MINFILE
NTS 092INE – KAMLOOPS LAKE

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Location, Access and Physical Features:

The Kamloops Lake map area, located in south-central British Columbia, contains 163 documented mineral occurrences. The map area is entirely within the Intermontane Belt and Thompson Plateau, a region of relatively low topographic and structural relief, with mainly sub-greenschist metamorphic grade rocks exposed its entire width. Kamloops Lake and the South Thompson River bisect the map area with the city of Kamloops, the service centre. Excellent access is provided by the Trans-Canada Highway (1/97) along the South Thompson River and Kamloops Lake, the Coquihalla (5) and Merritt Highways (5A) from the south, Yellowhead Highway (5) from the north along the North Thompson River, and numerous secondary gravel or dirt logging, ranching and mining roads. Both the Canadian Pacific and Canadian National railways transect the map area. The climate of the region can be severe with a temperature range from a maximum of 37 degrees Celsius or more in summer to lows of -28 degrees Celsius in winter. Precipitation is variable from area to area, but in general is low. The average amount of precipitation in Kamloops is 25 centimetres, at least half of which is contributed by snow.

General Geology and Mineralization:

The Quesnel tectonostratigraphic terrane occupies almost all of the Kamloops map area. This terrane consists of a volcanic arc and overlying set of sedimentary packages that developed on a deformed oceanic sediment/volcanic complex (Harper Ranch and Okanagan subterranes). Basement to Quesnel Terrane are Upper Devonian to Triassic Harper Ranch Group clastics, volcanics and carbonate which possibly represents a basinal facies related to a volcanic arc, and is overlain, 20 kilometres east of Kamloops (Mount Harper area), by volcanic rocks of the Nicola Group. The principal unit making up Quesnellia in this region is the Upper Triassic Nicola Group, a predominantly subaqueous island arc assemblage composed of volcanic and sedimentary rocks that have been intruded by Late Triassic-Early Jurassic alkalic and calcalkalic plutons and batholiths (e.g. Guichon Creek, Iron Mask, Wild Horse batholiths) forming a west-facing magmatic arc.

The Nicola Group occurs as a north-trending belt approximately 25 kilometres wide and 7.5 kilometres thick, extending from the U.S. border to north of Kamloops Lake. It is composed predominantly of augite-phyric andesites and intermediate to felsic pyroclastic rocks with subordinate amounts of greywacke, argillite and reefal limestone. The Nicola Group is broken into three blocks by two sub-parallel fault systems (the eastern one partly defined by the Cherry Creek Fault and Kamloops Graben; the western one partly defined by the Guichon Creek and Deadman River faults). Many of these faults were active during volcanism and sedimentation and appear to have controlled the locus and shape of subsequent intrusions, but have been active subsequently, especially during Eocene extension. In the west part of the map area the Nicola Group is overlain by arc-derived clastics of the Lower and Middle Jurassic Ashcroft Formation. The non-volcanic clastic Ashcroft Formation unconformably overlies the Nicola Group north of Mount Fehr and in the Sabiston Lake area. It has an eastern proximal facies derived in large part from the Nicola Group and associated intrusions, and a western distal facies.

Post-terrane accretion overlap assemblage rocks are entirely continental and preserved mainly in structural depressions. They include Eocene arc volcanics of the Kamloops Group and the extensive Miocene-Pliocene "plateau basalts", as well as scattered minor Pleistocene and Recent flows. With the exception of the younger basalts, granitic intrusions accompany the volcanics. The Kamloops Group unconformably overlies the Nicola rocks and the Iron Mask batholith. These include tuffaceous sandstone, siltstone, and shale with minor conglomerate, as well as basaltic to andesitic flows and agglomerate with minor dacite, latite, and trachyte.

