Chromium

By John L. Morning [1]

Technologic change in the manufacture of stainless steel during the past several years brought about increasing use of lower cost high-carbon ferrochromium in place of higher cost low-carbon ferrochromium. Although the domestic chromium alloy producers maintained their production pace of the previous year, increasing demand for chromium alloys was met by imports, which rose to a record high of 141,000 tons.

Table 1.—Salient chromite statistics
(Thousand short tons)

	1968	1969	1970	1971	1972
United States:					
Exports	13	49	41	35	20
Reexports	126	150	73	145	57
Imports for consumption	1,084	1,106	1,405	1,299	1,061
Consumption	1,316	1,411	1,403	1,093	1,140
Stocks Dec. 31: Consumer	912	675	733	1,019	857
World: Production	5,444	5,865	6,672	6,908	6,841

Legislation and Government Programs.—An amendment to Public Law 92–156 (section 503) allowed the importation of strategic and critical materials from Southern Rhodesia in 1972, and the Department of Treasury published regulations removing controls on these materials.[2] Various congressional efforts were made during the year to nullify section 503, but both the House and Senate rejected plans to reinstall the embargo. A Federal suit by some congressional members to reinstate the embargo was rejected by the court.

Government chromium stockpile material inventories and objectives are shown in table 2. Included in the inventories is material sold but unshipped. This includes chemical-grade chromite, 341,680 tons; metallurgical-grade chromite, 116,906 tons; and refractory-grade chromite, 6,772 tons.

General Services Administration (GSA) under various disposal programs offered for sale all three grades of chromite either by competitive bidding or by negotiated sales. Sales were as follows: Chemical-grade chromite, 1,796 tons, and refractory-grade

[1] Supervisory physical scientist, Division of Ferrous Metals.
[2] Federal Register. V. 37, No. 16, Jan. 25, 1972.

Table 2.—U.S. Government chromium stockpile material inventories and objectives
(Thousand short tons)

	Objective	Inventory by program, Dec. 31, 1972			
		National stockpile	Defense Production Act	Supplemental stockpile	Total
Chromite, chemical-grade	250	544	--	366	910
Chromite, refractory-grade	368	991	--	178	1,169
Chromite, metallurgical-grade	2,911	332	901	323	1,556
Ferrochromium, high-carbon	71	126	--	277	403
Ferrochromium, low-carbon	--	128	--	191	319
Ferrochromium-silicon	--	26	--	33	59
Chromium metal	4	1	--	7	8

chromite, 13,618 tons. Actual deliveries of chromite from government stockpiles from current or prior sales contracts were: Chemical-grade, 116,128 tons; metallurgical-grade, 53,366 tons; and refractory-grade, 14,416 tons.

A 1964 finding that chromic acid from Australia was sold at less than fair value within the meaning of the Antidumping Act, 1921, as amended, was revoked in 1972 by the Department of Treasury.[3]

DOMESTIC PRODUCTION

Domestic mine production of chromite ceased in 1961 when the last Government Defense Production Act contract was phased out. However, the United States continued to be one of the world's leading chromite consumers in producing chromium alloys, refractories, and chemicals. The principal producers of these products were as follows:

Company	Plant
Metallurgical industry:	
Airco Alloys and Carbide Div., Air Reduction Co. Inc	Calvert City, Ky.
	Niagara Falls, N.Y.
	Charleston, S.C.
Chromium Mining and Smelting Corp	Woodstock, Tenn.
Foote Mineral Co	Vancoram, Ohio
	Graham, W.Va.
Interlake Inc	Beverly, Ohio
Ohio Ferro-Alloys Corp	Brilliant, Ohio
Shieldalloy Corp	Newfield, N.J.
Union Carbide Corp	Niagara Falls, N.Y.
	Marietta, Ohio
Refractory industry:	
The Babcock & Wilcox Co	Augusta, Ga.
Basic, Inc	Maple Grove, Ohio
Corhart Refractories Co., Inc	Buckhannon, W.Va.
	Louisville, Ky.
E. J. Lavino & Co. (Div. of IMC)	Newark, Calif.
	Plymouth Meeting, Pa.
General Refractories Co	Baltimore, Md.
	Lehi, Utah
Harbison-Walker Refractories Co. (Div. of Dresser Industries, Inc.)	Hammond, Ind.
	Baltimore, Md.
Kaiser Aluminum & Chemical Corp	Moss Landing, Calif.
	Columbiana, Ohio
North American Refractories Co	Womelsdorf, Pa.
Ohio Fire Brick Co	Jackson, Ohio
Chemical industry:	
Allied Chemical Corp	Baltimore, Md.
Diamond Shamrock Corp	Castle Haynes, N.C.
	Kearny, N.J.
PPG Industries, Inc	Corpus Christi, Tex.

