Ray Gulch tungsten skarn, Dublin Gulch, central Yukon: Gold-tungsten relationships in intrusion-related ore systems and implications for gold exploration

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ABSTRACT

The Ray Gulch tungsten skarn and the Eagle Zone intrusion-related gold deposit are associated with the Dublin Gulch intrusion, which forms part of the mid-Cretaceous Tombstone Plutonic Suite. Tungsten mineralization occurs in a roof pendant of hornfelsed Neoproterozoic to Early Cambrian Hyland Group metasedimentary rocks. Five main paragenetic stages include Stage I wollastonite-quartz skarn and later Stage II pyroxene-garnet-scheelite skarn that forms the main tungsten mineralization. Stages III (quartz-scheelite-clinopyroxene), IV (quartz-amphibole-calcite) and V (quartz-K-feldspar-pyrrhotite-molybdenite-arsenopyrite-pyrite-chalcopyrite) are vein related and are volumetrically insignificant (<10 vol. %). Geochemical analysis of the skarn and veins indicates that the deposit lacks gold and bismuth. The earliest veins in the Eagle Zone are similar to Stage V veins at Ray Gulch. Gold at the Eagle Zone occurs in a later sericite-carbonate-bismuth-sulphide vein stage; this stage is critically absent from the skarn. Thus, although tungsten is commonly associated with intrusion-related gold mineralization, it predates gold-bismuth and may occur spatially separate from it.

RÉSUMÉ

Le gisement de skarn tungsténifère Ray Gulch et le gisement d'or Eagle Zone sont associés à l'intrusion de Dublin Gulch, qui constitue une partie de la suite plutonique de Tombstone du Crétacé moyen. La minéralisation en tungstène se trouve dans un enclave de roches métasédimentaires du Groupe de Hyland, d'âge Néoprotérozoïque à Cambrien précoce, qui ont été transformées en cornéennes. La paragenèse comprend cinq associations principales : l'association I (skarn à wollastonite-quartz) et, ultérieurement, l'association II (skarn à pyroxène-grenat-scheelite), qui constitue le principal corps minéralisé en tungstène; l'association III (quartz-scheelite-clinopyroxène), l'association IV (quartz-amphibole-calcite) et l'association V (quartz-feldspath potassique-pyrrhotine-molybdénite-arsénopyrite-pyrite-chalcopyrite) sont associées à des filons et présentent un volume peu important (<10 %). L'analyse géochimique des skarns et des filons indique que le gisement ne renferme ni or ni bismuth. Les filons précoces du gisement Eagle Zone sont similaires aux filons de l'association V du gisement Ray Gulch. L'or du gisement Eagle Zone se trouve dans des veines plus récentes renfermant l'association de séricite-carbonates-bismuth-sulfures; il est très important de noter que le skarn ne renferme pas cette association. Bien que le tungstène est couramment associé à une minéralisation en or reliée à une intrusion, celui-ci s'est formé avant l'or et le bismuth et peut donc se trouver à d'autres endroits.

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INTRODUCTION

The Ray Gulch tungsten skarn deposit is located within the Dublin Gulch property in central Yukon. The deposit consists of several tungsten-bearing skarn units containing drill-indicated and inferred reserves of 5.4 Mt at 0.82% WO_3 (Lennan, 1983). Adjacent to the Ray Gulch deposit is the Dublin Gulch – Eagle Zone gold resource, a granite-hosted, sheeted-vein deposit with an inferred and potential resource of 50.3 Mt at 0.93 g/t Au (Maloof et al., 2001).

Even though these two deposits were studied separately in the past (Lennan, 1983; Hitchins and Orssich, 1995; Maloof et al., 2001), previous reports did not discuss possible genetic links or timing of mineralization between the two deposits. Recent work focused on relogging and sampling a number of drill holes with emphasis on paragenetic relationships, as well as costean mapping and infill mapping within and around the deposit outskirts. The aims of this paper are to discuss the paragenetic and mineralization history of the skarn deposit, and to re-evaluate the skarn deposit in light of new data from the Eagle Zone (Maloof et al., 2001). This comparison enables consideration of the spatial and temporal relationships between tungsten and gold-bismuth in intrusion-related ore systems, which may be useful when exploring for gold in regions of known tungsten occurrences.

LOCAL GEOLOGY

The Dublin Gulch property is located in central Yukon Territory, approximately 70 km by road northeast of the town of Mayo (Fig. 1). The tungsten deposit is situated on a plateau at an elevation of approximately 1370 m and is surrounded by gently rolling hills and peaks of the Selwyn Ranges. The Eagle Zone is approximately 2.5 km southwest of Ray Gulch and occupies an area roughly 400 m by 600 m on the steep southwestern slopes of the Dublin Gulch intrusion (Maloof et al., 2001). Access onto the deposit sites is possible by four-wheel drive vehicle (a four-wheel quad bike is advisable), via a network of old, unmaintained drill roads.

The Dublin Gulch property is located within the Selwyn fold belt and is hosted by Neoproterozoic to Early Cambrian metasedimentary rocks of the Hyland Group. These units have been thrust over younger Mississippian Keno Hill Quartzite and intruded by mid-Cretaceous

