# MINERAL DEPOSITS OF ARCTIC CANADA: EXCERPTS FROM A CHAPTER IN "MINERAL DEPOSITS IN THE ARCTIC"

TE PALEOPROTEROZOIO

Sedimentary rocks

MESO- AND NEOPROTEROZOIC

Mineral deposits (by size)

Medium

Large

The Finlayson Lake district covers an area of 300 km by 50 km within the Yukon-Tanana terrane south of Ross

River. The district features five significant deposits, one described here, and numerous showings. Host rocks are

early Mississippian to early Permian age consisting of mafic and felsic volcanic rocks, phyllite, chert, volcanic-

The deposit dimensions are 750 m by 16 m max thickness: the deposit is open down dip. The ore types include: 1)

layered massive sulphides; 2) semi-massive replacement ore, and; 3) stringer sulphide veins. The massive sulphide

type includes pyrite, sphalerite, minor pyrrhotite, chalcopyrite and galena with rare antimonides, native gold and

electrum. The deposit is zoned, from copper-rich in the lower part to zinc- and lead-rich on the fringes. There is a

footwall stringer zone and weak hanging wall alteration (Peter et al., 2007). The deposit is classified as a volcanic-

derived sandstone and some limestone, conglomerate and diamictite in the upper part.

Wolverine (6.15 Mt 12.2% Zn, 1.6% Pb, 1.2% Cu, 363 ppm Ag, 1.7 ppm Au) – active mine

sediment-hosted massive sulphide (like the deposits in the Bathurst camp, New Brunswick).

The Coffee deposit (discovered in 1999) is located 130 km south of Dawson and

160 km northwest of Carmacks. The property is underlain by Paleozoic

metasediments, Cretaceous Coffee Creek granite and a portion of the Dawson

Range batholith. Deformation fabrics include metamorphic foliation, shearing

mineralization. Nineteen gold zones in total have been discovered (Sim and

(Jurassic) and brittle fracturing and faulting. These latter structures host gold

Kappes, 2014). Minerals found in association with micron-scale and "invisible"

gold include pyrite, micron-sized barite, an iron-barium arsenate, a phosphorus

Other deposits: White Gold, also epithermal Brewery Creek, Golden Revenue,

Mount Nansen, Skukum; intrusion related Lone Star, Dublin Gulch, Hyland Gold.

<u>Ultramafic-hosted Ni-Cu-PGE deposits</u>

Polymetallic U-Ag veins

fluorite, carbonates; Stage 2: arsenides, nickel sulphides, native sliver, native

produced additional native silver and bismuth (Gandhi et al., 2013).

phase, monazite and zircon (Mackenzie et al., 2015).

Other deposits: Fyre Lake, Kudz Ze Kayah, GP4F, Ice

Coffee (93 Mt 1.4 ppm Au)

Very large

Wolverine: laminated VMS ore,

Coffee: silicified, oxidized gold-bearing vein brecci

predominantly fine-grained pyrite

and sphalerite. Yukon Geological

Felsic-intermediate intrusives

Sediments, gabbro, volcanics

Sedimentary rocks

E PALEOPROTEROZOIC

Volcanics, intrusives

Sediments and volcanion

Sediments, volcanics

Meta Incognita microcontin

Volcanic rocks

Hearne craton

Superior craton

Felsic-intermediate intrusive

J.C. Harrison<sup>1</sup> and L.B. Chorlton<sup>1</sup>

The geology of Arctic Canada is divided into the cratons or granitic and metamorphic roots of the Canadian shield which contain much of the gold, copper, nickel, iron, uranium, rare earth elements and diamond deposits. The bounding Mesoproterozoic to Phanerozoic platforms, basins and accreted terrains of the Interior platform and Canadian Cordillera which extend into the High Arctic, contain much of the zinc, lead, gold, silver, copper, molybdenum and tungsten resources. Basement nuclei in the Canadian shield are the four Archean cratons. Oldest of these is the Slave craton (4030–2550 M on the west side of the shield. It is bound by Paleoproterozoic orogens: Thelon-Taltson to the east, Wopmay to the west and the Athapuskow aulcogen to the south in the east arm of Great Slave Lake. The Slave craton is associated with orogenic gold, volcanogenic massive sulphides (VMS), diamond-rich kimberlites and a large REE deposit. Lying to the east and underlying most of the remaining parts of the Canadian shield across the Canadian Arctic are the Rae (3250-2580 Ma) and Hearne (2740-2540 Ma) cratons. Significant in the Meso- to Neoarchean Rae craton are supracrustal rocks containing important resources of iron, orogenic gold of Paleoproterozoic age, uranium associated with a sub-Paleoproterozoic unconformity, nickel and commercially significant diamond-rich kimberlites. Known resoources in the

Hearne craton include nickel, copper, platinum group elements (PGE), uranium and VMS. The fourth craton is represented by the Superior craton, mostly located south of latitude 60 but also exposed in the northern extremity of Quebec. It is bound to the north by the Paleoproterozoic Cape Smith belt (1870–1800 Ma), part of the circum-Superior Trans-Hudson orogen. This belt is noted for its important resources of nickel, copper and platinum group elements. The other significant Paleoproterozoic belt is represented by the Wopmay orogen (1890–1840 Ma) which lies west of the Slave Craton. This features an eastern sedimentary belt and, to the west, the plutonic and volcanic rocks of the Great Bear magmatic zone. Noteworthy resources include iron oxide-copper-gold (IOCG), polymetallic veins and vein uranium The Precambrian cratons and Paleoproterozoic basins are fringed to north and west by Mesoproterozoic to upper Paleozoic shelf carbonate sequences. These rocks contain carbonate-hosted (MVT) zinc-lead deposits. Also present in this realm are iron deposits, notably the very large Crest deposit in Neoproterozoic strata. Southwestward the shelf succession

The western part of the Yukon is dominated by Jurassic and Cretaceous accreted terranes and associated granitoid rocks. This is a key realm for gold, polymetallic silver-lead-zinc veins and nickel-copper-PGE. Also associated with Mesozoic intrusives are tungsten and copper skarns, and copper-molybdenum porphyry deposits. Rounding out the resources of the Yukon are eleven gold placer districts of which the Klondike is most significant.

gives way to Cambrian to Devonian deep water sediments of the Selwyn Basin. Important resources within the Selwyn Basin

include three shale-hosted zinc-lead deposits in the Yukon and two significant VMS copper-zinc deposits.

