue, New York 22, N.Y., and is available at \$12.50 per copy.

A limited number of reprints were made available to us at no cost and as long as the supply lasts, extra copies can be furnished members upon request.

Sincerely yours,



Secretary



13. LEAD

Robert L. Ziegfeld and David M. Borcina

Lead Industries Association, New York, N. Y.

The importance of lead to the economy and well-being of the people of the world is exemplified by its close association with those items of commerce that contribute to a nation's standard of living. For example, lead is vital to all our modern means of rapid transportation—airplane, automobile, railroad and ship; it is essential to modern methods of communication and electrical power transmission, and to the use of X-rays and radium; it plays a vital role in the development and utilization of atomic energy; it is a part of the finest plumbing, one of the greatest contributions to the comfort and sanitation of modern homes, and it makes possible the economical production of many of industry's most useful chemicals and their derivatives.

These varying uses depend not upon a single property or characteristic of lead but upon many different properties. It is employed in some instances primarily for its weight or density, in others because of its resistance to corrosion, or its softness and malleability, or its ability to alloy readily with certain other metals to change or modify its properties. Lead is particularly unusual among the metals in that a third of all the lead consumed is the result of the properties of its chemical compounds, many of which like white lead, red lead, litharge and tetraethyl lead are of immense industrial importance.

As old as lead is, many of its more important applications are developments of the twentieth century. Tetraethyl lead, lead

azide, lead soaps for greases, lead in steel, lead alloys for stamping and leaded frits for porcelainizing aluminum, lead molds and lead compound stabilizers for plastics, and lead counterweights in aircraft are just a few of the recent applications that are making a decided impression on modern living.

Modern research has broadened the application of old or established uses of lead and is currently finding new uses for it, particularly the hundreds of lead compounds that are known but not yet commercially used. The United States was fortunate in having available within its own borders all of the lead needed for its growing economy during the major portion of the present industrial age. However, with the advent of World War II, when the demand increased beyond the capacity of its own mines and the availability of scrap the United States had to obtain lead outside its own borders. Since World War II, consumption has reached unprecedented heights and there is every reason to believe that the present level will be maintained and possibly increased in the foreseeable future.

Table 13-1 provides statistical data on the lead industry in the United States for the period 1925 to date.

The United States is and has been for a great many years the principal lead producing country of the world, now accounting for 20 to 25 per cent of the world output. The accompanying map of the United States locates the primary smelters and refineries and major mining districts (Figure 13-1).

TABLE 13-1. UNITED STATES LEAD PRODUCTION, IMPORTS, CONSUMPTION AND PRICES,
1925-1954 (EXCLUSIVE)
(In Short Tons)

Year	Average N.Y. Price (Cents per Pound)	Domestic Mine Production ^a	Domestic Secondary Production ^b	Imports ^c			Total Imports	Total Supply Mine, Secondary and Imports	Domestic Consumption ^d	Exports ^e
				Ores and Concentrates	Bullion	Refined Lead				
1925	9.02	684,000	226,000	44,800	70,000	7,000	122,100	1,033,800	856,500	100,800
1926	8.42	684,000	277,000	58,100	78,300	11,300	147,000	1,108,900	900,000	71,900
1927	6.76	665,500	276,000	40,600	118,300	2,500	161,400	1,102,900	840,950	125,300
1928	6.31	627,300	309,000	25,900	128,500	700	155,100	1,080,300	730,600	116,300
1929	6.83	649,000	311,000	31,300	83,100	1,700	116,100	1,075,100	972,300	73,300
1930	5.52	558,300	255,900	39,400	38,000	200	78,200	892,300	768,600	48,300
1931	4.24	404,000	234,700	20,900	32,300	—	53,200	692,500	567,700	21,700
1932	3.18	263,000	198,300	21,000	13,500	—	34,500	525,800	416,700	23,500
1933	3.87	272,700	224,500	6,000	1,000	100	7,700	504,900	449,500	22,900
1934	3.86	267,400	208,400	10,600	2,500	300	13,400	509,300	498,000	5,900 ^f
1935	4.07	311,100	270,400	20,000	1,900	2,100	24,000	625,500	538,900	7,000 ^g
1936	4.71	372,900	262,900	20,700	300	2,000	23,000	659,400	633,550	18,300 ^g
1937	6.01	464,000	275,100	34,100	1,800	5,000	40,900	780,900	679,700	20,100 ^g
1938	4.74	369,700	224,900	45,400	15,300	2,000	62,700	657,300	546,000	45,900 ^g
1939	5.05	414,000	241,500	30,800	48,900	5,800	85,100	740,600	667,000	71,400 ^g
1940	5.18	457,000	260,300	111,300	19,600	151,600	282,500	1,000,300	782,000	89,100 ^g
1941	5.79	461,000	297,000	82,100	24,700	274,300	381,000	1,239,800	1,049,900	14,900 ^g
1942	6.18	496,200	323,000	79,400	43,300	368,500	490,900	1,309,000	1,000,000	5,900 ^g
1943	6.59	453,300	342,100	70,000	4,000	244,000	318,000	1,114,000	1,100,000	13,300 ^g
1944	6.59	416,900	331,400	50,600	80	222,900	316,480	1,064,780	1,020,000	15,500 ^g
1945	6.50	390,900	363,000	70,000	—	227,500	297,500	1,051,300	1,000,000	1,900 ^g
1946	8.17	445,500	342,900	44,300	125	115,500	159,925	888,225	925,000	700
1947	14.67	384,200	212,000	50,900	1,000	150,500	211,900	1,108,100	1,172,000	1,000
1948	18.04	390,500	500,100	63,900	7,200	217,100	318,200	1,208,900	1,129,000 ^g	800
1949	15.36	400,900	412,200	107,300	2,300	275,200	384,800	1,207,000	969,000 ^g	1,100
1950	13.30	430,900	482,300	76,500	3,500	411,900	521,900	1,434,900	1,211,000 ^g	2,900
1951	17.50	396,200	518,100	67,500	2,300	179,000	248,800	1,153,100	1,151,000 ^g	1,300
1952	16.47	390,200	471,000	104,000	800	510,700	615,700	1,177,200	1,101,000 ^g	1,900
1953	13.00	345,000	435,000	100,900	900	385,100	586,900	1,317,300	1,151,000 ^g	800
1954	11.05	319,000	490,000	161,500	40	276,300	437,800	1,236,900	1,078,000 ^g	600