The Nicola Group has been divided up into four lithologic assemblages: a steeply dipping, east-facing "western volcanic belt" (this unit does not occur on the Kamloops Lake map sheet) consisting predominantly of subaqueous felsic, intermediate and mafic volcanics of calcalkalic affinity that grade upward into volcaniclastic rocks; a "central volcanic belt" composed of both subaqueous and subaerial basalt and andesite flows, volcanic breccias and lahars of both alkalic and calcalkalic (both plagioclase and augite-phyric) affinities; an overlying, westerly dipping "eastern volcanic belt" composed of predominantly subaqueous and subaerial alkalic (both augite and hornblende-phyric; shoshonites and ankaramites) intermediate and mafic volcanic flow, fragmental and epiclastic rocks; and an "eastern sedimentary assemblage" that is overlapped by the eastern volcanic belt and is composed predominantly of greywackes, siltites, argillites, alkalic intermediate tuffs and reefal limestones.

The Late Triassic and Early Jurassic alkalic intrusions that cut the Nicola Group (e.g. Iron Mask batholith) consist of medium to small, commonly fault-bounded stocks and dike swarms of diorite, monzodiorite, monzonite and syenite. In contrast, calcalkalic intrusions of the same age of the Nicola Group consist of generally larger stocks and batholiths (e.g. Guichon Creek and Wild Horse batholiths) of quartz diorite, granodiorite and granite. Of these, only the Guichon Creek batholith appears to have intruded its own volcanic pile. Calcalkalic plutonic rocks intrude all four belts of the Nicola Group, but alkalic plutonic rocks mostly intrude the eastern (alkalic) and, to a lesser extent, central volcanic belts.

The Late Triassic-Early Jurassic Guichon Creek batholith occurs in the extreme southwest corner of the map area and is one of a series of plutons that are associated and probably comagmatic with the Nicola Group. The batholith intrudes and metamorphoses volcanic and sedimentary rocks of the Nicola Group. The calcalkaline batholith is a large composite intrusion with a surface area of 1000 square kilometres but only about 115 square kilometres of the northeast corner of the batholith is exposed in the Kamloops Lake map sheet. Isotopic ages from the batholith average 202 +/- 8 Ma by potassium-argon, 205 +/- 10 Ma by rubidium-strontium, and 210 +/- 3 Ma by uranium-lead zircon methods. Gravity profiles suggest that the intrusion has a pipe-like root zone under Highland Valley, steeply inclined contacts on the east and west borders, and a relatively shallow, flat-lying base north and south of the root zone. Faults and fractures controlled the distribution of swarms of porphyry dikes and localized ore deposition. Almost all sulphide mineralization is either in or closely associated with veins, fractures, faults, or breccias.

The oldest rocks in the batholith lie at its edge, the youngest in its core. Large segments of the batholith consist of mappable "phases" with distinctive mineralogical and textural features. From edge to core these are the: Border, Highland Valley, Bethlehem, and Bethsaida phases. Mappable subunits or "varieties" occur within some phases: the Highland Valley phase consists of the Guichon and Chataway varieties; the Bethlehem phase has subareas that are mapped as the Skeena variety. Contacts between phases are generally gradational and rarely chilled; locally, however, they crosscut. Within the batholith, episodic dike emplacement began after intrusion of the Bethlehem phase.

The **Getty North** and **Getty South** deposits (092INE038, 43) are associated with a swarm of north-trending dikes and related intrusive breccia that cut Bethlehem and older rocks. The deposits are hosted in Guichon quartz diorite and are allied with a sheet-like body of Bethlehem granodiorite. Getty Copper Corporation estimates the Getty North Deposit to contain a global resource of 80 million tonnes of oxide and sulphide copper averaging 0.31 per cent, of which 35 million tonnes average 0.45 per cent. Over 15,000 metres of diamond drilling and 1768 meters of underground development by previous operators at the Getty South deposit has determined an initial deposit of 36 million tonnes of open pittable oxide and sulphide mineralization grading 0.47 per cent copper. Included in this deposit is 719,500 tonnes grading 1.41 per cent.

The Iron Mask batholith, located 5 kilometres southwest of Kamloops, is a multi-unit intrusion strongly elongated in a northwesterly direction. As a whole, the intrusion has alkaline affinity, is considered to be subvolcanic, and is comagmatic and coeval with Upper Triassic rocks of the Nicola Group that it intrudes. In the vicinity of the batholith, the Nicola Group is dominated by volcanic and volcaniclastic sedimentary rocks and are generally recognized by albitization of feldspars, occurrence of patchy epidote, and/or rare hematite alteration.

