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**1999 GEOLOGICAL EVALUATION
OF THE
KITCHENER SOUTH PROPERTY**

LATITUDE 49° 02' 00''N LONGITUDE 116° 19' 00''W

NTS 082F/01

FORT STEELE MINING DIVISION, BRITISH COLUMBIA, CANADA

PREPARED BY

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**DECEMBER 1999
GEOLOGICAL SURVEY BRANCH
ASSESSMENT REPORT**

26.117

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1.0 Abstract

The Kitchener South property comprises 52 claims with a total of 223 claim units. The property is the subject of an option agreement between Rio Algom Exploration Inc. (Rio Algom) and Abitibi Mining Corp. The claims are within the Fort Steele Mining Division, and located 15 kilometres southeast of Creston, B.C. Road access to the property is via Little Moyie Forest Service Road (FSR), its branches, and a powerline access road. Elevations range from 1060m to 1960m.

The Kitchener South property lies within the Purcell Anticlinorium. The Proterozoic aged Purcell Supergroup is exposed in the core of the Anticlinorium with the lower Aldridge Formation forming the basal part of the Purcell Supergroup. The lower Aldridge stratigraphy is the oldest exposed on the property and is represented here by the Ramparts facies, a proximal, quartz wacke dominated equivalent of thin bedded, rusty quartzitic wacke-siltstone dominated lower Aldridge more common elsewhere in the Purcell Anticlinorium. The lower Aldridge is conformably overlain by the middle Aldridge, which dominates exposures on the property. Syn-depositional gabbro sills and dikes have intruded all sedimentary units of the Aldridge Formation.

Although mineral exploration in the region dates back to the 1860's, the only significant base metal deposit located to date is Cominco's Sullivan deposit. The Sullivan deposit near Kimberley contained an estimated 170 MT grading 5.5% zinc, 5.8% lead and 59 gram per tonne silver. This sedimentary exhalative lead-zinc sulfide deposit is stratigraphically situated at the Lower Aldridge-Middle Aldridge contact (LMC).

The focus of exploration for Rio Algom on the Kitchener South property was concentrated along the LMC. Fieldwork was carried out from June 05-21, and July 29-31, 1999. Geological mapping and selected lithochemical sampling was geared towards confirming previous geological mapping and interpretations. The aim was to establish a clear distinction between middle Aldridge (A2) and lower Aldridge, Ramparts facies (AIR) stratigraphy, and map out the LMC. Particular attention was paid to the areas down dip of the LMC to look for structures that might influence the position of the LMC at depth. The LMC was mapped along the western margin of the property, with a gentle easterly dip. The Iron Range Fault and other faults disrupt and offset the trace of the LMC in the northwestern part of the property. Upon compiling the geological information at hand and constructing cross sections, it was determined that the LMC could not be tested at a reasonable depth where there was not already information indicating that the horizon was unlikely to host a Sedex deposit of appreciable size. Therefore no further work is recommended on this property.

2.0 Introduction

2.1 Property Location, Access and Physiography

The Kitchener South property comprises 52 claims with a total of 223 claim units. The centre of the claims is located approximately 15 kilometres southeast of Creston, B.C., within the Fort Steele Mining Division. The property is centred at latitude 49° 02' 00" north and longitude 116° 19' 00" west, and is covered by NTS map sheet 82F/01. (Figure 1, 2). The northern half of the



Rio Algom Exploration Inc.		
Kitchener South Property		
Location Map		
DATE Dec 99	DRAWN BY SW	DWG Fig. 1

property is bisected by the Little Moyie River, while the southern half covers the headwaters of east Mission Creek, and extends to the U.S. border.

Road access to the property is from Highway 3 via the Little Moyie FSR (a branch of the Carroll Creek FSR), various subordinate logging roads, and an access road that follows the power line. The southeastern corner of the property is accessible via the Charlie Creek FSR that leaves Highway 95 near Kingsgate, B.C. Several branch roads are not accessible due to decommissioning or bridges removed, but these can generally be walked.

The property is within the Moyie Ranges of the Purcell Mountains, at elevations ranging from 1067 metres a.s.l. in the northeast and southeast corners, to almost 1960 metres on a ridge top in the SE part of the property, at drainage divide between Moyie River to east and Little Moyie River to north. Vegetation at lower elevations consists of mature timber. Outcrop exposure is generally poor, except in steep gullies and along some ridge and hill tops. The climate is characterized by low to moderate precipitation with temperatures ranging from -30° Celsius in the winter to over 25° Celsius in the summer. The project area is generally accessible from mid-June to mid-October, depending on the preceding winter's snowfall.

2.2 Claim Status

The 52 claims of the Kitchener South property are owned by Abitibi Mining Corp., and subject to an option agreement dated April 22, 1999. Rio Algom Exploration Inc. is the operator. The claims cover an area of approximately 5462.5 hectares. A listing of claims and their status is attached in Appendix I.

2.3 Exploration History

Placer gold exploration and mining in the East Kootenay region began on the Wild Horse River near Ft. Steele in the mid-1860's. The discovery of the St. Eugene and Sullivan deposits switched the focus to lead and zinc. The iron prospects on Iron Range Mountain, northwest of the Kitchener South Property, have long been known.

Current exploration activities in the East Kootenays are mostly focussed on lead-zinc mineralization within the Aldridge Group, particularly in the Findlay-Skookumchuck Creek area, the Sullivan-North Star corridor, and the Moyie-Yahk area. On the Kitchener South property, Cominco had done some mapping and prospecting as part of their regional programs. A weak UTEM anomaly was investigated in 1987 by Cominco with a drill hole (S-87-1) that intersected two zones with disseminated sphalerite, Fe sulphides and rare chalcopyrite (BC Assessment Report 16769). Abitibi Mining Corp. carried out prospecting and mapping and some soil sampling on the Kitchener South property in 1997 and 1998, mostly in the Comiss Vent and Shorty Creek areas. Adjoining the north end of the Kitchener South property is the Car Property, currently optioned to Chapleau Resources.

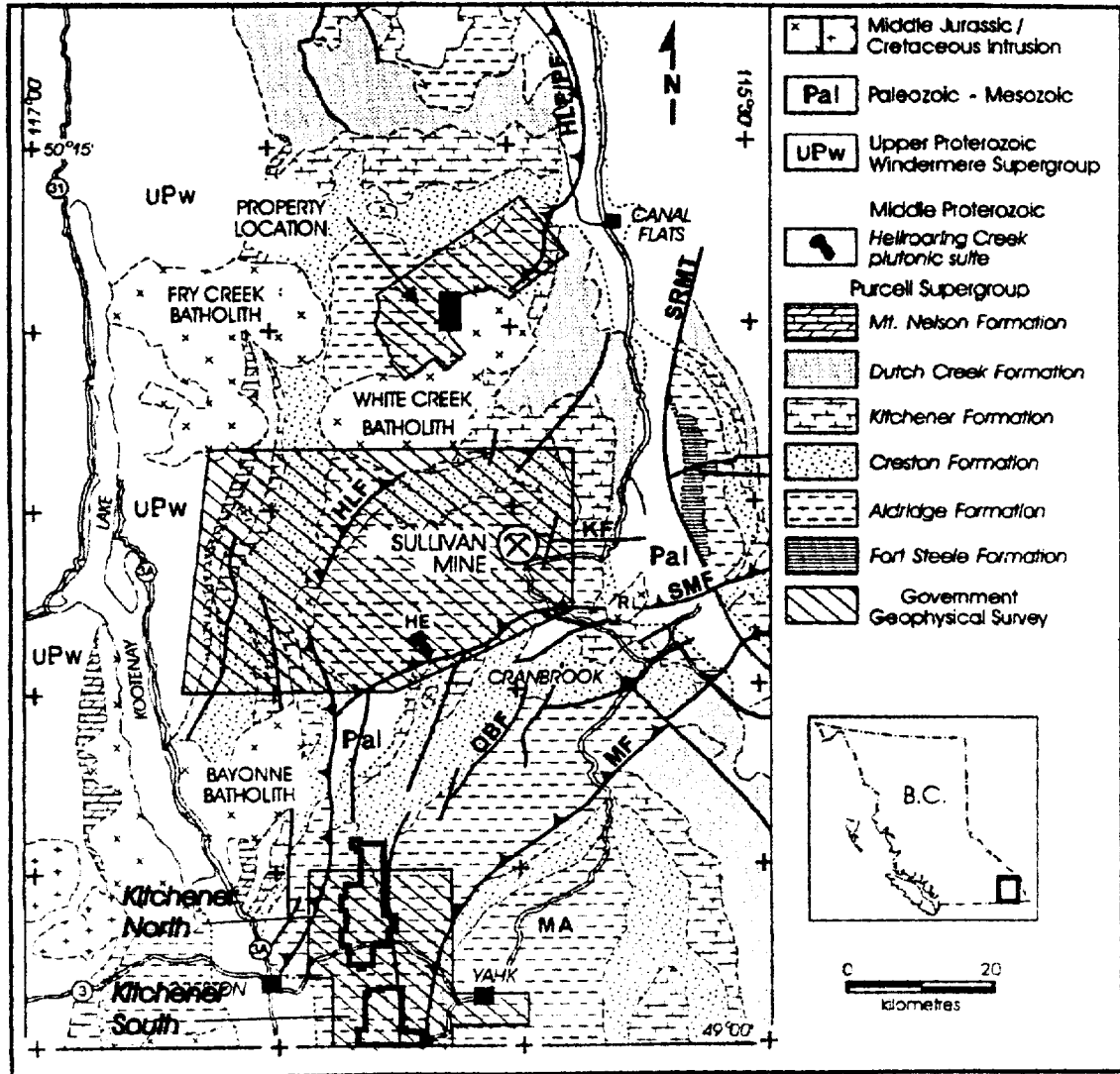
3.0 Regional Geology

The Kitchener area has previously been described by Rice (1941), Reesor (1993) and Brown et al. (1995). The following geological description is summarised from the latter map and from Brown and Stinson (1995).

The Kitchener South property is within Purcell Anticlinorium, a broad, gently north plunging structure cored by the Proterozoic Purcell Supergroup (Figure 2). The Purcell Supergroup comprises a siliciclastic and lesser carbonate sequence at least 12 kilometres thick deposited in an intracratonic rift basin (the Belt-Purcell Basin). The strata are preserved in an area 750 kilometres long and 550 kilometres wide extending from southeastern British Columbia to eastern Washington, Idaho and western Montana.

The claim area is underlain by the Aldridge Formation, the lowermost Purcell Supergroup strata. The lower Aldridge Formation exposed on the Kitchener South Property is designated the Ramparts facies, named after the cliff-forming Ramparts east of Creston. The Ramparts facies is made up of generally thick bedded, grey weathering quartz and quartzitic wackes. Sedimentary structures and bedforms suggest current activity and a shallow water environment. The thickness is unknown, although at least 700m is exposed east of Creston. This unit is considered to be a proximal facies-equivalent to the thin bedded, laminated and rusty weathering silicic siltstones and argillites of the lower Aldridge exposed further east and north in the Belt-Purcell basin. It may be correlateable with the Footwall Quartzite of the lower Aldridge in the Sullivan Mine area. If this is the case, then the siltstone package (and Sullivan horizon) overlying the Footwall Quartzite at Sullivan would not be exposed in the Kitchener South area, being replaced by influx of Ramparts facies quartz wackes.

The lower Aldridge (Ramparts facies) sediments grade upward into medium to thick bedded grey weathering turbidites of the middle Aldridge Formation. As both lower and middle Aldridge strata in the area are dominated by quartzitic wacke and quartz wacke, differentiating the two units is often difficult. The middle Aldridge turbidite units are mostly couplets of quartz wacke/quartzitic wacke with thinner siltstone or fine grained wacke top beds. The sediments display normal grading, flame structures, load casts and rare ripples. The middle Aldridge Formation is about 2,500 to 3,500 metres thick, rather monotonous in character, and underlies most of the property. Within the middle Aldridge formation are distinctive laminated siltstone (marker laminite) horizons comprised of alternating thin light and dark laminae. The patterns of light and dark laminae are distinctive for each siltstone unit. Thus these siltstone units are valuable as indicators of the middle Aldridge, and as stratigraphic markers, can be correlated over great distances. At the Sullivan Mine area in Kimberley, the various markers occur at known and measured distances above the lower-middle Aldridge contact (LMC). The distances can be used throughout the basin to estimate stratigraphic distance above the LMC, once the marker has been identified and correlated. However, the thickness variations in the clastic pile result in expanded distances between marker laminites and to the LMC in many areas. The distance from a given marker to the LMC in the Kitchener South property may be 2 to 3 times the correlative distance at the Sullivan Mine. Evidence from mapping suggests the latter case is closer.



Claim Boundary

Rio Algom Exploration Inc.

Kitchener South Property

Regional Geology

DATE Dec 99

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Fig.2

Both the lower and middle Aldridge Formations are intruded by Middle Proterozoic dioritic to gabbroic sills (Moyie intrusions). These sills can vary from a few to several hundred metres thick. They are near to syn-depositional, and were inferred to have intruded wet unlithified sediments. The sills expand the given stratigraphic section, without any loss of sedimentary units due to intrusion.

The upper Aldridge Formation, although not exposed on the Kitchener South property, consists of rusty weathering, thin-bedded siltstone and argillite and is typically 250 to 500 metres thick.

The most significant mineral deposit in the Belt-Purcell basin is Cominco's Sullivan deposit near Kimberley, BC. The deposit contained an estimated 170 million tonnes grading 5.5% zinc, 5.8% lead and 59 g/t silver. The deposit is hosted by siltstone and argillite of the lower Aldridge Formation, immediately below the contact with the middle Aldridge Formation. The Sullivan deposit is interpreted to be a sedimentary exhalative (Sedex) sulphide deposit formed in a fault controlled sub-basin within the Belt-Purcell basin.

