GEOLOGICAL AND GEOPHYSICAL REPORT

ON THE OLIVER PROPERTY, OLIVER, B.C.

RKL-1, RKL-2, POLVO, SYN, SYN-2, OLI-1, OLI-2 AND GUM CLAIMS

OSOYOOS MINING DIVISION

LATITUDE 49° 13' N; LONGITUDE 119° 35' W

N.T.S. MAP SHEET 82E/4E

For

British Newfoundland Exploration Limited

By

R.J. Beaty, B.Sc., M.Sc., D.I.C.

And

R.R. Culbert, PhD., P.Eng.

D.G. Leighton & Associates Ltd.

10 June 1978

CONTENTS

ILLUSTRATIONS

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GEOLOGICAL AND GEOPHYSICAL REPORT ON THE OLIVER PROPERTY, OLIVER, B.C.

INTRODUCTION

This report describes the results of geological mapping and radiometric surveys completed on the OLIVER property during the 1978 field season. These surveys are follow-up to geochemical (mainly soil sampling) work completed in 1977. Other work done on the property involved rock geochemistry which will be discribed in detail in a subsequent report.

Work on the OLIVER property was done at intervals, being part of a larger program involving regional surveys and other property exploration.

The conclusions set forth here are based on the work cited above.

SUMMARY AND CONCLUSIONS

1. The OLIVER property is comprised of eight unsurveyed mining claims (124 units) and eight reverted crown granted claims held in the name of British Newfoundland Exploration Limited.

2. The property, situated 3 km northwest of Oliver, British Columbia, is accessible by the Sawmill (Burnell) Lake road.

3. Work summarized in this report consisted of moderate to detailed scale geological mapping, prospecting and a radiometric grid survey over the Oliver plutonic complex.

4. The OLIVER property is underlain by a composite mid-Jurassic calc-alkaline plutonic complex of three distinct phases, all of quartz monzonite composition.

5. Many similarities exist between the geology of the central part of the Oliver plutonic complex and that of French plutonic complexes which house intra-granite uranium deposits. In the Oliver complex, patches of uraniferous quartz monzonite occur over the contact between the latest two phases of the plutonic complex. The uranium is loosely held in unaltered rock.

6. In the southern contact area, uraniferous fine grained quartz monzonite accompanied by thorium forms dikes and pods intruding metasedimentary rocks near the contact with the main mass of the pluton. The geological environment here appears to be very similar to that at the Midnite Mine in Washington State, a major uranium producer.

7. The primary exploration targets at present are:

   (i) the contact zone in the Wow Lakes area between the latest two phases of the plutonic complex where it coincides with areas of two-mica development and fracture zones;

   (ii) the base of metasedimentary rock roof pendants where they contact intrusive rock in the southern contact area.

Respectfully submitted,

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PROVINCE OF BRITISH COLUMBIA
R. R. CULBERT

10 June 1978

GENERAL DESCRIPTIONS

Location and Access

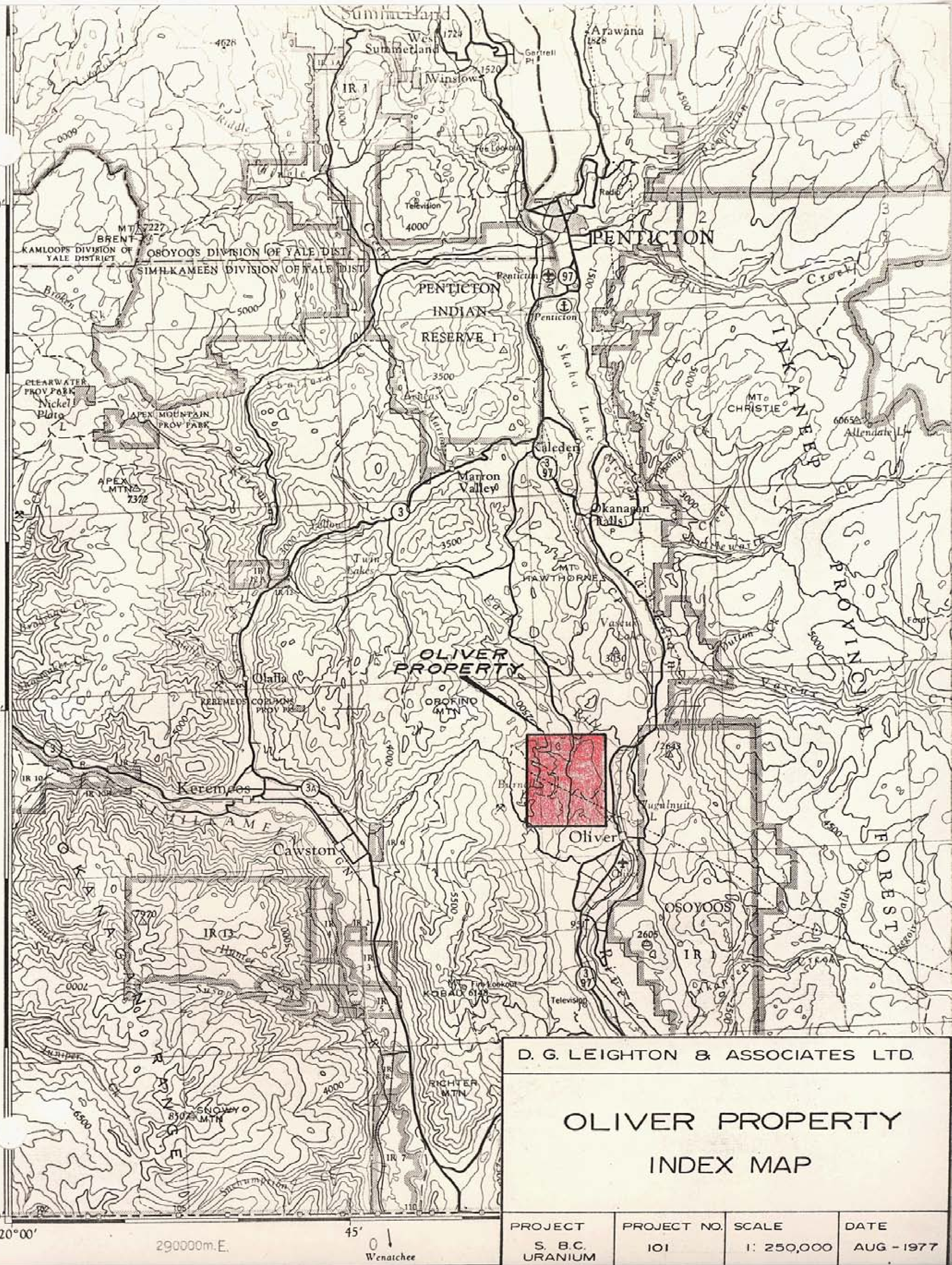
The Oliver plutonic complex is situated 3 miles northwest of Oliver, B.C. The geodetic co-ordinates are 49° 13' N Latitude and 119° 39' W Longitude. Access is excellent. From Oliver the Sawmill (Burnell) Lake paved road runs north-south through the property, from which several dirt roads extend, providing easy access to all areas of the intrusive complex.

Topography, Climate, Exposure

The property lies between 1,000 and 2,400 feet on the sparsely settled, pine-covered hills to the immediate west of Oliver. The land is used for grazing by cattle ranches in the vicinity. The climate is semi-arid. Alkaline lakes dot the area, many drying up by late summer.

