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GEOLOGY OF THE JAKES CORNER GEOPHYSICAL SURVEY AREA, SOUTHERN YUKON (105C/12 ,105D/8 AND 9)

by

Julie A. Hunt, Craig J.R. Hart and Steve P. Gordey

Canada

Yukon Government

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Julie A. Hunt, Craig J.R. Hart
Canada/Yukon Mineral Development Agreement
Geoscience Office
Box 2703 (F-3)
Whitehorse, Yukon
Y1A 2C6

and

Steve P. Gordey
Geological Survey of Canada
100 West Pender Street
Vancouver, B.C.
V6B 1R8

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INTRODUCTION

In March 1994, a DIGHEM V airborne EM and Magnetics geophysical survey was carried out over the Jakes Corner area in southern Yukon Territory. The survey area covers portions of three 1:50 000 NTS map sheets -- 105C/5, 105D/8 and 9. The survey consisted of approximately 2764 line kilometres and covered approximately 500 square kilometres. Flight lines were spaced at 200 metre intervals and flown in an azimuthal direction of 057°/237° at approximately 105 km/hr with an average EM bird height of 30 metres. More than 500 discreet bedrock conductors were identified. The results of this survey are available as Open File 1994-10 (G) (Smith, 1994).

The Yukon Prospectors Association proposed the survey and defined the area to be flown. This area, between Marsh and Teslin Lakes and north of the Alaska Highway, has high mineral potential and is close to the highway and available power. The purpose of the geophysical survey was to delineate zones suitable for hosting mineralization, thus promoting an increase in prospecting and exploration efforts in the region. Considering the proximity of the Alaska Highway, the area is thought to be underexplored. An obsolete geological database, no significant mineral discoveries and a limited amount of good bedrock exposure have hindered prevous exploration activity. The results of the geophysical survey provide an aid to focus exploration efforts.

The accompanying geological map is designed to be overlain upon the 1:50 000 geophysical maps of Open File 1994-10 (G). It incorporates published geological information which has been modified to accord with constraints provided by the geophysical data as well as from publicly available assessment reports and limited field checking. The map is highly interpretive, except for the eastern portions which benefit from recent mapping by Gordey and Stevens (1994b). Elsewhere, mapping concentrated on defining blocks with a uniform geophysical expression which could represent a particular rock unit. Sharp magnetic gradients between units are considered to represent faults, or where applicable, intrusive contacts. Structural relations between units are generally interpretive and may not be consistent throughout the map area.

The Dighem report (Smith, 1994) provided limited interpretation of the geophysical anomalies and no attempt was made to integrate geophysics with the known geology. This report describes the rock units that occur in the survey area and elaborates on the mineral deposit types that might occur there. A report and maps that interprets the geophysical anomalies is forthcoming (Open File 1995 9 (G) by M. Power).

THE SURVEY AREA

The survey area is within the Intermontane Belt physiographic province which, in southern Yukon, is characterized by subdued mountains separated by a few broad valleys. Glacial overburden and vegitative cover is fairly extensive, but generally less than a few metres thick except for the valleys. Tree-line is approximately 4300' above sea level. Generally, the southern and western boundaries of the survey are the Alaska Highway and associated power line. Services are available at Jakes Corner and the Lakeview Marina.

GEOLOGY

The area covered by the geophysical survey straddles the boundary between the east side of the Whitehorse map area (Wheeler, 1961) and the west side of the Teslin map area (Gordey and Stevens, 1994a, 1994b; Mulligan, 1963). No more detailed work than these 1:250,000 scale maps and reports is publicly available.

Tectonic Setting

The area is a structurally complex zone in which rocks of Stikinia and the Cache Creek terranes are juxtaposed. Cache Creek rocks represent a Mississippian to Jurassic, tectonically dismembered sea-floor (ophiolitic) assemblage dominated by volcanic, ultramafic and sedimentary rocks. Stikinia is represented by a Late Triassic to Middle Jurassic package of arc-derived sedimentary rocks with a minor volcanic component. Several suites of plutonic rocks intrude Stikinia and Cache Creek terranes but only two plutons are within the survey area. The survey area is bounded to the west by the Marsh Lake Fault and to the south by the Crag Lake Fault.

Cache Creek Terrane is considered to constitute a large thrust sheet that overlies Stikinia (Gordey and Stevens, 1994a). The thrust sheet and the footwall are locally cut by steep northeast and northwest-trending normal faults along which are faulted horsts of Stikinian strata. Consequently, the resultant map patterns are complex.

