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NICOLA LAKE REGION GEOLOGY AND MINERAL DEPOSITS

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PART A

GEOLOGICAL STUDIES IN THE NICOLA LAKE REGION (92I/SE)

By John M. Moore and Aaron R. Pettipas

INTRODUCTION

Since the late 1800s the region around Nicola Lake has been known for its many and varied mineral deposits, concentrated in the Stump Lake, Swakum Mountain and Iron Mountain areas (Figure 1, in pocket). Over 200 mineral occurrences are known in this relatively small area but only one major producing mine (Craigmont) has been discovered. Because of its accessibility, proximity to the Highland Valley camp and very encouraging prospects however, there is steady prospecting activity in the region.

Early geological studies established that the mineral occurrences are largely hosted by a thick Late Triassic volcanic assemblage, the Nicola Group, of which the type section (Dawson, 1896, page 131B *in* Cockfield, 1948) lies near Nicola Lake. The Nicola Group is complex and lies in a region of relatively low relief and limited exposure, compared to much of the Cordillera; studies to date have failed to establish the internal structure and stratigraphy of the group with any certainty. The advent in 1984 of LITHOPROBE, a major multidisciplinary earth science project based on continuous seismic reflection profiling to crustal depths, appeared to offer the prospect of gaining important new knowledge of the architecture of the Intermontane Belt, in which the Nicola Group lies. The LITHOPROBE Southern Cordillera Transect was accordingly routed through the Highland Valley and Nicola Lake areas. This report presents the results of new geological mapping and compilation, undertaken in 1988, initially to provide an adequate database for interpretation of the seismic data, and extended in 1989 from the transect line to better understand parts of the Nicola Group that had not been systematically mapped since the 1940s.

GEOLOGY

REGIONAL SETTING

The regional setting of the Nicola area is presented in Figure 2 (in pocket), a 1:250 000 compilation map of parts of NTS mapsheets 92I and 82L. The map is similar to that published by Moore (1989) except that it incorporates details and changes arising from fieldwork in the Nicola area in 1989, as well as new information from near Okanagan Lake, provided by K.L. Daughtry (personal communication, 1989). The geology was first mapped at 1:253 440 scale by Cockfield (1948) in the Nicola area and Jones (1959) in the Vernon area to the east. These authors summarized the earlier work in the region, including classic studies by G.M. Dawson and R.A. Daly, and reported in detail on the many small mines and mineral occurrences. More detailed mapping of the Nicola Group was subsequently carried out by Schau (1968), Preto (1979) and McMillan (1981). Ewing (1980, 1981) studied the Eocene volcanic rocks of the region and published an important synthesis of the early Tertiary tectonics. Monger and McMillan (1984, 1989) produced a new regional map of the Ashcroft sheet (92I) that includes the Nicola area; Okulitch (1979) remapped and recompiled parts of 82L. Moore (1989) and Moore and Pettipas (1990) have published short accounts of studies along the LITHOPROBE transect and in the Nicola horst.

The area of Figure 2 lies in the Intermontane Belt and is part of Quesnellia, except at the easternmost end where it is juxtaposed against high-grade metamorphic rocks of the Omineca Belt along the Okanagan shear zone (Parrish *et al.*, 1988). The western part is underlain primarily by Late Triassic arc-volcanic rocks and volcanogenic sedimentary facies of the Nicola Group, intruded by large Triassic-Jurassic plutons, among which the Guichon Creek batholith (McMillan, 1976, 1978) bounds the western end of the transect segment studied. The eastern part of the area is underlain mainly by Late Paleozoic rocks of oceanic affinity, in both unconformable and faulted contact with the Nicola Group (Moore, 1989); plutons range in age from Triassic to Cretaceous. Triassic volcanic facies may be more abundant in the east than shown (*see* Okulitch, 1979), but their extent is a matter of dispute. The Paleozoic and Triassic stratified rocks are complexly faulted and typically metamorphosed to low greenschist facies. They are overlain unconformably by clastic and volcanic rocks of Jurassic to Tertiary age, of less complex structure and largely unmetamorphosed. Eocene Kamloops volcanic rocks, mainly basalt and andesite, underlie large parts of the Okanagan Highlands.

There are two main sets of major faults: northwesterly striking, at least partly contractional features that are probably Mesozoic, and northerly striking Tertiary extensional faults. The latter have probably controlled Eocene sedimentation (Ewing, 1980) and are overlapped by Miocene basalt. The eastern margin of the Guichon Creek batholith, and the Nicola horst (Figure 2), are bounded by steep Tertiary faults.

GEOLOGY OF THE NICOLA LAKE AREA

Figure 3 (in pocket) is a more detailed map of the Nicola Lake area, at 1:100 000 scale (Merritt map-sheet: 92I/SE). In the southernmost part of the map area and to the south, toward Princeton, the Nicola rocks have been divided into three "belts" by Preto (1979) that contain distinct facies and assemblages. The **western belt** (TNW) is an easterly facing succession of calcalkaline, mainly plagioclase-phyric andesitic flows and breccias, with lenticular interlayers of limestone and bedded volcaniclastic rocks. Although flows are more abundant relative to clastic facies in the western part of the belt, the sequence reported by Preto (1979) in the southern part of the Nicola area is not evident on Swakum Mountain (Figures 1, 3) where sedimentary facies can be found throughout its entire width. The alternation of thick successions of massive uniform green flows and unsorted breccias with bioclastic limestones, volcanic conglomerate and local subaerial volcanic facies such as maroon scoriaceous breccias testifies to deposition near a rapidly fluctuating shoreline. Local felsic centres (TNWf) contain dacite and rhyolite flows, welded tuff and breccia, with intercalated heterolithic, intermediate to felsic volcaniclastics.

The **central belt** (TNc), as represented in the south-central part of the map area and probably in the extreme northwest, comprises mainly augite and plagioclase-phyric basaltic flows and associated breccias. These were considered by Preto (1979, pages 27-29) to be largely submarine and of alkalic composition; probable correlatives near Logan Lake are among the very few occurrences of pillow lava in the Nicola Group. Subvolcanic intrusions of diorite and gabbro are abundant in the central belt.

The **eastern belt** facies (TNe) consists almost entirely of mafic augite-phyric volcaniclastic rocks, ranging from coarse, probably laharic, breccias to fine wacke and siltstone; coarse facies predominate. In the fault blocks between the Nicola horst and Stump Lake there are thick successions of turbidite wacke. Fine-grained sedimentary facies of the Nicola Group (TNs), underlying the Meander Hills and the Douglas Lake area, are medium to thin-bedded wacke, siltstone and mudstone. An assemblage of red-brown, plagioclase-phyric subaerial andesitic flows and volcaniclastic rocks (TJv) that lies at the south edge of the map area, in the vicinity of Mount Nicola, contrasts with the surrounding Nicola Group facies, from which it is separated by faults and Ashcroft sedimentary rocks. Originally assigned to the Kingsvale (now Spences Bridge) Group by Preto (1979) but to the Nicola Group (central belt) by Monger and McMillan (1989), these rocks have yielded one questionable Jurassic fossil locality but remain of uncertain age. Similarity to a few of the Nicola units on Iron Mountain, and the presence of one copper prospect (62; all numbers denoting mineral occurrences refer to Table 1 and Figure 3, in pocket) suggest that the succession may be an emergent part of the western Nicola belt.

The Nicola Group rocks have been intruded by Triassic and Jurassic plutons (Figure 1), of which the Guichon Creek batholith (McMillan, 1976, 1978) is the largest and most important from the metallogenic standpoint. The stratified rocks are complexly faulted and regionally metamorphosed, typically to low greenschist facies.

The Nicola Group is overlain unconformably by clastic and volcanic rocks ranging in age from Jurassic to Tertiary, that are less altered but rotated to steep attitudes on mainly extensional faults. Clastics correlated with the Early and Middle Jurassic Ashcroft Formation (JA) are mostly unlayered, poorly sorted coarse conglomerate, with discontinuous interbeds of pyritic, rusty weathering sandstone and siltstone. In the Swakum Mountain area there is a grey, commonly fetid bioclastic limestone, up to 200 metres thick, near the base of the formation. Clasts in the conglomerate consist mainly of volcanic rocks resembling the Nicola Group, and granitic and dioritic boulders. At several localities a chert-pebble conglomerate (JAc), containing distinctive green clasts, overlies the polymictic conglomerate and may be of Cretaceous age, as suggested by Monger and McMillan (1989); however chert-bearing units are also found near the base of the succession, so the chert-clast conglomerate may also be Jurassic. Andesitic volcanic rocks of the Cretaceous Spences Bridge Group (KSB, KSBS) occupy the southwest corner of the area. Eocene clastic sediments (Es)("Coldwater beds"), that include coal at Merritt and Quilchena, and volcanic rocks (Kamloops (EK) and Princeton (EP) groups) occupy fault-bounded depressions; the Kamloops Group also underlies the highlands bounding the area on the northeast. The volcanic rocks are predominantly basalts and andesites, but rhyolitic centres occur north of Stump Lake and east of Guichon Creek.

The Nicola horst (Figure 1; "central Nicola horst" of Moore, 1989) is a major structure bounded by Tertiary faults. It contains both Nicola strata (comparable to central and eastern belt facies) and quartzite (metachert?), metaconglomerate and black schist of unknown age, that are penetratively deformed and metamorphosed to amphibolite facies. These are cut by a variety of plutonic rocks ranging from metagabbro and tonalite to granite. The youngest, and the only body that has escaped penetrative deformation and recrystallization, is the Paleocene (64.5±0.5 Ma) Rocky Gulch granodiorite.

The oldest strata that are consistently flat-lying are Miocene Chilcotin basalts (MC) that occur northeast of Lac Le Jeune and probably in smaller outliers elsewhere. These flows are difficult to distinguish from the Pleistocene and Recent "valley basalts" (PRV) that once filled the major drainage channels of the area, and now occur as remnants in the Nicola and Quilchena valleys.

The tectonic history of the area is dominated by brittle deformation. Only in the Nicola horst are penetratively deformed rocks encountered; these exhibit westerly plunging stretching features that are probably related to accretion of the Nicola arc in Mesozoic time. Most of the Nicola rocks are steeply tilted but not penetratively strained except near small shear zones and, although a few mesoscopic folds were seen, top criteria indicate that the strata face east, implying that blocks have been rotated on listric faults. In the Swakum Mountain area (Figure 4, in pocket), discontinuities along strike of the Nicola rocks imply an easterly striking fault, but in general the breaks must be oriented in a northerly direction. The Ashcroft strata occupy northwest to north-striking slices, bounded on their easterly sides by faults presumed to be normal. Major northwest trending lineaments are also seen within the Nicola rocks (*e.g.* Rey Creek valley). These structures are transected by northerly striking Tertiary fault systems in the Nicola River, Guichon, Clapperton and Quilchena Creek valleys; along these faults Eocene sedimentary and volcanic strata have been rotated to dips approaching the vertical, and the Nicola horst elevated relative to its surroundings. These faults are part of a regional system of Eocene extensional features, proposed by Ewing (1980) and elaborated by Monger and McMillan (1989). Where exposed, as in road cuts along the Coquihalla Highway and Nicola Lake, the fault zones exhibit intense shattering, veining and local alteration.

SWAKUM MOUNTAIN AREA

INTRODUCTION

Fieldwork was carried out in 1989 (Moore and Pettipas, 1990) with the objectives of resolving the stratigraphy and structure of the Nicola Group and gaining a better understanding of the architecture of the Nicola horst . West of the horst (Figure 1) the Nicola Group had been mapped at 1:25 000 scale as far north as 50°15′ (Preto, 1979; McMillan, 1981) but farther north there was only reconnaissance coverage (Cockfield, 1948; Monger and McMillan, 1984). Because of the large number of former small mines and mineral occurrences on Swakum Mountain (Figure 1), this area was selected for more detailed study. Excellent access is afforded from Merritt by the Coquihalla Highway and Mamit Lake road (Figure 4) and a number of seasonal forest access roads. Three weeks were devoted to mapping, using 1:15 000 aerial photographs and compiling at the same scale on a base enlarged from the 1:50 000 NTS topographic map. The geology of the area has proven to be much more complex and diverse than expected, and the new data obtained have implications for regional structure and metallogeny.

The Swakum Mountain rocks exhibit continuity with Nicola Group units mapped to the south (McMillan, 1981) but may be separated by a northwest-trending fault from those to the north on Mount Guichon (Figure 1).

LITHOLOGY

A generalized geological map of the area is presented in Figure 4. To date there are few paleontological age determinations in the study area, so most age assignments are tentative, but the relative ages of the major units are evident from field relationships. Rocks of the Nicola horst are not subdivided on the map but these are treated in more detail in this report. As noted, they are in part age-equivalent to units on Swakum Mountain.

The Nicola Group (western belt) is divided into five units based on predominant lithology, without implication of relative age. There is very little continuity of any unit in the area and, given the limitations of exposure and traverse density, the nature of most of their contacts remains uncertain. Lava flows (TNwv) are most abundant in the western half of the area; they are predominantly plagioclase-phyric andesites. Phenocrysts reach 2 centimetres or more and constitute up to 30 per cent of flows. Fresh augite phenocrysts are present in places, particularly around Revelle Lake and Saxon Lake, but are generally much subordinate or absent; a few samples contain hornblende phenocrysts. Most flows contain less than 5 per cent amygdules; where present these are filled with quartz, chlorite and/or calcite. Flow contacts are generally not visible; a few flows interbedded with breccia are 2 to 10 metres thick. Flows are in part intercalated with monolithologic flow or pyroclastic breccias, from which they are difficult to distinguish in the field.

Fragmental volcanic rocks are predominant in the Nicola Group. Breccias and tuffs (TNwb) are of similar composition to flows, and are distinguished from definite epivolcaniclastic rocks (TNws) by their monolithologic character, coupled with the absence of layering or rounding of fragments. Some of the breccias contain abundant aphanitic chips, now converted to dark green chlorite, that resemble hyaloclastite, and many breccias may be epiclastic debris flows with a relatively homogeneous source. Agglomerate (TNwba) *sensu stricto* is of a mappable thickness only south of Dartt Lake, where it contains maroon scoriaceous, rounded and spindle bombs in a calcite-rich lapilli-tuff matrix. Most of the volcaniclastic rocks are probably laharic deposits. They are heterolithic, containing a variety of andesitic and, in places, more felsic clasts, massive and unsorted, angular to subrounded, with modal fragment size varying from less than 1 centimetre to 5 centimetres. In a few places the finer facies are well layered and show features of turbidite wackes. Distinctly felsic rocks are generally subordinate to the intermediate volcaniclastics. Laharic breccias in the southwest part of the area consist predominantly of quartz-feldspar-phyric fragments, and a lenticular dacite welded tuff (TNwt) north of Dartt Lake is at least 500 metres thick.