Topography is varied, being gentle in the Wow Lakes area and more rugged in upland areas. The region has been glaciated, creating prominent bluffs, glacial lake deposits and slickensides on some outcrops.

As a result of a recent extensive forest fire, large areas are barren of trees and rock exposure is excellent, so that contacts may be traced with certainty over long distances.



D. G. LEIGHTON & ASSOCIATES LTD.
OLIVER PROPERTY
INDEX MAP
PROJECT
S. B.C. URANIUM
PROJECT NO.
101
SCALE
1: 250,000
DATE
AUG - 1977
OLIVER PROPERTY
PENTICTON
PENTICTON INDIAN RESERVE 1
West Summerland
Winslow
Arawana
Kaleden
Marron Valley
Okanagan Falls
MT. HAWTHORNE
OROFINO MTN
Oliver
OSOYOOS
Keremeos
Cawston
Olalla
MT. CHRISTIE
APEX MTN 7372
CLEARWATER PROV PARK
APEX MOUNTAIN PROV PARK
Nickel Plate
MT BRENT 7227
KAMLOOPS DIVISION OF YALE DISTRICT
OSOYOOS DIVISION OF YALE DIST
SIMILKAMEEN DIVISION OF YALE DIST
KEREMEOS COLUMNS PROV PK
Skaha Lake
Twin Lakes
KOBAU 6148
RICHTER MTN
SNOWY MTN
OKANAGAN RANGE
INKANEEP PROVINCIAL FOREST
120°00'
45'
290000m.E.
5440000m.N.
Wenatchee

Claims

The OLIVER property consists of the following claims held in the name of British Newfoundland Exploration Limited.

A.

Mineral Claims	Units	Record No.	Record Date
RKL-1	18	99	16 July 1976
RKL-2	20	100	16 July 1976
SYN	12	139	27 Oct. 1976
SYN-2	12	168	1 Dec. 1976
POLVO	18	140	27 Oct. 1976
GUM-1	20	169	1 Dec. 1976
OLI-1	8	274	18 May 1977
OLI-2	15	275	18 May 1977

B. Reverted Crown Granted Mineral Claims:

Name	Lot No.	Acreage	Record No.	Record Date
Atlas	664	50.88	360	24 Feb. 1978
Belmont Fr.	837	11.	361	24 Feb. 1978
Cornstock	729	51.65	362	24 Feb. 1978
Joe Dandy	447	20.608	363	24 Feb. 1978
Gilpin Fr.	838	7.33	363	24 Feb. 1978
Rob Roy	546	51.65	364	24 Feb. 1978
Silver Bow	730	20.66	365	24 Feb. 1978
St. John	803	51.65	366	24 Feb. 1978

These reverted crown granted mineral claims occur as inliers within the main group. Other reverted crown granted mineral claims within the property include those of the Susie Mine and Gypo quartz deposit owned by ASARCO and COMINCO respectively, and a small property mined for gold by a local group.

BACKGROUND

No record exists of previous uranium exploration or development work of any kind, notwithstanding that the area has been extensively prospected for gold vein deposits for more than eighty years, and that the area forms the site of the university of B.C. Geology Field School. Gold and silver were produced in substantial quantities from the Morning Star and Stemwinder deposits in the Fairview Camp to the immediate southwest of the Oliver property in the 1890's, and gold was produced from the Susie and Standard veins on the property (see Figure 5) as recently as 1974. The large Gypo quartz deposit on the east side of the property, owned by Cominco, has been mined for many years mainly as a source of silica for the smelter operation at Trail.

REGIONAL GEOLOGY AND PREVIOUS STUDIES

The Oliver plutonic complex occurs at the boundary of the Omineca and Intermontane tectonic belts. To the east are high grade metamorphic rocks of the Shuswap Complex and calc-alkalic intrusive rocks mapped by Little (1961) and Jackson (1976) as the Nelson and Valhalla complexes of early to middle Cretaceous age. To the north is a complex succession of alkalic volcanic rocks and associated sediments mainly of Tertiary age. West of the Oliver complex are Triassic sedimentary and volcanic rocks and large areas of middle to late Jurassic intrusive rocks. Paleozoic metasedimentary rocks and granodiorite intrusive rocks occur to the south.

The region immediately surrounding the property was mapped at 1:50,000 in 1929 by Bostock (1940). In 1961, Little (1961) compiled regional geology and issued the 4-mile G.S.C. map-sheet covering the property. Okulitch (1969) mapped the structure and metamorphic petrology of the Kobau metasedimentary rocks to the south of the property in a PhD. study, but did no work on the intrusive rocks. Richards (1968) made a thin section study of the Oliver complex as part of a B.Sc. thesis.

GENERAL GEOLOGY

Introduction

The Oliver plutonic complex is a composite pluton of Jurassic age. It is composed of at least three distinct phases, and possibly up to five. The main phases in the pluton are (youngest to oldest):

