

Cadmium

John Keating

The author is with the Mining Sector,
Natural Resources Canada.
Telephone: (613) 992-4409

Note to Reader: The last cadmium review was prepared in 1991. This review provides a brief update on market activities and presents Canadian and world statistics.

Cadmium is a naturally occurring element that is present in the earth's crust at an average concentration of 0.2 parts per million. The Geological Survey of Canada has calculated that the first metre of rock of Canada's land surface, excluding fresh-water areas, contains 4 950 000 t of cadmium.

As a metal, cadmium is soft, malleable and silver-white in colour with a relatively low melting point. The metal is traded worldwide with prices quoted for two forms depending on the purity, 99.95% or 99.99% pure.

MARKET OVERVIEW

Cadmium is mainly produced as a by-product of zinc mining and refining. On average, approximately 3 kg of cadmium are produced for every tonne of refined zinc. Therefore, the supply of cadmium is more dependent on zinc production than on cadmium demand. However, cadmium is also produced from recycled materials such as nickel-cadmium batteries, and some residues or intermediate materials. Approximately 10-15% of total Western World production is from recycled materials.

Cadmium metal production in the Western World declined by 14% from a record high of 16 800 t in 1991 to 14 400 t in 1994. Western World demand for cadmium also peaked in 1991 at 17 600 t before falling to about 15 900 t in 1994. The supply deficit that occurred during this period was partly offset by recycled refined material, sales from the U.S. Defense Stockpile and, to a lesser extent, imports from former Eastern Bloc countries. The deficit also resulted in a drawdown of consumer and producer stocks. For example, producer inventories at the end of 1994 had declined by 41% from 3900 t at the end of 1992.

The weekly average *Metal Bulletin* price for cadmium (99.99% purity) was US\$1.90/lb at the beginning of 1992. The price subsequently declined to a record low of \$0.49/lb in the third quarter of 1993 as demand softened because of the recession in several major economies, and producer inventories rose. Although demand remained soft, the price rebounded to \$2.30/lb by September 1994 in part because of a drawdown in producer stocks, which is believed to have occurred in order to replenish consumer inventories.

CANADIAN OVERVIEW

According to data from the World Bureau of Metal Statistics (WBMS), Canada is the second largest producer of refined cadmium metal in the world after Japan. Annual world data on mine production for cadmium are not available; however, Canada is the largest producer of zinc in concentrate and is therefore also considered to be the largest producer of cadmium in concentrate.

Since 1991, Canadian mine production of cadmium in concentrate (recoverable content) declined by 25% to a 10-year low of 1160 t in 1993, before increasing to 1460 t in 1994. The reduction was largely a result of mine closures and cuts in zinc production in response to low metal prices.

However, Canadian metal production of cadmium increased to a record high of 2130 t in 1994. The increase was partly a result of the commissioning of Cominco Ltd.'s new cadmium plant in Trail, British Columbia in 1992, and a rise in imports of zinc-lead concentrates containing cadmium from the company's Red Dog mine in Alaska.

USES

Cadmium's unique chemical and physical properties permit it to be used in a wide variety of applications, such as in rechargeable nickel-cadmium batteries, in coatings for corrosion protection on ships or aerospace applications, and in pigments for plastics or stabilizers in polyvinyl chlorides (PVCs) to protect from chemical attack, sunlight, or heat degradation.

Rechargeable nickel-cadmium batteries account for over 60% of cadmium demand, with 75% of the batteries used for cordless electronic equipment such as

power tools, computers and telephones. The remaining 25% are used for industrial applications to provide stand-by power in, for example, hospital operating theatres. New demand potential for nickel-cadmium batteries exists in the electric vehicle market, which is expected to expand in response to regulatory requirements for zero-emission vehicles in states such as California.

According to WBMS data, Japan is the largest consuming nation of cadmium followed by Belgium, the United States, France, the United Kingdom, Germany, and India. Together these countries accounted for 89% of Western World demand in 1994.

HEALTH AND THE ENVIRONMENT

Cadmium in elemental form can have adverse effects on certain forms of life depending on the concentration of exposure.

In 1993, the Canadian government completed an assessment of cadmium and its compounds under the *Canadian Environmental Protection Act*. The assessment found that certain forms of cadmium may be present in the environment or in food from natural or anthropogenic sources in a concentration that may have an effect on human health or the environment. Further work is being carried out to determine if there are levels of exposure that require further regulatory measures.

