This booklet has been revised from the original template by Danièle Héon (2004) with contributions by: Jeff Bond, George Gilbert, Dave Tenney, Forest Pearson, Robert Stroshein, Amy Stuart, Charlie Roots and Karen Pelletier.

For further information:

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(2) DOBROWOLSKY, H. and INGRAM, R., 1993. *A History of the Whitehorse Copper Belt.* Open File 1993-1 (I), Exploration and Geological Services Division, Yukon Region, Indian and Northern Affairs Canada.
(popular historical account of mine development, working conditions, infrastructure development, disasters and individual personalities associated with the mine)

(3) HART, C.J.R. and RADLOFF, J.K., 1990. *Geology of Whitehorse, Alligator Lake, Fenwick Creek, Carcross and part of Robinson Map areas 105D/11, 6, 3, 2 &7.* Open File 1990-4, Exploration and Geological Services Division, Yukon Region, Indian and Northern Affairs Canada.
(regional mapping report of rock types and distribution - for geologists)

(4) MACKAY, G., DIMENT, R. And FALKINER, J., Mackay, Falkiner and Associates 1993. *Whitehorse Copper Belt: A Simplified Technical History.* EGSD Open File 1993-2 (I), Exploration and Geological Services Division, Yukon Region, Indian and Northern Affairs Canada.
(non-technical summary of the geological setting for the mineral deposits and engineering details of the mining history of the copper belt)

(5) TENNEY, D., 1981. *The Whitehorse Copper Belt: Mining, Exploration and Geology (1967-1980).* Bulletin 1, Exploration and Geological Services Division, Yukon Region, Indian and Northern Affairs Canada.
(technical geological report with detailed information on the main deposits)

(6) TURNER, R.J.W., MOUGEOT, C.M., ROOTS, C.F., CLAGUE, J.J. and FRANKLIN, R., 2003. *Geoscape Whitehorse- geoscience for a Yukon community.* Geological Survey of Canada, Miscellaneous Report 82.
(educational poster on topics of community interest)

(7) WATSON, P.H., 1984. *The Whitehorse Copper Belt- A Compilation.* Open File 1984-1, 1:25 000 map, Exploration and Geological Services, Yukon Region, Indian and Northern Affairs Canada.
(large uncoloured map with marginal notes)

(8) YUKON GEOLOGICAL SURVEY, 2003, Geoscape Whitehorse- geoscience for a Yukon community, Whitehorse Copper Belt, 4-page pamphlet.
(for general reading)

(9) Yukon MINFILE, 2000. Exploration and Geological Services Division, Yukon Region, Indian and Northern Affairs Canada
(summary of technical information)

All publications available from the Yukon Geological Survey, Geoscience Information Sales and c/o Whitehorse Mining Recorder, Box 2703 (K102), Whitehorse, YT, Y1A 2C6. Phone (867) 667-5200; Fax (867) 667-5150; Email: geosales@gov.yk.ca. Visit our website at www.geology.gov.yk.ca.

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THE WHITEHORSE COPPER BELT, YUKON

A booklet to accompany
the annotated geology map
by Danièle Héon (2004)

YUKON GEOLOGICAL SURVEY

Yukon
Energy, Mines and Resources

HISTORY

The Whitehorse Copper Belt consists of more than 30 copper occurrences roughly distributed parallel to the Alaska Highway along a 30- kilometre long trend. The mining belt is located along the west side of the broad Yukon River valley near where Whitehorse is situated. After the discovery of copper near Whitehorse in 1897 by prospectors on their way to the Klondike, the first claims were staked in 1898 and by 1899 most of the presently known deposits had been found. During this early period, most ore was hand mined near the surface or from shallow adits (short tunnels) or shafts (steep vertical tunnels). Despite the gruelling physical labor involved in early mining techniques, by 1900 the first shipment of 8 tonnes of hand sorted high grade ore (45% copper) was sent to a smelter in Washington.

Since the early part of the century, mining has continued in several episodes of boom and bust that were directly related to the world price of copper. High-grade ore was extracted from nine underground mines between 1909 and1920, and transported by train and ship (from Skagway) to southern smelters mainly in southern British Columbia. Mining ceased after the First World War and resumed in the early sixties. By then, modern exploration and mining methods, grouping of individual claims into large properties by major mining companies, rising copper prices and successful financing led to the discovery of new copper resources and establishment of the infrastructure needed to mine them.

Six mineral deposits were mined between 1960 and 1982. Most were open pit excavations, but the Little Chief mine was also mined by underground methods. Mining ceased when the remaining ore at the Little Chief deposit was too deep to be economical and the world price of copper dropped. Today, undeveloped reserves of almost 3 million tonnes are distributed between five deposits.

The economic influence of the copper mines had a significant impact on transforming Whitehorse from a transportation hub on the way to the Klondike Gold Fields to a stable community. Although the town's location below the rapids initially attracted the development of the railway to the area at the turn of the century, its growth and importance as a rail hub came from investment in the Copper Belt mines.

The proximity of the town made this mining camp a very attractive one to work in. The Little Chief operation alone hired approximately 200 people for over 10 years. More than 10 million tonnes containing an average of 1.5% copper and significant values in gold and silver were mined between 1898 and 1982.

Today, the mines of the Whitehorse copper are fully decommissioned. Most of the mine structures have been removed or buried but some underground tunnels remain. Visitors should exercise caution when exploring the area.

Yukon Archives, Hamacher Fonds, Hougen Collection

A team of 12 horses hauls a 20-ton boiler to the Pueblo mine (ca. 1910).

Yukon Archives, R. Harrington Collection

30- Black cub south

502920 E, 6714905 N

This iron-skarn deposit was discovered by modern geophysical techniques as the bedrock in the area is covered by thick glacial sediments. The magnetic and electrical properties of the ore body were in sharp contrast with those of the surrounding rocks; the deposit was therefore found using magnetic and electrical "anomalies". It was excavated in 1971 while the Little Chief deposit was being readied for underground mining. The open pit produced 170,000 tonnes of copper ore consisting of bornite and chalcopyrite, but also of chalcocite, native copper and cuprite. In the waste rock piles you can find diopside, actinolite, talc, chlorite and garnet.

The linear shape of the mined-out pit shows that the deposit was a steep and narrow lens, roughly parallel to bedding (layering of sedimentary rocks). On hot summer days it is a popular swimming hole.

Black Cub south open pit looking to northwest.

Waste rock dump at Black Cub South.

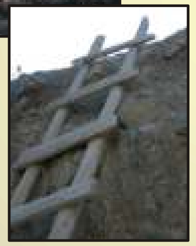
Limestone outcrop at the northern end of the waste dump.

31- Cowley Park

505918 E, 6715477 N

This calc-silicate skarn deposit is unusual in that it contains significant amounts of molybdenite (like at the War Eagle), in addition to silver, gold and copper. An excavation (left) marks where a 5000 tonne bulk sample was taken in order to test the recovery of metals at the mill. Reserves of 884,000 tonnes have been calculated but have not yet been mined.

