

# Geology and mineral deposits of the Mount Nansen camp, Yukon

*Craig J.R. Hart<sup>1</sup> and Mark Langdon<sup>2</sup>*

<sup>1</sup>*Yukon Geology Program (F-3), Box 2703, Whitehorse, Yukon, Y1A 2C6, e-mail: craig.hart@gov.yk.ca*

<sup>2</sup>*Mineral Resources, DIAND, 325-300 Main Street, Whitehorse, Yukon, Y1A 2B5*

Hart, Craig J.R. and Langdon, Mark. Geology and mineral deposits of the Mount Nansen camp, Yukon. *In: Yukon Exploration and Geology 1997*, Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, p.129-138.

## ABSTRACT

The Mount Nansen camp hosts approximately 30 mineral occurrences of epithermal and porphyry origin. The largest occurrence is the Brown-McDade with approximately 600 000 tonnes of drill-indicated reserves at 6.1 g/t Au and 55.5 g/t Ag. The majority of the northwest-striking, steeply dipping epithermal quartz/sulphide veins are found within a 12 km long by 3 km wide northwest-trending corridor called the Nansen trend. The precious-metal-bearing veins occur in all lithologies within the Nansen trend and contain (in order of decreasing abundance) pyrite, arsenopyrite, galena, sphalerite, chalcopyrite, stibnite and tetrahedrite. Two types of epithermal veins are recognized: an early "cherty" quartz-sulphide vein with fine-grained pyrite and arsenopyrite; and a later coarse-grained quartz-sulphide vein with pyrite, galena and sphalerite and higher precious metal values. Within the trend is the Mount Nansen porphyry complex which hosts two cores of potassic alteration. The character of mineral occurrences varies with increasing distance away from these Central Porphyry Zone and are here recognized as the Peripheral Porphyry, Transitional and Epithermal zones. Together, they comprise a porphyry-to-epithermal transition. Placer mining is predominant on creeks draining from the porphyry complex, implying a porphyry source for the placer gold.

## RÉSUMÉ

Le camp minier de Mount Nansen contient plus de 20 filons sulfurés aurifères dont celui de Brown-McDade (600 000 tonnes à 6,1 g/t d'au et 55,5 g/t d'Ag), où l'on a récemment extrait 3800 kg doré. La majorité des occurrences sont des filons sulfurés quartzeux à grain fin et de direction nord-ouest contenant (par ordre décroissant) de la pyrite, de l'arsénopyrite, de la galène, de la sphalérite et de la stibine. La majorité des occurrences filoniennes se trouvent dans un corridor granitique de direction nord-ouest de 12 km de longueur et de 3 km de largeur; ce corridor jouxte deux compartiments affaissés de volcanites du Groupe de Mount Nansen. La région contient en outre d'importantes occurrences de cuivre-molybdène porphyrique dans un porphyre quartzofeldspathique de 6 km sur 3 km injecté dans le corridor granitique. Bien que les filons soient inclus dans des roches de compositions diverses, ils sont spatialement associés aux intrusions de haut niveau de porphyre quartzofeldspathique.

## INTRODUCTION

The Mount Nansen camp (62°05'N, 137°10'W) is located approximately 42 km west of Carmacks and 160 north of Whitehorse (Fig. 1). The region is accessible along the recently upgraded, 62 km Nansen Road which departs from the village of Carmacks. The Mount Nansen area has had a long but intermittent history of exploration and mining starting with the discovery of the first lode gold vein in 1917. The Brown-McDade, Heustis and Webber veins were discovered in 1946 and saw brief production in 1967 and 1976. Considerable exploration over the past decade resulted in several discoveries. Presently, the Mount Nansen area hosts approximately 30 mineral occurrences – the majority are sulphide-bearing quartz veins – although there are also important porphyry occurrences.

Despite these discoveries, there is relatively little information available to the public. This paper documents a number of occurrences that are not currently listed on government maps and databases, accurately locates them and introduces the nomenclature in use by the exploration community. In addition, salient information from current exploration efforts is presented, with special attention to the gold-bearing veins. We also introduce a new interpretation for the geology of the region and a genetic concept for vein mineralization.

Prior to current mining operations (commenced in Nov. 1996) a combined ore reserve (in all categories) of approximately one million tonnes of 7.4 g/t Au and 148 g/t Ag was calculated from five different deposits within a two-kilometre radius (BYG, 1995). This included all that is minable by both open pit and underground methods. Approximately 450 000 tonnes is considered oxide ore. Processing of approximately 140 000 tonnes of oxide ore from the Brown-McDade open pit and Webber and Brown-McDade stockpiles from November 1996 to December 1997 yielded approximately 3800 kg of doré (Andersen and Stroshein, this volume). Currently the Dickson, Flex and Heustis zones are in various stages of stripping in preparation for mining. The Flex zone is planned as the next open pit (see Andersen and Stroshein, this volume).

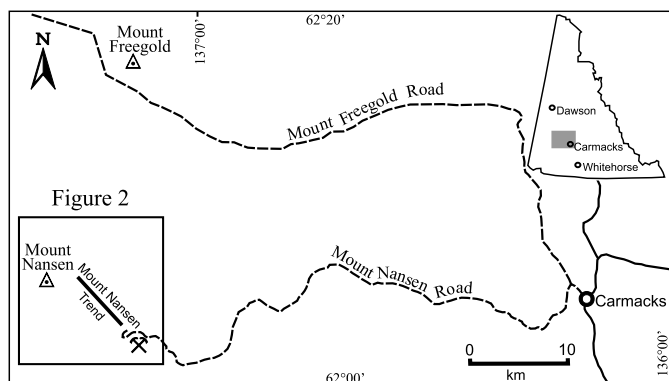


Figure 1. Location map of the Mount Nansen area.

