FLUORSPAR AND CRYOLITE

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SUMMARY OUTLINE

FLUORSPAR

SUMMARY

Despite the many difficulties of operation in 1943 the fluorspar industry established an impressive record in supplying the unprecedented demand for this mineral, which is essential in the manufacture of steel, aluminum, high-octane gasoline, insecticides, and many other commodities necessary for the successful prosecution of the war. Production and shipments (433,000 and 406,016 short tons, respectively) in 1943 were 28 and 13 percent greater than in 1942, the previous record year, and shipments were 54 percent more than in 1918, during World War I. Moreover, production and shipments were 11 and 4 percent, respectively, greater than consumption in 1943, which also reached an all-time high. Illinois not only maintained its rank as the chief producing State by shipping 23 percent more fluorspar than in 1942, the previous record year, but supplied 49 percent of the total shipments in 1943. Colorado and New Mexico also established new records in 1943. On the other hand, shipments from Kentucky declined for the second successive year and were 18 percent less than in 1942. Shipments by river or river-rail (49,913 tons) were 37 percent less than the all-time high of 1942. Imports in 1943 (43,570 tons) were 20 times those of 1942 and the largest since 1930. Exports—usually small—were only slightly higher than in 1942.

Despite the record production of fluorspar in 1943, the output of metallurgical grade lagged behind consumption during the first half of the year; consequently, inventories at consuming plants declined progressively until the end of June. Although supplies of fluorspar were not allocated, beginning January 1943 shipments of both metallurgical and ceramic grades were controlled by the War Production Board, which forbade any supplier to ship fluorspar to consumers having an inventory greater than a "practicable working minimum." Moreover, because of the scarcity of metallurgical-grade fluorspar,

[1] Figures on imports (unless otherwise indicated) compiled by M. B. Price, of the Bureau of Mines, from records of the United States Department of Commerce; those on exports of fluorspar supplied by the producers.

steel manufacturers were urged to use this grade sparingly and where possible to use flotation concentrates, the supply of which exceeded demand. That the domestic steel industry cooperated in complying with these requests is evidenced by the fact that the average consumption of fluorspar per long ton of basic open-hearth steel produced dropped from 6.4 pounds in 1942 to 5.9 pounds in 1943, and purchases of flotation concentrates totaled 3,638 tons. The flotation concentrates were used chiefly in basic electric steel furnaces. Some open-hearth operators experimented with flotation concentrates, but results were not entirely satisfactory, probably because of the fine size of the concentrates. Nevertheless, one operator found that a three-way mixture of 50 percent iron sinter, 30 percent gravel fluorspar, and 20 percent flotation concentrates proved satisfactory. The smaller consumption at steel plants resulted mainly from conservation measures, notwithstanding the fact that lower-grade fluorspar was used. Possible substitutes, such as ilmenite, sodium chloride, topaz, soda-ash briquets, and bauxite, were under study, but so far as known the use of these materials as substitutes for fluorspar was insignificant. However, it was reported that a considerable saving in fluorspar resulted from the increased use of roll scale. According to Norris,[2] "It appears at this time that the greatest saving of spar can be made by properly mixing fine roll scale with spar. Most heats can be shaped up with this mixture and at a net saving of spar."

Salient statistics of fluorspar in the United States, 1934–43, in short tons

Year	Shipments from domestic mines	Foreign trade		Consumption	Stocks at end of year			
		Imports for consumption	Exports		Consumers' plants	Domestic mines [1]	Government stockpile	Total
1934	85,786	16,705	522	110,600	57,600	50,586		108,186
1935	123,741	16,340	313	137,400	58,000	40,043		98,043
1936	176,877	25,504	240	182,400	72,600	29,958		102,558
1937	181,230	37,063	456	194,300	90,100	30,539		120,639
1938	80,403	19,622	788	115,100	71,800	34,996		106,796
1939	182,771	16,302	2,976	176,800	90,400	38,619		129,019
1940	233,600	11,873	8,482	218,500	102,100	43,866		145,966
1941	320,669	7,524	12,184	303,600	108,900	31,997		140,897
1942	360,316	2,151	9,020	360,800	96,000	19,429		115,429
1943	406,016	43,570	9,068	388,885	105,933	19,026	36,223	161,182

[1] Finished fluorspar only.

Contrary to expectation, the increase of $5 a ton in maximum prices for metallurgical-grade fluorspar, which became effective on November 23, 1942, did not stimulate production. Consequently, effective July 1, 1943, the base price was again advanced $5 a ton to $30 to $33, according to calcium fluoride and silica content. Concurrently, an average wage raise of about 24 percent was granted mine employees, and a uniform wage scale was put into effect for various classes of surface and mine labor in the Illinois-Kentucky district. The wage scale in Kentucky is 10 cents an hour less than in Illinois. Moreover, effective August 30, 1943, deliveries of the higher grades of metallurgical fluorspar were controlled by the War Produc-

[2] Norris, F. G., The Open-Hearth in 1943: Blast Furnace and Steel Plant, vol. 32, No. 1, January 1944, p. 75.

tion Board. These actions were followed by a marked improvement in production of metallurgical-grade fluorspar, which exceeded consumption for the remainder of 1943.

Production of ceramic and acid grades was more than adequate to meet requirements in 1943; however, the consumption of acid grade was advancing at a more rapid rate than production and was only slightly less than production during the latter half of 1943. The base prices for ceramic and acid grades were increased to $37 a ton on July 1, 1943.

Deliveries of fluorspar to consumers in the United States totaled 404,658 short tons in 1943 (388,902 tons from domestic mines and 15,756 tons from foreign sources); in addition, 35,884 tons of finished fluorspar (8,070 tons from domestic mines and 27,814 tons from foreign sources) were delivered to Government stock piles. In 1942 deliveries to consumers totaled 353,469 tons (351,300 tons from domestic mines and 2,169 tons from foreign sources); there were no deliveries to Government stock piles in 1942. Total deliveries to steel plants in the United States increased to 236,425 tons in 1943 from 225,502 tons in 1942, and those to domestic manufacturers of hydrofluoric acid advanced to 123,820 tons from 89,983 tons; sales to the glass and enamel trades declined moderately.

The average composite selling price ($29.35 a short ton) of all grades of fluorspar (both domestic and foreign) delivered to consumers in the United States was $4.69 more than in 1942 ($24.66). The average selling price of all grades of domestic fluorspar shipped in 1943 ($29.07) established a new peak and was $3.58 greater than the previous high of 1919. The average selling price, f. o. b. Illinois-Kentucky mines, of metallurgical-grade fluorspar shipped to domestic steel plants was $28.69 a ton ($23.82 in 1942) and of that shipped to domestic manufacturers of hydrofluoric acid $33.86 ($28.86 in 1942).

The total quantity of fluorspar shipped in and imported into the United States from about 1870 through 1943 was approximately 6,719,000 short tons, comprising 5,615,000 tons from domestic mines and 1,104,000 tons from foreign sources. It is noteworthy that of the total domestic shipments, 1,503,372 tons (27 percent) were shipped during the past 5 years (1939–43).

POST-WAR OUTLOOK

Consumption of fluorspar for several years after the war probably will be substantially greater than during the 5 pre-war years. The steel industry will, as heretofore, continue to influence profoundly the prosperity of the domestic fluorspar industry. Although some of the conservation measures effected during the war doubtless will be continued, it is believed unlikely that the average consumption of fluorspar per ton of steel produced will drop below that of 5.4 and 5.2 pounds, respectively, in 1939 and 1940. Although the production of steel will decline substantially with the ending of the war, many authorities believe that it will be maintained at a high level for some time. Should an annual average production of, say, 50,000,000 long tons of basic open-hearth and basic electric steels be maintained during the 5 post-war years an annual consumption of 145,000 to 150,000 short tons of fluorspar probably would be required.

Establishment of important new uses and a growing demand in some of the older uses for hydrofluoric acid have resulted in a large

increase in consumption of fluorspar during the war. During the 2 years 1942–43 the average consumption of fluorspar in the manufacture of hydrofluoric acid was 97,600 tons as compared with an average of 32,500 tons during the 5 years 1937–41. Although consumption will decline after the war, it is likely to be substantially greater than during the 5 years 1937–41.

It is believed that the future requirements of ceramic grades will exceed those for 1937–41, which averaged 20,000 tons, and future consumption in the production of iron castings, ferro-alloys, primary and secondary nonferrous metals, cement, and other miscellaneous operations will be maintained at least at the pre-war level and may advance somewhat.

