



Au-QUARTZ VEINS

I01

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Modified for Yukon by A. Fonseca

Refer to preface for general references and formatting significance.

May 30, 2005

IDENTIFICATION

SYNONYMS: Mother Lode veins, greenstone gold, Archean lode gold, mesothermal gold-quartz veins, shear-hosted lode gold, low-sulphide gold-quartz veins, lode gold.

COMMODITIES (*BYPRODUCTS*): Au (Ag, Cu, Sb).

EXAMPLES: (Yukon): Caribou Creek (115I 049), Venus (105D 005), Big Thing (105D 009), Tally-Ho (105D 030), Mt. Reid/Skukum Creek (105D 022), Violet (115O 073), Virgin (116B 007), Silvertown (116B 037);

(British Columbia (MINFILE #) - Canada/ International):

- Phanerozoic: Bralorne-Pioneer (092JNE001), Erickson (104P029), Taurus (104P012), Polaris-Taku (104K003), Mosquito Creek (093H010), Cariboo Gold Quartz (093H019), Midnight (082FSW119); Carson Hill, Jackson-Plymouth, Mother Lode district; Empire Star and Idaho-Maryland, Grass Valley district (California, USA); Alaska-Juneau, Jualin, Kensington (Alaska, USA), Ural Mountains (Russia).
- Archean: Hollinger, Dome, McIntyre and Pamour, Timmins camp; Lake Shore, Kirkland Lake camp; Campbell, Madsen, Red Lake camp; Kerr-Addison, Larder Lake camp (Ontario, Canada), Lamaque and Sigma, Val d'Or camp (Quebec, Canada); Granny Smith, Kalgoorlie and Golden Mile (Western Australia); Kolar (Karnataka, India), Blanket-Vubachikwe (Zimbabwe, Africa).

GEOLOGICAL CHARACTERISTICS

CAPSULE DESCRIPTION: Gold-bearing quartz veins and veinlets with minor sulphide minerals crosscut a wide variety of hostrocks and are localized along major regional faults and related splays. The wallrock is typically altered to silica, pyrite and muscovite within a broader carbonate alteration halo.

TECTONIC SETTINGS:

- Phanerozoic: Contained in moderate to gently dipping fault/suture zones related to continental margin collisional tectonism. Suture zones are major crustal breaks which are characterized by dismembered ophiolitic remnants between diverse assemblages of island arcs, subduction complexes and continental-margin clastic wedges.
- Archean: Major transcrustal structural breaks within stable cratonic terranes. May represent remnant terrane collisional boundaries.

DEPOSITIONAL ENVIRONMENT / GEOLOGICAL SETTING: Veins form within fault and joint systems produced by regional compression or transpression (terrane collision), including major listric reverse faults, second and third-order splays. Gold is deposited at crustal levels within and near the brittle-ductile transition zone at depths of 6-12 km, pressures between 1 to 3 kilobars and

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temperatures from 200° to 400 °C. Deposits may have a vertical extent of up to 2 km, and lack pronounced zoning.

AGE OF MINERALIZATION: Mineralization is post-peak metamorphism (*i.e.*, late syncollisional) with gold-quartz veins particularly abundant in the Late Archean and Mesozoic.

- **Phanerozoic:** In the North America Cordillera gold veins are post-Middle Jurassic and appear to form immediately after accretion of oceanic terranes to the continental margin. In British Columbia deposits are mainly Middle Jurassic (~ 165-170 Ma) and Late Cretaceous (~ 95 Ma). In the Mother Lode belt they are Middle Jurassic (~ 150 Ma) and those along the Juneau belt in Alaska are of Early Tertiary (~56-55 Ma).
- **Archean:** Ages of mineralization for Archean deposits are well constrained for both the Superior Province, Canadian Shield (~ 2.68 to 2.67 Ga) and the Yilgarn Province, Western Australia (~ 2.64 to 2.63 Ga).

HOST/ASSOCIATED ROCK TYPES: Lithologically highly varied, usually of greenschist metamorphic grade, ranging from virtually undeformed to totally schistose.

- **Phanerozoic:** Mafic volcanics, serpentinite, peridotite, dunite, gabbro, diorite, trondhjemite/plagiogranites, graywacke, argillite, chert, shale, limestone and quartzite, felsic and intermediate intrusions.
- **Archean:** Granite-greenstone belts - mafic, ultramafic (komatiitic) and felsic volcanics, intermediate and felsic intrusive rocks, graywacke and shale.

