A summary report on the geology of the Brown-McDade gold-silver deposit, Mount Nansen mine area, Yukon

Robert Stroshein

BYG Natural Resources Inc.[1]

Stroshein, R., 1999. A summary report on the geology of the Brown-McDade gold-silver deposit, Mount Nansen mine area, Yukon. *In:* Yukon Exploration and Geology 1998, C.F. Roots and D.S. Emond (eds.), Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, p. 231-236.

ABSTRACT

The Brown-McDade deposit was the first vein system discovered in the Mount Nansen camp and has produced approximately 34,000 ounces (1058 kg) of gold and 131,000 ounces (4,075 kg) of silver from 225,000 metric tonnes of ore since production began in November, 1996. Production rates have varied since the mill start-up but the carbon-in-leach (CIL) plant is currently operating near capacity at 700 metric tonnes per day.

Mining at the Brown-McDade open pit has exposed two separate and distinct deposit types. The first type is gold-silver vein mineralization hosted by a massive feldspar porphyry dyke. These fine-grained quartz-sulphide veins and vein breccia are enclosed by silicified and/or intensely clay-altered brecciated feldspar porphyry. The feldspar porphyry dyke has intruded along an igneous-metamorphic contact that has been mined over a strike length of 50 m in the southern portion of the pit. The second deposit type that occurs at the north end of the pit consists of a siliceous, sulphide-rich breccia in a pipe-like structure hosted by metamorphosed carbonate and clastic rocks of the Nasina Assemblage. The pipe is elongate in plan with a high-grade core approximately 15 m wide and 25 m long surrounded by a low-grade envelope consisting of quartz-sulphide stringers in a silicified breccia. The deposits are separated by a northeast-striking fault which truncates and offsets the main vein-dyke mineralization.

The ore is composed of fine-grained quartz and sulphides in narrow veins or as matrix to a breccia of silicified and pyritized wall rock fragments. Unoxidized ore contains dark grey silica and pyrite, arsenopyrite, sphalerite, galena, sulphosalts, bornite, stibnite and chalcopyrite. Gold is genetically related to the pyrite phase of the mineralization and occurs as 5 to 50 micron-sized inclusions in pyrite grains. Oxidation of sulphide minerals extends to depths of up to 70 m and a large portion of the gold grains have been exposed by oxidation of the sulphides and post-depositional cataclastic fractures in the pyrite. The silver mineralogy is not as well understood but appears to be related to the base metal sulphide mineralization.

RÉSUMÉ

Le gisement Brown-McDade, le premier réseau filonien découvert au camp Mount Nansen, a fourni approximativement 34 000 onces (1058 kg) d'or et 131 000 onces (4075 kg) d'argent extraits de 225 000 tonnes de minerai depuis les débuts de la production en novembre 1996. Le taux de production a varié depuis la mise en exploitation de l'usine, mais celle-ci est actuellement exploitée presque à sa pleine capacité de 700 tonnes par jour.

L'extraction de la fosse à ciel ouvert Brown-McDade a mis à nu deux types distincts et séparés de gisements. Les gisements du premier type sont des minéralisations en or et argent de type filonien dans un dyke de porphyre feldspathique massif et sont composés de filons de quartz et sulfures à grains fins et de brèche filonienne compris dans un porphyre feldspathique bréchique silicifié et/ou fortement argillisé. Le dyke de porphyre feldspathique a pénétré le long d'un contact entre roches ignées et métamorphiques que l'extraction a permis de suivre sur 350 mètres dans la partie sud de la fosse. Les gisements du deuxième type, à l'extrémité nord de la fosse, consistent en brèche siliceuse riche en sulfures dans une structure en forme de cheminée qui est encaissée dans des roches carbonatées et clastiques métamorphisées de l'assemblage Nasina. La cheminée présente en plan une forme allongée avec une partie centrale à teneur élevée mesurant approximativement 15 mètres de largeur sur 20 mètres de longueur et elle est entourée d'une enveloppe à faible teneur consistant en petits filons de quartz et sulfures dans une brèche silicifiée. Les gisements sont séparés par une faille orientée nord-est qui tronque et déporte la minéralisation filonienne-dyke principale.