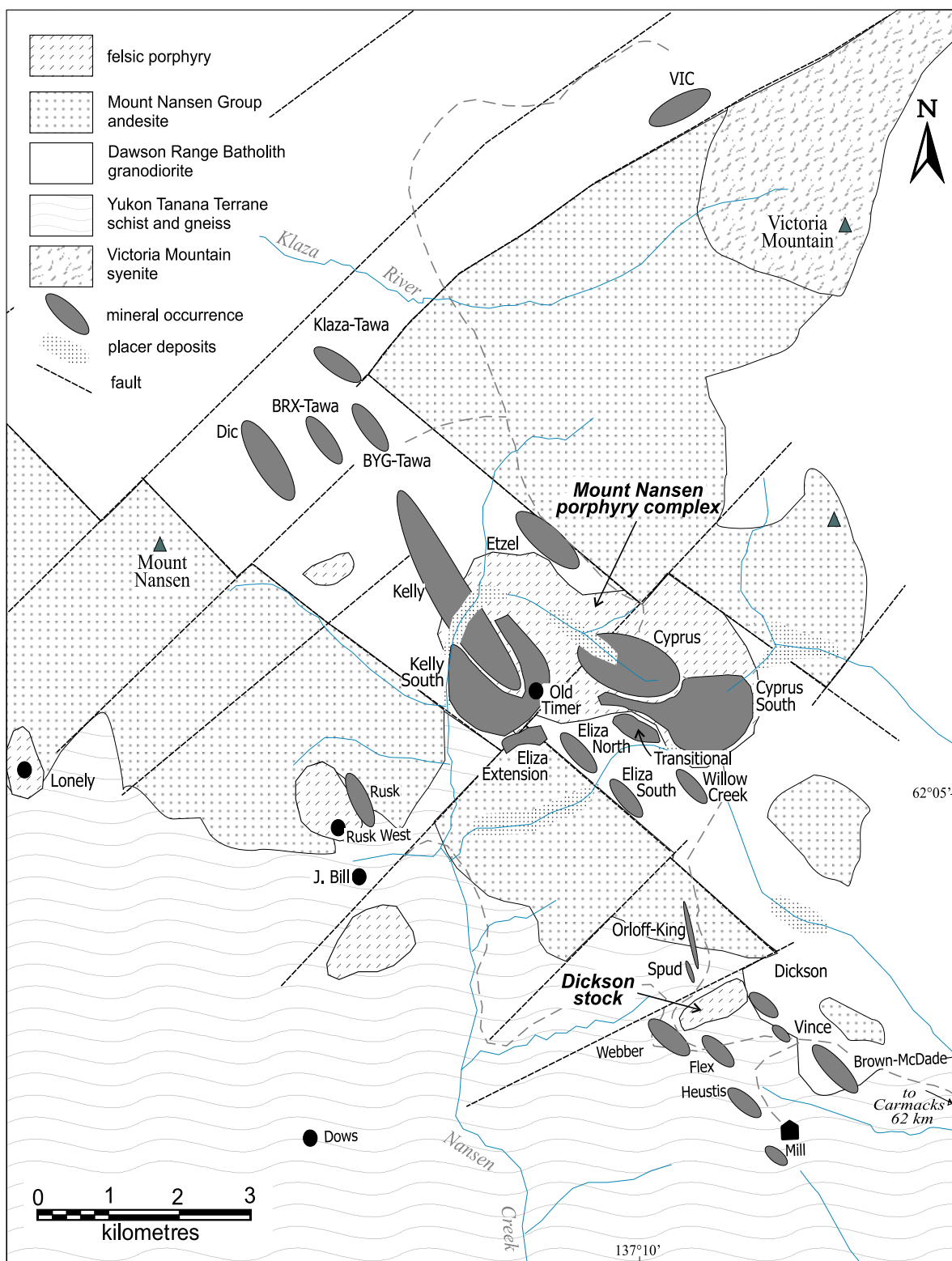
Several factors have changed the economics of the Mount Nansen camp: 1) Land tenure is essentially consolidated (through ownership or joint venture agreement with Aurchem Exploration Ltd.) by a single company – namely BYG Natural Resources Inc. This has allowed the aggregation of numerous properties and small ore bodies to be the focus of a single exploration effort and more efficient mine development; 2) Gold recovery has been significantly improved with the utilization of a cyanide circuit. Previous operations failed due to poor recovery of gold and silver using floatation technology on a mixed oxide and sulphide ore. This led to the belief that gold mineralization in the Mount Nansen camp was refractory in nature. Recovery of gold has been significantly enhanced (90%) using a cyanide circuit on an oxide-only ore. Silver recovery remains poor (~50%); 3) Milling capacity was increased to 700 tonnes per day with the recent addition (Sept. 1997) of a semi-autogenous grinding mill (SAG); 4) The opening of the BYG mine, mill and associated permitting and infrastructure enhances the viability of defining a new ore body.

## REGIONAL GEOLOGY

The regional geology of the Mount Nansen area has been described by Cairnes (1916), Bostock (1936) and Tempelman-Kluit (1984). The most recent study, by Carlson (1987), describes, in detail, the geology of the area. Although outcrop in this largely unglaciated region is sparse, geological mapping is continually upgraded by ongoing exploration, geophysical surveys and trenching.

The Mount Nansen area is within the Yukon-Tanana Terrane which is composed of variable amounts of Devonian and older meta-igneous and metasedimentary rocks. In the Mount Nansen area, the metamorphic rocks are dominated by chlorite schist and felsic orthogneiss, with lesser quartz-rich metasedimentary rocks and amphibolite.

