Yukon Platinum Occurrences & Potential

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Introduction

Interest in mineral occurrences containing platinum group elements (PGE - platinum, palladium, osmium, rhodium, ruthenium and iridium) has increased significantly as a result of recent dramatic price increases. PGE deposits, and even deposits with PGEs as a byproduct are not common in the northern Cordillera, with approximately 37 occurrences in Yukon reporting PGE mineralization or anomalous values. Approximately half of the known occurrences are developed in the Kluane belt in association with variably differentiated Late Triassic ultramafic sills, which intrude oceanic sedimentary and volcanic strata. The largest is the Wellgreen deposit, which has had limited production and current reserves approximating 669 150 t of 2.04% Ni, 1.42% Cu, 0.07% Co and 2.23 g/t Pd+Pt.

Kluane-type occurrences are typical in many respects to most PGE deposits worldwide in that they were formed by precipitation and gravitational accumulation of sulphide minerals in a fractionating mafic-ultramafic intrusion. These orthomagmatic sulphide occurrences probably provide the best geological targets for PGE deposits in the Yukon. There is, however, considerable evidence to suggest that other localities in the Yukon have similar potential, and unconventional styles of PGE mineralization deserve exploration consideration. Occurrences of placer PGE outside of the Kluane belt provide direct proof of other sources, whereas widespread exceptional regional geochemical results and unexplained gravity anomalies indicate further potential.

This open file provides compiled geological, geochemical and geophysical information that together identifies regions of PGE potential and highlights the possibility of unconventional PGE resources. Sources of information include Yukon Minfile (1997), the Yukon Digital Geology CD (Gordey and Makepeace, 1999) and the Bulletin on Kluane-type PGE occurrences of Hulbert (1997).

Yukon MINFILE occurrences with reported PGE mineralization or anomalies

SELWYN BASIN & MACKENZIE PLATFORM

Taiga

A thin (>40 cm) stratiform, massive pyrite-vaesite horizon outcrops throughout a region underlain by the Taiga Basin, a sub-basin of Selwyn Basin strata within Mackenzie Platform. The sulphide horizon yields values to 5.21% Ni and 904 ppb Au+PGE and is found within the middle member of the three member lower-Middle-Devonian-aged lower Earn Group, which consists of barite, baritic and carbonaceous shale. The sulphide horizon occurs at the upper contact of a distinctive unit comprised of limestone and baritic limestone balls with overlying chert. Although the sulphide horizon is thin, drill intersections include 25.5 m of 0.51% Ni and 0.41% Zn. Locally Ni mineralization is in two zones separated by barite, with higher grades in an upper zone associated with fossiliferous baritic and phosphatic black shale.
Yukon Exploration and Geology 1997, p. 125-125.

Sanguinetti, 116A 024 and Rein, 116B 128

Both occurrences are part of the Taiga property. Strong zinc anomalies and hydrozincite occurs at several localities overlying Devono-Mississippian Earn Group silty argillite and shale. Discontinuous lenses of barite within this sequence are up to 30 m thick. Limy shale and phyllitic carbonate of the Ordovician-Silurian Road River Formation have been thrust over the younger sequence by the Dawson Fault.
Mineral Industry Report, 1977, p. 49-51; 1978, p. 24
Yukon Geology and Exploration 1979-80, p. 292.

Tam (Falcon), 105I 044

Grit, shale and chert of the Selwyn Basin form the bedrock in this area. Six strongly anomalous Ni and Zn areas coincide with a recessive, metal-rich horizon, which marks the contact between calcareous shale and mudstone of the Ordovician to Devonian Road River Formation and turbidite deposits of the Devono-Mississippian Earn Group. The anomalies are centred around a calcareous spring tufa, which assays up to 18.5% Zn and 0.9% Ni. Soil samples returned values up to 11.4 ppm Ag, 405 ppm As, 1105 ppm Cu, >100 ppm Cd and 330 ppm Mo; elsewhere a soil anomaly yielded nickel values between 1440 and 2600 ppm, with high Zn numbers.
Exploration and Mining Geology, vol. 1, p. 39-62.
Mineral Industry Report 1973, p. 95, 100-102; 1974, p. 164-165.

Drizzle (Jet), 105O 023

Minor hydrozincite, smithsonite and malachite occur in a

thin impure limestone bed near the top of the Road River Group shale. Bedded barite was also found at two localities in overlying shale of the Devono-Mississippian Earn Group. Major Ni (3160 ppm), Zn (1%), V and Cu, with minor Mo, Ag, P and Mo soil anomalies identified a metalliferous horizon directly overlying a distinctive limestone layer. The limestone is pyritic, vuggy and contains shallow marine fossils of Early Devonian age and disseminated bitumen.
Yukon Exploration and Geology 1981, p. 176; 1982, p. 166.

Niddery (Jet), 105O 005

A linear multi-element geochemical anomaly (major Ni, V, Cu, and minor Mo, P, Cu) located a metalliferous horizon directly overlying pyritic and vuggy limestone with shallow marine fossils of Early Devonian age and disseminated bitumen. Soil samples taken from the recessive metalliferous horizon returned values up to 3160 ppm Ni, 1% Zn, and elevated levels of Cu, Cd, Ag, As and Mo. Two baritic lenses up to 30 m thick and 100 m long also occur in Earn Group carbonaceous shale. Soil sampling returned values of up to 1593 ppm Ni and 10,367 ppm Zn.
Geological Survey of Canada, Paper 69-55, p. 18.
Yukon Exploration and Geology 1983, p. 219; 1984, p. 136-138.