# **History of Mining**

The first attempt to conduct mining in Arctic Canada was a 1576 to 1578 British expedition led by Martin Frobisher who identified gold in hornblendite on southern Baffin Island and returned to Britain with more than 1000 tons of gold ore. The mined material was subsequently determined to contain no gold and the expedition was ultimately a major loss to its investors.

The subsequent history of mining in Arctic Canada has its beginnings in the search for placer gold in the Yukon. Although prospecting had uncovered gold along the Yukon River as early as 1883, a report by George Dawson (Geological Survey of Canada; GSC) identified the unglaciated areas of west central Yukon as having the greatest potential. Significant gold was discovered in river gravels of Bonanza Creek in August 1896. This became widely known and by July 1897 there was a major gold rush into the Klondike from the west coast of the US and from many parts of Canada. In total 30,000 to 40,000 would-be miners entered the region from 1897 to 1899.

Prospecting for gold uncovered new hard rock deposits. This included copper at Carmacks, Yukon (1887), and silver-lead-zinc at Keno Hill (1901). Further afield were new indications of nickel mineralization in northern Quebec (1898), gold along the Yellowknife River on the north side of Great Slave Lake (1898), of zinc and lead at **Pine Point** south of Great Slave Lake (1899), and of copper, uranium and cobalt at **Port Radium** on the east side of Great Bear Lake (1900). The carbonate-hosted deposits at Pine Point were low in silver and thus of limited interest to the mining community at this time. It would be sixty-six years before the area would become commercially viable.

A significant boost to the mineral exploration business was the introduction of float planes in the 1920s. This allowed large areas of remote country to be accessed as never before and was partly responsible for the discoveries of the 1930s. This led to the discovery of high grade uranium and silver ore in 1930 at what would become the Eldorado mine. Originally mined for radium as a source for cancer cures, it was soon recognized as a source of uranium for atomic weapons research and development during the war years. Exhausted in 1960 it was later reopened to recover silver and copper (1975-1982).

Renewed prospecting took place near Yellowknife in the early 1930s which led to the discovery of the Giant and Con gold mines in 1935 and to the establishment of the Yellowknife town site in 1936. As many as five mines were operating in the late 1930s. However, the outbreak of war brought much of this activity to an end. This area was again a significant mining centre after the war. Other gold properties were established in this period, elsewhere within the Slave craton, including Courageous Lake (1944) and Lupin (1960).

Events of the 1960s included discoveries of iron at Snake River, Yukon (Crest: 1961), at Mary River in northwestern Baffin Island (1965) and at **Roche Bay** on Melville Peninsula (1968-1970). This period was also noteworthy for the exploration for porphyry copper-molybdenum in the Yukon. This led to Red Mountain (1967) and Casino (1967), which precipitated a staking rush, and later the discovery of the Logtung tungstenmolybdenum deposit (1976). New properties associated with iron oxide-copper-gold (IOCG) mineralization were discovered at this time including the Minto deposit (1971), Yukon. Carbonate-hosted zinc-lead deposits also became commercially viable in this period, notably Pine Point (1965), Polaris in the Arctic Islands (1970), Gayna River (1974), and Nanisivik on Baffin Island (1976). Also noteworthy were discoveries of shale-hosted (sedex) zinc lead deposits including Anvil (1953, 1965), Tom and Jason (1951, 1974) and especially the large Howard's Pass deposit (1972). This latter announcement precipitated a major staking rush across the central Yukon. Volcanogenic massive sulphides (VMS) were also being discovered in the Yukon: Hasselberg (1955), and in the Slave craton, notably Hackett River (1966).

The latest significant development in the mining history of Arctic Canada has been the discovery of commercially significant diamond-bearing kimberlites. This was the vision of two men, Charles Fipke and Stewart Blusson, who tracked kimberlite indicator minerals extracted from Quaternary glacial river channels (eskers) and in so doing pin pointed the favourable kimberlite source in bedrock near Lac de Gras in the central Slave craton. This ten year endeavor ended with drilling of the first diamond-bearing kimberlite in 1991. The announcement of their discovery precipitated one of the biggest staking rushes in Canadian history. As well as the original **Ekati** property, other kimberlite prospects of economic significance were located at Snap Lake (1994), Diavik (1995), Gahcho Kue (1995), Qilalugaq (2000-2005), and Chidliak (2005).

# **Definition of a deposit**

Natural Resources Ressources naturelles Canada

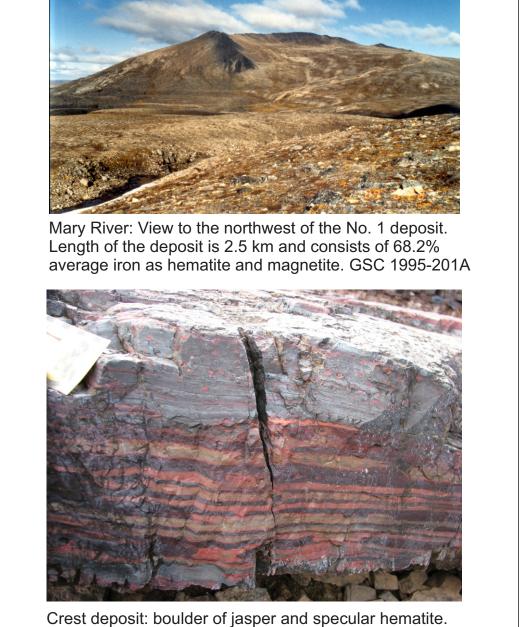
For the purposes of representing ore deposits in the Canadian Arctic on a 1:5 million scale

map, spatially distinct mineralized zones have commonly been grouped as one deposit. In this context, a deposit was defined as a cluster of genetically related occurrences on a property being investigated by one mineral industry organization (owners, operators, partners) in anticipation of these being mined at a profit as part of a single mine plan. Production and resource figures for these zones have been combined in the database (https://www.ngu.no/en/projects/overview-most-important-mineral-deposits-arctic), with a citation for the source of the resource figures which were National Instrument 43-101 technical reports wherever possible. Added to these deposits, many of which are actively being developed, are many small, short-lived past producers which are historically well-known but which would not have been mined under the current regulatory environment. Since production and all categories of resource data have been combined into global deposit size estimates, none of the figures included in the final table comply with National Instrument 43-101.