DEPOSIT FORM: Tabular fissure veins in more competent host lithologies, veinlets and stringers forming stockworks in less competent lithologies. Typically occur as a system of en echelon veins on all scales. Lower grade bulk-tonnage styles of mineralization may develop in areas marginal to veins with gold associated with disseminated sulphides. May also be related to broad areas of fracturing with gold and sulphide minerals associated with quartz veinlet networks.

TEXTURE/STRUCTURE: Veins usually have sharp contacts with wallrocks and exhibit a variety of textures, including massive, ribboned or banded and stockworks with anastomosing gashes and dilations. Textures may be modified or destroyed by subsequent deformation.

ORE MINERALOGY: [Principal and *subordinate*]: Native gold, pyrite, arsenopyrite, *galena*, *sphalerite*, *chalcopyrite*, *pyrrhotite*, *tellurides*, *scheelite*, *bismuth*, *cosalite*, *tetrahedrite*, *stibnite*, *molybdenite*, *gersdorffite* ($NiAsS$), *bismuthimite* (Bi_2S_2), *tetradymite* (Bi_2Te_2S).

GANGUE MINERALOGY: [Principal and *subordinate*]: Quartz, carbonates (ferroan-dolomite, ankerite ferroan-magnesite, calcite, siderite), *albite*, *mariposite* (*fuchsite*), *sericite*, *muscovite*, *chlorite*, *tourmaline*, *graphite*.

ALTERATION MINERALOGY: Silicification, pyritization and potassium metasomatism generally occur adjacent to veins (usually within a metre) within broader zones of carbonate alteration, with or without ferroan dolomite veinlets, extending up to tens of metres from the veins. Type of carbonate alteration reflects the ferromagnesian content of the primary host lithology; ultramafics rocks - talc, Fe-magnesite; mafic volcanic rocks - ankerite, chlorite; sediments - graphite and pyrite; felsic to intermediate intrusions - sericite, albite, calcite, siderite, pyrite. Quartz-carbonate altered rock (listwanite) and pyrite are often the most prominent alteration minerals in the wallrock. Fuchsite, sericite, tourmaline and scheelite are common where veins are associated with felsic to intermediate intrusions.

WEATHERING: Distinctive orange-brown limonite due to the oxidation of Fe-Mg carbonates cut by white veins and veinlets of quartz and ferroan dolomite. Distinctive green Cr-mica may also be present. Abundant quartz float in overburden.

ORE CONTROLS: Gold-quartz veins are found within zones of intense and pervasive carbonate alteration along second order or later faults marginal to transcrustal breaks. They are commonly closely associated with, late syncollisional, structurally controlled intermediate to felsic magmatism. Gold veins are more commonly economic where hosted by relatively large, competent units, such as intrusions or blocks of obducted oceanic crust. Veins are usually at a high angle to the primary collisional fault zone.

- Phanerozoic: Secondary structures at a high angle to relatively flat-lying to moderately dipping collisional suture zones.
- Archean: Steep, transcrustal breaks; best deposits overall are in areas of greenstone.

ASSOCIATED DEPOSIT TYPES: Gold placers (C01, C02), sulphide manto Au (J04), silica veins (I07); iron formation Au (I04) in the Archean.

GENETIC MODEL: Gold quartz veins form in lithologically heterogeneous, deep transcrustal fault zones that develop in response to terrane collision. These faults act as conduits for CO₂-H₂O-rich (5-30 mol% CO₂), low salinity (<3 wt% NaCl) aqueous fluids, with high Au, Ag, As, (± Sb, Te, W, Mo) and low Cu, Pb, Zn metal contents. These fluids are believed to be tectonically or seismically driven by a cycle of pressure build-up that is released by failure and pressure reduction followed by sealing and repetition of the process (Sibson *et al.*, 1988). Gold is deposited at crustal levels within and near the brittle-ductile transition zone with deposition caused by sulphidation (the loss of H₂S due to pyrite deposition) primarily as a result of fluid-wallrock reactions, other significant factors may involve phase separation and fluid pressure reduction. The origin of the mineralizing fluids remains controversial, with metamorphic, magmatic and mantle sources being suggested as possible candidates. Within an environment of tectonic crustal thickening in response to terrane collision, metamorphic devolatilization or partial melting (anatexis) of either the lower crust or subducted slab may generate such fluids.

