MAR 19920003: PINHORN

Received date: Dec 29, 1992

Public release date: Dec 30, 1993

19920003

REPORT ON

EXPLORATION PERMIT

6890010001 (9390010001)

IN THE MILK RIVER REGION

OF SOUTHERN ALBERTA

by

R.A. Burwash, Ph.D., P. Geol.
and
D.B. Nelson, B.Sc., P. Geol.

December 29, 1992

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

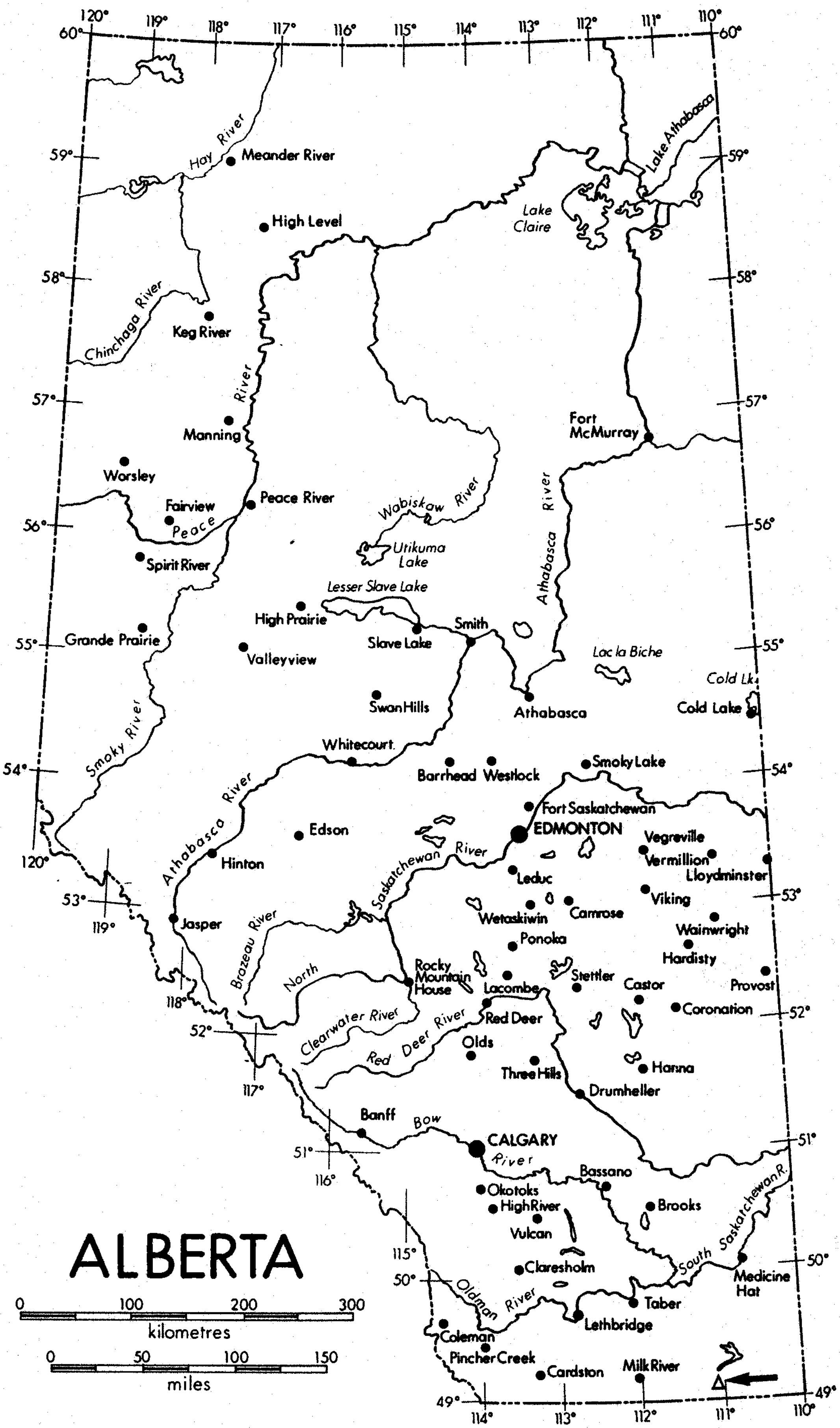


Fig. 1. Location of Two-Nine Property (Δ). Permit No. 6890010001

A. SUMMARY

Permit 6890010001 covers the W1/2 of Section 18, Township 2, Range 8, West of 4 and the E1/2 of Section 13, Township 2, Range 9, West of 4. In the NE1/4 of Section 13 the Upper Cretaceous Judith River Formation is intruded by a body of igneous breccia which in is turn, cut by a number of sub-parallel basic dykes. The dykes contain numerous inclusions of rocks of Paleozoic and Mesozoic age. Rounded fragments of Precambrian igneous and metamorphic rocks and xenoliths of ultramafic mantle material also occur.

The dyke rocks contain phenocrysts of olivine, diopside and phlogopite in a matrix of alkali feldspar, phlogopite, diopside and analcite. They share many common characteristics with lamproite dykes of West Australia and the potassic basic dykes of East Africa. The mineralogical composition of the mantle xenoliths suggests that the magma source for the dykes was at a depth of 100 km or more.

B. INTRODUCTION

Geologic field work carried out in June and October of 1989 indicated that most of the Tertiary intrusions in southern Alberta are relatively simple, single tabular bodies (ie. dykes) with only minor structural disturbance. A notable exception occurs in the NE1/2 of Section 13, Township 2, Range 9, West of the 4th Meridian. This quarter section forms part of the area of permit 6890010001. Here a deeply incised trellis drainage pattern has exposed a complex of multiple intrusions. The first requirement therefore was the preparation of a geologic map outlining the areal extent amd spatial relationships of the country rock and intrusive bodies. Mapping was initiated on October 6-9, 1989. Enlarged airphotos were used in conjunction with mapping along a base line and two cross-sections. The profiles were positioned to take advantage of the excellent exposure along two gullies.

