1999 GEOLOGICAL EVALUATION OF THE KITCHENER NORTH PROPERTY

LATITUDE 49° 10' 00''N LONGITUDE 116° 20' 00''W

NTS 082F/01

NELSON MINING DIVISION, BRITISH COLUMBIA, CANADA

PREPARED BY

L. GAL and S. WEIDNER
RIO ALGOM EXPLORATION INC
900 – 409 GRANVILLE STREET
VANCOUVER, BRITISH COLUMBIA
CANADA V6C 1T2

PHONE: (604) 688-3646
FAX: (604) 669-0447

DECEMBER , 1999

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1.0 Abstract

The Kitchener North property comprises 95 mineral claims with a total of 272 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 Nelson Mining Division, and located 14 kilometres northeast of Creston, B.C. Road access to the central and north parts of the property is via Provincial Highway 3, the Goat River Forest Service Road (FSR) and its several branch roads. The part of the property south of Goat River and Kitchener Creek is accessible via the Russell Creek FSR. Elevations on the property range from 700m to 1920m above sea level.

The Kitchener North 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 unit. The Ramparts facies is thought to be the equivalent of more distal, fine grained and thin bedded, rusty quartzitic wacke–siltstone dominated lower Aldrige that occurs to the north and east. The lower Aldridge is conformably overlain by the middle Aldridge, which dominates exposures on the property. Syn-depositional gabbro sills and dikes have intruded both the lower and middle units of the Aldridge Formation.

Small (probably Cretaceous age) granitoid plugs intrude the Aldridge Formation in the Russell Creek area. Thin lamprophyre dykes are also present locally.

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 North property was concentrated along the LMC. Fieldwork was carried out from June 22-July 3, and on July 28, 1999. Geological mapping and selected lithogeochemical 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 (A1R) 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 in the southwestern and west–central parts of the property, with a gentle easterly dip. The Erickson Fault cutting across the central part of the property, does not appear to offset the LMC. Northwest of the Goat River, the property covers the east flank of the Goat River anticline, which exposes lower Aldridge (and the LMC) in its core.

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 North property comprises 95 claims with a total of 272 claim units. The property is centred around the village of Kitchener (McConnell), which is located about 14 kilometres northeast of Creston, B.C. The Kitchener North property is within the Nelson Mining Division, covered by NTS map sheet 82F/01, and is centred at 49° 10' 00" north and longitude 116° 20' 00" west (Figure 1, 2). The northern 2/3 of the property is bisected by the Goat River, which bends westward at Kitchener. The southern section covers the drainage of Russell Creek.

Road access to the property is from Highway 3 via the Goat River Road to the northern part of the property, or via the Russell Creek FSR to the south part. The Six Mile-Crackerjack Creek areas were accessed by logging roads branching off the Arrow Park Road. Road access is quite good, as active logging is taking place in the area.

The property is within the Moyie Ranges of the Purcell Mountains, at elevations ranging from 700 metres above sea level along the Goat River, to 1920 metres on the north ridge of Mt. Thompson in the southwest corner of the property. Vegetation at lower elevations consists of mature timber. Outcrop exposure is generally poor, except on the east slope of Russell Creek Valley, and on the southwest slopes of Mt. Kitchener. Roadcuts afford the best exposures elsewhere. 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.

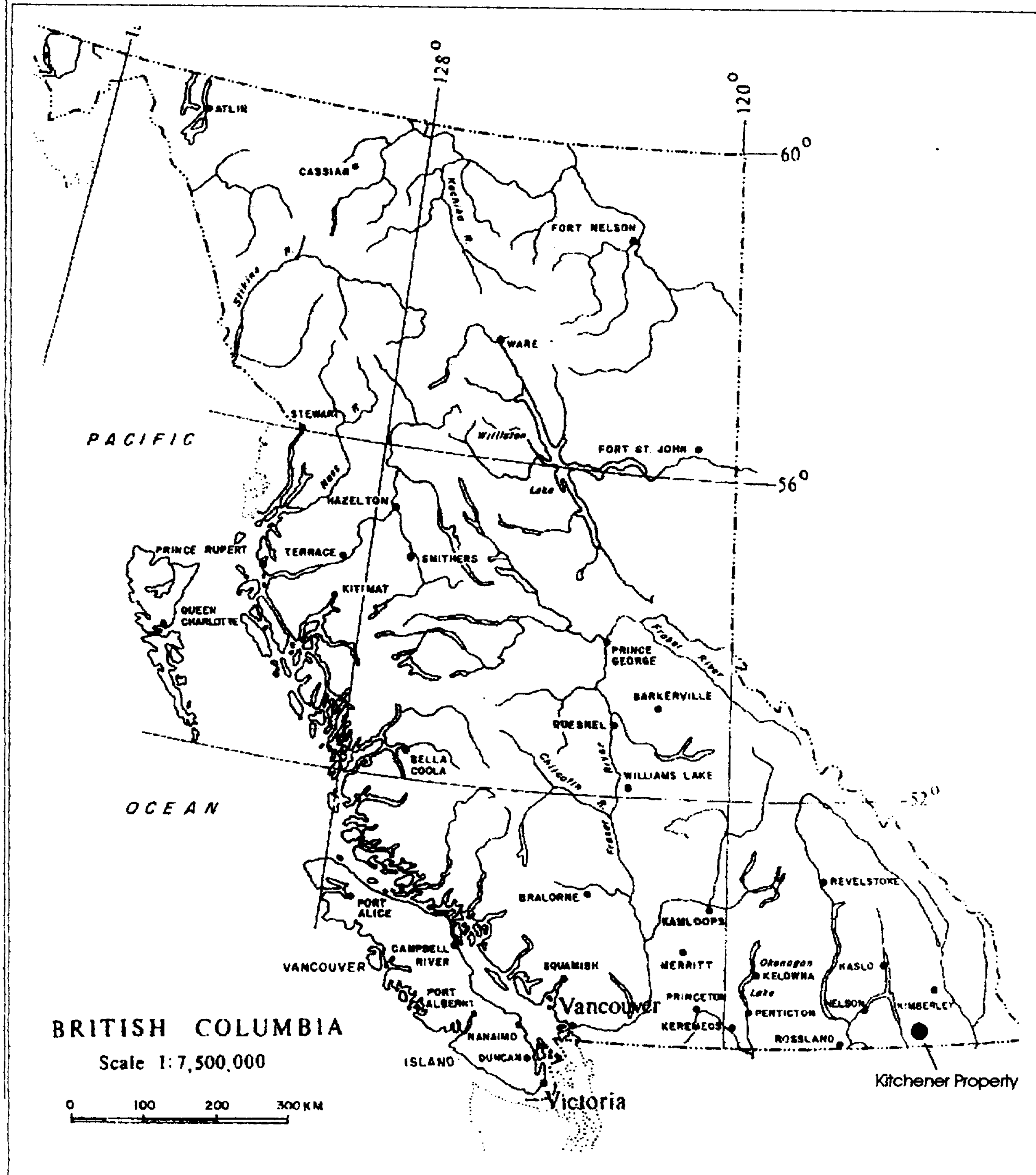
2.2 Claim Status

The 95 claims of the Kitchener North property are owned by Abitibi Mining Corp. Rio Algom Exploration Inc. is the operator, pursuant to option agreement dated April 22, 1999. The claims cover an area of approximately 6637.5 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, west of the Kitchener North 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. Cominco has done some mapping and prospecting in the Kitchener North area. Pacific Mariner Exploration drilled two holes on the east side of Russell Creek (the SUN area) in 1994. Abitibi Mining Corp. carried out prospecting and mapping on the Kitchener North property in 1997 and 1998, mostly in the areas around Kitchener Mountain, Leadville Creek and the SUN area. Each of these areas host Pb and



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Kitchener North Property

Location Map

DATE Dec 99	DRAWN BY SW	DWG Fig. 1

Zn soil geochemical anomalies. The Car Property, under option to Chapleau Resources, adjoins the south end of the Kitchener North prpoerty.