Foote Mineral Co. announced at yearend that it would stop ferrochromium production at its Vancoram, Ohio, plant. Anticipated pollution control costs connected with the operation together with writeoff costs made the action necessary, according to Foote.

Diamond Shamrock Corp. dedicated its new chromium chemicals plant at Castle Haynes, N.C., which began operation late in 1971. Reportedly the plant will process South African chromite.

A worldwide survey on chromium supply and demand was published early in the year.[4] This study presented information on supply and demand as well as worldwide trade by principal countries.

CONSUMPTION AND USES

Domestic consumption of 1,140,000 tons of chromite ore and concentrate containing about 353,000 tons of chromium was 4% higher than in 1971. Of the total chromite consumed, the metallurgical industry used 63.8%, the refractory industry 19.6%, and

[3] Federal Register. V. 37, No. 226, Nov. 22. 1972, p. 24838.

[4] Roskill Information Services Ltd. Chromium Minerals, Ferrochrome, Chromium and Chromium Chemicals: World Survey of Production and Consumption With Special Reference to Future Demand and Prices. London, January 1972, 236 pp.

the chemical industry 16.6%. The metallurgical industry consumed 727,000 tons containing 238,000 tons of chromium in producing 350,000 tons of chromium alloys and chromium metal. About 68.7% of the metallurgical-grade ore had a chromium-to-iron ratio of 3:1 and over; 18.5% had a ratio between 2:1 and 3:1; and 12.8% had a ratio of less than 2:1.

Producers of chromite-bearing refractories consumed 224,000 tons of ore containing 55,000 tons of chromium. The chemical industry consumed 189,000 tons of chromite containing 59,000 tons of chromium in producing 147,000 tons of chemicals (sodium bichromate equivalent).

The technologic change in manufacturing stainless steel, that of decarburizing a molten bath by one of several processes, was reflected in both production and consumption of chromium alloys. Domestic producers switched their product mix to a higher proportion of lower cost high-carbon ferrochromium to meet consumer demand. Consumers in 1971 used about equal quantities of high-carbon and low-carbon ferrochromium; whereas in 1972 the ratio was 1.5:1.

Chromium has a wide range of applications in the metallurgical industry. Its principal use is in stainless and heat-resisting steels, but its use in alloy and tool steels, cast iron, nonferrous alloys, and welding and alloy hard facings rods and materials accounted for 30% of chromium alloy consumption.

The refractory industry used chromium in the form of chromite, primarily for manufacture of refractory bricks for use in metallurgical furnaces and ladles. Some chromite, however, is employed for refractory purposes in mortars and in ramming, castable and gunning mixes, or directly for furnace repair.

The chemical industry consumes chromite for manufacture of sodium or potassium dichromate, the base material for a wide range of chromium chemicals used in electroplating, pigments, leather processing,

Table 3.—Consumption of chromite and tenor of ore used by primary consumer groups in the United States

(Thousand short tons)

Year	Metallurgical industry		Refractory industry		Chemical industry		Total	
	Gross weight	Average Cr_2O_3 (%)	Gross weight	Average Cr_2O_3 (%)	Gross weight	Average Cr_2O_3 (%)	Gross weight	Average Cr_2O_3 (%)
1968	804	49.7	311	34.1	202	45.1	[1] 1,316	45.4
1969	898	49.1	302	35.0	211	45.1	1,411	45.5
1970	912	48.0	278	35.9	213	45.3	1,403	45.2
1971	720	47.8	193	36.3	180	45.6	1,093	45.4
1972	727	47.9	224	35.9	189	45.7	1,140	45.2

[1] Data may not add to total shown because of independent rounding.

Table 4.—Production, shipments, and stocks of chromium ferroalloys and chromium metal

(Short tons)

Alloy	Production		Shipments	Producer stocks Dec. 31
	Gross weight	Chromium content		
1971:				
Low-carbon ferrochromium	111,861	78,056	104,143	26,730
High-carbon ferrochromium	132,169	88,977	146,643	28,370
Ferrochromium-silicon	92,145	35,983	86,020	19,823
Other [1]	17,426	13,069	15,899	4,851
Total	353,601	216,085	352,705	79,774
1972:				
Low-carbon ferrochromium	68,372	47,766	78,997	23,575
High-carbon ferrochromium	169,525	112,805	162,718	37,888
Ferrochromium-silicon	98,223	36,886	90,986	22,096
Other [1]	14,239	11,349	16,104	2,585
Total	350,359	208,806	348,805	86,144

[1] Includes chromium briquets, chromium metal, exothermic chromium additives, and other miscellaneous chromium alloys.