^a Engineering and Mining Journal.

^b U. S. Bureau of Mines.

^c Department of Commerce.

^d American Bureau of Metal Statistics.

^e Ceiling price of 6.50 cents per pound established Jan. 13, 1942, increased to 8.25 cents per pound June 3, 1946, and decontrolled Nov. 12, 1946. Excludes U. S. Government premium payments on mine production.

^f Ceiling price of 17.00 cents per pound established Jan. 26, 1951, increased to 10.00 cents per pound Oct. 2, 1951, and decontrolled Feb. 13, 1953.

^g Does not include lead shipped to the U. S. Government stockpile.

^h Does not include "Drawback" manufactures.

Source: Lead Industries Association.

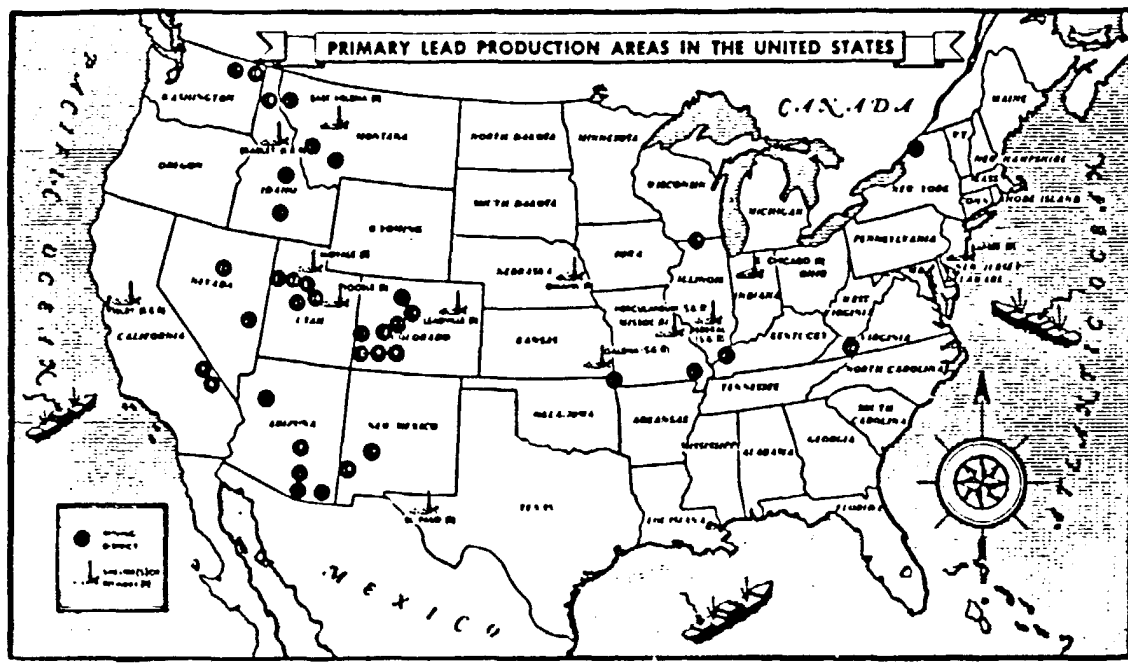


Figure 13-1. Primary lead production areas in the United States. (Courtesy Lead Industries Association.) See facing page for list of mining districts.

PRIMARY LEAD PRODUCTION AREAS IN THE UNITED STATES

State	No.	District	County or Counties
Arizona	1	Harshaw	Santa Cruz
	2	Warren (Hilcoe)	Cochise
	3	Pima	Pima
	4	Old Hat	Pinal
California	5	Big Bag	Yavapai
	6	Hunting Springs	Inyo
Colorado	7	Cano	Inyo
	8	Creede	Mineral
	9	Animas	San Juan
	10	Powder (Rio)	Dolores
	11	Upper San Miguel	San Miguel
	12	Hoofe	Ouray
	13	Tonichi	Gunnison
	14	Leadville	Lake
	15	Red Cliff	Eagle
	16	Warm Springs	Blaine
Idaho	17	Bay Horse	Custer
	18	Coeur d'Alene	Shoshone
Illinois	19	Upper Mississippi Valley	Northern part of state
	20	Kentucky and Southern Illinois	Harden
Kansas	21	Tri State Area	Clerks
Kentucky	22	Kentucky and Southern Illinois	Crittenden
Missouri	23	Tri State Area	12 counties in southwestern part of state
Montana	24	Southeastern Missouri Area	Southeastern Missouri
	25	Butte	Silver Bow
Nevada	26	Hedderston	Lewis & Clark
	27	Eagle	Essex
New Mexico	28	Battle Mountain	Lander
	29	Picche	Lincoln
New York	30	Central	Grant
	31	Magdalena	Socorro
Oklahoma	32	Tri State Area	St. Lawrence
Utah	33	Ophir	Ottawa
	34	Rush Valley	Tooele
	35	Bingham	Tooele
	36	Park City	Salt Lake
Virginia	37	Tintie	Summit, Wasatch
Washington	38	Austinville	Utah, Utah
	39	Bonsburg	Wythe
Wisconsin	40	Metairie	Stevens
	41	Upper Mississippi Valley	Pend Oreille

Missouri is the largest lead producing state in the Union, currently followed by Idaho, Utah, Colorado, Montana, Washington and Oklahoma. Lead mine production from approximately ten other states adds to the yearly total as can be seen from Table 13-2.