Samples of the different phases of the intrusive rock bodies were collected as well as portions of, or entire inclusions of Precambrian basement rocks and mantle rocks. Most of this field work was completed in 1990. Compilation of the field data is ongoing. The principal product is a geologic map (Figure 2) at a scale of 1:1000. Also included in this report are petrographic descriptions of two representive samples of the dyke rock and brief descriptions of the samples chosen for detailed chemical and isotopic analysis.

C. LOCATION AND ACCESS

Permit 6890010001 covers the W1/2 of Section 18, Township 2, Range 8, West of 4 and the E1/2 of Section 13, Township 2, Range 9, West of 4. Access to the property is from Coutts by way of a gravelled district road for 70 km east. The trail to the Old Taber Ranch leaves the gravel road in Section 14, Township 1, Range 9, West of 4. This trail is followed for 8 km north until it reaches the east boundary of Township 2, Range 9. Travel along the township line for 2 km leads to permit area.

The permit area is plotted on Alberta, Department of Mines and Minerals, Metallic Mineral Permit Areas Map, 1:750,000.

D. LICENCE TABULATION

Mr. D.B. Nelson applied for a metallic mineral exploration permit September 15, 1989. Metallic mineral exploration permit No. 6890010001 was issued to Mr. Douglas Bruce Nelson, of 5204 - 82 Avenue, Edmonton, Alberta, on January 3, 1990. The field work and report were done jointly by Dr. R.A. Burwash and Mr. D.B. Nelson.

E. WORK PERFORMED

I. HISTORY

The survey of the Canada-U.S.A. boundary across southern Alberta recorded a number of dykes, which Dawson (1875) inferred to be of Tertiary age. The much larger Sweetgrass Intrusions in Montana were described by a number of officers of the U.S. Geological Survey. Regional mapping by Williams and Dyer (1930) and Russell and Landes (1940) located the dykes more precisely. They are briefly described by Currie (1976, 1990). Most of the early workers describe the rocks as minette because of the abundant black mica. There are also references to andesite and feldspar porphyry.

Following successful development of gold deposits in the Black Hills of South Dakota small scale mining for gold was attempted in the Sweetgrass Hills of Montana. Oil and gas exploration has been carried out on both sides of the International Boundary. There are currently a number of producing oil and gas wells in the immediate vicinity south of Milk River.