The batholith comprises two major northwesterly trending plutons separated by 6 kilometres of younger volcanic and sedimentary rocks just south of Kamloops Lake. The larger pluton, the 18-kilometre long southern part of the batholith, is called the Iron Mask pluton. The smaller Cherry Creek pluton farther northwest outcrops on either side of Kamloops Lake. The combined exposure of the batholith, including the intervening younger rocks, is about 33 kilometres long and 5 kilometres wide. The Iron Mask pluton and the Cherry Creek pluton are separated by a thick sequence of Kamloops Group rocks occupying what appears to be a graben structure resulting from renewed fault movement around the margins of the plutons during Paleocene or Early Eocene time.

The Iron Mask pluton comprises four major, successively emplaced units designated as the Iron Mask Hybrid, Pothook, Sugarloaf, and Cherry Creek units. The composition and texture range from coarse-grained gabbro to microsyenite. Locally, an additional Picrite unit also occurs which is probably not genetically related to the batholith but its presence may have affected the ore deposition in the batholithic rocks. All phases contain some copper mineralization. The Cherry Creek pluton consists entirely of Cherry Creek unit. Isotopic dates (194 to 204 +/- 6 Ma) indicate that all of these units are of Late Triassic or earliest Jurassic age.

A major system of northwesterly trending faults, which, together with lesser northerly and northeasterly structures controlled the emplacement of the batholith's component units and the resultant mineral deposits. Structural control is strong in the entire Iron Mask Camp. Most of the porphyry phases and the associated mineral deposits are found only along the faulted edges of the pluton or along major cross structures.

Copper, gold and silver have been of significant interest in the Iron Mask batholith since the beginning of the 1900's, while iron and salt deposits have also played a small role in attracting exploration activities to the area. Amongst the earlier producers, the **Iron Mask** mine (092INE010) operated from 1901 to 1928 and produced 461 kilograms silver, 118 kilograms gold and 2445 tonnes copper from 165,555 tonnes mined. Early production was also recorded from the **Python** (092INE002) and **Copper King** (092INE024). Earlier geologic literature (G.M. Dawson, 1877) referred to magnetite occurrences in the batholith and from 1891 to 1902, production from the **Glen Iron** magnetite veins (092INE025) totalled 15,105 tonnes of magnetite ore. The discovery of the **Afton** deposit (092INE023) in 1971 and the comprehensive studies of the geology and structure that followed served as a contribution to the understanding of porphyry deposits of the Canadian Cordillera. Afton mine, a major copper and gold past producer, is located at the northwestern end of the Iron Mask pluton. It is at the western extremity of a west trending, intensely brecciated zone and is hosted entirely by rocks of the Cherry Creek unit. Supergene native copper with subordinate chalcocite accounted for 80 per cent of the orebody; hypogene mineralization consists mainly of bornite and chalcopyrite. The Afton mine dominates metal production from the Iron Mask batholith. Since the start of open-pit mining in 1977, production to the end of 1988 totalled 81,437 kilograms silver, 13,020 kilograms gold and 204,691 tonnes copper from 31.6 million tonnes mined. After the depletion of economic open-pit reserves at Afton in early 1989 mining commenced at the Ajax deposit (**West** and **East** pits, 092INE012, 13) in June 1989. The Ajax operations ceased in August 1991. In 1995, Afton Operating Corporation re-opened the Ajax West pit, extending the mine life from December 1996 to its closing in May 1997.

