Kena Mountain Gold Zone, Southern British Columbia

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INTRODUCTION

The discovery of a new style of gold mineralization on the Kena Gold property has resulted in a resurgence of exploration in a historical gold-copper mineral belt located south of Nelson. The Gold Mountain Zone (GMZ) was discovered in 2000 by follow-up trenching of gold-in-soil anomalies which straddle the contact between Rossland Group volcanic rocks and the "previously considered to be unmineralized" Silver King pluton. The Silver King pluton is one of six intrusive bodies that comprise a north to northwest trending, 4 x 20 km long prospective, and largely untested, magmatic belt that extends from Ymir north to Nelson (Figure 1). The regional geology and mineralization are described by Höy and Dunne (2001); however, the ages and controls of the different styles of mineralization and alteration on the Kena property are not fully understood.

The Kena Gold project is a private-public partnership developed between the Ministry of Energy and Mines and Sultan Minerals Inc. The main objectives of the project are: 1) map and sample exposures of Silver King intrusions (magnetic susceptibility, density and structural fabric measurements) along the length of the magmatic belt to assess the mineral potential of the suite as a whole; 2) log and sample core from the GMZ to characterize alteration and mineralization; 3) constrain age of deformation and/or mineralization; 4) establish a metallogenic model that accounts for the variety of mineralization types, and ultimately can be used to direct exploration along the length of this belt of early Middle Jurassic magmatic rocks.

A total of ten days were spent in the field mapping and sampling along the length of the prospective magmatic belt as well as examining drill core on the Kena property. This report summarizes the results of this work.

LOCATION

Mapping, sampling and deposit studies where conducted between Nelson and Ymir in southeastern British Columbia, NTS map sheet 82F/6. The Gold Mountain Zone is situated in the northern portion of the Kena property, approximately 5 km south of Nelson (Figure 1).

PREVIOUS WORK

Previous geological mapping of the Nelson map sheet was conducted by the Geological Survey of Canada, between 1948 and 1952 (Mulligan, 1952; Little, 1960), and the British Columbia Ministry of Energy, Mines and Petroleum Resources between 1987 and 1990 (Höy and Andrew, 1989a; Höy and Dunne, 1991). More detailed, property-scale mapping and deposit specific studies have been completed by various mining companies, and are available in provincial assessment reports.

Mineralization on the property was first described by G.M. Dawson of the Geological Survey of Canada, in the Annual Report for 1888-89. Old prospect pits, trenches and underground workings attest to early exploration on the claims, but little is recorded prior to 1973 when Otto Janout staked the Kena claims. Thereafter the Kena claims were optioned and explored by various companies for poly-metallic volcanic-hosted massive sulphide deposits, porphyry copper deposits, copper-silver±gold veins and copper-gold replacement mineralization, up until 1991 (Dandy, 2001). The property lay dormant until 1999 when a number of the known showings were acquired (Kena Gold Zone, Kena Copper Zone and Shaft/Cat Zone) and amalgamated by Sultan Minerals Inc. under the name Kena property (Figure 2).

Initial work by Sultan Minerals focused on two areas: the Kena Gold and Gold Mountain zones.

At the Kena Gold Zone previously drilled core was re-logged and untested intervals were split and sampled for analyses. The results from this work indicated that wide zones of low-grade gold mineralization are present throughout the Kena Gold Zone. Previous work looked for a relatively narrow, but higher-grade, gold target and had not recognized the lower-grade bulk tonnage potential of the Kena Gold.

At the Gold Mountain Zone, grid lines from earlier work were extended 900 m to the southwest to evaluate the high gold in soil samples and high chargeability present at the ends of the old grid lines. Soil sampling, magnetometer surveys and geological mapping were carried out over this grid, which for the first time tested the potential of the Silver King pluton. Rock chip sampling, followed by excavator trenching delineated a 120 m by 90 m area, centered on L11N, 3E that averaged 1.43 g/t Au from 3 m chip samples of altered Silver King intrusive rocks (Dandy, 2001).

In 2001 work continued at the Gold Mountain Zone, where a detailed alteration and mineralogy study by Kathryn Dunne and a structural geology study by David

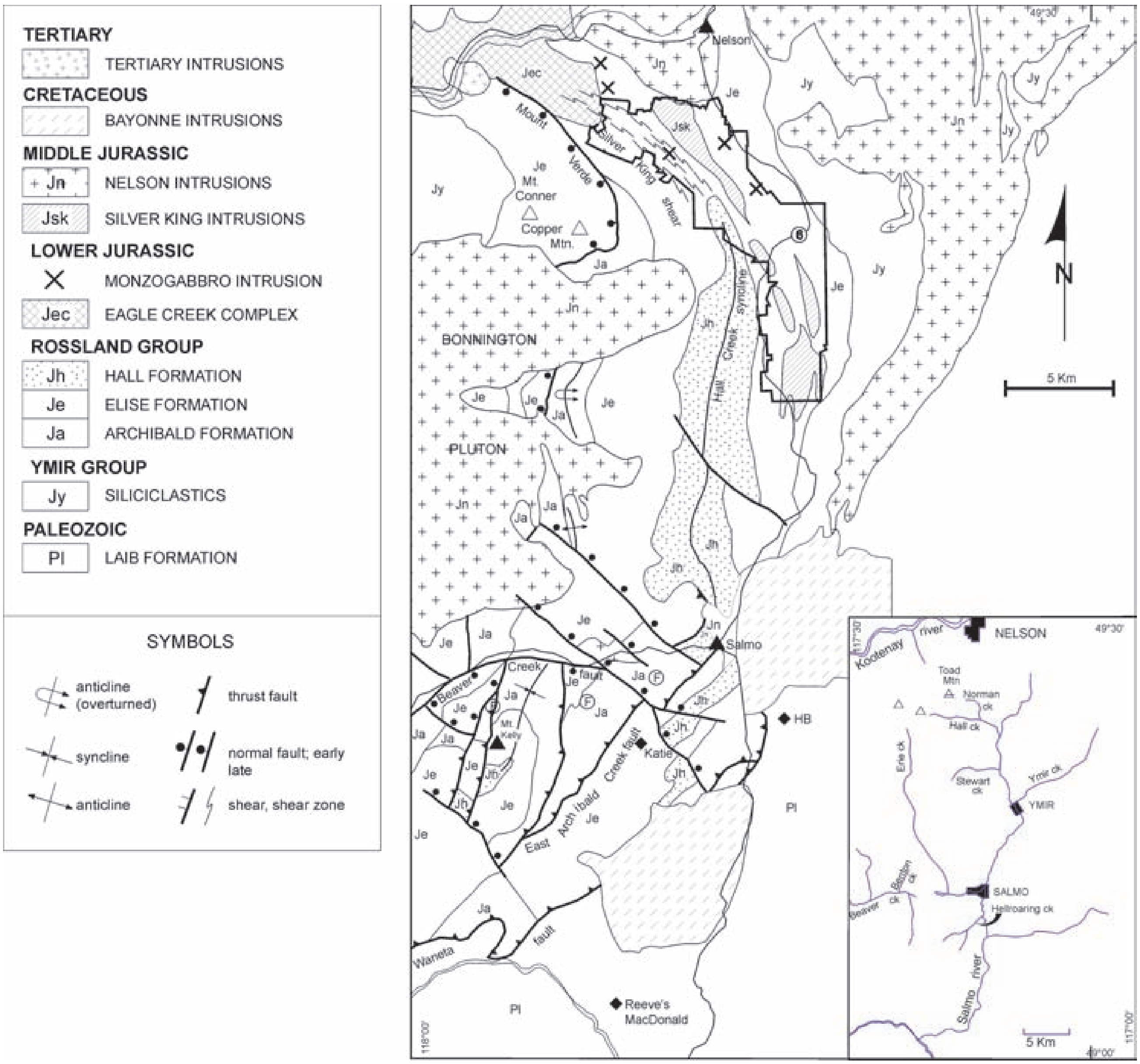

Figure 1. Geology map of the Nelson-Salmo area, southeast British Columbia (082F/SW) shows location of Silver King magmatic belt, extent of the Kena property and select deposits (after Höy and Dunne, 1997, 2001).

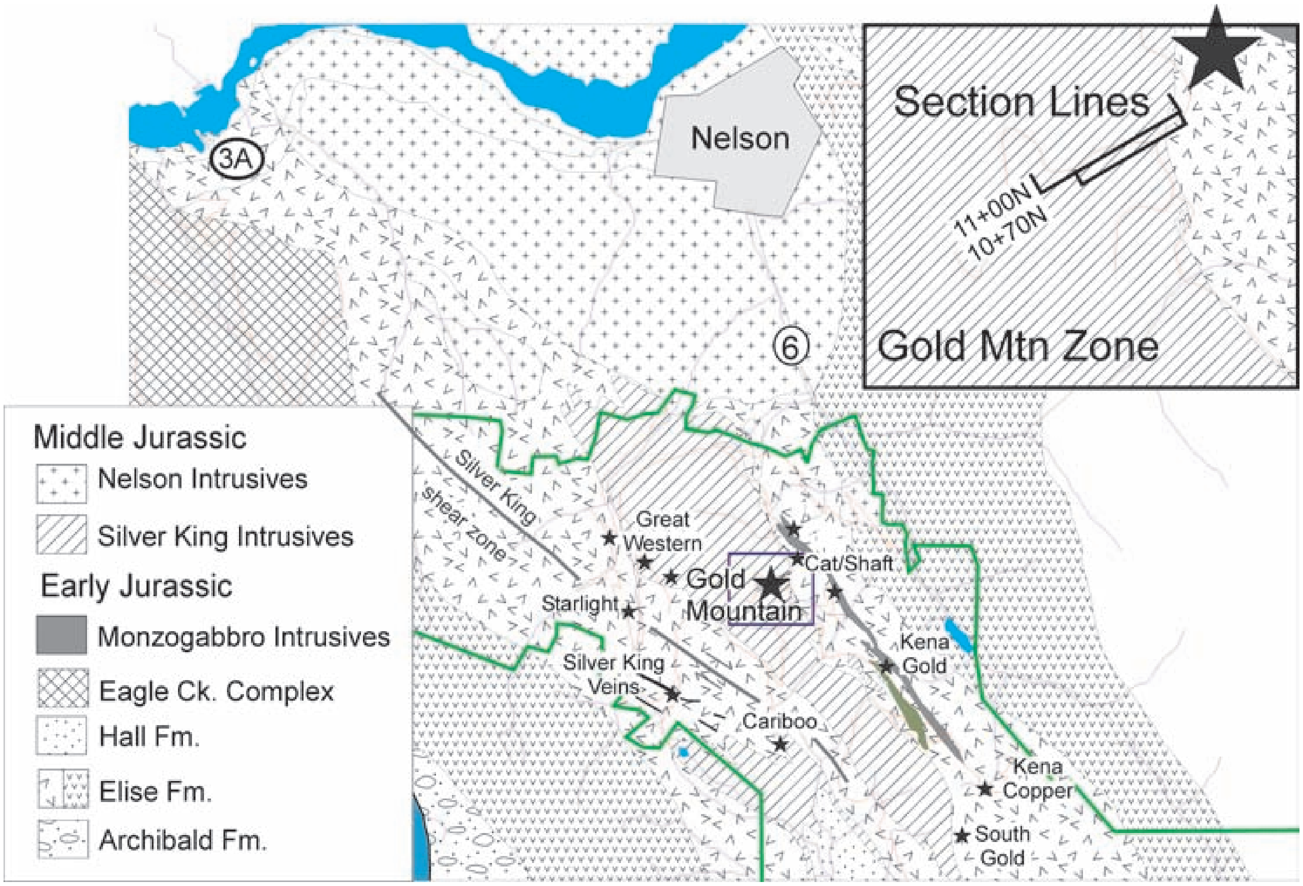

Figure 2. Geology map of the northern part of the Kena property, showing location of mineral deposits described in text. Inset shows location of section lines for Figure 6 (after Höy and Dunne, 1998).