The steep tabular ore lens is 300 m long and is enclosed in calc-silicate skarn at the contact between limestone and granodiorite. In addition to molybdenite, minerals include garnet, diopside, actinolite, tremolite, wollastonite, with disseminated chalcopyrite and bornite, and minor magnetite and serpentine.



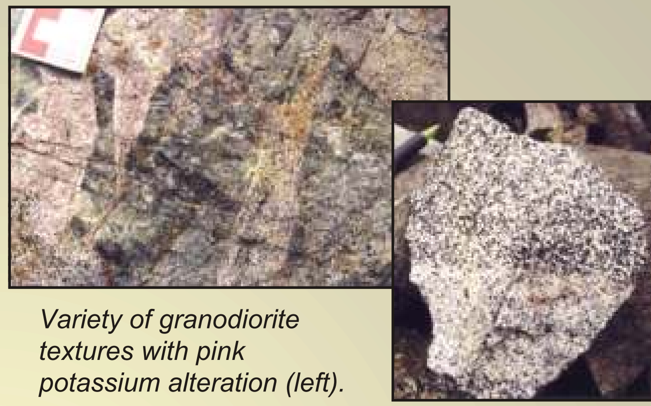
Walk around the cleared area, you'll discover many signs of past exploration.

Malachite on pit wall (left) and on closely-spaced fractures (above).

Access via Fireweed Drive/ Mary Lake Subdivision (#28-31)

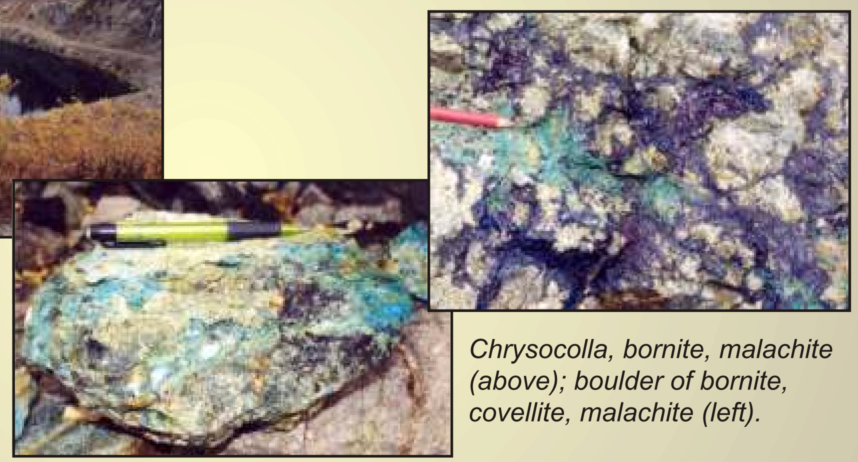
28- Keewenaw *502145 E, 6715811 N*

This is the only mine in the Copper Belt where the copper minerals are hosted in the granodiorite, rather than in the sedimentary rocks. This type of rock is called an endoskarn, as the skarn formed within the intrusive rock. Boulders at the base of the waste dump display complex alteration and intrusive textures.



Variety of granodiorite textures with pink potassium alteration (left).

Keewenaw pit looking north



Chrysocolla, bornite, malachite (above); boulder of bornite, covellite, malachite (left).

Highly oxidized rocks near the surface contain green copper-oxide, silicate and carbonate minerals. These minerals were not mined because the milling circuit was not set up for oxide minerals and so they remain in the waste piles. Deeper, where surface waters have not oxidized the rocks, the copper is in sulphide minerals such as in bornite, chalcopyrite, chalcocite and covellite (see the spectacular boulder beside trail to Wolf Creek, photo above center); there is no magnetite. Other skarn minerals include epidote, thulite and potassium feldspar. Native gold was reported. In the far wall of the open pit are black bands - narrow intrusions called dykes of magma that are similar to the volcanic rock called basalt that can be seen across Wolf Creek at the entrance of the workings (stop #27) and at Miles Canyon.

This was the last open pit mined by Whitehorse Copper Mines. It shut down in June of 1971 due to falling copper prices. In the lower part of the pit, 202,000 tonnes of copper-rich ore remains unmined.

29- Gem *502454 E, 6716089 N*

This large but low-grade magnetite skarn was discovered in 1967 using a geophysical method that measures magnetic values of rocks beneath the surface. Following diamond drilling based on these results, preparations were made for mining . The cover of overlying glacial sediments was stripped in 1970.

Further interpretation determined that the geometry of the deposit was more complicated than first thought and that it would be uneconomic to mine, so development work on this zone was halted. Approximately 600,000 tonnes of copper-rich ore remains unmined.

Rubble in the cleared area represents bedrock directly below, showing the distribution of white limestone and dark grey and green magnetite skarn.

General Geology

The copper minerals of the Whitehorse Copper Belt occur in a very specific geological setting called a copper skarn deposit. Skarn deposits form deep in the earth's crust, where hot, fluid-rich molten rock material (magma) intrudes through sedimentary rocks rich in lime, such as limestone. The interaction between the hot fluids in the magma and the limestone actually creates a new rock type called skarn. Two types of skarns occur in the Copper Belt, each defined by its own set of characteristic minerals.

Iron skarn (magnetite-serpentine skarn) is dark grey to black and green, and contains mainly magnetite (a magnetic mineral) and serpentine. The other type is called calc-silicate skarn because the minerals are rich in calcium and silica, and it contains mainly brownish-red garnet and light to dark green diopside, along with other minerals.

Copper minerals, like bornite, chalcopyrite and malachite, occur in both types of skarns but the magnetite skarns are mostly richer in copper than the calc-silicate skarns. Gold, silver and other metals were recovered as a by product in the milling process.

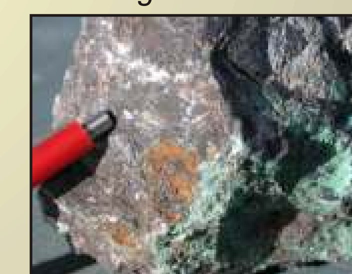
limestone (precipitated from seawater and reef organisms)

+

granodiorite (cooled from magma)

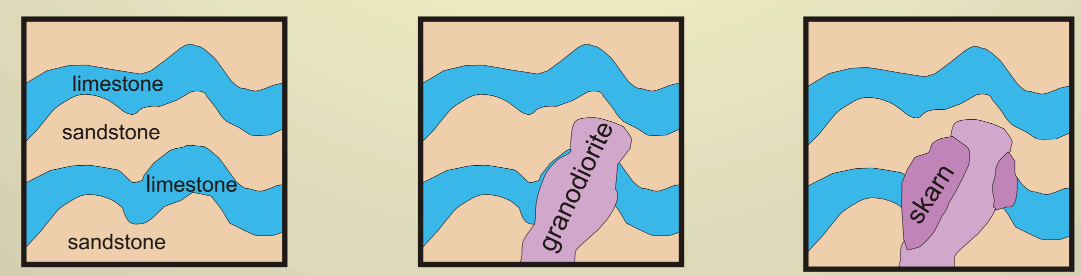
=

calc-silicate skarn or magnetite skarn



The magmatic rock hosting the Whitehorse Copper deposits is called granodiorite. Once cooled, the rock shows a mixture of light and dark minerals. The limestone can vary in colour from white to grey to almost black, and it can be massive or banded. In the Copper Belt, the copper deposits are commonly located where specific lime-rich sedimentary layers occur near the granodiorite, and where the contact between the two rock types is wavy or irregular.

