THE POTENTIAL FOR EMERALDS IN B.C. - A PRELIMINARY OVERVIEW

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INTRODUCTION

Discoveries of chromium-rich emerald at Regal Ridge in south-central Yukon, vanadium-rich emerald at Lened near the Yukon/N.W.T. border (Groat *et al*. 2002) has raised interest in the emerald potential of British Columbia and transparent gem exploration in general.

This report reviews associations of beryl, deposit models for chrome-rich beryl (emerald), and the common association of emerald with phlogopite schists. It examines a few areas of interest in B.C. based on a preliminary emerald potential map and literature review. A fieldwork component is focused on several beryl occurrences. Descriptions of three properties are appended and their location shown in figure 1. Examination of the Hellroaring pegmatite stock provided an opportunity to produce an updated map and to determine gem potential within this large target. The Omg claims at Laib Creek illustrate a prospecting success in revisiting old beryl showings. Dortatelle is in a geologic setting which appears conducive to emerald formation but there is no documentation of the showing since its discovery and brief description in the 1940s.

Figure 1: Location of field visits (Omg claims, Hellroaring Creek pegmatite, Dortatelle Creek)

Three weeks were spent in the field in August with the writer returning in October to augment mapping at Hellroaring Creek. A map of the Hellroaring Creek pegmatite body is included in this report. Funding was made available from the BC & Yukon Chamber of Mines, Rocks to Riches Program.

BERYL AND BERYLLIUM

Mulligan (1968) provides an overview of beryllium in Canada while Pell (1990) discusses the geologic setting of beryllium mineralisation in British Columbia. Burt (1982) provides an overview of the minerals of beryllium. Walton (1996) provides an excellent introduction to exploration criteria for emeralds.

Beryl or beryllium aluminum silicate ($Be_3Al_2Si_6O_{18}$) is a hard (7.5 to 8 on Moh scale), resistant mineral, often recognized due to faces of hexagonal prisms that project from the weathered skin of outcrops. It is the most common beryllium mineral in British Columbia. Other Be-bearing minerals in B.C. include the sulphosilicates danalite and helvite, as well as the yttrium bearing gadolinite. Most beryllium minerals are silicates and associated with other lithophile elements and metals such as tungsten, molybdenum, tin, uranium, niobium and tantalum.

Beryl tends to microfracturing and crystal fragments are typically the material found in the light fraction of stream sediments. Beryl, with a specific gravity close to rock forming silicates such as quartz and feldspar has apparently been recognized in placers. Unreferenced locations for beryl include Quesnel River and 111 Mile Creek in the Lillooet District (Mulligan 1966).

Gem-quality beryl is given different names based on color. Thus aquamarine is light-blue, heliodor (yellow-green), morganite (pink), emerald (green), and bixbite is red. Either chrome or vanadium may provide the deep green of emerald.

The variation in color is due to trace element substitutions (for example iron for aluminum). Some ions do not substitute in the framework atoms but occur in the middle of Si-O rings that are stacked parallel to the c-axis of the crystal. These "channel" ions may also affect the color. The oxidation state is also important. Ferric ions give rise to yellow, and ferrous ions in channels give rise to blue hues respectively. Combinations of the two are responsible for the many shades of sea green in aquamarine. Compositional zoning radial or normal to the c-axis can affect the overall hue and result in color banding.

B.C. EXPLORATION WORK

Beryl has received little prospecting attention in the province. It has traditionally been reported as a minor note of interest in geologic reports. A comparison of MINFILE with localities mentioned in a review of transparent gemstone (Wilson, 1997) also shows a proprietary dataset is available to gemologists and mineral collectors.

The regional distribution of beryl is poorly known. There is no regional stream sediment data on beryllium with which to evaluate the distribution of its most common mineral. By way of example, Brinck and Hofmann (1964) provide results of a regional stream sediment assessment for beryllium in Norway.

There are few exploration reports specific to gem beryl. Gauthier and Dixon (1997) working on the Anglo-Swiss claim block in the Slocan area describe beryl pegmatite and gem-corundum exploration targets. Their work followed discovery of aquamarine beryl in vugs in pegmatite (B.Q. claims) during logging operations at Passmore in the early 1990s. Discoveries of gem corundum and cordierite followed. A growing variety of gemstones including iolite, sapphire, garnet and aquamarine have been identified in the Slocan area.

Holland (1956) first described beryl showings from Ingenika Group metasediments cut by pegmatite dikes in the Horseranch area east of Cassiar. The mapping of ultramafics in the area Gabrielse (1963), Plint (1991) eventually led Wilson (1997) and Simandl and Wilson (1998) to prospect for emeralds where these pegmatites cut ultramafic rocks both near the original showing (Cassiar beryl: MINFILE # 104P 024) and at an ultramafic body near Harvey Lake to the north. Six new showings were found in the Harvey Lake area. Aquamarine occurs in simple and zoned pegmatites which carry garnet and tourmaline. Emerald was not found, in spite of pegmatite cutting chrome bearing ultramafic rocks. Simandl and Wilson (1998) concluded hydrothermal activity and structural preparation (shearing) to facilitate fluid interaction was lacking.