The OECD Chemicals Group and Management Committee is assessing if there are significant risks from exposure to cadmium that require international solutions. In 1994, the group completed a report entitled *Risk Reduction Monograph No. 5: Cadmium*, which outlined potential natural and anthropogenic sources of cadmium in the environment, available data on concentrations, and measures that countries have taken to manage risks from exposure.

Sweden will host an OECD workshop on sources of cadmium in the environment in October 1995. The

workshop will assess if there are transboundary concerns that require international solutions and identify possible management options where necessary.

OUTLOOK

The production of cadmium is, to a large extent, controlled by the production of zinc. At present, there is a large overhang of zinc metal stocks that will need to be reduced before the mine production of zinc can increase significantly.

In the short term, reductions in mine output could result in a supply deficit for the cadmium market given that demand for nickel-cadmium batteries and other uses is expected to increase as the major economies continue to grow. However, there may be a supply of cadmium available in intermediate smelting or refining materials, such as residues, to meet the growing demand. During the last few years, cadmium metal production and producer stocks have declined, while zinc metal production has increased. This likely means that producers have stockpiled intermediate materials containing cadmium rather than refining it into metal. Therefore, there may not be a supply deficit if the refined stockpiled material is sufficient to meet demand.

If supply can meet demand, then cadmium (99.99% purity) prices are forecast to continue to fluctuate between \$1.50 and \$2.00/lb in the short term. However, prices may increase significantly if there is a shortage of intermediate materials to process or if supply is disrupted.

In the medium to long term, it is expected that cadmium supply will increase to meet growth in demand as the mine production of zinc recovers.

Notes: (1) For definitions and valuation of mineral production, shipments and trade, please refer to Chapter 60. (2) Information in this review was current as of April 28, 1995.

TARIFFS

Item No.	Description	Canada			United States	E.U.	Japan ¹
		MFN	GPT	USA	Canada	MFN	MFN
2617.90.00.10	Cadmium ores and concentrates	Free	Free	Free	Free	Free	Free
2825.90.90.10	Cadmium oxide	Free	Free	Free	Free	11%	5.8%
2830.30	Cadmium sulphide	Free	Free	Free	Free	6.9%	3.7%
8107.10.10	Unwrought cadmium, not alloyed; powders, not alloyed	Free	Free	Free	Free	4%	5.1%
8107.10.20	Unwrought cadmium, alloyed; waste and scrap; powders, alloyed	8.8%	6.5%	Free	Free	4%	5.1%
8107.90	Cadmium and articles thereof, n.e.s.	8.8%	6.5%	Free	Free	6%	6.5%

Sources: Customs Tariff, effective January 1995, Revenue Canada; Harmonized Tariff Schedule of the United States, 1995; The "Bulletin International des Douanes," Journal Number 14 (16th Edition), European Economic Community, 1992-1993, "Conventional" column; 1st Supplement to Journal Number 14 (16th Edition), European Economic Community, 1993-1994, "Conventional" column; Custom Tariff Schedules of Japan, 1994.

¹ GATT rate is shown; lower tariff rates may apply circumstantially.

n.e.s. Not elsewhere specified.