II. GEOLOGY

1. INTRODUCTION

The incision of Two-Nine Coulee has exposed three bedrock units (Fig. 2, units 1, 2, 3) beneath the Pleistocene (unit 4) and Recent (units 5, 6, 7) unconsolidated cover. Very limited study was made of unit 1 (Cretaceous) and only the areal extent of units 4 to 7 was noted.

2. ROCK UNITS

2.1 Judith River Formation (unit 1)

The term Judith River, as described by McLean (1990) is used in our text for the Upper Cretaceous sandstone unit. The Judith River Formation is equivalent to Map units 5 and 6 (Foremost and Oldman Formations) on the Foremost Map-sheet of Irish (1967). In our study area the Judith River is a friable, light grey to buff, fine- to medium-grained sandstone with intercalated silts and bentonitic shales. Near the waterfall in Gully 3 a massive bed of sandstone has numerous bivalves concentrated along several bedding planes. Numerous fragments of ironstone occur in the colluvium along Two-Nine Coulee, suggesting that nodules or beds of ironstone occur in the eroded walls of the coulee. No coal seams were observed.

2.2 Intrusive Breccia (unit 2)

An igneous breccia unit intrudes the flat-lying Cretaceous sandstones. The light grey to buff colour of this breccia and its friable weathered surface layer make it difficult to differentiate from the Cretaceous sandstone on both standard and infra-red airphotos.

At the contact with the breccia the Judith River sandstones show weak contact metamorphism. Light-grey sandstone shows 5 to 10 mm "spots" which weather in positive relief. The mineralogical composition of the "spots" has not been determined, since the rock crumbles easily and is difficult to slab. Contact metamorphism, where observed around blocks of Cretaceous country rock in Gully 3 extends for less than a metre and does not change the friable sandstone into a hornfels.

The breccia is a polycomponent rock. Some of the fragments can be traced with relative confidence to their source. These include:

1) angular fragments of medium to dark grey Cretaceous shale;
2) angular fragments of petrified wood (Cretaceous);
3) slabs of laminated siltstone (Cretaceous or Jurassic);
4) blocks of crystalline limestone (probably Mississippian);
5) rounded to sub-angular clasts of foliated quartzofeldspathic gneiss and/or granite (Precambrian); and
6) rounded clasts of ultramafic rock (mantle).

The matrix enclosing these fragments varies from light grey (Rock Colour Chart, G.S.A. N7) to yellowish grey (5Y7/2). The matrix has sparce rounded cavities (vesicles?) but is otherwise massive. Elongate inclusions have random orientations. The only mineral recognizable megascopically is amber to black mica, with sparse flakes up to 1 cm in size. Most of the mica is 1 mm or less.

The inclusions range from pin-head size xenocrysts of feldspar, pyroxene and serpentine (altered olivine) to walnut-sized fragments of glimmerite, pyroxenite and granitic gniess. Sparce rounded clasts of Precambrian basement gneiss, often armored with a thin layer of basalt, occur in the intrusive breccia.

2.3 Potassic Mafic Dykes (unit 3)

A series of sub-parallel mafic dykes, with a maximum width of 10 m and an average width of 2 m intrude the breccia (map unit 2). The dyke rock is porphyritic, with phenocrysts of altered olivine (now serpentine), clinopyroxene and phlogopite in a matrix of alkali feldspar, clinopyroxene, phlogopite and opaque minerals. The mica phenocrysts with a maximum size of 10 mm constitute approximately 15% of the rock by volume. The conspicuous mica flakes have led most workers to identify the dyke rock as minette. To the writer the dyke rocks appear to be a potassium - rich alkali olivine basalt.

2.3.1 Basement Xenoliths

Inclusions in the dykes, while numerically less abundant than in the breccia, are still important. Angular clasts of many rock types in the Phanerozoic cover are present. More visible are the light-coloured granitic gneisses and granites from the Precambrian. Almost invariably the basement xenoliths are rounded to triaxial ellipsoids, suggesting abrasion or assimilation during transport. Many basement clasts when collected retain a rim of chilled fine-grained basalt. The composition of the Precambrian basement clasts examined to date are similar to those from drill cores from several hundred oil wells in

Alberta (see Burwash and Krupicka, 1969, 1979; Burwash and Culbert , 1976).