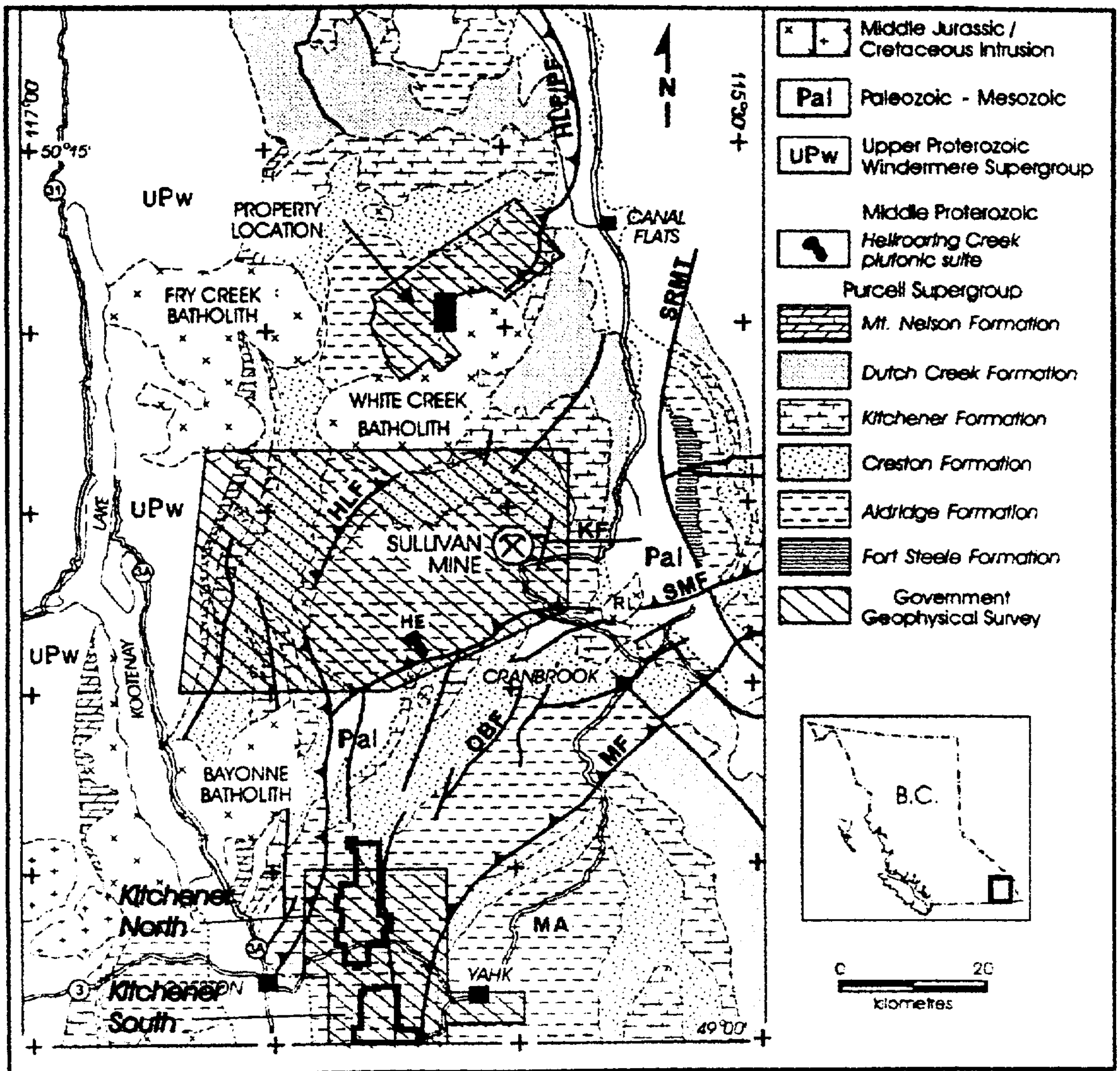
3.0 Regional Geology

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

The Kitchener North property is located within the 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 North 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. 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 rather monotonous in character, about 2,500 to 3,500 metres thick 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 siltsone 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 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 North property may be 2 to 3 times the correlative distance at the Sullivan Mine. Evidence from mapping suggests the latter case is closer.



BCGS, 1998

Claim Boundary

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Kitchener North Property

Regional Geology

DATE Dec 99	DRAWN BY SW	DWG 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, unconsolidated sediments. Thus, 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 North 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 of the Belt - Purcell basin.

The target of exploration on the Kitchener North property is a Sedex deposit, focussing on the lower-middle Aldridge contact (LMC) for a Sullivan-type horizon (SH). Throughout the region, other stratigraphic horizons within the Aldridge Formation are also receiving attention as possible hosts to massive sulphide mineralization.

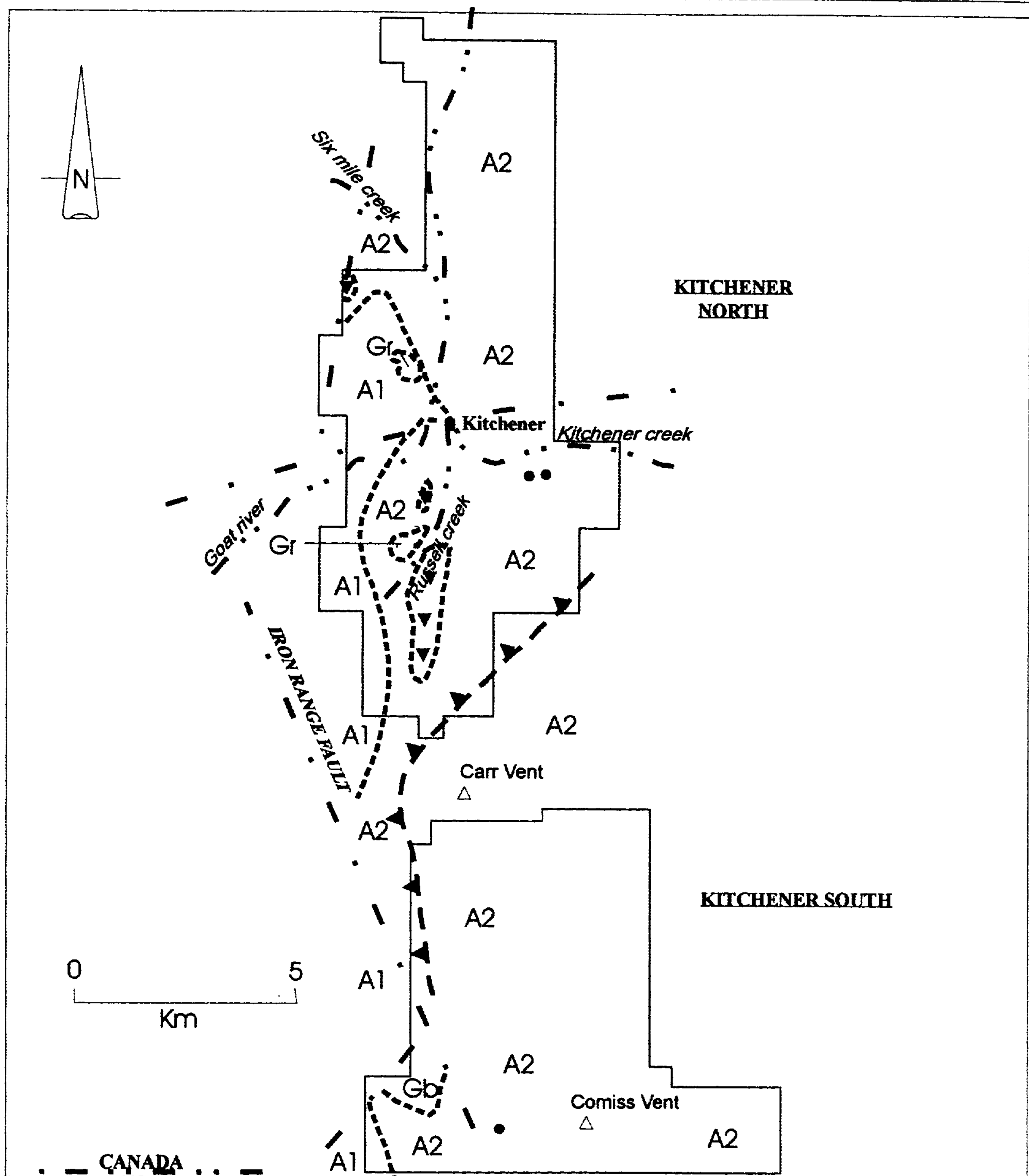
4.0 Property Geology

The Kitchener North property is underlain by Purcell Supergroup sediments of the lower and middle Aldridge Formations (Fig.3). Several gabbro sills intrude the sediments. The Aldridge Formation sediments mostly dip gently to moderately to the east, on the eastern limb of the Goat River anticline. The Goat River anticline, cored by lower Aldridge strata, closes northwest of the Goat River, indicating a gentle northward plunge.

