GEOCHEMICAL REPORT

ON THE

WK CHROME 1 CLAIM

Kamloops Mining Division

NTS Map 92 I/14
Lat. 50°57'N Long. 121°23'W

REPORT PREPARED BY:

W. Kovacevic
Owner and Operator

March 10, 1995

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APPENDICES

LIST OF ILLUSTRATIONS

INTRODUCTION

This report is based on examinations and geochemical rock sampling of the WK Chrome 1 claim by the owner W. Kovacevic during the period from May to October, 1994, as well as on data from various published reports and personal communication.

PROPERTY AND OWNERSHIP

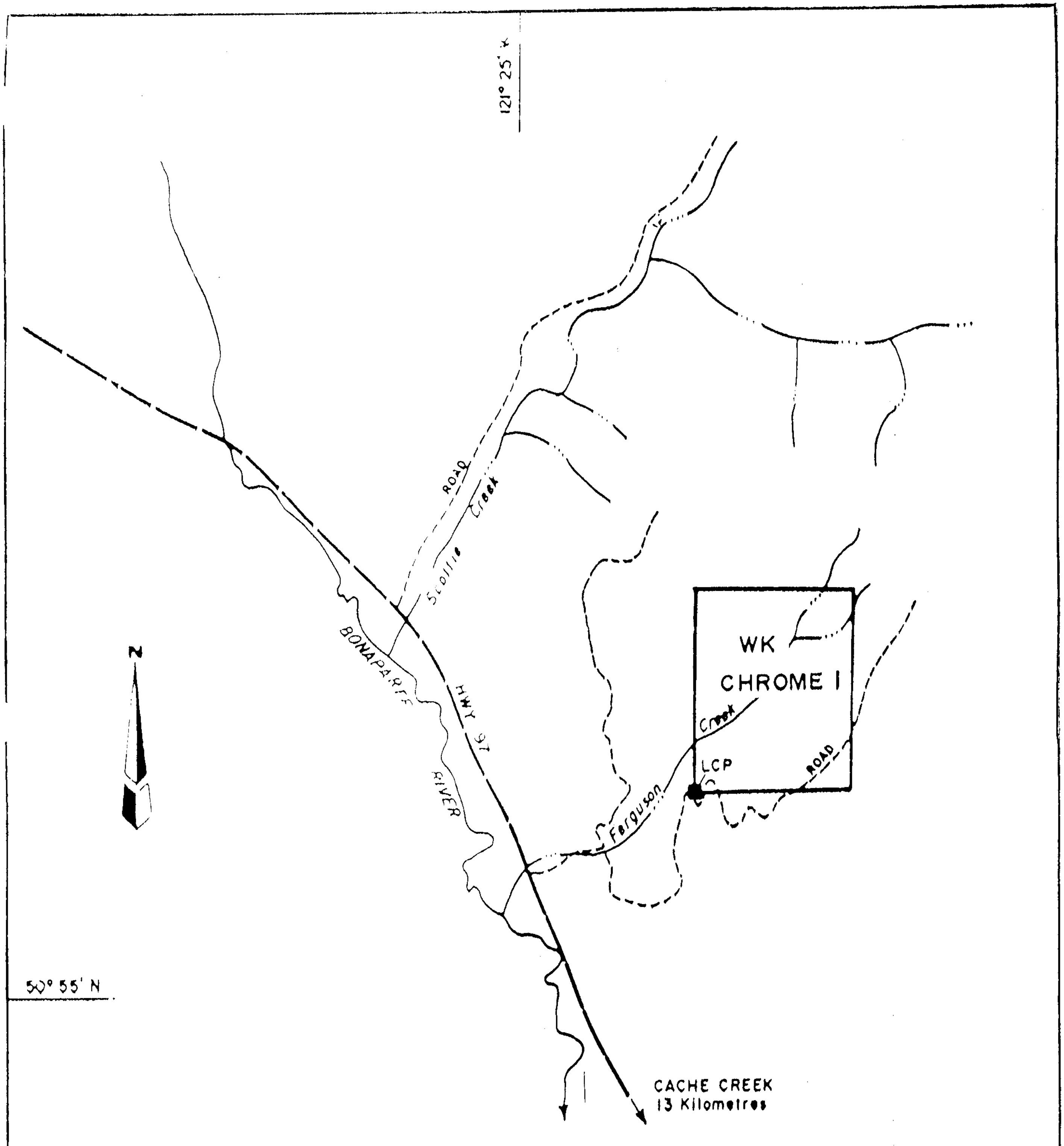
The WK Chrome 1 claim was staked on May 7 and 8, 1993, and recorded on May 10, 1993, Record Number 317307, Kamloops Mining Division. The claim is registered in the name of Willy Kovacevic and consists of 20 contiguous units.

LOCATION AND ACCESS

The property is located on Ferguson Creek, approximately 15 kilometers north-north west of the town of Cache Creek in southcentral British Columbia. The Geographic coordinates of the claim are 50°57'N. latitude by 121°23'W. longitude; N.T.S. 92 I/14W. Access is via Highway 97 from Cache Creek to Ferguson Creek; thence 3 kilometers east on a good logging road which branches of Highway 97.

TOPOGRAPHY AND PHYSICAL ENVIRONMENT

The claim straddles Ferguson Creek , approximately 3 kilometers northeast of its confluence with Bonapart River. Relief within the Ferguson Creek Valley is high, elevation range from 1,250 m in the north to less than 900 m in the southwest. The climate is semi-arid with temperatures ranging between -25° and +30°. The snowfall is moderate and the property is open for exploration from April to November. There is a sparse to moderate growth of pine, fir, aspen and low underbrush within the claim. Past logging operations, both north and south of Ferguson Creek, have harvested the larger ponderous pine and jackpine in the area, providing road access but little bedrock exposure. Outcrop is rare and is mainly confined to the cliffs along the creek valley and the rest of the claim is covered with glacial drift.



WK CHROME I CLAIM

KAMLOOPS MINING DIVISION, B.C.

LOCATION MAP

m 1000 0 1000 2000m.

NTS 92-I-14W	SCALE 1:50,000	FIG. 1

PREVIOUS WORK

The Ferguson Creek showings were first staked in 1939 as Henry Joe and Joe Henry. The Consolidated Mining and Smelting Company of Canada, Limited drove the adit in the bluff in 1931, probably in association with the testing of Scottie Creek showings which company also held at that time. The property was examined by H.M.A. Rice of the Geological Survey in 1942 and several samples were taken for analysis. The results are as follows:

Sample	% Cr_2O_3	% Fe_2O_3	Cr/Fe
Ferguson West	50	15	2.25 to 1
Ferguson East	44	15	2 to 1

A resource potential of 18,000 tones of "reasonably assured" material with 15% chromite and further 18,000 tones of equivalent material was estimated by Rice.

In 1977 the showings were staked as TIK 1 claim group and a ground magnetometer survey was done. The claims were allowed to lapse. The ground was staked by R. Lodmell as Chrome Hawk in 1983 and was sold to Qume Resources Ltd.. Qume cut a short grid over the shoving with intention to conduct an IP survey and, rock sampling of the shoving was done by J.D. Blanchflower, F.G.A.C. Geologist (Appendix I). The IP survey was not conducted. In 1986 the ground was restaked by Equinox Resources Ltd. A soil geochemical survey was done for nickel, chromium and platinum group of metals but the results were not encouraging. In 1987 the ground was restaked by R.J. Nethery, P.Eng. as Ferg Claim who geologically mapped the claim and sampled the shoving for Ni, Cr, Pt and Pd (Appendix II). The ground was held in 1991/92 by Michael Dickens as LIL 1 who recorded no work on the claims held.

In 1993 the ground was restaked as WK Chrome 1 by the present owner and the author of this report W. Kovacevic. A grid, consisting of 1km baseline and 2 km of grid lines was cut, slop corrected, chained and picketed to IP standard (Figure 4). The IP survey will be carried out by Tilava Mining Corporation who is funding the work and has the option to acquire the property.