The juxtaposition of these two terranes occurred after the deposition of the youngest sedimentary rocks involved in their deformation (early Toarcian Cache Creek cherts in Cordey *et al.*, 1991) but prior to the intrusion of the Fourth of July/Mt. Bryde plutonic suite at *circa* 172 Ma (Mihalynuk *et al.*, 1992; Gordey and Stevens, 1994a). Thus, structures in the area are largely contemporaneous with the amalgamation of these two terranes in early Middle Jurassic time.

General Geology

Cache Creek Terrane rocks are divisible into six fault-bounded units. Rock descriptions are modified from observations in the Teslin map area by Gordey (1992) and Gordey and Stevens (1994a, 1995):

1) The chert-greywacke package (**TrJts**) consists of 10-200 metre thick, structurally imbricated, steeply-dipping members. The greywacke is well indurated, medium-grey and fine- to coarse-grained with angular chert and argillite clasts and quartz, feldspar and hornblende grains. It is locally interbedded with grey-green ribbon chert and shale. In places the chert is intensely deformed, in contrast to the greywacke which lacks internal deformation and cleavage. Radiolaria from this unit range yield Middle Triassic (Ladinian) to Early Jurassic (Pliensbachian or early Toarcian) ages (Cordey *et al.*, 1991).

2) The carbonate unit (**CPc**) is a thick assemblage of Late Paleozoic massive and locally crinoidal and fusiline carbonate that occurs south of the Crag Lake Fault. Here, the carbonate is Lower Permian in age and forms the lower limb of an anticline that is overturned to the northwest (Monger, 1975).

3) Aphanitic and fragmental basalt and andesite (**Pv**) are massive, highly fractured, poorly indurated and non-magnetic. They are orange-grey and brown-grey weathering, olive grey-green to chrome-green, locally tuffaceous and commonly chloritic. They are further distinguished by abundant clasts of chert and carbonate which are locally up to 30 m across. These rocks are at least in part, Permian, on the basis of radiolaria collected from chert beds in this unit near Marsh Lake (F. Cordey pers. comm., 1991) and crinoidal limestone blocks that are correlated with the French Range Formation of Monger (1975).

4) Spherulitic andesite, basalt and minor dacite (**CPv**) are typically massive, and locally pillowed, grey to orange-grey weathering, greyish-green to dark grey and aphyric. The original stratigraphic relationships between this unit and Pv are uncertain, but both units have a similar, moderate magnetic response and relief.

5) The gabbro unit (**CTrg**) consists of brown to green weathering, massive, heavily chloritized, medium to coarse-grained, hornblende-pyroxene diorite and gabbro. This unit contains inclusions of volcanic country rocks and are probably intrusive in origin. This unit has a low magnetic response and steep gradients against the highly magnetic serpentinized ultramafic rocks.

6) Ultramafic rocks (**CTru**) consist of massive to foliated, orange to red weathering peridotite and variably serpentinized equivalents with irregularly shaped masses of dunite. The foliation is defined by 0.5-3 cm thick concentrations of coarse-grained orthopyroxene crystals in a matrix of finer grained olivine and pyroxene. Most occurrences are lithologically uniform, lack zoning and occur as fault slices within the volcanic units. These characteristics are typical of Alpine, rather than Alaskan-type ultramafic bodies. Ultramafic rocks in the survey area have the mineralogical and structural hallmarks of mantle tectonites, similar to those described in the Atlin area by Ash (1994).

Regions in the eastern survey area with high magnetic relief are coincident with areas mapped as ultramafic rocks by Gordey and Stevens (1994b). Other regions in the survey area with similar geophysical responses are therefore inferred to be underlain by ultramafic rocks. However, ultramafic rocks do not always have a high magnetic signature. Hydrothermal alteration of ultramafic rocks causes the olivine to alter to sepentinite, and to magnetite which yields the anomalously high and variable magnetic responses. Broad magnetic gradients may represent gradational contacts between serpentinized and fresh ultramafic rocks or volcanic rocks. Sharp gradients are generally interpreted as faults, or intrusive contacts between serpentinized ultramafic rocks and pyroxene gabbro which is relatively non-magnetic.