The target of exploration on the Kitchener South property is a Sedex deposit, focussing on the lower-middle Aldridge contact (LMC) for a Sullivan-type horizon (SH). But because both the middle Aldridge and lower Aldridge (Ramparts facies) strata seem to indicate a relatively high energy depositional environment, it is not known whether a quiescent sub-basin hosting a SH could occur here. Also, the similarities between the units make the determination of the LMC itself locally problematic.

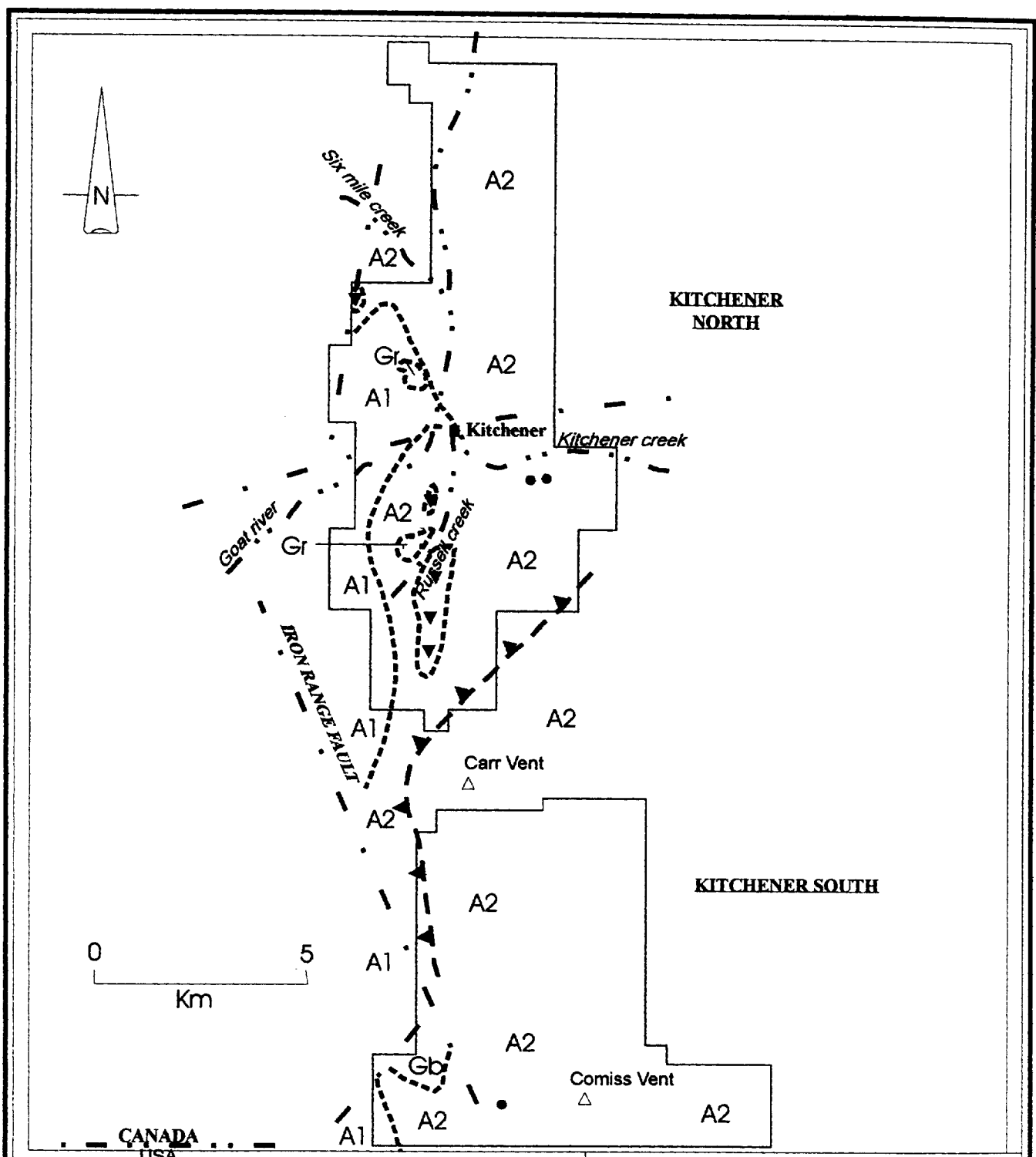
4.0 Property Geology

The Kitchener South property is underlain by Purcell Supergroup sediments of the lower and middle Aldridge Formations (Fig.3). Several gabbro sills intrude the sediments, including one large sill in the eastern half of the property. The Aldridge Formation sediments mostly dip gently to moderately to the east and west, in panels separated by north to northeast trending faults.

The lower Aldridge Formation (Ramparts facies) is exposed along the western margin of the property, in the steep gully of Mission Creek and the high ridges that form the eastern slopes of the Ramparts south of Mt. Thompson. The contact with middle Aldridge Formation is not often exposed, but was observed both as conformable and fault contacts. The LMC dips eastward at approximately -20° . In the Shorty Creek area in the southeastern corner of the property, Brown and Stinson (1995) noted a distinctive unit within the middle Aldridge containing volcanic and carbonate rocks. This area was not visited during the current program, being at a stratigraphy higher than the area interest.

Gabbroic sills and dikes sills have been mapped as being hosted in Lower Aldridge units in the south as well as in the central party of the property within Middle Aldridge units.

Structurally, the property is dominated by the Goat River Anticline (GRA), which trends north and stretches from the Creston Valley to the west, and is truncated by the Carroll Creek Fault east of the property. The anticline is open and plunges gently northward, exposing the lower Aldridge Formation in its core. The anticline is cut by a series of generally north trending faults,



- A2 M. Aldridge
- A1 L. Aldridge
- Gb Gabbro
- Gr Granitoid
- ▼ Fragmental
- △ Vent
- Creek
- - - Geologic Contact
- ▲- Thrust Fault
- . - Major Fault
- Drill Hole

Rio Algom Exploration Inc.
 Kitchener South Property

Property Geology

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the main one of which is the Iron Range Fault. The Iron Range Fault is a north-northeast trending fault with a proposed minor west-side down normal displacement.

Two mineral occurrences are documented in the B.C. MINFILE to occur on the Kitchener South property. The location of the Blackmore prospect (MINFILE 082SE076) is poorly known, but probably lies in the southeastern part of the property. This minor past producer yielded 373 grams of silver and 9 kg of lead from 5 tonnes of ore shipped in 1948, from a galena-bearing vein. The Sha occurrence (MINFILE 082SE104) was intersected in drill hole S-87-1, which was collared to test a weak UTEM anomaly. Two narrow zones (less than 3cm) of disseminated sphalerite with rare chalcopyrite were intersected within middle Aldridge sediments. The hole was drilled to 397m.

5.0 1999 Exploration Results

5.1 Objective and Exploration Target

The exploration target for Rio Algom Exploration Inc. on the South Kitchener property is a Sullivan-type sedimentary exhalative lead-zinc sulphide deposit stratigraphically situated at or near the lower Aldridge-middle Aldridge contact (LMC). Geological mapping by previous workers, including recent work by Brown et al. (1995) and Abitibi Mining Corp.(1998), was utilised as a base from which follow up could be done in additional detail.

The objective for the 1999 program was to confirm geology from previous workers to ascertain if the LMC does underlie the property and if the geology of the LMC could host a Sullivan – type horizon. In addition, it was to be determined if the LMC could be drill tested at a reasonable depth. As the LMC was the prime area of interest, mapping was concentrated mainly in the western part of the property. Little time was spent in the northern third, or southeastern corner of the property.

5.2 Procedure

A geological mapping program was conducted between June 5-21 and July 29-31, 1999 based out of Creston and Yahk. Mapping was done at a 1:10,000 scale utilizing TRIM base maps, air photos and previous geological data as compiled from assessment reports, unpublished data and published government files.

The mapping program was supervised by Siegfried O. Weidner, senior geologist for Rio Algom Exploration Inc. Mapping was completed by Leonard Gal, P.Geo. of Cardinal Exploration Ltd. and Patrick Donnelly. Field traverses were concentrated along the strike extent of the LMC and along section lines perpendicular to the LMC with an approximate line spacing of 2 - 3 kilometres. Geological outcrop maps and cross sections were constructed from field data. The aim was to understand the geometry of the LMC, to look for possible drill targets that could test the LMC at depth, where surface or near surface data did not already suggest that no massive sulphide occurred at the horizon.

For stratigraphic control purposes, stratigraphic "markers laminites" were sampled from the middle Aldridge Formation for later identification and verification of overall stratigraphy. Marker samples were forwarded to Dave Pighin of Supergroup Holdings Ltd. for cutting and identification of stratigraphy.

Rock samples collected were forwarded to Eco-Tech Laboratories for ICP and Au fire assay analysis (FA). Rock geochemical samples were taken to test if particular units were geochemically anomalous in base metal or "pathfinder element" content. One sample of granitoid dyke rock was submitted for whole rock geochemical analysis. In addition, several thin sections of quartz wackes from the middle and lower Aldridge were prepared to ascertain if there could be any petrographic basis for distinction between the two units, such as accessory mineral suite, relative amounts of feldspar, or textures of the clastic grains. The report by Vancouver Petrographics is included in Appendix VI of this report.

6.0 1999 Exploration Results

6.1 Geological Mapping

Results of the mapping are depicted in Appendix II as one geology map (Map 1) at a scale of 1:10,000 and a set of three cross sections (Map 2).

The following descriptions are derived from field notes describing outcrop exposures and hand samples. The geological units are listed from oldest to youngest.

Lower Aldridge (Ramparts facies) (A1R)

Lower Aldridge stratigraphy was seen as thick to medium bedded, medium, fine to locally coarse-grained quartzitic wacke and quartz wacke. In some exposures the relatively thick quartz wacke beds were separated by very thin greenish grey siltstone. Within the quartz wacke beds are locally black, very fine wispy laminations, possibly related to cross beds. Generally quartz wacke beds are stacked one upon another, forming characteristic bluffs and resistant cliffs in outcrop. Fresh surfaces are light to medium grey, and weather light grey to buff.

Middle Aldridge (A2)

Stratigraphy is typically thin to thick bedded with a light to medium grey, to rusty orange-brown weathered surface and a light grey to dark grey fresh surface. Often the middle Aldridge sediments appear to be turbiditic, with thin to medium beds of quartz wacke coupled with an overlying, thin bed of (sometimes) laminated siltstone. The lithologies include quartz wackes, quartzitic wackes, subwackes, siltstones and minor argillites. Sedimentary features such as load structures, cross-bedding, rip-up clasts and slumped bedding were also observed. Overall there are few siltstone and argillite beds, particularly those thicker than 20 cm or so. The middle Aldridge lithologies are generally lacking in a mud component, represented by micas (biotite + muscovite/sericite) in these metamorphosed sediments. Disseminated iron sulphides in the form of pyrite or

pyrrhotite generally make up less than 1.0% by volume. Exceptions to this occur locally, as at the Comiss Vent (station 132, UTM 551450E, 5429500N) and at stations 116 and 117 (UTM 555000E, 5433100N), where there are appreciable thicknesses of dark grey siltstone and argillite, often with abundant disseminated pyrrhotite.

Within the A2, time-stratigraphic laminite markers are present. Four laminite samples were positively matched to known marker horizon standards by D. Pighin of Supergroup Holdings Ltd. Appendix III contains a list of laminate locations and identifies those that could be classified as markers. Markers previously identified and matched (by Abitibi Mining Corp. consultants) were incorporated into the geological mapping and database. The marker locations were projected into constructed cross sections to aid geological interpretation.

Fragmental

Within the A2, in the southeastern quadrant of the property, the Comiss Vent is a known discordant tourmalinized fragmental. A 5m width of altered breccia, composed of rounded to angular quartz wacke fragments in an argillaceous matrix. The matrix is partially altered to black massive tourmalinite, while adjacent middle Aldridge strata are altered to brown tourmalinite. Minor lead and zinc are present in fractures. The vent outcrop was not examined during this program. Nearby road cut exposures (station 132, UTM 551450E, 5429500N) appeared to be thin to medium bedded, slightly rusty weathering, light to medium grey quartzitic wacke, and medium to dark bluish-grey siltstone and argillite. Laminated siltstone beds up to 60cm thick were present. Finer grained units were biotite rich, and some hosted biotite porphyroblasts. Foliation was locally very strongly developed, parallel to bedding. Chlorite, sericite and biotite alteration was observed. There was a 60 centimetre conformable mudchip breccia bed seen, along with mudchips in other beds. Massive aphanitic tourmalinite and albitized float was found in the area, which were probably derived from the vent complex. One float sample yielded anomalous lead and zinc. Because of the high stratigraphic position of this vent, it was not of prime interest in this program, although it indicated that hydrothermal processes were at work in this area.

Gabbro (gb)

The Moyie intrusives as in other parts of the Aldridge Formation are seen to intrude the lower and middle Aldridge Formation as sills and dikes. Compositionally, these rocks have been defined as gabbro to diorite, although the field term gabbro is here used to indicate all Moyie intrusions. They are dark grey to dark greenish brown on fresh surfaces and weather brown, dark grey or rusty. The intrusives are generally medium to coarse-grained, rarely fine-grained (except in local chill margins). Textures are equigranular to hornblende porphyritic. Locally coarse sprays of hornblende crystals up to 3cm long occur. Plagioclase phenocrysts are much more rare. Biotite chlorite and quartz occur as alteration and/or metamorphic phases. Disseminated pyrrhotite and traces of chalcopyrite have been observed. The Moyie intrusives are non-magnetic except

where disseminated pyrrhotite is present. Contacts with the Aldridge Formation are generally sharp and parallel bedding, but commonly bedding is disrupted in adjacent sediments. Contact zones may also be altered, especially albitized. Where cut or bounded by fault zones, the gabbros are often deformed and altered to fine to coarse-grained chlorite (+/- biotite) schist.

