INDIUM

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Canadian Developments

Canadian indium production statistics are withheld for confidentiality reasons. Domestic production of indium is derived from the processing of zinc ores. Two facilities in Canada recover indium: Cominco Ltd.'s operation at Trail, British Columbia, and Falconbridge Limited's Kidd Creek operation in Timmins, Ontario. Cominco produces high-purity indium while Kidd Creek's material is shipped to the United States for further refining. A press report in early January 1995 indicated that Cominco was then producing at a rate of about 20 t/y (or two thirds of its capacity of 30 t/y) and that production would increase during 1995.

In New Brunswick, Adex Mining Corporation continued evaluation of its Mt. Pleasant property. Mt. Pleasant had previously been operated by Billiton Metals Canada in the early 1980s as a tungsten producer, but closed due to low metal prices in 1985. Adex obtained rights to the property and funded a $525 000 program of drilling and metallurgical research in 1995. During the same year, Adex acquired 100% of Piskahegan Resources Limited and, consequently, full control of Mt. Pleasant. During 1995, a bulk sample was taken for metallurgical testing; at the end of January 1996, a production and financing decision appeared to be pending the outcome and evaluation of the metallurgical work.

Assuming work proceeds and the mine obtains the necessary permits to re-open, Mt. Pleasant would be the first primary indium mine. Depending on the recovery process and the ore grades mined, the output from Mt. Pleasant would be in the order of 25 t/y if an average grade of 1.5 troy oz/t were mined. Indium grades in various ore zones range from 1 to 4 oz/t. In addition to indium, the various ore zones contain bismuth, copper, zinc, gallium, molybdenum, tungsten and tin. Adex's public information about the operation noted that an increase in the operating rate to 2000 t/d improved the economics of the project. The costs associated with bringing the Mt. Pleasant mine into full production are projected to be between $35 million and $45 million.

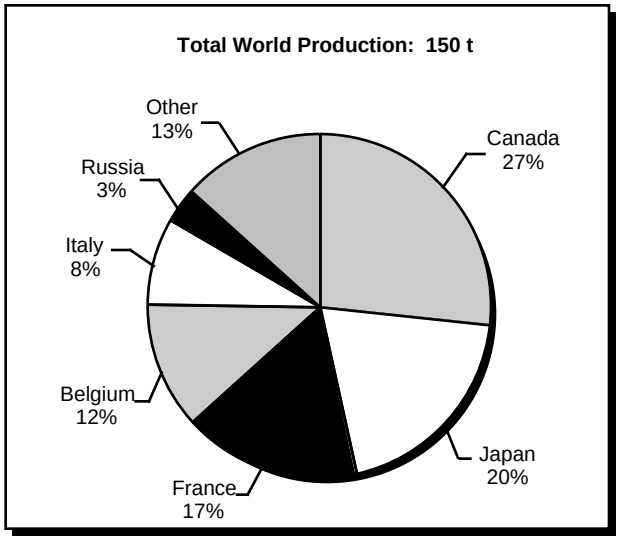
World Developments

Current world indium production is estimated at between 150 t/y and 200 t/y. Most indium is the by-product of zinc mining, but some indium is associated with tin, such as in the Mt. Pleasant deposit. Primary recovery of indium ceased in the United States in 1994, but some Canadian material is upgraded in U.S. facilities.

Indium refined metal production in 1994, as estimated by the U.S. Bureau of Mines (USBM), was: Canada, 40 t; Japan, 30 t; France, 25 t; Belgium, 18 t; Italy 12 t; and Russia, 5 t. Production levels in 1996 are expected to be higher.

Russian production of indium is a by-product of zinc, copper and tin mining. In late 1994, Russian exports were reported at 30 t for 1993. The weak prices in 1994 were partially blamed on increased exports from Russia, but in 1995 delays in Russian indium shipments were cited as reasons for dramatically increasing prices. Public information about Chinese production or exports is not readily obtainable; in the autumn of 1995, when prices were still rising, it was reported that Chinese exports were greater than domestic production.

Figure 1
World Refined Production of Indium, 1994



Source: U.S. Bureau of Mines.

Consumption and Uses

Precise public information on indium production and consumption is not available. World demand for indium in 1994 was estimated at about 140-150 t. Arconium Corp. estimated indium consumption for 1994 at 180 t. As a guess, consumption in 1996 will be similar to production in the range of 150-200 t.

