Prospecting Report

on the

Annex 2 M.C.

Part of Monument Group

4th South Fork Lemon Creek

Slocan Mining Division

British Columbia, Canada

Lat. 49°40' Long. 117°22'

Prepared by; R.M.MacKenzie

Prospector

1409 Front St.,

Nelson, B.C. V1L 4C5

TABLE OF CONTENTS.

1. Introduction.

This report is written for evaluation for assessment purposes as defined within the Mineral Act, Geological investigations, structure interpretations, et.all. The report is based wholly on my unqualified opinion obtained by study and experience.

2. Location and access.

The Annex 5763(7) and Annex 2 6026(5) are part of the Monument Group of Mineral Claims.The Annex is located on the West side of Monument Creek 7 km.from Lemon Creek.The Annex 2 is located on the 4th South Fork of Lemon Creek 4.5 km from Lemon Creek.The Annex 2 is wholly within the Slocan M.D. and the Annex extends Southerly into the Nelson M.D. All work performed was done within the Slocan M.D. boundarys.

The property lies at latitude 49°40' and longitude 117°22' and is plotted on NTS 82F/11W.

The topography of the property is moderate to very steep in places. Part of the property is covered by commercial timber which has been logged in the past.

Access to the property is by way of the Lemon Creek road from Hwy.9 to the Monument Ck.-4th South Fork junction at Km.11.At KM 1 the Monument Creek roads turns off to the East while the 4th South Fork road continues Southerly.

3. Property description and history.

The Annex consists of 20 units overlying cancelled C.G. Northern Pac. (5511) Grand Trunk(5510) and Great Northern(5509). The Annex 2 overlays the Ontario 6(5741).No other legal surveys have been done on the property. The Annex 2 consists of 20 units.

No systematic exploration has ever been done on the property. Amax may have examined the ground held on the south east side when they were assessing the Tungsten possibilities on the Monument claim in 1965. The work on the Ontario 6 C.G. appears to have been confined to the large quartz vein at L10E10S on map accompanying.

4. Regional Geology.

The area around the Annex 2 is underlain by metamorphosed volcanic rocks and metamorphosed sedimentary rocks belonging to the Jurassic Rossland Group and by granite belonging to the Cretaceous Nelson intrusives. In this area,the rock units of the Rossland Group occur as a series of roof pendants within the Nelson intrusive. The metamorphosed volcanics in the Rossland Group are originally fine grained andesites which have been altered to greenstones. The meta-sediments in the Rossland group are black argillites and tuffaceous slates that are generally pyritic.

5. LOCAL GEOLOGY AND MINERALIZATION.

On the Annex 2 a series of banded greenstones(altered andesites) and black fissile argillites (meta-sediments) belonging to the Rossland Group that strike Az 135° with undetermined dip. The greenstones are usually well epidotized and the black argillites have disseminated pyrite. These meta-volcanics and meta-sediments form a series of roof pendants in the granite intrusive. A large Silica flooded breccia zone lies northerly of the Rossland Group of rocks (Drawings 2 & 4). This breccia is enclosed in highly altered granitic rocks which is expressed in potassic,sericitic and argillic zones of fairly narrow width thence to propylitic assemblances which extend several km. into the granites.The breccia and related rocks are likely of sub-volcanic origin uplifted by the Vahalla tectonic activity (see appendix (C).

At L10E10S (Map 2) a large quartz vein is exposed as indicated. This is believed to be the working area of the Ontario 6 C.G.(L5741). Assays 55358 and 55359 are chip samples from this vein which has width exposures of up to 15 ft. as measured by the regional geologist. Assay 55361 is from 400m south where large blocks of float which seem to have the same features appear in overburden.

6.RECOMMENDATIONS.

A thorough study be made of assays obtained this year to indicate areas favorable for future consideration. Do preliminary examination of the Annex mineral claim. Establish relationship between mineralization on the Monument to the hydrothermal system on the Annex 2 with particular attention being paid to the Tungsten-Molly horizon. Complete drillin 3 holes on the Annex 2 and complete 4 short holes on the Monument claim to enhance this structure. Have a qualified report compiled on the Annex and Annex 2 as soon as prudent.

7.SUMMARY AND CONCLUSIONS.

The structures uncovered during the season indicate there is reasonable expectations of uncovering a large ore zone within the boundarys of this property. To do this will be beyond 1 mans reach therefore presentations will be made to as many major mining companys as possible for support. Hecla is mining a hydrothermal structure near Republic Wash. which may have been likewise affected by the

Vahalla activity. Communication with them is contemplated. Presently Placer-Dome is looking at the reports on the Monument and will be advised of the results of my work on the Annex 2 this year.

8. Bibliography.

H.W.Little	1960	Nelson map area west half, G.S.C. Memoir 308, 205PP.
O.E.Bradley	1967	Canadian Exploration Ltd.
D.Silversides	1968	Amax Exploration.
Sweetkind and Duncan		Fission-track evidence for Cenozoic uplift of the Nelson batholith, southeastern B.C.
P.J.Santos, P.Eng.		Assessment report # 18934 Oct.1988 covering Monument M.C.

9. Statement of qualifications.

1960-1961-1964-1965 Prospecting classes at Nelson, B.C.
Continuing studies of text books, publications and attending numerous "Round-up's"
Prospecting experience in the following areas; Nelson, Revelstoke, Golden Cranbrook, Hope, Lytton and Princeton-Tulameen districts.
Field work with numerous geologists on property examinations and underground.

10. Appendix.

(a) Assay certificates	envelope. attached back cover
(b) maps and illustrations	attached to main text
(c) Fission-track data.	envelope attached to back cover
(d) Drawings 1-2-3-4.	pouch

STATEMENT OF COSTS.

Item 11.

Assay Costs-	Acme Analytical Labs. & bus charges	$ 528.35
Equipment Rentals and supplies-		
	4 x 4 truck-7 weeks ç $ 195.00 week	$ 1365.00
	Fuel (truck,saw,drill)	$ 870.40
	Radio rental (acct hvy logging area)	$ 206.70
	Flagging tape,pickets,hip chain thread	$ 75.14
	8 days power saw road & drill pad clearing at $ 21.75 day (no standby charged)	$ 174.00
	J.K.S. packsack D.Drill ç $ 50.00 day	$ 150.00
	1 only size IEW drill bit Boyles	$ 171.44
Report preparation;		
	Drafting supplies	$ 63.95
	photo copying	$ 45.60
	blue printing	$ 72.00
	5 days typing drafting,office expence	$ 250.00

Labour allowance; R.M.MacKenzie-June 6-14-19-28;
Jly.8-9-17-19-22-24-27-30;
Aug.1-3-9-10-12-17-18-19-22-24-26;
Sept.5-7-13-20-23-24-29;
Oct.2-10-11-12. Total 36 days 288 hrs

P.Vlahovich(rodman) Jly. 8th,30th;
Aug.22-26 Total 4 days 32 hrs

L.Ranson (diamond driller set up & drill)
Sept.29th Oct.2nd,10th,11th,12th
Total 5 days 40 hrs

Total man hours 360 hours at $13.50 hr. $ 4860.00.

Total costs $ 8832.58

Item 12.

Diamond drill log.   size IEW 1" core

0 to .60m   metasediments,some pyrite crystals,minor silica veining in section no minerals seen in silica

Assay 55360 broken from first core showing 180 ppb AU (see assay sheets attached.

total meters drilled 7.6 meters. Due to very unseasonal weather unable to get to drill sight to pick up core box.Very wet slippery snow for several days which would have required plowing of road so sight abandoned until spring when core will be logged and assayed. First 2 feet split Oct.10th & assay taken home.

Qualifications; 3 years experience with qualified geologist splitting core and packaging assay sections as well as handling sludge etc. while working as property coordinator with International King Jack Resources.

Item 12.

Conclusion of Assay Results 1990.

Rock; Assay 55329 from small vein exposure near creek on Great Northern (5509)cancelled C.G. and compares with vein structures on the Monument claims. The significance of this assay is to indicate the source of this mineralization is in the direction of the Breccia or Syentoids.

55358 & 55359 from the large quartz vein on the Annex 2 as well as 55361 (float from 1 km south) are insignificant at this time. 55358 shows very slight elevation in U.

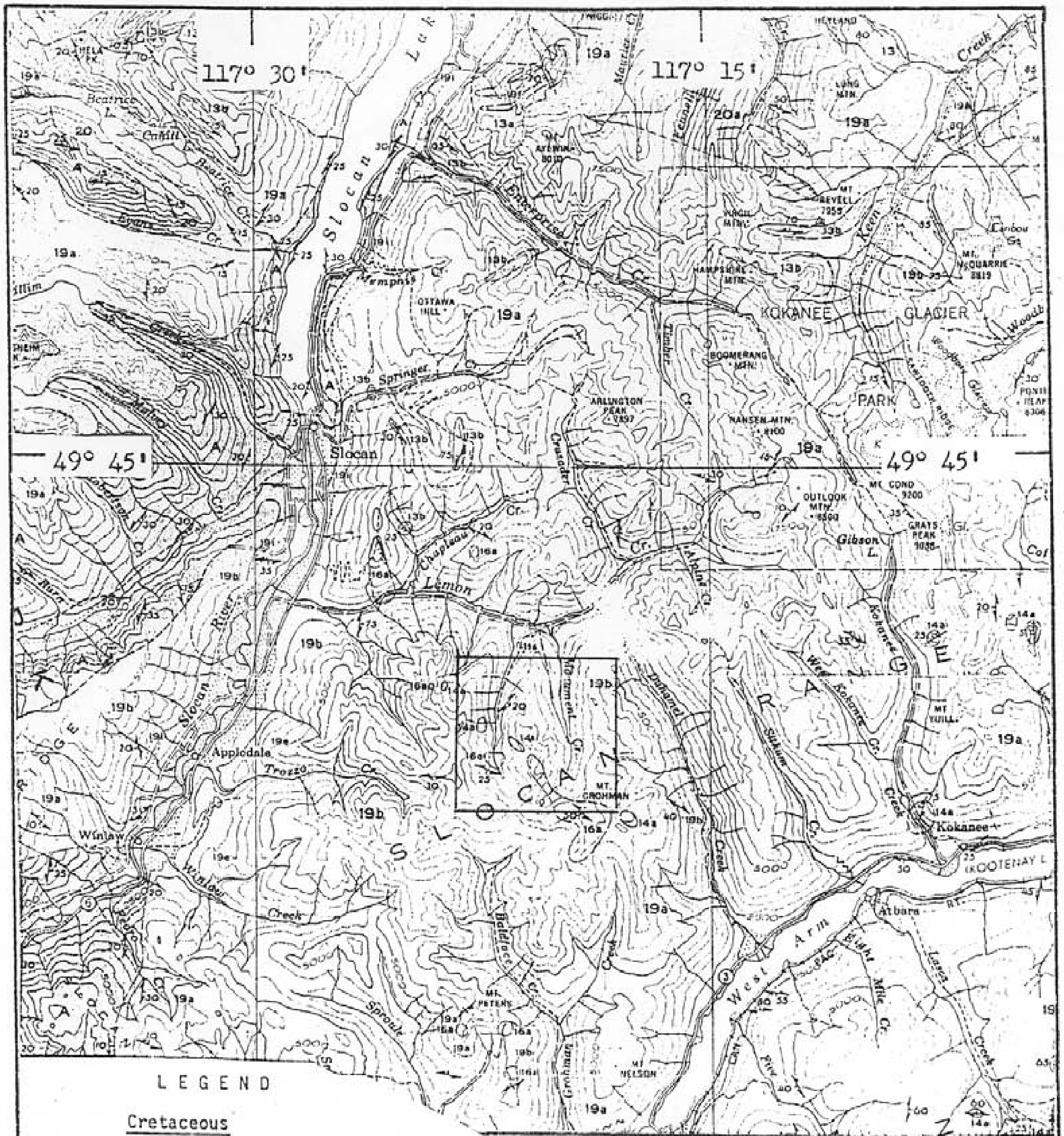
55360 from broken sections of drill core metasediments in DDH 1/90 shows values of 180 ppb AU and indicates a very close monitoring of the wallrock is required.the hole will be extended 3 meters into the footwall before being terminated next year.