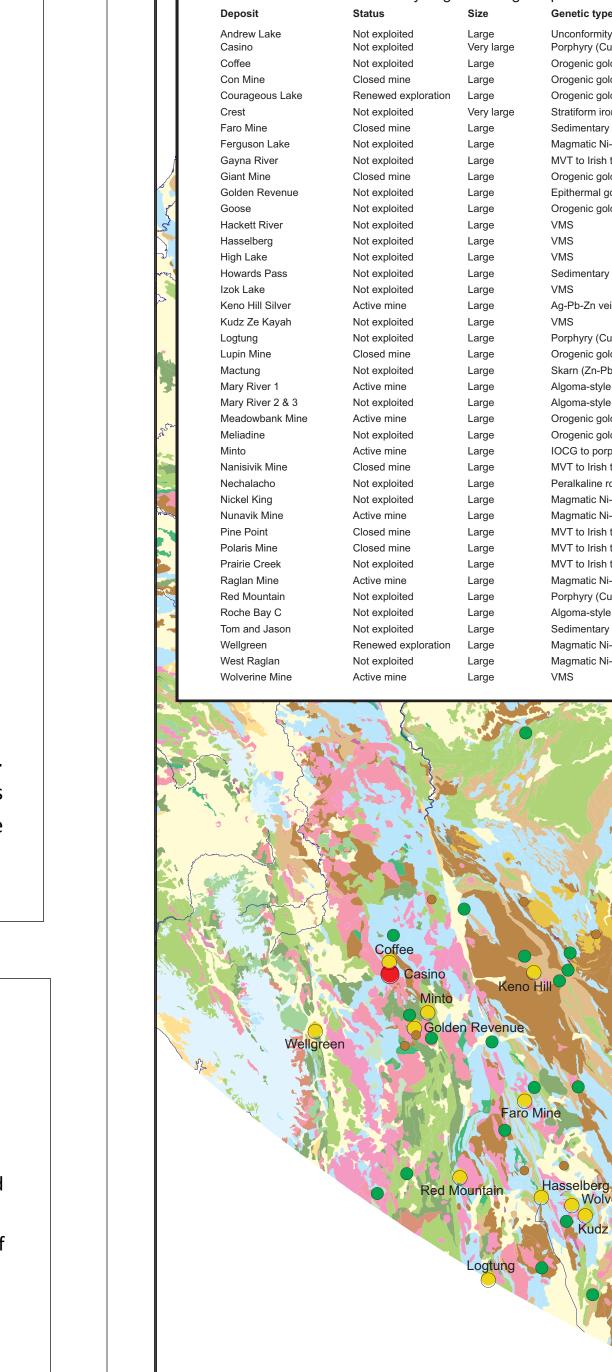
Deposit size was calculated based on copper equivalent metal content following the method described by Eilu et al., (2007). Deposits were described as Small, Medium, Large and Very Large based on the following thresholds: Small <100,000 t Cu eq; Medium 100,000-600,000 t; Large 600,000-10,000,000 t; Very Large in excess of 10,000,000 t. On this basis, most of the deposits described on this poster are classified as Large except where noted. Casino and Crest are considered Very Large.

Mary River (993 Mt 65.7% Fe) - active mine The tectonic setting of northwestern Baffin Island is one in which the Mary River Group (2.74 to 2.68 Ga) and associated deposits occur in west- and northeast-trending synforms overlying older Mesoarchean basement. Varieties of iron formation include oxide, silicate, pelitic and calcitic/ferroan dolomitic carbonate. The greatest thickness of iron formation occurs in the vicinity of the ore bodies: 52 to 195 m thick and traceable for up to 3.8 km. The ore zone mineralogy is mostly hematitemagnetite grading to hematite. Subsidiary phases include grunerite, anthophyllite, clinochlore, quartz, garnet, pyrite, pyrrhotite, chalcopyrite and covellite (Wahl et al., 2011).

Crest (Very large) (3200 Mt 43% Fe) The Neoproterozoic Crest deposit is located in the headwaters area of the Snake and Bonnet Plume rivers of the Mackenzie Mountains of northern Yukon. The deposit consists of fine-grained specular hematite with alternating jasper- rich bands. It has been traced for 51.5 km. Iron formation that is economically significant occurs up to 305 m above the sub-Rapitan contact. This zone attains a maximum thickness of 120 m of which 85 - 105 m is iron formation. Interlayered lithologies include hematite, dolostone, ankeritic carbonate, shale, sandstone, shaly conglomerate, and conglomerate. Types of iron formation include nodular, banded, and irregular intergrowths of hematite and jasper. The average iron content is 43%, the main impurity being apatite (McBean, 2006). Other deposits: Roche Bay, Alto



Nodular hematitic layer at the top. Yukon Geological Survey



# Volcanogenic Massive Sulphides (VMS)

☐ Kilometres

Hackett River (87 Mt 3.8% Zn, 0.5% Pb, 0.4% Cu, 144 ppm Ag, 0.23 ppm Au) The Hackett River property was acquired by Glencore Canada Corporation in 2011 It lies within the Neoarchean Hackett River greenstone belt of the northeastern Slave craton. At the base is the Siorak Formation (biotite schist, quartzofeldspathic gneiss, sericitic schist, amphibole gneiss) overlain by the Nauna Formation (volcanic flows, in part pillowed, mafic and felsic pyroclastics). This is succeeded by the Ignerit Formation consisting of dacitic and andesitic flows and pyroclastics (Clemmer et al., 2013). Intercalated with the flows are "white smoker" dolomitic and calcitic carbonates (Bleeker and Hall, 2007), iron formation, and sulphidic volcaniclastic rocks. The Ignerit Formation is host of the known VMS deposits. Cu-Pb-Zn and Ag ternary plots have been employed to infer an arc-like VMS setting Other deposits: Izok Lake, High Lake, Heninga Lake

