



# STRATIGRAPHY AND GEOLOGIC SETTINGS OF GOLD PLACERS IN THE CARIBOO MINING DISTRICT (93A, B, G, H)

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**KEYWORDS:** Economic geology, placer, Cariboo Mining District, gold, stratigraphy, auriferous gravels, exploration.

## INTRODUCTION

This report provides details on field activities in placer geology conducted by the Surficial Geology Unit of the British Columbia Geological Survey Branch. In 1989, studies of gold-bearing placer deposits at active mines were undertaken with the objective of identifying geological criteria useful for recognizing placer potential. This research was continued in 1990 and a total of over 60 different placer properties have been studied (Figures 4-6-1 to 3). Stratigraphic, sedimentologic and geomorphic factors have been used to classify each of these placers by geologic environment. A suite of geologic settings representative of each of these placer-producing environments is presented in this paper, whereas a complete report discussing the geology of each described site is forthcoming. The complexity of the observed geology indicates that detailed sedimentologic and stratigraphic studies are required to understand both the distribution of placer deposits in a regional sense and the location and extent of gold-bearing units at the local level.

The Cariboo Mining District was selected for initial study because of its long history of placer gold production. Since 1860, the district has produced 75 000 to 100 000 kilograms (about 2.5 to 3 million ounces) of gold, more than any other placer area in British Columbia (Anon., 1963; Boyle, 1979). Several large (200 cubic metres per day processed) placer mines are now active in the region, as well as over 200 small operations, including hand mining and exploration projects. Sites selected for this study are producing mines offering good section exposure. Sections in the active mines were mapped and lithologic, pebble-fabric and sedimentological studies were conducted. Samples were collected for textural, mineralogical and geochemical analysis. Gold production in each stratigraphic unit was determined, where possible, by discussions with miners.

## PREVIOUS WORK

General descriptions of placer deposits in the Cariboo area first appeared in 1874 in British Columbia Ministry of Mines Annual Reports. Johnson and Uglow (1926) completed descriptions of placer and lode gold deposits in the Wells-Barkerville area. Regional bedrock mapping was conducted by Tipper (1971) and more recently by Struick (1982). The Quaternary geology of the region was mapped by Tipper (1971) and recent investigations on the Quaternary and placer geology have been made by Clague (1987a, b, 1989) and Clague *et al.* (1990). Detailed sedimentologic evaluations of placer deposits have been completed in

unglaciated terrains, such as on the White Channel gravels in the Klondike area of the Yukon Territory (Morison and Hein, 1987). However, the geology of placer deposits in glaciated terrains remains poorly understood. Regional studies in British Columbia have been done, but detailed sedimentological analyses are lacking. Depositional environments of Cariboo placer deposits have recently been discussed by Eyles and Kocsis (1988, 1989a, b) and Levson *et al.* (1990).

## STRATIGRAPHY AND GEOLOGIC SETTINGS OF GOLD PLACERS

### TERTIARY PLACERS

Gold-bearing gravels of Tertiary or presumed Tertiary age have been mined in recent years in the Cariboo (Figure 4-6-1). Rouse *et al.* (1990) associated a number of placer deposits in the Cariboo with the late Tertiary Fraser Bend Formation. Dating was based on the palynology of the sediments, principally the occurrence of *Cedrus perilata* which became extinct in North America in the late Miocene, and the association of placers with volcanic clasts and ash that are generally limited to Tertiary successions. Gravels of the Fraser Bend Formation occur at elevations below 600 metres along the Fraser River in a north-south belt that is at least 150 kilometres long and less than 27 kilometres wide (Rouse and Mathews, 1979).

Recent and historical mining of Tertiary placer gravels has been concentrated along the Fraser River valley north of Quesnel. Underground mining was conducted at the Allstar mine on the west bank of the Quesnel River (Figure 4-6-1, Location 2) during the 1980s with reported approximate grades as high as 8.5 grams per tonne in the lowermost pay zone. Tertiary gravels in this area are confined by bedrock highs and 8.5 metres of the gravels are well exposed above river level (about 510 metres) at this location (Figure 4-6-4). At the base of the section up to 50 centimetres of sand, containing abundant fossil plant fragments, are overlain by cemented pebble gravels with some cobbly beds. The gravels are massive to crudely stratified and coarser beds exhibit scoured lower contacts. Trough-crossbedded sand and gravel lenses and horizontally laminated silt lenses also occur. Wood, at various stages of petrification, and coal fragments are common throughout the gravel succession.

Texturally mature gravels, believed to be Tertiary in age, and at least two other distinct younger gravel units, have been identified along the Big Bend (Quesnel Canyon) portion of the Quesnel River (Figure 4-6-1, Location 1). In the Horsefly area (Figure 4-6-1, Location 4), Miocene gravels have been mined since the start of the Cariboo gold rush in the 1850s; their age determined by bracketing K-Ar dates on volcanics. The gravels are underlain by a thick succession

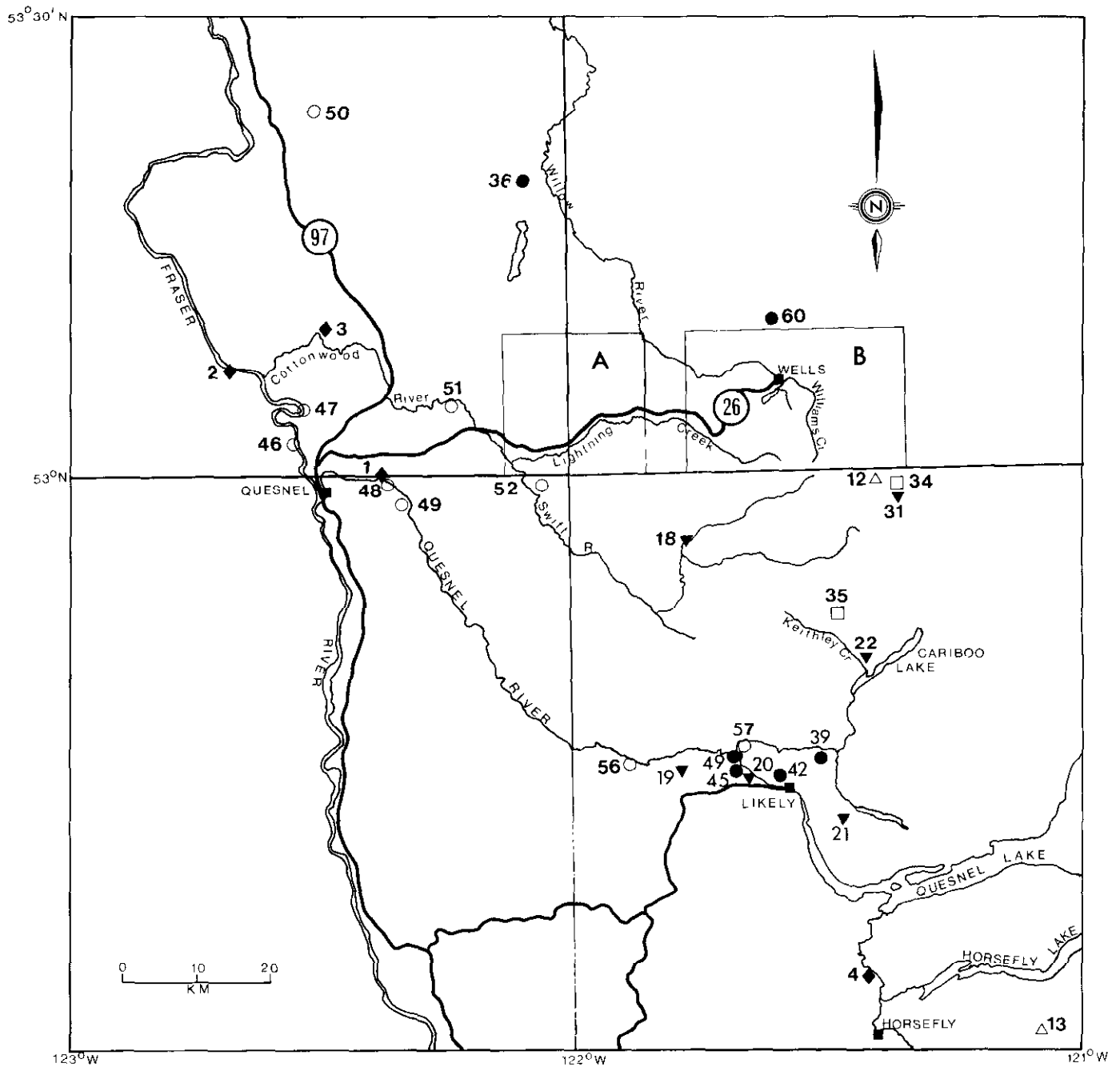


Figure 4-6-1. Location of the Cariboo placer mining area and study sites: solid diamonds – Tertiary placers; open triangles – paleogulch placers; solid triangles – buried channels; open squares – glacial placers; solid circles – outwash, colluvial and alluvial placers; open circles – low-terrace placers. Insets A and B show locations of Figures 4-6-2 and 3, respectively.

of horizontally laminated Eocene lacustrine sediments containing abundant plant fragments and fossil fish. Gold occurs mainly in the lower part of the gravels.