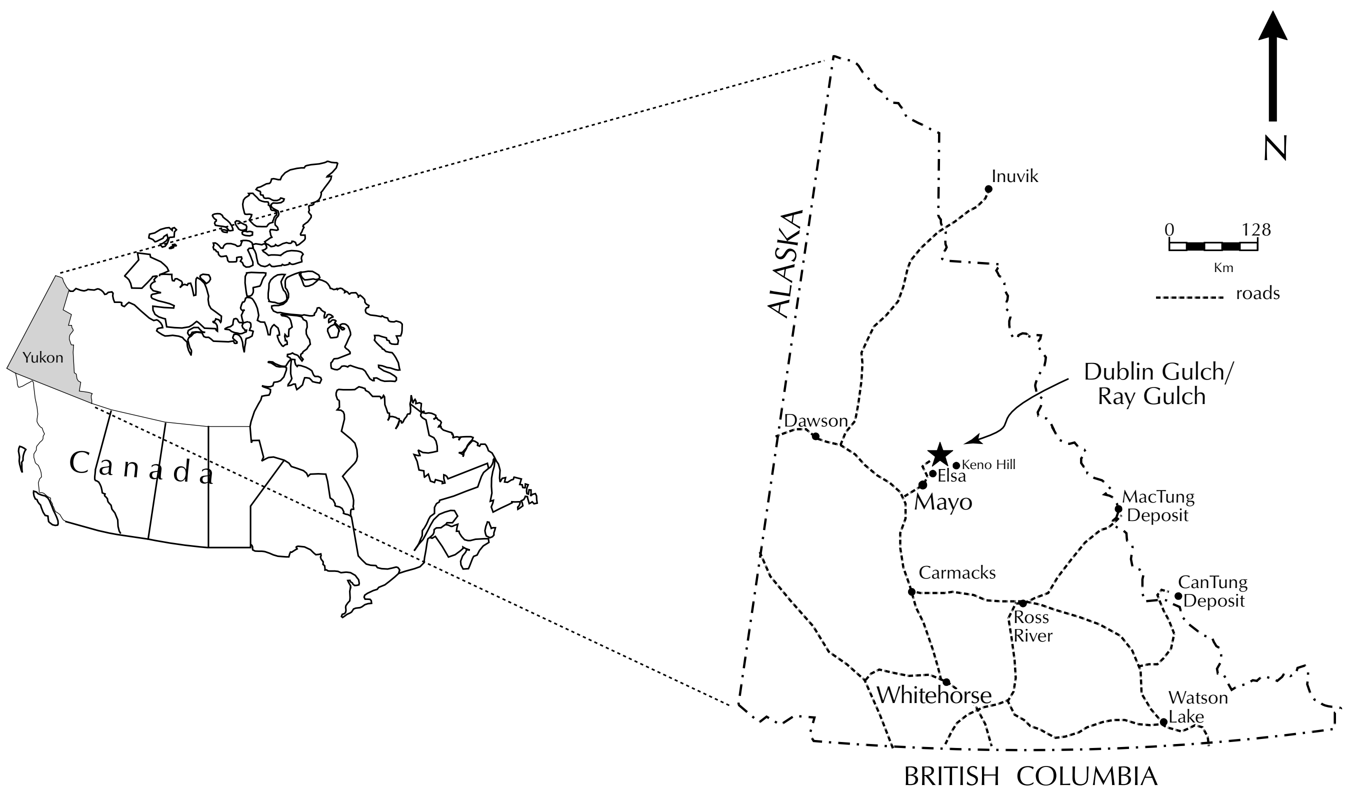

Figure 1. *Location map of the Ray Gulch tungsten skarn deposit.*

granitoid plutons of the Tombstone Plutonic Suite (Hitchins and Orssich, 1995). The Hyland Group in this area has been subdivided into four main lithological units: the Lower Schist, the Central Quartzite, the Upper Schist and the Grit Unit (Fig. 2; Lennan, 1983). The Ray Gulch deposit is hosted within the Grit Unit rocks and consists of interbedded gritty and micaceous quartzite, massive white quartzite, limestone and phyllite (Lennan, 1983). Several deformation events affected the rocks and metamorphism reached greenschist facies. Later contact metamorphism associated with the Dublin Gulch intrusion produced fine-grained quartz and biotite hornfels, with disseminated pyrrhotite and andalusite, and skarn within the limestone units.

Four phases of intrusive rocks have been identified in outcrop and/or drill core within the Dublin Gulch area. They are, from youngest to oldest: leucocratic granite and aplite, quartz monzonite, quartz diorite and granodiorite (Lennan, 1983). The main intrusive feature is the Dublin Gulch granodiorite stock, an elongate body that strikes 070° and dips shallowly to steeply to the north on the northern side of the intrusion, and steeply to the north on the southern margin. The surface dimensions of the intrusion are approximately 6 km by 2 km, with a hornfels aureole extending up to 2 km from the contact (Maloof et al., 2001).

MINERAL OCCURRENCES

Mineral occurrences within the property that are spatially related to the granodiorite stock include the Ray Gulch tungsten skarn deposit (Yukon MINFILE, 2001, 106D 027) and an array of gold-bearing sheeted-vein deposits (the Eagle, Olive, Shamrock and Steiner zones; Yukon MINFILE, 2001, 106D 025) within the east-central and northern contact zones (Maloof et al., 2001). Quartz-sulphide