Gold production from this portion of the Yellowknife Greenstone Belt has taken place

from three shear zones. The first gold was poured in 1938. Production from the

prolific Campbell shear commenced in 1946 and was continuous to 2002. The

primary host rock in the Campbell shear is chlorite-carbonate and sericite-

chlorite-carbonate schist. The ore is associated with intense quartz- ankerite

veining and alteration which is enveloped by sericite-ankerite schist. Sulphides

comprise a minor component of the ore (1-3%) and include pyrite, arsenopyrite,

lesser sphalerite, galena, chalcopyrite and sulphosalts. Other notable phases

include scheelite and tourmaline, the latter occurring in quartz veins or in

Other deposits: Giant, Hope Bay, Colomac, Courageous Lake, Lupin, Goose Lake,

Gabbro-hosted Ni-Cu-PGE deposits

The Ferguson Lake property is located in the Hearne craton southeast of the

Snowbird Tectonic Zone; part of the Yathkyed greenstone belt (~2.71-2.66 Ga).

The host of the magmatic Ni-Cu-PGE mineralization is gabbro and hornblendite.

This same body is 10 to 600 m thick and traceable from East to Central to West

zones, a distance of 12 km. The best grades occur in lenses, pods and stringers

(two to tens of metres thick) of massive to semi-massive ore consisting of 80-90%

pyrrhotite, lesser chalcopyrite, pyrite and pentlandite. Platinum group minerals

identified include two palladium tellurides, three palladium bismuthinides, and

Rare Earth deposit (Nechalacho)

The large Nechalacho deposit is located within the Paleoproterozoic Blatchford

Lake Complex which intrudes the Slave craton north of the East Arm of Great

Slave Lake. Early intrusive phases of the western lobe include: peridotite,

pyroxenite, layered gabbro, leucoferrodiorite, anorthosite, quartz syenite, and

granite. The eastern lobe features peralkaline granite, and (late) syenite.

Nepheline syenite is also present, intrudes the Thor Lake syenite, which hosts the

Thor Lake deposit. The age of the Thor Lake and Nechalacho phases are 2176.8+-

1.6 Ma and 2164+-11 Ma respectively (Mumford, 2014; Ciuculescu et al., 2013).

Mineralization in the agpaitic basal zone includes 4.6 to 9.1% ore minerals

including allanite, monazite, bastnaesite and synchysite (sources of light REE),

fergusonite (for Y, heavy REE, Nb, Ta), ferrocolumbite (Nb) and zircon (HREE, Nb,

Ta, Zr) (Ciuculescu et al., 2013). The Nechalacho deposits have been compared to

other peralkaline intrusions, notably: Strange Lake, Labrador; Illimaussaq in

Greenland, and; Lovozero on the Kola Peninsula in Russia.

(305 Mt 2335 ppm Nb, 1.18% REE, 196 ppm Ta, 1.81% Zr)

Ferguson Lake (58 Mt 5% Zn, 3.4% Pb, 33 ppm Ag, 0.3 ppm Au)

tourmalinite breccias (Hauser et al., 2006).

Yellowknife Gold Project

palladium and platinum arsenides.

Other deposit: Nickel King

Hackett River: massive sulphide with up to 30% buckshot pyrite in a matrix of dark red sphalerite and tremolite-altered

0.08 % Cu, 0.02 % Mo, 2.0 ppm Ag, 0.4 ppm Au

3.8 % Zn, 0.4 % Pb, 2.5 % Cu, 84 ppm Ag, 0.2 ppm A

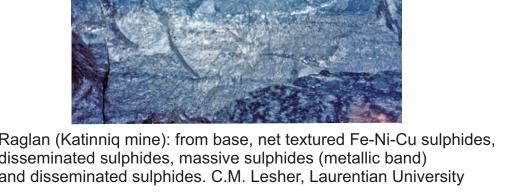
26.4 % Fe, 0.09 % P2O5

12.2 % Zn, 1.6 % Pb, 1.2 % Cu, 363 ppm Ag, 1.7 ppm Au

Ni, Cu (Pt, Pd)

Zn, Cu, Pb, Ag (Au) 6.154

bearing fault-fill quartz-carbonate veins hosted in a ductile shear zone.



Raglan (Katinnig mine): from base, net textured Fe-Ni-Cu sulphides, disseminated sulphides, massive sulphides (metallic band) and disseminated sulphides. C.M. Lesher, Laurentian University

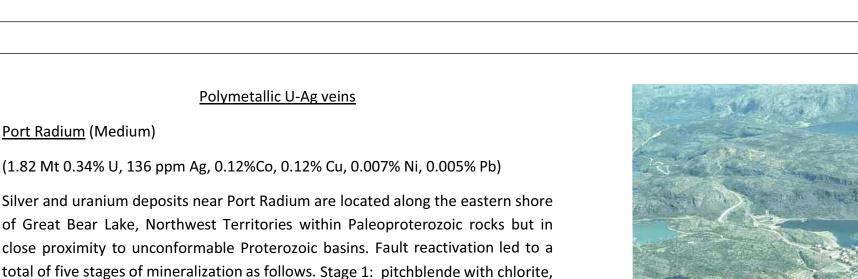
# McGill University.