GEOLOGY

The claim is underlain by volcanic and marine sedimentary rocks of the Permian-age Cache Creek Group. These rocks have been intruded by sill-like ultramafic bodies which host the Ferguson Creek and nearby Scottie Creek chromite mineralization. Both older rock types are unconformably overlain by an extensive cover of volcanic flows and breccias belonging to the Eocene-age Kamloops Group.

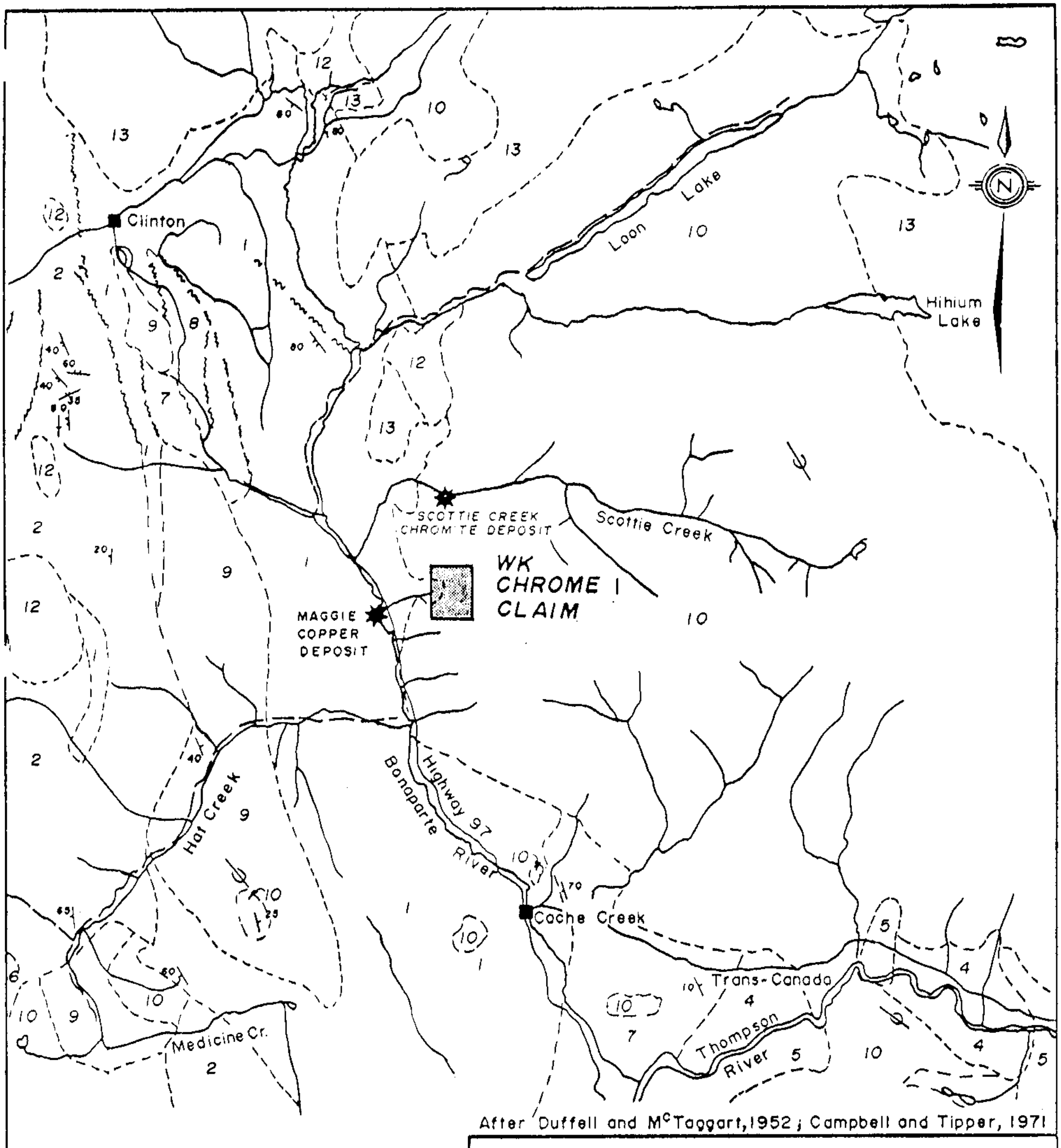
Outcrop on the property is generally restricted to the Ferguson Creek gorge. The chrome-bearing ultrabasics form rugged "hoodoo" like outcrops for over 400 meters along the north side of Ferguson Creek. Serpentinized dunite and harzburgite are exposed in outcrop and workings but the prospect is largely covered by a thick mantle of till and alluvium. The serpentinized dunite is massive and locally may have granular texture.

Chromite occurs as parallel layers of grains in the dunitic rocks. The dunite trends northerly and has a steep eastward dip. It has been traced across the creek and is inferred to continue further north and south.

1994 WORK PROGRAM COMPLETED

All previous works were concentrated on chromium and platinum group of metals ignoring the potential of the ground for other industrial minerals. The tertiary volcanic tuffs which outcrop along the upper area of Ferguson Creek are also of economic interest. During the 1994 exploration seasons, these substantial deposits of volcanic ashes have been subjected to preliminary test to determine the potential of the material as the source for natural pozzolan and zeolites.

During the period May 24 to May 27, 1994, D. Andric, geologist assisted by the owner and author of the report, examined and mapped the outcrops of the volcanic tuffs. Four samples were collected for assay (for location of samples # 1, 2, 3, and 4 refer to Figure 3 and 4) and one sample #6 together with one clay sample was collected in the immediate vicinity of the W.K. Chrome 1 LCP on the adjacent claim. All samples were delivered to B.C. Research Inc., Industrial Mineral Section. The assays were performed by Tim O'Hearn, P.Eng. and all samples classify as mineral admixture N (Natural Pozzolan Admixture in Portland Cement). The preliminary sampling was completed during the period October 18 to 21, 1994 by the author in company of one field assistant. Samples #7, 8, 9, and 10 collected from different outcrops (for location refer to Figure 3 and 4) were delivered to B.C. Research Inc. and all samples classify as mineral admixture N.



REGIONAL GEOLOGY MAP

WK CHROME I CLAIM

KAMLOOPS MINING DIVISION, B.C.

Drawn by: WK	Scale: 1:250,000
Date: MAY 1994	Figure No 2

LEGEND

TERTIARY

Miocene and/or Pliocene

13 Plateau lava; olivine basalt, basalt andesite, related ash and breccia beds; basaltic arenite.

Miocene

12 Deadman River Formation: shale, sandstone, tuff, diatomite, conglomerate, breccia.

Ologocene

11 Andesite, dacite, felsite, related tuff and breccia; greywacke, shale; minor lignite and conglomerate.

Eocene and (?) Ologocene

Kamloops Group

10 Skull Hill Formation: dacite, trachyte, basalt, andesite, rhyolite, related breccias.

Eocene

Coldwater Beds

9 Conglomerate, sandy shale, arkose, coal.

JURASSIC

Middle Jurassic

8 Shale, grit.

7 Chert-pebble conglomerate, greywacke.

Mount Lytton Batholith

6 Granodiorite, quartz diorite.

TRIASSIC

Upper Triassic

Guichon Creek Batholith

5 Granodiorite, quartz monzonite, quartz diorite.

Nicola Group

9 Augite andesite flows and breccia, tuff, argillite, greywacke, grey limestone.

PERMIAN AND/OR TRIASSIC

3 Serpentinite and serpentinized peridotite.

PERMIAN

Cache Creek Group

2 Marble Canyon Formation: massive limestone, limestone breccia and chert, minor argillite, tuff, andesitic and basaltic flows.

1 Basic volcanic flows, tuff, chert, limestone, argillite.

All samples, except the clay material, satisfy the chemical requirements for natural pozzolan for use as an admixture to Portland cement. Further testing must be carried out to determine if these materials satisfy the physical requirements as laid out in ASTM Designation: C618-89-a. For details of the assays and the report by Tim O'Hearn, P.Eng. refer to Appendix III of this report.

