

N49747

United States. Min
DEPARTMENT OF THE IN
ALBERT B. FALL, Secretary

UNITED STATES GEOLOGICAL
GEORGE OTIS SMITH, Director

MINERAL RES

OF THE

UNITED STATES

1919

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PART I—METALS

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WASHINGTON
GOVERNMENT PRINTING

1922

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The following tabular statement gives the general domestic production and consumption of refined lead compiled by the United States Geological Survey:

1919

LEAD.

By C. E. Siebenthal and A. Stoll.

SUMMARY.

The following tabular statement gives the general domestic production and consumption of refined lead compiled by the United States Geological Survey:

Summary of statistics of refined lead, 1918-19, in short tons.

PRODUCTION.	
Primary lead	.....
Secondary lead	.....
Total primary and secondary lead	.....
Refined lead	.....
Consumption of refined lead	.....
Stocks at end of year	.....
CONSUMPTION.	
Primary lead	.....
Secondary lead	.....
Total primary and secondary lead	.....
Refined lead	.....
Consumption of refined lead	.....
Stocks at end of year	.....

Primary lead, which is produced directly from ore, is here distinguished from secondary lead, which is obtained by refining skimmings, drosses, and old metals. The statistics are given on p. 329. Wherever in this report the word "lead" is used without qualification, it is understood to mean refined lead.

The output of refined lead in the United States in 1919 was 424,433 short tons, having a value of \$10,000,000. The total sales of pig lead in 1919, as compared with the total production, was in quantity of 21 per cent and a loss in value of 10 per cent.

INTRODUCTION.

An estimate of the production of refined lead in the United States received from every lead smelter in operation in the United States Geological Survey on January 1, 1919, included the actual production for the first 10 months of 1919 and estimates for the remainder of the year. The estimate is based on the production and consumption of refined lead for the imports and exports of lead in ore and bullion. The preliminary report on the mineral resources of the United States, published September 8, 1920, (The Minerals of the United States, showing production, consumption, imports, and exports for a period of years, and showing the estimated production and consumption of lead in the United States for a period of years.)

The statistics of production of lead in this country in 1919 have been compiled by the Geological Survey from confidential reports submitted by each lead-smelting company in operation during the year. The statistics of the recovery of secondary lead were also collected by the Geological Survey. The statistics of domestic consumption of refined lead are taken in part from the refinery returns and in part from the records of the Bureau of Foreign and Domestic Commerce, of the Department of Commerce, and the statistics of foreign production are compiled from the sources indicated in connection with the tables here presented.

PRODUCTION.

QUANTITY AND VALUE.

The refined lead produced in the United States from 1720 to 1914 from domestic ores and from foreign ores and base bullion and its value at the average price in New York are shown in a table in the chapter on lead in Mineral Resources for 1914. Details for years later than 1905 are shown in the table below.

Production, price per pound, and value of refined lead in the United States, 1720-1919.

Year.	Desilverized lead. ^{a,b}	Soft lead. ^c	Total production. ^b	From domestic ores and base bullion. ^b	From foreign ores.	From foreign base bullion.	Price per pound at New York. ^d	Value.
	<i>Short tons.</i>	<i>Short tons.</i>	<i>Short tons.</i>	<i>Short tons.</i>	<i>Short tons.</i>	<i>Short tons.</i>		
1720-1905.....	5,251,079	2,081,836	7,332,915	6,032,383	1,300,532			\$334,403,000
1906.....	313,886	90,860	404,746	338,200	28,803	39,743	\$0.057	46,141,000
1907.....	313,588	99,801	413,389	352,381	24,041	36,967	.053	43,819,000
1908.....	295,562	101,012	396,564	311,066	11,509	73,989	.042	33,311,000
1909.....	329,761	117,158	446,909	352,839	21,754	72,316	.043	38,434,000
1910.....	328,954	141,318	470,272	375,402	18,065	76,805	.044	41,384,000
1911.....	331,032	155,947	486,979	391,995	10,764	84,220	.045	43,828,000
1912.....	339,646	141,248	480,894	392,517	11,572	76,805	.045	43,280,000
1913.....	330,593	131,867	462,460	411,878	13,223	37,359	.044	40,696,000
1914.....	383,903	158,219	542,122	612,794	7,639	21,689	.039	42,286,000
1915.....	388,594	161,461	550,055	507,026	9,581	33,448	.047	51,705,000
1916.....	403,619	167,515	571,134	552,228	6,085	12,821	.069	78,917,000
1917.....	422,266	188,503	610,769	548,450	15,872	46,447	.086	105,052,000
1918.....	429,732	210,463	640,195	530,906	15,234	84,056	.071	90,908,000
1919.....	334,470	147,744	482,220	424,433	7,056	50,131	.063	51,115,000
	10,196,671	4,094,952	14,291,623	12,042,097	2,249,526			1,385,179,000

^a Desilverized soft lead is included; for quantity see p. 317.

^b Antimonial lead is excluded; for quantity see p. 318.

^c Desilverized soft lead is excluded.

^d For 1917, 1918, and 1919, average sales price.

PRODUCTION BY STATES.

The production of refined lead can with difficulty be apportioned according to sources of ore, owing to the fact that lead refiners treat products already smelted, whose origin may, as in custom refining, be unknown to them, because the identity of the ore is preserved only as far as the smelter. Accordingly, the following table is compiled, so far as possible, from smelter figures. It includes "pig lead" reported by all smelters running on Mississippi Valley or other "soft" lead ores and "work lead" produced at all other lead smelters, except that the greater part of the product reported by silver-lead smelters operated in conjunction with refineries is stated

in terms of refined lead. A like part of the antimonial lead is eliminated from the "work lead" produced and the figures of production of antimonial lead.

In addition to the domestic lead ores smelted in this country, quantities of domestic lead ore have been exported to Canada. In 1912 soft lead amounting to 63 tons was exported to Canada. In 1913 soft lead amounting to 63 tons was exported to Canada. In 1914 soft lead amounting to 63 tons was exported to Canada. In 1915 soft lead amounting to 63 tons was exported to Canada. In 1916 soft lead amounting to 63 tons was exported to Canada. In 1917 soft lead amounting to 63 tons was exported to Canada. In 1918 soft lead amounting to 63 tons was exported to Canada. In 1919 soft lead amounting to 63 tons was exported to Canada. The desilverized lead smelted in Canada amounted to 31 tons in 1914, to 137 tons in 1915, to 2,001 tons in 1916. In 1917 silver-lead ores from Montana smelted in Canada produced 4,570 tons of lead. In 1918 and 3 tons in 1919.