Granitoid dyke

A small east west trending granitoid dyke was mapped at station 097 (UTM 547550E, 5430900N). The rock is fine to grey weathering, medium grained, equigranular, and not foliated. The mineralogy is feldspar, biotite and quartz, with a colour index of about 20. Most of the biotite appears fresh, although some appears to have replaced hornblende.

6.2 Petrography

Early in the program, six hand samples of quartz wackes were submitted to Vancouver Petrographics for thin sectioning and descriptions. The report by Dr. Craig H.B. Leitch is included in Appendix VI. Samples were collected in pairs, one each from A1R and A2, in exposures that were close to each other, and appeared rather "clean". It was hoped that the samples, while appearing grossly similar, could be differentiated on the basis of microscopic textures, accessory mineral suites, or like criteria. Such criteria could then be used in the future with problematic outcrops encountered during mapping.

Unfortunately, no such clear differences between the A1R and A2 samples could be observed. The samples were all called fine-grained metawackes. However, the biotite and sericite components were greater than apparent in hand specimen, so the samples were not the "clean" quartz wackes as originally supposed. In any case, the field terms used originally were adhered to for the sake of consistency. All samples were dominantly quartz, with plagioclase (albite to oligoclase), sericite (muscovite), biotite and some K feldspar in varying amounts. Opaques, sphene, zircon, apatite, and epidote (zoisite, allanite?) made up the accessory mineral suite. Chlorite (locally replacing biotite), carbonate and limonite were found in some slightly altered samples. Interestingly, sample 086 (from station 086) contained up to 10% tourmaline (schorl) in fine disseminated needles. This sample was from A2 exposure on the east side of Mission Creek, conformable above A1R quartz wackes. This illustrates that there may have been some alteration / hydrothermal activity at the LMC here.

6.3 Structure

The Goat River Anticline (GRA) (Brown et. al, 1995) is the dominant structure in the property area. Most of the bedding on the property strikes about 350°, with a gentle to moderate easterly dip, on the east limb of the GRA. Local dip reversals probably indicate open subsidiary folds to the GRA. Foliations are generally developed only in the siltstones and argillites, and are often near parallel to bedding. Adjacent to fault zones, however, foliations are strongly developed, and parallel the fault zone.

The major fault crossing the Kitchener South Property is the Iron Range Fault. This fault trends north-northeast, and is interpreted to have minor west-side down normal displacement. The fault runs along the west side of the Kitchener South property. Where exposed, the fault zone is marked by very rusty weathering, highly fractured to soft crumbly altered rock. Locally the fault zone hosts strong quartz-albite-chlorite-pyrite alteration as shears, veins and pervasive flooding. The fault bifurcates in places. A fault associated foliation/shear measured in the west central part of the property indicates a steep western to sub-vertical dip.

A second fault zone with a similar orientation occurs east of the Iron Range Fault, at station 126 (UTM 550100E, 5429900N). This fault within A2 is marked by linear aligned outcrops of albite-chlorite-quartz-pyrite altered sediments, and sheared and chloritized gabbro. Sense of motion is not known, but the foliation dips moderately to steeply west.

An east west oriented fault-shear zone, with a moderate north dip, was observed at station 115 and adjacent outcrops (UTM 551100E, 5533475N). This fault cuts across a gabbro sill, altering the rock to chlorite schist.

In the southwest corner of the property, a northeast trending fault was observed to juxtapose a gabbro sill (deformed to chlorite schist) against Aldridge sediments. This fault is also inferred to offset the LMC which lies on the east valley slope above Mission Creek. Foliations indicate a moderate southeast dip to the fault plane. This dip would then indicate normal displacement, with A2 on the east side of the fault and A1R on the west side, in the footwall.

The LMC is exposed only in the southwestern corner of the property, where A2 rocks conformably overlie A1R in the valley of and to the west of Mission Creek. Elsewhere on the Kitchener South property, the LMC is not exposed, and the lower and middle Aldridge are in fault contact. This is assumed to be a thrust fault, carrying A1R in its hangingwall over A2. Although this fault was not mapped in outcrop, its existence and position can be inferred because A1R outcrops occur just west of the property, on the eastern slopes of the Ramparts south of Mt. Thompson (Map 2, Appendix II). These A1R outcrop are structurally and topographically higher than adjacent A2 strata to the east. A thrust fault interpretation was also reached by Brown et al (1995), for similar reasons (D. Brown, personal communication, 1999). This thrust fault would be older than the Iron Range Fault. In some places, the A1R and A2 may be separated by the Iron Range Fault, but this would require east-side down motion of the fault.

6.4 Alteration

A regional greenschist facies alteration is overprinted on all rocks on the property. Biotite and sericite (muscovite) and probable albite are commonly observed in quartzitic wackes, subwackes and siltstones. Biotite, muscovite and possible chloritoid locally occur as porphyroblast phases in some finer grained sediments. These are generally randomly oriented. Albite, chlorite, biotite and possibly tremolite occur in gabbros. The strongest alteration occurs in fault, fracture and shear zones, as well as in sediments at some contacts with gabbro sills. Albite, chlorite, pyrite, quartz (as stringers), and sericite are common in the disrupted zones. Fractures filled with quartz, calcite, chlorite, sericite or iron sulphides are locally observed. Albite-chlorite +/-biotite

and sericite alteration is locally found adjacent to gabbro sills. A feature of the quartz wackes and coarser quartz rich sediments of the Aldridge Formation are the presence of spherical to flattened ellipsoidal concretions. These are often located within particular beds, and are composed of quartz, feldspar (?), calcite, rather coarse biotite, and often garnet, chlorite sericite, tremolite, and locally sulphides. In many cases these light coloured concretions have dark, biotite rich "reaction rims". The mineral assemblage and texture of these bodies suggest metamorphism of a bulk composition differing from the host quartz rich sediments.

The albite and tourmaline (with chlorite, pyrrhotite, and biotite) alteration associated with the Comiss Vent is typical of such features, and is ascribed to fluids ascending through the sediment pile. The tourmaline alteration observed was massive, black and aphanitic.

6.5 Mineralization and Analytical Results

Known mineral occurrences are described in Section 4.0 under Property Geology with further details available in the BC MINFILE.

During the 1999 exploration program a total of fifteen (15) rock samples were collected for ICP analysis of 28 elements, and gold by fire assay. Sample descriptions are included in Appendix IV and results are tabled in Appendix V.

Generally, sampling was directed toward siltstone or argillite units with appreciable disseminated pyrrhotite (or pyrite), to see if they contained anomalous base metal contents, such as might be expected at a Sullivan horizon. For the most part, analytical results did not reveal any anomalous areas.

At the LMC, rusty weathering, pyrrhotitic A2 wackes and siltstones located above the A1R in the southwestern corner of the property along the power line access road analysed 8-12 ppm Pb and 22-25 ppm Zn, and up to 25ppm As (samples KLG31, 32; UTM 546850-547320E, 5428650N). A very rusty weathering, laminated siltstone-argillite package within the A2, with abundant disseminated pyrrhotite, yielded only 10-16 ppm Pb and 20-24 ppm Zn (stations 116-117, UTM 555000E, 5433100N, samples KLG 36, 37).

A sample of the granitoid dyke (sample KLG33, UTM 547550E, 5430900N) had 138 ppm Zn and 265 ppm Ba, although it appeared rather unaltered.

Siltstone and argillite samples from outcrop near the Comiss Vent were not anomalous in base metals, but contained up to 80 ppm As (sample KLG43, station 132, UTM 551450E, 5429550N). However, a float sample of quartz wacke with disseminated clots of biotite and pyrrhotite, collected downhill and south of the Comiss Vent, yielded 156 ppm Pb, 241 ppm Zn. This was the only anomalous sample from the collection and demonstrates that there may be mineralization associated with this vent, although it's stratigraphic level was not the focus of this program.

7.0 Conclusion and Recommendations

The Kitchener South Property comprises 52 claims with a total of 223 claim units, located in the Fort Steele Mining Division and centered about 15km southeast of Creston B.C. The property covers exposures of the Proterozoic lower and mostly middle Aldridge Formations of the Purcell Supergroup. The 1999 exploration program on the Kitchener South property consisted of geological mapping in the vicinity of the exposed LMC, and also along sections perpendicular to the LMC spaced 2-3km apart. Fifteen rock samples were collected and analysed. A single float sample with weakly anomalous Pb and Zn was collected from near the Comiss vent.

The LMC was traced in the southwestern corner of the property, dipping gently to the east. There was not enough stratigraphic control available to trace the LMC to depth, due mainly to lack out outcrop. At shallow depths, it is considered that a sizeable deposit at or near the LMC would have a geochemical or geophysical signature that would have been previously recognized. Furthermore, there was no "mud package" or Sullivan horizon identified at the LMC where exposed.

Elsewhere the lower and middle Aldridge Formations were inferred to be in faulted contact. The general lack of stratigraphic markers collected from the monotonous A2 made it virtually impossible to know the stratigraphic level within the thick package, especially considering the observed folds and faults of uncertain displacement. Where stratigraphic positions were known with some confidence, the LMC was generally too deep to test, given the thickened Aldridge section in the property area.

These problems, coupled with the Ramparts facies problems (i.e., could there be a Sullivan type horizon at the A2 – A1R contact), led to the conclusion that there was no clear drill target for the type of geological environment favourable for Sedex mineralization. Therefore no further work is recommended, and the property will be returned to the vendors.

8.0 Statement of Expenditures

The following expenses were incurred on the Kitchener South property:

Personnel

Leonard Gal, P. Geo*	20 days @ \$300/day	\$6,000
Patrick Donnelly, Assistant	20 days @ \$150/day	\$3,000
Siegfried Weidner**	8 days @ \$310/day	\$2,480

Benefits and H.O. Supervision \$1,215

Airfares

Vancouver – Cranbrook \$ 385

Accommodation

Hotel/Motel for crew \$1,106

Meals

2 man crew \$ 690

Groceries

Field Supplies/Lunches 2 man for 20 days \$ 471

Field Supplies

Consumables, maps, reports, equipment rental \$ 596

Transportation (includes fuel)

Truck Rental 20 days @ \$100/day \$2,000

Geological Services

Vancouver Petrographic \$ 872

Consultants

Supergroups Holdings Ltd.	\$ 199
G. Rodgers	\$ 150

Analytical

Eco-Tech Laboratories, Kamloops \$ 556

Miscellaneous

Drafting/Reproductions \$1,450

Total \$21,170

*Field supervision and administration, mapping, reporting and interpretation

** Program supervision and administration, reporting and interpretation

9.0 Statement of Qualifications

Leonard Gal

I, Leonard Gal, of North Vancouver, British Columbia hereby certify that:

- I am a Professional Geoscientist registered in good standing of the Association of Professional Engineers and Geoscientists of British Columbia (Registration No. 20425)
- I am a Fellow of the Geological Association of Canada (Fellow No. 6885).
- I am a graduate of the University of British Columbia, with a B.Sc. in Geology (1986).
- I am a graduate of the University of Calgary, with a M.Sc. in Geology (1989).
- I have been engaged in geological work more or less continuously since 1986, in North and South America and Australasia.
- The information in this report is based on work conducted by and supervised by myself, and upon review of unpublished and published reports and maps, and materials supplied by the operator.

Signed this 9 day of December, 1999.



Leonard Gal M.Sc., P.Geo

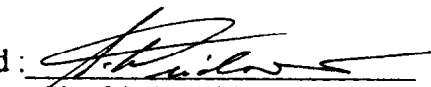
Siegfried Weidner

I, Siegfried O. Weidner, of Coquitlam, British Columbia, do hereby certify that:

- 1) I am a Senior Geologist employed by Rio Algom Exploration Inc. with an office located at #900-409 Granville Street, Vancouver, British Columbia, Canada, V6C-1T2
- 2) I am a graduate in Geology with a Bachelor of Science degree from the University of Toronto in 1984.
- 3) I have practised my profession as a geologist since graduation in 1984, the last 11 years with Rio Algom Exploration Inc.
- 4) I supervised the 1999 exploration program on the Kitchener South option property and have detailed knowledge of the contents of this report.

Dated this 16th day of December, 1999

Signed :


Siegfried Weidner
(Rio Algom Exploration Inc.)

