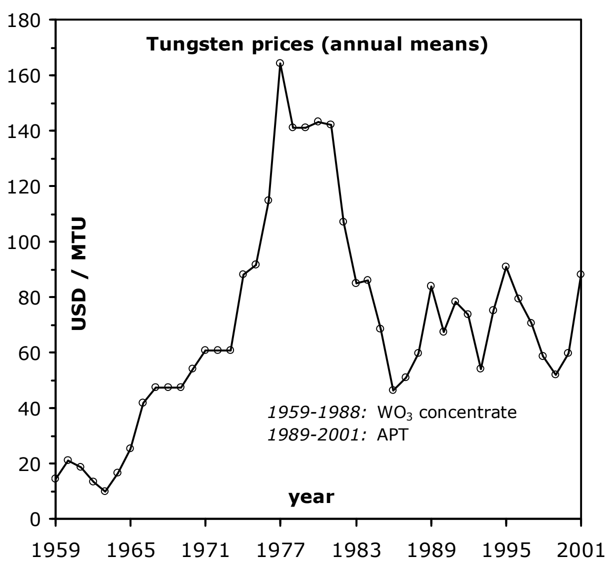
Exploring for tungsten in Quebec

1. ECONOMICS

The global tungsten market has greatly improved during the last few years, due mainly to the tighter control that China (the world's leading producer) has placed on its exports, and the desire by western processors to diversify the sources of their tungsten raw materials. Economic conditions are now optimal for tungsten exploration and production in Quebec.

Global tungsten production was estimated at 44,600 tonnes in 2001 (compare with 13.2 Mt for copper). China, with 83.0% of production, dominates the market, followed by the former USSR with 8.4%. Canada did not produce tungsten for many years, although Canada hosts significant tungsten reserves (16% of the world total, whereas China has 16% and Russia 14%).



Massive exports by China in the 1980s and 1990s caused the price of a metric ton unit (MTU=10 kg WO_3) to plummet from $164 US in 1977 to $46 US in 1986. Finally, in 1999, the Chinese government implemented export-controlling measures that resulted in a substantial rise in tungsten prices (average of $88 US in 2001).

Last year, BC-based North American Tungsten Corp. re-opened the CanTung mine in the Northwest Territories. This ore deposit was the largest tungsten producer in the western world before it shut down in 1986. The re-opening was made possible by a partnership agreement between Osram Sylvania and Sandvik AB to buy 100% of the Cantung concentrate. North American Tungsten recently delivered its first shipment to its partners (The Northern Miner, Feb. 19, 2002), and the company also plans to mine the nearby MacTung deposit in the near future.

2. ECONOMIC GEOLOGY

Three types of tungsten deposits are significant in terms of economically exploitable reserves: vein-type, including stockworks (44%), scheelite skarns (48%), and "stratabound" ores (5%).

Economic and geologic characteristics of the two first types of tungsten deposits are summarized in the table below. Orebodies in skarn-type deposits have two contrasting shapes: a narrow mineralized zone along an intrusive contact, like at Salau, France, or a stratabound morphology located further away from the intrusion, like at CanTung and MacTung (NWT).

Vein-type tungsten deposits often bear tin (e.g. Cornwall, UK), and some veins may be gold-rich. Tungsten is either dominant (with minor tin or gold) or low-grade (with dominant tin or gold).

The only example of a "stratabound" tungsten deposit is Mittersill, Austria, where scheelite is hosted by quartz veins that follow the schistosity in amphibolites (metaboninites) and quartz-rich gneisses (quartzites, felsic metavolcanic rocks?).