Lead ore bodies of commercial value occur in contact-metamorphic deposits, in veins and/or lodes formed by hot solutions at all depths. Massive deposits in gently folded beds of limestone, dolomite, chert, or sand-

stone are typified by lead deposits in southeastern Missouri. Examples of massive replacement deposits, usually in limestone or dolomite and genetically related to igneous activity, are ores of Leadville, Colorado; Bingham, Utah; Sullivan mine, British Columbia; Cerro de Pasco, Peru; and Broken Hill, Australia. Dipping, tabular deposits in the form of replacement lodes are typified by deposits of the Coeur d'Alene district, Idaho, and Park City, Utah.

The greatest lead-producing district in

TABLE 13-2. MINE PRODUCTION OF RENOVABLE LEAD IN THE UNITED STATES BY REGION AND STATE*
(In Short Tons)

Region and State	1925	1930	1935	1940	1945	1950	1954
East of the Mississippi:							
Illinois	474	248	436	1,808	3,006	2,729	2,624
Kentucky	96	101	132	369	129	86	76
New York	—	—	—	1,973	862	1,444	1,164
Tennessee	436	8,367	4,902	573	84	113	3
Virginia	2,179	—	—	2,265	4,243	2,254	2,496
Wisconsin	2,000	1,637	246	448	1,776	522	1,240
Total	6,074	10,253	5,836	7,144	10,006	8,178	8,008
West Central States:							
Arkansas	—	53	38	55	1	9	—
Kansas	15,001	12,910	10,992	11,927	7,370	9,497	3,355
Missouri	306,847	199,632	97,493	172,052	176,573	134,626	122,963
Oklahoma	78,467	23,052	23,405	21,240	12,664	31,724	12,470
Total	302,029	235,647	131,828	205,274	196,610	164,846	140,027
Western States:							
Arizona	10,281	4,246	7,793	13,366	22,967	26,363	8,800
California	4,148	1,740	567	1,772	7,224	15,921	2,330
Colorado	31,855	22,130	5,473	11,476	17,044	27,067	17,700
Idaho	123,363	134,058	79,020	104,834	68,447	100,025	64,636
Montana	22,008	10,653	15,549	23,008	9,999	19,617	14,734
Nevada	10,978	11,529	12,676	7,499	6,273	9,806	3,440
New Mexico	3,762	10,376	7,240	3,922	7,662	4,156	670
Oregon	—	3	30	35	1	17	6
South Dakota	—	—	4	7	—	—	—
Texas	31	198	522	305	—	129	—
Utah	166,844	115,495	61,516	75,698	80,817	44,733	43,700
Washington	2,902	576	103	2,555	3,902	10,334	10,040
Wyoming	—	—	3	—	3	—	—
Total	376,092	311,048	192,769	244,195	181,152	257,654	170,330
Alaska	699	1,365	670	779	11	149	—
Grand Total	684,804	556,313	331,103	457,362	390,871	420,827	318,965

* U. S. Bureau of Mines

the United States is in southeastern Missouri in the vicinity of the Bonne Terre and Flat River. Discovered in 1720 and productive since 1800, this area is currently producing around 125,000 tons annually. Hundreds of acres are underlain by flat lying ore bodies occurring mainly in the Boone Terre limestone of Cambrian age. The ore bodies lie above a depth of 600 feet and are of unusual size, averaging 10 to 15 feet in thickness, 200 to 300 feet in width and 1,000 feet or more in length. The only important ore

mineral is galena, which occurs in disseminated grains and large crystals. Other minerals include marcasite, pyrite, chalcopryrite, and calcite. The ore, carrying 2.5 to 3.5 per cent lead, is easily and economically mined. The deposits lie almost horizontally within a few hundred feet of the surface.

The Cœur d'Alene district in northern Idaho is the second largest lead-producing area in the United States. Mining has been carried on since 1884 with over 5,000,000 tons of lead produced. The district is in

highly folded pre-Cambrian quartzites, slates, and some impure limestones which were intruded by Cretaceous monzonitic masses. Massive faults cleave the area and small faults and shear zones adjacent to the large faults have been filled and replaced to form the ore veins. Disseminated grains and masses of galena and siderite, sphalerite, pyrite, and chalcopyrite, comprise the ore bodies which carry 3 to 12 per cent lead plus silver and zinc.

The principal source of Canadian lead is the great Sullivan mine at Kimberley, British Columbia. Ore minerals averaging 10 per cent lead and 4.5 per cent zinc and consisting of silver-bearing galena, sphalerite, and pyrite occur in a massive ore body some 6,000 feet long and up to 270 feet wide in a zone of tilted pre-Cambrian sediments.

Other productive lead deposits in North America include the replacement lodes of Bingham, Utah; the prolific fissures and bedded limestone replacements of Park City, Utah; the massive limestone replacements of Leadville, Colorado; and the sulfide replacement in altered tuffs at the Buchans mine in Newfoundland, and the lead-silver-zinc ores in the states of Chihuahua, Zacatecas, and San Luis Potosi in Mexico.