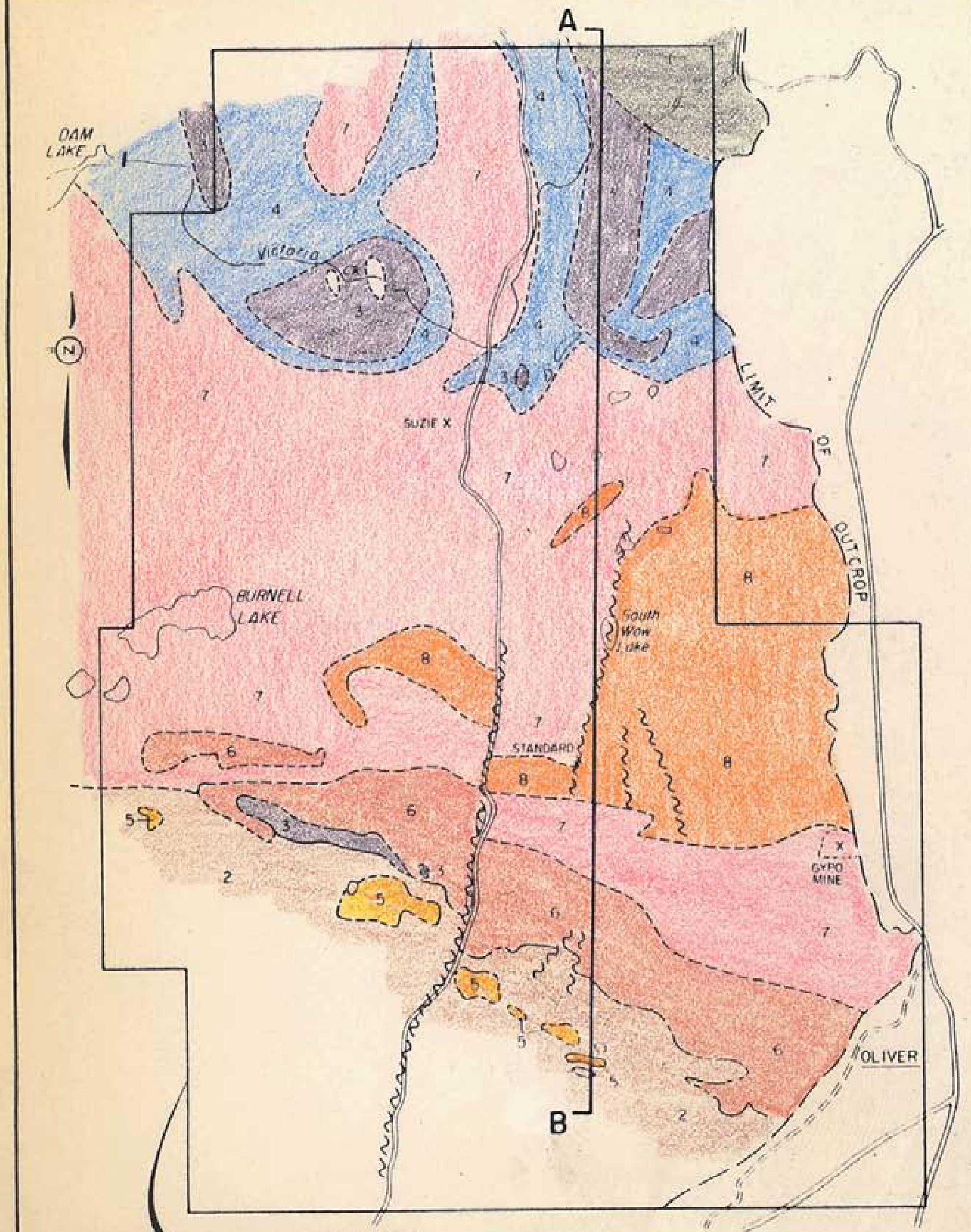
1. Muscovite-garnet quartz monzonite,

2. Porphyritic biotite quartz monzonite,

3. Biotite-hornblende quartz monzonite.

Dioritic rocks and fine-grained dikes and pods of quartz monzonite make up what may be two additional phases. Although Bostock (1940) called the first two main phases the "Oliver syenite" and "Oliver granite" respectively, it has been demonstrated from thin section studies of feldspar compositions by the writer and Richards (1968) that all phases have a model quartz monzonite composition. However, the earliest phase has a composition close to the granodiorite range and the latest phase composition is close to that of a granite, indicating a successive alkaline enrichment in younger phases. Unequivocal age relations were observed in the field between these phases.

Although Little (1961) has mapped the second two main phases as being part of the Valhalla plutonic event of Cretaceous age and the diorite and biotite-hornblende phases as being part of the older Nelson plutonic complex along with the Fairview granodiorite to the south, it is probable that the three main phases are part of the same plutonic event, probably Valhalla in age, with the diorite being older.



PERIMETER OF OLIVER PROPERTY CLAIM BLOCK

FIGURE 2 : GEOLOGY OF THE OLIVER PLUTONIC COMPLEX AT 1:25,000

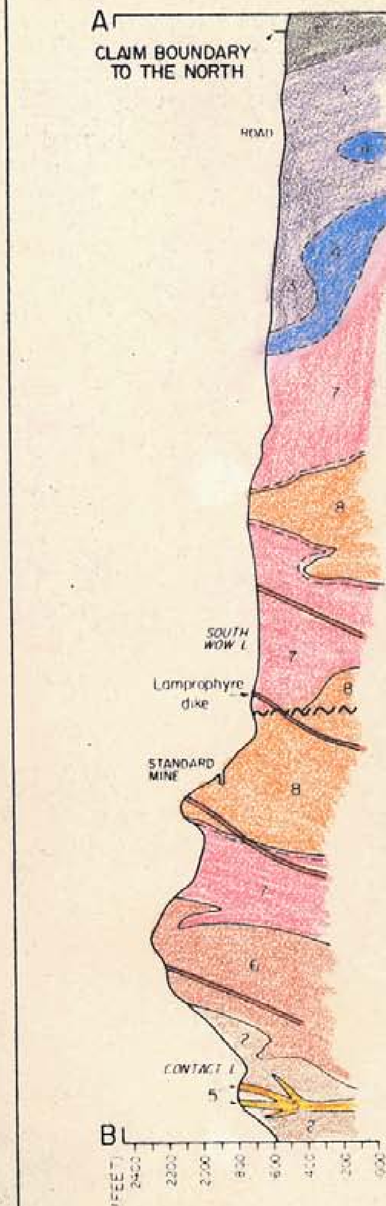


FIGURE 3 : NORTH-SOUTH GEOLOGICAL CROSS-SECTION ALONG BASELINE OLIVER PLUTONIC COMPLEX

LEGEND

- 8 Muscovite - garnet quartz monzonite
- 7 Porphyritic biotite quartz monzonite
- 6 Biotite - hornblende quartz monzonite
- 5 Fine grained quartz monzonite
- 4 Intermixed dioritic/porphyritic qtz monz rocks
- 3 Dioritic rocks
- 2 Kobau Group metasedimentary rocks
- 1 Shuswap terrain metamorphic rocks

VERTICAL EXAGGERATION = 3 X (APPROX)

FIG. 2 & 3

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OLIVER PROPERTY

GEOLOGY

m 50 0 50 100 150 m

PROJECT	PROJECT No	SCALE	DATE
S B C U	103	As shown	JUNE -1978

The Oliver plutonic rocks intrude on the south, the Kobau group of metasedimentary rocks, probably of Carboniferous age, and on the north Precambrian metamorphic rocks of the Shuswap Terrane and Triassic cherts and greenstones.

Dioritic Rocks

Bodies of dark green holocrystalline rock of diorite-gabbro composition occur in portions of the plutonic complex, especially in the northwest. The diorite has been extensively intruded and assimilated by the later porphyritic and biotite-hornblende phases, resulting in wide transition zones of complexly intermixed rocks of variable composition and grain size. Excellent examples of magmatic stoping and chilled margins may be observed over many hundred meters where these later phases cut the diorite. In places, "gneissic" lenses of nearly pure hornblende are found.

The "diorite" is composed almost entirely of plagioclase and hornblende in roughly equal amounts on average, though hornblende forms from 35 to 80 percent of the rock in places, and shows much variation in grain size. Up to five percent magnetite gives the rock a highly magnetic character, and in some places up to ten percent pyrrhotite occurs in association with fracture zones or diabase dikes. In thin section, the rock has a hypidiomorphic-granular texture. Plagioclase is highly sausseritized to albite and clinozoisite and is weakly zoned, and the rock is cut by numerous microfractures filled with epidote and clay minerals. The radioactivity of the diorite averages 100 cps and varies from 100 to 150 in the transition zones.

Though the diorite may be the oldest phase of the Oliver pluton, its higher degree of alteration and fracturing suggests that it is probably a separate older intrusion. It is likely not an amphibolite member of the much older Shuswap terrain bordering it and the Oliver pluton on the northeast because it may be seen intruding the Kobau metasedimentary rocks in the south contact area.

Biotite-Hornblende Quartz Monzonite

The oldest member of the Oliver plutonic complex is a dark, medium-grained biotite-hornblende quartz monzonite containing an average modal composition of 20% quartz, 22% microcline, 38% plagioclase, 12% biotite and 8% hornblende, with trace amounts of accessory sphene, apatite and zircon. This phase was mapped by Bostock (1940) as the "Oliver syenite" but contains far too much plagioclase and quartz to warrant that name. In thin section, the rock has a hypidiomorphic-granular texture. Plagioclase is sausseritized, but the mafic minerals are mostly unaltered except for traces of chlorite and clinozoisite.

