

EVALUATING BURIED PLACER DEPOSITS IN THE CARIBOO REGION OF CENTRAL BRITISH COLUMBIA (93A, B, G, H)

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INTRODUCTION

This paper is a report on the field activities and preliminary results of the 1992 placer geology program conducted by the Surficial Geology Unit of the British Columbia Geological Survey Branch. The program is designed to test models of placer deposition and preservation (Levson and Giles, 1991, in preparation; Levson and Morison, in press) developed from geologic data collected at mines in the Cariboo region and other glaciated areas of the Canadian Cordillera (Clague, 1989a, b; Eyles and Kocsis, 1989a, b; Levson *et al.*, 1990; Levson and Morison, 1991; Levson, 1992a, b; Levson and Kerr, 1992). The program includes an investigation of the utility and limitations of various subsurface exploration techniques for evaluating buried placer deposits. The Cariboo region (Figure 4-8-1) was selected as the study area because of the relative wealth of geologic data available. Current exploration activities are focusing on deeply buried (~20-100 metres) deposits with high placer potential. Detailed geologic data are required to identify and evaluate promising settings for these deposits, but the potential for locating new occurrences is limited by the lack of an adequate stratigraphic database. This program addresses this need for data by investigating the geology of economic placer deposits in areas where they are deeply buried by surficial sediments. The results of these studies are provided to industry through conference presentations,

field trips and publications in both technical (*e.g.*, Levson 1991a) and non-technical formats.

The 1992 placer geology program consisted of the following components:

- A drilling program testing theoretical geologic models of buried placer deposits in glaciated areas.
- An evaluation of geophysical tools for logging boreholes (for natural gamma radiation, apparent conductivity and magnetic susceptibility) at sites with good subsurface lithologic records.
- A study of ground-penetrating radar methods for identifying subsurface placer gravels.
- Tests of the applicability of seismic reflection and refraction surveys for locating paleochannel gravels below till deposits, in areas with good stratigraphic control.
- An investigation of gold recovery from placer gravels by reverse-circulation drilling.
- A field conference on the geology of placer deposits in the Cariboo region for the mining and exploration industry.
- Property visits to compile stratigraphic, sedimentologic and geomorphic data on producing and prospective placer deposits.

PREVIOUS WORK

The bedrock geology of the study area was mapped by Sutherland Brown (1957, 1963), Tipper (1959, 1961), Campbell (1978), Struik (1982, 1986, 1983) and Bailey (1989). Regional compilation maps were produced by Tipper *et al.* (1979) and Bailey (1990). The Quaternary geology of the region was mapped by Tipper (1971) and recent investigations of the Quaternary and placer geology have been made by Clague (1987a, b; 1988; 1989a, b; 1991) and Clague *et al.* (1990). Depositional environments of Cariboo placer deposits have recently been discussed by Eyles and Kocsis (1988; 1989a, b), Levson (1990) and Levson *et al.* (1990). Some implications of these studies for lode gold exploration were presented by Levson (1991b). Descriptions of geologic settings representative of each of the main placer-producing environments in the Cariboo was presented by Levson and Giles (1991). Levson (1991b) discussed geologic controls on exploration, evaluation and mining of placer deposits in each of the main settings. Trace element geochemistry studies of lode and placer gold deposits were conducted in the region by Knight and McTaggart (1990).

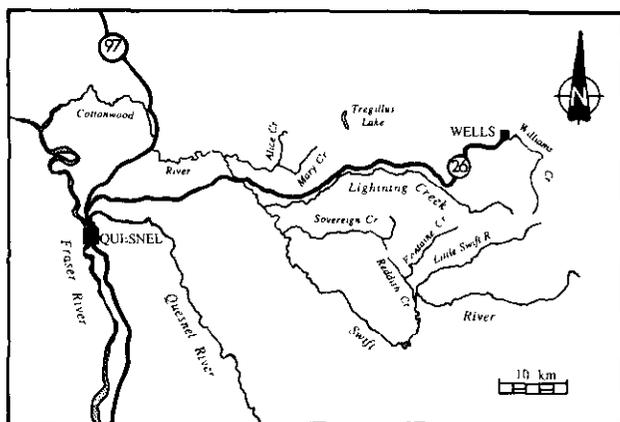


Figure 4-8-1. Location of study sites.

TABLE 4-8-1.