Nick 106D 092

Stratiform vaesite (NiS2), pyrite and minor sphalerite associated with bitumen form disrupted concretions, disseminations, framboids and pellet aggregates in Lower to Middle Devonian shale. The shale is in an outlier of Selwyn Basin rocks preserved in an east-trending graben on the Mackenzie Platform. The narrow (up to 10 cm) massive sulphide horizon lies at the contact between Middle Devonian black chert of the Earn Group and a distinctive concretionary unit of Lower Devonian age, which forms the top of the Road River Formation in this area. The concretionary unit consists of limestone balls 5 cm to 1.5 m in diameter in a matrix of black siliceous mudstone. Specimens grade up to 5.8% Ni, 1.56% Zn and 0.395% Mo and are associated with a distinctive suite of trace metals including Pt (up to 1000 ppb), Pd (up to 390 ppb), Re (up to 61 ppm), Ag, Au and Se. A drill intersection ranges from 0.37 to 5% Ni over narrow intervals, the widest being 2.9% Ni, 0.7% Zn, 0.16% Mo, 70 ppb Pt, 70 ppb Pd and 0.8 ppm Ag over 10 cm.
Exploration and Mining Geology, Vol. 1, p. 39-62.
Yukon Exploration 1991, p. 5.
Yukon Mining and Exploration Overview, 1988, p. 31; 1989, p. 7.
Hulbert et al., 1992

Porphyry, 106C 013

Middle Proterozoic Wernecke Supergroup is cut by hematite breccia and intruded by mafic sills and dykes. A 46 x 9 m lens-shaped-zone of feldspathized (albite) alteration developed peripheral to a body of Wernecke Breccia is mineralized with disseminated chalcopyrite, pyrite, chromite, magnetite and up to 40% hematite. Magnetic surveys indicate the mineralized area to be larger than that exposed.
Mineral Industry Report 1969 and 1970, p. 27-28.
Yukon Exploration and Geology 1983, p. 228-229.
Thorkelson, 2000

CACHE CREEK TERRANE

Squanga, 105C 012

A 20 x 4 m lens of chromite-bearing dunite occurs within a layered ultramafic sequence of Cache Creek Terrane ophiolitic rocks. Samples with up to 33.5% Cr_2O_3 locally contained anomalous PGE values up to 145 ppb Pt.
Yukon Exploration 1987, p. 88.

Lindsay, 105C 022

Weak Ni-Cu-Pt anomalies are related to magnetite and sulphides in serpentinized dunite and peridotite near the contact with Paleozoic sedimentary rocks of Cache Creek Terrane. Anomalous Au and Ag values have also been obtained. Although there is no indication of PGE values, the geological setting and mineralogy are appropriate.

TOG (Dalayee, Jube), 105C 028

In addition to the occurrence of a shear-hosted gold vein with listwaenitic alteration, the sheared and serpentinized ultramafic rocks (peridotite) also host a series of small chromite lenses, southwest of the gold-bearing structure. The largest chromite lens exposed by trenching measures 1.5 x 0.8 m. The best assay was 49.4% chromite and 14.0% Fe_2O_3. The rocks are part of an obducted ophiolitic sequence of Paleozoic Cache Creek Terrane.
Yukon Exploration 1989, p. 34; 1990, p.20, 151.
Yukon Mining and Exploration Overview, 1988, p. 17; 1989, p. 6.

Marsh, 105D 069

A quartz-carbonate alteration zone occupies the sheared, north-trending contact between Laberge Group greywacke, argillite and conglomerate and a serpentinized ultramafic body associated with Cache Creek volcanic rocks. The altered zone contains minor pyrite and pyrrhotite with traces of violarite ($FeNi_2S_4$), heazlewoodite (Ni_3S_2) and pentlandite. Selected samples assay up to 0.24% Ni, 0.02% Cu and 0.01% Co. Traces of chromite and asbestos fibres are also present.
Yukon Exploration 1985-86, p. 168-169; 1987, p. 109-110; 1989, p. 31.
Yukon Exploration and Geology 1982, p. 114.

Michie, 105D 071

A 3.7-m-thick chromite-magnetite lens of unknown length assayed 39.4% Cr_2O_3 and 5.7% Fe. It occurs in serpentinized peridotite of Cache Creek Terrane.

Military (Phil), 105D 178

Cache Creek Group serpentinitized ultramafic rocks contain magnetite and chromite. There are very high magnetic anomalies on the property and locally elevated gold values.

Yukon Exploration 1989, p. 35.

YUKON-TANANA TERRANE

Pyroxene Mountain, 115O 116

A multiphase intrusion of presumed Early Jurassic age that intrudes Yukon-Tanana Terrane metamorphic rocks, comprises peridotite, dunite and pyroxenite phases. Soil anomalies up to 280 ppb Pt and 150 ppb Pd have been outlined. This occurrence likely represents an Alaskan-type ultramafic intrusion.

Yukon Exploration 1987, p. 286, 294.

Yukon Exploration and Geology 1981, p. 224

Dunite Mountain, 105F 005

The Dunite Mountain ultramafic is an oval-shaped lopolith composed of partly serpentinized dunite above a major thrust fault within Slide Mountain Terrane. Chromite is ubiquitous but platinum values haven't been obtained. Asbestos fibres are reported.

Bald Eagle, 115O 090

Two 3-m-wide quartz veins cutting rusty-weathering muscovite-quartz schist of Yukon-Tanana Terrane Klondike Schist assemblage, reportedly returned Pt assay values as high as 68.6 g/t. This report of high-grade Pt in quartz veins seems geologically unreasonable, however, as occurrences of ultramafic rocks are not uncommon in the area, there may be some validity to the occurrence.