Structurally, Cache Creek rocks are very complex and the exhumation of mantle peridotites requires large thrust faults to bring them to surface. Tight and overturned folds and thrust faults are common in the bedded rocks. Northwest of Jakes Corner, the sinuous and abrupt nature of the northern margin of a prominent magnetic high is interpreted as one of these thrust faults. The broad magnetic gradient in the hanging wall is interpreted as a gradational contact with the non-magnetic volcanic rocks. The contacts of most ultramafic bodies are bounded by post-emplacement normal faults making it difficult to recognize the original stratigraphic or structural relations with other units.

Rocks of **Stikinia** within the survey area are dominated by Upper Triassic Lewes River Group and the Early Jurassic Laberge Group. Laberge Group (**JLs**) consists of massive, fine- to medium-grained greywacke, shale and siltstone with minor conglomerate. The sandstone is well indurated and occurs as individual thin to thick beds sharply bounded by argillite, as well as in uniform, fine- to medium-grained packages from 10 to 150 m thick. The sands are composed mainly of plagioclase with lesser monocrystalline quartz and minor orthoclase, hornblende, pyroxene and lithic fragments. Thinly interbedded grey, green and tan laminated argillite and siltstone form members up to 100 m thick. Conglomerate members range from a a few metres up to 200 m thick and contain pebble- to cobble-sized clasts of limestone, granitic rock, feldspar porphyry, andesitic volcanics, chert and dark grey argillite. A second type of conglomerate is dominated by limestone clasts set in a black calcareous mudstone matrix.

The Lewes River Group is also dominated by greywacke and sandstone (**uTrLs**) and is often indistinguishable from Laberge Group rocks. Locally however, it is overlain by a carbonate unit (**uTrLc**) which can be quite thick -- most notably north of Jakes Corner where several hundred metres of the massive Late Triassic (Norian) carbonate occur in the fault bounded panels. Rare beds of pillowed andesite up to 200 m thick are also noted in the Lewes River Group.

Structurally, the clastic rocks of Stikinia are uncomplicated with dips ranging from shallow to 70° and reversals of dip direction indicating northwest-trending, upright folds with wavelengths of a kilometer or more.

Plutonic rocks

Felsic plutonic rocks within the study area are not common and but form two small plutons east of the north end of Marsh Lake and local dykes. Dark weathering, massive, medium- to coarse-grained hornblende granodiorite (**mKg**) and quartz-diorite from just northwest of the geophysical survey area yielded a K-Ar hornblende age of 109 Ma (Hart, unpublished). Two bodies of pegmatitic syenite (**mKy**), in the western part of the survey area, were assigned a Cretaceous age by Wheeler (1961). A uniform geophysical expression between the two outcrops of the pegmatitic syenite indicate that the bodies are a single pluton. Magnetic highs on the periphery of this pluton are interpreted to be hornfels zones in adjacent sedimentary rocks that contain a small percentage of pyrrhotite. Sedimentary rocks with similar responses may also thought to be hornfels, which were developed adjacent to unexposed plutons or dykes.

POTENTIAL MINERAL DEPOSIT TYPES

The region underlain by the geophysical survey has high potential to host metallic mineral deposits. Seven types of mineral deposits may occur in the study area, based upon the known mineral occurrences in the area, and deposits hosted in similar rocks along strike: These are ultramafic-associated nickel-copper sulphide deposits, chromite deposits; volcanogenic massive sulphide deposits, gold in listwaenite-hosted quartz veins, structurally controlled epithermal vein deposits, asbestos deposits and skarn/replacement deposits in limestones.

More detailed accounts of mineral deposits associated with ultramafic rocks can be found in Nixon and Hammack (1991) and Gallagher *et al.* (1985).

1. Ultramafic-associated Nickel-Copper Sulphide Deposits

Potential nickel-copper showings may be associated with either the tectonized ultramafic (ophiolite) assemblages or the gabbroic to ultramafic intrusions of the Cache Creek Terrane. Those occurrences which are associated with ophiolitic rocks within the Cordillera are generally small and low grade (0.2-0.5% Ni). Nickel occurs in disseminated pentlandite, millerite and heazlewoodite. Occurrences in the intrusive rocks are typically larger and richer (0.5-5% Ni) and may contain gold, silver and platinum-group values. In this type, the mineralization is associated with gabbro plutons with phases of peridotite, dunite, pyroxenite and hornblende pyroxenite. The ores are composed of pyrrhotite, pentlandite and chalcopyrite which are disseminated or concentrated with the silicate minerals as a result of magmatic segregation of an immiscible sulphide melt.

The intrusive hosted deposits have high magnetic responses because of their pyrrhotite and magnetite content. Deposits are commonly clustered and possibly dismembered along faults. Mineralization may be concentrated along the base of gabbroic intrusions or remobilized along sulphide veins in fault zones.