Consequently, an average consumption of 225,000 to 250,000 tons for several years after the war appears to be possible.

PRODUCTION AND SHIPMENTS

Production of finished fluorspar totaled 405,600 short tons in 1943, including 159,758 tons of flotation concentrates. In addition, 66,000 tons of crude ore, equivalent to 27,400 tons of finished fluorspar, were mined but not milled in 1943. Thus, total production (expressed in terms of finished fluorspar) was 433,000 tons in 1943 compared with 337,000 tons in 1942. Of the quantity produced in 1943, 12 mines producing over 10,000 tons each supplied 212,000 tons or 49 percent, 12 mines producing 5,000 to 10,000 tons each supplied 80,000 tons or 18 percent, and 35 mines producing 1,000 to 5,000 tons each supplied 90,000 tons or 21 percent; thus, 59 mines produced 382,000 tons or 88 percent of the total. The remainder (51,000 tons or 12 percent) was produced in quantities ranging from a few tons to 1,000 tons from an undetermined number of small mines and prospects and reclaimed from waste dumps and old workings of abandoned mines.

Fluorspar shipments from domestic mines in 1943 were the largest on record and aggregated 406,016 short tons valued at $11,802,255, representing increases of 13 percent in quantity and 33 percent in total value over 1942. Of the 1943 total, 49,913 tons were shipped by river or river-rail for delivery to consumers as compared with 79,049 tons (an all-time high) in 1942.

Illinois (49 percent) and Kentucky (27 percent) supplied 76 percent of the fluorspar shipped in 1943 compared with 82 percent in 1942 and 86 percent in 1941. Shipments from Illinois and Kentucky in 1943 gained only 4 percent over 1942 compared with an increase of 52 percent in the West.

The average value of all grades of finished fluorspar shipped in 1943 was $29.07 a short ton ($4.38 more than the 1942 average).

The following table shows shipments of fluorspar, by States, 1942 and 1943. (For historical table, see Minerals Yearbook, 1941, p. 1401.)

Shipments of fluorspar in 1943 comprised 226,461 tons of fluxing gravel and foundry lump, 158,724 tons of flotation concentrates, 20,263 tons of ground, and 568 tons of acid lump. The bulk of the fluxing-gravel and foundry-lump fluorspar was shipped to steel plants and iron foundries, but a comparatively small tonnage moved to plants making cement, ferro-alloys, nickel, basic refractories, and fluxing compounds, to smelters of secondary metals, and to the Government stock pile. Hydrofluoric-acid plants took 77 percent of the flotation con-

Fluorspar shipped from mines in the United States, 1942–43, by States

State	1942			1943		
	Short tons	Value		Short tons	Value	
		Total	Average		Total	Average
Illinois	161,949	$4,306,750	$26.59	198,789	$6,292,789	$31.66
Kentucky	134,133	3,266,257	24.35	109,849	3,122,513	28.43
Colorado	31,743	640,938	20.19	49,145	1,164,868	23.70
New Mexico	23,291	530,025	22.76	37,050	986,094	26.62
Texas				960	19,281	20.08
Arizona				1,328	26,441	19.91
Washington	48	153,779	16.72			
Nevada	8,020			8,653	190,269	21.39
Utah	1,018			51		
Tennessee	114			57		
California				134		
	360,316	8,897,749	24.69	406,016	11,802,255	29.07

centrates shipped in 1943; the remainder went to aluminum- and magnesium-reduction works, to steel, ferro-alloy, glass, enamel, and nickel plants, to smelters of secondary metals, and to the Government stock pile. Over two-thirds of the ground fluorspar was shipped to glass and enamel plants; the remainder moved chiefly to manufacturers of welding rods, magnesium, ferro-alloys, and steel and to smelters of secondary metals. Except for 20 tons to a steel plant and 1 ton to a nonferrous smelter, all the acid lump fluorspar was shipped to hydrofluoric-acid plants.

The next table shows shipments of fluorspar, by grades and industries, in 1943.

Fluorspar shipped from mines in the United States in 1943, by grades and industries

Grade and industry	Short tons	Grade and industry	Short tons
Fluxing gravel and foundry lump:		Flotation concentrates:	
Ferrous	215,530	Ferrous	[1] 13,351
Nonferrous	3,313	Nonferrous	5,375
Cement	1,094	Glass and enamel	6,982
Miscellaneous	205	Hydrofluoric acid	121,983
Government stock pile	4,374	Miscellaneous	673
Exported	1,945	Government stock pile	3,696
	226,461	Exported	6,664
			158,724
Acid lump:			
Ferrous	20	Total:	
Nonferrous	1	Ferrous	228,996
Hydrofluoric acid	547	Nonferrous	10,189
	568	Cement	1,094
		Glass and enamel	21,059
Ground:		Hydrofluoric acid	123,680
Ferrous	95	Miscellaneous	3,884
Nonferrous	1,500	Government stock pile	8,070
Glass and enamel	14,077	Exported	9,044
Hydrofluoric acid	1,150		406,016
Miscellaneous	3,006		
Exported	435		
	20,263		

[1] Includes pelletized gravel.

SHIPMENTS, BY USES

The steel industry is the predominant purchaser of fluorspar, as is evident from the following table; it also consumes considerable hydrofluoric acid and sodium fluoride, in which fluorspar is the basic material.

Fluorspar shipped from mines in the United States, 1942–43, by uses

Use	1942				1943			
	Quantity		Value		Quantity		Value	
	Percent of total	Short tons	Total	Average	Percent of total	Short tons	Total	Average
Steel	62.51	225,233	$5,085,037	$22.58	54.38	220,809	$6,006,251	$27.20
Iron foundry	.95	3,408	65,073	19.09	.84	3,398	85,728	25.23
Glass	5.80	20,890	576,363	27.59	4.80	19,487	582,173	29.87
Enamel	.53	1,923	56,723	29.50	.39	1,572	50,620	32.20
Hydrofluoric acid	24.45	88,083	2,540,766	28.85	30.46	123,680	4,046,231	32.72
Miscellaneous	3.26	11,763	331,242	28.16	4.91	19,956	598,627	30.00
Government stock pile					1.99	8,070	185,652	23.01
	97.50	351,300	8,655,204	24.64	97.77	396,972	11,555,282	29.11
Exported	2.50	9,016	242,545	26.90	2.23	9,044	246,973	27.31
	100.00	360,316	8,897,749	24.69	100.00	406,016	11,802,255	29.07

USES

As figure 1 shows graphically, the steel industry is the chief consumer of fluorspar in the United States. Fluorspar is used as a flux in basic open-hearth and basic electric steel furnaces; a comparatively small quantity is employed in Bessemer-steel furnaces. The second-largest use is in the manufacture of hydrofluoric acid, which is utilized to make artificial cryolite and aluminum fluoride (aluminum raw materials), refrigerating mediums, and insecticides; hydrofluoric acid is also used in the electrolytic refining of metals, the pickling of metals, chromium plating, the processing of high-octane gasoline, and the etching of glassware, as well as for other purposes. The glass industry, which employs fluorspar as an opacifier and as a flux, ranks third in importance. The enamel industry uses fluorspar as an ingredient in frit; it formerly ranked fourth but dropped to tenth place in 1943. Comparatively small quantities of fluorspar are used in a number of miscellaneous operations, such as production of the finer grades of iron castings, chilled-iron rolls, primary and secondary nonferrous metals, cement, ferro-alloys, carbon electrodes, rock wool, basic refractory cements, and calcium carbide and cyanamid; as a paint pigment; as a binder for abrasives; in a formula for coating welding rods; as a boiler-cleaning compound; as a flux to deslag high-pressure generators; for stripping anodizing racks; as an ingredient in various types of fluxing compounds; and in the manufacture of surfacing for roofing.

One of the most important wartime developments in aviation-gasoline manufacture is the anhydrous hydrofluoric acid alkylation process, in which hydrogen fluoride is the catalyst instead of the usual sulfuric acid. Frey [3] has described this process. Another important wartime invention is the new aerosol dispenser for protection of the Army overseas from malaria mosquitoes, which uses Freon, a non-

[3] Frey, F. E., Commercial Alkylation with Hydrogen Fluoride Catalyst: Chem. and Met. Eng., vol. 50, No. 11, November 1943, pp. 126 and 128.

poisonous gas employed for refrigerating systems. Both developments resulted in greatly increased demand for acid-grade fluorspar in 1943. Considerable publicity was given to the use of sodium fluoride to retard tooth decay.