Rhys were undertaken. An additional six trenches and seven diamond drill holes were completed in the immediate vicinity of the discovery trenches (Dandy, 2001). Assay results from drilling were encouraging enough to warrant a second drill program in the fall that completed an additional 23 holes.

A two-phase exploration program began in early spring of 2002 with a 15-hole diamond drill program on two additional section lines through the Gold Mountain zone. All holes encountered significant widths of ~1g/t Au mineralization and many intersected narrower high-grade zones. On going soil geochemistry, geophysics and rock chip sampling was carried out over the newly acquired claims as well as follow-up on the gold soil geochemical anomalies recognized from the 2000 and 2001 fieldwork. The II Phase continued definition drilling over the Gold Mountain zone, completing another 5 holes and traced mineralization to the south and north of the main discovery zone. Assays are pending (vg noted). An additional 3 holes were drilled on the Starlight claim and a single hole tested the vein structure of the Great Western showings.

Recently Sultan Minerals has entered into an agreement with Kinross Gold whereby Kinross will finance not less than CAD $500,000 in expenditures on or before Dec. 31, 2002, and an additional CAD $500,000 by Sept. 4, 2003, to acquire an option to earn a 60% in the Kena gold-copper property owned by Sultan Minerals (News release, Mon. Sept. 9, 2002). Following this announcement drilling began again on the property and continued late into the fall of 2002. An additional 5696m of diamond drilling was completed in 31 holes.

REGIONAL GEOLOGICAL SETTING

The Omineca belt (Kootenay terrane) of southern British Columbia is the exhumed metamorphic-plutonic hinterland to the foreland, fold and thrust belt. It consists of variably metamorphosed and polydeformed Proterozoic to Tertiary rocks and marks the boundary between accreted terranes and rocks of the North American miogeocline.

Obduction of Quesnellia in the southern Canadian Cordillera began in the earliest Middle Jurassic in response to collision and thrusting of the Intermontane Superterrane over the western margin of North America (Monger *et al.*, 1982; Brown *et al.*, 1986; Murphy *et al.*, 1995). Archibald *et al.* (1983) document Barrovian metamorphism and major deformation circa 165-175 Ma in the Kootenay Arc, followed by exhumation and rapid cooling to <300°C prior to the end of the Jurassic. Leclair *et al.* (1993) constrain a second, regional penetrative deformation and metamorphic event in mid-Cretaceous, west of Kootenay Lake. Contraction appears to have continued until the latest Paleocene (Parrish *et al.*, 1988; Carr, 1992) at which time the southern Omineca underwent extension.

The character of magmatism along the North America margin at this latitude evolved from subduction-generated metaluminous, granitic melts emplaced prior to and accompanying the accretion of Quesnellia (in the Jurassic) to anatectic, peraluminous melts, produced (in the Cretaceous and Paleocene), in response to crustal thickening, metamorphism and partial melting. Widespread mafic volcanism and alkaline magmatism accompanied regional extension in the Eocene.

PROPERTY GEOLOGY

The Kena property is underlain by mafic, shosonitic volcanic and sedimentary rocks of the Rossland Group, an Early Jurassic volcanic arc succession that developed along the eastern margin of Quesnellia. The stratigraphy and tectonic setting of the Rossland Group have been well documented by Höy and Dunne (1997), who describe a tripartite subdivision (after Frebold and Little, 1962) including the Archibald, Elise and Hall formations, for the Nelson area (Figure 1 and 2).

The Early Jurassic, Sinemurian Rossland Group, in the Nelson area is intruded by comagmatic (Eagle Creek plutonic complex, Cat/Shaft monzogabbro complex), synkinematic (Silver King intrusions) and post-tectonic plutons (Nelson suite, Bayonne suite and Coryell syenites) as well as numerous mafic and felsic dikes (Little, 1960; Höy and Dunne, 1997, 2001). It is the mafic volcanic and synvolcanic intrusive rocks of the Elise Formation and younger synkinematic intrusions, which host mineralization on the Kena property.

ELISE FORMATION

A complete stratigraphic section of the Elise Formation is exposed along Highway 6 (Figure 1), south of Nelson, where the rocks have been subdivided into a lower unit of mafic flows and upper unit of predominantly mafic to intermediate pyroclastic rocks (Höy and Andrew, 1988, 1989b; Höy and Dunne, 1997).

The lower Elise is a sequence of primarily mafic flows and flow breccias, minor lahars and tuffs up to one kilometre thick. Coarse-grained augite porphyry flow breccias typically 0.5 to 1.0 m thick comprise the dominant lithology of the lower unit. It lies with apparent conformity on sedimentary rocks of the Ymir Group (Höy and Dunne, 1997). The upper Elise is a sequence of mafic to intermediate flows, tuffs and minor epiclastic deposits up to 2500 metres thick (Figure 4-5, in Höy and Dunne, 1997). A number of cyclical, sequences of mafic to intermediate, typically fining-upwards pyroclastic rocks characterize the Highway 6 section. In contrast to the mafic flows in the lower unit where augite phenocrysts dominate, tuffs in the upper unit are characterized by up to 20% plagioclase phenocrysts.

Geochemistry of the Elise Formation (Beddoe-Stephens and Lambert, 1981, Höy and Dunne, 1997) indicates both alkaline and subalkaline basalt, andesite, trachyandesite and hawaiite compositions. The subalkaline rocks show calcalkaline trends. The high alkalinity and trace element data indicate a shoshonitic affinity and an oceanic island arc setting (Beddoe-Stephens and Lambert, 1981). However, high concentrations of low field strength elements, and REE data are more comparable with values typical of continental margin arc basalts and andesites (Höy and Dunne, 1997, 2001).

EARLY JURASSIC - MONZOGABBRO INTRUSIONS

Small monzogabbro sills or stocks occur throughout the Elise Formation (Figure 1). These are interpreted to be high-level synvolcanic intrusions and locally are associated with copper-gold-magnetite mineralization (Höy and Dunne, 1997). The Shaft mafic intrusive complex is one of these monzogabbro intrusions. It follows the regional foliation, is up to 50 m in width and is more than 5 km long (Figure 2). Andrew and Höy (1989) describe the intrusion as a fine to medium grained porphyritic quartz diorite to monzodiorite. Petrographic examinations report 30 to 45 % plagioclase of labradorite composition, 5 to 10 % orthoclase, rare microcline and 2 to 3% quartz (op. cited, 1989). Biotite (10 to 25%), epidote (<10%) and chlorite (<5%); with or without carbonate and quartz, have replaced all of the primary mafic minerals. These minerals occur as irregular intergrowths and are pseudomorphic after amphibole and/or pyroxene. The feldspars have been altered to sericite. Opague minerals include disseminations, blebs and foliation parallel streaks of magnetite, pyrite and chalcopyrite. Andrew and Höy (1989) noted, "the biotite is widely distributed and occurs as sheaves of tabular crystals that have grown parallel to the schistosity", inferring that alteration was synkinematic. Biotite is part of the pervasive potassic alteration that hosts the copper-gold±magnetite mineralization at the Shaft, Cat and Kena Copper showings.

In addition to the Shaft mafic complex, a number of other sill-like bodies intrude the 1 km wide zone of volcanic rocks located adjacent to the eastern contact of the Silver King pluton (Figure 2). Lewis and Silversides (1991) describe a subvolcanic andesite porphyry unit with varying abundances of plagioclase phenocrysts. Where phenocrysts exceeded 10%, it resembles the Silver King porphyry and where phenocrysts are less, the unit resembles monzodiorite of the Shaft complex. The unit is dike-like and extends 2 km southeast from the Kena Gold zone following the regional foliation. Höy and Dunne (1997) present major oxide chemistry and grouped it with their monzogabbro unit.

There are also a number of narrow (2-20 m) sill-like bodies of Silver King (?) porphyry that intrude the areas northeast and southwest of the main Silver King pluton (Gold Creek and Giveout Creek areas). These are typically highly sheared and altered (epidote-chlorite-calcite±pyrite) and follow the regional foliation.

EARLY- MIDDLE JURASSIC SILVER KING INTRUSIONS

Six, north to northwest elongate quartz monzodiorite to granodiorite plagioclase porphyritic plutons of Early Middle Jurassic age intrude Early Jurassic volcanic strata along the overturned eastern limb of the Hall Creek syncline (Figure 1). Contact relationships with the Rossland Group rocks are either sharply discordant or complexly interdigitated and often intensely sheared. The contact generally follows the regional northwest structural fabric; in the vicinity of the Gold Mountain Zone the contact has variable northerly-trending orientations. In road exposures north of the GMZ the contact zone is sheared and steeply dipping, however, 200 to 300 metres south, the contact is comprised of metre-wide apophyses of porphyry that interfinger with strongly pyritized Elise volcanic rocks. Altered and partially digested xenoliths of metavolcanic rocks occur within the porphyry and are exposed in trenches at the "discovery zone". These relationships indicate that the porphyry is intrusive into the volcanic sequence.

The Silver King intrusions form white-weathering, resistant outcrops that for the most part conform to the dominant regional foliation. In hand sample the rock is characterized by 20 to 60 % white plagioclase phenocrysts in a variable dark green, grey or white matrix. Green actinolite and/or biotite have replaced hornblende. Coarse (0.5 mm), euhedral sphene is commonly visible in handspecimen.

Earlier petrographic studies characterized the Silver King intrusions as quartz diorite porphyry (Mulligan, 1952), leuco-diorite porphyry (Höy and Dunne, 1997) and quartz monzonite to quartz monzodiorite (Höy and Dunne, 2001; Wells, 2001). Thin sections show 30 to 60 % sodic plagioclase of andesine to labradorite composition, 5 % orthoclase, and 1 to 2% rounded, resorbed quartz. The plagioclase is extensively sericitized, particularly along outer zones of the phenocrysts and/or sausseritized (epidote+sericite±carbonate±chlorite), chiefly in the interior of the phenocrysts. Primary mafic minerals are rarely preserved. Irregular crystal aggregates and prismatic pseudomorphs after amphibole, of secondary biotite, epidote, carbonate, pyrite and chlorite have replaced the primary mafic minerals. The groundmass consists chiefly of plagioclase, orthoclase, quartz and alteration minerals (sericite-epidote-carbonate ±chlorite). Opague minerals comprise generally less than 1.5 % and include, in order of abundance, coarse euhedral sphene and fine disseminations of magnetite and pyrite.