Thin, grey limestone lenses (TNwl) are a minor but distinctive part of the Nicola succession. The greatest thickness observed, in the southeast corner of the area, is 100 metres. Typically, limy units consist of intercalated limestone up to a few metres thick and heterolithic volcanic breccia/conglomerate, with limestone clasts up to metre-scale. The limestone is invariably bioclastic, containing in places well-preserved molluscs and coral fragments. One such layer, east of the Lucky Mike deposit, is hematitic with large coral heads, and resembles the red reefoid limestone mapped on Iron Mountain south of Merritt (McMillan, 1981).

All the Nicola volcanic rocks have fine-grained or aphanitic matrices with abundant chlorite and epidote; biotite and amphibole are not evident in hand specimen. An exception is the skarn alteration zone, approximately delineated in Figure 4, where limestone is converted to coarse pyroxene-garnet rock and volcanic facies to fine-grained magnetite-bearing epidote amphibolite, locally with garnet and (?) pyroxene. At numerous localities within and beyond the skarn zone, the volcanic rocks are altered to rusty weathering carbonate-rich rocks containing fine ankerite and pyrite, with or without calcite. Generally these are elongate and associated with northerly trending topographic lineaments; the zone at Corona (Figure 4) is 600 metres long and up to 50 metres wide. Where carbonate alteration occurs within the skarn zone, magnetite is generally absent and appears to have been converted to pyrite.

The Nicola rocks are intruded by small bodies of augite or hornblende diorite (D) and, near Rey Lake, by coarse biotite granite (G). The diorite is massive, medium to coarse grained and magnetite bearing. Near Revelle Lake numerous small carbonate alteration zones occur near diorite bodies that generally appear less altered than the enclosing rocks. The granite is coarse and massive with subhedral quartz and potassic feldspar megacrysts. It resembles the Paleocene granite of the Nicola horst to the east (Moore, 1989) and has yielded a Paleocene K-Ar date of 68.9±2.5 Ma (Preto *et al.*, 1979). In the light of early Tertiary K-Ar updating of Mesozoic plutonic rocks elsewhere in the region in and around the Nicola horst (*see*, for example, the isotopic age data in Monger and McMillan, 1984) this figure may not represent the age of intrusion. Granite dikes, that are similar to the Rey Lake granite but less coarse and more distinctly porphyritic, are seen in drill core at Rey Lake, cutting skarn, and in outcrop at the northwest corner of the map area, where the host breccias are not conspicuously altered.

Clastic and carbonate rocks previously included in the Nicola Group, that occur in at least three and probably five separate locales in the map area, are tentatively correlated with the Early to mid-Jurassic Ashcroft Formation. Although most of the Ashcroft correlatives previously identified in the Nicola Lake region consist entirely of clastic rocks, these occurrences are different in that they contain notable carbonate units. McMillan (1974) however identified fetid dark limestone and limestone conglomerate, apparently similar to those in the Swakum area, in the Ashcroft succession near Ashcroft. The most striking examples of Ashcroft strata in the study area are two steeply dipping, fault-bounded slices that extend through the crest of Swakum Mountain and northward from Sophia Lake. These contain similar successions that pass eastward and upward from limestone (JAl) with thin pebbly, sandy and silty layers to thick, massive to weakly stratified coarse boulder conglomerate (JAc) containing poorly sorted, but rounded to well-rounded clasts in a dark green matrix with abundant volcanic plagioclase. Clasts comprise mainly porphyritic intermediate and felsic volcanic rocks, with medium-grained diorite and biotite granite that locally predominate, and minor sedimentary rocks. The succession on Swakum Mountain is topped by up to 80 metres of uniform, siliceous, pyritic sandstone (JAs). On the south flank of Swakum Mountain (locality "F", Figure 4), limy siltstone contains mid(?)-Jurassic ammonites (H.W. Tipper, personal communication, 1990). The stratigraphy as a whole is distinctive from that of the adjacent Nicola rocks by virtue of its relative continuity. The limestones contain fine to coarse fossil debris like the Nicola limestone, but in contrast they weather buff and are consistently fetid, whereas the Nicola carbonates are rarely so. The conglomerate is notably better rounded, coarser and less lithified than typical coarse Nicola clastics; although some epidote is present the clastic plagioclase is milky white rather than grey or green as in the Nicola rocks. Many of the more felsic volcanic clasts appear less altered than typical Nicola rocks. The presence of plutonic rocks is also distinctive, as are abundant chert pebbles and sand in some layers. Altogether the conglomerate and finer clastics resemble those of the "Clapperton conglomerates" that occur to the south near Merritt (Cockfield, 1948; McMillan, 1981), that have been assigned to the Jurassic Ashcroft Formation by Monger and McMillan (1984). It is evident from Figure 4 that the skarn alteration of Nicola carbonate and volcanic rocks around Swakum Mountain does not affect the immediately adjacent carbonate-clastic successions, indicating that they were laid down after the alteration event.

In the extreme southwestern part of the area, west of Saxon Lake, is a fault-bounded succession of mainly coarse clastic rocks that resemble those on Swakum Mountain except that they are easterly striking, contain no plutonic clasts and have abundant coarse fossil debris in the matrix. They rest at one locality on hornblende-phyric (dacite?) flows and are interlayered with and succeeded by volcanic sandstone, also bioclastic, fining upward to black siltstone with minor limestone. One fault block at this locality contains distinctive grey felsic welded tuff and breccia and hornblende dacite(?), with a conformable layer of the volcanic sandstone. Near Revelle Lake and Eve Lake are coarse volcanic conglomerate and sandstone that resemble the Saxon Lake occurrence, but lack the finer facies or carbonate rocks. All of these rocks are tentatively correlated with the Ashcroft Formation.

The Ashcroft succession has been intruded by a few augite-phyric mafic dikes west of Saxon Lake. At Sophia Lake and Swakum Mountain, distinctive dikes of tan-weathering, coarse quartz-feldspar porphyry cut sandstone and conglomerate.

Tertiary volcanic rocks, also unrecognized before the present work, are of minor extent. They include a small outlier of olivine basalt (TB) south of Dartt Lake and two isolated exposures of rhyolite (EER) near Guichon Creek, at the western margin of the area. The basalt is downfaulted against Nicola volcaniclastics to the east; it is at least 30 metres thick and minor variations suggest the presence of several flows. Although no flow contacts were recognized, flow features indicate a moderate easterly dip. Some flows contain peridotite nodules a few centimetres across, similar to those seen in basalt mapped as Miocene north of Lac Le Jeune (Monger and McMillan, 1984). The rhyolite is best exposed on ridges near the southwest corner of the area. There it is grey, strongly flow-laminated and contains open lithophysae up to 3 centimetres in diameter. The lamination is steeply inclined and the rock is locally brecciated. As contacts are not exposed it is not possible to state whether the rocks are flows or a dome.

Areas largely underlain by unconsolidated Quaternary cover (Q) occupy all major depressions as well as the flanks and down-ice ends of ridges and mountains.

STRATIGRAPHY and STRUCTURE

Nicola Group rocks in the area mostly strike northerly and dip steeply (Figure 4); scarce bedding indicators show that beds dip predominantly toward the east and are upright. As a whole they are bounded on the east and west by major fault systems that occupy the valleys of Clapperton Creek and Guichon Creek, respectively (Monger and McMillan, 1984; Moore, 1989). The Clapperton fault system appears to be normal, with a net dip slip of at least several kilometres, in order to have exhumed the relatively deep-seated rocks seen in the Nicola horst. The west-northwest-trending linear valley of Rey Creek, at the north side of the map area, may also contain a major break, as the Nicola Group on Mount Guichon to the north includes well-bedded wackes and coarse laharic deposits without close counterparts along strike to the south. Poor exposure on the south flank of the mountain and in the valley precludes a definite conclusion.

The lack of continuity or consistent succession within the Nicola Group suggests strongly that the stratigraphy has been broken into a large number of easterly tilted fault blocks, of unknown sense and displacement, hence an estimate of total thickness is not possible. In the study area there is a predominance of flows west of Swakum Mountain, and volcaniclastic rocks to the east. Carbonates and thick felsic units however occur to both sides. Most of the units south of an east-west line through Revelle and Dartt lakes have a north-northwest trend, whereas those to the north strike north-northeast. There is also a lack of continuity in at least some of the units, notably near Dartt Lake, that reinforces the proposal of an easterly striking fault along this line. There is, however, sufficient similarity of the units to the north and south to preclude the drawing of a lithologic boundary in this vicinity, such as shown by Monger and McMillan (1984).

The Ashcroft rocks at Swakum peak and Sophia Lake strike northerly and dip moderately to steeply east. On their west sides the successions contain thin, immature clastic layers near the base that include fragments of Nicola volcanic rocks; these and scarce top indicators indicate eastward facing of the succession and suggest that the western contact may be an unconformity. As the conglomerate and sandstone are succeeded structurally to the east by Nicola rocks, they must be downfaulted against them on the east, thus the successions lie in east-facing half-grabens. Relations at the Thelma and Bernice properties (Figure 4) indicate that the limestone is repeated by normal faulting. Faulting across the main graben structure is also required to juxtapose the thick limestone segments with the sandstone - thin limestone - conglomerate sequence north of Sophia Lake. The clastic rocks west of Saxon Lake occupy a small graben enclosed by Nicola rocks; it is plausible that the other occurrences described are in a similar setting, and the one at Revelle Lake may occupy a southerly extension of the same structure that contains the Sophia Lake succession. The similarity of the Swakum and Sophia Lake stratigraphy demands correlation and suggests that they are parts of the same succession, dismembered by extensional faulting. It should be emphasized that this interpretation is distinct from that put forth by Cockfield (1948, pages 59-60) and commonly quoted in subsequent exploration reports. He inferred that the limestones at Swakum Mountain and Sophia Lake, all of which he assigned to the Nicola Group, occupy the limbs of an asymmetric, southerly plunging anticline. The lack of continuity between these localities, coupled with the similar facing of the succession at each, does not support Cockfield's hypothesis. The differences between these and the other three occurrences, given their close proximity, argues that they are not simply lateral correlatives, but are of different age and may represent a different formation. It is possible, for example, that one correlates with the mid-Late Cretaceous Spences Bridge Group. Paleontology may answer this question.

The Ashcroft succession on Swakum Mountain lies on a variety of Nicola rocks and is not displaced across the proposed fault between Revelle and Dartt lakes, indicating that it was deposited on a relatively flat erosion surface that postdates some of the deformation of the Nicola Group. Its less-altered character, particularly the absence of skarn development adjacent to strongly altered Nicola rocks, also demonstrates a significant time gap between the two successions.

The occurrence of felsic tuff and flow rocks in conformable contact with the volcaniclastic rocks west of Saxon Lake, the general presence of euhedral clastic feldspar in all the Ashcroft rocks and the relatively fresh appearance of some of the volcanic clasts all indicate the existence of volcanic activity contemporaneous with clastic sedimentation in post-Nicola, possibly Early to mid-Jurassic time.

The Tertiary volcanic rocks also appear to occupy tilted fault blocks; flow lamination in the rhyolite may be in a steep primary orientation, but more probably has been rotated on a Tertiary fault separating the Guichon Creek batholith from the Nicola Group.

DEPOSITIONAL ENVIRONMENTS

Some Nicola volcanic features, such as red agglomerates and rounded clasts in debris flows, are clearly indicative of subaerial processes. The scarcity of well-defined bedding in the volcaniclastic rocks and the prevalence of massive, ill-sorted deposits implies that they are the product of subaerial lahars. Other criteria, such as the presence of reefoid limestone and hyaloclastite, demonstrate subaqueous deposition, as does the low incidence of oxidized, ropy or brecciated flow tops. All of these features are consistent with a transitional subaerial to shallow submarine environment, characterized by tectonic instability and ephemeral shorelines. At least some lahars flowed into the sea, burying patch reefs and carrying shore-worked debris with them. Synvolcanic faulting must have been an important control on deposition and may explain the abrupt termination of some units, such as the welded tuffs north of Dartt Lake. It would also permit the accumulation of relatively thick successions of subaerial and shallow subaqueous rocks. A similar scenario is indicated by the western belt succession on Iron Mountain near Merritt, mapped by McMillan (1981) and was also envisioned by Preto (1979) for Nicola rocks to the south and east of the present area.

The strata assigned to the Ashcroft Formation also present evidence of a transition, upward in the succession, from a submarine to a subaerial environment, accompanied by a substantial increase of relief in the source area. The continuity of succession over at least two separate blocks, as well as the occurrence of sandstone adjacent to the fault on Swakum Mountain, suggests that sedimentation was not related to the present boundary faults. The tabular character and continuity of the finer units suggest deposition on a well-established, stable erosion surface, and the composition of the conglomerate clasts indicates unroofing of at least some (synvolcanic?) plutons. The structures in the conglomerate are consistent with high-energy fluvial deposition; although this environment cannot be conclusively established in the map area, high-angle planar crossbeds seen in similar Ashcroft sandstones to the south near Merritt are supportive.

THE NICOLA HORST

INTRODUCTION

The Nicola horst (Figure 1) is a northerly trending block 40 kilometres long, entirely separated from the surrounding Nicola Group volcanic rocks by Tertiary normal faults. The horst, often referred to as the "Nicola batholith" in earlier studies, is actually a complex of Nicola Group rocks, sedimentary rocks of unknown age, tonalite and tonalite porphyry, all strongly deformed, metamorphosed to low amphibolite facies and intruded by granitoid rocks ranging in age from at least Early Jurassic to Paleocene. The adjacent Nicola Group rocks are of subgreenschist and greenschist grade and lack penetrative deformation.

Fieldwork in 1988 (Moore, 1989) and 1989 was devoted to mapping much of the horst at 1:50 000 scale. Hitherto unrecognized distinctions among the diverse plutonic and metamorphic units were made, and the penetrative linear and planar structures documented. The area of the horst has been extended significantly at its northern end, during the 1989 mapping, beyond that recorded by Monger and McMillan (1989) as a result of relocation of the boundary faults.