Australia ranks second to the United States in world lead production with deposits of 11 to 17 per cent lead in the famed Broken Hill, in New South Wales, and 7.5 to 9 per cent lead at Mt. Isa and Lake George. The chief lead producing district of Europe is in Yugoslavia. Italy's most important deposits are on the island of Sardinia. In Spain, at one time the world leading producer of lead, the chief district is the Linares-Carolina in the Sierra Morena. The Troja and Stantrg mines, averaging 8.7 per cent lead, are important deposits in Yugoslavia. The Baldwin mine in Burma has been a large producer.

The search for new ore is going on constantly. Recent discoveries include several new mines in Missouri and in Idaho where new ore bodies have been discovered and important extensions of old ones delineated.

Lead, as a by-product of new zinc mines, will add to the supply. New reserves in this country are being added each year at a rate that will replace or even exceed the lead annually extracted at present. For example, in 1947 hearings before the Subcommittee on Investigation of Natural Resources of the Senate Committee on Public Lands were published. In these hearings representatives of the United States Bureau of Mines and the United States Geological Survey estimated recoverable lead contained in reserves in the ground at about 6,500,000 tons in 1944, or about fifteen times the average 1935-44 rate of production. However, in the report of the President's Materials Policy Commission, published in 1952, reserves are estimated at about 7,000,000 tons in 1950, or about sixteen times 1950 production. These estimated reserves were somewhat higher in 1950 than in 1944 despite the fact that nearly 2,500,000 tons of lead had been mined from United States mines in the intervening six years. Both reports admit that the figures are minima.

It is not generally practical for a mining company to block out its reserves for more than a few years ahead of its mining operations for economic reasons. The usual practice is to try to find enough reserves to replace the amount extracted through new development work. Furthermore, the value of reserves change from time to time with changes in economic and technological conditions. For example, a large increase in demand may permit the mining of considerable amounts of low-grade ore. This does not change the amount of metal content actually in the ground but merely what may be profitably extracted under any given set of economic conditions. Also improved technology may add large amounts of ore to reserves either through better recovery or lowering costs.

World Lead Mine Production

The total world lead mine production is now exceeding the levels reached in 1937 and 1938 and there is every reason to expect

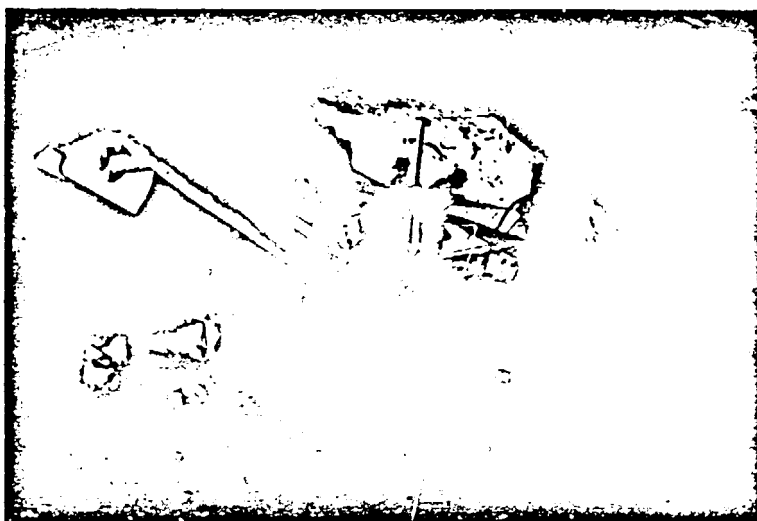


Figure 13.2. Interior of a lead mine showing loading and drilling equipment.

that the current levels of production will continue to rise, with part of the supply coming from new regions. For example, Asia, which accounted for more than 100,000 tons a year prewar, is now producing less than 40,000 tons a year. On the other hand, production from Africa has grown from slightly less than 75,000 tons in 1938 to more than 218,000 tons in 1954. Production in North America has declined approximately 10 per cent over the pre- and postwar years while South America showed material gains in the same period.

A complete summary of world lead production is given in Table 13.3.

The known world reserves of lead contained in ore have been estimated on the basis of the early 1954 world economic situation at 50,000,000 tons, or approximately 25 to 30 times annual consumption.

The outlook for increased production in many areas of the world is optimistic. In Canada, an increase in production may be expected as a result of several new mines

having been opened and the discovery of at least two entirely new zinc-lead districts. Increased production can also be expected of Mexico and Peru. The latter will increase its smelter production too. Important additions are the supplies expected from Morocco, Southwest Africa and East Africa. Australian production, based on reserves, will increase by 20 per cent.

The United States and Europe will maintain and increase present tonnage but their percentage of world output is expected to decline.

Consumption of Lead

To understand the industrial possibilities of lead some knowledge of its existing uses is necessary. Its applications are so broad throughout all industry that a review cannot hope to be complete, but it will be helpful.

