

Burrell Creek Map Area: Setting of the Franklin Mining Camp, Southeastern British Columbia (NTS 082E/09)

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Introduction

The Burrell Creek project includes geological mapping and data compilation of a large part of the 1:50 000 scale Burrell Creek map area (NTS 82E/09), located in the Columbia Mountains of southeastern British Columbia (Figure 1). The project is a northward extension of the Deer Park (Höy, 2010; Höy and Jackaman, 2010) and Grand Forks (Höy and Jackaman, 2005) mapping projects, which focused on the potential and controls of Tertiary mineralization within the southern Monashee Mountains in the Pentiction (east half) map area (NTS 082E, east half). These projects recognized and defined a variety of base- and precious-metal occurrences that appear to be related to prominent north- and northwest-trending regional structures. The Burrell Creek project focused mainly on a mafic intrusive complex that hosts deposits in the historical Franklin mining camp, and recognized and mapped a similar deeper level intrusive complex to the east in the footwall of the Granby extensional fault. Dating of both these complexes, in progress through a contract with the University of British Columbia (UBC), may allow insights into role of Tertiary extension in the development of the camp and further controls on the displacement along a major Eocene extensional fault.

Project Objectives and Results

The project involves mainly geological mapping, at a scale of 1:20 000, of selected areas of the Burrell Creek map area. It also includes compilation in digital format of all regional geological and geophysical data, geochemical data collected under the National Geochemical Reconnaissance (NGR) program and the BC Regional Geochemical Survey (RGS), and update of the MINFILE BC database (BC Geological Survey, 2012b). This information will be combined to produce a 1:50 000 scale map of the Burrell Creek map area, as well as 1:20 000 scale maps of areas with higher

mineral potential suitable for directing and focusing mineral exploration.

An important focus of the project is mapping and evaluation of Tertiary faulting and magmatic activity, and their relationship to mineralization. Results are summarized in this paper and in published maps (Höy and Jackaman, 2010). A final 1:50 000 scale map will be released by Geoscience BC in early 2013.

Geological and Exploration History

The Burrell Creek map area (Figure 1) is part of the Kettle Valley area (NTS 082E, east half), which was mapped at a scale of 1 inch to 4 miles (approximately 1:253 000) by Little (1957). More recently, Tempelman-Kluit (1989) mapped and compiled the Pentiction area (NTS 082E) at a scale of 1:250 000, making only minor modifications in the eastern part in the Burrell Creek area. The geology of the two 1:50 000 areas to the south, Grand Forks and Deer Park, was recently published by Höy and Jackaman (2005, 2010), based on new mapping and on compilation of previous studies, most notably by Preto (1970), Tempelman-Kluit (1989), Acton et al. (2002) and Laberge and Pattison (2007). The Greenwood mining camp, located immediately west of the Grand Forks area, has been studied in considerable detail, initially by Little (1979) and more recently by Church (1986) and Fyles (1990). Mapping east of the Burrell Creek area includes the regional study of the Lardeau (west half) area by Little (1960) and, farther southeast, more detailed geological mapping of the Rosslund and Nelson areas (Höy and Dunne, 2001, 2004). Recent geological mapping has focused on areas to the north (NTS 082L; Thompson, 2006) and several isolated areas in the western part of the Pentiction map area by the BC Geological Survey (Massey, 2006, 2007, 2010; Massey and Duffy, 2008; Massey et al., 2010).

Mineral exploration, focused largely in the south, dates back to the mid- to late 1800s, with discovery and development of rich gold and copper deposits in the Greenwood and Rosslund mining camps, as well as the building of smelters in Greenwood, Grand Forks and Trail. This area, referred to as the Boundary district, continues to be actively explored by several junior exploration companies and, in the Republic district of Washington State, has had recent

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gold production from Kinross Gold Corporation's Emmanuel Creek and Buckhorn deposits.

Mineralization in the Franklin mining camp, located in the southern part of the Burrell Creek map area, was discovered in the early 1900s (Drysdale, 1915). The only significant deposit in the camp, the Union mine, produced 122 555 tonnes grading 14.1 g/tonne Au and 353.4 g/tonne Ag, primarily in the early 1930s. The most recent exploration in the camp, included soil sampling, geological mapping and prospecting by Tuxedo Resources Ltd. in 2001–2004 (Caron, 2004) and rock sampling, trenching and limited diamond-drilling by Solitaire Minerals Inc. in 2004 (Caron, 2005).

Regional Geology

The Burrell Creek area is located on the northern extension of the Grand Forks Complex (Preto, 1970), one of a number of metamorphic core complexes in the southern Omineca Belt that appear to be related to Eocene faulting, extension and denudation (Tempelman-Kluit and Parkinson, 1986; Brown and Journeay, 1987; Parrish et al., 1988). The complex is bounded on the west by the west-dipping Granby fault and on the east by the east-dipping Kettle River fault. Normal movements on these faults were determined to be Early Tertiary, constrained by ages of intrusive rocks (Carr et al., 1987; Parrish et al., 1988). A variety of plutonic suites is recognized to the south and west of the Burrell Creek area