## PREGLACIAL AND INTERGLACIAL PLACERS

### PALEOCHANNEL SETTINGS

Preglacial and interglacial placers stratigraphically underlie till of the last (Late Wisconsinan) glaciation. Precise dating of these sediments is usually not possible as they are

beyond the limits of radiocarbon dating. A few finite radiocarbon dates have recently been recovered from Middle Wisconsinan interstadial sediments (Clague *et al.*, 1990) but such dates are rare due to the typical absence of organics in placer-gravel sequences. In addition, the coarse nature of most placer deposits precludes good preservation of pollen and volcanic ash, limiting the usefulness of palynological and radiometric dating techniques.

Preglacial and interglacial fluvial paleochannel placers occur in broad, low-gradient valleys and are potentially of

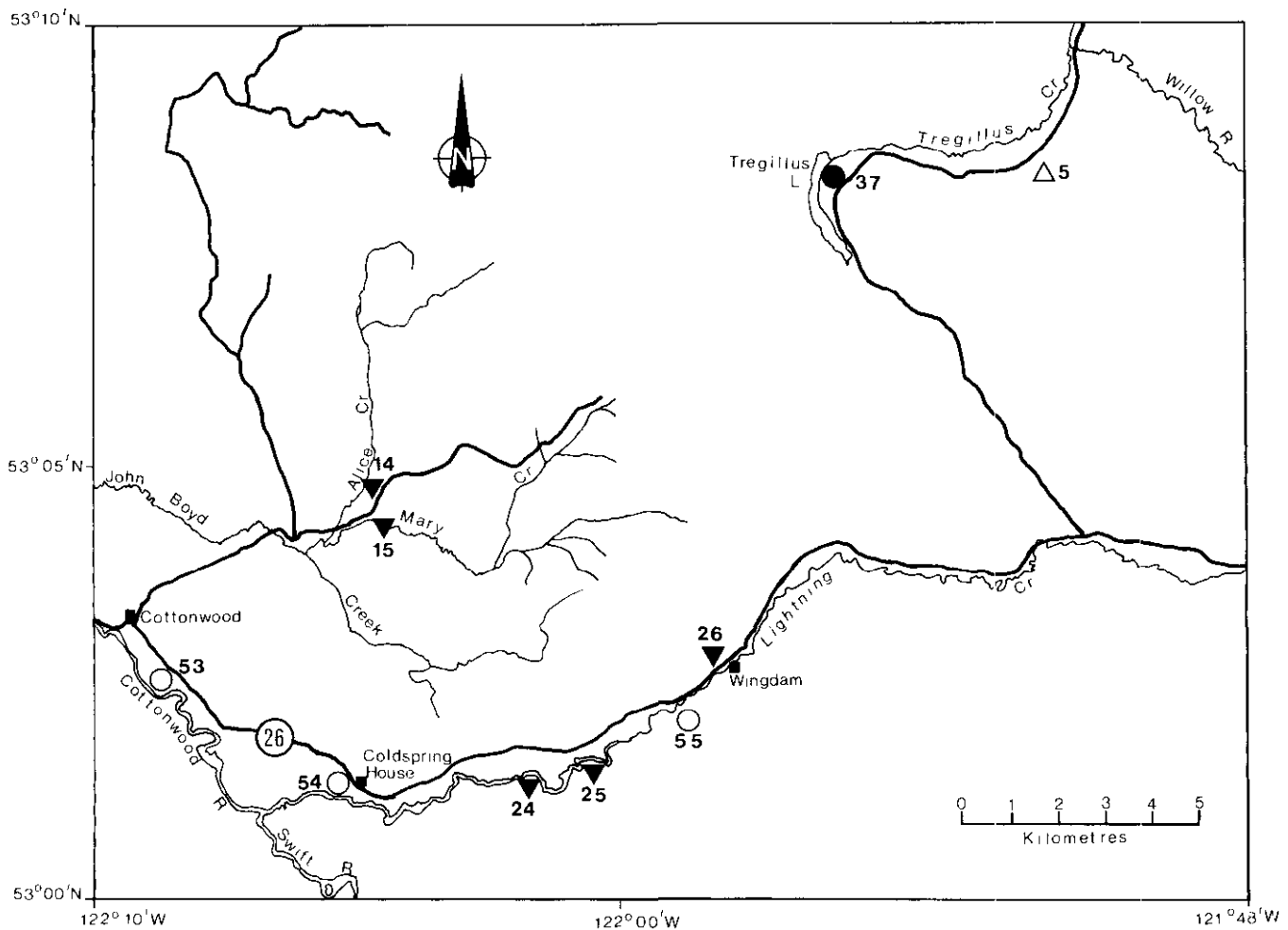


Figure 4-6-2. Location of study sites in the lower Lightning Creek area. Symbols as on Figure 4-6-1.

large volume. Three different types of buried-channel placer settings have been recognized in the Cariboo; abandoned trunk valleys, abandoned high-level valleys and buried channels in modern valleys. Abandoned trunk valleys are usually bedrock walled and infilled with stratigraphically complex sequences of sand, gravel and diamicton. Abandoned high-level valleys occur at elevations substantially higher than modern streams and may represent channel remnants from periods of relatively high base-level prior to more recent valley incision. Buried channels in modern valleys occur both below recent alluvium and in buried channels adjacent to modern creeks.

#### ABANDONED TRUNK VALLEYS

The valley excavated by hydraulic operations at the Bullion mine is a well-known example of a large abandoned Pleistocene valley in the Cariboo (Figure 4-6-1, Location 20). The Bullion mine occupies a bedrock-walled valley about 1 kilometre long and over 100 metres deep that is truncated at the north end by the modern Quesnel River. Sediments from two glacial periods (tills and glaciofluvial sands and gravels) and intervening nonglacial deposits are locally preserved in the mine area (Clague, 1987). The mine

has produced over 3860 kilograms (120 000 ounces) of gold. Gold was recovered mainly from the lowermost gravels on bedrock (Sharpe, 1939) but some gold also occurs in stratigraphically higher gravel units, probably overlying clay-rich till or lacustrine deposits that acted as false bedrock (Figure 4-6-5). North of Spanish Mountain, along the Cariboo River, Clague (1987b) identified a buried channel similar to the Bullion channel as a possible placer-exploration target.

Actively mined deposits at Spanish Mountain (Figure 4-6-1, Location 21) appear to infill the upper part of an elevated erosional channel cut in bedrock. Drilling results indicate that the bedrock channel is up to 74 metres deep. The lower 50 metres is infilled with clean pebble and boulder gravels. These gravels have not been mined extensively but there is a high potential that they are gold bearing, particularly at their base. The orientation of the channel is not well defined but appears to be oblique to the regional northwesterly strike of bedrock, topography and glacial ice flow. This orientation could provide an ideal situation for the development of a subglacial cavity and may account for the preservation of the placer deposits in the paleochannel (Levson *et al.*, 1990).