2.3.2 Mantle Xenoliths

The ultramafic xenoliths occurring in the mafic dykes are of prime importance in determining the probable depth of generation of the alkali olivine basalt magma and the nature of the mantle below this segment of the sialic crust. The ultramafic xenoliths consist of only two main minerals, diopside and phlogopite, with varying amounts of accessory apatite. Opaque minerals, which are minor accessories (less than 1%) consist of chrome spinel and ilmenite. The ratio of diopside to phlogopite varies in different xenoliths from diopside dominant to phlogopite dominant. The maximum content of apatite is approximately 10% (by volume). In these xenoliths feldspar, aluminosilicate minerals, orthopryoxene, olivine and garnet have not been detected.

3. SAMPLE DESCRIPTIONS

DAT 4-4. Xenolith of Precambrian basement. Banded gneiss with plagioclase (andesine), quartz, K-feldspar and biotite. Accessory minerals include magnetite, sphene, zircon and calcite. The plagioclase and biotite are both altered and quartz shows strain deformation.

DAT 4-5. Xenolith of ultramafic rock. Banded rock with varying proportions of two main minerals, diopside and phlogopite. Rock fabric- equigranular, medium- to coarse-grained. Maximum grain size ~ 8mm. Accessory minerals include apatite, traces of opaques (spinel?).

Oc 7-1. Dyke, Gully 3 (2+80N, 0+75E). Porphyritic, with phenocrysts of phlogopite (max. 1cm), diopside, olivine (altered to serpentine) and sparse K-feldspar in a dark grey matrix (50%). No visible foliation of phenocrysts.

Oc 8-1. Xenolith of Precambrian basement. Well-foliated gneiss with plagioclase (andesine) 60%, quartz 20%, microcline 10%, biotite 6%, hornblende 3% and sphene 1%. Accessory magnetite, apatite and zircon. Elongate quartz aggregates parallel to foliation. Rock is unaltered.

Oc 8-4. Xenolith of Precambrian basement. A plagioclase (andesine)-microcline-quartz-biotite gneiss. Accessory minerals are sphene, magnetite and apatite. The feldspars show moderate alteration; biotite mostly fresh.

Oc 8-6. Xenolith of ultramafic rock. A massive, medium-grained, granoblastic, greenish black rock with approximately 60% phlogopite and 40% green, prismatic diopside.

Oc 8-9. Xenolith of ultramafic rock. A massive, medium-grained, granoblastic, dark greenish grey rock. Composition: clinopyroxene (diopside) 60%, phlogopite 35%, apatite 5%. Rock is cohesive but pits when slabbed with a diamond saw.

Oc 8-12. Xenolith of ultramafic rock. A dark greenish grey rock, but colour varies with compositional variation across specimen. Granoblastic, average grain size 1mm. Composition: diopside 50-70%, phlogopite 30-50%, no visible apatite.

Oc 8-15. Xenolith of Precambrian basement. Banded gneiss with varying content of biotite in bands. Composition: plagioclase (andesine) 60%, quartz 25%, microcline 5%, biotite (average 10%, varies from 5 to 15%). Accessory minerals: magnetite, apatite, zircon.

Oc 8-16. Dyke rock. Porphyritic, with phenocrysts 0.5 to 4mm, matrix < 0.1mm. Dark greenish grey. Mica phenocrysts show preferred orientation parallel to direction of flow of magma. Composition: phenocrysts- phlogopite 13%, diopside 11%, olivine(pseudomorphs) 11%; matrix (65%), estimated- K-feldspar 50%, phlogopite 20%, diopside 10%, altered glass 10%, opaques 5%, apatite tr.

Oc 8-17. Xenolith of ultramafic rock. Dark greenish grey, granoblastic, medium-grained (2mm), massive. Composition: diopside 50%, phlogopite 40%, apatite 10%. Xenolith rimmed by fine-grained basalt.