The metamorphic rocks are intruded by several plutonic suites. The Early Jurassic suite includes the *Big Creek batholith* which is notable for its coarse grain-size, megacrystic alkali feldspars and its variable, but generally quartz-poor, composition. Quartz-rich, alkali feldspar megacrystic plutonic rocks which outcrop in the area are also considered to be Early Jurassic but may be part of the *Granite Mountain batholith*. The most prominent mid-Cretaceous plutonic rock is biotite-hornblende granodiorite of the *Dawson Range batholith*. This batholith intruded Yukon-Tanana Terrane rocks as an extensive sheet-like sill and is more or less continuous from Carmacks northwest to the Alaska. Another notable lithology, but of uncertain age, is sucrosic alkali-feldspar quartz syenite which forms a pluton in the Bow Creek drainage north of the upper Klaza River (Unit 8c of Carlson, 1987). The youngest suite forms a lithologically variable, irregular-shaped pluton composed of mafic syenites and alkali-feldspar-rich porphyry near Victoria Mountain (Unit 9e of Carlson, 1987).



**Figure 2.** Generalized geological map of the Mount Nansen trend. The white area includes granitic rocks of all ages and types, but is dominated by the mid-Cretaceous Dawson Range Batholith. The Tawa occurrences collectively comprise the Essansee occurrence (Yukon Minfile 1151 067) and the Eliza and Willow Creek occurrences comprise the Goulter occurrence (Yukon Minfile 1151 093).

There are two volcanic suites. The mid-Cretaceous (*circa* 108 Ma) *Mount Nansen Group* volcanic suite forms nested cauldrons composed primarily of andesitic fragmental units and flows. These rocks have a late phase of hypabyssal quartz-feldspar porphyry and quartz monzonite stocks, dykes, sills and minor pyroclastic flows. The Late Cretaceous *Carmacks Group* comprises extensive, and locally stacked, flows of shoshonitic basalt which unconformably overlie a pre-70 Ma surface which locally preserves sedimentary rocks.

## LOCAL GEOLOGY

Mineral occurrences in the Mount Nansen camp are hosted by various rock types within a 3-kilometre wide, northwest-trending corridor, known as the Mount Nansen trend (Fig. 2). The geology of the trend is largely controlled by northwest-trending faults; two are located on the flanks and several more are within the corridor. The gentle, rolling topography of the corridor is largely underlain by granodiorite with less abundant metamorphic rocks, and lies between steep and rugged relief comprising Mount Nansen Group volcanic rocks. Pendants of volcanic rock within the corridor indicate that volcanic rocks originally spanned the region but now remain as two distinct, nested volcanic packages.

The corridor is essentially a horst which also hosts a 5 x 3 km porphyry complex, a number of smaller satellite stocks and a swarm of northwest-trending porphyry dykes. The felsic intrusions may have assisted uplift of the horst. A satellite porphyry body, located near the Dickson and Flex occurrences (the Dickson stock), is notable by its proximity to the mineralization there (Fig. 3). Detailed descriptions of rocks in the Mount Nansen trend are given by Sawyer and Dickinson (1976).

## STRUCTURES AFFECTING MINERALIZATION

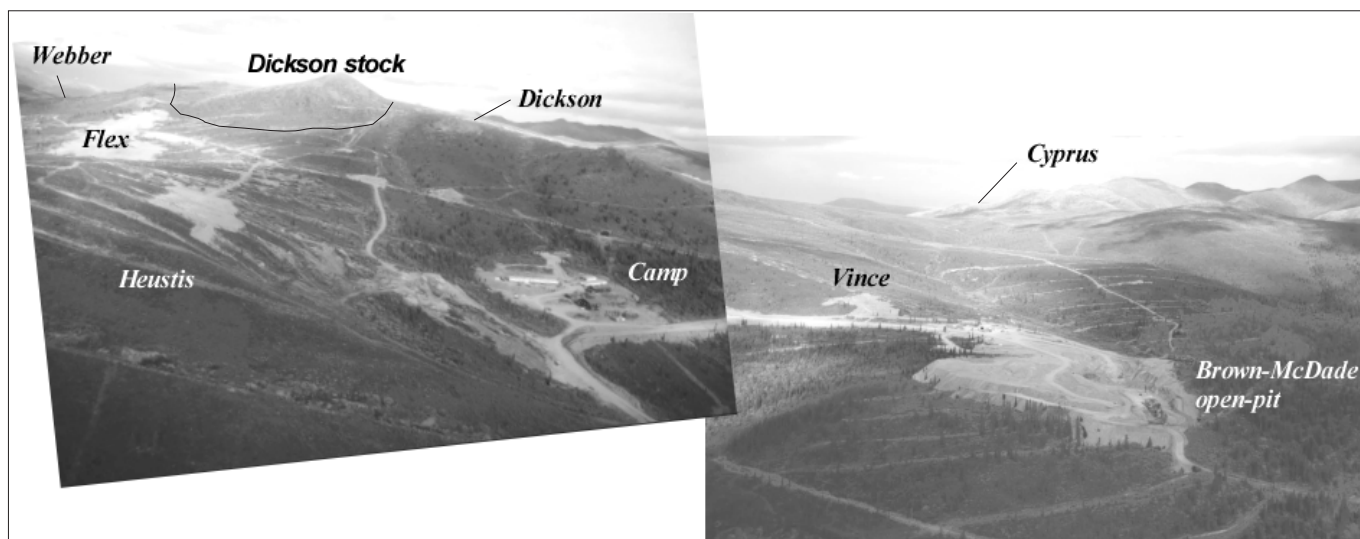
Three dominant structural orientations, which vary in character and sense of displacement, are recognized from air photos, geological discontinuities, geophysical images, topographic expression and bedrock exposures (mainly exploration trenches). The interaction of these structures are important in the formation of mineral deposits. The three main structural orientations are: 1) a northwesterly trend; 2) an 020° series; and 3) an east-northeasterly trend.