COMMENTS: These deposits may be a difficult deposit to evaluate due to "nugget effect", hence the adage, "Drill for structure, drift for grade". These veins have also been mined in British Columbia as a source of silica for smelter flux.

EXPLORATION GUIDES

GEOCHEMICAL SIGNATURE: Elevated values of Au, Ag, As, Sb, K, Li, Bi, W, Te and B ± (Cd, Cu, Pb, Zn and Hg) in rock and soil, Au in stream sediments.

GEOPHYSICAL SIGNATURE: Faults indicated by linear magnetic anomalies. Areas of alteration indicated by negative magnetic anomalies due to destruction of magnetite as a result of carbonate alteration.

OTHER EXPLORATION GUIDES: Placer gold or elevated gold in stream sediment samples is an excellent regional and property-scale guide to gold-quartz veins. Investigate broad 'deformation envelopes' adjacent to regional listric faults where associated with carbonate alteration. Alteration and structural analysis can be used to delineate prospective ground. Within carbonate alteration zones, gold is typically only in areas containing quartz, with or without sulphide minerals. Serpentinite bodies, if present, can be used to delineate favourable regional structures. Largest concentrations of free gold are commonly at, or near, the intersection of quartz veins with serpentinized and carbonate-altered ultramafic rocks.

ECONOMIC FACTORS

TYPICAL GRADE AND TONNAGE: Individual deposits average 30 000 t with grades of 16 g/t Au and 2.5 g/t Ag (Berger, 1986) and may be as large as 40 Mt. Many major producers in the Canadian Shield range from 1 to 6 Mt at grades of 7 g/t Au (Thorpe and Franklin, 1984). The largest gold-quartz vein deposit in British Columbia is the Bralorne-Pioneer which produced in excess of 117 800 kilograms of Au from ore with an average grade of 9.3 g/t.

ECONOMIC LIMITATIONS: These veins are usually less than 2 m wide and therefore, only amenable to underground mining.

IMPORTANCE: These deposits are a major source of the world's gold production and account for approximately a quarter of Canada's output. They are the most prolific gold source after the ores of the Witwatersrand basin.

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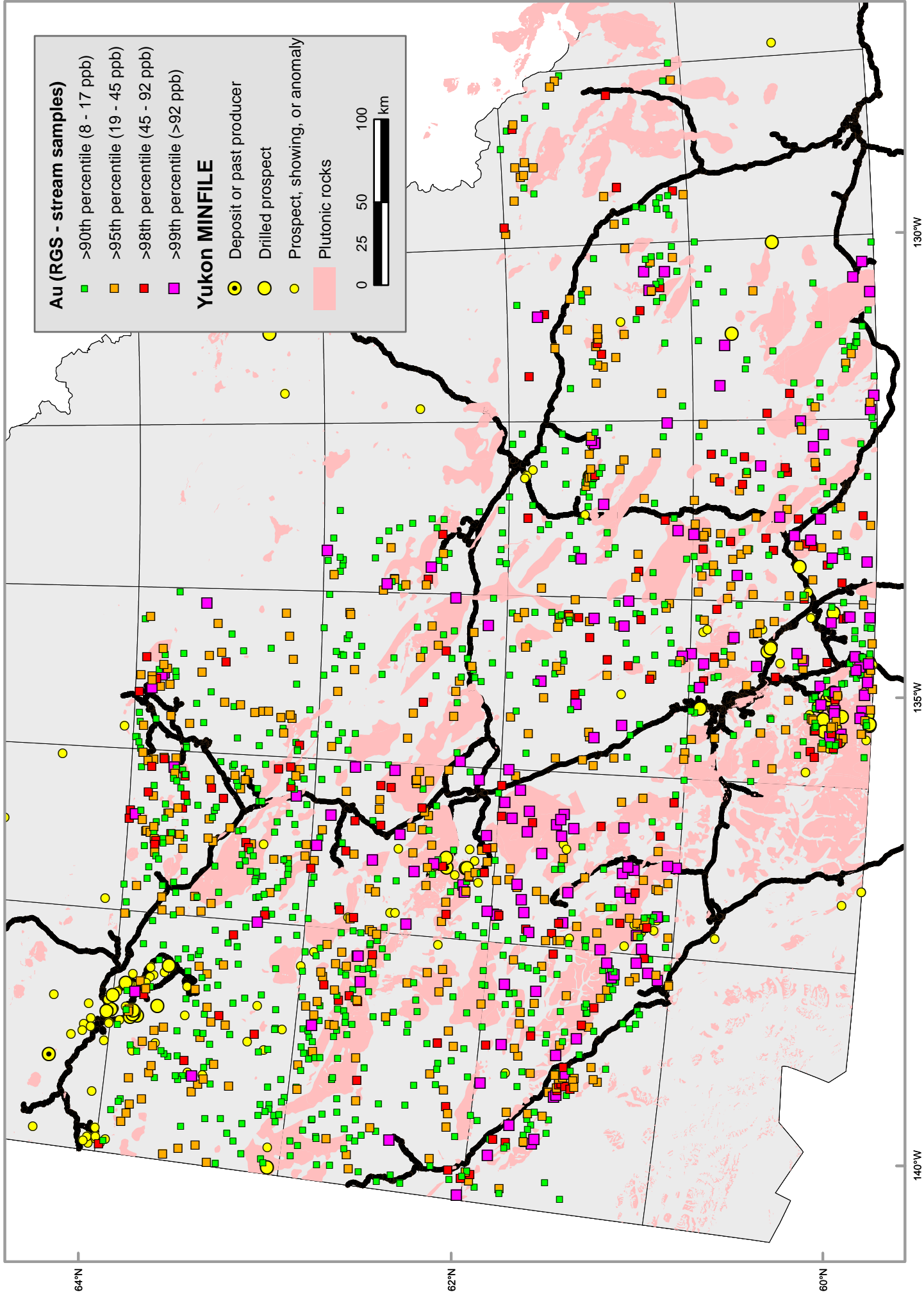
I01 - Au-quartz veins - BC deposits