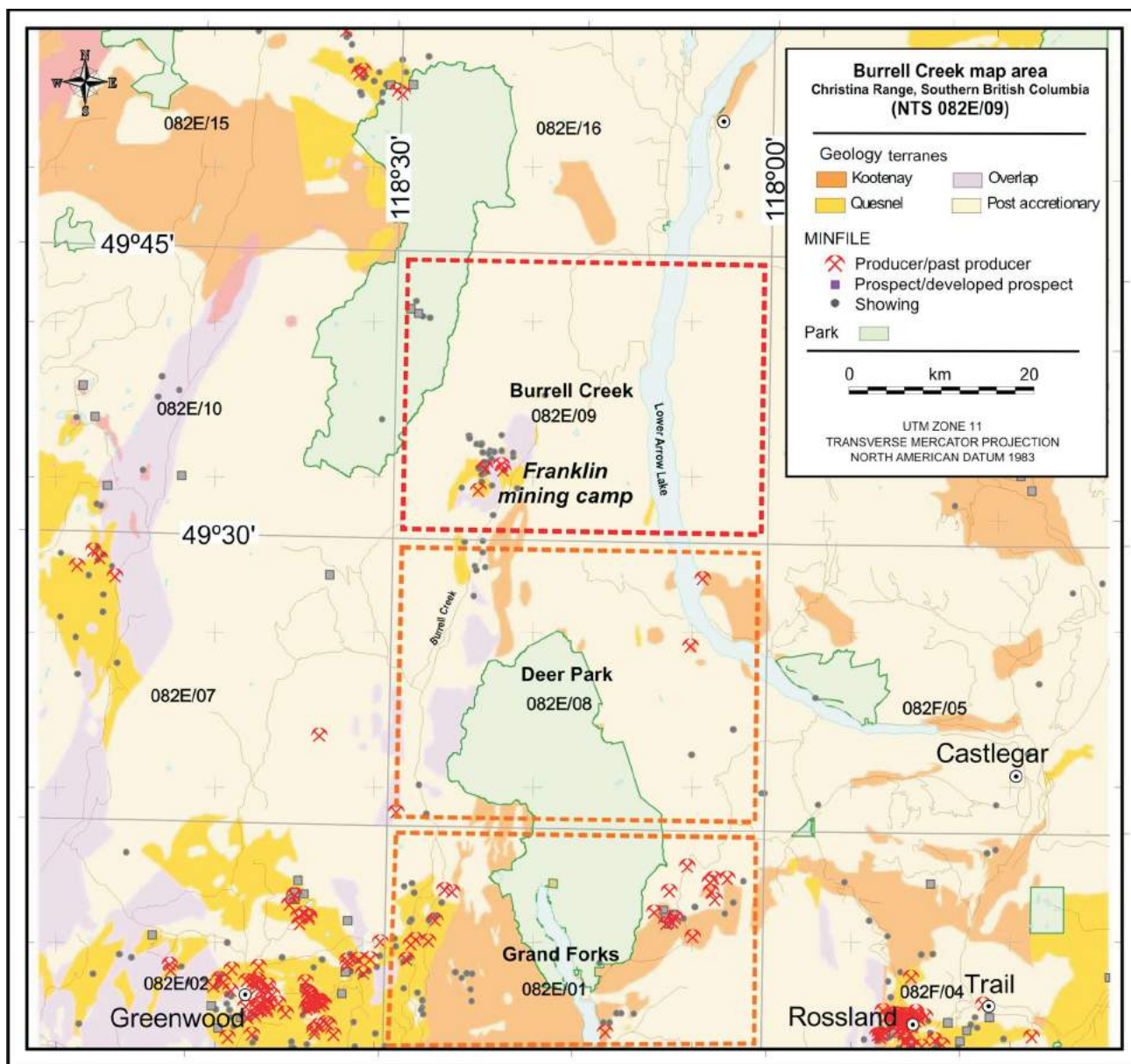


Figure 1. Locations of the 1:50 000 scale Burrell Creek map area (NTS 082E/09), two recently published maps to the south, BC MINFILE occurrences, mining camps and major lithological units in the southern Monashee Mountains and Okanagan Highlands of southeastern British Columbia. Modified from BC MapPlace (BC Geological Survey, 2012a).

(Little, 1957; Tempelman-Kluit, 1989), most notably Middle Jurassic 'Nelson' granodiorite, Cretaceous granite and Eocene 'Coryell' syenite.

Geology of the Burrell Creek Map Area

Introduction

The Burrell Creek map area is underlain mainly by Middle Jurassic, Cretaceous and Early Eocene intrusive rocks (Figure 2). In the vicinity of the Franklin mining camp, these intrude Late Paleozoic metasedimentary and metavolcanic rocks and are unconformably overlain by Eocene coarse-grained sedimentary rocks and volcanic rocks of the Kettle River and Marron formations. The structure of the area is dominated by north-trending, steep to relatively shallow dipping normal faults, including the inferred northern extensions of the Kettle River fault in the southeastern part of the area and the Granby fault that extends through the central part of the area to the northern limit of mapping. Virtually all known base- and precious-metal mineral occurrences are in the hangingwalls of these faults. The Union mine in the Franklin mining camp, the largest known metallic-mineral deposit in the area, produced silver, gold, lead and zinc from east-trending polymetallic veins until 1947, followed by heap leaching of tailings that continued to 1989.