Wilson (1997) reported poorly formed vanadian emerald is associated with the Red Mountain porphyry deposit near Stewart but information is minimal.

Beryl has also been evaluated as a potential source of beryllium metal. Recent evaluations include reports on the Hellroaring and Matthew Creek stocks (Anderson 2001, Soloviev 2001) and the wolframite-fluorite-beryl quartz veins peripheral to the Logtung deposit (Wengzynowski 1999). Beryl occurs in the main stockwork of tungsten-molybdenum mineralisation at Logtung. The stockwork has been known for some time but a separate halo of veins was found several kilometers to the south on the B.C. side of the border. The beryl is described as cloudy blue and up to 4 centimetres in length (see Mihalynuk article, this volume). Transparent (uncolored?) crystals up to 2 cm are also found in vugs with quartz.

Recent prospecting efforts in the Bayonne magmatic suite of southern B.C. has led to a number of new beryl localities (Blue Hammer, Omg claims). Jarrod Brown describes them in detail in this volume. The gem quality of beryl at various sites along the margins of the White Creek and Bayonne batholith (Shaw Creek phase) is still under evaluation by Eagle Plains Resources and Cream Minerals Limited.

The number of beryl occurrences in the province is estimated to stand at about 34; 8 new occurrences found in the last few years and 26 listed in MINFILE. Each occurrence may include several showings in proximity to each other.

There are additional reports of beryl or beryllium mineralisation which are not documented in MINFILE or in Wilson (1997). These three are derived from a Ministry industrial minerals file.

NTS 82M/6W Adams Lake

- (51 24 119 24): green crystal of beryl (1 inch diameter) in mica pegmatite near north end of Adams Lake is reported by unknown contact person at B.C. Ministry of Environment.

NTS 103I/16E Massa

- (54 58 128 10): gadolinite identified by x-ray diffraction from sample originating on Massa claims (map 2, ARIS report 8467).

NTS 93G/9 George Creek

- (53 35.4, 122 20): Light-green beryl with garnet and smoky quartz in pegmatite dikes reported in ARIS report 22365.

GEOLOGIC ASSOCIATIONS OF BERYL

Beryl is often associated with granitic intrusives that carry fluxing agents (boron, fluorine, phosphorus). Such magma is less viscous, persists to lower temperatures and later stages of magma differentiation before crystallization. Compositionally these volatile granites are usually peraluminous, mica and alkali feldspar rich, varying in composition from leucocratic granite (alaskite) to quartz syenite and quartz monzonites. They form in continental settings. The suite includes some peralkaline varieties that may carry sodic amphiboles and form in continental but extensional environments. The volatile granites are associated with mineralisation that may include tin, tungsten, molybdenum, uranium, thorium, niobium, tantalum, yttrium and rare earth elements. They are sometimes distinguished as fluorine-rich topaz (specialty) granites or as tourmaline granites. Pell (1990) tended to restrict the volatile-rich granites to the topaz granites of the Surprise Lake and Parallel Creek batholiths. However, tourmaline granites (with minor fluorite) are relatively common in B.C. and if not strictly "specialty" granites by all criteria they are certainly volatile-enhanced.

Griesen is a late stage, mica-rich, mineral assemblage which occurs with fluorine minerals and quartz along fractures in volatile granites and/or country rocks. Lithium micas (lepidolite, zinnwaldite) and tourmaline are also common in griesen. Although griesen has similarities to porphyry style phyllic (sericitic) alteration it is a coarse grained alteration which overlaps pegmatitic and hydrothermal stages of magma crystallization.

Near surface (epizonal) volatile granites, related pegmatites and griesen commonly contain miarolitic cavities. The better examples of gem aquamarines in B.C. are those crystals which line miarolitic cavities. Miarolitic granites are mentioned with fair frequency in B.C. geologic literature.

Apophyses of the larger bodies, smaller intrusions peripheral to larger batholithic bodies and unroofed cupolas may be enriched in beryl.

The volatile granites are more or less equivalent to the "fertile" granites that are parental to rare element pegmatites. Beryl is associated both with the LCT (Li-Cs-Ta) and NYT (Nb-Y-Ta) families of rare-element pegmatites that arise from fractionation of "fertile granites". In these families high field-strength elements (those with small radius but appreciable charge), such as niobium, tantalum, tin, tungsten, beryllium, respond in similar fashion to complex trends of fractionation and may be concentrated together with soluble alkali metals such as lithium, rubidium and cesium. The NYF family tends to be associated with alkaline rocks. Beryl may also be found in simple pegmatites though its gem varieties may be restricted.

DEPOSIT MODELS FOR EMERALD

Two broad types of emerald deposits are recognised worldwide (Schwarz, D. and Guilani, G. (2001). The first relates to the direct and local intrusion of granitic pegmatites within chromium and vanadium-bearing mafic and ultramafic rocks, sediments and metasediments. The second, rather broad in geologic setting (shales, low and high grade metasediments, greenstones, listwanites, suture zones), is linked to thrusts, faults and shear zones. Extended periods of fluid circulation in structurally permeable zones bring Be and Cr/V elements together from source rocks that may be far removed from each other. The common factor to both categories is the exchange of critical elements. In the case of the Columbian deposits the host shales are also the source of both beryllium and chromium (Banks et al., 2000).