Table 5.—U.S. consumption, by end use, and consumer stocks of chromium ferroalloys and metal in 1972

(Short tons, gross weight)

End use	Low-carbon ferro-chromium	High-carbon ferro-chromium	Ferro-chromium silicon	Other	Total
Steel:					
Carbon	1,255	2,498	470	W	4,223
Stainless and heat-resisting	93,851	122,189	56,036	176	272,252
Full alloy	15,103	37,415	4,499	3,471	60,488
High-strength low-alloy and electric	2,153	8,535	2,446	2,574	15,708
Tool	1,098	3,596	218	W	4,912
Cast irons	960	8,192	127	709	9,988
Superalloys	4,752	5,106	800	1,754	12,412
Alloys (excludes steels and superalloys):					
Welding and alloy hard-facing rods and materials	497	678	--	164	1,339
Other alloys [1]	1,049	1,112	W	2,449	4,610
Miscellaneous and unspecified	2,389	665	121	1,655	4,830
Total	123,107	189,986	64,717	[2] 12,952	390,762
Chromium content	83,460	122,521	25,387	8,030	239,398
Stocks December 31, 1972	10,666	1,206	3,391	[3] 1,304	27,422

W Withheld to avoid disclosing individual company confidential data, included in "Miscellaneous and unspecified."
[1] Includes magnetic and nonferrous alloys.
[2] Includes 3,591 tons of chromium metal.
[3] Includes 549 tons of chromium metal.

metal treatment, catalysts, and other applications.

The proposed Highway Safety Act of 1973 could lead to significantly increased use of chrome yellow paint for marking the Nation's highways. Chrome yellow (lead chromate) not only has high visibility, but also has good resistance to degradation by light and resistance to chemicals used to remove snow and ice from pavements. Chrome yellow contains a nominal 16% chromium.

STOCKS

Chromite stocks dropped significantly during the year as all three consuming industries reduced their inventories. Stocks decreased 10% in the metallurgical industry, 31% in the refractory industry, and 19% in the chemical industry compared with 1971 totals. Combined producer and consumer stocks of chromium alloys increased nearly 9%.

Stocks of chromium chemicals (sodium bichromate equivalent) at producer plants decreased from 14,271 tons in 1971 to 13,936 tons in 1972.

Table 6.—Consumer stocks of chromite, Dec. 31

(Thousand short tons)

Industry	1968	1969	1970	1971	1972
Metallurgical	396	296	387	667	601
Refractory	309	301	235	233	160
Chemical	207	143	111	119	96
Total	912	740	733	1,019	857

PRICES

Reversing the past 5-year trend, the published price for Soviet-metallurgical-grade chromite for 1972 delivery was 13 to 15% lower than in 1971. Based on 48% Cr_2O_3, 4:1 chromium-to-iron ratio, f.o.b. Russian ports, the price was quoted at $45.00 to $46.50 per metric ton. An adequate stock level and lower demand for chromite as a result of the high level of ferrochromium imports were responsible for the lower price quotation. Published price for Turkish chromite 48% Cr_2O_3, 3:1 ratio, per long ton, delivered Atlantic ports was $55 to $56; unchanged from the 1971 price. However, industry sources indicated that Turkish chromite was priced at $43 to $47 per long ton. South African Transvaal chromite 44% Cr_2O_3, no ratio,

delivered Atlantic ports was quoted at $25 to $27 per long ton until April and $24 to $27 for the balance of the year.

Strong competition from imported chromium alloys resulted in lower prices of chromium to consumers. For instance, the price of imported charge chromium started the year at 21 cents per pound of chromium, or 2 cents below the 23 cents per pound for domestic material. In April, the imported price dropped to a range of 20 to 21 cents per pound of chromium. To meet foreign competition, domestic producers lowered their price to 20 cents per pound in July, which caused a further reduction in the price of imported material to 19 to 19.5 cents per pound of chromium. In November, the domestic price for charge chromium ceased to be published. A similar price situation developed for domestic high-carbon ferrochromium which started the year at 26.7 cents per pound of contained chromium which was reduced to 23.7 cents in July. The price was withdrawn in October.

Selected chromium alloy prices published by Metals Week at midyear (July 13, 1972) were as follows:

Material	*Cents per pound of chromium*
High-carbon ferrochromium	23.7
Charge chromium	20.0
Imported charge chromium	19.0–19.5
Low-carbon ferrochromium (0.025% carbon)	39.5
Low-carbon ferrochromium (0.05% carbon)	38.0
Imported low-carbon ferrochromium (0.05% carbon)	35.0–36.0
Blocking chromium (high-silicon)	28.6
	Cents per pound product
Aluminothermic chromium metal	115
Electrolytic chromium metal	130

FOREIGN TRADE

Both exports and reexports of chromite dropped significantly compared with those of 1971; exports decreased 42% while reexports dropped 61%. Export shipments were to Mexico, 51%; Canada, 49%; and small quantities to three other countries. Reexports were shipped to five countries; Canada, 55%; Mexico, 33%; Spain, 7%; Ireland, 4%; and Morocco, 1%.