This phase is in direct contact with the Kobau metasedimentary rocks to the south. The contact is sharp and, curiously, is not marked by a chilled margin. Aplite dikes and pegmatite dikes are common in the metasediments near the contact. Although inliers of metasediments do occur within the intrusive for short distances from the contact with the metasediment, little intermixing is observable between these units, in direct contrast with the highly stoped and assimilated contact region between this phase and the diorite. Numerous elongated "amphibolite" xenoliths occur near the contact, aligned parallel to a weak foliation sometimes observable in mafic minerals in the intrusive and the regional foliation in the metasediments.

The contact between this phase and the porphyritic quartz monzonite phase is variable. On the western side of the map, the contact is sharp. The biotite-hornblende phase has been invaded by the porphyritic phase in dikes which grade into aplite as the distance increases from the parent body. Little assimilation is noted here, and the porphyritic phase has a chilled margin from 0.3 to 30 m wide.

Much of the contact, however, is marked by a transition zone up to 160 m wide. In this zone the coarse porphyritic biotite-rich phase changes to a rock with smaller phenocrysts, then to a hornblende-rich rock with no phenocrysts, then to the main biotite-hornblende quartz monzonite, and the mafic mineral content increases as the biotite-hornblende phase is approached.

The biotite-hornblende phase is moderately radioactive, averaging 200 cps, and the intrusive/Kobau contact may be virtually mapped by scintillometer on the basis of the differing radioactive signatures of the two units.

Fine-Grained Quartz Monzonite

Fine-grained quartz monzonite occurs as dikes and small bodies cutting the Koban metasediments in the south contact area. These bodies are anomolously radioactive at 300-600 cps but it is uncertain whether they represent a separate phase of the plutonic complex or are merely fine-grained equivalents of the biotite-hornblende phase of the main pluton. They are discussed in more detail in the "Detailed Geology - South Oliver Contact Area" section of this report.

Porphyritic Biotite Quartz Monzonite

Forming the largest mass of the Oliver plutonic complex is a distinct pink-tan porphyritic phase characterized by 3 to 6% unoriented pink feldspar phenocyrsts up to 3 cm long set in a light medium-grained matrix with an average modal composition of 28% quartz, 33% plagioclase, 30% microcline, 4% biotite and 1% hornblende.

In thin section, apatite, sphene and zircon are common, plagioclase is weakly zoned and strongly sericitized, biotite and hornblende are highly corroded and resorbed though only traces of chlorite and epidote are seen, microperthite is common and myrmekite is well developed between plagioclase and microcline grains. Radioactive emanation from zircon inclusions have produced brown pleochroic haloes in biotite. Bostock referred to this unit as the "Oliver granite" but it is in fact of quartz monzonite composition.

As mentioned previously (section on biotite-hornblende quartz monzonite), this phase intrudes the biotite-hornblende phase forming sharp and gradational contacts. It is in turn intruded by the muscovite-garnet phase. The latter contact is sharp or gradational. It is sometimes marked by a narrow quartz-feldspar pegmatite zone or, more significantly, by a "hybrid" zone 2-40(?)m wide consisting of a mixture of the porphyritic and muscovite-garnet phases. In this zone, garnet and/or muscovite may exist in porphyritic rock or biotite may occur in the muscovite-garnet phase.

Radioactivity in this phase averages 210 cps but ranges from 170 to 700 cps, being higher near the contact with the muscovite-garnet phase.

Muscovite-Garnet Quartz Monzonite

The youngest phase of the Oliver plutonic complex is a white-weathering friable non-porphyritic alaskite with a model composition of quartz monzonite, composed of 40% quartz, 28% microcline, 25% plagioclase, 5% muscovite and 2% garnet. Near the contact with the porphyritic phase, biotite is sometimes found at the expense of garnet suggesting variations in garnet-biotite equilibrium in the magma. Areas with two micas are not widespread, but their association with the contact region, with zones of higher radioactivity and with lineament intersections makes them favoured exploration targets.

In thin section, plagioclase is altered to sericite and albite. In rocks containing biotite and muscovite, allanite, apatite, sphene and zircon may also occur. The rock exhibits deformation textures such as curved albite twin lamellae in plagioclase, wavy extinction in quartz, myrmekitic textures, and much granulated quartz along grain boundaries, probably related to stresses during crystallization.

Most of the phase contains distinct tiny reddish garnets. Since much manganese oxide staining occurs in some areas forming black selvages near weathered surfaces and black stains on most mineral surfaces, especially in places where the garnet has been leached out, it is suggested that the garnet has high Mn content and is an almandine-spessartine mix. The alaskite is a likely paragenesis for this type of garnet (Deer, Howie, and Zussman, 1966). Green (1977) states that almandine-rich garnets in equilibrium with silicic melts indicates pressures of crystallization greater than 25 km, though a garnet with higher MnO content may crystallize at levels as shallow as 12 km. Areas of strong MnO staining are also co-extensive with areas of apple-green muscovite, due perhaps to higher chromium levels in those parts of the magma chamber. Muscovite in other areas is white.

Radioactivity in this phase is generally lower than in the porphyritic phase, averaging 140 cps, but varies from 80 to 400 cps, being higher in the contact region.

Dikes and Veins

The following dikes have been observed cutting the Oliver plutonic complex:

1. Lamprophyres: these distinctive brown-weathering dikes form near vertical sheets 3 to 15 m wide trending 030°. One extends south of the Wow Lake intermittently for up to 1,000 m and another has been traced from the Gypo Mine southward for at least 900 m. They are dark green fresh, holocrystalline, and contain up to 45% phenocrysts of augite, olivine, biotite and plagioclase set in a fine-grained matrix of K-feldspar, chlorite, apatite, epidote, sphene, carbonate and opaque (magnetite). This lamprophyre matches the description given for the variety named vogesite (Williams, Turner, Gilbert, 1953, p. 87) found in sub-volcanic environments as dike feeders to alkalic volcanic complexes. The lamprophyre dikes have high radioactivity, averaging 250 cps.. The lamprophyre at the Gypo Mine has a potassium-argon age of 52 my on biotite, but a regional hydrothermal event may have reset this date.

2. Hornblende lath monzonite: cuts the porphyritic phase near Burnell Lake, oriented at 040°.

3. Augite-plagioclase porphyry andesite: cuts all phases; trends 010°; composed 35% of augite, plagioclase and rare olivine phenocrysts in a very fine-grained albite (?), chlorite, apatite and opaque matrix.

4. Micro-quartz diorite: occurs as fine-grained dikes cutting all phases, especially in a swarm near Field School; composed of hornblende, biotite, plagioclase, quartz, K-feldspar, chlorite, epidote, sphene, apatite, zircon and opaques; trend 120°.

5. Albite porphyry dacite: occurs cutting the Kobau metasediments; composed of albite phenocrysts set in a very fine-grained matrix of plagioclase, chlorite, epidote and opaques.

6. Diabase: occurs rarely in dioritic rocks associated with iron-oxide zones and high pyrrhotite; composed of pyrrhotite, plagioclase, hornblende (50%, augite (15%), sphene, apatite and epidote.