The margins of the Silver King pluton, and specifically the narrow Silver King intrusive sills present in the Gold Creek area, are strongly sheared and altered. In thin section a cataclastic fabric is typically visible (Höy and Dunne, 1997, and this study). This fabric varies from an anastamosing foliation defined by sericite-quartz-calcite±biotite±chlorite minerals to protomylonite zones where plagioclase phenocrysts have been rotated (Plate 6-8, page 82; Höy and Dunne, 1997) together with grain size reduction. In samples from the Great Western showing, the foliation has transposed quartz-biotite-pyrite, and quartz-calcite±pyrite veinlets and as well, rotated plagioclase phenocrysts and boudins of sericite-carbonate altered groundmass. These relationships imply that the alteration and mineralization(?) of the Silver King pluton coincide with or predate the main phase of regional deformation.

Dunne and Höy (1992) interpreted the contact relationships and the foliated to massive nature of the intrusions as evidence to suggest the Silver King intrusions are a pre to synkinematic suite. Discordant uranium-lead zircon data indicates crystallization ages of the intrusions to be Aalenian (*ca.* 174-179 Ma), (Höy and Dunne, 1997).

MAFIC DIKES

Dark green lamprophyre dikes intrude the Elise Formation greenschists and metavolcanic rocks generally parallel to the main foliation. Fine-grained mafic and biotite lamprophyre dikes also cut the Silver King pluton and follow northwest and north trending shear zones in the monzodiorite. Higher-grade gold intersections commonly coincide with hangingwall and footwall sections adjacent to the mafic dikes, but the dikes themselves do not carry elevated gold values. Dikes typically return less than 0.05 g/t Au, immediate wall rocks to the dikes contain at least an order of magnitude higher gold. For example, 2 m intersections from drill hole 01GM-10 returned: 0.58 g/t Au from the footwall to a 2.04 m dike intersected at 58.96m, and 1.15 g/t Au and 0.86 g/t Au from hangingwall and footwall sections respectively of a second 2 m dike intersected at 117 m depth. Shear-hosted lamprophyre dikes were noted in workings at the Great Western, and in greenschsist units at the Starlight showing (*see* below).

GEOCHEMISTRY

Silver King intrusions define a 20 km long magmatic belt extending from Nelson south to Ymir (Figure 1). The northern most intrusion (Silver King pluton) hosts the Gold Mountain Zone (GMZ) and has received the most study to date (Dandy, 2001; and references therein). Porphyry Au-Cu mineralization and hydrothermal alteration overprint much of the primary composition of this intrusion. Sampling of additional intrusions from the belt was carried out to evaluate their potential to host similar Au-Cu mineralization and to characterize the major and trace element chemistry of the Silver King intrusive suite. A suite of 8 samples from 6 separate Silver King intrusions were collected and analyzed for major and trace element abundances. Major oxides were determined by lithium borate fusion and XRF analysis and trace element geochemistry was determined using pressed pellet and XRF analysis at Cominco Research Labs, Vancouver. The results are list in Table 1. The analyses are plotted together with data from twelve monzogabbro intrusive samples (Höy and Dunne, 1997) and six samples of monzodiorite from the Silver

TABLE 1
MAJOR OXIDE AND TRACE ELEMENT ABUNDANCES FOR INTRUSIVE ROCKS IN THE NELSON AREA

Sample	Intrusives	Easting	Northing	SiO2	TiO2	Al2O3	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	Cr2O3	Ba	LOI	Total
01GM-15	SK pluton	478459	5476204	63.58	0.38	17.29	3.57	0.09	0.75	4.8	4.57	2.86	0.15	*	678	1.39	99.5
01GM-17	SK pluton	478652	5476315	61.63	0.38	16.43	3.77	0.05	0.73	4.17	4.82	3.57	0.12	*	189	3.59	99.34
01GM-18	SK pluton	478741	5476134	61.65	0.38	16.94	3.28	0.05	0.75	4.21	5.15	3.41	0.11	*	424	3.34	99.34
01GM-7	SK pluton	479470	5475670	61.95	0.4	16.88	3.63	0.05	0.83	3.08	4.9	4.73	0.11	*	171	2.83	99.52
02JLO2-7	SK suite	479457	5473679	62.09	0.5	17.04	4.84	0.14	1.35	4.98	4.53	1.83	0.2	*	954	2.07	99.66
02JLO4-25	SK suite	483667	5461045	57.31	0.58	19.37	5.19	0.12	1.22	5.03	5.76	1.99	0.21	*	659	2.58	99.42
02JLO4-28	SK suite	480505	5474806	57.06	0.69	16.45	6.59	0.11	2.51	5.75	3.59	3.45	0.25	*	712	2.92	99.44
02JLO4-30	SK pluton	480418	5474158	62.84	0.38	17.11	3.73	0.1	0.75	4.46	4.8	2.59	0.11	*	839	2.48	99.43
02JLO5-33	SK pluton	477544	5477235	63.54	0.37	17.25	3.72	0.03	0.75	4.51	4.8	2.81	0.11	*	677	1.66	99.62
02JLO6-44-2	SK suite	482349	5469945	63.34	0.43	17.28	3.75	0.07	1	4.8	4.8	1.25	0.15	*	657	2.73	99.67
02JLO6-44-3	SK suite	482349	5469945	63.22	0.4	15.05	2.58	0.09	0.75	5.07	4.67	1.63	0.12	*	555	5.48	99.11
02JLO6-45	SK suite	482754	5468130	62.74	0.43	17.23	3.74	0.05	1.05	4.44	4.96	1.63	0.15	*	649	3.11	99.59
*01GM01	SK pluton	479346	5475910	63.39	0.25	15.21	5.28	0.02	0.38	1.75	4.44	5.07	0.07	0.036	100	4.04	99.96
*01GM10	SK pluton	479130	5475786	61.97	0.36	16.9	3.89	0.07	1.07	4.04	4.79	4.72	0.16	0.018	800	1.95	100
*01GM11	SK pluton	479132	5475902	63.03	0.39	16.6	3.14	0.03	0.86	3.17	5.22	4	0.12	0.018	700	2.37	100
*01GM11	SK pluton	479132	5475902	63.83	0.38	16.82	3.18	0.06	0.79	3.65	5.62	3.78	0.07	0.023	700	2.1	100.37
*01GM14	SK pluton	479329	5475553	64.73	0.4	17.86	2.92	0.04	0.74	3.34	5.46	3	0.08	0.018	800	1.33	99.99
*01GM15	SK pluton	478459	5476204	64.13	0.36	16.98	3.65	0.1	0.86	4.8	4.45	2.64	0.14	0.028	100	1.78	99.92
**R137-9	SK suite	478469	5473764	62.72	0.54	17.31	5.24	0.11	1.38	4.15	4.42	1.79	0.2	*	618	2.11	99.97
**R47-2	SK suite	483880	5461150	62.22	0.54	17.28	4.87	0.14	1.17	4.47	3.94	2.41	0.18	*	685	2.99	100.21
**R50-20	SK pluton	478716	5477323	63.6	0.42	17.31	3.46	0.06	0.79	4.05	4.7	3.3	0.12	*	614	2.46	100.27
**R78-2	SK suite	477274	5476245	65.05	0.38	16.48	2.31	0.08	1.02	3.54	2.41	3.78	0.15	*	1554	3.79	98.99
**R79-1	MNGB	479706	5475849	52.9	0.54	16.71	7.71	0.2	1.73	5.67	2.91	5.79	0.28	*	989	4.61	99.05
**R79-10	MNGB	479706	5475849	50.97	0.79	16.55	10.67	0.25	4.2	5.55	3.72	3.56	0.37	*	768	2.58	99.21
**R79-17	MNGB	479706	5475850	51.94	0.55	15.57	8.32	0.27	2.29	5.85	2.6	5.48	0.29	*	1106	6.47	99.63
**R79-21	MNGB	479706	5475850	55.5	0.62	18.08	7.99	0.22	2.62	2.71	4.62	4.39	0.31	*	925	2.45	99.51
**R79-3	MNGB	479706	5475849	54.77	0.61	17.32	7.62	0.18	2.62	5.32	3.56	4.76	0.59	*	1245	2.32	99.67
**R80-1b	MNGB	479714	5475852	55.6	0.57	17.15	7.32	0.12	2.3	3.16	4.87	5.07	0.33	*	916	2.89	99.38
**R80-6	MNGB	479712	5475849	54.29	0.57	16.91	7.44	0.14	2.45	3.91	4.52	5.27	0.32	*	891	3.4	99.22
**R82-3	MNGB	480854	5474376	52.67	0.82	16.07	10.17	0.24	3.68	5.24	4.49	3.09	0.31	*	436	2.68	99.46
**R82-8	MNGB	480854	5474376	52.07	0.72	16.5	9.67	0.05	4.08	0.49	1.9	8.92	0.31	*	1977	0.47	99.18
**R86-11	SK suite	481421	5473498	56.33	0.74	16.01	7.11	0.13	2.67	5.17	3.59	2.86	0.26	*	521	4.91	99.78
**R86-18	SK suite	481222	5473589	64.01	0.42	17.46	3.89	0.13	0.79	4.3	5.21	1.53	0.12	*	591	2.1	99.96
**R86-24	SK suite	481471	5473446	60.75	0.58	18.31	5.54	0.1	1.81	3.58	4.34	2.36	0.22	*	666	2.33	99.92
**R92-10	MNGB	481920	5473316	55.38	0.48	17.38	3.97	0.04	1.56	4.35	4.71	5.78	0.32	*	714	5.07	99.04
**R92-4	MNGB	481699	5473620	57.32	0.37	16.52	4.34	0.06	1.19	4.95	4.4	4.6	0.21	*	744	5.14	99.1
**R92-5	MNGB	481790	5473538	54.94	0.37	16.05	4.58	0.06	2.13	4.52	4.67	5.16	0.21	*	869	6.4	99.09

* Data from Wells, 2001

** Data from Höy and Dunne, 1997

King pluton (Wells, 2001). The chemical data is presented in three subgroups: samples of monzogabbro intrusions from the Kena area (Höy and Dunne, 1997); Silver King intrusives (with the exception of the Silver King pluton); and samples of the Silver King pluton (Figure 3).

The samples are from an area, which was metamorphosed to lower greenschist grade. In addition, many of the samples are from mineralized zones that are strongly altered by hydrothermal processes. As a result, losses on ignition (LOI) values are high and major element mobility has occurred for some samples. Petrographic studies reveal varying degrees of alteration.