Eocene Coryell Intrusions (Unit Ec)

The Coryell intrusions are a Middle Eocene, alkalic to sub-alkalic plutonic suite. They underlie a large part of the Burrell Creek map area, restricted mainly to the area between the Granby and Kettle River faults and north of a north-west-trending structural zone that includes the Franklin mining camp and a parallel fault, the Michaud Creek fault (Figure 2). The intrusions range from coarse-grained pink syenite with generally less than 10% biotite+hornblende to coarse-grained monzonite. Medium-grained and porphyritic phases are locally common, particularly in border zones, in exposures in the immediate hangingwall of the Granby fault and as suites of typically north-trending dikes.

Cretaceous Granite (Unit Kg)

Large exposures of granitic rock occur in the southern part of the Burrell Creek map area and form the axis of the mountain range in the northwestern part. These exposures are part of the Okanagan batholith, a large complex exposed throughout much of the Penticton map area to the west that Tempelman-Kluit (1989) indicated was "Cretaceous and/or Jurassic" in age. They are also similar to granitic rocks farther east, referred to by Little (1960) as the "Valhalla plutonic rocks" and interpreted to be Late Cretaceous by Parrish et al. (1988). They are often difficult to distinguish from granitic phases of the Nelson suite and differentiation of these two suites in the northwestern part of

the area requires more detailed work, including radiometric dating.

Exposures in the Burrell Creek area are mainly medium-grained leucocratic granite with minor (<10%) mafic content. Porphyritic phases, characterized by pink alkali feldspar phenocrysts, are less common. The granite is locally foliated and occasionally banded with pegmatite or more mafic phases.

The granite is typically fresh, although pegmatites, dikes, quartz veining and local brecciation with minor pyrite and jarosite alteration occur near contacts with both Coryell and Middle Jurassic intrusions.

Middle Jurassic Nelson Plutonic Suite (Unit Jgd)

Middle Jurassic granodiorite bodies occur throughout most of the area; unit Jgd includes, in the northern part, younger Cretaceous granite and, elsewhere, small stocks and dikes of Coryell syenite. 'Nelson' granodiorite has not been differentiated, comprising massive granodiorite, quartz diorite and, less commonly, granite. These phases range from massive and equigranular to porphyritic with large, subhedral, beige to pink feldspar phenocrysts in a medium- to coarse-grained granodiorite matrix. In the hangingwall of the Granby fault in the southern part of the map area, exposures are medium grained, more mafic and commonly veined and propylitically altered.

In the Franklin mining camp area, Nelson plutonic rocks intrude late Paleozoic basement metavolcanic and metasedimentary rocks and are unconformably overlain by conglomerate, grit and volcanic rocks of the Eocene Kettle River and Marron formations. As discussed below, their relationship to the Averill Plutonic Complex and associated mineralization is less clear.

Averill Plutonic Complex

Mineralization in the Franklin camp is spatially associated with the Averill Plutonic Complex, a suite of mafic alkalic intrusions that was originally interpreted to be Eocene (Drysedale, 1915) but is now considered to be Jurassic, based largely on a K-Ar date reported in Keep (1989). The complex has been studied in considerable detail by Keep (1989) and Keep and Russell (1988), and the following description is taken mainly from these papers.

The complex comprises five main units, ranging in composition from pyroxenite to syenite, which have been intruded by two dike swarms. The first four members of the suite include "pyroxenite, monzogabbro, monzodiorite and monzonite, and define a concentrically zoned intrusion with pyroxenite at the centre and monzonite at the edge. The fifth member, a syenite, was intruded through the centre of this