LITHOLOGY

Rock units of the horst are identified on the 1:100 000 geological map (Figure 3). The stratified rocks consist of strongly foliated and lineated quartzite metaconglomerate and interlayered graphitic mica schist (PMSM) as well as several units that are closely comparable to Nicola Group rocks except for their relatively high strain and metamorphic grade (TNM). The conglomerate and black schist are not comparable to any facies of the Nicola Group; they appear to structurally overlie the Nicola correlatives in the horst, although they are separated from them by plutonic units. The conglomerate comprises stretched pebble-size clasts mainly of white, grey and black quartzite in a biotite-muscovite-quartz matrix; a few fine granitoid clasts are also present. Staurolite and garnet accompany andalusite in the schist; the andalusite contains relict cores of kyanite that testify to uplift during metamorphism. The Nicola-like rocks are typified by hornblende pseudomorphs after augite phenocrysts and resemble units of the central and eastern belts. Those identified with the central belt comprise mainly uniform amphibolite or meta-augite porphyry; the remainder consist mostly of layered hornblende and hornblende-biotite schists that appear to be volcaniclastic metasediments. In the east-central part of the horst, between Nicola and Stump lakes, these rocks contain relict graded and load-cast beds, resembling those seen in Nicola Group rocks in the Stump Lake area. Near the north end of the horst, however, they are more strained and grain growth has obscured primary features.

The most strongly deformed intrusive rocks in the horst are leucocratic metatonalite and tonalite porphyry ($\mathrm{TJ_{tnm}}$), that exhibit comparable strain geometry to that of the metasediments. Metadiorite, varying to metagabbro and tonalite, is less penetratively and homogeneously strained, except near the boundary fault at the southwest end of Nicola Lake. Along the Clapperton fault system that bounds the west side of the horst, the metadiorite has been intruded by granodiorite to granite, that is also metamorphosed. A lenticular body of metaperidotite ($\mathrm{TJ_{um}}$) is converted to a pale amphibole (anthophyllite?)-rich assemblage. There are two distinct varieties of less-deformed but metamorphosed, coarse biotite granitoid rocks. The Le Jeune type ($\mathrm{TJ_{gdmL}}$) is a lenticular gneiss with augen of potassium-feldspar. It cuts the Frogmoore variety, that is less strongly foliated and more equigranular, but commonly contains mafic xenoliths with aspect ratios up to 10:1. Both units vary in composition from granite to tonalite, but are predominantly granite and granodiorite. The Le Jeune metagranodiorite has been approximately dated as earliest Jurassic by Rb-Sr whole rock isochron (R.L. Armstrong, personal communication, 1988). The southern part of the horst is dominated by the Rocky Gulch batholith, comprising a potassium-feldspar megacrystic granodiorite to granite that is superficially similar to the earlier units but is typically coarser, essentially massive and undeformed except for microscopic intracrystalline strain. It cuts the Frogmoore type, with which it is intimately mixed in the north-central part of the horst. Uranium-lead zircon dating yielded a Paleocene age of 64.5±0.5 Ma for the Rocky Gulch batholith (R.R. Parrish, personal communication, 1988).

STRUCTURE and METAMORPHISM

Foliation and lineation trends in the highly strained rocks are essentially uniform across the horst; foliations strike west-northwest and dip southward, stretching lineations plunge moderately westward. Kinematic indicators yield a mix of shear senses (Moore, 1989, reported predominantly contractional geometry on the basis of a smaller data set). The strong flattening and mixed shear sense are, however, consistent with a compressional regime. The horst is limited on the west by the Clapperton fault system and on the east by the Quilchena - Moore Creek system. These boundary faults cut the penetrative structural trends, as well as the Rocky Gulch granodiorite, and are probably Eocene as they are at least partly overlapped by Miocene Chilcotin basalt. The boundary faults are part of a regional extensional system (Ewing, 1980; Monger and McMillan, 1989) that in part divides facies of the Nicola Group and has localized Eocene sedimentation. Kinematic indicators in mylonitic metadiorite, recrystallized under amphibolite facies conditions along the southwest boundary fault, show contraction during ductile strain. The mylonite is brecciated and in contact with Nicola rocks at low greenschist facies, suggesting that the fault has been reactivated with extensional displacement. This fault extends southward, across Nicola Lake, where it forms the boundary between the western and central Nicola facies. A wedge of strongly deformed chert-pebble conglomerate, 10 to 20 metres thick, lies in this fault zone on the south shore of the lake; it is similar to that in the horst to the north except for lower metamorphic grade, and totally exotic to the adjacent Nicola rocks that exhibit less ductile strain. This contrast implies major tectonic transport along the fault at this site.

TECTONICS

Early strain features in the Nicola horst, that must be no older than Late Triassic (the age of the Nicola Group) are consistent with contractional tectonics and most probably relate to accretion of the Nicola arc. Although an unconformity has been mapped at the base of the eastern sedimentary facies of the Nicola Group, east of the project area where it lies on the Chapperon Group (Read and Okulitch, 1977), the presence of slices of exotic rocks between Nicola facies belts suggests significant early contraction. Eocene extension exhumed a deep level of a probably imbricate thrust stack, presently exposed to view in the Nicola horst.

MINERAL OCCURRENCES

The mineral deposits and metallogeny of the Nicola Lake region are treated in more detail in Part B by R.E. Meyers and T.B. Hubner. Known prospects are shown on Figures 3 and 4 and described in Table 1. The Swakum area is of particular interest in the light of the field relationships described above. There are two principal deposit types, both polymetallic: copper-bearing skarns within the alteration zone shown on Figure 4 and lead-zinc-copper-silver-gold quartz-stockwork veins associated with iron-rich carbonate alteration zones, both within and outside the skarn zone. The former type is exemplified by the Lucky Mike, where copper is accompanied by subordinate tungsten, silver, gold, lead and zinc. Old Alameda and the other deposits shown on Figure 4 are of the latter type.

A few important conclusions may be drawn. Field relationships show that the skarn alteration predates the Ashcroft sedimentary rocks. Similar reasoning indicates that the granite near Rey Lake, despite its spatial association with skarn, is also later than the alteration. In the absence of direct evidence, it is suggested that an unexposed intrusive body is responsible for the alteration zone.

In contrast, the carbonate alteration and associated mineralization are younger than the Ashcroft limestone at the Thelma and Bernice properties and also north of Swakum peak, where limestone is mineralized and, together with Nicola rocks and post-Ashcroft porphyry, silicified and altered to iron carbonate. This mineralizing event is clearly Jurassic or younger, and distinct from skarn formation.

Most of the few mineral occurrences in the Nicola horst are copper showings, with anomalous gold, associated with the metadiorite and included metabasalts near Nicola Lake. Molybdenum occurs on the Turlight property, and also in pegmatites cutting meta-Nicola volcaniclastic rocks near the north end of the horst.

PART B

MINERAL OCCURRENCES

By R.E. Meyers and T.B. Hubner

INTRODUCTION

The Nicola Lake region has a long and varied history of mineral resource exploitation. The area is dominated by the Nicola volcano-sedimentary belt which, throughout its length in the Intermontane Belt of British Columbia, is known for its association with major porphyry copper-gold and copper-molybdenum deposits. However, despite the base metal mining history in adjacent regions, the prime exploration focus in the Nicola Lake area has been on precious metals targets. The known mineral occurrences vary from quartz and quartz-carbonate veins to base metal bearing and, to a lesser extent, precious metal bearing skarns; porphyry deposits, so important elsewhere in the region, are generally under represented.

This report consolidates data collected and compiled on the mineral occurrences in the Nicola Lake area in 1988 and 1989 during mapping programs (Moore, 1989) associated with the LITHOPROBE transect and subsequent compilation of the geology of the 92I/SE map sheet (Moore and Pettipas, 1990).

HISTORY

In the 1890s prospectors working around Mineral Hill, near Stump Lake, discovered gold-silver-bearing quartz veins which were later staked as the Joshua, Tubal Cain, Enterprise and King William properties. During early development of the prospects the area was described as "...a new and enormously rich mining district...", having geology "...similar to that of the richest mining districts in Mexico..." (Dodd, 1887, pages 274-275) Encouraging statements such as this attracted numerous prospectors and geologists to the region and eventually mining companies were formed to develop the newly discovered mineral deposits.

During this period, and well into the 1920s, promising-looking discoveries were made at Iron Mountain near Merritt, Nicola Lake and Swakum Mountain. Most were gold-silver-bearing quartz veins containing variable amounts of lead, zinc and copper; at some localities barite, tungsten and molybdenum were also found.

Stump Lake saw the first major mine and mill development on the Enterprise - King William veins. This mine produced some 70 000 tonnes of gold-silver-lead-zinc-copper ore during intermittent operating periods between 1916 and 1942.

At Swakum Mountain the first discovery was the Lucky Mike copper-gold skarn in 1916, followed by the Old Alameda in 1920 and the Thelma/Bernice in 1927. The latter were polymetallic mesothermal to epithermal veins which produced about 80 tonnes of lead-zinc-silver-gold ore. In 1943, the Strategic Minerals Committee evaluated the Lucky Mike deposit for its tungsten potential, estimating a grade of 0.312 per cent WO_3.

By 1929, the Leadville/Comstock shaft was developed on Iron Mountain, with minor barite-rich lead-zinc-silver production. Small exploration shafts had already been sunk on the Charmer prospects, but without much success.

North of Nicola Lake, the Turlight (Copperado) copper-gold deposit was discovered and developed during 1928-29. Following several periods of exploration and construction, the property produced about 227 tonnes of 5 per cent copper ore by 1960.

During the 1950s, stimulated by discoveries in the Highland Valley to the northwest, the Promontory Hills, on the southern edge of the Guichon Creek batholith, became the focus of exploration programs. The initial strategy was to follow-up magnetic lows (using a Highland Valley model), until magnetite-copper skarn mineralization was recognized. Craigmont was discovered in 1957, brought to production in 1961, and until its closure in 1982, produced a total of 29 325 342 tonnes of ore averaging 1.37 per cent copper, 0.37 per cent iron, 0.0023 gram per tonne gold and 0.0071 gram per tonne silver.

Despite a long and intermittently aggressive history of exploration, only the Craigmont deposit became a major producing mine. However, more than 200 mineral occurrences have been discovered in this relatively small region, only a portion of which are shown in Figure 3 and listed in Table 1, and the prospects for new discoveries continue to be high.

MINERAL OCCURRENCES

SWAKUM MOUNTAIN

Since discovery of the Lucky Mike deposit in 1918, the Swakum Mountain area has been recognized as a mining camp and has yielded small but significant quantities of base and precious metals (Cockfield,1948). Although none of the early discoveries remain in production, there are many mineral occurrences that have not been thoroughly evaluated and exploration is active to the present day. There are two principal deposit types; both are polymetallic: (i) copper-bearing skarns within the alteration zone shown on Figure 3, and (ii) lead-zinc-copper-silver-gold quartz-stockwork veins associated with iron-rich carbonate alteration zones, that occur within and outside the skarn zone. The former type is exemplified by the Lucky Mike deposit (14), where copper is accompanied by subordinate tungsten, silver, gold, lead and zinc. Old Alameda (20), Thelma and Bernice (25) are representative of the latter type (only the main Swakum occurrences are shown in Figure 3; all the known prospects are plotted on Figure 4).

The Lucky Mike deposit occurs in a zone of coarse magnetite-pyroxene-calcite-epidote-garnet skarn localized in the footwall of the contact between andesite breccia and massive and brecciated limestone of the Nicola Group. The zone, which was drilled in 1943 (Cockfield 1948), 1964 and again in 1988 (Wells, 1989), strikes about 020° and dips steeply toward the east; it is at least 100 metres long and 5 to 25 metres thick. The main metallic minerals are magnetite, hematite, scheelite, pyrrhotite, pyrite and chalcopyrite; chalcopyrite forms patches up to about 4 centimetres across in the skarn. Tungsten content was estimated circa 1943 at 0.15 per cent WO_3. The zone varies from some 25 metres width at surface to 1 or 2 metres at 50 metres below surface (Wells, 1989).

Skarn alteration irregularly penetrates the volcanic rocks, where epidote and magnetite, with lesser pyroxene and garnet, are the main alteration minerals. Pyrite is locally prominent and has apparently formed at the expense of magnetite. It is typically associated with iron-rich carbonate alteration and may postdate skarn formation (*see* below). The extent of the alteration zone, determined mainly by the anomalous presence of magnetite in the normally nonmagnetitic intermediate to mafic flows and breccias, has been approximately outlined on Figure 4. The indicated area of 8.5 square kilometres is a minimum because exposure is poor; the zone is truncated against Ashcroft conglomerate by a normal fault to the west.

There are several prospected occurrences of chalcopyrite, with pyrite and magnetite, within the zone (17, 18). These are associated with prominent epidote alteration of volcanic rocks in the absence of limestone; scheelite is also reported at 17. At Rey Lake (11), chalcopyrite and molybdenite occur in porphyry-style veins, breccias and disseminations, but with spatially associated skarn alteration zones (McMillan, 1974). The only intrusive rocks observed in the area are quartz-feldspar-phyric granite and quartz monzonite. These rocks appear unaltered and thus to postdate the skarn alteration; the granitic rocks, which yielded a K-Ar biotite date of 67.2±2.5 Ma (McMillan, 1974), bear a close resemblance to the Paleocene Rocky Gulch granite of the Nicola horst. Ashcroft sedimentary rocks on Swakum Mountain and northeast of Sophia Lake, tentatively dated at Early to Middle Jurassic (this study), outcrop within tens of metres of altered Nicola rocks, but are unaffected by the skarn alteration. Given the association of alteration with subvolcanic diorite and gabbro elsewhere in the Nicola Group, it is probable that the Swakum Mountain skarn zone is related to a Late Triassic mafic pluton that is not exposed.

The majority of prospects on Swakum Mountain are associated with rusty weathering iron carbonate alteration zones. They typically contain disseminated pyrite in quartz-calcite stockwork-vein systems, exhibiting prominent brecciation and open drusy cavities. The main ore minerals are galena and sphalerite, with subordinate pyrite, chalcopyrite, tetrahedrite and gold. Silver values are associated with galena. At the Sunshine deposit (28-30), mineralization is associated with multiple stages of quartz-carbonate vein brecciation. The Sunshine and Corona (26) deposits are hosted by andesite flows and breccia and the Old Alameda (20) by felsic (dacite?) breccia, all of the Nicola Group. The Thelma and Bernice deposits (25) lie on the unconformity (?) between Nicola andesite breccia and conglomerate and overlying limestone of the Ashcroft Formation. Although the veins are concentrated in the Ashcroft limestone, the alteration, which appears to be related to a northerly striking fault, affects both units. The Old Evelyn deposit (24) is in the same limestone. The base of the Ashcroft succession is also mineralized on Swakum Mountain and north of Sophia Lake, where it comprises intercalated limestone and sedimentary breccia with cherty clasts (19) or pyritic sandstone and mudstone (16, 27). At several localities, earlier reports identified the host to these deposits as Nicola volcanic rocks, but although Nicola rocks crop out nearby, the only workings observed are in Ashcroft strata. Accordingly, the carbonate alteration and stockwork mineralization at Thelma and Bernice are not part of a zonal sequence with the skarn mineralization at the Lucky Mike, but instead appear to be structurally controlled and result from a distinctly later event. They appear to be related to both northerly striking faults and to the probable unconformity at the base of the Ashcroft Formation. At some occurrences (*e.g.* 19, 25), carbonate altered quartz-feldspar porphyry dikes cut the mineralized hostrocks.