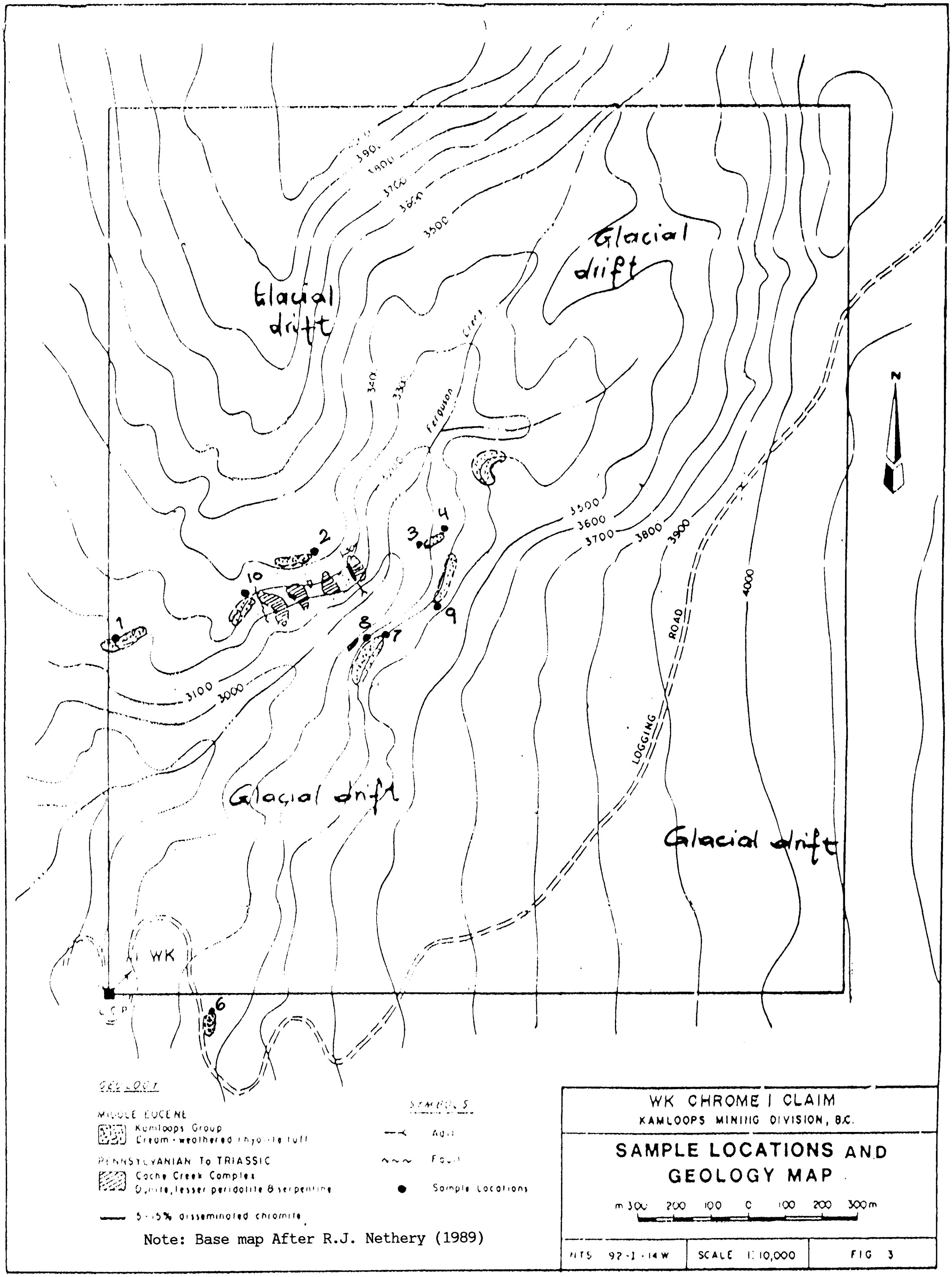
ECONOMIC IMPLICATION FOR THE FERGUSON CREEK INDUSTRIAL MINERAL DEPOSITS

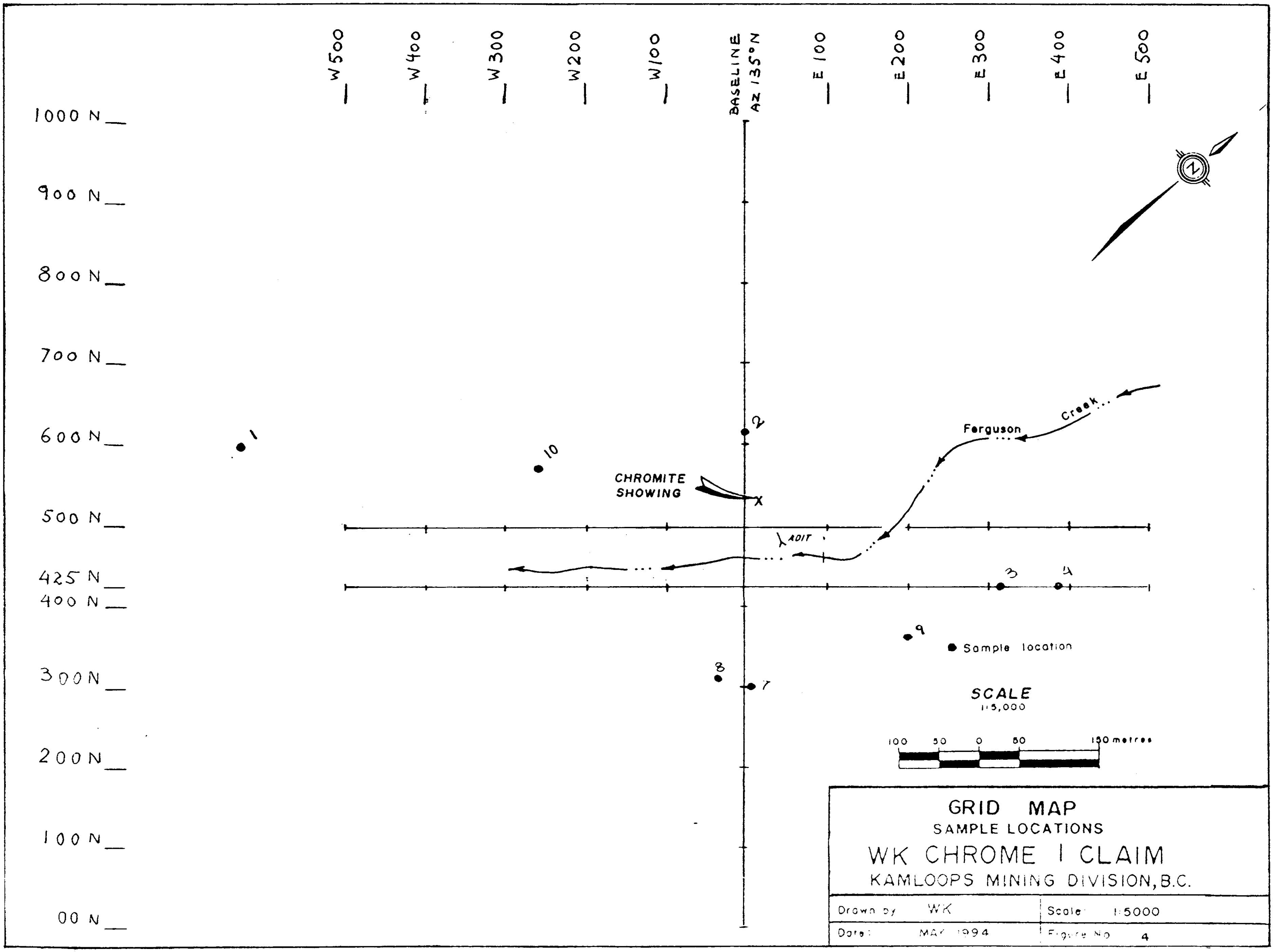
Chromite

Chromite is the sole commercial source of chromium. It is essential to many sectors of the defense and manufacturing industries. Because of its importance, it is classified as a strategic mineral and many countries, sockpile chromite ore and ferochrome as a strategic reserve. About 90% of the world's high-grade chromite reserves in large stratiform deposits are in Africa- largely in South Africa and Zimbabwe. This, combined with the fact that almost one third of the world's podiform reserves are in the former USSR has made chromite a politically sensitive mineral. Canada and U.S. are almost entirely dependent upon imports for its chromium needs.