Le minerai se compose de quartz avec sulfures de granulométrie fine dans des filons étroits ou prend la forme de gangue bréchique avec fragments de roche encaissante silicifiés et pyritisés. Le minerai non oxydé renferme de la silice gris foncé et des sulfures, notamment de la pyrite, de l'arsénopyrite, de la sphalérite, de la galène, des sulphosels, de la bornite, de la stibine et de la chalcopyrite. L'or est génétiquement relié à la phase pyrite de la minéralisation et prend la forme d'inclusions de 5 à 50 microns dans les grains de pyrite. Les minéraux sulfurés sont oxydés jusqu'à des profondeurs atteignant 70 mètres et une grande partie des grains d'or ont été mis à nu par oxydation des sulfures et par des fractures cataclastiques post dépôt dans la pyrite. La minéralogie de l'argent n'est pas aussi bien comprise mais semble reliée à la minéralisation en sulfures de métaux communs.

[1]*BYG Natural Resources Inc., General Delivery, Carmacks, Yukon Y0B 1C0*

INTRODUCTION

The Brown-McDade gold-silver deposit is located approximately 60 km along the Mount Nansen road west of Carmacks, south-central Yukon (Fig. 1). The deposit was discovered by prospectors Afe Brown and George McDade in 1943. The mineralization was explored underground in 1946 with approximately 750 m of drift and crosscut development. The deposit was explored intermittently by trenching, percussion drilling (17 holes, 1285 m) and surface diamond drilling (86 holes, 6535 m) between 1984 and the time of development of the open-pit mine in November, 1996.

BYG Natural Resources Inc. operates a 700-metric tonne-per-day carbon-in-leach (CIL) mill at the Mount Nansen site that has produced approximately 34,000 ounces (1058 Kg) of gold and 131,000 ounces (4075 Kg) of silver from 225,000 tonnes of ore. Past production has been from the Webber and Huestis veins in 1968-69 while all the current production has been from the Brown-McDade deposit (Fig. 2). Future production will be from underground on the lower Brown-McDade veins and breccia pipe as well as the Flex and other gold-silver rich zones on the property including the Webber and Huestis veins.

Mining of the Brown-McDade deposit has provided a detailed geological look at the deposit that has resulted in a revised exploration model for the deposit and other occurrences in the area.

REGIONAL GEOLOGY

The Brown-McDade gold-silver deposit in the Mount Nansen mine area is located in the Dawson Range within Yukon-Tanana Terrane (YTT). The YTT Early Mississippian metamorphic rocks are intruded by several plutonic suites (Carlson, 1987).

The metamorphic rocks are separated into two suites, meta-sedimentary and meta-igneous. Micaceous quartz-feldspar gneiss, schist, and quartzite of the Nasina Assemblage form the meta-sedimentary rock suite. Metamorphosed carbonate rocks exposed in the open pit are the first to be recognized in the area. The meta-igneous package includes biotite-hornblende feldspar gneiss and coarse-grained granodiorite orthogneiss with lesser amphibolite.

The metamorphic rocks have been intruded by foliated Upper Triassic and weakly foliated Jurassic diorite, granodiorite, and syenite batholiths.

The metamorphic and foliated plutonic rocks are intruded by mid-Cretaceous felsic plutonic rocks of the Coffee Creek Plutonic Suite and capped by the coeval mafic to intermediate volcanic flow and tuff rocks of the Mount Nansen Volcanic Suite (Johnston and Mortensen, 1994). Genetically related sub-volcanic feldspar porphyry dykes and plugs intrude all rock types (Sawyer and Dickinson, 1976).

The Late Cretaceous Carmacks Volcanic Suite, although absent in the immediate Mount Nansen area is voluminous in the region where relatively flat lying pyroclastic tuffs and flow units form prominent ridges capping the metamorphic rocks (Carlson, 1987). The Carmacks Volcanic Suite is magmatically related to the Prospector Mountain Plutonic Suite (Johnston and Mortensen, 1994).