2. Ultramafic-hosted Chromium

Concentrations of chromite are common in Alpine-type peridotites throughout the Canadian Cordillera, and several small occurrences are exposed in the study area within the Cache Creek Group. These deposits typically occur in tectonized and serpentinized peridotite and olivine cumulates near their contacts with gabbro. Their lenticular shape may be a primary depositional feature or result from tectonic dismemberment. There is very little or no sulphide mineralization associated with the chromite.

Within the survey area, a 1.3 x 1.7 metre pod of coarsely crystalline, massive chromite was discovered on the TOG occurrence (Minfile 105C 28). Samples yielded values ranging from 26% to 43% Cr_2O_3. At the Squanga showing (Minfile 105C 12) a 20 x 4 m area of chromite-bearing dunite assayed up to 33.5% Cr_2O_3 with 147 ppb platinum group elements.

3. Volcanogenic Massive Sulphide deposits

The possibility of volcanogenic massive sulphide deposits occurring in the study is suggested by the Kutcho Creek deposit in northern British Columbia. This deposit, 17 Mt of 1.6 Cu, 2.3% Zn, 29.2 g/t Ag (Bridge et al., 1986), is hosted in volcanoclastic and pyroclastic rocks thought to be Late Triassic members of the Cache Creek Group (Thorstad and Gabrielse, 1986). The ore body occurs as several lenses within a package of felsic, quartz-phyric rhyolite tuff that has been deformed to quartz-sericite schists. The ore-bearing horizon is defined by limonite staining of the schists. Although felsic volcanic rocks have not been documented within Cache Creek Terrane in Yukon, their extent may be limited such that they do not appear on regional scale maps and reports, or the VMS deposits may be associated soley with mafic volcanic rocks.

4. Listwaenite-associated Gold Veins (Motherlode)

Listwaenite is a rock type formed by intense carbonate and silica alteration and replacement of ultramafic rocks. Gold veins associated with listwaenite occur in the study area and are common among tectonically dismembered sea-floor assemblages in Cache Creek Terrane. The veins are hosted in fault zones which act as pathways for the hot, CO_2-rich fluids that alter the host rocks and form veins. The alteration is characterized by massive ankerite and dolomite with quartz flooding. This alteration removes most elements from the protolith ultramafic, leaving chromium, which reacts with potassium in the fluid to form bright chrome-green mica (fuchsite/mariposite). Listwaenite-associated gold veins in the northern Cordillera, are typically high grade and low tonnage, although in the southern Cordillera, deposits are high grade and high tonnage.

The intense hydrothermal alteration associated with listwaenite formation destroys magnetite in the serpentinized ultramafic wall rocks creating a narrow low-mag zone that contrasts with the highly magnetic country rocks. If graphite is formed along the host fault zone, then the zone will have a coincident zone of high resistivity.

Within the survey area, veins in listwaenite are dominated by white and waxy, bull-quartz with sparse accumulations of sulphide minerals. The veins are up to 3 metres thick and their continuity is dependent on the nature of the host structure and wall-rocks. The altered zones adjacent to the veins are commonly bright orange-red weathering and 10-20 metres in thickness.

Mineralization at the TOG property (Minfile 105C 28) consists of tetrahedite, chalcopyrite, galena and sphalerite which all occur with visible gold. Gold values in occurrences in the Atlin, B.C. area have a strong positive correlation with arsenic (Ash and Arksey, 1990). Mineralization at the TOG is associated with a second phase of quartz which is clear, grey and vuggy which cuts the massive white quartz, or as ribbon-banded quartz along the vein's margins. Gold tends to be coarse and native and, in most cases, appears to be confined to the veins and not present in the altered wall-rock. Locally however, graphitic zones are developed within the faults and may also be prospective. Felsic or lamprophyre dykes may also occur in the fault zones. In addition to the TOG occurrence, listwaenite is also notable on the Marsh showing (Minfile 105D 69), and the Resort and M'Clintock showings (Minfile 105D 67 and 102 respectively) just northwest of the study area.

5. Asbestos

Most economic asbestos deposits in the Cordillera are associated with ultramafic rocks of Slide Mountain Terrane (e.g. Cassiar, Clinton Creek) and not Cache Creek ultramafic rocks. Since asbestos is formed by hydrolysis of olivine (serpentinization) and the coincident formation of magnetite, asbestos deposits are associated with magnetic highs.

