# POLYMETALLIC MANTOS Ag-Pb-Zn[1] J01

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**Modified for Yukon by A. Fonseca and G. Bradshaw**
**Refer to preface for general references and formatting significance.**
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## *IDENTIFICATION*

SYNONYM: Polymetallic replacement deposits.

COMMODITIES (*BYPRODUCTS*): Ag, Pb, Zn (Au, Cu, Sn, Bi).

EXAMPLES: **(Yukon): Hyland Gold (095D 006), McMillan (095D 011), Groundhog (105F 029), Ketza River (105F 019), Tintina/Eagle (105G 006), Clark (106D 011);** (British Columbia - *Canada/International*): Midway (104O038) and Bluebell (082ENW026), *Prairie Creek (Northwest Territories, Canada), Leadville District (Colorado, USA), East Tintic District (Utah, USA), Eureka District (Nevada, USA), Santa Eulalia, Naica, Fresnillo, Velardena, Providencia (Mexico).*

## *GEOLOGICAL CHARACTERISTICS*

CAPSULE DESCRIPTION: Irregularly shaped, conformable to crosscutting bodies, such as massive lenses, pipes and veins, of sphalerite, galena, pyrite and other sulphide and sulphosalt minerals in carbonate hosts; distal to skarns and to small, high-level felsic intrusions.

TECTONIC SETTING: Intrusions emplaced into miogeoclinal to platformal, continental settings.

DEPOSITIONAL ENVIRONMENT / GEOLOGICAL SETTING: In northern Mexico, most are hosted by Cretaceous limestones. In Colorado, the principal host is the Devonian-Mississippian Leadville limestone; in Utah, the Permian Torweap Formation hosts the Deer Trail deposit. The most favourable hosts in the Canadian Cordillera are massive Lower Cambrian and Middle Devonian limestones, rather than impure carbonates and dolostone-quartzite units.

AGE OF MINERALIZATION: Canadian Cordilleran examples are Cretaceous to Eocene age; those in the southern Cordillera are typically Tertiary.

HOST/ASSOCIATED ROCK TYPES: Hosted by limestone and dolostone. The carbonates are typically within a thick sediment package with siliciclastic rocks that is cut by granite, quartz monzonite and other intermediate to felsic hypabyssal, porphyritic lithologies. There may be volcanic rocks in the sequence, or more commonly above, which are related to the intrusive rocks.

DEPOSIT FORM: Irregular: mantos (cloak shaped), lenses, pipes, chimneys, veins; in some deposits the chimneys and/or mantos are stacked.

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[1] Manto is a Spanish mining term denoting a blanket-shaped ore body which is widely used for replacement deposits of Mexico. It has been used to describe the orientation of individual lenses and also to describe a class of ore bodies.

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TEXTURE/STRUCTURE: Massive to highly vuggy, porous ore. In some cases fragments of wallrock are incorporated into the ore. Some deposits have breccias: fragments of wallrock and also of sulphide ore within a sulphide matrix.

ORE MINERALOGY (Principal and subordinate): Sphalerite, galena, pyrite, chalcopyrite, marcasite; arsenopyrite, pyrargyrite/proustite, enargite, tetrahedrite, geocronite, electrum, digenite, jamesonite, jordanite, bournonite, stephanite, polybasite, rhodochrosite, sylvanite, calaverite. Chimneys may be more Zn-rich, Pb-poor than mantos.

GANGUE MINERALOGY (Principal and *subordinate*): Quartz, barite, gypsum; minor *calc-silicate minerals*.

ALTERATION MINERALOGY: Limestone wall rocks are commonly dolomitized and/or silicified, whereas shale and igneous rocks are argillized and chloritized. Jasperoid occurs in some U.S. examples.

WEATHERING: In some cases, a deep oxidation zone is developed. Mexican deposits have well developed oxide zones with cassiterite, hematite, Cu and Fe carbonates, cerusite and smithsonite.