The carbonate alteration and associated mineralization are younger than the Ashcroft limestone at the Thelma and Bernice properties and also north of Swakum peak, where limestone is mineralized and, together with Nicola rocks and post-Ashcroft porphyry, silicified and altered to iron carbonate. Dating of the sedimentary rocks is needed to place an upper limit on the age of this mineralizing event, but it is clearly younger than, and distinct from, the skarn formation.

PROMONTORY HILLS

Prior to discovery of the Craigmont copper-iron deposit (32), exploration activity in the area was sporadic and is not well recorded. The earliest work was probably done several kilometres to the north, in the Guichon batholith, leading to the discovery and development of the Aberdeen mine (not shown) during the period 1907 to 1926.

The Nicola Group volcano-sedimentary sequence in the central part of Promontory Hills comprises reddish subaerial volcaniclastic rocks, augite and plagioclase-porphyritic andesitic lavas interlayered with volcanic-derived, laminated, waterlain epiclastic sediments and coarse breccias (McMillan, 1977). The central section is folded into a broad northeast-trending anticline, flanked to the north by quartzo-feldspathic flows, tuffs and breccias with volcanic-derived quartz-feldspar-rich wackes, sandstones, tuffs and argillite. Farther to the northeast limestone, limy grit, breccia and argillite occur within the succession. South of the anticline, reefoid limestone is interlayered with spherulitic andesitic flows and epiclastic volcanic-derived sediments. Closer to Craigmont, andesitic flows and breccias of the Spences Bridge Group unconformably overlie Nicola rocks. The Nicola rocks are intruded by the Late Triassic to Early Jurassic Guichon Creek batholith, the Coyle stock, which is probably a Late Triassic subvolcanic intrusion (McMillan, 1977), and by quartz-feldspar porphyry dikes and dioritic dikes which may be related to Spences Bridge Group volcanic rocks.

Skarn mineralization in the Craigmont area occurs within the limestone and limy clastic sedimentary rock sequence that hosts the Craigmont orebody. The sequence is folded into a tight subvertical antiform (Bristow, 1968); it is bounded on the west and south by steeply dipping faults and on the east by diorite and granodiorite of the Guichon Creek batholith. The mineralization is zoned and has developed progressively approaching the mine area and batholith. In the upper part of the section, limestone is converted to marble and clastic rocks are hornfelsed and weakly epidotized. Deeper in the section, near the orebodies and the intrusive contact, massive actinolite skarn is the dominent rock type and garnet skarn with minor diopside is developed locally. Bristow (1968) described the skarn assemblage as magnetite, hematite, actinolite, epidote, garnet, pyrite and diopside. Magnetite and hematite accounted for about 25 per cent of the orebody and chalcopyrite was the main economic mineral, occurring with minor bornite. Native copper and chalcocite occured as supergene minerals near the paleosurface and to depths of 300 metres in limonitic fault zones. The mine produced 29 325 340 tonnes of ore averaging 1.37 per cent copper, 0.37 per cent iron, 0.0023 gram per tonne gold and 0.0071 gram per tonne silver (calculated from MINFILE data). Ore reserves were exhausted in 1982, but the recovery of magnetite from stockpiles continued through 1989.

Several other copper-iron prospects have been explored in the area of the Craigmont pit. On the Marb claims (34, Key Group) chalcopyrite, magnetite, pyrite and pyrrhotite occur as stringers and disseminations in chloritic shears cutting biotite hornfels alteration in Nicola volcanic rocks (Bristow, 1988). A shallow exploration shaft was sunk on the Eric showing before 1935 (Phoenix Group, not shown), 1600 metres east of the open pit, in epidote-altered biotite hornfels. Chalcopyrite, specular hematite, magnetite and malachite occur in skarns within sandstones and greywackes intruded by dioritic and granitic dikes (Bristow, 1985).

IRON MOUNTAIN

Iron Mountain is underlain by Nicola western belt volcanic and volcano-sedimentary rocks (Preto, 1979; McMillan, 1978b; 1981). Two prospects have received most of the extensive exploration activity, which dates back to the 1890s (McKechnie, 1961). The Charmer/Judy (50) was staked in 1896 and the Comstock/Leadville (51) was discovered in 1927. Both properties received limited underground development; a small tonnage of barite zinc-lead-silver ore was mined at the Comstock, but otherwise no significant production has come from either of the two prospects. However, the association of barite with base and precious metals in a potential volcanogenic massive sulphide environment has continued to attract attention to the present day.

The Nicola volcano-sedimentary succession, which is well exposed on Iron Mountain, was mapped in detail by McMillan (1981). Amygdaloidal andesitic flows, flow breccia and rhyolite to dacite flows and breccias are interlayered with submarine lapilli ash-flow tuffs, mixed volcanic breccias, volcanic-derived siltstone and sandstone and impure limestone and limy breccia. Lithologic and stratigraphic interpretations have led to the suggestion that one or more volcanic centres occur within the sequence (McMillan, 1978b). The rocks have been locally folded and crosscut by northwest-trending normal faults.

Three small exploration shafts were sunk on the Charmer property; at the No. 2 Shaft, stockworks of quartz veins, quartz-specularite-chalcopyrite veins and quartz-poor veins of hematite±chalcopyrite cut intensely oxidized and silicified andesitic breccia and lapilli tuff. Massive, banded and bladed quartz occurs in veins up to about 10 centimetres wide. Near the shaft the veining forms a grid-like pattern, with only remnants of recognizable wallrock.

Mineralization at the Comstock deposit contrasts distinctly with that at the Charmer prospects. Massive galena, sphalerite and minor tetrahedrite(?) occur in a barite-"flooded" or replacement stockwork-like matrix. The host rocks are reddish-green potassium-feldspar bearing, moderately welded lapilli-ash rhyolite tuffs. McMillan (1978) interpreted two forms of lead-zinc-silver-barite mineralization as; 1) banded or bedded veins, and 2) rotated blocks of impure barite with sphalerite, galena and tetrahedrite in a sedimentary mélange.

At another small showing on the north flank of Iron Mountain (not shown on Figure 3), a copper-bearing vein 1 metre wide (155°/83°W) cuts augite-hornblende-plagioclase-phyric flow-top breccia and tuff. The vein is crudely zoned; the core contains breccia blocks of quartz-sericite-altered volcanic rock up to 20 centimetres across. On either side is a chalcopyrite-rich zone 20 centimetres wide, with azurite and malachite, bordered by about 5 centimetres of sericitic alteration; the wallrocks are altered with ankerite, malachite and azurite up to 2 metres from the vein margins.

NICOLA LAKE AREA

This area includes prospects north and south of the western end of Nicola Lake. The two main areas described are at Quilchena and between Nicola Lake and Pleasant Valley.

QUILCHENA

South of Quilchena, several copper-gold-silver prospects have been explored since the 1890s, following the discovery of the Guichon mine (71). No appreciable production has been reported in the area, although significant exploration efforts have focused on several prospects. The area is underlain by purplish red and green amygdaloidal augite-porphyritic flows and flow breccias, interlayered with tuffs, limestones and limy volcanogenic sediments (White, 1949; Preto, 1967; McMillan, 1981). The sequence is part of the central belt of the Nicola Group (Preto, 1979), near its boundary with the western belt.

The stratified rocks are intruded by small stocks and dikes of diorite, porphyritic and brecciated microdiorite and by later dikes of feldspar porphyry (White, 1949; McMillan, 1981). At some localities the microdiorite is cut by closely spaced northwest-trending joints that impart a sheeted appearance to the intrusion. Widespread epidote alteration characterizes the volcanic sequence in the area. Epidote fills amygdules and fractures and occurs as irregular wallrock alteration zones a metre or more in width. Several major north-trending faults that branch from the main Quilchena fault transect the area. A number of the vein prospects occur adjacent to these faults, or are associated with splays and tension fractures.

The precious and base metal bearing quartz veins at the Guichon mine occur immediately west of a major north-trending fault. They fill narrow shears and fractures and form irregular lenses and stringers that pinch and swell along the host structure. Calcite and pink potassium-feldspar are commonly associated with metallic minerals which include chalcopyrite, bornite, malachite and minor tetrahedrite. Narrow hematite-rich veinlets crosscut the veins and their wallrocks. McKechnie (1962) suggested that the veins may be coeval with the feldspar porphyry dikes that intrude the succession because some mineralized quartz veins were observed to cut the dike rocks and some dikes follow the same structures as the veins.

On the Sunnyboy (Iota; 70) claims, a northwest-trending (320°/73° NE) milky white quartz vein 10 to 30 centimetres wide (referred to by current owners as the "Master Vein"), contains bladed salmon-coloured calcite and chalcopyrite with minor pyrite and accessory galena, bornite and native gold. The vein cuts Nicola augite-phyric andesitic breccias and a feldspar-porphyritic microdiorite dike, the south end of which terminates in a partially quartz-flooded breccia zone. Scattered blebs of chalcopyrite occur in the quartz and parts of the dioritic wallrock are intensely epidotized. A secondary set of quartz veins (290°/80°N) 1 centimetre wide cut the diorite and the augite porphyry.

South of this area, several small copper-bearing veins occur in altered augite porphyry and diorite. Malachite-stained veinlets and stringers of bornite, chalcopyrite and pyrite are associated with minor epidote, quartz and carbonate. Two kilometres to the southwest, on the G&G1 claims (66), quartz-carbonate veins occur in a north-trending, steeply east-dipping shear zone that is exposed in trenches over a strike length of approximately

80 metres. These veins contain chalcopyrite, malachite and geochemically anomalous gold. The prospect occurs in reddish and grey-green Nicola volcanic rocks and porphyritic microdiorite. Rock-chip samples from the trenches returned gold values ranging from 26 ppb to 14 040 ppb, however, the highest gold assay on drill core from the zone is 260 ppb over 3 metres (Miller, 1987). This style of disseminated and stringer copper mineralization with weak, but anomalous gold values, may be part of a weakly developed, diorite-associated copper-gold porphyry system.

SOUTH NICOLA LAKE - PLEASANT VALLEY

This area lies at the southern boundary of the Nicola horst, where coarsely foliated biotite hornblende metadiorite and gabbro of the horst, containing a large mass of schistose metavolcanic rocks, is faulted against western belt Nicola volcaniclastic rocks. Most of the prospects in this area are copper occurrences hosted by the metadiorite; the main properties are the Copperado (Turlight) mine (77) and a prospect (TM; 78) to the east, at the contact with the Paleocene Rocky Gulch batholith. At Copperado, white quartz veins, dipping about 65° east, are mineralized with bornite and chalcopyrite. The veins cut the west-dipping mylonitic foliation of the metadiorite but are also folded and partly mylonitized. The hostrock contains a down-dip stretching lineation and kinematic indicators suggest that the penetrative deformation is associated with contractional faulting. The foliation shows ductile deformation at vein margins. Near the mine workings the foliated metadiorite is cut by an undeformed, unmineralized quartz feldspar porphyry that may be related to the younger granite. At the eastern prospect, relationships are similar, except that molybdenite is prominent in addition to bornite and chalcopyrite. These veins appear less deformed, but occur in small ductile shears that crosscut the main foliation. The foliated metadiorite host is cut by coarse undeformed dikes of Rocky Gulch granite. Two grab samples showed anomalous copper and gold values (220 ppb Au, 6.0% Cu from the mine dump; 72 ppb Au, 0.65% Cu from the eastern prospect).

The age of the metadiorite/gabbro is unknown. Its texture indicates that, before deformation and recrystallization under amphibolite facies conditions, it was a coarse plutonic rock, thus dissimilar to the fine to medium-grained subvolcanic diorites intruding the Nicola rocks to the south. It does, however, resemble facies of the Guichon batholith, to which it may be genetically related. The associated vein mineralization has porphyry copper affinities and may have been generated, or remobilized, during metamorphism and deformation.

The metavolcanic rocks south of Copperado are strongly foliated, fine-grained epidote-amphibole schists that are locally cut by shear zones with sericitic and/or iron carbonate alteration. They host syntectonic carbonate-quartz veins, some of which contain disseminated chalcopyrite. One of the two samples assayed returned an anomalous 56 ppb gold. The hostrocks appear to extend to the south shore of Nicola Lake, where they are tentatively correlated with the central facies of the Nicola Group.

There are numerous trenches in epidote-altered, augite and plagioclase-bearing Nicola volcanic sandstones near their faulted contact with the metadiorite. The trenches expose quartz and calcite veins with weak copper mineralization as malachite and minor sulphides. The rocks have locally developed cleavage, but metamorphism is low greenschist facies. Adjacent metadiorite is brecciated and, locally, carries similar mineralization. The boundary fault between the metadiorite and Nicola rocks is interpreted as an early contractional feature that was reactivated, probably in Tertiary time, as a normal fault.

STUMP LAKE

Mining at Stump Lake took place primarily between 1916 and 1944 (Cockfield, 1948). Although development work was started on several veins believed to hold promising potential, the bulk of ore produced was mined from the Enterprise vein (92). Total production is reported as 70 395 tonnes averaging 3.74 grams per tonne gold, 111.75 grams per tonne silver, 0.03 per cent copper, 1.42 per cent lead and 0.24 per cent zinc (calculated from Cockfield, 1948).

Most of the major veins in the camp are northerly trending, steeply east-dipping and less than a metre in average width, although vein widths of 2 or 3 metres have been reported (Dodd, 1887; Thomson, 1917). The veins are enclosed in west-dipping volcaniclastic rocks and volcanogenic and epiclastic sedimentary rocks containing abundant augite porphyry clasts. They have been followed along strike for up to 500 metres and down dip for 300 metres. The hostrock sequence was interpreted by Cockfield (1948) and others to range from volcanic flows to dioritic intrusions (Dodd, 1887), but has recently been reinterpreted by Moore (1989). The wallrocks and veins are cut, in places, by hornblende-porphyritic dikes of intermediate to mafic composition (Hedley, 1936). Brittle faulting has broken the succession into a number of rotated blocks. Movement on the faults is variable; historical descriptions of underground workings indicate that most vein off-sets were rarely more than a few metres.

The veins at Stump Lake consist of polymetallic quartz-sulphide and quartz-carbonate-sulphide assemblages that are mesothermal to epithermal in character. The most abundant metallic minerals are pyrite, chalcopyrite, galena, sphalerite and tetrahedrite, with small amounts of bornite, scheelite, arsenopyrite, pyrrhotite and native gold. Quartz is massive to weakly banded, milky white with metallic minerals distributed on partings and in crudely developed, sulphide-rich bands or layers parallel to vein walls.