LOG OF DRILL-HOLE NUMBER VL92-1 AT THE GALLERY RESOURCES LTD. MINE ON LIGHTNING CREEK.

Drill Log - Hole Number VL92-1

Location: Gallery Resources Ltd. mine, Hannador property, Lightning Creek
 NTS: 93 G/1 Cottonwood
 Latitude and longitude: 53°01'25"N, 122°01'50"W
 UTM: 5875200m N, 565200m E

Notes: The drill site is on the south side of Lightning Creek, approximately 1 kilometre downstream from its confluence with Moustique Creek; the hole is at the eastern end of the minesite at the top of a high terrace paralleling Lightning Creek. This hole is the same as Gallery Resources hole number 6. Exposures of massive, matrix-supported diamicton are present on the hill side about 10 metres above the drill collar. The presence of striated clasts and the varied clast lithology (including quartzite, phyllite, granite, basalt, dacite, andesite, gneiss, biotite schist, sandstone, chert and pebble conglomerate) indicates a glacial derivation. The section measured in 1990 by Levson and Giles (in prep.) is located about 200 metres northeast (220°) of the drill site.

Unit	Depth (metres)	Description:
1	0 - 3.0	Fine sand and silt: light olive-brown colour (Munsell code: 2.5Y 5/4); well sorted; no clasts; poor sample recovery; Sample 6-0-10.
2	3.0 - 6.7	Silt and clay: olive-brown colour (Munsell code: 2.5Y 4/4); no gravel clasts; very well sorted; Samples 6-10-15, 6-15-20.
3	6.7 - 9.1	Pebble gravel; sandy matrix; clast lithologies varied; approximate proportions: 40% quartzite, 20% phyllite, 20% vein quartz, 10% sandstone, 10% schist, etc. Samples 6-20-25, 6-25-30.
4	9.1 - 12.2	Pebble to cobble gravel; sandy matrix; clast lithologies varied; similar to unit 3 except for coarser beds at top and bottom of unit; Samples 6-30-35, 6-35-40.
5	12.2 - 17.7	Pebble gravel; minor, thin, sand lenses; gravels have a sandy matrix; clast lithologies varied; similar to unit 3; Samples 6-40-45, 6-45-50, 6-50-55.
6	17.7 - 18.3	Boulder gravel; little matrix; clast lithologies varied; similar to unit 3 except coarser; Sample 6-55-60.
7	18.3 - 29.0	Pebble gravel; similar to unit 5; minor, thin, sand lenses; cobble bed in lowest 0.5 metre at base of unit; gravels have a sandy matrix; clast lithologies varied; pebble-chip count results (n=95): 54% quartzite (27% red micaceous quartzite, 27% other quartzite), 32% vein quartz, 7% black argillite/phyllite, 3% metasiltstone, minor (<1%) schist, minor sandstone, minor hornblende dacite; Samples 6-60-65, 6-65-70, 6-70-75, 6-75-80, 6-80-85, 6-85-90, 6-90-95, VL-92001 (at 23 metres depth), VL-92002 (at 29 metres depth).
8	29.0 - 35.1	Pebble to cobble gravel; similar to unit 7 but with cobble beds at 30.5 - 32 metres and 33 - 34 metres; matrix is clay rich from about 29 - 32 metres, otherwise is sandy; iron oxide (red) staining present in some gravels; sand beds rare; clast lithologies varied; Pebble-chip count results (n=100): 57% quartzite (34% red micaceous quartzite, 23% other quartzite), 26% vein quartz, 10% black argillite/phyllite, 2% metasiltstone, 2% schist, 1% metavolcanics, 1% chert, 1% hornblende dacite; Samples 6-95-100, 6-100-105, 6-105-110, 6-110-115, VL-92003 (at 31 metres depth), VL-92004 (at 35 metres depth).
9	35.1 - 39.6	Cobble to boulder gravel; unit appears to coarsen with depth; minor pebble beds at 35.7 - 36.3 metres and 37.5 - 37.8 metres; sandy matrix; clast lithologies varied; large clasts are mainly quartzites; pebble-chip count results (n=50): 57% quartzite (28% red micaceous quartzite, 22% other quartzite), 24% vein quartz, 24% black argillite/phyllite, 2% hornblende dacite; Samples 6-115-120, 6-120-125, 6-125-130, VL-92005 (at 38 metres depth), VL-92006 (at 39.5 metres depth).
10	39.6 +	Bedrock: very dark gray (Munsell code: 5Y 3/1) to black (Munsell code: 5Y 2.5/1); lithology mainly argillite; Samples 6-130-135, 6-135-140, 6-140-145.

