# PORPHYRY Cu ± Mo ± Au L04

by Andre Panteleyev[1]

**Modified for Yukon by A. Fonseca**

**Refer to preface for general references and formatting significance**.

May 30, 2005

## *IDENTIFICATION*

SYNONYM: Calcalkaline porphyry Cu, Cu-Mo, Cu-Au.

COMMODITIES (*BYPRODUCTS*): Cu. Mo and Au are generally present but quantities range from insufficient for economic recovery to major ore constituents. *Minor Ag in most deposits; rare recovery of Re from Island Copper mine.*

EXAMPLES **(Yukon): Casino (115J 028), Revenue (115J 042), Nucleus (115I 107), Cash (115I 103), Stu (115I 011);**

(British Columbia - *Canada/International*):

- <u>Volcanic type deposits (Cu + Au ± Mo)</u> - Fish Lake (092O041), Kemess (094E021,094), Hushamu (EXPO, 092L240), Red Dog (092L200), Poison Mountain (092O046), Bell (093M001), Morrison (093M007), Island Copper (092L158); *Dos Pobres (USA); Far Southeast (Lepanto/Mankayan), Dizon, Guianaong, Taysan and Santo Thomas II (Philippines), Frieda River and Panguna (Papua New Guinea).*
- <u>Classic deposits (Cu + Mo ± Au)</u> - Brenda (092HNE047), Berg (093E046), Huckleberrry (093E037), Schaft Creek (104G015); ***Casino (Yukon, Canada)****, Inspiration, Morenci, Ray, Sierrita-Experanza, Twin Buttes, Kalamazoo and Santa Rita (Arizona, USA), Bingham (Utah, USA),El Salvador, (Chile), Bajo de la Alumbrera (Argentina).*
- <u>Plutonic deposits (Cu ± Mo)</u> - Highland Valley Copper (092ISE001, 011, 012, 045), Gibraltar (093B012,007), Catface (092F120); *Chuquicamata, La Escondida and Quebrada Blanca (Chile).*

## *GEOLOGICAL CHARACTERISTICS*

CAPSULE DESCRIPTION: Stockwork of quartz veinlets, quartz veins, closely spaced fractures and breccias containing pyrite and chalcopyrite with lesser molybdenite, bornite and magnetite occur in large zones of economically bulk-mineable mineralization in or adjoining porphyritic intrusions and related breccia bodies. Disseminated sulphide minerals are present, generally in subordinate amounts. The mineralization is spatially, temporally and genetically associated with hydrothermal alteration of the hostrock intrusions and wallrocks.

TECTONIC SETTINGS: In orogenic belts at convergent plate boundaries, commonly linked to subduction-related magmatism. Also in association with emplacement of high-level stocks during

[1] British Columbia Geological Survey, Victoria, B.C., Canada

extensional tectonism related to strike-slip faulting and back-arc spreading following continent margin accretion.

DEPOSITIONAL ENVIRONMENT / GEOLOGICAL SETTING: High-level (epizonal) stock emplacement levels in volcano-plutonic arcs, commonly oceanic volcanic island and continent-margin arcs. Virtually any type of country rock can be mineralized, but commonly the high-level stocks and related dykes intrude their coeval and cogenetic volcanic piles.

AGE OF MINERALIZATION: Two main periods in the Canadian Cordillera: the Triassic/Jurassic (210-180 Ma) and Cretaceous/Tertiary (85-45 Ma). Elsewhere deposits are mainly Tertiary, but range from Archean to Quaternary.

HOST/ASSOCIATED ROCK TYPES: Intrusions range from coarse-grained phaneritic to porphyritic stocks, batholiths and dyke swarms; rarely pegmatitic. Compositions range from calcalkaline quartz diorite to granodiorite and quartz monzonite. Commonly there is multiple emplacement of successive intrusive phases and a wide variety of breccias. Alkalic porphyry Cu-Au deposits are associated with syenitic and other alkalic rocks and are considered to be a distinct deposit type (see model L03). **Jurassic intrusions host the majority of porphyry prospects in Yukon. The Casino and Cash deposits, however, are hosted in Upper Cretaceous intrusive rocks; the Revenue deposit is hosted in mid-Cretaceous intrusive rocks; and the Stu deposit is hosted in Triassic intrusive rocks.**

DEPOSIT FORM: Large zones of hydrothermally altered rock contain quartz veins and stockworks, sulphide-bearing veinlets; fractures and lesser disseminations in areas up to 10 $km^2$ in size, commonly coincident wholly or in part with hydrothermal or intrusion breccias and dyke swarms. Deposit boundaries are determined by economic factors that outline ore zones within larger areas of low-grade, concentrically zoned mineralization. Cordilleran deposits are commonly subdivided according to their morphology into three classes - classic, volcanic and plutonic (see Sutherland Brown, 1976; McMillan and Panteleyev, 1988):