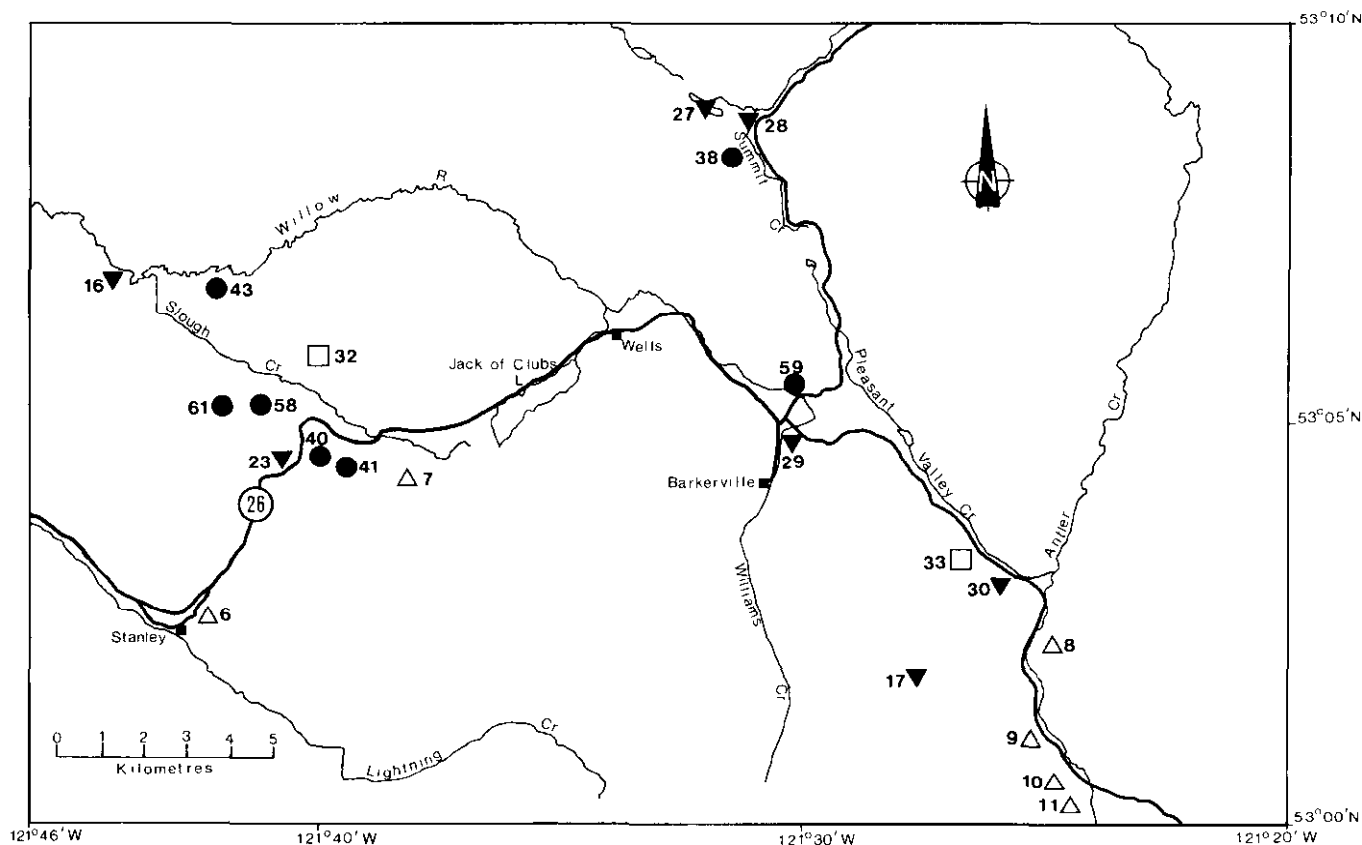


Figure 4-6-3. Location of study sites in the Wells-Barkerville area. Symbols as on Figure 4-6-1.

Preglacial and interglacial stream-channel placers in the Cottonwood River area have been mined in recent years at Mary and Alice creeks. The size, number and orientation of the channel(s) are unknown but outcrops of the channel gravels are spread over a distance of several hundred metres. A preglacial age of gold-bearing gravels in the region has recently been corroborated by palynological data (Rouse *et al.*, 1989). At Mary Creek (Figure 4-6-2, Location 15), the gold-bearing gravels are cemented, moderately to well sorted, imbricated, horizontally stratified and interbedded with trough-crossbedded sands (*cf.* Plate 6-3-1 in Levson *et al.*, 1990). They contain rich pay-zones with nuggets up to about 100 grams in size. Pay gravels at Alice Creek (Figure 4-6-2, Location 14) are similar, consisting of horizontally stratified sands interbedded with poorly to moderately sorted, clast-supported and discontinuously cemented gravels. They have been interpreted as low-sinuosity braided-river sediments (Eyles and Kocsis, 1989a). Gold values increase toward the base of the gravels with the main pay zone in the lower 3 to 5 metres over bedrock. Pay-streaks are sporadic, producing an average of 4 grams per cubic metre with a maximum return of about 9 grams.

Gold-bearing paleochannel gravels at both Mary and Alice creeks are stratigraphically overlain by a thick succession of Pleistocene sediments (*cf.* Figure 6-3-3 in Levson *et al.*, 1990). At Mary Creek the gold-bearing gravels are

overlain by two till units. Intertill sands and gravels and early postglacial gravels also contain some gold, probably reconcentrated from underlying units. At Mary Creek, glacial meltwater incised a channel and removed much (at least 20 metres) of the overburden. In contrast, gold-bearing gravels at the near-by Alice Creek mine are overlain by about 30 metres of overburden.

#### ABANDONED HIGH-LEVEL VALLEYS

An excellent example of a high-level buried valley placer is provided by the Streicek mine (Figure 4-6-3, Location 23). The southeast channel wall has been exposed down to a depth of 24 metres. The lowest exposed gold-bearing deposits are well-rounded to subrounded boulder gravels grading up into cobble to pebble gravels (Figure 4-6-6). Sorting and stratification increase with depth as does the abundance of openwork beds reflecting the increased influence of fluvial action. Overlying gravel units, exposed along the channel wall, are poorly sorted and have been reworked by gravity. They are dominated by angular clasts of local shale that dip steeply (45°) into the channel centre due to down-slope colluvial processes during channel infilling. The uppermost part of the gravel sequence was deposited as the channel was infilled prior to the last glaciation. These gravels are imbricated, poorly sorted, medium to large pebbles with an abundant silt and fine sand matrix. They are crudely stratified and some thin, openwork, small-

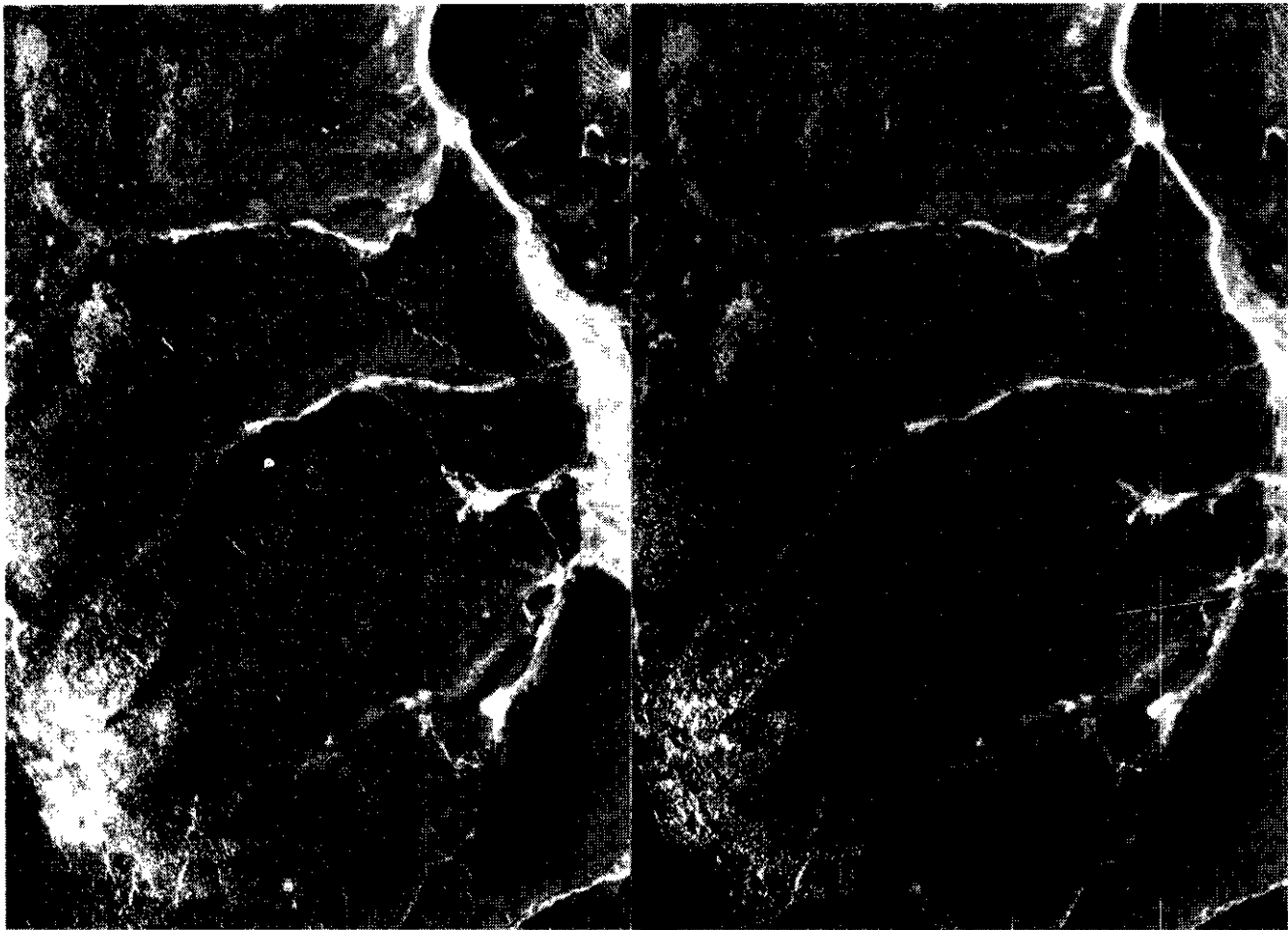


Plate 4-6-1. Airphoto stereo pair of gulch streams in the Antler Creek area.

pebble lenses occur. The gold-bearing gravel sequence is unconformably overlain by massive matrix-supported diamicton interpreted as a till deposited during the last glaciation.

#### BURIED CHANNELS IN MODERN VALLEYS

Buried-channel gravels in modern valleys are commonly exploited placers. The paleochannels may be buried directly under, or adjacent to, modern alluvial channels. Buried channels adjacent to modern streams are often segmented by recent erosion and their lateral extent is therefore often difficult to define. Paleochannels below modern streams commonly parallel the modern stream course but they can be deeply buried by alluvium and glacial deposits. In addition, these paleoplacers may be difficult to mine because of groundwater or surface-water problems.

