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BEDROCK GEOLOGY AND MINERALIZATION OF THE KLONDIKE AREA (EAST), 115 O/9,10,11,14,15,16 AND 116B/2

Exploration and Geological Services Division

Whitehorse, Yukon

DESCRIPTIVE NOTES

Previous mapping of this area was done at a scale of 1:250,000 by H.S. Bostock in 1936, 1936, and 1937, and was published as G.S.C. Map 731A (Bostock, 1942). The present mapping was done at a scale of 1:50,000 and was carried out by Geological Services Division, Yukon, assistant geologists Trio Jesse Duke and Kathi Salmon (in Baldwin, 1984). Assistance in field mapping done during 1983 in the area immediately northwest of this map area by Ruth Debicki, Kate Grapes and Lori Walton. Results of the 1983 work were published as an Open File Report by Exploration and Geological Services Division (Debicki, 1984).

The lithology may be subdivided into three broad categories, each of which has had a different history. The ages of the rocks in the three categories are Triassic or older, early Cretaceous and / or older, and late Cretaceous to early Tertiary.

Triassic or Older

The Triassic or Older rocks make up most of the bedrock in the area. Dates of metamorphism have been determined for some of them, but their actual ages are generally not known. Protoliths include sedimentary, volcanic and intrusive rocks. The rocks have undergone ductile shear, and some brittle shear deformation. The degree of deformation changes abruptly over short distances. In some places, breccia fragments in mafic volcanic breccia have not been flattened or ductile shear, elsewhere they have undergone moderate ductile shear, and elsewhere they have undergone open folded. Brittle deformation has also taken place. In addition, the rocks have undergone varying degrees of recrystallization which also change abruptly over short distances. Prograde metamorphism reached almandine-amphibolite facies. Some rocks were polymetamorphosed.

A wide variety of structural features is present in the Triassic or older rocks. Features include bedding, or S_0 structures such as are present in some sedimentary units. A poorly developed recrystallization foliation, or f_1 subparallel to bedding is present in some sedimentary units. A well developed foliation, parallel to the f_1 foliation is best developed in the mafic metavolcanic rocks. The bedding and f_1 foliation have been isoclinally folded, and an f_2 axial planar foliation developed. The recrystallization of the f_1 and / or chlorite parallel to the f_2 axial planar foliation is generally northwest-trending. Isoclinal folding has also occurred about an f_2 axis, which is typically northeast-trending; some recrystallization of muscovite and / or chlorite parallel to this fold axis has also taken place. Gentle, open, north-trending folds post-date the other structural features found in the Triassic or older rocks.

Early Cretaceous and / or Older

The early Cretaceous and / or Older rocks comprise spherioidally-weathering diabase which occurs as rare dykes 2m or less wide. The dykes are not deformed or metamorphosed, but in places poorly developed foliation and folds are present.

Late Cretaceous to Early Tertiary

The late Cretaceous to Early Tertiary rocks occupy only a small part of the 1984 map area, but are more extensive and adjacent area mapped in 1983. They include felsic intrusive and volcanic rocks, including rhyolite porphyry dykes and flows and tuffs, andesite dykes, and siltstone, greywacke, and conglomerate. They are undeformed except for syn-depositional slumping and are likely correlative with the Eocene Amelia Creek volcanics (Tempelman-Kluit, 1979; Ma 1-Grond et al., 1984). Volcanic rocks at Heyscham Mountain just south of the map area have been dated at 58 Ma (Lowey, 1985). The youngest rocks in the area are felsic tuffs, monolithic and heterolithic felsic breccias, and rhyolite porphyry dykes and plugs. The rhyolite porphyry has been dated at 56 Ma (T. Bundsen, Indiana Consultants) making it contemporaneous with the hosting Mayo batholith.

MINERAL OCCURRENCES

Seventeen mineral occurrences are described. All have been previously staked, or have had work done on them, but no references to staking or work done are known for several. Some previously described occurrences which are insignificant, and some claim groups which were staked on speculation are not described. Most references are to Bostock (1936), to MacLean (Lode mining in Yukon, Dept. of Mines, Mines Branch, Pub. No. 222, 205 p., 1916), H.M. Rowat (The Yukon Territory: its history and resources, Dept. of Interior, p. 147, 1916), and C.F. Gleeson; (Geol. Sur. Can. Bull. 173, 63 p., 1970). Annual reports of the Yukon Mining Commissioner, Annual Reports of the annual Mineral Industry Reports and Exploration and Geology Reports of Geology Division, D.I.A.N.D. and the Northern Cordillera Mineral Inventory (Archer, Cathro & Associates Ltd., 1972), and from field observations made during 1983 and 1984.