4. PETROGRAPHIC DESCRIPTIONS

SAMPLE #: RAB Oc7-1

LOCALITY: NE1/4 13-2-9W4; 2+80N, 0+75E

HAND SPECIMEN:
- MAIN MINERALS: PHLOGOPITE, DIOPSIDE
- GRAIN-SIZE CLASS: MEDIUM-GRAINED w/ SPARSE PHLOG. PHENOS TO 1 cm
- FABRIC: PORPHYRITIC
- COLOUR: WS. 5Y6/1, FS. 5Y3/1
- CLASSIFICATION: LAMPROITE

THIN SECTION:

MINERALS: (MODAL ANALYSIS)		%
PHENOCRYSTS >0.1mm		
PHLOGOPITE		14
CLINOPYROXENE		17
(OLIVINE)SERP/TALC		17
K-Fd		1
MATRIX <0.1mm	%	
K-Fd	40	
PHLOGOPITE	25	
CLINOPYROXENE	20	51
ALTERED GLASS	10	
OPAQUES	3	
APATITE	<1	

BULK CHEMICAL CLASSIFICATION: K-RICH BASALT

ROCK NAME: K-RICH ALKALI OLIVINE BASALT

PETROGRAPHER: R.A. BURWASH

SAMPLE #: RAB Oc8-16

LOCALITY: NE1/4 13-2-9W4; 2+80N, 0+50E

HAND SPECIMEN:

MAIN MINERALS: PHLOGOPITE, CLINOPYROXENE
GRAIN-SIZE CLASS.: HIATAL- MAX. PHENOS = 4mm(MICA)
MATRIX- V. FINE-GRAINED
FABRIC: PORPHYRITIC, MICAS SHOW PREFERRED ORIENTATION
COLOUR: WS. 5GY6/1, FS. 5GY3/1
CLASSIFICATION: LAMPROITE

THIN SECTION:

MINERALS: (MODAL ANALYSIS)		%
PHENOCRYSTS:		
CLINOPYROXENE		11
PHLOGOPITE		13
(OLIVINE)ANTIG/TALC		11
SANIDINE		<1
MATRIX:	%	
K-Fd	50	
PHLOGOPITE	20	
CLINOPYROXENE	10	64
ALTERED GLASS	10	
OPAQUES	<5	
APATITE	Tr	

BULK CHEMICAL CLASSIFICATION: K-RICH BASALT

ROCK NAME: K-RICH ALKALI OLIVINE BASALT

PETROGRAPHER: R.A. BURWASH

F. CONCLUSIONS AND RECOMMENDATIONS

The presence of abundant xenoliths of mantle rock in both the alkali olivine basalt dykes and the intrusive breccia suggest a deep source region for both rock bodies. The mineralogy of the xenoliths is indicative of a depth of crystallization of the order of 80 to 100 km. The basalt and breccia magmas must therefore have been generated at depths greater than this. This circumstance raises the possibility of the occurrence of diamonds in either the dykes or in the body of intrusive breccia.

The planned follow-up to the mapping and sampling includes:

1) whole rock chemical analysis of representative samples for major elements, minor elements and rare earth elements (REE);
2) isotopic analysis of selected samples for Sm-Nd, Rb-Sr and Pb-Pb, combined with REE data to determine the geologic history of the crust and mantle in the area; and
3) bulk sampling of the mafic dykes and of the intrusive breccia for separation of mineral suites indicative of conditions favouring diamond occurrence. Direct tests for the occurrence of microdiamonds can also be conducted using the heavy mineral separates.

[redacted]

R.A. Burwash, Ph.D., P.Geol.

PROFESSIONAL GEOLOGIST ALBERTA
D.B. NELSON

D.B. Nelson, B.Sc., P.Geol.

December 29, 1992
Edmonton, Alberta

G. REFERENCES

Alberta Geological Survey
1972: Geological Map of Alberta, scale 1:1,267,000

Burwash, R.A. and Culbert, R.R.
1976: Multivariate geochemical and mineral patterns in the Precambrian basement of western Canada; Canadian Journal of Earth Sciences; v. 13, p. 1-18.

Burwash, R.A., and Krupicka, J.
1969: Cratonic reactivation in the Precambrian basement of western Canada. I. Deformation and chemistry; Canadian Journal of Earth Sciences; v. 6, p. 1381-1396.
1970: Cratonic reactivation in the Precambrian basement of western Canada. Part II. Metasomatism and isostasy; Canadian Journal of Earth Sciences; v. 7, p. 1275-1294.

Currie, K.L.
1976: Alkaline Rocks of Canada, Geological Survey of Canada Bull. 239, p. 172
1990: Sweetgrass Hills Dykes. in Ed. D.J. Glass, Lexicon of Canadian Stratigraphy, v. 4, p. 621-622.

