LEAD INDUSTRIES ASSOCIATION

420 LEXINGTON 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 forseeable 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 INCLUSIVE

(In Short Tons)

Year	Average N. Y. price Cents per Pound[a]	Domestic Mine Production[b]	Domestic Secondary Production[b]	Imports[c]			Total Imports	Total Supply Mine, Secondary and Imports	Domestic Consumption[d]	Exports[c]
				Ores and Concentrates	Bullion	Refined Lead				
1925	9.02	684,400	226,900	44,500	70,600	7,000	122,100	1,033,400	856,500	103,800
1926	8.42	684,000	277,300	58,100	78,300	11,200	147,600	1,108,900	900,900	71,900
1927	6.76	665,500	276,000	40,600	118,300	2,500	161,400	1,102,900	840,850	125,300
1928	6.31	627,200	308,000	25,900	128,500	700	155,100	1,090,300	930,600	116,300
1929	6.83	648,000	311,000	31,300	83,100	1,700	116,100	1,075,100	972,300	73,300
1930	5.52	558,300	255,800	39,400	38,600	200	78,200	892,300	768,600	48,300
1931	4.24	404,600	234,700	20,900	32,300	—	53,200	692,500	567,700	21,700
1932	3.18	293,000	198,300	21,000	13,500	—	34,500	525,800	416,700	23,500
1933	3.87	272,700	224,500	6,000	1,600	100	7,700	504,900	449,500	22,800
1934	3.86	287,400	208,400	10,600	2,500	300	13,400	509,200	498,000	5,900[h]
1935	4.07	331,100	270,400	20,000	1,900	2,100	24,000	625,500	538,900	7,000[h]
1936	4.71	372,900	262,900	20,700	300	2,600	23,600	659,400	633,550	18,300[h]
1937	6.01	464,900	275,100	34,100	1,800	5,000	40,900	780,900	678,700	20,100[h]
1938	4.74	369,700	224,900	45,400	15,300	2,000	62,700	657,300	546,000	45,900[h]
1939	5.05	414,000	241,500	30,800	48,900	5,400	85,100	740,600	667,000	74,400[h]
1940	5.18	457,400	260,300	111,300	19,600	131,600	262,500	1,000,200	792,000	49,100[h]
1941	5.79	461,400	397,400	82,100	24,700	274,200	381,000	1,239,800	1,049,900	11,400[h]
1942	6.48[e]	496,200	323,000	79,400	43,900	366,500	489,800	1,309,000	1,000,000	5,800[h]
1943	6.50[e]	453,300	342,100	70,000	4,600	244,000	318,600	1,114,000	1,100,000	13,300[h]
1944	6.50[e]	416,900	331,400	93,600	60	222,800	316,460	1,064,760	1,000,000	15,500[h]
1945	6.50[e]	390,800	363,000	70,000	—	227,300	297,300	1,051,100	1,000,000	1,800[h]
1946	8.11[e]	335,500	392,800	44,300	125	115,500	159,925	888,225	925,000	700
1947	14.67	384,200	512,000	80,400	1,000	130,500	211,900	1,108,100	1,172,000	1,600
1948	18.04	390,500	500,100	63,900	7,200	247,100	318,200	1,208,800	1,129,000[g]	400
1949	15.36	409,900	412,200	107,300	2,400	275,200	384,900	1,207,000	898,000[g]	1,100
1950	13.30	430,800	482,200	76,500	3,500	441,800	521,800	1,434,800	1,211,000[g]	2,900
1951	17.50[f]	386,200	518,100	67,500	2,300	179,000	248,800	1,153,100	1,151,000[g]	1,300
1952	16.47[f]	390,200	471,300	104,600	400	510,700	615,700	1,477,200	1,101,000[g]	1,800
1953	13.49[f]	335,400	435,000	160,900	900	385,100	546,900	1,317,300	1,151,000[g]	800
1954	14.05	319,000	480,000	161,500	40	276,300	437,800	1,236,800	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 19.00 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.

