Antimony

By Charlie Wyche [1]

In 1972, domestic mine production of antimony, curtailed by a tragic fire at the Sunshine Mine, declined to the lowest level in more than 30 years. Secondary production also continued the downward trend from the 1969 high. The 18% increase in consumption of primary antimony, however, was supplied by a 75% increase in imports of ore, metal, and oxide.

The price of RMM brand antimony metal, in bulk, f.o.b. Laredo, Tex., was stable at 57 cents per pound throughout the year. The free world antimony price edged upward following buying interest from both consumers and dealers, and the People's Republic of China's reluctance to sell. The quoted price range of European lump ore, 60% antimony, declined during the first half of 1972 but reversed the trend in the second half and showed substantial strength at yearend.

Legislation and Government Programs.—Effective January 1, 1972, the General Modification of Tariff Schedules of the United States, Federal Register document 67–14749, filed on December 18, 1967 (Federal Register, v. 32, No. 244, Dec. 19, 1967, pp. 19002–19004, reduced the import duty on antimony metal TSUS No. 632.02 from 1.2 to 1.0 cents per pound. No further reduction is scheduled.

Under authorization of Public Law 92–105, enacted August 11, 1971, the General Services Administration (GSA) disposed of 70 tons of antimony from the Government stockpile in 1972. The total quantity authorized for disposal is 6,000 tons of "C" and "D" grades metal with a maximum of 800 tons to be sold each calendar quarter. All of the antimony was restricted to domestic consumption. Sales of the metal were in the form of granules, pigs, slabs, cakes, ingots, and broken pieces. All sales were made on an "as-is" basis and in keeping with its policy in stockpile sales, no warranties were made by GSA as to the chemical analysis, physical condition, or fitness for any use or purpose of the metal. Total Government inventory at the close of the year was 46,676 tons, of which 5,976 tons were surplus.

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Table 1.—Salient antimony statistics

(Short tons)

	1968	1969	1970	1971	1972
United States:					
Production:					
Primary:					
Mine	856	938	1,130	1,025	489
Smelter [1]	12,489	13,203	13,381	11,374	13,344
Secondary	23,699	23,840	21,424	20,917	22,500
Exports of ore, metal and alloys	109	207	543	1,023	121
Imports, general (antimony content)	17,343	17,032	18,654	13,595	23,743
Consumption [1]	18,520	17,843	13,937	13,707	16,124
Price: New York, average cents per pound	45.75	57.57	144.19	71.18	59.00
World: Production	67,628	73,001	77,124	70,891	75,035

[1] Includes primary antimony content of antimonial lead produced at primary lead refineries.

DOMESTIC PRODUCTION

MINE PRODUCTION

Domestic mine production from antimony ores and concentrates and coproduct antimony concentrates from silver mine production declined 52% to 489 short tons, the lowest level since 1953. Lead silver ores of the Coeur d'Alene district of Idaho contributed 345 tons, substantially below the 854 tons supplied in 1971. The drastic decline in production was due primarily to the 8-month closing of the Sunshine Mining Co., the only major domestic producer of antimony, following a disastrous fire in May. Tetrahedrite concentrates from Sunshine Mining Co., Hecla Mining Co., and Silver Dollar Mining Co. were processed into cathode metal, 96% antimony, at the Sunshine Mining Co. electrolytic plant. Byproduct antimony recovered at primary lead smelters from domestic lead ores totaled 516 tons. Most of this antimony was not recovered as the pure metal, but was processed to and consumed as antimonial lead.

The U.S. Antimony Corp. became a fully integrated mining, milling, refining, and sales organization. The company successfully completed a refining procedure to convert antimony sulfide concentrates to metallic antimony. Approximately 142 tons of antimony was produced in 1972, using this pollution-free process. In Nevada, one mine produced a small tonnage of antimony ore.

