GEOLOGY OF THE NIFTY Zn-Pb-Ba PROSPECT, BELLA COOLA DISTRICT, BRITISH COLUMBIA

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INTRODUCTION

The Nifty Zn-Pb-Ag-Ba prospect is located in the headwaters of the Noosegulch River valley, approximately 23 kilometres north-east of Hagensborg in west-central British Columbia (Figure 1). The area lies within the Stikine Terrane of the Coast Belt and is mostly underlain by various packages of mafic to felsic volcanic, volcaniclastic and sedimentary rocks (Figure 1). Many of these packages are of uncertain age and they are intruded by, and form roof pendants within, plutons of the Coast Belt. The volcanic rocks host several mineral occurrences, of which the Nifty prospect (B.C. Minfile number 093D) 006) is the most important and best explored. Other occurrences in the area include the Jamtart, Bella Coola Chief and Malachite Cliff occurrences as well as the Keen soil geochemical anomaly (Figure 1).

Despite exploration and drilling by various mining companies, the origin and age of the Nifty prospect have remained uncertain, and little has been reported about the chemistry of either the hostrocks or the mineralization. This paper describes the geology of the Nifty prospect. It also presents chemical data on the hosting volcanic rocks, the mineralization and its associated alteration halo, as well as some other intrusive and volcanic rocks elsewhere in the district. U-Pb data for zircons from a suite of quartz porphyry dikes that cuts the Nifty mineralization is also presented. The character and chemistry of the Nifty mineralization and its hostrocks suggest it represents a volcanogenic disseminated sulphide exhalite deposit, although an epigenetic origin has been also suggested (Morton and Birkland, 1993).

FIELD PROGRAM

The following was accomplished during the 1996 summer field program:

(1) Assay samples were collected of mineralized and altered rocks from the Nifty, Keen and Jamtart occurrences (Figure 1), and other sulphide-rich outcrops in the district.
(2) In order to determine the composition of the rocks hosting the mineral occurrences, samples of the unaltered volcanic, volcaniclastics and intrusive rocks were collected for major and trace element analyses. The bulk of this sampling effort was concentrated over the Nifty prospect.
(3) Two samples each of the felsic volcanics and quartz porphyry dikes at the Nifty prospect were collected to attempt age determination by U-Pb methods on zircons.
(4) A previously unrecorded copper showing named the Malachite Cliff occurrence, was discovered at 3500 feet elevation on the western slopes of the Noosegulch River valley at UTM 5816950N; 677070E.
(5) An area of rock slide potential was noted in cliffs high on the western flanks of the Noosegulch River canyon at UTM 5827200N; 674250E, close to the Jamtart mineral occurrence. The hazardous area is at an elevation of 1400m and comprises a number of high, unstable cliffs that lie above a scree slope which stretches down to the river. A large area of bedrock (400 m by 500 m) immediately above the cliffs shows evidence of chaotic subsidence and is cut by a series of wide, crevasse-like fissures. These tension fissures trend parallel to a northerly trending fault passing along Noosegulch River; they reach up to 1m wide and are estimated to be hundreds of metres deep. A landslide in this area could temporarily dam the Noosegulch River and lead to damage downstream.

PREVIOUS WORK

The Nifty claims were first staked and explored in 1929-1930 (Mandy, 1931) after prospectors working for Consolidated Mining Smelting Co. (now Cominco Ltd.) were attracted to the extensively rust-stained cliffs on the east side of the Noosegulch River. Trenching revealed a zone of sphalerite-galena-barite mineralization and, subsequently, a 9 metre-long adit was driven beneath this zone (Figure 2).

Baer (1973) geologically mapped the region at a scale of 1:250 000 and considered the volcanic rocks hosting the Nifty prospect to be part of the Middle Jurassic Hazelton Group, as defined by Tipper (1963).

LEGEND FOR FIGURE 1

(numbers in brackets represent rock units of Baer, 1973)

CENOZOIC

Olivine basalt (18)

Intrusive rocks-granite, syenite, granodiorite (13,14,16)
and dacitic volcanics (11)

CRETACEOUS

Andesitic volcanics; minor black slates (12)

CRETACEOUS AND/OR JURASSIC

Andesitic volcanics and tuffs; minor sediments
and dacitic volcanics (11)

Black slate and argillite (10)

TRIASSIC OR OLDER

Schistose metasediments (8)

Greenstone and chlorite schist (7)

Granodiorite, commonly foliated (5,6)

Diorite and quartz diorite, commonly foliated (3,4)

Ortho and paragneiss (1,2)

Fault

45 Strike and dip of sedimentary bedding or volcanic layering

Mountain or peak

Mineral occurrence

N=Nifty
K=Keen
MC=Malachite cliff
BC=Bella Coola Chief
J=Jamtart

Middle Jurassic (mid Bajocian) fossils
(Baer, 1973)

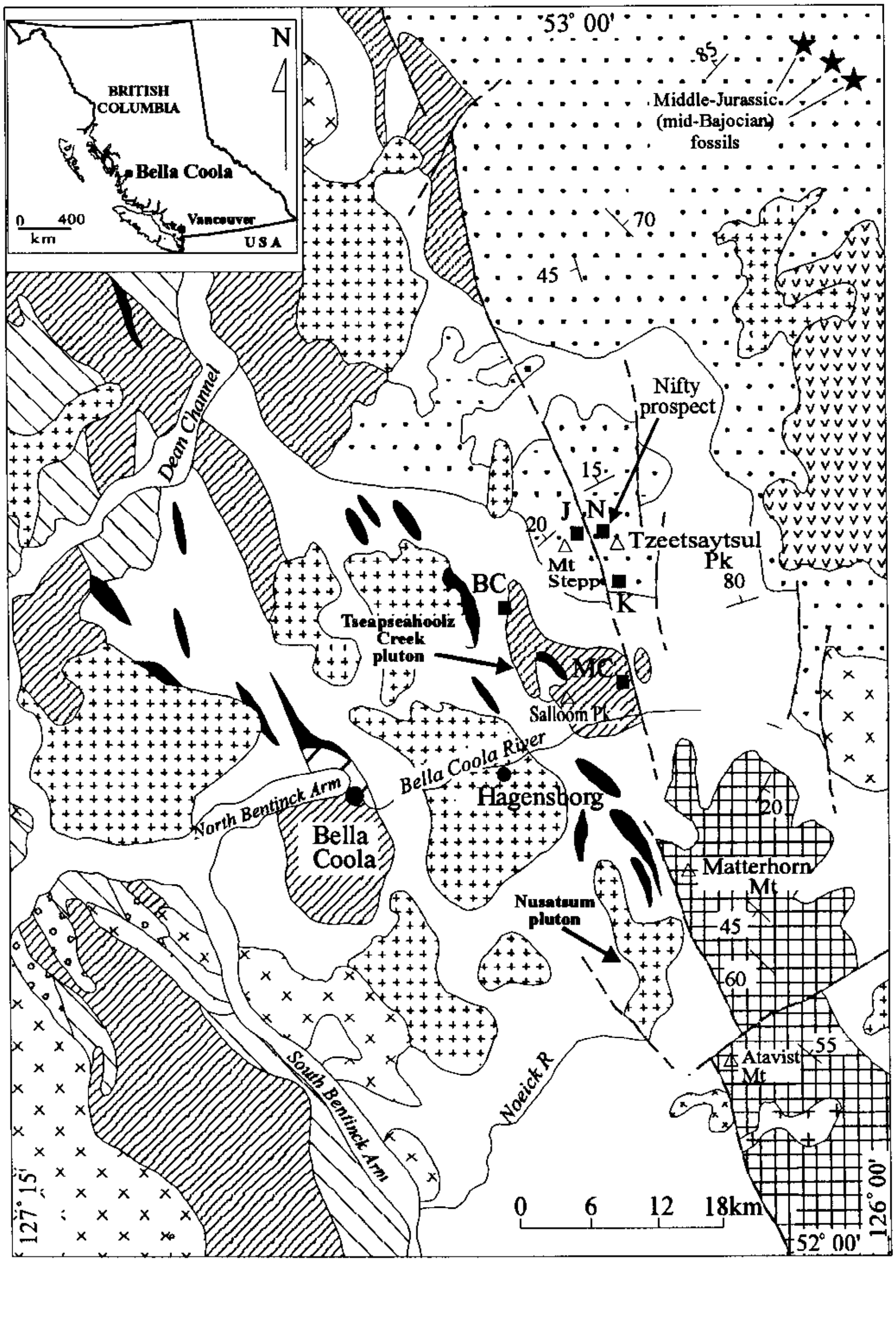
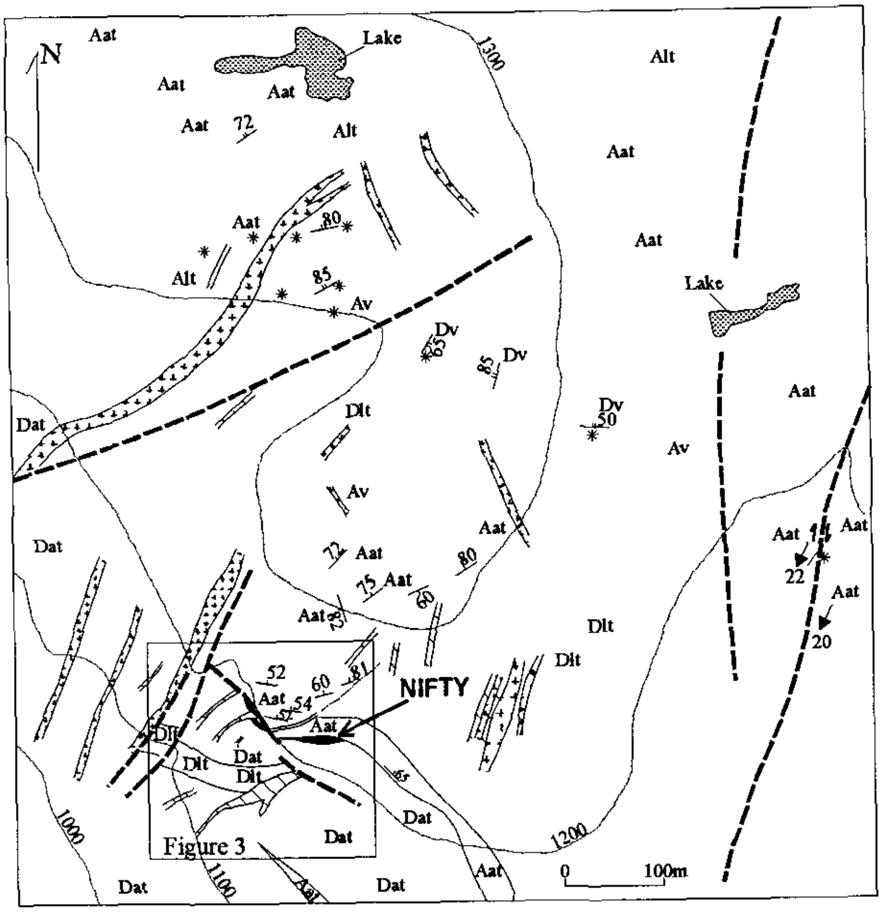


Figure 1. Regional geology of the Bella Coola district showing locations of the Nifty and other mineral occurrences. Adapted after Baer (1973).



Aat = Andesitic ash tuffs; massive to bedded
Alt = Andesitic lapilli tuffs; massive
Av = Andesitic volcanics; massive to flow banded
Dlt = Dacitic lapilli tuffs; massive
Dv = Dacitic volcanics; massive to flow banded to spherulitic
* = Veins and pods of red jasper

Intrusive rocks

Andesite dikes

Quartz porphyry dikes (c. 164 Ma)

Barite, massive to bedded, commonly sheared

Dat = altered dacitic to andesitic ash tuffs, minor lapilli tuff and possible volcanic flows

Dlt = altered dacitic to andesitic lapilli tuffs, minor ash tuff and possible volcanic flows

Fault
Geological contact
60 Strike and dip of bedding
85 Strike and dip of volcanic flow
22 Plunge of slickensliding
Direction of lateral fault movement
Nifty adit

Contour are in metres

Figure 2. Generalized geology in the vicinity of the Nifty prospect, Bella Coola. Adapted largely from Bailes and McArthur (1978, 1979) and observations of the authors.

However, Glen Woodsworth of the Geological Survey of Canada, in a talk presented in 1980, suggested that the rocks belong to the Early Cretaceous Gambier Group. In southern British Columbia the Gambier hosts the Brittania volcanogenic massive sulphide deposit (McColl, 1987). This latter correlation was accepted by many company geologists who subsequently explored the area. However, U-Pb dating presented in this paper demonstrates a pre-164 Ma (Middle Jurassic) age for the rocks hosting the Nifty prospect; this age is supported by the recent discovery of Jurassic marine fossils in the vicinity of Compass Lake, approximately 4 kilometres northeast of the Nifty prospect (Glenn Woodsworth, personal communication, 1997).

In the late 1970's, Pan Ocean Oil Ltd. mapped and soil sampled an extensive area around the Nifty prospect and the immediate vicinity of the prospect was mapped at a scale of 1:100 by J.R. Woodcock (Figure 3; Bailes, 1977). The company completed five drill holes, collared in hangingwall rocks, in an attempt to intersect downdip extensions of the sphalerite-galena-barite zone (Figure 3). The results of that work have been summarized by Lewis (1979, 1981). Although this drilling did not intersect economic mineralization at Nifty (Bailes, 1977; Bailes and McArthur, 1978), reconnaissance work resulted in the discovery of another small Pb-Zn showing (later called the Jamtart or West Side occurrence) situated west of Noosegulch Creek, approximately 2.4 kilometres south-west of Nifty (Figure 1). In addition, Pan Ocean discovered a Zn-Pb geochemical anomaly in soils about 6 kilometres south of the Nifty which is called the Keen occurrence (Figure 1; Bailes and McArthur, 1979).

In 1980 and 1981, Rio Tinto Canadian Exploration Ltd. conducted an exploration program over the Nifty and Keen properties (Holtby and Campbell, 1980; Lohman, 1981). The work included drilling in hangingwall rocks to test for downdip extensions of the Nifty mineralization. The first hole was abandoned at 175 metres due to ground problems; a second parallel hole drilled immediately nearby reached a depth of 495 metres. Both holes intersected sequences of andesitic and dacitic ash and lapilli tuffs with lesser amounts of intrusive rocks, but no economic mineralization was encountered.