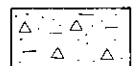
Gold-bearing deposits at the Ballarat mine (Figure 4-6-2, Location 29) infill an ancient bedrock channel adjacent to Williams Creek, which is one of the richest gold-producing streams in British Columbia. The lowest exposed gravels (Figure 4-6-7) in the Ballarat pit are moderately sorted, clast-supported, stratified pebbly gravels. Multiple scour

and channel-fill structures indicate deposition in a braided-river system. Lithologic analysis of these gravels suggests that they were not derived solely from a local tributary, but rather were deposited in the main valley system (Levson *et al.*, 1990). The gravels contain up to approximately 2 grams of gold per cubic metre and, in general, gold content increases with depth. Seismic, drilling and excavation results indicate that a variable gravel unit on the order of 10 metres thick is present below the lowest exposed gravel beds. Discontinuous, thin (< 2 to 3 metres thick), diamicton beds overlie bedrock highs along the south and north sides of the paleochannel. They exhibit sedimentary characteristics typical of modern debris-flow deposits such as poor sorting, disorganized fabric, gradational bed contacts and folded and boudinaged beds (Bull, 1972; Kochel and Johnson, 1984). Deposition of these locally derived debris-flow sediments along the margins of the channel was probably coeval with fluvial sedimentation in the channel centre.

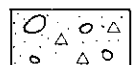
The gold-bearing gravels and associated debris-flow deposits that infill the paleochannel at the Ballarat mine were probably deposited in the last interglacial period. They are overlain by a complex succession of alluvial fan deposits (*see below*), ice-proximal gravels and an unconfor-

KEY TO FIGURES 4-6-4 through 4-6-14

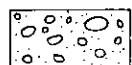
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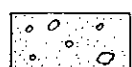
DIAMICTON - Matrix supported



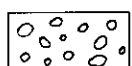
GRAVELLY DIAMICTON - Matrix to Clast supported



GRAVEL - Clast supported, Matrix filled



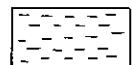
GRAVEL - Matrix supported



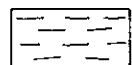
GRAVEL - Open framework



SANDS



SILTS

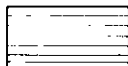


CLAYS

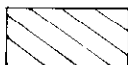


COVERED

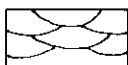
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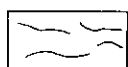
HORIZONTAL



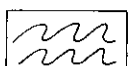
PLANAR - CROSS



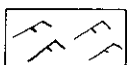
TROUGH - CROSS



CRUDE

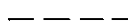


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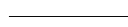


RIPPLED

CONTACTS:



GRADATIONAL



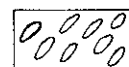
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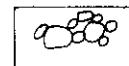
UNDULATORY



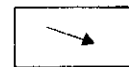
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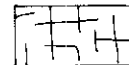
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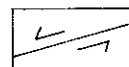
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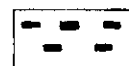
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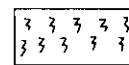
JOINTING



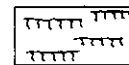
FAULTS



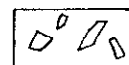
WOOD



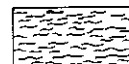
ORGANICS



SOIL or PALEOSOLS



INTRACLASTS



BEDROCK

mable capping sequence of till (Figure 4-6-7). Currently, economic gold placers occur only in reworked sediments that were deposited prior to the last glaciation.

Placer gravels in a buried channel adjacent to Lightning Creek (Figure 4-6-2, Location 24) are currently being mined. Paleoflow in the gold-bearing gravels was to the west, similar to the modern Lightning Creek channel which lies on the opposite side of the valley. Gravels yielding the highest gold concentrations are about 5 metres thick and sit unconformably on bedrock. More than 25 metres of glaciofluvial sand and gravel, with relatively low gold concentrations, conformably overlies the lower gravel sequence.

**PALEOGULCH SETTINGS**

Gulches are small narrow valleys with steep sides that commonly occur as tributaries to larger trunk valleys in

areas of high relief (Plate 4-6-1). They typically have steep gradients and carry large volumes of water and sediment during episodic flood events generated by unusual snow-melt or heavy rainfall events. These floods may recur at intervals of tens to hundreds of years and are capable of transporting large volumes of sediment. Large increases in the amount and size of material that can be moved by the stream occur as a result of the increased discharge and velocity. High stream capacity and competence are ideal for concentrating coarse placer gold and consequently gulch placers in the Cariboo have proven to be most productive. In many areas Holocene streams reoccupied preglacial and interglacial channels, eroding the overburden and, in some cases, reconcentrating the ancient placers. Holocene gulch placers were largely depleted in the 1800s due to ease of exploration and mining. Some paleogulch placers, however, were totally buried during the last glaciation. Locating,

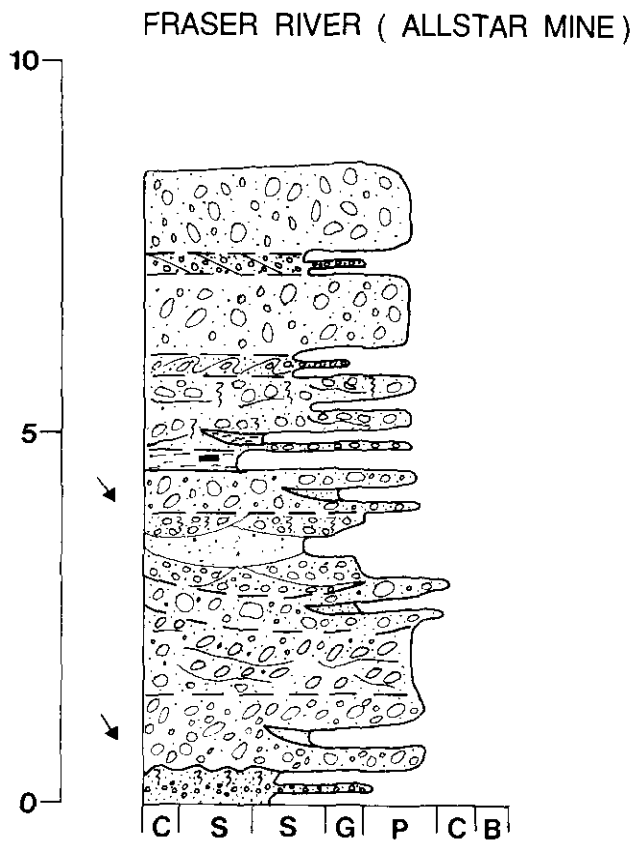


Figure 4-6-4. Stratigraphic column of Tertiary gravels and sands at the Allstar mine. Vertical scale in metres. Horizontal scale: C-clay S-sand S-silt G-granule P-pebble C-cobble B-boulder. Legend applies to all subsequent figures.

## BULLION MINE

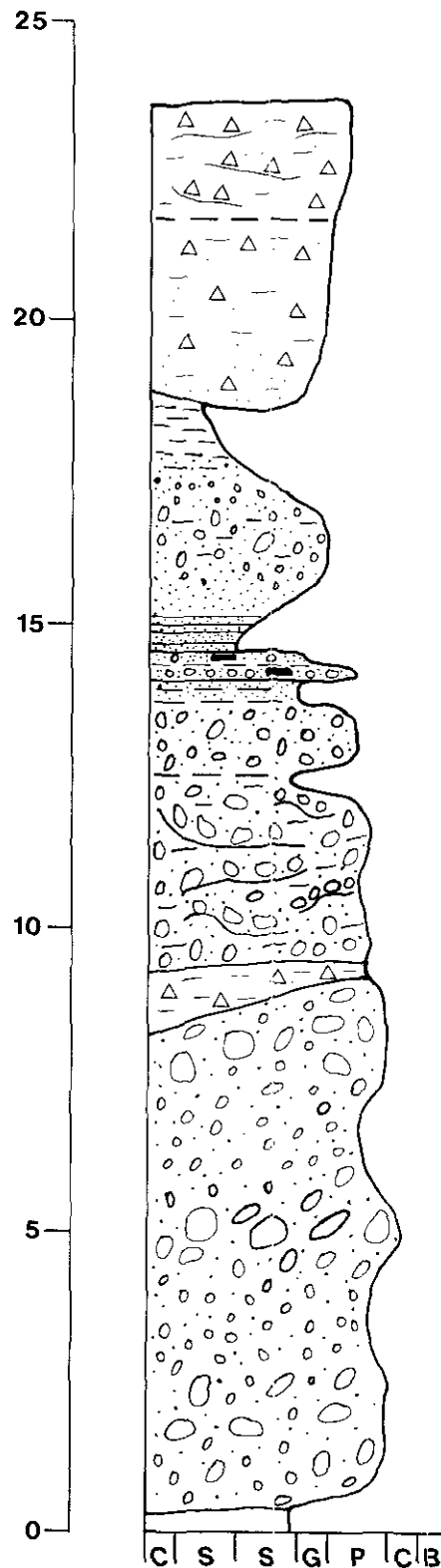


Figure 4-6-5. Stratigraphy of the Bullion mine (modified from Clague *et al.*, 1990) (Site 20).

evaluating and mining these buried, but potentially rich, placers can be both difficult and costly and usually requires detailed geologic information. At most active gulch-placer mines the glacial overburden is thick or has been partially excavated by *Holocene stream erosion*. Some of these paleoplacers were mined hydraulically in the past and modern workings commonly are either above the upper elevation reached by the hydraulic operations or along the valley sides where remnants of buried pay gravels are preserved.