Analyses of the Silver King intrusive suite fall in the subalkaline field on the total alkali-silica plot (Höy and Dunne, 1997; and this study) in marked contrast to the alkaline nature of the subvolcanic, monzogabbro intrusive suite (Figure 3-A). In detail, altered samples of the Silver King intrusive suite straddle positions transitional to the alkaline field. The alkaline nature of the monzogabbro intrusions is due mainly to the high potassium content of these rocks: a reflection of their comagmatic relationship with the shoshonitic Elise volcanic suite (Höy and Andrew, 1989b). Analyses of samples from the Silver King pluton also show elevated potassium content relative to most of the other feldspar porphyry bodies analyzed from the Silver King magmatic belt (Figure 3-B). Both, potassium and sodium enrichment of samples from the Gold Mountain and peripheral mineralized zones can be related to hydrothermal alteration processes, but the majority of samples of the Silver King pluton have consistently elevated potassium content (relative to other Silver King intrusives) that cannot be entirely related to secondary alteration. Separation of the intrusive suites and the isolation of the Silver King pluton data from the other feldspar porphyry bodies in the belt are shown clearly on a Na_2O/K_2O vs. SiO_2 plot (Figure 3-D).

Previous petrographic and chemical studies characterized the Silver King intrusions as leuco-diorite porphyry (Höy and Dunne, 1997) and quartz monzonite to quartz monzodiorite (Wells, 2001). Using data from the earlier studies in addition to the new data reported here the intrusive rock samples are classified according to CIPW normative mineral calculations using the QAP diagram (LeMaitre, 1989), which uses the same classification as Streckeisen (1976). The monzogabbro samples plot along the lower axis in the monzonite and syenites fields. The Silver King intrusive data define three distinct clusters: 1) a subset of samples from peripheral dikes (Cu Zone) or separate feldspar porphyry plutons (Cariboo, Three Friends, Salmo River) - cluster at the borders of granodiorite-monzogranite-quartz monzonite and monzodiorite, 2) least altered samples from within the Silver King pluton but distal from the GMZ - plot as quartz monzonite and 3) drill core samples of potassium and sodium enriched (altered) rocks from the GMZ - are displaced towards the alkali feldspar apex (P) into the quartz syenite field (Figure 3).

The intrusions are metaluminous and show Nb and Y trace element signatures of volcanic arc and syn-collisional granites (Figure 3-E and 3-F). Low (<100 ppm) Rb values are more characteristic of volcanic arc granites than syn-collisional granite (Y+Nb *vs*. Rb plot) (Höy and Dunne, 1997).

STRUCTURE

The structures in the Nelson area are predominantly north trending broad, east-verging folds and associated shears (Höy and Andrew, 1989b; Höy and Dunne, 2001). The Kena property (Figure 2) lies on the eastern limb of the Hall Creek syncline, a south plunging, west dipping overturned fold that deforms Early Jurassic Rossland Group rocks (~182 Ma) and Early Middle Jurassic Silver King intrusive rocks. Regional foliation trends northwest, dips steeply to the southwest and is axial planar to the Hall Creek syncline. Northwest of the closure of the Hall Formation the synclinal core zone is replaced by a kilometre wide shear zone, referred to as the Silver King shear (Höy and Dunne, 2001). This shear zone bounds the Silver King pluton and much of the Kena property to the west. The north-trending structures are cut and therefore constraint by the Middle Jurassic Bonnington and Nelson intrusions (~165 Ma).

In the vicinity of the Kena Gold zone and surrounding areas the dominant foliation (S_n) strikes 120-160^o and dips moderately southwest, with local dip reversals in the headwaters of Noman Creek. Foliation varies from typically penetrative in the metavolcanic rocks to a spaced foliation or lacking entirely in the Silver King pluton. Rhys (2000) recognized a second, more northerly trending spaced cleavage (S_n+1) and several north-striking, west-dipping shear zones up to 10 m thick, within and along the margin of the Silver King pluton. Asymmetric foliations and pressure shadows surrounding plagioclase phenocrysts suggest a sinstral shear sense on 2 of these structures but conflicting shear sense indicators have been obtained along strike (Rhys, 2000).

Crenulation of the dominant foliation S_n about west-trending, westerly plunging axis is well developed in greenschists and metatuffs within the Silver King shear zone, located southwest of the Silver King pluton (Figure 2).

MINERAL OCCURRENCES

The Kena property hosts a number of gold and gold-copper occurrences (Dandy, 2000, 2001), covering a large area located south of the town of Nelson (Figure 1 and 2). Mineralization occurs within the early Jurassic, Elise Formation metavolcanic rocks (Silver King, Starlight, Cariboo) and subvolcanic intrusive rocks (Shaft/Cat, Kena); early Middle Jurassic, Silver King intrusive rocks (Gold Mountain zone, Great Western), and is locally concentrated along the north-northwesterly trending contact zone between these units (Gold Mountain zone). The main focus of this study was to document the style and relationships of mineralization/alteration at the Gold Mountain Zone, however because Au-Cu porphyry systems can be large, peripheral showings were examined and their regional relationships are summarized below. Deposits pe-

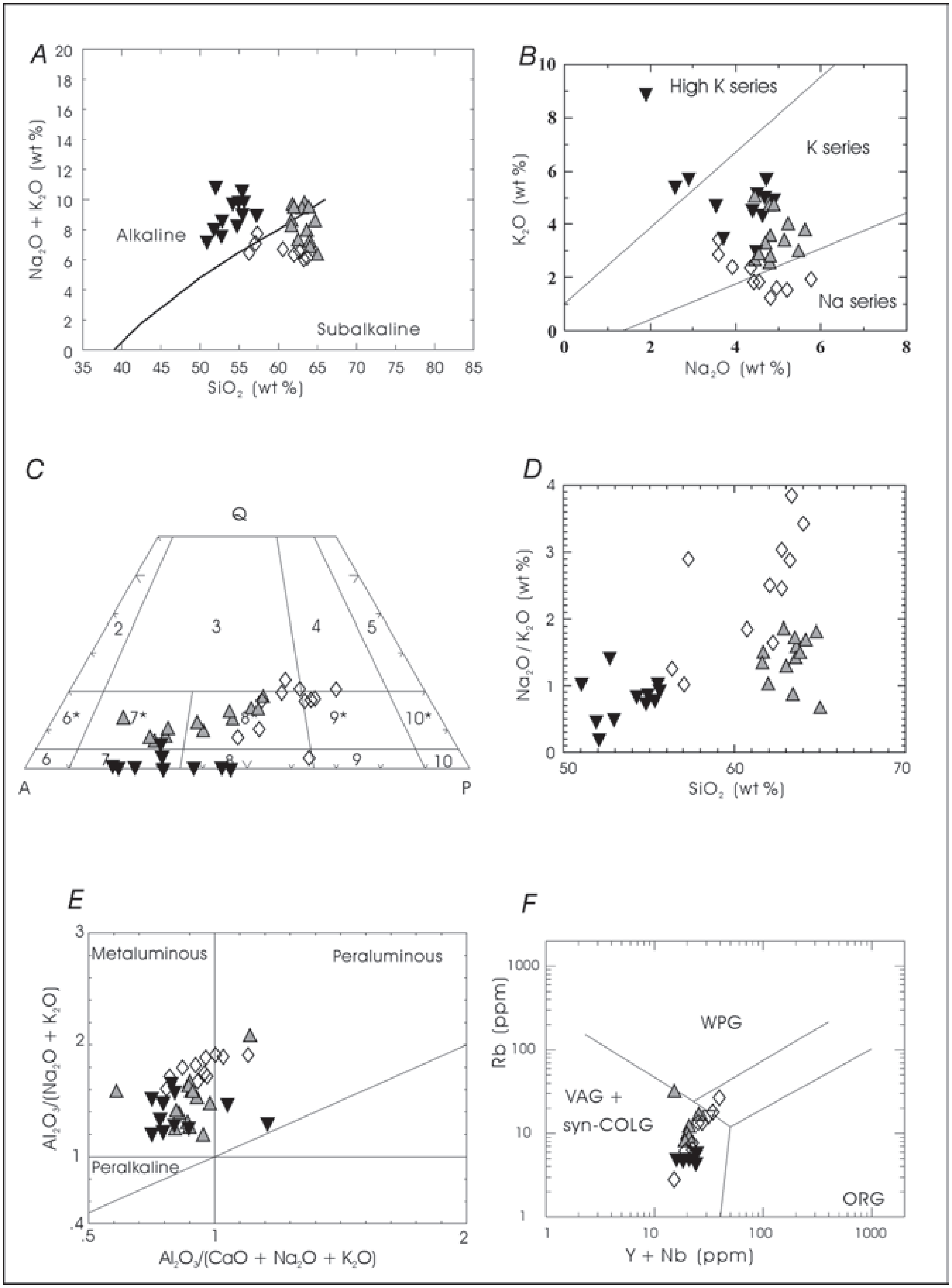

Figure 3. Major and trace element geochemical plots for Silver King intrusions (diamonds), monzogabbro intrusions (inverted filled triangle, data from Höy and Dunne, 1997), Silver King pluton (filled triangle); A) total alkali versus silica (after Irvine and Baragar, 1971); B) K_2O versus Na_2O (after Middlemost, 1975); C) plot of normative quartz-alkali feldspar-plagioclase compositions, projected onto the modal classification of Strekeisen (1976); D) Na_2O/K_2O versus silica; E) Shand's index diagram showing relative alumina saturation (after Shand, 1951); F) plot of Rb *versus* Y+Nb (after Pearce *et al*., 1984).

ripheral to the Gold Mountain zone occur primarily NE and SW of the Silver King pluton. The NE contact zone extends 2 km north of Gold Creek and 3 km south and contains foliation-parallel shears and zones of intense brittle fracturing that have localized alteration and copper-gold mineralization at the Shaft, Cat, Kena Gold and Kena Copper mineral showings. The SW contact zone extends approximately 5 km north from the headwaters of Gold Creek and is characterized by intense zones of foliation parallel shearing (Silver King shear zone) and hosts the Silver King, Starlight, Cariboo and Giveout Creek mineral showings.

GOLD MOUNTAIN ZONE (82FSW 379)

The Gold Mountain Zone is located 6 kilometres south of Nelson. It straddles the eastern contact of the Silver King pluton and Elise Formation metavolcanic rocks, but lies mainly within the pluton (Figure 2).

Exploration Parameters

The Gold Mountain Zone has a well-defined gold-in-soil geochemical signature (3300 m x 1400 m) that exhibits a northwesterly trend (Dandy, 2002). Gold values in soils overlying the Silver King pluton and contact zone are enriched relative to the values overlying the Elise volcanic rocks, and within the pluton there are specific large anomalous zones with significant elevated gold values. Along the northwest-trending, eastern contact zone between the intrusion and volcanic rocks soil values are generally >50 ppb Au. Gold values >100 ppb in soils define the Gold Mountain, Kena Gold and the South Gold zones that together are aligned in a northwest-trend, parallel to the regional foliation.

Results from a magnetometer survey that was carried out over the Gold Mountain grid (Dandy, 2001), indicated a strong response with generally higher magnetic susceptibility for areas located at the northern and northwestern portions of the pluton. Vein-stockwork, disseminated and locally magnetite breccias (Dunne, 2001; this study) have been mapped in the north and southern sections of the pluton. Relatively lower magnetic readings define a wide belt overlying the discovery area where pervasive potassium-silica-pyrite alteration is evident.

