

Tungsten

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CANADIAN DEVELOPMENTS

Until 1986, Canada was a major producer of tungsten ore and concentrate. Annual production reached a high of 3715 t of tungsten content (8% of world production) in 1984, after which prices collapsed as a result of increased exports from the People's Republic of China. The low-priced material from China eventually forced the closure of the Canadian operations at the Cantung and Mount Pleasant mines in the Northwest Territories and New Brunswick, respectively.

The Cantung mine operated by Canada Tungsten Mining Corporation Limited (Cantung), Canada's leading tungsten company, was recognized as the largest producer of tungsten concentrate in the Western World. Located in the Northwest Territories, the Cantung mine was in operation between 1962 and 1986 at a rate of about 4450 t/y of tungsten trioxide (WO₃). Higher-grade concentrates were marketed directly while lower-grade concentrates were sent to the Fort Madison, Iowa, plant for conversion to ammonium paratungstate (APT).

North American Tungsten Corporation Ltd. re-opened the mine in 2001 when prices increased; however, the company announced in December 2003 that it was forced to close the mine due to the termination of loans and purchasing agreements for the concentrate produced at the mine. At that time, prices had again fallen and the company sought legal protection under the *Companies' Creditors Arrangement Act*.

During 2004 and early 2005, the company was restructured and funds were raised to re-open the mine. The company emerged from protection under the *Companies' Creditors Arrangement Act* and resumed operations at the Cantung mine in September 2005. The mill was ramped up to 1000 t/d by February 2006.

The company has made improvements in the mill and underground operations, and the addition of equipment and new mining methods should result in better operating efficiencies over the longer term. An exploration drilling program was conducted at Mactung in 2005 and longer-term exploration programs are being developed for both the Cantung and Mactung properties. Feasibility studies for Mactung are expected to start in the second half of 2006.

WORLD DEVELOPMENTS

Portugal

Beralt Tin and Wolfram (Portugal) S.A. (owned by Primary Metals Inc.) operates the Panasqueira tungsten mine in Portugal, one of the world's largest producers of tungsten concentrates outside of China (www.primarymetals.ca). Panasqueira has been operating at a rate of 2400 t/d, but has upgraded and purchased new mining equipment to increase its mining rate to 3000 t/d in January 2006. Upgrades to the mill and mining methods are also expected to increase grades and recoveries. An exploration program to identify new resources both within and outside the mine began in November 2005.

Vietnam

Toronto-based Tiberon Minerals Ltd. is working on development of its Nui Phao property in Vietnam. Nui Phao contains over 55 Mt of proven and probable reserves, one of the largest tungsten-fluorspar deposits located outside China. The deposit also contains by-products, including bismuth, copper and gold. During 2005, the company completed an environmental assessment of the project and a feasibility study. In early 2006, off-take agreements were signed for tungsten, fluorspar and bismuth production.

China

Demand for all metals within China is increasing and tungsten is no exception. The increased demand for energy and metals in China has been one of the most influential elements in the markets' dramatic rise in base-metal prices. In addition, the Chinese government's export

Figure 1
Location of Cantung Mine, Northwest Territories



1. Cantung mine, North American Tungsten Corporation Ltd.

control policies for tungsten ores and intermediates have affected the world demand/supply balance. The Ministry of Commerce has announced that China will reduce the export tax rebates on various commodities, including tungsten, effective January 1, 2006, to 5% from the 8% applied in 2005. In addition, the export quota for 2006 was reduced 500 t to below 16 000 t.

EXPLORATION ACTIVITY

The New Brunswick, Yukon and B.C. governments provide information on the tungsten occurrences within their province. Links to their web sites are available at www.nrcan.gc.ca/mms/cmy/lcom_e.htm#Tungsten.