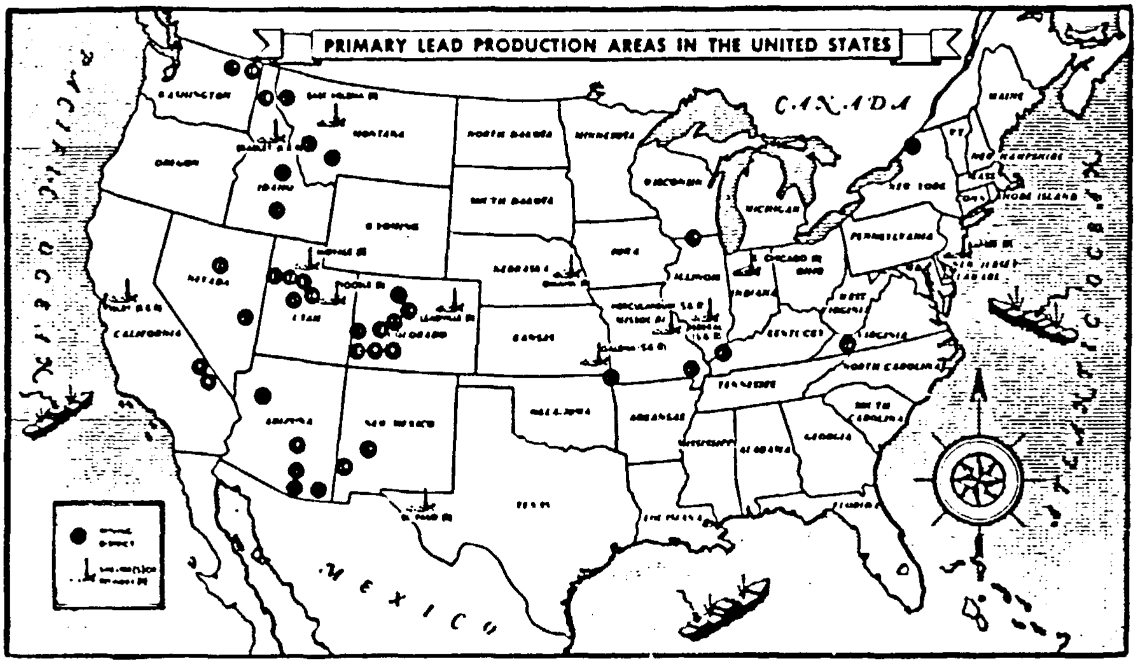

Figure 13.1. Primary lead production areas in the United States. (Courtesy Lead Industries Association) See facing page for list of mining districts.

Primary Lead Production Areas in the United States

State	No.	District	County or Counties
Arizona	[illegible]	Harshaw	Santa Cruz
	[illegible]	Warren (Bisbee)	Cochise
	[illegible]	Pima	Pima
	[illegible]	Old Hat	Pinal
	[illegible]	Big Bug	Yavapai
California	[illegible]	Resting Springs	Inyo
	[illegible]	Coso	Inyo
Colorado	[illegible]	Creede	Mineral
	[illegible]	Animas	San Juan
	[illegible]	Pioneer (Rico)	Dolores
	[illegible]	Upper San Miguel	San Miguel
	[illegible]	Sneffels	Ouray
	[illegible]	Tomichi	Gunnison
	[illegible]	Leadville	Lake
	[illegible]	Red Cliff	Eagle
Idaho	[illegible]	Warm Springs	Blaine
	[illegible]	Bay Horse	Custer
	[illegible]	Coeur D'Alene	Shoshone
Illinois	[illegible]	Upper Mississippi Valley	Northern part of state
	[illegible]	Kentucky and Southern Illinois	Hardin
Kansas	[illegible]	Tri State Area	Cherokee
Kentucky	[illegible]	Kentucky and Southern Illinois	Crittenden
Missouri	[illegible]	Tri State Area	12 counties in southwestern part of state
	[illegible]	Southeastern Missouri Area	Southeastern Missouri
Montana	[illegible]	Butte	Silver Bow
	[illegible]	Heddleston	Lewis & Clark
	[illegible]	Eagle	Sanders
Nevada	[illegible]	Battle Mountain	Lander
	[illegible]	Pioche	Lincoln
New Mexico	[illegible]	Central	Grant
	[illegible]	Magdalena	Socorro
New York	[illegible]		St. Lawrence
Oklahoma	[illegible]	Tri State Area	Ottawa
Utah	[illegible]	Ophir	Tooele
	[illegible]	Rush Valley	Tooele
	[illegible]	Bingham	Salt Lake
	[illegible]	Park City	Summit, Wasatch
	[illegible]	Tintic	Juab, Utah
Virginia	[illegible]	Austinville	Wythe
Washington	[illegible]	Bossburg	Stevens
	[illegible]	Metaline	Pend Oreille
Wisconsin	[illegible]	Upper Mississippi Valley	Lafayette, Iowa, Grant