1 - LEOTTA — Zn

The LEOTTA property was staked in 1969, after sphalerite was found in the panning sample collected from Too Much Gold Creek. According to maps available at the time, the claims were underlain by serpentinized peridotite, but current mapping shows that much of the area is underlain instead by massive to foliated dark grey to black carbonaceous quartzite, and carbonaceous schist carrying minor amounts of pyrite.

2 - GREEN GULCH — Au

A quartz vein cuts the hangingwall and footwall of a south-west-dipping thrust fault that has emplaced chlorite-quartz schist on the hangingwall against muscovite-feldspar-quartz schist on the footwall. The vein strikes 025°, and dips steeply southeast. It varies from 0.3m to 0.6m wide, and in places contains pyrite, chalcopyrite, galena, and gold. All five of the selected samples of vein material collected by MacLean contained at least 17 g/t Au. One sample of quartz with galena contained 20.9 g/t Au, and 6.2 g/t Ag, elsewhere on the property, a sample collected from quartz stringers contained 0.34 g/t Au, and 17 g/t Ag.

3 - LLOYD — Au

Several quartz veins cut the hangingwall and footwall of a southwest-dipping thrust fault which has emplaced chlorite-quartz schist on the hangingwall against muscovite-feldspar-quartz schist and muscovitic quartzite in the footwall. The veins trend northwest, and dip steeply southwest. They are 0.3m to 1.5m wide, and can be traced in pits, shafts, and bulldozer trenches for 250m along strike. The veins contain traces of pyrite and galena. Minor propylitic alteration occurs adjacent to the veins. Of 9 samples collected by MacLean, only 3 contained measurable amounts of gold. Values ranged from 0.1 g/t to white to rusty quartz with galena and pyrite. Selected samples containing sulphides collected in 1983 and 1984 contained 0.35 to 17 g/t gold, and only low values of silver.

4 - DOMINION — Au

The area is underlain by silver- to rusty-weathering muscovite feldspar-quartz schist to muscovitic quartzite. MacLean reported three quartz veins, each 0.9m wide separated by 18 m of rock, in a bulldozer trench. The veins consist of quartz 3.7m wide 150m west of the trench. The quartz contained minor amounts of pyrite and, galena, but assays for gold were trace or nil. When the property was visited in 1984, two trenches 30m apart were seen. They exposed a subhorizontal quartz vein 0.3m wide, and a 2m wide quartz stringer in foliation of the host schist. Samples collected from one trench, and 390m south of trenches from an outcrop of milky white quartz with weathered blebs of sulphides both contained no gold.

5 - GOLD RUN — Au

The property is underlain by well-foliated buff to pale green weathering muscovite-feldspar-quartz schist, which is in the footwall of a southwest-dipping thrust fault. Minor disseminated traces of galena and gold in pyritic quartz cutting the schist. One sample of quartz reportedly contained 58.2 g/t Au, and 51.3 g/t Ag, and a second sample contained 5.5 g/t Au and 13.0 g/t Ag. The gold content of 19 other samples was, reportedly, less than 0.1 g/t Au. Numerous pits, trenches, quartz boulders and test pits were present over a wide area, but no well defined vein structures were seen. The quartz was massive and milky white, with rusty stains on fracture surfaces and minor blebs of oxidized sulphides. A few partially digested wall rock inclusions were noted. Some quartz was brecciated with fine grained disseminated pyrite in the wall rock were noted. Some vein material has been fractured, and cemented by calcite. Three samples of quartz collected in 1984 did not carry significant values of gold.

6 - PORTLAND WEST — Au

This property is underlain by pale green weathering crenulated muscovite-feldspar-quartz schist with minor accessory biotite. A quartz vein cuts the schist. The vein is 0.3m to 1.5m wide, and 10m long. The vein trends 080°, dips steeply to the south, and cross-cuts the foliation. No sulphide minerals or gold were noted in the quartz.