METHODS

Sites with stratigraphic control and geologic evidence for buried placer potential were selected for field investigation by airphoto study and office review of existing data. Geologic data collected during previous studies in the Cariboo were used to help identify areas with high buried-placer potential. Fieldwork included a reverse-circulation drilling program to collect subsurface data needed to test stratigraphic correlations and depositional models. The efficiency of the drilling method for recovering gold was tested by New Era Engineering Corporation using radiotracers. Geophysical methods for evaluating buried placers (including borehole geophysics, seismic reflection and refraction techniques and ground-penetrating radar) were also investigated in conjunction with the Geological Survey of Canada. Shallow refraction hammer-seismic data were collected by Howard Myers. The effectiveness of these exploration techniques for evaluating buried deposits will be discussed elsewhere. Detailed descriptions of the procedures for each subsurface technique and preliminary results are described here.

DRILLING PROGRAM

A number of drill sites were selected in different geologic settings in order to test depositional models for placer deposits in British Columbia. Emphasis was placed on buried placer deposits in both trunk and tributary paleovalleys and two holes (VL92-5 and VL92-6) were drilled in a terrace-placer setting. The type of data collected during the drilling program is exemplified by the log of drill hole VL92-1 from Lightning Creek (Table 4-8-1).

The Mobile B80 drill used in this study (Plate 4-8-1) was fitted with a 115-millimetre (4.5-inch) diameter, skirted

rotary tri-cone bit and 89-millimetre (3.5-inch) diameter drill rods. The rods consisted of an inner tube to carry sample from the bottom of the hole to the surface and an outer annulus to carry the compressed air used to flush the drill cuttings from the hole. Approximately 1.60 litres per second (540 cubic feet per minute) of air compressed to 2.4 megapascals (350 pounds per square inch) was forced down the outer annulus of the rods. Water was added to the compressed air stream to lubricate the drill rods. Drill cuttings were forced up the inner tubing through the rotary head and hoses into a sampling cyclone and were collected in buckets. Holes remaining open after drilling was completed were cased with 5-centimetre (2-inch) diameter plastic (PVC) pipe to as great a depth as possible to accommodate the geophysical logging tools.

LIGHTNING CREEK AREA

Drill holes VL92-1 and VL92-2 were located in the Lightning Creek valley at the Hannador property of Gallery Resources Limited. An active exploration program at this site has targeted a buried deposit of probable interglacial age that is believed to lie parallel to and south of the modern Lightning Creek channel (Levson, 1991a). Preliminary results of the drilling program (Table 4-8-1) indicate that auriferous paleochannel gravels extend underneath a thick (30 m) sequence of glaciofluvial and fluvial deposits exposed on the south side of the valley.

ALICE CREEK AREA

Drill holes VL92-3 and VL92-4 were drilled to investigate buried river channel deposits in the Alice Creek area believed to be Tertiary in age (Rouse *et al.*, 1990). Deposits mined at Alice Creek are believed to be correlative with