Yukon Exploration and Geology 1983, p. 265; 1984, p. 203-206.

Yukon Exploration 1987, p. 296-299.

Sato, 115H 021

The Sato property, northwest of Whitehorse within Yukon Tanana Terrane, consists of a small, Late Cretaceous (78 Ma) multi-phase stock of diorite and porphyritic quartz monzodiorite within Early Jurassic granite. Mineralization is dominated by a porphyry-style occurrence of chalcopyrite, pyrite and magnetite in veinlets and disseminations. Alteration is zoned around the potassic zone, which also hosts the highest Cu grades, from 0.1 to 0.38% Cu. Au and Mo grades are low. Pan concentrates have returned values up to 4370 ppb Pt and 24,300 ppb Au.

Lewis and Mortensen, 1998

WRANGELLIA

Stride, 115A 037

A 1.6–km-wide variably serpentinized peridotite sill that intrudes Jura-Cretaceous Dezadeash Formation flysch contains accumulations of magnetite and chromite near its footwall contact. Very fine-grained platinum is present in stream gravels.

Geological Survey of Canada, Memoir 268, p. 56.

Dickson, 115G 005

Chalcopyrite and pentlandite associated with pyrrhotite outcrops in four places along a 75-m-thick peridotite sill that intrudes Permian Hansen Creek Formation argillite and limestone. A selected sample contained 5.1% Ni, 0.8% Cu, 0.13% Co and 3.8 g/t Pt.

Destruction, 115G 006

Massive and disseminated sulphides occur in a peridotite sill and associated gabbro dykes that intrude Permian chert and conglomerate. Massive sulphide mineralization in the gabbro yielded 2.5% Cu, 2.8% Ni, 0.29% Co, and 6.5 g/t Pt. A chip sample across disseminated gabbro was 0.7% Cu and 0.44% Ni.

Yukon Exploration 1987, p. 235

Kluane, 115G 099
Congdon, 115G 003

This summary includes the proximal Klu and Spy occurrences. PGE-Au-Cu-Ni mineralization occurs at the basal contact of the Triassic mafic-ultramafic Spy Sill, which extends over 6 km in length and is up to 100 m wide. The sill intrudes Pennsylvanian-Permian sedimentary and volcanic rocks. Chalcopyrite and pyrrhotite-bearing gabbro float taken from near the base of the sill yielded 2.04% Cu, 0.73% Ni and 1800 ppb Pt+Pd. Numerous sulphide occurrences have been located along a 3.6 km section of the Spy sill. Grab samples from the gabbro/siltstone contact assayed up to 3.1% Ni, 2.8% Cu, 0.2% Co, 1.0 g/t Au and 4.5 g/t Pt+Pd. Anomalous results from sampling within the Spy Sill away from the contact zone returned values including 3.29 g/t and 1.72 g/t Pt+Pd+Au. Narrow massive sulphide lenses at the Spy Showing returned values up to 75.8 g/t Pt, 7.9 g/t Pd, 7.0 g/t Au, 10.45% Cu and 2.60% Ni. Intermittent disseminated mineralization occurs over a minimum strike length of 950 m northwest of the Spy Showing. Southeast of the Spy Showing, mineralization over 2.7 km along the contact zone returned values including 2.50 g/t Pt+Pd+Au (0.70 g/t Pt, 1.14 g/t ppb Pd, 0.66 ppb Au) and 1.16 g/t Pt+Pd+Au (0.61 g/t Pt, 0.36 g/t Pd, 0.19 g/t Au). High grade massive sulphide mineralization at the basal gabbro/sediment contact was confirmed by sampling a 20 by 30 cm pod at the Wylie showing that returned 16.13 g/t Pt+Pd+Au (2.35 g/t Pt, 10.36 g/t Pd, 3.42 g/t Au), 1.51% Cu and 5.25% Ni.

Yukon Exploration 1987, p. 247, 249-250.

Yukon Exploration and Geology 1996, p. 23, 30.

Santoy Resources Website http://www.bmts.bc.ca/san/

Wash, 115G 100

Pyrrhotite, chalcopyrite and pentlandite occur as disseminations and fracture fillings in a Triassic peridotite/gabbro/pyroxenite sill, which intrudes

Pennsylvanian-Permian Station Creek formation sedimentary rocks. Sulphide-bearing gabbro and pyroxenite samples assayed up to 1.02% Ni, 0.46% Cu and 2860 ppb Pt+Pd.
Yukon Exploration 1987, p. 250

Linda, 115G 094

Pyrrhotite, chalcopyrite and pentlandite occur as disseminations, fracture fillings and massive lenses in, and along the margins of, a Triassic peridotite sill with gabbro and clinopyroxenite phases. Ni-Cu-PGE—in-soil anomalies occur over 2.5 km length. The best grades are in the gabbro and include 4.2% Ni, 0.68% Cu, 0.08% Co and 12.7 g/t PGE. A 1.2-m drill intersection gave 3.51% Ni, 1.66% Cu, 12.91 g/t PGE. A 6-m chip sample from a trench at the Mex showing contained 0.52% Ni, 0.54% Cu, 3.0 g/t PGE.
Yukon Exploration 1987, p. 237-238, 1988, p. 166.