Simandl (1999) provides some detailed summaries for emerald deposit types, including schist-hosted emeralds.

EMERALD AND AQUAMARINE

Although exploration for aquamarines may also lead to the discovery of emerald, exploration programs for aquamarine and emerald require slightly differing strategies. Aquamarine has a primary relationship to pegmatites in which the coloring agent (iron) is geochemically abundant.

The relationship of emerald to pegmatite is more indirect. The elemental exchange required for emerald formation tends to occur in the vanadium or chrome bearing wallrock and not the host intrusion (granite or pegmatite). As Cerny (1991) pointed out, hybridization of pegmatites by reaction with wall rocks is very limited. Studies by London (1995) also indicates pegmatites are essentially solidified prior to loss of fluids to wallrocks. This also minimizes opportunity for element exchange in the pegmatite itself. A review of literature does indicate a few examples of emerald in pegmatite. One example is the Australian Emerald Mine near Emmaville in New South Wales. Emeralds occur as 'bunches' in a solid quartz-topaz-mica pegmatite. In another example (Pezzota and Simmons 2001) describe emerald at pegmatite margins forming due to intense wallrock reaction (a kind of endoskarn effect?). On the other hand all Brazilian deposits are schist hosted and associated with K-metasomatism (Guilani et al., 1990).

PHLOGOPITE SCHISTS

The most common host to emerald is phlogopite schist derived from alteration or metamorphism of ultramafics. These are also described as blackwall schists, or glimmerites or phlogopitites.

In a typical example (Franqueira granite pegmatite in Spain) pegmatite cuts a dunite resulting in the formation of emerald-bearing phlogopitite near the pegmatite and tremolite bodies and an anthophyllite rim close to dunite (Fuertes-Fuente et al., 2000). Given that most ultramafics are not potassic, phlogopitite comprising upwards of 75% phlogopite $KMg_3AlSi_3O_{10}$ $(F,OH)_2$ represents potassium metasomatism. It may also represent fluorine metasomatism as fluorine often substitutes for the hydroxyl ion.

The development of phlogopite schists can be considered as part of a griesen assemblage which develops adjacent to volatile granites. According to Siems (1984) griesenisation of ultramafic rocks lead to olivine, pyroxene and amphibole altering to serpentine, phlogopite, talc and chlorite. Alteration minerals are enriched in fluorine, boron and the alkali metals.

Phlogopite schists are not mentioned in descriptions of altered ultramafic rocks in B.C. The usual description (e.g. in Ash, 2000) is listwanites, serpentinites, talc, magnesite, and mica-rich zones of mariposite/fuchsite. Possibly the postulated phlogopite schists are not specifically related to mineral deposits described. They may also be overlooked since the reaction zone at the contact of a small target, such as a beryllium bearing pegmatite, may be less than a metre wide.

Prospective ultramafics in B.C. should show signs of being affected by fluids from mid Cretaceous or later volatile granites. These signs may include high fluorine in water or sediment, presence of minerals such as sericite, fuchsite and tourmaline, phlogopite and other micas that may be sinks for volatile elements. Searching for combinations of serpentinite and fluorite or ultramafic and tourmaline in MINFILE does provide a few hits of interest.

Such prospective associations are supported by the association of emeralds in Pakistan with listwanites, occurring with greenish fuchsite and chrome-rich dravite tourmaline in talc-chlorite schists (Arif, Fallick and Moon 1996).

A YUKON PERSPECTIVE

The Regal Ridge emerald prospect, in the Finlayson district of the Yukon, occurs in mica schists within a metavolcanic unit that is underlain by ultramafics. Both form the roof to an underlying Cretaceous pluton that is part of the mid-Cretaceous Anvil suite. The emerald is found in quartz veins enveloped by tourmaline zones. Groat et al. (2002) note that the prospect is enriched in tungsten (scheelite) and several tungsten skarns are associated with the Anvil suite. The emeralds form in a halo of quartz veining and alteration which extends from the roof of the granite.

The Regal Ridge showing suggests B.C. has potential for emeralds within the veneers of ultramafic rocks and metavolcanics underlain by volatile granites.

Phlogopite schist and skarn host the Lened showing. The phlogopite schist interestingly represents the alteration of adjacent black shales and not ultramafics. Emeralds are found in the quartz veins which cut the skarn (Falck, 2003) and also apparently within the phlogopite schist (Groat et al., 2002). The showing is near tungsten mineralisation within a two-mica pluton, a member of the Selwyn suite. The Lened showing indicates Road River Group shales may be prospective in B.C.