Alteration adjacent to most veins is typically a carbonate-pyrite±mica assemblage. Near the Enterprise adit, sericite, dated at 73.2±2.5 Ma by K-Ar methods, and weak chlorite alteration penetrative foliation, apparently associated with localized shears, since this fabric is not widespread in the area. Veins exposed near the Joshua shaft (93) strike north-northeast and dip about 50° to the east. Alteration here is iron-carbonate with abundant green mica. At some localities multiple veins 5 to 10 centimetres wide are oriented parallel to prominent north and north-northeast trending fractures and joints. Similarly oriented veins with associated iron-carbonate and green mica alteration are exposed near the Planet (91) workings.

Early in the development of the camp the Enterprise, No Surrender (90) and King William (87) veins were recognized to be controlled by the same northerly trending structure (Cockfield, 1948). As suggested by Moore (1989), the orientation of these and other veins in the camp is subparallel, or conjugate to prominent fractures and faults, such as the early Tertiary Quilchena fault, which suggests that they formed during, or soon after, regional brittle faulting in an extensional tectonic environment.

DISCUSSION OF METALLOGENY

It is evident from the distribution of mineral occurrences (Figure 3) that certain map units and localities in the project area have a much higher incidence of deposits than others. Almost all prospects are in the western and central belts of the Nicola Group; the eastern belt, except for the Stump Lake area, contains notably fewer deposits and the fine-grained sedimentary facies are almost devoid of occurrences. Similarly, the Nicola horst and all post-Nicola volcanic and sedimentary units in the area are low in mineral potential.

Mineral occurrences in the Nicola Lake area are tentatively classified into five main groups:

1. Skarn-hosted copper-iron deposits, with or without gold, at or near contacts of Late Triassic or Jurassic intrusions, in the intrusive body or the wallrocks. Craigmont and probably the early Swakum Mountain occurrences are of this type. Craigmont is associated with the Guichon Creek batholith; the supposed source on Swakum Mountain is not exposed.
2. Porphyry-style copper-gold and copper-molybdenum deposits, associated with Triassic-Jurassic and younger plutons. This class is important because all the major Highland Valley and Iron Mask deposits are of this type. The south Nicola Lake and Quilchena occurrences lie in or near small, probably subvolcanic bodies of diorite/gabbro intrusive into the Nicola Group. The mineralization in the metadiorite and adjacent metavolcanics of the south Nicola area has been affected by at least part of the metamorphism and deformation that affect rocks of the horst and may have been remobilized during these events. At Rey Lake (11) copper-molybdenum mineralization occurs within and adjacent to a Late Cretaceous - Early Tertiary granitic intrusion; mineralization and intrusive rocks are generally undeformed.
3. Lead-zinc-barite deposits, possibly volcanogenic in origin, within Nicola felsic volcanic and volcaniclastic rocks. These are uncommon but at least one occurrence on Iron Mountain (51) is of this type. The scarcity of this type of deposit in the region may relate to the shallow marine or subaerial environment of much of the volcanic activity.
4. Precious metal bearing quartz veins. This category consists of two subclasses:
   - (a) Quartz lode deposits in low-grade metavolcaniclastic rocks that lack associated igneous intrusive bodies as exemplified by some veins in the Stump Lake camp. Sericitic alteration zones bordering the veins are schistose, indicating that syntectonic metamorphism may have generated the mineralizing fluids. Although it is possible that this event was of Mesozoic age (related to accretion of the Nicola island arc?), it could alternatively be related to Late Cretaceous to Eocene extensional faulting.
   - (b) Epithermal gold-silver-bearing quartz veins and alteration zones associated with Late Cretaceous to Tertiary extensional faults. Examples of these are documented east of the project area, in the Tertiary volcanic rocks near Okanagan Lake (*e.g.* Brett deposit; Meyers, 1988). There are, however, potential analogues in the project area: pyritic sericite-carbonate alteration zones in the Nicola Group (13) associated with the Clapperton fault system, bordering the west side of the Nicola horst, exhibit gold anomalies. North of Stump Lake, chalcedony veins (100) cut Tertiary conglomerate containing clasts of silicified wood; similar veins to the west (99) carrying fluorite have also been prospected for gold.
5. Stockwork quartz-carbonate veins, with open cavities, hosting polymetallic gold-silver-copper-lead-zinc mineralization. This is the predominant type on Swakum Mountain, where it is associated with prominent carbonate alteration zones and structures which crosscut and postdate Early to Middle Jurassic Ashcroft sediments, but also occur in Nicola rocks. Deposits of this type are also common in the Merritt - Iron Mountain area. The energy source for fluid generation and circulation is not clear in this case. It could relate to arc accretion, Cretaceous regional heating accompanying Spences Bridge volcanism, or to Late Cretaceous to Eocene extensional tectonics.

ACKNOWLEDGMENTS

This paper has benefited from discussions with Ken Daughtry, Bill McMillan and Vic Preto, who were all generous with their data and time. A critical review of the manuscript of Part B by McMillan is also gratefully acknowledged. Potassium-argon dating quoted in Part B was done by J. Harakal and D. Runkle at The University of British Columbia.

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BRITISH COLUMBIA GEOLOGICAL SURVEY

OPEN FILE 1990-29 ①

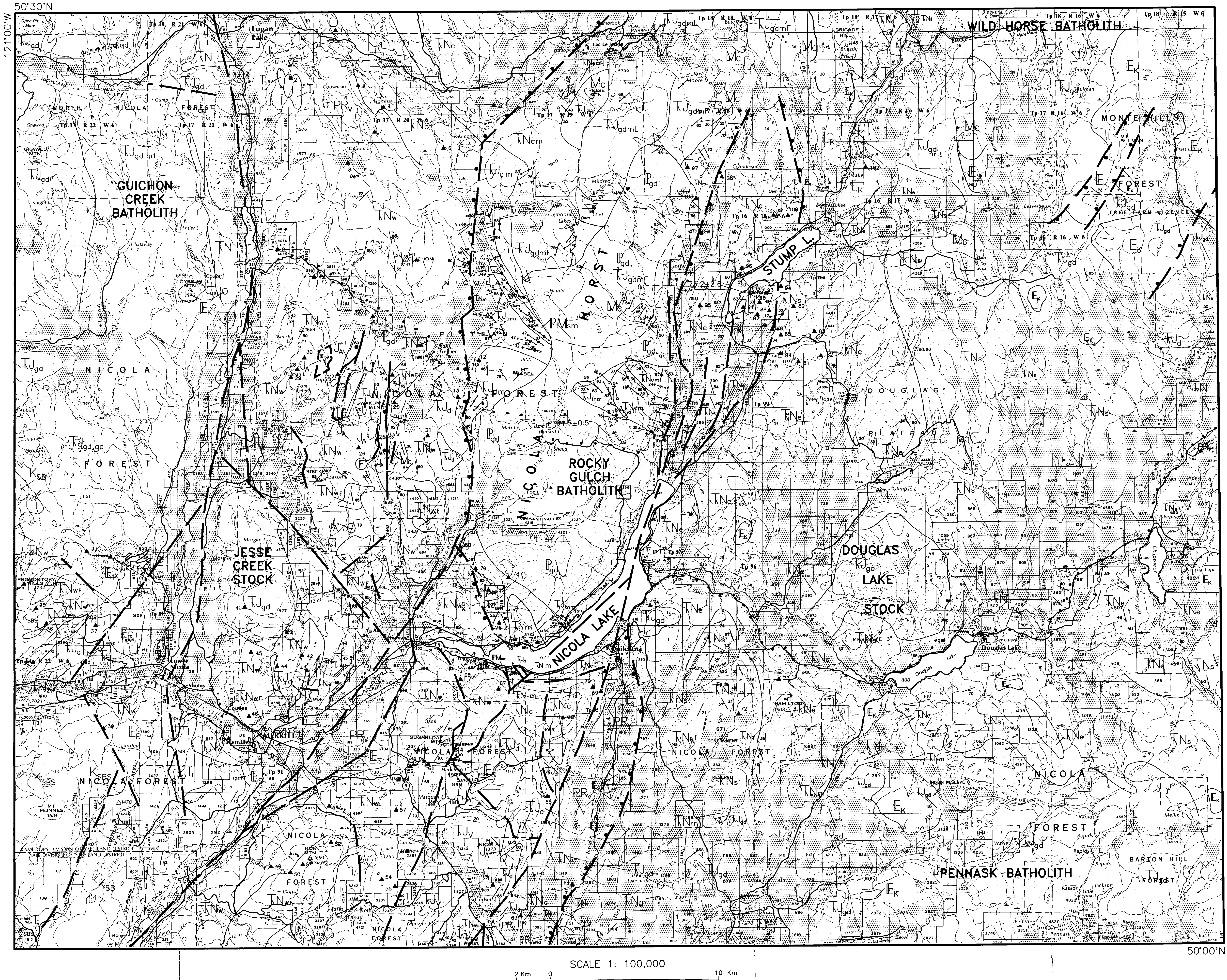
(SHEET 1 OF 2)

GEOLOGY AND MINERAL OCCURRENCES OF THE NICOLA LAKE REGION (92I/SE)

(Figure 3 and Table 1)

SCALE 1:100,000

Geological compilation by J.M. Moore and A.R. Pettipas
Mineral occurrence compilation by R.E. Meyers and T.B. Hubner
1989-90



LEGEND

LITHOLOGIC UNITS

QUATERNARY

▨	Glacial, fluvioglacial, fluvial and lacustrine deposits; colluvium, landslide deposits
PR_V	Olivine basalt, typically vesicular ("Valley basalt")

TERTIARY

T_I	Small intrusions of mainly intermediate composition

MIOCENE

M_C	Olivine basalt ("Chilcotin basalts")

EOCENE
KAMLOOPS GROUP

E_K	Mainly basalt and andesite; local rhyolite, breccia, tuff and sandstone

PRINCETON GROUP

E_P	Intermediate, locally mafic or felsic flows, characterized by acicular hornblende phenocrysts
E_S	Sandstone, conglomerate, argillite, coal ("Coldwater beds")

PALEOCENE

P_{gd}	Granodiorite, tonalite and granite with K-feldspar megacrysts, of ROCKY GULCH batholith and possibly REY LAKE pluton

MID AND LATE CRETACEOUS

SPENCES BRIDGE GROUP

K_{SB}	Intermediate, locally felsic and mafic flows and pyroclastic rocks; sandstone, shale, conglomerate

SPIUS CREEK FORMATION (SPENCES BRIDGE GROUP)

K_{SBS}	Mafic volcanic rocks

EARLY AND MIDDLE JURASSIC

ASHCROFT FORMATION

J_A	Polymictic conglomerate, pyritic sandstone and siltstone, mudstone, bioclastic calcarenite

LATE TRIASSIC and/or OLDER

TJ_{gd}	Hornblende-biotite and biotite granodiorite and quartz diorite (qd) of GUICHON CREEK, WILD HORSE and PENNASK batholiths, JESSE CREEK and DOUGLAS LAKE stocks and unnamed bodies
TJ_{gdm}	Metamorphosed hornblende-biotite and biotite quartz diorite, granodiorite and granite (gt) of Nicola horst; F: Frogmoore variety; L: Le Jeune variety
TJ_{tnm}	Metamorphosed, highly strained biotite leucotonalite and tonalite porphyry of Nicola horst
TJ_d	Augite, hornblende diorite, quartz diorite; includes subvolcanic intrusions into NICOLA GROUP. m:biotite-hornblende metadiorite of Nicola horst
TJ_{um}	Metaperidotite (Nicola horst)
TJ_V	Intermediate and mafic, maroon plagioclase- and augite-plagioclase-phyric sills and/or flows and volcaniclastic rocks; red volcanic conglomerate, sandstone, mudstone

LATE TRIASSIC

NICOLA GROUP

TN	Mafic and intermediate volcanic and volcaniclastic rocks, undivided; m:upper greenschist-low amphibolite facies metavolcanic rocks, mainly in Nicola horst: hornblende and biotite-hornblende schist, amphibolite
TN_w	Western volcanic facies: mafic to felsic, plagioclase-phyric flows, pyroclastic and epiclastic breccias, tuff, wacke, minor limestone and limestone conglomerate f: predominantly felsic flows, tuff, welded tuff
TN_c	Central volcanic facies: mafic and intermediate plagioclase-augite-phyric flows, locally pillowed, and breccia; subordinate tuff, limestone, wacke and siltstone
TN_e	Eastern volcanic facies: mafic hornblende- and augite-phyric, predominantly epiclastic breccia, turbidite wacke, local siltstone
TN_s	Sedimentary facies: volcanic sandstone, siltstone, argillite, tuff; local polymict conglomerate

PALEOZOIC(?) or MESOZOIC

PM_{sm}	Quartzite metaconglomerate, black staurolite-andalusite-mica schist

SYMBOLS

— —	Lithologic contact (broken where speculative)
······	Boundary of unconsolidated deposits
— • —	Fault; solid circles on downthrown side
▲	Base and/or precious metal occurrence (Table 1)
••••••	LITHOPROBE transect route
70	Bedding (inclined, vertical)
70	Cleavage / schistosity (inclined vertical)
70	Lineation (mineral aggergates, deformed clasts)
+	Uranium-lead zircon date locality *
∗	Potassium-argon sericite schist date locality *
Ⓕ	Fossil locality*

* Supplementary to Monger and McMillan (1984)

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Geological mapping by J.M. Moore (1988) and J.M. Moore and A.R. Pettipas (1989)

Base map: Merritt, B.C., Map 92I/SE, scale 1:100,000. Ministry of Environment, British Columbia, 1980

SCALE 1: 100,000

2 Km 0 10 Km

TABLE 1: Mineral occurrences in the Nicola Lake region. Numbers refer to symbols on Figures 3 and 4. (not all swakum mountain occurrences are shown on Fig. 3). Compilation by R.E. Meyers and T.B. Hubner from District Geologist files, Minfile data and field observations by Meyers, Hubner and the authors. Asterisks (*) denote occurrences that were visited.