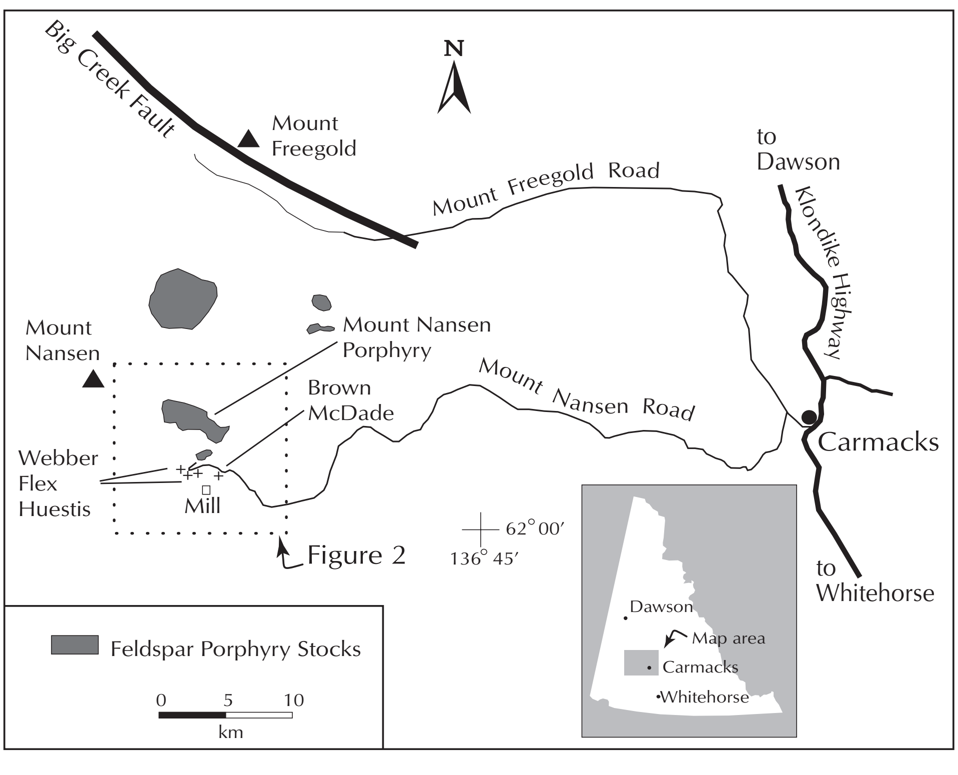

***Figure 1**. Location of veins (small crosses) in the Mount Nansen mine area.*

MOUNT NANSEN GEOLOGICAL AND METALLOGENIC SETTING

In the centre of the Mount Nansen property, a sub-volcanic feldspar porphyry intrusive complex of the Mount Nansen Volcanic Suite forms an east-west elongate zone about 3.2 km long by 1.6 km wide (Fig. 2). The Mount Nansen porphyry complex hosts disseminated copper-molybdenum mineralization in a diverse assemblage of porphyritic rocks including dykes, small plugs and breccia bodies (Sawyer and Dickinson, 1976).

The precious metal mineralization on the Mount Nansen property consists of structurally controlled planar veins with associated clay-rich and bleached alteration zones and pipe-like breccia systems peripherial to the central Mount Nansen porphyry complex. The mineralized vein zones range from narrow, simple quartz-sulphide veins to complex, anastomosing and braided systems that crosscut all rock types. The veins tend to occupy fractures in metamorphic rocks (Huestsis-Flex-Webber) or invade porphyry dykes that preferentially intrude zones of structural weakness such as faults (Orloff King) or intrusive contacts (Brown-McDade). Several mineralized breccia bodies have been identified within the porphyry complex (1972 Breccia), in older plutonic rocks (1998 Breccia), and in competent metamorphic rocks (north end of Brown-McDade).