Bibliography

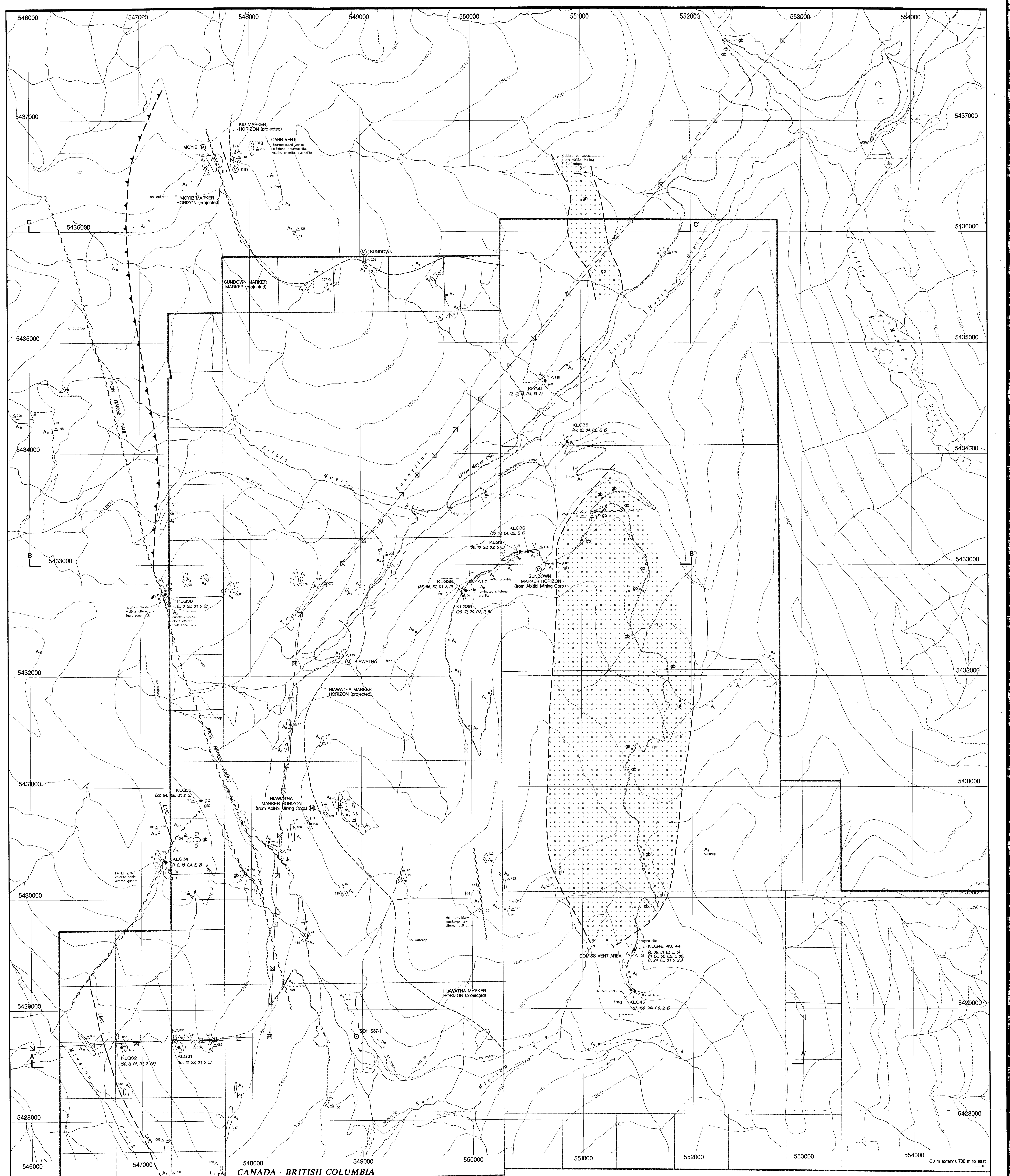
- Brown, DA and Stinson, P (1995) Geological Mapping of the Yahk Map Area, Southeastern British Columbia: An Update (82F/1). *in* Geological Fieldwork 1994, Grant, B and Newell, JM, eds. B.C. Ministry of Energy, Mines and Petroleum Resources, 1995-1
- Hoy, T (1993) Geology of the Purcell Supergroup in the Fernie West-Half Map Area, Southeastern British Columbia. B.C. Ministry of Energy, Mines and Petroleum Resources, Bulletin 84
- Reesor, JE (1993) Geology of the Nelson Map-area, (East Half 82F/1,2,7,10,15,11). Geological Survey of Canada, Open File 2721.
- Rice, HMA (1941) Nelson Map-area, East Half. Geological Survey of Canada, Memoir 228

APPENDIX I

Property Claim Status

APPENDIX II

Geology Maps and Sections



CANADA - BRITISH COLUMBIA

USA - IDAHO

Claim extends 700 m to east

LEGEND

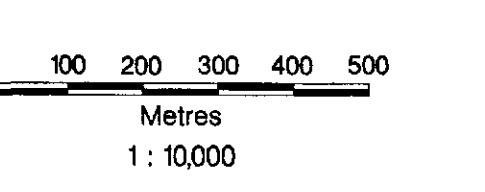
- ldh** LAMPROPHYRE DYKE
- gld** GRANITOID INTRUSIVE
fine to medium grained, equigranular tonalite or granodiorite
- gb** MOYIE INTRUSIONS
gabro - diorite
- gph** GRANOPHYRE
fine grained, massive, granoblastic, quartz-biotite-hornblende rock
- frag** FRAGMENTAL
massive, rusty weathering, fine grained, biotite-rich quartzitic wacke matrix, variable fragments
- A₂** MIDDLE ALDRIDGE
quartz wacke, quartzitic wacke, siltstone, minor argillite, thin to medium bedded, A-E turbidites
- A_w** LOWER ALDRIDGE (Ramparts Facies)
quartz wacke, quartzitic wacke, minor siltstone, medium bedded
- A₁** LOWER ALDRIDGE
quartzitic wacke, wacke, subwacke, siltstone, rusty weathering, thin bedded, fine grained, includes FWO footwall quartzite, medium bedded grey quartzite

SYMBOLS

- Geological contact inferred, assumed
- Projection of marker lamnite horizon
- Fault: observed, inferred
- Thrust fault
- Outcrop
- Area of small scattered outcrop/subcrop
- Angular float
- Rock sample location: sample number
(Assay values: Cu-ppm, Pb-ppm, Zn-ppm, Ag-ppm, Au-ppb, As-ppm)
- Marker lamnite location with name where identified
- Station number
- Bedding
- Foliation
- Anticline, syncline
- Drill hole
- PP99-1
- Workings: trench, adit, shaft
- Property boundary
- Cross section line

GEOLOGICAL SURVEY BRANCH
ANTICLINAL DIVISION

26,117

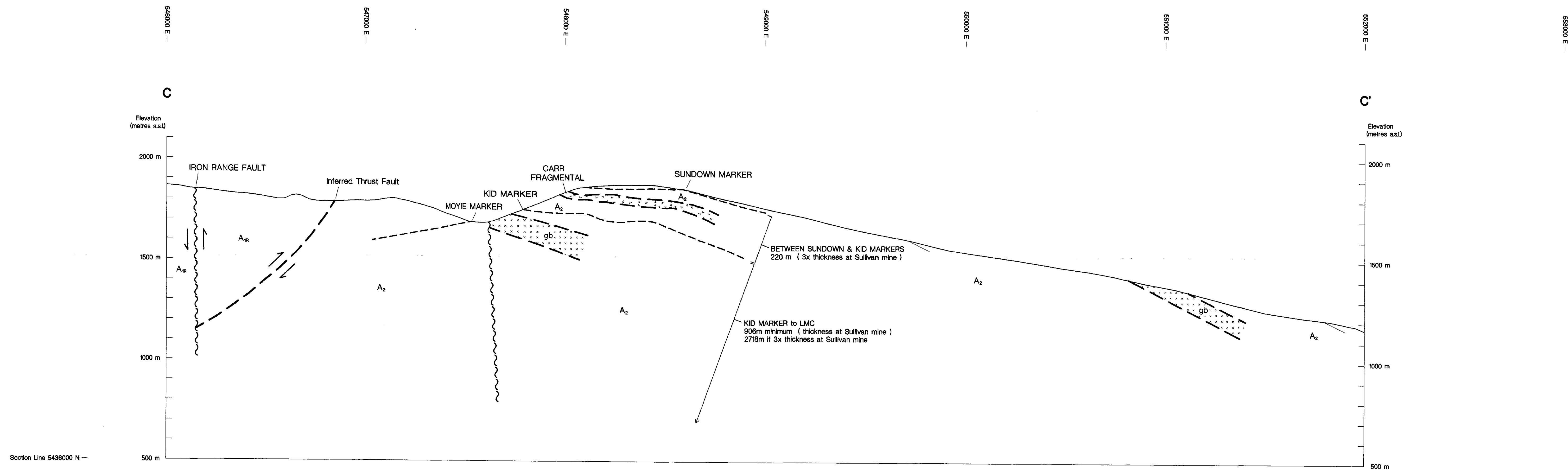


RIO ALGOM EXPLORATION INC.
KITCHENER SOUTH PROPERTY
Fort Steele M.D. British Columbia, Canada

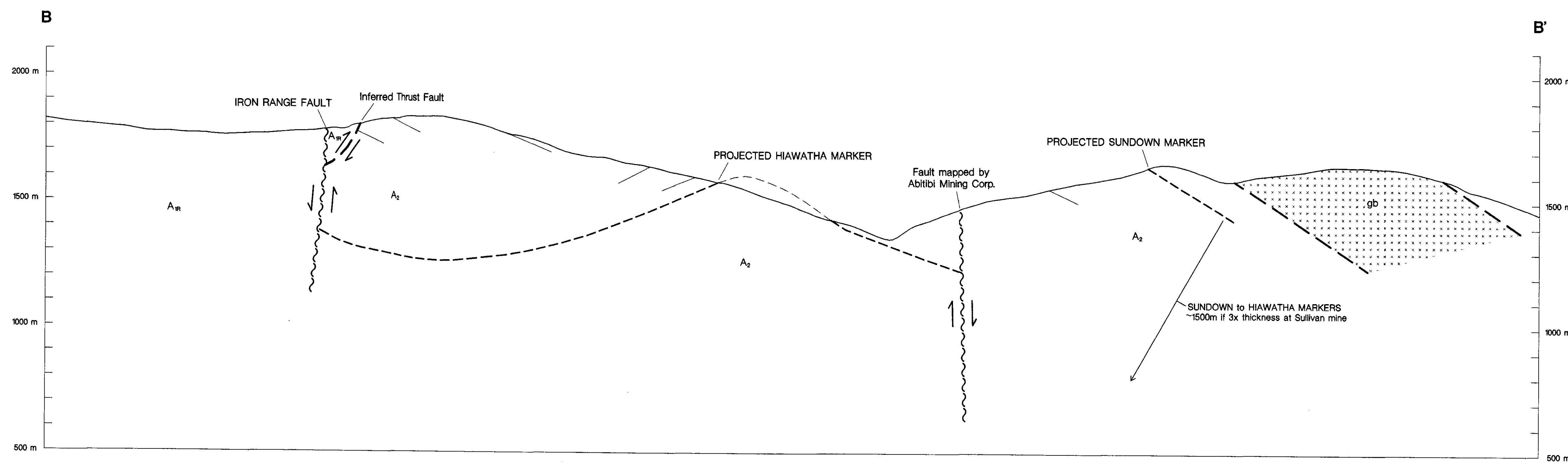
GEOLOGY

SCALE: 1:10,000 DATE: December 1999
DATA BY: L.P.G. S.D.W. APPENDIX: 2
TRM: 827,008 MAP: 1

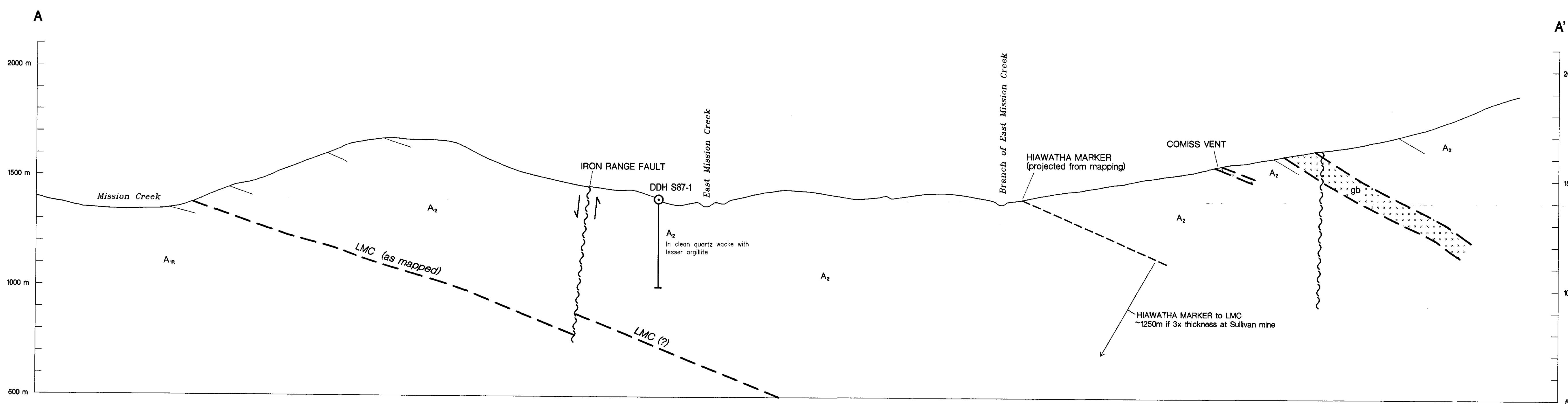
UNIVERSITY OF TORONTO LIBRARY



Section Line 5436000 N



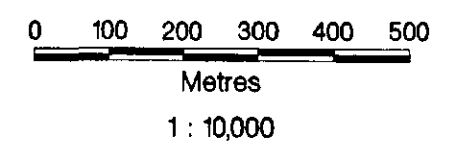
Section Line 5433000 N



Section Line 5428500 N

- LEGEND**
- [lph] LAMPROPHYRE DYKE
 - [gtd] GRANITOID INTRUSIVE
fine to medium grained, equigranular tonalite or granodiorite
 - [gb] MOYLE INTRUSIONS
gabbro - diorite
 - [gph] GRANOPHYRE
fine grained, massive, granoblastic, quartz-biotite-feldspar rock
 - [fzg] FRAGMENTAL
massive, rusty weathering, fine grained, biotite-rich quartzitic wacke matrix, variable fragments
 - [A2] MIDDLE ALDRIDGE
quartz wacke, quartzitic wacke, subwacke, siltstone, minor argillite, thin to medium bedded, A-E turbidites
 - [A3] LOWER ALDRIDGE (Ramparts Facies)
quartz wacke, quartzitic wacke, minor siltstone, medium bedded
 - [A1] LOWER ALDRIDGE
quartzitic wacke, wacke, subwacke, siltstone, rusty weathering, thin bedded, fine grained, (includes FWQ footwall quartzite, medium bedded grey quartzite)