Companies with Canadian exploration projects with tungsten, or with tungsten associated with other metals, include¹:

- Adex Minerals Corp., former Mount Pleasant mine in New Brunswick;
- Arcturus Ventures Inc., property in Finlayson Lake area, Yukon (www.arcturusventuresinc.com);
- Buchans River Ltd., Granite Lake, Newfoundland and Labrador (www.newlab.nf.ca), property optioned in early 2006 to Playfair Mining Ltd.;
- Copper Ridge Explorations Inc., option to acquire 100% of Kalzas property, Yukon (www.copper-ridge.com);
- Emgold Mining Corporation, option agreement to acquire property in Stewart, B.C., area (www.emgold.com);
- Freeport Resources Inc., Red Rose, former producer, Omineca, British Columbia;
- Geodex Minerals Ltd., Sisson Brook property, New Brunswick (www.geodexminerals.com);
- J.A.G. Mines Ltd., Beauce, Quebec (www.mines-jag.com/JAGenglish/Jag.html);
- Noront Resources Ltd., Burnt Hill, New Brunswick, former producer (granted option to Limerick Mines Limited in 2005) (www.norontresources.com);

¹ If your company has a tungsten property that you would like to have included, contact the Minerals and Metals Sector with details.

- Orphan Boy Resources Inc., Rain project, Revelstoke, British Columbia (www.orphanboy.com);
- Playfair Mining Ltd., various properties, Grey River, Newfoundland and Labrador; Risby, Yukon; and Lened, N.W.T. (www.playfairmining.com);
- Strategic Metals Ltd., various properties in the Yukon and northern British Columbia (www.strategicmetalsltd.com);
- Sultan Minerals Inc., Jersey Emerald property, Salmo, British Columbia, former producer (www.sultanminerals.com); and
- North American Tungsten Corporation Ltd., Cantung and Mactung properties in the Yukon, current producer (www.northamericantungsten.com).

Other Canadian-based companies with international interests include:

- Primary Metals Inc., which owns 100% of Beralt Tin and Wolfram (Portugal) S.A.;
- Beralt, which owns and operates the Panasqueira tungsten mine in Portugal, one of the world's largest producers of tungsten concentrates outside of China (www.primarymetals.ca);
- Dynacor Mines Inc., which acquired the Pasto Bueno tungsten mine in Peru (www.dynacor.com);
- Tiberon Minerals Ltd., with a tungsten-fluorspar deposit at Nui Phao in Vietnam (www.tiberon.com);
- Augusta Resource Corporation, with properties in the United States (www.augustaresource.com);
- Rome Resources Ltd., with various properties in Mexico (www.romermr.com); and
- Solomon Resources Limited, Sleitat Mountain, Alaska (www.solomonresources.ca).

USE AND PROPERTIES

Canada's use data for tungsten are confidential due to the low number of users.

Tungsten's properties include a very high density, the highest melting point of any metal at 3410°C, a low coefficient of thermal expansion, high tensile strength at elevated temperatures, high corrosion resistance, good thermal and electrical conductivity, and hardness. Tungsten metal is the hardest of the refractory metals and tungsten carbide is one of the hardest substances.

About 60% of tungsten concentrate is used for tungsten cemented carbide products such as tools and wear parts. Steel and metal products, including wire, electrical contacts and welding equipment, each account for 15% of tungsten use, nonferrous alloys and pigments/catalysts account for an additional 5%, and other uses account for 5% of use.

Ammonium paratungstate (APT) is the most important intermediate in the production of tungsten metal powder and tungsten carbide, and for some chemical uses of tung-

sten. It is used to produce tungsten trioxide ("yellow oxide" and "blue oxide"), which can be converted into tungsten powder for use in the manufacture of cemented carbides and lightbulb filaments, as well as other uses.

Due to its hardness, tungsten carbide has widespread application where intense wear and abrasion are encountered. This product is the preferred metal-working material for the cutting edges of machine tools and as a metal surface in forming and shaping dies. It is produced by the chemical combination of tungsten metal powder and finely divided carbon. Tungsten carbide is compacted to the desired form, using cobalt as a binder, and sintered to produce cemented tungsten carbide. Other uses of tungsten carbide include: tire studs, spikes for golf shoes, armour-piercing projectiles, and welding electrodes.

Tungsten can also replace lead in ammunition to produce environmentally friendly or "green" ammunition.

As an alloy constituent, tungsten is used primarily in the production of high-speed tool and die steels. Tungsten-bearing steels are used for the same applications as carbides, especially where lower operating temperatures are encountered.

Tungsten is also used in superalloys and nonferrous alloys. Tungsten-containing superalloys are being used increasingly in high-temperature applications and in highly corrosive environments because of their high-temperature strength and oxidation resistance.