For military purposes chrome is used primarily in alloys associated with ordinance, missiles, armor plate and motor components. In industry it is used in superalloys, commonly light weight and heat resistant, such jet turbine components, as well as in the making of stainless steel. Three-quarters of the chromium goes into ferrochrome used in manufacturing of stainless and other alloy steels. The remainder of chromite is used in number of nonmetallurgical industries, including chemicals, pigments, refractories, and foundry sands.

The Ferguson Creek deposit chromite concentrates to 50% Cr_2O_3 and a Cr/Fe ratio of 2.25:1 which is satisfactory for metallurgical grade (stainless and other chromium bearing steel alloys) with estimated price in the range of \$75-120/t . The mineralization concentrates readily on Wilfley table to 50% Cr_2O_3 and 15% Fe at grinds of -28 to 1 35 mesh, yielding a chrome-iron ratio of 2.25 to 1. Additional tests must be performed on the chromite mineralization to determine if its sulfur, phosphorus, SiO_2 etc. content are satisfactory.


Glacial drift
Glacial drift
Glacial drift
Glacial drift
3900
3800
3700
3600
3500
3300
3100
3000
4000
Ferguson
LOGGING
ROAD
WK
N
1
2
3
4
6
7
8
9
10
GEOLOGY
MIDDLE EOCENE
Kamloops Group
Cream-weathered rhyolite tuff
PENNSYLVANIAN To TRIASSIC
Cache Creek Complex
Dunite, lesser peridotite & serpentine
5-15% disseminated chromite
SYMBOLS
Adit
Fault
Sample Locations
Note: Base map After R.J. Nethery (1989)
WK CHROME I CLAIM
KAMLOOPS MINING DIVISION, B.C.
SAMPLE LOCATIONS AND GEOLOGY MAP
m 300 200 100 0 100 200 300m
NTS 92-I-14W
SCALE 1:10,000
FIG 3


W500
W400
W300
W200
W100
BASELINE AZ 135°N
E 100
E 200
E 300
E 400
E 500
1000 N
900 N
800 N
700 N
600 N
500 N
425 N
400 N
300 N
200 N
100 N
00 N
N
1
2
10
CHROMITE SHOWING
X
ADIT
Ferguson
Creek
3
4
9
8
7
Sample location
SCALE
1:5,000
100 50 0 50 150 metres
GRID MAP
SAMPLE LOCATIONS
WK CHROME I CLAIM
KAMLOOPS MINING DIVISION, B.C.
Drawn by WK
Scale 1:5000
Date: MAY 1994
Figure No 4

Pozzolan

The term "pozzolan" has been defined by the American Society for Testing Materials (ASTM) as " a siliceous or siliceous and aluminous material which itself possesses little or no cementitious value but will, in finely divided form and in presence of moisture, chemically react with calcium hydroxide at ordinary temperatures to form compounds possessing cementitious properties".

Pozzolanic material is mixed with standard portland cement, generally in the proportion of 10 - 40% by weight. Pumice and pumicite are the most important pozzolans, but opaline shale and diatomite are also used as the source for natural pozzolan. A major use of portland-pozzolan cement is in construction of large-mass concrete dams. Among the advantages claimed for pozzolan-portland cement are generally cheaper cost; lowering of heat of hydration; earlier development of maximum rate of heat development; improved workability; increased plasticity; decrease in segregation of the concrete ingredients; decrease in bleeding of water; improved water tightness of concrete; greater sulphate resistance; improved tensile strength; elimination of retardation of alkali-aggregate reaction.

Pozzolan is sold by itself and also pre-mixed with portland cement with an estimated price in the range of $15-25/t.

Zeolites

The tertiary volcanic tuffs, which outcrop along the upper area of Ferguson Creek, are also of economic interest as a potential source for natural zeolite. Preliminary tests indicate that most tuffs and sandstones in the area contain zeolites.

The most profitable applications of zeolites utilize their adsorption, ion exchange and molecular sieve properties. Present applications are in the following fields: construction industry as pozzolan; agriculture as soil conditioners, fertilizer regulators, deodorizers and feed supplements, aqua-culture in filtering systems; treatments of heavy metals and waste water, oxygen separators, solar energy storage; and domestic use as deodorizers and pet litter.

SUMMARY AND CONCLUSIONS

The ground, presently covered by WK Chrome I claim, has been known and partially explored by numerous operators since 1927. However, the poor outcrop exposure and the volcanic and alluvial cover has thwarted past exploration. Numerous sampling of the same showing and meaningless geochem/geophysic surveys have done little to improve the knowledge of the existing chromite mineralization. Since significant chromite mineralization occurs within the subject claim and nearby Scottie Creek and further north on Mika claim, it is reasonably to assume that the chromite lenses in the NE showing (Appendix II) could continue for some distance both north and south under the cover.

According to the conclusion of the previous examiners an IP geophysical survey may be useful since IP responds to certain chromite deposits, covered under volcanic, providing that they are large enough and are not masked by sulphides present in volcanics. Further exploration of the known showings should be tested by drilling.

Potential for other industrial minerals, mainly pozzolan and zeolite, do exist. The preliminary examination indicate that these minerals may by of substantial and possibly of enormous potential. Proximity to major transportation routes and, the cement plant in Marble Canyon which is located only a ½ hour drive on a paved highway, render these minerals commercially valuable. The cement plant may be both consumer of pozzolan and supplier of cement for ready mix.

REFERENCES

Blanchflower J.D. (1984) - Report on Chrome Hawk Claim, Kamloops Mining Division, British Columbia for Qume Resources Ltd..

Blanchflower J.D. (1994) - Personal communication

Nethery R.J. (1989) - Geological Report Ferg Claim, Kamloops Mining Division, British Columbia (Assessment Report).

Hancock K.D. Ultramafic associated Chromite and Nickel Occurrences in British Columbia (Open File 1900-27 (Chrome Ridge, Scottie Creek, Mika & Ferguson Creek occurrences p. 21-23).

Hancock K.D. Personal communication (1990-1993).

Harben P.W., Bates R.L. (1990) - Industrial Minerals Geology and World Deposits -(Chromite p. 52-61, Diatomite p. 102-105, Pumice & Scoria p. 217-219).

Harben P.W. (1992) - The Industrial Minerals Handy Book - A Guide to Markets, Specifications, & Prices (Chromite p. 21-22, Pumice & Scoria p. 67, Zeolites p. 94-95)

STATEMENT OF EXPENDITURES

PERSONNEL:		
D. Andric, Geologist May 24-27, 1994 3 days @ $200/day	$ 600.00	
W. Kovacevic May 24-27, 1994 3 days @ $175/day	525.00	
D. Gajic, Field Assistant Oct. 18-21, 1994 3 days @ $125/day	375.00	
W. Kovacevic Oct. 18-21, 1994 3 days @ $175/day	525.00	
Total Labor	$2,025.00	$2,025.00
TRANSPORTATION:		
GMC 4X4 Truck rental Borex Management Ltd. May 24-27, 1994 Oct. 18-21, 1994 8 x $75/day	600.00	
Gas	278.71	
Total Transportation	$ 878.71	$ 878.71
LODGING AND MEALS:		
Motel	290.92	
Groceries May 24-27, 1994 Oct. 18-21, 1994	332.96	
Total Motel/Meals	$ 623.88	$ 623.88
FIELD SUPPLIES:		
Maps/Photos	48,00	$ 48.00
CONTRACTOR'S EXPENDITURES:		
B.C. Research Inc. Assays & Report	$1,187.70	$1,187.70
TOTAL May/Oct, 1994 EXPENDITURES		$4,763.29