All assays done on the Breccia Jan 19th Volatiles are not significant as yet. It is felt this zone is very shallow in the carapice and likely not within the tempature-pressure range of precious minerals. Hearsay has it that Hecla's Republic Wash. property has a zone limit of 60 feet with absolutely no surface indications. I will be in contact with them,hopefully,for comparisons. While there are vuggy sections within the present outcrops, I feel they are too restricted and enclosed to allow mineral percipitation. I am watching Cheni Golds Lawyers property closely for their conclusion on ore zones.
Until further information is developed I cannot at this time consider a large geo-chem program on the Breccia zone.

Moss- The U values obtained is rather limited to the meta-sediment meta-volcanic area.Assay 55360 does not substantiate the presence of U therin. I understand there is a strong affinity between moss and U.This was defined at Pine Point.My conclusion is an accumulation from the mafic rock breakdown and should not be of concern at this time as all rock samples are that which normally occur in rocks.

There are significant Pb-Zn indications taken from freshets flowing through the altered granites along with minor elevations in several other minerals. All will have to be plotted before evaluation.55318-55331-55339 indicate some strike to the Pb-Zn. More prospecting and sampling will be done in this area next year.

Assay locations shown on drawings 2 and 3



LEGEND

Cretaceous

20	VALHALLA PLUTONIC ROCKS
19	NELSON PLUTONIC ROCKS

Jurassic

16	ROSSLAND FORMATION

Triassic

13	SLOCAN FORMATION

Permian and Pennsylvanian

A	MILFORD SERIES

N

Geology by H.W. Little, GSC Memoir 308
Map 1090A

TO ACCOMPANY ASSESSMENT REPORT

ANNEX 2 R.M.MACKENZIE-PROSPECTOR

Geologic map Lemon Creek area.

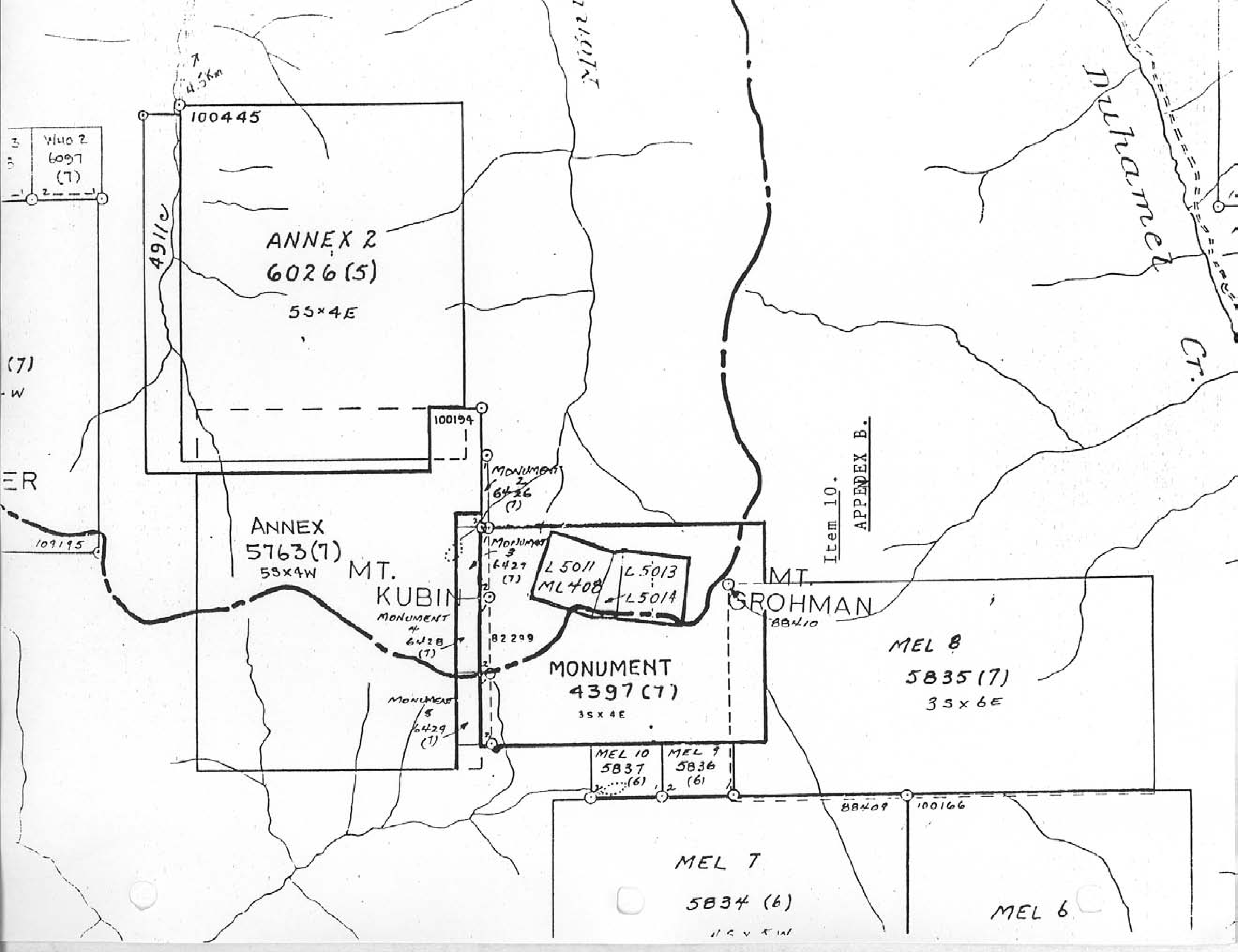
Slocan Mining Division.

Date- Jan. 1991

Scale
1 in.=4 miles

Item 10-APPENDIX B.

Item 10. APPEDEX B.



ADDENDUM TO REPORT 220950

The purpose of the traverses made were to obtain moss samples from all creeks surrounding the hydrothermal breccia as mapped on sheet 2 of 3. During this process some geological boundaries were noted but not examined for strike-dip-foliation etc.

Par. 5 on page 2 of the report explains the geology bounding the hydrothermal breccia. 1960 G.S.C.Memoir 308, Nelson map area West Half is most accurate but does not show the alteration sequences I refer to.

Assaying was done by Acme Labs Vancouver as follows.

ICP-.500 gram sample is digested with 3ml 3-1-2 HCL-HNO3-H2O at 95 deg.C for one hour and is diluted to 10ml with water. This leach is partial for MN FE SR CA P LA CR MG BA TI B W and limited for NA K and AL. AU detection limited by ICP is 3 PPM. AU* Anslysis by acid leach/AA from 10gm sample.

20950

Fission-track evidence for Cenozoic uplift of the Nelson batholith, southeastern British Columbia

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Apatite and zircon fission-track data from the Nelson batholith in southeastern British Columbia reveal that a significant amount of uplift has occurred since Paleocene time, including an episode of rapid uplift during Eocene time. Age versus elevation curves for apatite and zircon, combined with a calculated present depth to the 105°C apatite-annealing isotherm, suggest that some 6 km of apparent uplift has occurred in the vicinity of the Nelson batholith since Paleocene time. A period of rapid cooling and uplift occurred from 59 to 45 Ma, when the bounding faults of the adjacent Valhalla gneiss dome, the Valkyr shear zone, and the Slocan Lake fault zone were active. The rapid uplift is interpreted as being related to Eocene extension and the rise of the adjacent Valhalla gneiss dome during Eocene time.

L'étude des traces nucléaires dans l'apatite et le zircon du batholite de Nelson, dans le sud-est de la Colombie-Britannique, révèle que depuis le Paléocène il s'est produit un soulèvement appréciable, incluant un épisode de soulèvement rapide durant l'Éocène. Les âges pour l'apatite et le zircon versus les courbes d'élévation, combinés à la profondeur actuelle calculée pour l'isotherme de recristallisation de l'apatite à 105°C, suggèrent qu'aux environs du batholite de Nelson, il y a eu depuis le temps du Paléocène un soulèvement apparent de plus ou moins 6 km. Une période de refroidissement et de soulèvement rapides est apparue entre 59 et 45 Ma, au momemt où les failles délimitant le dôme de gneiss de Valhalla adjacent, la zone de cisaillement de Valkyr et la zone de failles du lac Slocan étaient actives. Le soulèvement rapide est interprété comme étant lié à une distension éocène et à l'ascension du dôme de gneiss de Valhalla adjacent durant le temps de l'Éocène.

[Traduit par la revue]

Can. J. Earth Sci. 26, 1944–1952 (1989)

Introduction

Although it has long been known that southeastern British Columbia was tectonically active during the Tertiary (Ewing 1981), it is only recently that large-scale Early and Middle Eocene normal faulting in the area has been recognized (Price 1979; Harms and Price 1983; Lane 1984; Tempelman-Kluit and Parkinson 1986; Carr *et al.* 1987; Parrish *et al.* 1985*b*, 1988). In particular, many of the faults bounding the metamorphic core complexes in southeastern British Columbia and northern Washington have been shown to have significant normal displacement in Eocene time. The Nelson batholith adjoins several important tectonic boundaries in southeastern British Columbia, including the boundaries of the Eastern Assemblage and Quesnellia Terrane and the bounding fault of the Valhalla gneiss dome, the Slocan Lake fault zone (SLFZ) (Archibald *et al.* 1983). The proximity of the Nelson batholith to the SLFZ allows the suggestion that Eocene dates from the Nelson batholith may be related to Eocene uplift of the Valhalla gneiss dome and normal movement along the SLFZ.

The technique of fission-track dating has been used in many areas to quantify uplift rates and magnitudes (Schaer *et al.* 1975; Gleadow and Lovering 1978; Harrison *et al.* 1979; Parrish 1983; Kelley and Duncan 1986) as well as the timing of uplift (Nelson 1982; Wagner *et al.* 1979; Zeitler *et al.* 1982). Fission-track dating is used here to constrain the Tertiary thermal and uplift history of the Nelson batholith and its relationship to the SLFZ.