Imperial Metals Corporation completed some soil, rock and stream sediment sampling on the Keen and Nifty properties in 1984 and 1989 respectively (Morton, 1984; Taylor 1989). It is believed that Imperial Metals drilled into altered footwall rocks immediately east of the Nifty adit but the results of this program are not available. In 1985, Cominco Ltd. once again completed a large program of mapping and sampling over the Nifty and Keen properties without economic success (Anonymous, 1985; Blackwell, 1985). The most recent exploration activity was in 1992 when the area was restaked and a geological and geochemical program was completed for Inco Exploration and Technical Services Inc., and Eastfield Resources Ltd. (Morton and Birkeland, 1993).

DISTRICT GEOLOGY

The geology of the Bella Coola area, adapted after Baer (1973) is presented in Figure 1. The area is underlain by varied packages of volcanic and lesser sedimentary rocks that generally form north to northwesterly trending pendants within intrusions of the Coast Plutonic Complex. The stratigraphic and structural relationships of these packages to one another are poorly understood and their ages range from Cenozoic to Triassic or older. The volcanic rocks are mostly of basaltic-andesitic composition but those hosting the Nifty prospect are distinct in containing some felsic lavas and tuffs (Figure 4). The sedimentary rocks include small, generally highly deformed units of black slate, argillite and greywackes. Some greywackes in the northeastern part of the Bella Coola mapsheet (Figure 1) contain fossils of middle Jurassic age (Tipper, 1963; Baer, 1973).

The roof pendant country rocks are intruded by, and in some instances thermally overprinted by, numerous plutons and small stocks of the Coast Plutonic Complex. These are largely of diorite-granodiorite composition and vary from massive rocks to intensely foliated orthogneisses. There is a westerly increase in both the regional metamorphic grade and structural deformation across the district. Consequently, in the southwestern part of the area (Figure 1), the country rocks and some of the older intrusions have been converted to schists and gneisses. North to north-westerly trending horizons of strongly foliated rock are interpreted to be ductile shear zones.

Our geological investigations and sampling were concentrated in four separate areas in the district. Most of the detailed work and sampling were conducted in and around the Nifty prospect (Figures 2 and 3) although some time was spent examining and sampling the rocks hosting both the Jamtart occurrence further west and the Keen Pb-Zn soil geochemical anomaly further south. In addition, some mafic volcanics and hornfelsed metasediments close to the Nusatsum pluton, south-west of Matterhorn Mountain (Figure 1) were also sampled. The analytical data for the rocks are presented in Table 1. Chemical plots indicate that the volcanic rocks adjacent to the Nusatsum pluton and those hosting the Jamtart and Keen properties are largely subalkaline, calcalkaline basalts and andesites that have a medium to high K_2O content (Figure 4).

GEOLOGY AND CHEMISTRY OF THE ROCKS HOSTING THE NIFTY PROSPECT

The geology of the Nifty area, compiled from the work of Bailes and McArthur (1978, 1979),

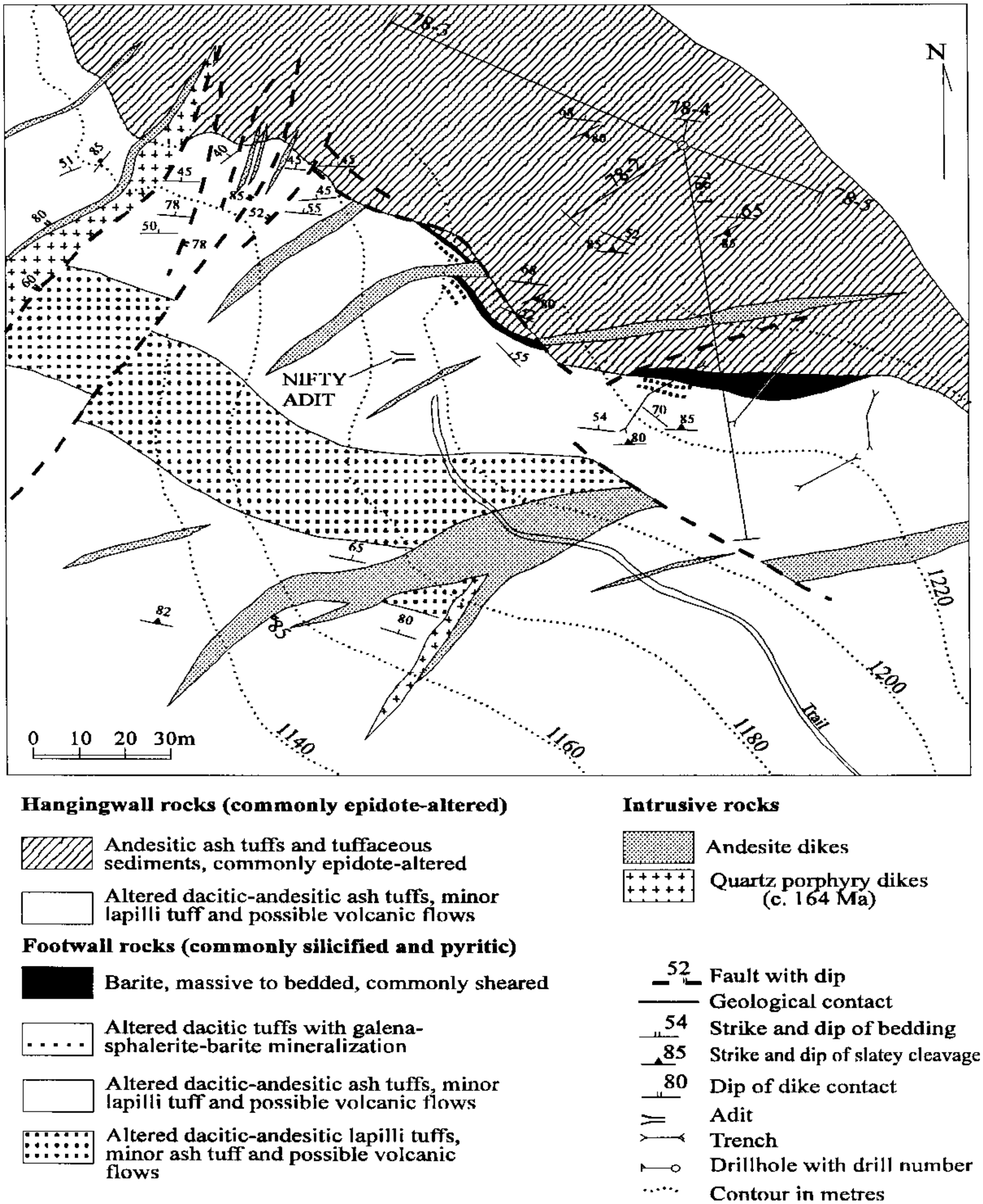
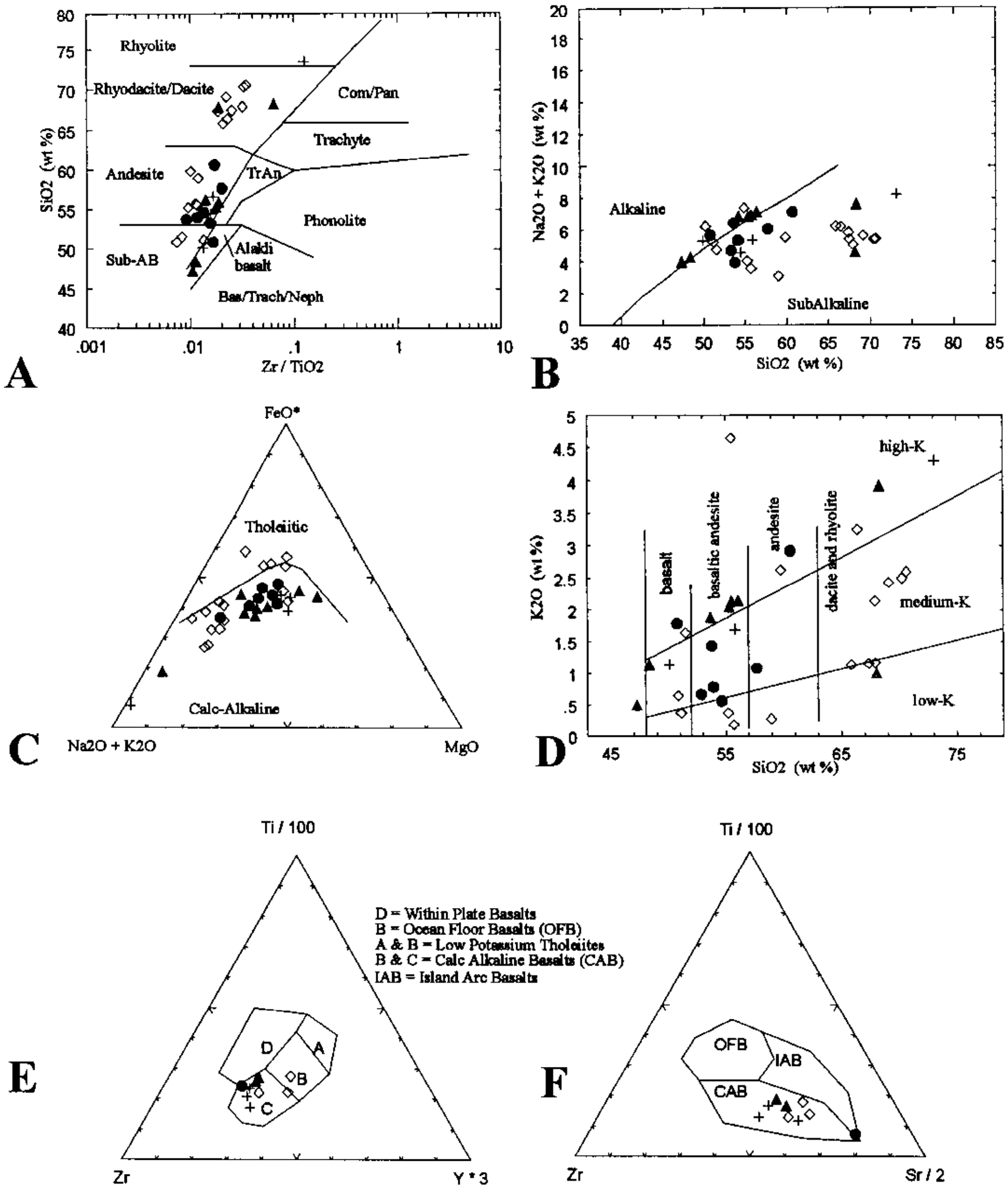


Figure 3. Geology of the Nifty prospect, Bella Coola. Adapted from the mapping of J.R. Woodcock (Bailes, 1977) and the authors. Note: distribution of the silicified and pyritic footwall rocks is shown in Figure 5.



◇ Volcanics & tuffs stratigraphically overlying the Nifty Prospect

● Volcanics & tuffs south of the Keen occurrence

▲ Volcanic rocks in the vicinity of the Jamtart occurrence

+ Hornfelsed volcanics adjacent to the Nasatsum pluton

Figure 4. Geochemical plots of some volcanic rocks in the Bella Coola district:
(A) SiO_2 versus log (Zr/TiO_2) plot (after Winchester and Floyd, 1977).
(B) Alkali versus silica plot (after Irvine and Baragar 1971).
(C) Triangular $Na_2O + K_2O$ - FeO - MgO plot (after Irvine and Baragar 1971).
(D) K_2O versus SiO_2 plot (after Le Maitre, 1989).
(E) Triangular Zr - Ti/100 - Y x 3 plot (after Pearce and Cann, 1973).
(F) Triangular Zr - Ti/100 - Sr/2 plot (after Pearce and Cann, 1973).

TABLE 1

MAJOR AND TRACE ELEMENT ANALYSES OF VOLCANIC ROCKS HOSTING THE JAMTART AND KEEN Pb-Zn OCCURRENCES AND INTRUDED BY THE NUSATSUM PLUTON, BELLA COOLA DISTRICT

	Volcanic rocks hosting the Jamtart occurrence.							
	GR96-85	GR96-88	GR96-89	GR96-90	GR96-91	GR96-91R	GR96-92	GR96-93
SiO_2	47.27	67.89	48.36	53.65	55.28	55.53	55.52	68.32
Al_2O_3	16.41	13.21	17.25	16.78	16.79	16.84	16.92	16.40
MgO	7.58	1.94	5.61	4.27	3.46	3.41	3.40	0.49
Na_2O	3.47	3.89	3.14	4.81	4.75	4.85	4.67	3.69
MnO	0.16	0.19	0.16	0.13	0.14	0.15	0.14	0.06
Fe_2O_3	9.97	5.96	9.18	8.06	7.78	7.71	7.78	2.09
TiO_2	1.22	0.70	1.22	0.91	0.93	0.94	0.92	0.29
P_2O_5	0.33	0.29	0.32	0.43	0.55	0.57	0.57	0.08
CaO	8.63	1.77	8.54	5.13	4.82	4.84	4.98	3.16
K_2O	0.50	1.07	1.13	1.88	2.05	2.06	2.14	3.92
Cr_2O_3	0.03	0.01	0.02	0.01	0.01	0.01	0.01	0.01
LOI	4.03	2.85	4.96	3.72	3.02	2.91	2.76	1.20
Total	99.60	99.77	99.89	99.78	99.58	99.82	99.81	99.71
Ba	240	322	623	915	989	983	945	1302
Y	23	38	24	23	31	27	29	17
Sr	373	55	459	390	521	522	558	1688
Zr	127	132	138	136	163	164	168	184
Nb	12	13	12	13	13	15	13	17
Ce	24	40	18	43	46	43	40	32
V	194	53	203	177	167	173	161	34

	Volcanic rocks hosting the Keen soil geochemical anomaly.								Hornfelsed volcanic rocks adjacent to the Nasatsum Pluton.			
	GR96-5	GR96-6	GR96-7	GR96-8	GR96-9	GR96-12	GR96-16	GR96-94	GR96-97	GR96-98	GR96-99	GR96-100
SiO_2	54.25	50.77	53.92	53.57	53.24	57.68	60.64	65.75	54.46	50.08	55.86	73.11
Al_2O_3	17.96	19.79	18.56	17.40	19.54	17.44	16.12	15.65	17.29	18.42	16.79	13.99
MgO	3.68	3.35	3.85	3.51	3.95	2.91	1.95	1.28	4.92	4.76	5.47	0.14
Na_2O	3.55	3.88	4.35	5.12	3.98	4.94	4.19	3.94	3.24	4.17	3.63	3.93
MnO	0.13	0.14	0.10	0.14	0.10	0.14	0.30	0.23	0.11	0.28	0.18	0.04
Fe_2O_3	7.54	8.70	7.88	7.74	7.32	6.65	5.75	4.33	8.00	8.82	7.56	0.76
TiO_2	0.71	0.67	0.77	0.68	0.71	0.58	0.65	0.54	0.90	1.42	0.82	0.06
P_2O_5	0.31	0.32	0.34	0.29	0.33	0.29	0.21	0.18	0.34	0.54	0.30	0.03
CaO	7.61	5.84	5.63	5.02	5.85	4.69	3.55	3.82	7.48	6.92	6.29	1.46
K_2O	0.54	1.78	0.79	1.30	0.70	1.08	2.92	2.23	1.30	1.14	1.69	4.30
Cr_2O_3	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.01
LOI	3.17	4.38	3.64	5.19	3.72	3.22	2.51	1.57	1.69	2.81	0.61	1.68
Total	99.46	99.63	99.84	99.97	99.45	99.63	98.80	99.53	99.75	99.38	99.21	99.51
Ba	383	734	436	435	429	496	1653	980	499	634	1100	869
Y	13	20	18	17	19	17	25	26	22	30	27	<5
Sr	886	1028	818	410	1032	914	252	351	538	486	354	329
Zr	94	105	93	87	111	116	111	133	140	188	157	75
Nb	11	11	8	10	10	13	13	13	14	15	14	11
Ce	32	10	41	20	26	16	9	20	30	21	23	7
V	138	177	142	125	147	117	122	61	189	221	182	<5

Analyses completed at the Cominco Reseach Laboratory, 1486 East Pender St., Vancouver, B.C. using steel mill grinding.