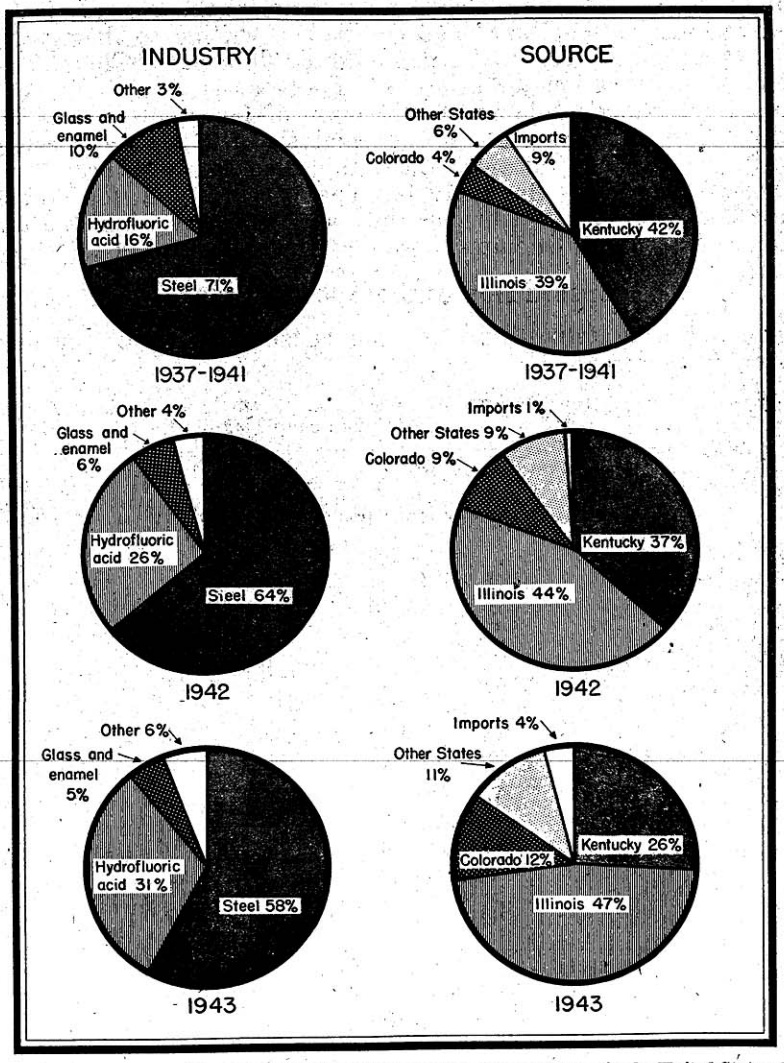

FIGURE 1.—Average annual fluorspar sales (domestic and foreign) to consumers in the United States, 1937–41, compared with 1942 and 1943, by consuming industries and by sources.

SPECIFICATIONS

The chief commercial grades of fluorspar are metallurgical, ceramic, and acid. The standard chemical specification for metallurgical grade is a minimum of 85 percent calcium fluoride and a maximum of 5 percent silica; it contains 72½ percent effective calcium fluoride. However, because of a scarcity of metallurgical-grade fluorspar in 1942, many consumers voluntarily accepted a lower-grade product.

Production of metallurgical-grade fluorspar continued to lag behind consumption during the first half of 1943, and as a consequence the Office of Price Administration, effective August 30, 1943, prohibited the sale or delivery of metallurgical-grade fluorspar containing more than 60 percent effective calcium fluoride unless the Steel Division of the War Production Board had certified in writing to the producer that the purchaser required a higher-grade fluorspar. The standard chemical specification for acid-grade fluorspar is a minimum of 98 percent calcium fluoride and a maximum of 1 percent each of silica and calcium carbonate, but a base analysis of 97½ percent calcium fluoride and 1½ percent silica was established by the Office of Price Administration on July 1, 1943. The specifications for ceramic-grade fluorspar vary widely, but the standard specification is a minimum of 95 percent calcium fluoride and a maximum of 2½ percent silica.

CONSUMPTION AND CONSUMERS' STOCKS

The following tables give data on consumption and consumers' stocks of fluorspar.

Fluorspar (domestic and foreign) consumed and in stock in the United States, 1942–43, by industries, in short tons

Industry	1942			1943		
	Consumption	Stocks at consumers' plants Dec. 31	In transit to consumers' plants Dec. 31	Consumption	Stocks at consumers' plants Dec. 31	In transit to consumers' plants Dec. 31
Basic open-hearth steel	217,100	63,400	4,084	205,676	61,195	3,008
Electric-furnace steel	25,300			28,236		
Bessemer steel	200			236		
Iron foundry	3,600	1,100	57	3,378	1,155	104
Ferro-alloys	4,200	1,000		3,882	2,331	
Hydrofluoric acid	81,600	19,000	585	113,614	27,951	1,443
Primary aluminum	2,000	1,100	49	2,758	1,008	55
Primary magnesium	700	400		3,025	1,026	158
Glass	18,500	7,200	596	20,592	6,184	283
Enamel	3,100	1,100	57	1,726	1,065	132
Welding rod	1,300	200	5	2,286	150	
Cement	400	200	49	262	1,046	
Miscellaneous	2,800	1,300	118	3,214	2,822	348
	360,800	96,000	5,600	388,885	105,933	5,531

Consumption and stocks of fluorspar (domestic and foreign) at basic open-hearth steel plants, 1939–43

	1939	1940	1941	1942	1943
Production of basic open-hearth steel ingots and castings, long tons	43,368,000	55,038,000	66,056,000	67,821,000	69,695,000
Consumption of fluorspar in basic open-hearth steel production, short tons	116,200	143,800	191,300	217,100	205,676
Consumption of fluorspar per ton of steel made, pounds	5.4	5.2	5.8	6.4	5.9
Stocks of fluorspar on hand at steel plants at end of year, short tons	69,900	79,800	84,200	60,400	57,200

The quantity of fluorspar used per long ton of basic open-hearth steel varies with each plant, each operator, each furnace, and each heat but probably ranges from less than 1 pound to 80 pounds. The average for all plants is generally 5 to 8 pounds—a relatively small proportion of the furnace charge. From 1921 (the first year for which these data were collected) to 1940 the average consumption of fluorspar per long ton of steel made declined almost steadily from 8.2 to 5.2 pounds; it increased to 5.8 pounds in 1941 and further to 6.4 pounds

in 1942—the highest since 1935. However, it declined to 5.9 pounds in 1943. The decreased consumption in 1943 was due chiefly to conservation measures, rather than to the use of substitutes. Although basic electric steel plants are small users of fluorspar as compared with basic open-hearth steel plants, the average consumption of fluorspar (12.8 pounds in 1943) per long ton of basic electric steel made is substantially greater. However, as in basic open-hearth, the average consumption of fluorspar per ton of basic electric steel made also declined in 1943.

Fluorspar was reported consumed in 37 States and the District of Columbia in 1943, but three States—Illinois, Ohio, and Pennsylvania—used 241,683 tons or 62 percent of the total consumption. In addition to being the chief fluorspar-producing State, Illinois was also the largest consuming State in 1943, taking 87,702 tons or 23 percent of the total. Although ranking third as a consumer of fluorspar in steel, Illinois was the largest consumer of fluorspar in hydrofluoric acid in 1943. Pennsylvania, the second largest consumer in 1943, ranked first in consumption in both steel and glass.

The next table shows, so far as possible without revealing the figures of individual companies, the consumption of fluorspar by States and by consuming industries.