Table 2.—Antimony mine production and shipments in the United States

(Short tons)

Year	Antimony concentrate (Quantity)	Antimony	
		Produced	Shipped
1968	5,263	856	941
1969	5,707	938	943
1970	6,681	1,130	1,029
1971	4,721	1,025	1,073
1972	2,072	489	547

SMELTER PRODUCTION

Primary.—Production of 13,344 tons of antimony from primary ores at domestic smelters represented a 17% increase above that of 1971. The increase was essentially in production of oxide, and sulfide compounds, as metal production increased only slightly above that of 1971. Byproduct antimonial lead output dropped to 731 tons, 35% below that of the previous year. The source of feed materials for the smelter was as follows: 92% from foreign antimony ores and base metal ores, and 8% from domestic mine production of antimony concentrate and as byproduct at domestic lead smelters. Antimony recovered as a lead-smelter byproduct represented 7% of the total primary antimony production. Over 90% of the byproduct antimony produced at primary lead smelters was consumed at the smelter in manufacturing antimonial lead. A small quantity was processed to oxide or recycled in residues.

Primary smelter products were divided as follows: Metal, 29%; oxide, 63%; antimonial lead, 5%; and sulfide and residues, 3%. The NL Industries, Inc., smelter at Laredo, Tex., and the Sunshine Mining Co. electrolytic plant at Big Creek, Idaho, produced antimony metal. Oxide was produced by American Smelting and Refining Co., McGean Chemical Co., Harshaw Chemical Co., M & T Chemicals Inc., and NL Industries. Bunker Hill Co., American Smelting and Refining Co., St. Joe Minerals Corp., and U.S. Smelting Lead Refinery, Inc., were the principal producers of byproduct antimonial lead. McGean Chemical Co., Hummel Chemical Co., and M & T Chemicals Inc. produced antimony sulfide.

Secondary.—Secondary antimony recovery, from lead scrap, was slightly higher than in 1971. The increase was due chiefly to secondary lead plants as recoveries at primary lead smelters increased to about 61 tons. Manufacturers and foundries recovered 902 tons of antimony in processing scrap, 194 tons more than in 1971. Sources of old scrap, which supplied 85% of the secondary antimony, consisted of the following: Batteries, 70%; type metal, 17%; babbitt, 5%; and miscellaneous material, 8%. Drosses and residues resulting from manufacturing and casting operations provided 3,400 tons, or 15% of the total secondary antimony. Antimony in scrap is usually recovered as antimonial lead, with additions or removal of antimony as required in the refining stage to meet specifications for the various antimonial lead alloys. About 2,570 tons of primary antimony was used by secondary smelters to supplement the secondary supply during 1972, compared with 2,850 tons in 1971.

Table 3.—Primary antimony produced in the United States

(Short tons, antimony content)

Year	Class of material produced					Total
	Metal	Oxide	Sulfide	Residues	Byproduct antimonial lead	
1968	3,617	6,518	133	417	1,804	12,489
1969	3,129	7,746	95	330	1,903	13,203
1970	3,732	8,261	23	384	981	13,381
1971	3,816	6,272	18	136	1,132	11,374
1972	3,837	8,343	232	201	731	13,344

Table 4.—Secondary antimony produced in the United States, by kind of scrap and form of recovery

(Short tons, antimony content)

Kind of scrap	1971	1972	Form of recovery	1971	1972
New scrap:			In antimonial lead [1]	15,839	17,200
Lead-base	3,269	3,100	In other lead alloys	5,067	5,280
Tin-base	73	300	In tin-base alloys	11	20
Total	3,342	3,400	Total	20,917	22,500
Old scrap:			Value (millions)	$29.8	$70.2
Lead-base	17,550	19,000			
Tin-base	25	100			
Total	17,575	19,100			
Grand total	20,917	22,500			

[1] Includes 59 tons of antimony recovered in antimonial lead from secondary sources at primary plants in 1971 and 120 tons in 1972.