STATEMENT OF QUALIFICATIONS

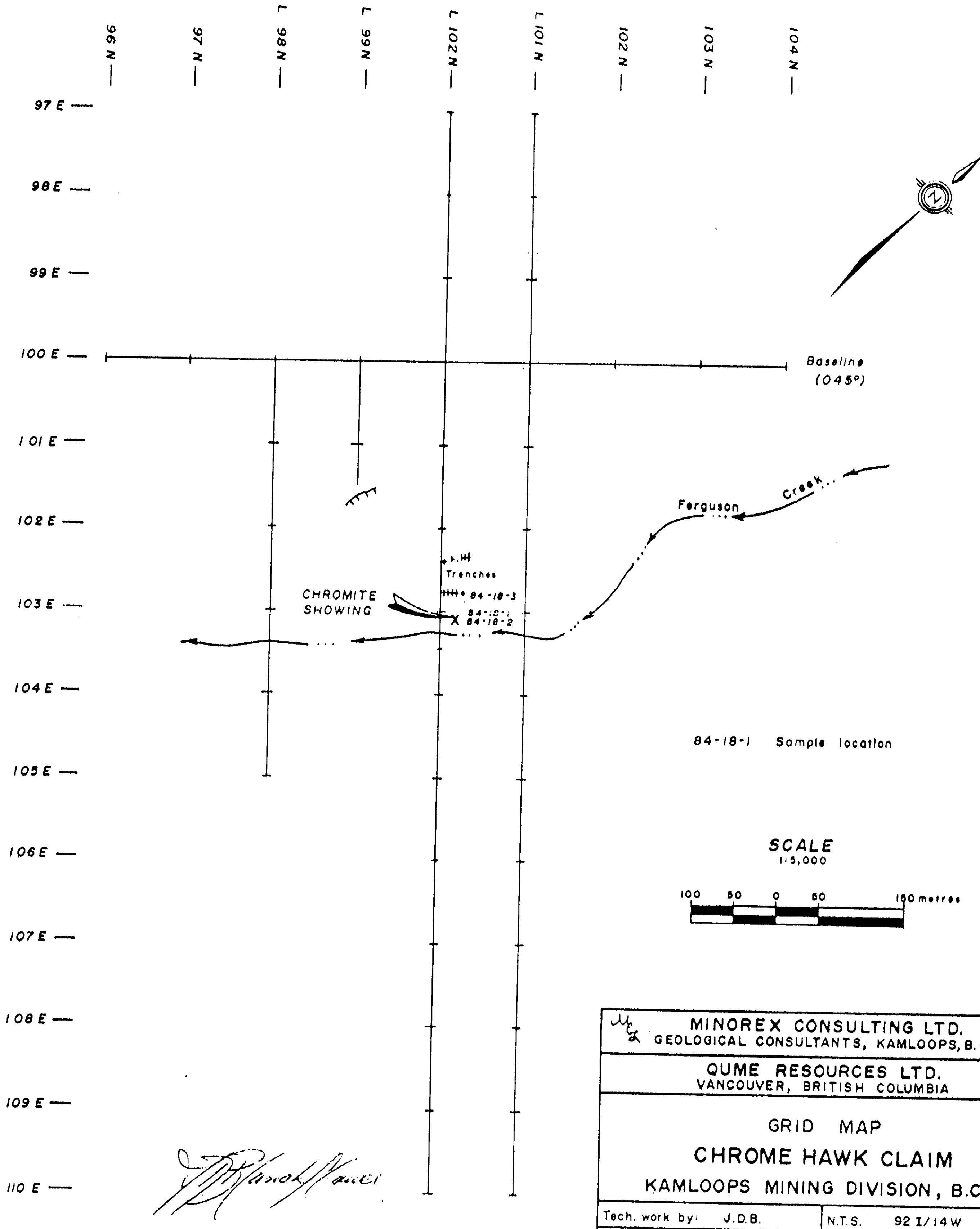
I, Willy Kovacevic, of the City of Vancouver, Province of British Columbia, DO HEREBY CERTIFY THAT I have the following prospecting and related experience:

1971	Completed The Canadian Securities Course (The Investment Dealers Association of Canada).
1972	Attended a prospecting course (hard rock) organized by The B.C. & Yukon Chamber of Mines.
1975-1976	Developed and shipped polymetalic ore from Adams Plateau, B.C. to Cominco (Borex Mining Ltd. Spar I and Spar II claims).
1976	Attended a prospecting course (placer gold recovery) organized by B.C. & Yukon Chamber of Mines.
1977-1978	As the President of Lorcan Resources Ltd. (VSE public company) supervised and participated in gephysical and diamond drilling (Lost Cabin Mine, California). Worked as diamond driller helper.
1977-1979	Prospected and gechemically surveyed group of claims owned by Mineta Resources Ltd. (VSE public company) in Monashee Range, B.C.. Prospected and geochemically surveyed in southcentral B.C. for Tilava Mining Corporation (as owner).
1980-1983	Explored for oil and gas in USA, produced and marketed oil in Clinton County, Kentucky for Robico Investment Ltd. (as owner) and for group of VSE public companies, Mineta Resources Ltd., Westam Oil Ltd. and Boram Oil Ltd. (as principal).
1983-1990	Supervised and participated in various phases of exploration on the properties owned by Star of Mineta Ltd. as principal (Kirkland Lake, Ontario, Adams Plateau, B.C., Golden Loon claims Little Fort, B.C..)
1993-1995	Prospected and geochemically surveyed WK Chrome I industrial mineral prospect (chromium, pozzolan and zeolite) Clinton, B.C..

W. Kovacevic

Willy Kovacevic
Prospector

APPENDIX I



MINOREX CONSULTING LTD.
GEOLOGICAL CONSULTANTS, KAMLOOPS, B.C.

QUME RESOURCES LTD.
VANCOUVER, BRITISH COLUMBIA

GRID MAP
CHROME HAWK CLAIM
KAMLOOPS MINING DIVISION, B.C.

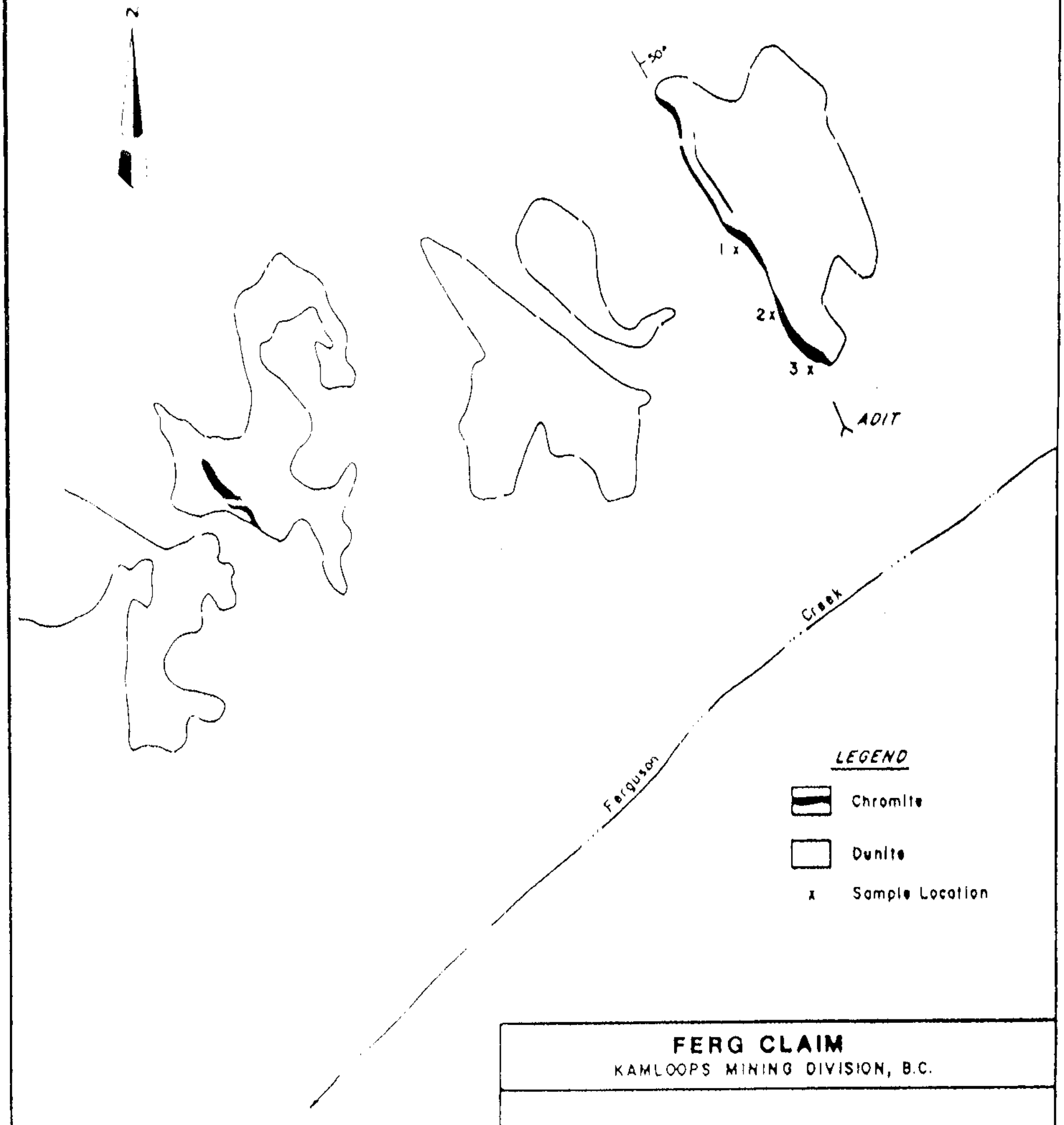
Tech. work by: J.D.B.	N.T.S. 92 I/14 W
Drawn by: P.J.M.	Scale: 1:5000
Date: May 1984	Figure No. 4