We would still be cranking our automobiles and using gaslights on them were

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TABLE 13.3. WORLD LEAD PRODUCTION^a

Country	1949	1950	1951	1952	1953	1954	1955
United States	692,300	558,300	331,100	280,726	300,831	420,827	318,965
Canada	127,000	106,500	100,300	200,437	173,497	163,607	219,240
Newfoundland	4	20,200	30,200	31,856	27,900		
Mexico	205,200	265,300	202,700	311,253	235,875	292,433	238,763
Total North America	994,700	1,010,300	712,300	922,294	818,103	876,867	777,050
Argentina	8,500	3,300	2,800	26,125	20,370	25,800	28,700
Bolivia		13,300	10,700	14,578	10,481	34,398	30,002
Chile	4,700	750	110	1,016	60	3,637	3,500
Peru		21,800	31,800	63,982	36,154	71,534	119,823
Total South America	13,200	39,100	45,010	105,701	66,965	135,007	172,115
Austria	6,000	9,900	6,200	5	1,802	1,864	3,422
Belgium	72,300						
Czechoslovakia	2,400	5,900	4,200	4,808	1,619		
Denmark		200	280	85	110	137	282
France	22,600	11,800	3,700	5,311	3,318	12,115	11,496
Germany	77,700	67,200	65,100	105,921		49,533	74,420
Greece	5,900	8,200	2,500	4,519	770	2,543	4,131
Italy	27,000	31,000	27,200	43,541	2,778	42,230	50,044
Poland	30,100	13,300	4,700	5,842	7,700	20,000	24,000
Romania		1,100	2,500	6,203	3,707		
Spain	152,200	121,000	73,000	35,083	25,853	41,754	39,877
Sweden		6,800	9,800	9,502	22,153	21,902	23,454
United Kingdom	3,300	22,800	46,200	33,312	3,370	3,361	7,306
Yugoslavia	12,100	22,600	71,000	83,646		94,827	92,736
Other Europe	900						
Total Europe	414,600	321,600	319,500	415,497	77,649	246,435	363,470
Burma	32,500	69,100	81,000	99,712		12	12,722
China, including Hong Kong		3,800	1,800	7,716	937		
India					116	702	1,974
Japan	3,700	4,000	8,200	13,000	7,181	12,011	22,076
Korea, Republic of		150	2,000	11,000	2,310	44	300
Turkey	5,300	7,800	4,800	6,173			
Philippines						989	2,014
Total Asia	61,500	106,450	98,000	127,601	10,546	13,726	36,546
Algeria		8,000	320	3,071	263	1,436	11,216
Belgian Congo					906		
Fr. Equatorial Africa					3,300	2,000	3,833
Fr. Morocco	4,700		126	20,944	12,245	53,747	80,516
N. Rhodesia					1,906	15,327	16,800
S. W. Africa	20,300			19,302		29,802	63,306
Tunisia	13,800	6,300	20,833	7,056	20,700	20,700	20,700
Other Africa	500	1,000	8,000	8,000			
Total Africa	18,700	30,100	7,700	74,162	25,356	123,101	218,365

TABLE 13.2. *Continued*

Country	1925	1930	1935	1938	1943	1950	1954
Australia	163,000	221,000	219,000	307,293	174,774	231,971	311,308
Russia	1,100	9,000	80,000	76,000	14,100	123,070	229,500
Total	1,660,800	1,730,930	1,502,230	1,933,104	1,240,623	1,792,309	2,100,932

Source: American Bureau of Metal Statistics.

* Unknown. * Included with Germany. * Included in Other Africa. * Production included with Belgium and Germany. * Production is shown for Belgium in 1925 principally because it was not possible to allocate smelter receipts to point of origin. Belgium has no mine production itself.

* Does not include ore exported to European countries, principally Belgium and Germany.

* Included with Other Europe.

* Major world lead producing districts and/or areas:

United States

Southeastern Missouri
Coeur d'Alene, Idaho
West Mountain, Utah
Tri State, Kansas, S. W. Missouri and Oklahoma
Summit Valley, Montana
Park City, Utah
Upper San Miguel, Colo.
Pueblo, Nevada
California, Colo.
Tintic, Utah
Metalline, Wash.

Canada

Kimberly

Newfoundland

Buchans

Mexico

Chihuahua
Zacatecas
San Luis Potosi
Guerrero

Guatemala

Colima

Argentina

Aguilas
Galinganta

Bolivia

Huanchara
Tupiza
La Quiaca

Pera

Cerro de Pasco
Huayra
Yulcan
Atacocha
Cachapala
Cerro Pasquero
Colquijirra

Austria

Kreuth-Hausberg

Carthago

Priferan

France

Aude
Tarn
Heraut
Aveyron

Germany

Harz Mountains
Rhine-land

Greece

Laurium

Italy

Venezia Euganea
Lombardy
Sardinia
Iglesias
Ariano

Poland

Upper Silesia

Spain

Sierra Morena Range
Sierra Nevada Range

Sweden

Norrbotten
Kopparberg

U.S.S.R.

Eastern Kazakhstan
Tadjikistan
Kirghizistan
North Osetian
Tatarsk

Yugoslavia

Trepan
Mexico

Burma

Bandwin

Japan

Honshu

Australia

Queensland:
Mount Isa
New South Wales:
Broken Hill
Captain's Flat
Tasmania

Africa

French Morocco:
Zellidja
Mideit

Northern Rhodesia:

Broken Hill
S. W. Africa:
Tsumeb

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TABLE 13-1. WORLD LEAD PRODUCTION AND CONSUMPTION 1946-1953
(In Short Tons)

	1947	1948	1949	1950	1951	1952	1953	1954
Primary smelter production ^a	1,430,000	1,517,200	1,714,000	1,676,000	1,629,400	1,664,000	2,020,000	2,133,000
Secondary smelter production	671,000	674,700	664,300	673,500	724,700	644,500	654,200	646,300
Total production	2,101,000	2,191,900	2,378,300	2,350,300	2,354,100	2,308,500	2,674,200	2,779,300
Consumption ^b	2,149,300	2,132,700	1,950,000	2,432,700	2,490,400	2,244,100	2,472,700	2,611,300
Apparent excess or deficit	-48,300	59,200	428,300	-82,400	-136,300	64,400	201,500	168,000

^a Wherever possible, scrap processed at primary smelters has been deducted and is accounted for in the secondary production figures.