Economic and geologic characteristics of the two main types of tungsten (W) deposits

	Vein-type	Scheelite skarns
ECONOMICS		
Typical sizes	Veins: 10s to 100s of Kt.; groups of veins, stockworks: Mt to 10s of Mt	Most exploitable deposits contain >10,000 tons of W
Typical grades	0.3 to 1.5% WO_3 for veins, lower for stockworks	Underground mines generally grade >0.4% WO_3, and >1% in remote areas
Canadian examples	*Appalachians*: Burnthill (NB), 4 Mt @ 0.12% WO_3; Grey River (NF), 0.52 Mt @ 1.09% WO_3; *Cordillera*: Kalzas (Yukon), Red Rose and Regal Silver (BC)	MacMillan Pass (Mactung, Yukon-NWT), 60-63 Mt @ 0.95% WO_3; Canada Tungsten (Cantung, TWT), 9 Mt @ 1.42% WO_3
Foreign examples	Panasqueira (Portugal), 31 Mt @ 0.3% WO_3; Chicote Grande (Bolivia), 21.2 Mt @ 0.43% WO_3; Mount Carabine (Australia), 35 Mt @ 0.1% WO_3; Henerdon (Cornwall, UK), 42 Mt @ 0.43% WO_3	Shyzhuyuan (China), 170 Mt @ 0.33% WO_3 (including a stockwork); Tymyauz (Russia), 50.8 Mt @ 0.6% WO_3; Sangdong (South Korea), ~20 Mt @ 1.0% WO_3; King Island (Tasmania), 14 Mt @ 0.8% WO_3
GEOLOGY		
Tectonic context	Collision zones, continental arcs, continental rifts	Continental margins; continent-continent collision zones / subduction zones?

.... ***Characteristics of related intrusions*** • • .... Age • Late-orogenic to anorogenic, mostly Late Paleozoic, Mesozoic and Cenozoic • Syn-orogenic (++) to late-orogenic (-), mainly middle Paleozoic to Late Cretaceous • • • • • • Geochemistry • Granites, ilmenite series if related to Sn mineralization ("specialized granites"); strong fractionation; type A or S, enriched in lithophile and volatile elements • Quartz diorite, quartz monzonite or granodiorite, calc-alkaline trend; type I or type S • • • • • • Texture • Presence of aplites, porphyry., granophyric or micrograph. text., comb-layered quartz • Coarse- to medium-gr. intrusions, porphyr. text., K feldspar megacrysts, aplites and pegmatites • • • • • • Emplacement depth; size • 1-4 km; batholith cupolas, small isolated cupolas, small subvolcanic intrusions • 5-15 km; ranging in size from stocks to large batholitic plutons • • • • • • Alteration • Greisen in upper parts: Li-, F-, and B-bearing minerals (topaz, tourmal., fluorite, micas), (albite, microcl., chlor., qtz, dissem. sulfides • Generally unaltered but intrusive borders can show argillic or greisen alteration • • • • • • Host rock characteristics • • • • • • Lithology • No typical host rock, but often in thick, non-carbonate sedimentary piles (10 km-thick in SE China). • Platform carbonates and pelites, recrystallized during contact metamorphism • • • • • • Alteration • Greisen selvages around veins; greisenization may be pervasive throughout host rock in stockworks • Metasomatism of marbles and calc-silicate hornfels = skarns; prograde phase: pyrox., garnet, calcite, dolom., qtz, vesuv., wollast.; retrograde phase (highest W grades): hornbl., biot., plag., epid., sphene, chlor., actin., apatite • • • • • • Ore Characteristics • • • • • • Location and shape • Location: contained within parent magmatic rock or surrounding host rocks; shape: veins <1 cm to several m-thick veins, typically 10-20 cm thick, distributed in single veins, narrow vein networks, sheeted vein zones, stockworks, or breccias • Mainly stratabound exoskarns (in recrystallized limestone), with orebodies reaching 100s of m in length (but < 15 m in thickness); located 10s of m away from intrusion, along a lithological contact (e.g. limestone/pelite) • • • • • • Mineralogy • W in wolframite [(Fe,Mn)WO4], but sometimes in scheelite; accomp. by cassit., stannite, molybd., bismuthinite, chalcopyrite, sphalerite, pyrite, pyrrhotite, hematite, arsenopyrite • W in scheelite (CaWO4); accompanied by chalcopyrite, sphalerite, molybdenite, pyrrhotite, late pyrite, magnetite, native bismuth, bismuthinite • • • • • •

Climax-type porphyry molybdenum (Mo) deposits may also contain low-grade tungsten. These deposits could become a major source of tungsten in the future, together with porphyry W-Mo deposits such as Logtung, Yukon and Mount Pleasant, New Brunswick.