Major element oxides in percent; trace elements in ppm.

Fe_2O_3 = total iron as Fe_2O_3

For analytical methods see Table 2.

1 = Fused Disc - X-ray fluorescence

2 = Pressed pellet - X-ray fluorescence

3 = LOI calculated after heating predried samples to 1100^0 for 4 hours.

Ba = Fused disc analysis for XRF calibration.

TABLE 1 CONTINUED

Sample descriptions

Volcanic rocks in the vicinity of the Jamtart occurrence, west of the Noosegulch River and Nifty Prospect	
GR96-85	Grey, weakly layered, fine grained ash tuff with trace pyrite
GR96-88	Green, silicious, fine grained vesicular lava flow or sill
GR96-89	Dark green, fine grained vesicular lava flow or sill
GR96-90	Grey, massive, fine grained volcanic rock. Minor epidote and pyrite
GR96-91	Grey, massive volcanic rock with feldspar phenocrysts. Minor epidote and pyrite
GR96-91R	Grey, massive volcanic rock with feldspar phenocrysts. Minor epidote and pyrite
GR96-92	Grey, massive volcanic rock with feldspar phenocrysts. Minor epidote and pyrite
GR96-93	Pale grey, fine grained, flow banded felsic volcanic
Volcanic rocks south and southwest of the Keen soil geochemical anomaly, east of the Noosegulch River.	
GR96-5	Dark green, massive volcanic with feldspar phenocrysts up to 4 mm. Minor epidote
GR96-6	Dark green, massive volcanic with minor lapilli fragments
GR96-7	Dark green, massive volcanic with feldspar phenocrysts up to 4 mm. Minor epidote
GR96-8	Dark green, massive volcanic with feldspar phenocrysts up to 2 mm.
GR96-9	Dark green, massive volcanic with feldspar and hornblende phenocrysts up to 4 mm.
GR96-12	Dark green, massive to weakly layered ash tuff with clasts and crystals up to 4 mm.
GR96-16	Pale grey-green, massive, fine grained volcanic. Trace pyrite.
GR96-94	Silicified, pervasively altered volcanic with 1 to 3 percent finely disseminated pyrite.
Hornfelsed volcanic rocks adjacent to the Nasatsum pluton, SE of Hagensborg	
GR96-97	Dark, fine grained and massive, hornfelsed silicious meta-volcanic
GR96-98	Dark, fine grained and massive, hornfelsed silicious meta-volcanic
GR96-99	Dark, fine grained, massive, weakly hornfelsed, amygdeloidal mafic volcanic
GR96-100	Pink, fine grained, felsic volcanic or sill

Blackwell (1985) and our own observations is illustrated in Figures 2 and 3. The area is underlain by a moderate to steep northerly dipping and east to north-east striking package of dust, ash and lapilli tuffs with subordinate amounts of volcanic flows, volcanic breccias and tuffaceous sediments. No sedimentary younging indicators have been recognized. However, based largely on the orientation of the interpreted footwall and hangingwall alteration at Nifty, the stratigraphy is believed to face northwards with no significant structural repetition.

A general stratigraphic succession is recognized. The lowest part of the succession occurs immediately south and south-west of the Nifty property. Due to the pervasive alteration related to the Nifty hydrothermal system, the original lithologies and composition of the rocks in the lower footwall sequence are uncertain. However, they are believed to include massive to well bedded lapilli, ash and dust tuffs of rhyodacite-dacite to basalt composition, as well as some rare, thin units of fine-grained, possibly silty or argillaceous sediments.

The lower sequence is overlain by a thin barite unit (Figure 3) which also forms a caprock to the mineralization. This in turn passes up to a 500 to 600 metre-thick hangingwall sequence of mafic tuffs with minor mafic flows and rare, thin units of rhyodacitic-dacitic flows, tuffs and volcanic breccias. At the base of this hangingwall package, the mafic tuffs tend to be well layered, epidote-altered rocks that are dark to medium green in colour. Further north however, and higher in the sequence, the mafic rocks include maroon colored units that are commonly more massive; this change suggests that they were deposited in an emerging basin and that the environment altered from shallow submarine to subaerial and highly oxidized.

Most of the tuffs in the area are massive, but well preserved layering and sedimentary bedding are seen locally, particularly in the lower part of the sequence, in the immediate hanging and footwall rocks of the Nifty prospect. Tuffs form dark green to maroon colored rocks with angular to well-rounded clasts that are generally less than 10 centimetres in diameter. Coarser varieties of volcanic tuff breccia contain fragments exceeding 0.3 metres in size. The volcanic and tuffaceous clasts are generally matrix supported and vary from monomictic to polymictic. In the latter, clasts vary considerably in texture, colour and composition; grey, pink, red, green and black porphyritic and non porphyritic fragments are present. They are mainly massive to flow banded mafic volcanics and ash and lapilli tuffs with lesser amounts of leucocratic and felsic material of presumed rhyodacitic-dacitic composition. Where felsic clasts are abundant in the tuffs, broken quartz crystals are also common. Many of the massive and bedded mafic tuffs are characterized by epidote alteration.

The mafic volcanic flows are mostly massive and fine-grained. They locally contain random to well orientated feldspar phenocrysts up to 4 millimetres in length. Rarely, well rounded quartz phenocrysts up to 2 millimetres in length are present, and pervasive epidote alteration is a common feature. The felsic flows generally form thin (< 10 metres thick) units ranging from pink to grey to greenish brown in colour. They comprise fine grained siliceous rocks that vary from massive to flow banded and from equigranuar to porphyritic; the latter varieties contain phenocrysts of feldspar as well as rounded crystals of quartz. Some felsic volcanic units are characterized by deformed spherulites as well as hollow lithophysae up to 1 centimetres in diameter.

Pods, disrupted layers and cross-cutting veins of red jasper, up to 30 centimetres thick, occur locally throughout the volcanic sequence. They are most common approximately 500 metres north of the Nifty prospect (Figure 2) and are believed to represent distal products of exhalite activity. In rare instances, the jasper has replaced the original fine grained matrix in the coarser lapilli tuffs. The jasper contains minor amounts of disseminated coarse pyrite, white quartz, and veinlets of specular hematite; some veins are rimmed with epidote. However, assays show no anomalous quantities of metals in the jaspers.

Major and trace element analytical results on the less altered volcanic and tuffaceous rocks that overlie the Nifty prospect are presented in Table 2. Geochemical plots (Figure 4) suggest these rocks are bimodal; they include a calc-alkaline suite of rhyodacite-dacite composition as well as some tholeiitic basalts and andesites. Most of the Nifty volcanic rocks have a low to medium potassium content (Figure 4D), and tectonic discrimination plots indicate the mafic volcanics are calcalkaline basalts (Figs. 4E and F).

MINERALIZATION AND GEOCHEMISTRY OF THE NIFTY PROSPECT

Three distinct zones of alteration are recognized at the Nifty property: (1) an upper stratabound barite cap, (2) an underlying zone containing sporadic amounts of pyrite, sphalerite, galena and barite, and (3) a lower extensive and discordant zone of pervasive silicification and fine-grained pyrite that is barren of economic mineralization. The uppermost capping unit consist predominantly of white, massive to sheared barite. It locally exceeds 10 metres in thickness and has a strike length of at least 130 metres (Figure 3). It is sharply overlain by a thick sequence of well layered, epidote-altered mafic ash tuffs.

The barite horizon is underlain by a zone of altered tuffs that contains some barite and sporadic veins, masses and disseminations of sulphides. This sulphide-bearing zone is less than 10 metres thick and is discontinuously traceable along strike for approximately 90 metres (Figure 3). Sulphides include abundant massive pyrite with lesser amounts of brown to black sphalerite and galena, and trace amounts of tetrahedrite-tennantite and some other Ag or Pb-bearing minerals, including polybasite ($9Ag_2S.Sb_2S_3$).

The mineralized zone passes gradationally down into massive to well bedded lapilli, ash and dust tuffs that are believed to have originally been largely of rhyodacitic composition. These rocks are highly altered and are interpreted to represent a footwall alteration zone related to the hydrothermal feeder system responsible for the overlying Nifty barite and Pb-Zn-Ag mineralization. The footwall alteration forms a discontinuous, rust-weathered, 120 by 220 metres zone, that extends south-west and west of the Nifty Zn-Pb-Ba showing (Figure 5). The rocks in this zone are intensely bleached, silicified and contain between 1 and 5 percent by volume finely disseminated pyrite.

To determine any vertical and lateral geochemical variations in the hydrothermal system, a number of lithogeochemical samples were collected on two traverse lines across the prospect. One line trended southwest and passed vertically down through the barite cap, the underlying mineralized zone and the footwall alteration; the other line was run in a northwest direction, subparallel to the topographic contours, and passed laterally through the barren footwall alteration zone. Figures 6A and B illustrate the vertical and lateral chemical changes in the Nifty host rocks noted from sampling these two lines. Assay results of selected grab samples from the capping barite unit, the Zn-Pb-Ba-bearing zone and the underlying siliceous-pyritic footwall zone are presented in Table 3. Gold and copper values are extremely low, but parts of the barite cap rocks and the underlying sphalerite-galena-bearing zone contain anomalous quantities of Ba, Zn, Pb, Ag, Cd, Sb, Sr, As and Hg. Increased values of K_2O in the sphalerite-galena zone and in parts of the underlying footwall mark areas of potassic-feldspar alteration. Generally, the extensive zone of silicified and pyritic footwall rocks is not enriched in economic base metals. However, higher Na_2O values at the top of the footwall zone suggests the sphalerite-galena mineralization is immediately underlain by a unit of possible albitic alteration (Figure 6A). The samples collected laterally across the footwall alteration show a progressive increase in MgO (up to 2 per cent) towards the north-western margin of the zone, suggesting a corresponding increase in chloritic alteration.

STRUCTURE IN THE NIFTY PROSPECT AREA

One major episode of post-ore deformation is recognized, and the related small-scale asymmetric open to tight folds indicate that the Nifty area lies on a steeply-dipping, northern limb of a large anticline of unknown age. The small-scale folds have steeply dipping axial planes and, in some of the finer grained tuffaceous sedimentary rocks, a pronounced easterly trending fracture cleavage is developed (Figure 3). Bedding-cleavage intersection measurements indicate that the fold axes plunge 15 to 25 degrees in a east to south-east direction.