Primary lead smelted or refined in the United States, 1907-1919, by sources, in short tons.

Source of ore.	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919
Domestic ore:													
Alabama	2,118	1,464	1,571	1,571	1,571	1,571	1,571	1,571	1,571	1,571	1,571	1,571	1,571
Arizona	638	515	977	977	977	977	977	977	977	977	977	977	977
Arkansas	52,552	28,729	30,865	38,542	30,442	37,030	42,840	41,198	32,332	33,046	29,577	29,238	2,104
California	123,292	98,464	103,747	108,951	117,335	127,780	137,827	177,827	180,680	170,059	174,045	142,640	88,091
Colorado	408	362	273	263	308	513	619	427	910	670	867	1,010	977
Illinois	1,798	2,253	2,783	1,308	2,522	1,837	1,504	1,043	1,320	1,737	2,663	5,023	7,951
Iowa	122,451	122,451	141,105	161,639	182,293	182,610	182,610	194,273	193,634	218,233	218,197	187,743	150,341
Kansas	2,445	2,445	2,445	2,445	2,445	2,445	2,445	2,445	2,445	2,445	2,445	2,445	2,445
Missouri	3,480	3,796	4,792	2,246	1,082	5,699	6,142	5,996	7,683	4,861	12,334	8,726	5,058
Montana	2,047	586	1,350	1,890	1,371	2,511	1,821	741	2,157	3,280	3,428	5,149	1,418
Nevada	404	1,409	2,268	2	35	34	10	3,916	4,346	10,969	19,646	58,755	49,964
New Hampshire	18	13	7	8	33	12	37	2	5	12	34	28	18
New Mexico	55,540	42,455	66,648	60,605	54,833	60,605	71,069	88,973	106,115	111,760	82,091	76,169	65,102
North Carolina	341	291	120	339	612	53	8	143	457	740	925	968	1,000
Ohio	3,573	4,013	3,252	3,909	3,966	3,301	2,639	1,819	2,632	3,121	2,800	4,275	3,975
Oklahoma	896	36	317	101	48	120	63	99	113	113	145	59	119
Oregon	1,890	1,290	1,735	2,237	1,987	3,131	3,765	4,125	4,562	5,478	6,480	5,359	4,887
South Carolina	375,099	310,762	363,319	389,211	405,853	415,395	436,430	534,482	537,012	596,221	579,383	536,878	427,826
Tennessee	288	3,150	3,150	3,310	582	1,774	5,976	2,942	328	1,738	1,738	1,519	644
Utah	2,907	162	66	25	122	29	16	2	1,174	1,231	1,100	7,550	69
Virginia	20,234	10,148	16,944	11,704	7,333	7,407	4,512	2,386	5,407	1,917	7,607	4,798	12
Washington	919	1,186	1,186	2,995	2,677	2,332	2,617	1,821	2,829	2,866	3,533	1,101	2,537
Wisconsin	2,716	179	1,500	76,805	84,220	76,805	37,339	21,689	33,173	1,072	6,750	8,108	587
Wyoming	34,251	73,210	70,816	76,805	84,220	76,805	37,339	21,689	33,173	1,072	6,750	8,108	587
Foreign:													
Canada	61,008	84,898	94,070	94,870	94,884	88,377	50,582	29,328	45,029	18,906	62,310	100,290	57,787
Mexico	438,107	385,660	457,889	494,081	500,847	508,772	487,012	568,810	580,041	615,127	641,704	657,168	485,012
South America													
Grand total.													

* The lead produced by these States is nonantimonial or antilead.

SOFT LEAD.

The lead ores of the Mississippi Valley are almost free and the lead produced from them is known as "soft lead." A little lead ore of this kind is also mined in Washington Western States, but this ore has been generally smelted treating argentiferous lead ore, and thus the resulting lead has been distinguished from the desilverized product of the soft-lead ore. With two exceptions, the smelters running exclusively on soft-lead ores do not desilverize their product. Their output of the column headed "Soft lead" in the table on page 314. production of refined lead for 1920-1919. However, soft-lead ore has been annually smelted and some purchased lead has been desilverized by the silver-lead smelters. The St. Louis Smelting & Refining Co. has regularly desilverized product. In 1915 the St. Joseph Lead Co. installed desilverizing kettles, and a part of its product has since been desilverized soft lead, for the years prior to 1906, has been recorded separately from the lead produced from silver-lead ores, though the lead content of the soft-lead ores so smelted and sized has been recorded since 1894. Since 1906 the quantity of lead produced by each State has been recorded, as shown in the preceding table. In the following table the undesilverized soft-lead smelters is given in the first column and the lead output from soft-lead ores smelted and desilverized in the second column. The figures do not give the total lead recovered from soft-lead ores, for the lead recovered from pigments, which are made principally from soft-lead ore, is taken into account. The lead content of pigments directly from ore in 1919 is given in the fourth column, and the output of soft lead in the fifth column. The percentage of total production of soft lead makes of the total domestic lead, composed of refined domestic lead plus lead in pigments in antimonial lead, is shown in the last column. As noted, the percentage ranges from 37 to over 50 in the preceding review. A little foreign lead is incorporated in the lead loaded zinc pigment, but as it is difficult to determine the quantity is involved it has been disregarded.

Soft lead produced in the United States, 1907-1919, in short tons.