Fluorspar (domestic and foreign) consumed in the United States in 1943, by States and industries, in short tons

State	Steel	Iron foundry and ferro-alloys	Non-ferrous metals	Glass and enamel	Hydro-fluoric acid	Other	Total
Alabama	13,011	13	508				13,532
Georgia							
Arkansas			(1)				(1)
California	6,122	(1)	1,322	(1)	(1)	23	9,855
Oregon							
Washington		(1)				81	
Colorado	15,119	(1)					17,765
Iowa							
Missouri		(1)	(1)	1,110			
Oklahoma							
Texas			(1)		(1)		
Connecticut	2,159	(1)	(1)	(1)		(1)	2,450
Massachusetts		63	(1)	(1)			
Rhode Island							
Delaware	1,323				(1)		26,454
District of Columbia							
New Jersey			(1)	(1)	(1)	(1)	
Illinois	22,291	397	142	3,409	(1)	(1)	87,702
Indiana	17,534	600	164				20,287
Kansas			(1)			(1)	(1)
Louisiana			(1)				(1)
Kentucky	13,831	(1)	(1)	1,855		(1)	16,992
Maryland							
West Virginia			(1)			(1)	
Michigan	16,727	771	(1)	(1)		(1)	19,383
Minnesota							
Wisconsin		(1)		119		(1)	
Mississippi				(1)			(1)
Nebraska			(1)				(1)
Nevada			(1)				(1)
New York	13,005	(1)	930	740		(1)	17,749
North Carolina			(1)			(1)	(1)
Ohio	52,831	1,824	828	12,312	(1)	(1)	68,610
Pennsylvania	59,755						85,371
South Dakota						(1)	(1)
Tennessee	440	(1)	(1)	(1)			1,175
Virginia						(1)	311
Wyoming						(1)	(1)
Undistributed [1]		3,592	4,476	2,773	113,614	3,071	1,249
	234,148	7,260	8,370	22,318	113,614	3,175	388,885

[1] Included under "Undistributed."

[2] Includes entries indicated by "(1)" above.

PRICES

The increased maximum prices for metallurgical-grade fluorspar, which became effective November 23, 1942, and ranged from $25 to $28 a short ton according to calcium fluoride and silica content, did not stimulate production as anticipated. Consequently, effective July 1, 1943, new base prices of $30 to $33 a ton for metallurgical-grade fluorspar were established by the Office of Price Administration in Revised Maximum Price Regulation 126 (Fluorspar), issued July 1, 1943. However, beginning August 30, 1943, the War Production Board controlled deliveries of the higher grade of metallurgical fluorspar. The new regulation also advanced the base prices of acid and ceramic grades of fluorspar to $37 a short ton.

STOCKS AT MINES OR SHIPPING POINTS

According to reports of producers, the quantity of fluorspar in stock at mines or shipping points at the close of 1943 totaled 115,937 tons or 125 percent more than in 1942. These stocks comprised 19,026 tons of finished fluorspar and 96,911 tons of crude fluorspar (calculated to be equivalent to 42,000 tons of finished fluorspar).

Stocks of fluorspar at mines or shipping points in the United States, December 31, 1942 and 1943, by States, in short tons

State	1942			1943		
	Crude [1]	Finished	Total	Crude [1]	Finished	Total
Arizona	30		30			
California	150		150	150	7	157
Colorado	3,601	1,067	4,668	39,108	892	40,000
Idaho				50		50
Illinois	10,521	13,984	24,505	34,079	6,363	40,442
Kentucky	1,774	3,970	5,744	6,541	10,498	17,039
Nevada					200	200
New Mexico	15,605	312	15,917	16,983	573	17,556
Texas					293	293
Utah	500	96	596		200	200
	32,181	19,429	51,610	96,911	19,026	115,937

[1] The greater part of this crude (run-of-mine) fluorspar must be beneficiated before it can be marketed.

TECHNOLOGIC DEVELOPMENTS

Laboratory tests of the Heavy-Media Process for the milling of fluorspar ores having proved encouraging, mills employing this process were installed in 1943 by three companies—Rosiclare Lead & Fluorspar Mining Co. at Rosiclare, Ill., Western Fluorspar Corporation at Northgate, Colo., and Metals Reserve Co. at Gila, N. Mex. The mills of the Western Fluorspar Corporation and Metals Reserve Co. began operating in December 1943. The mill of the Rosiclare Lead & Fluorspar Mining Co. began operating in March 1944, and according to A. H. Cronk, superintendent, "The results are very encouraging and are somewhat better than the laboratory results as determined by the American Cyanamid Co." A fourth company has a Heavy-Media Process mill under consideration. This method of milling is reported to be very satisfactory for free-milling ore and to be more efficient than jigging. Ferrosilicon is used for the heavy medium.

A flotation plant was completed by the Zuñi Milling Co. at Los Lunas, N. Mex., in 1943, and plants are under construction near Cave in Rock, Ill., by the Minerva Oil Co.; near Marion, Ky., by the Corod Minerals Corporation; at Albuquerque, N. Mex., by the American Fluorspar Co.; near Salida, Colo., by the Chaffee County Fluorspar Corporation; and near Forney, Idaho, by A. E. Chambers. The flotation mill of Indian Metals Co. at Lordsburg, N. Mex., which was destroyed by fire, was rebuilt during 1943. Output of flotation concentrates again gained phenomenally, totaling 159,758 short tons in 1943 compared with 106,974 tons in 1942 and 64,627 tons in 1941.

FLUORSPAR INDUSTRY IN 1943, BY STATES

Arizona.—Production in Arizona in 1943, totaling 1,328 short tons of finished fluorspar, came from mines and prospects in Greenlee, Maricopa, and Yuma Counties; most of that from Greenlee County was shipped to flotation plants at Deming and Lordsburg, N. Mex. The flotation concentrates recovered from the fluorspar, rather than the run-of-mine material, have been credited in the statistics to Arizona. The fluorspar from Yuma County was shipped to steel plants in California. The fluorspar from Maricopa County came from the Big Spar, Contact, and Good Luck mines near Wickenburg and was also shipped to steel plants.

California.—Production of fluorspar in California in 1943 was 141 short tons, of which 134 tons were shipped to steel plants. It was produced at the Red Bluff mine near Midland, Riverside County, by E. T. Hermann.

Some Nevada fluorspar was ground at the plant of the Industrial Minerals & Chemical Co. at West Berkeley and shipped to nonferrous smelters and magnesium-reduction plants in 1943. The ground fluorspar is credited in the statistics to Nevada.

Colorado.—Greatly accelerated production at mines in Boulder and Chaffee Counties is indicated by the shipment of 49,145 short tons of fluorspar from Colorado in 1943 compared with 31,743 tons in 1942. Shipments in 1943 established a new record for Colorado and exceeded the previous record made in 1918 by 28 percent; they comprised 22,778 tons of fluxing gravel and foundry lump fluorspar, 25,946 tons of flotation concentrates, and 421 tons of ground fluorspar. Seventy-seven percent went to steel and hydrofluoric-acid plants but some to iron foundries and nonferrous smelters and to glass, enamel, ferroalloy, cement, and magnesium-reduction plants. A small tonnage of fluxing gravel was shipped to the Government stock pile at Chicago.

Production of finished fluorspar in Colorado totaled 49,000 tons in 1943. In addition, 35,500 tons of crude ore, equivalent to 11,500 tons of finished fluorspar, were mined but not milled in 1943. Thus, total production (expressed in terms of finished fluorspar) was 60,500 tons in 1943. Output came from Boulder, Chaffee, Jackson, Jefferson, Mineral, and Park Counties, but mines in Boulder, Chaffee, and Jackson Counties supplied 90 percent of the State total.

During 1943 Harry M. Williamson & Son added jigs and tables to their flotation mill in Boulder County to make possible the production of both fluxing gravel and flotation concentrates. Production of finished fluorspar was about 5 percent less than in 1942 and comprised 51 percent fluxing gravel and 49 percent acid-grade flotation

concentrates. The ore treated in the mill came from the company-operated Argo, Brown Spar, and Emmett mines in Boulder County. Some milling ore was sold to the nearby flotation mill of the General Chemical Co. The shaft at the Emmett mine was sunk an additional 200 feet to a depth of 475 feet. At the Argo shaft a new hoist house, a head frame, and an ore bin were erected, a drift was driven on the winze level to a point under the shaft, and a raise was driven to the bottom of the old shaft.

Production of flotation concentrates at the mill (near Jamestown) of General Chemical Co. about tripled that in 1942. The output of the mill was shipped to the hydrofluoric-acid plants of the company. The flotation-mill feed comprised ore from the company-operated Alice, Burlington, Chancellor, and Yellow Girl mines in Boulder County and some purchased ore. This company also operates a flotation mill in New Mexico.

The Colorado Fluorspar Corporation, which operates a combination flotation-jig mill and a mine near Salida, Chaffee County, produced about 67 percent more finished fluorspar than in 1942. Production in 1943 comprised 61 percent fluxing gravel and foundry lump and 39 percent flotation concentrates. Development consisted of about 1,200 feet of drifting, which resulted in opening additional ore reserves.