- SYMBOLS**
- Geological contact: inferred, assumed
 - - - - - Projection of marker laminitic horizon
 - ~ Fault: observed, inferred
 - Thrust fault
 - Measured bedding attitude
 - S87-1 ○ Drill hole



GEOLOGICAL SURVEY BRANCH
ANNUAL REPORT

26,117

RIO ALGOM EXPLORATION INC.	
KITCHENER SOUTH PROPERTY Fort Steele M.D. British Columbia, Canada	
GEOLOGICAL CROSS SECTIONS A-A', B-B', C-C'	
SCALE: 1:10,000	DATE: December 1999
DATA BY: L.P.G., S.O.W.	APPENDIX: 2
TRIM: 82E000	MAP: 2

APPENDIX III**Identified Marker Laminites
Time Stratigraphic Marker Horizons Within the Middle Aldridge**

Station Number	Marker Horizon	Comments
130	Hiawatha	Abitibi Mining Corp. also collected Hiawatha marker to the south; both exposures used in projecting the position of this marker
236	Sundown	Abitibi Mining Corp. collected Sundown marker east of the Car Vent
240	Kid	Off the property, just below the fragmental of the Car Vent
241	Moyie	Off the property, located across a fault zone from 240 (Kid)

APPENDIX V

Analytical Results

Et #	Tag #	Au(ppb)	Ag	Al %	As	Ba	Bi	Ca %	Cd	Co	Cr	Cu	Fe %	La	Mg %	Mn	Mo	Na %	Ni	P	Pb	Sb	Sn	Sr	Ti %	U	V	W	Y	Zn	
21																															
22																															
23																															
24																															
25																															
26																															
27																															
28																															
29																															
30																															
31																															
32		station																													
33	07333	Δ082	5	<0.2	2.01	<5	5	10	0.04	<1	9	58	<1	3.11	<10	2.57	270	1	0.05	16	30	8	15	<20	<1	<0.01	<10	57	<10	<1	23
34	07334	Δ085	5	<0.2	1.41	5	90	15	0.15	<1	16	45	67	3.44	20	0.65	271	<1	0.02	10	380	12	<5	<20	<1	0.15	<10	14	10	33	22
35	07335	Δ086	<5	<0.2	1.09	25	75	5	0.18	<1	15	75	50	2.95	<10	0.67	225	4	0.03	15	330	8	<5	<20	2	0.14	<10	16	<10	16	25

QC DATA:

Resplit:

1	07301	5	<0.2	1.18	<5	105	<5	0.08	<1	11	121	39	2.54	10	0.45	233	1	0.04	11	150	14	<5	<20	4	0.13	<10	22	<10	24	34
---	-------	---	------	------	----	-----	----	------	----	----	-----	----	------	----	------	-----	---	------	----	-----	----	----	-----	---	------	-----	----	-----	----	----

Repeat:

1	07301	<5	<0.2	1.17	<5	100	5	0.08	<1	10	112	40	2.50	10	0.44	233	<1	0.04	11	150	14	<5	<20	4	0.12	<10	23	<10	24	33
10	07310	<5	<0.2	2.94	<5	275	20	0.59	<1	43	77	12	5.92	<10	1.69	679	<1	0.06	26	290	14	<5	<20	7	0.20	<10	99	<10	<1	84
19	07319	25	<0.2	1.27	<5	85	5	0.08	<1	13	59	34	2.99	<10	0.50	227	<1	0.02	15	280	12	<5	<20	<1	0.12	<10	16	<10	20	33

Standard:

GEO'99		135	1.0	1.72	65	145	5	1.88	<1	19	66	76	3.98	<10	0.98	650	<1	0.02	23	630	22	<5	<20	55	0.12	<10	77	<10	7	71
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 ECO-TECH LABORATORIES LTD.
 Frank J. Pezzotti, A.Sc.T.
 B.C. Certified Assayer

14-Jul-99

ECO-TECH LABORATORIES LTD.
10041 East Trans Canada Highway
KAMLOOPS, B.C.
V2C 6T4

ICP CERTIFICATE OF ANALYSIS AK 99-231

RIO ALGOM EXPLORATION INC.
900-409 GRANVILLE STREET
VANCOUVER, BC
V6C 1T2

Phone: 250-573-5700
Fax : 250-573-4557

ATTENTION: SIG WEIDNER

No. of samples received: 14
Sample type: Rock
PROJECT #: 9905
SHIPMENT #: None Given
Samples submitted by: P. Donnelly

Values in ppm unless otherwise reported
station

Et#.	Tag #	Au(ppb)	Ag	Al %	As	Ba	Bi	Ca %	Cd	Co	Cr	Cu	Fe %	La	Mg %	Mn	Mo	Na %	Ni	P	Pb	Sb	Sn	Sr	Ti %	U	V	W	Y	Zn	
1	07336	107	<5	<0.2	2.21	<5	265	15	0.31	<1	18	82	22	4.48	<10	0.59	915	<1	0.03	7	370	64	<5	<20	6	0.29	<10	108	<10	22	138
2	07337	100	5	0.4	2.56	<5	20	<5	0.04	<1	5	83	1	3.44	<10	2.94	177	5	<0.01	9	470	8	15	<20	2	<0.01	<10	17	<10	<1	10
3	07338	113	5	0.2	0.92	<5	45	<5	0.05	<1	9	48	47	2.28	20	0.46	144	4	0.02	20	330	12	<5	<20	7	0.04	<10	9	<10	5	84
4	07339	116	5	0.2	1.01	<5	50	<5	0.04	<1	8	51	36	2.47	10	0.44	173	2	0.01	12	400	10	<5	<20	<1	0.02	<10	8	<10	<1	24
5	07340	116	5	0.2	0.95	5	50	<5	0.05	<1	11	40	30	2.28	30	0.43	197	5	0.01	20	410	16	<5	<20	<1	0.02	<10	7	<10	9	20
6	07341	118	<5	<0.2	1.42	<5	75	10	0.46	<1	13	58	36	3.06	20	0.72	336	3	0.02	25	480	46	5	<20	14	0.07	<10	13	<10	14	87
7	07342	118	<5	0.2	0.89	5	60	<5	0.17	<1	10	65	26	2.37	20	0.49	270	5	0.02	19	490	10	<5	<20	8	0.03	<10	8	<10	8	29
8																															
9	07344	120	10	0.4	0.91	<5	45	<5	0.04	<1	2	38	2	1.78	20	0.44	168	2	0.02	3	370	12	<5	<20	<1	0.01	<10	8	<10	<1	18
10	07345	132	5	<0.2	1.92	5	75	20	0.08	<1	8	22	4	3.01	60	1.27	180	<1	<0.01	34	490	38	15	<20	<1	0.14	<10	16	<10	25	81
11	07346	132	5	0.2	1.58	80	60	<5	0.13	<1	6	34	11	2.72	80	0.97	175	<1	<0.01	10	880	28	<5	<20	4	0.06	<10	10	<10	21	52
12	07347	132	5	<0.2	1.81	25	55	5	0.07	<1	10	70	7	2.94	60	1.19	213	2	<0.01	21	430	24	10	<20	<1	0.09	<10	13	<10	19	85
13	07348	132	<5	0.8	0.25	<5	25	<5	0.61	3	5	82	17	1.17	10	0.09	266	<1	0.01	9	100	156	<5	<20	15	<0.01	<10	2	<10	3	241
14																															

QC DATA:

Resplt:	1	07336	5	<0.2	2.19	<5	255	15	0.32	<1	18	88	22	4.41	<10	0.58	903	<1	0.03	6	370	70	<5	<20	2	0.30	<10	106	<10	21	138
Repeat:	1	07336	<5	<0.2	2.18	<5	265	20	0.30	<1	18	78	22	4.42	<10	0.58	903	<1	0.02	5	380	62	<5	<20	8	0.29	<10	106	<10	23	138
Standard:	10	07345	-	<0.2	1.87	<5	80	25	0.08	<1	8	24	4	2.98	60	1.24	179	<1	<0.01	37	480	38	15	<20	<1	0.13	<10	15	<10	23	82
GEO'99			140	1.6	1.72	55	155	10	1.51	<1	19	81	89	3.56	<10	0.92	662	<1	0.02	27	640	20	10	<20	57	0.10	<10	75	<10	12	65

df/231
XLS/99


ECO-TECH LABORATORIES LTD.
Frank J. Pezzotti, A.Sc.T.
B.C. Certified Assayer



**ASSAYING
GEOCHEMISTRY
ANALYTICAL CHEMISTRY
ENVIRONMENTAL TESTING**

10041 E. Trans Canada Hwy., R.R. #2, Kamloops, B.C. V2C 6T4
Phone (250) 573-5700 Fax (250) 573-4557
email: ecotech@mail.wkpowerlink.com

WHOLE ROCK CERTIFICATE OF ANALYSIS AK99-231

**RIO ALGOM EXPLORATION
900-409 GRANVILLE STREET
VANCOUVER, BC
V6C 1T2**

16-Jul-99

ATTENTION: SIG WEIDNER

*No. of samples Received: 14
Sample Type: Rock
PROJECT #: 9905
SHIPMENT #: None Given
Sample submitted by: P. Donnelly*

Values expressed in percent

ET #.	Tag #	station ↓	BaO	P2O5	SiO2	MnO	Fe2O3	MgO	Al2O3	CaO	TiO2	Na2O	K2O	L.O.I.
1	07336	A097	0.07	0.04	68.37	0.15	7.55	0.97	12.27	3.75	1.02	1.63	2.70	1.50

QC/DATA:

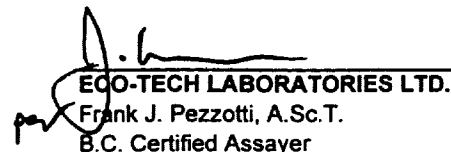
Repeat #:

1	07336		0.07	0.05	68.49	0.14	7.58	1.02	12.07	3.77	1.04	1.53	2.73	1.50
---	-------	--	------	------	-------	------	------	------	-------	------	------	------	------	------

Standard:

MRG1			0.04	0.07	39.35	0.17	17.38	13.24	8.56	14.35	3.64	0.75	0.23	2.22
SY2			0.08	0.40	59.28	0.32	6.22	2.76	12.04	7.79	0.14	4.26	4.87	1.84

XLS/98
df/wr205


ECO-TECH LABORATORIES LTD.
Frank J. Pezzotti, A.Sc.T.
B.C. Certified Assayer

E CH L TOR D.
 10041 East Trans Canada Highway
 KAMLOOPS, B.C.
 V2C 6T4

ICP CERTIFICATE OF ANALYSIS AK 99-350

RIO ALGOM EXPLORATION LTD.
 900-409 GRANVILLE STREET
 VANCOUVER, BC
 V6C 1T2

Phone: 250-573-5700
 Fax : 250-573-4557

ATTENTION: SIG WEIDNER

No. of samples received: 19
 Sample type: Rock
 PROJECT #: 9905
 SHIPMENT #: None Given
 Samples submitted by: P. Donnelly

Values in ppm unless otherwise reported

Et #.	Tag #	Au(ppb)	Ag	Al %	As	Ba	Bi	Ca %	Cd	Co	Cr	Cu	Fe %	La	Mg %	Mn	Mo	Na %	Ni	P	Pb	Sb	Sn	Sr	Ti %	U	V	W	Y	Zn	
1																															
2		stn.																													
3																															
4	7433	Δ095	5	<0.2	1.91	15	65	<5	0.11	<1	9	41	71	3.06	20	1.49	291	1	0.01	16	430	26	5	<20	3	0.08	<10	13	<10	56	48
5	7434	236	5	0.4	0.69	<5	60	<5	<0.01	<1	3	51	38	2.17	<10	0.21	61	3	0.01	4	220	12	<5	<20	<1	<0.01	10	6	<10	<1	18
6	7435	239	5	<0.2	0.83	5	40	<5	0.71	<1	11	39	35	2.32	<10	0.44	443	4	0.01	22	470	34	<5	<20	25	<0.01	<10	6	<10	<1	172
7	7436	239	<5	0.2	0.81	<5	40	<5	0.03	<1	3	45	23	1.80	10	0.35	128	2	0.01	6	540	38	<5	<20	5	<0.01	<10	6	<10	1	46
8																															
9																															
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19																															

APPENDIX VI

Petrographic Report



Vancouver Petrographics Ltd.

8080 GLOVER ROAD, LANGLEY, B.C. V3A 4P9
PHONE (604) 888-1323 • FAX (604) 888-3642

PETROGRAPHIC REPORT ON 14 THIN SECTIONS

Report for: S. Weidner, Senior Geologist
Rio Algom Exploration Inc.
900-409 Granville Street
Vancouver, B.C. V6C 1T2.

Invoice 990426

Sept. 2, 1999.

SUMMARY:

This suite of Aldridge Formation rocks consists of mainly fine-grained meta-siltstone (032, 044, 045) or quartz wacke (034, 048, 064, 067, 086, 087, 094, 096, 099, 131), depending on presence of significant feldspar, typically <2% in the siltstones and 15-25% in the wackes. Note, however, that sericite contents are higher in the "siltstones" (25-45%, locally to 60% in argillaceous or "mudstone" layers); since sericite does replace feldspar in altered rocks, a lithologic distinction based on sericite versus feldspar can be unreliable. One sample, KSW 04, is a typical "granophyre" caused by intrusion of Moyie gabbro sills into wet sediments (a granoblastic-textured hornfels characterized in the field by coarse biotite and quartz, and in thin section by micrographic quartz-albite intergrowth).