TABLE I

Sample Descriptions and Assay Summaries

Sample No.	Description	Assay/Analysis				
		Cr %	Au p.p.b.	Ag p.p.m.	Ni p.p.m.	Co p.p.m.
84-18-1	Chip sample across 2 m. of serpentinized peridotite with numerous thin chromite layers and disseminations. Located on known showing immediately NW of sloughed-in C.M. & S. adit.	14.58	35	0.8	1,190	46
84-18-2	Chip sample across 1 m. of serpentinized peridotite with chromite lenses and disseminations. Approximately 2 m. SE of 84-18-1 site.	18.27	35	0.7	1,160	30
84-18-3	Grab sample from updip extension of low-angle shear structure cutting the mineralized outcrop. Approximately 10 m. NW of 84-18-1 site.	0.78	L5	0.8	1,900	71

APPENDIX II



Note: Base Map After McTaggert (1943)

FERG CLAIM
KAMLOOPS MINING DIVISION, B.C.

SAMPLE LOCATIONS MAP

METRES 20 0 20 40 METRES

NTS 92-I-14W	SCALE 1:1500	FIG. 2

SAMPLE RESULTS

The chip sampling was undertaken with the intent of checking the chromite grade of the most favorable showing. The average grade for the three samples is 21.5% chromium. The nickel assays were insignificant but previous sampling by Equinox Resources revealed the showing due grade 0.08 to 0.28% Ni over a fairly wide area. It is not certain if the nickel is in a silicate or a sulphide. Sample results are as follows:

Sample No.	%Ni	%Cr	Pt oz/ton	Pd oz/ton
1	0.01	22.47	---	---
2	0.01	18.31	---	---
3	0.01	23.74	0.001	0.001

APPENDIX III

BCRI

CHARACTERIZATION OF ROCK SAMPLES AND PRELIMINARY ASSESSMENT FOR USE AS POZZOLANIC MATERIAL

Prepared for:

Tilvana Mining Corporation
415-470 Granville Street
Vancouver, B.C. V6C 1V5

Prepared by:

B.C. Research Inc.
3650 Wesbrook Mall
Vancouver, B.C. V6S 2L2

Project No: 2-21-0734

July 13, 1994

BC Research Inc.
3650 Wesbrook Mall
Vancouver, BC
Canada V6S 2L2
Canada
Tel: (604) 224-4331
Fax: (604) 224-0540
USA
Tel: (206) 738-0958
Fax: (206) 733-3590

Value creation through innovation

SAMPLES

Six rock samples from the Clinton area in B.C. were received on June 14, 1994 for cation exchange capacity (CEC), whole rock analysis (WRA), and sulphite (SO_3) analysis. These analyses will indicate the potential for use as an ion exchange and/or a pozzolanic material.

ANALYSIS

CEC

CEC was carried out by the ammonium acetate method. Results are expressed in milliequivalent (meq) per 100 grams.

WRA

WRA was carried out by Chemex Labs. in Burnaby, B.C. using x-ray fluorescence (XRF). Major oxides and Loss on Ignition (LOI) were determined.

RESULTS

CEC

The results of the CEC analysis are shown in Table 1. Sample WK1+LCP has the highest CEC at 62 meq/100g, which should indicate the presence of zeolitic constituents. All remaining samples have low CEC.

WRA

The results of the WRA analysis are attached in Appendix A. Silicon dioxide (SiO_2), aluminum oxide (Al_2O_3), and iron oxide (Fe_2O_3) ranged 54.20 to 61.39%, 14.98 to 17.19% and 4.49 to 8.52%, by weight, respectively. LOI ranged 5.13 to 15.26% by weight.

Table 2 shows results of the SO_3 analysis. All samples were <0.1% SO_3, by weight.

DISCUSSION

Sample WK1+LCP may represent low to moderate grade zeolitic material. X-ray diffraction analysis should be carried out to confirm the presence of zeolite(s). If sufficient tonnage is available and accessible, this material may have potential for application in agriculture (soil enhancement or odor control) or other industries which utilise low to medium grade natural zeolites.

According to ASTM Designation C618-89a, Standard Specifications for Fly Ash and Raw or Calcined Natural Pozzolan (see Appendix B) for use as a Mineral Admixture in Portland Cement, the chemical requirements are as follows:

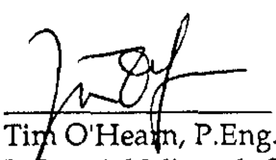
	Mineral Admixture Class		
	N	F	C
SiO_2, plus Al_2O_3, plus Fe_2O_3, min., %	70.0	70.0	50.0
SO_3, max., %	4.0	5.0	5.0
Loss on Ignition (LOI), max., %	10.0	6.0	6.0

Class N - raw or calcined natural pozzolans
F - fly ash from anthracite or butuminous coal
C - fly ash from lignite or sub-bituminous coal

Sample C-LL Road is clay-like and thus, is unsuitable for use as pozzolanic material. All the remaining samples classify as mineral admixture N. All samples satisfy the $SiO_2+Al_2O_3+Fe_2O_3$ condition of 70.0% minimum, and the SO_3 condition of 4.0 maximum. All samples, except WK1+LCP, satisfy the LOI condition of 10.0% maximum.

Therefore, samples CL+625N, BL+625N, L425N+310E, and L425N+390E satisfy the chemical requirements for natural pozzolan for use as an admixture in Portland cement. Further testing must be carried out to determine if these materials satisfy the physical requirements as laid out in ASTM Designation: C618-89a.

Sample C-LL Road should be analyzed by XRD to determine the type of clay, approximate purity and should also be characterized for its swelling ability.



Tim O'Hearn, P.Eng.
Industrial Minerals Section
Environmental Sciences and Engineering

Table 1: CEC Results

Sample I.D.	CEC (meq/100 g)
CL+625N	19
BL+625N	32
L425N+310E	34
L425N+390E	35
C-LL Road	23
WK1+LCP	62

Table 2: SO_3 Results

Sample I.D.	SO_3 (Wt. %)
CL+625N	<0.1
BL+625N	<0.1
L425N+310E	<0.1
L425N+390E	<0.1
WK1+LCP	<0.1

APPENDIX A

WRA RESULTS

Chemex Labs Ltd.

Analytical Chemists * Geochemists * Registered Assayers
212 Brooksbank Ave., North Vancouver
British Columbia, Canada V7J 2C1
PHONE: 604-984-0221

To: B.C. RESEARCH INC.
3650 WESBROOK MALL
UNIVERSITY OF BRITISH COLUMBIA
VANCOUVER, BC
V6S 2L2

Comments: ATTN: TIM O'HEARN

CERTIFICATE A9418420

B.C. RESEARCH INC.

Project: 2-21-0734
P.O. # : R 43349

Samples submitted to our lab in Vancouver, BC.
This report was printed on 29-JUN-94.