The lower Aldridge Formation (Ramparts facies) is exposed on the ridge between Thompson and Russell Creeks, and in the anticlinal closure northwest of the Goat River. The vast bulk of the property is underlain by middle Aldridge strata. The LMC west of Russell Creek dips about 15°-20° eastward, and the ridge exposes extensive dip slope exposures of middle Aldridge. Northwest of the Goat River, the contact is complicated by faulting and folding, but probably dips gently to moderately east and north.

Gabbroic sills and dykes occur within the middle and lower Aldridge, and some have been traced for great distances. Small granitoid plugs of probable Cretaceous age have been mapped in the Russell Creek area, and intrude all Proterozoic units. One of these granitoid plugs northwest of Kitchener was previously mapped as gabbro.

Structurally, the property is dominated by the Goat River Anticline (GRA), which trends north, plunges gently, and is truncated by the Okell Fault to the west and Carroll Creek Fault to the east. The GRA is cored by lower Aldridge strata, and the fold closes northwest of the Goat River around Crackerjack Creek. The Kitchener North property covers the eastern flank of this anticlinal closure. The Iron Range Fault lies west of the property, in Thompson Creek and along



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

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Kitchener North Property

Property Geology

DATE	Dec.99	DRAWN BY	SW	DWG	Fig.3

the crest of Iron Range Mountain. The Iron Range Fault is a north-northeast trending fault with a interpreted minor west-side down normal displacement.

Several mineral occurrences are documented in the B.C. MINFILE to occur on the Kitchener North property. These are summarised in the Table 1.

Table 1. MINFILE occurrences

MINFILE No.	MINFILE Name	Host Rock	Mineralization	Grades
082FSE006	Leadville, Star No.1	Aldridge adjacent Moyie sill	Ag, Pb, Zn vein	Grab 720 g/t Ag, 1.4 g/t Au, 61% Pb, 10.2% Zn
082FSE040	Empire State	Moyie sill	Cu – Ni vein	Grab 0.52% Ni
082FSE042	Creston Hill	Moyie sill	Cu vein	
082FSE069	Blue Rain	Aldridge	Ag – Cu vein, disseminated	10 g/t Ag
082FSE073	Tigar 1	Moyie sill	Cu vein, disseminations	
082FSE075	Senasael	Moyie sill	Cu	
082FSE089	Star (west)	Aldridge	Ag, Pb, Zn vein	6m drill core @ 75 g/t Ag, 8.3% Pb, 0.71% Zn
082FSE092	Great War	Aldridge – Moyie sill contact	Fe oxide breccia, vein	
082FSE094	Kitchener - Sullivan	Moyie sill	Cu – Ag vein	0.95m @ 35 g/t Ag, 6%Cu
082FSE098	Creston	Quaternary – Recent sediments	clay	

It is apparent that most mineralization is associated with veins or disseminated copper in the Moyie gabbro sills. However, there are several Ag–Pb–Zn showings and minor past producers in the Leadville area, 7 kilometres north of Kitchener that are hosted in Aldridge Group sediments.

5.0 1999 Exploration Results

5.1 Objective and Exploration Target

The exploration target for Rio Algom Exploration Inc. on the North Kitchener property is a Sullivan-type sedimentary exhalative lead-zinc sulphide deposit stratigraphically situated at the Lower Aldridge-Middle Aldridge contact. Geological information as mapped 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.

The objective for the 1999 program was to confirm geology from previous workers to ascertain if the LMC does underlie the property and could be drill tested at a reasonable depth. Because the LMC was the prime area of interest only the west side of Russell Creek and the area northwest of the Goat River and south of Crackerjack Creek was investigated. No work was done in the northern third of the property.

5.2 Procedure

The 1999 exploration program on the Kitchener North property consisted of geological mapping in the vicinity of the exposed LMC, and also along sections perpendicular to the LMC spaced 1-3km apart. Stratigraphic marker horizons (marker laminites) from within the middle Aldridge were also collected and identified to help determine stratigraphic level within the monotonous middle Aldridge sequence. This mapping facilitated the construction of geological cross sections (Appendix II). 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. Rock geochemical samples were also taken to test if particular units were geochemically anomalous in base metal or "pathfinder element" content. Geochemistry results revealed no anomalies in fragmental units, or prospective siltstone – argillite units.

A geological mapping program was conducted between June 22-July 3, and on July 28, 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 mapping was concentrated along the strike extent of the LMC and along section lines perpendicular to the LMC with an approximate spacing of 1-3 kilometres.

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. Analytical samples collected were forwarded to Eco-Tech Laboratories for ICP and Au fire assay analysis (FA). 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.

6.0 1999 Exploration Results

6.1 Geological Mapping

Results of the mapping are depicted in Appendix II as a set of two geology maps (Map 1a, 1b) 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. Biotite is quite common in some beds.

In some exposures the relatively thick quartz wacke beds were separated by very thin greenish or grey siltstone or fine-grained wacke. Within the quartz wacke beds are locally black, very fine wispy laminations. Cross beds and ripple laminations were seen in some outcrops. 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 white to light grey or 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. Overall, there are few siltstone and argillite beds, particularly those thicker than 20 centimeteres 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. There are exceptions to the above, particularly on the lower part of the east side of Russell Creek, where there is a large area with exposures of siltstone within the middle Aldridge. Another area with considerable laminated siltstone and argillite occurs in the northwestern part of the property (Station 051, UTM 546000E, 5446000N). Sedimentary features such as load structures, cross-bedding, rip-up clasts and slumped bedding were also observed.

Within the A2, time-stratigraphic laminite markers are present. Only two marker laminite samples were identified from several laminated samples submitted. 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.

Fragmental

On the west-side of the Upper Russell Creek valley, there are a few roadside exposures and float of massive fragmental rock. The fragmental is massive, medium to fine grained wacke. The rock is rather rusty weathering, locally resembling a granophyre in its salt and pepper texture. The quartz wacke is quite biotite rich. Fragments include altered wacke, chloritic dark grey mudchips, and tremolite altered fragments. White coloured small ovoid fragments may be albitized, small dark biotized fragments (+/- chlorite) with albite rims are common. Fragments are mostly rounded, but some angular and rectangular ones occur. Albitization also occurs in the envelopes of some fractures. Some of the larger fragments (or concretions?) contain garnet with tremolite and chlorite. Fragments are not that common, maybe 2-6% by volume. Pyrite and/or pyrrhotite is disseminated throughout, and in fractures. Quartz – chlorite veins locally cut the rock.

The distribution of the fragmental float and outcrop over an area approximately 1 by 2 kilometres suggests that it is a sheet like body, conformable with the A2 which form dip slope exposures on the west slope above Russell Creek.

Further outcrops of fragmental occur 2 kilometres north of the main body, over a distance of approximately 400m. This rock is similar to the main body, but contains less sulphides and is only slightly rusty weathering. The outcrops are exposed in flat open areas, roughly parallel to the slope of the hill. These dip slope exposures are further evidence that the fragmental unit is a single conformable sheet, its outcrop pattern due to erosion and topography.

A fragmental unit of greater interest was found in the extreme northwest corner of the property. In a clearcut, a hill formed by chloritic altered, chaotic mudchip breccia fragmental in grey argillite–siltstone matrix crops out, adjacent to an albite–chlorite–pyrite–quartz altered fault zone, marked by a linear array of resistant outcrops. Furthermore, this alignment of altered and sheared fault zone rock can be followed to the south and north across Six Mile Creek, where a tourmalinite outcrop was discovered. The mudchip breccia fragmental and tourmalinite associated with the fault structure suggests that it could be an important, perhaps basin bounding fault.

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. Several thin gabbro sills were mapped on the west side of Russell Creek within the A2. Gabbro sills were also mapped northwest of the Goat River within the A1R. 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, although thin sills (and locally developed chill margins) are fine grained. Textures are equigranular to hornblende (and more rarely plagioclase) porphyritic. Locally coarse sprays of hornblende crystals up to 3 centimetres long occur. 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 often sharp and parallel bedding, but commonly bedding is sheared or 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.