7. Tephrite: occurs in the Wow Lakes area.

8. Fine-grained quartz monzonite ("quartz latite"): occurs as dikes and pods in the South Oliver area.

9. Aplite: occurs as thin dikes (5 to 15 cm wide) cutting all phases; composed of quartz (25%), microcline (40%), plagioclase (35%) and traces of biotite and accessories.

Except for lamprophyres and the fine-grained quartz monzonite dikes, the dikes are not radioactive. They occur in two general sets at 030° and 120°.

Quartz veins occur in all phases and in the metasedimentary rocks, and have been extensively explored in trenches, adits and pits for precious metals. The largest vein is the Gypo body, which occurs near the contact between the porphyritic and muscovite-garnet phases. It is accompanied on its footwall by a greisen zone containing fluorite, muscovite, phlogopite, apatite, calcite and sulphides (pyrite, chalcopyrite, molybdenite, pyrrhotite:

A.J. Sinclair, personal communication). Quartz veins are not usually associated with radioactivity except at the Gypo and Susie deposits. Wall rock alteration is weak.

Simple pegmatites occur in two areas: at the muscovite-biotite phase/porphyritic phase contact and, more rarely, in the Kobau near its contact with the biotite-hornblende phase. They are composed of coarse feldspar, muscovite and smoky quartz, and have higher radioactivity at 200-300 cps.

Structure and Age

Except for the biotite-hornblende phase, which is weakly foliated and has aligned inclusions parallel to a regional foliation in metasedimentary rocks, the intrusive phases are not noticeably deformed. Emplacement of the biotite-hornblende phase, therefore, probably occurred at the end of the deformation event causing the regional foliation in the Kobau.

Strong lineations are visible in air photos, oriented in three sets at 015°, 345° and 120°. The latter set parallels the regional foliation. The intrusive rocks have been faulted in some areas, with offsets of 400 m or more, but major lineaments do not appear to be areas of displacement and probably only represent fracture zones. In general, intrusive phases are only weakly fractured and shear zones are not common (due to recessive weathering). It is likely that the 015° and 345° joint sets and orientation of the dikes at 015° to 040° were the result of a north-south stress system operating in late Cretaceous-Tertiary time.

The age of the Oliver complex is still uncertain. White et al. (1968) dated muscovite in the muscovite-garnet phase and the

Gypo Mine at 140 my but biotite from the biotite-hornblende phase and porphyritic phase gave illogical dates of 118 and 103-82 my respectively. Sericite from the Susie and Standard Mines were dated at 114 and 117 my. Recently, however, R.L. Armstrong has redated the Oliver complex at 160 my (A.J. Sinclair, personal communication, June 1978), a middle-Jurassic date.

Summary

The Oliver plutonic complex appears to be a zoned composite pluton of mid-Jurassic age. A successive increase towards the centre of the pluton is seen in quartz and K-feldspar content, coupled with a decrease in biotite, hornblende, apatite and epidote. This enrichment in silica and alkalinity suggests fractional crystallization in three phases from a parent calc-alkaline magma. The in-part concordant, in-part discordant contact of the pluton with the Kobau metasedimentary rocks, the widespread evidence of assimilation, the absence of miarolitic textures, the low grade (greenschist) metamorphism in contact rocks, the presence of aplite and pegmatite dikes, and garnet equilibrium considerations all suggest the depth of emplacement was Mesozonal, perhaps ranging from 12-18 km. The forceful emplacement of the intrusion is evidenced by the severely contorted Kobau rocks at the south contact.

DETAILED GEOLOGY

South Oliver Contact Area

The area along the southern contact of the Oliver plutonic complex was selected for detailed mapping for three reasons:

1. to delineate and study the radioactive pods and dikes of fine-grained quartz monzonite which occur in the meta-sedimentary rocks near the contact and contain up to 95 ppm uranium;

2. to examine the zones of radioactivity in limestone beds near the contact which contain up to 105 ppm uranium;

3. to study the petrology of the Oliver plutonic complex in some detail to assess its similarities to French uraniferous granite bodies.

A control grid was extended over the contact region, used for geological mapping at 1:2000 scale and for a grid radiometric survey. The geology is portrayed in Figure 6 at 1:4000 scale.

Within the property, most of the contact is between the biotite-hornblende quartz monzonite and the Kobau. On the southwestern side of the property the Kobau is in direct contact with the porphyritic biotite quartz monzonite which interfingers with the biotite-hornblende phase. A 700 m slice of dioritic rocks also occurs on the west side in contact on the south with the Kobau and on the north with the biotite-hornblende phase. These phases have been described in detail in the previous section and will not be repeated here.

The Kobau group in the mapped area consists of moderately to highly deformed schists, phyllites, quartzitic schists, limestone and laminated quartzite. Although Okulitch (1969) mapped the area in 1967, he lacked the benefit of a ground control grid, and many of his contacts are displaced. He concentrated on a structural interpretation and showed that three phases of deformation have affected the rocks, resulting in tight recumbent folds with east-trending axes, overturned and normal folds with steep axial planes along southeast trending axes and refolded recumbent structures. Greenschist facies metamorphism accompanied the first phase. A narrow zone of hornblende-hornfels occurs in the metasedimentary rocks at the contact. Regional foliation parallels primary bedding and is consistent over most of the exposed Kobau on the map at 115°-130°. Since radioactivity in all members of the Kobau except the limestone member averaged only 100 cps, no attention was given to mapping the Kobau in any detail.

Within the Kobau are several discontinuous beds of graphitic limestone varying from 1 to 12 m in width and from 10 to 180 m in length. The limestone has been coarsely recrystallized to marble and in thin section is remarkably pure, averaging 93% calcite, 5% quartz and 2% opaque grains. Calcite twin lamallae are curved and 1-2% quartz appears detrital in origin. Even where it occurs in contact with the biotite-hornblende or dike quartz monzonite, the limestone shows absolutely no sign of skarnification or alteration, surprising in view of its high graphite content especially near the intrusive. This affirms that the limestone is pure, and also indicates a very low oxygen fugacity in the intrusive rocks. The purity, high carbon content and discontinuous nature suggest that the limestone was entirely organic in origin.

In contrast to its areas of contact with felsic igneous rocks, the limestone occurring 50-80 m from the dioritic rocks west of the road has been extensively skarnified to a fine-grained mixture of diopside-actinolite-quartz-calcite, indicating a much higher oxygen fugacity in the system and extensive iron and silica metasomatism. Actinolite occurs as green prismatic crystals and acicular masses and diopside is found as green stubby grains up to 40% of the rock. The skarn occurs near a high-pyrrhotite diabase dike and near a 250 m wide gossan zone of silicified ferruginous quartzite in which iron has been introduced from the adjacent diorite.

Zones of radioactivity in the limestone are extremely irregular. Most limestone is not radioactive, averaging only 60-80 cps. Two or three patches reach 200 cps, and in only one bed is there consistent 200 cps and one small zone up to 700 cps. Despite detailed investigation of that bed, no pattern of radioactivity was discerned. A small pyrrhotite-quartz vein occurs near the hot spot, but no radioactivity is associated with it. The one hot spot is probably due to a small patch of pyrrhotite zone of reduction in the limestone and is of a very localized nature.