- <u>Volcanic type deposits</u> (e.g. Island Copper) are associated with multiple intrusions in subvolcanic settings of small stocks, sills, dykes and diverse types of intrusive breccias. Reconstruction of volcanic landforms, structures, vent-proximal extrusive deposits and subvolcanic intrusive centres is possible in many cases, or can be inferred. Mineralization at depths of 1 km, or less, is mainly associated with breccia development or as lithologically controlled preferential replacement in hostrocks with high primary permeability. Propylitic alteration is widespread and generally flanks early, centrally located potassic alteration; the latter is commonly well mineralized. Younger mineralized phyllic alteration commonly overprints the early mineralization. Barren advanced argillic alteration is rarely present as a late, high-level hydrothermal carapace.
- <u>Classic deposits</u> (e.g., Berg, **Casino**) are stock related with multiple emplacements at shallow depth (1 to 2 km) of generally equant, cylindrical porphyritic intrusions. Numerous dykes and breccias of pre, intra, and post-mineralization age modify the stock geometry. Ore bodies occur along margins and adjacent to intrusions as annular ore shells. Lateral outward zoning of alteration and sulphide minerals from a weakly mineralized potassic/propylitic core is usual. Surrounding ore zones with potassic (commonly biotite-rich) or phyllic alteration contain molybdenite ± chalcopyrite, then chalcopyrite and a generally widespread propylitic, barren pyritic aureole or 'halo'.
- <u>Plutonic deposits</u> (e.g., the Highland Valley deposits) are found in large plutonic to batholithic intrusions immobilized at relatively deep levels, say 2 to 4 km. Related dykes and intrusive breccia bodies can be emplaced at shallower levels. Hostrocks are phaneritic coarse grained to porphyritic. The intrusions can display internal compositional differences as a result of differentiation with gradational to sharp boundaries between the different phases of magma emplacement. Local swarms of dykes, many with associated breccias, and fault zones are sites of mineralization. Ore bodies around silicified alteration zones tend to occur as diffuse vein

stockworks carrying chalcopyrite, bornite and minor pyrite in intensely fractured rocks but, overall, sulphide minerals are sparse. Much of the early potassic and phyllic alteration in central parts of ore bodies is restricted to the margins of mineralized fractures as selvages. Later phyllic-argillic alteration forms envelopes on the veins and fractures and is more pervasive and widespread. Propylitic alteration is widespread but unobtrusive and is indicated by the presence of rare pyrite with chloritized mafic minerals, saussuritized plagioclase and small amounts of epidote.

TEXTURE/STRUCTURE: Quartz, quartz-sulphide and sulphide veinlets and stockworks; sulphide grains in fractures and fracture selvages. Minor disseminated sulphide minerals commonly replacing primary mafic minerals. Quartz phenocrysts can be partially resorbed and overgrown by silica.

ORE MINERALOGY (Principal and *subordinate*): Pyrite is the predominant sulphide mineral; in some deposits the Fe oxide minerals magnetite, and rarely hematite, are abundant. Ore minerals are chalcopyrite; molybdenite, lesser bornite and rare (primary) chalcocite. Subordinate minerals are *tetrahedrite/tennantite, enargite and minor gold, electrum and arsenopyrite*. In many deposits late veins commonly contain galena and sphalerite in a gangue of quartz, calcite and barite.

GANGUE MINERALOGY (Principal and *subordinate*): Gangue minerals in mineralized veins are mainly quartz with lesser *biotite, sericite, K-feldspar, magnetite, chlorite, calcite, epidote, anhydrite and tourmaline*. Many of these minerals are also pervasive alteration products of primary igneous mineral grains.

ALTERATION MINERALOGY: Quartz, sericite, biotite, K-feldspar, albite, anhydrite/gypsum, magnetite, actinolite, chlorite, epidote, calcite, clay minerals, tourmaline. Early formed alteration can be overprinted by younger assemblages. Central and early formed potassic zones (K-feldspar and biotite) commonly coincide with ore. This alteration can be flanked in volcanic hostrocks by biotite-rich rocks that grade outward into propylitic rocks. The biotite is a fine-grained, 'shreddy' looking secondary mineral that is commonly referred to as an early developed biotite (EDB) or a 'biotite hornfels'. These older alteration assemblages in cupriferous zones can be partially to completely overprinted by later biotite and K-feldspar and then phyllic (quartz-sericite-pyrite) alteration, less commonly argillic, and rarely, in the uppermost parts of some ore deposits, advanced argillic alteration (kaolinite-pyrophyllite) .

WEATHERING: Secondary (supergene) zones carry chalcocite, covellite and other $Cu_2S$ minerals (digenite, djurleite, etc.), chrysocolla, native copper and copper oxide, carbonate and sulphate minerals. Oxidized and leached zones at surface are marked by ferruginous 'cappings' with supergene clay minerals, limonite (goethite, hematite and jarosite) and residual quartz.