EMERALD POTENTIAL MAP

The emerald potential map is based on the concept that intersects of volatile granites and ultramafics offer the most prospective target for emeralds in B.C. Ultramafics are known to be chrome-bearing and are generally well defined in areal extent. Phlogopite schists, related to ultramafics, are the most common host for emeralds worldwide and thus offer the best opportunity for exploration success. Mineral pathfinders can be drawn from MINFILE and include beryl, other beryllium bearing minerals, fluorite, tourmaline, tungsten, tin, niobium, pegmatite, and chromite. Molybdenum was omitted as it provides a wide scatter and the relationship to tungsten is similar and is geochemically more direct. Very few MINFILE occurrences (3) record lithium minerals such as lepidolite and spodumene. Symbols were chosen that would nest within each other so that sets of association are more easily displayed. Intrusives were subdivided by age. At present only Cretaceous and younger intrusions are plotted, as well as Proterozoic age intrusions related to miogeoclinal rocks at the margin of ancestral North America.

The main area of interest is the Omineca belt which is underlain by continental crust fragments welded by post collisional plutonic suites of a continental magmatic arc that extends along a 1600 kilometre belt into the Yukon. Logan (2002, 2002a) describes intrusive-related metallogenic characteristics of this belt.

In British Columbia dismembered ophiolitic assemblages are present in the Cassiar, Manson, Barkerville and Greenwood-Rossland areas (Ash, 2000). These are the displaced and eroded remnants of the oceanic Slide Mountain terrain.

Discrete ultramafic bodies form a relatively small part of these large klippe-like areas within the Omineca belt. There are nevertheless several juxtapositions of ultramafic bodies and volatile-bearing granites evident on the emerald potential map. Several of these are in areas of little exploration activity. One surprise in the East Kootenays is a little known ultramafic body cut by a border phase of the beryl prospective White Creek batholith.

Though the Atlin area lies in the Intermontane belt it is included as it represents a major intersect of ultramafic rocks of the Cache Creek terrain and mid Cretaceous intrusives.

Areas further to the west also appear to be locally prospective on the basis of associations of beryl, tungsten and tin. Pell (1990) in fact suggested volatile-rich granites might be found anywhere Sr87/86 ratios exceeded 0.704. However they are outside the scope and focus of the present overview.

The areas touched upon in this report include Surprise Lake batholith and the Cassiar batholith near the Yukon border (Figure 2). This area of interest expands on the area described as a potential beryl/emerald camp straddling the B.C./Yukon border (Neufeld et al., 2002, figure 1).

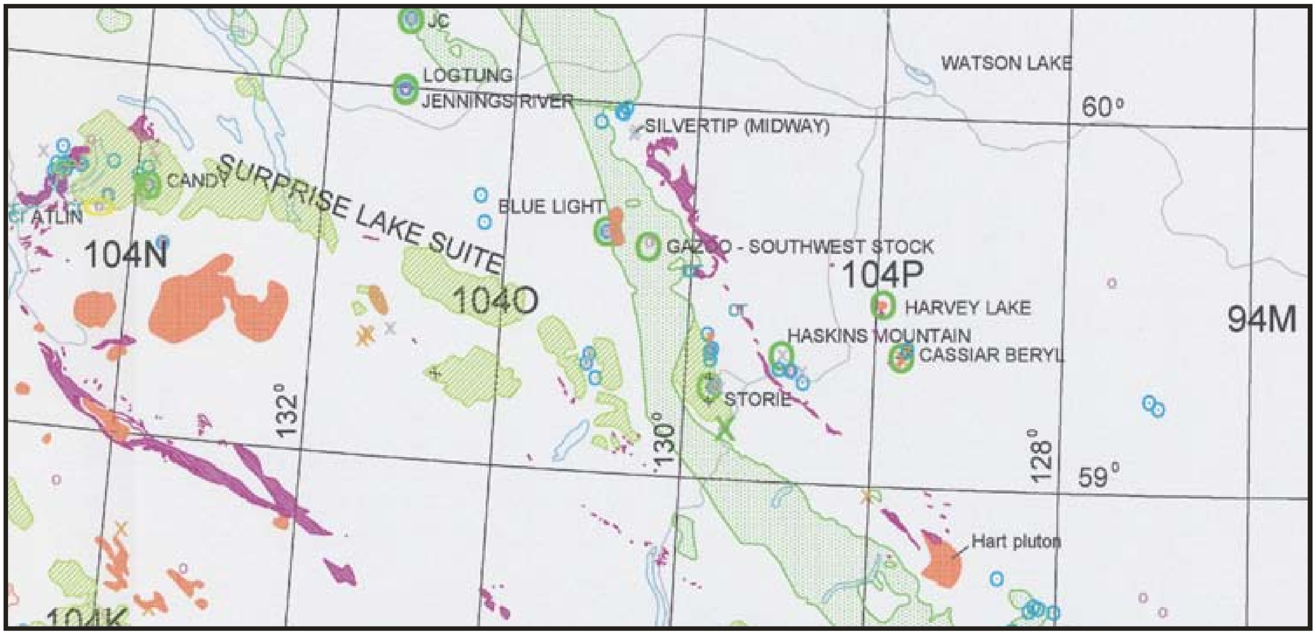
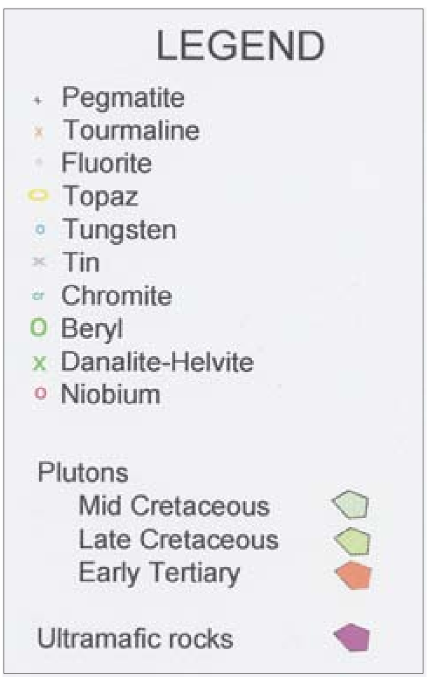