Au-quartz vein deposits (BC)

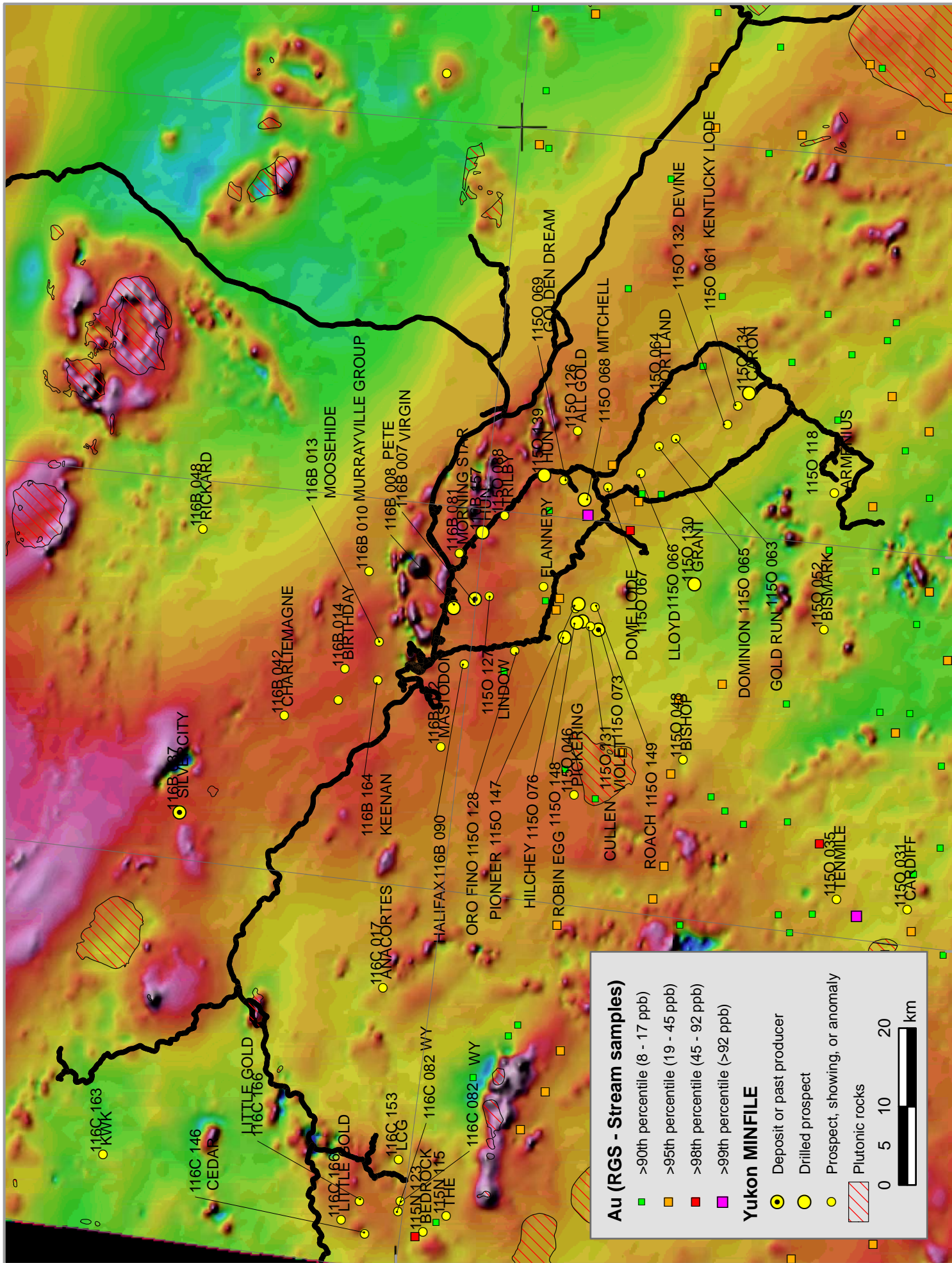
Deposit	country	tonnage	Au (g/t)	Ag (g/t)	Cu %	Pb %	Zn %
VALENTINE	CNBC	30 706	14.70	0.08	0.00	0.00	0.00
ATHABASCA	CNBC	59 924	13.14	4.83	0.00	0.02	0.03
CARIBOO HUDS	CNBC	66 640	13.60	15.18	0.00	0.00	0.00
MT. ZEBALLOS	CNBC	74 268	12.75	5.98	0.00	0.02	0.00
BAYON	CNBC	81 903	16.01	45.82	0.00	0.05	0.03
MERIDIAN	CNBC	88 762	6.13	1.86	0.00	0.00	0.00
B.C.	CNBC	93 874	0.33	71.00	4.36	0.00	0.00
HUNTER	CNBC	94 003	12.01	0.00	0.00	0.00	0.00
CENTRAL ZEBA	CNBC	104 381	12.05	24.63	0.01	0.01	0.14
MORNINGSTAR	CNBC	110 273	3.94	42.99	0.01	0.08	0.00
CARIBOO-AMEL	CNBC	124 451	20.39	8.11	0.00	0.04	0.07
WAYSIDE	CNBC	137 069	4.25	0.67	0.00	0.00	0.00
RELIANCE	CNBC	139 000	6.68	0.00	0.00	0.00	0.00
BANBURY	CNBC	174 360	10.18	2.27	0.01	0.00	0.00
GRANITE-POOR	CNBC	181 118	11.18	5.25	0.00	0.01	0.01
CONGRES	CNBC	193 581	9.21	1.38	0.00	0.00	0.00
ALPINES	CNBC	206 251	14.39	14.10	0.00	0.31	0.02
SNOWBIRD	CNBC	226 000	6.86	0.00	0.00	0.00	0.00
GOLD BELT	CNBC	236 502	10.63	4.49	0.00	0.00	0.00
YELLOWGIANT	CNBC	246 980	17.32	0.00	0.00	0.00	0.00