Typical minerals are quartz, feldspar(s) (both plagioclase of albite or albite-oligoclase composition, and K-feldspar), white mica (sericite and muscovite), biotite (in places chloritized), and accessory carbonate, sphene, opaques (?mainly ilmenite, rare limonite in part after ?sulfide), epidote-group minerals such as clinozoisite-zoisite-allanite (REE-bearing epidote), zircon, apatite. Two samples (044 and 086) contain significant tourmaline (15 and 10% respectively) and could be classed as weak "tourmalinites". Other alteration (sericite, chlorite, carbonate, epidote-group minerals) are harder to evaluate in rocks that may contain significant white mica in their unaltered state, or in which chlorite-sericite may be very late. The maximum grain size, as indicated by detrital quartz, is mainly in the 0.1-0.3 mm range (three samples, 086, 094, and 096, have coarser "grits" to 0.6 mm, and in one sample, 032, it is about 25 microns).

The short answer to your main question, is there an identifiable difference between units A1 and A2, is, I believe, no. Both at a hand specimen/offcut slab scale, and in thin section, I see no easily supportable differences that can be traced through the entire set of six pairs of samples (you might want to try and line up the six pairs of offcuts yourself and try this). In some cases there is more similarity between the samples of the pair both in textural appearance and mineralogy (e.g., 086 and 087) or in mineralogy (131 and 099). Features such as tourmaline, carbonate, chlorite and epidote are essentially superposed and thus largely irrelevant. My experience in the Aldridge, drawn largely from research at Sullivan and aimed at distinguishing precursor lithologies in order to apply Gresens volume-factor corrections to altered rocks, showed me that trying to make

lithologic separations by mineralogy is difficult, and that even within fairly well-defined units (defined by Cominco mine staff on the basis of long-standing stratigraphy) the mineralogical or textural variation can be significant on a hand-specimen scale. There is just so much small-scale variation in these monotonous rocks that only large-scale features are reliable in making stratigraphic distinctions. I am sorry that the papers by myself and Dr. Bob Turner (still with the GSC) that were supposed to be published in a GSC volume are still not out yet; a lot of material in them would bear on the problem you have submitted here. Please feel free to call me and discuss your central question further (or any other questions you may have arising from the descriptions appended below).

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032: FINE-GRAINED SERICITE-QUARTZ-BIOTITE METASILTSTONE CONTAINING ELONGATE LIMONITIC CASTS AND BIOTITE-SPHENE+KSPAR "OOIDS"

From Unit A2 (Aldridge Fm. quartzites and wackes); hand sample is very fine-grained, well layered to almost laminated, grey to creamy buff in colour. Occasional swallow-tail pseudomorph crystal casts are present; some layers have a vaguely ooid texture. Both these latter features stain yellow for K-feldspar in places in the etched slab. The rock is not magnetic and shows no reaction to cold dilute HCl. Modal mineralogy in thin section is approximately:

Sericite	45%
Quartz	40%
Biotite	10%
K-feldspar	2%
Sphene	1-2%
Epidote (?)	<1%
Limonite	<1%
Tourmaline	tr

The section is broadly divisible into two halves, one of which is biotitic (grey in hand sample) and one sericitic (creamy buff in hand sample). In the former, biotite forms up to 15% of the rock; in the latter, biotite generally forms only a few percent of the rock.

In the sericitic portion, grain size is very fine (about 15-20 microns) and consists mainly of sericite and quartz as sub- to euhedral and sub- to anhedral crystals respectively; quartz is rarely up to 40 microns. In some layers there may well be epidote as well (clusters up to 15 microns across of minute crystals mostly <5 microns across). In this size range, it can be difficult to separate this material from similar-sized sphene except with an SEM. Rarely, slightly larger clusters of this ?epidote/sphene contain minor opaques to 15 microns diameter. An unusual feature of the sericitic portion is the presence of elongate crystal casts with random orientation (now almost entirely plucked out during section preparation, leaving voids up to 1 mm long by 50 microns thick). In the hand specimen, these are brown and look like biotite crystals, but in thin section the only ones retaining any filling contain only limonite. Similar casts elsewhere in the Aldridge in my experience contain chlorite and/or carbonate; the ones with swallow-tail shape have been suggested as possible gypsum pseudomorphs suggestive of former hypersaline conditions, but this is speculative.

In the biotitic portion, the matrix is similar (sericite, quartz and biotite of about 15-30 micron diameter); biotite is also present as clotty concentrations up to 0.5 mm diameter composed of subhedral flakes to 0.15 mm size with yellow to brown pleochroism, in places mixed with limonite aggregates, sphene to 15 microns and possibly ?allanite to 10 microns (distinguished by presence of pleochroic haloes in the biotite). In some layers the biotite is concentrated, with sphene, as 10-20 micron subhedra, in small oval ooid ring shapes up to 1 mm in diameter, about a core that is clear but to judge by the yellow stain in etched slab is likely K-feldspar (subhedra mostly <25 microns in diameter; rarely to 0.2 mm). Rare tourmaline crystals form euhedra to 50 microns that are distinguished by deep green-brown pleochroism indicating schorlitic (Fe-rich) composition.

034: FINE-GRAINED QUARTZ-PLAGIOCLASE-BIOTITE-SERICITE WACKE (ACCESSORY SPHENE-KSPAR-EPIDOTE/ALLANITE; RARE ZIRCON, APATITE, OPAQUE)

From Unit A1 (also Aldridge Fm. quartzites and wackes); hand sample is fine-grained with a salt-and-pepper texture caused by fine biotite flakes; in places distinct fragments with subrounded shapes up to almost 1 cm long or feathery flattened shapes to 2 cm are visible, especially on the weathered (but non-lichen covered) or cut surfaces, respectively. The rock is not magnetic and shows no reaction to cold dilute HCl except in rare small vugs, and only traces of stain for K-feldspar in the etched slab. Modal mineralogy in thin section is approximately:

Quartz	50%
Plagioclase (albitic)	15-20%
Biotite (rarely chloritized)	15-20%
Sericite	13-15%
Sphene	1%
K-feldspar	<1%
Epidote, ?allanite	tr
Zircon, apatite	tr
Opaque, carbonate	tr

This appears to be a fairly typical fine Aldridge wacke, composed of abundant quartz and feldspar (mainly plagioclase with a composition near albite), biotite and white mica (sericite) with accessory sphene.

Quartz grains are mainly sub- to anhedral, and less than about 0.3 mm in diameter, with undulose extinction and minor sutured boundaries indicating strain. In some grains, inclusions of sericite near the margins may indicate overgrowths. Plagioclase grains or crystals are mainly subhedral and less than about 0.25 mm diameter, with distinct negative relief compared to quartz and extinction on 010 up to 15 degrees indicating an albitic composition more sodic than An₁₀. K-feldspar is difficult to distinguish in thin section, but in a few places clusters of crystals up to almost 1 mm long that lack twinning may be the Kspar indicated by the etched slab.

Biotite flakes are mainly subhedral, up to 0.15 mm in diameter, with brown to greenish brown pleochroism. Sericite flakes are smaller (mainly less than 75 microns, subhedral) and in places appear to occupy former feldspar sites. Traces of chlorite are found in biotite around K-feldspar. Carbonate is not seen in thin section but is indicated by reaction in hand specimen.

Sphene occurs as minute sub- to anhedral crystals mainly less than 25 microns in diameter (rarely euhedral, to 50 microns) generally closely associated with biotite and rarely cored by opaque (likely ilmenite) mostly <15 microns but rarely tabular, up to 0.1 mm long. In places clusters of epidote crystals contain cores of or are associated with subhedral pink to orange-coloured ?allanite (REE-bearing epidote) crystals up to 0.1 mm long, or opaques to 50 microns; rare zircon crystals form stubby euhedra up to 75 microns long and rare apatite forms sub- to anhedral up to 50 microns in diameter.

Unfortunately, no fragments were cut in the thin section, so they cannot be evaluated.

045: FINE-GRAINED QUARTZ-SERICITE-BIOTITE METASILTSTONE, FINE LENSEY TO LAMINATED TEXTURE, SCATTERED CARBONATE-SPHENE-BIOTITE/CHLORITE CLOTS

From Unit A2; hand sample is a fine-grained salt-and-pepper textured wacke that in etched slab displays a faint lamination and a somewhat clotty texture. The rock is not magnetic but shows trace reaction to cold dilute HCl in small white patches that weather out to vugs around the outer portions of the sample; there is no stain for K-feldspar in the etched slab. Modal mineralogy in thin section is approximately:

Quartz	50%
Sericite	25%
Biotite	15-20%
Carbonate (mainly calcite)	3-5%
Chlorite	2-3%
Sphene	1%
Opaque	<1%
?Allanite	tr

The bulk of this slide consists of fine-grained quartz and sericite (white mica) plus variable biotite, and accessory sphene. The laminated nature of the sample is caused by variation in biotite content from about 5% to 25% of wispy, discontinuous, vaguely defined laminae up to about 1 mm thick. The biotite-poor areas tend to be lensey, almost like small fragments of up to several mm long that have been flattened in the plane of foliation. In these areas, quartz is coarser than in the more biotite-rich matrix, forming subhedral interlocking crystals up to 0.1 mm in size; the average size of quartz in the matrix is less than 50 microns. Sericite forms fine subhedral flakes throughout, rarely over about 25 microns in diameter. Biotite forms subhedral medium brown flakes that are mainly <0.1 mm in diameter; they are rarely chloritized and/or associated with opaques (see below). Minor accessory sphene is commonly associated with biotite, forming ragged clusters up to 0.15 mm across of sub- to anhedral crystals mostly <25 microns in diameter. In places, pleochroic haloes in adjacent biotite indicate the presence of traces of ?allanite (REE-bearing epidote) as minute crystals mostly <10 microns in size.

Feldspar (plagioclase) is not definitely identifiable due to the lack of grains that show either twinning or relief difference against quartz. Therefore, I suspect it is generally not present (the abundance of sericite, which likely replaces the feldspar, supports this) but I have known cases in the Aldridge where a more calcic plagioclase, with relief near that of quartz, is present and can only be detected with difficulty.

Carbonate, likely mostly calcite to judge by the reaction in hand specimen, occurs mainly as subhedral crystals up to 0.5 mm in diameter that form aggregates as much as 1 mm across. Locally the carbonate contains minor sphene/limonite, or is associated with biotite or chloritized biotite and opaques and quartz, both as subhedral crystals up to 0.25 mm in diameter. Commonly the carbonate is leached/weathered out (or plucked out during section preparation), leaving voids up to about 1 mm in maximum dimension. Chlorite is length-slow, with anomalous blue birefringence, indicating moderately Fe-rich composition; flakes are up to 0.1 mm in size.

044: FINE-GRAINED META-SILTSTONE/INTERLAYERED MUDSTONE (QUARTZ-SERICITE-MINOR BIOTITE), ABUNDANT SCHORLITIC TOURMALINE AND ACCESSORY OPAQUES

From Unit A1; hand sample is a fine-grained, buff-grey, massive rock with abundant small (<1 mm) dark clots; similar material is also found along narrow fracture veinlets perpendicular and parallel to a crude bedding defined by 2-3 mm thick layers of very fine-grained, dark rock. This sample looks to be altered (i.e., not normal Aldridge). The rock is not magnetic and shows no reaction to cold dilute HCl, and no stain for K-feldspar in the etched slab. Modal mineralogy in thin section is approximately:

Quartz	45%
Sericite	35%
Tourmaline (schorl)	15%
Biotite (partly chloritized)	3-5%
Opagues (?sulfide, ?ilmenite)	1%
?Sphene, epidote/allanite	<1%

The bulk of this slide consists of fine-grained quartz and sericite; biotite is not abundant, forming scattered medium brown flakes up to 0.2 mm in diameter or clotty aggregates to 0.35 mm. Quartz crystals are mainly anhedral to subhedral and <0.1 mm in diameter, but scattered grits (detrital grains) up to 0.25 mm occur, and next to the fine-grained layer (see below), concentrations of coarser quartz (commonly 0.15 mm diameter) occur. Sericite flakes are mostly subhedral and less than 50 microns in diameter. Small aggregates (to 35 microns across) of a high-relief mineral may be ?sphene, epidote, or allanite, or all three.

There is abundant tourmaline in this sample, forming the dark clots throughout the rock and along fractures (and therefore more likely to be of hydrothermal origin). The tourmaline forms clots up to 2.5 mm long composed of subhedral crystals up to 1.25 mm long. Minor opaques forming irregular aggregates up to 0.25 mm across associated with the tourmaline are possibly partly sulfide or limonite after former sulfides (also possibly partly ?ilmenite), reinforcing the premise of hydrothermal alteration. However, the composition is distinctly Fe-rich (schorl), to judge by the dark green-brown colour/pleochroism (my research at Sullivan suggests an Fe:Fe+Mg, or F:M, ratio of around 0.8 or over). This is therefore not as prospective from an exploration viewpoint (or at least not as proximal) as a more Mg-rich tourmaline. Along the fractures, discontinuous clots of tourmaline are partially joined.

In the fine-grained layers, the rock varies from almost entirely composed of sericite as flakes of about 20-30 microns in diameter, with coarser rounded to ragged flakes of biotite up to 1 mm in diameter, accessory opaques to 0.15 mm diameter, and only minor tourmaline (at the border with the coarser material), to more quartz-rich, with more abundant tourmaline and biotite/quartz clots. The former is typical of metamorphosed argillaceous (?mudstone) layers in the Aldridge, in my experience. Biotite is slightly chloritized in places, to a moderately Fe-rich (length-slow, anomalous blue) variety in flakes up to 0.15 mm in diameter.