Glen, 115G016

Pyrrhotite, pentlandite and chalcopyrite comprise a lens of semi-massive sulphide at the base of a Triassic peridotite/ gabbro sill that intrudes Permian tuff, sandstone and slate and Pennsylvanian-Permian pyroclastic rocks. A grab sample assayed 3.6% Ni and 0.7% Cu. Percussion drilling intersected anomalous platinum values.
Mineral Industry Report 1978, p. 46.
Yukon Geology and Exploration 1979-80, p. 256.

Canalask, 115F045

Pyrrhotite with lesser pentlandite, sphalerite, pyrite, marcasite and chalcopyrite occur as fine-grained disseminations and small massive lenses in Pennsylvanian-Permian Station Creek formation volcanic strata approximately 100 m from the base of the footwall contact with a 75-m-wide sill of peridotite, olivine gabbro, serpentinized dunite and picrite. The 107 x 15 m main zone have reserves of approximately 450 000 t of 1.5% Ni, with low Cu and Co, and trace to very low Au and PGE values. Coarse, net-textured sulphides in the footwall of the sill yielded a 3.3-m drill intersection of 0.94% N, 0.33% Cu, 1.85 g/t Pt+Pd. A surface sample from another target contained 0.4% Ni, 0.1%Cu and 12.1 g/t Pd+Pt.
Mineral Industry Report 1973, p. 60-61.
Yukon Exploration and Geology 1995, p. 12, 13, 16; 1996, p. 24, 30.
Geological Survey of Canada Bulletin 506.

Wellgreen, 115G024

Disseminated and massive sulphides of pyrrhotite, chalcopyrite and pentlandite with magnetite occur at the base of the marginal gabbro and olivine clinopyroxenite within a 600-m thick ultramafic sill that intrudes Pennsylvanian-Permian pyroclastic and sedimentary rocks. A reserve, now partly mined, of 669 150 t of 2.04% Ni, 1.42% Cu, 0.07% Co and 2.23 g/t Pd+Pt was determined in the massive sulphide in gabbro near the footwall contact. Inclusion of disseminated ores increased the current reserves to 0.36% Ni, 0.35% Cu and 0.84 Pt+Pd. High-grade intersections have yielded results including 7820 ppb PGE over 9.8 m.
Geological Survey of Canada, Bulletin 506.

Airways, 115G025

Localized lenses of massive chalcopyrite and nickeliferous pyrrhotite occur over a 60 x15 m zone along the contact of the olivine gabbro phase of an ultramafic sill where it intrudes Pennsylvanian-Permian cherty argillite. Disseminated sulphides occur in the main phase serpentinized peridotite. A chip sample assayed 2.51% Ni, 0.57% Cu and 6.8 g/t Pd+Pt.
Yukon Exploration 1987, p. 238-240.
Geological Survey of Canada, Bulletin 506.

Onion, 115K 077

Pyrrhotite, chalcopyrite and pyrite occur at four?? localities along the 2000-m length of a 150-m-wide Triassic differentiated ultramafic sill that extends from the Canalask deposit and intrudes Pennsylvanian-Permian volcanic and sedimentary rocks. Magnetite, pentlandite, heazlewoodite and niccolite are present in the main showing. Samples from the marginal gabbro contained up to 2.66% Ni, 1.08% Cu, and >3000 ppb PGEs.
Geological Survey of Canada Bulletin 506.

Epic, 115F 047

Soil samples taken from above a peridotite sill that is the extension of that on the Canalask property yielded several anomalies up to 88 ppb Pt and 46 ppb Pd. Grab samples contained up to 204 ppb Pt and 365 ppb Pd.

Pickhandle, 115F 043

A peridotite sill that intrudes Pennsylvanian-Permian volcanic and sedimentary strata yielded mineralized samples with assays of 6.55% Cu, 0.56 % Ni, 204 ppb Pt and 365 Pd.

Interpretation of Regional Silt Geochemical Anomalies

The Geological Survey of Canada carried out regional silt geochemical surveys throughout Yukon, however they did not analyze the material for Platinum Group Elements. However, as elevated chromium, cobalt and nickel values are commonly coincident with orthomagmatic PGE occurrences, these elements can be used as pathfinders for PGE mineralization and may be useful in discerning favourable host rocks and prospective exploration targets. Additionally, Cu is typically associated with Ni in magmatic occurrences with sulphide mineralization, and coincident Cu-Ni anomalies are noted on the map.

Geochemical anomalies on the map that overlie rocks northeast of the Tintina Fault within the Selwyn Basin are considerably higher and more numerous than found elsewhere in the Yukon. This has the effect of reducing populations of anomalies found elsewhere, in particular in the region between the Tintina and Denali faults where numerous anomalous results occur but are below the 98th percentile cutoffs. Explorationists attempting to display these anomalies should consider adjusting the percentile cut-offs in light of these dramatic regional variations. There are numerous intriguing anomalies in the region between the Tintina and Denali faults and explorationists are encouraged to search these anomalies out.

The following is an evaluation of the anomalous regions as defined by the anomaly clusters on the accompanying map.

1. Southern Ogilvie Mountains

An extremely high density of >99 percentile chromium-in-silt anomalies occur along the northwestern margin of the Selwyn Basin, that is south of the Dawson Thrust, approximately 60 km north of Dawson City. They trend from the Tintina Fault to north of Keno City. The anomalies have a strong spatial correlation with exposures of Cambro-Silurian subaqueous mafic volcanic flows and dykes considered to be equivalent with the Marmot Formation (see inset map). The high chromium values reflect high initial values in the volcanic rocks, but may also indicate the crystallization and accumulation of chromite within slowly cooling flows or intrusions. Several of the very high chromium values have coincident, anomalous nickel, copper or cobalt values, which increase the likelihood of a cumulate source.