Several phases of brittle faulting are identified. One of the earliest phases strikes southeast and appears to have accompanied local shearing along the Nifty barite horizon. Several later phases strike northerly to east north-east. Moderately plunging slickenslides on a northerly trending fault situated approximately 600

TABLE 2
MAJOR AND TRACE ELEMENT ANALYSES OF VOLCANIC ROCKS STRATIGRAPHICALLY OVERLYING THE NIFTY PROSPECT, BELLA COOLA DISTRICT

	Sample / Method	GR96-19	GR96-20	GR96-26	GR96-52	GR96-52R	GR96-53	GR96-54	GR96-57	GR96-58	GR96-59
SiO_2	1	50.86	51.51	51.10	70.64	70.40	67.36	67.47	55.53	55.22	55.68
Al_2O_3	1	16.89	18.57	16.60	14.77	14.67	15.40	15.34	21.73	17.02	16.24
MgO	1	5.58	2.65	5.36	1.19	1.27	1.28	1.48	1.44	2.75	3.48
Na_2O	1	5.29	3.08	4.84	2.83	2.84	4.65	4.23	2.45	3.67	3.38
MnO	1	0.18	0.31	0.15	0.07	0.07	0.09	0.09	0.08	0.22	0.21
Fe_2O_3	1	10.71	9.62	8.54	2.69	2.81	3.80	3.74	6.85	9.07	9.13
TiO_2	1	0.95	0.87	1.02	0.38	0.39	0.51	0.51	0.87	0.87	0.82
P_2O_5	1	0.28	0.19	0.34	0.09	0.08	0.11	0.13	0.28	0.21	0.23
CaO	1	3.72	7.41	6.07	2.34	2.38	3.34	3.45	2.09	6.66	6.93
K_2O	1	0.65	1.64	0.37	2.60	2.55	1.16	1.17	4.65	0.37	0.19
Cr_2O_3	1	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
LOI	3	4.60	3.79	5.10	2.16	2.22	1.68	1.44	3.85	3.46	3.34
Total		99.72	99.66	99.51	99.77	99.69	99.39	99.06	99.83	99.53	99.64
Ba	1	343	742	497	779	772	413	463	967	305	271
Y	2	28	22	26	23	29	25	26	24	26	27
Sr	2	414	321	487	230	228	321	285	157	353	426
Zr	2	70	72	138	132	128	94	128	100	83	92
Nb	2	8	13	15	13	15	10	11	13	10	12
Ce	2	14	14	12	26	16	12	29	<5	9	15
V	2	272	191	174	55	63	103	77	232	197	209

	Method	GR96-70	GR96-71	GR96-72	GR96-73	GR96-74	GR96-103
SiO_2	1	66.44	65.86	59.82	67.92	58.94	69.14
Al_2O_3	1	14.74	15.36	16.29	15.07	15.08	13.85
MgO	1	0.52	1.53	1.55	1.46	3.16	0.76
Na_2O	1	2.93	5.09	2.91	2.93	2.82	3.21
MnO	1	0.08	0.12	0.12	0.12	0.19	0.08
Fe_2O_3	1	4.23	5.92	11.15	4.01	9.18	4.51
TiO_2	1	0.67	0.82	0.97	0.42	0.79	0.70
P_2O_5	1	0.25	0.29	0.20	0.16	0.21	0.22
CaO	1	3.11	1.63	1.07	2.51	6.61	2.06
K_2O	1	3.25	1.14	2.62	2.14	0.28	2.43
Cr_2O_3	1	0.01	0.01	0.01	0.01	0.01	0.01
LOI	3	3.69	2.14	3.04	2.41	2.74	2.78
Total		99.92	99.91	99.75	99.16	100.01	99.75
Ba	1	524	365	596	864	141	568
Y	2	41	37	15	23	25	40
Sr	2	96	170	54	290	387	118
Zr	2	152	169	98	134	94	155
Nb	2	13	15	11	11	15	15
Ce	2	32	37	<5	23	27	32
V	2	51	52	180	78	195	52

Analyses completed at the Cominco Reseach Laboratory, 1486 East Pender St., Vancouver, B.C. using steel mill grinding.
Major element oxides in percent; trace elements in ppm.
Fe_2O_3 = total iron as Fe_2O_3
Methods
1 = Fused Disc - X-ray fluorescence
2 = Pressed pellet - X-ray fluorescence
3 = LOI calculated after heating predried samples to 1100^0 for 4 hours.
Ba = Fused disc analysis for XRF calibration.

TABLE 2 CONTINUED

Sample descriptions	
GR96-19	Grey-green, massive, fine grained, equigranular volcanic
GR96-20	Dark grey, massive volcanic with feldspar phenocrysts up to 3 mm.
GR96-26	Grey-green, weakly layered ash tuff with epidote veinlets
GR96-52	Core sample of dark brown lapilli tuff.
GR96-52R	Core sample of dark brown lapilli tuff.
GR96-53	Core sample of dark brown ash tuff.
GR96-54	Core sample of dark brown lapilli tuff.
GR96-57	Maroon coloured tuff with feldspathic lapilli and quartz fragments
GR96-58	Light grey to maroon coloured, massive, equigranular crystal tuff
GR96-59	Maroon coloured, fine grained and massive crystal tuff
GR96-70	Pale grey to pink, fine grained, flow banded felsic volcanic with feldspar and quartz crystals up to 2 mm.
GR96-71	Pale grey to pink, fine grained, flow banded felsic volcanic with spherulites up to 1 cm.
GR96-72	Dark, fine grained, mafic crystal tuff
GR96-73	Grey, cherty dust tuff
GR96-74	Pale grey, fine grained, flow banded volcanic
GR96-103	Light grey, fine grained, flow banded felsic volcanic

metres east of the Nifty prospect (Figure 2) indicate late dextral transverse movement. Some north-east trending faults are relatively old and have controlled the emplacement of the quartz porphyry and andesitic dikes, although post-intrusion reactivation of these fractures is commonly seen along the dike margins. Some north-east striking faults and dikes that cut the Nifty footwall rocks are believed to have followed precursor fractures that were conduits to the hydrothermal system.

Many of the late faults, particularly those along dike margins, are associated with sets of shallow and steeply dipping milky white quartz veins up to 10 centimetres thick. Irregular, sigmoidal tension gash veins are present, as well as regular, parallel vein sets spaced between 1 to 5 centimetres apart. They contain minor epidote and pink potassic feldspar but no sulphides were identified. An epidote-rich alteration halo is present around some veins. They occur both in the Nifty area and in the vicinity of the Keen soil geochemical anomaly approximately 6 kilometres further south.

MICROPROBE ANALYSES OF THE NIFTY MINERALIZATION

Two samples of strongly altered and mineralized tuff (GR96-38 and GR96-95) containing sphalerite and galena in a gangue of quartz, pyrite, barite and feldspar were subjected to microprobe analysis, and the data are presented in Tables 4A to 4E. The sphalerite has low quantities of iron and cadmium (<1.5 weight per cent and <0.6 weight per cent, respectively), and the galena contains less than 0.17 per cent silver (Tables 4A and 4B). Some sphalerites contain exsolution blebs of chalcopyrite up to 30 microns in diameter. Rarely, galena is cut by microfractures containing various unidentified silver and/or lead-bearing minerals, some of which are believed to be late oxides and sulphates. Small, micron-sized grains of tetrahedrite-tennantite, polybasite-pearcite ($9Ag_2S.Sb_2S_3$) and some other unidentified minerals were also detected and analysed (Table 4C).

The barite crystals in the gangue contain up to 2.67 weight per cent SrO. One crystal containing 0.5 per cent PbO was detected, but in most of the barite analysed, the CaO and PbO values were extremely low or undetectable (Table 4D). The gangue also includes feldspars containing up to 16.6 weight per cent K_2O and 9.6 weight per cent BaO (Table 4E). Within individual feldspar crystals, the barium content exhibits extreme variations on a micron scale.

U-Pb GEOCHRONOLOGY OF THE IGNEOUS ROCKS

Two felsic volcanic flows in the hangingwall sequence together with a post-ore quartz porphyry felsic dike at the Nifty prospect were sampled for U-Pb geochronology. Unfortunately, both samples of the felsic flows yielded insufficient zircons for dating. However, the 30 kilogram sample of quartz-feldspar porphyry dike yielded an abundant amount of good quality, clear, colourless, stubby prismatic zircon crystals. Mineral separation and U-Pb analytical techniques are described by Mortensen *et al.* (1995). All mineral separation and analytical work was carried out at the Geochronology Laboratory at the University of British Columbia.

U-Pb data are listed in Table 5 and plotted on Figure 7. Five of the strongly abraded zircon fractions are concordant or slight discordant, the latter having apparently lost a minor proportion of their radiogenic lead. Furthermore, the data suggests there are no older inherited zircon components within the analyses fractions. The weighted average $^{207}Pb/^{206}Pb$ age of 164.3 ± 4.4 Ma provides a good age estimate, but the overlap of concordant ellipses A and C with concordia provides the best age estimate at 164.2 +1.2/-0.9 Ma (Figure 7). These data indicate that the Nifty

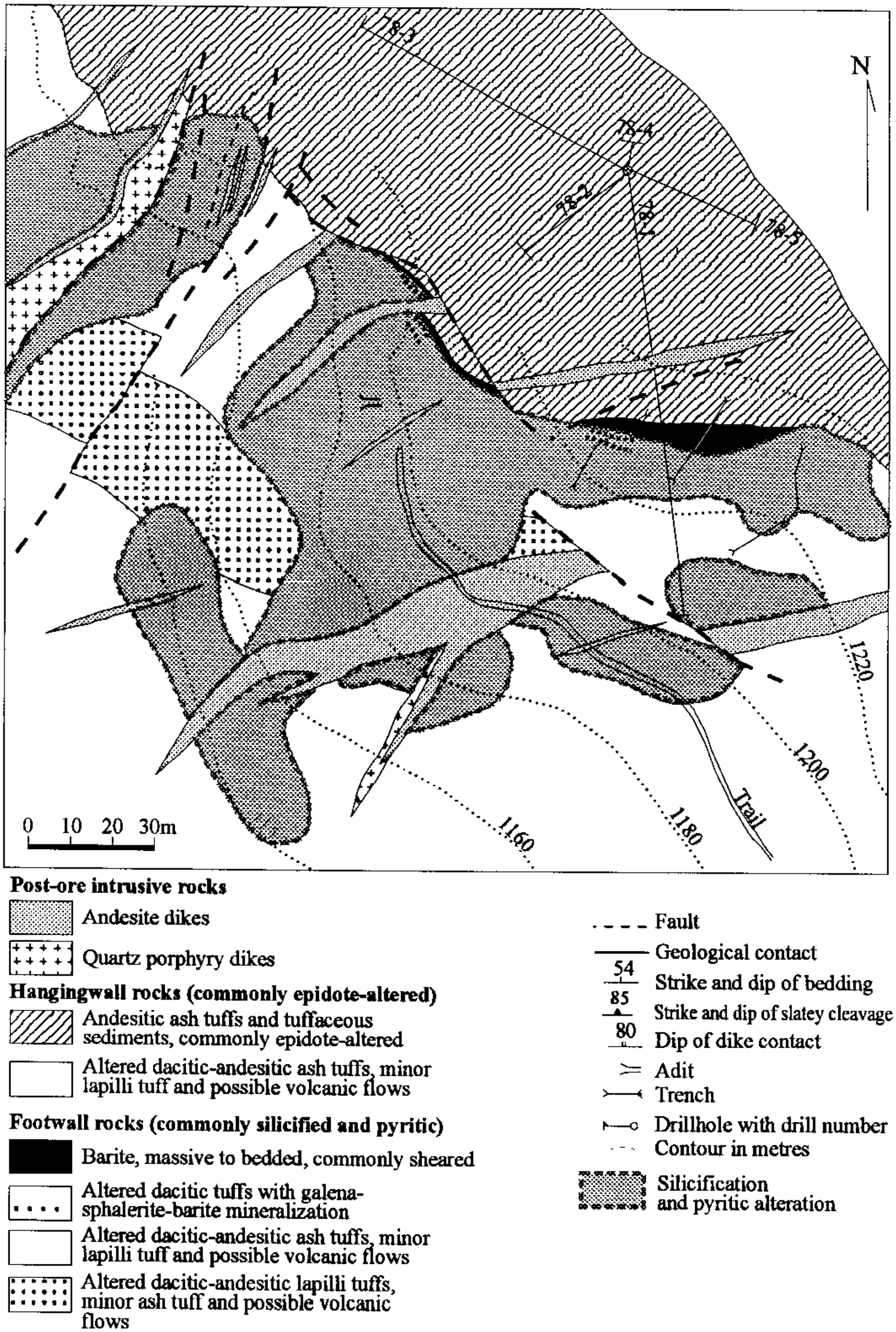


Figure 5. Geology of the Nifty area showing distribution of the silicified and pyritic footwall rocks.

TABLE 3
MAJOR AND TRACE ELEMENT ANALYSES OF SELECTED MINERALIZED GRAB SAMPLES
FROM THE NIFTY PROSPECT, BELLA COOLA DISTRICT

	Method	GR96-35	GR96-36	GR96-37	GR96-38	GR96-39	GR96-40	GR96-41	GR96-42	GR96-43	GR96-44	GR96-45
SiO_2	1	13.05	52.15	18.85	45.88	77.86	75.97	70.71	67.93	73.74	74.94	78.44
Al_2O_3	1	4.69	5.53	5.70	14.33	8.01	9.35	13.18	15.24	12.30	9.10	9.45
MgO	1	1.37	0.79	1.25	0.64	0.20	0.27	1.57	1.66	0.73	0.55	0.79
Na_2O	1	4.21	1.57	3.48	1.10	0.41	0.39	3.33	3.43	0.69	0.16	0.27
MnO	1	0.01	0.03	0.02	0.05	0.02	0.01	0.13	0.09	0.02	0.04	0.03
Fe_2O_3	1	0.63	0.98	3.06	7.51	1.04	1.15	5.05	3.69	2.63	3.30	1.95
TiO_2	1	0.36	0.36	0.40	0.84	0.39	0.45	0.43	0.49	0.52	0.42	0.38
P_2O_5	1	0.34	0.10	0.13	0.21	0.12	0.14	0.10	0.15	0.13	0.15	0.12
CaO	1	0.65	0.31	0.44	0.51	0.83	0.48	1.79	2.68	0.33	1.57	0.63
K_2O	1	0.63	3.38	1.14	6.58	5.56	6.47	1.29	1.81	6.26	5.50	5.48
LOI	3	1.93	1.87	5.00	8.58	1.39	1.38	1.94	2.09	2.02	2.38	1.69
Total		27.87	67.07	39.47	86.23	95.83	96.06	99.52	99.26	99.37	98.11	99.23
K_2O/Na_2O		0.15	2.15	0.33	5.98	13.56	16.59	0.39	0.53	9.07	34.38	20.30
Ba	1	391640	177348	336822	21196	13264	14037	950	634	3510	1744	1888
Y	2	<5	<5	<5	<5	16	9	27	26	12	12	22
Sr	2	6845	2708	5168	245	93	100	221	242	87	152	45
Zr	2	97	70	92	73	57	60	137	137	93	75	126
Nb	2	9	8	9	6	10	9	10	13	12	9	14
Ce	2	<5	<5	<5	<5	<5	<5	19	13	<5	<5	<5
V	2	36	<5	<5	420	32	55	82	75	93	52	26
Au (ppb)	4	<2	9	7	<2	11	7	<2	<2	5	5	<2
As	4	54	87	300	350	59	59	13	22	25	12	11
As	5	19	75	119	57	33	28	< 5	NA	9	< 5	< 5
Co	4	4	7	7	23	5	3	7	8	4	10	6
Hg	4	<1	5	2	15	<1	<1	<1	<1	<1	<1	<1
Mo	4	23	7	24	250	9	<1	<1	<1	12	5	7
Sb	4	39	34	54	90	10	9.8	2.4	5.2	2.6	2.3	1.1
Sb	5	79	31	83	120	20	13	< 5	NA	6	< 5	< 5
Th	4	1.2	<0.5	<0.5	<0.5	1.1	1.9	4	2.4	2.2	1.9	3.3
W	4	<1	<1	27	15	7	13	<1	<1	<1	<1	<1
Cu	5	87	34	48	274	174	12	7	NA	7	40	6
Pb	5	1059	203	622	32404	10850	335	27	NA	30	33	28
Zn	5	22742	3342	6006	99999	8947	5726	121	NA	36	1651	42
Ag	5	132.2	26.6	176.7	181.9	10.4	3.5	0.25	NA	0.25	0.25	0.25
Cd	5	45.4	17.2	19.9	596.6	70.3	35.7	0.4	NA	< .4	7.4	0.4
Zn/Zn+Pb		0.96	0.94	0.91	0.76	0.45	0.94	0.82	NA	0.55	0.98	0.60
Zn/Pb		21.47	16.46	9.66	3.09	0.82	17.09	4.48	NA	1.20	50.03	1.50
Pb/Ag		8	8	4	178	1043	96	108	NA	120	132	112

Analyses completed at the Cominco Reseach Laboratory, 1486 East Pender St., Vancouver, B.C. and Activation Labs., Ancastor, Ontario.
Major element oxides in percent; trace elements in ppm except Au in ppb. NA = element not analysed.
Fe_2O_3 = total iron as Fe_2O_3

Methods

1 = Fused Disc - X-ray fluorescence
2 = Pressed pellet - X-ray fluorescence
3 = LOI calculated after heating predried samples to 11000 for 4 hours.
4 = Thermal neutron activation analysis
5 = ICP
Ba = Fused disc analysis for XRF calibration.