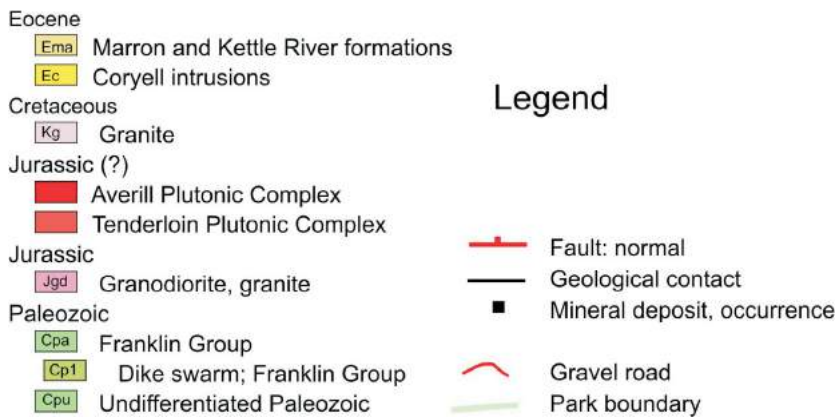
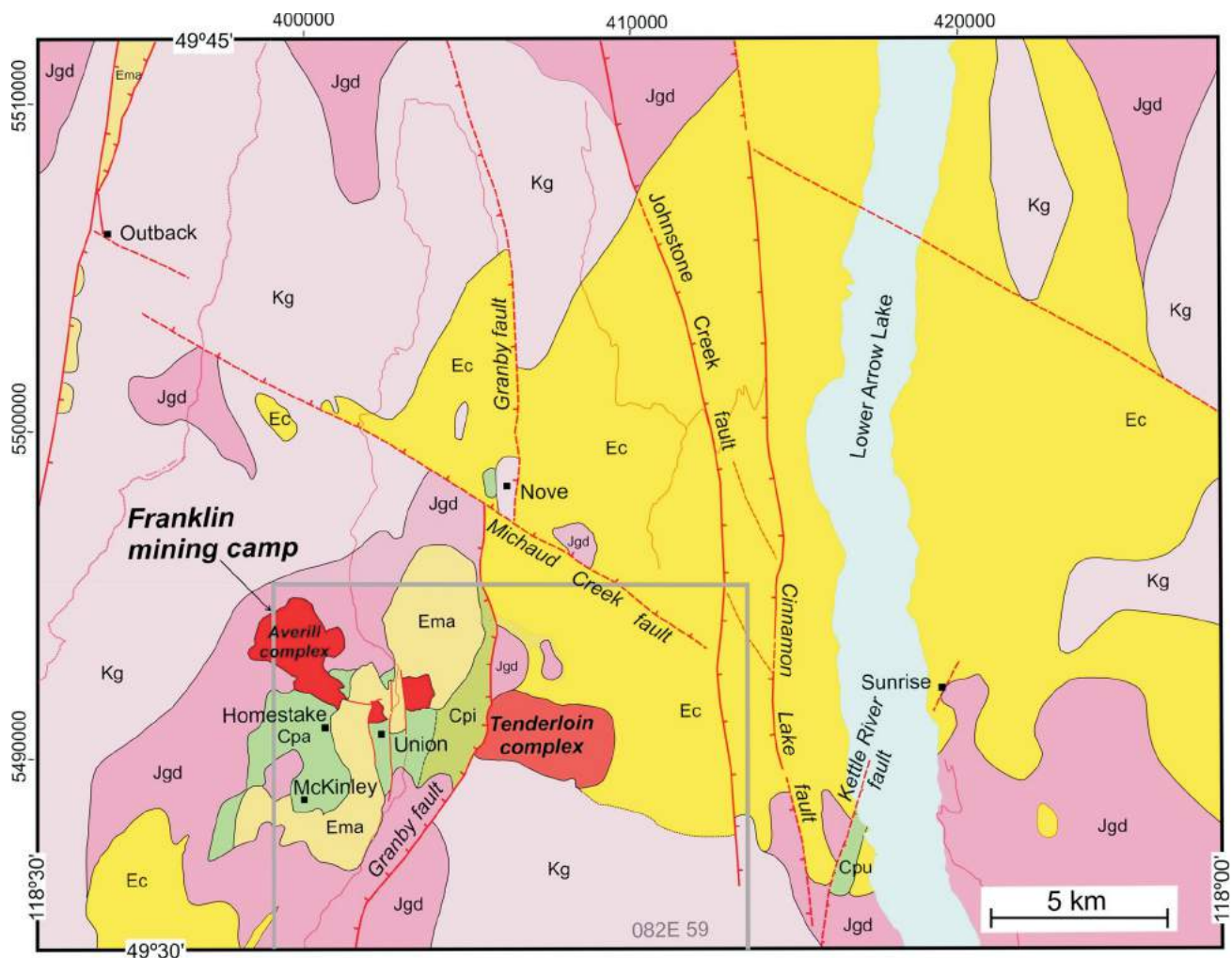


Figure 2. Geology of the Burrell Creek map area (NTS 082E/09), including data from Drysdale (1915), Little (1957), Keep (1989) and Tempelman-Kluit (1989), with selected mineral occurrences.

concentric zonation, causing brecciation of the pyroxenite and monzogabbro” (Keep, 1989).

The pyroxenite (unit Apx; Figure 3) is medium to coarse grained and black, and consists mainly of augite and biotite, with interstitial alkali feldspar and minor sphene and apatite. The mineralogy of the monzogabbro (unit Amg) is

similar to that of the pyroxenite, comprising mainly augite, with hornblende, biotite, alkali feldspar±plagioclase. Monzodiorite, the dominant phase in the complex (unit Amd), is intermediate in composition, comprising mainly augite, biotite, hornblende and alkali feldspar. Monzonite (unit Am), the outermost shell of the zoned Averill Complex, comprises mainly alkali feldspar and plagioclase, with intersti-