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Geologic setting

The Nelson batholith lies in southeastern British Columbia between Kootenay Lake and Slocan Lake (Fig. 1). The batholith is a large, composite pluton of granodiorite to quartz monzonite composition (Little 1960, 1982; Sinclair and Libby 1969) and consists of a main body north of Kootenay Lake, an elongate "tail" south of the lake, and associated plutons such as the Bonnington pluton to the south. The batholith is one of several large plutons that intruded during the final stages of accretion of a group of consolidated terranes during the Middle Jurassic (Monger 1977; Monger and Price 1979; Monger *et al.* 1982; Brown *et al.* 1986). The northern and southern margins of the Nelson batholith intrude metavolcanic, metasedimentary, and ultramafic rocks of the Eastern Assemblage (Lower Permian Kaslo Group) and the Quesnellia Terrane (Upper Triassic Slocan Group and Lower Jurassic Rossland Group) (Little 1960, 1982; Read and Wheeler 1976; Corbett and Simony 1984; Klepacki 1983; Klepacki and Wheeler 1985; Klepacki *et al.* 1985). Both terranes were obducted onto the Proterozoic and Paleozoic passive continental margin rocks of the Kootenay Arc during the Late Triassic to Early Jurassic (Monger 1977; Monger *et al.* 1982; Archibald *et al.* 1983; Brown *et al.* 1986). The northern margin of the Nelson batholith intrudes rocks of both terranes and cuts across all faults within the terranes (Klepacki and Wheeler 1985); in many places, a contact aureole 1 km wide overprints the regionally metamorphosed country rock (Cairnes 1934; Childs 1968; Archibald *et al.* 1983). The Nelson batholith adjoins the Proterozoic and Paleozoic rocks of the Kootenay Arc along its eastern border (Rice 1941; Little 1960). This border is charac-

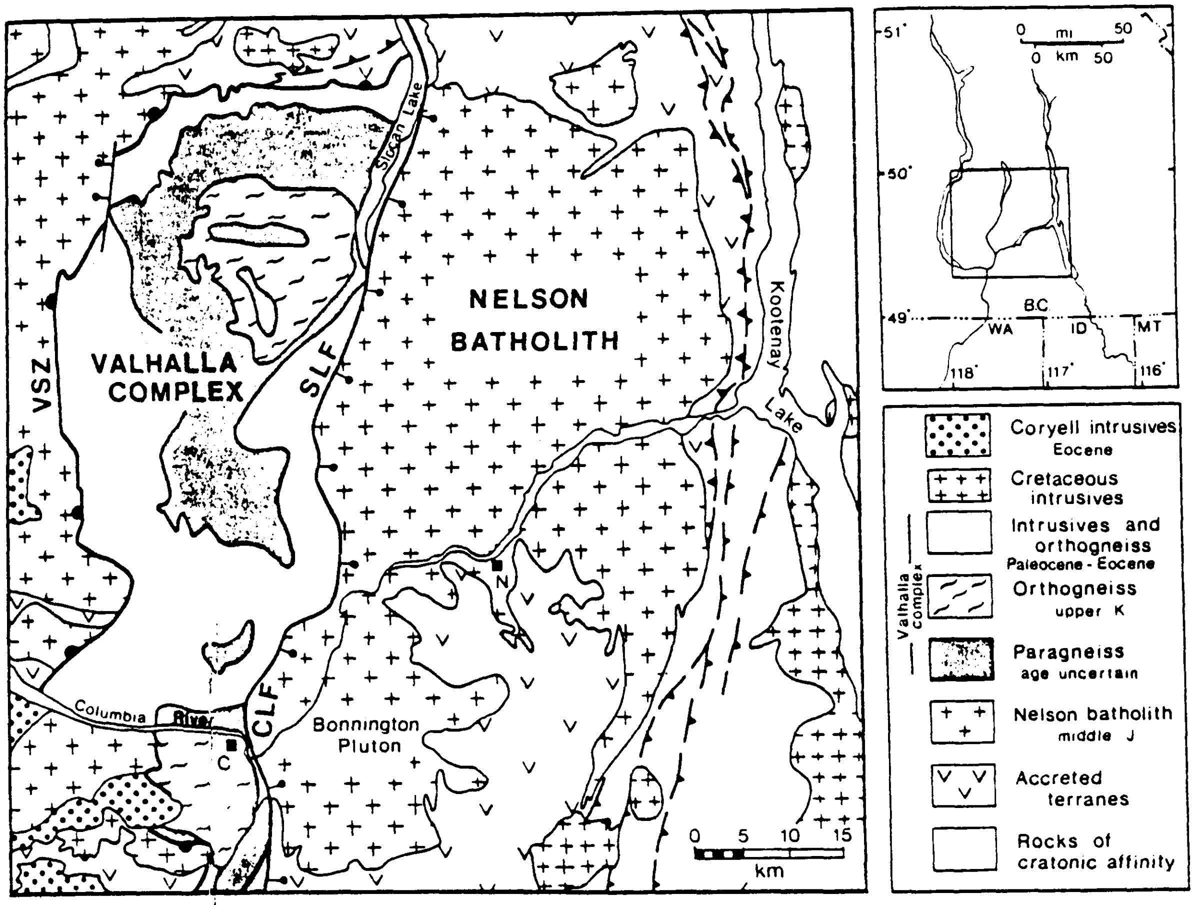

FIG. 1. Generalized geologic map of the Nelson batholith and surrounding areas. Rocks of cratonic affinity include Precambrian Purcell and Windermere supergroups and Eocambrian to Pennsylvanian rocks of the Kootenay Arc. Accreted terranes are dominantly Late Triassic Eastern Assemblage east and north of the Nelson batholith and Early Jurassic Quesnellia south and west of the Nelson batholith. Abbreviaitons: SLF, Slocan Lake Fault; VSZ, Valhalla Shear Zone; CLF, Champion Lake Fault; C, town of Castlegar; N, town of Nelson; J, Jurassic; K, Cretaceous. Map compiled from Parrish *et al.* (1985*b*), Carr *et al.* (1987), Klepacki and Wheeler (1985), Corbett and Simony (1984), Journeay and Brown (1986), Little (1960, 1982), and Rice (1941).

terized by a zone of mylonitic and crushed prophyritic granite several hundred metres wide, with a contact-metamorphic zone only a few tens of metres wide (Cairnes 1934; Fyles 1967; Archibald *et al.* 1983).

The Valhalla metamorphic core complex lies to the west of the Nelson batholith (Fig. 1). The polydeformed complex consists of arched sheets of orthogneiss and paragneiss with shallowly outward-dipping metamorphic layering and mylonitic foliation and pervasive east–west mineral lineations (Reesor 1965; Simony 1979; Parrish 1984; Parrish *et al.* 1985*a*, 1985*b*; Carr 1985; Carr *et al.* 1987). Recent work has documented that a significant amount of ductile strain occurred during Eocene time (Corbett and Simony 1984; Carr 1985; Carr *et al.* 1987; Parrish 1984; Parrish *et al.* 1985*a*, 1985*b*, 1988). The high-grade rocks of the Valhalla complex are roofed by and separated from the lower grade rocks of the Nelson batholith, Quesnellia Terrane, and Eastern Assemblage by the ductile Valkyr shear zone (VSZ) and the SLFZ – Champion Lake Fault, a mylonitic, eastward-dipping brittle–ductile shear zone. Both shear zones have significant east-directed Eocene displacement (Corbett and Simony 1984; Carr 1985; Carr *et al.* 1987; Parrish 1984; Parrish *et al.* 1985*a*, 1988). The SLFZ has been detected as a shallowly dipping seismic relector underlying the Nelson batholith (Cook *et al.* 1987). A similar reflector has been detected associated with mylonites flanking the Kettle Dome in northeastern Washington (Hurich *et al.* 1985).

The Nelson batholith has yielded K–Ar dates ranging from 49 to 171 Ma (Gabrielse and Reesor 1964; Nguyen *et al.* 1968; Duncan 1982; Archibald *et al.* 1983). Rb–Sr mineral and whole-rock isochrons and hornblende $^{40}Ar/^{39}Ar$ spectra determined from samples from the Nelson batholith confirmed a Late Jurassic (160–150 Ma) emplacement age for the batholith (Duncan *et al* 1979; Duncan and Parrish 1979; Duncan 1982; Harrison 1985). Results of preliminary fission-track dates (Duncan 1982) and recent $^{40}Ar/^{39}Ar$ spectrum analyses from the batholith (Harrison 1985) suggested that the batholith may have been involved in the Tertiary thermal event first noted in the Okanagan Valley (Ross 1974; Medford 1975; Mathews 1981).

Analytical techniques

Fresh granodiorite rock samples weighing 3–5 kg were collected for this study along two traverses, one a north–south traverse across the Nelson batholith and the other traverse near

TABLE 1. Fission-track analytical data, Nelson batholith

Sample	Latitude	Longitude	Altitude (m)	Mineral	ρ_s (10^6t cm^{-2})	Tracks, s	ρ_i (10^6t cm^{-2})	Tracks, i	ϕ ($10^{14}\lambda$ cm^{-2})	Date (Ma ± SE)	η, s/i
KH1	49°44′50″	117°08′58″	2804	Apatite	0.43	236	0.70	388	8.98	32.6±3.1	50/50
					0.45	247	0.59	326		40.6±3.4	50/50
KH1	49°44′50″	117°08′58″	2804	Zircon	24.8	336	19.0	260	8.61	62.4±5.3	11/11
KH2	49°44′39″	117°08′55″	2484	Apatite	0.27	435	0.46	733		33.0±2.2	100/100
					0.27	152	0.47	263	9.24	31.9±2.9	50/50
					0.31	170	0.45	251		37.3±3.2	50/50
KH2	49°44′39″	117°08′55″	2484	Zircon	20.9	412	20.0	394	8.46	52.7±2.9	16/16
KH3	49°44′20″	117°09′39″	1981	Apatite	0.21	339	0.41	652	8.82	27.4±2.1	100/100
					0.23	126	0.39	219		30.3±2.8	50/50
KH3	49°44′20″	117°09′39″	1981	Zircon	13.7	202	13.7	202	8.52	50.7±2.4	12/12
KH4	49°41′22″	117°08′20″	1676	Apatite	0.37	721	0.60	1164	8.90	33.6±2.0	100/100
KH4	49°41′22″	117°08′20″	1676	Zircon	17.0	367	17.0	372	8.55	50.5±3.2	18/18
KH5	49°37′33″	117°08′25″	914	Apatite	0.087	169	0.34	652	9.59	14.9±1.4	100/100
					0.13	145	0.41	453		18.3±2.0	100/100
KH5	49°37′33″	117°08′25″	914	Zircon	11.0	158	12.0	174	8.62	45.6±4.5	12/12
OM1	49°44′44″	117°11′24″	2469	Apatite	0.27	431	0.48	775	9.50	30.8±2.0	100/100
SS1	49°49′42″	117°06′08″	2688	Apatite	0.32	621	0.38	741	8.73	42.5±2.6	100/100
SS1	49°49′42″	117°06′08″	2688	Zircon	16.3	321	13.1	258	8.48	62.8±5.0	16/16
SS2	49°48′48″	117°07′28″	2591	Apatite	0.39	432	0.65	719		35.0±3.3	100/100
					0.16	124	0.22	179		41.6±2.9	50/50
SS3	49°50′55″	117°02′55″	2545	Apatite	0.14	80	0.19	104	9.84	45.1±4.8	50/50
SS3	49°50′55″	117°02′55″	2545	Zircon	15.3	226	14.3	212	8.59	55.6±3.3	12/12
SP1	49°52′07″	117°04′41″	2438	Apatite	0.17	323	0.23	452	10.1	43.2±3.5	100/100
SP2	49°52′22″	117°05′00″	2240	Apatite	0.21	237	0.34	381	9.15	34.0±2.1	100/100
SP3	49°52′33″	117°05′03″	2240	Apatite	0.18	85	0.28	134	9.07	34.3±3.2	25/25
SP3	49°52′33″	117°05′03″	2240	Zircon	17.4	364	17.0	356	8.54	52.0±3.1	17/17
SP4	49°52′41″	117°05′01″	2172	Apatite	0.12	226	0.17	330	10.2	41.7±4.1	100/100
SP6	49°53′40″	117°05′06″	1524	Apatite	0.13	74	0.25	137	9.93	32.0±3.1	50/50
					0.086	48	0.20	111		25.4±2.9	50/50

NOTES: ρ_s, spontaneous track density; ρ_i, induced track density; ϕ, thermal neutron dose; SE, standard error; η, number of grains or fields counted; s, spontaneous decay constant; i, induced decay constant; λ^{238} (fission) = 7.00×10^{-17} a^{-1}; λ^{238} (alpha) = 1.55125×10^{-10} a^{-1}, λ^{235} (alpha) = 9.8485×10^{-10} a^{-1}. Other constants: ^{238}U/^{235}U = 137.88; $\alpha_f = 580 \times 10^{-24}$ cm^{-2}.

the eastern contact of the Bonnington pluton. In addition to the granitic suite, one sample of the metamorphic country rock north of the Nelson batholith yielded enough apatite separate to be dated. The 22 apatite and 19 zircon concentrates were separated from the rocks using standard heavy-liquid and magnetic separation procedures. The minerals were dated as outlined in Naeser (1978). The samples were irradiated at the Georgia Institute of Technology nuclear reactor, and the neutron flux was calibrated using the Fish Canyon zircon fission-track dating standard (Naeser and Cebula 1978) and National Bureau of Standards glass SRM962. Dates were calculated according to the fission-track age equation in Fleischer *et al.* (1975). The errors in the fission-track ages were calculated using the technique described in Johnson *et al.* (1979). Analytical results are presented in Table 1.