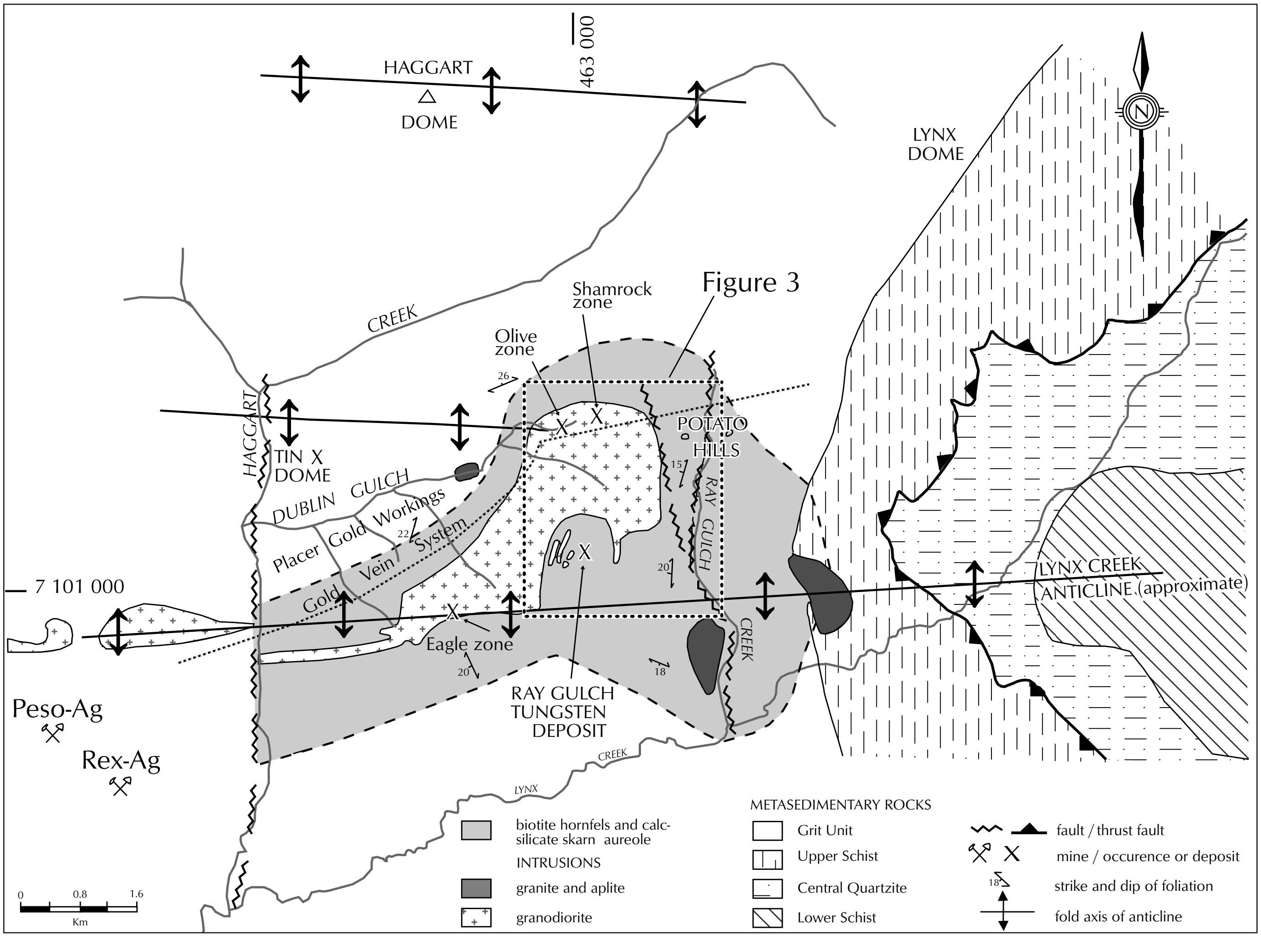

Figure 2. *Geological map of the Dublin Gulch area and surrounding prospects (after Lennan, 1983).*