Granophyre

Workers at the Sullivan Mine used the term granophyre to describe the granoblastic (and microscopically granophyric) textured, altered sediments composed of quartz, feldspar and biotite. These granophyres are considered to have formed through alteration similar to contact metamorphism, due to intrusion of adjacent sills. While these granophyres are situated adjacent to sills, they do not occur universally, and are in fact rather uncommon.

Interest in them stems from the fact that they occur at the Sullivan deposit, in close proximity to the footwall of the deposit and associated with the gabbro "arch".

Texturally, these granophyres can resemble biotitic wackes, altered gabbros or even fine grained granitic intrusions. Thus there is some confusion in identifying them in the field. One rock mapped as an intrusive plug (see granitoid, below) during this project and by Brown et al (1995) was identified in thin section as a granophyre. The field relationships suggest otherwise, but it could be that the granitoid plug, and fragmental sheets mentioned above, are part of one granophyre–fragmental complex extending along the west side of Russell Creek.

One granophyre unit of unknown thickness was mapped adjacent to a gabbro sill, 550m southeast of the junction between Kitchener Creek and the Goat River. The outcrops mapped as A1R (station 034, UTM 546900E, 5443350N) 1.1 kilometres south-southwest of here may also be granophyre, given the massive nature of the outcrop.

Granitoid

As mentioned above, a granitoid plug was mapped to outcrop along a small tributary on the west side of Russell Creek. A thin section of this rock was subsequently identified as a granophyre. However, field relationships seem to suggest otherwise. In an area of very poor outcrop, this unit forms large rounded outcrops, bluffs and blocky talus piles. The oval pattern of outcrop / float distribution suggests an intrusive. Also, exposed contacts with gabbro and A2 are heavily fractured, sheared locally and rusty or altered. This is at odds with the gradational contact one might expect between granophyre and gabbro.

The rock is fine to medium grained, equigranular, quartz rich, with abundant biotite flakes. Locally there appears to be chloritized amphibole (station 042) which would also suggest intrusive. The rock is massive, with no suggestion of relic bedding. Tourmaline needles were noted with quartz on some fractures and veins. At station 073 (UTM 548250E, 5444050N), on the west side of Russell Creek, another small plug of granitoid rock outcrops, at the north end of a fragmental outcrop. Again the morphology of the outcrops vary, with the fragmental being flat dip slopes and the granitoid forming small rounded outcrops and bluffs. It appears quite fresh and light grey on weathered and fresh surfaces.

A third granitoid body was mapped at the junction of Six Mile and Crackerjack FSRs, along the Goat River one kilometre northwest of Kitchener. This fine grained, equigranular biotite feldspar quartz intrusive was mapped as a Moyie sill by Brown et al (1995), and as A2 by Abitibi Mining Corp. workers.

Lamprophyre

Rare, young lamprophyre dykes intrude the Proterozoic units. One subcropping green grey dyke was mapped northwest of Goat River, near the Six Mile – Comanche road junction (near station 062, UTM 545900E, 5446200N). The rock featured abundant large megacrysts of slightly chloritized phlogopite. The lamprophyre dykes are probably related to several diatremes that are exposed on both sides of the Goat River valley north of Kitchener.

6.2 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 south of the Goat River strikes generally northward, with gentle to moderate east dips on the east flank of the GRA. In fact, the west side of Russell Creek is essentially a dip slope of A2, lying above A1R which outcrops near the ridge top and forms west facing bluffs on the ridge between Russell and Thompson Creeks. On the east side of Russell Creek, A2 strata continue a gentle to moderate easterly dip, forming high bluffs. Northwest of the Goat River and south of Six Mile Creek, bedding attitudes are more variable in the nose of the GRA. Foliations are generally developed only in the siltstones and argillites, and are often near parallel to bedding. Adjacent to fault zones, foliations are strongly developed, and parallel the fault zone.

The Iron Range Fault lies west of the Kitchener North property. This fault trends north-northeast, and is interpreted to have minor west-side-down normal displacement. In the Russell Creek valley, only minor faults were mapped. The most significant of these is at station 030 (UTM 547450E, 5443600N) two kilometres southwest of Kitchener. Here, a 1-2m wide zone of strong albitization trending about 320° and dipping steeply east marks the fault or shear zone. The zone crosscuts gently dipping quartzitic wackes, quartz wackes and siltstones. Peripheral to this albitization is chlorite–tremolite, and then chlorite altered sediments.

A couple of north trending faults were mapped on the southwest slope of Kitchener Mtn. At stations 257 - 258 (UTM 549350E, 5447600N), strong shearing occurs within nearby gabbro and A2.

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, forming in chlorite schist.

In the northwest corner of the property, a north trending fault was indicated by the alignment of sheared and distorted albite–chlorite–quartz-pyrite altered outcrops. This fault is associated with mudchip breccia fragmental and massive tourmalinite (see *Fragmental*, above). It may represent a basin bounding growth fault. The fault zone is marked by sheared and altered rocks at stations 052, 066 and 074, over a distance of almost 2.5km. Its position corresponds to an unnamed fault mapped by Brown et al. (1995). Shear and fracture fabrics associated with these outcrops indicate steep to moderate dips variably to east and west associated with this fault. The fault occurs near the core of the GRA, and separates A1R from A2 in its southern part.

6.3 Alteration

A regional greenschist facies alteration is overprinted on all rocks on the property. Biotite, 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 possible tremolite occur in gabbros. The strongest alteration occurs in fault, fracture and shear zones. 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 present. 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, coarse biotite, and often garnet, chlorite, sericite, tremolite, and locally sulphides. In many cases these light coloured concretions have dark, biotite rich, or white, albitized "reaction rims". The mineral assemblage and texture of these bodies suggest metamorphism of a bulk composition differing from the host quartz rich sediments.

Black massive tourmalinite, tourmalinized wackes and albitized sediments were observed in poorly exposed outcrop, and float at the top of the ridge west of Russell Creek and north of Mt. Thompson. This alteration is of interest because it lies at or near the LMC. However, the poor exposure precluded any investigation of its form or extent.

The tourmalinite outcrop at the northwest corner of the property is within the A2, but it is not far from the LMC, based on exposures of A1R close by to the south. Other forms of alteration are sericite and albite, chlorite, quartz alteration associated with faults and shear zones, as mentioned previously.

The large sheet-like fragmental exposed west of Russell Creek did not have tourmaline alteration associated, but did feature albite, sericite, quartz alteration along with considerable biotite and Fe sulphides.

6.4 Petrography

Early in the program, seven hand samples of quartz wackes were submitted to Vancouver Petrographics for thin sectioning and descriptions. One granitoid sample was also submitted. The report by Dr. Craig H.B. Leitch is included in Appendix VI. Samples were collected as pairs, one each from A1R and A2, in exposures that were close to each other, and appeared to have little matrix material. 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 termed fine-grained metawackes, metasiltstones and meta quartz wackes. The differentiation of siltstones and wackes was made on the basis of relative abundance of plagioclase and sericite, while the quartz wacke had higher quartz content. Generally, the sericite and biotite components were greater than apparent in hand specimen, so the samples were not "clean" quartz wackes as originally thought. 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. Sample 044 (from station 044) contained up to 15% tourmaline (schorl) in fine disseminated needles. This sample was from probable A1R near the LMC on the ridge top west of Russell Creek, about 350m north of the tourmalinite occurrence.

The granitoid sample (KSW04) submitted for thin sectioning, from the northwest part of the main body, was identified as a "typical" granophyre. It was further identified as a granoblastic intergrowth of micrographic textured quartz/albite and clotty biotite, with minor sericite–chlorite–epidote alteration.

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 thirty-three (33) rock samples were collected for ICP-28 and gold by fire assay (FA) analysis. One granitoid sample was submitted for whole rock geochemistry. Sample descriptions are included in Appendix IV and results are tabled in Appendix V.

Generally, sampling was directed toward fragmental units or siltstone or argillite units with appreciable disseminated pyrrhotite (or pyrite), to see if they contained anomalous base metal contents. Altered and/or mineralized shear or fault zones were also sampled. No anomalous base metal values were encountered in the sampling.