Year.	Soft pig lead.			Soft lead recovered in pigments.	Total soft lead.	Percentage of total domestic lead.
	Undesilverized.	Desilverized.	Total soft pig lead.			
1907	99,801	29,820	129,620	6,574	136,204	37.0
1908	101,012	29,869	130,881	7,377	138,258	37.5
1909	117,158	32,532	149,690	7,292	156,982	38.0
1910	141,318	27,952	169,270	7,603	176,873	38.5
1911	155,947	35,687	191,634	7,678	199,312	39.0
1912	141,248	29,789	171,037	10,323	181,360	39.5
1913	131,867	29,433	161,300	10,998	172,298	40.0
1914	158,219	43,508	201,725	11,914	213,639	40.5
1915	181,461	44,001	225,462	12,782	238,244	41.0
1916	167,515	48,244	215,759	13,252	229,011	41.5
1917	188,503	56,288	244,791	12,870	257,661	42.0
1918	210,463	47,418	257,881	13,093	270,974	42.5
1919	147,744	57,938	205,682	11,479	217,161	43.0

* Includes domestic refined lead, domestic lead in antimonial lead, and domestic lead in zinc pigment.

ANTIMONIAL LEAD.

The production of by-product antimonial lead from argentiferous lead ores derived from all sources, as reported by all lead refineries operating in this country, is shown for the period 1871-1906 (earlier years being estimated from the output of desilverized lead) in a table in the chapter on lead in Mineral Resources, 1914. The figures for later years are given in the table below. Since 1909 producers have been asked to distinguish between the by-product antimonial lead derived from ore and bullion of foreign origin and that from domestic ores. Inasmuch as the antimonial skimmings are worked up in batches, the output of antimonial lead in any one year does not necessarily correspond strictly to the bullion refined during that year; hence the output of antimonial lead is distributed as between domestic and foreign in proportion to the lead refined from domestic and from foreign bullion during the year. The total antimonial lead produced during the period 1907-1919 was equal to 5.13 per cent of the total lead refined from domestic and foreign bullion during that period.

By-product antimonial lead produced in the United States, 1907-1919.

Year.	Total lead refined from base bullion (short tons).	Percent- age of by- product anti- monial lead.	Antimonial lead.						
			From domestic ore (short tons).	From foreign ore (short tons).	Quantity (short tons).	Value.	Total.		Lead content, by difference (short tons).
							Antimony content.		
							Short tons.	Percent- age.	
1907.....	283,759	3.5	7,780	2,130	9,910	\$1,322,985	1,561	15.8	8,349
1908.....	265,683	5.1	9,274	4,355	13,629	1,204,771	2,440	17.9	11,189
1909.....	297,219	4.3	8,889	4,007	12,896	1,231,019	2,360	18.3	10,536
1910.....	301,002	4.7	10,140	3,929	14,069	1,338,090	2,229	15.8	11,840
1911.....	295,365	4.8	9,636	4,442	14,078	1,380,556	2,254	16.0	11,824
1912.....	309,857	4.4	8,549	5,003	13,552	1,311,348	1,949	14.4	11,603
1913.....	301,160	5.6	14,667	1,998	16,665	1,591,854	2,508	15.0	14,157
1914.....	340,397	4.9	15,475	1,102	16,567	1,672,167	2,693	16.2	13,874
1915.....	344,663	6.7	19,371	3,863	23,224	3,605,736	3,425	14.8	19,799
1916.....	335,375	7.2	17,246	6,792	24,038	4,483,582	3,490	14.5	20,548
1917.....	365,998	6.1	15,279	3,307	18,586	3,781,660	2,769	14.8	15,817
1918.....	382,314	4.9	10,777	7,793	18,570	2,826,360	2,666	13.8	15,904
1919.....	286,538	5.2	9,674	4,200	13,874	1,513,968	1,943	14.0	11,931
Average.....		5.13						15.3	

Details of the production and consumption of antimony in the United States are given in the chapter on antimony in Mineral Resources, 1919.

LEAD.

LEAD PIGMENTS.

PIGMENTS SMELTED DIRECTLY FROM ORE.

In addition to leaded zinc oxide and zinc-lead oxide noted more particularly in connection with the production of pigments, two other lead pigments are made directly from ore, namely, sublimed white lead and sublimed blue lead. The white lead consists of lead sulphate 75 per cent, lead oxide 25 per cent, and zinc oxide 5 per cent. Sublimed blue lead consists of lead sulphate 50 to 53 per cent, lead oxide 41 to 38 per cent, and zinc oxide 5 per cent. Sublimed blue lead contains proportions of lead sulphide, lead sulphite, and zinc oxide. Lead oxide contains from 46 to 50 per cent of lead sulphide to 46 per cent of zinc oxide, and a small quantity of lead sulphate. No zinc-lead oxide is made at present. Leaded zinc oxide contains from 4 to 20 per cent in lead sulphate, the remainder being lead oxide, with a small portion of zinc sulphate.

The lead content of pigments smelted directly from ore is given in the fourth column of the table on page 317. As there are no producers of sublimed lead or basic lead sulphate, the output of each is not revealed. The production of leaded zinc oxide is given in the chapter on zinc.

PIGMENTS MANUFACTURED FROM PIG LEAD.

The pigments manufactured from pig lead, which include red lead, orange mineral, and litharge, show a decrease in price per ton of 10 per cent from the average in 1918 to a decrease of 25 per cent in the average price of pig lead. There was, however, an increase in the output of each. White lead in particular made a noteworthy gain.

Manufactured lead pigments marketed in the United States, 1918.

Pigment.	1918			
	Quantity (short tons).	Value.		Quantity (short tons).
		Total.	Per ton.	
White lead:				
In oil.....	82,799	\$17,224,480	\$208.03	109,005
Dry.....	20,089	3,542,368	176.33	30,085
Red lead and orange mineral.....	30,089	5,928,667	197.17	32,362
Litharge.....	48,874	8,825,724	180.68	46,739

SECONDARY LEAD.

Secondary lead is obtained mainly from skimming the slag from primary lead smelters, and from the recovery of lead by refining these materials constitute part of the lead industry. This business is carried on by small refineries scattered over the United States, and by smelters and refineries working primary lead frequently advantageous to incorporate material from secondary

product of the secondary refineries is of two classes—pig lead and lead in alloys. The lead in alloys may have been recovered in the form of pig lead and alloyed at the refinery, or it may have been refined as an alloy, being brought to the desired composition by the addition of the requisite metal.

Secondary lead recovered in the United States, 1909-1919, in short tons.