Several mines along Antler Creek are typical of operations working buried gulch gravels (Plate 4-6-1). Mining at Stevens Gulch (Figure 4-6-3, Location 10) has exposed approximately 1 metre of poorly sorted, medium to large-pebble gold-bearing gravels sitting on bedrock, overlain by several metres of colluvial diamicton, sands and minor gravel (Figure 4-6-8). The lower gravel contains coarse nuggets (commonly 8 to 16 grams) and is probably a remnant gulch placer left along the valley side by previous mining activities. A debris-flow origin is suspected because of the massive structure, chaotic fabric, dominance of angular local clasts and poor sorting of the gravels.

At California Gulch (Figure 4-6-3, Location 11) pebble to cobble gravels with some boulders are buried by over 10 metres of glaciofluvial sand and gravel and 2 metres of

HIGH BENCH ( STREICEK MINE )

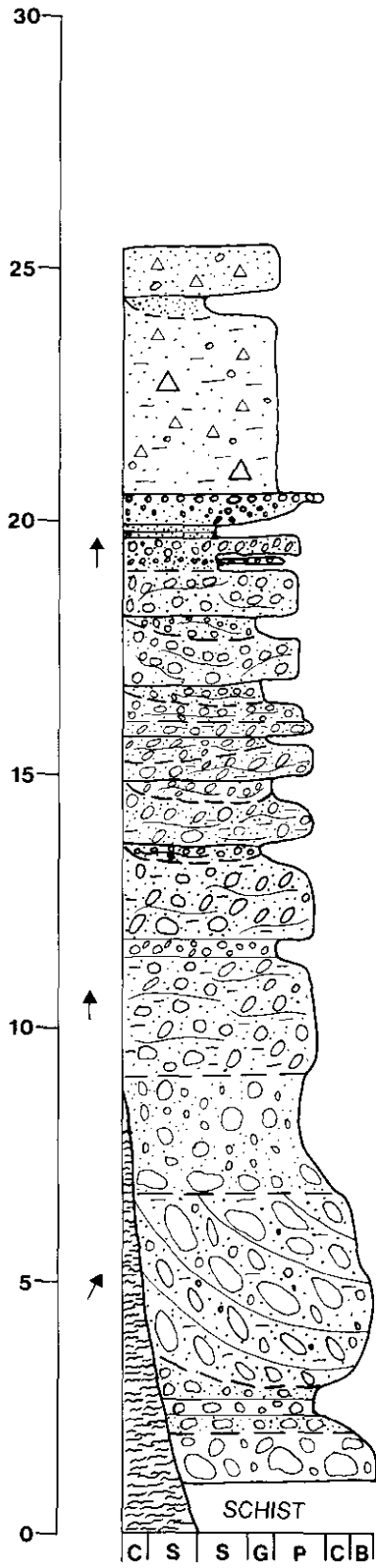


Figure 4-6-6. High-level buried-valley gravels overlain by till at the Streicek mine (Site 23).

BALLARAT MINE

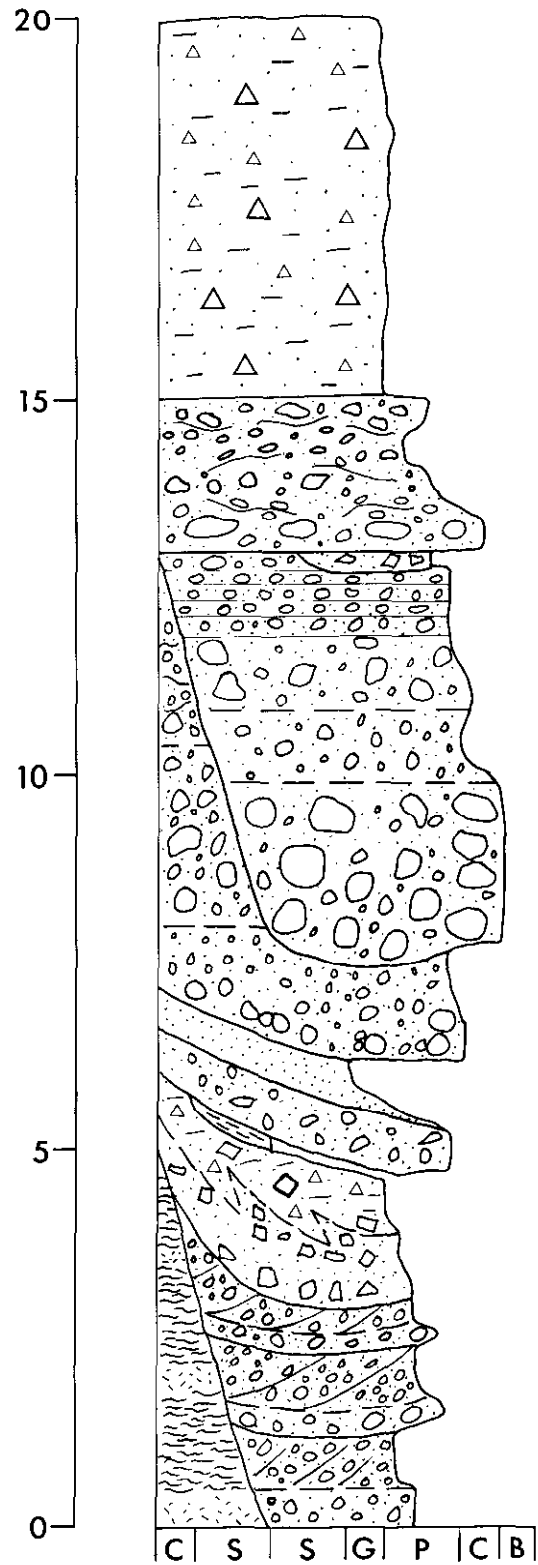


Figure 4-6-7. Paleochannel gravels overlain by till at the Ballarat mine (Site 29).



## STEVENS GULCH

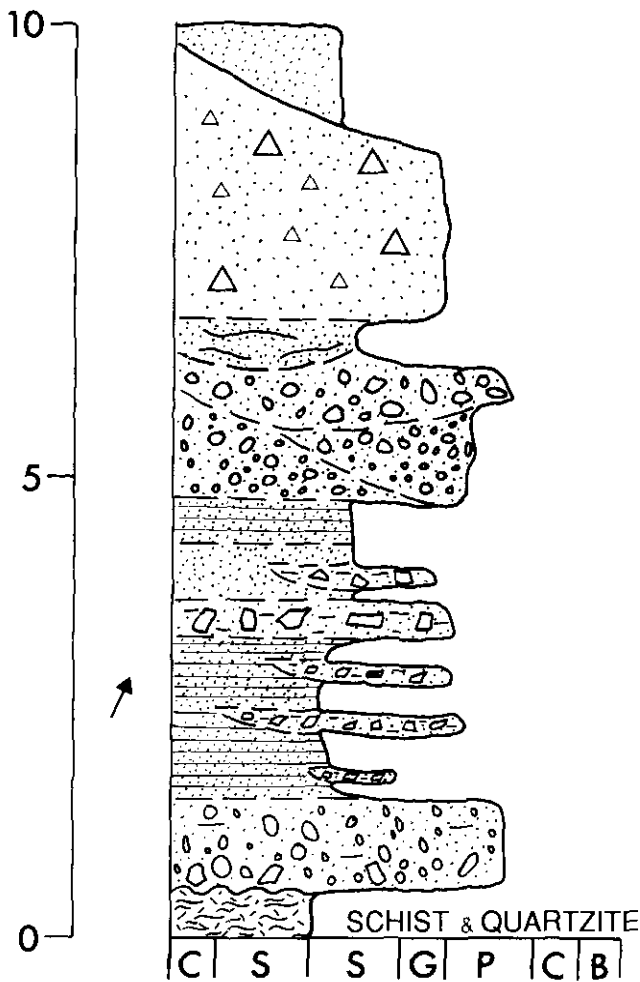


Figure 4-6-8. Gold-bearing, poorly sorted gravels overlain by colluvial diamicton, silt, sand and gravel at Stevens Gulch (Site 10).