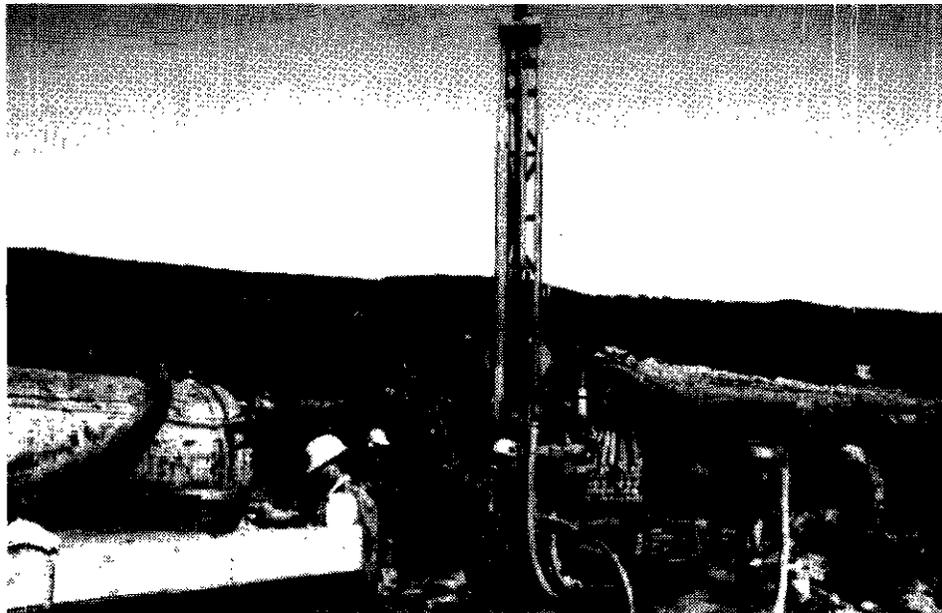


Plate 4-8-1. The reverse-circulation drill used in this study drilling hole number VL92-3, due west of the Alice Creek mine. The cyclone on the right hand side of the drill is used to catch the drill samples.

those at the nearby Mary Creek mine (Levson and Giles, 1991) but the extent and orientation of the paleochannel system is not known. Holes VL92-3 and VL92-4 were 'wildcat' holes drilled in an attempt to constrain the paleogeography of the buried channel. The location of hole VL92-3 (Plate 4-8-1), due west of the Alice Creek mine, was chosen on the basis of industry drill records (Ed Kruckowski and Jack Wyder, personal communication, 1992). These data defined a deep channel in the Alice Creek valley with a cross-sectional geometry suggestive of a west-trending paleochannel. Bedrock was intersected in hole VL92-3 under till at a depth of about 10 metres, well above base level in the Alice Creek paleochannel. These data, together with the known distribution of bedrock outcrops in the area, provide a new constraint on the orientation of the paleochannel system. These results lead to the hypothesis that placer gravels mined on the east side of Alice Creek must have been deposited in a paleochannel system that either extends to the north or swings sharply to the south. To test this, hole VL92-4 was drilled about 1 kilometre north of the Alice Creek mine. Several metres of gold-bearing gravels were encountered in this deep hole with bedrock occurring at 36 metres depth. These gravels are believed to be the deposits of a northerly extension, possibly a tributary channel, of the main paleochannel system.

COTTONWOOD RIVER AREA

Holes VL92-5 and VL92-6 were drilled along the Cottonwood River to investigate Holocene terrace gravels and possible older paleochannel deposits in that area. The holes were collared on opposite sides of a broad, low terrace on the south side of the Cottonwood River. The terrace is a few metres higher than the present channel and directly upstream from a bedrock-floored canyon into which the Cottonwood River valley narrows. High ridges on both sides of the canyon are comprised mainly of bedrock to the north of the river and unconsolidated Quaternary sediments to the south. Small bedrock knolls are also exposed at low water levels along the present course of the river upstream from the canyon. Gravels occur throughout the entire drilled sequence above bedrock which was intersected at a depth of about 20 metres in both holes. The gravels are gold bearing with the highest gold recovery occurring in coarse gravel beds at the bottom of the holes; the latter are interpreted to be erosional lag gravels.

Bedrock exposures in the modern channel of the Cottonwood River, particularly those along the canyon directly below the drill sites, constrain the depth of Holocene incision of the river to that of the present-day channel. Consequently, as bedrock is nearly 20 metres below the present channel base at the drill sites, the gravels in the lower part of the sequence must predate the Holocene. They are believed to be interglacial or preglacial gravels deposited in a paleochannel that presumably lies south of the present river and may extend under the thick Quaternary deposits south of the canyon. Deep-channel gravels on the southwest side of the terrace have been previously mined at one site near the valley side. Mining was stopped when the gravels could no longer be removed because they were covered by, and apparently extended underneath, a thick clay (glaciolacustrine?) sequence.

The placer operation at this site is currently evaluating the potential for mining these paleochannel gravels in areas where they may be preserved below Holocene terrace gravels.

SOVEREIGN CREEK AREA

Holes VL92-7 and VL92-8 were drilled in the Sovereign Creek region in an area with excellent potential for a large-volume buried paleochannel placer deposit of interglacial or preglacial age. This deposit occurs in a recently discovered buried valley that apparently trends northwesterly parallel to Sovereign Creek. The paleochannel gravels were intersected in drill hole VL92-7 at depths from 8 to 27 metres. They overlie bedrock and are overlain by diamicton units with interbedded silty clays interpreted, respectively, as till and glaciolacustrine sediments.