ORE CONTROLS: The irregular shapes of these deposits and their occurrence in carbonate hosts emphasize the importance of ground preparation in controlling fluid channels and depositional sites. Controlling factors include faults, fault intersections, fractures, anticlinal culminations, bedding channelways (lithologic contrasts), karst features and pre-existing permeable zones. In several districts karst development associated with unconformities is believed to have led to development of open spaces subsequently filled by ore. Some deposits are spatially associated with dikes.

GENETIC MODEL: Manto deposits are high-temperature replacements as shown by fluid inclusion temperatures in excess of 300 °C, high contents of Ag, presence of Sn, W and complex sulphosalts, and association with skarns and small felsic intrusions. They are the product of pluton-driven hydrothermal solutions that followed a variety of permeable pathways, such as bedding, karst features and fracture zones.

ASSOCIATED DEPOSIT TYPES: There is probably an overall outward gradation from granite-hosted Mo-Cu porphyries (L04), endoskarns (K) and possibly W- and Sn mineralization (L06?), through exoskarns (K01, K02) and into Ag-Pb-Zn veins (I05), mantos (J01) and possibly Carlin-type sediment-hosted Au-Ag deposits (E03). Only some, or possibly one, of these types may be manifest in a given district. Ag-Pb-Zn vein, manto and skarn deposits belong to a continuum which includes many individual occurrences with mixed characteristics.

COMMENTS: In the Canadian Cordillera, most mantos are located in the miogeocline (western Ancestral North America, Cassiar and Kootenay terranes) because of the essential coincidence of abundant carbonate and presence of felsic intrusions. There is one known example in Upper Triassic limestone on Vancouver Island, which probably formed distal to skarn mineralization related to a mid-Jurassic intrusion. Most mantos in the Canadian Cordillera are Late Cretaceous to Eocene, coinciding with the age of youngest, F-rich intrusions of the A-type (anorogenic) granite suite. In Mexico, mantos are associated with Early to mid-Tertiary volcanic rocks and cogenetic intrusions. The Colorado deposits may be associated with Tertiary sills, and the Deer Trail deposit in Utah has given a 12 Ma sericite age. **The Ketza River deposit in central Yukon is a gold-rich polymetallic manto deposit for which silver and base metal grades have not been quoted. Recent work at the Hyland Gold deposit revealed some attributes characteristic of Carlin-type sediment-hosted gold-silver deposits.**

## *EXPLORATION GUIDES*

GEOCHEMICAL SIGNATURE: B.C.: Ag, Pb, Zn, Sn in stream silts, F in waters. U.S.: Districts show outward zoning from Cu-rich core through broad Ag-Pb zone to Zn-Mn fringe. Locally Au, As, Sb, Bi. Jasperoid contains elevated Ba + Ag.

GEOPHYSICAL SIGNATURE: Subsurface granite associated with Midway deposit has negative magnetic signature.

OTHER EXPLORATION GUIDES: Concentration of Ag-Pb-Zn vein deposits in or near carbonates.

## *ECONOMIC FACTORS*

TYPICAL GRADE AND TONNAGE: Individual deposits average about a million tonnes grading tens to hundreds of grams/tonne Ag and approximately 5 to 20% combined Pb-Zn. Mexico: Santa Eulalia district produced about 24 Mt in this century, grading about 300 g/t Ag, 8% Pb, 9% Zn. U.S.: Leadville deposit mined 30 Mt 70-130 g/t Ag, 12-15% Pb-Zn. B.C.: Midway geological resource is 1 Mt grading 400 g/t Ag 7% Pb, 9.6% Zn. In many mining districts the early production came from oxidized ore zones that can have higher grades and be easier to mine.

ECONOMIC LIMITATIONS: Generally, although not always, these deposits tend to be small, highly irregular and discontinuous. The Mexican deposits have yielded large quantities of ore because, due to low labour costs, mining provided an effective and low-cost exploration tool.

IMPORTANCE: As sources of base metals, manto deposits are overshadowed on a world scale by the giant syngenetic classes such as sedimentary exhalitive and volcanogenic massive sulphides. However, because of their high precious metal contents, they provide exciting targets for small producers.