NICOLA PROJECT
MINERAL DEPOSITS COMPILATION
92I/SE
Page 1

MAP NO	PROPERTY	NTS	MINFILE No.	STRAT-UNIT ASSOC	INTRUSIVE ASSOC	DEPOSIT TYPE	PRIMARY MINERALS	ACCESSORY MINERALS	ALTERATION CHARACTER	STRUCTURAL TREND	SAMPLE/PRODN GRADES (assayed/ calculated)	DEVELOPMENT	SELECTED REFERENCES
001	FORD,CHARTRANDT'S	92I/7E	92ISE-009	NICOLA		Vein	Cc,Bn	Mal,Cal	Alb, Prop	310/30	9.46g/t Ag	Adit-12m	GEM1973-186,AR151
002	SA	92I/7E	92ISE-167	NICOLA,volc,sed	Tert Stk.	Vein/Stkwk	Cc,Bn,Cp	Mal	Oxid			Trenching	AR4413,GSCMEM249
003	RHYOLITE	92I/7E	92ISE-021	NICOLA,volc,sed		Vein/Shear	Py,Sph,Cp	Mal,Azr,Cal	Oxid,Pyr,Carb	340/Shear	0.37%Cu,0.04g/tAu (Grab)	Trenching	AR18048
004	JHC,HOMFRAY	92I/7E	92ISE-147	NICOLA,and,flow		Vein/Dissem	Cc,Cp	Epdt,Chl,Hem,Mal	Prop,Oxid		14.2g/tAg,4.27%Cu (Chip)?	Drilling	AR17337,15060
005	PLUG	92I/7E	92ISE-155	NICOLA,schist	Qfp	Porphyry?	Py,Cp,Gal,Sph	Mar,Epdt	Carb,Prop,Oxid,Pyrt	340 scht	7.50g/tAu,67.5g/tAg (Grab)	Drilling	AR18048,4041
006	DES	92I/7E		NICOLA,volc	Lat dyke	Porphyry	Cp	Cal	Prop,Carb				
007	BERTHA,MOLY	92I/7E	92ESE-012	NICOLA		Shear	Py,Cp,Pt	Mal,Azr	Carb,Epdt,Chl	N-S	7.01g/tAg (c)	Shaft-23m	MAR1930-195,AR180
008	POM POM	92I/7E	92ISE-170	NICOLA,volc,sed	Dio dyke	Stkwk	Cp,Bn,	Cal,Epdt,Hem	Prop,Oxid		0.17%Cu		AR18048,GEM1973-1
009	RWS	92I/7W	92ISE-086	NICOLA,volc,sed	TJgd	Shear	Py,Cp	Cal,Hem,Chl,Ser	Prop,Ser				AR2497,GEM1970-37
010	MAD ARAB	92I/7W	92ISE-067	NICOLA,flow,breccia		Vein/Fault	Py,Gal,Sph		Carb	NE Veins	44.6g/tAg,1.4g/tAu	Adit-2.7m	MAR1967-161,1968-
011*	REY	92I/7E	92ISE-160	NICOLA,breccia	Gt Porph	Skarn/Stkwk	Py,Cp,Mo	Cal	Skarn,Epdt,Sil	N-S bdlng	21488292 T 0.23%Cu,0.023%Mo	Drilling	AR5320,CMH 1985-8
012	CLAP	92I/7E	92ISE-174	NICOLA,volc	TJgd	Vein/Dissem	Cp,Bn,Cc,Mo	Mal,Epdt	Oxid,Epdt,Arg,Chl		0.4%Cu,0.2%Mo (Grab)		AR6040,5678
013*	CLAPPER	92I/7E	92ISE-135	NICOLA,and,tuff,bx	TJd	Vein/Dissem	Py,Cp,Cc,Mt,Spec,Sp	Gal,Mal,Kaol	Carb,Kaol,Arg,Sil	NW	4.75g/tAu,144g/tAg (Chip)	Trenching	AR18042,2105
014*	LAST CHANCE,LUCKY MIKE	92I/7E	92ISE-027	NICOLA,lst,breccia	And dyke	Skarn/Vein	Cp,Po,Pyrr,Gal,Sph	Wol,Mal,Azr	Skarn	NE-Shears	5.7g/tAg,0.04g/tAu	Shaft, Adit	MAR1915-36,AR1858
015	ALAMEDA 1	92I/7E	92ISE-095	NICOLA,volc,sed		Skarn	Py,Gal,Cp,Sph	Epdt,Cal	Skarn	180/35		Shaft	AR12897,GSCMEM249
016	ALAMEDA 3	92I/7E	92ISE-097	NICOLA/ASHCROFT		Vein	Cp,Gal,Sph,Py			030/NW		Shaft-5.5m 1927-40	MAR1959-36,GSCMEM
017*	GOLD GOSSAN	92I/7E	92ISE-106	NICOLA,flow,breccia		Vein/Shear	Py,Gal,Cp,Sch	Epdt	Sil	295/80		Adit-21m	GSCMEM249
018	GLORIA 1	92I/7E	92ISE-105	NICOLA,flow,breccia		Vein	Py,Cp	Tel,Lim	Oxid	190/75		2 Shafts-15m 1927-40	GSCMEM249
019	ALAMEDA 4	92I/7E	92ISE-098	ASHCROFT,sed		Vein	Cp,Gal,Sph,Py			050/80		Trenching 1918-40	MAR1959-36,GSCMEM
020*	OLD ALAMEDA	92I/7E	92ISE-094	NICOLA,felsic bx		Vein	Py,Gal,Sph,Cp			N-S Veins	180.0g/tAg,8.67g/tAu (Chip)	Shaft-38m	AR18583,GSCMEM249
021*	ALAMEDA 2	92I/7E	92ISE-096	NICOLA,felsic tuff		Vein/Shear	Py,Cp,Gal					Shaft-6.1m 1927-40	GSCMEM249
022	ALAMEDA 5	92I/7E	92ISE-099	ASHCROFT,sed?		Breccia	Py,Gal,Tet					Trenching 1918-40	MAR1959-36,GSCMEM
023	ALAMEDA 6	92I/7E	92ISE-100	NICOLA,flow,breccia		Vein/Shear	Py,Cp					Shaft-15m,Trench 1927-40	MAR1959-36,GSCMEM
024*	OLD EVELYN	92I/7E	92ISE-103	ASHCROFT,lst		Skarn	Py,Gal,Sph	Gar,Epdt	Skarn	150/30		Adit-24m 1927-30	MAR1928-24,GSCMEM
025*	THELMA,BERNICE	92I/7E	92ISE-101,102	ASHCROFT,lst		Vein	Py,Gal,Sph,Cp,Tet	Epdt,Gar,Ank	Carb	160/30	2911.4g/tAg,0.38g/tAu (c)	2Shafts-67,35m 1926-38	MAR1928-224,GSCME
026*	CORONA	92I/7E	92ISE-104	NICOLA,flow,tuff		Vein	Py,Gal,Sph,Tet	Lim,Ank	Carb,Oxid	220/80	2442.1g/tAg,0.1g/tAu (Grab)	Shaft-20m 1927-31	AR15312,GSCMEM249
027*	SOPHIA	92I/7E	92ISE-059	ASHCROFT,sed		Vein/Shear	Py,Sph,Gal,Cp	Cal,Hem	Carb,Oxid,Ser,Pyrt	220/45	0.01%Cu,0.05%Zn (Chip)	Drilling,Trenching	AR15318,12386
028*	SUNSHINE 1	92I/7W	92ISE-129	NICOLA,and.breccia		Vein/Shear	Py,Gal,Cp,Sph,Pyrr	Cal	Sil	225	12.34g/tAg,4.8%Zn,1.7%Pb(DDH)	Adit-300m 1968	AR8036,MAR1967-16
029*	SUNSHINE 8	92I/7W	92ISE-127	NICOLA,and,breccia		Vein/Shear	Gal,Sphl			265/65		Drilling,Trenching	AR6742,MAR1965-15
030*	SUNSHINE 11,13	92I/2E	92ISE-128	NICOLA,and.breccia		Vein/Shear	Py,Gal,Cp,Sph			225	2.4g/tAg,0.17%Cu,4.1%Zn (DDH)	Trenching,Drilling	AR8036,MAR1966-16
031	AC	92I/2E	92ISE-133	NICOLA,breccia	TJd	Vein	Cu Sulphides	Cal	Carb			Drilling	AR15506,MAR1967-1
032*	CRAIGMONT	92I/2W	92ISE-035	NICOLA/SPENCES BR.	TJgd	Skarn	Mag,Cp,Spec,Py,Cc,Bn	Cal,Hem	Skarn		1.34%Cu,19.8%Fe,Blk Sample	Open pit,u/g	OF1988-28,CIM MTG
033	MERCHANTS	92I/2W		NICOLA/SPENCES BR.	TJgd	Skarn	Py,Pyrr,Cp	Hem,Epdt,Act			0.40%Cu,8.40%Fe (DDH)	Drilling	AR14102,6811
034	BETTY LOU	92I/2W	92ISE-173	NICOLA,volc,sed	TJgd	Skarn	Py,Cp,Gal,Sph,Mt	Gar,Epdt,Act	Skarn,Biotite			Trenching,Drilling	AR17677,16492
035	HANK 30	92I/2W	92ISE-038	NICOLA,volc	TJgd	Vein/Skarn	Cp,Mt,Py,Co,Spec	Cal,Gar,Epdt	Prop,Skarn	NE/SE		Drilling 1960?	MAR1963-51,1960-3
036	HANK 1-4	92I/2W	92ISE-039	NICOLA,volc,sed	TJgd	Vein/Skarn	Cp	Spec,Cal,Epdt,Gar	Prop,Skarn	NE/SE		Trenching 1958	MAR1963-51,1958-2
037	ARH-NORTH CHALCO	92I/2W	92ISE-040	NICOLA,volc,sed	TJd	Skarn	Cp,Py,Mt	Hem,Gar	Skarn,Oxid				AR5771,MAR1960-26
038	TEX,WADE	92I/2W	92ISE-041	NICOLA,volc,sed	TJd	Stkwk	Cp,Bn,Py,Pyrr	Cal,Sid	Carb,Prop,Oxid,Ser	NNE/W		Trenching 1960-61	AR441,MAR1961-41
039	LAW	92I/2W	92ISE-148	SPENCES BR./NICOLA	Diab dyke	Vein/Dissem	Cp,Bn,Mt,Sph,Py	Spec	Skarn,Prop		320.9g/tAg,2.83g/tAu (c)	Drilling	MAR1967-166,1966-
040	RYE	92I/2W	92ISE-043		TJgd	Stkwk	Cp,Py,Mt,Bn	Mal,Azr,Hem	Oxid			Trenching	AR2375,MAR1963-52
041	JUSTICE	92I/2W	92ISE-044		TJgd	Vein/Dissem	Cp,Mt	Cal,Mal,Chl	Ser,Oxid			Trenching	AR6132,MAR1962-55
042	CHASE	92I/2W	92ISE-045	NICOLA,sed	TJd	Skarn	Py,Cp,Sph	Hem	Skarn				AR10210,8728
043*	CINDERELLA	92I/2W	92ISE-168	NICOLA,and,lst	TJd	Vein,Skarn,Stwk	Py,Cp,Spec,Mt,Mal	Cal,Epdt	Skarn,Oxid,Alb	NNW		4 Shafts	AR7218,MAR1964-94
044	VAL	92I/2W	92ISE-064	NICOLA,volc		Disseminated	Py,Cp,Bn	Lim	Oxid			Trenching,Drilling 1972	AR1799,Expl 1972-
045	MIKE	92I/2W	92ISE-083	NICOLA,and	Rhy/Apl dyk	Disseminated	Py,Cp,Bn	Lim	Oxid				AR2466,GEM1970-37
046	DOE	92I/2W		NICOLA,and		Vein/Shear	Py,Mal	Cal	Carb,Oxid	135/70	0.15%Cu (Chip)	Trenching	AR12514
047	COPPER BELLE	92I/2E	92ISE-121	NICOLA,flow	TJd	Vein	Cp,Spc,Ru	Cal	Oxid	090/20	253.0g/tAg (c)	4 Adits 1908-13	AR9088,MAR1966-16
048	ANACONDA	92I/2W	92ISE-050	NICOLA,and		Vein?	Spec	Py,Cp,Cal	Oxid,Chl			Shaft-3m,2 Adits-9m,61m	MAR1915-231,GSCME
049*	DIANE,STIRLING	92I/2W	92ISE-022	NICOLA,volc,sed		Veins in Shears	Py,Cp,Sph	Spec,Hem,Mal,Azr	Oxid,Prop,Chl		15.56g/tAu,16.43g/tAg (DDH)	Trenching,Drilling	AR17721,16058
050*	CHARMER,JUDY	92I/2W	92ISE-053	NICOLA,tuff,breccia		Vein	Cp,Hm(Specularite)		Sil,Potassic,Oxid	NW Veins	10.1g/tAu (Chip)	3 Shafts	MAR1963-53,AR1681
051*	LEADVILLE,COMSTOCK	92L/2W	92ISE-052	NICOLA,rhy flow,bx		Vein/Shear	Gal,Sph,Ba		Oxid	NE Veins	64.1g/tAg (c)	Shaft-30.5m (inclined)	GSCMEM249,AR16817
052	LD	92I/2E	92ISE-156	NICOLA,vol sst,tuff		Vein	Sph,Gal,Cp,Py	Tet,Ba			6.3g/tAg,0.8%Pb,0.046%Zn (c)	Trenching	AR12136,FDVK1978-