Up to 10 volume percent of the rocks in the Kobau within 800 m of the southern contact are made up of irregular masses of fine-grained quartz monzonite. The smaller sized pods are most common near the contact, and the larger pods occur in a roughly linear fashion about 400 m from the contact, trending 300°. South of the line of larger pods, few rocks of this unit crop out. The largest pod is more than 600 m long and 350 m wide.

Fine-grained quartz monzonite is distinguished in hand specimen from biotite-hornblende quartz monzonite on the basin of its finer grain size, lower mafic composition and stronger foliation. The light grey dike rock is more fractured than the main phase, but only one obvious shear zone was seen and few faults were mapped in. In thin section, the fine-grained rock is composed of a fine to medium-grained equigranular mixture of 30-35% plagioclase sausseritized to albite, epidote, sericite and sphene, 30% quartz, 25-30% microcline, 8-10% biotite and 0-2% hornblende. With the exception of one sample, all thin sections showed many minute subhedral inclusions of zircon (thorite) in biotite, forming pleochroic haloes due to radioactive emanations. Hornblende and biotite are commonly zoned and apatite and sphene are abundant. The rock has a higher accessory mineral content than the main biotite-hornblende phase.

The fine-grained pods have higher average radioactivity than the main biotite-hornblende phase, which varies from 150-250 cps, averaging 180 cps. The small dikes are highly variable but average 250 cps and go as high as 750 cps. An apparent trend is exhibited in the radioactivity of the three larger bodies. The pod farthest east (near "Contact Lake") varies from 200-400 cps, the central fine-grained pod varies from 300-500 cps and the largest, most strongly foliated pod on the west side varies from 400-600 cps over its whole area.

Despite detailed mapping, the origin of the fine-grained pods is not certain. The contact between these dikes and pods with the Kobau is everywhere discordant. No chilled margins were seen, but xenoliths of quartzite and schist occur in the bodies. Evidence favouring the pods and dikes being a separate phase than the biotite-hornblende phase is as follows:

1. The fine-grained pods have higher radioactivity, a higher degree of foliation and a different mineral composition (a lower mafic mineral content and higher accessory mineral content) than the main phase.

2. Nowhere was an unequivocal chilled margin seen in the main phase; it occurs in a medium-grained texture right to its contact with the Kobau.

3. Nowhere was the main phase seen to grade gradually into a fine-grained dike, even though within a dike considerable variation in grain size was seen from pegmatite to aplite.

4. The large pods of fine-grained rock should be large enough to develop the same appearance as the main mass, but they exhibit a different appearance.

Despite the above evidence, however, the writer favours the notion that the dikes represent a fine-grained contact equivalent of the biotite-hornblende phase and are merely "apophoses" of that intrusion occurring in the Kobau. Evidence for this origin is:

1. The fine-grained rocks are intimately associated with the contact of the Kobau and biotite-hornblende phase.

2. Nowhere was a fine-grained pod seen cutting the main biotite-hornblende phase. This should occur if the fine-grained rock is a separate later phase.

3. The variations in mineral composition and grain size can be explained by assimilation of metasedimentary rocks during emplacement.

4. The variations in radioactivity can be explained by the common enrichment noted in uraniferous granites on intrusion margins and in late-magamtic dikes and veins, though curiously the rare pegmatite veins noted in the south contact area are of lower radioactivity than the fine-grained dikes.

In any case, the fine grained dikes and pods are clearly related to the main phase and may have intruded the Kobau along structurally favourable areas during late stages of deformation of the Kobau from late stage fluids following initial intrusion of the biotite-hornblende phase.

Close similarities exist between the geology of this area and that of the Midnite Mine area in central Washington. In that deposit, uraninite and coffinite occur along permeable zones in roof pendants of argillites and schists adjacent to the contact with a uraniferous quartz monzonite. Major ore bodies extend outward from the contact zone but, with one exception, do not have any surface expression. Ore deposition is considered to be by late stage (magmatic) hydrothermal fluids, with recent supergene enrichment due to circulating ground waters.

The background uranium concentration of the Oliver quartz monzonite is higher than that of the Midnite Mine. The metasedimentary rocks are very similar in appearance, and structural traps such as faults and cores of folds are common. The area is a favourable exploration target.

Central Oliver Area

The Central Oliver area was mapped in detail by Dr. K. Lu in order to attempt to explain geological controls on very anomalous lake water samples in the Wow Lakes area on uraniferous lake sediments and on patchy zones of very high radioactivity within the intrusive complex. Topography in the area is gentle, with granitic bluffs and hills overlooking enclosed drainage basins and grass covered rangeland.

Five types of rocks are found in the mapped area: porphyritic biotite quartz monzonite, dioritic rocks, muscovite-garnet quartz monzonite, a transition unit containing muscovite and biotite, and dike rocks of variable composition. Rock distribution is shown in Figure 5. The first three rock types have been described in the previous section (General Geology) and will not be repeated here in detail.

The porphyritic phase forms most of the area, with the dioritic rocks cropping out to the north and the muscovite-garnet phase to the east. The transition zone occurs along the contact between the porphyritic and muscovite-garnet phases. In addition, a "hybrid zone" occurs as an inlier in the porphyritic phase near the contact with the muscovite-garnet rock. This zone is complex, and is perhaps due to magmatic mixing of the later muscovite-garnet phase with the porphyritic phase. Biotite may have formed at the expense of garnet, and occurs only in patches. Muscovite and/or garnet may also occur in porphyritic rock in this zone.

Lamprophyre, augite-feldspar porphyry andesite and microdiorite dikes have invaded the rocks, oriented at 15° - 35°. Jointing and fracturing is oriented in two sets at 300° and 15° - 35°.

The radioactivity of the porphyritic phase averages 160 cps, in contrast to the lower average radioactivity of 100 cps in the muscovite-garnet phase in this area. Radioactivity is higher in the contact region, and localized areas within this zone run as high as 1000 cps. Highest lake sediment values occur in lakes lying over this contact region.

The central area of the Oliver plutonic complex has considerable similarities to petrographic descriptions of the French granitic bodies which house intragranite uranium deposits. In both areas, porphyritic biotite "granites" occur in association with muscovite or muscovite-biotite bearing non-porphyritic granites and lamprophyre dikes. Faulting appears to be more dominant in the French plutonic complexes, but this may be due solely to better exposure or abundant subsurface information from drilling and tunnelling in the French deposit. Fracture zones are recessive and are not commonly observed at Oliver, but many lineaments exist on air photos.

Mineralization in French intragranite uranium deposits occurs (briefly) as altered pitchblende occurring as very fine grains with or without pyrite in irregular zones within the contact region between the "mica granite" and porphyritic phases. Ore grade is higher where lamprophyre dikes intersect this region. Mineralization is structurally controlled (related to fault zones), and is also related to depth from surface. In one deposit (Pierres Plantees), a body of altered rock called episyenite bears high uranium grades and is considered to have resulted from fault-controlled metasomatization of the other igneous phases. Although ore grade is high, these deposits are of small tonnage and are difficult to exploit.

It is considered that the most favourable area for uranium concentration at Oliver is the contact transition zone where muscovite and biotite occur together, especially where lamprophyre dikes and fault zones occur to form plumbing systems and traps for uranium deposition. One such area exists southeast of South Wow Lake, where three lineaments, an extrapolated shear zone, and a lamprophyre dike all intersect within the transition zone where a two-mica phase has been seen.