Several small asbestos showings occur in the study area. The most notable is the Riba occurrence (Minfile 105C 10), where strong, free milling asbestos fibers up to 0.5 cm have been identified over a 150 x 35 m area in serpentinized peridotite.

6. Epithermal Veins

Although the survey area has a dearth of felsic plutonic and volcanic rocks, which are generally associated with epithermal precious metal vein deposits, large faults and many late, steep faults in the study area could provide a favourable environment for epithermal vein formation. Epithermal veins near the Mt. Skukum and Engineer mines are sulphide-poor, thus contributing little electrical conductivity, but have intense, and locally extensive propylitic wall rock alteration which destroys mafic minerals and magnetite.

Regions considered likely to host epithermal deposits are proximal to the Marsh Lake and Crag Lake faults, as well as an intensely faulted region north of Jakes Corner, and zones peripheral to the plutons near Marsh Lake.

7. Skarn/Replacement

Carbonate in the Cache Creek and Lewes River groups may host skarn deposits -- particularly where in contact with granitic intrusions, or in areas of hornfels or numerous faults. Limestone beds cut by steeply dipping faults are favourable hosts for replacement-type lead-zinc deposits Magnetic minerals such as pyrrhotite and magnetite are typical of copper-tungsten-molybdenum skarn assemblages whereas conductive minerals such as pyrite and galena would likely be typical of replacement-type deposits.

CONCLUSIONS

The geophysical maps and recent geological mapping have been combined to produce a new geological map of a structurally complex region in southern Yukon. The survey area covers the contact between Cache Creek Terrane and Stikinia. The geophysical data provides evidence to support suggestions that Cache Creek rocks occur as a thrust sheet overlying rocks of Stikinia. This region is prospective for several types of mineral deposits. Exploration should concentrate on zones hosting the faulted contacts between these two terranes and on the margins of the ultramafic bodies, particularly adjacent to faults or gabbroic units. The most successful exploration project will integrate the geophysical and geological data with geochemistry and basic prospecting.

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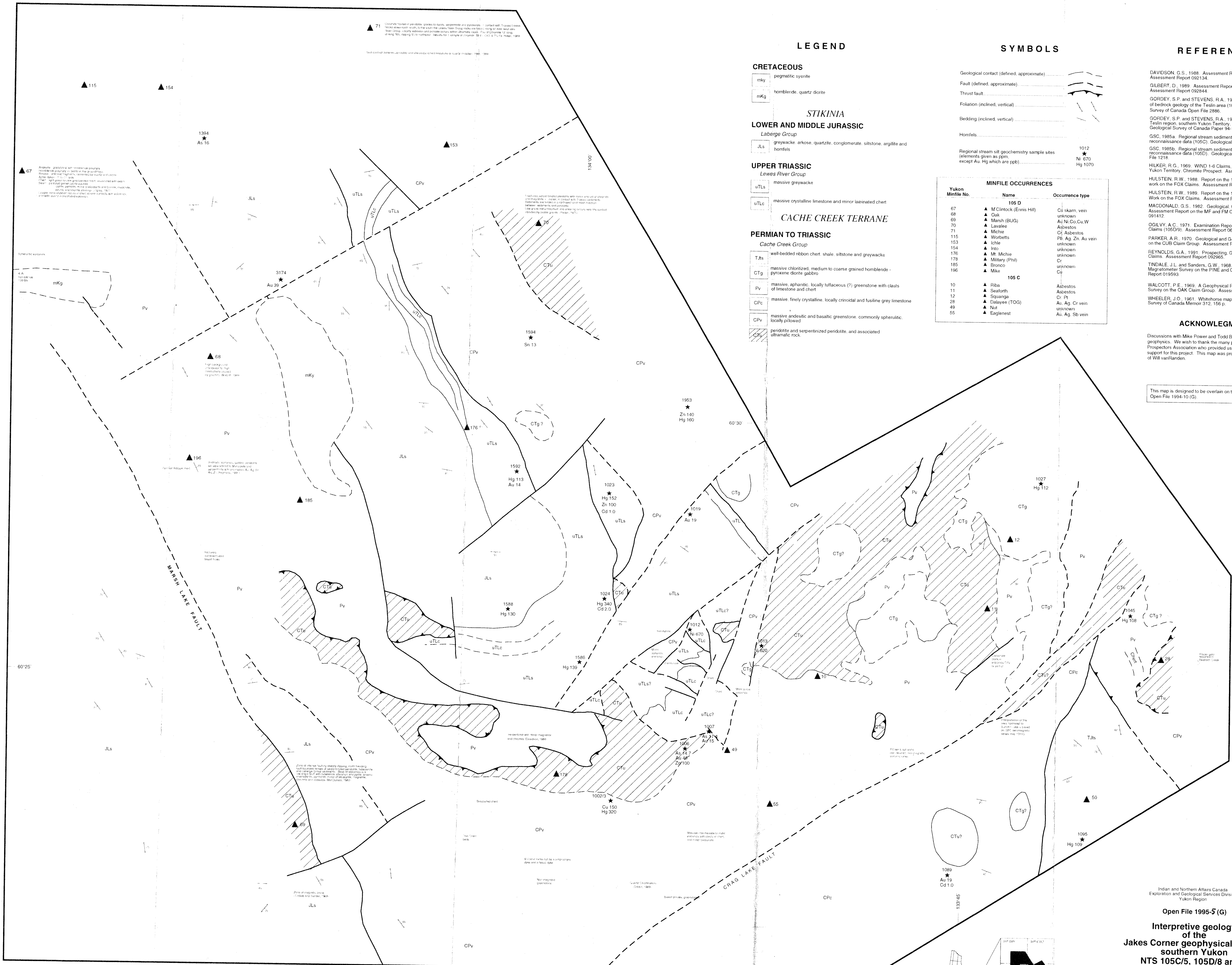