Ferrochromium exports increased 40% to 12,861 tons valued at $4,341,539. West Germany, 36%; Canada, 30%; United Kingdom, 23%; and Sweden, 9% were the leading recipients of shipments. Reexports of ferrochromium decreased to 78 tons from 625 tons in 1971. Canada received 86% of the reexports.

Chromium and chromium alloys (wrought and unwrought) and waste and scrap exports totaled 200 tons valued at $303,576. Of the 24 countries receiving shipments, Canada accounted for 23%, Jamaica 16%, Venezuela 10%, and the Netherlands 9%.

Exports of pigment-grade chromium chemicals totaled 166 tons, valued at $290,340. Canada received 54% of the shipments and the balance was dispersed among 18 countries. Exports of non-pigment-grade chromium chemicals totaled 1,265 tons valued at $1,526,092. Japan received 27%, Canada 19%, France 15%, Italy 9%, and 25 countries the balance.

Exports of sodium chromate and dichromate increased 31% compared with 1971 totals, rising to 4,035 tons. Canada was the leading recipient with 69% of the shipments, and 22 other countries accounted for the balance.

Imports of chromite in 1972 decreased 18% in quantity and 13% in value compared with 1971 totals. Imports from the U.S.S.R. rose 41% compared with those of 1971, while those from Turkey and the Republic of South Africa fell 70% and 41%, respectively.

Imports of ferrochromium accelerated, reaching a record high of 141,271 tons valued at $34,588,000. This compares with the former high year of 1971 when ferrochromium totaled 85,187 tons. The Republic of South Africa supplied 34% and Japan 21% of the low-carbon ferrochromium. High-carbon ferrochromium was supplied by the Republic of South Africa, 42%; Southern Rhodesia, 16%; and Finland, 9%.

Table 7.—U.S. exports and reexports of chromite ore and concentrates

(Thousand short tons and thousand dollars)

Year	Exports		Reexports	
	Quantity	Value	Quantity	Value
1970	41	2,582	73	2,572
1971	35	2,094	145	6,081
1972	20	824	57	1,946

Table 8.—U.S. imports for consumption of ferrochromium, by country [1]

(Short tons and thousand dollars)

Year and country	Low-carbon ferrochromium (less than 3% carbon)			High-carbon ferrochromium (3% or more carbon)		
	Gross weight	Chromium content	Value	Gross weight	Chromium content	Value
1971:						
Belgium-Luxembourg	--	--	--	110	71	25
Brazil	--	--	--	1,382	847	291
Canada	184	111	43	515	360	159
Finland	--	--	--	10,903	5,772	1,138
France	1,086	773	425	4,255	2,927	1,125
Germany, West	5,033	3,728	2,343	6,738	4,392	1,620
India	2,260	1,623	800	--	--	--
Japan	7,390	4,882	2,943	12,992	8,363	2,924
Norway	3,458	2,409	1,460	300	211	85
South Africa, Republic of	14,633	8,661	3,459	7,174	3,871	956
Sweden	5,434	4,036	2,492	220	151	52
Turkey	1,120	750	357	--	--	--
Total	40,598	26,973	14,322	44,589	26,965	8,375
1972:						
Belgium-Luxembourg	39	28	17	1,554	1,021	237
Brazil	--	--	--	4,205	2,535	651
Canada	45	30	17	--	--	--
Finland	--	--	--	6,887	3,612	681
France	465	336	177	--	--	--
Germany, West	2,949	2,163	1,211	2,316	1,519	501
Italy	--	--	--	1,653	1,075	320
Japan	14,134	9,598	5,434	3,577	2,267	736
Netherlands	--	--	--	827	556	183
Norway	6,282	4,505	2,422	3,318	2,272	766
Rhodesia, Southern	3,578	2,581	1,403	11,835	8,075	1,910
South Africa, Republic of	23,095	14,406	5,955	30,890	17,113	4,361
Sweden	9,608	7,125	3,958	1,171	796	269
Turkey	6,882	4,703	2,312	--	--	--
Yugoslavia	1,117	774	416	4,844	3,176	651
Total	68,194	46,249	23,322	73,077	44,017	11,266

[1] Revisions in 1969: Less than 3% carbon Western Africa n.e.c.—deleted. Republic of South Africa should read gross weight 22,050 short tons, chromium content 13,706 short tons ($5,503); 1970; delete Mozambique, Republic of South Africa should read gross weight 1,120 short tons, chromium content 620 short tons ($140).