Figure 2: Northern Portion of Emerald Potential Map (NTS 104N, 104O, 104P)



SURPRISE LAKE BATHOLITH

The Surprise Lake batholith is an equigranular and miarolitic alaskite of Late Cretaceous age. It is host to numerous showings that include tungsten, tin and fluorite. The volatile character of the intrusion is evidenced by the presence of up to 15 % topaz in sheared alaskite at the southern contact of the intrusion (MINFILE 104N 086 Dixie). According to Littlejohn and Ballantyne (1982) an F-rich phase deposited Li-mica, cassiterite, beryl, wolframite, fluorite, arsenopyrite and columbite-tantalite in small pods within roof rocks.

The Surprise Lake batholith intersects ultramafic bodies that are part of Cache Creek ophiolitic complex on its north and west margins. Many large ultramafic roof pendants are also present and are outlined in a map of the batholith (Bloodgood et al., 1989). There are several ultramafic bodies that also border the separate body known as the Mt. Leonard stock. In terms of a griesen model for emeralds there are associations of fluorite with serpentinite and tin/tungsten mineralisation at the south end of the Leonard stock (for example MINFILE 104N 069 Silver Diamond) that merit ground re-examination for beryl.

Beryl is found in the vicinity of Mt. Weir. The area is near the apex of the batholith. Showings include:

- Beryl-quartz veins associated with wolframite or molybdenite-bearing host rocks near Zenazie Creek north of Mt Weir.
- Beryl with fluorite and sphalerite in mafic dikes cutting alaskite near Caribou Creek (Schroeter, 1978).
- Danalite in mafic dikes northeast flank of Mt. Weir (Schroeter ibid).

Gem topaz and beryl in miarolitic cavities in the area reported by Wilson (1997) may be related to the Surprise Lake batholith or a peripheral body.

The Mt. Leonard alaskite hosts a tungsten-molybdenum deposit (Adanac). Any distal wolframite-quartz veins on the periphery of the Adanac porphyry should be scrutinized for beryl. If this halo of veins extends to areas of ultramafic exposure, chrome beryl may be present.

Ballantyne and Littlejohn (1982) mention the lack of a pegmatite phase associated with the Surprise Lake batholith. Some references in Christopher (1980) and MINFILE 104N 066 (Candy) do indicate local pegmatite development and thus rare element pegmatite of the LCT or NYT class may be present together with beryl.

NORTHERN CASSIAR BATHOLITH

This batholith varies from granodiorite to granite in composition and is principally of mid-Cretaceous age.

The intrusive phases of interest for beryl are known as the young Cassiar granites and are of Late Cretaceous age. They are principally peripheral bodies (Kuhn, Lamb Mountain, Contact) or internal phases (Storie, Troutline) that are fluorine-rich, with associated tungsten and molybdenum mineralisation, as well some silver-lead-zinc veins (Bradford and Godwin 1988). Some are known to carry beryl. For example, Pantaleyev (1980) reports rare vuggy quartz veins with green beryl associated with quartz porphyries at the Storie molybdenum deposit. Beryl with quartz veins is also associated with a late quartz monzonite stock intruding the main batholith at Toozaza Creek (Kyba, 1978). There is some pegmatite here as well.

POSSIBLE EXPLORATION TARGETS

A cryptic intrusion, a member of this suite, is invoked as responsible for fluorine-rich, sericitic alteration in Sylvester rocks near the Midway deposit and the presence of topaz-bearing quartz porphyry dikes at the deeper levels of the deposit (Bradford and Godwin, 1987). The interpretation of an intrusive body is supported by aeromagnetic surveys. In the presence of Be-bearing solutions the large alteration halo in Sylvester roof rocks may include a griesen-style emerald deposit. This is an obvious target for ground scrutiny, including baseline stream sediment sampling for beryllium.

The Eocene Mount Haskin and Mount Reed stocks cut Cassiar platformal rocks but are near the Sylvester contact. They are bordered by skarns and reported to carry beryllium minerals (personal communication D. Hora). Tourmaline coats fractures of the leucogranite of Mount Haskin stock and fluorite with phlogopite, molybdenite and scheelite is noted at Mt Reed. Any signs of Eocene intrusive activity in Sylvester rocks immediately to the west should be investigated.

Further to the south in the Cry Lake sheet much of the Sylvester allocthon is in direct contact with batholithic Cassiar rocks. In this area the leucocratic Hart pluton of Eocene age cuts ultramafics of the allochthon and fluorite is noted at the contact (Gabrielse 1998).