Tungsten wire is used for filaments in incandescent lamps and for heating elements in both fluorescent lamps and vacuum tubes. Minor amounts of tungsten are also used to make chemicals and compounds for non-metallurgical applications. Some of the end uses include dyes, chemical reagents, catalysts, lubricants, paints and varnishes.

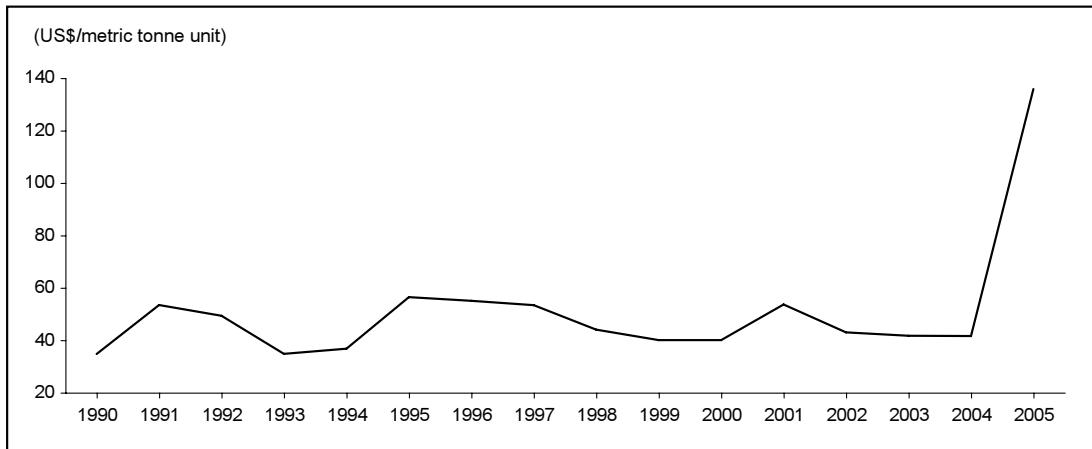
PRICES

Tungsten prices increased substantially in 2005 and remained strong during the early part of 2006. The U.S. spot price for tungsten ore peaked at a monthly average of US\$200 per metric tonne unit (mtu) in June 2005. Prices subsequently weakened, but closed the year with an average of US\$187/mtu in December 2005. Prices for other intermediate tungsten products all around the world have enjoyed comparable increases.

Initiatives taken by the Chinese government in changing export quotas (discussed above) are likely to have a continuing impact on tungsten markets.

Various tungsten prices can be found in journals such as *Platts Metals Week* and *Metal Bulletin*. Most are given in metric tonne units, which is 1% of one metric tonne or 10 kg of contained tungsten trioxide (WO₃).

Figure 2
Tungsten Ore, U.S. Spot Prices, 1990-2005



Source: *Platts Metals Week*, annual average of weekly prices.

Notes: (1) For definitions and valuation of mineral production, shipments and trade, please refer to Chapter 65. (2) Most information in this review was current as of March 31, 2006. (3) Although HS codes are often not specific enough to identify individual tungsten-containing compounds, if you feel that publication of additional trade statistics would assist you or your company, please contact the Minerals and Mining Statistics Division by telephone at 1-800-267-0452 or by e-mail at info-mms@nrcan.gc.ca. (4) This and other reviews, including previous editions, are available on the Internet at www.nrcan.gc.ca/mms/cmty/com_e.html.

NOTE TO READERS

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TARIFFS

Item No.	Description	Canada			United States	EU	Japan
		MFN	GPT	USA	Canada	Conventional Rate (1)	WTO (2)
2611.00	Tungsten ores and concentrates	Free	Free	Free	Free	Free	Free
2841.80	Salt of oxometallic or peroxometallic acids: tungstates (wolframates)	5.5%	3%	Free	Free	5.5%	3.3%
2849.90.10	Carbides, whether or not chemically defined: other: tungsten carbide	Free	Free	Free	Free	4.1%-5.5%	2.5%
7202.80	Ferro-alloys: ferro-tungsten and ferro-silico-tungsten	Free	Free	Free	Free	Free	2%
81.01	Tungsten (wolfram) and articles thereof, including waste and scrap:						
8101.10	Powders	Free	Free	Free	Free	5%	Free
8101.94	Unwrought tungsten, including bars and rods obtained simply by sintering	Free	Free	Free	Free	5%	Free
8101.95	Bars and rods, other than those obtained simply by sintering, profiles, plates, sheets, strip and foil	Free	Free	Free	Free	6%	Free
8101.96	Wire	Free	Free	Free	Free	6%	Free
8101.97	Waste and scrap	Free	Free	Free	Free	Free	Free
8101.99	Other	Free-3%	Free	Free	Free	7%	Free