Four countries, Norway, the Republic of South Africa, Southern Rhodesia, and Sweden, supplied 8,427 tons of ferrochromium-silicon valued at $846,106. Southern Rhodesia accounted for 72% of the total.

Chromium carbide imports from West Germany and the United Kingdom totaled 158 tons valued at $459,519. West Germany accounted for nearly 93% of the total.

Imports of chromium metal, unwrought and waste and scrap, increased to 1,894 tons from 1,632 tons in 1971. Total value rose to $3,791,079 from $2,965,641. Of the seven countries supplying imports, the United Kingdom accounted for 60% and Japan 27%.

Imports of chromium-containing pigments were as follows: Chrome green, 450 tons; chrome yellow, 7,530 tons; chromium oxide green, 1,383 tons; hydrated chromium oxide green, 183 tons; molybdenum orange, 659 tons; strontium chromate, 3 tons; and zinc yellow, 1,461 tons. Total value of these products was $6.3 million, 40% higher than in 1971. Chromium yellow accounted for 60% of total value of these products. The leading supplier was Japan, which furnished 49% of total value.

Sodium chromate and dichromate imports totaled 5,748 tons valued at $1,159,815; 10% less than in 1971. Imports were principally supplied by U.S.S.R., 44%; Japan, 33%; and the Republic of South Africa, 10%.

Table 9.—U.S. imports for consumption of chromite, by grade and country

(Thousand short tons and thousand dollars)

Country	Not more than 40% Cr_2O_3			More than 40% but less than 46% Cr_2O_3			46% or more Cr_2O_3			Total		
	Gross weight	Cr_2O_3 content	Value	Gross weight	Cr_2O_3 content	Value	Gross weight	Cr_2O_3 content	Value	Gross weight	Cr_2O_3 content	Value
1971:												
Finland	--	--	--	(1)	(1)	1	--	--	--	(1)	(1)	1
Iran	--	--	--	--	--	--	12	5	381	12	5	381
Pakistan	--	--	--	--	--	--	35	17	1,013	35	17	1,013
Philippines	147	48	3,055	12	5	207	--	--	--	159	53	3,262
Rhodesia, Southern	--	--	--	--	--	--	26	12	768	26	12	768
South Africa, Republic of	11	4	134	271	120	3,177	140	65	1,961	422	189	5,272
Turkey	83	32	1,894	75	33	2,313	180	85	6,056	338	150	10,263
U.S.S.R.	33	13	r 812	--	--	--	274	151	r 10,101	307	164	r 10,913
Total	274	97	r 5,895	358	158	5,698	667	335	r 20,280	1,299	590	r 31,873
1972:												
Iran	--	--	--	14	6	346	--	--	--	14	6	346
Malagasy Republic	13	4	390	--	--	--	--	--	--	13	4	390
Pakistan	--	--	--	--	--	--	27	13	909	27	13	909
Philippines	122	39	2,835	--	--	--	9	4	201	131	43	3,036
Rhodesia, Southern	--	--	--	27	12	876	65	31	1,876	92	43	2,752
South Africa, Republic of	--	--	--	141	62	1,704	108	51	1,520	249	113	3,224
Turkey	32	13	742	13	6	368	56	34	1,804	101	53	2,914
U.S.S.R.	63	24	909	--	--	--	371	202	13,147	434	226	14,056
Total	230	80	4,876	195	86	3,294	636	335	19,457	1,061	501	27,627

r Revised.
1 Less than ½ unit.

Table 10.—U.S. import duties

Tariff classification	Articles	Rate of duty, Jan. 1, 1973 [1]
	CHROMIUM ORES AND METAL PRODUCTS	
601.15	Chromium ore	Free.
607.30	Ferrochromium, less than 3% carbon	4% ad valorem.
607.31	Ferrochromium, over 3% carbon	0.625 cent per pound on chromium content.
632.18	Unwrought chromium other than alloys: waste and scrap [2]	5% ad valorem.
	CHROMIUM CHEMICAL AND RELATED PRODUCTS	
420.08	Potassium chromate and dichromate	1.1 cent per pound.
420.98	Sodium chromate and dichromate	0.87 cent per pound.
422.92	Chromium carbide	6% ad valorem.
	CHROMIUM PIGMENTS	
473.10	Chrome green	5% ad valorem.
473.12	Chrome yellow	Do.
473.14	Chromium oxide green	Do.
473.16	Hydrated chromium oxide green	Do.
473.18	Molybdenum orange	Do.
473.19	Strontium chromate	Do.
473.20	Zinc yellow	Do.