7 - PORTLAND — Au

The PORTLAND property is underlain by muscovite-feldspar-quartz schist on the southwest, hangingwall of a southwest-dipping thrust fault, and by muscovite-feldspar-quartz schist, muscovitic quartzite, and minor chlorite schist on the northeast, footwall of the fault. MacLean reported "barrel leads" or foliaform lenses of quartz, along with vein quartz. The quartz exposures are in a series of widely separated trenches.The quartz veins are approximately 0.5m wide, and are composed of milky white quartz with minor amounts of pyrite and galena. Strikes and dips of 300° and 20° northeast, and 030° and 58° southeast were determined for veins exposed in trenches approximately 600m apart. Analysis of 4 samples from the various lenses and veins collected by MacLean contained 0.1 g/t Au, and no silver and gold in all but one sample of vein material, which contained 0.7 g/t Au and 4.1 g/t Ag. One sample with trace gold contained 5.5 g/t Ag.

8 - BURNHAM EAST — Au

This property is underlain by well foliated muscovite-feldspar-quartz schist with minor biotite. It lies in the footwall of a southwest dipping thrust fault, and is about 1000m from the BURNHAM property. The schist is cut by a quartz vein dipping steeply cross-cuts the foliation and strikes 027° and dips 51° southeast. No alteration of the wallrock, and no sulphides in the quartz were seen when the property was visited in 1984.

9 - BURNHAM — Au

The BURNHAM property is underlain by muscovite-feldspar-quartz schist and chlorite-quartz schist. It lies in the hangingwall of a southwest dipping thrust fault which juxtaposes quartzofeldspathic and minor chlorite-quartz schist in the hangingwall against chlorite-muscovite-feldspar-quartz schist and calcareous schist in the footwall. Several trenches and a shaft have been dug exposing massive milky quartz crosscutting muscovite-feldspar-quartz schist. In one trench, a vein 1m thick striking 025° and dipping 55° southeast is exposed. In a second trench 170m west of the first, a vein 2m thick striking 230° and dipping 28° south is exposed. A shaft 250m west of the second trench exposed a 2m wide quartz vein striking 140° and dipping 50° southwest. In all three trenches, and at the shaft, west of the lines, or at differ different trenches, a selected sample of milky quartz with rusty stains on fracture surfaces, collected in 1984, contained no gold.

Geological History

The structural features present, and the available age dates allow a preliminary reconstruction of the geological history of the Klondike area which is compatible with that of the tectonostratigraphic interpretations of Wheeler (1961), Monger et al. (1982), and Gabrielse (1967, 1976). A sequence of sedimentary and felsic and mafic volcanic rocks formed, at least in part, prior to the Late Mississippian or about 330 million years ago. Burial resulted in prograde metamorphic features and low-grade metamorphism. Quartz monzonite intruded the rocks at about the same time, enclosing fragments of relatively undeformed country rock. By the end of Triassic time or about 208 million years ago, the rocks of a terrane of which the Klondike area is part, had been folded, faulted, and intruded by the Mayo and Minto composite terrane. At the time of the joining event, metamorphism with grades ranging up to almandine-amphibolite facies resulted in the formation of the f_2 isoclinal folds, and development of the recrystallization foliation took place. Also at this time, a significant megascopic characteristic of the Klondike was developed. Discontinuities or breaks were formed when competent units were folded and rotated to subhorizontal or overturned, juxtaposed previously unconnected sequences. The faults are marked in places by pods of highly altered serpentinite. Subsequent to the joining event, and formation of the composite terrane, mafic intrusions were emplaced. Later, the composite terrane was thrust northeastward-moving North America in a collisional event, along with greenschist facies recrystallization resulted. The effects of this collision may have been felt as far south as the Coast Mountains batholith, and continued to as late as Early Cretaceous, or 135 million years ago. Subhorizontal thrust sheets of Rwaka weakly sheared serpentinite in the northern part of the Klondike were likely emplaced at the time of this collision.The Early Cretaceous was a period of extensive plutonism, and perhaps at the waning stages of this event, younger open folds may also have formed during the waning stages of the f_3 event, or during the Late Cretaceous to Early Tertiary in response to right-lateral movement on nearby Tintina Fault. The unmetamorphosed and undeformed felsic intrusive and felsic volcanic and tuffaceous rocks also formed during the Late Cretaceous to Early Tertiary.