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 sandstone 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 RECOVERABLE LEAD IN THE UNITED STATES BY REGIONS AND STATES*
(In Short Tons)

Region and State	1925	1930	1935	1940	1945	1950	1954
East of the Mississippi:							
Illinois	474	248	436	1,508	3,006	2,729	2,824
Kentucky	96	101	132	360	129	66	76
New York	—			1,973	862	1,464	1,168
Tennessee	436	8,367	4,902	573	54	113	5
Virginia	2,170			2,295	4,243	3,254	3,496
Wisconsin	2,900	1,537	296	445	1,776	532	1,240
Total	6,074	10,253	5,836	7,144	10,069	8,178	8,608
West Central States:							
Arkansas	—	53	38	55	1	9	—
Kansas	15,001	12,010	10,802	11,927	7,370	9,467	3,355
Missouri	208,547	199,632	97,493	172,052	176,575	134,626	123,863
Oklahoma	78,487	23,052	23,405	21,240	12,664	20,724	12,809
Total	302,029	235,647	131,828	205,274	196,610	164,846	140,027
Western States:							
Arizona	10,281	4,246	7,783	13,266	22,867	26,383	8,900
California	4,148	1,780	567	1,772	7,224	15,931	2,330
Colorado	31,855	22,130	5,673	11,476	17,044	27,007	17,700
Idaho	123,363	134,058	79,020	104,834	68,447	100,025	68,636
Montana	22,008	10,653	15,509	23,036	9,999	19,617	14,738
Nevada	10,978	11,529	12,676	7,499	6,273	9,408	3,440
New Mexico	3,702	10,378	7,290	3,822	7,062	4,150	870
Oregon	—	5	30	35	1	17	6
South Dakota	—	—	4	7	—	—	
Texas	31	198	322	205	—	129	—
Utah	166,844	115,495	61,516	75,688	40,817	44,753	43,700
Washington	2,802	576	103	2,555	3,902	10,334	10,040
Wyoming	—	—	3	—	3		
Total	376,002	311,048	192,700	244,195	184,152	257,654	170,330
Alaska	699	1,365	670	779	11	149	—
Grand Total	684,904	558,313	331,103	457,392	390,851	430,827	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 Bonne 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, chalcopyrite, 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 Coeur 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

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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 Trepca and Stantrg mines, averaging 8.7 per cent lead, are important deposits in Yugoslavia. The Bawdwin 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

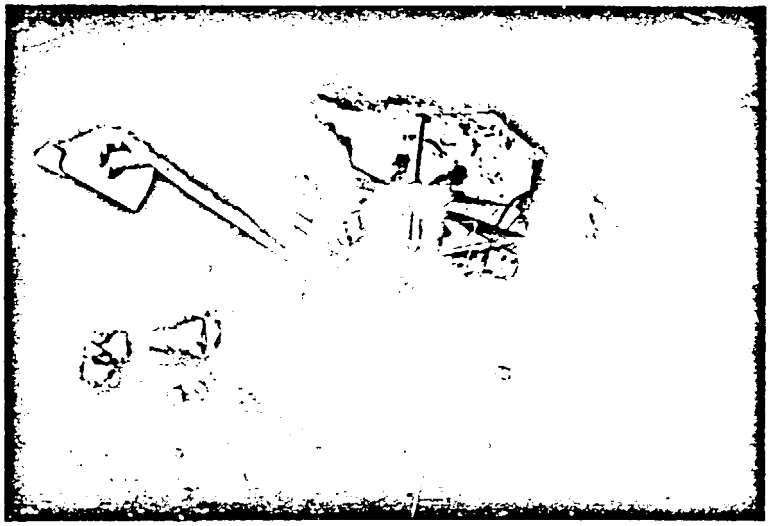

Figure 13.2. Interior of a lead mine showing loading and drilling equipment.