Gabrielse (1963, p. 88) mentions granite-pegmatite dikes with quartz, muscovite, potash feldspar, biotite, minor tourmaline and garnet cutting metamorphosed rocks of the Sylvester Group northwest of Blue River. They should be examined to further assess distribution, mineralogy and contact effects.

PART 2: FIELDWORK RESULTS

HELLROARING CREEK BODY

GEOLOGIC SETTING

The Hellroaring Creek pegmatite is an intrusion of middle Proterozoic age (1365 +- 3 Ma, J. Mortensen, unpublished data) that outcrops on a ridge between Hellroaring and Angus Creeks, about 4 kilometers south of St. Mary Lake and 18 km southwest of the town of Kimberley B.C. The intrusive body, up to 1000 metres wide and about 4 kilometres long is oriented along a northwest axis. It intrudes a Lower Aldridge sequence of rusty siltstones with abundant sills of Moyie gabbro (Figure 3). The east-striking St. Mary fault extends across Angus Creek and truncates the south end of the intrusion. A 50-foot- wide exposure of massive quartz is probably a vein that plugs the fault. The St. Mary fault is offset by an acute angled fault such that pegmatite reappears to the south, separated from the northern mass by a fault wedge of Creston Formation. The pegmatite is then truncated again by the continuation of the St. Mary fault.

The intrusion lies at the core of a faulted domal structure and sediments and Moyie sill dip away from the intrusion on its flanks.

The northeast flank of the intrusion is linear and marked in one exposure by a quartz vein at least 4 metres wide in sharp but undulating contact with pegmatite. The vein is believed to plug a fault. A sequence of faults is interpreted to define a down-dropped block on the northeast flank.

In the northwest corner the intrusive contact of the main body dips steeply at about 60 degrees and is bordered by a series of moderately dipping sills within Aldridge sediment. Similar relationships are seen elsewhere on the flanks of the main body.

The trace of the main pegmatite on the southwest flank varies from conformable to crosscutting relationships with the host sequence of Moyie sills and Aldridge sediment. Bedding dips and cleavage development suggest folding in Aldridge sediments. The trace of the contact is subparallel to axial plane cleavage.

The contact on the eastern flank of the body has a large indentation. Moyie Sill outcrops within this "embayment" and there is a v-shaped area of Aldridge sediments dipping at moderate to high angles. Pegmatite