# Nunavik (27 Mt 0.9% Ni, 1.1% Cu, 0.05% Co, 2.2 ppm Pd, 0.5 ppm Pt) - active mine

Port Radium (Medium)

Other deposits: Terra Silver; Rayrock

Host rock ultramafic bodies in the Paleoproterozoic Cape Smith belt have a dyke- or channel-like (or trough-like) geometry, individually 100 - 200 m wide and traceable along strike for several kilometres. In general, sulphides occur in the basal part of various ultramafic sheets with massive sulphide lenses at the base grading up into net-textured (25-75%) sulphides and a wider halo of less significant disseminated sulphides (Armstrong et al., 2010). The sulphide mineralization includes pyrrhotite, pentlandite (major carrier of cobalt), chalcopyrite and accessory galena, sphalerite, cubanite and cobaltite (a cobalt arsenic sulphide). Platinum group minerals include sudburyite (lead antimonide), PGE tellurides including michenerite (a palladium bismuth telluride), merenskyite (a palladium telluride), moncheite (a platinum telluride), kotulskite (a palladium telluride), and sperrylite (Pt arsenide); gold is carried in electrum (a gold-silver Other deposits: Raglan (active mine), West Raglan, Rankin Inlet, Wellgreen



2016

bismuth. Stage 3: polymetallic sulphides, silver tellurides; stage 4: carbonates, native bismuth, minor native silver. These stages are intruded by Western Channel Diabase at 1.59 Ga. The fifth and final stage, post-Western Channel diabase, Aerial view looking east of the Port Radium Mine site on Great Bear

Lake. GSC 2015-119

Wellgreen: high-grade ore consisting of pyrrhotite-rich massive sulphide with

lesser amounts of chalcopyrite, pentlandite and magnetite.

The Kiggavik deposit W of Baker Lake in the Kivalliq region of Nunavut ocation (Sissons site). Four of the deposits are to be mined by open pit, ar one by underground methods. The deposits lie just outside the Paleoproterozoic Aberdeen Sub-basin of the northeastern late Paleoproterozoic

The host rock at Kiggavik is Neoarchean granite, metagreywacke with minor iror al., 2014). Ore is also enclosed by alteration and features desilicification and conversion of feldspar to sericite and illite. The ore minerals include uraninite, foliation and fracture fillings. Other minerals in trace quantity include galena copper sulphides, gold and electrum, molybdenite, bismuth minerals, iron oxide and others (Robinson et al., 2014).

Kiggavik Main Zone: showing vermiform texture (irregular roll front like feature) and

# Mississippi Valley-type deposits (MVT

Pine Point (110 Mt 5.6% Zn, 2.5% Pb)

and diagenetic alteration forming in karst-induced porosity in the host rock. In total there are 97 known deposits within three northwest ore trends, distributed over a strike length of 68 km and a width of 6 km. The mineralization occurs as sphalerite, galena, marcasite and pyrite and as a replacement of karst-fill karst structure and replacive Presqu'ile dolomite. Sphalerite occurs in colloform masses. Galena is present in a nested form inside sphalerite. Other ore-related anhydrite and fluorite. Bitumen and pyro-bitumen are also found, particularly in trap settings above the ore bodies. Hydrogen sulphide gas has also been reported (Siega and Gann, 2014).

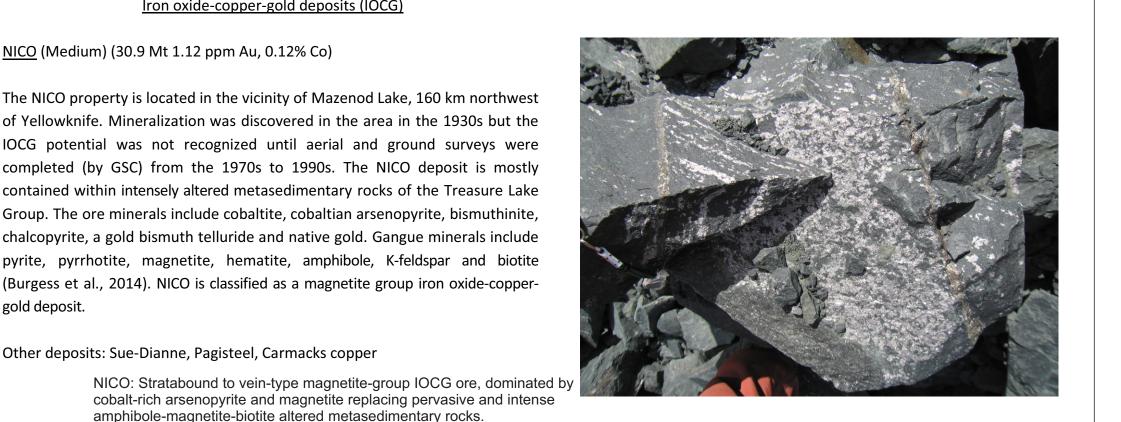


NICO (Medium) (30.9 Mt 1.12 ppm Au, 0.12% Co)

The NICO property is located in the vicinity of Mazenod Lake, 160 km nort OCG potential was not recognized until aerial and ground surveys were

> Other deposits: Sue-Dianne, Pagisteel, Carmacks copper cobalt-rich arsenopyrite and magnetite replacing pervasive and intens amphibole-magnetite-biotite altered metasedimentary rocks.

Iron oxide-copper-gold deposits (IOCG



Polaris (20 Mt 13.4% Zn, 3.6% Pb)

The Polaris zinc-lead district spans an area of 450 km (north-south) by 130 km (east-west) coinciding with the Late Silurian-Early Devonian Cornwallis Fold Bel and the Boothia Uplift in the central Canadian Arctic Islands. The host rock is th upper Thumb Mountain Formation of Late Ordovician age. The dimensions of th Polaris deposit (mined out from 1982 to 2002) are 800 m x 300 m x 20-100 m thick There are two distinct parts to the deposit: the Panhandle zone (two ore types, in the upper part of the deposit) and the Keel zone (three ore types, in the lower part). In general, the mineralization features colloform sphalerite, also occurring ir disseminated form and as aggregates. Galena occurs in dendritic and skelet forms and in polycrystalline veins (Dewing, 2007).