Year.	Pig lead.	Lead in alloys.	Total recovered lead.	Value.
1909	18,360	23,327	41,687	\$3,685,000
1910	29,492	25,930	55,422	4,877,000
1911	27,389	26,895	54,284	4,886,000
1912	30,266	36,902	67,168	6,045,000
1913	33,104	39,730	72,834	6,409,000
1914	29,337	31,725	61,062	4,768,000
1915	36,400	42,500	78,900	7,416,000
1916	66,700	39,600	106,300	13,289,000
1917	45,100	48,400	93,500	10,082,000
1918	41,146	65,954	107,100	13,788,000
1919	55,684	66,416	122,100	12,643,000

MINE PRODUCTION.

The preceding tables give the quantity of lead recovered by smelting and refining operations either as metallic lead, or in the alloy antimonial lead, or as lead in pigments. The following table shows the source or derivation of the domestic lead that is recovered by smelting and refining operations. The origin of the lead is much more accurately shown by the mines reports, because smelters necessarily treat mixtures of ores, sometimes long after they have been received, so that the actual output of metallic lead may not correspond at all closely to the product of the mines for the same year. The data for this table are taken from the chapters on gold, silver, copper, lead, and zinc in the Eastern, Central, and Western States.

It should be understood that strict comparisons between the States are not possible, because the form of statement is not uniform, the lead being stated as recovered lead in some States, lead content in others, and as partly one and partly the other in still other States. It is hoped that this practice, which is largely necessitated by conditions, can be soon abandoned in favor of stating the lead as recovered metal.

MINE PRODUCTION, 1907-1919.

The following table gives the output of lead since 1907, the first year in which there were mines reports for all lead-producing States. Missouri holds first rank in mine production of lead throughout the period, with Idaho in second and Utah in third place. Colorado held fourth place until 1918 when Oklahoma went into that rank,

LEAD.

State.	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919
Alaska	2,330	1,504	1,549	1,248	5,137	3,403	8,072	7,502	437	830	852	564	687
Arizona	12	15	24	63	64	31	18	41	63	13,531	11,733	6,262	5,102
Arkansas	1,313	619	751	1,435	699	572	1,757	2,126	2,290	6,294	10,934	6,686	1,784
California	42,708	26,100	38,036	38,036	34,840	37,621	43,649	37,106	34,405	32,457	33,995	32,880	18,535
Colorado	116,912	103,414	107,993	114,129	136,278	142,093	158,936	174,263	173,000	187,541	196,780	147,348	91,171
Idaho	830	399	285	373	964	1,282	939	717	954	1,072	1,439	2,273	2,105
Illinois	242	51	38	20	60	63	65	15	14	34	34	1,439	2,105
Iowa	2,535	2,516	1,300	2,412	2,859	2,371	2,427	1,409	1,212	1,648	3,025	7,252	11,283
Kansas	34	10	41	22	106	106	118	16	251	153	123	185	86
Kentucky	138,671	144,450	159,435	161,015	178,888	177,089	170,118	192,412	210,444	232,088	254,115	194,115	163,290
Missouri	1,874	2,298	2,053	2,053	3,216	3,723	5,493	6,405	8,319	12,418	13,839	15,458	17,615
Montana	3,126	3,623	4,020	2,436	1,532	9,750	8,172	6,405	3	4,107	48	1,439	1,443
Nevada	1,905	437	2,515	2,160	1,453	2,747	1,973	882	2,271	4,554	1,443	4,199	1,443
New Hampshire	532	1,781	3,427	2,888	2,501	3,388	6,228	7,556	7,306	12,115	25,358	56,097	53,872
New Mexico													
New York													
North Carolina													
Oklahoma													
Oregon													
Pennsylvania													
South Dakota													
Tennessee													
Utah	57,960	44,389	74,243	61,492	68,244	70,155	83,652	85,662	110	18	34	27	16
Virginia	70	38	99	99	417	235	816	127	2	25	2,531	1,705	2,188
Washington	410	575	144	61	424	64	101	133	148	100,748	89,261	83,944	61,915
Wisconsin	3,490	4,138	3,664	4,413	3,353	2,851	1,866	1,494	2,322	3,043	4,139	4,533	4,214
	375,013	336,404	398,096	395,213	441,100	457,365	500,188	527,892	561,641	622,975	650,949	581,654	443,694

COMPARISON OF TOTALS BASED ON SMELTER RETURNS AND ON MINE RETURNS.

The statistics of lead actually recovered by the smelters as refined pig lead, in antimonial lead, and in pigments, and the statistics of mine production (lead content of ores produced) are compared over a period of years in the following table:

Domestic lead recovered and lead mined in the United States, 1907-1919, in short tons.

Year.	From smelter reports.	From mine reports.	Smelter excess	Mine excess.
1907.....	365,606	375,013	.....	9,507
1908.....	326,657	336,434	.....	9,747
1909.....	367,393	386,036	.....	30,643
1910.....	391,543	386,313	.....	3,770
1911.....	407,767	441,180	.....	33,393
1912.....	410,169	457,305	.....	47,206
1913.....	435,343	500,189	.....	64,846
1914.....	537,676	522,892	14,784	.....
1915.....	536,312	561,641	.....	25,329
1916.....	580,225	622,976	.....	42,751
1917.....	574,338	650,949	.....	76,611
1918.....	552,218	581,654	.....	19,436
1919.....	444,250	443,694	694,556	.....
	5,939,387	6,287,284	.....	347,897

The smelter totals represent actual recovery and are found by summing up the total production of refined lead reported by all companies, by calculating the lead content of domestic antimonial lead, and recalculating all pigments back to equivalent metallic lead on the basis of average analysis of product. The lead recovered from secondary sources is excluded from these totals, as it has already been reckoned once as pig lead. In collecting the data for compiling the mine totals, each producing property is requested to report the actual tonnage of lead ores and concentrates shipped, and from this tonnage the lead content is reckoned by assay value. The quantities thus obtained from all the producing properties in each State are combined to make the total. It is clear that by either method the correctness of the totals is dependent upon complete and correct returns from every producing mine and smelter. It is further essential to the correctness of the mine totals that the assay content be correctly estimated.