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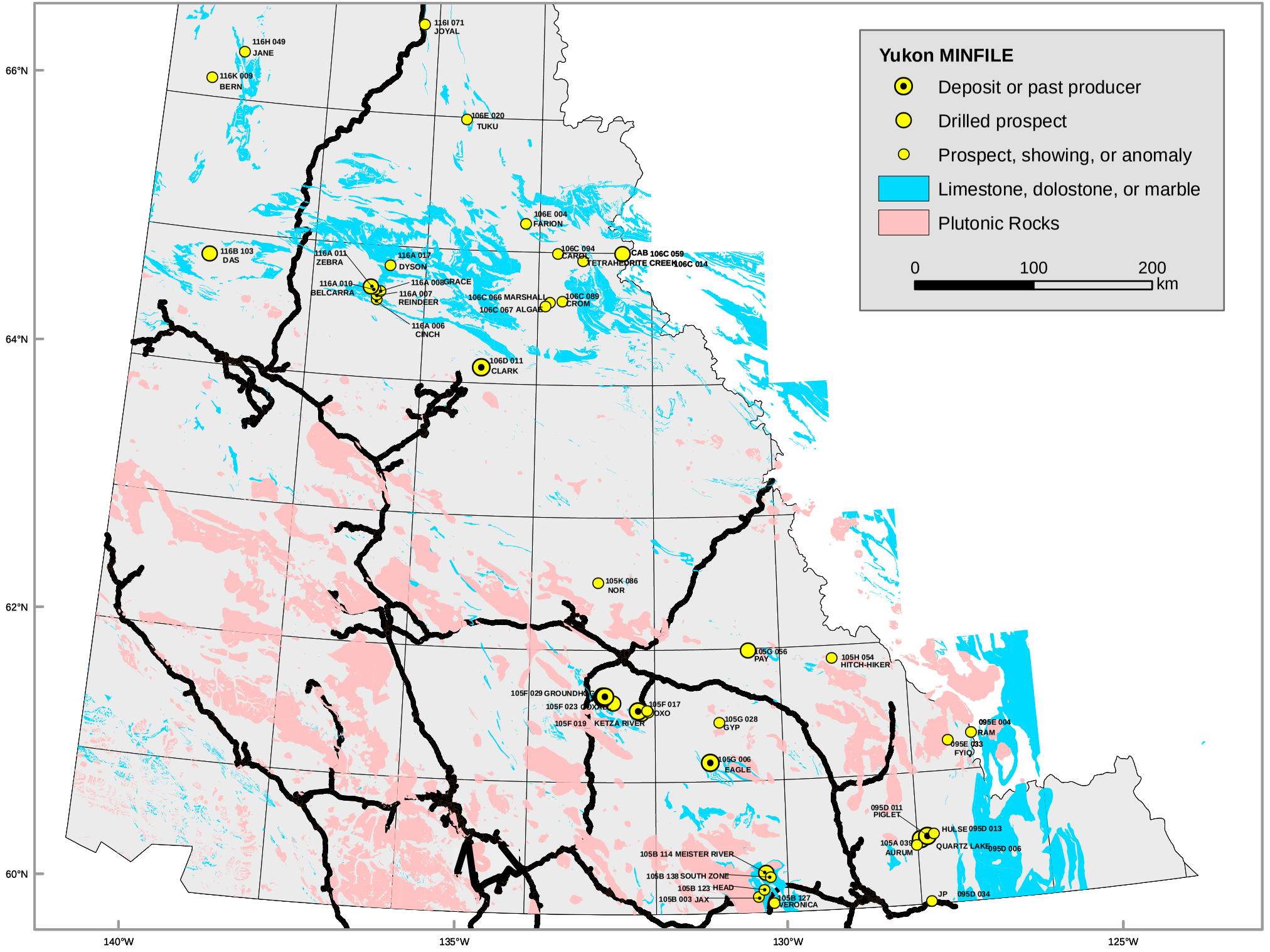
## J01 - Polymetallic mantos Ag-Pb-Zn - BC and Yukon deposits