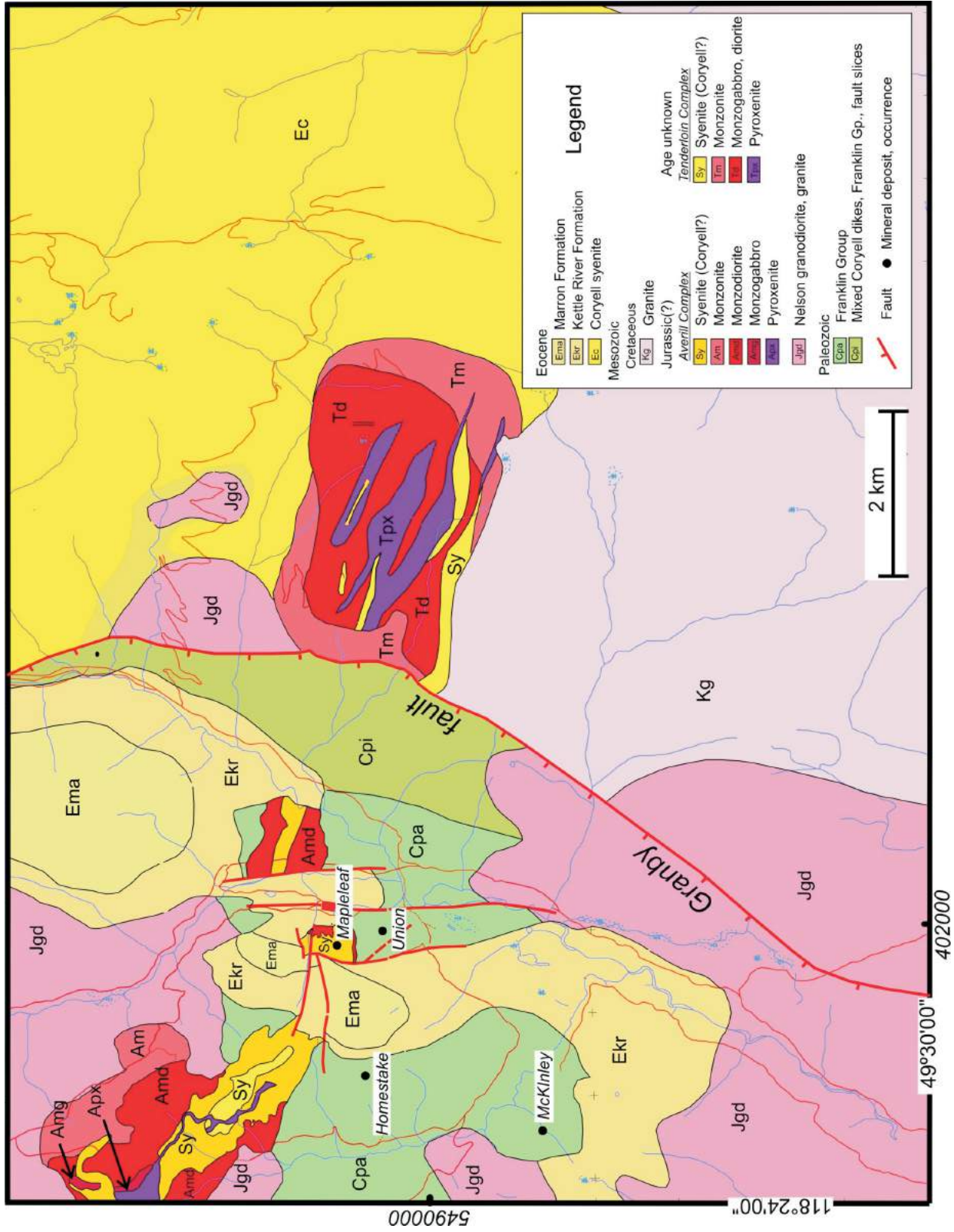


Figure 3. Geology of 1:20 000 scale TRIM map 082E/059 covering the Franklin mining camp, with data from Drysdale (1915), Keep (1989), Tempelman-Kluit (1989) and Caron (2004, 2005); location indicated by grey rectangle on Figure 2.

tial augite and biotite. Based on field, petrographic and whole-rock and trace-element data, Keep (1989) argued convincingly that these phases represent a cogenetic suite. The syenite (unit Sy), however, is distinctive in that it contains no plagioclase and clearly intruded the earlier phases. It is similar in composition to Coryell syenite, and hence may be part of that suite and not the Averill Complex.

Drysdale (1915), based on field relationships and their alkalic composition, proposed that rocks of the Averill Complex were Eocene in age, related to the Coryell Plutonic Suite. However, a sample of pyroxenite, taken from the base of a scree slope, returned a K-Ar date of 150 ± 5 Ma (unpublished data, UBC Geochronology Laboratory; cited in Keep, 1989), indicating a Jurassic age. To further constrain this age and those of other phases of the Averill Complex, five samples have been submitted to the UBC Geochronology Laboratory for Ar-Ar dating.

Tenderloin Plutonic Complex

A lithologically similar intrusive complex, located approximately 6 km east of the Averill Complex, has been mapped during the course of this study and named the 'Tenderloin Plutonic Complex' (Figure 2). Neither petrographic nor geochemical work has been done on it, and the following descriptions and nomenclature are based only on field observations. The complex is roughly concentric with an inner zone of pyroxenite and gabbro, surrounded by monzogabbro, diorite and monzonite (Figure 3). The intrusive complex trends west-northwest, particularly in the western and central parts; foliation and gneissosity within several phases, most notably the marginal monzonite, parallel this trend. Dikes of syenite parallel the west-northwest trend and these, based on crosscutting relationships and petrology, may be part of the Coryell suite. All phases are relatively fresh, with only minor alteration of augite to hornblende and chlorite.

The pyroxenite (unit Tpx) forms several east-northeast-trending lenses that appear to pinch out to the east near the margins of the complex. The pyroxenite is typically black, comprising mainly medium- to coarse-grained augite and biotite with up to 10% plagioclase (Figure 4). The monzogabbro and diorite (unit Td) appear to be gradational with the pyroxenite, containing mainly augite, biotite and up to approximately 50% plagioclase. The unit is coarse to medium grained and commonly cut by thin alkali feldspar veins (Figure 5). It forms the bulk of the Tenderloin Complex.