ORE CONTROLS: Igneous contacts, both internal between intrusive phases and external with wallrocks; cupolas and the uppermost, bifurcating parts of stocks, dyke swarms. Breccias, mainly early formed intrusive and hydrothermal types. Zones of most intensely developed fracturing give rise to ore-grade vein stockworks, notably where there are coincident or intersecting multiple mineralized fracture sets.

ASSOCIATED DEPOSIT TYPES: Skarn Cu (K01), porphyry Au (K02), epithermal Au-Ag in low sulphidation type (H05) or epithermal Cu-Au-Ag as high-sulphidation type enargite-bearing veins (L01), replacements and stockworks; auriferous and polymetallic base metal quartz and quartz-carbonate veins (I01, I05), Au-Ag and base metal sulphide mantos and replacements in carbonate and non-carbonate rocks (M01, M04), placer Au (C01, C02).

COMMENTS: Subdivision of porphyry copper deposits can be made on the basis of metal content, mainly ratios between Cu, Mo and Au. This is a purely arbitrary, economically based criterion, an artifact of mainly metal prices and metallurgy. There are few differences in the style of mineralization between deposits although the morphology of calcalkaline deposits does provide a basis for subdivision into three distinct subtypes - the 'volcanic, classic, and plutonic' types. A fundamental contrast can be made on the compositional differences between calcalkaline quartz-bearing porphyry copper deposits and the alkalic (silica undersaturated) class. The alkalic porphyry copper deposits are described in a separate model - L03.

## *EXPLORATION GUIDES*

GEOCHEMICAL SIGNATURE: Calcalkalic systems can be zoned with a cupriferous (± Mo) ore zone having a ‘barren’, low-grade pyritic core and surrounded by a pyritic halo with peripheral base and precious metal-bearing veins. Central zones with Cu commonly have coincident Mo, Au and Ag with possibly Bi, W, B and Sr. Peripheral enrichment in Pb, Zn, Mn, V, Sb, As, Se, Te, Co, Ba, Rb and possibly Hg is documented. Overall the deposits are large-scale repositories of sulphur, mainly in the form of metal sulphide minerals, chiefly pyrite.

GEOPHYSICAL SIGNATURE: Ore zones, particularly those with higher Au content, can be associated with magnetite-rich rocks and are indicated by magnetic surveys. Alternatively the more intensely hydrothermally altered rocks, particularly those with quartz-pyrite-sericite (phyllic) alteration produce magnetic and resistivity lows. Pyritic haloes surrounding cupriferous rocks respond well to induced polarization (I.P.) surveys but in sulphide-poor systems the ore itself provides the only significant IP response.

OTHER EXPLORATION GUIDES: Porphyry deposits are marked by large-scale, zoned metal and alteration assemblages. Ore zones can form within certain intrusive phases and breccias or are present as vertical 'shells' or mineralized cupolas around particular intrusive bodies. Weathering can produce a pronounced vertical zonation with an oxidized, limonitic leached zone at surface (leached capping), an underlying zone with copper enrichment (supergene zone with secondary copper minerals) and at depth a zone of primary mineralization (the hypogene zone).

## *ECONOMIC FACTORS*

TYPICAL GRADE AND TONNAGE:

Worldwide according Cox and Singer (1988) based on their subdivision of 55 deposits into subtypes according to metal ratios, typical porphyry Cu deposits contain (median values):

| | |
|---|---|
| Porphyry Cu-Au: | 160 Mt with 0.55 % Cu, 0.003 % Mo, 0.38 g/t Au and 1.7 g/t Ag. |
| Porphyry Cu-Au-Mo: | 390 Mt with 0.48 % Cu, 0.015 % Mo, 0.15 g/t Au and 1.6 g/t Ag. |
| Porphyry Cu-Mo: | 500 Mt with 0.41 % Cu, 0.016 % Mo, 0.012 g/t Au and 1.22 g/t Ag. |

A similar subdivision by Cox (1986) using a larger data base results in:

| | |
|---|---|
| Porphyry Cu: | 140 Mt with 0.54 %Cu, <0.002 % Mo, <0.02g/t Au and <1 g/t Ag. |
| Porphyry Cu-Au: | 100 Mt with 0.5 %Cu, <0.002 % Mo, 0.38g/t Au and 1g/t Ag. (This includes deposits from the British Columbia alkalic porphyry class, B.C. model L03.) |
| Porphyry Cu-Mo: | 500 Mt with 0.42 % Cu, 0.016 % Mo, 0.012 g/t Au and 1.2 g/t Ag. |

British Columbia porphyry Cu ± Mo ± Au deposits range from <50 to >900 Mt with commonly 0.2 to 0.5 % Cu, <0.1 to 0.6 g/t Au, and 1 to 3 g/t Ag. Mo contents are variable from negligible to 0.04 % Mo. Median values for 40 B.C. deposits with reported reserves are: 115 Mt with 0.37 % Cu, ~0.01 % Mo, 0.3g /t Au and 1.3 g/t Ag.