Several samples were collected from the fragmental sheet exposed west of Russell Creek. Base metal values were low, attaining maxima of 64 ppm Cu, 16 ppm Pb and 69 ppm Zn. Northwest of the Goat River, a package of grey laminated siltstones and wackes with disseminated and laminae of pyrite was sampled. Maximum values from these samples (KLG 14-16) were just 62 ppm Cu, 10 ppm Pb and 33 ppm Zn. A sample of the tourmalinite at the northwest corner of the property (KLG23) returned 22ppm Pb, and a sample of adjacent mudchip breccia fragmental only 4 ppm Pb. Further south, along the albite altered fault zone, the chlorite altered mudchip fragmental yielded very low base metal values. The highest base metal value obtained in sampling was 159 ppm Cu from an altered, pyritic gabbro (KLG04).
Two samples were taken from tourmalinite and wacke fragmental at the top of the ridge west of Russell Creek (KLG 53, 54). These were not anomalous.

7.0 Conclusions and Recommendations

The Kitchener North Property comprises 95 claims with a total of 272 claim units, located in the Nelson Mining Division and centered about the village of Kitchener, 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 1-3 kilometres apart. Thirty-three rock samples were collected and analysed. No anomalous valued were obtained. The LMC was traced along the western side of the property west of Russell Creek. Here the LMC dips eastward about parallel to the dip of the slope, so that below Russell Creek it is probably only 200-250m to LMC. At this depth any deposit of size would have been indicated by government or industry airborne geophysical surveys. Northwest of the Goat River, the LMC is exposed on the east flank of the GRA, closing to the north in the vicinity of Six Mile Creek. A projection of the LMC eastward across the Goat River would place the contact at about 740–750m below the Lamb marker traced on the SW slop of Mt. Kitchener. This is about the same Lamb to LMC distance as at the Sullivan Mine. However, the stratigraphy in the Kitchener area is at least thickened two times from that around Kimberley, so the LMC is likely much deeper than 750m. This in turn suggests an east-side down fault in the Goat River valley, or a major down warped fold. Previous mapping does not place a structural break in the Goat River Valley.

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 the location of the LMC could be ascertained with some confidence, the depth was shallow enough that any sizeable deposit would have been previously indicated by geophysics or perhaps geochemistry. 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 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 Ro 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 North option property and have detailed knowledge of the contents of this report.

Dated this 10th day of December, 1999

Signed : ____________________
Siegfried Weidner
(Rio Algom Exploration Inc.)

9.0 Statement of Expenditures

The following expenses were incurred on the Kitchener North property:

Personnel		
Leonard Gal, P.Geo*	13 days @ $300/day	$3,900
Patrick Donnelly, Assistant	13 days @ $150/day	$1,950
Siegfried Weidner**	5 days @ $310/day	$1,554
Benefits and H.O. Supervision		$ 810
Airfares		
Vancouver – Cranbrook		$ 256
Accommodation		
Hotel/Motel for crew		$ 738
Meals		$ 460
Groceries		
Field Supplies/Lunches	2 man for 13 days	$ 314
Field Supplies		
Consumables, maps, reports, rental equipment		$ 397
Transportation (includes fuel)		
Truck Rental	13 days @ $ 100/day	$1,300
Geological Services		
Vancouver Petrographic		$ 581
Consultants		
Supergroups Holdings Ltd.		$ 133
G. Rodgers		$ 100
Analytical		
Eco-Tech Laboratories, Kamloops		$ 371
Miscellaneous		
Drafting/Reproductions		$1,134
Total		**$13,998**

*Field supervision and administration, mapping, reporting
**Program supervision and administration, reporting, interpretation

APPENDIX I

Property Claim Status

Kitchener North Option
Claim Schedule

AREA	OWNER	Party	NO	CLAIMS	FMC	NTS	REG DATE	EXPIRY	DISTRICT	UNITS
Kitchener	Abitibi	Abitibi	349527	KITCH 3	122797	082F01W	19960804	20001126	Nelson	12
Kitchener	Abitibi	Abitibi	350006	LEAD 9	122797	082F01W	19960824	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	350007	LEAD 10	122797	082F01W	19960824	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	350008	LEAD 11	122797	082F01W	19960824	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	350009	LEAD 12	122797	082F01W	19960824	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	351817	LEAD 5	122797	082F01W	19961005	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	351818	LEAD 6	122797	082F01W	19961005	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	351819	LEAD 7	122797	082F01W	19961005	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	351820	LEAD 8	122797	082F01W	19961005	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354198	KITCH 21	122797	082F01W	19970302	20001126	Nelson	16
Kitchener	Abitibi	Abitibi	354199	KITCH 22	122797	082F01W	19970304	20001126	Nelson	18
Kitchener	Abitibi	Abitibi	354200	KITCH 23	122797	082F01W	19970304	20001126	Nelson	20
Kitchener	Abitibi	Abitibi	354201	KITCH 28	122797	082F01W	19970304	20001126	Nelson	10
Kitchener	Abitibi	Abitibi	354202	KITCH 4	122797	082F01W	19970224	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354203	KITCH 5	122797	082F01W	19970224	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354204	KITCH 6	122797	082F01W	19970224	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354205	KITCH 7	122797	082F01W	19970224	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354206	KITCH 8	122797	082F01W	19970227	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354207	KITCH 9	122797	082F01W	19970227	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354208	KITCH 10	122797	082F01W	19970227	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354209	KITCH 11	122797	082F01W	19970224	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354210	KITCH 12	122797	082F01W	19970225	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354211	KITCH 13	122797	082F01W	19970225	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354212	KITCH 14	122797	082F01W	19970225	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354213	KITCH 15	122797	082F01W	19970225	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354214	KITCH 16	122797	082F01W	19970225	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354215	KITCH 17	122797	082F01W	19970225	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354216	KITCH 18	122797	082F01W	19970225	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354217	KITCH 19	122797	082F01W	19970225	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354218	KITCH 20	122797	082F01W	19970226	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354219	KITCH 24	122797	082F01W	19970226	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354220	KITCH 25	122797	082F01W	19970301	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354221	KITCH 26	122797	082F01W	19970301	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354222	KITCH 27	122797	082F01W	19970301	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354263	KITCH 29	122797	082F01W	19970302	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354264	KITCH 30	122797	082F01W	19970302	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354265	KITCH 31	122797	082F01W	19970302	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354266	KITCH 32	122797	082F01W	19970302	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354267	KITCH 33	122797	082F01W	19970309	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354268	KITCH 34	122797	082F01W	19970309	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354269	KITCH 35	122797	082F01W	19970315	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354270	KITCH 36	122797	082F01W	19970315	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354271	KITCH 37	122797	082F01W	19970309	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354272	KITCH 38	122797	082F01W	19970309	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354398	KITCH 39	122797	082F01W	19970304	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354399	KITCH 40	122797	082F01W	19970304	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354400	KITCH 41	122797	082F01W	19970304	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354401	KITCH 42	122797	082F01W	19970304	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354402	KITCH 43	122797	082F01W	19970304	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354403	KITCH 44	122797	082F01W	19970304	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354405	KITCH 46	122797	082F01W	19970304	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354406	KITCH 47	122797	082F01W	19970304	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354407	KITCH 48	122797	082F01W	19970304	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354409	KITCH 50	122797	082F01W	19970305	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354410	KITCH 51	122797	082F01W	19970305	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354411	KITCH 52	122797	082F01W	19970305	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354412	KITCH 53	122797	082F01W	19970305	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354413	KITCH 54	122797	082F01W	19970305	20001126	Nelson	1