2. West Hart River (south margin of Taiga Basin)

Several nickel anomalies with supporting cobalt and chromium anomalies form an east-trending belt that mimics the southern margin of the Taiga Basin (see inset map). This basin hosts Road River and Earn Group equivalent rocks of the Selwyn Basin, but is built upon the Mackenzie Platform. This strata hosts the Taiga stratibound Ni-Mo-PGE occurrence and associated showings (Butterworth and Caufield, 1998). Additionally, the Dawson Thrust may have associated mineralization.

3. Wernecke Mountains 1 (Nick Basin)

Numerous nickel anomalies, some with coincident copper, occur within a region underlain by a sub-basin of Road River and Earn Group Selwyn Basin strata. These rocks represent the Nick basin and host stratiform Ni-Zn-PGE mineralization (Hulbert et al., 1992).

4. Wernecke Mountains 2

Several high cobalt values occur in the upper Bonnett Plume River area of the Wernecke Mountains. The cobalt is probably associated with either occurrences of Wernecke Breccia, which typically have a Cu-Au-Co-U metallogenic association, or the Bear River dykes.

5. Craig

A dense assortment of nickel and chromium anomalies are co-spatial with the east-trending Dawson Fault near the Craig mineral occurrence. In this particular region, the fault hosts sheared and serpentinized ultramafic intrusions that may be equivalent to Cambro-Ordovician volcanic strata (Tempelman-Kluit, 1981).

6. Keno Hill

Sporadic occurrence of cobalt, with fewer copper and chromium anomalies occur along the northern margin of Selwyn Basin between 139° and 134° W latitude, largely between the Dawson and Robert Service thrusts. The anomalies are largely coincident with localities of the Triassic Keno Hill sills that intrude Keno Hill Quartzite. Notable exposures in the western part of the belt (near the Dempster Highway) are not anomalous, whereas sparse anomalies continue further east. These sills are recognized as being locally differentiated and may host cumulate zones and sulphide mineralization.

7. YT-NWT border

A dense cluster of nickel anomalies with associated copper are underlain by Earn Group unit DME2.

8. Macmillan Pass

Widespread, highly anomalous nickel with associated copper values and local cobalt occur throughout eastern Selwyn Basin from eastern Lansing, across Niddery Lake and into Nahanni map area. Underlying the anomalous regions are Paleozoic basinal clastic rocks of the Road River and Earn groups. Cambro-Silurian Marmot Formation submarine basalt flows occur locally within the stratigraphy.. However, unlike occurrences north of Dawson, these occurrences evidently do not have associated chromium anomalies, suggesting an alternative source for the anomalies. The sedimentary rocks are likely responsible for the anomalies. Locally, in clusters at 8A and 8B , there are coincident cobalt anomalies and a

spatial association with the Triassic gabbro sills similar to the Keno Hill area. However, the sills cannot explain the more widespread anomalies, which are likely a function of extremely high background values, and stratiform Ni-Zn-PGE mineralization in the black shales of Road River and Earn Group. Notable occurrences of elevated Ni, Zn, V, Cu and Mo have been discovered with local accumulations of barite in the area.

9. Don Creek area

A 50-km-long belt of high nickel anomalies with coincident copper and supporting cobalt anomalies overlie a region underlain by Earn Group underlain by DME1. The Falcon occurrence of Zn and Ni with Ag, Cu and Mo soil samples supports the likely presence of stratiform Zn-Ni-PGE mineralization.

10. Upper Hyland River

A wide array of cobalt anomalous values underlie a large region near the NWT border west of Tungsten. Clastic rocks of the upper Proterozoic to lower Paleozoic Hyland group dominate the bedrock geology, with proximal Cretaceous intrusions and associated hornfels zones. The source of the anomalies is unknown but perhaps indicates the presence of unmapped basic igneous rocks. 10A . This northwest-trending region has a higher density of anomalies, with coincident nickel and copper anomalies, but similarly has no apparent geological explanation.

11. Simpson Ranges

Sporadic anomalies dominated by nickel occur within the region bounded by the Tintina and Frances Lake faults. The region is underlain by Yukon-Tanana Terrane and the anomalies are largely coincident with exposures of ultramafic rocks. The ultramafic rocks were previously considered to be part of obducted oceanic crust of Slide Mountain Terrane, but recent mapping and geochemistry has confirmed them to be intrusions into the sedimentary and volcanic Yukon-Tanana Terrane. Cluster 11A has a high density of nickel and chromium anomalies while 11B lacks significant chromium but has more copper.

12. North Pelly Mountains

Two clusters of nickel anomalies occur in association with ultramafic rocks that occur on the leading edge of Yukon-Tanana Terrane juxtaposed with Cassiar Terrane. A cluster of Ni anomalies north of Quiet Lake (12A) likely result from the underlying basalt and ultramafic rocks of the St. Cyr klippe that are attributed to Slide Mountain Terrane. The more northerly cluster is underlain by similar rocks of the Dunite klippe (12B).

13. Teslin Plateau

Clusters of nickel anomalies between Marsh Lake and the Teslin River overlie Cache Creek Terrane volcanic strata that are largely ophiolitic in origin. These rocks locally host chromite lenses and nickel-bearing silicates, which are characteristic of oceanic crustal rocks. The clusters of anomalies are proximal to ultramafic rocks with extremely high aeromagnetic anomalies. Cluster 13A appears to be associated with a large ultramafic body known to have cumulate textures and layering.