### NORTHWEST-TRENDING STRUCTURES

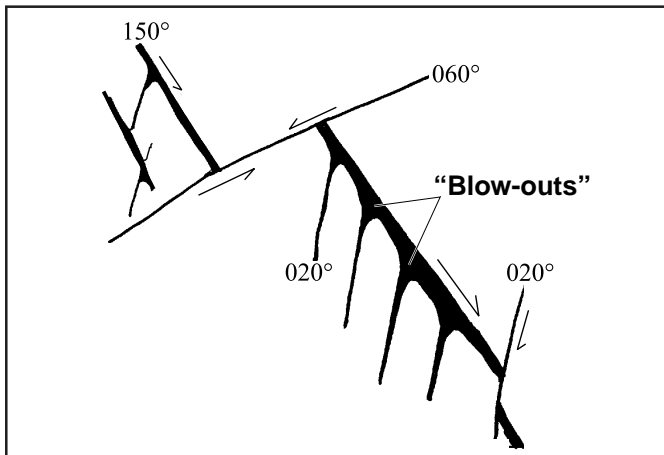
Numerous parallel, northwest-striking fault zones are continuous throughout the Mount Nansen region and define a regional structural trend of 130° to 150°. These structures are continuous, form wide zones with numerous faults that host porphyry dykes, and contain mineralized quartz veins. Although significant vertical displacements (normal sense) are known on the faults that bound the granodiorite corridor, right-lateral movement is also recognized. Mineralization largely post-dates the vertical motion but slickenslides on veins and dykes in these faults indicate subsequent strike-slip motion.

### 020° STRUCTURES

A secondary structural trend approximating 020° (varies between 005° to 045°) is characterized by their discontinuity and a general lack of intense shearing. The structures are typically fractures occupied by narrow mineralized quartz veins and porphyry. Many 020° structures terminate at their intersection with a northwest structure or curve sharply into the northwest trend. Consequently there is generally little or no offset of the northwest structures and the 020° series; instead



**Figure 3.** View northwesterly of the mineral occurrences near the Dickson porphyry stock. The Mount Nansen porphyry stock is in the background low-lying hills near the Cyprus occurrence.



**Figure 4.** Schematic diagram of the interactions of vein structures. Black indicates mineralization.

they create a network of discontinuous interconnections between them. This has important implications for vein formation, discussed later in this paper. Although the strike of both the 020° series and the northwest-trending structures varies, the angular relationship between them does not. In most cases, a consistent angular relationship of approximately 60° is apparent. Observed fault offsets are typically sinistral, with offsets of less than 15 m although a right lateral offset of about 12 m was recognized cutting the **Vince** vein.

The intersection of numerous 020° veins with the main northwest veins appears to be the structural recipe required to form larger, and wider, ore-bodies (Fig. 4). In the Brown-McDade open pit, a series of six to ten 020° series veins intersect and join the main northwest structure over an interval of about 300 metres. The 020° veins vary from 0.2 to 3.0 m in width and their intersection with the main vein creates ore pods or “blow-outs” which increases the tonnage of the Brown-McDade deposit.

### EAST-NORTHEAST-TRENDING STRUCTURES

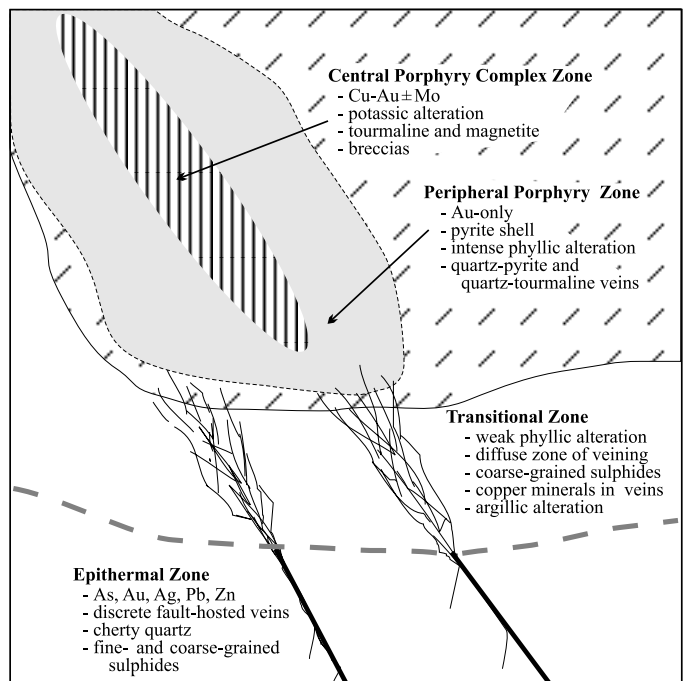
A third regional set is expressed as faults, fractures and joints that trend northeasterly between 050° and 080°. The faults are continuous but many have not been previously identified through mapping because their offsets are not very large. The structures are apparent on air photos and airborne magnetics surveys however, and have been recognized in trenches. Displacements are sinistral. Most of these cross-faults do not contain mineralization except for minor faulted blocks of earlier veins. An exception is a fault within the Eliza Creek Extension where a 10 to 30 m wide, 065/80°S shear zone contains sheared and highly oxidized fragments of argillic-altered andesite, mineralized by a quartz-pyrite stockwork. A trench excavated along the shear yielded 21.3 metres of 1.5 g/t Au and 11.3 g/t Ag.

In summary, epithermal mineralization is dominantly hosted by the northwest and 020° structures, and intersection of these

structures creates a “blow-out” where vein thickness increases considerably. Mineralization largely post-dates the large vertical displacement of these structures. The 020° fractures become dominantly extensional near the intersection. These extensional blow-outs, when filled with vein material, add considerable tonnage of ore-grade material to the veins. In three dimensions, the blow-outs probably have the general form of steeply plunging cylinders. The 020° structures are interpreted to have originated as oblique extension to the strike-slip motion of the northwest-trending system.