Formation of skarn



Time 1: (150-170 million years ago) tilting and folding of sedimentary rocks

Time 2: (112 million years ago) intrusion of hot granodiorite magma into sedimentary rocks

Time 3: (a few million years as the magma cools) interaction between hot magma and limestone produces skarn deposits

Skarn Minerals

Main Copper Minerals

Courtesy MacBride Museum

Bornite and **chalcopyrite** (left), both copper sulphide minerals, are the main ore minerals. They can be found in both calc-silicate skarn and magnetite-serpentine skarn. **Bornite** (Cu_5FeS_4) Is brownish-bronze but usually tarnished to purple and blue, and is sometimes called peacock ore.

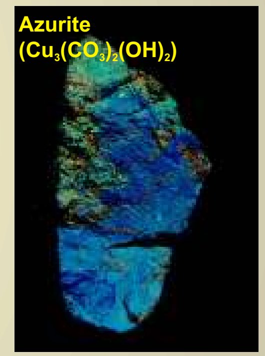
Chalcopyrite ($CuFeS_2$) is brass yellow, and is sometimes called fools' gold.

Other less common copper minerals found associated with the skarns include tetrahedrite, chalcocite, cuprite, melanconite, covellite, native copper and valeriite. Gold and silver have been extracted during the milling process; they occur within the crystal structures of some copper sulphide minerals. Reports of visible gold are rare.
Popular rocks and minerals guidebooks show pictures of the other skarn minerals found in the copper belt that are not shown here.

Courtesy MacBride Museum

Valleriite ($4(Fe,Cu)S$-$3(Mg,Al)(OH)_2$), a brassy copper ore mineral, is a rare but important copper mineral in the belt.

Secondary copper minerals, which form when the sulphide minerals are weathered and oxidized at the surface, can be found on most of the old mine dumps including: **malachite** (dull to bright green finely granular and aggregate), **azurite** (bright blue powdery coating) and **chrysocolla** (bright blue and green porcelain-like crust, left). These minerals can be useful prospecting tools for locating copper-sulphide skarns beneath the surface.



Azurite ($Cu_3(CO_3)_2(OH)_2$)

Courtesy MacBride Museum

Malachite ($Cu_2CO_3(OH)_2$)

Other Common Minerals

Calc-silicate skarn

Garnet $(Ca,Fe,Mg,Mn)_3(Al,Cr,Fe,Mn)_2$ and Diopside $CaMgSi_2O_6$

Pink and white **calcite** ($CaCO_3$) and green diopside crystals in massive garnet.

Some nonmetallic minerals include: **epidote** (light yellow to yellowish green or pistachio-green, prismatic crystals and crystalline aggregates), **garnet** (yellowish to reddish brown, commonly massive but crystals can be found), **diopside** (light green, fine to medium-grained masses), **serpentine** (yellowish green to olive green, greasy wax-like appearance), and **calcite** (white and salmon-pink, fine grained masses and blocky crystals, scratches with a pen knife or nail).

Other less common calc-silicate skarn minerals include wollastonite, tremolite, actinolite, quartz and feldspar.

Magnetite-serpentine skarn

Epidote $Ca_2(Al,Fe)_3(SiO_4)_3(OH)$

Serpentine ($Mg_3Si_2O_5(OH)_4$) can be massive, platy or fibrous, as when it is in asbestos form. It is usually green (left), but collectors come here to sample its unusual yellow colour. It can be scratched with a knife, and alters to talc.

Magnetite (Fe_3O_4), an iron oxide, is dark black, dense and strongly magnetic. The red tool is a pencil magnet for scale.

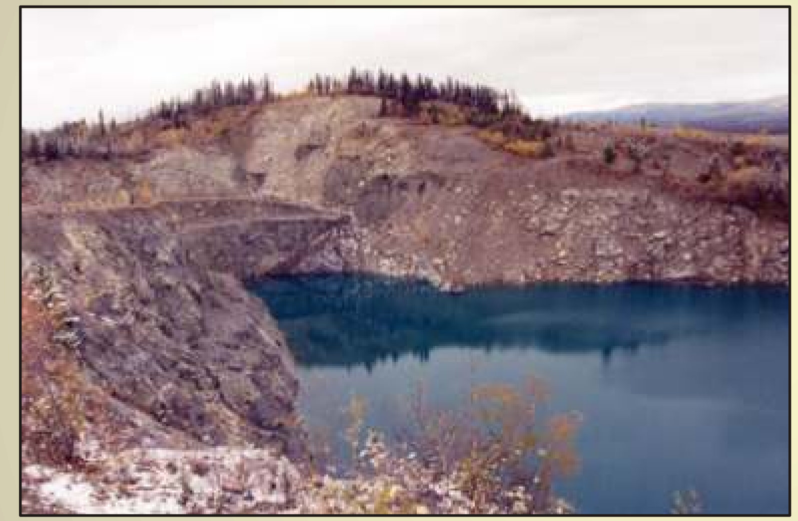
24- Little Chief pit

496741 E, 6722062 N

The Little Chief mine, which included the Middle Chief deposit, was the largest of the Copper Belt mines. It provided employment for approximately 200 people for more than 10 years.

Although the deposit was one of the first staked in the early 1900s, it was not worked in the early days because of its relative low grade at a time when broken rock was moved by human and horsepower.

Later, modern exploration methods(geophysics and deep drilling) outlined a deposit that was mined by open pit from 1967 to 1969. Drilling from the bottom of the pit outlined an even bigger deposit than what had been mined from the surface: 7.4 million tonnes were mined underground between 1972 to 1982.



The deposit was a classic magnetite (iron) skarn, with bornite, chalcopyrite and valleriite as the main ore minerals. A small amount of gold and silver were also recovered during the milling process. Garnet and diopside from some calc-silicate skarn west of the ore lense can be found on the remaining bench, on the west side of the pit. This is a good place to find thulite, a pretty pink skarn mineral.

Top: Little Chief pit, looking northeast
Right: slumping ground on east side of pit; dotted lines mark scarps.

Gradual collapse and subsidence on the east side of the pit resulted from the failure of a crown pillar in the underground mine. The waste dump on the flat area further to the east yields better mineral samples and provides a safer collecting site than the edge of the mined-out pit.