## SPANISH MOUNTAIN

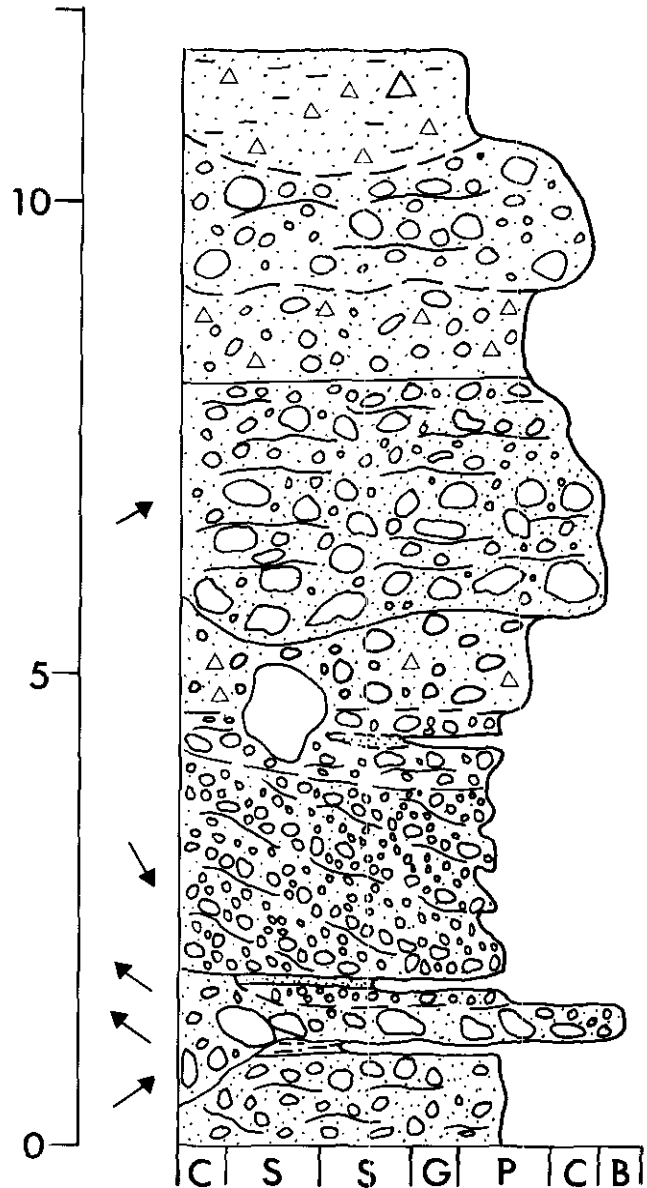


Figure 4-6-9. Gold-bearing gravels buried below till at the Spanish Mountain mine (Site 21).

matrix-supported diamicton interpreted as till. The lower gravels are poorly sorted, clast-supported and massive to crudely bedded. They were probably deposited by a flow with high discharge and sediment load, possibly in a gulch setting predating the last glaciation.

Mining activities in 1989 and 1990 at Beggs Gulch (Figure 4-6-3, Location 9) targeted a buried system that may parallel, and lie to the northwest of, the modern stream channel. Underground adits in both bedrock and unconsolidated materials have been excavated in the past in attempts to locate the buried channel. Modern mining has proceeded from near the valley bottom at about the 1190-metre level and has exposed well-sorted sand beds that dip up to 50° to the northwest (300°) and grade vertically into a sandy, boulder gravel. Sharp lateral and vertical variations in the grain size and sorting of the mined deposits are suggestive of highly variable flow conditions typical of gulch settings.

In addition to large buried-gulch placers, small abandoned channels adjacent to modern gulches are potential

placer targets. A small paleochannel along the southeastern margin of Beggs Gulch, at an elevation of about 1220 metres, has been mined for coarse gold with one small plunge pool being particularly lucrative. Bedrock exposed at the base of the channel has been smoothed by water action and the channel was filled with coarse gravels, some clasts being up to a few metres in diameter.

### PALEOALLUVIAL FAN SETTINGS

At the Spanish Mountain mine (Figure 4-6-1, Location 21), gold is found in poorly sorted and crudely stratified coarse gravels interpreted as debris-flow deposits (Figure 4-6-9). Interbedded lenses of better sorted gravel,

sand and silt are interpreted as fluvial channel deposits. The gold-bearing gravels are capped by poorly exposed diamicton interpreted as till, suggesting that the placer deposits predate the last glaciation in the area. The sediments are mainly locally derived alluvium and may include some subglacial deposits. Gold content is generally consistent throughout the mined sequence, averaging about 1 gram per cubic metre, not including gold finer than 100 mesh (0.149 mm), and the gold appears to originate locally (V. McKeown, personal communication, 1989).

At the Ballarat mine, a complex unit of sands and gravels with gold concentrations up to approximately 2 grams per cubic metre, stratigraphically overlies older pay gravels (see Figure 6-3-6 in Levson *et al.*, 1990). Lithologic and paleoflow analyses of the lower gravels indicate that they were derived almost entirely from a small tributary stream. The characteristically steep (up to 25°) and consistent dip of massive gravel beds and the lateral continuity of strata suggest deposition in a fan-delta environment. Sedimentary structures representative of this unit, such as massive and normally graded sands, horizontally laminated silts and fine sands, climbing ripples and syndepositional deformation structures, are common in subaqueous environments. Interpretations of the overlying sediments indicate a progressive shift from a fan-delta to a dominantly subaerial alluvial fan environment.

In the fan centre, fining-upward channel-fill gravel sequences with erosional lower contacts probably represent deposition in main channels (Figure 4-6-7). Near the fan margins, poorly sorted gravel and diamicton beds are interpreted as gravelly debris-flow deposits (*c.f.* Larsen and Steel, 1978; Burgisser, 1984). Disorganized to weakly imbricated, large-clast clusters, such as those that occur in these beds, form during the waning stage of high-discharge events (Brayshaw, 1984). The uppermost deposits in the sequence are clast-supported, poorly sorted diamictons interpreted as debris-flow deposits. The diamictons exhibit crude horizontal bedding, minor openwork pebbly interbeds, weak imbrication and normal grading, sometimes with a thin, inversely graded basal zone. These characteristics are typical of debris-flow deposits (Burgisser, 1984; Kochel and Johnson, 1984). Lithologic and fabric data (Levson *et al.*, 1990) also support an alluvial-fan origin for these deposits.

### GLACIAL PLACERS (TILL AND GLACIOFLUVIAL SEDIMENTS)

Glacial placers occur in sediments deposited directly by glacial ice or by meltwaters flowing near glaciers. Glacial processes that result in the deposition of tills do not allow for the removal of light minerals and the concentration of gold and other heavy minerals. Dilution of gold concentrations also occurs due to mixing of distally and locally derived sediments. In rare cases, subglacial meltwaters can concentrate gold from previously deposited sediments but these placers are usually small. Tills deposited by glaciers over-riding older stream placers can be locally productive where the gold concentration in the original placer was exceptionally high. At Cunningham Creek (Figure 4-6-3,

## TREGILLUS LAKE

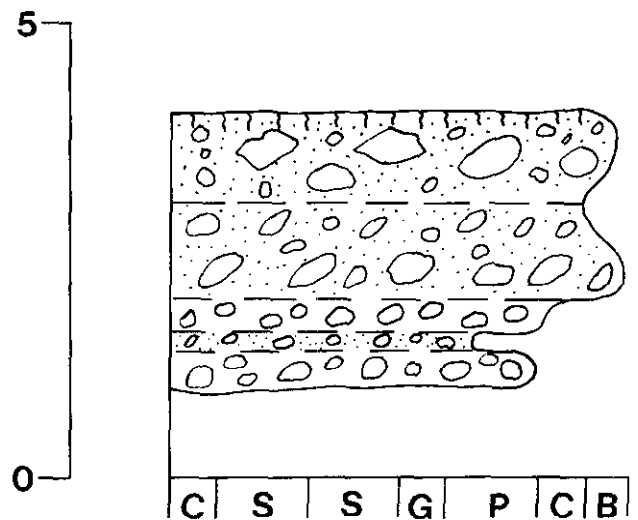


Figure 4-6-10. Stratigraphic column of mined glaciofluvial sediments at Tregillus Lake (Site 37).

Location 34), till and debris-flow deposits carry mineable quantities of gold. Glaciers flowing down the Cunningham Creek valley probably incorporated the gold from rich paleochannel placers upvalley.

Economic gold concentrations are also rare in glacial outwash deposits, usually being restricted to areas where meltwaters have reworked older placers. Outwash gravels along the northeast side of Tregillus Lake (Figure 4-6-3, Location 37) contain gold concentrations of approximately 0.15 to 0.35 gram per cubic metre. Gold within the gravels was probably derived from older placer deposits upstream. Placers underlying lodgement till at the south end of Tregillus Lake (Eyles and Kocsis, 1988) are a possible source. The glaciofluvial deposits at the north end of the lake are poorly to moderately sorted cobble gravels with clasts up to 2 metres in diameter overlying small to large-pebble gravels (Figure 4-6-10). Gold is most concentrated in the coarse gravels in the uppermost 1 to 2 metres, reflecting the typical association between coarse lag gravels and placer gold concentrations.

### POSTGLACIAL PLACERS

Postglacial placer deposits occur in a variety of depositional environments. Postglacial gulch gravels were the most productive, accessible and easily mined of all the Cariboo placers and few remained beyond the turn of the century. Floodplain and low-terrace deposits were also largely mined out in the 1800s. However, fine gold carried many kilometres downstream from the original source area is still mined in some areas. In addition, higher terrace gravels can be locally productive. Postglacial colluvial and alluvial fan placers are also mined locally.