3. Exploration

The main exploration methods for tungsten include geological prospection (with a ultraviolet (UV) lamp), alluvial prospection, soil geochemistry, and some geophysical techniques.

Selection of an exploration target should be based on geological criteria, with favorable granitoids being the primary consideration.

◘ It appears that the most efficient method for defining tungsten targets is alluvial prospection combined with soil geochemistry. Fine scheelite particles are resistant enough to make alluvial prospection a very effective technique (the Mittersill deposit was discovered in this way). In soils, tungsten dispersion is limited due to the low solubility of scheelite and wolframite. Consequently, higher-dispersion elements such as As, Bi, Cu, F, Mo, P, Pb, Sb and Sn should be used.

Geophysical methods cannot resolve tungsten-bearing minerals from gangue, but may still be applicable during several exploration stages. In the early stage, magnetic and gravity surveys can be used to delineate plutons. Later, electrical and magnetic ground-based methods are suitable due to the electrical conductivity of pyrrhotite and the strong magnetic susceptibility of some iron-bearing minerals that commonly accompany skarns. Induced polarization can work well for ore deposits containing disseminated sulfides (the discovery of Mont Pleasant is one such example).

Optimal use of the UV lamp is in the dark or in very low light conditions (at night or underground). During the daytime, one can place a tent on the outcrop or examine the sample in a bag. UV lamp dealers are listed on the accompanying web site: www.sidex.ca.

Main tungsten exploration methods

	Vein-type	**Scheelite skarns**
Geology	1. Post-orogenic to anorogenic granites, enriched in lithophile and volatile elements 2. Geisen-type alteration 3. Mineralogical zoning	Look for a favorable context (syn-orogenic, calc-alkaline intrus. in sedim. rocks deposited along a contin. margin), and 1) import. hornfels zone, 2) thick limestone seq., 3) irreg. intrus. contacts, and 4) struct. and stratig. traps
Geochemistry: primary dispersion	Aureoles of Sn, W, Cu, Zn, Pb, Rb, Li, F, B	Low dispersion?
Geochemistry: secondary dispersion	Cover material: Sn, W, Cu, Zn, Pb, Rb, Li, F, B; streams: cassiterite, wolframite, scheelite, topaz, tourmaline	Scheelite in heavy-mineral concentrates from streams; soils and glacial sediments are less efficient
Geophysics	– Radiometric data can help locate U-, Th- and K-bearing granites – Magn. data can locate intrusions: "specialized granites" have a low suscept. – Gravity: can locate hidden intrusions	Aeromagnetic data can help locate shallow intrusions (magnetic-high ring with a central magnetic-low)
Short wave UV lamp	Less scheelite than in skarns	Scheelite normally becomes bluish white, but becomes yellow if it contains Mo

4. QuEbec’S POTENTIAL

Tungsten exploration in Quebec has been highly neglected in the past: great discoveries may be awaiting you in the Grenville Province or the Appalachian Mountains!

Most auriferous quartz veins in the Abitibi Subprovince contain minor amounts of scheelite, and Quebec produced some tungsten from these deposits during World War II.