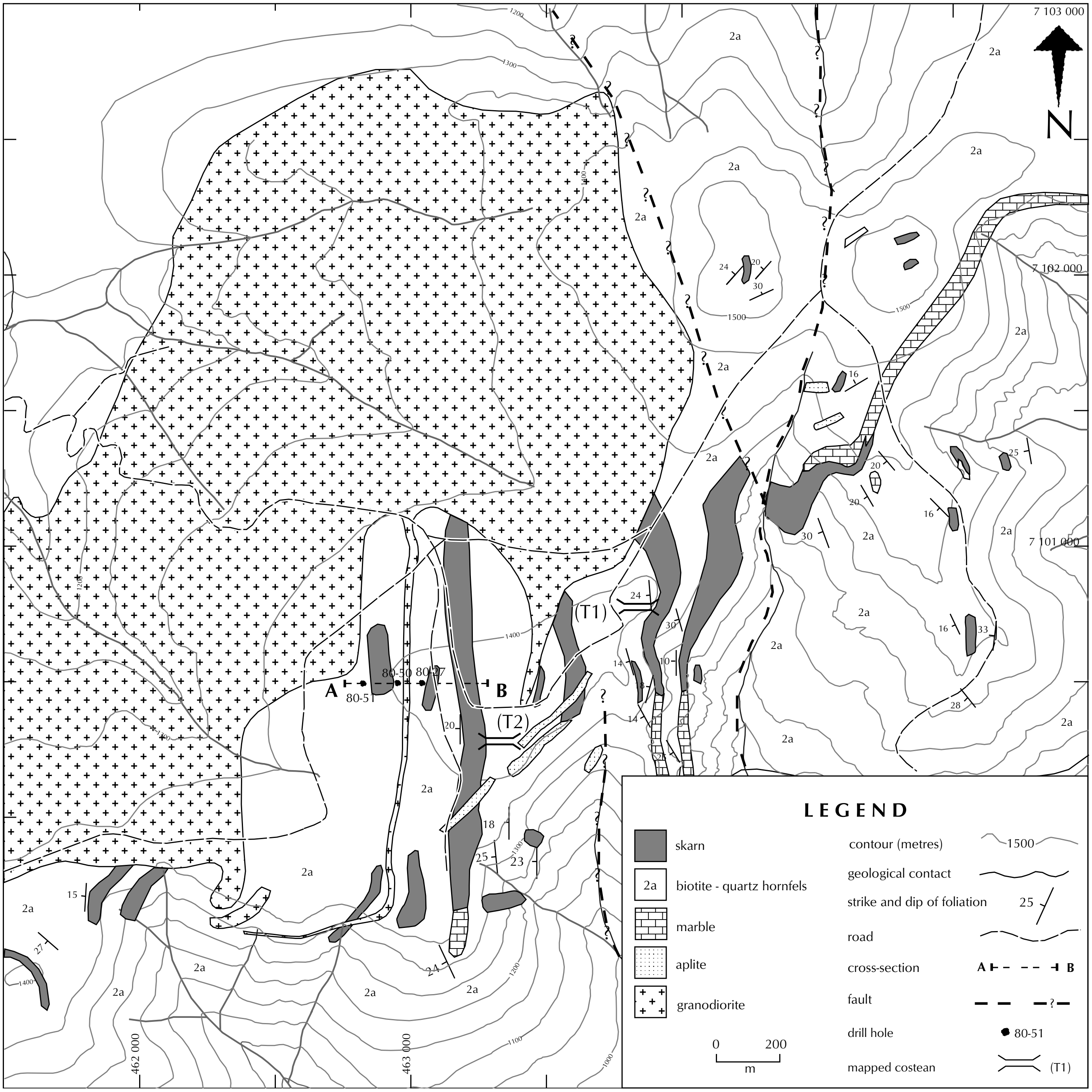

Figure 3. *Simplified geological map of the Ray Gulch tungsten skarn deposit. Diamond holes 80-27, 80-50 and 80-51 were logged and sampled along with 2 costeans (T1 and T2). This map was compiled using maps from Lennan (1983) and data collected from field observations.*

mineral fissure veins occur between Haggart Creek and Potato Hills, and cassiterite-bearing breccias of Tin Dome can be found to the south of the stock (Fig. 2; Hitchins and Orssich, 1995; Yukon MINFILE, 2001, 106D 024). Deposits outside of the Dublin Gulch intrusion zone include the Len and Tag gold showings, the Shanghai and Skate silver showings, and the Rex and Peso quartz-sulphide mineral fissure veins (139 000 tonnes at 719 g/t Ag and 3.7% Pb) located to the west of Haggart Creek (Fig. 2; Yukon MINFILE 2001, 106D 018, 019, 020, 021).

DEPOSIT GEOLOGY AND CONFIGURATION

The tungsten deposit is hosted within a hornfelsed roof pendant and occupies the crest and northern limb of the westerly plunging Lynx Creek antiform (Fig. 2; Lennan, 1983). Foliation in the local rock units changes from a northerly strike and 25° westerly dip in the central portion of the deposit, to a strike of 15° and dip of 25° west-northwest in the northern portion of the deposit (Fig. 3; Lennan, 1983). The Dublin Gulch granodiorite stock crops out along the northern, eastern and western margins of the deposit and plunges south and west under the metasedimentary rocks that host the deposit (Lennan, 1983). Dark green pyroxene-rich skarn lenses host the majority of the scheelite found in the deposit. Minor scheelite is also found in later crosscutting veins.

The deposit consists of six main mineralized zones that have a northerly strike and a westerly dip of approximately 25° (Fig. 4; Lennan, 1983). Zone 1 has the highest elevation and Zone 6 has the lowest elevation, with each zone comprising several skarn horizons of varying thickness. The skarn horizons are laterally continuous, massive and generally coarse grained. Tungsten grade increases proportionally with pyroxene content, and with increasing depth toward the granodiorite contact. The grade of the zones are as