Dawson, G.M.
1875: Report on the Geology and Resources of the Region in the vicinity of the forty-ninth parallel from Lake of the Woods to the Rocky Mountains. British North American Boundary Commission, Montreal.

Irish, E.J.W.
1967: Foremost, Alberta. Geological Survey of Canada, Map 22-1967, scale 1:253,440

McLean, J.R.
1990: Judith River Formation. in Ed. D.J. Glass, Lexicon of Canadian Stratigraphy, v. 4, p. 322.

Russell, L.S. and Landes, R.W.
1940: Geology of the Southern Alberta Plains, Geological Survey of Canada, Memoir 221.

Williams, M.Y. and Dyer, W.S.
1930: Geology of southern Alberta and southwestern Saskatchewan, Geological Survey of Canada, Memoir 221.

H. CERTIFICATES

CERTIFICATION

I, D.B. Nelson of [redacted] Edmonton, Alberta, certify and declare that:

1. I am a graduate of the University of Alberta with a B.Sc. (1981) in Geology.

2. I am a registered as Professional Geologist with the Association of Professional Engineers, Geologists and Geophysicists.

Dated at Edmonton, Alberta on DECEMBER 29/92.

D.B. Nelson, P. Geol.

CERTIFICATION

I, R.A. Burwash of [redacted] Edmonton, Alberta, certify and declare that:

1. I am a graduate of the University of Minnesota with a Ph. D. in Geology.

2. I am a registered as Professional Geologist with the Association of Professional Engineers, Geologists and Geophysicists.

Dated at Edmonton, Alberta on December 29, 1992.

[redacted]

R.A. Burwash, Ph. D., P. Geol.

I. COSTS

Transportation, provisions and camp		
truck rental 5 days @ $25.00	$ 125.00	
gas	161.96	
provisions	250.00	
camp	100.00	

		$ 636.96
Geological Map		
2 geologists 2.5 days	$1,625.00	
map compilation 3 days @ $400/day	1,200.00	
drafting	280.00	