With equal conditions affecting the mines and the smelters, the stocks in the ore bins of the smelters should run about even from year to year, and the mine and smelter totals, allowance being made in the former for losses in smelting, should show reasonable agreement. As may be seen from the table, however, there are frequent irregularities in the mine-excess column. The causes of these irregularities fall into four categories. The first is lag, by which is meant the time that elapses between the shipment of ore by the mine and the reduction of the ore by the smelter. This is frequently considerable, for ore raised near the end of the year may remain in the stock bins of the smelter until the succeeding year, and, unless balanced by an equivalent lag from the preceding year, will thus lead to an apparent "mine excess." If, through accident, business depression, or otherwise the mines close down, the smelters largely con-

LEAD.

sume their stocks of ore, and the result may be an apparent excess." The second source of difference is found in mine totals in the arbitrary calculation of metal content. The dry assay in vogue in the Western States gives results too low. A decision of the United States circuit court recognizes a differential of 1.5 per cent between the chemical analysis, and in actual practice the discrepancy is even greater than that. Lastly, these totals do not take except in certain of the Western States, the loss in smelting from 2 to 5 per cent in the treatment of easily reducible ores reaching 10 per cent or more in the more refractory ores running over 20 per cent is allowed by the Treasury. In smelting in bond foreign lead ores running high in arsenic. Lag being left out of account, the totals would show a mine excess equal to the smelting loss. Any discrepancy appears in the table may reasonably be ascribed to one of these items. In the long run, barring error and allowing for losses and exportation of ore, the "mine excess" will be equivalent "smelter excess."

By referring to the table comparing the mine and smelter totals it will be seen that twice during the last 13 years the lead by the mines has been less than the output of the smelters. The other years the mine production has been considerable. The total output of lead in refined lead, antimonial lead, and pigments by the smelters during the 13 years was 5,939,387 tons. The output of the mines for the same period was 6,287,284 tons. The excess of mine production over smelter production was 347,897 tons.

TRADE CONDITIONS.

WORLD'S PRODUCTION.

World's production of lead by countries where smelted but not necessarily refined.

[Reduced where necessary to metric tons.]

Country.	1913	1914	1915	1916	1917
Africa:					
Rhodesia.....	295	186	25	(a)	5,022
Tunis.....	(a)	(a)	(a)	(a)	(a)
Australia.....	110,444	101,788	102,721	184,072	144,960
Austria-Hungary.....	(a)	(a)	(a)	(a)	(a)
Belgium.....	108,480	70,890	18,770	15,560	29,746
Canada.....	17,202	16,581	19,740	19,379	20,706
France.....	28,817	29,601	14,589	24,278	21,234
Germany:					
Upper Silesia.....	41,300	36,950	28,750	41,620	32,960
Other Germany.....	139,800	181,500	108,000	(a)	(a)
Great Britain.....	30,960	20,000	16,020	12,980	11,614
Greece.....	18,000	20,684	11,605	9,424	1,422
India (Burma).....	6,951	10,717	18,738	14,011	17,388
Italy.....	21,674	20,464	21,812	24,362	16,287
Japan.....	8,777	4,562	4,764	11,871	15,807
Mexico.....	41,500	14,863	38,319	13,232	50,212
Russia.....	1,628	1,080	965	540	(a)
South America:					
Spain.....	93	249	137	177	177
Bolivia.....	198,829	148,624	171,474	147,407	176,808
Sweden.....	1,235	1,396	1,917	2,976	3,174
Turkey.....	13,900	(a)	(a)	(a)	(a)
United States.....	885,642	472,126	468,656	506,490	511,542
Other countries.....	(a)	(a)	(a)	(a)	(a)

(a) Statistics not available.

In the absence of official Mexican reports of smelter output of lead, or of export of Mexican lead into the United States in the form of bullion and pig lead are given for South America.

The foregoing statistics of the world's production of lead, though incomplete, give some idea of the foreign production during the World War. The figures in black-faced type are taken from the official statistics of the countries named; those in ordinary type are taken from statistical handbooks, consular reports, market letters, and trade journals. There is always a possibility of duplication in figures showing world production, for some countries send "work lead" or base bullion to other countries for refining. Furthermore, secondary and antimonial lead are included in the figures showing the foreign production, so that to put the United States on an equal footing in the statistics it would be necessary to include in its production the domestic output of secondary lead and antimonial lead. The figures for the United States represent refined lead that was smelted in this country, whatever the source of the ore.

IMPORTS AND EXPORTS.

WAREHOUSE TRANSACTIONS.

Lead imported into the United States as metal or ore may be entered for immediate consumption, the duty being paid and the lead going direct to the consumer; or it may be entered for warehouse, bond being given for double the amount of the estimated duty. In the accompanying tables the phrase "general imports" indicates the total imports, including both lead entered for immediate consumption and lead entered for warehouse. From warehouse the lead may be withdrawn for consumption by payment of duty, or it may remain in bond for smelting and refining, finally being either withdrawn for consumption or exported from warehouse with cancellation of bond. The lead entered for immediate consumption and that withdrawn from warehouse for consumption make up the "imports for consumption," which are expressed in the same terms as those under which they were imported. By-product antimonial lead made by refining lead of foreign origin in bonded smelting warehouse can be withdrawn for consumption as type metal (T. D. 31201). The lead imported for consumption may be actually used in this country, or it may be manufactured into articles which are exported; in the latter event the manufacturer is entitled to the benefit of a drawback of 99 per cent of the duties paid. In the table on page 329, showing foreign lead exported in manufactures with benefit of drawback, the lead is shown in the form in which it was originally imported. On account of diversity of form it is not feasible to show the articles exported with benefit of drawback. The foreign lead given in the table as exported from warehouse is likewise shown in the form in which it was imported and entered for warehouse. Foreign lead exported from warehouse has, since July 1, 1915, been included by the Bureau of Foreign and Domestic Commerce in the domestic exports as "from foreign ore."