25 Valerie mineral showing (*496654 E, 6721713 N*)
26 Stockpile of coal from the Coal Lake deposit (*498007 E, 6718950 N*)
27 Outcrop of Miles Canyon Basalt (*502242 E, 6716367 N*)

22- Big Chief

496485 E, 6722482 N

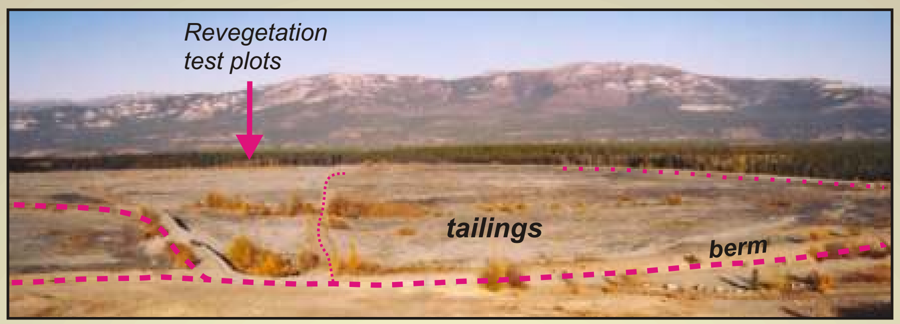
This impressive showing received the biggest name of the Chief deposits, but it did not extend at depth and therefore was never mined. Trenches and pits found here were dug about 1903.

Banded magnetite and yellow serpentine skarn

Malachite from the Big Chief showing is visible from the haul road (top photo, looking east). The bottom photo reveals the contact between grey limestone (right) and dark green magnetite-serpentine- malachite skarn (left).

23- Tailings and Revegetation

496929 E, 6722798 N

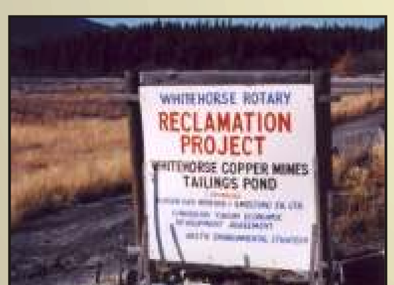


View of the tailings pond looking east.

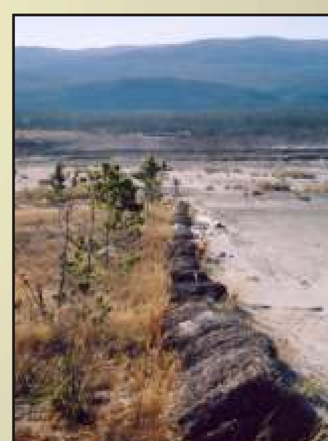
The tailings pond contains the pulverized rock from which copper minerals have been removed by the milling process (10 million tonnes from 15 years of milling occupy 55 hectares in the main pond area). The slurry was impounded behind berms (or levees) made of crushed rock. The water drained out, leaving tailings that are 0-4 metres deep in the main pond. Because they are dry and chemically neutralized by the abundant limestone, they pose no risk to the local groundwater. The main impact is dust created when strong winds blow across the fine-grained tailings.

23A Re-vegetation test plots

497258 E, 6723360 N



Little vegetation has naturally taken root on the tailings, due to poor soil conditions. A 2-year study was undertaken by Craig and Craig* (1) which utilized readily available compost from various sources and volunteer labor from various community groups. The study showed that composting and irrigation sufficiently improved soil conditions so that planted native grasses thrived and germinated, trees survived, wind erosion was reduced, and birds and animals returned. Modern mining reclamation practices, put in place after the 1982 mine closure, now require that disturbed areas be revegetated after completion of mining.



Planted grasses and pine seedlings grow where compost was added to mine tailings.

** Doug and Joan Craig of Whitehorse have been long time advocates of advancing community environmental conciousness. They pioneered the composting program at the Whitehorse landfill site, spearheaded the wind turbines project on Haeckel Hill and initiated the re-vegetation project at Whitehorse Copper with support from the Rotary Club and countless volunteers. Doug Craig passed away in November, 2005 leaving a significant legacy in community and science advancements.*

MAP OF WHITEHORSE COPPER BELT

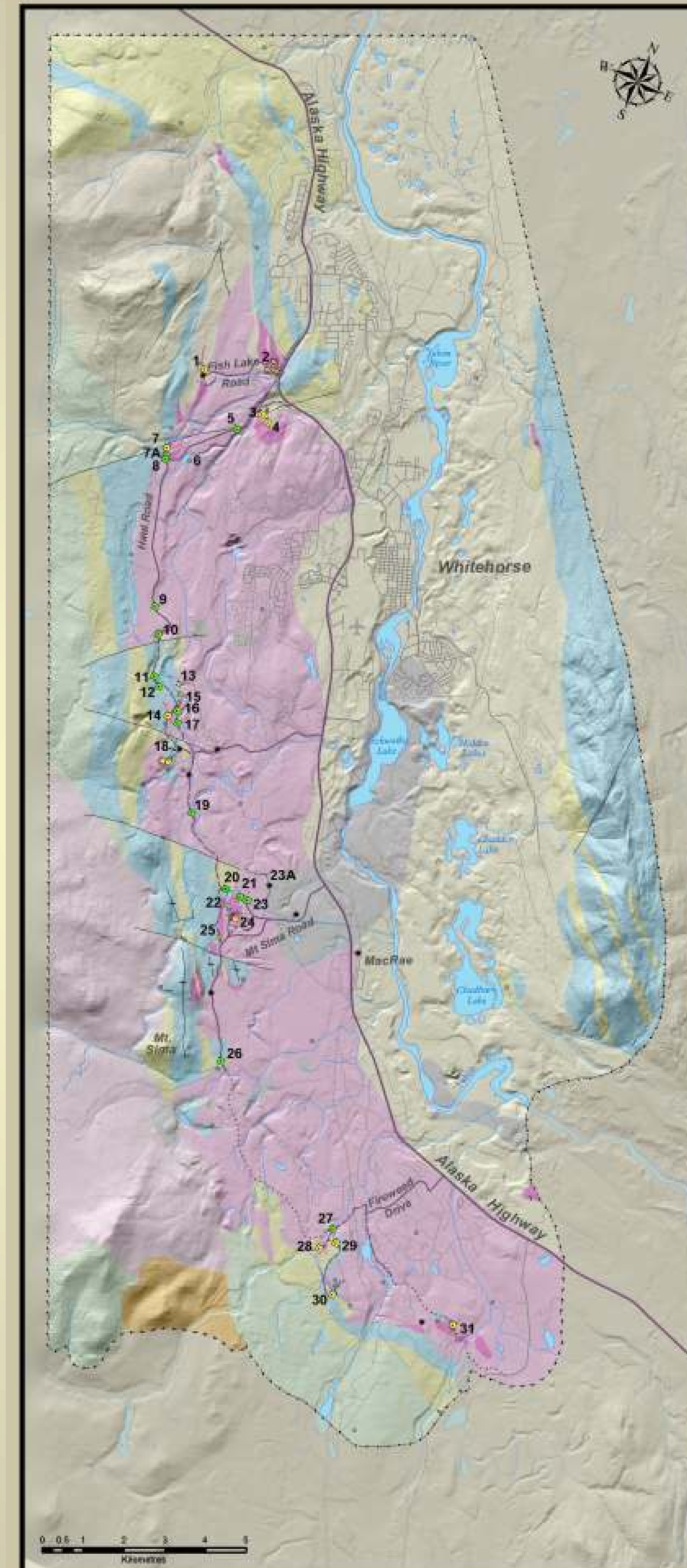
The map shown here is a small scale reproduction of the geological map which accompanies this booklet. It is included here to summarize the locations of each of the stations described in this booklet.
For a legend of the geological units and to see more detail on the topography and access roads and trails, please refer to the full size geological map. In general, the two main rock types of interest are granodiorite (pink) and limestone (blue).