Results

Apatite fission-track dates from the Nelson batholith vary from 45.1 to 14.9 Ma (Fig. 2). Zircon dates vary from 64 to 46 Ma (Fig. 3). There is no apparent geographical variation of fission-track dates; all age variations appear to correlate with elevation difference.

Apatite dates show a simple linear variation with elevation (Fig. 4). Age error is shown for each sample as a horizontal bar, and multiple dates from the same sample are shown as separate bars. Zircon dates (Fig. 5) are again well correlated, but there is a dogleg in the trend at 2.6 km.

The scatter of the apatite data (Fig. 4) probably represents local variation of apatite apparent age within the batholith. Fission tracks in apatite anneal at very low temperatures (105°C ± 10°C) and correspondingly shallow depths (Naeser and Faul 1969; Calk and Naeser 1973; Naeser 1978). An apatite sample buried 3 km deep may only require a temperature increase of a few tens of degrees to anneal its fission tracks. A low closure temperature makes apatite susceptible to the thermal effects of shallow dike intrusion or fluid flow along faults and joints. Some of the samples for this study were collected near joints, veins, or dikes, which may have affected the apatite date. Apatite dates affected by local temperature variations would be shifted to the left on the apparent are versus elevation plot. Zircons are only reset by larger thermal perturbations and do not show the same local variations in apparent age (Fig. 5).

Interpretation

Uplift history

The apatite dates (Fig. 4) define an apparent uplift rate of around 80 m Ma^{-1} for the period between 45 and 20 Ma. One sample taken from Kootenay Arc rocks east of the batholith, SP8, is significantly older than samples taken at this elevation within the batholith. This older date may be the result of differential uplift between the Nelson batholith and the Kootenay Arc. Sample SP8 was not included when the apatite data were regressed, since it may have had a different thermal history from the rest of the samples. The apatites record a period of slow post-Eocene uplift of the Nelson batholith. If it is assumed that the apparent uplift rate approximates the actual rate of uplift and erosion, the total erosion between 45 and 20 Ma is around 2.0 km.

The amount of apparent uplift between 20 Ma and the present can be estimated by calculating the present depth at which the apatites have a date of zero (the 105°C isotherm) using the formula

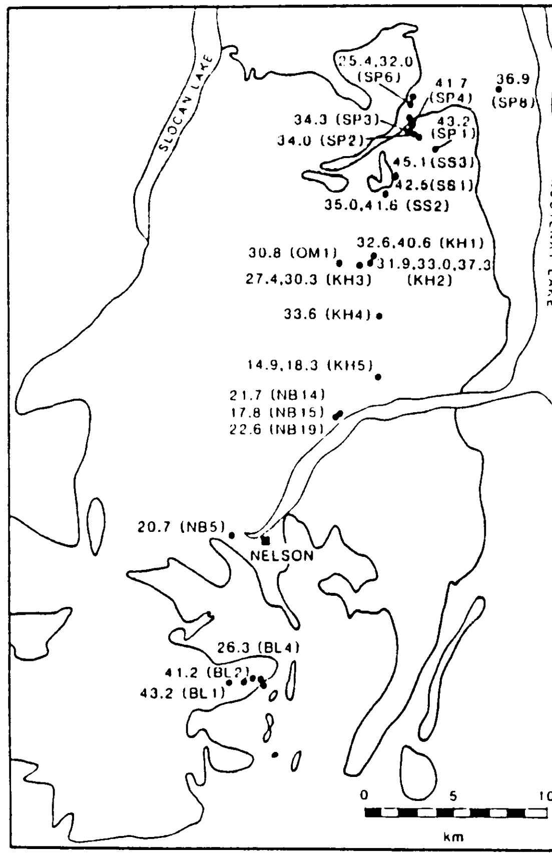

FIG. 2. Location map of apatite fission-track dates, Nelson batholith. Fission-track date is shown beside each sample location. Sample numbers are in parentheses.

$$T(Z) = Q^*(Z/K) + D^2(A_0/K)(1 - e^{(-Z/D)}) + a$$

where $T(Z)$ is the temperature at depth Z below the average surface altitude, Q^* is the reduced heat flow, K is the conductivity, D is the scale height of the assumed exponential heat-production layer. A_0 is the surface heat production, and a is the mean atmospheric temperature at the average altitude. Values for these variables are as follows: A_0, 1.0 W m^{-3}; K, 2.5 W m^{-1} K^{-1} (Lewis 1976); Q^*, 75 mW m^{-2} (Davis and Lewis 1984); D, 8 km. The average altitude in the vicinity of the Nelson batholith is 1.7 km, and the probable mean annual temperature at that altitude is approximately 5°C. Using these figures, the 105°C apatite annealing isotherm is approximately 3 km below the average surface elevation. This calculated depth is dependent upon the value used for reduced heat flow (and its variation through time) and upon the effect of topography. Although presently measured values for Q^* remain a consistent 75 mW m^{-2} across southern British Columbia (Davis and Lewis 1984), reduced heat flow might be reasonably varied between 63 mW m^{-2} (1.5 heat-flow units (HFU)) and 93 mW m^{-2} (2.2 HFU), producing a possible variation of ±500 m in the depth to the 105°C isotherm.

Because of the large amount of relief in the Nelson batholith, the effect of topography on subsurface temperature must be considered. Isotherm shape was calculated using a two-dimensional downward-continuation model where the effect of topography was superimposed on an initial gradient of 33°C–km^{-1}. Isotherms were found to roughly parallel the topography, although in a subdued fashion. The depth to the

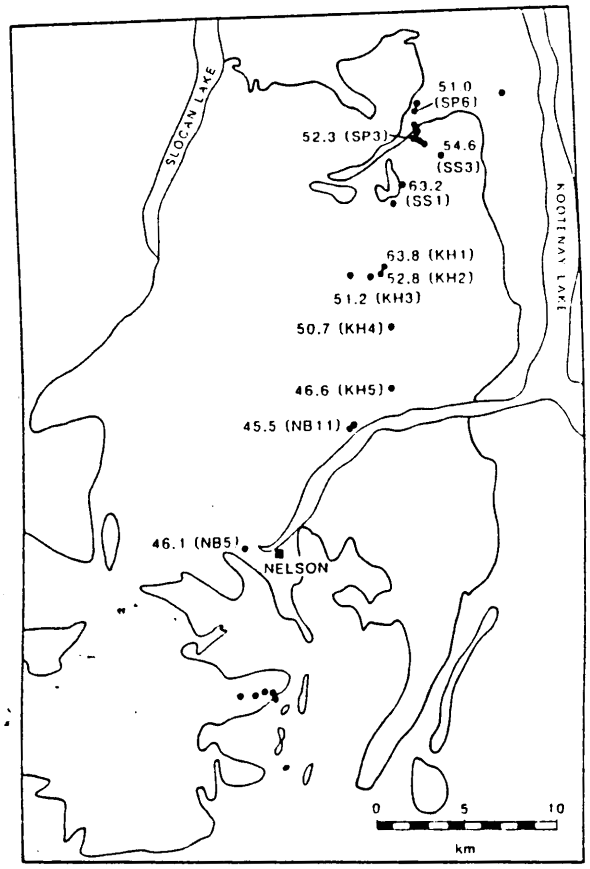

FIG. 3. Location map of zircon fission-track dates, Nelson batholith. Fission-track date is shown beside each sample location. Sample numbers are in parentheses.

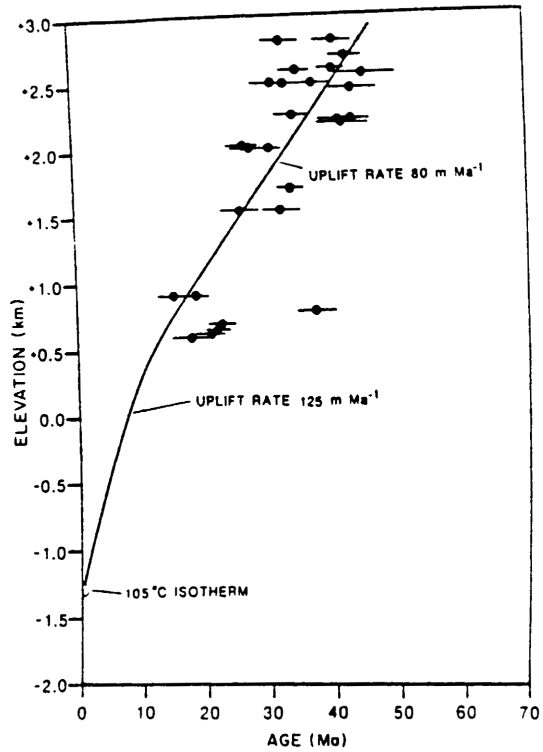

FIG. 4. Apatite fission-track apparent age vs. elevation, Nelson batholith. Error bars are 1SE. The calculation of the present-day position of the 105°C isotherm (open circle) is discussed in the text. The least-squares fit of the apatite data yields an apparent uplift rate of 80 m Ma^{-1}.

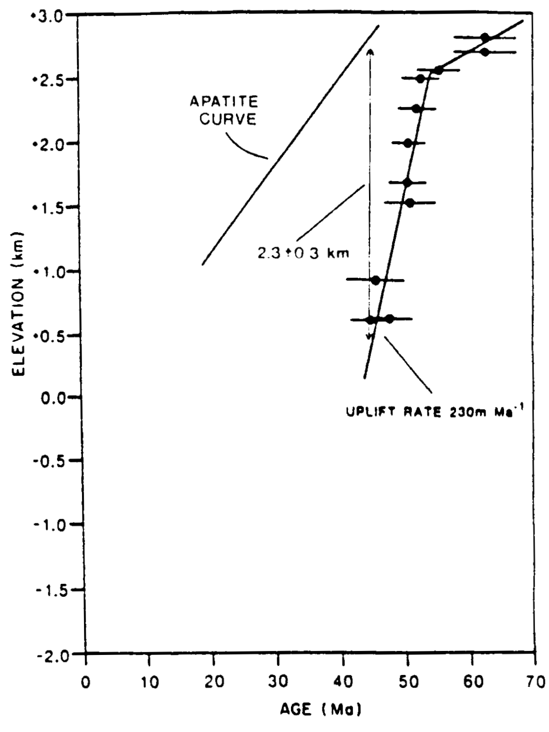

FIG. 5. Zircon fission-track apparent age vs. elevation, Nelson batholith. Zircon dates are shown as solid circles with error bars of 1SE. The least-squares fit of the zircon data yields an apparent uplift rate of about 230 m Ma^{-1}. The apatite curve from Fig. 4 is shown. Zircon and apatite dates overlap at 44 Ma. The difference in elevation of 2.3 ± 0.3 km is used to calculate a paleogeothermal gradient, as discussed in the text.