Kitchener North Option
Claim Schedule

AREA	OWNER	Party	NO	CLAIMS	FMC	NTS	REG DATE	EXPIRY	DISTRICT	UNITS
Kitchener	Abitibi	Abitibi	354414	KITCH 55	122797	082F01W	19970305	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354415	KITCH 56	122797	082F01W	19970305	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354415	KITCH 58	122797	082F01W	19970306	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354416	KITCH 57	122797	082F01W	19970306	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354569	KITCH 83	122797	082F01W	19970307	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354570	KITCH 85	122797	082F01W	19970307	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354571	KITCH 87	122797	082F01W	19970307	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354572	KITCH 89	122797	082F01W	19970307	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354673	KITCH 59	122797	082F01W	19970403	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354674	KITCH 60	122797	082F01W	19990408	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354675	KITCH 61	122797	082F01W	19970403	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354676	KITCH 62	122797	082F01W	19970403	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354677	KITCH 63	122797	082F01W	19970403	20001126	Nelson	1
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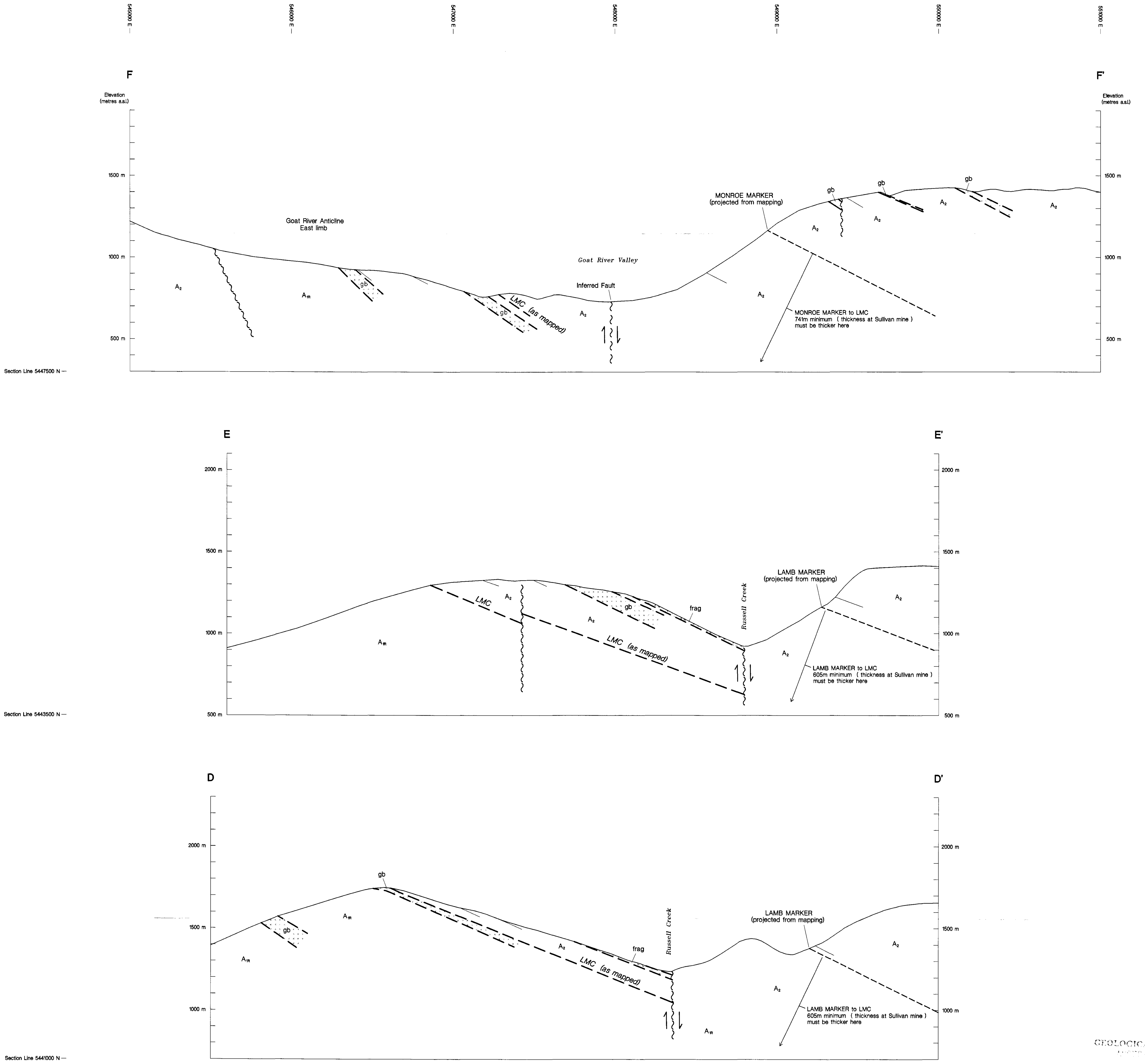
Kitchener	Abitibi	Abitibi	354679	KITCH 65	122797	082F01W	19970403	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354680	KITCH 66	122797	082F01W	19970403	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354681	KITCH 67	122797	082F01W	19970402	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354682	KITCH 68	122797	082F01W	19970402	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354683	KITCH 69	122797	082F01W	19970402	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354684	KITCH 70	122797	082F01W	19970402	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354685	KITCH 71	122797	082F01W	19970403	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354686	KITCH 72	122797	082F01W	19970403	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354687	KITCH 73	122797	082F01W	19970403	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354688	KITCH 74	122797	082F01W	19970403	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	354689	KITCH 81	122797	082F01W	19970402	20001126	Nelson	1
Kitchener	Abitibi	Abitibi	358297	KITCH 135	122797	082F01W	19970812	20001126	Nelson	12
Kitchener	Abitibi	Abitibi	358298	KITCH 136	122797	082F01W	19970811	20001126	Nelson	20
Kitchener	Abitibi	Abitibi	358299	KITCH 137	122797	082F01W	19971810	20001126	Nelson	20
Kitchener	Abitibi	Abitibi	358300	KITCH 138	122797	082F01W	19970807	20001126	Nelson	20
Kitchener	Abitibi	Abitibi	358301	KITCH 139	122797	082F01W	19970806	20001126	Nelson	18
Kitchener	Abitibi	Abitibi	368369	KITCH144f	122797	082F01E	19990408	20001126	Nelson	3
Kitchener	Abitibi	Abitibi	354404	KITCH 45	122797	082F01W	19970304	20011126	Nelson	1
Kitchener	Abitibi	Abitibi	354404	KITCH 45	122797	082F01W	19970304	20011126	Nelson	1
Kitchener	Abitibi	Abitibi	354408	KITCH 49	122797	082F01W	19970305	20011126	Nelson	1
Kitchener	Abitibi	Abitibi	359256	KITCH 144	122797	082F01W	19970917	20011126	Nelson	20
Kitchener	Abitibi	Abitibi	354690	KITCH 90	122797	082F01W	19970402	20071126	Nelson	1

Updated: Dec 01,1999 94 271

APPENDIX II

Geology Maps and Sections

Claim boundary extends to north (see inset)
Mount Kitchener
KITCHENER NORTH CLAIM BLOCK
MAP AREA
INSET MAP 1 : 100,000
MONROE MARKER HORIZON (from Abitibi Mining Corp.)
LAMB MARKER HORIZON (projected)
Six Mile Creek
Goat River
Kitchener
Kitchener Creek
Russell Creek
Thompson Creek
Mount Thompson
ERICKSON FAULT
IRON RANGE FAULT
Highway 3
Powerline
DDH S94-1, 2
LEGEND
lph LAMPROPHYRE DYKE
gtd GRANITOID INTRUSIVE
fine to medium grained, equigranular tonalite or granodiorite
gb MOYIE INTRUSIONS
gabbro - diorite
gph GRANOPHYRE
fine grained, massive, granoblastic, quartz-biotite-feldspar rock
frag 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
A1R 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 laminite horizon
Fault: observed, inferred
Thrust fault
Outcrop
Area of small scattered outcrop/subcrop
Angular float
PLG32 (50, 8, 25, 0.1, 2, 25) Rock sample locaton: sample number
(Assay values: Cu-ppm, Pb-ppm, Zn-ppm, Ag-ppm, Au-ppb, As-ppm)
Marker laminite location with name where identified
Station number
Bedding
Foliation
Anticline, syncline
PP99-1 Drill hole
Workings: trench, adit, shaft
Property boundary
Cross section line
0 100 200 300 400 500
Metres
1 : 10,000
LUMINAI DRAFTING LTD. kit–northgeo
26,119
RIO ALGOM EXPLORATION INC.
KITCHENER NORTH PROPERTY
Nelson M.D. British Columbia, Canada
GEOLOGY
SCALE: 1 : 10,000
DATE: December 1999
DATA BY: L.P.G. S.O.W.
APPENDIX: 2
TRIM: 82F.009, 019, 029
MAP: 1



LEGEND

lph	LAMPROPHYRE DYKE
gtd	GRANITOID INTRUSIVE fine to medium grained, equigranular tonalite or granodiorite
gb	MOYIE INTRUSIONS gabbro - diorite
gph	GRANOPHYRE fine grained, massive, granoblastic, quartz-biotite-feldspar rock
frag	FRAGMENTAL massive, rusty weathering, fine grained, biotite-rich quartzitic wacke matrix, variable fragments
A_2	MIDDLE ALDRIDGE quartz wacke, quartzitic wacke, subwacke, siltstone, minor argillite, thin to medium bedded, A-E turbidites
A_{1R}	LOWER ALDRIDGE (Ramparts Facies) quartz wacke, quartzitic wacke, minor siltstone, medium bedded
A_1	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 laminite horizon
- Fault: observed, inferred
- Thrust fault
- Measured bedding attitude
- DDH S87-1 ⊙ Drill hole

0 100 200 300 400 500
Metres
1 : 10,000

RIO ALGOM EXPLORATION INC.