CONGRESS	CNBC	267 505	11.31	0.00	0.00	0.00	0.00
GEORGIA RIVER	CNBC	290 751	28.79	22.50	0.73	0.00	0.00
DOME MOUNTAIN	CNBC	294 372	12.53	67.36	0.00	0.00	0.00
KOOTENAY	CNBC	305 608	11.47	4.27	0.00	0.02	0.02
SPUD VALLEY	CNBC	414 754	11.95	3.02	0.00	0.00	0.00
TAURUS	CNBC	436 315	7.19	1.00	0.00	0.00	0.00
RENO NUGGET	CNBC	455 208	17.71	8.09	0.00	0.02	0.02
DEBBIE	CNBC	472 321	6.23	0.00	0.00	0.00	0.00
PRIVATE	CNBC	527 311	16.17	7.68	0.01	0.02	0.00
TAMARA	CNBC	560 046	4.50	0.00	0.00	0.00	0.00
QUEEN	CNBC	653 160	14.47	4.78	0.00	0.00	0.00
ERICKSON	CNBC	741 405	15.96	4.03	0.00	0.00	0.00
CPW	CNBC	838 004	1.95	0.00	0.00	0.00	0.00
SURF INLET	CNBC	973 427	13.28	6.97	0.33	0.00	0.00
ISLAND	CNBC	1 011 875	12.13	1.78	0.00	0.00	0.00
EDYEPASS	CNBC	1 443 182	6.99	3.65	0.01	0.00	0.00
STEMWIND	CNBC	1 549 675	3.76	40.75	0.00	0.01	0.00
CAROLIN	CNBC	1 916 425	2.78	0.11	0.00	0.00	0.00
CARIBOO GOLD	CNBC	2 057 944	13.26	1.39	0.00	0.00	0.00
POLARIS-TAKU	CNBC	3 283 357	13.68	0.11	0.00	0.00	0.00
BRALORNE	CNBC	8 260 230	16.74	3.38	0.00	0.00	0.00
FRASER GOLD	CNBC	12 000 000	1.90	0.00	0.00	0.00	0.00