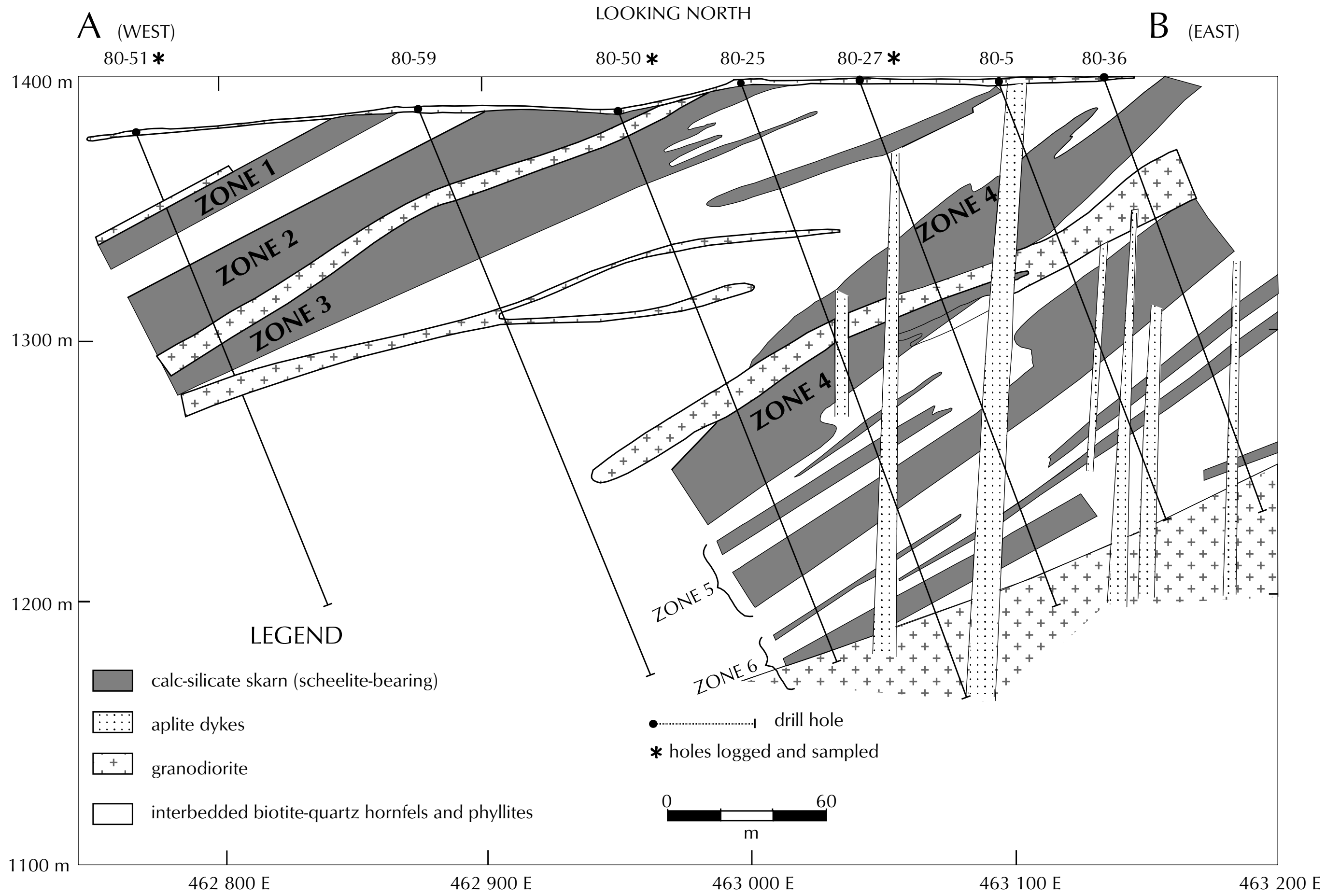

Figure 4. *Geological cross-section of the Ray Gulch tungsten skarn (modified after Lennan, 1983). Refer to Figure 3 for cross-section location.*

follows: Zone 1 – 0.40% WO_3, Zone 2 – 0.51% WO_3, Zone 3 – 0.55% WO_3, Zone 4 – 0.65% WO_3, Zone 5 – 0.75% WO_3, Zone 6 – 1.03% WO_3 (Lennan, 1983).

MINERALOGY AND PARAGENESIS

The deposit consists of two mineralogically different skarn types: an early scheelite-barren wollastonite-quartz skarn (Stage I), and the scheelite-rich pyroxene skarn (Stage II; Fig. 5). The principal minerals found within these skarn types are clinopyroxene, wollastonite, plagioclase, quartz, calcite, amphibole, scheelite and garnet, with accessory amounts of sphene, apatite, vesuvianite, clintonite and allanite (Lennan, 1983). Wollastonite-quartz skarn is a fine-grained, siliceous rock, white to pale light green with banding defined by alternating lenses of wollastonite, quartz, calcite, K-feldspar, pyroxene and relic bedding (Fig. 6a). This rock unit makes up approximately 5% of the total rock mass in the deposit. The wollastonite-quartz skarn was subsequently overprinted by the Stage II scheelite-bearing pyroxene skarn (Fig. 6b). The amount of wollastonite-quartz skarn within pyroxene skarn horizons decreases as pyroxene alteration intensifies with depth. The pyroxene skarn is a medium- to coarse-grained dark green rock composed of clinopyroxene, plagioclase, quartz, grossular garnet, disseminated 0.2 to 5 mm scheelite grains and calcite (Fig. 6c), with minor amphibole that is typically the product of retrograde alteration of pyroxene. Locally, scheelite also occurs as large subhedral grains in later veins. On average, pyroxene skarn consists of up to 70% clinopyroxene, 10% quartz, 10% feldspar, 5-10% grossular garnet, 5-15% amphibole, 5% calcite and variable amounts of scheelite (up to 3%).

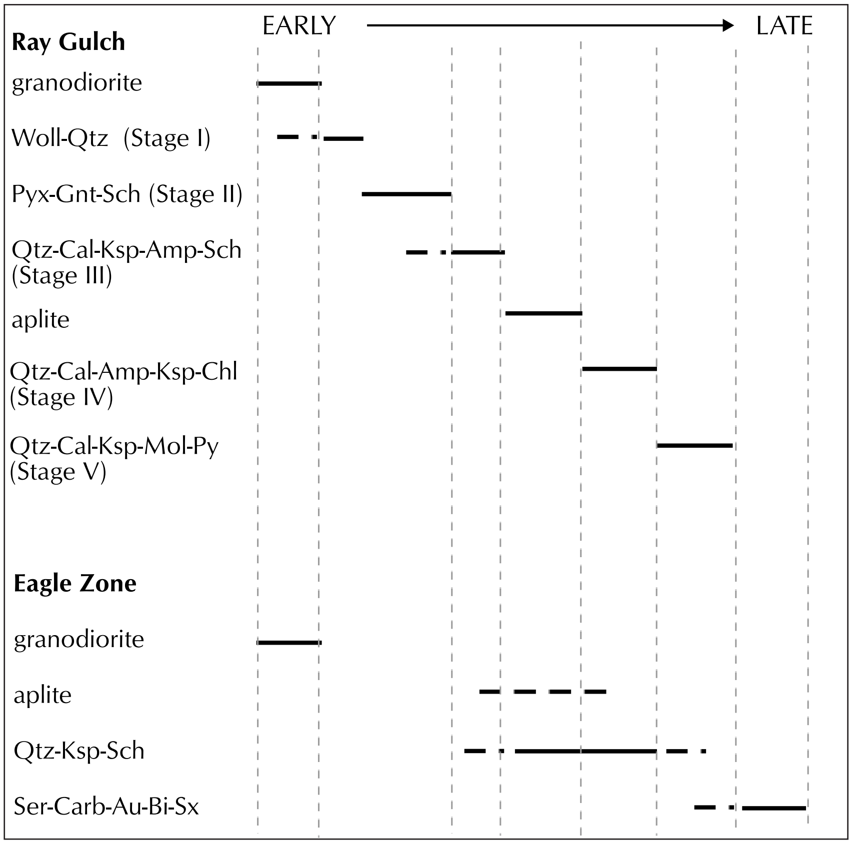

Figure 5. *Comparison of the paragenesis at Ray Gulch and Eagle Zone. The gold mineralization occurs in a distinct event postdating scheelite. Abbreviations: Woll = wollastonite; Qtz = quartz; Pyx = pyroxene; Gnt = garnet; Sch = scheelite; Cal = calcite; Amp = amphibole; Ksp = K-feldspar; Chl = chlorite; Mol = molybdenite; py = pyrite; Ser = sericite; Sx = sulphide minerals.*