An Induced Polarization survey was conducted over the discovery area to test the response of the auriferous sulphide mineralization in the Silver King pluton. After a strong chargeability response was obtained over the “discovery” area, IP was completed over the rest of the grid and defined a number of additional geophysical anomalies (Walcott, 2001). Areas of high chargeability and coincident high resistivity correlate well with the gold soil geochemical anomalies (Dandy, 2002) and reflect pyrite content of mineralization and accompanying potassic-silica alteration.

Mineralization/Alteration

Hydrothermal alteration mineral assemblages present in drill core in and around the Gold Mountain zone are similar to the principal alteration types developed around gold-rich porphyry deposits of the Pacific rim (Sillitoe, 1979; 2000). These alteration types include: potassium-silicate (K-spar, quartz), propylitic (chlorite, epidote, calcite, albite), intermediate argillic (sericite, clay, chlorite, hematite) and sericite (quartz-sericite-pyrite). Not present on the Kena property is an advanced argillic alteration zone, which is commonly developed in the upper, volcanic-hosted parts of a porphyry system (Sillitoe, 1993).A study of rocks in the vicinity of the Kena Gold Mountain Zone identified six (6) alteration mineral assemblages (Dunne, 2001). These include: tourmaline stockwork, magnetite dominant and magnetite+pyrite assemblages (potassic); magnetite + quartz assemblage (propylitic); pyrite dominant assemblage (sericite); and quartz stockwork alteration zones (Table 2). A systematic mapping program of the alteration assemblages and their distribution in and around the Silver King pluton remains to be undertaken. The following describes the assemblages but controls on their distribution have not been established.

POTASSIC

Potassium alteration of the rocks on the Kena property is subtle and recognized chiefly by staining samples with sodium cobaltinitrate (Dunne, 2001, this study). Pervasive alkali flooding affects the finer-grained volcaniclastic rocks and the groundmass of the quartz monzonite porphyry in particular. It generally consists of fine-grain admixture of potassium feldspar, plagioclase, quartz and biotite±sericite. The alteration is primarily microfracture-controlled and only rarely is alteration evident from potassium feldspar±quartz veinlets. Locally plagioclase phenocrysts are fractured and cut by secondary orthoclase veinlets and variably altered by fine dustings of sericite

TABLE 2
MAJOR ALTERATION TYPES AND MINERAL ASSEMBLAGES FROM THE GOLD MOUNTAIN ZONE AND SURROUNDING AREA

Potassic	
tourmaline stockwork	tourmaline+quartz+K-spar+pyrite
magnetite dominant	magnetite+K-spar+biotite± chlorite±epidote±hematite ± tourmaline±pyrrhotite
magnetite + pyrite	magnetite+pyrite+K-spar+biotite± chlorite±epidote ±carbonate± sericite±quartz
Propylitic	
magnetite + quartz dominant	magnetite+quartz+chlorite+sericite± epidote±pyrite±carbonate
Sericitic	
pyrite dominant	pyrite+sericite+K-spar+chlorite±quartz± carbonate± tourmaline
quartz stockwork	quartz+pyrite+sericite+K-spar+chlorite± hematite±malachite± chalcopyrite± tourmaline±gypsum (after anhydrite)

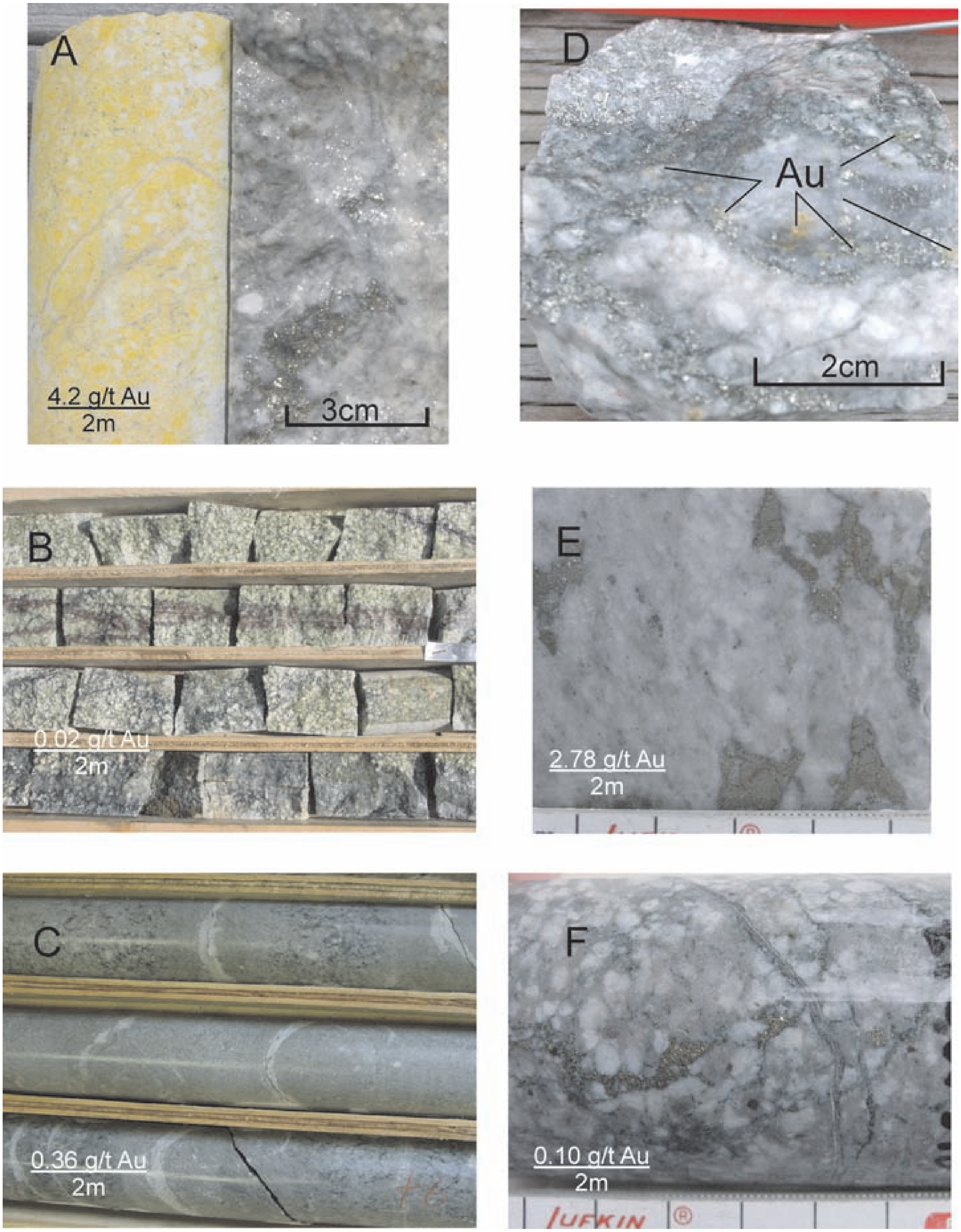

Figure 4. Drill core from the Kena Property. A) Pervasive potassic alteration (K-spar-pyrite-qtz), Na-cobaltinitrate stained SK porphyry (01GM-07, 42.95-43.15 m), B) Propylitic alteration, (chlorite-epidote- calcite-pyrite), SK porphyry cut by oxidized, hematitic mm wide chlorite-calcite-pyrite fractures (01GM-18, 118.25-124.6 m), C) Sericite alteration (quartz-sericite-pyrite-calcite), pale-grey bleached, SK porphyry textures destroyed (02GW-01, 76.8-79.6 m), D) Visible gold (01GM-03, 48.77 m), E) Silica-sericite altered foliated SK porphyry with coarse crystal aggregates of pyrite, up to 3 cm across (01GM-18, 31.3-31.4 m), F) Potassium altered SK porphyry, pyritized and cut by late calcite-chlorite-sericite stockwork, (01GM-17, 81.7-81.8 m).

and/or epidote. The original porphyry texture may or may not be preserved (Figure 4A). Potassium feldspar-biotite±magnetite±pyrite±epidote assemblages characterize potassic alteration in the Silver King pluton, quartz±pyrite±tourmaline is locally present as stockworks and fracture-coatings, but may be related to sericite alteration (Dunne, 2001). At the Kena gold zone (86LK-20, 81.0 m), potassium-flooded metavolcanic rocks are accompanied by 3 to 5% disseminated pyrite. Alteration is fractured controlled, pervasive and consists of wide envelopes of green biotite with zones of up to 20% iron±copper sulphides. The sulphide-rich zones contain coarse crystal aggregates of inclusion-rich, mesh-texture pyrite, and lesser amounts of chalcopyrite; as fracture fillings, inclusions in, and localized along pyrite grains boundaries. Veinlets contain a mineral assemblage of quartz-pyrite-calcite-biotite and lesser amounts of sericite.

Rare veinlets with hydrothermal actinolite-biotite-pyrite-quartz-calcite assemblages and wide epidote envelopes were noted within samples of pervasive potassic altered metavolcanic rocks (01GM-07 and Trench-9). The rocks from locations close to the porphyry contacts contain assemblages which characterize both potassic and propylitic alteration types.

PROPYLITIC

Propylitic alteration is characterized by a diffuse, pervasive pale green epidote overprint. Primary textures are preserved (Figure 4B). Pyrite content may be modestly higher, than that associated with the potassic alteration, but insufficient samples have been studied. Propylitic alteration overprints the pervasive potassic altered Silver King porphyry in hole 01GM-18 (182.5m). Plagioclase phenocrysts are fractured, and veined with a mineral assemblage of chlorite-epidote-calcite±quartz. Magnetite occurs as patchy vein fillings intergrown with chlorite and remnant green biotite. Pyrite and chalcopyrite are concentrated in veinlets together with epidote and calcite±quartz.

Fracture-controlled, auriferous propylitic alteration assemblage overprints potassium alteration in drill hole 01GM04, at 84.3 m depth (16.34 g/t Au over 2 m). The bleached, potassium-flooded matrix to the porphyry contains pale green, sausseritized plagioclase and epidotized amphiboles that are cut by a 2-5mm wide magnetite-pyrite-epidote veinlet and tight (<0.5mm) bifurcating fractures filled with younger sericite-quartz±pyrite assemblages (Figure 5). The veinlet mineralogy is symmetric about a magnetite core, which consists of an intergrowth of pyrite-epidote±calcite±quartz gradational outwards into a chlorite-pyrite±epidote±chalcopyrite assemblage. The veinlet contains visible gold: associated with magnetite in the core; intergrown with pyrite along the margins; and interstial to epidote in the alteration envelope peripheral to the veinlet (Figure 5). Gold grains are also present in fractures crosscutting pyrite, with or without chalcopyrite. For the most part the gold occurs as clusters of fine grains typically < 2 ì.

INTERMEDIATE ARGILLIC

Intermediate argillic alteration includes a sericite-clay mineral-chlorite-hematite assemblage, characterized by a pale green and/or red (hematitic) overprint to the potassium-silicate assemblage (Brown, 2001; after Sillitoe, 2001). Green, waxy clay minerals replace plagioclase, magnetite is oxidized to hematite and biotite is replaced by chlorite. Narrow sections in core from widely separated drill holes (01GM-12, -14, -9; from Brown, 2001; and this study) contain these characteristic assemblages.