105°C isotherm varies between 2.5 and 3.5 km, being greatest under the high peaks and least under the valleys. Thus the depth to the 105°C isotherm, calculated by using an average surface elevation, has an error of approximately ±500 m. Possible variations in regional heat flow add an additional uncertainty of ±500 m to the calculated depth of the 105°C isotherm, so that the total uncertainty may be ±1 km, although the two errors are not strictly additive. If it is assumed that the isotherms have remained parallel to the surface, the 20 Ma samples at the level of Kootenay Lake (0.7 km) have been uplifted about 2.5 km in the past 20 Ma, an average apparent uplift rate of 125 m Ma^{-1} (0.125 km Ma^{-1}). This estimated apparent uplift rate is shown on the apatite apparent age versus elevation plot (Fig. 4).

The zircon dates (Fig. 5) define a rapid apparent uplift rate of 230 m Ma^{-1} (0.230 km Ma^{-1}) for the period 55–45 Ma. A few older dates may define a very low pre-55 Ma apparent uplift rate of 0.03 km Ma^{-1}; however there are too few data to place much confidence in this part of the curve. Total apparent uplift for this period is about 2.5 km. If the apparent uplift indicated by the zircons and apatites and the calculated depth to the apatite-annealing isotherm are combined, some 5–7 km of apparent uplift is suggested for the Nelson batholith since the beginning of Eocene time. The above apparent uplift rates represent one model of uplift derived from best-fit curves of the mineral dates. The amount of apparent uplift will only equal the true amount of erosion if the geothermal gradient was constant (Parrish 1983). Given the uncertainties in the apatite and zircon dates, the scatter of data points on the apparent age

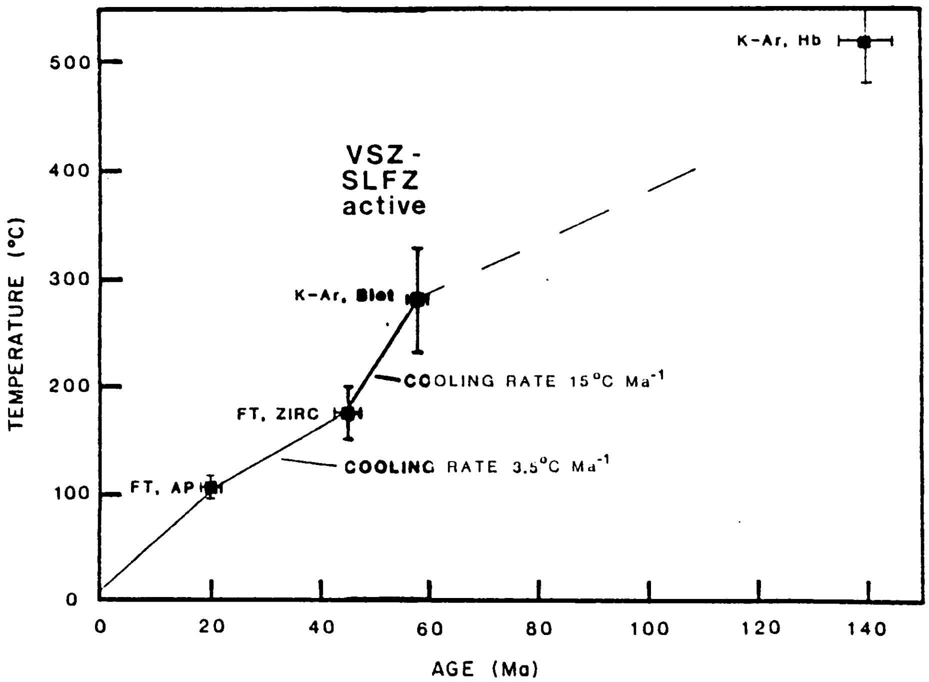

FIG. 6. Apparent cooling history of NBII-1 locality. Plot of mineral age vs. blocking temperature for fission-track (FT) and K–Ar data. Cooling rate increases dramatically between 60 and 45 Ma, the time that the Valkyr shear zone (VSZ) and Slocan Lake fault zone (SLFZ) were active. AP, apatite; Biot, biotite; Hb, hornblende; ZIRC, zircon.

versus elevation plots, and uncertainties in estimating the geothermal gradient at that time, other models are certainly possible.

Cooling history of the batholith

Mineral dates can be combined with their established closure temperature to estimate a cooling rate for a particular sample. A cooling curve has been constructed for one Nelson batholith sample, taken from a locality 1 km west of the town of Nelson. This cooling curve (Fig. 6) uses K–Ar hornblende and biotite dates from Duncan (1982), analyses of $^{40}Ar/^{39}Ar$ spectra from Harrison (1985), and fission-track zircon and apatite dates from this study. Closure temperatures used are 105° ± 10°C for apatite (Naeser and Faul 1969; Calk and Naeser 1973; Naeser 1978); 175° ± 25°C for zircon (Naeser 1978; Harrison *et al.* 1979); 280 ± 50°C for K–Ar in biotite (Harrison and McDougall 1980); and 530° ± 40°C for K–Ar in hornblende (Harrison and McDougall 1980). These cooling data could be fit by a straight line, which is more typical of a history of uplift and erosion than one of thermal resetting (Harrison *et al.* 1979). The slope of a portion of this curve will yield a cooling rate in degrees Celsius per million years. For the period from 40 to 20 Ma, the sample cooled approximately 70°C from the closure temperature of zircon (175°C) to the closure temperature of apatite (105°), yielding an average cooling rate of 3.5°C Ma^{-1}. Cooling rates during Eocene time were much higher (15°C Ma^{-1}) and were the result of rapid uplift during that time (Archibald *et al.* 1984; Parrish 1984; Okulitch 1985; Harrison 1985; Parkinson 1985; Tempelman-Kluit and Parkinson 1986; Carr *et al.* 1987; Parrish *et al.* 1988).

The apatite and zircon curves for the Nelson batholith overlap at 44 Ma (Fig. 5). An approximate geothermal gradient at this time can be calculated by dividing the difference in closure temperature between apatite and zircon (around 70° ± 15°C) by the projected altitude difference between the curves (2.3 ± 0.3 km; error indicates the likely range) (Parrish 1983). The resulting paleogeothermal gradient at 44 Ma is 30° ± 5°C km^{-1}. This value is very similar to the present-day gradient of 35°C km^{-1} (Blackwell 1969; Jessop and Judge 1971; Davis and Lewis 1984).

The Nelson batholith cooled by about 100°C during the time that the VSZ and the SLFZ were active (59–45 Ma) (Fig. 6). If it is assumed that the paleogeothermal gradient of 30° ± 5°C km^{-1} calculated above was constant throughout this time, then the Nelson batholith appears to have been uplifted by 3 ± 1 km during the time that the VSZ and SLFZ were active. Following Eocene extension, the Nelson batholith and the Valhalla complex probably had very similar uplift and thermal histories, as the SLFZ was inactive after this time.

Discussion and conclusions

The high-grade metamorphic core complexes in southern British Columbia and northeastern Washington have been shown to be bounded by shallowly dipping brittle–ductile mylonite zones that were the locus of significant extension (Cheney 1980; Rhodes and Cheney 1981; Harms 1982; Harms and Price 1983; Corbett and Simony 1984; Tempelman-Kluit and Parkinson 1986; Carr *et al.* 1987; Parrish *et al.* 1988). Extension is tightly constrained to Eocene time by intrusive cross-cutting relations with the mylonites and by dates of the mylonites (Rhodes and Cheney 1981; Harms 1982; Harms and Price 1983; Corbett and Simony 1984; Tempelman-Kluit and Parkinson 1986; Carr *et al.* 1987; Parrish *et al.* 1988). Eocene extension was accompanied by significant amounts of uplift, resulting in the tectonic denudation of high-grade metamorphic terranes. Widespread Eocene ages along the Okanagan Valley, originally ascribed to a Tertiary thermal event (Ross 1974; Medford 1975; Mathews 1981), have been reinterpreted as cooling ages associated with significant uplift related to extension along the Okanagan shear zone, which bounds the western margin of the Okanagan gneiss dome (Tempelman-Kluit and Parkinson 1986). The Valhalla complex immediately to the west of the Nelson batholith was uplifted at least 10 km during Eocene time (Parrish *et al.* 1988); however, fission-track data from the Nelson batholith suggest that the batholith experienced only 3 ± 1 km of uplift at this time. This disparity in amount of uplift emphasizes the importance of the SLFZ as a major structure bounding two fundamentally different crustal segments from different crustal levels: the low-grade, upper crustal Nelson batholith was tectonically shed off the high-grade, mid-crustal Valhalla complex as the complex rose to shallow crustal levels during the Eocene.

Significant amounts of uplift associated with extension have been suggested for metamorphic core complexes in the Basin and Range Province (Crittenden *et al.* 1980; Miller *et al.* 1983; Bartley and Wernike 1984). Estimates of uplift in the Snake Range of Nevada range from 6 or 7 km (Gans and Miller 1983; Miller *et al.* 1983) to 15 km (Bartley and Wernike 1984) and are compatible with the amount of Eocene uplift suggested for the Valhalla complex (Parrish *et al.* 1988) and suggested here for the Nelson batholith. In contrast with some of the metamorphic core complexes in the southwestern United States (Rehrig 1986), roof rocks of Canadian core complexes, such as the Valhalla and Okanagan complexes, appear to have been affected by significant uplift and thermal disturbance, probably as the result of their formation at deeper crustal levels. Core complexes of the southwestern United States are thought to have formed at shallow crustal levels as a result of high heat flow, shallow intrusion, and fluid-induced strain softening (Rehrig 1986). Canadian core complexes, however, appear to have been derived from deeper crustal levels, probably as a result of overthickening of the crust as a result of the formation of basement duplexes during Mesozoic compressional events (Brown *et al.* 1986).

Acknowledgments

This paper could not have been completed without the help of C. W. Naeser and S. Kelley in setting up and running the Fission-track dating laboratory at Southern Methodist University. The fieldwork and laboratory work were supported by the U.S. Department of Energy contract 81ER10973 to D. Blackwell and I. J. Duncan. David Blackwell made many useful suggestions during the course of the study. Thoughtful reviews by R. Parrish and R. Price resulted in major improvements to this manuscript.

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DATE RECEIVED: JAN 19 1990
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GEOCHEMICAL ICP ANALYSIS

.500 GRAM SAMPLE IS DIGESTED WITH 3ML 3-1-2 HCL-HNO3-H2O AND .2 ML HF AT 95 DEG.C FOR ONE HOUR AND IS DILUTED TO 10 ML WITH WATER.
ANALYSIS BY HYDRIDE ICP. ALL ALIQUOT ARE 10X DILUTED BECAUSE HIGH SB, BI.
- SAMPLE TYPE: ROCK PULP HG ANALYSIS BY FLAMELESS AA.