1 Not applicable to Communist countries.
2 Duty temporarily suspended on waste and scrap.

WORLD REVIEW

Brazil.—Cia. de Ferro Ligas da Bahia, S.A. (FERBASA) continued to be Brazil's principal producer of chromite and ferrochromium. Early in 1972, following a period of negotiations initiated in 1971, FERBASA reached an agreement with several Japanese groups (Mitsui & Co. and others) to form a new company, called Cia. de Mineração Serra da Jacobina (SERJANA), which will conduct exploration work for

new chromite deposits. At the present time, the Japanese will not participate in FERBASA's ferrochromium operations. FERBASA plans to increase its low-carbon ferrochromium production with the installation of a 3,500-kilovolt-ampere electric furnace. Annual production capacity of the enlarged plant will be on the order of 5,512 short tons per year.

Brazilian Chrome Resources Development (BCRD) initiated an exploration program to develop additional reserves at the Pedrinhas chromium mine in the State of Bahia. Chromite is mined at Pedrinhas to supply FERBASA and for export. BCRD is owned by two Japanese trading companies and six Japanese consumers.

New Guinea.—American Metal Climax Inc. (AMAX) continued to explore a chromite deposit near the Sela River south of Lae.

Table 11.—Chromite: World production by country

(Thousand short tons)

Country [1]	1970	1971	1972 [p]
Albania	516	[e] 589	[e] 671
Brazil	30	[e] 31	[e] 33
Colombia	([2])	1	[e] 1
Cyprus	37	45	33
Finland	133	123	[e] 123
Greece	29	27	[e] 26
India	299	288	310
Iran [e]	220	194	198
Japan	36	35	27
Malagasy Republic	[3] 144	154	[e] 154
Pakistan	32	27	36
Philippines	624	476	388
Rhodesia, Southern [e]	400	400	400
South Africa, Republic of	1,573	1,812	1,635
Sudan	52	23	25
Turkey	572	665	[e] 710
U.S.S.R. [e]	1,930	1,980	2,040
Yugoslavia	45	38	31
Total	6,672	6,908	6,841

[e] Estimate. [p] Preliminary.
[1] In addition to the countries listed, Argentina has produced less than 500 tons of chromite annually in each of the three years listed in the table, and Bulgaria, Cuba, North Korea and North Vietnam also produce chromite but available information is inadequate to make reliable estimates of output levels.
[2] Less than ½ unit.
[3] Exports.

India.—In 1969, the Geological Survey of India (GSI) initiated an extensive study of chromite occurrences in Andhra Pradesh, Bihar, Maharashtra, Mysore, Orissa, and Tamil Nadu, and has since assisted in the conservation of existing ore and in the improvement of the small-mine industry's operating methods. Currently, the GSI places the total chromite reserve at 13.9 million tons. Of the total, lump ore comprises 1.6 million tons; fines 4.7 million tons, and unclassified ore 7.6 million tons. A breakdown by type of ore indicates 3.9 million tons represents metallurgical and chemical-grade ores, and 10 million tons refractory-grade ore.

India's chromite production in 1971 decreased nearly 4% compared with that of 1970. However, the value of chromite production increased from $2.1 million in 1970 to $2.5 million in 1971. For the third consecutive year all chromite exports were to Japan. Shipments by grade of ore were as follows: Over 48% Cr_2O_3, 59,304 tons; 38 to 48% Cr_2O_3, 15,653 tons; and below 38% Cr_2O_3, 30,606 tons.

Ferrochromium production decreased from 14,708 in 1970 to 13,756 tons in 1971. The major producer, the privately owned Ferroalloy Corp. Ltd., accounted for 80% of India's output while the public sector firm, Industrial Corp. of Orissa, Ltd., produced 15%. The balance was produced by three other concerns, one of which was in the public sector. Ferrochromium exports fell sharply in 1971 to 4,625 tons from 9,274 in 1970. The United States received 52% of total exports.

A recently revised study by the Government of India Planning Commission estimates India's chromite demand pattern through 1983 as follows: 1973, 330,000 tons; 1978, 386,000 tons; and 1983, 408,000 tons.

Iran.—The Industrial Development and Renovation Organization of Iran was reported to be planning construction of a ferrochromium plant near Bandar Abbas with an annual capacity of 50,000 tons.

Malagasy Republic.—In 1972 Cie. Minière d'Andriamena (Comina) cutback production of chromite at its Malagasy mine owing to sales difficulty. In 1971, Comina stockpiled about six months output because of lack of sales. France and Japan are the principal recipients of Malagasy chromite.