^b Includes newly mined lead as well as scrap lead consumed.

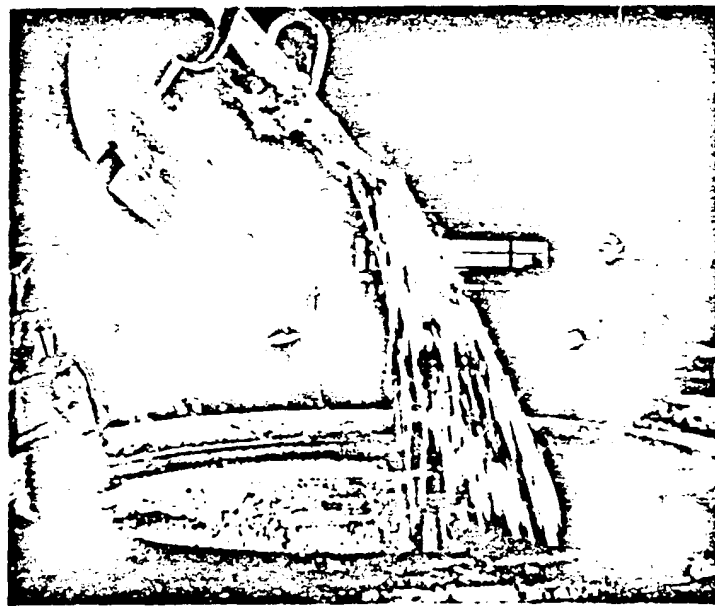


Figure 13-3. Pouring molten lead from a ladle.

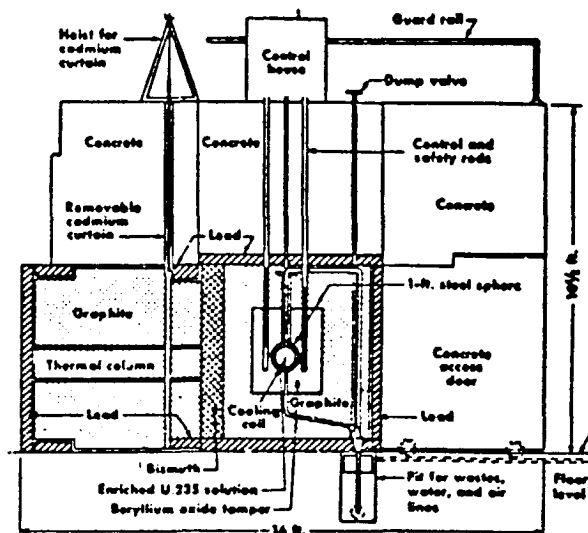


Figure 13-4. Diagram of nuclear reactor showing lead shields necessary to prevent radiation loss and to protect personnel from gamma ray poisoning.

it not for the peculiar electrochemical properties of lead and its oxides utilized in storage batteries. The same type of battery propels submarines under water, lights and air-conditions railway cars, is used in telephone communication, provides emergency power in utility plants, powers industrial trucks and mine locomotives, lights miners' lamps, and now even provides the power for pocket flashlights and hearing aids. The corrosion resistance and flexibility of lead accounts for its application as sheathing for power and telephone cable regardless of whether it is used underground, under water or strung on poles. A seamless lead sheath extruded around the insulated conductors prevents the entrance of moisture.

Equipment and pipelines made of or lined with lead, which resists the fiery attack of sulfuric acid and other corrosives, make possible the lower cost production of many of today's chemical wonders. The density of lead supplies the necessary ballistic properties to small arms ammunition. Lead azide,

a chemical compound, has become a standard detonator explosive for ammunition. Lead is found as an alloying element in bronzes and ballistics and as the principal ingredient of lead-base bearing alloys and in soft solders. The density and atomic weight of lead make it the most efficient material to economically confine the X-ray and gamma ray. Tetraethyl lead in high octane gasoline has been a major factor in making possible the tremendous power of our airplane and automobile engines. Red lead paint is a standard protection for modern steel structures of all kinds; white lead is one of the basic paint pigments used in the protection and beautification of our homes. Modern plumbing and electrical installations, to which lead contributes so much, have made possible the advances in building construction of recent years. The plastics industry makes extensive use of metallic lead molds.

The largest single use for lead in the United States is in the manufacture of lead-

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acid storage batteries. In recent years storage batteries have accounted for almost a third of all the lead consumed. In 1953 and 1954, the use of lead in the manufacture of tetraethyl fluid for gasoline was second largest, a position long held by the cable industry which is the third largest consumer in the United States.

TABLE 13.3. USE OF LEAD IN THE UNITED STATES
(In Short Tons)

	1952	1953	1954	1955	1956	1957
White lead	131,000	83,900	80,000	65,500	41,000	34,000
Red lead and litharge*	42,000	32,000	47,500	50,000	68,200	75,900
Storage batteries	180,000	163,000	175,000	230,300	285,000	310,900
Cable covering	136,000	208,000	38,900	107,000	107,000	136,900
Building	88,000	67,000	22,000	65,000	68,000	61,500
Tetraethyl	-	-	15,000	49,500	75,000	111,100
Ammunition	31,500	33,300	29,300	56,000	43,000	32,900
Foil	32,500	26,000	15,900	21,500	15,000	3,200
Bearing metal	34,000	30,000	13,000	14,000	42,000	32,900
Solder	35,000	27,000	20,000	24,000	47,000	88,100
Type metal	15,000	16,000	15,000	16,900	25,000	36,500
Calking	30,000	21,000	12,000	19,200	35,200	60,200
Other uses†	81,000	71,000	45,000	61,700	132,100	165,100
Total	856,500	768,600	538,900	762,000	1,000,000	1,278,000

Source: American Bureau of Metal Statistics

* Includes antimonial lead.