RADIOMETRIC SURVEY

Instrumentation

All prospecting and radiometric survey work was carried out using French SPP2NF scintillometers.

Ground Control

Control for the radiometric grid was by chain and compass survey. Readings were taken at 50 m intervals on lines 500 m apart over most of the grid and 200 m apart in the southern contact area. The lines were also used as control in mapping the various phases of the Oliver plutonic complex. The baseline extends 4,400 m north-south across the intrusive complex.

Results and Interpretation

Results of the radiometric grid survey are given in Figure 4. The radiometric grid survey was useful mainly in assisting mapping of intrusive phases of the Oliver plutonic complex. Its use in delineating zones of high radioactivity was limited because of the highly localized nature of those zones, and because of variable outcrop exposure, degree of leaching and overburden depth. However, used as a rapid, low-cost exploration tool in conjunction with grid mapping and prospecting on a moderate scale over the pluton, it provided useful information on background variation in the intrusive phases. Results are summarized as follows:

Kobau metasedimentary rocks	60 - 140 cps, avg. 110 cps
Dioritic rocks	60 - 100 cps, avg. 100 cps

Biotite-hornblende quartz monzonite	170 - 270 cps, avg. 200 cps
Fine-grained quartz monzonite ("aplite")	160 - 600 cps, avg. 250 cps
Porphyritic biotite quartz monzonite	170 - 250 cps, avg. 210 cps
Muscovite-garnet quartz monzonite	80 - 210 cps, avg. 140 cps

Low counts relate to areas of overburden. Variations in radioactivity between the phases are due partly to variations in K^{40} content.

Radioactive Occurrences and Disequilibrium

Anomalous radioactive occurrences in the intrusive rocks of Oliver may be roughly divided into two classes. The first of these are patches of uraniferous granite occurring in loosely defined zones within the biotite quartz monzonite. The second class involves radioactive phases of the fine grained quartz monzonite, which occur largely along the southern margin of the intrusion.

These two classes of radioactive occurrence appear to represent two very different temperature regimes during which uraniferous hydrothermal fluids were active. This difference is marked both by the level of accompanying thorium (usually an indication of relatively high temperature transport) and by the degree to which uranium is locked into mineral matrices, as opposed to being available to cold extractive leaching. During the fine-grained quartz monzonite phase of uranium mobility there was copious thorium involved, with over 500 ppm being encountered in some samples. The radioactive greisen of the Gypo quartz pit was also found to have considerable thorium and near-equilibrium uranium, suggesting that this was dominantly a hydrothermal deposition of at least moderate temperature. The uranium in the fine-grained quartz monzonite is not very leachable by either cold acid or by carbonate solutions.

The strange radioactive patches in the main biotite quartz monzonite body have up to a few hundred ppm of uranium, yet thorium contents which are little, if any, above background. Leaching tests have shown that most of this uranium is loosely bound and easily stripped. Equilibrium measurements show an unusual tendency toward an excess of daughter products over the parent uranium, presumably reflecting the selective nature of "alkaline transport" leaching, which mobilizes uranium while leaving radium and ionium. These "patches" are a very peculiar form of uranium occurrence, in view of their small size and lack of visible alterations. Both thin section work and multi-element geochemistry have failed to show anything else really distinctive about the uraniferous patches as compared to the surrounding rock. This again points to the low temperature and presumably late-stage nature of the fluids depositing this uranium. We consider it very significant that such a potent fluid was active over a portion of the intrusion during the cooling stages of plutonium. This significance is assigned not only by comparison to the French intragranite deposits, but also because at this stage a fluid would likely be guided to a major extent by fractures and unusually susceptible to a variety of uranium "traps", both physical and chemical.

BREAKDOWN OF COSTS

For assessment purposes (approximate only).

Wages and Salaries	$6,900.00	
Benefits at 12%	828.00	$ 7,728.00
Meals and accommodation		2,100.00
Transportation - mainly truck rental		1,100.00
Assay costs including equilibrium tests		3,800.00
Miscellaneous; includes report preparation, geophysical equipment rental, etc.		2,300.00
TOTAL		$17,028.00

CERTIFICATION

I, R.R. Culbert, do hereby certify that:

1. I am a practicing Professional Geological Engineer with offices at 3152 West 10th Avenue, Vancouver, B.C.

2. I am a graduate of the University of British Columbia, BASc. (1964), PhD. (1971).

3. I have practiced mining exploration for fifteen years, most of which were based in British Columbia.

4. I am a member in good standing of the Association of Professional Engineers of the Province of British Columbia.

5. I have personally visited the OLIVER property and supervised exploration work carried out there.

Respectfully submitted,

R.R. Culbert, PhD., P.Eng.

10 June 1978

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PAY PERIOD: 1 – 15 ☒ / 16 – 30 ☒ — Mar. 19 78

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1	OLIVER PROPERTY	103	BRINEX
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3			
4			
5			

Name/Project	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Time Total	Rate	Amount	Benefits		
L. O. ALLEN																																					
R.J. BEATY																X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		15 D	100	1500 –	180 –		
																G	G	G	G	G	G	G	I	I	I	I	G	G	G	I							
R.J. BILQUIST	X	X	X	X	X									X	X	X	X	X	X													11 D	85.00	935 –	112 20		
	F	F	F	F	F									P	P	P	P	P	P																		
R.R. CULBERT																																					
K.I. LU	X	X	X	X	X									X					X													7 D	150.00	1050 –	126 –		
	G	G	G	G	G									G					G																		
TOTALS																																33 D		3485 –	418 20		

CLASSIFICATIONS

- A Airphoto Work
- B Budget
- C Compilation/Drafting
- D Drill Supervision
- E Expediting
- F Line Cutting/Surveys
- G Geological (Mapping)
- H Geochemical (Sampling)
- I Geophysical (Surveys)
- J Trenching
- K Cooking/Camp
- L Logging Core
- M Mobilization/Demobilization
- N General Supervision
- O Data Analysis
- P Prospecting
- Q Consultation
- R Research
- S Staking
- T Travel
- U Underground Surveys
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- Y Secretarial/Office
- Z ....

BENEFITS: includes; W.C., U.I.C. & Insurance 12 **% Salary Total**

REMARKS; Room & board @ $35.00/man/day
∴ 33 D × 35.00 = $1155.00

PREPARED BY: D.G. Leighton

APPROVED:

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PAY PERIOD 1 – 15 ☒ / 16 – 30 ☒ — April 19 78

Name/Project	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Time Total	Rate	Amount		Benefits	
L.O. ALLEN		X	X	X	X	X	X	X		X																						8 D	50.00	400	00	48	–
		F	F	F	F	F	F	F		F																											
R.J. BILQUIST		X	X	X	X	X	X	X	X	X																						9 D	85.00	765	–	91	80
		P	P	P	P	P	P	P	P	P																											
R.J. BEATY																																					
															X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			15 D	100.00	1500	–	180	–
R.R. CULBERT															G	G	G	G	G	G	G	G	G	G	G	G	G	G	G								
																											X	X	X	X	X	5 D	150.00	750		90	–
K.I. LU																											G	G	G	G	G						
TOTALS																																32 D 5 D		2665 750	–	319 90	80 –

CLASSIFICATIONS

- A Airphoto Work
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- C Compilation/Drafting
- D Drill Supervision
- E Expediting
- F Line Cutting/Surveys
- G Geological (Mapping)
- H Geochemical (Sampling)
- I Geophysical (Surveys)
- J Trenching
- K Cooking/Camp
- L Logging Core
- M Mobilization/Demobilization
- N General Supervision
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- S Staking
- T Travel
- U Underground Surveys
- V Property Examination
- W Legal
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- Y Secretarial/Office
- Z ....