Pakistan.—The West Pakistan Industrial Corp. (WPIDC) is a semi-government agency which plans and supports industrial projects in Pakistan. WPIDC earmarked $2.3 million for a ferrochromium processing plant in the North West Frontier Province, 74% of which would be financed by Chinese credit.

Philippines.—Output of chromite de-

creased 18% compared with that of 1971; 77% was classified as refractory-grade and 23% metallurgical-grade. Exports of refractory-grade chromite totaled 314,229 tons. The United States received 47%, Japan 15%, and the United Kingdom 12%; the balance was shipped to nine other countries. Japan received all of the 75,919 tons of metallurgical-grade chromite exported.

Rhodesia, Southern.—United Nations economic sanctions, which were applied in 1966, brought retaliation by the Rhodesian Government in the form of an embargo on mining news, primarily production data. Firm production data has been unavailable since 1965.

Rio Tinto (Rhodesia) Ltd. (RTR) reportedly requested government approval for building a chromium smelter complex at Eiffel Flats near Gatooma. Production could occur in 1975 depending on world demand and government approval. The company was also considering using the facilities as a custom smelter. In preparation, RTR acquired the total share capital of Rhodesian Mining Enterprises Ltd. and the claims and assets of Great Dyke Chrome Mines Ltd. Rhodesian Mining had two mines in operation, the Jester and Feoch mines, and the O'Meath mine on standby. Great Dyke Chrome mines held a large number of claims in the Darwendale area of the Great Dyke. RTR also had an option to purchase the entire share capital of Frances Mines Ltd.

South Africa, Republic of.—Chromite production in the Republic of South Africa totaled 1,635,000 tons and was down 10% compared with 1971 figures. Of the total, 504,000 tons was classified as less than 44% Cr_2O_3; 1,078,000 tons from 44 to 48% Cr_2O_3; and 53,000 tons as over 48% Cr_2O_3. Local sales of chromite accounted for 359,000 tons and exports 1,386,000 tons. Local sales and exports moved in opposite directions compared with 1972; local sales decreased 19% while exports increased 8%.

Despite the downturn of chromite production in South Africa, the Transvaal Consolidated Land and Exploration Co., Ltd., a subsidiary of Barlow Rand Ltd., reported annual chromite sales increased for its reporting period ending September 30. According to the firm's annual report, the group owns a substantial portion of South Africa's chromite reserves and the combined production of its three mines makes it the largest single producer of chromite in South Africa.

Initial work has been completed on increasing chromite production at the Grasvally Chrome mine owned by African Metal Corp. Ltd. (AMCOR) and operated by Cromore Ltd. Mining began in 1962 and for the past eight years production ran about 500 tons per month. The current expansion project when completed in early 1976 will bring production capacity to 275,000 tons annually, of which 220,000 will be available for export.

South Africa's ferrochromium output received a major boost when the Associated Manganese Mines of South Africa and United States Steel Corp.'s new plant at Machadodorp came into production in December. Full production capacity of the plant will be about 4,409 short tons per month.

AMCOR's new chromium ferroalloy furnace was near completion at yearend. The new furnace with a rated capacity of 50,000 tons of charge chromium annually will bring AMCOR's total ferroalloy production capacity to 125,000 tons annually, of which 80% will be available for export.

Sweden.—Airco Alloys AB, a wholly owned subsidiary of Airco Alloys and Carbide Div. of Airco Inc., brought onstream a 75,000-kilovolt-ampere furnace, reportedly the largest in the world for ferroalloy production. Although being used for ferrosilicon production, the firm also plans on using the facility for production of ferrochromium. The new unit replaces four smaller units at the plant and is equipped with a sand filter dust control system for removing pollutants.

Turkey.—Etibank was authorized to develop chromite deposits near Cakmak, Islahiye, Turkey. The agreement calls for extracting 500 tons of chromite per year. Etibank also signed similar agreements for development of chromite deposits at Kirkpinar and Kuzoluk.

International Mining Corp., Chrome Resources S.A., and Foote Mineral Co. joined forces to construct a plant for concentration of chromium ore in Turkey. Shipments of chromium concentrate were expected to begin late in the year.

Yugoslavia.—The geology of Yugoslavian chromite deposits was described.[5]

[5] Grafenauer, S. Recent Results on Alpine-Type Chromite Deposits. Mining Met. Quart., (Rudarskometalurski Zbornic, No. 1, 1971, pp. 1–10) translated from Slovenian, 1972, pp. 5–14.

TECHNOLOGY

Processes for the production of stainless steel continue to be developed and improved. Most of the processes utilize lower cost high-carbon ferrochromium rather than higher cost low-carbon ferrochromium.