Japan has been the largest consumer of indium metal, used in indium-tin oxide (ITO). Imports in 1994 were 85 t, with consumption of indium in ITO estimated at 45 t. Japan also produces indium from the processing of domestic and imported zinc concentrates. Estimated total U.S. consumption of indium in 1994 was 70 t.

ITO is transparent and electrically conductive. It is used in the manufacture of thin-film transistor (TFT) liquid crystal display (LCD) screens for computers, CD players, electronic games, instrumentation panels and military applications. Some of the higher growth markets for indium in ITO have been for use in laptop computers and touch screen displays. The LCD market is expected to increase rapidly as various electronics companies in Japan announced new capacity during 1994 and 1995. An estimate in 1994 put the total production of LCD screens from Japan at 4.5 million. The demand for indium for use in ITO in Japan appears to have exceeded the growth rates for demand in other applications.

Markets for ITO in screens and displays are expected to double from 1994 to 2000. However, there is a question whether indium supplies can support this growth rate at a price that will not result in significant substitution by other materials, unless indium recycling rates are increased or the quantity of indium used per application is reduced. Other oxides such as zinc-tin are possible substitutes for ITO, but their performance is currently inferior to that of ITO.

Other uses for indium include in lead-free solders, windscreen de-misting systems, architectural glass and solar applications, specialty automotive mirrors that reduce headlight glare, jewellery, and dental appliances. More unusual uses include in anti-static coatings for spacecraft, lasers, or light-emitting diodes (LEDs) to replace incandescent lights in critical applications. Indium Corporation of America produces 99.99999% pure indium for use in electro-optical devices and "exotic" electronic devices. It also markets a lead-free solder, Indalloy 227, composed of 77.2% tin, 20% indium, and 2.8% silver. The target market for this solder appears to be the electronics industry where the use of lead could be a concern.

Prices

The price of indium[1] quadrupled from December 1994 (US$131/kg) to December 1995 (US$551/kg). Despite predictions that higher prices in early 1995 could not be sustained, prices rose almost steadily in 1995, ending the year with a December 1995 price of US$551/kg, down slightly from November's price of US$560/lb. For comparison, indium prices were US$131/kg in December 1994 and US$141/kg in December 1993. The main reasons for the increasing prices in 1995 were continued strong growth in the electronics sectors, both in Japan and elsewhere, and uncertainty about supply from Russia. The average price for 1995 was US$457/kg compared to US$132.50/kg in 1994. Figure 2 shows average monthly indium prices from 1993 to 1995.

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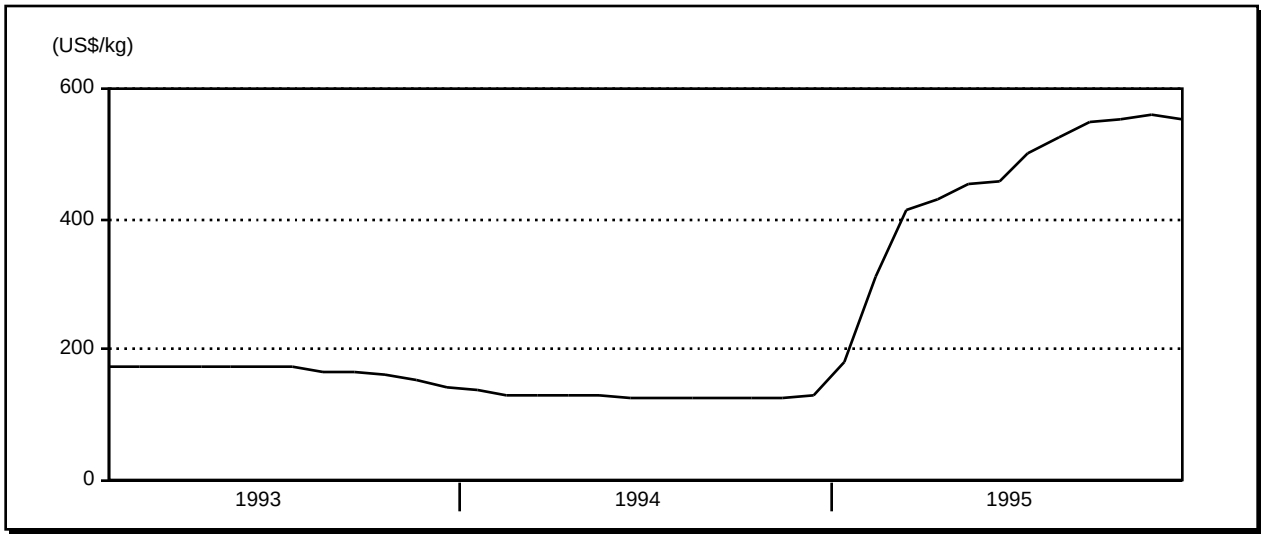
[1] The monthly price cited is mean of the average monthly low and average monthly high prices reported by the *Metal Bulletin*. The annual price is the mean of the average yearly low and average yearly high prices reported by the *Metal Bulletin*.