JAKES CORNER GEOPHYSICAL SURVEY AREA

SCALE 1:50 000

LEGEND

CRETACEOUS

mky	pegmatitic syenite
mKg	hornblende, quartz diorite

STIKINIA

LOWER AND MIDDLE JURASSIC

Laberge Group

JLs	greywacke, arkose, quartzite, conglomerate, siltstone, argillite and hornfels

UPPER TRIASSIC

Lewes River Group

uTLs	massive greywacke
uTLc	massive crystalline limestone and minor laminated chert

CACHE CREEK TERRANE

PERMIAN TO TRIASSIC

Cache Creek Group

TJts	well-bedded ribbon chert, shale, siltstone and greywacke
CTg	massive chloritized, medium to coarse grained hornblende - pyroxene diorite gabbro
Pv	massive, aphanitic, locally tuffaceous (?) greenstone with clasts of limestone and chert
CPc	massive, finely crystalline, locally crinoidal and fusiline grey limestone
CPv	massive andesitic and basaltic greenstone, commonly spherulitic, locally pillowed
CTu	peridotite and serpentinized peridotite, and associated ultramafic rock.

SYMBOLS

Geological contact (defined, approximate)

Fault (defined, approximate)

Thrust fault

Foliation (inclined, vertical)

Bedding (inclined, vertical)

Hornfels

Regional stream silt geochemistry sample sites (elements given as ppm, except Au, Hg which are ppb) — 1012 ★ Ni 670 Hg 1070

MINFILE OCCURRENCES

Yukon Minfile No.	Name	Occurrence type
	105 D	
67	▲ M'Clintock (Ennis Hill)	Cu skarn, vein
68	▲ Oak	unknown
69	▲ Marsh (BUG)	Au,Ni,Co,Cu,W
70	▲ Lavalee	Asbestos
71	▲ Michie	Cr, Asbestos
115	▲ Worbetts	Pb, Ag, Zn, Au vein
153	▲ Ichle	unknown
154	▲ Into	unknown
176	▲ Mt. Michie	unknown
178	▲ Military (Phil)	Cr
185	▲ Bronco	unknown
196	▲ Mike	Cu
	105 C	
10	▲ Riba	Asbestos
11	▲ Seaforth	Asbestos
12	▲ Squanga	Cr, Pt
28	▲ Dalayee (TOG)	Au, Ag, Cr vein
49	▲ Nut	unknown
55	▲ Eaglenest	Au, Ag, Sb vein

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This map is designed to be overlain on the 1:50 000 geophysical maps of Open File 1994-10 (G).

Indian and Northern Affairs Canada
Exploration and Geological Services Division
Yukon Region

Open File 1995-5 (G)

Interpretive geology of the Jakes Corner geophysical survey, southern Yukon NTS 105C/5, 105D/8 and 9

1:50 000 scale

by

Julie A. Hunt, Craig J.R. Hart
Canada/Yukon Mineral Development Agreement
Geoscience Office

and

Steve P. Gordey
Geological Survey of Canada, Vancouver, B.C

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