WHITEHORSE COPPER BELT HAUL ROAD

The Haul Road was built in 1970 to link the largest skarn deposits so that large trucks could carry mined rock to the concentrating plant (called the "mill) west of MacRae (near the Mt. Sima access road today). Some parts of this gravel road are suitable for passenger vehicles (see large version of map).

KEY TO DEPOSITS

1. War Eagle
2. Anaconda/ Copper Queen/ Rabbits Foot
3. Copper King
4. Carlisle
5. Fish Lake Road Lookout
7. Pueblo
7A. Pueblo Commemorative Plaque
8. McIntyre Marsh Viewing Platform
9. McIntyre Creek Meltwater Channel
10. Haul Road: Till Exposure
11. Haul Road: Limestone Outcrop
12. Spring Creek
13. Empress of India
14. Grafter
15. Best Chance
16. Grafter Extension
17. Haul Road: Granodiorite Cliff
18. Arctic Chief
19. White Pass Spur Line
20. Lite Chief Portal
21. Mill Site
22. Big Chief
23. Tailing and Revegetation
23A. Revegetation Test Plots
24. Little Chief Pit
28. Keewenaw
29. Gem
30. Black Cub South
31. Cowley Park



Access through Municipal Landfill (#1 & 2)

1- War Eagle

490443 E, 6734179 N → These are UTM coordinates, a grid system found on topographic maps. If using a GPS, set it to UTM/Noid83.

This deposit was originally staked by Sam McGee, a successful engineer and teamster made famous by a Robert Service poem. Underground mining in the early 1900s was followed by open pit mining in the early 1970s.

War Eagle North open pit: sedimentary beds dip towards the south at left; red iron oxide alteration at right.

Malachite is visible on the west slope of Rabbitsfoot Canyon, just north of the junction of the landfill with the Alaska Highway. This limestone outcrop is near the contact with the granodiorite. Observe it while driving by; the high speed traffic makes it difficult to pull off the road in the narrow canyon.

At the War Eagle, the calc-silicate skarn occurs totally within sedimentary rocks. The contact with the igneous granodiorite is not exposed in the pit; it is assumed to be located about 300 m east of the pit. The ore minerals are chalcopyrite and bornite, with some molybdenite, a silvery mineral. Some large boulders in the bluish black rock waste dump, near the current tire dump, show nice examples of skarn.

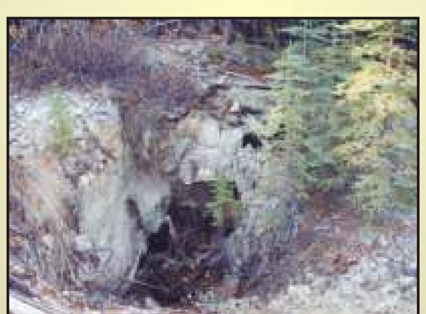
The War Eagle North still contains evidence of copper mineralization at the bottom of the pit but It could not be mined economically due to the pit design. Since used as a land-fill site, the pit is now filled in with about a 30 m thickness of garbage.

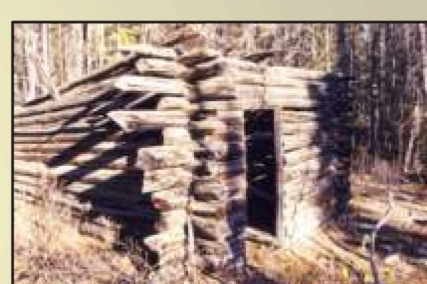
The southern extension of the deposit, which proved to be small and shallow, is outlined by the War Eagle South excavation. The one wall is now revegetated with trees and scrap metal outlines the eastern edge of the excavation.

2- Anaconda/ Copper Queen/ Rabbits Foot

492063 E, 6734906 N
491876 E, 6734845 N
491907 E, 6735086 N
491951 E, 6734915 N
491839 E, 6734851 N

Park near the landfill kiosk and turn left (south), following the outside of the electric fence until the end of the clearing. The first workings are located there. Other workings are distributed parallel to the dump road, between the electric fence and the "Don't trash the planet" sign.





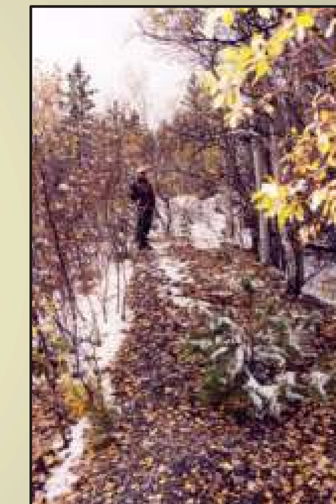
Old excavations and outbuildings dating from the early 1900s are distributed west and south of the landfill road. Many outcrops are well mineralized in malachite (green), bornite (bluish black) and garnet (reddish-brown). Some trenching was done in the 1990s.

19- White Pass spur line

494766 E, 6724182 N

In 1907, the White Pass and Yukon Railway began a spur line to connect the Pueblo mine to the main railway. It was halted for 16 months in 1908 due to falling copper prices, but was completed in 1910. At the peak of mining daily trains took the ore to Skagway, where it was shipped to Washington for smelting. The spur line remained in operation until mining ceased after World War I.

The Copper Haul Road, built by New Imperial Mines in 1969, followed the same course as the railway. Where the valley bottom is flat, the rail bed can still be seen just east of the Haul Road. After almost 100 years, the berm and break-in-slope are still visible.

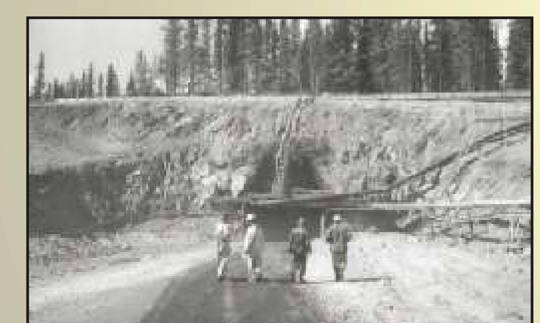


Little Chief Mine and Mill Site Operations(#20- 24)

20- Little Chief Portal

496326 E, 6722824 N

The Little Chief was the largest deposit in the Copper Belt, providing 60% of all the copper produced. Its entrance (visible in left photo and marked with red arrow in right photo) has been filled in with crushed rocks. A sloping tunnel (called a decline) led to the Little and Middle Chief deposits located further south. A shaft also provided access and ventilation. The floor of a small building is all that remains of the old storage buildings; all of the equipment was removed.