A marginal phase (unit Tm), comprising mainly monzonite but grading to quartz monzonite and monzodiorite, surrounds the more mafic phases of the Tenderloin Complex. It typically contains 10–25% mafic minerals, mainly augite, hornblende and biotite, in a matrix of plagioclase, minor alkali feldspar and occasional minor quartz. Exposures



Figure 4. Massive medium-grained pyroxenite of the Tenderloin Complex.

on the northwestern margin of the complex commonly show foliation textures and mineral segregations that are highly variable but generally approximately parallel to the margins of the intrusion and are assumed to be primary flow banding. Similar but north-trending fabrics occur within the monzonite unit on the eastern margin of the complex. In both localities, several syenite dikes, ranging from a few tens of centimetres to several metres thick, cut the monzonite, oriented parallel to the fabric.

Syenite (unit Sy) occurs as large east-trending dikes within the central and southern parts of the complex, cutting the more mafic phases; in eastern exposures, syenite dikes that cut monzonite trend more northerly parallel to the contact with the Coryell syenite. In the western exposures, large slabs of syenite, ranging from several to tens of metres thick, trend northerly; sheared contacts with the monzonite suggest that these are fault slabs related to the Granby fault.

The Tenderloin Complex has many similarities to the Averill Complex, including composition, zoning, its age relative to syenite and its west to northwest orientation (Figure 3). The Averill Complex is assumed to be Jurassic



Figure 5. Monzogabbro of the Tenderloin Complex, showing thin crosscutting alkali feldspar and plagioclase veins; width of main vein approximately 2 cm.

in age, based on a single 150 Ma K-Ar date on pyroxenite. The age of the Tenderloin Complex is not known, but five samples of monzogabbro and monzonite have been submitted to the Pacific Centre for Isotopic and Geochemical Research at UBC for Ar-Ar dating; these data and the new data from the Averill Complex will enable better comparisons between the two.

Late Paleozoic Succession (Unit CPa)

Metasedimentary and metavolcanic rocks, exposed in the Franklin camp area, comprise mafic volcanics, argillite, siltstone and minor limestone and chert. A number of veins and mineralized skarns in the camp are hosted by these rocks. Rocks of unit CPa are commonly tightly folded, silicified, fractured and veined, and cut by dikes of various ages. Farther east, in the immediate hangingwall of the Granby fault, these rocks (unit Cpi, Figures 2, 3) are intruded by numerous Coryell dikes that are locally sheared and intensely silicified or alkali feldspar altered.

These successions, named the Franklin Group by Drysdale (1915), have been correlated with the Carboniferous to Permian Anarchist Group and are similar to Paleozoic exposures described as Knob Hill in the Greenwood area (Church, 1986; Fyles, 1990; Massey, 2006) and rocks assigned to the Paleozoic Anarchist Group in the McKinney mining camp, located 40 km southwest of the Franklin camp (Massey and Duffy, 2008). However, Caron (2004) correlated the Franklin Group with the Triassic Brooklyn Formation in the Greenwood mining camp; until definite dating or rock geochemistry is done, a correlation with older Paleozoic rocks is assumed.

Eocene Kettle River Formation (Unit Ekr)

The Kettle River Formation comprises up to several hundred metres of conglomerate and feldspathic grit with rare plant fossil material and numerous sedimentary structures, including crossbedding, ripple marks and small scours (Drysdale, 1915). These structures and the coarse massive conglomerate facies indicate shallow-water and alluvial-fan deposition. Clasts and 'grit' within the formation were largely derived from the underlying Franklin Group but also include clasts derived from the Averill Complex (Caron, 2005) and from tuffaceous and flow rhyolite deposited contemporaneously with the sediments (Drysdale, 1915). The attitude of the Kettle River Formation is variable but generally dips to the northeast at angles up to 45°, indicating that some block faulting occurred either contemporaneously with or following deposition. It is overlain, locally unconformably, by andesitic and trachytic flows of the Marron Formation.

Eocene Marron Formation (Unit Ema)

The 'Midway volcanic group' caps Tenderloin Mountain and Mount McKinley mountains immediately north and

south of the Franklin camp area (Figure 3). The volcanic rocks vary in composition from alkalic basalt to trachyte, and range from well-banded basic tuff and blocky tephra to flows (Drysdale, 1915). They are correlated with the Marron Formation, which is exposed in grabens and depressions to the west in the Penticton map area (Tempelman-Kluit, 1989).

Structure

The structure of the Burrell Creek area is dominated by north- and northwest-trending normal faults that record a period of Tertiary extension in southern BC. These faults played a role in the distribution of both intrusive bodies and mineralization in the map area and in the Boundary district to the west and southwest. The Granby and Kettle River faults (Little, 1957; Preto, 1970) bound the high-grade Grand Forks Complex; these faults extend northward into the Deer Park area and the southern part of the Burrell Creek area (Tempelman-Kluit, 1989; Höy and Jackaman, 2010). Detailed structural and metamorphic studies of both hangingwall and footwall rocks suggest that depth contrasts reach approximately 5 km across both the Granby (Lalonde and Pattison, 2007) and Kettle River faults (Cubley and Pattison, 2009).