048: FINE-GRAINED META-WACKE (QUARTZ--SERICITE--PLAGIOCLASE--MINOR BIOTITE--CALCITE--OPAQUES); PARTIAL CHLORITIZATION OF BIOTITE

Not included in list of samples divided into units A1 and A2; hand sample is somewhat similar in appearance to 044, being a fine-grained grey rock with scattered darker clots. However, near the weathered margin these clots weather out leaving voids as in 045; in the unweathered portion, these clots react to cold dilute HCl. The rock is not magnetic; there is no stained outcut to determine K-feldspar on, but two thin sections are prepared (only one studied in detail). Modal mineralogy in thin section is approximately:

Quartz	60%
Sericite (white mica)	15-20%
Feldspar (mainly plagioclase)	15%
Biotite (chloritized in places)	5%
Carbonate (mainly calcite)	1-2%
Opaque (?mainly ilmenite)	<1%
Limonite	<1%
Zircon, apatite, sphene	tr
?Allanite	tr

The bulk of this slide consists of a framework of abundant sub- to anhedral quartz (likely mostly detrital grains of around 0.15 mm average diameter) and lesser, interstitial feldspar (mainly plagioclase as subhedral crystals up to 0.1 mm in diameter) and white mica (subhedral flakes mostly <0.1 mm in diameter, commonly <30 microns). Plagioclase grains not commonly twinned, but where seen, extinction angles up to 15 degrees on 010 and negative relief compared to quartz suggests albitic composition (likely homogenized due to burial diagenesis, and subsequent metamorphism). There could be K-feldspar present, but in the absence of an etched and stained slab it is difficult to be sure. Biotite is scattered throughout as ragged, an- to subhedral flakes (or chloritized equivalents) up to 0.5 mm in diameter. Pleochroism of biotite is medium brown; chlorite is pale green, with length-slow, anomalous blue birefringence indicating moderate Fe content. Carbonate is not common, but in places forms subhedra up to 0.25 mm in diameter associated with chlorite (after biotite) and containing minor sphene (subhedra to 50 microns). In places, aggregates up to 2.5 mm long of chlorite/chloritized biotite, sericitized ?feldspar, and carbonate plus apatite and opaques look to be after former ?clasts.

Accessory opaques mainly form clusters to 0.2 mm diameter of smaller subhedral crystals rarely over about 50 microns in diameter. The identity of these opaques is not clear, however since sphene is not seen in this sample, and the TiO₂ content is generally fairly constant in the Aldridge sediments, it is likely to be mostly ?ilmenite. However, minor limonite stains spreading out from the opaques also suggest the possibility of some ?sulfide. Rare zircon crystals (likely detrital) are euhedral to subhedral, up to 60 microns long. Apatite forms sub- to anhedral crystals up to 75 microns long scattered through the rock. Dark pleochroic haloes in some biotite suggests the presence of adjacent minute crystals to 10 microns in size of allanite or REE-bearing epidote.

064: FINE-GRAINED META-QUARTZ WACKE (QUARTZ-PLAGIOCLASE-SERICITE-ACCESSORY CHLORITE AFTER BIOTITE, OPAQUES); POSSIBLY WEAKLY SERICITIZED

From Unit A2; hand sample is a massive, fine-grained, grey (where fresh) to creamy-buff or rusty, limonite-stained (where weathered) siliceous sediment. The rock is not magnetic and shows no reaction to cold dilute HCl, and no stain for K-feldspar in the etched slab. The general appearance, colour, and rust stain suggest a sericitized Aldridge sample (such sericitic alteration forms a large, but irregular halo around the Sullivan deposit, and is known from other prospects in the Lower Aldridge). However, modal mineralogy in thin section shows that abundant plagioclase is still present, so sericitization is weak:

Quartz (largely detrital)	65%
Plagioclase	15%
Sericite	15%
Chlorite (after biotite)	3-5%
Opaques (mainly limonite)	1-2%
Zircon, apatite	tr

This slide consists mainly of a framework of detrital quartz and lesser, interstitial plagioclase feldspar, sericite and chloritized biotite associated with accessory opaques. The quartz grains are mainly sub- to anhedral, locally up to 0.6 mm but commonly averaging around 0.3 mm in diameter; they are strained (undulose extinction, minor suturing of borders) and appear to show minor overgrowths (especially into adjacent plagioclase). Plagioclase crystals are mainly subhedral, up to 0.25 mm long, and clouded by incipient clay or altered by fine sericite flakes. Twinning is not generally visible, but negative relief compared to quartz indicates an albitic composition. Sericite flakes are mostly subhedral and less than 0.1 mm in diameter. Biotite is mainly partly (to locally completely) replaced by chlorite and significant limonite that interleave the former biotite books (subhedral to ragged, up to 0.1 mm in diameter); part of the opaques interleaving the biotite is likely to be rutile. It is not clear how much, if any, of the limonite is derived from the possible weathering of former ?sulfide. Chlorite is only weakly pleochroic and has weakly anomalous blue birefringence (length-slow) indicating moderate Fe content. In places there are clotty concentrations up to 0.5 mm across of chlorite and limonite

Scattered, likely detrital, zircons are subhedral to broken in outline and up to 100 microns in size. Apatite occurs as sub- to anhedral crystals up to 65 microns in diameter.

Thin section analysis suggests that this sample may represent a weakly sericitized Aldridge metasediment (formerly a ?fine wacke to judge by the abundance of feldspar present), although the appearance is of a quartzite.

067: FINE-GRAINED META-WACKE (QUARTZ-PLAGIOCLASE-SERICITE-BIOTITE-ACCESSORY SPHENE-?ILMENITE-ZIRCON-APATITE-?ALLANITE)

From Unit A1; hand sample is a massive to rarely laminated, grey-white, fine-grained quartzite or wacke (minor speckled appearance due to fine biotite). The rock is not magnetic and shows no reaction to cold dilute HCl, and no stain for K-feldspar in the etched slab. Modal mineralogy in thin section is approximately:

Quartz (detrital)	60%
Plagioclase	17-20%
Sericite	10%
Biotite	10%
Sphene	1-2%
Opaque (?ilmenite)	<1%
Zircon, apatite	tr
?Allanite	tr

This is typical unaltered Aldridge metawacke: framework of detrital quartz with lesser, interstitial plagioclase feldspar and white mica (sericite), plus scattered clotty biotite and concentrations of accessory minerals such as sphene, opaques, and allanite.

Quartz grains are generally subangular to subrounded, with maximum dimension about 0.3 mm. Development of undulose extinction due to strain is relatively mild; most crystals have slightly serrated margins, suggesting minor overgrowths.

Feldspar crystals/grains, also likely originally detrital, are mainly of 0.15 mm size or less, but in places subhedral to subrounded grains up to 0.3 mm long occur. Most are untwinned, but some show polysynthetic twinning with extinction $\gamma^{\circ}10$ up to 13 degrees, and relief negative compared to quartz, indicating a composition near albite or albite-oligoclase (An_{5-10}). Many crystals show incipient alteration to the fine flakes of sericite (averaging about 30-40 microns in diameter) that are abundant in the matrix between quartz grains.

Distribution of biotite also tends to be between the framework quartz grains; the biotite forms subhedral flakes up to 0.15 mm in diameter with deep brown pleochroism. Commonly associated with the biotite are irregular-shaped clusters of accessory minerals that include sphene, sphene cored by opaque (likely ilmenite, although rutile is also a possibility), and traces of allanite (REE-bearing epidote, distinguished by presence of pleochroic haloes in adjacent biotite). Sphene forms subhedral crystals up to about 50 microns in size although generally much smaller; opaques are subhedral and up to 50 microns. Scattered subhedral zircon (?detrital) up to 50 microns and apatite to 65 microns are seen.

The faint laminations seen at one end of the slide are caused by minor concentrations or variations in abundance of the dark minerals (biotite and accessory sphene-opaques). They may represent original bedding in a fine (siltstone-sized) quartz-rich wacke, now metamorphosed to greenschist facies.

086: FINE-GRAINED META-WACKE (QUARTZ-PLAGIOCLASE-KSPAR-RELICT BIOTITE)
ALTERED TO WEAK TOURMALINE (SCHORL) AND MUSCOVITE

From Unit A2; hand sample is fine-grained, massive and grey, with conspicuous dark spots mainly <1 mm in diameter that partially weather out, suggesting the presence of carbonate in them; rare limonitic spots suggest the former presence of traces of ?sulfide. However, the rock is not magnetic and shows no reaction to cold dilute HCl. There is minor yellow stain for K-feldspar in the etched slab, where fine grains interstitial to quartz are indicated. Modal mineralogy in thin section is approximately:

Quartz	55%
Plagioclase	15%
K-feldspar	10%
Tourmaline (schorlitic)	10%
Muscovite (white mica)	5%
Chlorite, relict biotite	2-3%
Opaque	1%
Sphene	1%
Zircon, apatite	<1%

Thin section examination reveals that this sample is actually a very weak "tourmalinite", characterized by the presence of fine needles of dark (schorlitic) tourmaline throughout the rock, although generally in concentrations of <10%. The bulk of the rock is composed of quartz and lesser, interstitial feldspar (both plagioclase and K-spar) and rather coarse (blastic) white mica (muscovite). Biotite is essentially absent, but there are rare relict flakes and scattered chlorite flakes probably after former biotite; tourmaline tends to replace these sites, with which are also associated relatively abundant fine opaques.

Quartz occurs as mostly ?detrital grains up to a maximum of 0.6 mm in diameter that show mild undulose extinction due to strain, and minor serrated borders indicating possible overgrowths and/or suturing during strain. Feldspar grains are generally smaller (to a maximum of about 0.3 mm in size). Twinning in plagioclase (extinction $Y^{\circ}10$ about 10 degrees) and relief slightly negative compared to quartz indicate a composition near albite-sodic oligoclase (An_{10-15}). K-feldspar grains are sub- to anhedral, untwinned, mainly <0.15 mm in size, with relief slightly negative compared to plagioclase.

Tourmaline forms slender needles mostly <10 microns thick by up to 100 microns long, as well as stubby prisms up to 0.2 mm long. Muscovite flakes are ragged to subhedral in outline, up to 0.5 mm in diameter, and poikilitically enclose quartz and feldspar grains. Relict biotite sites have ragged to subhedral outlines up to 0.15 mm across, and are mainly entirely replaced by chlorite as subhedral crystals to 0.1 mm in diameter with optical characteristics (length-slow, weakly anomalous birefringence) indicative of moderate Fe content.

Opaques form generally tabular to subhedral or irregular clusters up to 0.2 mm across of ?mainly ilmenite, although minor limonite staining in places suggests traces of sulfide could have also been present. Sphene forms fine subhedral to rounded crystals mainly <35 microns in size, commonly in clusters up to 0.15 mm across associated with tourmaline, opaques, or chlorite/relict biotite crystals.

Both zircon (subrounded subhedra to 100 microns long) and apatite (subrounded, almost anhedral, to 65 microns) are relatively abundant in this slide compared to the norm for Aldridge in my experience.

087: FINE-GRAINED META-WACKE (QUARTZ-PLAGIOCLASE-KSPAR-BIOTITE-MUSCOVITE WITH ACCESSORY SPHENE-?ILMENITE) QUARTZ-FELDSPAR-MUSCOVITE-CALCITE CLOTS

From Unit A1; hand sample is massive, fine-grained, and dark grey (similar to 086), with minor K-feldspar indicated by yellow stain in the etched slab, and scattered white clots to 1 mm diameter that do not react to cold dilute HCl. The rock is not magnetic; modal mineralogy in thin section is approximately:

Quartz	50%
Plagioclase (?albite-oligoclase)	15%
K-feldspar	10%
Biotite (rarely chloritized)	10-12%
Muscovite	2-3%
Sphene	<1%
Opaque (?mainly ilmenite)	<1%
Zircon, apatite	tr
Carbonate	tr

Although lacking tourmaline, this sample has several striking similarities to its counterpart in Unit A2: it contains similar blastic white mica (muscovite), and similar amounts of K-feldspar interstitial to the quartz framework. However, biotite is much more abundant and evenly dispersed in this sample.

Quartz grains are variable in size, ranging from an average in the matrix of about 0.1 mm up to a maximum of about 0.3 mm in diameter. Scalloped or sutured boundaries in places could be the result of strain or of overgrowths on the detrital grains; only mild undulose extinction is seen. Feldspars, as in 086, include both twinned plagioclase (mainly subhedral crystals or grains up to 0.2 mm long) and rarely "grid" twinned K-feldspar (?microcline) as mainly anhedral crystals to 0.1 mm in diameter. Distinct negative relief of plagioclase compared to quartz suggests an albitic composition, reinforced by extinction on 010 up to 13 degrees (?An₁₀).

Biotite is noticeably more abundant in this sample, in contrast to many other samples in the suite; it forms subhedral deep brown flakes up to about 0.2 mm in diameter, commonly aggregating in irregular clusters to about 0.5 mm across with other minerals such as muscovite and only rarely chloritized. White mica flakes are commonly euhedral in the matrix (about 50-75 microns in diameter) but more ragged as porphyroblastic (?or relict detrital?) flakes up to 0.5 mm in diameter. Chlorite is as described for 086, associated with traces of limonite.

Accessory sphene forms subhedra to 75 microns in size, commonly cored by lesser opaque ?ilmenite up to 50 microns in diameter; both are commonly associated with biotite clusters. Rare zircon and apatite form subhedral to rounded crystals up to 50 and 45 microns respectively.

The white patches in this rock appear to be areas up to 1.5 mm in diameter lacking in biotite, containing instead relatively abundant quartz, feldspar, and minor muscovite and carbonate (not detected by HCl in hand specimen but likely calcite; scattered subhedra to 0.1 mm). Voids and minor chloritization are in part associated with these white patches; in places there is incipient clay-sericite alteration of feldspars, making them appear cloudy and probably imparting the white appearance in hand specimen.