Sample descriptions

GR96-35 Massive barite from barite cap.
GR96-36 Massive barite from barite cap.
GR96-37 Massive barite from barite cap.
GR96-38 Sphalerite-galena-barite mineralization
GR96-39 Sphalerite-galena-barite mineralization
GR96-40 Barite alteration with minor sphalerite
GR96-41 Silicious, pyritic footwall dust-tuffs
GR96-42 Silicious, pyritic footwall lapilli tuffs
GR96-43 Bleached, pyritic footwall rocks
GR96-44 Silicious, pyritic footwall tuffs
GR96-45 Silicious, pyritic footwall tuffs

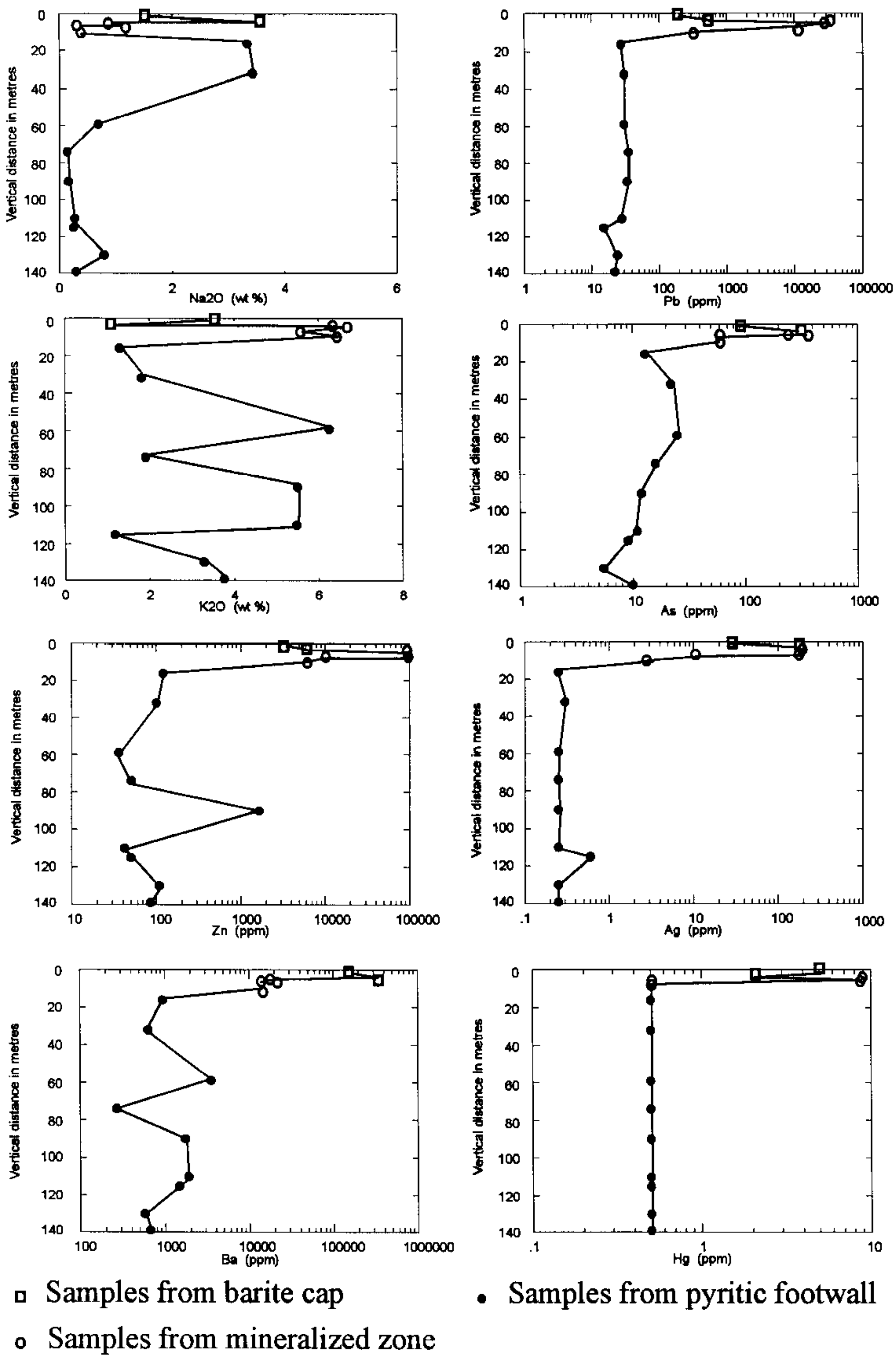


Figure 6. Chemical changes noted in the Nifty Prospect:
A. Vertical chemical variations from the barite cap down into the footwall alteration.

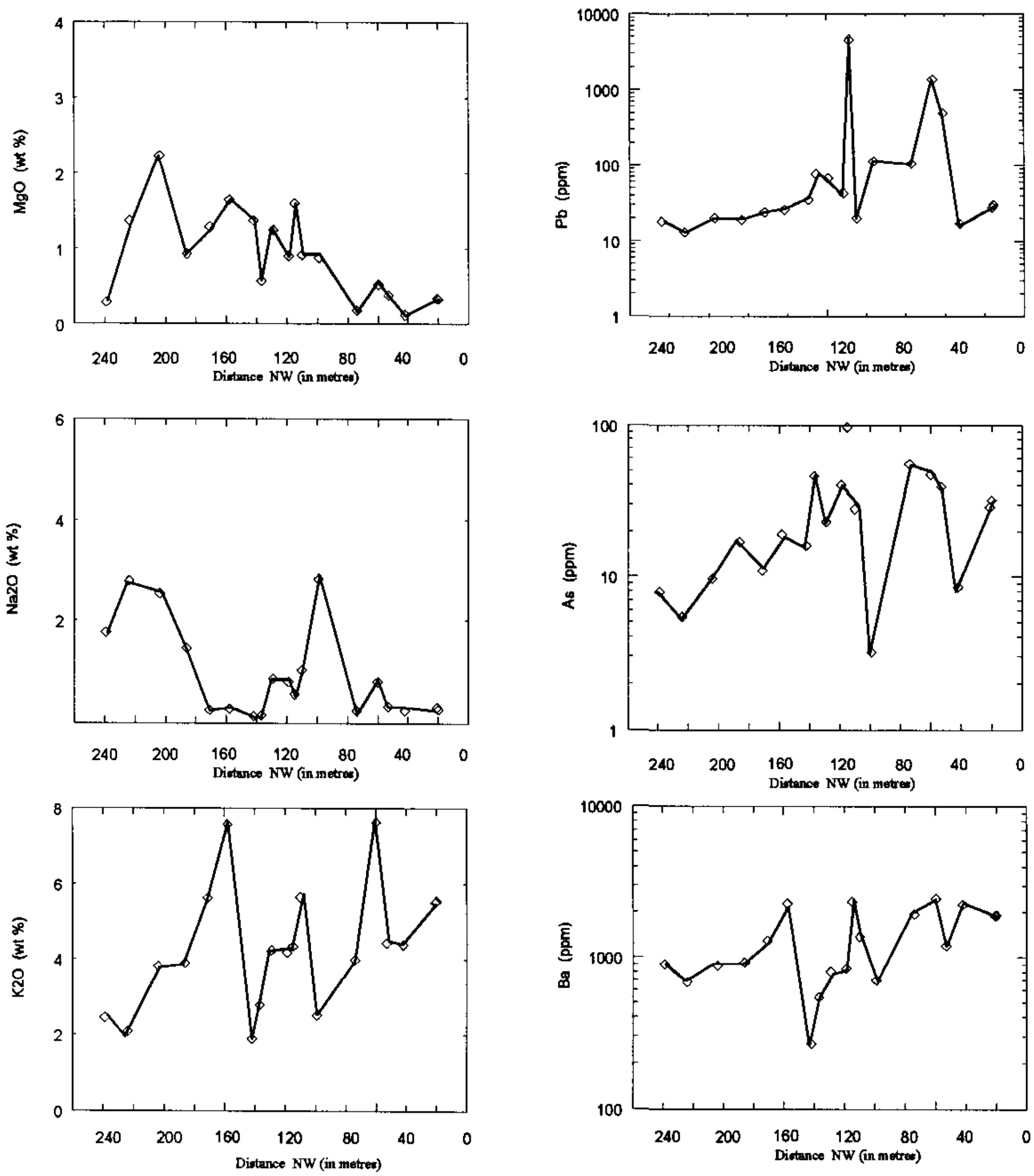


Figure 6. Chemical changes noted in the Nifty Prospect:
B. Lateral chemical variations through the footwall silicified and pyritic alteration zone.

TABLE 4A
REPRESENTATIVE MICROPROBE ANALYSES OF SPHALERITE AT THE NIFTY PROSPECT, BELLA COOLA DISTRICT, B.C.

	Sample GR96-38					Sample GR96-95				
Crystal	401/056	338/040	324/033	408/342	468/082	407/037	417/368	426/246	420/068	420/068
Point	605-1	605-4	605-5	605-11	605-13	605-14	605-16	605-19	605-24	605-25
Description	1	1	1	2	3	1	1	4	5	6
Zn	67.00	66.48	66.56	64.97	65.32	66.58	66.08	64.90	63.35	65.43
Cd	0.33	0.35	0.28	0.40	0.33	0.27	0.61	0.46	0.44	0.59
Fe	0.10	0.13	0.18	0.48	0.88	0.14	0.19	0.93	1.43	0.44
Mn	0.00	0.00	0.03	0.02	0.03	0.02	0.03	0.00	0.02	0.01
Ag	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.09	0.03
Sb	0.00	0.00	0.00	0.04	0.00	0.04	0.03	0.01	0.06	0.04
As	0.02	0.01	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.04
S	32.86	32.81	32.78	33.00	32.92	32.37	32.85	32.52	32.63	33.27
Total	100.31	99.78	99.83	98.90	99.48	99.43	99.82	98.81	98.02	99.87

Data in weight percent.
Description:
1 = massive sphalerite
2 = 30μ sphalerite grain.
3 = 60μ sphalerite grain with pyrite inclusions.
4 = massive sphalerite with minute chalcopyrite inclusions.
5 = 100μ sphalerite grain with minute chalcopyrite inclusions.
6 = 60μ sphalerite grain.

TABLE 4B
REPRESENTATIVE MICROPROBE ANALYSES OF GALENA AT THE NIFTY PROSPECT, BELLA COOLA DISTRICT, B.C.

	Sample 96GR-38					Sample 96GR-95				
Crystal	412/346	385/336	358/319	417/286	404/090	388/105	391/160	473/237	472/311	418/063
Point	606-1	606-4	606-6	606-9	606-14	606-18	606-19	606-20	606-21	607-1
Description	1	2	3	4	5	6	2	2	7	8
As	0.00	0.00	0.00	0.00	0.03	0.01	0.00	0.05	0.05	0.17
Zn	0.02	0.14	0.08	0.00	0.53	0.24	0.01	0.10	0.00	0.00
Mn	0.03	0.00	0.01	0.00	0.00	0.05	0.00	0.02	0.00	0.00
S	13.41	13.35	13.47	13.37	13.39	13.27	13.53	13.63	13.51	13.40
Cu	0.01	0.00	0.05	0.03	0.06	0.00	0.00	0.04	0.01	0.08
Sb	0.02	0.00	0.10	0.06	0.05	0.00	0.00	0.02	0.00	0.01
Pb	85.92	85.85	84.99	86.74	85.61	86.94	85.66	85.80	85.53	86.68
Fe	0.06	0.04	0.09	0.01	0.00	0.00	0.09	0.03	0.00	0.00
Cd	0.16	0.04	0.06	0.01	0.08	0.06	0.00	0.02	0.07	0.01
Ag	0.16	0.13	0.03	0.04	0.13	0.00	0.02	0.01	0.04	0.15
Total	99.79	99.56	98.88	100.26	99.88	100.57	99.31	99.72	99.21	100.49

Data in weight percent.
Description
1 = 20μ grain
2 = 50μ grain
3 = 15μ grain
4 = 25μ grain
5 = 150μ grain
6 = 100μ grain
7 = 200μ grain
8 = massive galena

TABLE 4C
REPRESENTATIVE MICROPROBE ANALYSES OF Ag-BEARING SULPHIDES AT THE NIFTY PROSPECT, BELLA COOLA DISTRICT, B.C.

	Sample GR96-38						Sample GR96-95		
Point	606-2	606-3	606-5	606-7	606-12	606-15	606-24	607-5	607-6
Description	1	1	2	3	4	5	6	7	7
Cu	35.65	34.28	32.44	35.27	0.28	8.47	17.66	3.05	2.73
Fe	0.81	0.69	0.73	0.67	0.23	0.13	1.30	0.03	0.06
Ag	6.44	6.96	5.69	6.49	64.79	59.48	10.14	65.12	64.96
Zn	6.98	6.79	6.64	7.06	0.16	0.04	3.55	0.07	0.06
Mn	0.01	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.03
Pb	0.00	0.00	0.00	0.00	15.29	4.61	29.17	1.98	0.88
Cd	0.20	0.24	0.17	0.26	4.93	0.08	0.78	0.04	0.19
Sb	11.34	12.32	11.12	11.80	0.70	3.21	14.48	11.07	12.52
As	12.89	11.96	11.95	12.74	3.12	4.84	2.97	0.88	0.65
S	25.11	25.41	24.11	25.38	11.88	15.73	18.93	15.93	16.46
Total	99.43	98.64	92.84	99.66	101.40	96.60	98.98	98.17	98.53

Data in weight percent.