Table 5.—Byproduct antimonial lead produced at primary lead refineries in the United States

(Short tons)

Year	Gross weight	Antimony content				
		From domestic ores [1]	From foreign ores [2]	From scrap	Total	
					Quantity	%
1968	28,363	1,300	504	203	2,007	7.1
1969	24,741	1,174	729	179	2,082	8.4
1970	20,438	598	383	203	1,184	5.8
1971	19,686	828	304	59	1,191	6.0
1972	15,051	516	215	319	1,050	7.0

[1] Includes primary residues and a small quantity of antimony ore.
[2] Includes foreign base bullion and small quantities of foreign antimony ore.

CONSUMPTION AND USES

Industrial consumption of antimony in various end products totaled 38,624 tons, an increase of 12% above that of 1971. Primary antimony contributed 16,124 tons, 42% of the total, and secondary antimony, 22,500 tons. Secondary antimony was used predominantly in the manufacture of antimonial lead and other hard-lead alloys.

Consumption of primary antimony increased 18% in comparison to that of the previous year. Consumption increased for all classes of material consumed except byproduct antimonial lead. Antimony metal and antimony oxide represented 34 and 52%, respectively, of the material consumed, and antimonial lead about 5%. Consumption of primary antimony in metal products increased 11%, principally in that used for antimonial lead. Increases were reported for all products except ammunition, cable covering, solder, and type metal.

Nonmetal products required 23% more antimony in 1972 than in 1971. One of the largest uses was in flameproofing chemicals and compounds. Demand for flame-retardant materials increased when the U.S. De-

partment of Transportation safety standard went into effect. This standard established specific flammability restrictions for interior components of passenger cars, trucks, and buses. In order to meet this requirement, automotive companies added various flame-retardant materials to their 1973 model interiors. Consumption in plastics, rubber products, and pigments also continued the upward trend. A total of 1,118 tons of antimony was consumed in "Other" nonmetal products. Three compounds, antimony sulfide, and potassium pyro-antimonate, with a wide range of applications, and sodium antimonate predominantly an opacifying agent in enamel and glass, accounted for 54% of the total. Approximately 19% was consumed as antimony chloride (pentachloride and trichloride), and the remaining 27% was used in a variety of chemical compounds.

Table 6.—Industrial consumption of primary antimony in the United States

(Short tons, antimony content)

Year	Class of material consumed						
	Ore and concentrate	Metal	Oxide	Sulfide	Residues	Byproduct antimonial lead	Total
1968	299	6,561	9,363	75	418	1,804	18,520
1969	507	6,275	8,756	72	330	1,903	17,843
1970	380	4,989	7,157	46	384	981	13,937
1971	387	5,080	6,944	28	136	1,132	13,707
1972	1,226	5,473	8,389	104	201	731	16,124

Table 7.—Industrial consumption of primary antimony in the United States, by class of material produced

(Short tons, antimony content)

Product	1968	1969	1970	1971	1972
METAL PRODUCTS					
Ammunition	156	115	102	67	64
Antimonial lead	6,817	6,723	5,246	5,430	6,149
Bearing metal and bearings	755	758	481	515	559
Cable covering	178	55	38	36	19
Castings	46	33	16	20	39
Collapsible tubes and foil	50	56	35	22	20
Sheet and pipe	105	105	77	74	108
Solder	255	242	286	178	177
Type metal	423	541	220	177	142
Other	258	137	73	102	105
Total	9,043	8,765	6,574	6,621	7,382
NONMETAL PRODUCTS					
Ammunition primers	33	37	27	23	23
Fireworks	37	30	17	4	4
Flameproofing chemicals and compounds	2,774	2,096	1,774	1,524	2,280
Ceramics and glass	2,037	2,108	1,820	1,840	1,695
Pigments	859	722	610	592	644
Plastics	2,318	2,558	1,667	1,810	2,391
Rubber products	440	433	519	525	587
Other	979	1,094	929	768	1,118
Total	9,477	9,078	7,363	7,086	8,742
Grand total	18,520	17,843	13,937	13,707	16,124

STOCKS

Industrial stocks of primary antimony declined from the 9,740 tons at the end of the first quarter to a low of 8,481 tons at the end of the second quarter, increased to 9,130 tons by the end of the third quarter, and totaled 8,622 tons at yearend. Increases in oxide and sulfide stocks failed to offset decreases in metal, residues, antimonial lead, and ore and concentrates. Government stocks of antimony metal totaled 46,676 tons at the close of 1971. Of the total inventory, the strategic stockpile contained 24,645 tons and the supplemental stockpile contained 22,031 tons.