Granby Fault

The Granby fault is a west-dipping normal fault that, throughout most of its length, has truncated Coryell intrusive rocks in its hangingwall, and high-grade metamorphic rocks of the Grand Forks Complex in its footwall in the south and mainly Jurassic and Cretaceous intrusions farther north. In the southern part of the Burrell Creek area (Figure 2), late Paleozoic rocks of the Franklin Group, Middle Jurassic granodiorite and Tertiary sedimentary and volcanic rocks of the Kettle River and Marron formations occur in the hangingwall, with mainly Cretaceous granite, Coryell syenite and the Tenderloin Plutonic Complex in the footwall. Farther north, in the central part of the map area, Coryell rocks occur in the hangingwall, but these are typically finer grained, commonly porphyritic and cut by numerous dikes in contrast to the more massive and coarser grained syenite in the footwall. The fault is a high-level brittle structure, marked by brecciation, locally intense chloritic alteration and, east of the Franklin camp, numerous parallel splays that produce a wide zone of interlayered Coryell syenite, Paleozoic metavolcanic rocks and monzonite of the Tenderloin Complex.

The displacement along the fault in the Burrell Creek area is not known. Correlative Coryell rocks clearly show marked differences across the fault, with finer grained porphyritic phases, dikes and pervasive alteration in the hangingwall contrasting with coarser, more massive phases to the east. The fault is younger than the ca. 51 Ma Coryell syenite and

Middle Eocene Marron Formation volcanic rocks (Parrish et al., 1988; Carr and Parkinson, 1989).

Kettle River Fault

The Kettle River fault is shown on all regional maps as truncated by the Coryell intrusions in the central part of the Deer Park map area (Parrish et al., 1988; Tempelman-Kluit, 1989). Based on more recent studies, it has been projected northward through the Deer Park area into the southern part of the Burrell Creek map area (Höy and Jackaman, 2010). It is inferred to be exposed in the southeastern part of the area, where it juxtaposes Paleozoic metavolcanic and metasedimentary rocks in its hangingwall with Coryell and Middle Jurassic intrusive rocks in the footwall (Figure 2). On the east side of Lower Arrow Lake and on strike with the inferred trace of the fault is a zone of high-level shearing and brecciation associated with epithermal-style gold mineralization on the Sunrise property.

Johnstone Creek and Cinnamon Lake Faults

The Johnstone Creek and Cinnamon Lake faults, two newly recognized north-trending structures, were mapped in the southern part of the Burrell Creek area and projected northward the length of the map area along prominent topographic linears and truncation of map units (Figure 2). Both are late, post-Coryell, high-level brittle faults that are locally marked by brecciation, shearing and chloritic alteration. Normal displacement along these is restricted to a few hundred metres.

Northwest-Trending Structures

The Averill and Tenderloin complexes are on a west-northwest-trending 'structural zone' in the southern part of the Burrell Creek map area (Figure 2). The zone is marked by preferred orientations of intrusive bodies and the northern limit of a Cretaceous intrusion. The only exposures of Paleozoic rocks in the map area occur within this zone in the hangingwalls of the Granby and Kettle River faults, and the northerly orientation of the Granby fault is deflected to the northeast within the zone. The zone is inferred to be the locus of an older structural zone that controlled, in part, the distribution of intrusive complexes and mineralization in the Burrell Creek map area, as well as the distribution of intrusions and regional structures to the northwest in the Penticton map area. Although there is little evidence of large-scale Eocene faulting within the zone, several faults in the Franklin camp, with tens to a few hundred metres of offset, are recognized (Figure 3). In addition, approximately 5 km to the north, the northwest-trending Michaud Creek fault cuts Eocene Coryell intrusions.

The Michaud Creek fault is a north-dipping normal fault that trends northwesterly through the central part of the map area. It is marked by topographic linears and offset of Coryell, Middle Jurassic and Cretaceous intrusive rocks.

Veins of the Nove mineral occurrence (MINFILE 092ENE045) are in its immediate hangingwall, and the Sunrise occurrence (Kennedy, 2005) is located near the intersection of the northern extension of the Kettle River fault and the approximate southeastward projection of the Michaud Creek fault (Figure 2).

Mineralization

The focus of the present study is mainly on the structural controls and timing of mineralization in the Franklin mining camp and their implications for the regional distribution and controls of base- and precious-metal deposits in the eastern part of the Penticton map area. The Franklin camp is located in the southwestern part of the Burrell Creek map area, and several other vein occurrences are known throughout the remainder of the area. Mineralization in the camp, summarized below, is taken from detailed studies by Drysdale (1915) and from more recent provincial-government assessment reports, including Pinsent and Cannon (1988) and Caron (2004, 2005).

Drysdale (1915) and subsequent workers recognized three styles of mineralization in the camp; in addition, Caron (2004, 2005) recognized Eocene epithermal mineralization. The four styles are

- 1) small lenses of magnetite-, pyrrhotite-, chalcopyrite- and/or arsenopyrite-bearing skarns in altered and brecciated Franklin Group metavolcanic and metasedimentary rocks adjacent to Jurassic plutons and the Averill Complex;
- 2) minor platinum, palladium and silver associated with chalcopyrite in pyroxenite and syenite phases of the Averill Complex;
- 3) silver and/or gold mineralization, with or without base-metal mineralization, in silicified shears and faults; this style of mineralization characterizes the Union mine, the main producer in the camp; and
- 4) Eocene epithermal gold mineralization.