A widespread propylitic alteration zone around the Mount Nansen porphyry complex has affected most rocks on the property. Rocks in the vicinity of the Brown-McDade deposit

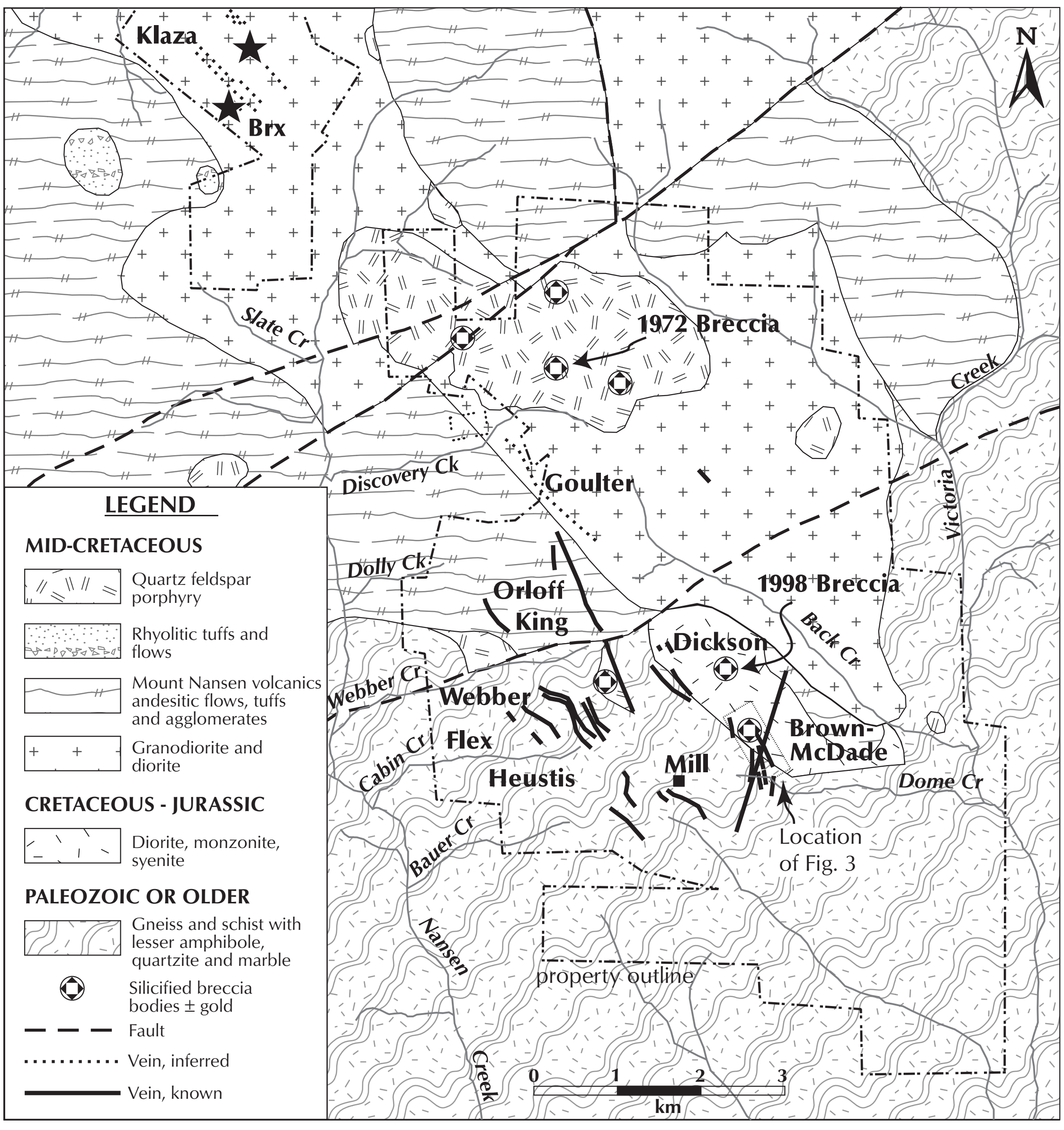

Figure 2. *Geology of the Mount Nansen area.*

contain epidote, calcite, pyrite and magnetite replacement of hornblende characteristic of the propylitic alteration mapped near the porphyry complex (Sawyer and Dickinson, 1976).

The Mount Nansen area was beyond the limit of the most recent continental glaciation although earlier incursions moved up the valley bottoms (Sawyer and Dickinson, 1976). Weathering extends to depths of up to 70 m below surface and includes leaching and oxidation in the mineralized zones. Sulphides are commonly altered to limonite or other oxides.