KITCHENER NORTH PROPERTY
Nelson M.D. British Columbia, Canada

**GEOLOGICAL CROSS SECTIONS
D-D', E-E', F-F'**

SCALE: 1 : 10,000	DATE: December 1999
DATA BY: L.P.G. S.G.W.	APPENDIX: 2
TRIM: 82F.009, 019, 029	MAP: 2

LUMINAI DRAFTING LTD.

APPENDIX III

Time Stratigraphic Marker Horizons (Marker Laminites)

Station Number	Marker Horizon	Comments
243	Lamb	Matched
244	Lamb	Matched

APPENDIX IV

Analytical Sample Descriptions

Tag Number	Sample Number	Station Number	Formation	Description
KLG01	7304	040	A2?	Float of hematite breccia (Iron Range Mtn. Type mineralization)
KLG02	7305		A2-Frag.	Russell Creek fragmental, Km 17
KLG03	7306		A2-Frag	Russell Creek fragmental, Km 18
KLG04	7307	025	Gab	Altered pyritic gabbro
KLG05	7308	040	A2-Frag	Medium grained wacke fragmental with disseminated pyrite, biotite – albite altered clasts. Russell Creek
KLG06	7309	044	A1R?	Quartz wacke with biotite – sulphide nodules
KLG07	7310	025	Gab, Granophyre?	Gabbro (or granophyre) with biotite – albite altered clasts, sulphides disseminated
KLG08	7311	040	Frag	Fragmental
KLG09	7312	034	A1R, Frag?	
KLG10	7313	027	Frag.	Slightly rusty fragmental with biotite – albite altered clasts
KLG11	7314	047	Frag.	Slightly rusty fragmental
KLG12	7315		Frag.	
KLG13	7316	030	A2 altered	Tourmaline tremolite garnet altered envelope in wacke with some quartz vein material
KLG14	7317	051	A2	Laminated siltstone with thin pyrite laminae and pyritized mudchips
KLG15	7318	051	A2	Laminated siltstone and wacke with pyrite concentrated on laminations
KLG16	7319	051	A2	Crossbedded wacke with siltstone laminae
KLG17	7320	061	A2 altered	Albitized and chloritized wacke, rusty weathering
KLG18	7321	061	A2 or gab?, altered	Chlorite – pyrite – tremolite altered wacke, or possibly altered gabbro
KLG19	7322	060	A2	Distorted (slumped?) bedded wacke and siltstone with pyrite disseminated and in laminations
KLG20	7323	060	A2	Laminated siltstone – wacke
KLG21	7324	060	A2	Wacke with siltstone, disturbed bedding
KLG22	7325	062	A2	Laminated, pyritized wacke – siltstone
KLG23	7326	066	Tourmalinite	Brown massive aphanitic tourmalinite
KLG24	7327	066	Frag.	Mudchip breccia fragmental with chloritized fragments
KLG25	7328	070	Frag.	Slightly rusty fragmental, biotite rich with a little disseminated pyrite
KLG26	7329	071	Frag.	Biotite rich fragmental, not rusty
KLG27	7330	072	Frag	Biotite rich fragmental, not rusty
KLG28	7331	074	Frag.	Chlorite altered fragmental
KLG29	7332	074	A2 altered	Albite – pyrite – chlorite – quartz altered and veined quartz wacke
KLG40	7343		GRANITOID	WHOLE ROCK
KLG46	7349	126	GABBRO	Chloritized gabbro, or ?
KSW01	7301		A2	Pyritic siltstone
KSW02	7302		Frag.	Russell Creek fragmental
KSW03	7303		A2	Pyritic siltstone

APPENDIX V

Analytical Results

30-Jun-99

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

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

ICP CERTIFICATE OF ANALYSIS AK 99-191

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

ATTENTION: SIG WEIDNER

No. of samples received: 35
Sample type: Rock
PROJECT #: 9905
SHIPMENT #: None Given
Samples submitted by: P. Donnelly

Values in ppm unless otherwise reported

Et #.	Tag #	station	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	07301	KSW01	<5	<0.2	1.21	<5	115	<5	0.09	<1	11	115	43	2.55	10	0.45	235	1	0.04	11	140	12	<5	<20	6	0.13	<10	23	<10	24	33
2	07302	KSW02	<5	<0.2	1.27	<5	105	5	0.16	<1	14	143	64	3.35	<10	0.58	269	<1	0.02	16	330	8	<5	<20	<1	0.15	<10	17	<10	34	36
3	07303	KSW03	<5	<0.2	1.56	<5	85	<5	0.16	<1	22	47	82	3.94	<10	0.66	397	8	0.02	25	420	52	<5	<20	10	0.14	<10	14	<10	20	47
4	07304	Δ040	<5	<0.2	0.10	<5	25	15	0.02	<1	42	130	5	8.28	<10	<0.01	47	11	0.04	10	40	<2	<5	<20	<1	0.05	20	74	10	<1	<1
5	07305	KLG02	<5	<0.2	1.13	<5	90	5	0.11	<1	11	80	53	2.96	<10	0.51	263	<1	0.02	10	260	16	<5	<20	1	0.14	<10	16	<10	26	50
6	07306	KLG03	<5	<0.2	1.17	<5	85	5	0.14	<1	12	87	22	2.89	<10	0.57	262	<1	0.02	11	290	10	<5	<20	2	0.15	<10	16	<10	27	35
7	07307	Δ025	5	<0.2	2.44	<5	35	<5	1.06	<1	55	56	159	4.79	<10	1.35	518	1	0.11	66	240	12	<5	<20	11	0.09	<10	63	<10	<1	52
8	07308	Δ040	<5	<0.2	1.07	<5	60	5	0.15	<1	14	100	51	2.88	<10	0.52	288	3	0.02	16	280	10	<5	<20	<1	0.12	<10	15	<10	23	43
9	07309	Δ044	<5	<0.2	0.24	30	30	<5	0.01	<1	6	103	76	0.96	<10	0.03	55	3	<0.01	6	110	<2	<5	<20	<1	0.01	<10	2	<10	4	<1
10	07310	Δ025	<5	<0.2	2.98	<5	280	20	0.61	<1	43	79	12	5.98	<10	1.72	690	<1	0.06	26	310	14	<5	<20	8	0.21	<10	100	<10	1	85
11	07311	Δ040	<5	<0.2	1.57	5	100	20	0.12	<1	13	82	11	3.43	20	0.66	376	<1	0.02	14	290	14	<5	<20	<1	0.16	<10	22	10	35	69
12	07312	034	<5	<0.2	1.32	<5	110	15	0.13	<1	11	74	4	3.19	<10	0.47	395	<1	0.02	10	250	8	<5	<20	<1	0.18	<10	17	<10	21	53
13	07313	027	<5	<0.2	1.56	<5	150	10	0.17	<1	17	74	41	3.88	<10	0.68	279	<1	0.03	12	310	12	<5	<20	3	0.20	<10	37	<10	23	38
14	07314	047	5	<0.2	1.12	<5	85	10	0.19	<1	7	94	20	3.13	<10	0.54	188	<1	0.02	3	290	12	<5	<20	2	0.16	<10	16	<10	11	35
15	07315	KLG12	<5	<0.2	1.22	<5	120	10	0.10	<1	6	66	13	2.81	<10	0.50	263	<1	0.02	1	310	10	<5	<20	9	0.16	<10	17	<10	14	28
16	07316	Δ030	<5	<0.2	0.57	10	45	<5	0.04	<1	5	10	2	0.75	140	0.12	102	<1	<0.01	1	260	6	<5	<20	<1	0.03	<10	4	<10	66	4
17	07317	Δ051	<5	<0.2	1.26	<5	90	<5	0.14	<1	16	58	35	3.36	10	0.48	250	<1	0.02	17	290	10	<5	<20	<1	0.15	<10	15	<10	38	25
18	07318	051	<5	<0.2	1.61	<5	90	5	0.08	<1	20	35	62	4.10	<10	0.67	277	<1	0.02	21	250	10	<5	<20	2	0.14	<10	19	<10	20	28
19	07319	051	10	<0.2	1.33	<5	95	5	0.08	<1	13	60	34	3.09	<10	0.53	236	<1	0.02	15	280	10	<5	<20	<1	0.12	<10	17	<10	20	33
20	07320	061	<5	<0.2	0.27	<5	20	<5	0.08	<1	3	170	4	0.79	<10	0.08	88	<1	0.03	4	120	6	<5	<20	2	0.07	<10	6	<10	13	<1