SAMPLE PREPARATION

CHEMEX CODE	NUMBER SAMPLES	DESCRIPTION
214	6	Rcvd as pulp; mesh size checked

ANALYTICAL PROCEDURES

CHEMEX CODE	NUMBER SAMPLES	DESCRIPTION	METHOD	DETECTION LIMIT	UPPER LIMIT
902	6	Al2O3 %: XRF	XRF	0.01	100.00
906	6	CaO %: XRF	XRF	0.01	100.00
2590	6	Cr2O3 %: XRF	XRF	0.01	100.00
903	6	Fe2O3 %: XRF	XRF	0.01	100.00
908	6	K2O %: XRF	XRF	0.01	100.00
905	6	MgO %: XRF	XRF	0.01	100.00
1989	6	MnO %: XRF	XRF	0.01	100.00
907	6	Na2O %: XRF	XRF	0.01	100.00
909	6	P2O5 %: XRF	XRF	0.01	100.00
901	6	SiO2 %: XRF	XRF	0.01	100.00
904	6	TiO2 %: XRF	XRF	0.01	100.00
910	6	LOI %: XRF	XRF	0.01	100.00
2540	6	Total %	CALCULATION	0.01	105.00

Chemex Labs Ltd.
Analytical Chemists * Geochemists * Registered Assayers
212 Brooksbank Ave., North Vancouver
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Project : 2-21-0734
Comments: ATTN: TIM O'HEARN

Certificate Date: 29-JUN-94
Invoice No. : I9418420
P.O. Number : R 43349
Account : LPV

CERTIFICATE OF ANALYSIS A9418420

SAMPLE	PREP CODE		Al_2O_3 % XRF	CaO % XRF	Cr_2O_3 % XRF	Fe_2O_3 % XRF	K_2O % XRF	MgO % XRF	MnO % XRF	Na_2O % XRF	P_2O_5 % XRF	SiO_2 % XRF	TiO_2 % XRF	LOI % XRF	TOTAL %	
#1	214	--	17.19	5.98	0.01	6.25	1.08	2.02	0.05	3.06	0.22	58.18	0.59	6.27	100.90	81.62
#2	214	--	15.65	4.08	0.01	5.00	2.08	2.19	0.12	2.62	0.35	58.87	0.65	8.63	100.25	79.52
#3	214	--	14.98	3.25	0.01	4.49	1.95	2.07	0.09	2.42	0.23	61.39	0.50	8.85	100.25	80.26
#4	214	--	15.72	3.79	0.01	4.84	1.70	1.94	0.11	2.59	0.28	59.45	0.65	9.05	100.15	80.04
#5	214	--	15.04	6.81	0.03	8.52	1.40	3.83	0.13	3.63	0.29	54.20	1.71	5.13	100.70	
#6	214	--	15.73	2.63	0.02	5.66	0.78	3.25	0.02	1.44	0.13	54.40	0.72	15.26	100.05	

CERTIFICATION: [signature]

APPENDIX B

ASTM DESIGNATION C618-89a

Designation: C 618 – 89a

Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for use as a Mineral Admixture in Portland Cement Concrete[1]

This standard is issued under the fixed designation C 618; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This specification has been approved for use by agencies of the Department of Defense. Consult the DoD Index of Specifications and Standards for the specific year of issue which has been adopted by the Department of Defense.

1. Scope

1.1 This specification covers fly ash and raw or calcined natural pozzolan for use as a mineral admixture in concrete where cementitious or pozzolanic action, or both, is desired, or where other properties normally attributed to finely divided mineral admixtures may be desired or where both objectives are to be achieved.

NOTE—Finely divided materials may tend to reduce the entrained air content of concrete. Hence, if a mineral admixture is added to any concrete for which entrainment of air is specified, provision should be made to assure that the specified air content is maintained by air content tests and by use of additional air-entraining admixture or use of an air-entraining admixture in combination with air-entraining hydraulic cement.

1.2 The values stated in inch-pound units are to be regarded as the standard.

2. Referenced Documents

2.1 *ASTM Standards:*

C 260 Specification for Air-Entraining Admixtures for Concrete[2]

C 311 Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland-Cement Concrete[2]

3. Terminology

3.1 *Definitions:*

3.1.1 *fly ash*—finely divided residue that results from the combustion of ground or powdered coal.

NOTE—This definition of fly ash does not include, among other things, the residue resulting from: (1) the burning of municipal garbage or any other refuse with coal; or (2) the injection of lime directly into the boiler for sulfur removal; or (3) the burning of industrial or municipal garbage in incinerators commonly known as "incinerator ash."

3.1.2 *pozzolans*—siliceous or siliceous and aluminous materials which in themselves possess little or no cementitious value but will, in finely divided form and in the presence of moisture, chemically react with calcium hydroxide at ordinary temperatures to form compounds possessing cementitious properties.

4. Classification

4.1 *Class N*—Raw or calcined natural pozzolans that comply with the applicable requirements for the class as given herein, such as some diatomaceous earths; opaline cherts and shales; tuffs and volcanic ashes or pumicites, any of which may or may not be processed by calcination; and various materials requiring calcination to induce satisfactory properties, such as some clays and shales.

4.2 *Class F*—Fly ash normally produced from burning anthracite or bituminous coal that meets the applicable requirements for this class as given herein. This class fly ash has pozzolanic properties.

4.3 *Class C*—Fly ash normally produced from lignite or subbituminous coal that meets the applicable requirements for this class as given herein. This class of fly ash, in addition to having pozzolanic properties, also has some cementitious properties. Some Class C fly ashes may contain lime contents higher than 10 %.

5. Chemical Composition

5.1 Fly ash and natural pozzolans shall conform to the requirements as to chemical composition prescribed in Table 1. Supplementary optional chemical requirements are shown in Table 2.

6. Physical Properties

6.1 Fly ash and natural pozzolans shall conform to the physical requirements prescribed in Table 3. Supplementary optional physical requirements are shown in Table 4.

7. Methods of Sampling and Testing

7.1 Sample and test the mineral admixture in accordance with the requirements of Methods C 311.

7.2 Use cement of the type proposed for use in the work and, if available, from the mill proposed as the source of the cement, in all tests requiring the use of hydraulic cement.

8. Storage and Inspection

8.1 The mineral admixture shall be stored in such a manner as to permit easy access for proper inspection and identification of each shipment. Every facility shall be provided the purchaser for careful sampling and inspection either at the source or at the site of the work as may be specified by the purchaser.

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[1] This specification is under the jurisdiction of ASTM Committee C-9 on Concrete and Concrete Aggregates, and is the direct responsibility of Subcommittee C09.03.10 on Fly Ash, Slag, Mineral Admixtures, and Supplementary Cementitious Materials.

Current edition approved Oct. 27, 1989. Published December 1989. Originally published as C 618 – 68 T to replace C 350 and C 402. Last previous edition C 618 – 87.

[2] *Annual Book of ASTM Standards*, Vol 04.02.

TABLE 1 Chemical Requirements

	Mineral Admixture Class		
	N	F	C
Silicon dioxide (SiO_2) plus aluminum oxide (Al_2O_3) plus iron oxide (Fe_2O_3), min, %	70.0	70.0	50.0
Sulfur trioxide (SO_3), max, %	4.0	5.0	5.0
Moisture content, max, %	3.0	3.0	3.0
Loss on ignition, max, %	10.0	6.0[A]	6.0

[A] The use of Class F pozzolan containing up to 12.0 % loss on ignition may be approved by the user if either acceptable performance records or laboratory test results are made available.

TABLE 1A Supplementary Optional Chemical Requirement

NOTE—This optional requirement applies only when specifically requested.

	Mineral Admixture Class		
	N	F	C
Available alkalies, as Na_2O, max, %[A]	1.5	1.5	1.5

[A] Applicable only when specifically required by the purchaser for mineral admixture to be used in concrete containing reactive aggregate and cement to meet a limitation on content of alkalies.