ECONOMIC LIMITATIONS: Mine production in British Columbia is from primary (hypogene) ores. Rare exceptions are Afton mine where native copper was recovered from an oxide zone, and

Gibraltar and Bell mines where incipient supergene enrichment has provided some economic benefits.

END USES: Porphyry copper deposits produce Cu and Mo concentrates, mainly for international export.

IMPORTANCE: Porphyry deposits contain the largest reserves of Cu, significant Mo resources and close to 50 % of Au reserves in British Columbia.

## *SELECTED BIBLIOGRAPHY*


Beane, R.E. and Titley, S.R., 1981. Porphyry Copper Deposits Part II; Hydrothermal Alteration and Mineralization. *In:* 75th Anniversary Volume, *Economic Geology*, pages 235-269.

**Bower, B., Payne, J., Delong, C. and Rebagliati, C.M. 1995. The oxide-gold supergene and hypogene zones at the Casino gold-copper-molybdenum deposit, west-central Yukon. *In:* Schroeter, T.G. (ed.), Porphyry Deposits of the Northwestern Cordillera of North America, Canadian Institute of Mining, Metallurgy and Petroleum, Special Volume 46, p. 352-366.**

Cox, D.P., 1986. Descriptive Model of Porphyry Cu, *also* Porphyry Cu-Au and Porphyry Cu-Mo; *in* Mineral Deposit Models; *United States Geological Survey,* Bulletin 1693, pages 76-81, *also* pages 110-114 and 115-119.

Cox, D.P. and Singer, D.A., 1988. Distribution of Gold in Porphyry Copper Deposits; *U.S. Geological Survey*, Open File Report 88-46, 23 pages.

**Godwin, C.I., 1976. Casino. *In:* Porphyry deposits of the Canadian Northwestern Cordillera, Canadian Institute of Mining, Metallurgy and Petroleum, Special Volume 15, p. 344-354.**

**Godwin, C.I., 1975, Geology of the Casino porphyry copper-molybdenum deposit. Unpublished Ph.D thesis, University of British Columbia, Vancouver, BC.**

Gustafson, L.B. and Hunt, J.P., 1975. The Porphyry Copper Deposit at El Salvador, Chile; *Economic Geology*, Volume 70, pages 857-912.

**Leblanc, E.R., 1981. The mineralogy and ore petrology of the Stu copper deposit. Unpublished B.Sc. thesis, St. Francis Xavier University, Antigonish, Nova Scotia.**

Lowell, J.D. and Guilbert, J.M., 1970. Lateral and Vertical Alteration-Mineralization Zoning in Porphyry Ore Deposits; *Economic Geology,* Volume 65, pages 373-408.

McMillan, W.J., 1991. Porphyry Deposits in the Canadian Cordillera. *In:* Ore Deposits, Tectonics and Metallogeny in the Canadian Cordillera, *B. C. Ministry of Energy, Mines and Petroleum Resources*, Paper 1991-4, pages 253-276.

McMillan, W.J. and Panteleyev, A., 1988. Porphyry Copper Deposits. *In:* Ore Deposit Models, Roberts, R.G. and Sheahan, P.A., (Eds.), Geoscience Canada Reprint Series 3, *Geological Association of Canada*, pages 45-58; also *in* Geoscience Canada, Volume 7, Number 2, pages 52-63.

**Sinclair, W.D., Cathro, R.J., and Jensen, E.M., 1981. The Cash porphyry Copper-molybdenum deposit. Canadian Institute of Mining and Metallurgy Bulletin, vol. 74, p. 67-76.**

Schroeter, T. G. (Ed.), 1995. Porphyry Copper Deposits of the Northwestern Cordillera of North America. *Canadian Institute of Mining, Metallurgy and Petroleum,* Special Volume 46, 852 pages.

Sutherland Brown, A. (Ed.), 1976. Porphyry Deposits of the Canadian Cordillera; *Canadian Institute of Mining and Metallurgy,* Special Volume 15, 510 pages.

Titley, S.R., 1982. Advances in Geology of the Porphyry Copper Deposits, Southwestern North America; *The University of Arizona Press,* Tucson, 560 pages.