## BURNS CREEK

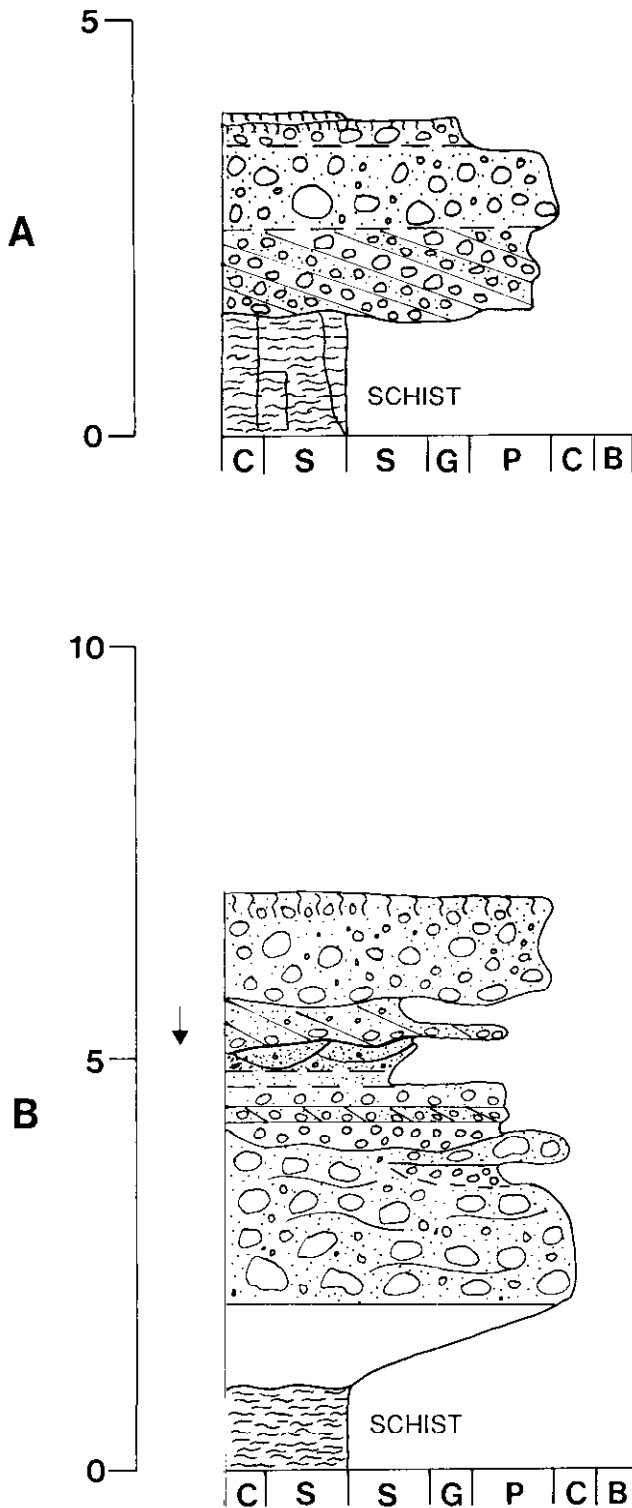


Figure 4-6-11. (A) Gold-bearing high-terrace gravels on Burns Mountain (Site 41), (B) Barren gravels upvalley of site A).

## HIGH TERRACES

Terrace gravels occurring well above modern river levels were commonly formed in early postglacial times. It is often difficult to differentiate glaciofluvial gravels deposited in terraces near the ice margin from proximal, proglacial stream sediments deposited shortly after local deglaciation. Sedimentation in proximal braided streams is largely aggradational and characterized by multiple shifting channels. Consequently, the resultant gravels form large-volume deposits with low gold concentrations. Gold content is highest at the base of channel-fill sequences. Typical high-terrace gravels, are exposed at a mine on Burns Mountain (Figure 4-6-3, Location 41). Where the terrace gravels overlie older gulch-placer deposits they contain mineable quantities of gold (Figure 4-6-11a). Elsewhere, the gravels are almost devoid of gold (Figure 4-6-11b). Glaciofluvial streams reworked and, to a certain extent, diluted the older placers. Paleocurrent data indicate that flow was perpendicular to the older streams and consequently gold occurs only downstream of the intersection with the paleochannel.

## LOW TERRACES

Low-terrace gravels are presently being mined at several locations on lower Lightning Creek and the Quesnel and Cottonwood rivers (Figures 4-6-1 and 2, Locations 48-57). The distribution of mines along the lower reaches of these rivers is only in part a reflection of geology. To a large extent, historical mining activity has depleted low-terrace placers in the upper reaches of these streams. Relatively coarse gold was recovered from these easily mined Holocene terrace placers. Progressively finer gold is carried farther downstream where mining activities are limited by the efficiency of fine gold recovery. The ability of the miner to locate sedimentary environments and specific facies where fine gold is concentrated is also a critical factor in these downstream placers.

Low-terrace gravels typically are well-sorted, horizontally stratified, imbricated, well-rounded pebble to cobble gravels (Figure 4-6-12). Planar and trough-crossbedded gravel beds occur locally. Sandy interbeds and lenses are common and the gravel sequences are typically capped by up to about 1 metre of overbank fines. The latter commonly exhibit weak horizontal laminations and contain abundant organic material. Scoured lower contacts in gravel beds are often overlain by concentrations of coarse clasts. Channel lags formed during periods of relative channel stability and are primary placer targets. Overlying bedded gravel sequences contain less gold and reflect bar sedimentation during aggradational phases.

Productive postglacial colluvial and alluvial placers are relatively rare in the Cariboo. A small operation along Williams Creek (Figure 4-6-3, Location 59) is recovering gold from a thin colluvial deposit overlying a bedrock surface that slopes 15° to 20° toward the valley centre (205°). A clast-supported, sandy pebble-gravel directly over bedrock is the most productive unit (Figure 4-6-13). Some gold is also recovered from overlying dredge tailings left from a previous operation that mined a small paleochannel

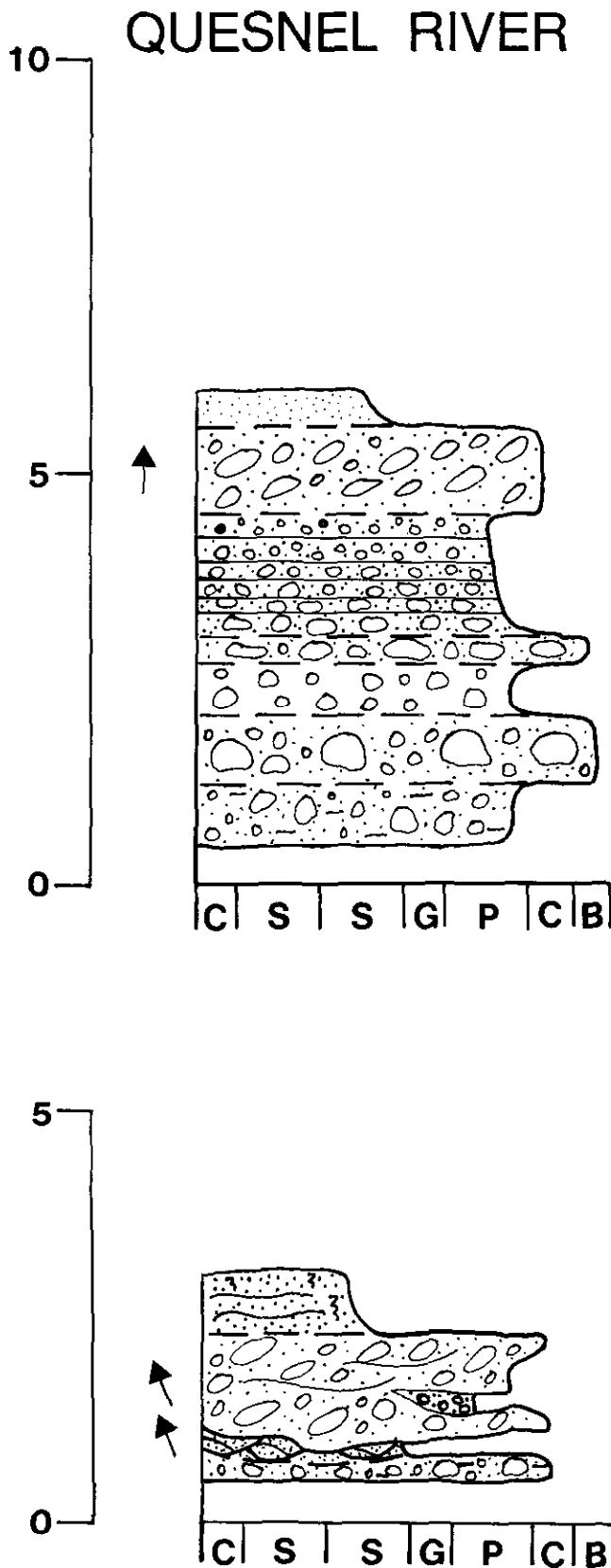


Figure 4-6-12. Low-terrace gravels on the lower Quesnel River (Site 49).