## THE PORPHYRY TO EPITHERMAL TRANSITION

There are approximately 30 mineral occurrences in the Mount Nansen camp (Table 1). Most occurrences in the Mount Nansen trend are adjacent to porphyry stocks — specifically the sulphide-bearing quartz veins near the Mount Nansen porphyry complex and the Dickson stock. Mineralization associated with the Mount Nansen porphyry complex displays notable changes in metal ratios, vein character and alteration-style outward from two central zones. Four mineralized zones defining a porphyry to epithermal vein transition are recognized — the Central Porphyry Zone, a Peripheral Porphyry Zone, a Transitional Zone and an Epithermal Vein Zone (Fig. 5).



**Figure 5.** Characteristics that define porphyry to epithermal transitions. The diagram schematically represents the relationships of mineralization observed on the southwest side of the Mount Nansen porphyry complex. See text for discussion.

PROPERTY DESCRIPTIONS

Table 1. Summary of characteristics of mineral occurrences in the Nansen trend.

Yukon Minfile	Name	Host lithology	Vein attitude	Description
<b>Epithermal Vein Mineralization near the Mount Nansen Mine</b>				
064	Brown-McDade	Granodiorite in north, schist and gneiss in south	1° 160/65SW 2° 020	Total reserve 600 000 tonnes of 6.1g/t Au and 55 g/t Ag; open-pit oxide reserve 201 600 of 7.1 g/t Au 69 g/t Ag; production (11/96 to 10/97) 16 000 oz Au, 83 000 oz Ag produced from 124 000 tonnes of ore; a 500 m long strike length; complex veins formed by intersection of two trends
065	Webber	Schist and gneiss	155/70SW	Underground reserve of 85 000 tonnes of 9.4 g/t Au and 560 g/t Ag; 600 m strike length; four narrow (0.3-2.0 m) sub-parallel veins
065	Heustis	Schist and gneiss	140/80NE	Underground reserve of 123 800 tonnes of 14.1 g/t Au and 291g/t Ag; 530 m long; narrow sulphide-rich high-grade veins with galena and sphalerite; deep drill intersection at 425 m of 5.25 m of 4.1 g/t Au and 74 g/t Ag
065	Flex	Schist and gneiss	170/70W	Total reserve 109,000 tonnes of 5.9 g/t Au and 269 g/t Ag; open-pit oxide reserve of 67 507 tonnes of 4.9 g/t Au, 182 g/t Ag; 650 m long; veins complicated by offsets along northeast-trending faults
065	Dickson	Granodiorite	140/SW	A 660 m long zone of 5 to 6 Au-Ag-Pb-Zn-Sb veins; 3 m of 17.6 g/t Au, 80 g/t Ag; sulphide>oxide
	Vince	Schist and Gneiss	110/80S	A 50 m long zone averaging 2.5 m wide; best trench sample 3.0 m of 21.1 g/t Au and 74.7 g/t Ag; drill intersection of 14.4 m (~7 m true width) of 3.6 g/t Au and 20.9 g/t Ag
065	Orloff King	Andesite	150/45SW	Reserve of 84 500 tonnes of 2.1 g/t Au, 52 g/t Ag; single 280 m long, 3 m wide vein
	Spud	Andesite	NW	One vein partially explored by trenching
	Mill	Schist and gneiss		A few narrow low grade veins in a zone next to the mill; no drilling
<b>Central Porphyry Zone</b>				
066	Cyprus	Quartz monzonite porphyry		Early 1970s drilling explored the central porphyry complex Cu-Mo zone; hypogene Cu grades 0.1% to 0.15% which doubles in the supergene zone; anomalous but erratic Au
	Kelly	Quartz monzonite porphyry and qfp	NW	A 275 m wide, 2.5 km northwest-trending potassic alteration zone with coincident Cu-Mo-Au soil geochemical and geophysical anomalies; trench sample of 8.0 m of 0.86 g/t Au and 0.25% Cu
<b>Peripheral Porphyry Zone</b>				
066	Cyprus South	Granodiorite and qfp	NW	Several sulphide-bearing quartz veins and stockworks within the phyllic zone of the porphyry complex; wide drill intersection of low grade gold, 65 m of 0.31 g/t Au
	Oldtimer	Granodiorite and qfp		Sulphide-poor quartz veins and silicified; Free gold identified in polished sections, grab sample values up to 9 g/t
	Kelly South	Granodiorite and qfp		Gold values associated with pyrite shell in phyllic-altered zone peripheral to potassic zone
<b>Transitional Zone</b>				
	Eliza Creek Extension	Granodiorite and andesite	1° 150/80W 2° 020 mineralized shear zone at 065/80S	Northernmost extension of Eliza Creek veins and stockworks strongly associated with porphyry stocks, breccia and argillic/phyllic alteration; drill intersections of 48.8 m of 4.3 g/t Ag and 5.3 g/t Ag including a few high grade zones including 6.0 m of 17.5 g/t Au and 27.13 g/t Ag
	Transitional	Granodiorite	150/75W	Four main veins and stockworks, similar vein character to Eliza Creek Extension argillic alteration zone