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

TABLE 13.3 WORLD LEAD PRODUCTION*

Country	1925	1930	1935	1938	1945	1950	1954
United States	662,300	558,300	331,100	380,726	390,831	430,827	318,965
Canada	127,000	166,500	160,300	200,457	173,497	165,607	219,240
Newfoundland	4	20,200	30,200	31,856	27,900		
Mexico	205,200	265,300	202,700	311,255	226,878	262,433	239,785
Total North America	994,700	1,010,300	742,300	922,294	818,103	856,957	777,050
Argentina	8,500	3,300	2,800	26,125	20,200	25,400	28,700
Bolivia		13,300	10,700	14,578	10,481	34,396	30,002
Chile	4,700	730	110	1,016	60	3,657	3,300
Peru		21,800	31,400	63,982	56,154	71,554	119,823
Total South America	13,200	39,100	45,010	105,701	96,905	135,007	172,118
Austria	6,000	9,800	6,200	b	1,402	1,904	5,432
Belgium	72,300						
Czechoslovakia	2,000	3,800	4,200	4,409	1,619	•	•
Finland	•	200	250	85	110	157	292
France	22,600	11,800	3,700	5,511	3,318	12,115	11,496
Germany	77,700	67,200	65,100	105,921	•	49,533	74,420
Greece	5,900	8,200	2,300	4,519	770	2,543	4,131
Italy	27,000	33,000	27,300	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	3,500	6,233	3,707	•	•
Spain	152,300	121,000	73,000	35,063	28,853	41,754	39,877
Sweden	•	6,000	9,800	9,502	22,153	24,992	33,454
United Kingdom	3,300	22,800	46,200	33,312	3,209	3,261	7,306
Yugoslavia	12,100	22,000	71,000	85,640	—	94,937	92,736
Other Europe	900						
Total Europe	414,000	323,400	319,500	415,497	77,649	356,435	363,470
Burma	52,900	89,100	81,000	86,712	—	12	12,722
China, including Hong Kong	—	3,000	1,800	7,716	937	—	—
India	—	—	—		116	702	1,974
Japan	3,700	4,000	8,300	13,000	7,181	12,011	22,096
Korea, Republic of	—	150	2,000	11,000	2,310	44	200
Turkey	5,300	7,800	4,900	6,173		—	-
Philippines	—	—	—			909	2,034
Total Asia	61,900	106,450	98,000	127,601	10,546	13,738	38,946
Algeria		8,000	330	5,071	263	1,436	11,218
Belgian Congo		•	•	•	906		—
Fr. Equatorial Africa		•	•	•	3,200	2,000	3,833
Fr. Morocco		4,700	136	30,944	12,245	53,747	90,818
N. Rhodesia		•	•	•	1,926	15,327	16,800
S. W. Africa		20,300		19,302		29,802	65,308
Tunisia		13,800	6,300	20,833	7,056	20,790	30,306
Other Africa		500	1,000	8,032	—	—	-
Total Africa	16,700	50,100	7,700	74,162	35,556	123,101	218,368

TABLE 13.3. *Continued*

Country	1925	1930	1935	1940	1945	1950	1954
Australia	165,000	221,000	249,700	307,293	174,774	231,971	311,508
Russia	1,100	9,000	40,000	76,000	14,100	123,070	228,500
Total	1,669,800	1,730,930	1,502,230	1,953,104	1,240,423	1,702,300	2,100,952

Source: American Bureau of Metal Statistics.

[a] Unknown. [b] Included with Germany. [c] Included in Other Africa. [d] Production included with Belgium and Germany. [e] 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.