RIO ALGOM EXPLORATION ICP CERTIFICATE OF ANALYSIS AK 99-191 ECO-TECH LABORATORIES LTD.

Et #.	Tag #	station	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	07321	A061	<5	<0.2	2.65	10	50	15	1.38	<1	23	74	67	2.85	<10	0.93	328	<1	0.25	27	250	16	10	<20	41	0.13	<10	56	<10	3	35
22	07322	060	5	<0.2	1.55	<5	130	10	0.11	<1	16	47	33	4.03	<10	0.62	323	<1	0.01	17	310	10	<5	<20	<1	0.18	<10	19	<10	18	38
23	07323	060	<5	<0.2	0.71	<5	60	5	0.08	<1	19	30	30	3.02	20	0.29	201	1	0.02	23	280	6	<5	<20	<1	0.05	<10	8	<10	21	47
24	07324	060	5	<0.2	1.32	5	120	10	0.11	<1	10	56	17	3.03	<10	0.44	228	<1	0.02	9	290	10	<5	<20	<1	0.17	<10	17	<10	22	19
25	07325	062	10	<0.2	1.46	<5	65	5	0.13	<1	18	40	45	3.77	10	0.64	315	<1	0.02	21	340	10	<5	<20	<1	0.10	<10	16	<10	30	47
26	07326	066	45	0.4	0.07	30	<5	25	<0.01	<1	3	258	4	0.44	20	0.01	88	<1	<0.01	7	30	22	<5	<20	<1	<0.01	<10	<1	<10	5	<1
27	07327	066	10	<0.2	0.17	10	15	<5	<0.01	<1	<1	68	1	0.16	20	<0.01	24	1	<0.01	<1	30	4	<5	<20	<1	<0.01	<10	1	<10	3	<1
28	07328	070	<5	<0.2	1.16	<5	90	10	0.16	<1	12	76	19	2.87	<10	0.52	281	<1	0.02	13	290	12	<5	<20	<1	0.15	<10	15	<10	18	25
29	07329	071	<5	<0.2	1.69	<5	205	15	0.18	<1	15	120	5	3.73	<10	0.70	502	<1	0.03	11	270	8	<5	<20	4	0.22	<10	43	<10	17	50
30	07330	072	<5	<0.2	0.71	5	75	5	0.06	<1	8	75	4	1.82	20	0.21	393	2	0.02	5	280	4	<5	<20	<1	0.04	<10	12	<10	17	24
31	07331	074	5	<0.2	0.21	<5	20	<5	<0.01	<1	<1	103	<1	0.17	30	<0.01	25	<1	<0.01	1	40	4	<5	<20	<1	<0.01	<10	1	<10	4	<1
32	07332	074	<5	<0.2	1.22	<5	20	<5	3.25	<1	5	38	<1	2.65	20	2.80	407	2	0.06	13	80	4	20	<20	62	<0.01	<10	22	<10	5	6
33	[redacted]																														
34	[illegible]																														
35	[redacted]																														

QC DATA:

			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
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

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

df/191
XLS/99

14-Jul-99
ECO-TECH LABORATORIES LTD.
10041 East Trans Canada Highway
KAMLOOPS, B.C.
V2C 6T4

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

ICP CERTIFICATE OF ANALYSIS AK 99-231

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

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

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
8	07343 KLG40	5	<0.2	3.19	<5	530	20	0.43	<1	24	86	6	5.84	<10	1.14	685	<1	0.10	8	400	20	<5	<20	7	0.29	<10	181	<10	19	76
14	07349 Δ126	5	<0.2	5.75	<5	20	15	0.08	<1	33	133	2	6.62	<10	6.90	827	3	<0.01	23	280	22	15	<20	<1	0.05	<10	206	<10	<1	90
QC DATA:																														
Resplit:																														
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
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
Standard:																														
GEO'99		140	1.6	1.72	55	155	10	1.51	<1	19	61	89	3.56	<10	0.92	662	<1	0.02	27	640	20	10	<20	57	0.10	<10	75	<10	12	65

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

df/231
XLS/99

Eco·Tech LABORATORIES LTD.

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 #	BaO	P205	SIO2	MnO	Fe203	MgO	Al203	CaO	TIO2	Na2O	K20	L.O.I.
[redacted]													
8	07343 KLG40	0.09	0.11	66.35	0.12	9.05	2.07	13.02	2.67	0.88	1.91	2.94	0.80

QC/DATA:
Repeat #:

[redacted]

Standard:		BaO	P205	SIO2	MnO	Fe203	MgO	Al203	CaO	TIO2	Na2O	K20	L.O.I.
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

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

XLS/98
df/wr205

ECH ATO TD.
10041 East Trans Canada Highway
KAMLOOPS, B.C.
V2C 6T4

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

ICP CERTIFICATE OF ANALYSIS AK 99-350

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

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 #	station	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																															
3																															
4																															
5																															
6																															
7																															
8	7437	Δ244	<5	<0.2	0.72	15	55	5	0.02	2	15	35	19	2.67	10	0.18	407	2	0.01	20	220	12	<5	<20	<1	0.04	<10	9	<10	5	159
9	7438	Δ254	10	0.4	0.56	15	65	<5	0.02	1	15	86	5	2.53	<10	0.23	141	2	0.01	24	250	8	<5	<20	<1	<0.01	<10	5	<10	<1	40
10	7439	269	5	<0.2	0.19	95	25	<5	0.05	<1	6	100	56	0.73	<10	0.01	80	3	<0.01	9	190	4	<5	<20	<1	<0.01	<10	1	<10	30	<1
11	7440	268	10	0.2	0.10	<5	10	<5	0.11	<1	1	114	21	0.28	<10	<0.01	80	2	<0.01	6	160	<2	<5	<20	<1	<0.01	<10	<1	<10	17	<1
[redacted]																															
13	7442	038	<5	<0.2	1.42	<5	150	<5	0.19	<1	8	90	3	2.67	<10	0.70	414	<1	0.01	6	270	8	<5	<20	<1	0.12	<10	26	<10	29	43
14																															
15																															
16																															
17																															
18																															
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).

CHB Leitch, P.Eng

Craig H.B. Leitch, Ph.D., P.Eng (250) 653-9158
492 Isabella Point Road, Salt Spring Island, B.C. V8K 1V4

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 psuedomorphs 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 An_{10}. 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 anhedra 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 dificulty.

Carbonate, likely mostly calcite to judge by the reaction in hand specimen, ocurrs 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 moderatly 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%
Opaques (?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 an- 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 offcut 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 TiO_2 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 posssibility 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 Y^010 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^010 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 ACCESORY 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 (?An_{10}).

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 clusteres 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 sericte 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 SO, there ia 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-PLAGICOLASE-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 plagioclaase 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 An_{10}.

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" (GRANOBLASTIC 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 worker's 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 $<An_{10}$ (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 <50 microns in diameter) of sericite, and lesser ?epidote-group mineral such as ?zoisite (low birefringence; rounded crystals mainly <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 <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.