TABLE 1. CANADA, CADMIUM PRODUCTION AND TRADE, 1992-94, AND CONSUMPTION, 1991-93

Item No.	1992		1993		1994P	
	(kilograms)	(\$000)	(kilograms)	(\$000)	(kilograms)	(\$000)
PRODUCTION (all forms)¹						
Ontario	605 068	1 462	592 629	760	791 654	2 734
British Columbia	403 566	975	262 363	337	270 603	935
New Brunswick	149 797	362	126 133	162	165 337	571
Quebec	100 349	242	101 725	131	120 313	416
Manitoba	132 038	319	78 323	100	110 573	382
Northwest Territories	-	-	-	-	17	...
Nova Scotia	2 281	6	-	-	-	-
Total	1 393 099	3 366	1 161 173	1 490	1 458 497	5 038
Refined ²	1 962 813	..	1 888 255	..	2 129 133	..
IMPORTS						
2617.90.00.10	Cadmium ores and concentrates					
	United States	3 076	30	3 180	31	12
	Total	3 076	30	3 180	31	12
2825.90.90.10	Cadmium oxide					
	United States	3 732	77	3 821	78	2 246
	Belgium	5 629	112	2 288	45	1 197
	United Kingdom	333	7	418	8	563
	Total	9 694	197	6 527	132	4 006
2830.30	Cadmium sulphide					
	United States	11 136	7	25 659	17	109 601
	Total	11 136	7	25 659	17	109 601
8107.10.10	Unwrought cadmium, not alloyed; powders, not alloyed					
	Bulgaria	-	-	-	-	9 053
	United States	5 067	63	1 007	10	4 692
	Belgium	-	-	-	-	2 722
	Other countries	312	3	752	7	100
	Total	5 379	66	1 759	18	16 567
8107.10.20.10	Unwrought cadmium, alloyed; powders, alloyed					
	Mexico	-	-	-	-	18 000
	United States	21	...	34	1	-
	Total	21	...	34	1	18 000
8107.10.20.20	Cadmium waste and scrap					
	United States	-	-	12	...	109
	Total	-	-	12	...	109
8107.90	Cadmium and articles thereof, n.e.s.					
	United States	17 230	210	13 953	157	18 874
	France	-	-	-	-	531
	Other countries	-	-	-	-	349
	Total	17 230	210	13 953	157	19 754
EXPORTS						
2830.30	Cadmium sulphide					
	United States	-	-	-	-	2
	Total	-	-	-	-	2
8107.10	Unwrought cadmium; waste and scrap; powders					
	Japan	482 206	1 060	550 171	632	528 593
	United States	514 939	1 402	612 718	858	586 785
	Sweden	-	-	-	-	229 087
	People's Republic of China	176 192	364	141 120	176	119 775
	France	71 531	184	138 544	201	120 825
	United Kingdom	172 984	2 026	229 906	262	190 617
	Other countries	122 926	1 161	183 477	192	123 151
	Total	1 540 778	6 202	1 855 936	2 327	1 898 833
						4 753

TABLE 1 (cont'd)

Item No.	1992		1993		1994 ^p	
	(kilograms)	(\$000)	(kilograms)	(\$000)	(kilograms)	(\$000)
EXPORTS (cont'd)						
8107.90	Cadmium and articles thereof, n.e.s.					
	United States					
	39 045	90	1 004	7	4 536	36
	Total					
	39 045	90	1 004	7	4 536	36
CONSUMPTION						
	1991		1992		1993^{p a}	
	(kilograms)					
	Cadmium metal ³					
	Plating					
	13 594		17 371		17 933	
	Solders, other alloys and other uses ⁴					
	58 093 ^r		68 737 ^r		71 317	
	Total					
	71 687 ^r		86 108 ^r		89 250	

Sources: Natural Resources Canada; Statistics Canada.

– Nil; . . Not available; . . . Amount too small to be expressed; n.e.s. Not elsewhere specified; ^p Preliminary; ^r Revised.^a Increase in number of companies being surveyed.¹ Production of refined cadmium from domestic ores, plus recoverable cadmium content of exported ores and concentrates. ² Refined metal from all sources and cadmium sponge. ³ Available data as reported by consumers. ⁴ Chemicals and pigments.

Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, CADMIUM PRODUCTION AND EXPORTS, 1975 AND 1980-94

	Production		Exports
	All Forms ¹	Refined ²	Cadmium Metal
	(kilograms)		
1975	1 191 674	1 142 508	637 797
1980	1 033 000	1 302 955	1 095 825
1981	833 788	1 293 265	1 452 904
1982	886 055	1 162 390	769 505
1983	1 107 000	1 296 000	1 365 111
1984	1 605 286	1 756 707	1 369 422
1985	1 716 731	1 696 192	1 477 415
1986	1 483 907	1 551 732	1 382 807
1987	1 481 496	1 571 444	1 156 555
1988	1 663 978	1 693 708	1 112 616
1989	1 710 527	1 619 798	1 433 144
1990	1 333 664	1 470 229	1 282 603
1991	1 549 087	1 829 059	1 452 481
1992	1 393 099	1 962 813	1 579 823
1993	1 161 173	1 888 255	1 856 940
1994 ^p	1 458 497	2 129 133	1 903 369

Sources: Natural Resources Canada; Statistics Canada.

^p Preliminary.¹ Production of refined cadmium from domestic ores plus recoverable cadmium content of exported ores and concentrates. ² Refined metal and cadmium sponge from all sources.

TABLE 3. CADMIUM END USES, 1 1991-93

	1991	1992	1993
	(%)		
Batteries	60	61	63
Pigments	18	16	15
Stabilizers	10	11	10
Coatings	7	7	7
Alloys	2	2	2
Miscellaneous	3	3	3

Source: Cadmium Association.

¹ Percentage of market share in market economy countries.