Other deposits: Blende, Gayna River, Nanisivik, Prairie Creek

# <u>Sedimentary-exhalative deposits (SEDEX)</u>

Howard's Pass (potentially very large) (389 Mt 4.9% Zn, 1.6% Pb) The Howard's Pass property is located along the Yukon-Northwest Territories border 350 km northeast of Whitehorse. The Howard's Pass Formation hosts all the ore deposits. Typical rocks include, from the base: pyritic siliceous mudstone; calcareous mudstone; cherty mudstone; the mid-Llandovery Active Member containing all the known zinc and lead mineralization), and uppermost, siliceous mudstone. The Active Member ranges from 0 - 60 m in thickness. The lead-zinc mudstone is a laminated cherty unit containing up to 70% sulphides and consisting of quartz, sphalerite, galena, minor pyrite and only local calcite. Trace constitiuents include chalcopyrite, tetrahedrite, molybdenite, pyrrhotite, polydymite, millerite and gersdorffite (Goodfellow & Jonasson, 1986). The Active Member has been identified over a strike length of 37.5 km within which there are



sphalerite in host black shale (Yukon Geological Survey)

# <u>Tom and Jason</u> (31 Mt 6.6% Zn, 3.8% Pb, 39 ppm Ag)

The Tom and Jason deposits are located along the eastern margin of the largely deep-water facies Selwyn Basin. Devonian strata on the Tom property include pyritic mudstone with sand layers, siltstone, barite, and Pb-Zn-Ag-bearing sulphides. Hydrothermal vent facies include ankerite and quartz veins containing pyrite, chalcopyrite and galena. Sulphide-barite mineralization occurs as laminae within sediment host rocks and collectively is found in stratiform lenses up to 40 m thick and traceable for up to 1200 m along strike. In total there are three mineralized zones at Tom. Ore minerals include fine to coarse sphalerite, galena and minor chalcopyrite with accessory barite, pyrite, pyrrhotite, quartz, and iron carbonates (Rennie, 2007).

The Logtung deposit is located 165 km west of Watson Lake near the BC-Yukon

border. The deposit is characterized by a quartz vein stockwork and a sheeted vein

set centred on a quartz-feldspar intrusion complex. The property is, nevertheless,

underlain by skarn and hornfelsed metasedimentary rocks. The mineralized zone

molybdenite and molybdoscheelite. There is also a sulphide facies associated with

is 2.5 km x 1.0 km. Minerals of economic significance include scheelite,

northeast-striking sheeted quartz-pyrite veins that includes beryl, fluorite,

bismuthinite, chalcopyrite, sphalerite and pyrrhotite (Molavi et al., 2011).

<u>Diamondiferous kimberlites</u>

Other deposits: Anvil, Clear Lake, Mel

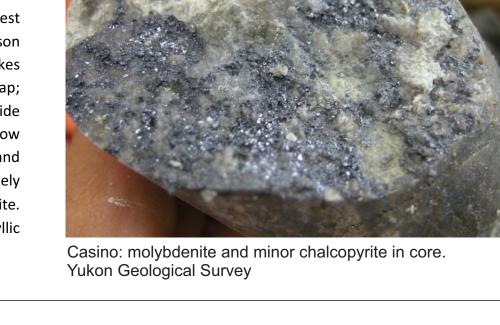
Logtung (425 Mt 0.08% W, 0.03% Mo)



Tom: polished slab of laminated galena and sphalerite ores.

# <u>Casino</u> (Very large) (2753 Mt 0.16% Cu, 0.02% Mo)

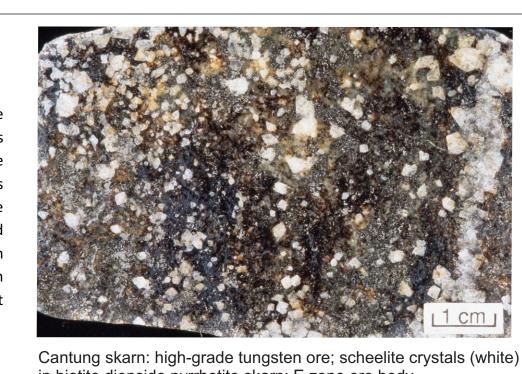
The Casino deposit is located in the Dawson Range Mountains 300 km northwest of Whitehorse in the west central Yukon. Cretaceous intrusions in the Dawson Range batholith include potassic quartz diorite, granodiorite, diorite and dykes and plugs of quartz monzonite. Mineralization types include leached cap; supergene oxide; supergene sulphide; and hypogene. The supergene sulphide zone is notably enriched in copper and features digenite, and chalcocite. Below the weathered zone, mineralization is typically found in stockwork veins and breccias. Hypogene mineralization in the potassic zone consists of finely disseminated pyrite, chalcopyrite, molybdenite and minor sphalerite and bornite. Gold, copper, molybenite and tungsten are present in higher grades in the phyllic zone (Huss et al., 2013).



# Mactung (45 Mt 0.73% W)

The Mactung property straddles the Yukon- Northwest Territories border in the eastern Selwyn Basin. A typical feature of this deposit is the location of skarns above the altered apex of Late Cretaceous quartz monzonite plutons. The mineralization consists of a pyroxene-pyrrhotite-scheelite skarn and, less commonly, a garnet-pyroxene-scheelite skarn. Disseminated pyrite occurs in some phyllite units, and galena and sphalerite in quartz veinlets. Pyrrhotite and scheelite occur in veins, fracture fillings and disseminations in the upper skarn zone. The Mactung deposit is classified as a contact metasomatic skarn (with hydrothermal fluids originating in a nearby stock) (Narcisco et al., 2009; Selby et



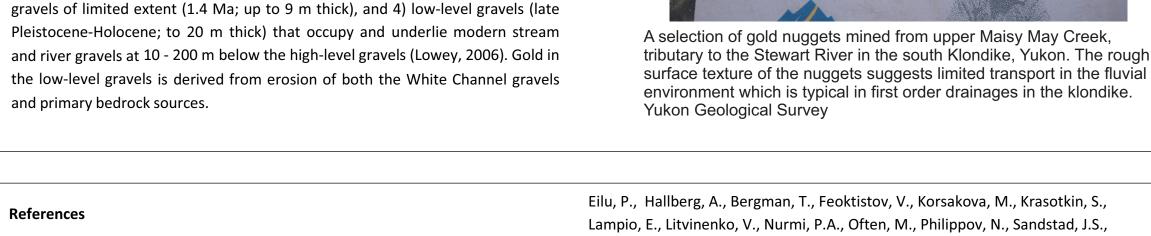


in biotite diopside pyrrhotite skarn; E zone ore body.