Economic Geology

Epithermal mineralization was recognized in the Late Cretaceous to Early Tertiary volcanic rocks (Lowey, 1985). It is likely that the hosting Mayo batholith, that the target sought by early prospectors who were looking for gold-bearing quartz veins. The quartz veins in the area are mesothermal and commonly have inclusions of country rock, and flattened interlocking quartz crystals. The veins are associated with greenschist assemblages of galena, chalcopyrite, and pyrite, usually with gold associated, are also present in some places, as are antaxitic, argillic, or pyritic wallrock alteration. The alteration usually does not extend more than a few cm from the veins. Veins in the Klondike area are described in the section heading "Mineral Occurrences". Metabiomorphogenic quartz "veins" present as stringers parallel to foliation, or as isoclinally folded lenses are not gold-bearing.

Relationship of the known gold-bearing occurrences to structure is interesting. Most of the mesothermal quartz veins lie within a km of one of the steeply dipping thrust faults, or northwest trending structural discontinuities. The presence of carbonate (quartz, carbonate, talc) in the pods of altered serpentinite suggests that the fluids that were responsible for the formation of the original of the ultramafic rocks in the formation of lode gold deposits. In the Mother Lode district of California, the faults are thought to have been the conduits for mineralizing fluids, through auriferous quartz veins, and were also responsible for alteration of serpentinite pods. In Arizona, countless gold bearing zones are found in carbonate alteration along, and in brecciated country rock above some the single faults. In these cases, it appears that the structures are more important in the formation of the gold deposits than the altered ultramafic rocks found along the structures. Also Tertiary rhyolite dykes and plugs in the map area, as well as the Late Cretaceous to Early Tertiary intermediate volcanic and intrusive rocks are spatially related to the discontinuities another suggestion of their significance as potential conduits

Exploration targets in the area also include copper in shear zones, gold in quartz veins associated with felsic intrusive horizons in metamorphosed felsic volcanic rocks, chrysotile asbestos in weakly altered serpentinite of the flat lying thrust sheets, and uranium in the Tertiary marsitic quartz-feldspar rhyolite porphyry.

REFERENCES

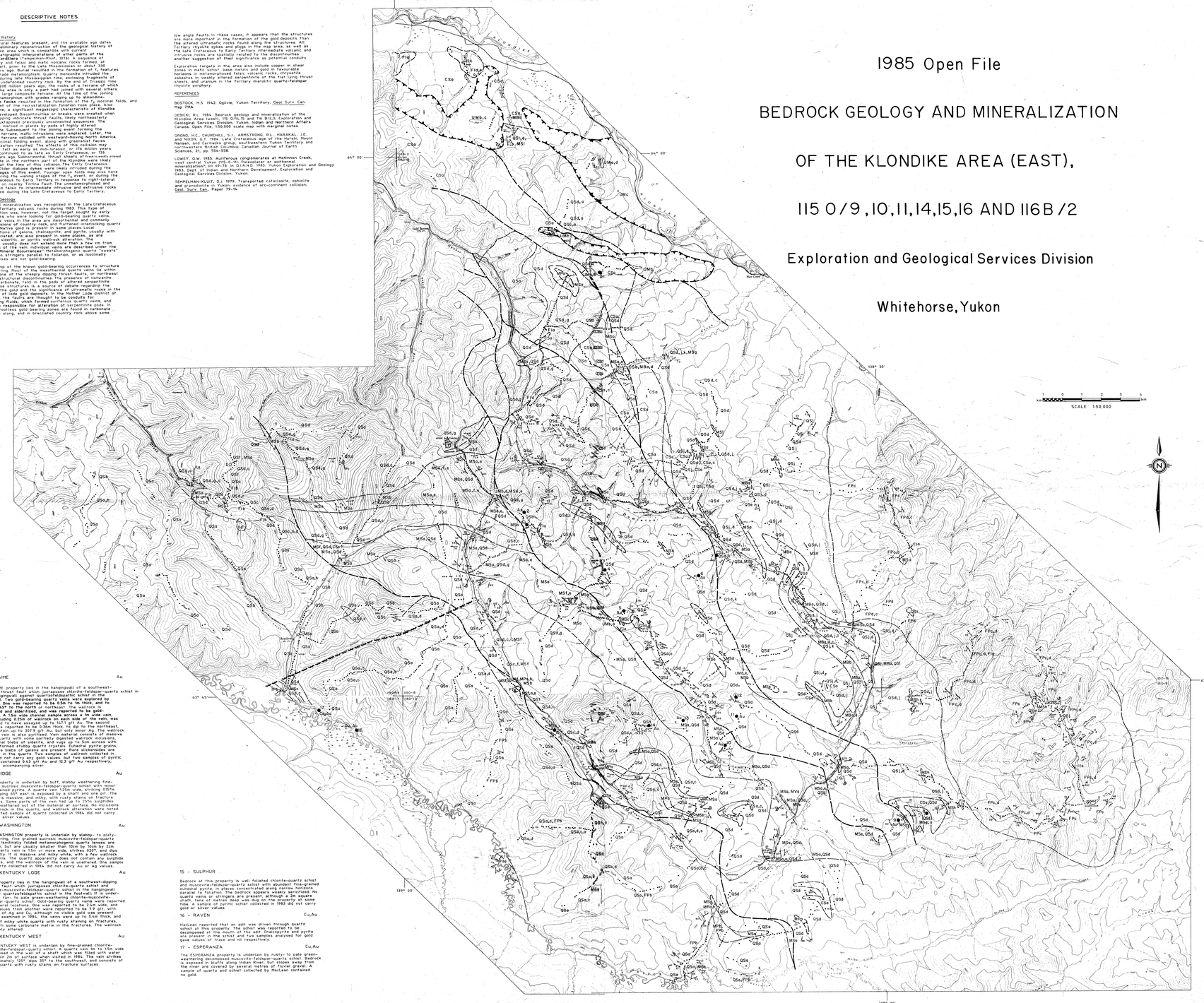
BOSTOCK, H.S. 1942. Ogilvie, Yukon Territory, Geol. Surv. Can. Map 731A.