During 1943 the Chaffee County Fluorspar Corporation, with a property near Salida, produced and sold some crude ore to a local mill, did considerable development, and in the fall began to construct a flotation mill.

The flotation mill of Kramer Mines, Inc., near Salida, which started operating in October 1942, made a substantial output of concentrates in 1943. The mill feed comprised chiefly ore from the company mines near Salida and Poncha Springs, Chaffee County, and Northgate, Jackson County; some purchased ore mainly from the Chaffee County was also milled. The company did considerable development at its claims in Jackson County. Fleming [4] has described the Chaffee County mines and mill of the Kramer Mines, Inc.

The Western Feldspar Milling Co., Denver, ground 421 short tons of fluorspar, which was shipped to glass plants in 1943. The ore was supplied by the American Fluorspar Corporation. The Western Feldspar Milling Co. discontinued grinding fluorspar in July 1943.

The American Fluorspar Corporation, operating mines near Salida and Poncha Springs (Chaffee County), produced 9 percent more finished fluorspar than in 1942, but its output of milling ore almost tripled the 1942 figure. The flotation mill of the Fluorspar Processing Co.—on property of the American Fluorspar Corporation, which supplies its milling ore—produced 103 percent more fluorspar concentrates than in 1942. Reconditioned flotation cells, a drier, and pumps were installed in the mill, and new loading bins and an elevator to loading bins were constructed. Other improvements included concrete floors throughout the mill and a boiler to provide hot water.

The Western Fluorspar Corporation mill near Northgate, Jackson County, which was destroyed by fire on December 10, 1942, was rebuilt during 1943 and began operating in December. The mill uses the Heavy-Media Process for separating fluorspar from gangue material, with ferrosilicon as the heavy medium. During the building

[4] Fleming, Roscoe, Fluorspar Helps Wage War: Compressed Air Mag., vol. 48, No. 10, October 1943, pp. 7160-7163.

of the mill the company mined a substantial tonnage of ore, some of which was hand-sorted and shipped.

The Wagon Wheel Gap mine of the Colorado Fuel & Iron Corporation was operated 10 months in 1943 as compared with 11 months in 1942; production therefore declined slightly.

Small quantities of fluorspar, which were shipped to steel mills, were produced at the Augusta mine in Jefferson County and the Lake George and Bear Cat mines in Park County.

Idaho.—The Chamac mine near Forney, Lemhi County, was being developed during 1943 by A. E. Chambers, who since October has been constructing a 70-ton flotation mill.

Anderson [5] has described the fluorspar deposits near Meyers Cove, Lemhi County.

Illinois.—Production of finished fluorspar in Illinois was 191,000 short tons in 1943; about 94 percent came from Hardin County and 6 percent from Pope County. In addition, 24,000 tons of crude ore, equivalent to about 13,000 tons of finished fluorspar, were mined but not milled. Thus, total production in 1943 (expressed in terms of finished fluorspar) was 204,000 tons. Considerable Kentucky fluorspar is milled in Illinois, and some Illinois fluorspar is milled in Kentucky; the finished fluorspar so recovered, as well as that shipped, is credited in the statistics to the State of origin. The Argo, Austin, Blue Diggings, Crystal, Daisy-North Daisy, A. L. Davis, Deardorff, Dimick, Douglas, Fairview, Good Hope, West Green, Hillside, Lead Hill, Midway-North Boundary-Air Shaft, Roberts, Rosiclare, Stewart, and Victory properties supplied about 85 percent of the fluorspar produced in Illinois in 1943; the remainder came from many mines and prospects, including the Cave in Rock, Eureka No. 4 and No. 5, East Green, Hawkins Shaft, J. W. Hill, Last Chance, Lost 40, Rock Candy Mountain, Rose Creek, South Boundary-Deep Shaft, and Wall.

Shipments of fluorspar from Illinois (198,789 tons) constituted 49 percent of the total shipped in 1943 and established a new record—23 percent greater than in 1942, the previous record year. The 1943 shipments comprised 89,789 tons to steel plants, 89,599 tons to hydrofluoric-acid plants, 6,741 tons to glass and enamel plants, 2,333 tons to Algeria, Canada, and Peru, and 10,327 tons to iron foundries, nonferrous smelters, aluminum- and magnesium-reduction plants, and ferro-alloy, nickel, and welding-rod manufacturers. Of the 1943 total, 36,643 tons were shipped by river or river-rail to consumers compared with 42,250 tons in 1942.

The Fluorspar Products Co. operated the Lead Hill and Stewart mines and milled purchased ore from various properties. Shipments were 38 percent more than in 1942.

The Aluminum Ore Co., the largest producer of fluorspar in the United States in 1943, produced 58 percent more fluorspar at its flotation plant than in 1942. The mill feed comprised ore from the company-operated Argo, Blue Diggings, Fairview, Good Hope, Hamp and Last Chance mines and some purchased ore, chiefly from the Rose Creek and Rock Candy Mountain mines. The new 700-foot shaft at the Fairview mine, on the Argo-Blue Diggings veins, was completed and put into operation in June 1943. Underground develop-

[5] Anderson, A. L., The Antimony and Fluorspar Deposits near Meyers Cove, Lemhi County, Idaho. Idaho Bureau of Mines and Geol., Pamph. 62, March 1943, 22 pp.

ment was carried forward on the Argo vein on various levels operating through the Blue Diggings shaft. Development was continued on the various levels from the Blue Diggings and the Fairview shafts. Additional boiler and generating capacity was installed to take care of the electrically operated Fairview mine.

In 1943, as in 1942, considerable output was lost at the Crystal mine of the Crystal Fluorspar Co. because of two strikes. Production was about the same in both years. An unknown ore body below the creek bed was found by drilling, and a shaft was being sunk on this ore body. The company did 20,500 feet of churn and diamond drilling in 1943.

Production of gravel fluorspar and flotation concentrates by Hillside Fluor Spar Mines was 12 and 15 percent, respectively, less than in 1942. The mill feed comprised ore from the Dimick, Hillside, and Wall mines at Rosiclare, Ill., the Keystone mine near Marion, Ky., and tailings from previous milling operations. Production and shipments of finished fluorspar from the Keystone mine have been credited in the statistics to Kentucky. The Hillside Fluor Spar Mines were acquired on June 1, 1943, by the Inland Steel Co., which will operate the property as a separate unit and continue to serve other consumers.

The Victory mine of the Victory Fluorspar Mining Co. produced 14 percent less fluorspar than in 1942.

Most of the output from the mine of the General Finance Corporation was sold to local mills. However, some of the ore was milled by the company, and the fluxing-gravel fluorspar produced was shipped to steel plants.

The flotation mill of the Mahoning Mining Co. produced 12 percent more fluorspar concentrates than in 1942. The mill feed comprised ore from the A. L. Davis, Deardorff, East Green, and West Green mines and some purchased ore. Production of finished fluorspar comprised 76.5 percent acid-grade and 23.5 percent pelletized gravel. Shaft sinking and underground development were completed at the East Green mine, which began producing in 1943. The flotation-mill expansion program was completed during 1943.

James W. Patton & Sons again treated tailings from the Crystal mine in its flotation mill and also treated some tailings from the C. R. Babb mine for Roberts & Frazer.

The Yingling Mining Co. operated the Rose Creek mine, and the output was sold to a local mill for treatment; however, the company also purchased and milled ore from the Douglas mine, which it acquired in December.

The Minerva Oil Co. continued development at its mine near Cave in Rock and was constructing a flotation mill near the mine. Both units were expected to get into production during March 1944.

The Rosiclare Lead & Fluorspar Mining Co. operated the Daisy-North Daisy, Eureka No. 4 and No. 5, Hawkins Shaft, Midway-North Boundary-Air Shaft, Rosiclare, and South Boundary-Deep Shaft in 1943, but the Rosiclare mine was the chief producer. Production at the gravity-concentration mill and flotation mill was 21 and 8 percent greater than in 1942. Shipments of fluorspar of all grades were 22 percent greater than in 1942. A Heavy-Media Process mill for separating fluorspar from gangue material was nearing completion at the close of 1943. The separating cone is 14 feet in diameter, and

ferrosilicon is to be used for the heavy medium. The ore treated will be plus 10-mesh to 1 inch. The minus 10-mesh ore will be flotation-mill feed. The Heavy-Media mill will eliminate the use of jigs. Three diamond drills were operated to find additional ore bodies and new veins; some of the results were satisfactory. The Hawkins, a new mine about 1 mile north of the Rosiclare vein, was opened, and mining in good ore was in progress at the 100-foot level. A submersible pump having a capacity of 1,800 gallons a minute at 650-foot head and equipped with a 350-horsepower motor was installed in the Rosiclare mine in 1943 for pumping protection. This gives a pumping capacity of 8,800 gallons a minute, or about double the inflow of water. A 500-kilowatt turbine generator was added to the power plant.