# Gold placers (Klondike)

Initial discoveries in 1896 included gold placers on Quartz Creek, Gold Bottom Creek and most significantly on Bonanza Creek which precipitated a massive staking rush. The Klondike area is unglaciated and therefore has not experienced glacial dispersion. This limits the lode gold source to several named ridges: Lone Star Ridge and Violet Ridge of which Lone Star has received the most significant attention. However, the gold content of these lodes does not account for the large volume of mined placer gold (Chapman et al., 2010). Placer gold occurs in four settings: 1) the lower part of the high-level White Channel gravels (5-3 Ma; up to 46 m thick) stratified with and overlain by; 2)

glaciofluvial Klondike gravel (Pliocene; up to 53 m thick), 3) intermediate terrace



Armstrong, T., Puritch, E. & Yassa, A., 2010. Technical report on the Allammaq, Expo, Ivakkak, Mequillon, Mesamax and Puimajuq Ni-Cu-PGE deposits of the Nunavik nickel project, Nunavik, Quebec. Goldbrook ventures Inc. 165 p. Gandhi, S.S., Potter, E.G. & Fayek, M., 2013. Polymetallic U-Ag veins at Port Bleeker, W. & Hall, B., 2007. The Slave craton; geological and metallogenic evolution, in W.D. Goodfellow (ed.); Mineral Deposits of Canada: a synthesis of Radium, Great Bear magmatic zone, Canada. Geological Survey of Canada, Open major deposit-types, district metallogeny, the evolution of geological provinces, File 7493, 1 poster.

and exploration methods: Geological Association of Canada, Mineral Deposits

Burgess, H., Gowans, R.M., Hennessey, B.T., Lattanzi, C.R. & Puritch, E., 2014.

Division, Special publication no. 5, 849-880.

Publications in this series have not been edited; they are released as submitted by the author.

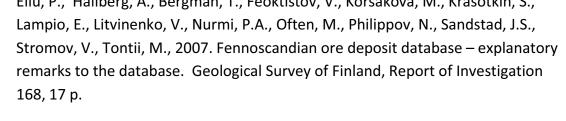
doi:10.4095/299515

Technical report on the feasibility study for the NICO gold-cobalt-bismuth-copper project, Northwest Territories, Canada. Fortune Minerals Limited. 385 p. Chapman, R.J., Mortensen, J.K., Crawford, E.C. & Lebarge, W., 2010 Microchemical studies of placer and lode gold in the Klondike District, Yukon, Canada: 1. Evidence for a small, gold-rich, orogenic hydrothermal system in the Bonanza and Eldorado Creek area. Economic Geology 105, 1369-1392. Ciuculescu, T., Foo, B., Gowans, R., Hawton, K., Jacobs, C. & Spooner, J., 2013. Technical report disclosing the results of the feasibility study on the Nechalacho rare earth elements project. Avalon Rare Metals Inc. 307 p.

Clemmer, S.G., Cote, A., Shannon, J.M. & Riles, A., 2013. Hackett River property

royalty, NI43-101 technical report, Nunavut Canada. Sabina Gold and Silver Corp

Dewing, K., Turner, E. & Harrison, J.C., 2007b. Geological history, mineral occurrences, and mineral potential of the sedimentary rocks of the Canadian Arctic Archipelago; in W.D. Goodfellow (ed.); Mineral Deposits of Canada: a synthesis of major deposit-types, district metallogeny, the evolution of geological provinces, and exploration methods: Geological Association of Canada, Mineral Deposits Division, Special publication 5, 733-753.



Goodfellow, W.D. & Jonasson, I.R., 1986. Environmetn of formation of the deposits of Northern Cordillera, CIMM Special volume 37, 19-50. Hauser, R.L., McDonald, D.W. & Siddorn, J.P., 2006. Geology of the Miramar Con

(ed.); Grutter, H.S. (ed.); Heaman, L.M. (ed.); Scott Smith, B.H. (ed.); Lithos 76,

Western Copper and Gold Corp., M3PN120001, 248 p. feasibility study. NI 43-101 Technical Report, Hatch Ltd. and JDS Energy & Mining Inc., Mountain Province Diamonds Inc., 2013-05-27, 296 p.

Eilu, P., Hallberg, A., Bergman, T., Feoktistov, V., Korsakova, M., Krasotkin, S. Lampio, E., Litvinenko, V., Nurmi, P.A., Often, M., Philippov, N., Sandstad, J.S.,

Howard's Pass (XY) Zn-Pb deposit, Selwyn Basin, Yukon. Morin, J.A. (ed.); Mineral

Mine, in Gold in the Yellowknife greenstone belt, Northwest Territories; results of the EXTECH III multidisciplinary research project. Anglin, C.D., Falck, H., Wright, D.F., Ambrose, E.J. (eds.); Special; Publication – Geological Association of Canada, Mineral Deposits Division 3, 95-115. Heaman, L.M., Kjarsgaard, B.A. & Creaser, R.A., 2004. The temporal evolution o North American kimberlites; <u>in</u> Selected papers from the Eighth International Kimberlite Conference, volume 1: the C.Roger Clement volume; Mitchell, R.H.

Huss, C., Drielick, T., Austin, J., Giroux, G., Casselman, S., Greenaway, G., Hester, M. & Duke, J., 2013. Casino Project: Form 43-101F1 Technical Report: Feasibility Study. NI Form 43-101F1 Technical Report. M3 Engineering & Technology Corp., Johnson, D. D., Meikle, K., Pilotto, D. & Lone, K., 2014. Gahcho Kué Project 2014

Other deposits: Cash, Red Mountain

Although hundreds of kimberlite pipes have been discovered in the Archean Slave craton and in Archean portions of the Rae and Hearne cratons, most of these are small isolated. In northern Canada the majority of the kimberlite pipes are small and low tonnage, hence feasibility is enhanced by multiple diamondiferous pipes in close proximity (Kjarsgaard, 2007) creating sufficient tonnage for a mine life of