DEBICKI, R.L. 1984. Bedrock geology and mineralization of the Klondike area (east), 115O/9, 10, 11, 14, 15, 16 and 116B/2. Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada. Open File, 1:50,000 scale map with marginal notes.

GROND, H.C., CHURCHILL, S.J., ARMSTRONG, R.L., HARAKAL, J.E. and SUTTER, J.F. 1984. Geochronology of the Klondike Schist, Mount Harlan, and Carmacks group, southwestern Yukon Territory and northwestern British Columbia. Canadian Journal of Earth Sciences, 21, pp. 554-558.

LOWEY, G.W. 1985. Auriferous conglomerates at McKinnon Creek, west central Yukon (115L-9,10). Paleoplacer or epithermal mineralization? pp. 69-78. In D.I.A.N.D. 1985. Yukon Exploration and Geology 1983. Dept. of Indian and Northern Development, Exploration and Geological Services Division, Yukon.

TEMPELMAN-KLUIT, D.J. 1979. Transported cataclasite, ophiolite and granodiorite in Yukon: evidence of arc-continent collision; Geol. Surv. Can., Paper 79-14.



LEGEND

LATE CRETACEOUS TO EARLY TERTIARY

Felsic intrusive and volcanic rocks

- Fl — Felsic intrusive and volcanic rocks
  - Flp — light coloured quartz-feldspar rhyolite porphyry and rhyolite
  - Flb — Tan coloured lattle and biotite-quartz latite porphyry
  - Flc — coarse porphyry dyke
  - Fld — monolithic rhyolite
  - Fle — heterolithic rhyolite breccia
  - Flf — layered rhyolite lapilli tuff

Intermediate intrusive and volcanic rocks, and associated sedimentary rocks

- Il
  - Ia — massive dark grey weathering intrusive andesite
  - Ib — massive chocolate brown weathering extrusive andesite
  - Ic — andesitic lapilli tuff
  - Id — siltstone, greywacke, and conglomerate
  - Ie — tan coloured dacite and amphibole-feldspar latite porphyry

EARLY CRETACEOUS AND / OR OLDER

- DD — Diabase dykes
  - DD — dark brown diabase

TRIASSIC OR OLDER

Rocks of varying metamorphic grade and degree and style of deformation

Felsic plutonic rocks

- FP,QS
  - FPa — foliated equigranular biotite granodiorite
  - FPb — foliated coarse grained granodiorite
  - QSa — blocky weathering light grey to pinkish feldspar quartzite
  - QSh — pink and green banded muscovite-feldspar-quartz schist
  - FPc — porphyritic quartz monzonite and aplite dykes
  - FPd — foliated fine to coarse grained quartz monzonite