SIGNED BY.......... D.TOYE, C.LEONG, J.WANG; CERTIFIED B.C. ASSAYERS

MacKENZIE HOLDINGS FILE # 90-0039R

SAMPLE# (1)	As PPM	Sb PPM	Bi PPM	Ge PPM	Se PPM	Te PPM	Hg PPB
ROCK SAMPLE	2.4	2.3	.7	.4	.2	.4	10

Breccia between L14E + L15E Taken Oct 1989

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ASSESSMENT REPORT

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GEOCHEMICAL ANALYSIS CERTIFICATE

ICP - .500 GRAM SAMPLE IS DIGESTED WITH 3ML 3-1-2 HCL-HNO3-H2O AT 95 DEG. C FOR ONE HOUR AND IS DILUTED TO 10 ML WITH WATER.
THIS LEACH IS PARTIAL FOR MN FE SR CA P LA CR MG BA TI B W AND LIMITED FOR NA K AND AL. AU DETECTION LIMIT BY ICP IS 3 PPM.
- SAMPLE TYPE: ROCK AU* ANALYSIS BY ACID LEACH/AA FROM 10 GM SAMPLE.

DATE RECEIVED: JAN 2 1990 **DATE REPORT MAILED:** Jan 5/90 **SIGNED BY** .... D.TOYE, C.LEONG, J.WANG; CERTIFIED B.C. ASSAYERS

MacKENZIE HOLDINGS File # 90-0039

SAMPLE# (1)	Mo PPM	Cu PPM	Pb PPM	Zn PPM	Ag PPM	Ni PPM	Co PPM	Mn PPM	Fe %	As PPM	U PPM	Au PPM	Th PPM	Sr PPM	Cd PPM	Sb PPM	Bi PPM	V PPM	Ca %	P %	La PPM	Cr PPM	Mg %	Ba PPM	Ti %	B PPM	Al %	Na %	K %	W PPM	Tl PPM	Au* PPB
ROCK SAMPLE	2	5	6	12	.1	7	1	58	.42	2	5	ND	4	8	1	2	3	4	.06	.017	6	5	.02	210	.01	2	.13	.01	.08	1	1	1

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GEOCHEMICAL ANALYSIS CERTIFICATE

MacKenzie Holdings File # 90-2737 Page 1

1409 Front St., Nelson BC V1L 4C5 Submitted by: R.M. MacKENZIE

SAMPLE#	Mo ppm	Cu ppm	Pb ppm	Zn ppm	Ag ppm	Ni ppm	Co ppm	Mn ppm	Fe %	As ppm	U ppm	Au ppm	Th ppm	Sr ppm	Cd ppm	Sb ppm	Bi ppm	V ppm	Ca %	P %	La ppm	Cr ppm	Mg %	Ba ppm	Ti %	B ppm	Al %	Na %	K %	W ppm	Au* ppb
A 55306	1	13	79	181	.4	8	3	1094	1.01	2	611	ND	1	171	4.0	2	2	16	2.38	.121	165	32	.21	52	.01	4	.91	.01	.20	1	1
A 55307	2	20	59	159	1.9	7	3	879	.76	2	269	ND	1	128	12.3	2	2	10	1.44	.115	149	17	.16	61	.01	8	.63	.01	.22	1	12
A 55308	2	39	82	275	.5	7	7	1599	1.47	6	236	ND	1	114	7.3	2	2	26	1.37	.117	139	20	.41	143	.03	4	1.13	.01	.17	1	5
A 55309	2	59	83	105	1.8	7	5	1403	.45	2	395	ND	1	200	6.5	2	2	10	2.65	.135	168	15	.13	102	.01	4	.77	.01	.25	1	3
A 55310	1	9	62	72	.3	4	4	865	1.30	2	37	ND	4	120	2.2	2	2	24	.76	.062	43	14	.19	100	.03	2	.78	.01	.08	2	1
A 55311	1	10	35	65	.2	6	5	552	1.47	2	24	ND	4	70	1.8	2	2	28	.46	.052	35	12	.20	67	.03	2	.89	.01	.07	1	1
A 55312	2	17	35	108	.1	11	5	820	1.50	2	191	ND	6	118	2.5	2	3	23	1.51	.130	114	26	.49	108	.05	5	.92	.01	.20	1	8
A 55313	1	28	99	167	.1	21	8	1238	1.98	2	64	ND	6	86	2.8	2	2	29	1.21	.136	89	31	.74	76	.05	7	1.03	.01	.16	1	2
A 55315	1	19	102	87	.1	12	4	1152	.81	4	85	ND	1	187	3.0	2	2	16	1.06	.109	71	22	.25	116	.02	5	1.34	.01	.18	1	1
A 55316	1	13	227	140	.2	7	3	1447	.75	5	62	ND	1	202	5.6	3	3	13	1.28	.110	76	15	.13	137	.03	6	1.22	.01	.12	2	4
A 55317	1	12	97	91	.1	6	4	1017	.85	2	163	ND	1	219	3.2	2	2	14	1.24	.126	190	41	.16	153	.02	2	1.48	.01	.10	1	2
STANDARD C	18	58	40	131	7.2	70	31	1095	3.86	42	20	7	38	53	18.6	15	22	55	.54	.098	39	59	.87	180	.07	34	1.80	.06	.14	11	-

ICP - .500 GRAM SAMPLE IS DIGESTED WITH 3ML 3-1-2 HCL-HNO3-H2O AT 95 DEG. C FOR ONE HOUR AND IS DILUTED TO 10 ML WITH WATER.
THIS LEACH IS PARTIAL FOR MN FE SR CA P LA CR MG BA TI B W AND LIMITED FOR NA K AND AL. AU DETECTION LIMIT BY ICP IS 3 PPM.
- SAMPLE TYPE: P1 Moss Mat P2 Rock AU* ANALYSIS BY ACID LEACH/AA FROM 10 GM SAMPLE.

DATE RECEIVED: JUL 20 1990 **DATE REPORT MAILED:** July 28/90 **SIGNED BY.** C. Leong ...D.TOYE, C.LEONG, J.WANG; CERTIFIED B.C. ASSAYERS

Moss Samples

SAMPLE#	Mo ppm	Cu ppm	Pb ppm	Zn ppm	Ag ppm	Ni ppm	Co ppm	Mn ppm	Fe %	As ppm	U ppm	Au ppm	Th ppm	Sr ppm	Cd ppm	Sb ppm	Bi ppm	V ppm	Ca %	P %	La ppm	Cr ppm	Mg %	Ba ppm	Ti %	B ppm	Al %	Na %	K %	W ppm	Au* ppb
A 55314	7	10	21	14	4.3	10	2	45	1.74	5	5	ND	1	4	.2	2	68	4	.03	.010	2	10	.03	13	.01	2	.16	.01	.07	4	1

SMALL Qz VEIN

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SAMPLE#	Mo ppm	Cu ppm	Pb ppm	Zn ppm	Ag ppm	Ni ppm	Co ppm	Mn ppm	Fe %	As ppm	U ppm	Au ppm	Th ppm	Sr ppm	Cd ppm	Sb ppm	Bi ppm	V ppm	Ca %	P %	La ppm	Cr ppm	Mg %	Ba ppm	Ti %	B ppm	Al %	Na %	K %	W ppm	Au* ppb
A 55318	1	43	201	245	.1	20	9	1982	2.51	8	127	ND	1	121	6.9	2	3	36	1.58	.167	196	33	.81	80	.05	7	1.26	.01	.17	2	1
A 55320	2	13	40	140	.1	12	6	737	2.11	3	86	ND	1	125	2.5	2	3	31	1.37	.163	85	29	.61	154	.07	4	1.30	.02	.19	2	1
A 55321	2	17	52	173	.2	10	7	882	2.11	6	65	ND	1	192	4.1	2	2	31	1.59	.211	61	27	.60	142	.07	8	1.34	.02	.25	7	1
A 55322 →	1	16	119	156	.1	8	6	872	1.88	34	31	ND	1	123	3.6	2	4 ←	32	.89	.137	34	19	.50	111	.05	2	1.40	.01	.12	5	3 ←
A 55323	2	43	62	132	.2	13	10	752	2.43	2	34	ND	1	102	2.9	2	2	47	1.22	.161	26	22	.89	152	.07	4	1.40	.02	.39	86	1
A 55325 →	3	47	136	169	.2	35	13	780	2.54	8	75	ND	1	118	3.6	2	2	49	1.42	.120	55	55	1.30	126	.08	2	1.76	.02	.31	1	2 ←
A 55326	2	66	143	137	.9	65	20	735	3.91	2	16	ND	2	517	2.8	2	8	53	1.97	.490	101	93	1.80	454	.17	2	2.08	.03	.63	2	1
A 55327 →	1	55	82	145	.3	73	19	610	3.66	3	11	ND	4	698	2.0	2	2	53	1.73	.494	94	86	2.03	593	.24	2	2.34	.03	.70	3	3 ←
A 55328	2	57	148	203	1.5	36	16	878	3.90	4	36	ND	1	113	3.0	2	5	73	1.00	.157	52	69	1.49	190	.13	2	2.28	.02	.51	11	1
A 55331	2	22	389	225	.4	15	7	3470	1.85	10	5	ND	1	93	7.1	3	5	27	1.16	.127	51	20	.47	155	.04	4	1.09	.01	.20	2	1
STANDARD C	19	57	42	132	6.9	71	32	1052	3.96	39	21	7	38	53	18.6	15	20	56	.48	.093	38	60	.88	182	.07	34	1.88	.06	.14	11	-

ICP - .500 GRAM SAMPLE IS DIGESTED WITH 3ML 3-1-2 HCL-HNO3-H2O AT 95 DEG. C FOR ONE HOUR AND IS DILUTED TO 10 ML WITH WATER.
THIS LEACH IS PARTIAL FOR MN FE SR CA P LA CR MG BA TI B W AND LIMITED FOR NA K AND AL. AU DETECTION LIMIT BY ICP IS 3 PPM.
- SAMPLE TYPE: P1 Moss Mat P2 Rock AU* ANALYSIS BY ACID LEACH/AA FROM 10 GM SAMPLE.