Microprobe analysis of clinopyroxene revealed considerable compositional variation within each skarn type. There is an evolutionary trend toward iron enrichment from pyroxene in the wollastonite-quartz skarn to the pyroxene found in the scheelite-bearing skarn. This tendency toward iron-enriched pyroxenes in the later stages of prograde growth of calcic tungsten-bearing skarn is a common worldwide phenomenon (Einaudi et al., 1981). Stage I wollastonite skarn consists of ferrosalite pyroxene, a calcium-iron pyroxene with a magnesium content of approximately 20 mol% to 30 mol%. The average composition of these pyroxenes is $Hd_{60}Di_{38}Jo_2$. Stage II pyroxene skarn contains abundant hedenbergite, with a slight variation from $Hd_{92}Di_5Jo_3$ to $Hd_{81}Di_{17}Jo_2$. The manganese component (johannsenite) of these pyroxenes is low, below 5 mol%. The presence of abundant hedenbergite pyroxene and grossular garnet suggests formation occurred in a reduced environment, since oxidized skarns typically produce magnesium-rich pyroxenes and garnets (Kwak, 1994). Scheelite analysis revealed a very low powellite composition, below 1 wt.% molybdenum, further suggesting a reduced environment.

Three main stages of vein paragenesis were recognized and postdate skarn formation. Stage III veins consist of quartz-scheelite-clinopyroxene ± K-feldspar ± calcite ± sphene ± biotite. The veins are typically only a centimetre wide and contribute less than 10% of the total veining in the skarn deposit. They contain coarse-grained, subhedral scheelite, and lack amphibole and visible alteration selvages (Fig. 6c). These veins are commonly found within pyroxene skarn units, and the intergrown nature of pyroxene and scheelite in some of these veins suggests they may have been part of the main pyroxene skarn formation. These veins crosscut granodiorite intrusive

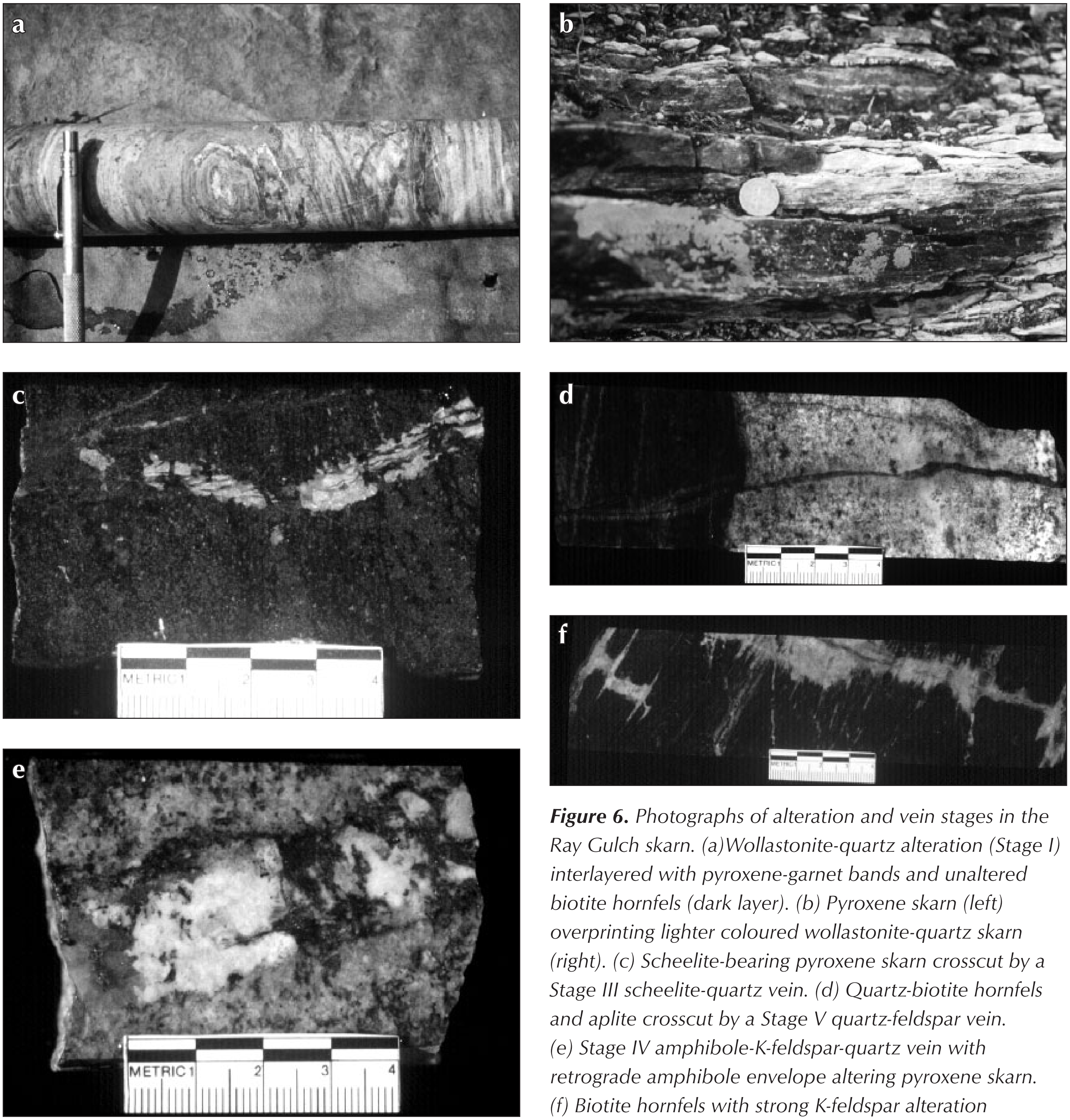

Figure 6. *Photographs of alteration and vein stages in the Ray Gulch skarn. (a)Wollastonite-quartz alteration (Stage I) interlayered with pyroxene-garnet bands and unaltered biotite hornfels (dark layer). (b) Pyroxene skarn (left) overprinting lighter coloured wollastonite-quartz skarn (right). (c) Scheelite-bearing pyroxene skarn crosscut by a Stage III scheelite-quartz vein. (d) Quartz-biotite hornfels and aplite crosscut by a Stage V quartz-feldspar vein. (e) Stage IV amphibole-K-feldspar-quartz vein with retrograde amphibole envelope altering pyroxene skarn. (f) Biotite hornfels with strong K-feldspar alteration envelope (± fine molybdenite flakes) around a Stage V quartz-feldspar vein.*

units, but not the aplitic dyke units. Aplitic dykes distinctly crosscut the pyroxene skarn stages and do not show any alteration equivalent to endoskarn in the granodiorite. The emplacement of these aplitic dykes was followed by late stage (Stage IV and Stage V) veining events (Fig. 6d).