I01 - Au-quartz veins - Yukon MINFILE

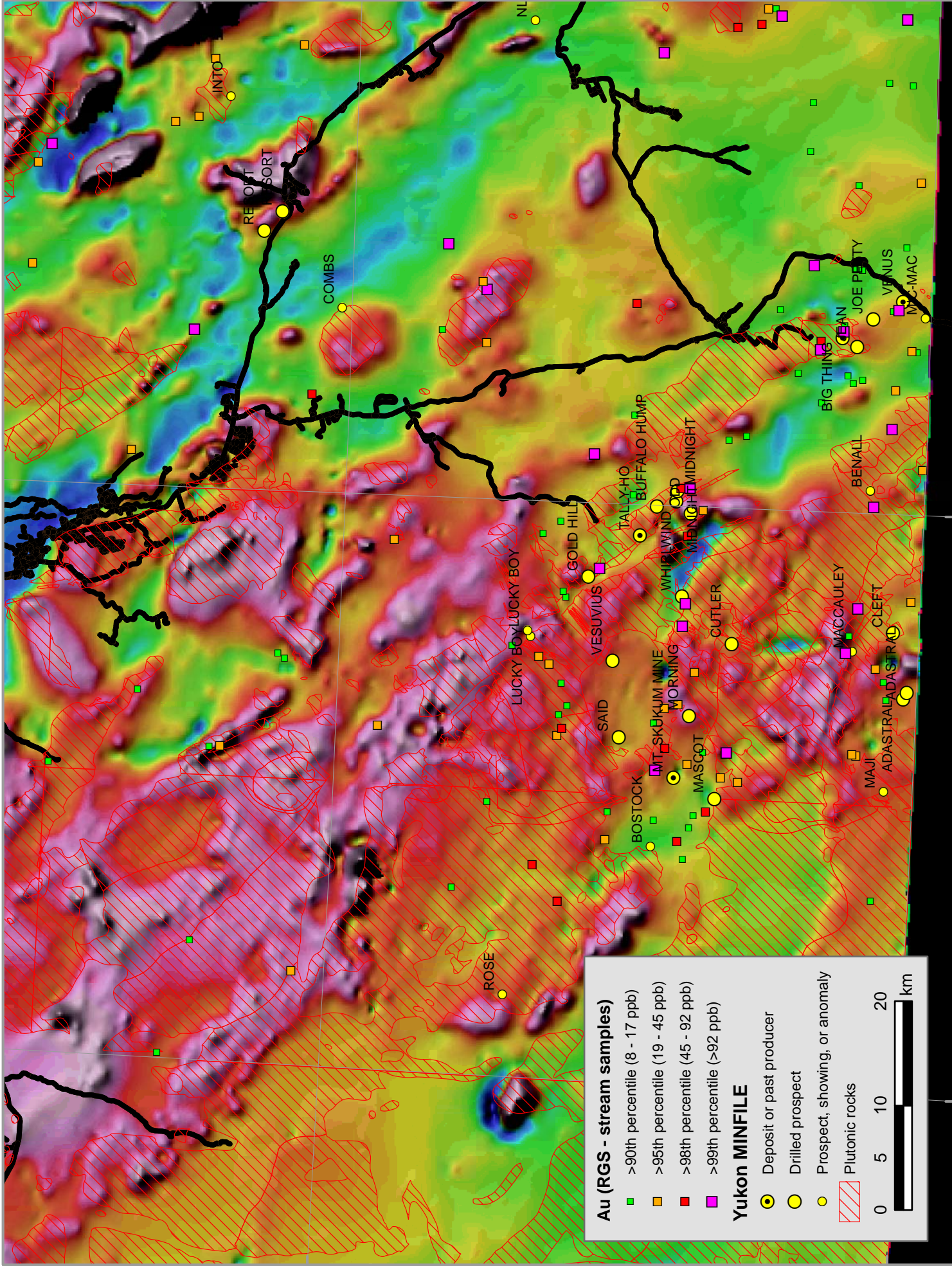
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116B 007	VIRGIN, GORDON, JEAN, OPHIR	UNDERGROUND PAST PRODUCER	105F 032	PONY	SHOWING
116B 037	SILVERCITY, CARBONATE, YUKON BEAUTY	UNDERGROUND PAST PRODUCER	105F 044	WATERFALL	SHOWING
115I 049	CARIBOU CREEK	OPEN PIT PAST PRODUCER	105F 045	DANGER	SHOWING
105C 028	DALAYEE, TOG, JUBE	DRILLED PROSPECT	105F 046	KINDLE	SHOWING
105D 006	MONTANA, JOE PETTY	DRILLED PROSPECT	105F 118	QUILLO	SHOWING
105D 008	JEAN	DRILLED PROSPECT	105G 031	ROB	SHOWING
105D 020	CHARLESTON, MASCOT	DRILLED PROSPECT	105H 102	FER	SHOWING
105D 029	MT. ANDERSON, TYCOON, WHIRLWIND	DRILLED PROSPECT	105H 103	SUGAR BOWL	SHOWING
105D 032	BUFFALO HUMP	DRILLED PROSPECT	105J 039	WENDY	SHOWING
105D 033	MT. STEVENS, HAWK EYE, MIDNIGHT, HIDDEN ORE	DRILLED PROSPECT	105J 043	VG	SHOWING
105D 036	GOLD HILL, DAIL	DRILLED PROSPECT	105O 004	ALP	SHOWING
105D 047	CUTOFF	DRILLED PROSPECT	105O 049	FAENZI	SHOWING
105D 090	ADASTRAL, RUBY	DRILLED PROSPECT	106D 028	ELLIS	SHOWING
105D 127	CUTLER	DRILLED PROSPECT	115A 036	ARCHIBALD, JS, GREEN, COLTON	SHOWING
105D 136	CLEFT	DRILLED PROSPECT	115H 045	AL	SHOWING
105D 157	PENNYCOOK, JUBILEE	DRILLED PROSPECT	115I 015	LYDEN	SHOWING
105D 161	VESUVIUS	DRILLED PROSPECT	115I 046	LIL	SHOWING
105D 166	ARSCOTT, SAID	DRILLED PROSPECT	115I 084	LONELY	SHOWING
105F 121	SEAGULL CREEK, TAY-LP	DRILLED PROSPECT	115I 101	PANTHER	SHOWING
105O 032	NEVE, BRICK	DRILLED PROSPECT	115I 106	HAPPY	SHOWING
115H 047	SHUT, KILLER GOLD, RUBY RANGE PROJECT	DRILLED PROSPECT	115I 121	STODDART, SEYMOUR	SHOWING
115H 055	LIB, KILLER GOLD, RUBY RANGE PROJECT	DRILLED PROSPECT	115I 122	GRIZZLY	SHOWING