DATE RECEIVED: JUL 29 1990 **DATE REPORT MAILED:** Aug 8/90. **SIGNED BY** .... D.TOYE, C.LEONG, J.WANG; CERTIFIED B.C. ASSAYERS

SAMPLE#	Mo ppm	Cu ppm	Pb ppm	Zn ppm	Ag ppm	Ni ppm	Co ppm	Mn ppm	Fe %	As ppm	U ppm	Au ppm	Th ppm	Sr ppm	Cd ppm	Sb ppm	Bi ppm	V ppm	Ca %	P %	La ppm	Cr ppm	Mg %	Ba ppm	Ti %	B ppm	Al %	Na %	K %	W ppm	Au* ppb
A 55319	6	6	8	36	.1	11	2	142	.83	2	5	ND	8	9	.2	2	5	4	.20	.014	9	10	.07	87	.01	5	.34	.02	.10	1	11
A 55324	3	13	21	36	.1	9	1	85	.47	4	5	ND	6	7	.2	2	2	1	.14	.003	2	7	.03	11	.01	2	.13	.03	.07	1	1
A 55329	10	21	1350	482	111.0 ✓	10	3	206	1.66	2	5	ND	1	2	58.3	2	364	2	.04	.003	2	7	.02	13	.01	5	.06	.01	.02	48	19
A 55330	3	2	15	32	.3	8	1	81	.58	2	5	ND	18	5	.4	2	2	1	.05	.006	4	7	.01	21	.01	2	.23	.04	.08	1	4
A 55332	4	7	13	33	.5	33	6	239	1.28	2	5	ND	4	159	.2	2	4	10	.11	.030	13	18	.04	105	.01	3	.43	.01	.07	1	1
A 55333	3	11	6	29	.1	58	9	232	1.33	2	5	ND	1	102	.2	2	2	16	.16	.054	9	36	.11	30	.01	4	.39	.01	.04	1	1
A 55334	6	4	7	22	.1	12	3	135	.74	2	5	ND	2	14	.2	2	2	5	.05	.017	4	8	.02	22	.01	4	.26	.01	.08	1	1
A 55335	3	4	8	12	.1	6	1	104	.45	2	5	ND	5	3	.2	2	2	2	.03	.005	2	6	.01	11	.01	2	.17	.01	.06	1	3
STANDARD C	19	57	39	132	6.9	69	32	1078	3.94	39	25	7	38	52	18.6	13	19	56	.55	.090	38	56	.93	182	.07	32	1.95	.06	.14	13	-

✓ ASSAY RECOMMENDED

55329 LIKELY GRAND TRUNK OR NORTHERN PAC. VEIN S.E. SIDE ANNEX 2

Rock

ACME ANALYTICAL LABORATORIES LTD. 852 E. HASTINGS ST. VANCOUVER B.C. V6A 1R6 PHONE(604)253-3158 FAX(604)253-1716

GEOCHEMICAL ANALYSIS CERTIFICATE

MacKenzie Holdings File # 90-3810 Page 1

1409 Front St., Nelson BC V1L 4C5

SAMPLE#	Mo ppm	Cu ppm	Pb ppm	Zn ppm	Ag ppm	Ni ppm	Co ppm	Mn ppm	Fe %	As ppm	U ppm	Au ppm	Th ppm	Sr ppm	Cd ppm	Sb ppm	Bi ppm	V ppm	Ca %	P %	La ppm	Cr ppm	Mg %	Ba ppm	Ti %	B ppm	Al %	Na %	K %	W ppm	Au* ppb
A 55336	3	6	2	18	.1	7	1	62	.62	2	5	ND	4	7	.2	2	2	4	.09	.019	3	9	.04	14	.01	5	.24	.01	.09	1	1
A 55340	1	3	18	22	.1	1	1	159	.63	2	5	ND	26	17	.2	2	2	3	.22	.023	39	1	.02	56	.01	2	.22	.03	.14	2	1
A 55341	1	48	8	83	.2	145	30	1514	6.17	2	5	ND	2	748	.2	5	2	45	8.28	.469	39	84	2.87	402	.01	2	.52	.01	.20	1	2
A 55342	1	11	10	29	.1	1	4	352	1.56	2	5	ND	2	36	.3	2	2	13	.25	.033	9	1	.04	337	.01	2	.24	.03	.13	2	3
A 55345	3	10	15	66	.1	7	3	305	1.83	2	5	ND	12	10	.2	2	2	8	.17	.055	14	7	.14	47	.01	2	.69	.01	.12	1	3
A 55346	1	3	10	12	.1	1	1	61	.47	2	5	ND	11	5	.2	2	2	2	.26	.008	2	2	.02	36	.01	2	.55	.01	.12	2	2

ICP - .500 GRAM SAMPLE IS DIGESTED WITH 3ML 3-1-2 HCL-HNO3-H2O AT 95 DEG. C FOR ONE HOUR AND IS DILUTED TO 10 ML WITH WATER.
THIS LEACH IS PARTIAL FOR MN FE SR CA P LA CR MG BA TI B W AND LIMITED FOR NA K AND AL. AU DETECTION LIMIT BY ICP IS 3 PPM.
- SAMPLE TYPE: P1 ROCK P2 MOSS MAT AU* ANALYSIS BY ACID LEACH/AA FROM 10 GM SAMPLE.

DATE RECEIVED: AUG 23 1990 **DATE REPORT MAILED:** Aug 30/90. **SIGNED BY** C. Leong ..D.TOYE, C.LEONG, J.WANG; CERTIFIED B.C. ASSAYERS

SAMPLE#	Mo ppm	Cu ppm	Pb ppm	Zn ppm	Ag ppm	Ni ppm	Co ppm	Mn ppm	Fe %	As ppm	U ppm	Au ppm	Th ppm	Sr ppm	Cd ppm	Sb ppm	Bi ppm	V ppm	Ca %	P %	La ppm	Cr ppm	Mg %	Ba ppm	Ti %	B ppm	Al %	Na %	K %	W ppm	Au* ppb
A 55337	3	23	141	275	2.6	9	7	2136	1.80	2	261	ND	1	153	12.0	2	2	22	1.84	.167	182	19	.28	101	.02	12	1.22	.02	.21	1	4
A 55338	5	12	117	197	1.2	8	5	1799	1.72	5	311	ND	3	84	6.2	2	5	23	.96	.090	209	20	.26	74	.05	7	1.43	.01	.11	1	1
A 55339	1	19	483	259	.9	9	7	2324	2.15	10	236	ND	1	169	6.5	4	3	35	2.30	.175	101	12	.48	77	.04	12	1.22	.01	.18	1	2
A 55343	4	36	111	291	1.3	9	8	1709	1.96	6	231	ND	2	120	6.0	4	2	34	1.40	.110	100	18	.53	135	.05	10	1.27	.01	.19	1	2
A 55344	3	49	184	333	1.8	11	8	1618	1.72	3	372	ND	2	152	11.2	3	3	31	1.84	.126	214	25	.47	146	.04	12	1.18	.01	.13	1	1

ACME ANALYTICAL LABORATORIES LTD. 852 E. HASTINGS ST. VANCOUVER B.C. V6A 1R6 PHONE(604)253-3158 FAX(604)253-1716

GEOCHEMICAL ANALYSIS CERTIFICATE

MacKenzie Holdings File # 90-5481 Page 1

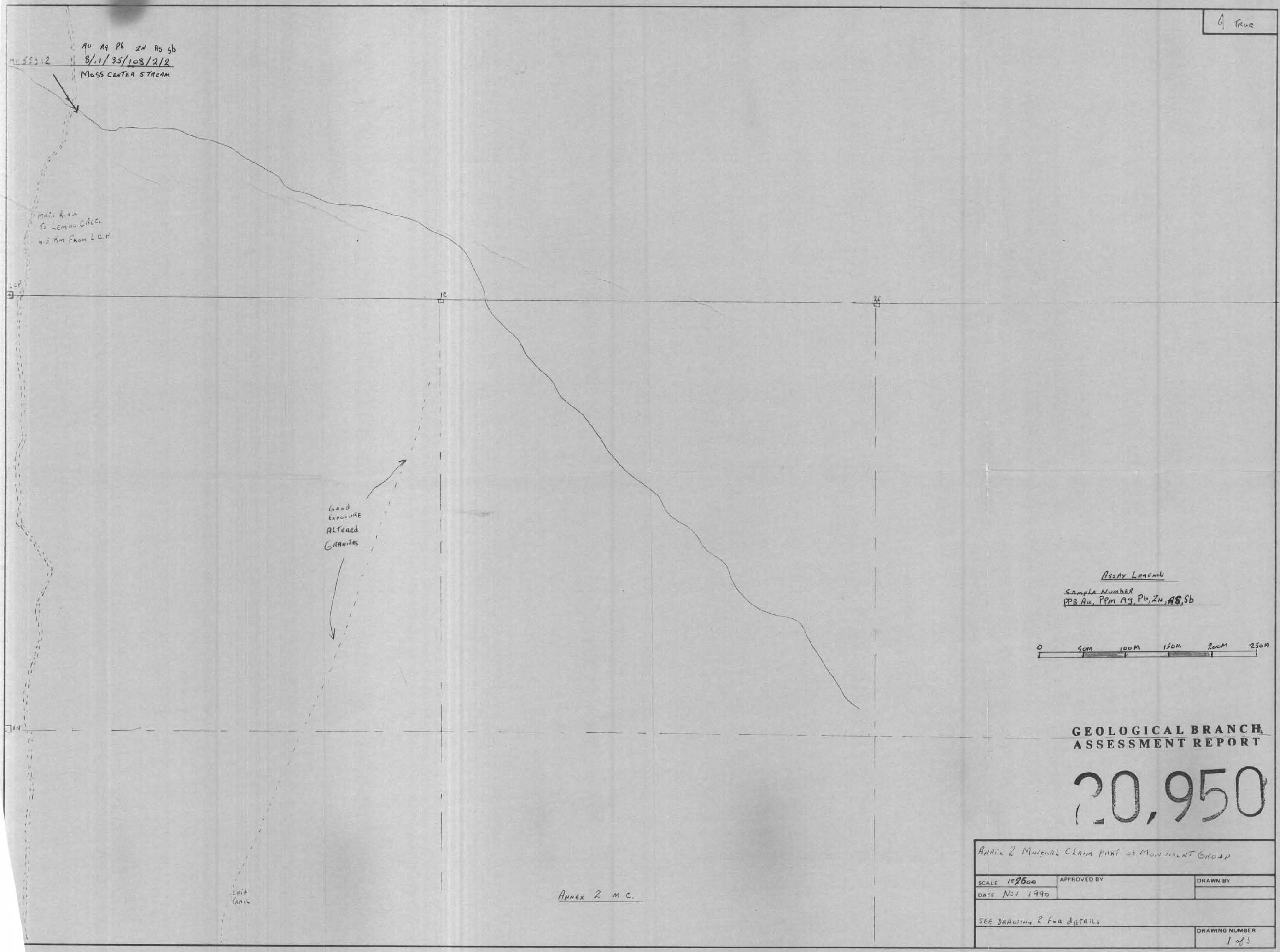
1409 Front St., Nelson BC V1L 4C5

SAMPLE#	Mo ppm	Cu ppm	Pb ppm	Zn ppm	Ag ppm	Ni ppm	Co ppm	Mn ppm	Fe %	As ppm	U ppm	Au ppm	Th ppm	Sr ppm	Cd ppm	Sb ppm	Bi ppm	V ppm	Ca %	P %	La ppm	Cr ppm	Mg %	Ba ppm	Ti %	B ppm	Al %	Na %	K %	W ppm	Au* ppb
A 55352	1	19	110	117	.4	13	6	862	1.90	2	64	ND	1	130	2.2	3	2	34	.72	.105	46	25	.48	98	.06	7	1.36	.02	.21	1	1
A 55353	1	16	402	129	.8	6	5	1699	.57	4	67	ND	1	317	8.4	4	2	8	1.92	.163	70	22	.16	208	.02	11	1.16	.02	.34	1	4
A 55354	1	21	94	100	.6	6	6	889	1.71	2	81	ND	1	135	2.4	3	3	30	.91	.100	66	18	.41	89	.05	5	1.25	.02	.18	1	1
A 55355	1	9	86	44	.3	5	3	575	.74	4	70	ND	1	100	1.1	2	2	16	.55	.091	43	13	.13	42	.02	6	.90	.02	.25	1	1
A 55356	1	10	108	80	1.0	7	3	850	.99	2	281	ND	1	164	2.8	2	2	21	.82	.130	57	32	.16	110	.02	6	1.51	.02	.24	1	2
A 55357	1	71	87	141	.4	126	20	837	3.05	3	113	ND	1	445	2.6	5	3	51	1.38	.210	38	92	3.66	178	.15	9	2.78	.04	.27	1	6