The items foreign lead exported from warehouse, domestic exports of lead "from foreign ore," and foreign lead exported in manufactures with benefit of drawback make up the total foreign lead going out of the country. Lead in warehouse and deductions by liquidation being disregarded, the difference between the sum of these exports of foreign lead and the total imports of lead constitutes the foreign lead consumed in this country. For the sake of simplicity

this foreign lead is carried on the bonded custom in the form in which the lead was entered until it is exported. It must be clearly understood, therefore, that the table of foreign exports of lead, on a later page, shows lead content of ore and base bullion but as refined lead refined from them. Since 1914, however, all foreign lead has been classed as lead, "pigs and bars," except articles manufactured from foreign lead and exported with drawback. For articles not made wholly of lead to give weights, but each shipment on which drawback is accompanied by a manifest of the imported lead articles and the duty paid thereon. From these figures the statement of the total quantity of foreign lead exported with the benefit of drawback.

The following table is taken from the reports of Foreign and Domestic Commerce. For the reason that lead is shown in the terms in which it was imported, a considerable part of the lead stated as remaining in warehouse doubtless represents refined lead waiting for a favorable market for shipment. If the table gives a fair idea of the fluctuations at different times and in different localities.

Lead remaining in warehouse in the United States, Dec. 31, 1919.

Year.	Form in which lead was entered for warehouse.		Remaining at—				
	Lead in ore and base bullion.	Pigs, bars, and old.	New York.		Chicago, Ill.	El Paso, Tex.	Total.
			Newark, N. J.	Perth Amboy, N. J.			
1910.....	71,794,443	149,082	7,548,936	36,112,136	21,090,631	6,930,000	63,681,705
1911.....	8,869,713	93,082	2,777,692	2,308,322	964,884	2,500,000	8,550,900
1912.....	20,801,182	93,802	1,880,828	17,666,768	484,671	1,700,000	19,733,069
1913.....	10,620,953	.....	8,785,551	.....	80,880	1,800,000	10,666,431
1914.....	15,333,084	3,837	10,309,592	8,401,728	94,775	1,800,000	19,515,115
1915.....	24,338,933	.....	8,575,115	.....	185,257	1,800,000	10,560,372
1916.....	23,667,358	1,070,298	8,575,115	.....	4,732,635	6,800,000	15,182,948
1917.....	47,853,945	5,370,445	19,015,511	.....	4,757,315	18,900,000	41,742,821
1918.....	33,997,822	944,483	(b)	.....	(b)	.....	(b)
1919.....	90,952,684	468,154	(b)	.....	(b)	.....	(b)

^a Kansas City before 1914.

^b Not available.

IMPORTS.

The following tables are taken from the reports and records of the Bureau of Foreign and Domestic Commerce:

Lead imported and entered for consumption in the United States, 1910-1919.

Year.	Lead in ore.		Base bullion.		Pigs, bars, and old.		Sheets, pipe and shot.		Not otherwise spec. mod.	Total value.
	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.		
1910.	7,998,850	\$198,196	16,543,167	\$337,223	6,776,066	\$212,858	39,779	\$1,972	\$4,843	\$755,092
1911.	1,474,254	26,563	17,376,459	352,595	7,112,749	242,423	63,151	2,855	7,213	631,654
1912.	836,881	24,760	22,729,487	462,559	5,101,823	110,469	31,184	2,305	5,468	605,551
1913.	2,306,972	76,835	17,665,227	388,116	4,621,270	105,738	39,171	3,291	12,710	585,690
1914.	5,459,961	188,749	8,904,649	301,195	575,290	12,281	62,552	2,753	81,894	586,872
1915.	2,665,792	96,010	15,496,230	519,355	997,368	32,951	201,510	17,059	107,680	772,955
1916.	10,125,993	368,824	5,242,171	208,277	6,388,097	331,235	532	63	106,560	1,014,989
1917.	5,438,931	207,370	6,965,849	470,539	1,756,223	85,743	12,538	2,699	10,287	776,636
1918.	6,064,902	344,080	3,559,071	180,070	1,139,950	56,604	6,892	924	36,723	618,191
1919.	4,106,823	196,363	31,790,663	1,130,937	10,174,115	416,094	8,018	628	17,187	1,760,209

Type metal imported and entered for consumption in the United States, 1910-1919.

Year.	Type metal.		Lead content.	
	Gross weight (pounds).	Value.	Quantity (pounds).	Percentage.
1910.	13,394,199	\$485,493	11,176,830	84.9
1911.	8,390,470	310,058	6,936,711	82.7
1912.	581,411	18,668	477,006	82.0
1913.	567,004	20,098	467,988	82.5
1914.	1,509,638	45,373	1,322,188	87.6
1915.	2,768,261	107,607	2,424,306	87.6
1916.	1,162,386	83,816	923,473	79.4
1917.	551,794	35,938	513,166	93.0
1918.	13,394,803	816,042	11,000,498	82.1
1919.				
Average lead content, 1910-1919.				

General imports of lead into the United States, in ore, base bullion, and refined, 1910-1919, by sources, in pounds.

Year.	Canada.	Mexico.	South America.	Europe.	Other countries.	Total imports.
1910.	206,979	203,290,307	6,598,263	2,714,796	4,394,421	217,204,766
1911.	270,947	172,633,470	4,778,221	509,101	1,651,544	179,903,233
1912.	319,497	159,455,664	3,207,936	829,139	3,300,356	167,121,592
1913.	338,669	95,693,439	8,766,327	810,019	8,685,612	114,293,969
1914.	381,007	46,282,207	2,417,744	4,898,552	2,604,293	56,670,803
1915.	2,303,170	94,247,384	5,420,667	217,773	802,516	102,991,410
1916.	12,600,216	46,305,670	6,235,768	575,750	2,845,949	70,659,333
1917.	11,738,379	125,782,769	4,550,460	8,045,809	5,520,323	156,643,820
1918.	28,225,878	162,259,199	1,962,124	62,610	4,705,049	197,214,760
1919.	10,391,116	126,541,614	6,604,416	89,840	288,142	141,813,127

LEAD.

General imports of lead into the United States, 1910-1919.