BROWN-MCDADE DEPOSIT GEOLOGY

The Brown-McDade open-pit mine encompasses two distinct deposits separated by a complex, steeply dipping, northeasterly trending fault zone which crosscuts the pit at an acute angle 30 to 40 m north of the underground adit (Fig. 3). The southern two-thirds (350 m) of the pit has been developed to exploit a complex vein system made of planar veins, vein breccias and mineralized and altered wallrock. The northern portion of the pit encompasses an elongate breccia zone 25 m wide by 70 m long with intensely mineralized internal pipe-like zones in the central portion.

The host rock for the planar vein system is a feldspar porphyry dyke that has intruded the contact between weakly foliated hornblende diorite of probable Jurassic age and metamorphic rocks of the Devono-Mississippian Nasina Assemblage. The vein-dyke-contact system trends north northwest and dips at 70° southwest. The vein-dyke complex is being mined along a 350 m strike length, currently 45 m below the original surface. The width of the dyke enclosing the vein system varies from several metres to greater than 30 m. On one section on the 1250 bench, four 2 m channel samples across the exposed dyke on the 1250 bench yielded an average grade of 21 g/t gold and 108 g/t silver. The 2 m wide vein mineralization of the interval assayed 51.6 g/t gold and 201 g/t silver. Thickening of the dyke and contained veins occurs with embayments in the footwall diorite contact (Fig. 3).

The vein-dyke system gradually diminishes in thickness at the south end of the deposit where the diorite-metamorphic contact turns eastward. The north end of the vein-dyke complex is truncated by a north northeasterly trending system of post-mineralization faults. The faults are interpreted to have left-lateral offsets consistent with observations at other localities on the property (Anderson and Stroshein, 1997). The sense of movement from the re-location of the footwall diorite to the hanging wall of the deposit suggests that the northern extension of the vein-dyke complex has been offset as much as 200 m to the southwest.

The sulphide-rich breccia-hosted deposit is located at the northern end of the open pit in the hanging wall of the north northeast trending, offsetting fault system. The gold-silver rich breccia mineralization (grades of 9-34 g/t gold and 25-90 g/t silver) forms an irregular pipe-like body elongate in plan, approximately 15 m wide by 25 m long. The pipe appears to plunge at a moderate to steep angle (50°-70°) towards the