Joslyn Stainless Steel, a division of Joslyn Manufacturing and Supply Co. and a pioneer in the development of the argon-oxygen decarburization (AOD) process, believes that it has perfected a process for substituting nitrogen for a significant part of the argon used in the process. Spartan Steel and Alloy Ltd. (United Kingdom) also found that nitrogen can partially replace the more expensive argon.

Allegheny Ludlum, Inc., teamed up a basic oxygen furnace (BOF) with a hot blast cupola furnace at its Natrona, Pa., plant.[6] Stainless steel scrap, high-carbon ferrochromium, and molybdenum oxide are cold charged to the BOF furnace to which the cupola hot metal is added. Optimum charge rate has been 66.5% hot metal. Chromium recovery rates range from 88.7 to 92.5%.

For the production of most nickel stainless steel grades, Allegheny utilizes a vacuum refining process (AVR) which employs an electric furnace for melting and a vacuum refining unit. Decarburizing is achieved by injecting oxygen below the liquid metal surface while it is held at reduced pressure. Chromium yield in the AVR unit was reported at 98.1% and overall chromium recovery at 92.6%.[7]

Sweden's Uddeholm Steel Corp. developed a stainless steel process similar to the AOD process, but in place of argon to carry off the carbon monoxide, water vapor is injected through the furnace bottom. Reduced refractory wear is claimed; however, the process is limited to stainless grades containing less than 0.15% carbon. The firm reports a savings of $8 per ton in the manufacturing of stainless steel.

Outokumpu Oy (Finland) continued to develop a process for the production of electrolytic chromium. Chromium metal containing 200 to 300 ppm oxygen, 20 to 40 ppm nitrogen, and 10 ppm sulfur was purified in bulk to less than 1 ppm oxygen, 5 ppm nitrogen, and less than 5 ppm sulfur. The material was then processed into a wrought bar by direct extrusion in an evacuated sheath.[8] Small quantities of interstitial elements in chromium metal in the past has prevented processing commercial chromium metal to ductile metal.

An improved electrorefining process was developed for the preparation of high-purity chromium with low-interstitial content. High-purity commercial chromium metal was electrorefined in a chromic chloride ($CrCl_2$) electrolyte at cathode current densities of 40 to 210 amperes per square foot. Average current efficiency and chromium recovery were 96% and 99%, respectively.[9]

Two new chromium plating processes were developed that could substantially reduce repair and salvage costs. The first was an electrolytic process that can be taken to the automobile bumper. The second was a hard chromium plating system primarily intended for use in moldmaking and tool and die operations for salvaging worn or mismatched parts.

The Central Research Institute (India) reported the development of a self-regulating, high-speed chromium salt. The performance characteristics of the formulation demonstrate the following advantages over conventional plating: Higher production rate; formation of smoother, brighter, and harder deposits; less frequent need for accessories such as jigs; and elimination of control of critical constituents such as sulfate.[10]

Bureau of Mines researchers determined low-temperature heat capacities and high-temperature enthalpies calorimetrically for sodium chromate.[11]

---

[6] Iron Age. Chromium Recovery Improved in Stainless Refining. V. 209, No. 23, June 8, 1972, pp. 59–60.

[7] Work cited in footnote 6.

[8] Sced. I. R. Production of High-Purity Wrought Chromium by Hydrogen Reduction and Extrusion Without Intermediate Melting. J. Less Common Metals, v. 27, No. 3, June 1972, pp. 261–267.

[9] Lei, K. P. V., J. M. Hiegel, and T. A. Sulivan. Electrolytic Preparation of High-Purity Chromium. J. Less-Common Metals, v. 27, No. 3, June 1972, pp. 353–365.

[10] Journal of Mines, Metals and Fuels. Formulation for High-Speed Chromium Plating. V. 20, No. 4, April 1972, p. 124.

[11] Ferrante, M. J., J. M. Stuve, and M. P. Krug. Low-Temperature Heat Capacities and High-Temperature Enthalpies of Sodium Chromate. BuMines RI 7691, 1972, 12 pp.

Geological studies on chromite included a discussion of occurrences in Sabah, North Borneo and in the lavas from volcano eruptions in Hawaii.[12]

[12] Hutchison, Charles S. Alpine-Type Chromite in North Borneo, With Special Reference to Darvel Bay. Am. Mineralogist, v. 57, Nos. 5–6, May–June 1972, pp. 835, 856.
Evans, Bernard W. and Thomas L. Wright. Compostion of Liquidus Chromite from the 1959 (Kilavea Iki) and 1965 (Makaopuhi) Eruptions of Kilavea Volcano, Hawaii. Am. Mineralogist, v. 57, Nos. 1–2, January–February, 1972, pp. 217–230.