Description

1 = 20µ grain of tetrahedrite-tennantite

2 = 10µ grain of tetrahedrite-tennantite

3 = 15µ grain of tetrahedrite-tennantite

4 = 2µ grain of unknown mineral. Approx. $(Ag,M)_2S$ where M is a metal

5 = Polybasite-pearceite? Approx. $9Ag_2S.Sb_2S_3$

6 = Unknown mineral. Approx. $(Cu,Fe)_2(Pb,Ag,Zn,Cd)_2(Sb,As)S_4$

7 = Unknown mineral. Approx. (Ag,Cu)(Sb,S)

TABLE 4D
REPRESENTATIVE MICROPROBE ANALYSES OF BARITE GANGUE, THE NIFTY PROSPECT, BELLA COOLA DISTRICT, B.C.

	Sample GR96-38				Sample GR96-95				
Crystal	468/225	469/223	478/225	467/224	401/230	394/197	399/195	424/295	425/122
Point	97-608-1	97-608-4	97-608-5	97-608-7	97-608-9	97-608-10	97-608-11	97-608-12	97-608-15
BaO	62.68	62.70	61.64	62.15	63.76	64.18	64.71	64.05	63.53
SrO	1.95	1.96	2.44	2.67	1.31	1.23	1.18	1.33	1.14
CaO	0.11	0.00	0.02	0.03	0.00	0.02	0.00	0.01	0.01
PbO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.53
SO_3	34.19	34.49	34.41	33.84	34.54	34.21	34.84	34.76	34.81
Total	98.94	99.14	98.51	98.68	99.60	99.63	100.73	100.15	100.03

Data in weight percent

TABLE 4E
REPRESENTATIVE MICROPROBE ANALYSES OF FELDSPAR GANGUE
THE NIFTY PROSPECT,. BELLA COOLA DISTRICT, B.C.

	Sample GR96-38						Sample 96GR-95					
Crystal	410/074	415/125	416/175	440/200	443/236	428/257	411/144	413/106	418/084	419/267	418/270	454/245
Pt.	11	13	14	15	17	18	2	4	5	8	9	10
Na_2O	0.19	0.20	0.21	0.29	0.25	0.30	0.22	0.26	0.27	0.28	0.29	0.23
K_2O	16.59	15.60	12.34	14.24	15.59	12.16	14.47	12.77	12.48	14.07	13.52	16.39
Fe_2O_3	0.05	0.14	0.04	0.03	0.05	0.26	0.02	0.03	0.05	0.01	0.03	0.04
BaO	0.09	0.99	1.34	4.41	1.46	9.59	3.90	8.00	8.74	5.57	6.83	0.08
CaO	0.00	0.00	0.00	0.00	0.01	0.05	0.00	0.00	0.00	0.01	0.01	0.00
Al_2O_3	18.71	18.73	13.99	19.82	18.43	21.45	19.33	20.51	20.01	20.10	20.19	18.24
SiO_2	64.53	64.64	72.01	60.21	64.17	57.65	63.53	59.67	56.68	60.14	58.34	64.90
Total	100.16	100.30	99.94	99.00	99.97	101.46	101.47	101.24	98.24	100.18	99.22	99.88

Data in weight percent

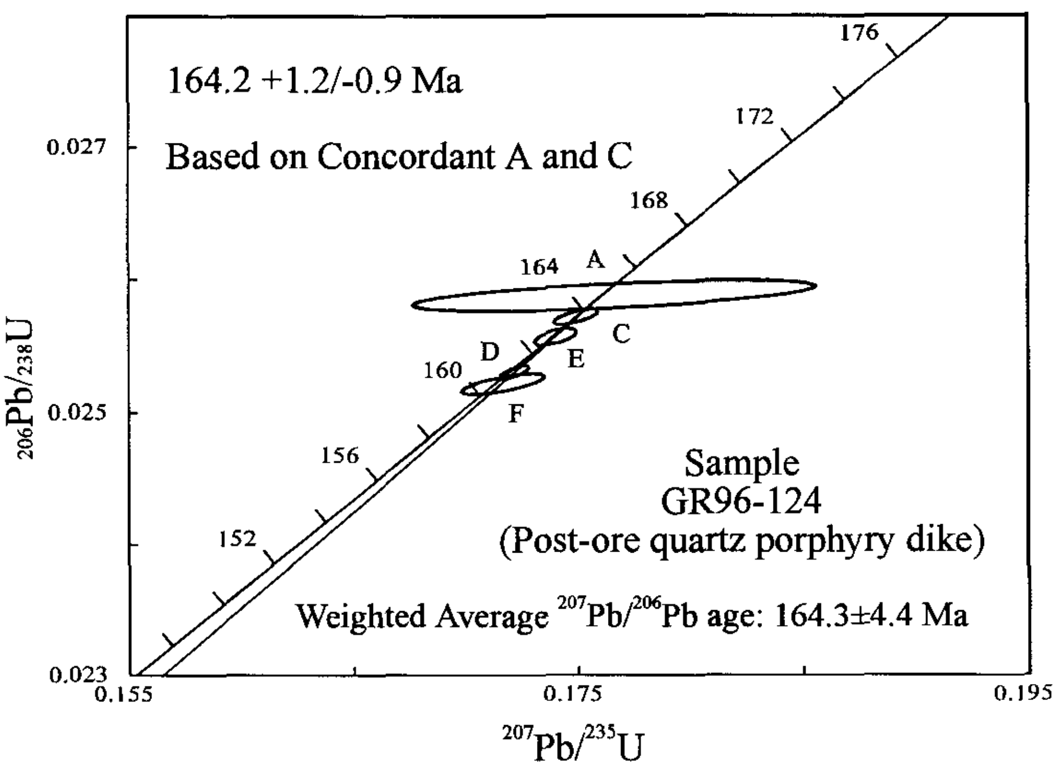


Figure 7. Concordia diagram for a quartz porphyry dike at the Nifty prospect.

TABLE 5
U-Pb ANALYTICAL DATA OF QUARTZ PORPHYRY DIKE, NIFTY PROSPECT, BELLA COOLA DISTRICT

Fraction[1]	Wt	U^2	Pb^{*3}	$^{206}Pb^4$	Pb^5	$^{208}Pb^6$	Isotopic ratios (1s,%)[7]			Apparent ages (2s,Ma)[7]	
	mg	ppm	ppm	^{204}Pb	pg	%	$^{206}Pb/^{238}U$	$^{207}Pb/^{235}U$	$^{207}Pb/^{206}Pb$	$^{206}Pb/^{238}U$	$^{207}Pb/^{206}Pb$
A c,N5,p,s	0.005	112	3.0	131	8	13.9	0.02588 (0.22)	0.1766 (2.5)	0.04951 (2.4)	164.7 (0.7)	172 (113)
C c,N5,p,s	0.063	194	5.2	1129	18	13.0	0.02572 (0.11)	0.1749 (0.29)	0.04933 (0.22)	163.7 (0.4)	163 (10)
D m,N5,p	0.080	332	8.8	3581	12	14.2	0.02531 (0.10)	0.1722 (0.19)	0.04934 (0.13)	161.1 (0.3)	164.2 (6.0)
E m,N5,p,s	0.020	336	9.1	2135	5	14.6	0.02557 (0.12)	0.1740 (0.27)	0.04936 (0.22)	162.8 (0.4)	165 (10)
F m,N5,p,s	0.030	239	6.3	381	31	13.7	0.02522 (0.16)	0.1717 (0.54)	0.04938 (0.44)	160.6 (0.5)	166 (21)

:

Description and location of sample No. GR96-124: Fine grained felsic dike, approximately 2m thick, containing phenocrysts of feldspar and rounded, glassy quartz up 4 mm in diameter. Dike intrudes hangingwall andesitic tuffs and volcanics approximately 100 m east-northeast of the Nifty Prospect at UTM 675150E; 5828850N.

Notes: Analytical techniques are listed in Mortensen et al. (1995).

1 Upper case letter = fraction identifier; All zircon fractions air abraded; Grain size, intermediate dimension: cc=>134mm, c= >134 mm and >104mm, m=<104mm and >74mm, f=<74mm; Magnetic codes:Franz magnetic separator sideslope at which grains are nonmagnetic (N) or Magnetic (M); e.g., N1=nonmagnetic at 1°; Field strength for all fractions =1.8A; Front slope for all fractions=20°; Grain character codes: p=prismatic, s=stubby.

2 U blank correction of 1pg ± 20%; U fractionation corrections were measured for each run with a double ^{233}U-^{235}U spike (about 0.004/amu).

3 Radiogenic Pb

4 Measured ratio corrected for spike and Pb fractionation of 0.0035/amu ± 20% (Daly collector) and 0.0012/amu ± 7% and laboratory blank Pb of 3-5pg ± 20%. Laboratory blank Pb concentrations and isotopic compositions based on total procedural blanks analysed throughout the duration of this study.

5 Total common Pb in analysis based on blank isotopic composition

6 Radiogenic Pb

7 Corrected for blank Pb, U and common Pb. Common Pb corrections based on Stacey Kramers model (Stacey and Kramers, 1975) at the age of the rock or the $^{207}Pb/^{206}Pb$ age of the fraction.

mineralization and its hostrocks are pre-164 Ma (Middle Jurassic) in age.

INTRUSIVE ROCKS

Four suites of intrusive rocks in the district were examined and geochemically sampled. Two of these represent minor intrusions comprising post-ore dikes of quartz porphyry and andesite which are well developed around the Nifty prospect (Figure 2). The other two suites occur as larger plutons, one of which is informally named the Tseapseahoolz Creek pluton (Figure 1) and hosts the Malachite Cliff Cu occurrence. The other, informally named Nusatsum pluton, intrudes a package of mafic calc-alkaline basalts (Figure 4) and minor metasediments that outcrop south of the Bella Coola River (Figure 1) but is not associated with any known mineral occurrences.

MINOR INTRUSIONS

The volcanic and volcaniclastic package hosting the Nifty prospect are cut by two contrasting suites of minor intrusions, both of which post-date the mineralization and hydrothermal alteration. The oldest suite is a pale grey weathering quartz ± feldspar porphyry that forms dike swarms and isolated bodies generally less than 25 metres thick (Figures 2 and 3); U-Pb dating on zircons reveals the suite to be Middle Jurassic in age. These leucocratic, fine to medium grained rocks are characterized by euhedral to subhedral phenocrysts of feldspar and rounded crystals of glassy quartz up to 5 millimetres in width; quartz crystals are more common in the central portions of the dikes. Most of these rocks are massive but a thin-layered flow foliation is seen in some dikes, and angular xenoliths of country rock are present locally. Fine grained, chilled margins are seen on the edges of some dikes, and many bodies are cut by tension gash veins of milky quartz. The country rocks immediately adjacent to some quartz porphyry dikes are silicified.

Analytical results of unaltered samples of quartz porphyry are presented in Table 6. This suite is subalkaline and calcalkaline and the rocks are peraluminous granodiorites (Figure 8A, B, C and D). Trace element plots (Figure 8E and F) show that the quartz porphyry dikes represent "volcanic arc" intrusions as defined by Pearce *et al.* (1984).

Younger mafic dikes, up to 15 metres in width, are also extremely common and widespread on the Nifty claims (Figures 2 and 3); in many cases these intrusions have been controlled by, and have followed, the margins of the older quartz porphyry dikes. They are dark grey to green coloured, massive to well flow banded and fine to medium-grained rocks that vary from equigranular to porphyritic; the latter contain plagioclase phenocrysts up to 4 millimetres long. Some dikes also have spherical to elongate vesicles up 1 centimetres in length. Where feldspar phenocrysts and vesicles are present in the same dike, it is common for the vesicles to be more abundant in the centre of the body while the phenocrysts tend to be better developed closer to the dike margins. Many dikes are cut by veins of milky quartz similar to those cutting the quartz porphyry dikes or younger veins of epidote. These rocks are subalkaline, calcalkaline and metaluminous (Table 6; Figure 8A, B and D). Most range in composition from gabbro to quartz diorite and tonalite and trace element plots show them to be "volcanic arc" intrusions as defined by Pearce *et al.* (1984) (Figure 8C, E and F).

MAJOR INTRUSIONS

TSEAPSEAHOOLZ CREEK PLUTON (Unit 4 of Baer, 1973)

This body lies about 10 kilometres north-east of Hagensborg and is exposed in the southern part of Tseapseahoolz Creek valley and on the slopes of Salloom Peak (Figure 1). It forms an elongate, north-west trending pluton that includes rocks described by Baer (1973) as "foliated, chloritized quartz diorite" with lesser amounts of granodiorite and diorite. Our work establishes that the north-eastern margin of the pluton west of Noosegulch River extends considerably further northwards than is shown by Baer (1973); in this area it hosts the Malachite Cliff Cu occurrence (Figure 1).

In exposures along logging roads up the east side of Tseapseahoolz Creek the rocks in the pluton are generally coarse grained, massive and highly epidotized. They vary from a biotite-bearing granodiorite with less than 5 percent mafic minerals to a dark colored diorite-quartz diorite with more than 20 percent biotite and amphibole. Some rocks in this area are cut by pink veins of coarse grained potassium feldspar and quartz, as well as late, narrow dike of fine grained andesite.

Three lithochemical samples were collected from the east side of Tseapseahoolz Creek; plots indicate these rocks are subalkaline and calcalkaline (Table 6; Figure 8A and B). Two of the leucocratic, biotite-bearing samples have a granodiorite composition and are peraluminous whereas a more mafic, hornblende-bearing sample is a metaluminous quartz diorite (Figure 8C and D). Trace element plots show all samples fall within the "volcanic arc" field as defined by Pearce *et al.* (1984) (Figure 8E and F).