TABLE 4. REFINED CADMIUM PRODUCTION BY COUNTRY, 1991-94

Country	1991	1992	1993	1994
(tonnes)				
AMERICAS				
Canada	1 809.8	1 992.8	1 945.8	2 167.8
United States	1 875.9	1 913.6	1 138.6	1 125.7
Mexico	1 235.9	728.9	596.2	558.9
Peru	537.0	386.0	240.0	240.0
Other Americas	189.0	172.0	183.6	184.0
Total	5 647.6	5 193.3	4 104.2	4 276.4
EUROPE				
Belgium	1 816.3	1 549.7	1 572.8	1 556.1
Finland	593.0	590.0	785.0	548.0
France	271.0	250.8	138.5	5.6
Germany	1 061.0	960.5	1 069.3	1 119.6
Italy	657.0	742.0	517.0	623.3
Netherlands	549.1	594.0	525.5	306.7
Norway	236.5	250.2	212.5	287.8
Spain	344.0	328.8	328.8	328.8
United Kingdom	449.3	383.0	458.1	469.5
Yugoslavia	280.0	362.0	362.0	362.4
Other Europe	20.0	–	–	–
Total	6 276.3	6 011.0	5 969.5	5 607.8
ASIA				
India	271.0	313.1	254.8	216.3
Japan	2 773.5	2 922.2	2 825.9	2 614.1
South Korea	570.0	568.0	568.0	567.6
Other Asia	22.0	21.0	21.0	21.6
Total	3 636.5	3 824.3	3 669.7	3 419.6
AFRICA				
Algeria	78.0	65.0	65.0	64.8
Namibia	67.8	56.6	17.7	42.1
Zaire	96.0	95.0	95.0	94.8
Total	241.8	216.6	177.7	201.7
OCEANIA				
Australia	1 076.0	1 001.4	950.7	909.5
Total	1 076.0	1 001.4	950.7	909.5
Total Western World	16 878.2	16 246.6	14 871.8	14 415.0
OTHER COUNTRIES				
Bulgaria	232.0	194.0	266.0	..
Poland	364.0	132.0	149.0	..
Romania	10	10	–	–
U.S.S.R.	2 000.0	1 320.0	1 500.0	..
People's Republic of China	1 125.0	1 200.0	1 270.0	..
North Korea	200.0	200.0	200.0	..
Total	3 931.0	3 056.0	3 385.0	..
Total world	20 809.2	19 302.6	18 256.8	..

Source: World Bureau of Metal Statistics.
– Nil; .. Not available.

TABLE 5. REFINED CADMIUM CONSUMPTION¹ BY COUNTRY, 1991-94

Country	1991	1992	1993	1994 ^p
	(tonnes)			
AMERICAS				
Canada	255.0	159.7	157.2	41.4
United States	3 342.6	3 721.1	2 698.6	1 629.4
Mexico	155.3	136.6	139.2	139.2
Other Americas	153.0	150.0	150.0	150.0
Total	3 905.9	4 167.4	3 145.0	1 960.0
EUROPE				
Belgium	2 640.0	2 640.0	2 640.0	2 640.0
France	1 420.0	1 500.0	1 500.0	1 500.0
Germany	652.0	651.6	651.6	651.6
Italy	330.0	374.5	364.8	364.8
Sweden	156.0	239.0	239.0	238.8
United Kingdom	825.5	715.1	622.0	663.5
Other Europe	227.0	246.4	246.4	246.0
Total	6 250.5	6 366.6	6 263.8	6 304.7
ASIA				
Japan	6 370.6	5 527.0	5 937.6	6 615.3
South Korea	400.0	380.0	380.0	380.4
India	446.0	446.4	446.4	446.4
Other Asia	134.0	138.8	138.8	139.2
Total	7 350.6	6 492.2	6 902.8	7 581.3
OCEANIA				
Australia	25.0	24.0	24.0	24.0
Total	25.0	24.0	24.0	24.0
AFRICA				
Total Africa	30.0	20.0	20.0	20.4
Total Western World	17 562.0	17 070.2	16 355.6	15 890.4
OTHER COUNTRIES				
U.S.S.R.	1 800.0	1 250.0	..	..
People's Republic of China	490.0	500.0	..	..
Other	320.0	295.0	..	..
Total	2 610.0	2 045.0	..	..
Total world	20 172.0	19 115.2	..	..

Source: World Bureau of Metal Statistics.

.. Not available; ^p Preliminary.¹ Apparent consumption.