During the course of study in 1979 and 1982 by Y.T.J. Kwong for Bulletin 77, selected samples from the various phases of the Iron Mask batholith had also been analysed for other precious metals. Detectable amounts of palladium were noted in most samples analysed. While copper, gold and silver remain the main commodities sought in the Iron Mask batholith; palladium is an attractive byproduct metal that could be developed with proper extraction techniques. Recent work (2000-03) by DRC Resources Corporation and Abacus Mining and Exploration Corporation in the Iron Mask Camp has focused on this potential. DRC Resources is evaluating the Afton deposit for a possible underground operation for the remaining southwest plunging, higher grade copper-gold-palladium-silver mineralization. Indicated mineral resources for the main zone are 34.3 million tonnes of 1.55 per cent copper, 1.14 grams per tonne gold, 0.125 gram per tonne palladium and 3.42 grams per tonne silver. In 2002, Abacus Mining completed 3300 metres of drilling on its Rainbow property (092INE028). Results from this first phase drill program extend the known zones and has intersected mineralized sections of copper-gold and in places palladium mineralization. Previous work delineated the No. 2 zone containing a resource of 15.858 million tonnes grading 0.528 per cent copper. Exploration drilling on Rainbow, utilizing newly conceived target selection concepts, has resulted in the discovery of the Nos. 17 and 22 zones. The No. 22 zone lies some 200 metres southeast of No. 2 zone and is likely an extension of the No. 2 zone at depth. The No. 17 zone, which is completely buried, is the most easterly zone drilled to date. Along strike, and within the northwest trending structural corridor that hosts Afton-Pothook and the Rainbow deposits, is the Coquihalla East zone. Teck Cominco first recognized this gold-rich, copper-poor style of mineralization in the 1990s. Surface sampling of the **Coquihalla East** zone (092INE120) yielded 6.36 grams per tonne gold, 0.83 gram per tonne palladium and 1.0 per cent copper.

The **Crescent** deposit (092INE026) is one of three deposits lying along an east-west trending structural corridor that runs through the Afton deposit to the west and the **Big Onion** deposit (092INE011) to the east. The **DM and Audra** deposits (092INE030) west of the Crescent lie within this structural corridor. The zones of mineralization appear focused at junctions of this fault and northwest-trending faults as breccia bodies and areas of disseminated mineralization associated with potassic alteration. A resource on the small near-surface area on the DM zone is 2.685 million tonnes grading 0.38 per cent copper and 0.27 gram per tonne gold, and at Big Onion, 3.266 million tonnes grading 0.71 per cent copper and 0.44 gram per tonne gold. No resource has been calculated for the Audra zone but there are some significant drillholes (e.g. P-76-13 assayed 0.96 per cent copper over 64 metres). An induced polarization survey carried out in 1996 shows the DM and Audra zones to be part of a much larger system extending for 1200 metres west of the Crescent pit. The survey also indicates that the three near-surface zones form a larger system at depth but this has not been tested.

There are currently four producing mines in the Kamloops Lake map area. Lafarge Canada Inc. began quarrying the south end of the **Harper Ranch** deposit (092INE001) to supply an adjacent cement plant. The quarry produces about 260,000 tonnes limestone annually. The **Walhachin** railroad ballast quarry (092INE064) located on the south side of the Canadian Pacific Rail mainline, across from the village of Walhachin, is owned and operated by CP Rail. Western Industrial Clay Products Ltd. produces domestic and industrial absorbents, principally from its **Red Lake** (092INE081) Fuller's earth deposit near Kamloops. The Lafarge Kamloops Cement Plant is mining a rhyolite ash tuff at **Buse Lake** (092INE123), which is used as a silica-aluminate source for the cement manufacturing process.

Placer gold production in the Kamloops map area was first recorded from **Tranquille River** (092INE106) between 1876 and 1880. Total combined placer gold production from Tranquille River, **Criss Creek** (092INE104) and **Lanes Creek** (092INE054) totalled 76,101 grams.

In the Carabine Creek area on the north shore of Kamloops Lake, the **Copper Creek** (092INE036) property produced 143 flasks of mercury between 1895-97 and 1924-27. The Copper Creek property was one of the early cinnabar discoveries in the province in the early 1890s. Cinnabar mineralization is associated with dolomite veins and stringers that occur in fracture and shear zones in highly faulted Nicola Group volcanic breccias and interbedded tuffs. Mercury showings of the Savona Mercury Belt are associated with faulted, carbonate and/or silica altered zones within Triassic or Jurassic metasediments or metavolcanics and are spatially related to Tertiary intrusions. The **Tunkwa Lake** mercury prospect (092INE039) is believed to cap one of these Tertiary bodies and is thought to represent the upper, low temperature horizon of an epithermal system that could carry precious metal values at depth.