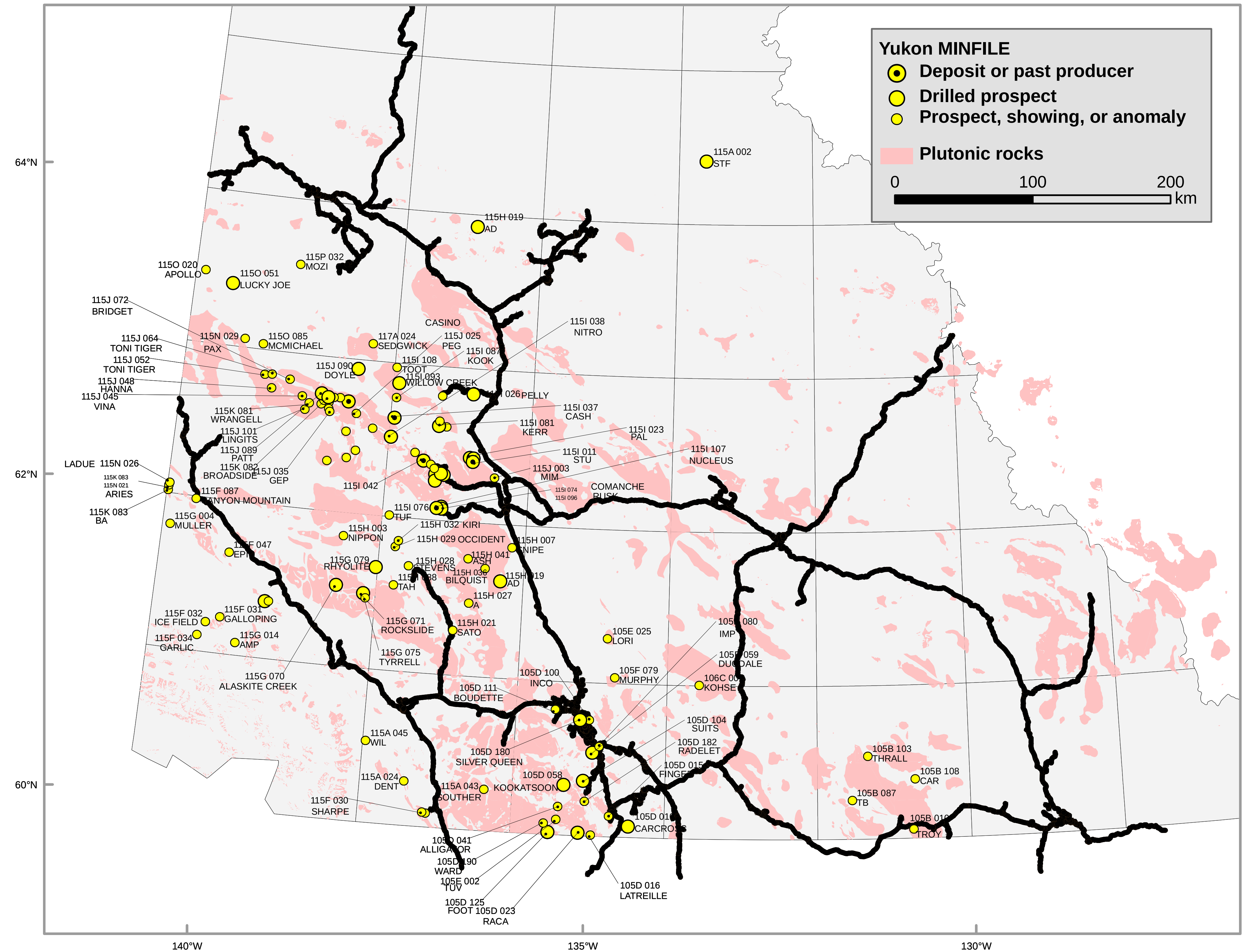
Titley, S.R. and Beane, R.E., 1981. Porphyry Copper Deposits Part I. Geologic Settings, Petrology, and Tectogenesis. *In:* 75th Anniversary Volume, *Economic Geology*, pages 214-234.