Yukon Archives Whitehorse Star Collection

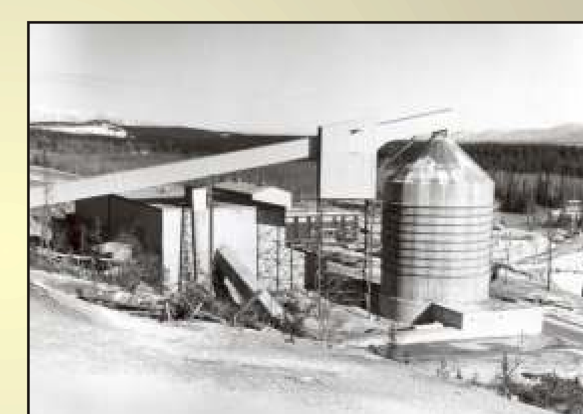
Miners at the portal, circa 1970.

Modern view looking west

21- Mill Site

496724 E, 6722803 N

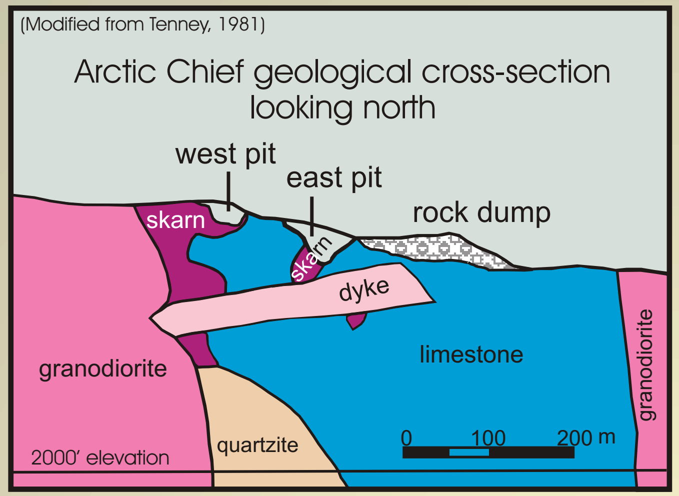
The mill site was located west of the tailings pond. The underground ore was transported to the surface using a series of inclined conveyor ramps. It was stored in the cylindrical ore bin, and was then crushed and ground into a slurry. The copper minerals were separated by chemical reactions causing the copper minerals to float to the top of the slurry. When dried, the copper-rich powder concentrate was trucked to Skagway, and carried by container-ship to Japanese smelters via Vancouver. The ground waste rock was stored in the tailings pond (see #23).



Yukon Archives, Richard Harrington Collection

New Imperial Mines Ltd.: Surface buildings, circa 1970. The cylindrical tank was a storage bin for finely crushed ore.

18- Arctic Chief

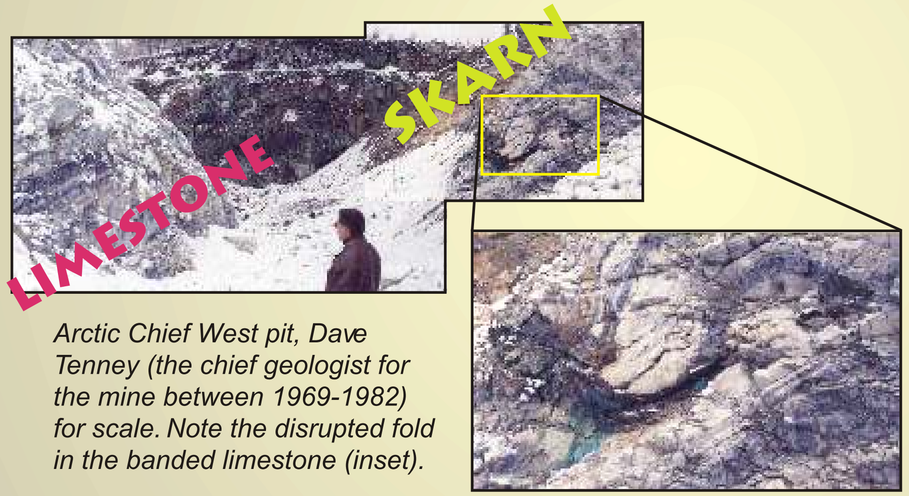


Two separate pods of dark magnetite-serpentine skarn with brown and green garnet-diopside skarn occur on the west flank of a pendant of sedimentary rock enclosed in granodiorite. The Arctic Chief West was mined underground in the early 1900's. Both deposits were later mined as two separate open pits in the late 1960's. These deposits were quite rich as they contained 1.5% copper with the highest silver and gold grades of the recent mines. A third zone, the Arctic Chief South, was not rich enough to be mined.

This is a popular area for mineral collecting; rock falls are common so use caution and stay away from the pit walls.

Arctic Chief west *493605 E, 6725078 N*

Private property, phone 633-3677 for permission to access

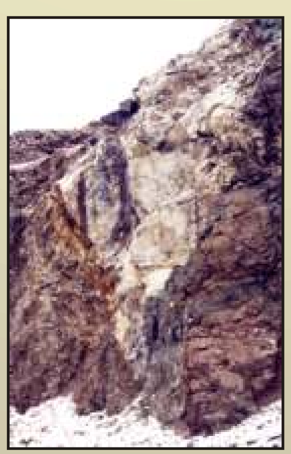


Arctic Chief West pit, Dave Tenney (the chief geologist for the mine between 1969-1982) for scale. Note the disrupted fold in the banded limestone (inset).

The west pit contains a lens of magnetite skarn at the contact between limestone and granodiorite. The dark and rusty skarn lens stands out in contrast with the light grey limestone. Folding of the limestone layers is evident in the pit wall. Timbers sticking out half-way up the north wall mark the location of an old mining tunnel.

Garnet and diopside samples are abundant on the pit floor, as well as attractive diopside and pink calcite crystals. Yellow serpentine is present.

Arctic Chief East *493706 E, 6725162 N*



Arctic Chief East pit (above) exposes a wedge of limestone totally surrounded by garnet-diopside skarn (right).

Patches of dark magnetite skarn occur on the pit walls (with spectacular azurite and malachite). A wide granitic dyke cuts off the ore lens. Vertical drill holes, used to load explosives for blasting, are still visible on the north wall.

Large boulders at the entrance to the pit display the copper minerals (chalcopyrite, bornite, malachite) and skarn minerals (garnet, serpentine, diopside), without needing to enter the mined area.

Access through Copper Belt Mining and Railway Theme Park (#3 & 4)

3- Copper King

492201 E, 6733801 N

Road access to the Copper King is through the Copper Belt Mining and Railway Theme Park. A rough road (take a right at the power line) leads to the adit area on the south bank of McIntyre Creek (top photo). A left fork leads to the workings on the south side of the bluff. A short dirt road branching off Fish Lake Road also leads to the adit area but the small bridge across McIntyre Creek has been washed out, blocking access.

Looking at the Copper King adit area from the Fish Lake Road.

The original adit has been covered over, but some old timbers can be seen through the waste material, near McIntyre Creek. Some machinery remains.