Yukon Minfile	Name	Host lithology	Vein attitude	Description
<b>Epithermal Vein Zone</b>				
093	Eliza Creek South	Quartz diorite, schist and gneiss, minor andesite	1° 150\75SW 2° 020	Two main Au-Ag-Pb-Zn veins with a number of other sub-parallel veins, extensive clay alteration; trench samples 3.0 m of 1.0 g/t Au; 7.9 m of 3.4 g/t Au
093	Eliza Creek North	Quartz diorite and andesite		Northern continuation within the argillic alteration zone of the porphyry complex, veins have higher Cu values; 1.5 m of 10.3 g/t Au
	Etzel	Andesite, granodiorite and qfp sill	NW	A zone of Au, Ag, Pb and Zn veins along the edge of the porphyry complex near the volcanic-granodiorite contact
	Willow Creek	Granodiorite and quartz diorite	1° 150/75W 2° 130	Three Au-Ag-Pb-Zn veins with 60 to 90 m strike lengths; contain sulphosalts; 8.5 m of 5.1 g/t Au and 7.0 m of 3.5 g/t Au; veins terminated by 000° faults
067	Tawa - BRX	Granodiorite		Several 1-2 m wide, 825 m long Au-Ag-Pb-Zn veins; values to 43 g/t Au, 102 g/t Ag over 1.1 m
067	Tawa - Klaza	Granodiorite	NW	An anastomosing vein system (at least three veins) exposed for over 300 m by trenching; 8.0 m of 4.2 g/t Au and 47 g/t Ag including 11.1 g/t Au and 216 g/t Ag over 1.0 m
067	Tawa - BYG	Granodiorite	NW	Two trenches 180 m apart expose 1.5-4 m wide Au-Ag-Pb-Zn veins; possible extension of Klaza
117	Dic	Andesite	NW	Mineralized zone associated with the volcanic-granodiorite contact; westernmost of the Tawa veins
<b>Other mineral occurrences</b>				
096	Rusk	Andesite	NW	Several Au-Ag-Pb-Zn veins within a 100 m wide zone of argillic alteration; high silver values to 3000 g/t, and associated Sb
096	Rusk West	Quartz feldspar porphyry (qfp)		Disseminated and fracture-filled mineralization found within and around a rhyolite stock, associated Cu, Mo, Pb, Zn and Au soil geochem anomalies peripheral to stock; single drill hole (1970) intersected 3.0 m of sphalerite stringers
096	J.Bill	Andesite and qfp		A 2-8 m wide jarositic weathering, silicified breccia; Au, Ag, Pb and Zn mineralization; the breccia is adjacent to a qfp sill and has Au-in-soil anomalies
119	Dows	Schist and gneiss	040°	A >350 m long quartz-sulphide vein, locally chalcedonic, locally stibnite-rich; extensive clay alteration; drilling results includes 2.43 g/t Au over 7.5 m and 1.02 g/t Au over 1.5 m
084	Lonely	Quartz feldspar porphyry		Pyritiferous and altered rhyolite plug with quartz stringers, minor chalcopryrite
122	Grizzly	Andesite		Quartz-arsenopyrite vein up to 6 m wide traced for 150 m; vein float assayed 42.5 g/t Au and 59.94 g/t Ag
068	VIC	Syenite	080°	Several steeply-dipping, narrow high grade gold veins; a newly uncovered quartz-gold stockwork remains untested (grab sample 17.4 g/t Au)

Data are compiled from Langdon (1995), Yukon Minfile (1997), BYG (1995), Melling (1995) and observations made by the authors.

## CENTRAL PORPHYRY ZONE

Copper-molybdenum-gold mineralization is found in two locations within the porphyry complex – each centred on a core of potassic-alteration. The eastern potassic zone (**Cyprus**) was explored in the late 1960s and early 1970s with approximately 4500 m of drilling in 26 holes. Average hypogene grades of 0.12% Cu and 0.01% Mo below 60 to 90 m depth were found to approximately double in the supergene oxide enrichment zone above. Local higher grade zones of 0.6% Cu and 0.06% MoS<sub>2</sub> and rare precious metal grades are associated with extensive fracturing (Sawyer and Dickinson, 1976). These were centred on zones of weak potassic alteration which included tourmaline breccia, quartz veining, and lesser biotite enrichment within the dominantly phyllic-altered porphyry.

The western potassic zone (**Kelly**) was explored during 1994-97. It is approximately 275 metres wide and its northwest-trend has a potential strike length of 2.5 kilometres, as defined by coincident geochemical and geophysical anomalies, including: 1) Au, Cu and Mo soil geochemical anomalies; 2) high chargeabilities with moderate resistivities; 3) a distinct high magnetic anomaly observed in both ground and airborne surveys. Trenching and diamond drilling confirmed the potassic alteration zone that is manifest mainly by biotite enrichment and has associated quartz-pyrite stringers that locally include chalcopyrite, chalcocite, molybdenum, rare bornite and minor fluorite. Magnetic anomalies result from magnetite veins and quartz-magnetite stringers which also occur within the potassic alteration zone.

A drill hole in the Kelly zone intersected sub-economic copper and molybdenum mineralization throughout the entire 229 m of core. The strongest mineralization was in a 19 m intersection of the potassic-altered quartz monzonite porphyry breccia. This zone also yielded the highest gold grades including 8.0 m of 0.86 g/t Au and 0.25% Cu.

## PERIPHERAL PORPHYRY ZONE

Peripheral portions of the porphyry complex are characterized by a pyrite halo with strong phyllic (pyrite-sericite) alteration enveloping the potassic cores. Gold is the only ore mineral. Quartz flooding and associated quartz, quartz-pyrite and quartz-tourmaline stringers and stockwork with extensive brecciation overprint the phyllic-altered rocks. This zone is also typified by high chargeability with very low resistivity, a very low and flat magnetic response and widespread gold-in-soil anomaly. The anomalies also suggest a strong northwest structural control of mineralization and alteration. Arsenic, which is commonplace throughout most of the sulphide-bearing quartz veins, is noticeably absent from the entire porphyry complex.

The **Cyprus South** mineral occurrence is within a phyllic-altered northwest-trending porphyry dyke which is about 150 m wide. The dyke contains quartz-pyrite stockworks up to 60 m wide. Gold values over these widths average 0.3 g/t. The **Old-Timers** showing is a northwest-trending zone of silicified and phyllic-altered quartz monzonite and granodiorite. Quartz veining and

breccia with a low pyrite content are exposed in old hand-dug pits. Free gold has been panned from the rubble within the pit and has been observed in polished sections. Sampling yielded values of up to 9.0 g/t Au. Drill holes, collared on the western edge of the **Kelly** occurrence in 1997, intersected a 4.0 m wide zone of 1.34 g/t Au and another of 3.7 m of 18.9 g/t Ag with elevated tungsten values.