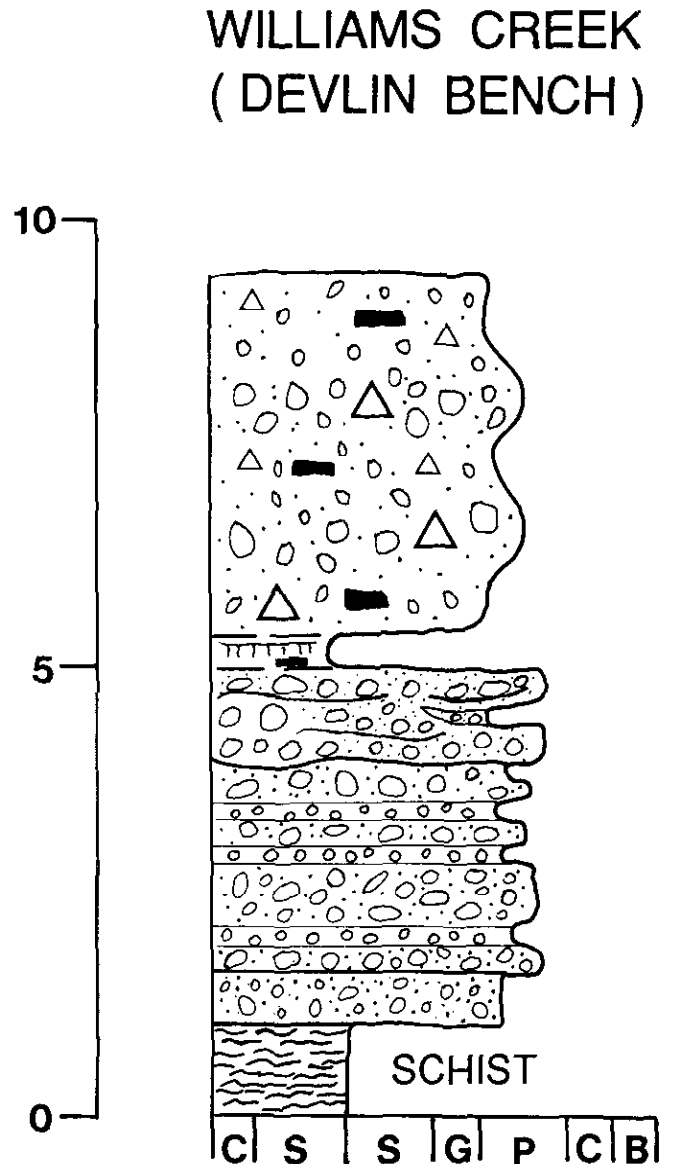


Figure 4-6-13. Colluvial sediments along Williams Creek (Site 59).

on the valley bottom. In the Nelson Creek area (Figure 4-6-3, Location 61) postglacial alluvial deposits consisting of interbedded diamicton and poorly sorted gravels (Figure 4-6-14) are gold bearing and currently being mined. Resedimentation of older deposits along the valley slope occurred by gravity-dominated processes with minor fluvial reworking. The reworked deposits include paleogulch gravels that were historically mined in the area and tills that incorporated older gold-bearing gravels during glaciation. Deposition occurred mainly in the period immediately following deglaciation, when lack of vegetation and climatic conditions enhanced slope instability.

### CONCLUSIONS

Information gathered from geologic studies at active placer mines in the Cariboo region has identified several

## NELSON CREEK

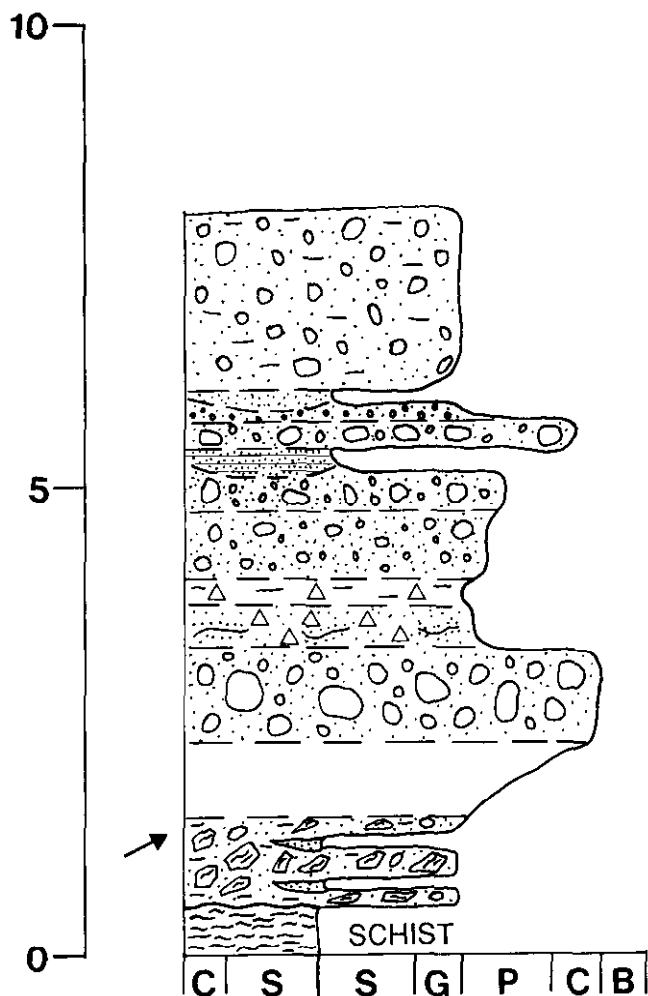


Figure 4-6-14. Alluvial and colluvial sediments near Nelson Creek (Site 61).

important geologic settings that support productive gold mining. Placer gravels of Tertiary age in the Cariboo occur mainly west of the Cariboo Mountains in the Quesnel trough. They are commonly buried by thick sequences of Quaternary sediments. Underground mining of these cemented gravels has been productive only in a few locations in the Cariboo where grades as high as 8.5 grams per tonne gold have been reported. Locally, however, they can contain significant gold concentrations which warrant further exploration. In addition, gold reconcentrated in younger fluvial deposits, unconformably overlying Tertiary gravels, may support productive placer mines.

The largest volume placers in the Cariboo are preglacial and interglacial fluvial deposits. They are being mined mainly in areas where they have been exposed by meltwater or postglacial fluvial erosion. The largest buried-valley systems have little relation to modern drainage patterns and the main obstacle to mining is typically thick overburden.

Paleochannel placers buried below modern alluvium have the additional problem of water drainage whereas high-level buried channels often need water. These mining problems are somewhat offset by the potential richness and large volume of the paleovalley placers. Geophysical (seismic, ground-penetrating radar and magnetometer) studies and drilling programs are needed to locate and evaluate these paleochannel placers. Detailed stratigraphic and sedimentologic data, such as thickness, depth and geometry of strata, paleochannel orientation, and paleoflow direction, are required to trace gold-bearing units.

Although smaller in size than buried-valley placers, paleogulch gravels commonly contain significantly higher gold concentrations. They have historically been the richest gold producers in the Cariboo but these deposits are both difficult to locate and to mine because of the deep overburden. Most operations in the past have mined gravels buried below, or exposed by, modern gulch channels. Likewise, present mining operations have focused on remnant paleogulch gravels left by previous hydraulic mining operations in modern gulches. Potential exists for some high-grade buried paleogulch channels, especially in the high-relief regions along the upper reaches of creeks like Lightning, Antler and Cunningham.

Alluvial fan deposits predating the last glaciation support two of the largest mines in the Cariboo. These placers are large in volume but generally lower grade than fluvially deposited placers of similar age.

Placers deposited during the last glaciation are relatively rare and lower grade than older placers. Economically viable quantities of gold contained within till have been documented only in areas where the glaciers overrode pre-existing, relatively rich fluvial placers. Similarly, gold-rich glaciofluvial deposits occur where older gold-bearing gravels have been eroded by the younger glacial meltwaters. Although lower grade, these placer deposits have the added advantage of occurring at or near the surface and therefore can be mined with minimal overburden removal costs.

Placer mines exploiting postglacial terrace deposits are common in the Cariboo. High-level terraces typically support large-volume, low-grade placer mines. The gravels were deposited in aggradational braided streams shortly after deglaciation. Gold is distributed throughout the deposits, mainly at the base of multiple channel-fill sequences. Low-terrace placers have been largely depleted by mining except on downstream reaches where mainly fine-grained gold is recovered. Some productive low-terrace placers occur in areas with underlying Tertiary or interglacial gravels.

This analysis of sedimentary environments at Cariboo placer mines illustrates the highly varied geologic settings of placer gold deposits in glaciated areas. An understanding of the sedimentary origin of existing placers is needed to identify other sites where gold-bearing placers have been deposited and preserved. The potential for discovery of new placer deposits is good in the Cariboo. Preglacial and interglacial fluvial and alluvial deposits are the best targets. Detailed geologic studies of existing exposures are needed to help understand the paleodrainage patterns of preglacial and interglacial fluvial systems and thereby identify proba-

ble gold-bearing deposits. Further development of these placers will require seismic and drilling exploration programs.

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