094: FINE-GRAINED META-WACKE (QUARTZ-BIOTITE-PLAGIOCLASE-SERICITE-KSPAR), PARTLY CHLORITIZED IN ZONES, PATCHES AND ALONG FRACTURES

From Unit A2; hand sample is divisible into two portions, pale grey and creamy buff in colour, both containing irregular, widely scattered rusty blebs that are likely the result of weathering of sulfides. An irregular blotchy texture is vaguely visible (it is enhanced in the etched slab, which reveals traces of K-feldspar as minute interstitial grains in certain areas). White patches somewhat similar to those in 087, but larger (up to 0.5 cm across) are present. The rock is not magnetic and shows no reaction to cold dilute HCl; minor pale-coloured fracture envelopes appear to be ?serictic. Modal mineralogy in thin section is approximately:

Quartz	60%
Biotite	10-15%
Plagioclase (albitic)	10-15%
Sericite (white mica)	5-10%
K-feldspar	3-5%
Chlorite (after biotite)	2-3%
Opaque (?ilmenite), trace sphene	1%
Epidote/allanite	<1%
Zircon	tr

The grey portion of this sample is distinguished by the presence of fine biotite, which is less abundant and chloritized in the creamy portion. White patches in the grey rock are also caused by chlorite, probably after biotite, in places containing minor epidote. Similarly, the fracture envelopes are also marked by chloritization of biotite.

The bulk of the rock consists of scattered to abundant, relatively coarse quartz "grits" up to almost 0.6 mm in diameter, in a matrix of finer-grained quartz, feldspars, biotite flakes and white mica (sericite to 50 microns and muscovite to 0.15 mm). Quartz grains, mostly detrital, are subrounded to subangular, with minor overgrowths visible on the larger grains; minor undulose extinction indicates strain. There is no obvious organized pattern to grain size variation to indicate bedding. Feldspars, present in the fine-grained "hash" or matrix between detrital quartz grains, likely includes both plagioclase and K-feldspar (lack of obvious twinning makes positive identification difficult, and both feldspars are partly altered to fine sericite, but yellow stain in etched slab confirms the presence of minor Kspar). Grain size of plagioclase is mainly less than 0.1 mm (in places to 0.25 mm), and shapes are mainly irregular or anhedral. Negative relief of plagioclase against quartz in rare twinned grains suggests albitic composition. K-feldspar tends to be finer (rarely over 0.1 mm) and anhedral; it is difficult to distinguish except by relief difference.

Biotite forms subhedral to somewhat ragged flakes mainly less than 0.2 mm in diameter, although commonly aggregated to rounded shapes to 0.5 mm or elongate lenses to 1.8 mm long. Opaques associated with biotite appear mainly tabular, to 0.1 mm, and likely represent ?ilmenite; traces of ?sphene are rarely associated with the opaques. Chlorite flakes occur in aggregates up to 1.2 mm across, composed of subhedral flakes up to 0.5 mm in diameter with length-slow, anomalous blue birefringence indicating moderate to high Fe content. Included rare crystals of epidote and allanite (with pleochroic haloes) are <50 microns in size. Rare zircon crystals are subhedral, to 50 microns.

096: FINE-GRAINED, SERICITIC META-WACKE (QUARTZ-SERICITE-PLAGIOCLASE-BIOTITE-KSPAR, ACCESSORY SPHENE-OPAQUE)

From Unit A1: hand sample is a fine-grained, massive, pale grey rock that is distinguished by fine-grained, rounded quartz "grits" that show up in the etched slab as dark grey grains up to almost 1 mm in size; these are very similar to the quartz grits in 094. The rock is not magnetic and shows no reaction to cold dilute HCl, but there is minor yellow stain for K-feldspar in the etched slab. Modal mineralogy in thin section is approximately:

Quartz	50%
White mica (sericite, muscovite)	25%
Plagioclase	15%
Biotite	5%
K-feldspar	2-3%
Sphene	1-2%
Opaques	<1%
Zircon	tr

This slide consists of quartz and feldspar grains (mainly about 0.25 mm in diameter) and distinctive coarser quartz (and rare, sericitized feldspar) "grits" up to about 0.6 mm in diameter, set in a well-defined hash of sericite, lesser biotite, opaques and sphene.

Quartz grains are generally subangular to subrounded, rounding apparently increasing with greater size. Some grains show indications of minor overgrowths; most do not show significant undulose extinction. Feldspar grains are generally subrounded; twinning in plagioclase with extinction on 010 up to 15 degrees suggests albitic composition, although the sericitic matrix prevents comparison of refractive indices with quartz. K-feldspar grains are not readily differentiated, but are clearly indicated by yellow stain in the etched slab.

White mica occurs both as discrete, larger eu- to subhedral flakes of muscovite (?possibly detrital) that are up to 0.35 mm in diameter, as well as the much more abundant fine sericite (20-30 micron flakes) in the matrix (with abundant fine limonite stain throughout). Biotite forms small subhedral to ragged crystals almost always <0.1 mm in diameter, with pale brown (washed-out) pleochroism suggestive of partial "bleaching" (incipient conversion to white mica by leaching of Fe and Mg).

Sphene is relatively abundant, occurring as clusters up to 0.05 mm across composed of subhedra mostly <30 microns in diameter. Lesser opaques, in places associated with or coring sphene, form granular aggregates up to 75 microns across; they may be mostly ?ilmenite and possibly some ?rutile. Rare zircon occurs as stubby subhedra to 50 microns long.

Although the mineralogy and proportions are not greatly different between 094 and 096; and there are similarities in grain size of both "grit" grains and matrix, when compared under the microscope they look quite different; 094 is quartz-rich, especially in the matrix, and 096 is sericite-rich in the matrix. Although this could be due to sericite alteration of the matrix feldspar, there is generally too much fresh-looking plagioclase in 096 to support such a hypothesis. Also, the lack of any obvious altered texture in the rock argues against significant (hydrothermal) sericitization.

131: FINE-GRAINED, MASSIVE, EVEN-TEXTURED META-WACKE (QUARTZ-PLAGIOCLASE-SERICITE-BIOTITE); MINOR CARBONATE-CHLORITE ALTERATION

From Unit A2; hand sample is a dark grey, very fine-grained, massive rock that is cut by scattered pale green (?chloritic) fracture envelopes. Along what is marked as S0, there is an area of brown stained, weathered rock with apparently coarser-grained and porous texture; it may be a ?fragment or simply a weathering feature. Neither it nor the main rock type is magnetic or reacts to cold dilute HCl; there is no stain for K-feldspar in the etched slab. Modal mineralogy in thin section is approximately:

Quartz	50%
Plagioclase (?albite-oligoclase)	20%
White mica (sericite, muscovite)	15%
Biotite	10%
Carbonate (?dolomite/ankerite)	2-3%
Opaque (?ilmenite)	1%
Chlorite	<1%
Sphene, ?epidote	<1%
Zircon	tr

This is a relatively fine, uniform, even-textured wacke in which the framework quartz and feldspar grains are all about 0.1-0.2 mm in diameter. Quartz grains have anhedral or subangular outlines and commonly show undulose extinction; minor overgrowths may be present. Plagioclase feldspar grains are subrounded to subangular, with negative relief against quartz and extinction on 010 in rare twinned grains up to 12 degrees suggesting an albitic or albite-oligoclase composition. Many grains are fresh or show only slight (incipient) alteration to clay-sericite, but a few sericitized pseudomorphs up to 0.2 mm long may also represent former feldspar grains. Sericite forms either abundant fine subhedral flakes mostly <35 microns in diameter, or else is found as larger, discrete (?detrital) flakes up to 0.3 mm in size.

Carbonate occurs as scattered subhedral crystals up to about 0.15 mm in size, or in places groups of crystals; lack of reaction in hand specimen suggests it may be dolomite or ankerite. In places the carbonate is associated with chlorite (likely after biotite) as pale green subhedral flakes up to 0.1 mm in diameter (near-zero to weakly anomalous birefringence indicates only moderate Fe content).

Opaques form small clusters up to 0.1 mm across of small subhedra mostly <20 microns in diameter, in places at the cores of or associated with sphene of similar grain size; in places it is difficult to be sure that all the minute grains of high-relief mineral are sphene, since some ?epidote may also be present. Traces of zircon are present as needle-like euhedra to 80 microns long.

099: FINE-GRAINED META-WACKE (QUARTZ-PLAGIOLASE-SERICITE-BIOTITE-ACCESSORY OPAQUE; SLIGHT CHLORITE-EPIDOTE/ZOISITE ALTERATION)

From Unit A1; hand sample is a fine-grained, grey-brownish, massive, even-textured rock. The rock is not magnetic and shows no reaction to cold dilute HCl, and no stain for K-feldspar in the etched slab. However, the etched slab reveals a variation from mainly sericitic to local patches richer in biotite. Modal mineralogy in thin section is approximately:

Quartz (mainly detrital)	50%
Plagioclase (albite-oligoclase)	20%
Sericite	15%
Biotite	10%
Opaque (?ilmenite, rare limonite)	1-2%
Chlorite (after biotite)	1-2%
Epidote, ?zoisite, allanite	1%
Apatite, zircon	<1%

This is a fairly typical Aldridge wacke, composed of abundant detrital quartz grains and somewhat smaller, interstitial plagioclase feldspar (partly altered to and partly mixed with a fine "hash" of micaceous minerals, sericite and biotite, and fine quartz plus accessory opaques).

Quartz grains are typically subangular in outline, up to a maximum of 0.3 mm in diameter, and display textures indicative of overgrowth. Minor undulose extinction indicates modest strain. Plagioclase grains are subhedral to sub-angular, up to 0.15 mm in diameter, and are distinguished by slightly negative relief compared to the quartz and in places polysynthetic twinning with extinction on 010 up to about 12 degrees indicating albite-oligoclase, about An₁₀.

Sericite (white mica) forms mainly fine subhedral flakes of <50 microns diameter; in places, very fine (10 micron) flakes are seen replacing plagioclase. Biotite forms small subhedral deep brown flakes rarely up to 0.2 mm in diameter, but in places clustering together to over 0.5 mm across. In the latter case, the biotite is in places associated with subhedral crystals of epidote (normal birefringence) and Fe-poor epidote-group mineral with anomalous blue birefringence (?zoisite or clinozoisite) up to 0.3 mm in diameter, limonite (possibly after sulfide crystals that were up to 0.15 mm across), and chlorite after biotite. The chlorite is moderately Fe-rich as indicated by anomalous blue, length-slow birefringence. The biotite-rich area is roughly circular, about 1.5 cm in diameter, and has vague fuzzy boundaries with less biotitic rock.

Opaques are mostly clusters up to 0.1 mm across of tiny subhedral to tabular crystals <35 microns in size, but rarely larger crystals up to 0.35 mm in size are seen; they may be mostly ?ilmenite. Traces of allanite (REE-bearing epidote) are found as small sub- to euhedral crystals up to 65 microns long, generally included in biotite clusters and marked by dark brown to black pleochroic haloes in the adjacent biotite. Apatite forms stubby subhedral prisms up to 125 microns long with cloudy cores caused by inclusions. rare zircon euhedra are up to 50 microns long.

KSW-04: "GRANOPHYRE" (GRANBLASTIC INTERGROWTH OF MICROGRAPHIC-TEXTURED QUARTZ/ALBITE AND CLOTTY BIOTITE; MINOR SERICITE-CHLORITE-EPIDOTE ALTERATION)

Described as possible intrusive; the hand sample does have a typically medium-grained intrusive appearance, with abundant quartz, feldspar and biotite. However, this is typical of the so-called "granophyre" (granoblastic hornfels) found in the Aldridge near or adjacent to certain gabbro sills (Moyie Intrusions) due to alteration around the intrusions into wet sediments. The rock is not magnetic, but shows minor reaction to cold dilute HCl and traces of yellow stain for K-feldspar in the etched slab. Modal mineralogy in thin section is approximately:

Quartz (micrographic)	55%
Plagioclase (albitic)	20%
Biotite	15%
Sericite	5%
Chlorite	1-2%
Carbonate (mainly calcite)	1%
Opaque (?ilmenite), trace sphene	1%
Epidote, ?zoisite, ?allanite	1%
K-feldspar	tr
Apatite	tr

In thin section, the characteristics of "granophyre" are clearly visible: micrographic-textured intergrowths of quartz and alkali feldspar (albite) for which this rock type was originally named by Sullivan workers White and Gunning, and coarse clotty biotite. The biotite and clotty quartz are the field criteria; the micrographic texture is the petrographic confirmation. The quartz crystals are large and blastic, with subhedral polygonal outlines up to 3.5 mm in diameter. Plagioclase crystals intergrown with or included in the quartz are subhedral to irregular, up to 1 mm in diameter, and are rarely twinned but have negative relief compared to the quartz, indicating albitic composition probably $\langle An_{10}$ (this is supported by spindle-shaped irregular twinning characteristic of albite in places). In places the plagioclase is partly altered (up to 50% replaced) by fine flakes (mainly $\langle 50$ microns in diameter) of sericite, and lesser ?epidote-group mineral such as ?zoisite (low birefringence; rounded crystals mainly $\langle 15$ microns in size). K-feldspar, indicated as traces in the etched slab, is not readily distinguishable in thin section.

Biotite forms fairly coarse, subhedral to somewhat ragged medium brown crystals up to 1 mm in diameter (aggregating to several mm in places). Chlorite forms subhedral flakes up to the same size as biotite (likely a replacement of biotite) with pale green pleochroism and weakly anomalous, but length-fast, birefringence indicating only moderate Fe content. Opaques intergrown with the biotite/chlorite are commonly tabular subhedra up to 0.4 mm in diameter, and are likely ilmenite (traces of ?sphene coat some of the opaques). Traces of apatite (rounded subhedra to 65 microns diameter) are associated with the biotite/opaque clusters, and traces of ?allanite are indicated by dark pleochroic haloes in biotite adjacent to the $\langle 35$ micron crystals.

Carbonate, likely mostly calcite to judge by the reaction in hand specimen, forms ragged poikilitic subhedra up to 0.5 mm in diameter that in places enclose quartz crystals, or are associated with chlorite-epidote group mineral alteration of biotite.