115I 068	DIVIDE, VIC, DISCOVERY CREEK	DRILLED PROSPECT	115J 098	SIZZLER	SHOWING
115I 112	WHALE	DRILLED PROSPECT	115J 102	NOWHERE	SHOWING
115O 068	MITCHELL	DRILLED PROSPECT	115N 123	BEDROCK	SHOWING
115O 076	HILCHEY	DRILLED PROSPECT	115O 010	TREVA	SHOWING
115O 077	BUCKLAND	DRILLED PROSPECT	115O 035	TEHMILE	SHOWING
115O 130	GRANT	DRILLED PROSPECT	115O 065	DOMINION, PATTERSON, QUEEN DOME	SHOWING
115O 134	CARON	DRILLED PROSPECT	115O 126	ALL GOLD	SHOWING
115O 139	HUN	DRILLED PROSPECT	115O 127	LINDOW	SHOWING
115O 148	ROBIN EGG	DRILLED PROSPECT	115O 128	ORO FINO	SHOWING
115O 150	PIONEER	DRILLED PROSPECT	115O 131	CULLEN	SHOWING
116B 008	MACLEAN, GOLDEN AGE, KLEAN, PETE	DRILLED PROSPECT	115O 147	PARNELL	SHOWING
116B 157	BEN LEVY, BLUEBELL, PRED, DAWSON, HUN	DRILLED PROSPECT	115O 149	ROACH	SHOWING
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105D 040	LEGAL TENDER, MINERAL HILL, LUCKY BOY	PROSPECT	116B 072	MASTODON, BIG CONTACT, BIG JOE, JOE	SHOWING
105D 177	BENALL	PROSPECT	116C 153	GLASMACHER, LCG	SHOWING
105O 051	DALL, HARLAN	PROSPECT	105D 137	MACCAULEY	ANOMALY
115A 049	DOLLIS, CHARLIE, CHUCK, JIM, JEAN, ROBIN, BURGER	PROSPECT	115H 049	MT. BARK	ANOMALY
115G 106	BERDAHL	PROSPECT	115H 051	MACINTOSH, MAG, JIMBO	ANOMALY
115H 060	MOM	PROSPECT	115H 053	BOWEN, ARC	ANOMALY
115O 031	CARDIFF	PROSPECT	115H 058	MCKINLEY	ANOMALY
115O 046	PICKERING	PROSPECT	115O 052	BISMARK	ANOMALY
115O 061	PAYNE, AIME, KENTUCKY LODE	PROSPECT	115O 075	MARIPOSA	ANOMALY
115O 063	GOLD RUN	PROSPECT	115O 093	FLANNERY	ANOMALY
115O 064	PORTLAND	PROSPECT	115P 049	PIRATE	ANOMALY
115O 066	LLOYD	PROSPECT	116C 082	YAREMICO	ANOMALY