Table 8.—Industry stocks of primary antimony in the United States, December 31

(Short tons, antimony content)

Stocks	1968	1969	1970	1971	1972
Ore and concentrate	2,791	2,227	2,973	3,582	3,562
Metal	1,323	1,273	1,598	1,367	1,332
Oxide	1,921	2,053	2,932	2,697	3,179
Sulfide	127	108	39	22	182
Residues and slags	199	307	948	647	176
Antimonial lead [1]	265	371	357	322	191
Total	6,626	6,339	8,847	8,637	8,622

[1] Inventories from primary sources at primary lead refineries only.

PRICES

The domestic price of antimony metal, 99.5%, RMM brand, and 99.8%, "Lone Star" brand, held at 57 and 68 cents per pound, respectively, in bulk, f.o.b., Laredo, Tex., (59 and 70 cents at New York). The dealer price for imported metal, duty paid, New York, also continued at 60 cents per pound. The domestic price of oxide continued unchanged at 69 cents per pound in carload lots.

At the beginning of the year, the quoted price of European lump ore, 60% contained antimony, at New York was $8.64 to $10 per short-ton unit. The price began to decrease in February due to lack of demand resulting from a slowdown in the U.S. economy. From February to August quotations were 25 to 30 cents per short-ton unit lower than earlier in the year. Prices eased in the second quarter and at yearend the quotation ranged from $7.60 to $8.60 per short-ton unit.

The GSA quoted prices for "C" (99.0%) and "D" (97.6%) metal were 54 and 51.5 cents per pound, respectively, f.o.b., designated Government storage locations.

Table 9.—Antimony price ranges in 1972

Type of antimony	Price per pound
Domestic metal [1]	$0.57
Foreign metal [2]	.535–0.57
Antimony trioxide [3]	.69–.77

[1] RMM brand, f.o.b., Laredo, Tex.
[2] Duty-paid delivery, New York.
[3] Quoted in Metals Week.

FOREIGN TRADE

Exports of antimony in alloys, metal, scrap, and waste totaled 121 tons and were valued at $84,800, only one-tenth the value of exports in 1971. Exports were destined for 12 countries. Canada, France, the United Kingdom, West Germany, and Chile, in declining order of receipts, accounted for 93% of the total. The quantity of antimony oxide exports increased to 311 tons valued at $276,600. Consignments were made to 15 countries. Canada imported 34% of the oxide, followed by West Germany and Taiwan with 33% and 13%, respectively. The remainder was divided among 13 other countries.

General imports of antimony of all categories totaled 23,743 tons (antimony content), a 75% increase from the 1971 deliveries and the highest level on record. The increase was essentially as antimony in ore and concentrate which increased from 22,100 to 33,500 tons gross weight. Oxide imports increased from 2,800 to 5,000 tons gross weight and metal imports from 1,700 to 2,400 tons. The Republic of South Africa and Bolivia supplied 59 and 15%, respectively, of the ore and concentrate imported. The People's Republic of China supplied almost half of the metal. The United Kingdom, Belgium-Luxembourg, and France supplied essentially all of the oxide imports (83%).

Additional imports included 129 tons of alloy containing 83% or more antimony by weight, 67% of which came from Mexico; 31 tons was received from United Kingdom; and 11 tons was supplied by Taiwan. Total value of this material was $136,314.