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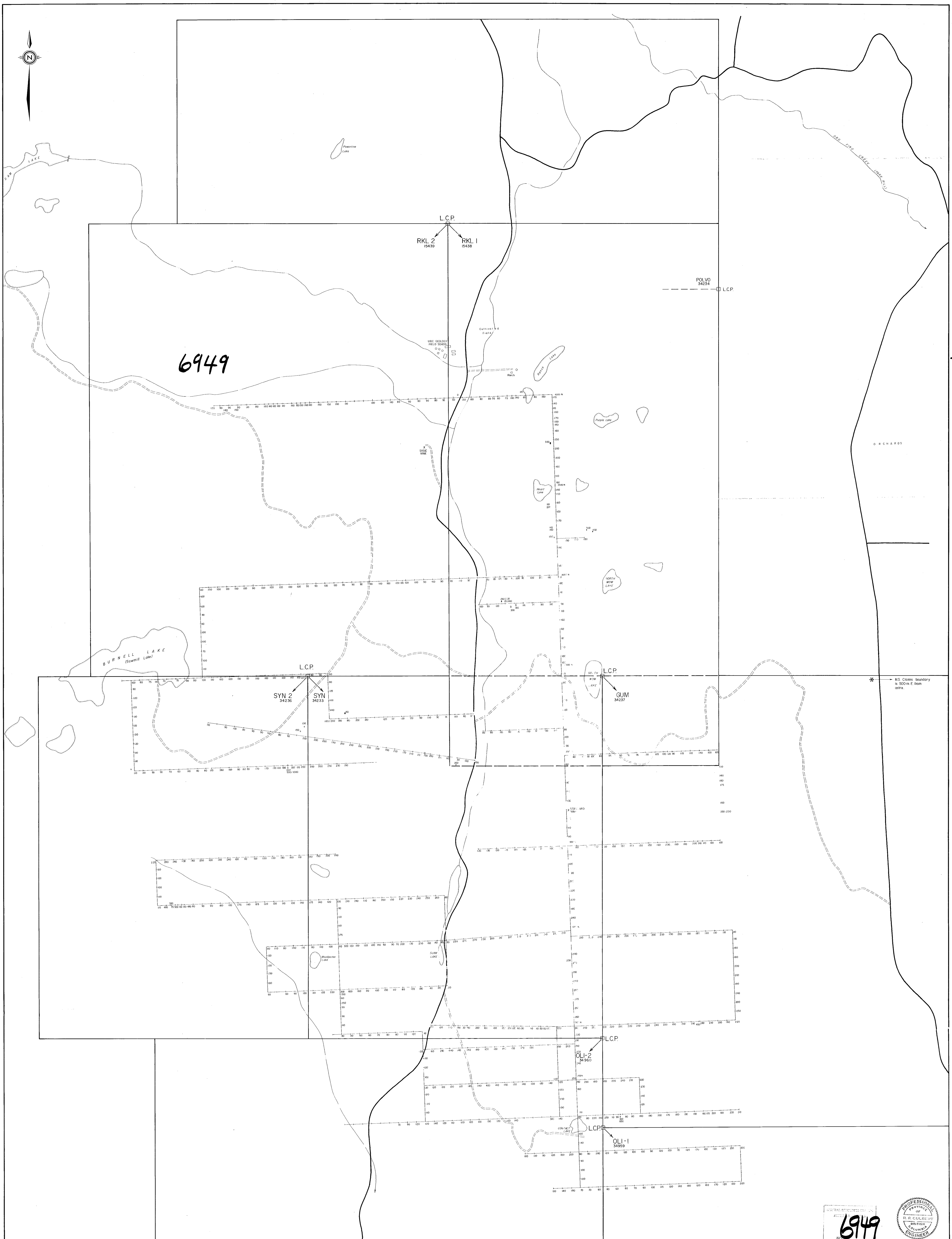
5 D × 35.00 175.00
1295.00

PREPARED BY: D. G. Leighton

APPROVED:



PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA R. R. CULBERT

FIGURE 4

D. G. LEIGHTON & ASSOCIATES

OLIVER PROPERTY

RADIOMETRIC GRID SURVEY

SCALE 1:500

METRES 10 5 0 10 20 30 40 METRES

PROJECT	PROJECT No.	DATE	DRAWN
S.B.C. URANIUM	103	JUNE-1978	Altair


6949
L.C.P.
RKL 2
15439
RKL 1
15438
POLVO
34234
L.C.P.
SYN 2
34236
SYN
34233
GUM
34237
OLI-2
34960
OLI-1
34959
BURNELL LAKE
(Sawmill Lake)
VICTORIA CREEK
EDGE OF OUTCROP
ORCHARDS
AREA MAPPED IN DETAIL: K. LU
AREA MAPPED IN DETAIL BY: R. BEATY
SEE FIGURE 6
ZONE OF HIGH MnO_2
Gypo Quartz Quarry
N.S. Claims boundary is 500m E. from extra.
LEGEND
TERTIARY
La Lamprophyre dikes
Other dikes: andesite, augite porphyry, ?phonolite, hornblende – lath monzonite, dacite.
OLIVER PLUTONIC COMPLEX MID-JURASSIC
Mg QM Muscovite – garnet quartz monzonite
T_3 Contact zone: may contain muscovite and biotite together, may be pegmatitic; may be porphyritic.
pb QM Porphyritic biotite quartz monzonite ("Oliver granite")
T_2 Transition zone: may be porphyritic; contains abundant hornblende & little biotite
bh QM Biotite-hornblende quartz monzonite ("Oliver syenite")
fg QM Fine grained quartz monzonite.
T_1 Zone of intermixed porphyritic biotite quartz monzonite and dioritic rocks.
Di Dioritic rocks.
KOBAU GROUP CARBONIFEROUS ?
K Metasedimentary rocks: massive and laminated quartzite, schist, limestone, phyllite.
SHUSWAP
S High grade metamorphic rocks
Defined geological contact
Inferred geological contact
Inferred fault
Legal corner post
Dirt road
Paved road
X Old working: pit, adit, trench
Grid control lines: stations every 50m.
MINERAL RESOURCES BRANCH
6949
PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
R. R. CULBERT
FIGURE 5
D. G. LEIGHTON & ASSOCIATES
OLIVER PROPERTY
GEOLOGICAL COMPILATION
SCALE 1:5000
METRES 100 50 0 100 200 300 400 METERS
PROJECT S.B.C. URANIUM
PROJECT No. 103
DATE JUNE-1978
GEOLOGY: R.Beaty, K.Lu

D. G. LEIGHTON & ASSOCIATES

OLIVER PROPERTY

DETAILED GEOLOGY OF SOUTH CONTACT AREA

SCALE 1:4000

METRES 100 0 100 200 300 METRES

PROJECT	PROJECT No.	DATE	GEOLOGY
S. B.C. URANIUM	103	JUNE – 1978	R. BEATTY