Year.	Lead in ore (lead content).	Base bullion.	
		Gross weight.	Lead content.
1910.	94,761,054	118,061,415	115,000,000
1911.	35,695,180	141,481,852	138,000,000
1912.	19,577,499	152,420,624	149,000,000
1913.	19,883,213	96,908,170	94,000,000
1914.	23,649,637	33,444,503	32,000,000
1915.	18,185,140	88,247,995	83,000,000
1916.	35,086,100	24,943,660	24,000,000
1917.	41,292,876	109,279,097	103,000,000
1918.	37,070,340	155,810,003	149,000,000
1919.	19,673,856	116,317,160	112,000,000

Basic carbonate (corroded) white lead, red lead, litharge, and entered for consumption in the United States, 1910-1919.

Year.	Corroded white lead.		Red lead.		Litharge.
	Quantity.	Value.	Quantity.	Value.	
	Pounds.		Pounds.		Pounds.
1911.	741,071	\$46,213	1,063,533	\$42,471	24,000
1912.	687,705	46,494	757,908	33,854	32,000
1913.	672,109	45,266	99,832	4,903	34,000
1914.	596,567	40,203	12,564	2,934	83,000
1915.	339,157	24,608	1,908	132	20,000
1916.	88,617	8,050	20,467	5,302	1,000
1917.	20,238	1,965	60	13	20,000
1918.	508	202	5	1	20,000
1919.	21,213	2,490	7,199	1,136	20,000

EXPORTS.

DOMESTIC EXPORTS.

The average difference between the prices of lead at London for the 10 years prior to 1914 was a pound and the price at New York was the half a pound. In case, exports of domestic pig lead should be temporary or very unusual circumstances. The Bureau of Foreign and Domestic Commerce reports exports of lead articles manufactured in this country, whether the lead is of domestic or foreign origin, no table of exports of domestic lead is given, because such a table would duplicate the table of exports of domestic lead in manufactures exported with benefit of duty. Exports of domestic pig lead began, however, in 1914.

In 1914 the price of lead at London rose about a pound early in January and remained between one and a half a pound above throughout the year. The export of domestic lead at a profit, and the decrease

ore and bullion from Mexico rendered it necessary to satisfy the foreign demand with domestic lead, the exports of which assumed large proportions. The movement commenced in March, 1914, and by the end of the year had reached large proportions. Likewise in 1915 the price of lead at London was from one-fourth to 1 cent a pound higher than the price at New York, except for the period of high prices in the United States during June and July, and exports of domestic lead continued heavy throughout the year.

Exports of refined lead from domestic ores reached the maximum both as to quantity and value in 1916. They dropped off almost one-half in 1917, showed a further decline in 1918, and were down to 10,510 tons in 1919.

Refined lead made from domestic ores and exported from the United States, 1914-1919.

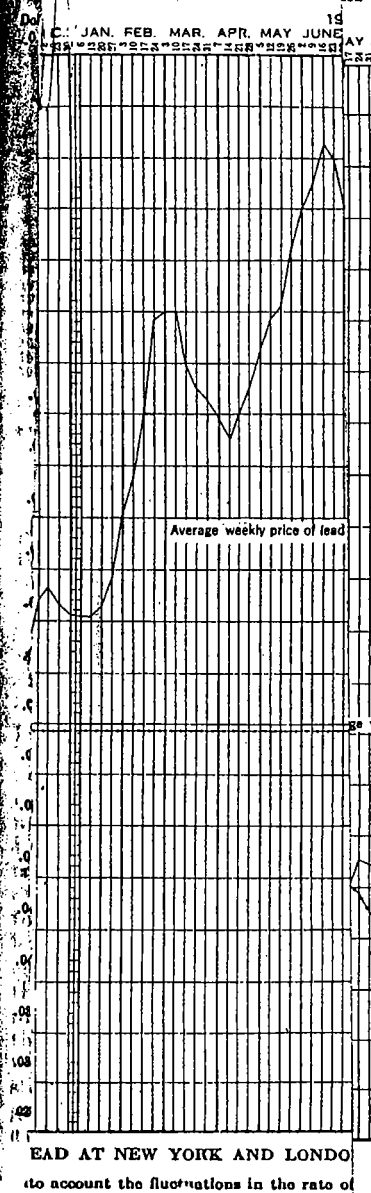
Year.	Quantity (short tons).	Value.
1914.....	58,722	\$4,501,674
1915.....	88,306	7,028,518
1916.....	100,500	13,494,065
1917.....	53,688	9,660,595
1918.....	41,831	5,899,881
1919.....	10,510	1,471,255

White lead exported from the United States, 1913-1919.

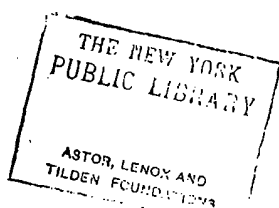
Year.	Quantity (pounds).	Value.
1913.....	15,002,384	\$905,393
1914.....	17,645,535	1,017,575
1915.....	25,310,360	1,409,423
1916.....	27,435,054	2,137,072
1917.....	19,737,399	2,089,659
1918.....	15,588,916	1,756,739
1919.....	28,033,485	3,037,292

FOREIGN EXPORTS.

By foreign lead exports are meant the exports of lead of foreign origin which has been smelted, refined, or manufactured in this country and then shipped abroad. The following table, made up from the records of the Bureau of Foreign and Domestic Commerce, shows the total lead exported for a period of years; but it must be borne in mind, as pointed out on a previous page, that prior to 1915 the actual exports were not in the form shown in the table, which is the import form, but instead consisted of refined lead and lead manufactures. Since July 1, 1915, the exports of foreign lead heretofore classed as "ore," "base bullion," and "pigs, bars, and old" are all included in "pigs, bars, and old" as domestic manufactures of lead from foreign ore. The quantities given for lead exported from warehouse are exact, but the quantities given for lead in manufactures are subject to the waste in manufacturing.



LEAD AT NEW YORK AND LONDON
to account the fluctuations in the rate of



LEAD.