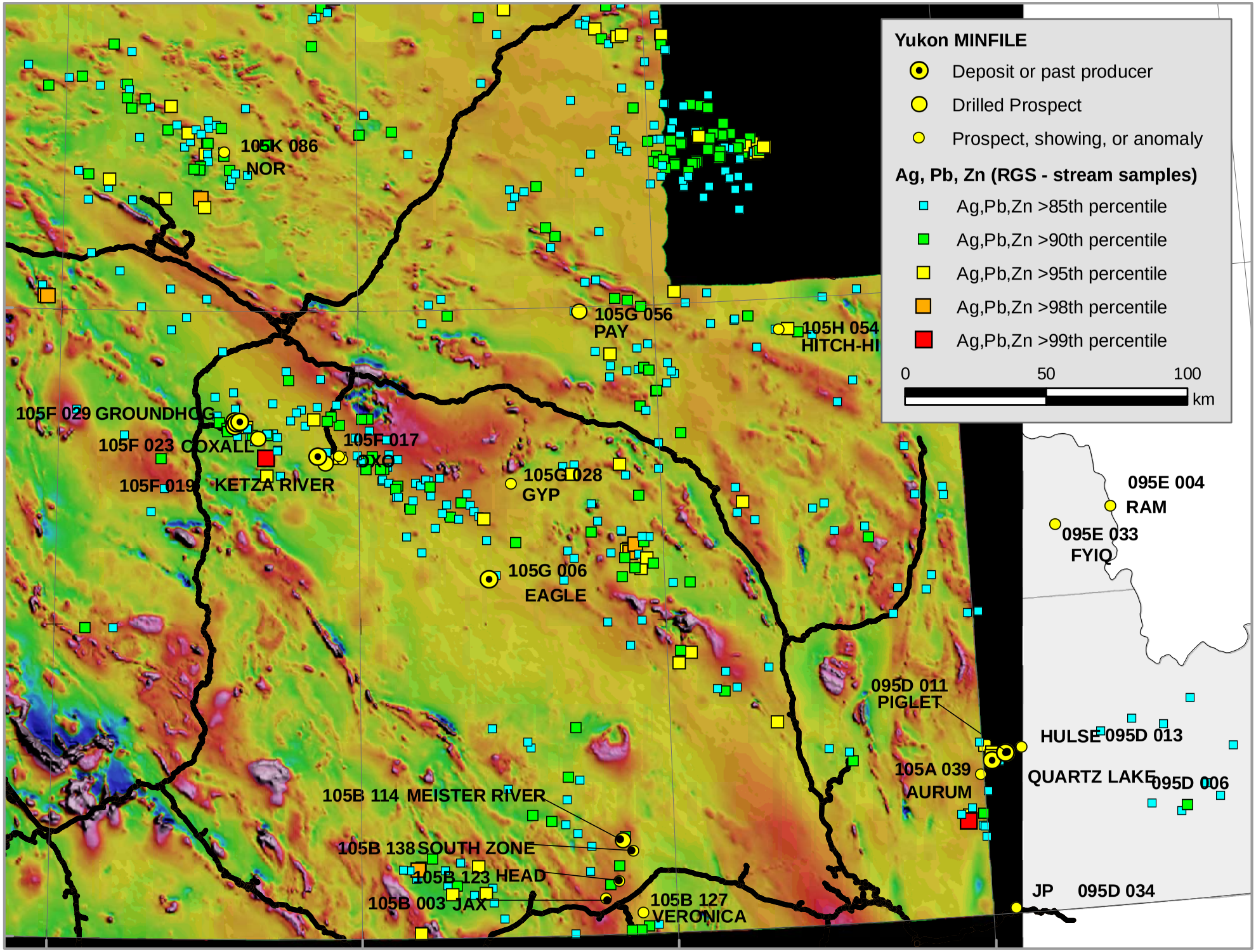
| Deposit | country | tonnes | Au (g/t) | Ag (g/t) | Cu % | Pb % | Zn % |
|---|---|---|---|---|---|---|---|
| PARADISE | CNBC | 64 635 | 0.0 | 354.7 | 0.00 | 11.21 | 5.61 |
| EAGLE/TINTINA | CNYT | 90 900 | 0.0 | 686.0 | 0.00 | 6.00 | 10.00 |
| KOOTENAY | CNBC | 115 679 | 0.0 | 51.3 | 0.00 | 5.47 | 1.14 |
| GROUNDHOG | CNYT | 200 951 | 0.0 | 91.9 | 0.00 | 3.18 | 4.01 |
| BAMTENAY | CNBC | 270 000 | 0.0 | 0.0 | 0.76 | 0.00 | 0.00 |
| CLARK | CNYT | 327 050 | 0.0 | 255.0 | 0.00 | 4.59 | 4.60 |
| QUARTZ LAKE | CNYT | 400 000 | 0.0 | 214.0 | 0.00 | 9.30 | 1.70 |
| KETZA RIVER | CNYT | 1 000 000 | 13.7 | 0.0 | 0.00 | 0.00 | 0.00 |
| QUARTZ LAKE/MCMILLAN | CNYT | 1 100 000 | 0.0 | 62.0 | 0.00 | 4.10 | 8.30 |
| MIDWAY | CNBC | 1 180 000 | 0.0 | 404.5 | 0.00 | 7.90 | 9.60 |
| SILVERTIP | CNBC | 2 570 000 | 0.6 | 325.0 | 0.00 | 6.40 | 8.80 |
| BLUEBELL | CNBC | 4 820 029 | 0.0 | 0.0 | 0.06 | 4.85 | 5.17 |
| HYLAND GOLD | CNYT | 6 750 000 | 2.0 | 0.0 | 0.00 | 0.00 | 0.00 |
| MEL | CNYT | 6 800 000 | 0.0 | 0.0 | 0.00 | 2.00 | 7.10 |