NICOLA PROJECT
MINERAL DEPOSITS COMPILATION
92I/SE
Page 2

MAP NO	PROPERTY	NTS	MINFILE No.	STRAT-UNIT ASSOC	INTRUSIVE ASSOC	DEPOSIT TYPE	PRIMARY MINERALS	ACCESSORY MINERALS	ALTERATION CHARACTER	STRUCTURAL TREND	SAMPLE/PRODN GRADES (assayed/ calculated)	DEVELOPMENT	SELECTED REFERENCES
053	CHATKO,BOY	92I/2E	92ISE-130	NICOLA,volc,sed		Skarn/Vein	Cp,Mt,Spec,Py	Hem,Epdt,Cal	Skarn,Sil,Oxid			Adit-1.5m,Trench	AR15100,12257
054	DOT,EVA	92I/2E	92ISE-159	NICOLA,volc,sed		Skarn/Stkwk	Sph,Pyrr,Py,Bn	Mt,Hem,Epdt,Chl	Skarn,Prop,Oxid			Trenching	AR4107,MAR1967-16
055	BLUE JAY	92I/2E	92ISE-188	NICOLA,volc,sed		Dissem	Cu,Cp,Cc					Drilling	MAR1968-202,1967-
056	ELL,BELL,IT	92I/2E	92ISE-082	NICOLA,volc,sed		Vein/Shears	Py,Cp,Bn,Sph	Oxides	Prop,Sil,Epdt,Oxid	070 Shears	133.7g/tAg,0.34g/tAu (Grab)	Shaft, X-cut-36.6m	AR12194
057	JPG 1	92I/2E	92ISE-183	NICOLA,volc,sed		Porphyry?	Cu,Cp,Bn,Sph	Mal,Azr,Hem,Cal	Prop,Oxid			Shaft	AR10483,9318
058	JPG 2	92I/2E	92ISE-182	NICOLA,volc,sed		Skarn	Cp	Mal,Azr,Epdt	Skarn,Oxid		1.04%Cu,20.15g/tAg (Grab)	Shaft	Rpt.(Timmins),Bul
059	BR1,EAST	92I/2E	92ISE-181	NICOLA,volc,sed	TJd	Skarn	Cp,Mag,Py,Cc,Bn	Epdt,Mal,Azr	Skarn,Oxid		1.37%Cu (Comp)		AR18256,Co.Rpt.19
060	SOO,BEN	92I/2E	92ISE-051	NICOLA,volc,sed		Skarn	Mt,Cp,Py	Mal,Bn,Epdt,Lim	Skarn,Oxid	NNE/55E	12.8g/tAg,1.0%Cu (Chip)	Trenching,Drilling	AR18256,9009
061	RALPH,JAN	92I/2E	92ISE-122	NICOLA,volc,sed		Skarn	Cp,Bn,Py,Mt	Mal,Cal,Epdt	Skarn,Prop,Oxid,Sil		0.53%Cu (Chip)	Shaft,Drilling	AR9009,7861
062	PORCUPINE	92I/2E	92ISE-054	NICOLA,volc	TJd	Dissem/Stkwk	Cc,Cp,Bn,Cu,Spec,Py	Mal,Azr,Zeo,Cal	Oxid,Zeol		125191 T 2.0%Cu	Shaft-15m	AR7946,MAR1963-54
063	DOR	92I/2E	92ISE-164	NICOLA,and,bx,lahar	TJd	Vein/Shear	Cp,Cc	Cal,Mal	Prop,Oxid	N-S Shears	0.12%Cu (Chip?)	3 Shafts<3m	AR4779,PROS 1989
064	MINT	92I/2E	92ISE-084		TJgd	Vein/Stkwk	Cp,Mo,Py	Mal,Azr	Prop,Oxid,Ser,Arg		0.67%Cu,0.16%Mo (Grab)	Drilling,Trenching	AR17277,5984
065	THEL/SUN,ME	92I/2E	92ISE-165	NICOLA,volc	TJd	Vein/Porphyry?	Py,Bn,Cp,Mo	Cal			25.71g/tAg,5.43%Cu (Grab)	Shaft-3m,Trenching	AR12957,4325
066	G&G 1	92I/2E	92ISE-120	NICOLA,flow,intr	TJd	Vein	Cp,Py	Cal	Prop		0.46%Au (DDH)	Trenching,Drilling	AR15852,15572
067	MOUSE,DING	92I/2E	92ISE-047	NICOLA,volc,sed	Porph dyke	Vein	Gal,Py,Bn,Cp	Tet,Mt,Spec,Cal,Mal	Prop,Oxid			Trenching	AR1798,MAR1968-20
068	IRON KING	92I/2E	92ISE-131	NICOLA,volc,sed		?	Limonite	Si	Oxid		52%Fe,52%Si	Trenching	MAR1915-231,GSCME
069*	CAT,HIGHGRADE	92I/2E	92ISE-118,119	NICOLA,flow		Vein/Shear	Bn,Cp,Tet	Mal	Prop,Oxid	NW Vein	0.02%Cu(Chip)	Trenching	MAR1967-169,AR159
070*	SUNNYBOY,CLIFF,ROY	92I/2E	92ISE-049,117	NICOLA,flow,bx	Dio dyke	Vein	Au(native),Cc,Bn	Cal	Oxid,Prop	NW Vein	7.8g/tAu,23.3g/tAg (c)	Trenching 1961-67	PROSP1988,MAR1967
071	GUICHON,QUILCHENA	92I/2E	92ISE-048	NICOLA,bslt flows		Vein in shear	Cp,Bn,native Cu	Cc,Mo	Prop,Oxid,Carb	NW Veins	24g/tAu,137g/tAg (DDH)	7 short Adits, 1945-48	MAR1949-120,AR807
072	MAY	92I/1W		NICOLA,tuff,rhy		Vein?/Dissem	Cp,Py,Cc,Mar	Mal,Azr,Ank	Carb,Oxid		0.66%Cu,2.17g/tBa (Grab)	Prosp	AR11202,10164
073	BRUCE	92I/1W	92ISE-026	NICOLA,tuff,and,bx		Vein/Stkwk	Cp,Sph	Mal,Hem,Epdt,Cal	Oxid,Prop	315/60	1.44%Cu (DDH)	Drilling	AR15232
074	MAG	92I/1W	92ISE-087	NICOLA,volc,sed	TJgd	Vein/Dissem	Py,Cp,Bn	Epdt	Prop,Pyrt				AR2564,2563
075*	NICOLA LAKE,BONA VISTA	92I/2E	92ISE-046	NICOLA,amphibolite	TJd	Veins in shears	Cp,Py,Bn	Azr, Mal	Prop,Sil,Carb	N-S shears	15.6g/tAu,9.6g/tAg/0.46m(Chip)	3 Adits-20+m	AR12137,AR7217,VS
076*	NIK	92I/2E	92ISE-143	NICOLA,amphibolite	TJd,(foltd)	Stkwk/Dissem	Py,Cp,Bn	Mal,Azr,Cal	Oxid,Chl,Prop			Drilling	AR12137,7121
077*	COPPERADO,TURLIGHT	92I/2E	92ISE-055		TJd,(foltd)	Vein/Shear	Bn,Cp,Cc	Mal	Prop,Oxid	NW Veins	48.6g/tAg,0.7g/tAu (c)	Shaft-137m,Drift	MAR1949-115,AR105
078*	COPPERADO TM1-TM6	92I/2E	92ISE-125		TJd,Tert gt	Vein/Shear	Cp,Mo,Bn,	Mal	Prop,Oxid	325/85	17.1g/tAg,0.2%Cu,0.07%Mo(DDH)	Trenching,Drilling	AR10518,MAR1967-1
079*	COPPERADO-P66	92I/2E	92ISE-123		TJd,(foltd)	Vein/Shear	Cp,Py,Bn	Cal,Mal	Prop,Oxid				AR10518,MAR1969-1
080*	PEACOCK	92I/2E	92ISE-132		TJd	Vein	Py,Cp,Bn	Mal,Azr	Prop,Oxid	N-S Veins		3 Shafts-3.0m,6m,15m 1897-15	MAR1908-138
081	JOHANNESBURG,AZELA,SCOTIA	92I/8W	92ISE-032,030	NICOLA,sed,breccia		Veins in shear	Py,Gal,Sph,Tet,Cp,Au	Bn,Asp,Pyrr,Sch,Mt	Prop,Sil,Carb	NE Veins	268g/tAg,2.5g/tAu (DDH)	Shaft-24m, 2nd Shaft-?	GSCMEM249,AR8310
082	CIG 100	92I/8W	92ISE-158	NICOLA,sed,breccia		Vein	Py,Sph	Mal	Carb,Prop,Oxid		624.6g/tAg,23.65g/tAu (Float)		AR17489,14785
083	MARY REYNOLDS	92I/8W	92ISE-115	NICOLA,sed,breccia		Vein/Shear	Py,Gal,Cp,Sph,Tet	Cal	Sil,Prop,Carb,Pyr	NNE/SE	239.27g/tAg,0.66g/tAu (Grab)	3 Shafts,3 Adits 1889-67	AR17163,GSCMEM249
084	JENNY LONG,MOON	92I/8W	92ISE-031,113	NICOLA,sed,breccia		Vein	Gal,Sph,Py,Cp	Sch	Prop,Sil	N-S Veins	167.3g/tAg,9.1g/tAu (c)	Shaft-85m,Trench	GSCMEM249,AR13152
085	IXL#6	92I/8W	92ISE-184	NICOLA,sed,breccia		Vein in Shears	Py,Gal,Sph,Tet	Epdt	Sil,Prop	010/60	126.15g/tAg,0.68g/tAu (Grab)	Shaft 1937-42	AR13152,5152
086	RAVEN	92I/8W	92ISE-114	NICOLA,sed,breccia		Vein	Py,Gal,Cp,Sph,Tet	Epdt	Sil,Prop	020/65	69.93g/tAg,0.68g/tAu (Grab)	Shaft 1937-42	AR5152,GSCMEM249
087	K.WILLIAM,SILVER K.,MARION C.	92I/8W	92ISE-110-11,177	NICOLA,sed,breccia		Vein	Py,Cp,Gal,Sph,Wo	Cal,Epdt	Sil,Prop	NNW/SE	55.82g/tAg,1.64g/tAu (DDH)	3 Shafts 1882-42	AR5152,13152,GSCM
088	EMULATOR	92I/8W	92ISE-112	NICOLA,sed,breccia		Vein	Py,Gal,Cp,Sph,Wo	Cal,Epdt	Sil,Prop	335/75	219.0g/tAg,10.2g/tAu (DDH)	Adit-27m	AR13152,GSCMEM249
089	DON,SCOTTIE	92I/8W	92ISE-136	NICOLA,volc,sed		Vein/Shear	Py,Cp,Gal,Sph,Sch	Cal,Lim,Epdt,Chl	Carb,Prop,Ser,Oxid	NNW/E	75.4g/tAg,1.47g/tAu (Chip)	3 Shafts	AR18495,BULL#10-1
090	NO SURRENDER,MAYBELL FR.	92I/8W	92ISE-175,176	NICOLA,sed,breccia		Vein	Py,Cp,Gal,Sph	Cal,Tet	Prop	N-S Veins	198.14g/tAg,3.51g/tAu (Chip)	Shaft	AR13152,5565
091*	PLANET	92I/8W	92ISE-029	NICOLA,sed,breccia		Vein	Py,Cp,Gal,Sph	Asp,Tet	Prop,Sil,Carb	N-S,Veins		Shaft-30m,Trench	GSCMEM249,AR13152
092*	ENTERPRISE	92I/8W	92ISE-028	NICOLA,sed		Vein	Py,Gal,Sph	Qz,Carb	Prop,Sil,Oxid,Chl	NNW veins	219.4g/tAg,10.2g/tAu(DDH)	Adit/UgDev-2182m, Shaft-98m	AR13152,MAR1930-2
093*	JOSHUA,TUBAL CAIN	92I/8W	92ISE-109,108	NICOLA,sed,breccia		Vein/Shear	Py,Gal,Sph,Cp,Sch	Tet,Epdt,Cal	Sil,Prop,Pyr	356/65	823.3g/tAg,20.51g/tAu (c)	2 Shafts/2 Adits 1882-42	MAR1933-178,GSCME
094	ARGUS	92I/8W		NICOLA,sed,breccia		Vein/Shear	Py	Hem,Cal	Oxid,Carb		4.11g/tAg (DDH)	Drilling	AR7133
095	TIC-TAC-TOE	92I/8W	92ISE-187	NICOLA,volc,sed		Vein	Py,Cp,Bn,Mt	Tet,Sid,Azr,Hem	Prop,Carb,Oxid	E-W	4.8g/tAg,0.13%Cu,0.21g/tAuDDH		AR11434,11050
096	BAG	92I/8W	92ISE-107	NICOLA,rhy,tuff		Vein	Py		Kaol,Sil,Pyr		0.88g/tAu,3.7g/tAg (Grab)		AR11719
097	SAR	92I/8W	92ISE-163	NICOLA,amphibolite	TJgd	Vein/Shear	Cp					Trenching	AR4326,GEM1973-19
098	ANDERSON	92I/8W	92ISE-166	NICOLA,volc,sed		Vein/Skarn	Py,Cp,Pyrr,Mo,	Epdt	Skarn,Arg,Prop	190/85	6.51g/tAu (Chip)	Adit	AR13788,GSCMEM249
099*	REDBIRD	92I/8W	92ISE-179	NICOLA,sed,breccia		Vein	Py,Fl		Oxid,Prop,Sil,Arg		2.0g/tAu,0.002g/tAg (Grab)	Trenching,Drilling	AR16075,Co.Rpt.19
100	CINDY	92I/8W	92ISE-134	NICOLA,volc,sed		Vein/Fract	Py,Cp	Ft,Ma,Cal	Prop,Arg,Oxid,Sil	NW-NE	0.70g/tAu (DDH)	Trenching,Drilling	AR16075,11397
101	TRUMP	92I/8W	92ISE-161	NICOLA,sed,breccia		Vein	Py,Cp,Sph,Bn,Pyrr	Tet,Cal,Mal,Azr	Carb,Prop,Oxid		137.1g/tAg,1%Cu (Grab)		AR13940,4165
102	NAP	92I/8W	92ISE-169	NICOLA,volc	Lamp dyke	Disseminated	Cp,Sph,Py		Sil,Carb	E-W	0.23g/tAu (PCDH)	Drilling	AR16345,4500
103*	SACK	92I/8W	92ISE-166	NICOLA,amphibolite	Peg dykes	Disseminated	Mo,Py					1-Adit	AR4323,13788

BC
Ministry of Energy, Mines and Petroleum Resources
Geological Survey Branch

OPEN FILE 1990–29 ②
(SHEET 2 OF 2)

LOCALITY MAP OF THE STUDY AREA
(Figure 1)

COMPILATION MAP OF THE LITHOPROBE TRANSECT BETWEEN GUICHON CREEK BATHOLITH AND OKANAGAN LAKE
(Figure 2)
SCALE 1:250,000

GEOLOGY OF THE SWAKUM MOUNTAIN AREA
(Figure 4)
SCALE 1:50,000

Geological compilation by J.M. Moore and A.R. Pettipas
Mineral occurrence compilation by R.E. Meyers and T.B. Hubner
1989–90