Stage IV consists of quartz-amphibole (hornblende, actinolite, and ferrohastingsite)-calcite ± plagioclase ± K-feldspar ± biotite ± sphene ± epidote ± chlorite ± minor molybdenite ± pyrrhotite (Fig. 6e). The most common appearance of this vein type is as sheeted veinlets cutting both pyroxene skarn and wollastonite skarn, and more rarely granodiorite and aplite. They have a strong amphibole alteration selvage that locally extends for more than a few millimetres into the host rock. Although there is scant recorded large-scale retrograde alteration, this stage represents the majority of the hydrous minerals found in the skarn. Abundant actinolite crystals occur in veins, while ferrohastingsite and hornblende are associated with the alteration of clinopyroxene grains around the crosscutting veins. This vein style contributes approximately 20 to 30% of total vein types in the deposit.

Stage V consists of quartz-K-feldspar ± calcite ± epidote ± chlorite ± sphene ± pyrrhotite ± molybdenite ± arsenopyrite ± pyrite ± chalcopyrite. The majority of Stage V veins are entirely composed of quartz-feldspar. Molybdenite is common in quartz-calcite veins that have a strong feldspathic alteration selvage (Fig. 6f). This stage of veining is the most predominant in the skarn deposit, making up approximately 60 to 70% of veins found in the skarn. The veins range in width from a few millimetres up to 5 cm. The veins crosscut all units within the deposit, but are most abundant in the intrusive units. Although strong feldspar alteration selvages typically accompany these veins, only minor sericite alteration occurs where veins crosscut granodiorite and aplite units. The quartz-feldspar-rich veins that cut hornfels units display the most intense selvage development, commonly replacing biotite-rich lenses up to 2 cm away from the vein. Sulphide minerals are rare and confined to vein assemblages, with the exception of pyrrhotite, which is found in biotite-rich lenses in hornfels and as minor infill in veins. The overall sulphide content of the skarn is in the order of 1% to 2%.

GEOCHEMISTRY

Geochemical analysis was undertaken to assess the overall metal composition, especially gold and bismuth contents of the various units (Table 1). Unaltered host rocks displayed very low metal content, gold was below detection, and tungsten no greater than 3 ppm. This is substantiated by a lithogeochemical study of the area by Gleeson and Boyle (1977) that reported the average tungsten content of the area as approximately 2 ppm, similar to host units found at MacTung (1-3 ppm) and Scheelite Dome (2 ppm). Igneous rock samples returned metal values generally below 100 ppm. Unaltered granodiorite samples from within Ray Gulch were typically barren of any tungsten mineralization. However, analysis of granodiorite from the Eagle Zone displayed an apparent enrichment of tungsten (average 160 ppm from nine samples). Both the wollastonite-quartz skarn and pyroxene skarn had low to below-detection results for most metals. In the past, only selected samples of core from Ray Gulch had been analysed for gold, with preliminary results indicating that the skarn contained no significant amounts of gold mineralization. Lennan (1983) mentions scattered quartz-arsenopyrite veins in core and outcrop that assayed between 2 and 30 g/t Au, which are perhaps genetically related to the sheeted vein complex found at the Eagle Zone. Recent analysis confirms the low gold results; the highest was 148 ppb Au from a quartz vein in a sample of pyroxene skarn that also returned a value of 400 ppm W. Pyroxene skarn returned values between 9.7 ppb and 38.1 ppb Au; other units were below detection. Gold deposits within the Tombstone gold belt (British Columbia and Yukon Chamber of Mines, 2000) have been found to have a strong correlation with bismuth. Gold in the Eagle Zone occurs as free grains with molybdenite, lead-bismuth sulphosalts, galena and bismuthinite (Maloof et al. 2001). Bismuth was very low in all samples analysed from the Ray Gulch skarn, consistent with the low to below-detection gold values.

DISCUSSION

The Ray Gulch tungsten deposit is one of many tungsten skarns in the Yukon Territory associated with mid-Cretaceous intrusions. The Ray Gulch deposit likely formed early in the magmatic-metasomatic history of the Dublin Gulch area (Fig. 5). The abundance of veins in the skarn is minor when compared to that in the Eagle Zone. Veins in the skarn deposit comprise less than 10% of total units observed in drill core and are rarely more than 1 cm thick.

Table 1. *Lithogeochemical data (by Neutron Activation Analysis) for a variety of samples collected around the Ray Gulch tungsten skarn.*