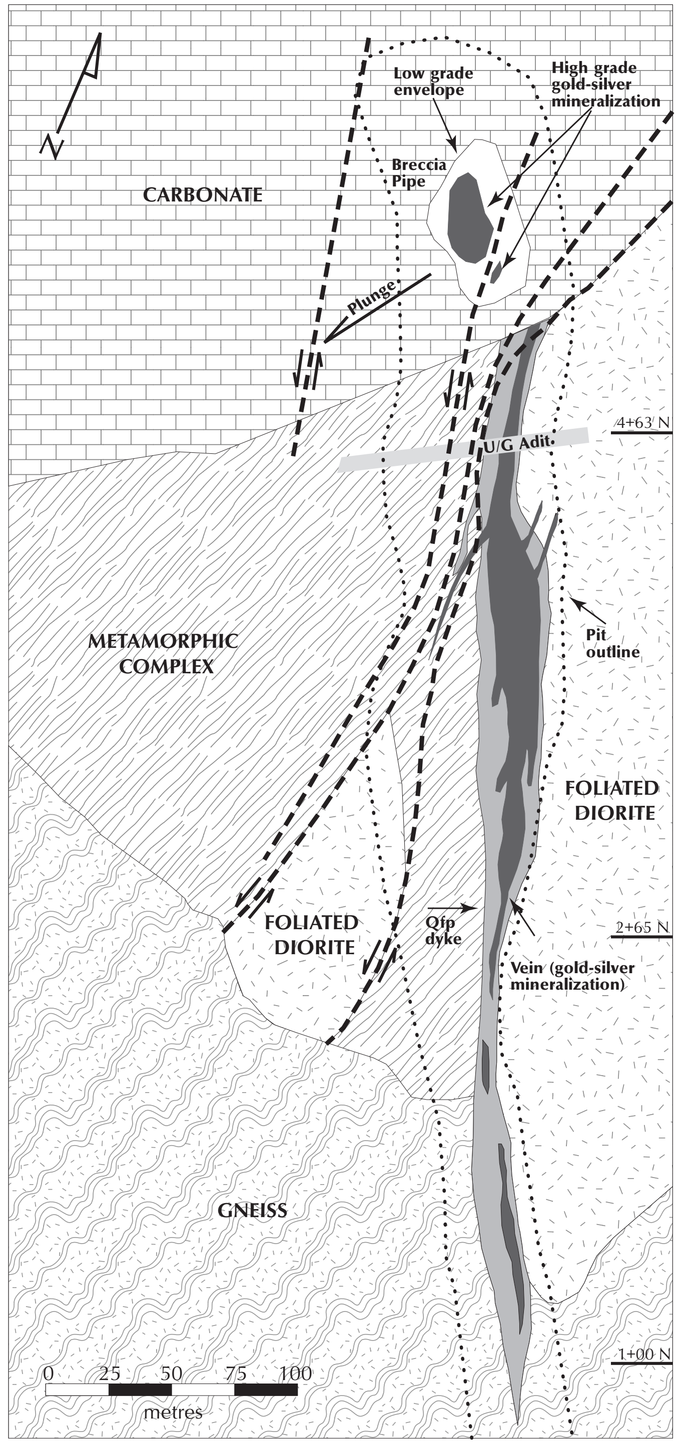

Figure 3. *Geology map of the Brown-McDade mine. The outline of the current open pit is indicated by a dotted line.*

southwest and is contained within a broader breccia envelope of low grade brecciated and weakly mineralized rock approximately 70 m long by 25 m wide. The host rock of the breccia pipe exposed in the pit is a re-crystallized limestone that is locally marble. A drill hole intersected the mineralization 60 m down plunge hosted by fine-grained metamorphosed clastic rocks (23.8 m grading 11.7 g/t gold and 24 g/t silver).

The unbrecciated limestone is massive and thick bedded, striking at 120° and dipping 40° to the north. Foliation of the metamorphic rocks strikes northwest to northeast with northerly dips of 30° to 50°. Cleavage trends north to northeast, with 50° to 80° northwest dips, except where folding is present.

PRECIOUS METAL MINERALIZATION

The mineralization is typically epithermal with veins and vein breccias enveloped by silicified and bleached clay alteration zones in the wallrock. Silicification of the brecciated wall rock adjacent to the vein contact and of fragments within the vein breccias is distinguished by very fine vugs in the rock, yellow weathering colour and drusy quartz lining cavities in the breccia. The vein and silicified zone is commonly 1 to 3 m wide. Enveloping the vein zone, disseminated pyrite content increases away from the veins with decreasing silicification in the phyllic alteration zone that can extend up to 10 m in width. Argillic alteration is distinguished by the presence of kaolinite and montmorillinite which generally developed throughout the feldspar porphry outside of the silicic and phyllic zones. The mineralized and altered feldspar porphyry dyke ranges from 8 to 33 m wide.

The gold- and silver-rich sulphide consists of pyrite, arsenopyrite, sphalerite, galena, sulfosalts, bornite, stibnite and chalcopyrite. Gold is genetically related to an early pyrite phase of the mineralization and occurs as 5 to 40 micron-sized inclusions in the pyrite (Lister, 1988). The gold grains have a fineness of approximately 800 (Saager and Bianconi, 1971; Lister, 1988). The gold grains have been exposed by oxidation of the sulphide minerals as well as by post-mineral cataclasis.

Assay results indicate that the breccia-hosted mineralization has higher gold grades relative to the silver values than the vein-hosted mineralization. The gold to silver ratio from assays of the breccia-hosted mineralization is approximately 1:3, whereas that of the vein mineralization is approximately 1:7. The silver content appears to be related to the amount of the base metal in the ore. Galena and sphalerite are more abundant in the vein mineralization than in the breccia-type mineralization.