Production at the Roberts mine in Pope County, operated by Roberts & Frazer of Illinois (Kentucky Fluor Spar Co. affiliate), was substantially greater than in 1942. The known ore in this mine was exhausted in November 1943.

The Rock Candy Mountain mine, also in Pope County, operated by the Big Creek Mining Co., produced considerable crude ore, which was sold to local mills.

Kentucky.—Production of finished fluorspar in Kentucky was 116,500 short tons in 1943. In addition, 5,000 tons of crude ore, equivalent to 2,500 tons of finished fluorspar, were mined but not milled. Thus, production (expressed in terms of finished fluorspar) totaled 119,000 tons in 1943. Shipments again declined and amounted to 109,849 tons—a decrease of 18 percent from 1942 and 23 percent less than the all-time record for 1941. The 1943 shipments comprised 89,419 tons to steel plants, 10,153 tons to glass and enamel plants, 1,739 tons to hydrofluoric-acid plants, 1,889 tons to Canada, and 6,649 tons to iron foundries, nonferrous smelters, and cement, ferroalloy, aluminum-reduction, and miscellaneous plants. Of the 1943 total, 15,270 tons were shipped to consumers by river or river-rail compared with 36,799 tons in 1942.

Output in Caldwell County came chiefly from the Crook, Glass, Hollowell & Hobby, Hughett, Perkins, and Senator mines, most of it being from the Hollowell & Hobby, Hughett, and Senator mines.

Output at the mine of Hughett Mining Co. near Princeton about doubled that of 1942.

The New York & Kentucky Mining Co., operating the Hollowell & Hobby mine near Princeton, produced 12 percent more fluorspar than in 1942.

The Midland Minerals Corporation, which was organized late in 1942, commenced operations at the Senator mine near Princeton in January 1943 and produced a substantial tonnage of fluxing-gravel fluorspar during the year.

The major part of the output in Crittenden County came from a few mines—Bachelor, Davenport, Keystone, Pigmy, Tabb, and Watson (Eagle). Most of the remainder came from many smaller mines (including the Babb, Barnes, Blue, Columbia, Gilless, Guill, Hodge, Krause, La Rue, Marion Lake, Summers, and Watkins) and from numerous prospects; some was reclaimed from waste dumps and old workings of abandoned mines.

The Eagle Fluorspar Co. worked the Adams, Babb, Guill, and Watson (Eagle) mines and produced 33 percent less finished fluorspar

than in 1942. The Babb mine was under development in 1943. Perry and Loyd reworked the Watson tailings and recovered considerable fluorspar.

Operations at the Summers mine and mill of R. J. Forester were suspended in July 1943; consequently, production was substantially less than in 1942.

The Tabb mines and mill of the United States Coal & Coke Co. produced 14 percent less finished fluorspar than in 1942, but shipments declined 47 percent. The company did considerable development in 1943.

The Kentucky Fluor Spar Co. and affiliates did the largest volume of business in its history; tonnage and dollar sales were 8 and 16 percent, respectively, greater than in 1942, the previous record year. The company operates a mill near Marion, and through its mining divisions (Roberts & Frazer and Hettiger & Frazer), operated the C. R. Babb, Carr, Ellis, and Wright mines in Livingston County, the Pepper Box mine in Crittenden County, and the Roberts mine in Pope County, Ill., in 1943. About three-fourths of the company supply came from these mines, and the remainder chiefly from the Barnes, Blue, Hollowell & Hobby, and Nancy Hanks.

Production at the Keystone mine of Hillside Fluor Spar Mines was substantially less than in 1942. Although the fluorspar from this mine is finished at the company mill at Rosiclare, Ill., production and shipments are credited in the statistics to Kentucky.

At the Pigmy mine of the Pigmy Corporation (subsidiary of the Rosiclare Lead & Fluorspar Mining Co.) production was 11 percent less than in 1942. A newly located ore body was developed further by extension of the 100-foot level, and the results were very encouraging. A diamond drill was operated on the Pigmy property during 1943, and the results indicated further downward extension of the ore body on the west side of the property.

During 1943 the National Fluorspar Co. sank a 300-foot shaft on a newly discovered ore body in its Davenport mine. A new 7-inch Pomona pump and a 66-horsepower Diesel engine will be installed in 1944. The power plant was being moved to the new location. The lower working levels of the old shaft were flooded from March to July; meanwhile, production was confined to a small tonnage of low-grade ore from the upper levels and to the re-treatment of about 1,000 tons of tailings. Consequently, production of finished fluorspar was 22 percent less than in 1942.

Output at the Bachelor mine of the Delhi Fluorspar Corporation was at a greatly reduced rate in 1943. However, the company purchased both finished fluorspar and milling ore from many producers, and consequently its shipments were much greater than in 1942.

Shipments of fluorspar by L. Conyer, operating a mill near Marion, were two and one-half times those of 1942. Conyer does not operate any mines but purchases milling ore from various mines. The bulk of the ore milled in 1943 was supplied by the Hughett Mining Co. and Craighead Bros.

The Corod Minerals Corporation was constructing a flotation mill near Marion in 1943. It mined a small quantity of ore at the Columbia mine.

In Livingston County most of the fluorspar output came from the C. R. Babb, Carr, Junior, Nancy Hanks, and Wright mines, from

C. R. Babb and Nancy Hanks tailings, and from the reclaiming plant working Klondike tailings.

Output at the C. R. Babb, Carr, Ellis, and Wright mines of Roberts & Frazer was slightly greater than in 1942. E. W. Frazer reworked the tailings at the C. R. Babb mine and recovered 1,130 tons of fluorspar. Some tailings from the C. R. Babb mine were treated at the Patton flotation mill in Illinois and 186 tons of acid-grade concentrates were recovered.

Production at the Nancy Hanks mine, operated by W. V. Haynes, Jr., was retarded somewhat because of development during 1943, and output of finished fluorspar was slightly less than in 1942. Tinsley & Loyd reclaimed a substantial tonnage of fluorspar from Nancy Hanks tailings.

Butler & Moodie, operating the Junior mine and reclaiming fluorspar from the Klondike-mine tailings, recovered 29 percent more fluorspar than in 1942.

In the Central Kentucky district production of fluorspar increased to 2,469 short tons in 1943 (79 tons in 1942). Output in this district came from the Faircloth mine in Woodford County, near Wilmore, operated by Ralph E. Jones; the Lone Oak mine near Harrodsburg in Mercer County, operated by the Lone Oak Ore Co.; and a property near Talmage, also in Mercer County, operated by Mercer Minerals, Inc. The Twin Chimney mine near Mundys Landing in Mercer County was acquired by the Lone Oak Ore Co. and began producing fluorspar in January 1944. The Faircloth mine was equipped with an electrically operated hoist and a pump in 1943. A new ore body was found one-fourth mile from the Faircloth mine. The shaft at the mine of Mercer Minerals, Inc., was sunk 125 feet.

Nevada.—Shipments of fluorspar from Nevada in 1943 (8,653 short tons) were 8 percent greater than in 1942 but 4 percent under the all-time record of 1941. Most of the 1943 total went to steel plants, but some was shipped to hydrofluoric-acid, ferro-alloy, and cement plants and to nonferrous smelters.

The chief producing mine in Nevada in 1943 was the Baxter in Mineral County, operated by V. S. Baxter. Production was 10 percent more than in 1942. The other chief producing mine was the Daisy in Nye County, operated by J. Irving Crowell, Jr.; production was also 10 percent greater than in 1942. A carload of fluorspar was produced and shipped from the Cirac mine in Churchill County, operated by E. S. Perry and associates.

New Mexico.—Production of finished fluorspar in New Mexico totaled 37,300 short tons in 1943. In addition, 1,400 tons of crude ore, equivalent to 400 tons of finished fluorspar, were mined but not milled in 1943. Thus, total production (expressed in terms of finished fluorspar) was 37,700 tons in 1943. The output came chiefly from Grant, Luna, Sierra, and Valencia Counties.