# L04 - Porphyry Cu-Mo-Au - BC and Yukon deposits

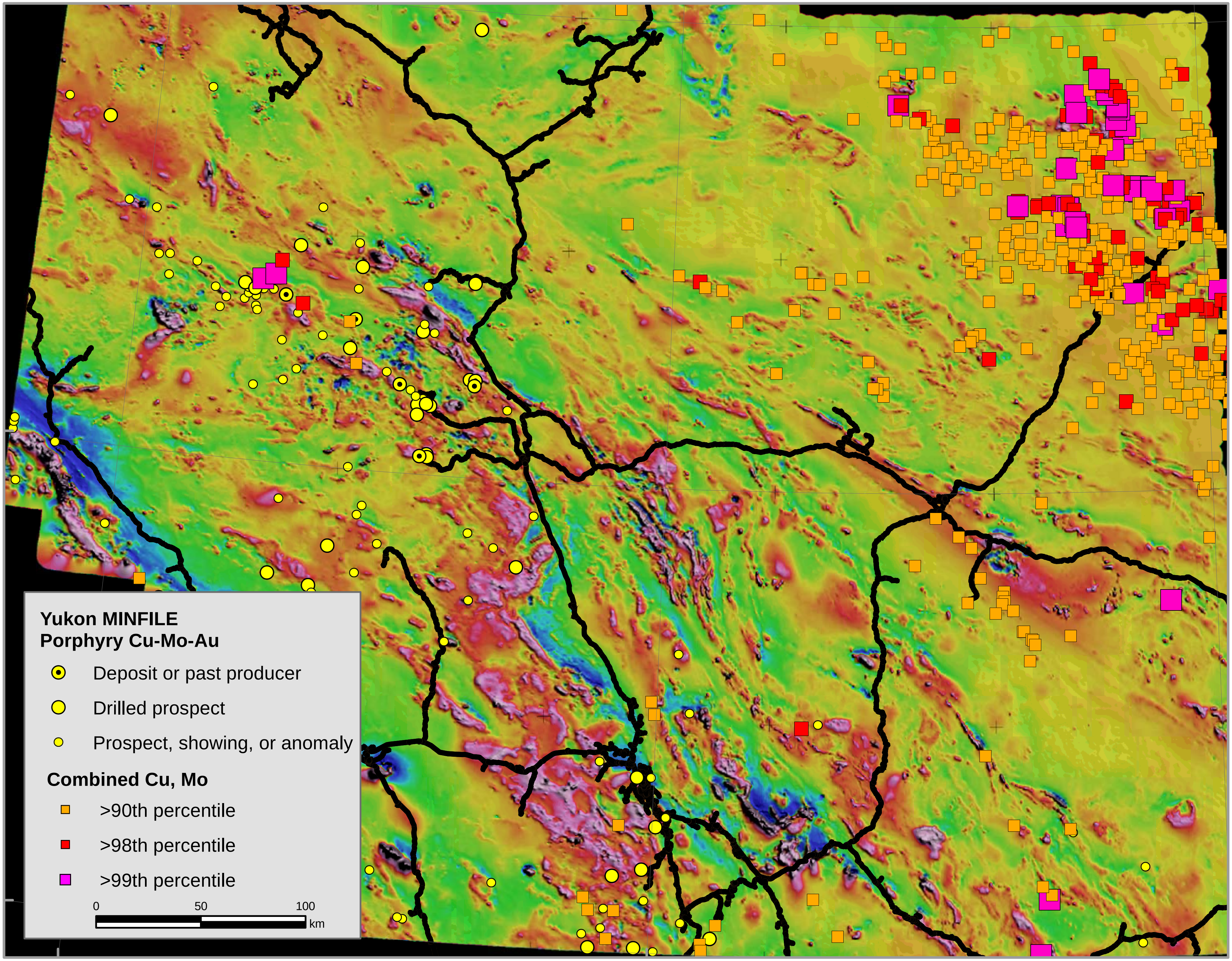
| Deposit | country | tonnes | Cu (%) | Mo (%) | Au(g/t) | Ag(g/t) |
|---|---|---|---|---|---|---|
| NUCLEUS | CNYK | 211 900 | | | 3.160 | |
| TASEKO | CNBC | 9 501 800 | 0.580 | 0.000 | 0.750 | 17.000 |
| KRAIN | CNBC | 14 000 000 | 0.560 | 0.010 | 0.000 | 0.000 |
| OX LAKE | CNBC | 17 000 000 | 0.330 | 0.040 | 0.000 | 0.000 |
| BIG | CNBC | 18 000 000 | 0.360 | 0.000 | 0.000 | 0.000 |
| NANIKA | CNBC | 18 144 000 | 0.440 | 0.009 | 0.210 | 0.380 |
| WILLIAMS CREEK | CNYK | 20 000 000 | 1.060 | | 0.450 | |
| REY | CNBC | 21 488 290 | 0.230 | 0.020 | 0.000 | 0.000 |
| RED DOG | CNBC | 25 000 000 | 0.350 | 0.000 | 0.440 | 0.000 |
| EAGLE | CNBC | 30 000 000 | 0.410 | 0.010 | 0.200 | 2.710 |
| GNAT | CNBC | 30 000 000 | 0.390 | 0.000 | 0.000 | 0.000 |
| SWAN | CNBC | 36 000 000 | 0.200 | 0.000 | 0.000 | 0.000 |
| CASH | CNYK | 36 300 000 | 0.170 | 0.018 | 0.200 | 0.400 |
| DOROTHY | CNBC | 40 800 000 | 0.250 | 0.010 | 0.000 | 0.000 |
| ANNOTH | CNBC | 43 381 160 | 0.270 | 0.000 | 0.000 | 0.000 |
| LOUISE | CNBC | 50 000 000 | 0.300 | 0.020 | 0.300 | 0.000 |
| KERR | CNBC | 60 000 000 | 0.860 | 0.000 | 0.340 | 2.000 |
| GRANISLE | CNBC | 66 434 150 | 0.420 | 0.000 | 0.130 | 1.330 |
| HI-MAR | CNBC | 82 000 000 | 0.300 | 0.000 | 0.300 | 0.000 |
| MORRISON | CNBC | 86 000 000 | 0.420 | 0.000 | 0.340 | 3.400 |