The paleovalley containing the auriferous deposits is separated from the modern Sovereign Creek valley by a bedrock high which has been exposed by recent mining and forms the northeast wall of the buried valley. Hole VL92-8 was drilled to help define the southern extent of the paleovalley and its general orientation. Drilling results indicate that the channel gravels thin substantially to the south. Bedrock was encountered at shallow depths (16.5 m), suggesting that the drill site is located near the southwest margin of the paleochannel.

REDDISH CREEK AREA

Holes VL92-9 and VL92-10 were drilled between Fontaine Creek and the Little Swift River to test the potential of a large buried "trunk" valley trending northwesterly parallel to the Reddish Creek valley. Previous stratigraphic studies in the Little Swift River area (Levson and Giles, 1991; Levson, 1991a; Levson and Giles, in preparation) suggested that a large paleovalley placer deposit may occur in the region. Past mining strategies have targeted southwesterly flowing streams such as the Little Swift River and Fontaine Creek, but little attention has been paid to the possibility of a northwesterly trending paleochannel, possibly following the strike of the Eureka thrust. This fault separates the Barkerville and Quesnel terranes (Struik, 1988) and may have provided a major structural control on preglacial drainage patterns in the area. Drill hole VL92-9 was drilled southeast of the Fontaine Creek valley and intersected gold-bearing gravels of similar thickness and type to those currently being mined along it. Hole VL92-10 was a 'wildcat' hole drilled part way between the Little Swift River and Fontaine Creek. The occurrence of auriferous gravels at the bottom of this hole provides new evidence that strongly supports the hypothesis that a large northwesterly trending paleovalley exists in this area.

GOLD RECOVERY TESTS

The reverse-circulation drill used in this study was tested at four sites using gold radiotracers as part of a broader research program on drilling methods conducted by R. Clarkson of New Era Engineering Corporation. Information on radiotracers (very low level radioactive gold particles) and their use in gold recovery research has been

provided by Clarkson (1991). The results and preliminary conclusions presented here apply only to the four sites tested during this study.

For each test, four sizes of radiotracers were used: 0.18 millimetre (-65+100 mesh), 0.36 millimetre (-35+48 mesh), 0.72 millimetre (-20+28 mesh) and 1.44 millimetres (-10+14 mesh). The radiotracers were placed in the middle of barren compacted gravels and frozen into a solid cylindrical shape. The test gravel cylinders were 300 millimetres (12 inches) long and 90 to 100 millimetres (3.5 to 4 inches) in diameter. The test procedure involved drilling to the desired depth (10 to 35 m) and pulling the drill rods out of the hole. The open hole depth was then measured and caved portions were redrilled until the desired depth was reached (where practical). The radioactive test cylinder was then dropped down the hole and the depth of penetration was determined and increased if necessary by pushing with the drill stem. Gravel stemming was then dumped into the hole and compacted before redrilling. The collar of the hole, drill cuttings, drill equipment, sample collection equipment and personnel were checked for radioactive gold during and after completion of the drilling (Plate 4-8-2). Radioactive particles were detected using a scintillometer. Their locations were recorded and all detected particles were collected. Drill samples containing tracers were processed in a small sluice and by hand panning until each radioactive particle present in the concentrate was recovered.

Most of the recovered radiotracers were out of the holes by the time the bit had reached 3 metres beyond the depth where the test cylinders were originally placed. The addition of water to the compressed air stream increased segregation and entrapment of gold tracers. Water addition also increased spillage losses and made it difficult to collect and

contain the samples. Although surges of high-pressure air were used to flush the system, many tracers were caught and remained in the hose fittings and sampling cyclone. To remove them, the cyclone and hose fittings were disconnected and cleaned out after the hole was completed. As the collars of the holes were not sealed a high proportion of the cuttings and tracers was forced up outside the drill rods onto the ground near the collars (blow-by).

Between 2 and 98 per cent of the tracers were recovered from the four holes tested. In the hole with the deepest sample depth (35 m) only 2 per cent of the tracers were recovered, one was on the ground next to the collar and the other was trapped in the cyclone. Even in shallower holes (10 m) with relatively high recoveries, many of the tracers were lost due to spillage and to blow-by around the collar of the hole. Some of the tracers were trapped in the sample cyclone and its plumbing.