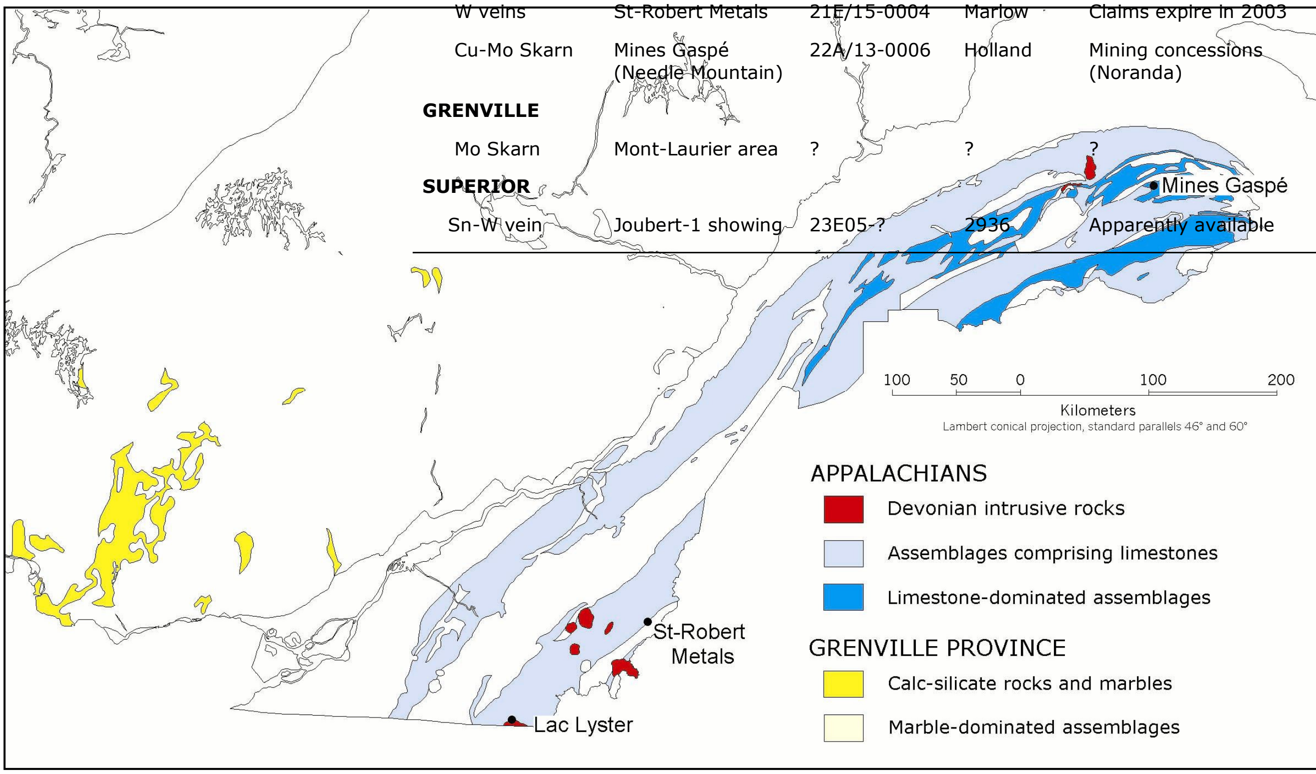
In the Appalachians, tungs-ten has been found within polymetallic vein-type deposits of the Gaspé-Connecticut Valley Synclinorium. An example from the Beauce region is the abandoned St-Robert Metals mine. Scheelite skarns could also be discovered where felsic plutons intrude carbonates, like at the Lyster Lake deposit in the Eastern Townships.

Near Murdochville (Gaspésie), scheelite locally crosscuts the copper skarns of Mines Gaspé deposit. Theoretically, all limestone-bearing assemblages in the Appalachians (see map below) have the potential to host tungsten skarns. In the Grenville province, favorable tar-gets include the Mont-Laurier terrain with its platform carbonates (marbles) intruded by several types of granitoid rocks. In this region, molybdenum skarns are found proximal to lime-stone-granitoid contacts.

In Precambrian rocks, the potential for scheelite skarns appears greater than that for vein-type deposits since the latter are thought to be emplaced at shallower depths (1-4 km compared to 5-15 km).

List of selected tungsten deposits in Quebec, with available claims as of February 27 (2002), according to the GESTIM database

Deposit type	Name	COGITE #	County	Claim availability
APPALACHIANS				
W skarn	Lyster Lake	21E/04-0006	Barnston	No active claims
W veins	St-Robert Metals	21E/15-0004	Marlow	Claims expire in 2003
Cu-Mo Skarn	Mines Gaspé (Needle Mountain)	22A/13-0006	Holland	Mining concessions (Noranda)
GRENVILLE				
Mo Skarn	Mont-Laurier area	?	?	?
SUPERIOR				
Sn-W vein	Joubert-1 showing	23E05-?	2936	Apparently available



Geologic map of southern Quebec (modified from DV 2001-07) showing rock assemblages of the Appalachian and Grenville provinces that include limestone, marble or calc-silicate units. Also shown are the approximate locations of some tungsten showings.

To learn more, check the complete web site on www.sidex.ca.