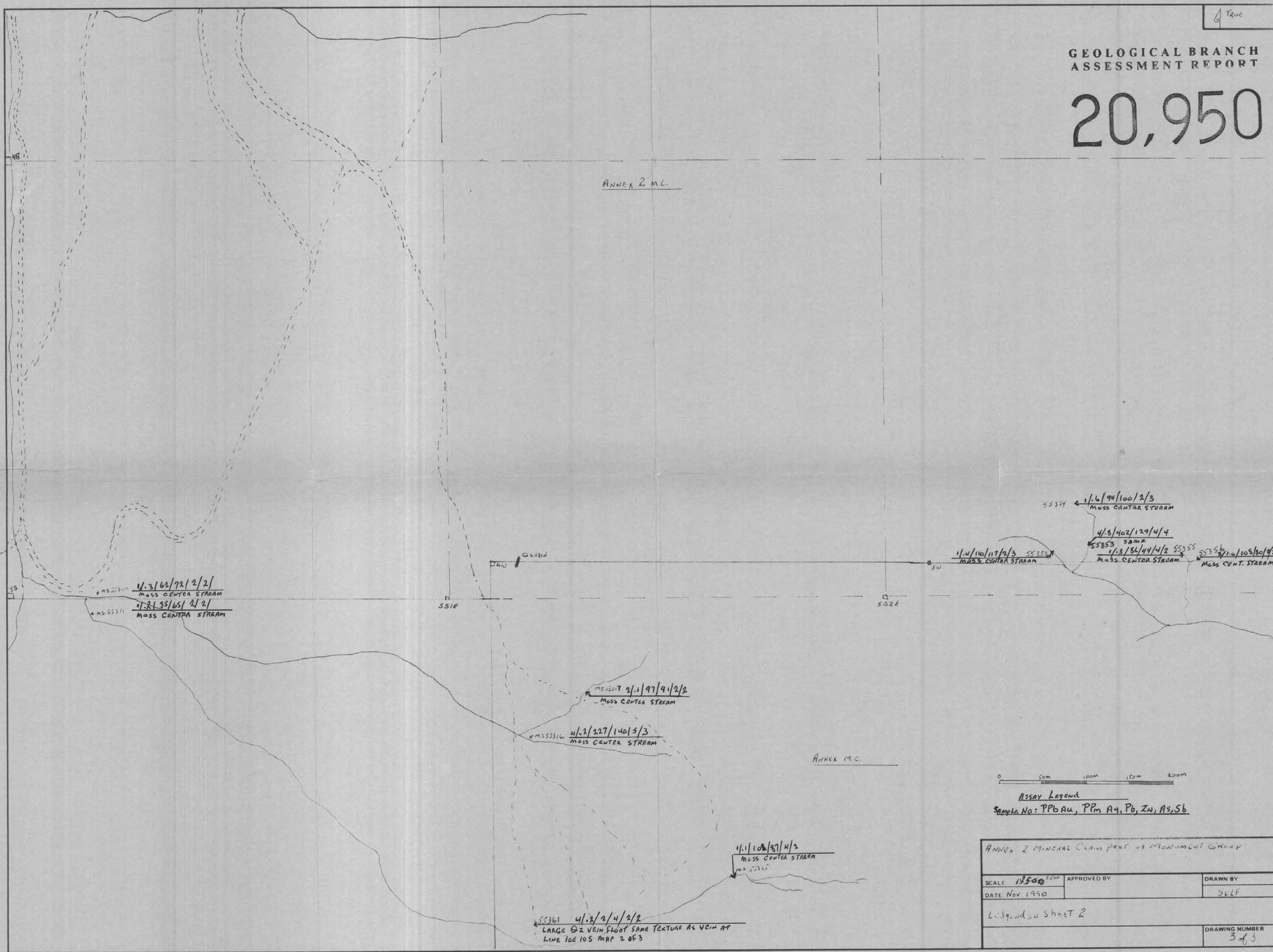
ICP - .500 GRAM SAMPLE IS DIGESTED WITH 3ML 3-1-2 HCL-HNO3-H2O AT 95 DEG. C FOR ONE HOUR AND IS DILUTED TO 10 ML WITH WATER.
THIS LEACH IS PARTIAL FOR MN FE SR CA P LA CR MG BA TI B W AND LIMITED FOR NA K AND AL. AU DETECTION LIMIT BY ICP IS 3 PPM.
- SAMPLE TYPE: P1 MOSS MAT P2 ROCK AU* ANALYSIS BY ACID LEACH/AA FROM 10 GM SAMPLE.

DATE RECEIVED: OCT 23 1990 **DATE REPORT MAILED:** Oct 31/90. **SIGNED BY**..C. Leong......D.TOYE, C.LEONG, J.WANG; CERTIFIED B.C. ASSAYERS

SAMPLE#	Mo ppm	Cu ppm	Pb ppm	Zn ppm	Ag ppm	Ni ppm	Co ppm	Mn ppm	Fe %	As ppm	U ppm	Au ppm	Th ppm	Sr ppm	Cd ppm	Sb ppm	Bi ppm	V ppm	Ca %	P %	La ppm	Cr ppm	Mg %	Ba ppm	Ti %	B ppm	Al %	Na %	K %	W ppm	Au* ppb
A 55358	5	23	6	28	1.4	6	4	165	1.27	2	6	ND	4	14	.2	2	4	8	.30	.075	4	3	.21	66	.03	4	.49	.01	.36	1	3
A 55359	10	16	10	18	1.1	5	3	43	.97	2	5	ND	2	5	.2	2	4	6	.09	.043	3	4	.05	45	.01	3	.29	.01	.18	2	2
A 55360	2	40	11	230	.6	24	15	573	2.45	2	5	ND	2	33	.8	3	3	53	.57	.116	5	14	.85	115	.12	2	1.21	.05	.62	1	180
A 55361	4	4	2	4	.2	13	1	40	.41	2	5	ND	1	2	.2	2	2	2	.01	.004	2	12	.02	7	.01	2	.05	.01	.04	1	4


TRUE
Au Ag Pb ZN As Sb
8/.1/35/108/2/2
MOSS CENTER STREAM
L.C.P.
Good
EXPOSURE
ALTERED
GRANITES
ASSAY LEGEND
Sample Number
PPB Au, PPm Ag, Pb, Zn, AS, Sb
0
50M
100M
150M
200M
250M
Annex 2 M.C.
GEOLOGICAL BRANCH
ASSESSMENT REPORT
20,950
SCALE 1:2500
DATE NOV 1990
APPROVED BY
DRAWN BY
SEE DRAWING 2 FOR DETAILS
DRAWING NUMBER
1 of 3

GEOLOGICAL BRANCH
ASSESSMENT REPORT
20,950
TRUE
LOCATION LINE
Good Exposure Altered Granites on Skid Road
1/4.3/21/14/5/2
12" Qz vein bordering Breccia
2/.1/99/167/2/2
Moss Center Stream
1/.1/201/245/8/2
Moss Center Stream
1/.4/389/225/10/3
Moss Center Stream
1/.1/8/36/2/2
6FT Sheared Rusty granite
Limestone Float
4/.3/15/32/2/2/
Altered granite some chalc veinlets
ALL 10m Channel on Breccia
1/.1/7/22/2/2
1/.1/6/9/2/2
1/.5/13/33/2/2
3/.1/8/12/2/2/
3/.1/35/16/2/2
2/.1/10/12/2/2
All 10m samples on Breccia
Good Exposures Alteration Sequences along Road
2/.9/483/259/10/4
Moss Day Freshet
1/.1/6/12/2.4/2.3/
10ft chip Chal. Breccia
1/.1/2/18/2/2/
6FT Chal. Breccia
Breccia Bluffs
1/1.2/117/197/5/2/
Moss Center Stream
4/2.6/141/275/2/2
Moss Center Stream
Moss Center Stream
1/.4/79/181/2/2
12/1.9/59/159/2/2
3/.5/82/275/6/2
Good Exposures Roof Pendants Meta Sed. + Vol. Especially in Creek Faults
3/1.4/6/28/2/2/
14FT Qz vein
2/1.1/10/18/2/2
14FT Qz vein
180/.6/11/230/2/3
0-2' DD Core
3/83/105/1.3/2/2
Moss Center Stream
2/111/291/1.3/6/4
Moss Center Stream
1/184/333/1.8/3/3
Moss Center Stream
55318 1/.1/201/245/8/2
Moss Center Stream
Roads 4x4
Skid Trails
Qz-Chalcy Breccia
Creek or Freshet
12345 Assay Locations
Quartz Veins
0 50m 100m 150m 200m 250m
Assay Legend
Sample No.: PPb Au, PPm Ag, Pb, Zn, As, Sb
Annex 2 M.C. Part of Monument Group
SCALE 1:2500
APPROVED BY
DRAWN BY
DATE Nov 1990
DRAWING NUMBER
2 of 3


TRUE
GEOLOGICAL BRANCH
ASSESSMENT REPORT
20,950
48
ANNEX 2 M.C.
55354 1/.6/94/100/2/3
MOSS CENTER STREAM
4/.8/402/129/4/4
55853 SAME
1/.4/110/117/2/3 55352
MOSS CENTER STREAM
1/.3/86/44/4/2 55355
MOSS CENTER STREAM
55356 2/1.0/108/80/2/2
MOSS CENT. STREAM
QZ VEIN
3W
55
1/.3/62/72/2/2/
MOSS CENTER STREAM
MS 55311
1/.2/35/65/2/2/
MOSS CENTER STREAM
551E
552E
MS55317 2/.1/97/91/2/2
MOSS CENTER STREAM
MS55316 4/.2/227/140/5/3
MOSS CENTER STREAM
ANNEX M.C.
1/.1/10?/87/4/2
MOSS CENTER STREAM
55361 4/.2/2/4/2/2
LARGE QZ VEIN FLOAT SAME TEXTURE AS VEIN AT
LINE 10E 10S MAP 2 OF 3
0 50m 100m 150m 200m
ASSAY LEGEND
SAMPLE NO: PPb Au, PPm Ag, Pb, Zn, As, Sb
ANNEX 2 MINERAL CLAIM PART OF MONUMENT GROUP
SCALE 1:2500
APPROVED BY
DRAWN BY
SELF
DATE NOV 1990
Li.Sqendon Sheet 2
DRAWING NUMBER
3 of 3

Annex 2
Timbered
See Grid Map 2 of 3
Talus Creep
Talus Creep
Talus Creep
Talus Creep
LCP
Northern Pacific (5511) Cancelled
Grand Trunk (5510) Cancelled
Great Northern (5509) Cancelled
Great Western (5507) Cancelled
Monument
Monument No3 L 5011
No2 FR
Monument No2 L 5013
Monument L 5012 (Cancelled)
Annex
TRUE N.
Traverse Routes
Creeks (Approx)
Roads (Approx)
Silica Flooded Breccia
Argillitic and Carbonate Sericite Alteration
Meta Sed. + Vol. Minor Limestone Roof Pendants in Granite Intrusions
Mostly Propylitic Granites ?
Syenitoid Rocks
Quartz Vein
GEOLOGICAL BRANCH ASSESSMENT REPORT
20,950
0M 500M 1000M 1500M
Monument Group Mineral Claims
SCALE
APPROVED BY
DRAWN BY
Self
DATE Nov 1990
Geology and Claim Location
DRAWING NUMBER
4