Shipments from New Mexico totaled 37,050 short tons, a gain of 64 percent over the all-time high of 1942. Most of the 1943 shipments were flotation concentrates, which moved chiefly to hydrofluoric-acid plants, but some was shipped to steel, glass, enamel, ferro-alloy, and magnesium-reduction plants and to the Government stock pile at East St. Louis, Ill. Most of the metallurgical-grade fluorspar went to steel plants and iron foundries, but some was shipped to the Government stock pile at Chicago.

The flotation mill of the General Chemical Co. at Deming was operated at about the same rate as in 1942. The mill feed comprised ore from the company Spar Group and Sadler mines in Luna County and the Osmer mine in Grant County, and considerable purchased ore from local mines. Virtually all the flotation concentrates produced were shipped to the hydrofluoric-acid plants of the company.

The flotation plant of the Zuñi Milling Co. at Los Lunas made its initial production in March 1943 and was the largest producer of fluorspar in New Mexico in 1943. Most of the concentrates were shipped to hydrofluoric-acid plants, but some were shipped to the Government stock pile at East St. Louis, Ill., and to glass plants. The mill feed is supplied by the Navajo mine in Valencia County. In addition to supplying milling ore to the flotation plant, the Navajo mine shipped 7,700 tons of fluxing-gravel fluorspar. The Navajo mine was acquired during the latter part of 1943 by the Shattuck Denn Mining Corporation, which has also taken over management of the flotation plant at Los Lunas.

The flotation mill of the Indian Metals Co. at Lordsburg was destroyed by fire on March 28, 1943; it was rebuilt and began operating again in July. Consequently, production was substantially less than in 1942. The mill feed is supplied by various mines and prospects in Arizona and New Mexico. The 1943 shipments went to steel, hydrofluoric-acid, and magnesium-reduction plants.

Production of flotation concentrates at the mill of P. L. Grattan at Deming was 66 percent greater than in 1942. The mill feed was supplied by the company mine and by purchased ore. The 1943 shipments moved to hydrofluoric-acid, steel, enamel, and magnesium-reduction plants.

J. K. Stanland continued development at the Blue Diamond mine in Dona Ana County, in the course of which some milling ore was produced and shipped to a local flotation plant. The gravity-concentration mill under construction was not completed in 1943.

A mill for producing fluxing-gravel fluorspar was completed and put into operation at Gila on December 27, 1943. The mill is owned by the Metals Reserve Co. and will be operated for it by the International Minerals & Chemical Co. to mill ore purchased from surrounding mines. Concentration is by the Heavy-Media Process, using ferrosilicon as the heavy medium. Pending completion of the mill a substantial tonnage of ore was accumulated at the mill; most of it was supplied by Brown & Johnson Corporation, chiefly from the Clum mine near Gila, and by McCray & Penn from the Burro Chief mine near Tyrone.

The Lyda K mine in Sierra County, owned by Kinetic Chemicals, Inc. (du Pont subsidiary), was put in operation in the early part of 1943 to produce a small quantity of metallurgical fluorspar and at the same time to carry on further exploration and development. The ore was found to be difficult to convert to metallurgical grade by simple hand sorting; after 201 tons were produced and shipped, production was discontinued, but development was continued the remainder of the year. The middle or No. 2 shaft was being deepened to explore on the 220-foot level a section of the ground that had not been explored earlier when diamond drilling was conducted in the south half of the ore body. Deepening of the shaft was expected to be completed in early 1944, after which drifting along the vein will be conducted.

In June 1943 J. K. Stanland acquired the Bonita mine, where he did considerable development, in the course of which some ore was taken out and milled at the plant of Both Mining & Milling Co. This mine was acquired on December 9 by the Bonita Trust, which continued development and produced a small quantity of metallurgical-grade fluorspar.

During the first half of 1943 Both Mining & Milling Co. produced a small tonnage of fluxing-gravel fluorspar at the Bonita mine in Valencia County. The company did custom milling for others at its concentrating plant at Grants.

Development was in progress during 1943 at the Blackbird prospect near Albuquerque in Bernalillo County by the American Fluorspar Co. A jig mill was constructed but proved unsatisfactory. Subsequently, a flotation mill was purchased and was being installed at Albuquerque. It was expected to be completed in March 1944.

Tennessee.—A small quantity of ore mined at a property presumably in Smith County near Rome was trucked to Marion, Ky., where it was finished in the mill of Delhi Fluorspar Corporation.

Texas.—Previous commercial production of fluorspar in Texas has consisted of small amounts of milling ore, which were shipped to a flotation plant at Deming, N. Mex. In 1943, however, production amounted to 1,253 tons, of which 960 tons were shipped to steel plants. Production came from the Glass & O'Brien mine in Burnet County and the Eagle Springs, Fenley, and Eagle Mountains mines in Hudspeth County. Operations at the Glass & O'Brien and Eagle Springs mines were discontinued during 1943. At the Eagle Mountains mine, operated by the Texas Fluorite Co., a concentrating mill was under construction. The fluorspar deposits of Hudspeth County have been described by Evans [6] and those of Burnet County by Barnes.[7]

Utah.—Only 1 car (51 tons) of fluorspar was shipped from Utah in 1943 compared with 1,018 tons (an all-time high) in 1942. It was shipped by the Western Fluorite Co., which also did development at its properties in Beaver County. Fred Staats, operating the Staats mine, also in Beaver County, produced a small quantity of fluorspar in 1943 but made no shipments. The Tintic Standard Mining Co. continued development work at the Cougar mine near Milford in Beaver County, where a concentrating mill was nearing completion at the end of 1943.

FOREIGN TRADE

Imports.—Imports of fluorspar for consumption in the United States in 1943 were the largest since 1930 and reached 43,570 short tons (1,854 tons containing more than 97 percent calcium fluoride and 41,716 tons containing not more than 97 percent calcium fluoride), valued [8] at $643,409, compared with 2,151 tons (1,882 tons containing more than and 269 tons containing less than 97 percent calcium fluoride), valued [8] at $35,529 in 1942. The value assigned to the higher-

[6] Evans, G. L., Fluorspar Deposits in the Eagle Mountains of Hudspeth County, Tex.: Bureau of Econ Geol., Univ. of Texas, Min. Resource Circ. 26, June 21, 1943, 13 pp.

[7] Barnes, V. E., Preliminary Reconnaissance Report on Fluorite in the Spring Creek Area of Burnet County, Tex.: Bureau of Econ. Geol., Univ. of Texas, Min. Resource Circ. 27, May 31, 1943, 6 pp.

[8] As defined in sec. 402 of the tariff act of 1930, "The value of imported merchandise * * * is the foreign value or the export value, whichever is higher—that is, the market value or the price at which the merchandise, at the time of exportation to the United States, is offered for sale in the principal markets of the country from which exported, including the cost of containers or coverings and all expenses (including any export tax) incident to placing the merchandise in condition ready for shipment to the United States."

grade foreign fluorspar averaged $16.98 and $22.46, respectively, in 1942 and 1943, and that of the lower-grade $13.30 and $14.43, respectively. The cost to consumers in the United States also includes duty, loading charges, insurance, consular fee, and freight to consuming plants. The duty on fluorspar containing not more than 97 percent calcium fluoride is $5.625 a short ton and on fluorspar containing more than 97 percent calcium fluoride, $3.75 a short ton.

Fluorspar imported for consumption in the United States in 1943, by countries[1] and customs districts

Country and customs district	Containing more than 97 percent calcium fluoride		Containing not more than 97 percent calcium fluoride		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
Mexico:						
Buffalo			96	$2,785	96	$2,785
El Paso	773	$10,161	6,112	62,694	6,885	72,855
Laredo	1,081	31,474	12,453	130,290	13,534	161,764
	1,854	41,635	18,661	195,769	20,515	237,404
Newfoundland: Buffalo			7,144	175,829	7,144	175,829
Spain: Philadelphia			15,341	222,676	15,341	222,676
Union of South Africa: New York			570	7,500	570	7,500
Total: 1943	1,854	41,635	41,716	601,774	43,570	643,409
1942	1,882	31,951	269	3,578	2,151	35,529

[1] For historical table, see Minerals Yearbook, 1941, p. 1401.

The following table, compiled from data furnished to the Bureau of Mines by importers, shows the quantities of imported fluorspar delivered to consumers in the United States in 1942 and 1943, irrespective of the year of importation into the United States; it differs from the preceding table, which shows the quantities received in the United States during 1942 and 1943. The quantities in the following table are based upon the actual outturn weights ascertained by sworn weighers and represent the weights on which duty was paid and entries were liquidated.