TABLE 2 Physical Requirements

	Mineral Admixture Class		
	N	F	C
Fineness:			
Amount retained when wet-sieved on 45 μm (No. 325) sieve, max, %[A]	34	34	34
Strength activity index:[B]			
With portland cement, at 7 days, min, percent of control	75[D]	75[D]	75[D]
With portland cement, at 28 days, min, percent of control	75[D]	75[D]	75[D]
With lime, at 7 days min, psi (kPa)	800 (5500)	800 (5500)	...
Water requirement, max, percent of control	115	105	105
Soundness:[C]			
Autoclave expansion or contraction, max, %	0.8	0.8	0.8
Uniformity requirements:			
The specific gravity and fineness of individual samples shall not vary from the average established by the ten preceding tests, or by all preceding tests if the number is less than ten, by more than:			
Specific gravity, max variation from average, %	5	5	5
Percent retained on 45-μm (No. 325), max variation, percentage points from average	5	5	5

[A] Care should be taken to avoid the retaining of agglomerations of extremely fine material.

[B] Neither the *strength* activity index with portland cement nor the pozzolanic activity index with lime is to be considered a measure of the compressive strength of concrete containing the mineral admixture. The *strength* activity index with portland cement is determined by an accelerated test, and is intended to evaluate the contribution to be expected from the mineral admixture to the longer strength development of concrete. The weight of mineral admixture specified for the test to determine the *strength* activity index with portland cement is not considered to be the proportion recommended for the concrete to be used in the work. The optimum amount of mineral admixture for any specific project is determined by the required properties of the concrete and other constituents of the concrete and should be established by testing. *Strength* activity index with portland cement is a measure of reactivity with a given cement and may vary as to the source of both the fly ash and the cement.

[C] If the mineral admixture will constitute more than 20 % by weight of the cementitious material in the project mix design, the test specimens for autoclave expansion shall contain that anticipated percentage. Excessive autoclave expansion is highly significant in cases where water to mineral admixture and cement ratios are low, for example, in block or shotcrete mixes.

[D] Meeting the 7 day or 28 day *strength* activity index will indicate specification compliance.

9. Rejection

9.1 The mineral admixture may be rejected if it fails to meet any of the requirements of this specification.

9.2 Packages varying more than 5 % from the stated weight may be rejected. If the average weight of the packages in any shipment, as shown by weighing 50 packages taken at random, is less than that specified, the entire shipment may be rejected.

9.3 Mineral admixture in storage prior to shipment for a period longer than 6 months after testing may be retested and may be rejected if it fails to meet the fineness requirements.

TABLE 2A Supplementary Optional Physical Requirements

NOTE—These optional requirements apply only when specifically requested.

	Mineral Admixture Class		
	N	F	C
Multiple factor, calculated as the product of loss on ignition and fineness, amount retained when wet-sieved on No. 325 (45-μm) sieve, max, % [A]	....	255	....
Increase of drying shrinkage of mortar bars at 28 days, max, % [B]	0.03	0.03	0.03
Uniformity Requirements:			
In addition, when air-entraining concrete is specified, the quantity of air-entraining agent required to produce an air content of 18.0 vol % of mortar shall not vary from the average established by the ten preceding tests or by all preceding tests if less than ten, by more than, %	20	20	20
Reactivity with Cement Alkalies: [C]			
Reduction of mortar expansion at 14 days, min, %	75	....	....
Mortar expansion at 14 days, max, %	0.020	0.020	0.020

[A] Applicable only for Class F mineral admixtures since the loss on ignition limitations predominate for Class C.

[B] Determination of compliance or noncompliance with the requirement relating to increase in drying shrinkage will be made only at the request of the purchaser.

[C] The indicated tests for reactivity with cement alkalies are optional and alternative requirements to be applied only at the purchaser's request. They need not be requested unless the fly ash or pozzolan is to be used with aggregate that is regarded as deleteriously reactive with alkalies in cement. The test for reduction of mortar expansion may be made using any high-alkali cement in accordance with Methods C 311, Section 35.1 if the portland cement to be used in the work is not known, or is not available at the time the mineral admixture is tested. The test for mortar expansion is preferred over the test for reduction of mortar expansion if the portland cement to be used in the work is known and available. The test for mortar expansion should be performed with each of the cements to be used in the work.

10. Packaging and Package Marking

10.1 When the mineral admixture is delivered in packages, the class, name, and brand of the producer, and the weight of the material contained therein shall be plainly marked on each package. Similar information shall be provided in the shipping invoices accompanying the shipment of packaged or bulk mineral admixture.

BCRI

CHARACTERIZATION OF ROCK SAMPLES AND PRELIMINARY ASSESSMENT FOR USE AS POZZOLANIC MATERIAL

Prepared for:

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Prepared by:

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Project No: 2-21-0734

November 25, 1994

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Value creation through innovation

According to ASTM Designation C618-89a, Standard Specifications for Fly Ash and Raw or Calcined Natural Pozzolan (see Appendix B) for use as a Mineral Admixture in Portland Cement, the chemical requirements are as follows:

	Mineral Admixture Class		
	N	F	C
$SiO_2 + Al_2O_3 + Fe_2O_3$, min., %	70.0	70.0	50.0
SO_3, max., %	4.0	5.0	5.0
Loss on Ignition (LOI), max., %	10.0	6.0	6.0

Class N - raw or calcined natural pozzolans
F - fly ash from anthracite or butuminous coal
C - fly ash from lignite or sub-bituminous coal

All samples classify as mineral admixture N. All samples satisfy the SiO_2+Al_2O_3+Fe_2O_3 condition of 70.0% minimum, SO_3 condition of 4.0 maximum, and the LOI condition of 10.0% maximum.

Therefore, all samples satisfy the chemical requirements for natural pozzolan for use as an admixture in Portland cement. Further testing must be carried out to determine if these materials satisfy the physical requirements as laid out in ASTM Designation: C618-89a.

Tim O'Hearn, P.Eng.
Industrial Minerals Section
Environmental Sciences and Engineering

Table 1: CEC Results

Sample I.D.	CEC (meq/100 g)
7	34
8	34
9	37
10	37

Table 2: SO_3 Results

Sample I.D.	SO_3 (Wt. %)
7	<0.1
8	<0.1
9	<0.1
10	<0.1

APPENDIX A

WRA RESULTS

ACME ANALYTICAL LABORATORIES LTD. 852 E. HASTINGS ST. VANCOUVER B.C. V6A 1R6 PHONE(604)253-3158 FAX(604)253-17[illegible]

WHOLE ROCK ICP ANALYSIS

B.C. Research Inc. PROJECT 2-21-0734 File # 94-4150

3650 Wesbrook Mall, Vancouver BC V6S 2L2

SAMPLE#	SiO2 %	Al2O3 %	Fe2O3 %	MgO %	CaO %	Na2O %	K2O %	TiO2 %	P2O5 %	MnO %	Cr2O3 %	Ba ppm	Ni ppm	Sr ppm	Zr ppm	Y ppm	Nb ppm	Sc ppm	LOI %	SUM %	
7	58.94	14.57	4.50	2.98	3.58	2.09	2.90	.52	.21	.07	.006	707	29	342	119	19	<10	10	9.4	99.95	79.97
8	57.23	16.08	5.31	2.23	4.59	2.05	2.17	.65	.22	.09	.005	684	29	369	123	21	<10	14	8.4	99.21	78.62
9	58.34	15.58	5.10	1.89	4.22	2.19	2.13	.63	.25	.08	.004	799	29	411	107	18	<10	11	9.1	99.72	79.02
10	58.90	15.36	5.07	2.40	3.64	2.25	2.04	.68	.21	.05	.002	626	24	349	136	21	<10	13	8.9	99.68	79.33
RE 10	59.22	15.45	5.07	2.45	3.67	2.34	2.10	.70	.19	.05	.006	627	28	352	127	21	<10	14	8.9	100.32	79.74 K.

.200 GRAM SAMPLES ARE FUSED WITH 1.2 GRAM OF LIBO2 AND ARE DISSOLVED IN 100 MLS 5% HNO3. Ba IS SUM AS BaSO4 AND OTHER METALS ARE SUM AS OXIDES.
- SAMPLE TYPE: PULP Samples beginning 'RE' are duplicate samples.

DATE RECEIVED: NOV 16 1994 DATE REPORT MAILED: Nov 24/94. SIGNED BY C. Leong ....D.TOYE, C.LEONG, J.WANG; CERTIFIED B.C. ASSAYERS