14. Kluane Ranges Belt

As expected nickel with coincident anomalies of other metals characterize this belt and are spatially associated with known mineralization and exposures of ultramafic sills.

15. Southern Kluane Ranges Belt

Southeast of Kluane Lake, the belt is defined by several chromite anomalies, which is unlike characteristics of the more northerly portion of the belt The significantly different geochemical character indicates either a dramatic change in the geochemistry of the Kluane ultramafic suite, or a different suite entirely. The proximal Pyroxenite Creek Alaskan-type intrusion and allied intrusions may be generating this geochemical signature.

Placer PGEs in Yukon

The occurrence of placer platinum in **Yukon River** was reported as early as 1887. Dawson (1887-88, Part R, p. 156) states that "platinum was found in association with bar gold placers on the Yukon River and on nearly all of the important tributaries that had been worked". Although platinum was reported to have been found, no production was recorded. Placer platinum has been reported a number of times from the **Teslin River**. A 1906 report (Anonymous, 1906) indicated that black sand obtained from the Teslin River and treated using gravity methods by the USGS contained recoverable platinum and osmiridium. The report indicated that the lower 15 miles of the river were staked and yielded gold and platinum. The assertions were contested by Holmes (1907), who indicated that thorough prospecting of the Teslin River gravels yielded little black sand, and assays indicated no trace of platinum group elements. Subsequently, the Yukon Territorial Assay office indicated that platinum occurs, but is extremely fine-grained (Sime pers. comm. to W.E. Cockfield, 1918). No production was recorded.

A small amount of placer platinum was recovered from **Ferguson Creek**, a tributary of the Kaskawulsh River during 1916 and 1917 (O'Neill and Gunning, 1934).

In addition to coarse-grained nuggety gold, **Burwash Creek** has associated platinum, native silver and native copper nuggets. The gold and platinum nuggets are smooth, well worn and usually flat. The coarsest platinum was about the size of duck shot, and grades of 0.0005 to 0.001 ounce per cubic yard of gravel were noted (Cockfield in O'Neill and Gunning, 1934). In addition to

the creek gravels, platinum has been obtained from bench gravels on the right side of Burwash Creek. Similarly, placer platinum was reported by Cockfield on **Tetamagouche Creek** approximately a quarter mile above its mouth.

The only recent documentation of placer platinum in Yukon is contributed by Ballantyne and Harris (1991), who identified and described alluvial PGE grains from a heavy mineral concentrate from **Florence Creek,** northwest of Breaburn. "Remarkable quantities of black sand can be recovered and non-magnetic heavy fraction assays 32 opt Au and 70 ppm Pt" (Wonga in Ballantyne and Harris, 1991). The alluvium is predominantly northerly transported glaciofluvial outwash overlying morainal veneers that cover the region. Placer platinum has been reported from Barker Creek and nearby drainages, but confirmation is lacking.

In Alaska, placer platinum has been identified at **Woodchopper** and **Fourth of July** Creeks, and **Lucky Gulch** in drainages near the Charley and Seventy Mile rivers area (Mertie, 1942). Alaska also has recorded platinum production from **Lituya Bay** placers (100 km southwest of Haines), which are likely derived from the layered intrusion at Mount Fairweather (Cobb, 1973).

Gravity Anomalies

Positive gravity anomalies may indicate the presence of dense rock units such as mafic and ultramafic intrusions. Most of the southern Yukon has Bouger gravity values between -70 and -120 milligals (Geological Survey of Canada, 1992). Some regions are characterized by widespread high gravity (>-40 milligals) values such as the western Ogilvie Mountains (north of Dawson) and the Klondike Plateau between Dawson and Beaver Creek. These regions are likely underlain by shallow crust or hosts widespread occurrences of mid-crustal ultramafic rocks.

There are approximately a dozen discreet anomalies that are <100 km². Typically they have values of 10 to 40 milligals greater than surrounding background values. In southernmost Yukon an anomaly occurs in Cache Creek Terrane straddling the BC border (south of Mt. Bryde). The existing geology maps show no reason for its occurrence making the source of the anomaly uncertain. Ultramafic rocks known to occur north of the Alaska Highway do not yield a high gravity anomaly.

North-trending anomalies near the abandoned settlement of Big Salmon are in a region underlain by Late Paleozoic andesite, basalt and greenstone of the Semenoff Assemblage. Very little is known of these rocks and they are ascribed by Gordey and Makepeace (1999) to the Quesnel Terrane. They have very high magnetic susceptibilities.

The anomaly at Minto is underlain by Late Triassic Povoas Formation volcanic rocks of Stikine Terrane. There is however, an occurrence of young volcanic rocks on the west side of the river, which may have a shallow level intrusion that gives rise to the anomaly.

Large anomalies west and east of Tatlmain Lake are difficult to relate to the geology, which is dominated by Yukon-Tanana Terrane (YTT) metamorphic rocks and the Tatlmain batholith. Locally there are ultramafic rocks within Yukon-Tanana Terrane, but the anomalies are much larger than the local exposures of these rocks.

Much of the region between Dawson and Beaver Creek is underlain by a widespread positive gravity anomaly. The cause of this anomaly is uncertain, but it may reflect a region of thinned crust. Within this regional high, there are several discreet anomalies. The anomaly north of Wellesley Lake may be related to ultramafic oceanic rocks of the Windy-McKinley terrane. This sequence of rocks is poorly understood, but associated occurrences of serpentinized harzburgitic ophiolite within these rocks are known. However, none of the known occurrences have as significant a gravity anomaly. Hosted in YTT rocks near the Alaska border, anomalies in the Lower Ladue River area are co-spatial with very similar ultramafic rocks, but of the Slide Mountain Terrane. South of Dawson near the Reindeer Mountain, a similar anomaly also in YTT rocks, is without a geological foundation.