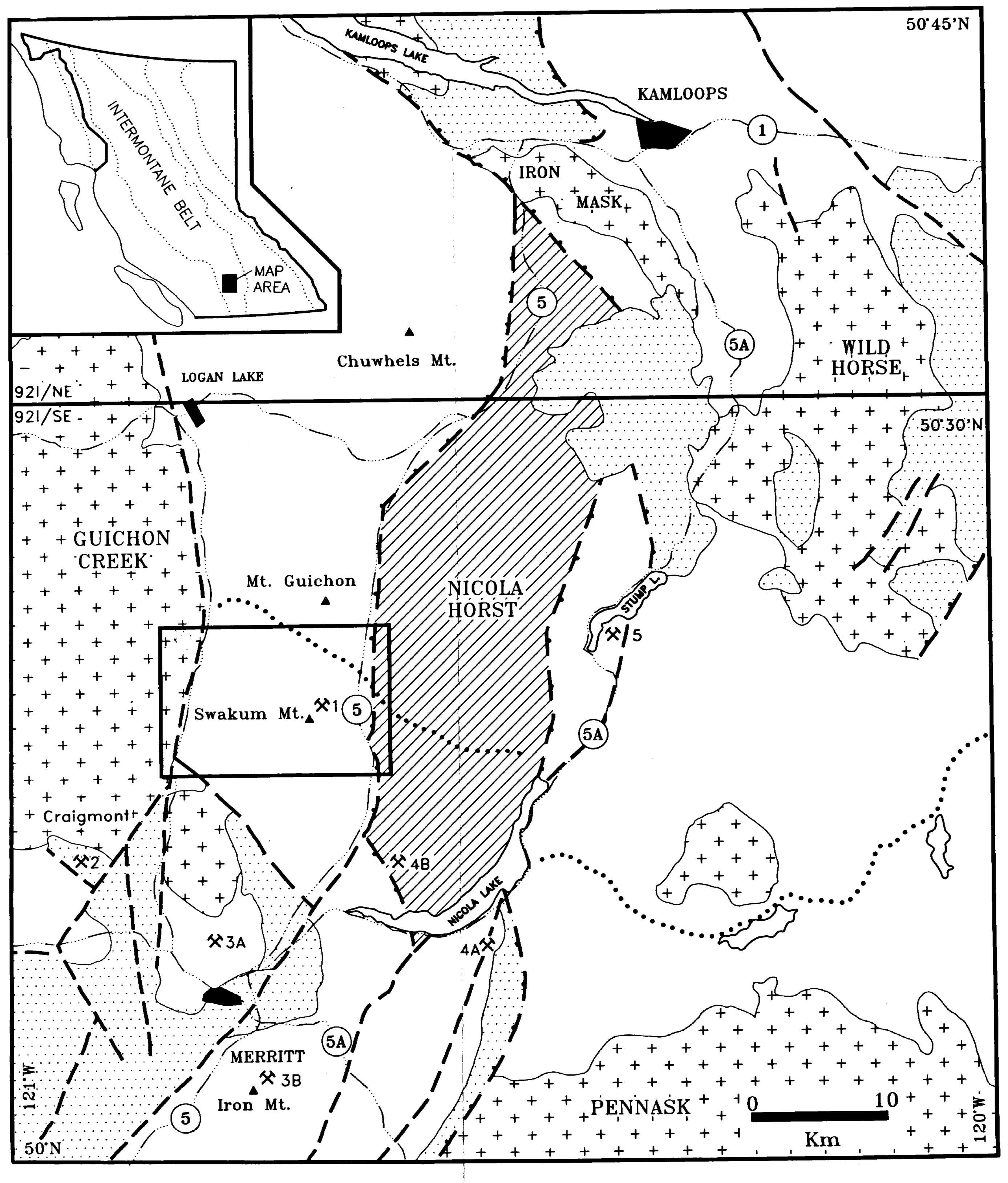
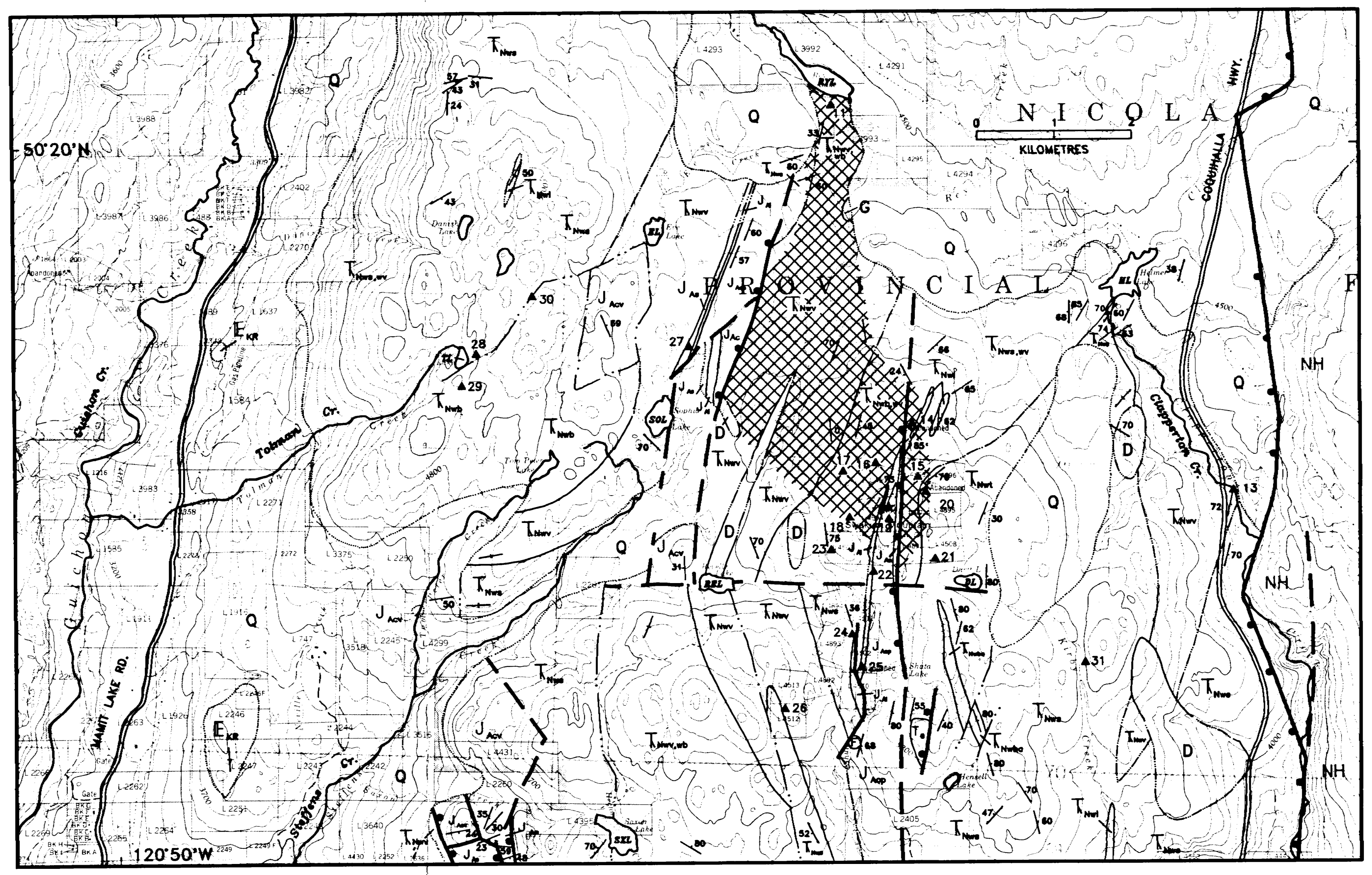


Figure 1: Locality map of the study area. Nicola Group rocks (and minor pre–Nicola rocks in the NE) unpatterned; crosses: Triassic–Jurassic plutons; dots: post–Nicola stratified rocks. Swakum Mt. map area (Figure 4) is outlined. Cross–hammer symbols denote concentrations of mineral occurrences: Swakum Mt. (1); Craigmont (2); Merritt (3A); Iron Mt. (3B); Quilchena (4A); south Nicola (4B); Stump Lake (5).



LEGEND

LITHOLOGY

QUARTERNARY

Q	Glacial, fluvioglacial and fluvial gravel, sand and clay

TERTIARY

Miocene (?)

T_B	Olivine basalt flows with ultramafic inclusions

Eocene (Kamloops Group) (?)

E_{KR}	Flow–laminated rhyolite flow rocks and breccia or dome

EARLY TO MIDDLE JURASSIC

Ashcroft Formation

J_{As}	Sandstone; pebble conglomerate
J_{Ac}	Polymict boulder conglomerate (v:volcanic clasts; p:plutonic and volcanic clasts); subordinate sandstone
J_{Al}	Limestone; subordinate siltstone interbeds

LATE TRIASSIC AND YOUNGER(?)

Intrusive Rocks

G	Biotite granite with K–feldspar megacrysts (Rey Lake)
D	Diorite: subvolcanic (?) bodies in Nicola Group

LATE TRIASSIC

Nicola Group (Western Belt)

T_{Nwl}	Limestone; polymict volcanic conglomerate with abundant limestone clasts
T_{Nwt}	Dacite or rhyolite tuff, tuff–breccia
T_{Nws}	Heterolithic andesite–dacite laharic breccia; wacke
T_{Nwb}	Monolithic andesite breccia, tuff (a: agglomerate)
T_{Nwv}	Andesite and basalt flows, flow breccia

TRIASSIC, JURASSIC (AND OLDER ?)

NH	Undifferentiated metamorphic and plutonic rocks of the Nicola Horst

SYMBOLS

Lithologic contact (defined, inferred)
Fault (defined, inferred; dots on downthrown side)
Topographic lineament
Extent of skarn alteration
70 Strike and dip of bedding (inclined, vertical)
70 Strike and dip of cleavage/schistosity (inclined, vertical)
★ Mountain peak
Main road, highway
▲26 Mineral occurrence location (Table 1)
Ⓕ Fossil locality

Former Mines:

▲20	Old Alameda
▲25	Bernice, Thelma
▲26	Corona
▲14	Lucky Mike
▲28	Sunshine

Lakes:

DL	Dartt
EL	Eve
HL	Heimer
REL	Reveille
RYL	Rey
SOL	Sophia
SXL	Saxon

Figure 4: Geology of the Swakum Mountain area, Scale 1: 50,000

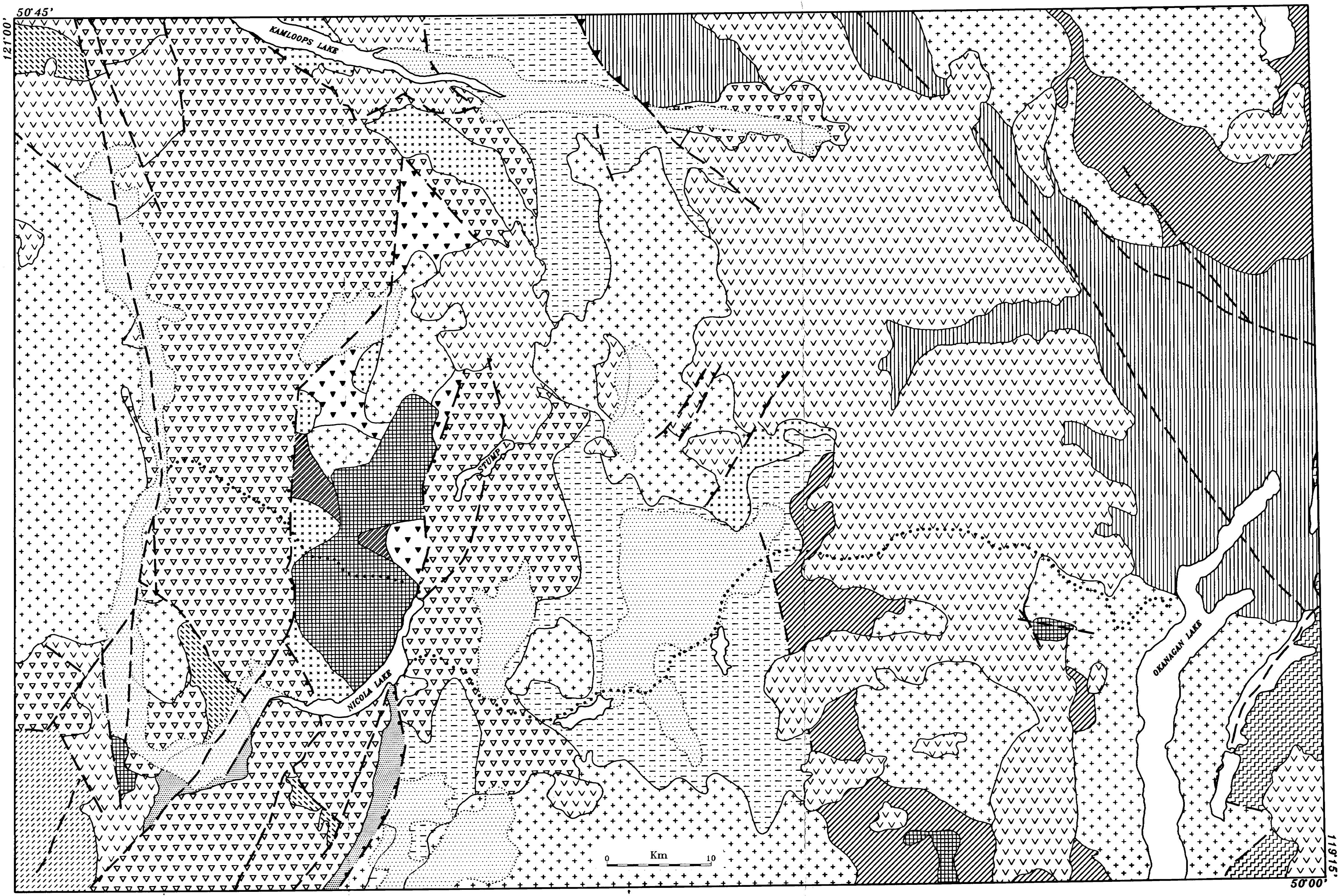


Figure 2:

Compilation map of the LITHOPROBE transect between the Guichon Creek Batholith and Okanagan Lake. Scale 1:250,000. Sources: Jones (1959), Okulitch (1979), Monger and McMillan (1984, 1989), K.L. Daughtry (pers. comm.) and field work by the authors.

Scale 1: 250,000

LEGEND

LITHOLOGIC UNITS

QUATERNARY
Glacial and fluvial deposits

TERTIARY
Granitic rocks
Volcanic rocks

EOCENE
"Coldwater beds"

CRETACEOUS
SPENCES BRIDGE Group

JURASSIC
ASHCROFT Formation

MESOZOIC
Granitic intrusive rocks
Mafic and ultramafic intrusive rocks

LATE TRIASSIC
NICOLA Group (metamorphosed rocks in Nicola horst)
NICOLA Group (predom. volcanic and coarse volcaniclastic)
NICOLA Group (predom. sedimentary)

MESOZOIC (or older?)
Metaconglomerate, schist; metatonalite

MID TO LATE PALEOZOIC and TRIASSIC
HARPER RANCH Group, associated rocks (includes some NICOLA Group)

EARLY TO LATE PALEOZOIC
SILVER CREEK Formation, CHAPPERON Group and associated rocks

PALEOZOIC (and older ?)
OKANAGAN COMPLEX: gneiss and migmatite

SYMBOLS

UNIT CONTACT
UNIT CONTACT (INFERRED UNDER QUATERNARY)
QUATERNARY BOUNDARY
LAKE BOUNDARY
FAULT
DIP–SLIP FAULT (DOTS ON DOWN–THROWN SIDE)
THRUST FAULT
LITHOPROBE TRANSECT LINE