| HUCKLEBERRY | CNBC | 100 000 000 | 0.560 | 0.017 | 0.000 | 0.000 |
| GAMBIE | CNBC | 114 000 000 | 0.290 | 0.010 | 0.000 | 1.000 |
| WHITIN | CNBC | 124 000 000 | 0.060 | 0.030 | 0.000 | 0.000 |
| HIGHMONT | CNBC | 125 000 000 | 0.220 | 0.020 | 0.000 | 0.000 |
| BETHLEHEM | CNBC | 134 000 000 | 0.440 | 0.000 | 0.010 | 0.740 |
| CATFACE | CNBC | 138 000 000 | 0.460 | 0.000 | 0.050 | 0.000 |
| BELL | CNBC | 143 000 000 | 0.420 | 0.000 | 0.200 | 0.480 |
| POPLAR | CNBC | 144 000 000 | 0.370 | 0.020 | 0.000 | 0.000 |
| O.K. | CNBC | 155 000 000 | 0.390 | 0.020 | 0.000 | 0.000 |
| POISON MOUNTAIN | CNBC | 159 000 000 | 0.330 | 0.010 | 0.310 | 0.000 |
| HUSHAMO | CNBC | 173 000 000 | 0.270 | 0.010 | 0.340 | 0.000 |
| CASINO | CNYK | 178 200 000 | 0.303 | 0.028 | 0.376 | |
| MAGGIE | CNBC | 181 000 000 | 0.280 | 0.030 | 0.000 | 0.000 |
| BRENDA | CNBC | 183 000 000 | 0.250 | 0.040 | 0.010 | 1.060 |
| KEMESS | CNBC | 230 000 000 | 0.230 | 0.000 | 0.650 | 0.000 |
| BERG | CNBC | 238 000 000 | 0.390 | 0.030 | 0.050 | 2.840 |
| JAR | CNBC | 260 000 000 | 0.430 | 0.020 | 0.000 | 0.000 |
| ISLAND COPPER | CNBC | 373 000 000 | 0.370 | 0.017 | 0.110 | 0.940 |
| GIBRALTAR | CNBC | 965 000 000 | 0.320 | 0.010 | 0.070 | 0.150 |
| FISH LAKE | CNBC | 976 000 000 | 0.250 | 0.000 | 0.480 | 0.000 |
| SCHAFT CREEK | CNBC | 1 000 000 000 | 0.300 | 0.020 | 0.140 | 1.200 |
| HIGHLAND VALLEY COPPER | CNBC | 1 200 000 000 | 0.372 | 0.010 | 0.005 | 1.730 |