SERICITE

Sericite alteration is comprised of pale gray quartz-sericite-pyrite±calcite assemblages, which overprint all earlier alteration types. It is characterized by the complete destruction of primary igneous textures in the porphyry. The white plagioclase crystal boundaries become indistinct and merge into a grey, sericite±silica flooded-groundmass. The mafic minerals alter progressively from biotite to chlorite or completely to sericite. The alteration comprises centimetre-wide envelopes to narrow pyrite-calcite-tourmaline-quartz veins. Alteration is fracture-controlled and where fracture densities are high and coalesce, metre-wide zones of sericite alteration form (Figure 4C). The sericitic alteration (pyrite-dominant) contains quartz±tourmaline veinlets and stockworks that host the bulk of the gold mineralization at the Gold Mountain Zone (Dunne, 2001).

Quartz-only veining, stockwork zones and locally sheeted veins occur along the northern margins of the Silver King pluton. Large float blocks of bullish quartz veins containing coarse sheaves of tourmaline crystals and chlorite selvages are present along the southwest contact of the intrusive. The quartz contains no visible pyrite. Sheeted, millimetre wide quartz-pyrite±chalcopyrite veinlets with sericite±chlorite alteration envelopes cut the pluton along its southwestern margin. These veinlets are oriented 313/35^{o} parallel to the regional dominant foliation of the Silver King Shear Zone. Grab samples returned low gold values.

Pyrite, pyrite+magnetite or magnetite is present in varying amounts up to rock-forming proportions in the porphyry (Dunne, 2001). Pyrite occurs as disseminated blebs, crystal aggregates associated with epidote-calcite±chlorite assemblages or as fracture-fillings in quartz-calcite-sericite±tourmaline±chlorite veinlets (Figure 4E, F). The morphology of pyrite varies from inclusion-rich, growth zoned grains, often forming the cores to larger subhedral crystals, to inclusion-free, commonly fractured crystal aggregates. The former occurs disseminated throughout the porphyry or metavolcanic rocks, the latter, fills fractures and veins. Magnetite occurs as disseminations and replacement zones comprised of patchy intergrowths with biotite and chlorite in the matrix of the porphyry, as veinlets crosscutting plagioclase phenocrysts and as matrix to magnetite breccias. Minor to trace amounts of chalcopyrite are present as fracture-fillings, inclusions and intergrowths with pyrite. A light grey mineral, probably sphalerite or tetrahedrite (trace amounts) is associated with, and fills fractures in pyrite from drill hole 01GM-7. Trace amounts of molybdenum are also present in quartz-sericite veinlets.

Gold occurs primarily as free grains but in a variety of relationships and mineral associations. Grain size varies from very fine "snow-flake" gold (Wells, 2001) to millimetre-sized blebs of visible gold (Figure 4D). Gold always occupies late fractures. It occurs as fine, sub-rounded inclusions in veinlet-pyrite, as fracture-fillings to brecciated veinlet pyrite and as colloidal grains in quartz and a late calcite (?) gangue. Gold also occurs together with pyrite and magnetite in a veinlet (01GM-4, 84.3m) that crosscuts pervasive potassium alteration.

Gold Distribution

Gold and trace metal abundances were determined by neutron activation analyses for a limited suite (12) of Silver King intrusives. All six samples of quartz monzodiorite collected from separate plutons across the Silver King magmatic belt contain less than 2 ppb Au, while most samples of Silver King pluton contain elevated gold values and show variable alteration. Two of the least altered samples of Silver King pluton, however contained less than 2 ppb Au, indicative that mineralization is closely associated with alteration.

Mineralization at the GMZ consists primarily of disseminated blebs of pyrite±chalcopyrite and rare pyrrhotite (Rhys, 2000; Dunne, 2001) and lesser stringers and fracture veinlets. At the "discovery" zone (GMZ) gold values of 1 to 3 g/t Au correspond directly with intervals of pervasive potassium alteration and pyritization, which coincide with higher fracture and veinlet densities. Pyrite±quartz±tourmaline±calcite veinlet density varies positively with gold concentration, particularly in holes 01GM-1 and 01GM-3 (Rhys, 2001). Measurements of pyrite coated fractures, joints, cleavage, quartz±pyrite veins and iron oxide-coated

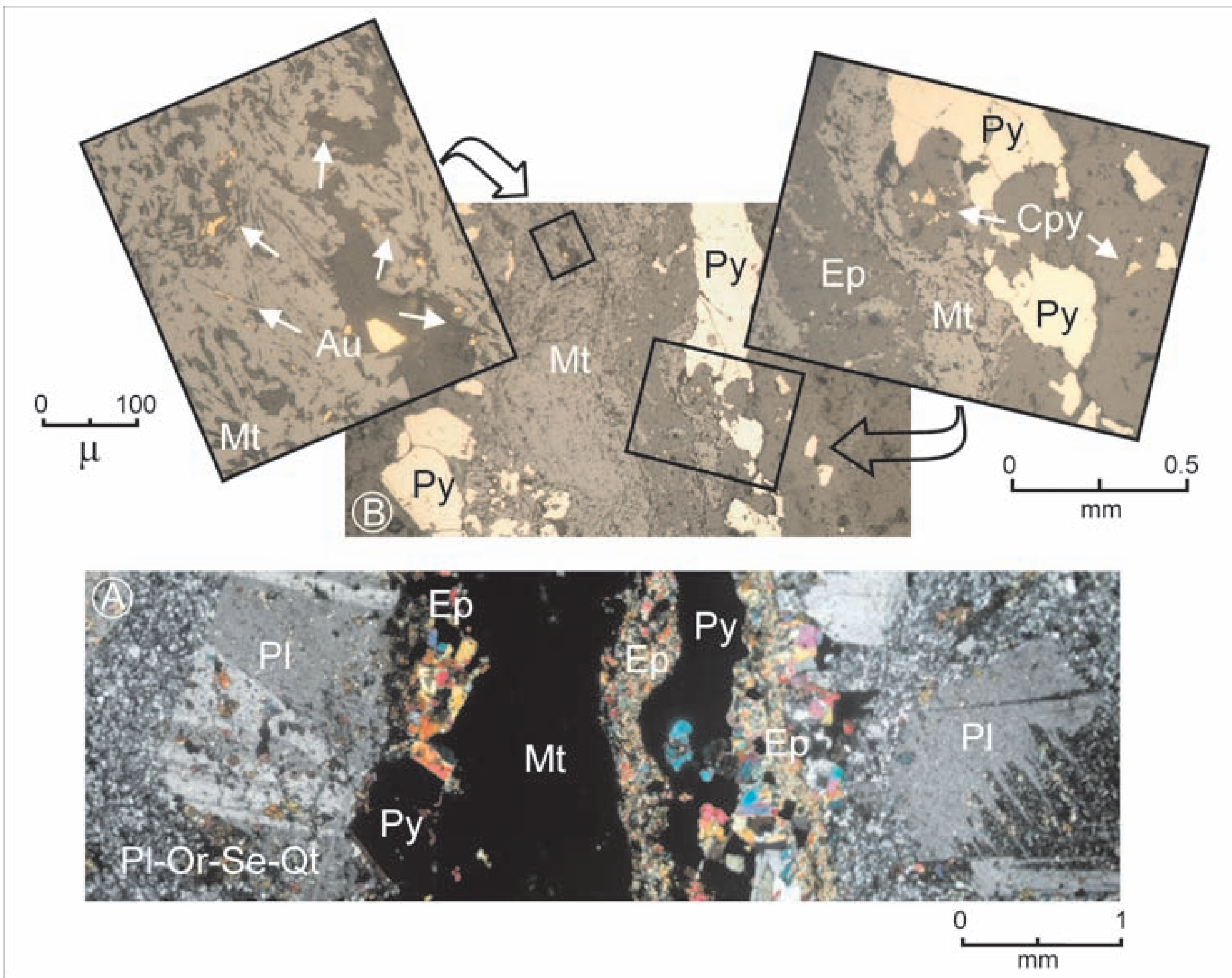

Figure 5. Photomicrograph of auriferous magnetite veinlet cutting quartz monzonite from the Gold Mountain Zone (01GM-04, 84.3 m). A) Characteristic porphyry texture of Silver King pluton, large plagioclase phenocrysts in a fine-grained plagioclase-orthoclase-sericite-quartz matrix, cut by a magnetite-pyrite-gold vein. The vein is mantled by epidote-pyrite±chalcopyrite and chlorite alteration envelope (transmitted light, x-nicols). B) Field of view reduced to show the distribution of opaque minerals in the vein. Insets show the grain size and relationships between gold and magnetite mineralization in the center of the vein, and the chalcopyrite-pyrite-quartz±gold and epidote assemblage that is present along the margins of the vein (reflected light).

joints from surface trench exposures of the GMZ (Rhys, 2001), show a consistent veinlet and fracture orientation, which have steep to moderate southerly dips, with strikes ranging between 330-150°. Shallow dipping features and those with north to north-northeast trends were rare. These orientations are the same at the Great Eastern/Western showings (*see* below) and as peripheral mineralized veins contained within the metavolcanic rocks (Kena Gold).

Definition drilling of the Gold Mountain Zone shows wide zones of alteration and gold mineralization, which hosted within the pluton and locally, extend beyond the contact zone into the metavolcanic country rocks. Section 11+00N and Section 10+70N reproduced and modified from Dandy (2002), show the geology and gold assays from 2000 and 2001 diamond drilling at the GMZ (Figure 6). Drill core was sampled on 2 metre intervals and analyzed for gold and other metals. From this raw assay data, continuous intervals of greater than 1 g/t Au were isolated, the assay values combined and an average grade determined. This average grade was then applied to the entire intersection, grouped into populations of greater than 1, >2, >3, >5 or >10 g/t Au and plotted onto the section lines (Figure 6).

On section L11+00N, higher-grade and wider intersections of gold mineralization occur in a zone below the “discovery” trenches (3+00E), giving continuity to, and expanding the area of anomalous gold values outlined by surface chip sampling. A second zone of higher-grade intersections straddles and follows the porphyry/metavolcanic contact zone. Some of the highest gold assays have come from intervals of porphyry and metavolcanic rocks located within 20 m above and below this contact zone. It is difficult to project the higher-grade intersections from one section line to the next or to determine their prospective orientations.