## Yukon MINFILE

| MINFILE | NAMES | STATUS |
|---|---|---|
| 105F 019 | KETZA, PEEL, 3B, BOOM | UNDERGROUND PAST PRODUCER |
| 095D 006 | MCMILLAN, QUARTZ LAKE | DEPOSIT |
| 105F 029 | GROUNDHOG | DEPOSIT |
| 105G 006 | TINTINA, EAGLE | DEPOSIT |
| 106D 011 | CLARK | DEPOSIT |
| 105B 114 | MEISTER, WEST ZONE, MEISTER RIVER, MR | DRILLED PROSPECT |
| 105F 017 | OXO | DRILLED PROSPECT |
| 105F 023 | COXALL | DRILLED PROSPECT |
| 106D 012 | CAMERON | DRILLED PROSPECT |
| 116A 011 | ZEBRA | DRILLED PROSPECT |
| 095D 013 | HULSE | PROSPECT |
| 095E 004 | TWIN, RAM, DELL, SUNSET, U2, NEIL, FOX | PROSPECT |
| 105B 003 | LUCK, JAX | PROSPECT |
| 105G 028 | GYP | PROSPECT |
| 095E 033 | HOOPER, FYIQ | SHOWING |
| 105B 127 | VERONICA | SHOWING |
| 105B 138 | HAIRSINE, SOUTH ZONE | SHOWING |
| 105F 068 | REGEHR, SOUTH FAULT, F4 ZONE, F6 ZONE | SHOWING |
| 105H 054 | HITCH-HIKER | SHOWING |
| 105K 086 | MARKS, ZEUS, ZED, NOR | SHOWING |
| 106C 066 | MARSHALL | SHOWING |
| 106C 067 | ALGAE | SHOWING |
| 116A 007 | REINDEER | SHOWING |
| 116A 010 | BELCARRA | SHOWING |
| 116A 017 | DYSON | SHOWING |
| 105A 039 | AURUM | ANOMALY |
| 105B 123 | HEAD, TACKLE | ANOMALY |
| 116A 006 | CINCH | ANOMALY |
| 116A 008 | GRACE | ANOMALY |
| 116H 049 | JANE | ANOMALY |
| 116I 071 | JOYAL | ANOMALY |




Map of Yukon showing plutonic rocks, carbonate rocks and possible polymetallic manto occurrences




Map of southeast Yukon showing polymetallic manto occurrences, Ag-Pb-Zn geochemistry and regional magnetics