NUSATSUM PLUTON (Unit 13 of Baer, 1973)

This northerly trending, elongate body, which Baer (1973) believed to be of Eocene or Palaeocene age, lies about 20 kilometres south-south-east of Hagensborg and 7 kilometres south-west of Matterhorn Mountain (Figure 1). The central parts of the body comprise massive, coarse grained and equigranular biotite-hornblende-bearing rocks containing 5 to 8 percent mafic minerals. These rocks are subalkaline, calcalkaline, peraluminous granodiorites (Table 6; Figure 8A, B, C and D) that are volcanic arc-related (Figure 8E and F), similar to the other intrusions sampled in the district.

The marginal rocks in the Nusatsum pluton are considerably more mafic than those in the main body; they contain up to 20 percent hornblende and biotite, and are believed to be of diorite-quartz diorite composition. The mafic volcanic and metasedimentary country rocks adjacent to the pluton have been converted to a biotite hornfels that locally contains fine disseminated pyrite and some rare garnet. The thermal aureole contains irregular dikes of mafic diorite that probably originated from the adjacent pluton.

GEOLOGY OF THE MALACHITE CLIFF OCCURRENCE

Whilst flying by helicopter, the senior author noted malachite staining on some cliffs high on the western slopes of the Noosegulch River valley. The cliffs are located at an elevation of 3500 feet at UTM 5816950N; 677070E (Figure 1). This copper occurrence, which was previously unreported, has been named the "Malachite Cliff" occurrence. A field traverse down to the occurrence from the overlying ridge-top passed over massive, coarse grained pinkish grey, leucocratic and equigranular granodiorites of the Tseapseahoolz Creek pluton. These rocks are generally unaltered and contain between 4 and 6 percent mafic minerals comprising coarse biotite with minor hornblende. In the vicinity of the occurrence, the pluton locally contains abundant xenoliths and large screens of hornfelsed metasediments and greenstone. The pluton is also cut by numerous dikes of fine-

TABLE 6
MAJOR AND TRACE ELEMENT ANALYSES OF INTRUSIVE ROCKS, BELLA COOLA DISTRICT

	Andesite dikes at the Nifty Prospect										
	GR96-28	GR96-34	GR96-46	GR96-50	GR96-51	GR96-55	GR96-56	GR96-66	GR96-67	GR96-68	GR96-69
SiO_2	52.45	56.89	63.34	53.84	53.97	55.00	54.65	50.59	51.73	55.82	57.66
Al_2O_3	15.75	14.87	15.40	16.73	16.85	14.17	16.17	17.89	17.18	14.29	14.76
MgO	3.65	3.45	2.13	4.60	4.54	2.87	4.23	4.31	4.88	2.89	3.15
Na_2O	3.43	4.32	3.51	3.64	2.49	3.00	2.41	3.56	5.73	4.21	4.40
MnO	0.19	0.18	0.13	0.17	0.15	0.21	0.14	0.16	0.18	0.19	0.18
Fe_2O_3	9.13	9.72	6.97	8.22	8.47	9.29	8.00	9.78	9.99	9.50	9.57
TiO_2	1.35	1.03	0.68	0.73	0.73	1.00	0.70	0.90	0.86	1.01	1.04
P_2O_5	0.48	0.29	0.20	0.28	0.27	0.27	0.25	0.17	0.24	0.27	0.29
CaO	5.99	4.07	2.56	5.30	6.28	5.98	7.42	7.27	5.33	5.49	4.08
K_2O	1.23	0.70	1.77	1.54	2.11	1.16	1.78	1.16	0.50	0.45	0.29
Cr_2O_3	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
LOI	5.59	4.07	3.15	4.12	3.35	6.78	3.64	3.83	2.94	5.49	4.42
Total	99.25	99.60	99.85	99.18	99.22	99.74	99.40	99.63	99.57	99.62	99.85
Ba	1569	891	532	757	865	380	622	750	486	1002	298
Y	32	22	24	21	19	27	20	23	20	26	26
Sr	379	243	175	566	536	193	546	569	465	382	389
Zr	143	90	89	88	88	85	87	72	72	91	94
Nb	16	11	12	12	12	11	12	9	13	9	11
Ce	<5	<5	21	18	12	35	8	<5	5	<5	12
V	250	241	126	178	187	206	148	235	249	191	211
Rb	7.5	7.5	40	7.5	55	31	38	7.5	7.5	7.5	7.5

	Quartz porphyry dikes at the Nifty Prospect					Tseapseahoolz Creek pluton			Nusatsum pluton	
	GR96-27	GR96-33	GR96-64	GR96-65	GR96-124	GR96-75	GR96-76	GR96-77	GR96-101	R96-102
SiO_2	71.17	72.61	69.69	70.32	74.43	72.33	71.97	56.46	72.96	72.79
Al_2O_3	13.90	13.64	13.38	13.30	12.93	14.48	14.58	17.08	14.73	14.64
MgO	0.87	0.73	1.05	0.87	0.58	0.67	0.58	3.70	0.44	0.40
Na_2O	2.72	3.22	2.79	3.48	3.13	4.56	4.46	3.32	4.67	4.62
MnO	0.07	0.06	0.10	0.07	0.05	0.07	0.07	0.13	0.07	0.07
Fe_2O_3	2.63	2.47	3.29	3.42	2.25	2.02	2.06	7.67	1.60	1.55
TiO_2	0.28	0.26	0.30	0.32	0.22	0.21	0.21	0.69	0.19	0.18
P_2O_5	0.10	0.08	0.08	0.08	0.07	0.09	0.10	0.18	0.09	0.09
CaO	2.13	1.70	2.95	2.45	1.66	1.99	1.93	6.98	1.87	1.83
K_2O	2.69	2.45	2.54	2.16	2.34	2.43	2.59	1.72	2.70	2.71
Cr_2O_3	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02
LOI	3.00	2.56	3.68	3.26	2.06	0.82	0.94	1.83	0.46	0.70
Total	99.57	99.79	99.86	99.74	99.73	99.68	99.50	99.77	99.79	99.60
Ba	959	949	807	1263	1169	908	947	515	1076	1071
Y	21	23	21	18	26	12	15	15	6	10
Sr	108	163	125	120	209	290	296	535	396	389
Zr	141	144	118	128	129	106	108	98	82	79
Nb	11	11	15	10	12	11	10	11	15	11
Ce	8	18	17	<5	24	9	<5	11	<5	<5
V	37	30	54	38	27	20	27	191	15	26
Rb	62	57	58	33	7.5	50	7.5	42	7.5	7.5

Major element oxides in percent; trace elements in ppm.
Rb = Thermal neutron activation analysis completed at Activation Labs., Ancastor, Ontario.
For analytical methods of other elements and oxides *see* Table 2.

TABLE 6 CONTINUED

Sample descriptions

Andesite dikes at the Nifty Prospect.

GR96-28	Grey, massive, fine grained and equigranular rock with 1 percent disseminated pyrite.
GR96-34	Grey-green, massive, fine grained, equigranular and visicular dike with rare, small xenoliths.
GR96-46	Grey-green, massive, fine grained, equigranular dike with some feldspar veinlets.
GR96-50	Grey-green, fine grained, weakly flow banded dike with feldspar phenocrysts up to 3 mm.
GR96-51	Grey-green, fine grained, weakly flow banded dike with feldspar phenocrysts up to 3 mm.
GR96-55	Grey-green, fine grained, visicular dike
GR96-56	Grey-green, fine grained, visicular dike
GR96-66	Dark green, massive, fine grained, visicular dike
GR96-67	Dark green, massive, visicular dike
GR96-68	Dark green, massive, visicular dike
GR96-69	Dark green, massive, visicular dike

Quartz porphyry dikes at the Nifty Prospect.

GR96-27	White to grey, massive dike with quartz phenocrysts up to 4 mm.
GR96-33	White to grey, massive dike with quartz phenocrysts up to 2 mm. Slightly weathered.
GR96-64	White to grey, massive dike with quartz phenocrysts up to 3 mm.
GR96-65	White to grey, massive dike with quartz phenocrysts up to 5 mm.
GR96-124	White to grey, massive dike with quartz phenocrysts up to 4 mm.

Tseapseahoolz Creek Pluton

GR96-75	Grey, massive, coarse grained, equigranular granodiorite with 5 percent biotite
GR96-76	Grey, massive, coarse grained, equigranular granodiorite with 5 percent biotite
GR96-77	Mafic, massive, coarse grained quartz diorite with 15 to 20 percent biotite and hornblende

Nusatsum Pluton

GR96-101	Pale grey, massive, coarse grained, equigranular granodiorite with 8 to 10 percent biotite
GR96-102	Pale grey, massive, coarse grained, equigranular granodiorite with 5 to 8 percent biotite

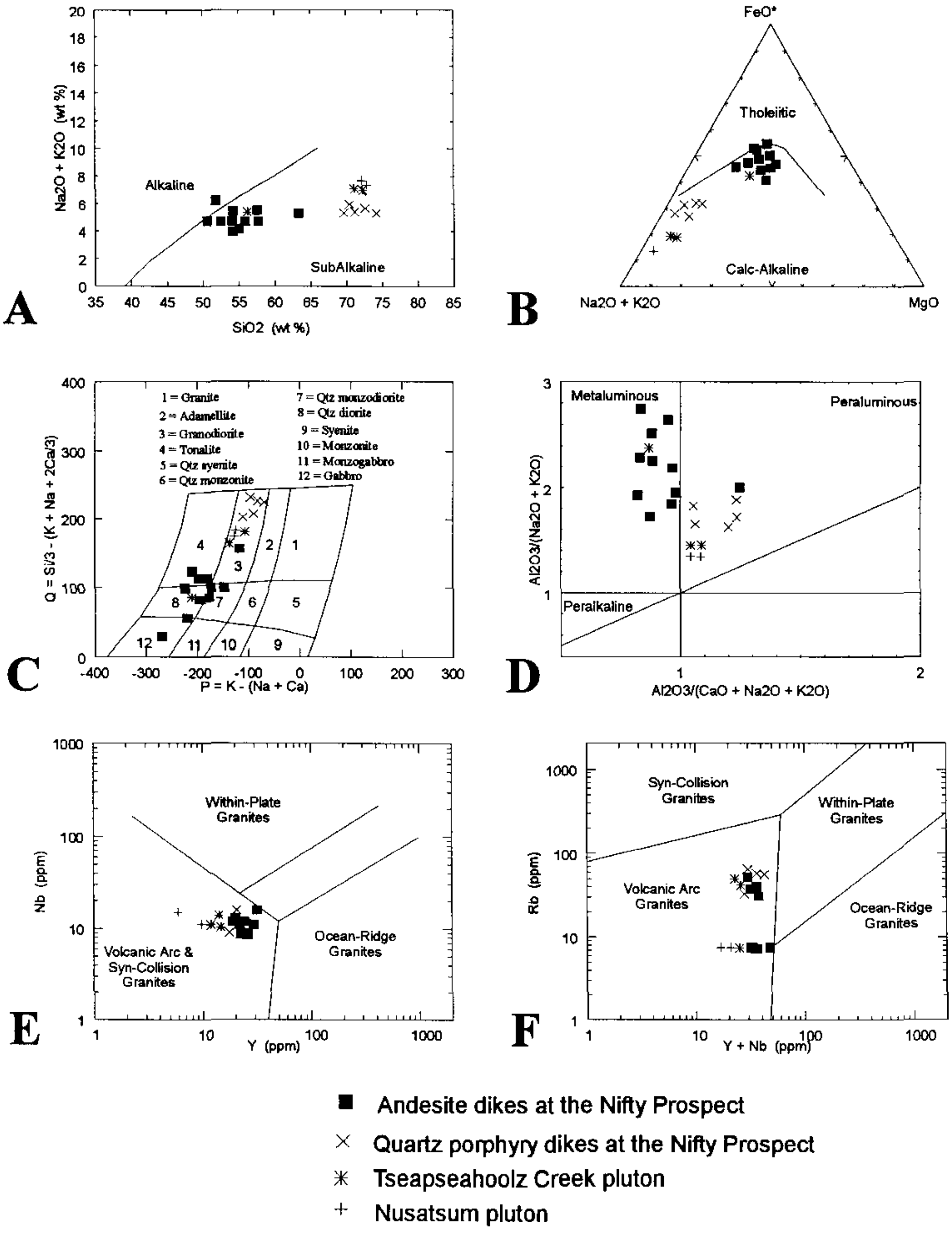


Figure 8. Geochemical plots of some major and minor intrusive rocks in the Bella Coola district:
(A) Alkali versus silica plot (after Irvine and Baragar 1971).
(B) Triangular $Na_2O + K_2O$ - FeO - MgO plot (after Irvine and Baragar 1971).
(C) Plot (after Debon and Le Fort, 1983) illustrating intrusive rock compositions.
(D) Plot (after Maniar and Piccoli, 1989) differentiating metaluminous and peraluminous intrusive rocks.
(E) Triangular Zr - Ti/100 - Y x 3 plot (after Pearce and Cann, 1973).
(F) Triangular Zr - Ti/100 - Sr/2 plot (after Pearce and Cann, 1973

grained andesite which are generally less than 1 metre wide.

At the occurrence, there is an estimated 30 to 40 metre high cliff of leucocratic granodiorite. The plutonic rocks are cut by a subvertical set of narrow shear fractures and joints that trend north, subparallel to the cliff-face. These fractures have controlled some narrow (5 centimetre to 1 metre) dikes of greenstone that show no chilled margins or thermal haloes. The source of the malachite staining occurs approximately 20 metres up the cliff face, and is inaccessible. However, malachite-stained float at the base of the cliff comprises granodiorite cut by thin (< 1 centimetre) shear fractures filled with euhedral quartz, minor pyrite and traces of chalcopyrite. Two grab samples of granodiorite with quartz-sulphide veinlets gave maximum assays of 530 ppm copper, 1.1 ppm silver, 32 ppm molybdenum and 10 ppb gold. Mineralization at the Malachite Cliff occurrence is probably related to a northerly-striking fault set, and it may be similar in origin to the Bella Coola Chief copper occurrence (Day, 1987), situated further northwest (Figure 1). It probably has little economic potential, but suggests that the north trending faults visible in air photographs along the Noosegulch valley have a potential for hosting copper-bearing veins.