Foreign lead exported from the United States,

Year.	Exported from warehouse.					
	Lead content of ore.		Lead content of base bullion.		Pigs, bars, and old.	
	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.
1910.....	22,508,090	\$248,220	117,045,333	\$2,262,057	19,507	\$1,710
1911.....	39,276,820	730,247	151,988,205	3,093,290	12,311,102	244,000
1912.....	12,796,703	219,859	116,907,305	2,478,256	107,170	3,400
1913.....	11,721,714	271,985	77,253,891	1,827,538	111,506	4,400
1914.....	6,724,625	245,205	10,944,350	378,289	25,421,500	913,300
1915.....	(a)	.....	(a)	.....	77,236,303	2,738,200
1916.....	(a)	.....	(a)	.....	19,760,088	1,111,000
1917.....	(a)	.....	(a)	.....	75,304,480	6,650,000
1918.....	(a)	.....	(a)	.....	118,832,244	8,309,000
1919.....	(a)	.....	(a)	.....	81,951,396	4,536,200

^a Since July 1, 1915, the Bureau of Foreign and Domestic Commerce has reported as "domestic exports, of pigs, bars, etc., produced from foreign."

CONSUMPTION.

In statements of consumption of lead in these years it was the custom to take into account the same amount at the beginning and at the end of the year. It is for the individual year this gives closer figures than that account of trade stocks should also be taken into account; but this is manifestly outside the scope of this Survey. It was found impossible to obtain the amount of stocks after 1906; hence consumption was calculated out reference to domestic stocks. At that time, part, from one-fourth to one-fifth, of the lead smelted in this country was lead of foreign origin smelted in this country. It was possible to obtain statistics of the stocks of the lead reported annually by the Bureau of Foreign and Domestic Commerce as "merchandise remaining in warehouse." For the years 1907 to 1917, inclusive, therefore, consumption was calculated by taking the production of ores and using the total imports and exports of lead in forms—ore, bullion, and pigs—and likewise the change in lead in warehouse at the beginning and end of the year. Complete statements of stocks of refined lead have not been reached that a better conclusion may be had by basing the calculation, as was done in the total production of both domestic and foreign lead transactions in refined lead, disregarding alterations in stocks. The "apparent consumption" calculated and given in the table below for the years of the war is the average for the four years just prior to the war.

Apparent consumption of refined primary lead in the United States, refinery stocks disregarded, in short tons.

	1910-1913 average.	1914	1915	1916	1917	1918	1919
Supply:							
Stock in bonded warehouses, Jan. 1.	79	-----	2	-----	535	2,085	472
Imports of pigs, bars, and old.	1,008	148	410	5,055	5,793	5,240	5,107
Production.	475,151	542,122	550,055	571,134	610,769	640,195	482,220
	476,838	512,270	550,467	576,789	617,097	648,120	487,799
Withdrawn:							
Exports of foreign lead:							
From warehouse.	70,256	21,545	38,618	0,880	37,052	59,416	40,978
In manufactures, with benefit of drawback.	10,505	9,489	3,983	5,171	7,537	3,426	1,938
Exports of domestic lead.	-----	68,722	88,306	100,600	53,089	41,831	10,510
Stock in bonded warehouses, Dec. 31.	-----	2	-----	536	2,085	472	234
	80,761	89,758	130,907	116,086	101,562	105,145	53,659
Apparent consumption.	396,077	462,512	419,560	460,703	515,535	542,975	434,140

PRICES AND VALUE.

At the beginning of 1919 lead was quoted on the New York market at 5.75 cents, but it went slightly below 5 cents in April and May, after which it steadily climbed until the close of the year, when it was quoted at 7.5 cents. The average of quotations for immediate delivery at New York in 1919 was 5.8 cents a pound. The average price, as figured from the total sales during the year, was 5.3 cents a pound, as compared with 7.1 cents a pound in 1918. These are the figures used in calculating the value of the lead produced from domestic ores in the United States in those years.

Prices quoted on lead by the American Smelting & Refining Co. in 1919, in cents a pound.

January 21.....	5.50	July 18.....	5.75
January 31.....	5.25	July 24.....	6.00
February 7.....	5.00	September 15.....	6.25
February 20.....	5.10	October 16.....	6.50
February 25.....	5.25	October 23.....	6.75
April 9.....	5.00	December 3.....	6.90
May 16.....	5.10	December 12.....	7.00
May 19.....	5.25	December 18.....	7.15
June 11.....	5.40	December 26.....	7.50
July 14.....	5.50		

The London price of lead for prompt shipment was £40 per long ton (8.5 cents a pound) at the beginning of the year but it rapidly fell from this level to £22 a long ton (4.59 cents a pound) by June 25. After remaining comparatively stationary for three months the price began to rise and reached £45 10s. a long ton (7.76 cents a pound) at the end of the year. Although the price per ton in pounds sterling was higher at the end of the year than at the beginning, the actual value in cents per pound was lower at the end of the year, owing to the depreciation of exchange rates. Through the first third of the year the London price was much above the St. Louis price, but for the remainder of the year it was considerably below.

The fluctuations in the price of lead at New York and London are graphically shown in Plate III, which gives curves of the average weekly price of lead in those markets for the years 1914 to 1919, inclusive.

As stated on page 313, the value of the output of refined lead in the United States from domestic ores in 1919 was \$44,990,000, at the average price of refined lead, as compared with \$76,667,000, based on the average price in 1918, a loss of \$31,677,000, or 41 per cent.

GOLD, SILVER, COPPER ARIZONA

(MINES)

By V. C.

PRODUCE

GENERAL STATEMENT

The mines of Arizona produce gold, silver, copper, lead, and zinc, containing gold, silver, copper, lead, and zinc, valued at \$111,157,872. The value of the output decreased about 45 per cent. The mines and 15 producers from placer and 13 placer producers in 1918. The value of all the metals, but paid in 1919 by 13 companies among them the Dodge Corporation, owning mines in Arizona, paid dividends amounting to \$1,000,000, was not included in the State total of its properties at Mo. separately.

Mine production of gold, silver, copper, and zinc, 1918 and 1919.

Year.	Number of producers.	Ore.	Gold, s.
1918.....	499	19,038,486	\$5,435,027
1919.....	339	13,727,403	\$4,506,413
Decrease, 1919....	130	5,311,083	\$928,614

* Includes small placer production.

Ores produced from mines in Arizona decreased from 19,038 short tons less than in 1918. The silver value per ton increased from \$10.62 in 1918 to \$10.62 in 1919.

* Valuable assistance in the preparation of these tables was rendered by Bessie N. Patchell, of the U. S. Bureau of Mines.