Table 10.—U.S. imports for consumption of antimony, by country

Country	1971			1972		
	Short tons (gross weight)	Short tons (antimony content)	Value (thousands)	Short tons (gross weight)	Short tons (antimony content)	Value (thousands)
Antimony ore:						
Australia	54	36	$41	56	34	$19
Bolivia	2,610	1,593	2,131	4,071	2,562	1,536
Canada	22	10	9	--	--	--
Chile	489	311	537	2,759	1,722	1,096
Germany, West	--	--	--	57	25	15
Guatemala	1,230	615	134	315	158	35
Honduras	296	118	44	77	19	6
Mexico	9,540	2,314	847	8,261	2,217	820
Morocco	229	103	63	365	150	70
Mozambique	679	402	478	--	--	--
Peru	69	34	16	44	27	19
South Africa, Republic of	6,400	3,826	4,273	17,224	10,160	5,766
Thailand	143	92	100	313	138	55
United Kingdom	341	165	114	--	--	--
Total	22,102	9,619	8,787	33,542	17,212	9,437
Antimony metal including needle or liquated:[1]						
Belgium-Luxembourg	175	--	231	138	--	135
Bolivia	10	--	9	--	--	--
Brazil	--	--	--	55	--	50
Canada	(2)	--	26	1	--	15
China, People's Republic of	16	--	17	1,017	--	973
Czechoslovakia	2	--	2	--	--	--
France	65	--	87	59	--	64
Germany, West	11	--	14	(2)	--	8
Hong Kong	--	--	--	66	--	65
Italy	17	--	18	--	--	--
Japan	649	--	796	86	--	103
Malaysia, Republic of	17	--	17	--	--	--
Mexico	233	--	149	362	--	194
Netherlands	11	--	7	22	--	23
Singapore	--	--	--	5	--	5
Spain	11	--	13	12	--	13
Taiwan	63	--	68	106	--	101
Thailand	77	--	101	--	--	--
Turkey	32	--	28	37	--	30
United Kingdom	88	--	136	160	--	142
Yugoslavia	193	--	242	254	--	246
Total	1,670	(3)	1,961	2,380	(3)	2,167
Antimony oxide:						
Belgium-Luxembourg	439	--	569	610	--	651
Canada	1	--	1	--	--	--
China, People's Republic of	--	--	--	85	--	79
France	692	--	1,047	1,359	--	1,502
Germany, West	50	--	59	172	--	186
Japan	330	--	552	556	--	633
Netherlands	47	--	66	52	--	62
United Kingdom	1,232	--	2,023	2,198	--	2,653
Total	2,791	(3)	4,317	5,032	(3)	5,766

[1] Includes needle or liquated (value in thousands): 1971—Belgium-Luxembourg, 32 tons ($47); 1972—Belgium-Luxembourg, 73 tons ($68); United Kingdom, 5 tons ($7).
[2] Less than ½ unit.
[3] Content not reported.

Table 11.—U.S. imports for consumption of antimony

Year	Antimony ore			Needle or liquated		Antimony metal [1]		Antimony oxide	
	Short tons (gross weight)	Antimony content		Short tons (gross weight)	Value (thousands)	Short tons (gross weight)	Value (thousands)	Short tons (gross weight)	Value (thousands)
		Short tons	Value (thousands)						
1970	34,415	13,820	$12,733	18	$54	1,290	$3,493	4,256	$10,023
1971	22,102	9,619	8,787	32	47	1,638	1,914	2,791	4,317
1972	33,542	17,212	9,437	78	75	2,302	2,092	5,032	5,766

[1] Does not include alloy containing 83% or more of antimony; 1970—United Kingdom, 179 short tons ($378,740); Turkey, 18 short tons ($50,411); Japan, 13 short tons ($31,346); 1971—United Kingdom, 120 short tons ($120,093); Turkey, 32 short tons ($29,022); Japan, 22 short tons ($18,453); Mexico, 85 short tons ($113,319); Thailand, 11 short tons ($10,356); 1972—Mexico, 87 short tons ($79,294); United Kingdom, 31 short tons ($25,327) ;Taiwan, 11 short tons ($31,693).