		3,105.00
Thin section preparation	$ 664.83	

		664.83
Thin section analyses		
8 hrs @ $40/hr	$ 240.00	

		560.00
Publications	200.16	

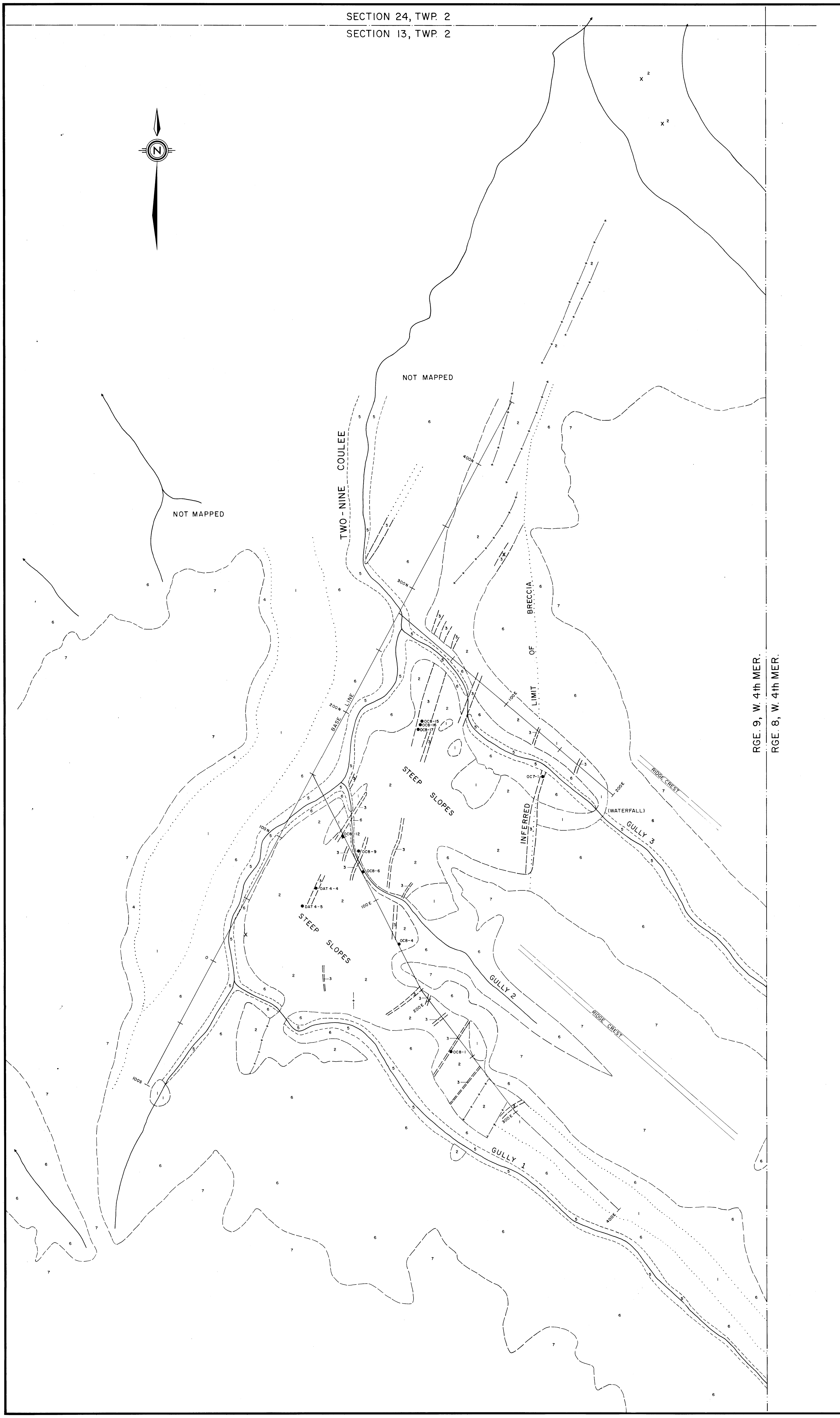
		200.16
Report preparation	500.00	

		500.00
		=========
		$5,346.95

Respectively submitted

PROFESSIONAL GEOLOGIST
D. B. NELSON
ALBERTA

D.B. Nelson, B.Sc., P.Geol.



LEGEND

RECENT

7	PRAIRIE; UNCULTIVATED
6	COLLUVIUM; MUD-FLOWS, ROCK FRAGMENTS
5	ALLUVIUM; SAND, CLAY

QUATERNARY

4	GLACIAL DRIFT; SAND, GRAVEL, BOULDERS (UPPER WEST WALL OF TWO-NINE COULEE)

TERTIARY

3	POTASSIC MAFIC DYKES
2	INTRUSIVE BRECCIA

CRETACEOUS

1	JUDITH RIVER Fm; SANDSTONE LIGHT GREY

SYMBOLS

X ISOLATED OUTCROP

GEOLOGICAL CONTACTS (OBSERVED, INFERRED)

CREEK, INTERMITTENT

RIM OF COULEE OR GULLY

AIRPHOTO LINEAMENT

LOW TOPOGRAPHIC RIDGE

TOWNSHIP SURVEY LINE

SECTION SURVEY LINE

● OCB-12 LOCATION OF ANALYZED SAMPLE

TOPOGRAPHIC BASE FROM:
ADEN, ALBERTA, NTS 72 E/3, 1:500,000, EDITION 2, 1976
AIR PHOTO AS 849-159 (8-8-62)
AIR PHOTO AS 3078-108 (8-8-84)

GEOLOGIC MAPPING BY:
R.A. BURWASH AND D.B. NELSON; 1989 TO 1992
SCALE: 1:1000 (APPROXIMATE)

FIG. 2

TWO-NINE PROPERTY

PROVINCE OF ALBERTA

METALLIC MINERAL EXPLORATION
PERMIT No. 6890010001
PRELIMINARY MAP OF GEOLOGY
AND SAMPLE LOCATIONS

NTS 72 E/3

COMPILED BY R.A. BURWASH Ph.D., P. Geol.

EDMONTON, ALBERTA DECEMBER, 1992

SCALE: 1:1000 (APPROXIMATE)

SCALE 30 20 10 0 25 50 75 METRES

Drawn by: W.J. Skewchuk Drafting Services