SUMMARY

Gold-silver veins and breccias at Mount Nansen are epithermal deposits related to a variety of structural settings including intrusive contacts, narrow fractures or breccia bodies. The Brown-McDade mine has exploited two types of deposits: a vein system hosted by a massive feldspar porphyry dyke that has intruded along an igneous-metamorphic contact zone, and a pipe-like breccia body within competent metamorphic rocks. A swarm of northwest-trending veins occupy fractures within metamorphic rocks 2 km west of the Brown-McDade in the Huestis-Flex-Webber system. Other mineralized breccia bodies have been explored within the Mount Nansen porphyry complex and in the foliated plutonic rocks north of the Brown-McDade deposit.

The mineralization is likely genetically related to the Mount Nansen Porphyry complex located in the centre of the Mount Nansen property. Gold has been mined from placer deposits flanking the porphyry system, and low-grade precious metal values occur within silicified breccia zones within the copper-molybdenum porphyry system.

Information derived from detailed mapping and sampling has lead to a revised geological model for the precious metal deposits in the vicinity of the Mount Nansen porphyry complex. The origional exploration model focussed on northwest-trending fault-controlled veins related to large scale regional structures. Numerous gold-silver occurrences and anomalies on the property will be re-evaluated and investigated applying the evolving geological model and concepts (Fig. 2).

In profile, the Brown-McDade deposit exhibits a well developed near-surface oxide gold enrichment zone for both the vein- and breccia-type bodies. Priority exploration targets are the potentially enriched oxidized zones capping breccia pipes or veins within large feldspar porphyry intrusions. Numerous gold-in-soil anomalies have been untested in the competent homogeneous rocks north of the Brown-McDade deposit. More anomalies occur closer to the Mount Nansen porphyry complex.

The narrow vein systems hosted by the metamorphic rocks are potentially economic because of the high gold-silver values if the density of veining can produce signifigant volumes for bulk mining. Skarn-type alteration has been noted at several localities in limy rock units along road cuts between the Brown-McDade deposit and the Huestis-Flex-Webber vein system. No gold values have been obtained from these occurrences, but this potential type of mineralization was not previously recognized or evaluated in the Mount Nansen camp.

ACKNOWLEDGEMENTS

The author is indebted to his co-workers who have contributed to the successful operation of the Brown-McDade mine, especially geologists Neil Firt and Ken Lord. I would also like to thank BYG Natural Resources Inc. for support in the preparaton of this report. Diane Emond edited this report and Panya Lipovsky drafted relevant figures.

REFERENCES

Anderson, F. and Stroshein, R., 1997. Geology of the Flex gold-silver vein system, Mount Nansen area, Yukon. *In:* Yukon Exploration and Geology 1997, Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, p. 139-143.

Carlson, G.G., 1987. Geology of Mount Nansen (115-I/3) and Stoddart Creek (115-I/6) map areas, Dawson Range, central Yukon. Exploration and Geological Services Divison, Yukon, Indian and Northern Affairs Canada, Open File 1987-2.

Johnston, Stephen, T. and Mortensen, James, K., 1994. Regional setting of porphyry Cu-Mo deposits, volcanogenic massive-sulphide deposits, and mesothermal gold deposits in the Yukon-Tanana Terrane, Yukon. *In:* Yukon Metallogeny: Recent Developments, Abstracts and Proceedings, Canadian Institute of Mining and Metallurgy, District 6 Annual General Meeting, J.L. Jambor (ed.), p. 30-34.

Lister, D., 1988. Report on the sulphide mineralogy of the Brown-McDade zone, Mount Nansen property. Unpublished company report, BYG Natural Resources Inc. and Chevron Minerals Ltd., 49 p.

Saager, R. and Bianconi, F., 1971. The Mount Nansen gold-silver deposit, Yukon Territory, Canada. Mineralium Deposita (Berl.), vol. 6, p. 209-224.

Sawyer, J.P.B. and Dickinson, R.A., 1976. Mount Nansen, porphyry copper and copper-molybdenum deposits of the calc-alkaline suite. *In:* Porphyry Deposits of the Canadian Cordillera, T. G. Schroeter (ed.), Canadian Institute of Mining and Metallurgy, Special Vol. 15, p. 336-343.