WORLD REVIEW

World production in 1972 increased about 5,000 tons to a high of more than 75,000 tons. The most significant increase was in Thailand, which gained about 3,000 tons compared with 1971 production. Production increases were also reported in Mexico and Bolivia, which more than compensated for declines in output from the United States, Peru, Morocco, and Honduras.

The market was weak and demand was at a low level when the year began. A firming trend in world antimony prices began developing in midyear, and this trend continued throughout the remainder of 1972. The antimony industry was optimistic, based mainly on the use of antimony oxide for flame retardancy in the vinyl plastic field, especially in automotive applications. As a result, antimony producers around the world continued to develop new mines and to expand existing ones.

Table 12.—Antimony: World production (content of ore except where otherwise indicated) by country

(Short tons)

Country	1970	1971	1972 p
North America:			
Canada [1]	363	162	235
Guatemala	r 1,430	976	e 1,000
Honduras	378	160	33
Mexico [2]	4,925	3,705	e 4,700
United States	1,130	1,025	489
South America:			
Argentina	--	15	e 15
Bolivia [3]	12,970	12,861	14,472
Peru (recoverable) [2]	r 1,286	1,127	882
Europe:			
Austria (recoverable)	672	515	e 530
Czechoslovakia e	660	660	660
Italy	1,432	1,295	e 1,300
Portugal	[4] --	[4] --	11
Spain	r 87	122	150
U.S.S.R. e	7,400	7,600	7,700
Yugoslavia	3,197	3,204	3,171
Africa:			
Algeria	66	e r 66	e 66
Morocco	r 2,008	2,174	929
South Africa, Republic of	19,147	15,704	16,062
Asia:			
Burma	72	141	144
China, People's Republic of e	13,000	13,000	13,000
Japan	7	3	e 6
Korea, Republic of	--	--	3
Malaysia (Sarawak)	198	317	226
Pakistan e	33	34	50
Thailand	2,598	2,529	5,234
Turkey	3,053	2,435	e 2,500
Oceania: Australia [5]	r 1,012	1,061	1,467
Total	r 77,124	70,891	75,035

e Estimate. p Preliminary. r Revised.

[1] Antimony content of smelter products.

[2] Includes antimony content of antimonial lead.

[3] Data for 1970 are the sum of exports by small and medium mines and COMIBOL output; data for 1971 and 1972 reportedly represent total exports.

[4] 1970 and 1971 revised to zero.

[5] Antimony content of antimony concentrates, lead concentrates and lead-zinc concentrates.

Australia's Antimony Corp. N.L. placed the Dorrigo antimony mine in New South Wales on a production basis in view of the increased world market price of antimony concentrate. The company anticipates that prices will continue to firm as a result of projected improvement in the world economy, particularly in the United States. Production plans are for an output of about 4,000 tons per year of antimony concentrate representing gross annual sales of $2 million at the 1972 price level.

Munga Creek Minerals reported further work on the main shaft at the Munga Creek antimony mine at Kempsil, New South Wales. Following sublevel development, stoping was in progress, and a continuous supply of good ore has been assured. In the fourth quarter of 1972, the company produced 9,500 tons of antimony concen-

trate. Mill capacity will be doubled as soon as the main shaft comes into production.

An antimony plant came on stream in Italy. Azienda Minerali Metallici Italiani S.p.A. (AMMI) began operating its mine and metallurgical plant, at Manciano, near Grosseto. The antimony deposit contains an estimated metal reserve of 20,000 tons. Initial capacity of the plant has been scheduled at about 150 tons per year of metallic antimony.

In the Republic of South Africa at Consolidated Murchison Goldfields and Development Co. Ltd.'s plant, 547,000 tons of ore were milled during 1972, yielding 24,400 tons of antimony concentrate and cobbed ore. Although this output represented a 10% increase in the milling rate compared with that of 1971, the production of concentrate increased only marginally as the grade of ore mined was lower. To overcome this possible limiting condition on metal production, a decision was made in September to locate a new shaft, to be known as the Athens shaft, at the Weigel ore body. This ore body, which was mined and treated successfully at fairly shallow depths in the past, was selected in preference to the New Monarch ore body where preliminary work showed it to be more irregular. Working costs per ton milled were reduced by 12% compared with those of 1971. The increased milling rate could result in insufficient ore being available from the Alpha section of the mine by 1975.