The bedrock geology in the area of anomalies west of McQuesten near Ice Chest Mountain, consists largely of felsic Cretaceous granite. Local occurrences of mafic, amphibolitic or ultramafic rocks are too small to account for the anomaly and may be more widespread than mapped.

The Western Ogilvie Mountains region contains the most significant gravity anomaly in Yukon, and the only one on the northeast side of the Tintina Fault. The anomalous region is >-60 milligals and is roughly parallel to the Tintina Fault. The region has a considerable amount of Paleozoic volcanic rocks in the stratigraphy, but regions with greater amounts to the east do not show the same anomaly. Within this high, there are regions with discreet anomalies to >-35 mg.

Stratiform Ni-Zn-PGEs

The correlation of a large number of widespread nickel with coincident copper anomalies in east-central Yukon (Macmillan Pass region) is indicative of extensive regional enrichments in these metals. Locally, soil anomalies and mineralization are most commonly associated with Earn Group clastic sedimentary rocks, above its contact with the Road River Formation. However extensive anomalies also occur in drainages over the Road River Group. Mineralization associated with these rocks include the Tiaga and Nick occurrences (described above) as well as the widespread distribution of barite occurrences.

The nature and mode of occurrence of sedex Ni-An-PGE occurrences is controversial (Hulbert et al., 1992; Goodfellow, 1996; Coveney and Chen, 1991).and their economic potential has not been demonstrated. However, the widespread and extremely high concentrations of anomalous metals in silt samples indicates a high potential for discovery of similar sedex deposits throughout the distribution of Selwyn Basin. It seems probable that the metals were accumulated by organic complexing and concentrated as a result of very low sediment deposition. Steady-state deposition was disrupted in the Upper Devonian by extensional faulting, which encouraged fluid migration and hydrothermal circulation. This also encouraged deposition of widespread barite deposits and associated biogenic blooms, which further promoted metal enrichment, giving a region of highly anomalous sedimentary rocks. Earn Group strata are also host to Zn-Pb sedex deposits (Abbott et al., 1986).

Mafic Sills in North American stratigraphy

Orthomagmatic sulphide deposits with PGEs could be hosted in any of the four (or more) suites of mafic sills and dykes that occur within the miogeoclinal North American stratigraphy. 1) Middle Proterozoic (Hart River [1.38 Ga] and Bear River) intrusions occur north of the Dawson Fault; 2) unnamed Cambro-Ordovician sills intrude Hyland Group south of the Fault; 3) unnamed Middle and/or Late Paleozoic sills cut Road River on both sides of the Dawson Fault; and 4) Triassic Galena suite sills largely intrude below the Robert Service Thrust. All suites are remarkably similar despite their diverse ages (Abbott, 1995). Most sills are continuous (up to 40 km), quite thick (to 250 m), coarse to very coarse grained and dominated by clinopyroxene and plagioclase. Differentiation is apparent in all three suites with cumulates of (variably serpentinized) pyroxenite and opaques at the bases and gabbroic tops. The most pronounced differentiation occurs in those of Cambro-Ordovician age (Abbott, 1995). The Bear River dykes in the Wernecke area are age equivalent with the PGE-bearing Muskox intrusion at 1.27 Ga (Thorkelson, 2000)

Sills of Middle Triassic age (~232 Ma) occur mainly south of the Tombstone Thrust in Dawson and Larsen Creek map areas but are widespread in the footwall of the Tombstone Thrust further east in Nash Creek map area. The sills are up to 4 km long and 50 m thick and range from hornblende-augite diorite to pyroxene gabbro. Mafic sills of uncertain age have also been reported cutting Wernecke Supergroup in the Coal Creek Inlier (Thompson et al., 1992).

Marmot Formation

The rocks are dominated by vesicular and amygdaloidal basalt flows and breccias; some flows have cumulate augite megacrysts at their bases. Hypabyssal equivalents of the flows occur as dykes, which locally occur in swarms (i.e., south of the Deadman Pluton north of Dawson). Locally clinopyroxenite and gabbro intrusions are exposed in outcrop (Roots, 1988). Limited whole-rock geochemistry indicates that these rocks trend towards alkalic and tholeiitic composition, with high titanium values. These rocks are correlated with the Marmot Formation.

Alaskan-type Ultramafic Intrusions

Zoned intrusions with early or cumulate ultramafic phases in Cordilleran settings are known as Alaskan, or Ural-type intrusions and host PGE mineralization in adjacent British Columbia and Alaska. Most of these intrusive complexes are Early Jurassic or middle Cretaceous in age. Early Jurassic ultramafic intrusions with elevated PGE values occur at Joseph Creek and Butte Creek in Alaska's Eagle quadrangle; these are considered to be small bodies above Alaskan-type intrusions (Newberry, 1998). The best Yukon example is Pyroxene Mountain, but geochronological and geochemical constraints are not documented. Near Logtung, Jurassic? ultramafic and mafic rocks form a small composite stock with associated dyke swarm that vary in composition from pyroxenite, peridotite and serpentinite, through gabbro and diorite, to monzonite and syenite (Abbott, 1981). These rocks have characteristics similar to Alaskan-type intrusions. The area has a small cluster of nickel anomalies. The Big Creek Batholith near Mount Freegold is considerably larger than most Alaskan-type intrusions, but has a wide range of lithological phases that are slightly alkalic, including cumulate and layered mafic phases of pyroxenite.