Several other areas of mineralization are known in the Burrell Creek map area. The Sunrise property is located on the east side of Lower Arrow Lake along the inferred northern projection of the Kettle River fault (Figure 2). It was discovered in 2004 during a regional prospecting program by Kootenay Gold Inc. (Kennedy, 2005). Mineralization comprises epithermal gold-quartz-chalcedony veins associated with minor pyrite and pyrrhotite in north-trending faults that cut Eocene syenite and Jurassic granodiorite. Mineralization is clearly syn to post Eocene, with veins cutting both Coryell syenite and late alkali feldspar porphyry dikes.

The Nove property occurs in the central part of the map area, immediately north of the Michaud Creek fault (Figure 2). Mineralization comprises anomalous gold and silver associated with minor chalcopyrite, bornite and galena in

veins along the north-trending sheared contact of Coryell syenite and a small Cretaceous(?) granitic stock (Wilkinson, 2001). Several other precious-metal occurrences, referred to as the Outback property (Bohme, 1991), are located on a parallel structure west-northwest of the Nove property. These comprise mainly epithermal gold mineralization related to a complex array of faults near the intersection of the northwest-trending structure and a north-trending Eocene extensional fault. The property is now within Granby Provincial Park.

A number of other small vein occurrences were discovered during the course of this regional mapping project. All comprise quartz veining associated with brecciation, pyrite and considerable limonitic alteration, and all occur along either the north- or northwest-trending faults.

Summary of the Geological History

The oldest rocks in the Burrell Creek area, the Franklin Group, comprise a package of mafic volcanic and sedimentary rocks that were deposited in Late Paleozoic time. These were intruded by mainly calcalkaline granodiorite of the Middle Jurassic Nelson plutonic suite. A variety of mineral deposits, including copper-gold veins in the Rosland camp, silver-lead-zinc veins in the Ymir and Nelson camps and skarn and vein deposits in the Greenwood camp, are related to intermediate to mafic phases of Middle Jurassic plutons. The Averill Plutonic Complex, and the Tenderloin Plutonic Complex to the east, were both emplaced along a strong west-northwest-trending linear, and vein and skarn mineralization was deposited in the higher levels of the Averill Complex and host Franklin Group.

Syenites of the Coryell suite were emplaced during a period of regional extension in Early Eocene time. Their broadly north-south orientation in the eastern half of the Penticton map area reflects east-west extension and emplacement along north-trending zones of structural weakness. On a more local scale, emplacement of Coryell plutons also appears to be controlled, in part, by the loci of earlier northwest-trending structures; the batholith in the Burrell Creek area is largely restricted to the area north of the 'Averill-Tenderloin' structural zone, and its contact with the Cretaceous granite follows this zone.

The west-northwest-trending Michaud Creek fault cuts the Coryell pluton in the central part of the map area, indicating that this trend remained a zone of crustal weakness throughout Eocene time. Tertiary epithermal precious-metal mineralization is preferentially located along this structure, most notably where it intersects prominent north-trending Tertiary extensional faults; for example, Outback mineralization occurs in the immediate hangingwall of the west splay of the Granby fault, the Nove occurrence is in the hangingwall of the Granby fault, and Sunrise is along the inferred extension of the Kettle River fault. Late, north-

trending, epithermal gold mineralization, recognized in the Granby camp, includes the White Bear occurrence (Caron, 2005). This style of mineralization contrasts markedly with deeper level vein and skarn mineralization of Jurassic(?) age, supporting reactivation of structures and repeated and superposed mineralizing events in the camp.

Summary and Discussion

The distribution of both Jurassic and Tertiary mineralization is controlled by two prominent structural trends: north-trending Eocene extensional faults and an earlier northwest-trending zone that localized mineralization in the Franklin camp and Eocene occurrences farther north.

Mineralization characteristic of the Franklin camp is restricted to the hangingwall of the Granby fault and is clearly related to higher levels in the mafic alkalic Averill Complex. A lithologically similar intrusion, the Tenderloin Complex of unknown age, is exposed at deeper structural levels in the footwall of the fault and is unmineralized.

Similar structural trends may have localized deposits elsewhere in the Penticton map area and farther east in the Slocan camp. Mineralization in the Deer Park area, south of the Burrell Creek map area, commonly occurs where north-trending structures are deflected to the northwest and silver-lead-zinc veins in the Slocan camp are located along west-trending faults above a major deflection in the north-trending Slocan Lake fault.

Many mineral camps and deposits in the eastern half of the Penticton map area are preferentially located in the hangingwalls of north-trending Eocene extensional faults. This preferred regional distribution is due, in part, to a genetic relationship to these faults, as exemplified in the Burrell Creek map area by Eocene epithermal-style gold mineralization, but also to the realization that hangingwall panels contain and expose higher intrusive levels and structures, both of which are more favourable settings for mineralization. Recognition and mapping of these major structural intersections will help direct and focus mineral exploration throughout the southern Monashee Mountains and the Okanagan Highlands of southeastern BC.

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