Great Eastern and Western (82FSW 171,172)

The Great Eastern/Western showings are located east of the Gold Mountain Zone close to the western contact of the Silver King pluton. Gold mineralization occurs in quartz veins and shear zones hosted entirely within the Silver King pluton. The shear zones, like those in the adjacent greenschists and metavolcanic rocks are northwest trending, parallel to the dominant foliation, while the quartz veins trend easterly with generally steep north and south dips. Early exploration and development work focused on three veins, “A”, “B”, and “C” (Fahrni, 1946). The three veins are located along a single(?) or multiple foliation parallel shears, with “A” at the southern end, “B” located 215 m northwest and “C” located a further 275 m northwest. At its southern end the shear zone strikes 116/63° SW and at its northwestern end the same(?) northwest-trending shear dips 800° SW and contains two narrow lamprophyre dikes. The shear zone and wallrock to the veins are extensively altered and bleached. Pyrite, carbonate and sericite alteration assemblages replace the sheared monzonite and envelope narrow quartz-pyrite-sericite veins and quartz-calcite-pyrite veins. Samples of schistose monzonite from the shear at “A” vein returned 1.71 g/t Au, from the shear at “B” vein returned 0.32 g/t Au, and from the shear at “C” vein, two samples returned 1.37 g/t Au and 0.32 g/t Au (Fahrni, 1946).

Vein orientations are highly discordant to the northwest trending shear(s). The “A” vein strikes 72/80° SE, the “B” vein 290/85° N and the “C” vein 260/85° N. The “C” vein cuts and offsets the northwest-trending shear zone that contains the lamprophyre dikes (Fahrni, 1946) and narrow east-trending, sheeted quartz± tourmaline veins, located east of the “A” portal, appear to crosscut the dominant southeast-trending foliation (Figure 7). Deposition of the “C” vein and sheeted quartz veins crosscut the dominant foliation and therefore post-date it’s development. Exposures in all of the old workings have generally narrow widths of quartz material (5 cm) with similar widths of altered pyritized, quartz monzonite wallrock. A 30 cm sample of quartz and wallrock from the face of the “A” vein returned 6.17 g/t Au (Fahrni, 1946). Quartz-tourmaline-sericite breccias and narrow quartz±pyrite veins cut quartz monzonite at the “B” vein workings.

A single hole was drilled (121.92 m) to test the area of the “C” vein (August 2002). Alteration and mineralization of the porphyry is controlled by narrow fractures. Fracture density increases down section where sericite-quartz-pyrite-calcite stockworks have bleached and destroyed the igneous texture and rarely host auriferous quartz-pyrite-calcite veinlets. Visible gold is present in core, but gold assays returned only three widely separated 2 m intervals containing 1-2 g/t Au.

Narrow, mineralized quartz veins at the Great Eastern and Western workings contain visible gold in east-trending structures that locally, post-dates development of the foliation and define a structural corridor that when project further east intersects the “discovery” area at the Gold Mountain Zone.

PERIPHERAL MINERALIZATION

The Kena Gold Zone (82FSW 237)

The Kena Gold Zone has been the focus of most of the earlier work on the Kena Property. The mineralized showings (Main and Neil) are located 3 km southeast of the Gold Mountain Zone in Elise Formation metatuff and metabasalt units, approximately 500 m northeast of the Silver King pluton. A large number of synvolcanic diorite and monzogabbro intrusions, sill-like bodies of younger, intermediate to felsic plutons and lamprophyre dikes intrude the volcanic rocks in this northwest-trending zone adjacent to the Silver King pluton. The area contains foliation-parallel shears and zones of intense brittle fracturing that have localized potassic (orthoclase and biotite) and sericitic (sericite, quartz and carbonate) alteration assemblages and associated copper-gold mineralization.

Initial percussion drilling (4 holes, 250 m total) by Ducanex Resources Ltd. recognized an east trending, south dipping mineralized zone that contained 1.37 to 1.70 g/t Au over 6 to 10 m thick intervals in potassic, sericitic altered volcanic rocks (Johnson, 1974; 1975). Subsequent work on the Kena Gold Zone includes trenching, geophysical-, geo-

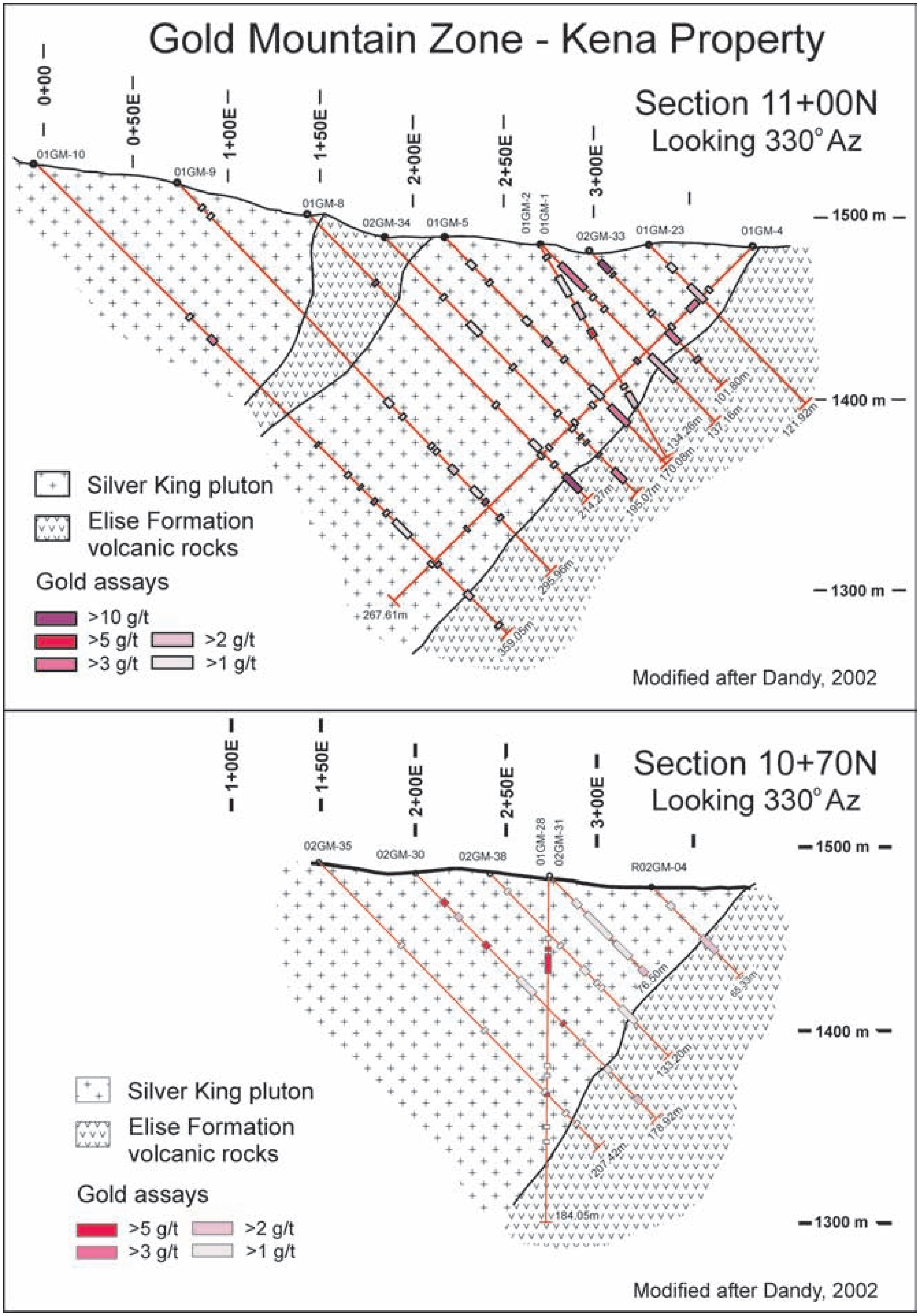

Figure 6. Section Line 11+00N and Line10+70N showing geology (from Dandy, 2002) and calculated average gold grades of the Gold Mountain Zone. The gold assays were calculated from continuous, 2m intersections grading >1 g/t Au.

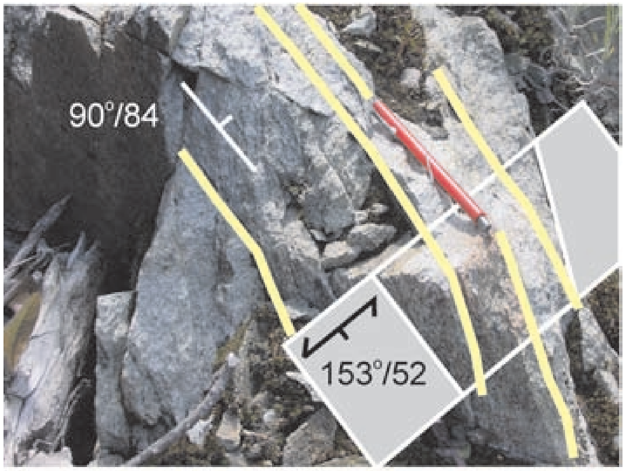

Figure 7. Narrow, east-trending sheeted quartz veinlets cutting the dominant foliation S_n (153/52°) in the Silver King pluton. Outcrop located east of the "A Vein" portal, Great Western showings.

chemical- and geological surveys and forty-seven drill holes aggregating 6 502 m (Sirola, 1982; Johnston, 1985, 1986; Black, 1987; Lewis and Silversides, 1991; Lisle, 1991).

Alteration and mineralization are spatially associated with subconcordant, mafic (monzogabbro suite) and intermediate (Silver King suite) intrusions and replace fracture and crackle breccia zones that have developed in both the intrusive and volcanic country rock (Johnston, 1986). The broad northwest-trending zone of alteration and mineralization follows brecciated, lithologic contacts and the dominant foliation, evidence that both played an important role in controlling the distribution of alteration and gold mineralization. East-striking subvertical fracture sets are conspicuous in the vicinity of the Main Zone (Johnston, 1985) and quartz-pyrite veins with potassium, sericite, quartz and calcite alteration following this trend consistently carry >2 g/t Au (Rhys, 2000). East-trending fracture sets are prominent at the Gold Mountain Zone and host the majority of the mineralization (Rhys, 2001).

At the main showing orthoclase-biotite-silica alteration assemblages have bleached the metavolcanic rocks to a pale grey-brown colour. Pyrite, chalcopyrite, lesser malachite and bornite, occur as foliation parallel blebs and stringers, filling fractures or as matrix to breccias within the alteration zones. Johnston (1986) suggested that the gold at the Kena is associated with a fine-grained "yellow pyrite" distinct from the variety disseminated throughout the metavolcanic rocks. Bimodal gold grades and pyrite types might be specific to the exploration target; with "silvery pyrite" associated with the newly recognized wide zones of lower grade gold mineralization that surround, narrower higher-grade ("yellow pyrite?") intersections at the Kena Gold zone (Dandy, 2000). Late, (sulphide-free) fractures filled with calcite and specular hematite cut the potassic and sericitic alteration.

Shaft/Cat Zone (82FSW 331)

The Shaft and Cat mineralized zones are spatially associated with an early mafic intrusive complex that intrudes augite porphyry flows and tuffs of the upper Elise Formation (Andrew and Höy, 1989). The Shaft lies within 500 m of the eastern contact zone of the Silver King pluton adjacent to the Gold Mountain Zone, and the Cat, approximately 500 m to the northwest. The mafic intrusive is up to 50 m in width, 5 km long and parallels the regional foliation and eastern margin of the Silver King pluton.