Though common in BC and Alaska, the Yukon's only Cretaceous Alaskan complex is the **Pyroxenite Creek** ultramafic complex near Haines Junction, which is a 6.5 x 2.5 km composed of phases of augite-magnetite, olivine, and hornblende pyroxenite with a gabbro-diorite margin

(Sturrock et al., 1980). Although mineralization has not been documented, there are proximal Ni, Co and Cr silt anomalies, and the nearby Stride occurrence (115A 037) is likely related to a coeval intrusion.

Alkalic Porphyries

PGEs are known to be associated with alkalic Au-Cu porphyry occurrences in British Columbia, in particular, those that are alkalic in geochemistry and Early Jurassic in age are most likely to have elevated PGE values.. Furthermore, these bodies are preferentially located in Stikinia and Quesnellia. Yukon examples of Early Jurassic alkalic intrusions with known Au-Cu porphyry-style mineralization include the Teslin Crossing pluton (Hart, 1997) and potentially other members of the Mt. Bryde suite. Some of these alkalic intrusions have pyroxenitic margins and inclusions. Potentially, the enigmatic Minto and Williams Creek Cu occurrences, which are hosted in potassic Early Jurassic intrusions, may also be PGE enriched. The similarities in age, geochemical affiliation, and tectonic setting between Au-Cu alkalic porphyries and Alaskan-type PGE-hosting ultramafic intrusions, suggest that there may be a continuum them.

Alkalic intrusions with known porphyry-style mineralization, but of Cretaceous age, would include the Carmacks intrusions. Also known as the Prospector Mountain suite, these variably alkalic stocks and laccoliths are coeval and cogenetic with Carmacks Group volcanic rocks and locally host or are associated with porphyry copper mineralization (Casino, Cash, Sato) in the Dawson Range. Intrusions at Mount Pitts, Prospector Mountain, Victoria Mountain, Seymour Creek may be considered prospective targets.

The flows themselves, which have very high MgO values, may also be prospective as there are numerous Ni anomalies between 40 and 150 ppm coming from drainages over thick accumulations of Carmacks Group flows in the Dawson Range near Apex Mountain, Miller Ridge and Mt. Pitts. Some of the associated intrusions are dominantly mafic and intriguing, but difficult to identify where intruding mafic volcanic rocks. Aeromagnetic anomalies may help in their identification.

Ophiolitic Sequences/Alpine-type Ultramafic Rocks

Alpine-type ultramafic rocks are most commonly part of obducted oceanic crust and are apparent in Cache Creek, Slide Mountain, Yukon-Tanana, and Windy-McKinley terranes. Those in Cache Creek Terrane are known to have associated chromite lenses; these have the best chance to host associated PGE mineralization. PGE mineralization associated with ophiolites are typically enriched in Ir, Os and Rh and poorer in Pt and Pd. PGE mineralization in Cache Creek Terrane rocks may account for reports of Teslin River placer platinum, and placers in Ruby Creek near Atlin, and Thibert Creeks near Dease Lake.

Ultramafic rocks in Cache Creek Terrane, however, are not all Alpine-type as ultramafic rocks with intrusive contacts, coarse-grain size, cumulate phases and magmatic layering have been noted. These rocks may represent an under-recognized lithology with PGE potential more akin to Alaskan-type deposits. Larger ultramafic bodies with PGE potential occur in the Jubilee Mountain, Mitchie Creek and Squanga Lake areas.

Kluane Belt

Kluane ultramafic intrusions preferentially occur as sills along the mechanical competency contrast at the contact between the Hasen Creek and Station Creek formations. This provides a prospective prospecting target. Although thicker sills may preferentially generate larger deposits, the original sill geometries have been disrupted by deformation and original thickness' may not be represented. Additionally, economic grades have been derived from sills which are only 150 m thick. The best mineralization is concentrated as a result of riffling of sulphide minerals along irregularities at the base of the intrusion. Locally, aeromagnetic anomalies in the belt are without co-spatial ultramafic exposures, mineral occurrences or geochemical anomalies, and thus they likely represent blind targets.

Craig

Serpentinized and quartz-carbonate-altered ultramafic rocks with basic volcanics are exposed in a series of fault-bounded lenses, each 1-2 km long, within the near-vertical, 3-4 km wide, Dawson Fault zone. The rocks are speculatively assigned to the early Paleozoic Marmot Formation (Tempelman-Kluit, 1981). Asbestos and magnetite were noted. The nickel and chromium anomalies associated with this area indicate that these ultramafic rocks warrant evaluation. The proximal Craig occurrence is a Ag-Pb-Zn vein target.

Florence Creek

Placer platinum at Florence Creek is underlain by innocuous Early Jurassic granodiorite of the Aishihik Batholith, but two proximal rock types may be prospective. Long Lake suite quartz monzonite locally has an alkalic geochemistry and may have marginal mafic or ultramafic phases akin to Alaskan-type ultramafic intrusions, such as the coeval Pyroxene Mountain intrusion and other Early Jurassic intrusions in Alaska and BC. More probable, however, is the likelihood of magmatic sulphides and PGEs being derived from cumulate phases in Lewes River Group mafic volcanic feeders. Clasts in outwash gravels are particularly rich in coarse-grained clinopyroxenite, typical of root zones within the volcanic arc. Proximal high magnetic anomalies occur in regions underlain by granodiorite. Inclusions of bornite-dignite inclusions in PGE placer grains suggest that copper may be a good pathfinder element.

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