† Exclusive of oxides for storage batteries.

‡ Chiefly pipe, sheet and extrusions. Includes lead used in chemical construction.

§ Among "Other uses" are lead for brass making, collapsible tubes, lead lined pipe, and other containers, lead headed nails, railway equipment, shipbuilding, scale, washers, weights and ballast, castings of sundry descriptions and quantities used in the automobile industry. Also lead for chemical products, including insecticides, colored pigments, rubber manufacture, etc., all of these being substantial annual uses. However, the estimate of "Other Uses" in the aggregate is largely "by difference." Probably included is more or less lead that might be distributed under some of the heads listed above.

¶ Included in "Other uses."

TABLE 13.4. LEAD CONSUMPTION OF THE UNITED KINGDOM*
(In Short Tons)

	1952	1953	1954	1955
Cable	84,200	129,500	96,500	96,100
Batteries (excluding oxides)	30,700	28,000	30,400	33,500
Oxides and compounds:				
Battery	25,300	22,900	26,000	31,100
Other uses	31,700	29,300	34,900	30,700
Tetraethyl lead	-	5,200	6,000	17,100
White lead	22,500	22,800	21,000	13,300
Sheet and pipe	81,300	93,000	89,000	86,000
Ammunition	10,300	4,200	4,000	5,000
Foil and collapsible tubes	8,900	2,700	4,400	5,000
Solder	10,700	11,300	14,200	14,000
Alloys	9,900	14,200	17,000	16,900
Miscellaneous uses	12,900	16,100	19,500	24,000
Total	229,800	301,000	367,500	375,800

* Included with Oxides and Compounds: Other Uses.

† The British Bureau of Non Ferrous Metal Statistics.

A complete summary of lead consumption in the United States for 1954 and for every fifth year since 1925, is given in Table 13-5.

The difference in the consumption pattern of the United States and the United King-

dom shown in Table 13-6 can be explained by the number of automobiles in each of the two countries, approximately 55,100,000 motor vehicles in the United States as against 4,000,000 in the United Kingdom.

TABLE 13-7. LEAD CONSUMPTION OF THE WORLD*
(In Short Tons)

	1925	1930	1934
United States	925,000	1,211,000	1,078,000
Canada	62,000	54,700	68,000
Mexico	7,000	10,000	12,000
Argentina	25,000	36,000	28,700
Brazil	20,000	21,000	29,200
Other America	4,000	9,100	3,000
Total America	1,044,700	1,345,800	1,220,300
Austria		10,000	19,300
Belgium	45,000	55,000	49,500
Czechoslovakia	10,000	27,500	27,500
Denmark	8,500	12,100	11,000
France	53,700	65,100	108,700
Germany	18,000	110,000	185,200
Italy	11,000	48,100	55,000
Netherlands	15,000	26,000	40,000
Poland	12,000	20,000	24,000
Spain	24,100	21,000	26,000
Sweden	22,000	31,000	37,200
Switzerland	25,500	21,000	17,300
United Kingdom	355,300	367,500	375,000
Yugoslavia	6,500	8,100	6,500
Other Europe	14,000	23,000	25,000
Total Europe	672,500	851,300	1,022,000
India	4,500	17,100	14,700
Japan	29,500	27,100	31,000
Other Asia	5,100	1,000	3,500
Total Asia as reported	39,100	47,000	60,000
Africa	5,000	10,000	17,000
Australia and New Zealand	30,000	34,000	52,000
Russia	32,000	123,000	228,500
Total	114,300	167,900	296,000
Grand total	1,864,300	2,432,700	2,611,300

Source: American Bureau of Metal Statistics

* Includes both primary and secondary lead but does not include Governmental stockpiling.

Imports and Exports

The major portion of the lead moving through international trade channels is in the form of refined pig lead. Each pig weighs from 60 to 110 pounds depending on the producing refinery.

Significant quantities of lead ore, matte and concentrates are moved to countries with smelting and refining facilities. However, we can expect this total to diminish as industrialization programs of the producing countries, now shipping sizable tonnages of ores and concentrates, expand to include

TABLE 13-8. LEAD IMPORTS AND EXPORTS BY PRINCIPAL COUNTRIES
(In Short Tons of Pigs and Bars)

	1952	1953	1954
Imports			
United States	510,700	285,100	276,300
Canada	350	250	150
Belgium	21,500	24,000	24,000
Denmark	12,000	13,700	18,300
France	55,500	44,000	24,200
Germany	7,500	22,000	65,300
Italy	9,300	10,700	14,700
Netherlands	25,500	38,200	48,000
Norway	8,000	8,500	10,000
Sweden	12,000	14,000	15,000
Switzerland	10,000	12,500	17,300
United Kingdom	164,000	201,500	221,200
Exports			
United States	1,700	000	000
Canada	129,700	102,000	116,000
Belgium	60,000	54,700	57,300
Denmark	7,000	4,900	7,000
France	6,000	12,200	18,700
Germany	34,700	41,500	34,000
Italy	1,000	25	00
Netherlands	2,670	3,200	8,000
Switzerland	000	125	00
N. Rhodesia	12,300	13,100	15,000
Australia	150,000	166,200	178,000

Source: American Bureau of Metal Statistics

their own smelting and refining operations. Prior to 1940, imports and exports of the United States were approximately in balance. With the advent of World War II, however, the United States became the largest importing country in the world with the bulk of its imports coming from Mexico, Canada, Central and South America. Other major suppliers are Australia, Yugoslavia and Africa (Table 13-8).