115O 067	HUNKER DOME, DOME LODE	PROSPECT	116C 146	CEDAR, BIRCH	ANOMALY
115O 069	FAWCETT, ALPHONSE, BRANDON, HILLSBOROUGH	PROSPECT	117C 026	FIRTH	ANOMALY
115O 118	ARMENIUS	PROSPECT	115A 050	CASHIN, KID, JUNIOR	UNKNOWN
115O 132	DEVINE, KENTUCKY LODE	PROSPECT	115I 028	MINNESOTA	UNKNOWN
116A 031	AUSSIE, AREA 5	PROSPECT	115N 096	STADNYK	UNKNOWN
116B 010	LEPINE, MURRAYVILLE GROUP, WELLS GROUP, KLEP	PROSPECT	115N 115	THE	UNKNOWN
116C 163	KINK, KWK	PROSPECT	115O 005	COOPER	UNKNOWN
116C 166	LITTLE GOLD	PROSPECT	115O 012	NORTHERN LIGHTS	UNKNOWN
095D 033	CUZ, HYLAND	SHOWING	115O 048	BISHOP	UNKNOWN
105C 055	EAGLENEST	SHOWING	115O 106	HAKONSON	UNKNOWN
105D 019	BOSTOCK	SHOWING	116B 013	MOOSEHIDE, BROADLEDGE, DAWSON NUGGET, TELLURIUM	UNKNOWN
105D 112	COMBS	SHOWING	116B 014	RELIANCE, BIRTHDAY, MORNING STAR, JOHN MORRIS	UNKNOWN
105D 184	MOVEMENT	SHOWING	116B 042	CHARLIEMAGNE, JOSEPHINE GROUP, MARY GROUP	UNKNOWN
105D 188	MIC-MAC	SHOWING	116B 048	RICKARD	UNKNOWN
105D 189	MT. BYNG	SHOWING	116B 081	HATTIE, MORNING STAR	UNKNOWN
105D 197	JOE CREEK	SHOWING	116B 090	HALIFAX, MCDONALD, DERNIER, DUNDAS, SPEC	UNKNOWN
105D 198	NLC	SHOWING	116B 092	HALE, STARBRIGHT, RIVERSIDE, CHALMERS, NOBLE	UNKNOWN
			116B 164	KEENAN	UNKNOWN
			116C 017	ANACORTES	UNKNOWN



Map of Yukon showing Au regional geochemistry, Au quartz vein MINFILE occurrences and the distribution of plutonic rocks



Map of the Klondike region, western Yukon showing Au quartz vein occurrences, Au regional geochemistry, regional magnetics and plutonic rocks



60°30'N

60°N

136°W

135°W

Map of the Wheaton River region, south central Yukon showing Au quartz vein occurrences, Au regional geochemistry, regional magnetics and plutonic rocks