Figure 2
Indium Prices, 1993-95
Ingot, Minimum 99.7%, Average Metal Bulletin Free Market Price



Source: *Metal Bulletin*.

As well as new indium production potentially from Mt. Pleasant or from increased by-product recovery in existing lead-zinc operations, an important factor in the future supply/demand balance will be increased recovery from recycling operations. The success rate in the utilization of sputtering targets which use ITO has been low, about 25%. The remainder has generally been discarded or stockpiled. Some recycling may have occurred to produce lower-grade alloys for applications other than ITO manufacture. With increased indium prices, greater effort can be expected to reduce wastage so that the amount of indium used per successful application will decrease. While newer fabricators have cut wastage rates, significant quantities of indium in ITO targets are still scrapped. Such rejected targets represent an above-ground stockpile of indium. Higher prices will promote increased reprocessing; some sources put US$400/kg as the threshold for economic viability of recycling ITO targets. Once they are started and investment costs are sunk, the recycling operations may be sustainable at lower indium prices.

With time, the significantly higher prices will elicit additional supply to the market. But with the very strong growth rates forecast for electronics products using indium, strong demand will act to support prices. Continued significant price volatility with prospects for lower prices may occur as this relatively small market of by-product metal is affected by substitution and recycling.

Notes: (1) For definitions and valuation of mineral production, shipments and trade, please refer to Chapter 70. (2) Information in this review was current as of January 31, 1996.

TARIFFS

Item No.	Description	Canada			United States
		MFN	GPT	USA	Canada
8112.91	Unwrought; waste and scrap; powders				
8112.91.10.30	Unwrought indium, not alloyed; powders, not alloyed	2%	Free	Free	Free
8112.91.20.13	Unwrought indium, alloyed; waste and scrap; powders, alloyed	2%	1%	Free	Free
8112.99.90.30	Indium and articles thereof, n.e.s.	4.5%	3%	Free	Free

Sources: Customs Tariff, effective January 1996, Revenue Canada; Harmonized Tariff Schedule of the United States, 1996.
n.e.s. Not elsewhere specified.

TABLE 1. CANADA, INDIUM PRODUCTION AND IMPORTS, 1993-95

Item No.		1993		1994		1995p	
		(kilograms)	($000)	(kilograms)	($000)	(kilograms)	($000)
PRODUCTION		x	x	x	x	x	x
IMPORTS							
8112.91.10.30	Unwrought indium, not alloyed; powders, not alloyed						
	United States	434	73	1 043	178	2 292	571
	People's Republic of China	–	–	–	–	116	19
	Japan	39	6	–	–	–	–
	Total	473	80	1 043	178	2 408	591
8112.91.20.13	Unwrought indium, alloyed; waste and scrap; powders, alloyed						
	United States	62	10	279	47	290	49
	Total	62	10	279	47	290	49
8112.99.90.30	Indium and articles thereof, n.e.s.						
	United States	902	153	651	109	887	185
	United Kingdom	12	2	32	5	51	8
	Japan	15	2	16	2	23	3
	Total	929	157	699	118	961	198

Sources: Natural Resources Canada; Statistics Canada.
– Nil; n.e.s. Not elsewhere specified; p Preliminary; x Confidential.
Notes: Indium export statistics are included with certain other metals as a total and are therefore not available. Numbers may not add to totals due to rounding.