At least five active placer mines are located on streams that drain the Peripheral Porphyry Zone. It was reported that the gold recovered from one creek became finer-grained and that the silver content of the electrum decreased from the normal 20% as placer mining progressed further into the porphyry complex (T. Fraser, pers. comm. 1996).

## TRANSITIONAL ZONE

The Transitional Zone outside of the porphyry complex is characterized by sulphide veins which overprint porphyry-style mineralization and alteration. The zone has less intense phyllic alteration and brecciation than described in the Peripheral Porphyry Zone. Veins generally contain coarse-grained pyrite and minor chalcopyrite and lack the “cherty” quartz and fine-grained sulphide veins typical of more distal veins. Veins are generally confined to faults, but where they cut previously brecciated stockworks and phyllic-altered rocks associated with the porphyry mineralization they tend to become diffuse and permeate wide areas.

Strong northwest-trending Au, Ag, Pb, Zn, Cu and As soil geochemical anomalies form numerous zones that are coincident with the quartz-sulphide veins subsequently discovered by trenching and drilling. Gold anomalies are typically wider in the Transition Zone than in the Epithermal Zone because they reflect elevated gold values contained in the pyrite shell associated with the porphyry complex. Weak to moderate chargeability and resistivity anomalies from the veins are distinguishable from a background of elevated sulphide content associated with porphyry mineralization.

The **Eliza Creek Extension** is an example of mineralization in the Transitional Zone. Six sub-parallel veins strike northwest for about 300 metres into the Peripheral Porphyry Zone where they become diffuse and the mineralization dissipates. Free gold was observed in cuttings from six reverse-circulation drill holes in this area of the Transitional Zone. Drill assay results include:

### Vein 1

- 48.8 m of 4.25 g/t Au and 5.30 g/t Ag (RC94-5)
- 8.3 m of 1.78 g/t Au and 16.5 g/t Ag (DDH97-4)
- 1.9 m of 4.29 g/t Au and 1.0 m of 2.7 g/t Au (DDH97-3)

### Vein 2

- 15.2 m of 3.62 g/t Au and 50.08 g/t Ag (RC94-7A)
- 18.4 m of 3.82 g/t Au and 43.28 g/t Ag including
- 4.6 m with 6.8% Zn, 0.8% Pb and 0.2% Cu (RC94-21)

### Vein 3

- 11.6 m of 3.63 g/t Au and 27.8 g/t Ag (Trench sample)



## EPITHERMAL VEIN ZONE

Vein mineralization is extensive throughout the Mount Nansen camp and is the current focus of mining activity. There are literally hundreds of veins, varying in width and degree of mineralization, across the Nansen trend but they are stronger and more abundant within 3 or 4 main northwest-trending structural zones. There are two types of veins: an early “cherty” quartz-sulphide vein and a later coarse-grained sulphide vein. The “cherty” veins are composed of very fine-grained disseminated pyrite and arsenopyrite with blue, grey and white cryptocrystalline quartz. The coarse-grained veins are dominated by pyrite and include abundant sphalerite and galena, and locally chalcopyrite and tetrahedrite. The quartz is clear, milky or light grey and locally crystalline. Stringers and banded varieties of this mineralization occur locally where they cut and upgrade the “cherty” quartz-sulphide veins. Hydrofracturing in both vein types has resulted in brecciated sulphide minerals. Many veins are overprinted by white to yellow chalcedonic quartz.

Most veins occupy brittle fractures and shears that also locally contain variably altered felsic dykes. Strike lengths up to 900 m have been confirmed, although several may be discontinuous for many kilometres. Vein widths vary to 8.0 m, although mineralized zones up to 25 m have been determined at the **Brown-McDade** system. Most of the veins are confirmed to depths of 50 to 100 m by drilling, but a single deep drill hole on the **Heustis** vein confirms its continuity of character to a depth of at least 425 metres.

### Structure of epithermal veins

The majority of the larger veins are northwest-trending and dip steeply to the west. The hanging wall is typically a fault. Fault zones host as many as four veins which typically contain brecciated wall-rock and brecciated quartz fragments. Some veins are simple, narrow and continuous whereas others form complex, anastomosing systems. As mentioned previously, the intersections of veins are important features in defining ore shoots and increasing the tonnage of the deposits. Ore shoots typically occupy 30-50% of individual veins (R. Stroschein, pers. comm., 1998).

### Mineralogy

Ore mineralogy varies between the veins but most are dominated by pyrite, arsenopyrite, galena and sphalerite with lesser stibnite, chalcopyrite, bornite, tetrahedrite and later sulphosalts. Acanthite, electrum, argentite and chalcopyrite have been reported from the **Willow Creek** occurrence (Bremner, 1991). Bindheimite, jamesonite, bouronite, freibergite have been reported from the **Webber** (Melling, 1995). Jamesonite, bouronite have been reported from the **Brown-McDade** (Lamb, 1947). Calcite and gypsum typically form late, fracture-filling minerals, but are usually leached from near-surface outcrops.

Gold grains or electrum are associated with pyrite, chalcopyrite and arsenopyrite but most commonly occur as grains within quartz. Most of the Mount Nansen epithermal ore contains between 10% and 25% of the total gold as free gold or electrum. High gold and weak silver values tend to be associated with the arsenopyrite. Silver grades correlate well with galena. Silver to gold ratios average about 20:1 but vary from vein to vein from 10 to 200:1. Gold grades decrease away from the hanging wall.