Mineralization consists of disseminations and stringers of pyrite-chalcopyrite-magnetite and pyrite±chalcopyrite-quartz-epidote-calcite veins. Alteration of the diorite/monzogabbro is biotite-dominant (Andrew and Höy, 1989), and the association with magnetite and secondary potassium feldspar is typical of potassic alteration (Rhys, 2000). Local zones of intense chlorite-sericite-carbonate±quartz had been interpreted to represent a late sericite alteration overprint of an earlier (?) propylitic alteration (Andrew and Höy, 1989). Gold and copper mineralization occurs mainly within the monzodiorite complex but also in the Elise volcanic rocks and in the margins of the Silver King porphyry (Andrew and Höy, 1989). If the monzodiorite complex was the mineralizer, the Shaft/Cat gold-copper mineralization would predate the gold mineralization at Gold Mountain Zone hosted in the Silver King porphyry. The similar alteration and mineralization assemblages present suggest a single event related to the youngest host (Silver King porphyry). From the distribution of mineralization, alteration and intense shearing parallel to the regional foliation, Andrew and Höy (1989) suggested the likelihood of strong structural control; Rhys (2000) on the other hand, thought that the principal control of mineralization was lithology and alteration rather than structure.

Silver King Mine (82FSW 176)

The Silver King mine is located 7 km south of Nelson, on the northeast side of Toad Mountain. The Hall brothers first staked the Silver King claims in 1886. The property produced high-grade silver-copper ore continuously between 1889 and 1910 and then intermittently from 1913 to 1948. Production from 1889 to 1958 totaled 202 049 tonnes yielding 138.2 tonnes of silver, 8.8 kgs gold, 6 790 tonnes copper, 15.23 tonnes of lead and 4.07 tonnes of zinc. All of the production came from the Main Silver King vein structure.

The Silver King property is dominated by thoroughly sheared Elise Formation volcanic rocks and sill-like apophyses of Silver King intrusives which host three main mineralized structures; the Main Silver King Vein, the Iroquois Vein and the Kohinoor Vein. The veins dip steeply south and sub-parallel the northwest-trending Silver King Shear Zone. The silver/copper mineralization appears to be controlled by cross-structures intersecting the Iroquois Vein. The mineralization consists of pyrite-chalcopyrite-galena±sphalerite±tetrahedrite±bornite in quartz-calcite-siderite veins. W.R. Baragar (personal communication, in Little, 1960) describes a rare copper-silver sulphide mineral, stromeyerite that is associated with bornite in the veins.

The productive ore bodies were found at the intersection of the northwest veins and E-striking cross structures.

Starlight (82FSW 174)

The Starlight showings lie southwest of the Great Western workings on the west side of Giveout Creek. Surface stripping and underground workings explore a wide quartz vein which on surface has an apparent width of 2 metres. The vein strikes southeast and dips shallower than the regional schistosity. Approximately 25 m below the surface exposure, the vein is explored underground by 100 m of crosscuts and 45 m of drifting. Within the drift the vein is narrow and discontinuous (Fahrni, 1946) but reported to carry values in gold.

Three holes were drilled on the Starlight vein structure in August 2002. Drill intersections of the vein structure showed varied, and substantially narrower widths (<1.0 m), than exposed at surface and generally low gold grades, but visible gold was noted. A 12 m intersection in drill hole 02SL-02 (85-97 m) returned elevated gold grades (1.97 g/t Au) from a quartz stockwork zone in strongly foliated, altered metavolcanics rocks in the footwall section of the vein. Gold grades in the other two holes returned generally low values, with one or two slightly elevated values over less than metre intervals.

North Star (82FSW 276, 333)

North of the Starlight and adjacent to the Great Western claims are three volcanic-hosted, conformable Au±Cu mineralized alteration zones: Giveout Creek North, Giveout Creek South and Black Witch (Höy and Andrew, 1989c). These are associated with sheared and foliated intrusions of probable Silver King affinity (Höy and Dunne, 2001), and have mineralogy and alteration assemblages similar to the Kena Gold zone located on the east side of the Silver King pluton. The mineralization consists primarily of pyrite with minor chalcopyrite, as foliation parallel stringers and disseminations distributed throughout a pervasive carbonate-quartz-sericite alteration zone and have been informally classified as “conformable gold” mineralization (Höy and Andrew, 1989b). Gold values do not correlate with other metals, but Cu-Ag-Pb has a strong positive correlation (Höy and Andrew, 1989c), an assemblage found at the Silver King mine. In addition, some mineralization occurs in late, post-kinematic, crosscutting quartz veins (Höy and Andrew, 1989c).

CONTROLS ON MINERALIZATION

Gold mineralization on the Kena property occurs within early Jurassic, Elise Formation metavolcanic and subvolcanic intrusive rocks, early Middle Jurassic, Silver King intrusive rocks, and is locally concentrated along the north-northwesterly trending contact zone between these units (Gold Mountain zone).

Mineralization within the metavolcanic rocks occupies structures that generally parallel the dominant northwest-trending foliation, but may have steeper dips. These occurrences fall into the synkinematic shear-related or conformable gold category of (Höy and Dunne, 1989b). The zones/structures have pervasive iron-carbonate±sericite±chlorite alteration envelopes. In detail the northwest-trending contact zone between porphyry and metavolcanic rocks (Gold Mountain Zone) varies in strike and character from sheared or interdigitated to sharp. It is pervasively potassium-altered and variably pyritized. Higher-grade intervals are localized above and below this contact (Figure 6).

Highly discordant to the regional foliation shears are east-trending quartz-pyrite veins that are well developed at the Kena Gold zone in altered metavolcanic rocks and within the Silver King pluton at the Gold Mountain and Great Western zones. The easterly-trending quartz-pyrite veins at the Kena Gold consistently carry >2 g/t Au (Rhys, 2000). Mineralization hosted within the Silver King pluton occupies fractures and veinlets, which show a preferred easterly trend and steep south dip (Gold Mountain Zone, Rhys, 2001 and Great Western area, this study).

The productive ore bodies at the Silver King mine, albeit Cu-Ag rich, ±Zn±Pb replacements, occurred at the intersection of northwest-trending veins and an E-directed shear (Aylward, 1983). Gold values are not recorded for greater than 90 % of production from the Silver King mine (prior to 1913), but when under development by Consolidated Mining and Smelting Company of Canada (Limited) between 1913 and 1914, a totaled of 15,500 tonnes grading about 261 g/t Ag, 1.8% Cu and 0.5 g/t Au were produced. Ore mineralogy at the Silver King is unique to many of the other deposits in the area, but if the production figures from these two years are correct they suggest that gold was deposited in parts of the system, possibly on younger cross structures.

The steep, east-trending zone of higher-grade gold mineralization at the Kena Gold Zone (Johnston, 1985; Rhys, 2000; this study), the preferred easterly trend and steep southerly dips of mineralized fractures at the Gold Mountain Zone (Andrew, 2000; Rhys, 2001) and Great Western showings (Fahrni, 1946; this study) and the repeated reference to (E-W) cross-structures as the control for mineralization at the Silver King mine (Little, 1960), indicate structural controls particularly east-trending structures are important hosts for some of the higher grade gold mineralization on the Kena property. The identification of these potential higher-grade targets and/or structural corridors has important economic significance for some of the larger lower-grade zones.

AGE OF MINERALIZATION

Gold-copper mineralization in the Rossland Group includes stratiform massive sulphides, skarns and shear-related veins, and is generally interpreted as coeval with Early Jurassic volcanism. On the Kena property the monzogabbro intrusive suite and the Silver King pluton host intrusion-related porphyry-style alteration and gold mineralization (Dandy, 2000; Dunne, 2001). The early

Middle Jurassic intrusions are deformed (synkinematic, Dunne and Höy, 1992) and post-date the Elise Formation volcanism by ca 10 Ma. The dominant northwest-trending foliation and deformation of rock units as young as 174-179 Ma are truncated by Nelson suite intrusive rocks that constrain the main deformation event to pre 170-166 Ma. Petrographic studies indicate that the gold emplacement was either pre or syn-kinematic (Rhys, 2000; Wells, 2001; and this study). Mineralization at the Kena, Shaft/Cat, Great Western and Gold Mountain zones has all been affected by the main deformational event and development of S_n (regional foliation). Veinlets cutting the volcanic rocks are frequently folded and transposed; those within the Silver King pluton are less affected. Hydrothermal biotite associated with mineralization at the Shaft/Cat is aligned parallel to S_n suggesting that potassic alteration was synkinematic (Andrew and Höy, 1989). Rhys (2000) has recognized isolated pyrite-chalcopyrite stringers at the Gold Mountain Zone that he interprets to represent late remobilization of disseminated sulphides.

Early to Middle Jurassic deformation is well constrained in Southern British Columbia and is related to the late collision of the eastern edge of Quesnellia with the North American craton between 184 and 174 Ma (Murphy *et al.*, 1995; Colpron *et al.*, 1996). A suite of synkinematic felsic dikes and sills at Kootenay Lake (Fyles, 1964) yielded a U-Pb zircon age of 173±5 Ma (Smith *et al.*, 1992) and at the north end of the Kootenay Arc the Kuskanax batholith (173±5 Ma, Parrish and Wheeler, 1983) intrudes northeast-verging structures associated with the emplacement of Quesnellia.

SUMMARY

The Silver King pluton is chemically distinct; with relatively higher alkali content than the other Silver King intrusions as well as a quartz monzonite composition.

Hydrothermal alteration mineral assemblages present in drill core in and around the Gold Mountain zone are similar to the principal alteration types developed around gold-rich porphyry deposits (*i.e.* potassic, propylitic, intermediate argillic and sericite).

Age of mineralization is equivocal. Au-Cu mineralization is hosted by Sinemurian volcanic rocks and synvolcanic monzogabbro intrusions, Aalenian (Silver King pluton) intrusives and in synkinematic (*ca*. Aalenian) structures (shears, fractures and vein stockworks) that are truncated by Bajocian (170-166 Ma) intrusions .

Adjacent to the GMZ are higher-grade, mineralized quartz vein systems (Starlight and Great Western), which contain visible gold and some historically limited production. These appear to lie along an east-trending structural corridor that intersects the GMZ discovery area.

CONCLUSIONS

The 2002 Kena project carried out reconnaissance mapping, sampling and deposit studies within a relatively focused belt (4 x 20 km) of early Middle Jurassic magmatic rocks in southern British Columbia. Results from Pb-isotopic studies, polished section and SEM work are pending but field observations, thin section studies and geochemistry support an intrusion-related Au-Cu porphyry system, related to the early Middle Jurassic Silver King pluton as causative to the alteration and gold mineralization at the Gold Mountain zone. Mineralization at some of the peripheral showings (*i.e.* Kena, Shaft/Cat) may also be related to this same system.

Gold mineralization occurs in areas of pervasive pyritized Silver King pluton and within 20 m of the contact with volcanic rocks. It consists primarily of disseminated blebs of pyrite±chalcopyrite and lesser stringers and veinlets. The latter follow a preferred easterly trend, and similar oriented structures at the Kena, Great Western and Silver King mine have localized consistently higher-grades of mineralization. The identification of these potential higher-grade targets and/or structural corridors has important economic significance for the larger lower-grade zones.

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