Sample description	Ag	As	Au (ppb)	Ba	Ca (%)	Co	Cr	Fe (%)	La	Mo	Sb	Sn	Te	Th	W	Zn	Zr	Bi
wollastonite skarn	-5	5.21	-5	706	14.2	9.71	171	2.91	36.4	-5	0.54	-500	-5	17.8	-2	117	-500	0.9
granodiorite with quartz vein	-5	5	-5	688	3.22	2.74	214	1.14	32.1	-5	0.68	-500	-5	19.8	-2	-100	-500	0.97
quartz-amphibole-feldspar vein	-5	-5	148	-800	3.42	3.57	362	2.43	20.3	-20	1.3	-1000	-10	1.95	21,400	-100	910	1.03
aplite with quartz vein	-5	-1	-5	604	2.94	-1	208	0.32	23.1	-5	0.57	-500	-5	13.4	3.89	-100	-500	1.09
granodiorite	-5	3.01	-5	-100	8.03	3.37	156	2.1	50	-10	0.86	-500	-5	20.4	-2	-100	-500	1.03
aplite with quartz vein	-5	2.84	-5	-100	2.96	-1	245	0.33	4.37	-10	4.64	-500	-5	24.3	2.49	-100	-500	1.09
quartz-pyroxene-feldspar vein	-5	-15	-50	-2000	11	-1	79.5	4.29	25.7	-40	-5	-2000	-20	-2	100,000	-100	-3000	1.08
quartz vein in pyroxene skarn	-5	-1	-5	185	-1	1.93	750	0.76	0.66	-10	-0.2	-500	-5	-0.5	1130	-100	-500	1.02
quartz-pyroxene vein in granodiorite	-5	2.99	-5	-100	1.27	1.34	478	0.57	5.89	-5	0.79	-500	-5	1.94	62	-100	-500	1.03
granodiorite with quartz vein	-5	4	-5	1720	4.62	7.34	168	2.81	58.1	-10	0.8	-500	-5	24.3	4.84	133	-500	1.05
biotite hornfels	-5	1.71	-5	708	1.46	6.61	192	2.19	37.2	-5	0.65	-500	-5	17	-2	-100	-500	1.09
quartz vein in hornfels	-5	3.03	-5	105	1.58	1.69	521	0.7	9.15	5.9	0.42	-500	-5	4.68	92.6	-100	-500	1.09
endoskarn with quartz vein	-5	4.71	-5	138	14.8	21.1	111	9.43	43.7	-10	0.85	-500	-5	30.7	16.2	171	-500	1.05
biotite hornfels	-5	4.3	-5	880	1.49	10.5	224	3.19	55.4	-5	0.35	-500	-5	20.4	11.5	116	-500	0.96
biotite hornfels with quartz vein	-5	14.4	-5	974	1.02	12.2	193	3.77	63.5	6	0.47	-500	-5	23.4	-2	-100	-500	0.99
pyroxene skarn with quartz vein	-5	-10	-20	-1000	10.9	20.8	65.2	9.48	23.5	86.4	3.1	-1500	-15	-2	48,100	-100	2350	1.04
pyroxene skarn	-5	-10	-20	-1000	10.1	25.1	83.7	10.7	47.1	60.4	4.41	-1500	-15	2.56	46,300	-100	1640	1.02
pyroxene skarn	-5	-5	-15	-500	9.35	7.43	132	3.84	87.6	27.6	1.65	-500	-10	8.49	13,200	-100	586	1.09
pyroxene skarn with amphibole veins	-5	3.28	-5	-200	18.4	33.1	54.2	17.7	17.2	8.3	0.69	-500	-5	7.15	816	225	-500	0.96
pyroxene skarn with amphibole veins	-5	2.11	-10	-500	12.6	18.2	75.1	9.35	39.5	20	0.54	-500	-5	12.2	2550	-100	520	~
pyroxene skarn	-5	2.63	12.6	316	12.5	37.5	38.2	8.84	41.9	-5	0.56	-500	-5	13.8	214	105	-500	~
limestone	-5	1.52	-5	174	37.2	2.9	9.1	0.29	5.48	-5	0.27	-500	-5	2.32	26.5	-100	-500	~
limestone	-5	1.84	-5	160	34.8	6.12	7.5	0.54	6.82	-5	-0.2	-500	-5	2.07	61.9	-100	-500	~
wollastonite skarn	-5	1.4	-5	426	9.3	24.8	26.3	0.95	15.5	6.2	0.29	-500	-5	6.4	334	-100	-500	~
pyroxene skarn	-5	-1	-5	475	12.8	50.1	-5	16.2	0.58	68.6	-0.2	-500	-5	-0.5	3450	126	-1000	~
pyroxene skarn	-5	-2	38.1	3130	10.3	29	-10	10.8	35.7	171	4.86	-1000	-10	-2	24,400	-100	-5000	~
pyroxene skarn	-5	3.53	-5	716	11.6	33.7	62.8	8.52	41.8	24.2	0.47	-500	-5	13.5	1300	115	-500	~
pyroxene skarn	-5	1.65	-5	370	15.8	40	17.3	16.6	17.7	40.3	0.48	-500	-5	2.58	2010	107	-500	~
pyroxene skarn	-5	3.82	-5	237	14.3	42.7	65.1	9.68	49.2	-5	0.78	-500	-5	17.4	258	307	-500	~
pyroxene skarn	-5	1.37	9.7	-100	15.1	33.8	37.4	15.1	28.3	11.9	0.45	-500	-5	9.15	665	194	-500	~

Notes

- Au is ppb, Fe and Ca are in wt %; all other results are in ppm.
- Negative number indicates values below detection limits.

In the Eagle Zone, veins are 0.5 to 10 cm wide and vein densities range from <1 to >20 per metre with an average of 5 per metre. The veins, which developed along sheeted east-trending fracture zones, comprise early quartz-K-feldspar-scheelite with later calcite-muscovite ± molybdenite ± galena ± sphalerite ± Pb-Bi-Sb-sulphosalts ± gold ± bismuthinite (Maloof, et al., 2001). Significantly, the gold-bearing veins in the Eagle Zone that cut early quartz-feldspar-scheelite veins are lacking in the Ray Gulch skarn. This explains the low gold and bismuth content in the latter.

This study has established that the tungsten mineralization was temporally and spatially separate from, and occurred earlier than gold-bismuth mineralization in this system, even though it is likely that the mineralizing fluids evolved from a similar magmatic source. Other gold-tungsten occurrences need to be carefully evaluated in light of this data with a special emphasis on the timing and spatial distribution of gold and tungsten, and controls on fluid pathways and precipitation sites.

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