# The Gahcho Kué property, held by De Beers Canada Exploration and Mountain

Provinces Diamonds Inc., is located 60 km N of the East Arm of Great Slave Lake. It is currently ramping up to full production by early 2017. Four significant named kimberlite bodies (Hearne, 5034, Tuzo and Tesla) are located on the property. The kimberlites are early Cambrian age (542-534 Ma) (Heaman et al., 2003 or 2004) and range from 1.2 to 2.1 ha. Kimberlite facies include tuffisitic kimberlite, transitional tuffisitic kimberlite, transitional hypabyssal kimberlite and hypabyssal kimberlite. Tuffisitic kimberlite is matrix-supported breccia containing 30 - 95% often unaltered granitoid clasts; less commonly clasts of diabase, gneiss and volcanic rocks. Transitional tuffisitic kimberlite is darker and country rock xenoliths are less common. Hypabyssal kimberlite is fresh, competent and black to dark green. The matrix is well crystallized and includes monticellite, phlogopite, spinel, carbonate, serpentine and perovskite. Mantle xenocrsts include garnet and clinopyroxene There are also mantle xenoliths of garnet lherzolite and eclogite (Johnson et al.

Other productive diamond mines and prospects include Ekati (active mine)

Diavik (active mine), Snap Lake (closed), Jericho (closed), Chidliak and Qilalugaq.



Kjarsgaard, B.A., 2007. Kimberlite diamond deposits; in W.D. Goodfellow (ed.); Mineral Deposits of Canada: a synthesis of major deposit-types, district metallogeny, the evolution of geological provinces, and exploration methods: Geological Association of Canada, Mineral Deposits Division, Special publication 5,

## Canada. Ore Geology Reviews, 28, 431-450. McBean, C., 2006. Snake River iron ore. Chevron Canada Resources, 97 p. Molavi, M., Hollett, G., Board, W. S., Bolu, M., Smith, P., Lemieux, J., Netherton, D. E., Nyland, E. & Weston, S., 2011. Northern Dancer Project, Yukon, Canada -

Lowey, G.W., 2006. The origin and evolution of the Klondike goldfields, Yukon,

Preliminary Economic Assessment. NI 43-101 Technical Report, AMC Mining Consultants (Canada) Ltd., Largo Resources Ltd., 2011-03-28, 151 p. Narcisco, H., Iakolev, I., De Ruijter, M. A., Impey, G., Cowie, S., Tanase, A., Nichols, A., Collins, J., Goodall, N., Lacroix, P. & Trimble, R., 2009. Amended Technical Report on the Mactung Property. NI 43-101 Technical Report, Wardrop

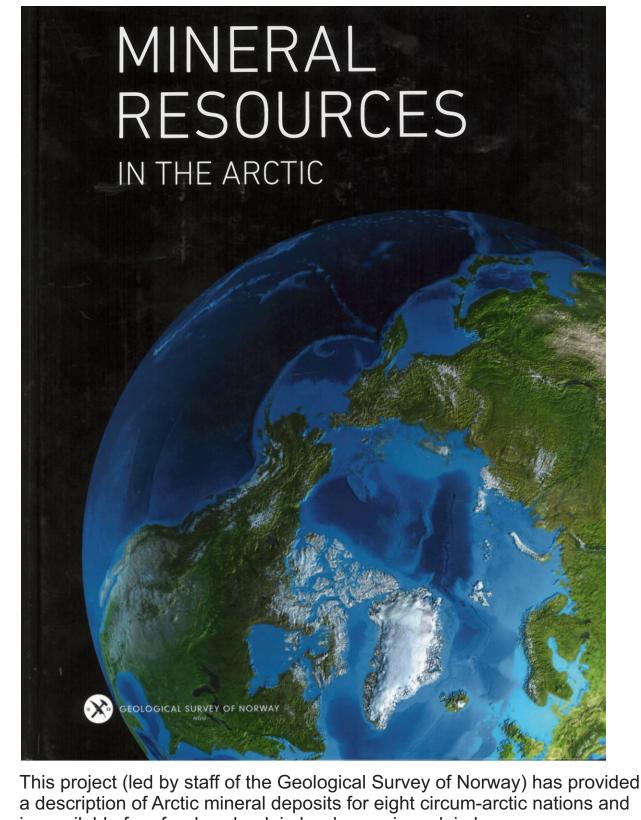
Engineering, North American Tungsten Corporation Ltd., 2009-04-03, 372 p. Peter, J., Layton-Matthews, D., Piercey, S., Bradshaw, G., Paradis, S., Boulton, A 2007. Volcanic-hosted massive sulphide deposits of the Finlayson Lake district; in W.D. Goodfellow (ed.); Mineral Deposits of Canada: a synthesis of major deposittypes, district metallogeny, the evolution of geological provinces, and exploration methods: Geological Association of Canada, Mineral Deposits Division, Special publication 5, 471-508.

## Rennie, D.W., 2007. Technical report on the Tom and Jason deposits, Yukon Territory, Canada. Hudbay Minerals Inc., 202 p. Robinson, S.V.J., Paulen, R.C., Jefferson, C.W., McClenaghan, M.B., Layton-Matthews, D., Quirt, D. & Wollenberg, P., 2014. Till geochemical signatures of the Kiggavik uranium deposit, Nunavut Geological Survey of Canada Open File 7550,

Siega, A.D. & Gann, P., 2014. NI 43-101 summary technical report update of the Pine Point mine development project, Northwest Territories, Canada. Tamerlane Ventures Inc., 274 p.

Yukon Territory, Canada. NI 43-101 Technical Report, SIM Geological Inc. and Kappes, Cassiday & Associates, Kaminak Gold Corp., 2014-03-12, 136 p. Wahl, G.H., Gharapetian, R., Jackson, J.E., Khera, V. & Wortman, G.G., 2011. Mary River iron ore trucking NI43-101 technical report. Baffinland Iron Mines Corp., 240

Sim, D. & Kappes, R., 2014. Mineral Resource Evaluation, Coffee Gold Project,



a description of Arctic mineral deposits for eight circum-arctic nations and is: available free for download; in hard copy; in a plain language summary on a circum-arctic map and; as a tabulated database of the significant ore



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