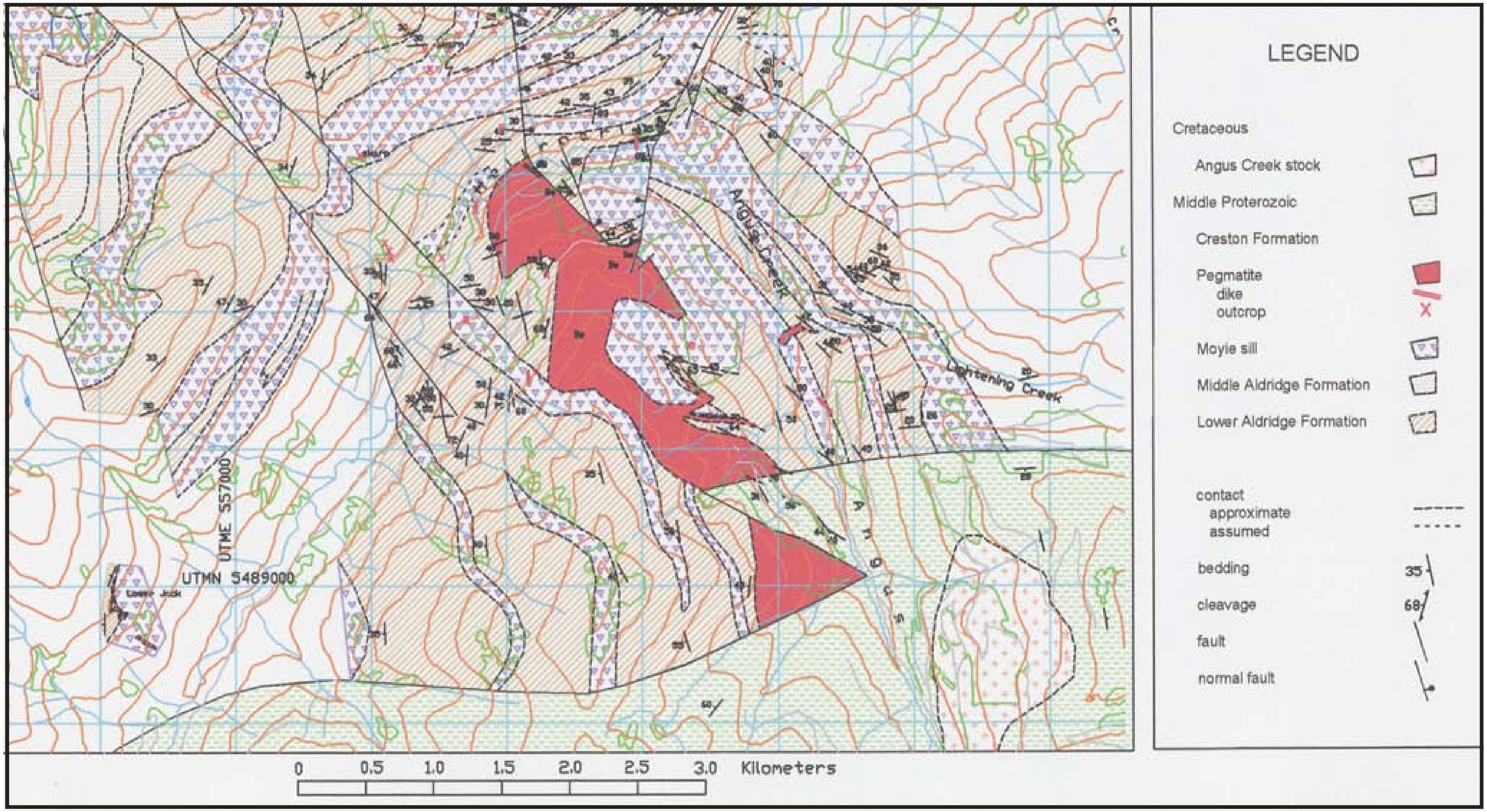


Figure 3: Geology Map, Hellroaring Creek pegmatite.

sills and wide dikes cut the sequence. The dikes probably connect to the main body of the pegmatite. The embayment suggests a roof zone but the metamorphic effects are less than would be expected in a roof zone. More work is required to define the geometry. One geometric hypothesis is the presence of a steeply plunging fold.

SATELLITIC BODIES

Scattered small dikes and sills occur up to three kilometers from the main body but their extent and orientation is unclear due to poor exposure. A few have been traced for several hundred metres. A small "plug" is only partially exhumed along a tributary to Angus Creek (Lightening Creek). In the valley walls a lower "bench" of pegmatite is mantled by contorted and schistose Aldridge Formation.

Small folds immediately adjacent to dikes appear to be related to intrusion and plastic deformation of wallrock.

Pegmatites are bordered by either Aldridge sediments or Moyie sills. Some pegmatites have clearly intruded along the contact between sills and Lower Aldridge sediments.

There is insufficient data to deduce if there is a geometric pattern to the distribution of dikes and sills.

COMPOSITION

The Hellroaring pegmatite is composed of albite, microcline, quartz, muscovite, tourmaline with very minor garnet and beryl. Most of the main body is alaskite granite with hypidiomorphic granular texture. Concentrations and aggregates of muscovite, tourmaline and quartz occur locally. Tourmaline is commonly developed in wall rocks immediately adjacent to pegmatite. The fabric of the pegmatite may be locally complex with varying intergrowth fabrics, local mineral aggregates, coarser crosscutting pegmatitic phases, irregular quartz veins and masses. Stockscheider fabric (minerals oriented normal to cooling margins) is evident at some dike margins, borders of rafted metasediments, and internal to the pegmatite.

The main body does is not strongly zoned as the same principal mineral phases appear in various parts of the main body but in different proportions. White (1987) suggested a microcline-rich graphic granite phase dominates the north end of the body. Although it dominates a few outcrop areas graphic granite does not form a distinctive body. Whole-rock analytical data (Na2O and K2O) does suggest a separation of albitic and potassic phases in the intrusion.

Grain size varies in a striking manner. Muscovite books up to 20 cm across are seen in the Lightening Creek body and quartz and feldspar crystals of the same size occur in a large outcrop area on the northwest side of the main pegmatite body. Tourmaline occurs as large globular masses, also as needle rosettes, and isolated large barrel crystals.

Some pegmatites exhibit microbrecciation together with fine greenish sericite alteration. Others show weak foliation and augen feldspars in a texture of cataclasis.

Quartz veins bordered by thin pegmatite possibly plug minor faults near the contact of Moyie sills and Aldridge sediments.

A small area of skarn adjacent to a pegmatite sill is present on the north side of Hellroaring creek. It is rich in garnet with grey wollastonite. Fluorescence under UV suggests the presence of scheelite. Other skarns, possibly forming a northern arc, are noted in Anderson (1999).

BERYL IN THE HELLROARING CREEK BODY

Beryl occurs as sparse clusters of hexagonal prisms or as single crystals in the northern part of the Hellroaring Creek body. Crystals about a cm wide and 5 or more centimeters long are typical. A 15 cm long dihexagonal crystal is exposed in a pegmatite on the northwest side of the main body. The crystal is white with a very pale patchy bluish hue. Elsewhere very pale whitish-green crystals occur as well as crystals which are more or less translucent. Completely opaque crystals are common.

Photo 1: Large crystal of beryl imbedded in Hellroaring Creek pegmatite; pencil for scale.

Two sills peripheral to the Matthew Creek body and a distal sill (Lower Jack) to the main Hellroaring body are enriched in beryl. The Lower Jack pegmatite has a quartz core and is poor in tourmaline. Pale beryl (1 by 5 cm) occurs with quartz and coarse booklets of mica near the enlargement of the sill and its quartz core. Beryl in a sill peripheral to the Matthew Creek pegmatite occurs in an encrusting quartz-poor phase that mantles deformed schistose rafts of Aldridge sediments near the base of the sill. The beryl crystals form a crude arc above the raft. Simple prisms are present with rounded terminations and some crystals appear corroded against matrix.