Intermediate plutonic rocks

- IP
  - IPa — weakly foliated chlorite metadiorite
  - IPb — strongly foliated chlorite metadiorite

Mafic plutonic rocks

- MP
  - MPa — weakly foliated amphibolite
  - MPb — strongly foliated amphibolite

Quartzofeldspathic schistose rocks

- QS
  - QSb — buff to pale green weathering well foliated muscovite-feldspar-quartz schist with quartz and feldspar porphyroclasts, and minor biotite
  - QSc — buff weathering well foliated muscovite-feldspar-quartz schist with quartz porphyroclasts
  - QSd — buff weathering well foliated muscovite-feldspar-quartz schist
  - QSe — light green weathering hornblende/muscovite-feldspar-quartz schist
  - QSf — dark grey weathering sericite-quartz schist
  - QSg — buff to khaki weathering massive muscovite-feldspar-quartz (aplitoid)
  - QSi — white to dark grey weathering well foliated muscovite-quartz-feldspar with or without quartz porphyroclasts
  - QSj — muscovite-quartz schist with more than 5% garnet, and with or without chlorite
  - QSk — biotite-quartz schist, with or without garnet
  - QSl — quartzite
  - QSm — kyanite-garnet-muscovite-quartz schist

Carbonaceous rocks

- CS
  - CSa — massive to foliated dark grey to black carbonaceous quartzite and muscovite-quartz schist
  - CSb — black carbonaceous marble and carbonaceous muscovite-quartz-calcite schist
  - CSc — muscovite-feldspar-quartz schist with carbonaceous wisps
  - CSd — silty carbonaceous schist with mafic tuffaceous component

Marble

- MB
  - MBa — cream and grey banded marble, with or without minor quartz, muscovite, and garnet
  - MBb — massive cream to light grey marble
  - MBc — marble with more than 5% garnets
  - MBd — grey to dark grey muscovite-quartz-calcite schist, with or without garnet

Mafic metavolcanic rocks

- MV
  - MVa — andesitic tuff to tuff breccia
  - MVb — massive andesitic greenstone
  - MVc — foliated andesitic greenstone

Mafic schistose rocks

- MS
  - MSa — light to medium green and buff weathering chlorite-quartz schist
  - MSb — dark green weathering chlorite schist
  - MSc — silvery green weathering actinolite-chlorite schist
  - MSd — grey-brown weathering quartz-amphibole schist
  - MSe — light to medium green and buff weathering calcareous chlorite-quartz schist; calcite may be disseminated, in thin layers, or as small pink blebs
  - MSf — silvery green weathering muscovite-chlorite-quartz schist with bluish quartz porphyroclasts
  - MSg — garnet-feldspar-chlorite schist
  - MSh — garnet-hornblende schist
  - MSi — mottled green and black biotite-epidote schist

Ultramafic rocks

- UM
  - UMa — massive dark green serpentinite
  - UMb — massive dark green serpentinite
  - UMc — fractured and altered serpentinite with or without chrysotile
  - UMd — foliated strongly altered serpentinite, including talc schist and listwanite
  - UMe — coarse crystalline rusty weathering white marble

SYMBOLS

- rock in rubble piles, felsenmeer and soil; small outcrop; area of outcrop.
- geological boundary
- F_3 event thrust fault
- F_3 event thrust fault
- fault or lineament
- dyke.
- bedding, top unknown (horizontal, inclined, vertical).
- foliation (f_1 or indeterminate) (horizontal, inclined, vertical).
- foliation (apparent f_2) (horizontal, inclined, vertical).
- foliation (apparent f_3) (horizontal, inclined, vertical).
- lineation
- axial plane of small scale folds (inclined, vertical, with plunging fold axis).
- joint (horizontal, inclined, vertical).
- mineral occurrence (see list of occurrences).

Geology by R.L. Debicki and G. Baldwin, 1984.

It is recommended that reference to this report be made in the following form:
Debicki, R.L. 1985. Bedrock geology and mineralization of the Klondike Area (east), 115O-9, 10, 11, 14, 15, 16, and 116B-2. Exploration and Geological Services Division Yukon, Indian and Northern Affairs Canada, Open File 1, 50,000 scale map with marginal notes.

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