CONCLUSIONS

The Nifty Zn-Pb-Ag-Ba prospect represents a shallow-marine, low temperature volcanogenic massive sulphide system that is characterized by disseminated mineralization with an atypical VMS metal tenure. An exhalative origin is indicated by: (1) the stratiform and conformable nature of the barite cap which probably represents a chemical sedimentary unit; and (2) the sporadic occurrence of pyritic, red jasper pods and veins in the hosting sequence (particularly in the hangingwall rocks).

The prospect is hosted by a package of bimodal (basalt-andesite and rhyodacite-dacite) volcanic rocks that contains both tholeiitic and calc-alkaline signatures. Variations in the colour and character of the stratigraphic section suggest the hostrocks were deposited in an oxidized, emerging basin environment that progressively changed from shallow marine to subaerial.

A U-Pb date of 164 Ma on zircons from a suite of post-ore quartz porphyry dikes demonstrates that the Nifty mineralization and its hosting package are Middle Jurassic or older. This radiometric age date, the bimodal chemistry of the volcanics, and the presence of Jurassic fossils at Compass Lake, four kilometres north-east (Glen Woodsworth, personal communication, 1997) and in another roof-pendant approximately 50 kilometres to the north-northeast (Figure 1), supports Baer's (1973) view that the package hosting the Nifty prospect belongs to the Middle Jurassic Hazelton Group.

The Nifty prospect comprises a caprock of massive barite which passes down into a zone of strongly altered tuffs containing sporadic sphalerite, galena and pyrite in a gangue dominated by quartz, barite and feldspar. This mineralization is underlain by a thick and extensive zone of barren silicification that contains disseminated, fine-grained pyrite. This zone probably represents footwall alteration developed adjacent to the original hydrothermal conduits responsible for the overlying Zn-Pb-Ag-Ba mineralization. These conduits are now probably occupied by younger, post-ore dikes.

Microprobe analyses show that the barite in both the barite cap and in the underlying mineralized zone contains moderate amounts of SrO (up to 2.67 weight per cent). The ore minerals consist primarily of sphalerite and galena with trace amounts of tetrahedrite-tennantite, polybasite ($9Ag_2S.Sb_2S_3$), chalcopyrite and some other unidentified Ag or Pb-rich sulphides, oxides and sulphates. The chalcopyrite occurs as small (<30 microns) inclusions in other sulphides whereas the other trace minerals form either minute and discrete grains in the gangue or late microscopic veinlets. Sphalerite has a low Fe and Cd content and some crystals contain minute exsolution blebs of chalcopyrite. Galena is Ag-poor and is cut rarely by microfractures containing various unidentified Ag or Pb-rich minerals. The gangue includes potassium and barium-rich feldspars which may indicate that the hydrothermal fluids were highly saline.

As well as having anomalous quantities of Ba, Zn and Pb, Ag and Cd, the mineralization is weakly enriched in As, Hg and Sb. The very low values of Au and Cu, and anomalous amounts of Hg (up to 15 ppm) suggests that the Nifty formed in a relatively low temperature hydrothermal system. No Hg-bearing minerals were detected. However, tetrahedrite-tennantite and sphalerite can contain Hg in their crystal lattice and this may account for the moderate Hg anomalies in the mineralization at the Nifty prospect. The distribution of Na_2O, MgO and K_2O in the footwall rocks indicates the existence of various vertically and laterally distributed alteration zones rich in either albite, chlorite or K-feldspar.

The massive, non-bedded nature of the barite cap, which lacks sedimentary reworking, suggests it precipitated in sea water above a hydrothermal vent or vents. Both the barite and the sulphides were possibly deposited in narrow, fault-controlled topographic depressions on the sea floor, resulting in elongate ore zones (Figure 9). The presence of red jasper veins and pods in the hangingwall succession (Figure 2) shows that hydrothermal activity continued in the area well after the formation of the Nifty mineralization.

A postulated model for the Nifty prospect involves oxidised, saline and low temperature hydrothermal fluids rising to the shallow sea floor along conduits that cut tuffs and tuffaceous sediments (Figure 9). Later, these conduits were reactivated by northeast-trending faults which subsequently controlled

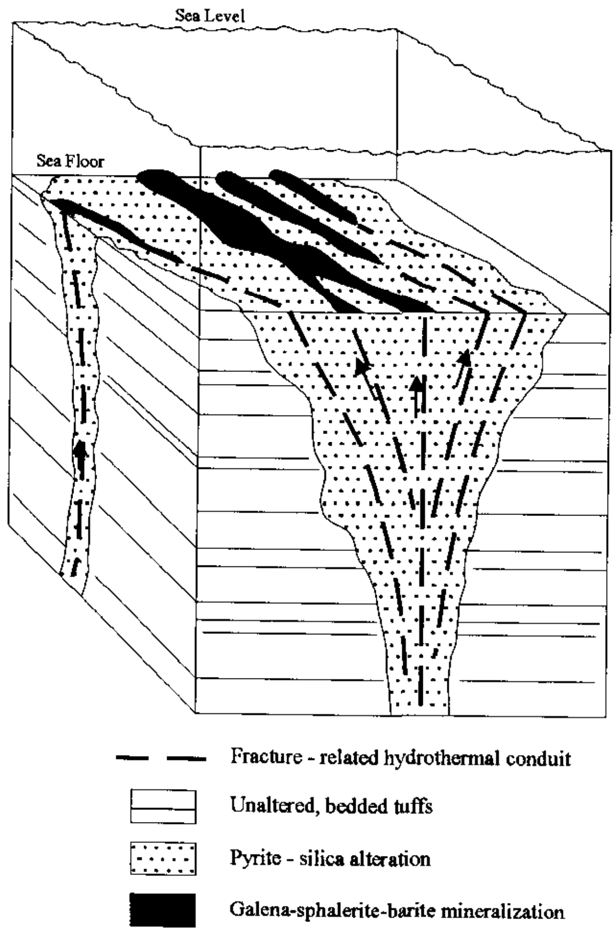


Figure 9. Postulated model for the Nifty Prospect: Volcanogenic hydrothermal fluids rising to the sea-floor along fractures. Precipitation of barite cap in elongate, structurally controlled seafloor depressions, accompanied by deposition of disseminated Pb-Zn-Fe sulphides immediately under the cap and development of an extensive barren footwall alteration zone. The conduits later controlled the emplacement of various post-ore intrusions, including a 164 Ma (Middle Jurassic) suite of quartz porphyry dikes.

the emplacement of the quartz porphyry and younger andesitic dikes.

The Nifty rocks have been folded and deformed; they currently lie on the northern, steeply dipping limb of a major anticline. Small-scale fold measurements demonstrate that the major fold has gently (15 to 25 degrees), east to south-east plunging axes. Although the exposed mineralization is relatively minor, blind and elongate orebodies could be present. The plunge of these postulated linear orebodies would be partly controlled by: (1) the strike of the faults marking the original hydrothermal conduits, (2) the orientation of the original sea floor surface, and (3) the easterly trending fold axes. Consequently, detailed geological mapping to determine the geometry of the fold structures, to outline the mineral alteration zones and locate the original hydrothermal conduits are essential prerequisites to any future drilling at the prospect.

The age, bimodal tholeiitic and calc-alkaline chemistry and oxidized, shallow-marine depositional environment of the Nifty hostrocks are similar to the Hazelton Group package hosting the Eskay Creek deposit in northwestern British Columbia (Alldrick, 1993; Roth, 1993; MacDonald *et al.*, 1996), and a correlation is possible. Thus, the volcanic roof pendants in the Bella Coola area and those elsewhere along the Coast Belt should be re-evaluated as potential hostrocks for Eskay Creek-type VMS deposits. Furthermore, because the volcanic rocks that stratigraphically overlie the Nifty prospect show local evidence of hydrothermal activity in the form of jasper veins, it suggest that the subaerial rocks in the package warrant exploration for epithermal targets.

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REFERENCES

Alldrick, D.J. (1993): Geology and Metallogeny of the Stewart Mining Camp, northwestern British Columbia; . *B.C. Ministry of Energy Mines and Petroleum Resources*, Bulletin 85, 105 pages.

Anonymous (1985): Geology and Geochemistry of the Nifty, Nifty 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 and 14 and Keen, Keen 2, 3 Mineral Claims; Unpublished Report for Cominco Ltd. *B.C. Ministry of Energy Mines and Petroleum Resources*, Assessment Report 14115.

Baer, A.J. (1973): Bella Coola - Laredo Sound Map-Areas, British Columbia; *Geological Survey of Canada*, Memoir 372, 119 pages.

Bailes, R.J. (1977): Geology and Geochemistry of a Portion of the Nifty 2 and Nifty 5 Claims, Skeena Mining Division; Report for Pan Ocean Oil Ltd. *B.C. Ministry of Energy, Mines and Petroleum Resources*, Assessment Report 6735

Bailes, R.J., and McArthur, G.F. (1978): Geology and Geochemistry Nifty 2, 3, 4, 5 Mineral Claims, Skeena Mining Division; Report for Pan Ocean Oil Ltd. *B.C. Ministry of Energy Mines and Petroleum Resources*, Assessment Report 6836.

Bailes, R.J., and McArthur, G.F. (1979): Geology, Geophysics and Geochemistry of a Portion of the Keen 1 and 2 Mineral Claims, Skeena Mining Division; Report for Pan Ocean Oil Ltd. *B.C. Ministry of Energy, Mines and Petroleum Resources*, Assessment Report 7216.

Blackwell, J.D. (1985): Geology and Geochemistry of the Nifty, Nifty 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 and 14 and Keen, Keen 2,3 Mineral Claims; Report for Cominco Ltd. *B.C. Ministry of Energy, Mines and Petroleum Resources*, Assessment Report 14115.

Day, W.C. (1987): Report on the Bella Coola Chief Group of Claims; Unpublished report for Green Lake Resources Ltd. *B.C. Ministry of Energy, Mines and Petroleum Resources*, Assessment Report 15867.

Debon, F., and Le Fort, P, (1983): A Chemical-mineralogical Classification of Common Plutonic Rocks and Associations; *Royal Society of Edinburgh Transactions*, Earth Sciences, Volume 73, pages 135-149.

Holtby, M.H, and Campbell, C.J. (1980): Geological Report on the Nifty 2, Nifty 5, Keen 1 and Keen 2 Mineral Claims. Report for Rio Tinto Canadian Exploration Ltd. *B.C. Ministry of Energy Mines and Petroleum Resources*, Assessment Report 8528.

Irvine, T.N., and Baragar, W.R.A. 1971. A Guide to the Chemical Classification of the Common Volcanic Rocks. Canadian Journal of Earth Sciences, Volume 8, pages 523-547.

Le Maitre, R.W. (1989): A Classification of Igneous Rocks and Glossary of Terms; *Blackwell Publishing*, Oxford, 193 pages.

Lewis, T.D. (1979): Nifty (93D/9W); *in* Geological Fieldwork 1978, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Paper 1979-1, pages 94-96.

Lewis, T.D. (1981): 1978 - Nifty Deposit (93D/9W); *in* Geology in British Columbia 1977-1981, *B.C. Ministry of Energy, Mines and Petroleum Resources*, pages 103-107.

Lohman, G. (1981): Nifty 8 Mineral Claim, Skeena Mining Division, Drilling and Geophysics 1981; Report for Rio Tinto Canadian Exploration Ltd.

Mandy, J.T. (1931): North-Western Mineral Survey District (No. 1): Nifty; Annual Report of the B.C. Ministry of Mines for 1930, *British Columbia Ministry of Mines*, pages A55 and A61.

Macdonald, A.J., Lewis, P.D., Thompson, J.F.H., Nadaraju, G., Bartsch, R.D., Bridge, D.J., Rhys, D.A., Roth, T., Kaip, A., Godwin, C.I. and Sinclair, A.J. (1996): Metallogeny of an Early to Middle Jurassic Arc, Iskut River Area, northwestern British Columbia; *Economic Geology*, Volume 91, pages 1098-1114.

Maniar, P.D. and Piccoli, P.M. (1989): Tectonic Discrimination of Granitoids; *Geological Society of America Bulletin*, Volume 101, pages 635-643.

McColl, K.M. (1987): Geology of Britannia Ridge, East Section, Southwest British Columbia; Unpublished M.Sc. thesis, *The University of British Columbia*.

Mortensen, J. K., Ghosh, D.K. and Ferri, F. (1995): U-Pb Geochronology of Intrusive Rocks Associated with Copper-Gold Porphyry Deposits in the Canadian Cordillera; *in*, Porphyry Deposits of the Northwestern Cordillera of North America, Schroeter, T.G., Editor, *Canadian Institute of Mining, Metallurgy and Petroleum*, Special Volume 46, pages 142-158.

Morton, J.W. (1984): Grid Establishment and Geochemical Survey Keen Grid Nifty Property; Report for Imperial Metals Corporation, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Assessment Report 12747.

Morton, J.W. and Birkland, A.O. (1993): Geochemical and Geological Reconnaissance Report on the

B.C. Ministry of Energy Mines and Petroleum Resources, Assessment Report 10409.

Cutfinger Claims; Report for Eastfield Resources Ltd., and Inco Exploration, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Assessment Report 23031.

Pearce, J.A. and Cann, J.R. (1973): Tectonic Setting of Basic Volcanic Rocks Determined Using Trace Element Analyses; *Earth and Planetary Science Letters*, Volume 19, pages 290-300.

Pearce, J.A., Harris, N.B.W., and Tindle, A.G. (1984): Trace Element Discrimination Diagrams for the Tectonic Interpretation of Granitic Rocks; *Journal of Petrology*, Volume 25, pages 956-983.

Roth, T. (1993): Surface Geology of the 21A Zone, Eskay Creek, British Columbia (104B/9W); *B.C. Ministry of Energy, Mines and Petroleum Resources*, Geological Fieldwork 1992, Paper 1993-1, pages 325-330.

Stacey, J.S. and Kramers, J.D. (1975): Approximation of Terrestrial Lead Isotope Evolution by a Two-Stage Model; *Earth and Planetary Science Letters*, Volume 26, pages 207-221.

Taylor, A.B. (1989): Geochemical Survey on the Western Nifty Group; Report for Imperial Metals Corporation, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Assessment Report 19201.

Tipper, H.W. (1963): Nechacko River Map-Area, British Columbia. *Geological Survey of Canada*, Memoir 324.

Winchester, J.A. and Floyd, P.A. (1977): Geological Discrimination of Different Magma Series and their Differentiation Products Using Immobile Elements; *Chemical Geology*, Volume 20, pages 325-343.