The beryl of the Hellroaring Creek body is not of gem quality. However, it is not uniformly opaque either and shows variations in crystal development, size, hue and translucence. There is a small potential to discover gem beryl.

LAIB CREEK

The area of the OMG claims on the west side of Kootenay Lake corresponds to an apohysis of the Bayonne batholith that extends up Laib Creek valley and is not shown on the regional map of Reesor (1996). A few days were spent in the area tracing an intrusive-sediment contact on the claims. The main showing consists of the face of a large boulder with beryl crystals in random orientations. The crystal encrusted face may represent one wall of an original fissure vein. The matching wall may be present in other nearby plucked boulders in the lee of an outcrop knob (roche moutonee). The beryl crystals are greenish blue with many hairline fractures. A candy-strip banding normal to the crystal axis is evident with opaque bands and translucent bands alternating.

Elsewhere bluish beryl crystals are widely scattered within a white muscovite granite and crosscutting coarser pegmatite. The pegmatite may contain crystal masses of quartz and mica up to 25 cm diametre. The density of beryl crystals is extremely low, on the order of one per tens of metres in the muscovite granite. Often smoky quartz is associated with this phase and a bit of garnet occurs as small euhedral crystals. In the area of interest muscovite granite contains blocks of biotite granodiorite but also grades into this phase.

Host rocks are metasediments of the Proterozoic La France Group. These vary from phyllitic to schistose shales to more medium bedded quartzose sandstones. A few mafic sills occur in the sediments and they may be the source of a few amphibolitic rafts in the granite.

Traversing from valley floor upwards onto valley slopes the transition is from intrusive rock with abundant raft material into lit par lit alterations of granite and sediments and then into sediment. The Omg claims cover an area where an apophysis of the main batholith is apparently unroofed and exposed along the valley bottom.

The general presence of disseminated beryl in the Bayonne batholith is encouraging. Further work in this area should look for and prospect small satellite intrusions within the sediments outside the main batholith.

DORTATELLE CREEK

The site was visited to examine its emerald potential within juxtaposed volatile granites and chrome bearing ultramafics. The ultramafics are part of a chain of Alaskan ultramafic complexes on the east side of the Intermontane belt near the Ingenika fault. Potential volatile granites include the Davie Creek (Kliyul) molybdenum bearing body found a few miles to the east (MINFILE # 094D 113). It may be Cretaceous in age. The Dortatelle showing is described as hosted in a pegmatite block in moraine (Lord, 1948). Pegmatites are inferred to outcrop nearby and other showings of molybdenite and chromite are noted in the vicinity. Abundant white quartz blocks with molybdenite, and pink granitic debris were located within the moraine. Nearby exposures of serpentinised ultramafics contain chrome mica. The granitic debris is sparse and in strong color contrast to the overwhelming dominance of Takla greenstone and ampibolite in moraine aprons and ridges. No granite or pegmatite outcrops occur in the valley despite abundant outcrop exposures in glacial valley walls and creek ravines. The beryl-bearing block mentioned in the report (Lord, 1948) was not found. This is perhaps not surprising given the extensive boulder fields that comprise moraine aprons and ridges.

The train of granitic debris upslope in the moraine tongue suggests a source from glacial ice that overrode the ridge (or a source that underlies the remnant glacier and obscures bedrock). A traverse was conducted into the adjacent valley into an area of granitic outcrop behind the glacier. Stream sediment samples were taken and submitted for analysis.

Analytical results show very low values of beryllium are present. The conclusion is that the source of beryl mineralisation is not local to the valley.

SUMMARY AND CONCLUSIONS

Beryl is an under-prospected mineral in B.C. Exploration for emerald may complement re-evaluation of alteration halos of granophile tungsten-molybdenum prospects in the vicinity of ultramafic bodies. The Yukon discoveries suggests tungsten showings in the vicinity of ultramafic bodies at Horseranch Range and elsewhere should be revisited.

Exploration for emerald requires a different strategy than aquamarine as it depends on wall rock for an immediate source of chromium or vanadium.

The intersection of ultramafics and volatile granites, together with pathfinder elements, on an emerald exploration map suggests prospecting targets. Discoveries of phlogopite schist zones peripheral to small tourmaline or fluorine-bearing granitic bodies or pegmatite are of prime interest. Griesen alteration of ultramafics, presence of tourmaline, sericite, margarite or fuchsite in altered ultramafics or high fluorine in waters draining areas of ultramafic rocks may be a lead to emeralds, particularly if stream sediment analysis can also demonstrate elevated values of beryllium.

The light coarse fraction of stream sediment in placer areas near altered ultramafics and potassic Cretaceous granites should be examined for beryl.

Field examinations were completed at the Hellroaring Creek, Laib and Dortatelle Creek localities. The Laib occurrence deserves further work. The Hellroaring Creek body is judged to have low potential to discover gem beryl. Further work is necessary to establish if the source of Lord's 1948 pegmatite block can be located.

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