# L04 - Porphyry Cu-Mo-Au - Yukon MINFILE

| MINFILE | NAMES | STATUS |
|---|---|---|
| 105C 009 | RED MOUNTAIN, FOX, BOSWELL RIVER | DEPOSIT |
| 115I 037 | CASH | DEPOSIT |
| 115I 107 | NUCLEUS, GOLDEN REVENUE | DEPOSIT |
| 115J 028 | CASINO | DEPOSIT |
| 105D 010 | CARCROSS | DRILLED PROSPECT |
| 105D 023 | FAWLEY, RACA | DRILLED PROSPECT |
| 105D 058 | KOOKATSOON | DRILLED PROSPECT |
| 105D 059 | DUGDALE, COWLEY PARK | DRILLED PROSPECT |
| 105D 104 | SUITS, KING LAKE | DRILLED PROSPECT |
| 105D 180 | SILVER QUEEN | DRILLED PROSPECT |
| 115A 002 | DALTON, STF | DRILLED PROSPECT |
| 115G 015 | CORK | DRILLED PROSPECT |
| 115G 070 | RAFT, ALASKITE CREEK | DRILLED PROSPECT |
| 115G 071 | ROCKSLIDE | DRILLED PROSPECT |
| 115G 079 | RHYOLITE | DRILLED PROSPECT |
| 115I 023 | PAL | DRILLED PROSPECT |
| 115I 026 | PELLY | DRILLED PROSPECT |
| 115I 038 | KLAZAN, NITRO | DRILLED PROSPECT |
| 115I 042 | REVENUE, GOLDEN REVENUE | DRILLED PROSPECT |
| 115I 050 | GRANGER, RAG | DRILLED PROSPECT |
| 115I 066 | CYPRUS, MT. NANSEN | DRILLED PROSPECT |
| 115I 070 | MALONEY, POT | DRILLED PROSPECT |
| 115I 074 | COMANCHE | DRILLED PROSPECT |
| 115I 081 | KERR | DRILLED PROSPECT |
| 115I 093 | GOULTER, WILLOW CREEK, ELIZA, DISCOVERY CREEK | DRILLED PROSPECT |
| 115I 094 | GIANT | DRILLED PROSPECT |
| 115J 036 | ZAPPA, MOTHERS, KOFFEE | DRILLED PROSPECT |
| 115J 089 | PATTISON, PATT, ROSS | DRILLED PROSPECT |
| 115J 090 | INDIANA, DOYLE | DRILLED PROSPECT |
| 115J 101 | ANA, AZTEC | DRILLED PROSPECT |
| 115K 082 | TRUDI, BROADSIDE, SNOW, BA | DRILLED PROSPECT |
| 105B 087 | MCPRES, I, TB | PROSPECT |
| 105E 002 | TUV, MARS | PROSPECT |
| 106C 001 | KOHSE | PROSPECT |
| 115A 012 | CAVE, SANDY, MUSH, MOLLY, ROCKY | PROSPECT |
| 115F 034 | GARLIC | PROSPECT |
| 115I 032 | PHELPS | PROSPECT |
| 105B 103 | THRALL | SHOWING |
| 105D 015 | FINGER | SHOWING |
| 105D 016 | LATREILLE | SHOWING |
| 105D 041 | ALLIGATOR | SHOWING |
| 105D 100 | INCO, RED RIDGE, RED TOP | SHOWING |
| 105D 190 | WARD | SHOWING |
| 105F 079 | MURPHY | SHOWING |
| 115A 024 | DEVILHOLE, GREEN EAGLE, JOY, DENT | SHOWING |
| 115A 043 | SOUTHER | SHOWING |
| 115A 045 | TATSHENSHINI, WALL, SKY, TUF, WIL | SHOWING |
| 115F 030 | SHARPE | SHOWING |
| 115F 031 | GALLOPING | SHOWING |
| 115F 047 | EPIC | SHOWING |
| 115F 087 | CANYON MOUNTAIN | SHOWING |
| 115G 069 | TALBOT | SHOWING |
| 115H 003 | NIPPON, AH, RAZ | SHOWING |
| 115H 007 | SNIPE | SHOWING |
| 115H 021 | SATO, MAK, KL | SHOWING |
| 115H 038 | TAHTE, TAH | SHOWING |
| 115H 041 | ITTLEMIT, ASH | SHOWING |
| 115I 045 | NEWKIRK | SHOWING |
| 115I 076 | TUF | SHOWING |
| 115I 108 | TOOT | SHOWING |
| 115J 002 | KLOT, CHRIS, K, BGD | SHOWING |
| 115J 003 | MIM | SHOWING |
| 115J 017 | COCKFIELD, RAY, CO, DR, COFIELD, KOKUP, OKE, ITEN | SHOWING |
| 115J 040 | BOREAL, DUCHESS, PRINCESS | SHOWING |
| 115J 044 | BID | SHOWING |
| 115J 045 | VINA | SHOWING |
| 115J 052 | TONI TIGER, W, CAFFEINE | SHOWING |
| 115J 072 | SCROGGIE, C, SC, BRIDGET | SHOWING |
| 115J 091 | AMOCO, CC | SHOWING |
| 115N 021 | ARIES | SHOWING |
| 115N 026 | LADUE | SHOWING |
| 115O 085 | MCMICHAEL | SHOWING |
| 105B 010 | TROY | ANOMALY |
| 105B 108 | REGIONAL, CARIBOU, CAR | ANOMALY |
| 105D 080 | IMP | ANOMALY |
| 115G 004 | MULLER | ANOMALY |
| 115G 014 | AMP | ANOMALY |
| 115G 075 | TYRRELL | ANOMALY |
| 115H 027 | POPLAR, A | ANOMALY |
| 115H 028 | STEVENS, JON | ANOMALY |
| 115H 029 | OCCIDENT, STEVE | ANOMALY |
| 115H 032 | KIRI | ANOMALY |
| 115I 029 | DELTA | ANOMALY |
| 115I 039 | COM | ANOMALY |
| 115I 048 | EDGAR | ANOMALY |
| 115I 087 | KOOK | ANOMALY |
| 115I 102 | LUMBY | ANOMALY |
| 115J 025 | PEG, GAP | ANOMALY |
| 115J 029 | HOLE | ANOMALY |
| 115J 031 | CLEVELAND, CUB | ANOMALY |
| 115J 032 | RONGE, CASH, GUN, BARB, GUY | ANOMALY |
| 115J 034 | GEP | ANOMALY |
| 115J 035 | AZTEC | ANOMALY |
| 115J 048 | HANNA, FBH, EX | ANOMALY |
| 115J 064 | LYON, HOLE | ANOMALY |
| 115K 081 | WRANGELL | ANOMALY |
| 115N 029 | PAX | ANOMALY |
| 115O 020 | APOLLO | ANOMALY |
| 115P 032 | MOZI | ANOMALY |
| 115H 036 | BILQUIST, ZN, YAM | UNKNOWN |
| 115J 015 | CROCK, ELW | UNKNOWN |



Map of Yukon showing porphyry Cu-Mo-Au occurrences and the distribution of plutonic rocks




Map of Yukon showing Cu-Mo-Au porphyry occurrences, regional magnetics and Cu-Mo regional geochemistry