In Bolivia, contracts for the structural steel to be used in the construction of the buildings housing a new antimony smelter were signed. Construction of the smelter is expected to be completed in 1975, with an estimated annual input capacity of 13,200 short tons of antimony concentrate averaging 60% antimony. This input quantity will result in a total annual output of close to 7,200 tons of antimony in the form of antimony trioxide. The patented process, developed in Czechoslovakia, to be used in the smelter is a system of volatilization and reduction of the antimony sulfide concentrate.

In 1972, Consolidated Durham Mines and Resources Limited began production at its Lake George area antimony property near Fredericton, New Brunswick, Canada. The mill has a capacity in excess of 400 tons per day; however, during 1972 production was maintained at 125 to 150 tons per day. Ore reserves at the 318-claim Durham Property were estimated at 150,000 tons, averaging 7% stibnite in two parallel veins.

TECHNOLOGY

One United States patent relating to the electrowinning of antimony from stibnite was issued during the year. U.S. patent 3,657,081, issued to W. C. Holmes on April 18, 1972, described a process in which concentrated stibnite ore is leached with a solution of sodium sulfide. The leached solution is electrolyzed in a diaphragm cell using the leach solution as the catholyte and stripped catholyte as the anolyte. A portion of the resulting oxidized anolyte is treated with chlorine gas to precipitate antimony and sulfur; the antimony precipitate is returned to the leaching circuit; and sufficient sulfur is discarded to maintain the sulfide sulfur concentration of the leaching solution at a predetermined level.

The results of the investigation of the metastable phases in liquid-quenched alloys of chromium and manganese with antimony,[2] and the transport and thermoelectric properties of compacts of bismuth and Bi–12 atomic percent antimony alloy powder were reported.[3]

Another important technical development during the year included a process for removal of surface antimony from antimony lead alloys by sulfuric acid-hydrogen peroxide pickling.[4] The surface antimony results from positive battery plates releasing a large proportion of their surface antimony during plate formation.

A recent development in the use of antimony with silver has produced a new brightening solution that adds hardness, exceptional brightness, and tarnish resistance in silver plating.[5] Called Techni-

[2] Speight, J. D. Metastable Phases in Liquid-Quenched Alloys of Chromium and Manganese With Antimony. Met. Trans., v. 3, No. 4, April 1972, pp. 1011–1012.

[3] Cochrane, G., and W. V. Youdelis. Transport and Thermoelectric Properties of Bismuth and Bi–12 Atomic Percent Alloy Powder Compacts. Met. Trans., v. 3, No. 11, November 1972, pp. 2843–2850.

[4] Crompton, T. R., and G. Uitenbroek. Removal of Surface Antimony From Antimony Lead Alloys by Sulfuric Acid–Hydrogen Peroxide Pickling. J. Electrochem. Soc., v. 119, No. 6, June 1972, pp. 655–660.

[5] Skillings' Mining Review. V. 62, No. 5, Feb. 3, 1973, p. 15.

Silver E, the product allows an increase in amperage in the plating bath to 20 amperes per square foot of material, about double the usual level. The increased current density produces a plated item that requires no buffing or retouching after the plating process. The treatment increases tarnish resistance to about four times the amount usually found in silver plating.

An article published in 1972 on the flotation of stibnite from some Indian ores showed that the mineral could be floated after grinding through 48 mesh.[6] It could be floated easily at low pH with a mineral oil as collector and pine oil as frother. Stibnite could also be floated effectively with xanthates, provided the pulp is preconditioned with soluble lead or copper salts.

[6] Vijayakuman, K., and K. K. Majumdar. Studies on the Flotation of Stibnite. J. Mines, Metals and Fuels, v. 20, No. 11, November 1972, pp. 342–346.