Imported fluorspar delivered to consumers in the United States, 1942–43, by uses

Use	1942			1943		
	Short tons	Selling price at tidewater, including duty		Short tons	Selling price at tidewater, including duty	
		Total	Average		Total	Average
Steel	269	[1] $6,700	[1] $24.91	15,616	[1] $503,000	[1] $32.21
Hydrofluoric acid	1,900	53,500	28.16	140	3,535	25.25
	2,169	60,200	27.75	15,756	506,535	32.15

[1] Estimated.

Exports.—Producers of fluorspar reported exports of 9,044 short tons of fluorspar valued at $246,973 in 1943 compared with 9,016 tons valued at $242,545 in 1942. The exports by producers in 1943 comprised 1,936 tons of fluxing gravel, 435 tons of ceramic ground, and 6,364 tons of flotation concentrates to Canada, 9 tons of fluxing gravel to Algeria, and 300 tons of flotation concentrates to Peru. In addition

to the fluorspar exported by producers in 1943, brokers exported 24 tons—5 to Brazil, 16 to Chile, 1 each to Colombia and Uruguay, and the remainder to Argentina, Cuba, El Salvador, and Mexico.

Fluorspar reported by producers as exported from the United States, 1939–43

Year	Short tons	Value		Year	Short tons	Value	
		Total	Average			Total	Average
1939	2,976	$74,443	$25.01	1942	9,016	$242,545	$26.90
1940	8,482	178,467	21.04	1943	9,044	246,973	27.31
1941	12,184	277,782	22.80				

WORLD PRODUCTION

The following table shows world production of fluorspar by countries from 1937 to 1943, insofar as statistics are available. Because of restriction on the publication of statistics by the governments of many countries, few figures are available since 1939.

World production of fluorspar, 1937–43, by countries, in metric tons [1]

[Compiled by B. B. Waldbauer]

Country [1]	1937	1938	1939	1940	1941	1942	1943
Argentina (shipments)	350	1,406	739	597	2,027	2,350	(2)
Australia:							
New South Wales	55						
Queensland	1,410	2,479	20	888	706	[3] 914	(2)
Victoria		804			132		
Canada	136	197	218	4,041	5,020	5,624	10,965
Chosen	11,000	[4] 34,207	(2)	(2)	(2)	(2)	(2)
France	51,430	51,920	(2)	(2)	(2)	(2)	(2)
Germany:							
Anhalt	13,662	10,462	(2)	(2)	(2)	(2)	(2)
Baden	13,637	21,350	(2)	(2)	(2)	(2)	(2)
Bavaria	62,455	59,919	(2)	(2)	(2)	(2)	(2)
Prussia	30,514	22,956	(2)	(2)	(2)	(2)	(2)
Saxony	8,074	12,063	(2)	(2)	(2)	(2)	(2)
Thuringia	16,117	22,405	(2)	(2)	(2)	(2)	(2)
India, British			20	(2)	(2)	(2)	(2)
Italy	13,385	12,186	(2)	(2)	(2)	(2)	(2)
Mexico (exports)	(2)	(2)		9,271	10,521	5,365	22,269
Newfoundland (shipments)	8,479	8,944	11,227	14,697	11,581	[3] 32,660	66,170
Norway	1,692	1,676	2,367	(2)	(2)	(2)	(2)
Southern Rhodesia		156		(2)	(2)	(2)	(2)
South-West Africa		585	105	(2)	(2)	(2)	(2)
Spain	4,250	8,596	8,408	9,097	15,410	[3] 48,000	(2)
Tunisia	1,676	2,060	2,473	(2)	(2)	(2)	(2)
Union of South Africa	3,615	4,736	10,322	7,421	[3] 3,900	4,185	[5] 2,317
U. S. S. R.	[3] 70,000	(6)	(2)	(2)	(2)	(2)	(2)
United Kingdom	42,837	33,866	[7] 17,521	(2)	(2)	(2)	(2)
United States (shipments)	164,408	72,940	165,806	211,917	290,905	326,871	368,330
	519,000	456,000	(2)	(2)	(2)	(2)	(2)

[1] In addition to countries listed China produces fluorspar, but data of output are not available.
[2] Data not available.
[3] Estimate.
[4] Exports.
[5] January to September, inclusive.
[6] Estimate included in total.
[7] January to June, inclusive.

Canada.—According to the Dominion Bureau of Mines, production of fluorspar in Canada has been small and intermittent, the total output from 1905 through 1942 being approximately 65,000 short tons, about half of which came from Ontario and the remainder from British Columbia. Although production increased to 12,087 short tons in 1943 (6,199 tons in 1942), output falls far short of consumption and the greater part of the requirements is met by importations from Mexico, Newfoundland, and the United States. Imports were 77,436 tons in 1943 (47,783 tons in 1942). Most of the Canadian output in 1942 and 1943 came from the Madoc area in Ontario, but a little was

mined in Nova Scotia. The Dominion Government has furnished financial and other assistance in developing fluorspar deposits and has also set prices for the various grades produced.

Mexico.—Production of fluorspar in Mexico was about 17,300 short tons in 1943 compared with 3,300 tons in 1942. Exports were 24,547 tons in 1943 compared with 5,914 tons in 1942. The Azul mine near Taxco, Guerrero, supplied about 70 percent of the total output in 1943.

Newfoundland.—Production of fluorspar in Newfoundland in 1943 was more than double that of 1942. The fluorspar is produced by the St. Lawrence Corporation of Newfoundland, Ltd., and Newfoundland Fluorspar, Ltd., the latter a subsidiary of the Aluminum Co. of Canada, Ltd. The output of the St. Lawrence Corporation of Newfoundland, Ltd., is shipped to Canada and the United States; and that of Newfoundland Fluorspar, Ltd., is shipped to Arvida, Canada, where the Aluminum Co. of Canada, Ltd., has a flotation plant to mill the ore to acid grade.

The fluorspar deposits of Newfoundland have been described by Van Alstine.[9]

South Africa.—Fluorspar has become increasingly important in South Africa during recent years because of the growth of the steel industry. The fluorspar occurrences in the Union of South Africa and South-West Africa have been described recently.[10]

CRYOLITE

Imports of cryolite were 46,400 long tons valued at $3,117,888 in 1943 compared with 64,565 long tons valued at $3,859,875 in 1942. The cryolite imported in both years came from Greenland.

Cryolite occurs in commercial quantity and is mined at only one place—Ivigtut, Greenland. Gibbs[11] has described the mine at Ivigtut, grades of ore produced, methods of processing and purification, and various uses of cryolite.

Artificial cryolite was manufactured in the United States in 1943 by the Aluminum Ore Co., at East St. Louis, Ill. Production was 27 percent greater in 1943 than in 1942. Plants for the manufacture of artificial cryolite were completed at Bauxite, Ark., by the Aluminum Ore Co., and at Cornwells Heights, Pa., by the Pennsylvania Salt Manufacturing Co., but were not operated in 1943.

The chief use of cryolite is as a flux in the reduction of aluminum; comparatively small amounts are used in glass, enamels, abrasives, and insecticides.

A sizable proportion of the cryolite used in the United States is made from fluorspar. According to Frary:[12]

> The fluorspar is treated with sulfuric acid to produce hydrofluoric acid, and this is neutralized with the proper amounts of soda ash and aluminum hydrate to produce the cryolite, which is a double fluoride of sodium and aluminum (Na_3AlF_6). The artificial cryolite is quite satisfactory and, in fact, considerably lower in objectionable impurities than the natural cryolite usually used. There would be no serious difficulty in getting along with the artificial product if the supply of natural cryolite from Greenland is shut off.

[9] Van Alstine, R. E., Fluorspar Deposits of St. Lawrence, Newfoundland: Econ. Geol., vol. 39, No. 2, March–April 1944, pp. 109–132.

[10] Kent, L. E., and others, Fluorspar in the Union of South Africa and South-West Africa: Union of South Africa, Dept. of Mines, Geol. Ser., Bull. 14, Pretoria, 1943, 69 pp.

[11] Gibbs, A. E. (technical director, Pennsylvania Salt Manufacturing Co.), Cryolite as a Chemical Raw Material: Chem. Ind., vol. 38, May 1936, pp. 471–476.

[12] Frary, F. C., Cryolite from Fluorspar: Steel, vol. 108, No. 26, June 30, 1941, p. 4.