Sources: Canadian *Customs Tariff*, effective January 2006, Canada Border Services Agency; *Harmonized Tariff Schedule of the United States*, 2006; *Official Journal of the European Union* (October 27, 2005 Edition); *Customs Tariff Schedules of Japan*, 2006.

(1) The customs duties applicable to imported goods originating in countries that are Contracting Parties to the General Agreement on Tariffs and Trade or with which the European Community has concluded agreements containing the most-favoured-nation tariff clause shall be the conventional duties shown in column 3 of the Schedule of Duties. (2) WTO rate is shown; lower tariff rates may apply circumstantially.

TABLE 1. CANADA, TUNGSTEN TRADE, 2003-05

Item No.	2003		2004		2005 (p)		
	(kilograms)	(\$000)	(kilograms)	(\$000)	(kilograms)	(\$000)	
EXPORTS							
2611.00	Tungsten ores and concentrates	5 332 049	24 657	2 816 759	5 156	1 860 170	10 579
8101.10	Tungsten (wolfram) powders	344 777	3 171	341 803	6 362	199 527	7 395
8101.99	Tungsten (wolfram) and articles thereof, n.e.s.	77	17	481	35	482	84
	Total exports	5 676 903	27 845	3 159 043	11 553	2 060 179	18 058
IMPORTS							
2611.00	Tungsten ores and concentrates	1 272	20	3 809	40	16	...
2841.80	Tungstates (wolframates)	36 399	118	98 597	308	537 529	1 909
2849.90.00.10	Tungsten carbide	155 004	5 440	190 311	6 431	176 017	6 956
7202.80	Ferro-tungsten and ferro-silico-tungsten	3 134	26	9 590	105	20 133	334
8101.10.00.10	Tungsten powders, not alloyed	61 180	1 656	110 181	3 377	106 418	4 005
8101.10.00.20	Tungsten powders, alloyed	24 377	1 294	24 403	1 209	60 366	3 202
8101.94.00.10	Unwrought tungsten, sintered bars and rods, not alloyed	6 289	387	4 444	250	6 250	372
8101.94.00.91	Unwrought tungsten, not alloyed	3 541	73	1 419	33	5 406	99
8101.94.00.92	Unwrought tungsten, alloyed	3 360	135	2 747	112	5 569	239
8101.95.00.10	Tungsten not alloyed, other than that obtained simply by sintering	3 719	218	2 418	138	1 242	87
8101.95.00.21	Tungsten bars and rods, not alloyed; profiles, plates, sheets, strip and foil	4 643	248	5 915	270	8 267	415
8101.95.00.22	Tungsten bars and rods, alloyed, other than that obtained simply by sintering; profiles, plates, sheets, strip and foil	15 903	1 080	14 226	952	14 852	1 139
8101.96.00.10	Tungsten wire, not alloyed	5 656	296	4 756	284	3 691	243
8101.96.00.21	Tungsten wire, alloyed, not coated or covered	170	11	5 749	333	8 160	413
8101.96.00.22	Tungsten wire, alloyed, coated and covered	40 584	1 865	7 630	351	4 416	239
8101.97	Unwrought tungsten, waste and scrap	2 554	115	5 588	274	13 198	588
8101.99.10	Tungsten (wolfram) and articles, thereof, n.e.s.	11 181	604	18 113	1 169	9 594	687
8101.99.90	Tungsten, other	16 315	858	24 869	1 564	27 392	1 737
	Total imports	395 281	14 444	534 765	17 200	1 008 516	22 664

Sources: Natural Resources Canada; Statistics Canada.

– Nil; ... Amount too small to be expressed; n.e.s. Not elsewhere specified; (p) Preliminary.

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