[f] Does not include ore exported to European countries, principally Belgium and Germany.

[g] Included with Other Europe.

[h] 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.
- Pioche, Nevada
- California, Colo.
- Tintic, Utah
- Metaline, Wash.

Canada
- Kimberly

Newfoundland
- Buchans

Mexico
- Chihuahua
- Zacatecas
- San Luis Potosi
- Guerrero

Guatemala
- Coban

Argentina
- Aguilar
- Galingasta

Bolivia
- Huanchaca
- Tupiza
- La Quiaca

Peru
- Cerro de Pasco
- Huaron
- Vulcan
- Atacocha
- Casapalca
- Cerrapasquio
- Colquijirca

Austria
- Kreuth Bleiberg

Czechoslovakia
- Pribram

France
- Aude
- Tarn
- Herault
- Savoie

Germany
- Harz Mountains
- Rhineland

Greece
- Laurium

Italy
- Venezia Euganea
- Lombardy
- Sardina:
  - Iglesias
  - Arbus

Poland
- Upper Silesia

Spain
- Sierra Morena Range
- Sierra Nevada Range

Sweden
- Norrbotten
- Kopparberg

U.S.S.R.
- Eastern Kazakhstan
- Tadjikistan
- Kirghizstan
- North Ossetian
- Tetyukhe

Yugoslavia
- Trepca
- Mezica

Burma
- Bawdwin

Japan
- Honshu

Australia
- Queensland:
  - Mount Isa
- New South Wales:
  - Broken Hill
  - Captains Flat
- Tasmania

Africa
- French Morocco:
  - Zellidja
  - Midelt
- Northern Rhodesia:
  - Broken Hill
- S. W. Africa:
  - Tsumeb

TABLE 13-4. WORLD LEAD PRODUCTION AND CONSUMPTION 1946 1953
(In Short Tons)

	1947	1948	1949	1950	1951	1952	1953	1954
Primary smelter production[a]	1,430,600	1,517,200	1,714,000	1,876,800	1,829,400	1,958,900	2,020,900	2,133,000
Secondary smelter production	671,000	674,700	564,300	673,500	724,700	698,500	658,200	646,500
Total production	2,101,600	2,191,900	2,278,300	2,550,300	2,554,100	2,657,400	2,679,100	2,779,800
Consumption[b]	2,189,300	2,132,700	1,959,000	2,432,700	2,490,800	2,289,100	2,472,700	2,611,300
Apparent excess or deficit	−87,700	59,200	319,300	117,600	63,300	368,300	206,400	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.

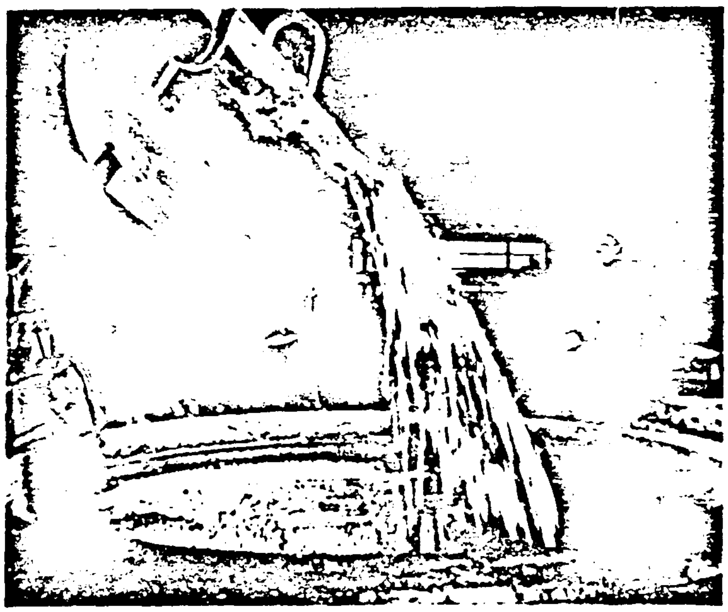

Figure 13-3. Pouring molten lead from a ladle.