### Alteration of epithermal veins

Most veins are enveloped by bleached alteration zones that are up to 10 m wide. The extent and width of the alteration is dependent on the host rock. Granodiorite host rocks are the most extensively altered; andesite is less altered. Argillic alteration is predominant, indicated by kaolinite and illite, with lesser montmorillonite. Phyllic alteration is common but is less extensive and much less well developed in the metamorphic rocks than it is in the granitic rocks. Phyllic alteration is characterized by alteration to sericite, silicification and sulphidization with disseminated pyrite. Dykes associated with veins are intensely argillically altered (Smuk et al., 1997). Metamorphic rocks are most resistant to alteration but become bleached.

The depth of oxidation varies considerably, from as little as 5 m on north-facing slopes, to as deep as 150 metres within faults and shear zones. Scorodite, limonite and melanterite staining is typical in oxidized veins. Manganese wad is extensive along the vein perimeters. In many cases, the alteration zones are extensively oxidized, but the quartz vein may not be. Secondary cerussite is reported from the **Willow Creek** occurrence (Bremner, 1991).

## EXPLORATION CONSIDERATIONS

Recommended exploration methods include time-domain IP surveys, soil geochemistry with Au, Ag, Pb, Zn, As, Sb and Cu, airborne and ground magnetic and VLF-EM surveys, and air photograph interpretation followed up with trenching and drilling. Exploration success also requires a geological understanding of the structural and other mineralizing controls within the porphyry-to-epithermal transition. In addition, exploration should focus on the main structural zones within and on the margins of the corridor.

The intense alteration, brecciation and oxidation of mineralized zones in the Mount Nansen camp makes core recovery, logging and sampling difficult. Recognition of rock types in the ore zones can be difficult and core recovery of rubble or clay-rich vein material is sometimes poor. In a recent exploration program at Brown-McDade, ore versus host-rock was determined by a cutoff assay of 4 g/t Au. However, clay-rich materials were often washed out during drilling. Since the fine-

grained ore fractions contain a considerable percentage of the contained gold, the grades of the recovered core were less than those encountered during mining. As a result, ore reserve calculations may be underestimated.

Gold grades within the vein material may also be difficult to deduce with confidence because of the presence of high-grade stringers and patches, and free gold. For this reason, as well as those mentioned previously, the correlation of grades within a deposit, or even between twinned holes, can be extremely variable.

## CONCLUSIONS

Most of the mineral occurrences that comprise the Mount Nansen trend occur in a horst which represents the exposed sub-volcanic zones of Mount Nansen Group volcanism. Very few occurrences are in the andesite, thereby suggesting that mineralization is preferentially emplaced at lower structural levels.

Much of the mineralization in the Mount Nansen trend can be placed in a zoned porphyry to epithermal transition framework which is centered around potassic alteration cores. The proximity of the epithermal veins to the Central Porphyry complex, the Dickson stock and porphyry dykes promotes a model that links ore genesis with the magmatism.

The formation of large epithermal ore bodies relies on the structural interaction of the northwest and the 020° fracture systems. The intersection of these structures creates a "blow-out" where the vein thickness increases considerably. The 020° fractures become entirely extensional at the points where they intersect the strike-slip motion of the northwest-trending series. These extensional blow-outs, when filled with vein material, add considerable tonnage to the veins. Although the third dimension is incompletely known, the blow-outs probably form steeply plunging cylindrical ore shoots.

## ACKNOWLEDGEMENTS

The authors wish to acknowledge the support of BYG Natural Resources, Inc. and Aurchem Exploration Ltd. for access to the properties and open exchange of information. Farrell Andersen of BYG was particularly helpful. Field assistance by Vikki Meyer is appreciated. The manuscript has been improved with helpful reviews and comments from Charlie Roots and Robert Stroshein, but the authors accept responsibility for errors in interpretation and acknowledge their different opinions.

## REFERENCES

- Bostock, H.G., 1936. Carmacks District, Yukon (115I). Geological Survey of Canada Memoir 189.
- Bremner, T., 1991. Goulter mineral occurrence. *In: Yukon Geology 1990*. Exploration and Geological Services Division, Indian and Northern Affairs Canada, Yukon, p. 33-35.
- BYG, 1995. 1995 Annual Report, BYG Natural Resources Inc., 18 p.
- Cairnes, D.D., 1916. Summary Report 1915. Geological Survey of Canada, p. 20-33.
- Carlson, G.C., 1987. Bedrock geology of the Mount Nansen and Stoddart Creek map areas (115I/03 and 115I/06). Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, Open File 1987-2.
- Lamb, J., 1947. The Geology and Mineralogy of the Brown-McDade Mine. Unpublished B.Sc. thesis. University of British Columbia.
- Langdon, M., 1995. Brief summary of the Mount Nansen properties, Whitehorse District, Yukon, NTS 115I/3. Private report for Aurchem Exploration Ltd., 13 p.
- Melling, D.R., 1995. Summary Report: 1995 Exploration program, Mount Nansen Gold project (115I/3); for BYG Natural Resources Inc.
- Sawyer, J.B.P. and Dickinson, R.A., 1976. Mount Nansen. *In: Porphyry Deposits of the Canadian Cordillera*. Canadian Institute of Mining and Metallurgy, Special Volume 15, p. 79-82.
- Smuk, K.A., Williams-Jones, A.E. and Francis, D., 1997. The Carmacks hydrothermal event: an alteration study in the southern Dawson Range. *In: Yukon Geology 1996*. Exploration and Geological Services Division, Indian and Northern Affairs Canada, Yukon, p. 92-106.
- Tempelman-Kluit, D.J., 1984. Geology of Laberge (105E) and Carmacks (115I) map areas. Maps with legends, 1:250 000 scale. Geological Survey of Canada Open File 1101.
- Yukon Minfile. Northern Cordilleran Mineral Inventory. Updated bi-annually by Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada. Available from IMS Services, 204-402 Hanson Street, Whitehorse, Yukon Y1A 1Y8, 867-633-4900.