In the Heffley Lake area, the **Heff** skarn (092INE096) represents an unusual Cu +/- Au +/- REE +/- P-bearing magnetite skarn whose location and distinctive chemistry suggests it differs from the typical iron skarns occurring along the west coast of British Columbia. It possibly resulted from a hydrothermal system similar to those responsible for deposits in the Ernest Henry (Australia)-Candelaria (Chile)-Wernecke Breccias (Canada) spectrum. The Heff skarn lacks the extensive brecciation and widespread Na +/- K metasomatism that characterizes many deposits of the Ernest Henry-Candelaria-Wernecke Breccias spectrum.

Two main types of mineralization have been discovered on the **Walloper** property (092INE090): lead-zinc bearing mesothermal quartz veins, and precious metal bearing epithermal quartz veins and chalcedonic breccia associated with pyritic sericite-carbonate alteration zones. Nicola Group basaltic tuffs, tuffaceous sediments and possibly mafic volcanic rocks are intruded by a 12 square kilometre Triassic intrusion varying in composition from gabbro to diorite to monzonite to monzonite-diorite breccia.

The **Homestake** (092INE082) is one of the oldest known gold-quartz vein properties in the province, having been reported upon by G.M. Dawson in 1888. It occurs north-northwest of Heffley Creek in an area where brownish weathering, highly fractured porphyritic quartz monzonite intrudes biotite and sericite schist and argillite of the Harper Ranch and/or Nicola groups. The quartz veins traverse both the intrusive rock and metasediments.

Tertiary rocks are widely distributed in the Kamloops area. A number of localities for agate, geodes and jasper are known but the best collecting areas appear to be in the hills north of Kamloops Lake from Tranquille to Copper Creek where agates are abundant (**Tranquille River Agate**, 092INE157). A good collecting area for green opal, agate and geodes are along the cliffs below the microwave tower site on **Mount Savona**, (092INE158). At the **Rosseau** showing (092INE056), a zeolite mineral, ferrierite, is found in a rock cut on the Canadian National Railway line 5 kilometres east of Carabine Creek.

A number of small-undrained saline lakes some dry occur in the vicinity of Kamloops. Although most of these contain sodium sulphate as a major constituent, several contain relatively concentrated solutions or crystal-beds in which sodium carbonate predominates. The **Lake No. 1** sodium carbonate deposit (092INE077) was worked from 1931 to 1935 and about 907 tonnes of impure natron or sal soda shipped to Vancouver and Calgary. The **Cedars** sodium sulphate deposit (092INE076) may contain 90,710 to 181,420 tonnes of impure mirabilite in the lake, which would amount to a sodium sulphate content of 36,284 to 72,568 tonnes.

In 1996, work on the **Basin** claims (092NE115) between the Trans-Canada Highway and Kamloops Lake resulted in the discovery of a significant resource of sodium bentonite (smectite-montmorillonite) within a particular unit of the Eocene Tranquille Formation.

Significant molybdenite mineralization at the **Roper Lake** prospect (092INE071) occurs in a zoned quartz monzonite stock, which intrudes Nicola Group volcanics.

Exploration potential remains high for metallic and industrial minerals in the Kamloops Lake map area. Some indicators of mineralization to aid exploration in the Iron Mask batholith are intense potassium feldspathization, albitization, carbonatization, and propylitization; these reflect concentrated hydrothermal activity that might, in some stages involve ore formation. Picrite bodies, especially if fractured, are effective in causing sulphide precipitation if they interact with ore-bearing solutions. For supergene ore, oxidized rocks exhibiting red ochreous alteration or intense malachite staining deserve careful examination. To explore for shallowly buried mineralization, geochemical sampling of stream sediments and old drainage systems is recommended. Taking the overall geological environment into consideration, the southeastern end of the Iron Mask pluton is a prime exploration target for another Afton-type deposit.

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