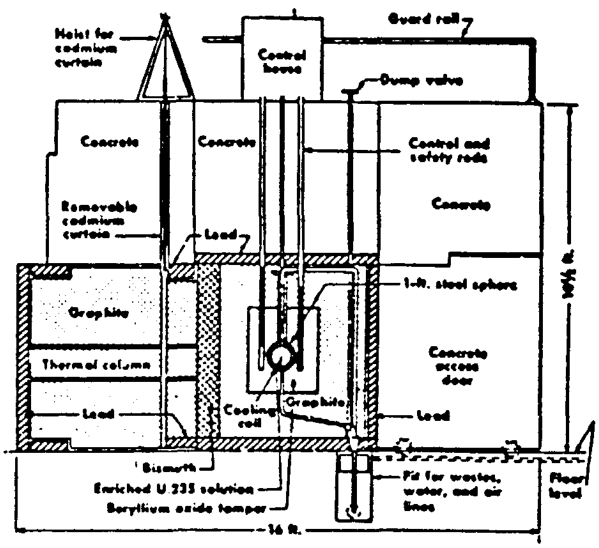

Figure 13 4. Diagram of nuclear reactor showing lead shields necessary to prevent radiation loss and to protect personnel from gamma ray poisoning.

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 Babbitts 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-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 13.5. USE OF LEAD IN THE UNITED STATES
(In Short Tons)

	1925	1930	1932	1940	1945	1950	1954
White lead	131,000	83,900	80,000	65,500	41,000	34,000	19,000
Red lead and litharge[a]	42,000	32,000	47,300	59,400	68,200	73,900	56,800
Storage batteries	180,000	163,000	175,000	220,200	285,000	406,800	310,900
Cable covering	156,000	208,000	38,900	107,400	107,000	136,800	122,800
Building[c]	88,400	67,000	22,000	65,000	68,000	61,500	50,400
Tetraethyl	*	*	15,000	49,200	75,900	111,100	160,600
Ammunition	31,300	33,300	29,200	56,000	43,000	32,800	29,300
Foil	32,500	26,000	15,900	23,500	15,600	3,200	4,000
Bearing metal	34,000	20,000	13,000	14,000	42,000	22,800	20,500
Solder	35,000	27,000	20,000	24,000	47,000	88,100	59,600
Typemetal	15,000	16,000	15,000	16,800	25,000	26,900	26,100
Calking	30,000	21,000	12,000	19,200	35,200	60,200	42,700
Other uses[d]	81,100	71,400	45,400	61,700	132,100	136,900	163,100
Total	856,300	768,600	538,900	782,000	1,000,000	1,211,000	1,078,000

Source. American Bureau of Metal Statistics

[a] Includes antimonial lead.

[b] Exclusive of oxides for storage batteries.

[c] Chiefly pipe, sheet and extrusions. Includes lead used in chemical construction.

[d] Among "Other uses" are lead for brass making, collapsible tubes, lead lined pipe, and other containers, lead headed nails, railway equipment, shipbuilding, seals, 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 13.6. LEAD CONSUMPTION OF THE UNITED KINGDOM[a]
(In Short Tons)

	[illegible]	[illegible]	1950	1954
Cable	84,200	129,300	96,300	98,100
Battery (excluding oxides)	30,700	28,400	30,800	33,300
Oxides and compounds:				
Battery	25,200	22,900	28,000	31,100
Other uses	33,700	29,300	34,900	30,700
Tetraethyl lead	*	5,200	6,000	17,100
White lead	22,200	22,800	21,400	13,300
Sheet and pipe	81,300	93,000	89,800	88,000
Ammunition	10,300	4,200	4,000	5,000
Foil and collapsible tubes	8,900	2,700	4,800	5,400
Solder	10,700	11,300	14,200	14,000
Alloys	9,900	14,200	17,000	16,900
Miscellaneous uses	12,900	16,100	19,300	24,000
Total	329,400	381,100	367,300	373,000

* Included with Oxides and Compounds: Other Uses.