Malachite (green) and azurite (blue, left); garnet (unusual honey-coloured, above).

This calc-silicate skarn deposit is hosted in a pendant, or island, of sedimentary rocks totally surrounded by granodiorite. The main ore minerals are bornite and chalcopyrite, with minor molybdenite, and the skarn minerals are garnet, diopside and wollastonite.

Good mineral samples can be found in the waste dump just south of the creek and in the trenches and pits located on top of the rock bluff as well as south of it.

Jack McIntyre staked this first claim of the Copper Belt in 1898. The first ore shipped from the Copper Belt also came from here in 1900 when 8 tonnes of high-grade copper ore was shipped south. Episodic underground mining continued until the First World War.

The first mine disaster in the Copper Belt took place here in 1907 when one of the mine owners (William Grainger) and a mine employee (Gilbert Joyce) were preparing the workings to show a potential investor and asphyxiated themselves with carbon monoxide from an underground fire that was lit to melt ice covering the showings.

4- Carlisle *492415 E, 6733672 N*

This is all that remains of the Carlisle, a small underground mine from the turn of the last century. Signs of copper mineralization can be found in the calc-silicate waste material that now covers the old mine site. This deposit is located on the same limestone pendant as the Copper King and has similar minerals associated with it.

Located at the junction between the 10K and the Powerline ski trails (Whitehorse Cross Country Ski Club), this occurrence is accessible by 4WD vehicle following the same access road as to the Copper King and by taking a series of left forks. Park before the snowmobile club trail sign and walk to the ski trail.

Access via Fish Lake Road (#5,7)

5- Fish Lake Road Lookout

491792 E, 6733207 N

This roadside pullout is located on the Fish Lake Road, 1.5 km west of it's junction with the Alaska Highway, near the top of a steep section in the road.

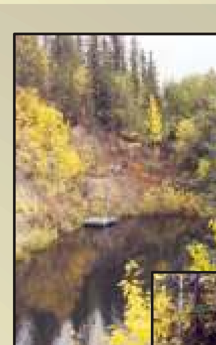
This lookout offers a good exposure of the granodiorite and a great view of the McIntyre meltwater channel (see stop 9). Notice the steep banks and flat, narrow creek bed, distinctive features of a long-lived glacial meltwater channel developed in bedrock. Upstream, the valley cross-sectional shape is wider and shallower because the stream eroded less resistant glacial sediments.

Hard as granite? Look again!
If you look at these cliffs you'll find some rock is solid and strong, but other parts are soft and crumbly. Look around and note that the rock is most crumbly along the top surface of the outcrop and along fractures cutting through the rock. In these areas, water has destroyed the black mica (contains iron which makes it rusty) causing the rock to disintegrate. The coarse material resulting from weathering of granitic rock in place is called "grus".

7- Pueblo

490417 E, 6732051 N

Located at the crossroads of the Fish Lake Road and the Copper Haul Road, this former mine site is now partly occupied by a fish hatchery.

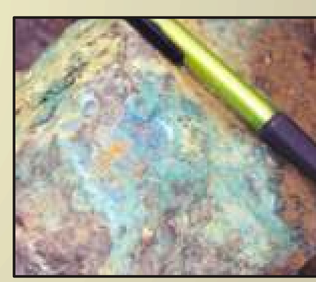


The Pueblo was the largest of the early mines. Ore production between 1912 and 1920 was 128,000 tonnes grading 3.5% copper and representing 86% of the production from the entire Copper Belt at the time.

At the southern end of the small lake (top right), a bouldery till (see stop 8) overlies oxidized (rusty) copper skarn (middle right), indicating that glaciers eroded the bedrock down to the level of mineralization before depositing the till.

Pueblo Mine, Yukon Archives, John Scott Fonds

This skarn is unusual as it contains specular hematite (specularite), a non-magnetic metallic grey form of iron oxide. Chalcopyrite is the only copper sulphide, while the copper oxide minerals malachite and azurite are the dominant economic minerals. Oxidation of the skarn was relatively deep because abundant faults in the area allowed surface and subsurface water to penetrate. The copper ore minerals are malachite, azurite, cuprite and chrysocolla. Most of the old mine is flooded and reclaimed (by the fish farm) so mineral collecting is limited.



Malachite (green) and azurite (blue)

7a- This plaque, located on the Fish Lake Road at the entrance to the Icy Waters fish farm, remembers the six miners who perished in the 1917 cave-in.

The Pueblo was a "wet" mine because faults (zones where rock is broken by earth movement) allow water to penetrate easily. During mining, pumps ran continuously to keep the tunnels clear, but water pressure caused the roof to collapse on March 21st, 1917, trapping nine miners. A diamond-drill crew established a speed record by tunnelling 85-feet (26 m) in 72 hours, and rescued three survivors. Rescue efforts continued for eight days to reach five men remaining at the 200-foot level, but conditions were so unsafe that the effort was halted and their bodies remain entombed. This part of the mine was never re-opened, although other parts of the deposit were excavated until 1920.

15- Best Chance

493414 E, 6726350 N

The name of this small deposit, originally staked as the "Last Chance" claims, was changed when results proved encouraging. Underground mining in the early 1900's was followed by some drill testing in the 1950s, which outlined a small deposit considered uneconomic at the time.

The skarn outcrop consists of spectacular solid black magnetite, brassy yellow chalcopyrite and dark blue bornite. Did you bring a magnet?
In places copper is altered to bright green malachite; very little serpentine is present, which is unusual for an iron skarn.

Old excavations are located around the main outcrop, next to the Haul Road, and further east in the trees. The white cement pillar on top of the outcrop is a geodetic survey point.

Robert Stroshein, former geologist at the mine for Hudson Bay Mining and Smelting Ltd, carefully inspects a century-old excavation. Note the malachite staining on the rock face.

16- Grafter extension

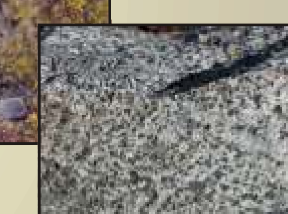
493383 E, 6726302 N

This outcrop, located across the haul road (west side) from the Best Chance, reveals the formation of a skarn from limestone at the contact between limestone and granodiorite.

17- Haul Road: Granodiorite Cliff

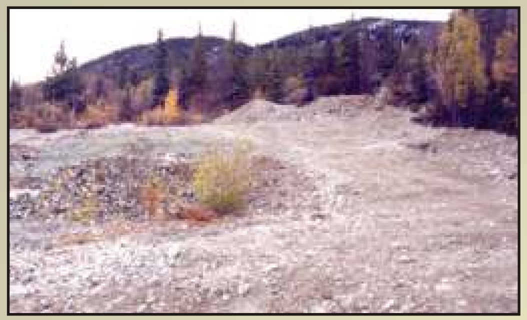
493525 E, 6726033 N

The intrusion which caused the formation of skarn in the copper belt and locally at Best Chance is exposed on the east side of the haul road. Notice the straight parallel fractures, called joints, which form due to pressure. The salt-and-pepper texture is caused by the light and dark minerals, feldspar and hornblende, respectively.