The movement of lead ores and concentrates through international trade channels is difficult to determine. It does appear, however, that Belgium, France, Netherlands, and Germany, outside of the United States, are the leading importers of this commodity, with the bulk of their supply coming from Africa and South America.

Productivity

The usual norms of industry-wide productivity utilized in manufacturing industries cannot be applied to the mining industry as a whole because no two mining operations are ever alike. Productivity of individual operations can of course be measured in various ways, among these are: ore mined per unit of labor, recoverable metal per unit of labor, ore mined per dollar of labor cost, recovered metal per ton of ore, rated horsepower per unit of labor, and rated horsepower per unit of recoverable metal.

The U. S. Bureau of Mines in its "Materials Survey-Lead" published in May, 1951, stated:

"The effect of the depression on the United States lead and zinc industry was to force the shut-down of marginal operation and bring about a sharp curtailment of production by organizations that remained active. To sustain operations in the face of exceedingly low metal prices, it was necessary to mine higher-grade ores. Hence the index of recoverable lead and zinc per ton mined increased from 124.1 in 1929 to a high of 160.8 in 1932, the year of lowest combined lead and zinc production since 1902. Productivity in terms of ore mined per man-hour showed a steady increase from 57.4 in 1926

to 74.2 in 1931, but was slightly lower in 1932 than in 1931 because of heavy requirements for standby and maintenance. As production and employment gradually increased under the stimulus of higher prices, ore-mining efficiency increased over the period from 1929 to 1941, when the index reached 107.7. Part of this improvement is attributable to improved practices and increased mechanization, especially in underground drilling and loading.

"The index of recoverable lead and zinc per man-hour after a peak of 120.8 in 1933 declined to 90.1 in 1937 and was 98.3 in 1941. This was brought about, in spite of generally improved ore-mining efficiency, by a sharp decline in the ore-tenor index from its 1932 peak of 160.8 to pre-World War II lows of 93.5 in 1937 and 91.2 in 1941.

"During World War II the high rate of demand for lead and zinc was met by utilizing lower-grade ores under the incentive of the Premium Price Plan. Hence, the ore-tenor index declined during this period. By reason of labor shortages and generally poorer labor quality, mechanization was stimulated, but shortages in equipment prevented full use of this means of gaining labor efficiency, and it was only by heavy curtailment of development work that ore-mining efficiency was maintained at a reasonably steady level. Consequently, the index of recoverable lead and zinc per man-hour roughly paralleled the ore-tenor index.

"By the end of World War II intensive mining, coupled with cessation of development work, had depleted many deposits. Strong consumer demand accompanied by high metal prices in 1946 permitted the continued utilization of low-grade ores, but conditions were less favorable during 1947 through 1949 when it became necessary to mine higher-grade ores to offset heavy development costs, interruptions due to strikes, and steadily mounting wage scales. Even with greatly accelerated mechanization, the ore-mining labor index for 1949 was only 78.2, and the recoverable metal labor index was 85.1, while the ore-tenor index had

TABLE 13.9. IMPORTS OF LEAD INTO THE UNITED STATES BY COUNTRY
(In Short Tons of Lead Content)

Country	1962				1963				1964			
	Use and Waste	Bulbs	Pipe and Bars	Total	Use and Waste	Bulbs	Pipe and Bars	Total	Use and Waste	Bulbs	Pipe and Bars	Total
Canada	11,937		104,521	116,458	39,242		49,030	88,272	66,788		39,147	105,935
Mexico	2,497		196,872	199,369	3,443		190,731	194,174	2,147		84,836	86,983
Guatemala	4,721	306		5,027	8,341	736		9,077	2,736			2,736
Bolivia	18,473		635	19,108	19,984		230	20,214	16,230			16,230
Chile	3,197			3,197	3,341			3,341	173			173
Peru	26,210	123	42,169	70,502	32,842	123	32,216	65,181	34,797	41	20,046	54,884
El Salvador	126			126								
Honduras	346			346	1,080			1,080	1,643			1,643
Belgium			1,745	1,745			2,017	2,017			330	330
Denmark			166	166			1,273	1,273			3,932	3,932
France			551	551			230	230				
Germany (West)	55		6,052	6,107			4,016	4,016			790	790
Netherlands			2,747	2,747			1,961	1,961			156	156
Spain			3,310	3,310							3,540	3,540
Yugoslavia	370		53,997	54,367			51,838	51,838			24,465	24,465
Algeria												
Fr. Morocco			6,690	6,690	2,633		9,254	11,887			2,313	2,313
United Kingdom			4,216	4,216			1,146	1,146			2,346	2,346
Union of So. Africa	22,656			22,656	29,777			29,777	35,367			35,367
Australia	8,932		82,940	91,872	30,706		70,316	101,022	21,557		56,445	77,992
Japan	3			3							10	10
Philippines	2,146			2,146	2,940			2,940	2,181			2,181
Other Countries	316		21	337	540		416	956	1,161			1,161
Total	104,515	340	510,720	615,624	160,929	160	345,051	506,940	161,522	41	276,247	637,750
U. S. Exports			1,762	1,762			113	113			619	619

Source: American Bureau of Metal Statistics

risen to 108.8. The apparent rise in the ore-mining labor index and in the ore-tenor index in 1949 relative to 1946 was due in part to the decline of tailings re-treatment in the Tri-State district."

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