[a] 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 Kingdom 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)

	1946	1950	1954
United States	925,000	1,211,000	1,078,000
Canada	62,800	54,700	68,000
Mexico	7,000	10,600	12,800
Argentina	25,900	38,600	28,700
Brazil	20,000	21,800	29,200
Other America	4,000	9,100	3,600
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	27,300	27,500
Denmark	8,300	12,100	11,000
France	83,700	65,100	108,700
Germany	18,000	110,800	195,200
Italy	14,000	48,100	55,800
Netherlands	15,000	28,800	40,000
Poland	12,000	30,000	24,000
Spain	34,100	21,800	28,000
Sweden	32,800	31,600	37,200
Switzerland	23,500	21,400	17,300
United Kingdom	335,300	367,500	375,000
Yugoslavia	6,200	8,100	6,300
Other Europe	14,000	23,000	25,000
Total Europe	672,300	851,300	1,022,600
India	4,300	17,100	14,700
Japan	39,300	27,100	51,600
Other Asia	5,100	3,800	3,500
Total Asia as reported	49,100	47,000	68,800
Africa	3,000	10,000	17,000
Australia and New Zealand	30,000	34,900	52,800
Russia	32,900	123,000	228,500
Total	114,200	167,900	298,800
Grand total	1,874,200	2,432,700	2,611,800

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, matté 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	385,100	276,300
Canada	350	250	130
Belgium	21,500	24,600	21,000
Denmark	12,300	13,700	18,300
France	55,500	44,000	24,200
Germany	7,500	22,800	65,300
Italy	9,300	10,700	14,700
Netherlands	23,500	38,200	48,000
Norway	8,300	8,500	10,900
Sweden	12,900	14,900	15,000
Switzerland	10,800	12,500	17,300
United Kingdom	164,800	301,500	221,200
Exports			
United States	1,760	800	600
Canada	129,700	102,900	116,400
Belgium	60,400	54,700	53,300
Denmark	7,900	4,900	7,400
France	6,900	12,200	15,700
Germany	34,700	41,800	34,400
Italy	1,000	25	50
Netherlands	2,670	3,240	8,800
Switzerland	800	125	50
No. Rhodesia	12,200	13,100	15,000
Australia	150,000	166,200	178,900

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 COUNTRIES
(In Short Tons of Lead Content)

Country	[illegible]				[illegible]				[illegible]			
	Ore and Matte	Bullion	Pigs and Bars	Total	Ore and Matte	Bullion	Pigs and Bars	Total	Ore and Matte	Bullion	Pigs and Bars	Total
Canada	11,937		104,531	116,468	39,242		49,000	88,242	40,788		59,867	100,548
Mexico	2,487		198,872	201,359	3,443		140,751	144,194	2,167		68,695	70,862
Guatemala	4,721	206		4,927	5,391	736		6,127	2,716			2,716
Bolivia	18,473		635	19,108	18,984		220	19,204	14,230			14,230
Chile	3,197			3,197	3,341			3,341	673			673
Peru	28,210	123	42,169	70,502	32,842	133	32,216	65,191	26,797	41	30,048	56,886
El Salvador	126			126				0				0
Honduras	305			305	1,080			1,080	1,643			1,643
Belgium			1,785	1,785			2,017	2,017			330	330
Denmark			106	106			1,275	1,275			3,902	3,902
France			551	551			230	230				0
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			5,309	5,309				0			5,540	5,540
Yugoslavia	370		53,997	54,367			51,138	51,138			28,465	28,465
Algeria				0				0			2,313	2,313
Fr. Morocco			6,099	6,099	2,632		9,259	11,891			15,242	15,242
United Kingdom			4,216	4,216			1,148	1,148			2,396	2,396
Union of So. Africa	22,656			22,656	29,777			29,777	35,367			35,367
Australia	8,932		82,800	91,732	20,706		70,348	91,054	21,557		58,445	80,002
Japan	5			5				0			10	10
Philippines	2,146			2,146	2,990			2,990	2,160			2,160
Other Countries	315		21	336	500		806	1,306	1,191			1,298
Total	104,515	389	510,720	615,624	160,929	869	385,071	546,869	161,522	41	276,287	437,850
U. S. Exports			1,762	1,762			803	803			609	609

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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