Access via Haul Road/Central (#14-19)

14- Grafter *493222 E, 6726095 N*



Located along an access road approximately 300 m west of the Haul Road, a steep, pipe-shaped magnetite-serpentine skarn lies within granodiorite. Chalcopyrite was the main ore mineral mined. Excellent samples of epidote, malachite, massive red garnet and fine grained diopside can be found in the loose bulldozed mine waste material. The rare mineral thulite is also found here in massive form.

View westward at the old camp after mining, about 1930.

Yukon Archives, John Scott Fonds.

Try to locate some small hand-dug trenches in an outcrop of *magnetite* skarn in the trees, just south of the main open bulldozed area. *493277 E, 6726092 N*

This deposit produced 12,200 tonnes of high grade ore (6% copper) by underground mining between 1905 and 1909. A vertical shaft led to three levels, the deepest being about 150 m below the surface. The headframe, shop, boilers and other equipment have all been dismantled, and the old openings were blocked by bulldozing the waste rock over them. Remaining deposits were tested by drilling in 1974 and 1990; trails in this area were made to move the drill rig.

Above: classic calc-silicate skarn consisting of coarse reddish-brown garnet with fine grained light green diopside; right: malachite coating.

Ruins of the supports of a bucket cableway, which carried mined rock to the railway line, are found between the Grafter and the Copper Haul road.

A few trenches in skarn, and 10 cm diameter steel tubes marking the location of diamond drill holes (drill casing), are located a few meters up the access road to the west. The position of the gradual contact between the limestone, skarn, and granodiorite can be determined from the exposed rocks. *493193 E, 6726054 N*

Access via Copper Haul Road/North (#8-13)

8- McIntyre Marsh Viewing Platform: Birds, Wetland, Glacial Deposit *490387 E, 6732025 N*

The top brownish layer results from weathering of the till.

White crumbly **caliche** (calcium carbonate), seen as horizontal or vertical layers and seams, formed from the evaporation of groundwater.

South of the junction of Fish Lake Road and Copper Haul Road is a large parking area, pit toilet and kiosk built by City of Whitehorse to recognize an important wildlife area. Signboards describe the birds and aquatic life. Near the kiosk is a bluff - the remnant of a glacial deposit.

Till deposits are left over after moving glaciers scraped the underlying bedrock, carrying clay, silt, sand, pebbles and boulders in the ice, and then the sediment-laden meltwater plastered the resulting mixture on the surface of the bedrock like smearing peanut butter on a piece of bread. Layering at the top of the section indicates later modification by streams.

9- McIntyre Creek Meltwater Channel *491806 E, 6728386 N*

What is unusual about this valley? In typical drainage systems, it is not common to find a stream flowing in a direction parallel to the main valley floor, in this case the Yukon River Valley.

This is an example of a meltwater channels which formed at the end of the last ice age. Meltwater flowed off the side of valley glaciers, carving channels roughly oriented parallel to the main valley direction, as water was flowing parallel to the ice-filled valley.

The resulting channels are mostly steep-sided valleys with flat bottoms, they now contain only small streams and marshes.

McIntyre meltwater channel looking northeast.

The meltwater carved through (or eroded) glacial sediments and bedrock, exposing some of the copper occurrences. Early workings, such as the Pueblo, Copper King, Empress of India and Big Chief, are located in or adjacent to meltwater channels. You could say that erosion first "discovered" these deposits!

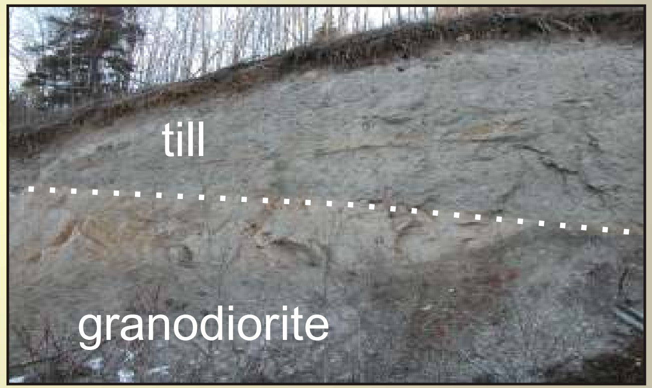
The upper part of McIntyre Creek follows a meltwater channel along the east side of the haul road.

10- Haul Road: Till Exposure

492171 E, 6727809 N

In constructing this road, bulldozers carved this hillside, revealing glacial till (see stop 8) deposited on top of the granodiorite. The dashed line marks the surface of the rock outcrop before it was covered by glacial deposits.

As at stop # 5, the granodiorite is soft and crumbly because the minerals have been altered by percolating ground water.



11- Haul Road: Limestone Outcrop

492725 E, 6726665 N

White and grey banded limestone is visible at the northern end of this large outcrop.

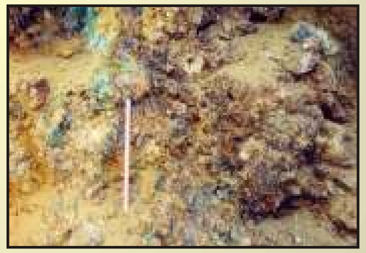
Outcrops at the top of the slope east of the road are marble, the remnants of a limestone reef (220 million years old) cooked by intruding granodiorite. At the south end the marble is exposed beside the road. Look for 50 cm wide intrusions of diroite (salt-and-pepper color) slanting upward through this marble outcrop.

12- Spring Creek

493142 E, 6726927 N

These sites were hand-dug around 1910. They are reached by a bulldozer trail that was used for test-drilling during the 1970s.

A caved in adit (0.5 m X 1 m wide) is located on a sharp contact (yellow dash in photo) between limestone (top) and a skarn (bottom) that contains epidote, garnet, malachite, azurite and quartz.



An excavation in a clearing reveals abundant pink banded and massive garnet, along with malachite, bornite, epidote and quartz. The upright pencil is 16 cm high.

13- Empress of India

This deposit is located 500 m east of the haul road, across the creek. No trails lead to it.

Between 1900 and 1910, trenches were dug at the top of the bluff, and two tunnels were driven into limestone at the base. The trenches contain bornite, chalcopyrite, malachite, azurite, epidote, garnet, actinolite and abundant quartz, at the skarn-limestone contact. The garnet here is unusual (photo top right); its amber colour indicates lower iron content than the more common red variety.

Amber coloured garnet crystals.

The two excavations (trenches) at the top of the bluff are located 100 m apart (far left photo). One contains many colourful minerals such as epidote, actinolite, quartz, amber-coloured garnet, calcite, malachite and azurite. An impressive malachite-stained face is located a bit further to the south (middle photo).

Adit: a horizontal or nearly horizontal passage driven from the surface for the working or dewatering of a mine.

At the base of the bluff, one 3 metre deep adit has timbers at the entrance, its roof is partially collapsed. The base of the tin can dates to the early 20th century.

Another **adit** is located on the west bank of the creek, driven through barren (unmineralized) limestone.

DANGER: Extreme caution should be used near these adits.