Natural gamma logs (*see below*) were obtained from three of the four holes tested. In all three logs, anomalous peaks in the gamma radiation, indicating the presence of tracers, were observed at the approximate penetration depths that the test cylinders initially reached after being dropped down the holes. No anomalous peaks occurred more than 1 to 2 metres above these depths. This suggests that attempts to push the radioactive test cylinders to the bottom of the holes with the drill rods caused part of the samples to be lodged in the side of the hole at or near the depth of initial penetration. In this regard, it is interesting to note that the test with the highest initial penetration of the sample cylinder relative to the hole depth (10 m in a 10.5 m hole) yielded the best tracer recovery (98%). Similarly, the hole with the lowest initial penetration (4 m in a 36.5 m hole) yielded the lowest recovery (2%). In this latter case,



Plate 4-8-2. Searching drill-sample collection area for gold radiotracers using a scintillometer.

numerous anomalous gamma peaks were detected between the initial penetration depth and the base of the log (15 m) suggesting that the test cylinder was pushed at least part way down the hole. These results indicate that caving of open holes in wet, unfrozen materials presents a major difficulty in testing gold recovery in this method of reverse-circulation drilling.

Material derived from caving along the walls of the drill hole may also result in the introduction of significant amounts of sediment (and gold) into the sample over any one sample interval. Caving may occur when boulders are encountered or when saturated gravels are drilled. Gold values may be overestimated as a result of caving if all of the recovered gold is assumed to have come from a volume of sediment calculated on the basis of hole diameter. This problem can be avoided if the actual volume or weight of the recovered sample is used to determine gold concentrations. Up-hole contamination can also introduce errors in determining gold values for any one sampled interval. Up-hole contamination occurs, for example, when the blow-by is lost.

Although results of the four radiotracer tests suggest that unsealed, uncased reverse-circulation drilling is not a reliable method of determining gold values in unfrozen placer gravels, this method does provide samples which are suitable for determining the lithology and stratigraphy of the surficial deposits. Depth to bedrock is also readily determined as bedrock cuttings are generally easy to recognize. Losses due to blow-by can be reduced by drilling a short length (3 to 6 m) of casing (Odex) into the hole and sealing off the drill rods with a packing case. Losses in the drill hole may also be reduced if casing is used for the total length of the hole (especially if the casing is driven ahead of the bit). Losses and carry-over from the sampling hose, fittings and cyclone can be reduced with designs that eliminate gold traps and with frequent thorough cleaning. Other methods of reverse-circulation drilling should be tested at several locations to determine which drilling equipment and procedures maximize gold recovery on a consistent and predictable basis.

GEOPHYSICAL PROGRAM

BOREHOLE LOGGING

Seven cased drill holes (VL92-1, VL92-4, VL92-7, VL92-10, DH-14, DH-17, and TH-9) were logged by the Geological Survey of Canada using the Geonics EM-39 logging system (Plate 4-8-3). Apparent conductivity, naturally occurring gamma radiation and magnetic susceptibility were recorded in six of the seven holes. Only natural gamma radiation was measured in one of the holes at Sovereign Creek (DH-14) due to the presence of steel casing in the hole.

The radius of penetration for the conductivity probe is estimated to be 1 to 1.5 metres and, as the tool is claimed by the manufacturer to be unaffected by fluids in the plastic casing, the conductivity measured is taken to be that of the surrounding formation and associated groundwater. The results of a conductivity log of drill hole VL92-1 at the

Gallery Resources mine at Lightning Creek are given in Figure 4-8-2. High conductivity in the upper several metres of the hole corresponds well with lithologic data (Table 4-8-1) showing high silt and clay contents in Units 1 and 2. Low conductivity in the gravelly deposits underlying Unit 2 contrasts sharply with the high conductivity in the overlying fine-grained sediments.

The gamma tool detects the decay of uranium, thorium and potassium, although for practical purposes the tool measures, quantitatively, the abundance of clay in the strata surrounding the borehole. Low gamma readings are an indication of coarse-grained sediments, and high gamma readings are attributable to fine-grained materials. A natural gamma log for drill hole VL92-1 is provided in Figure 4-8-3. The natural gamma peak at 5 metres depth corresponds well with a similar peak in the conductivity log at the same depth. The natural gamma log shows more variability and fluctuations than the conductivity log, possibly reflecting a greater sensitivity to textural changes such as sand and silt content in the gravelly units at this site.

The magnetic susceptibility probe measures how strongly the material adjacent to the borehole is affected by a magnetic field, in this case the earth's field. It is accepted that the overall susceptibility of a lithology is dependent only on the amount of ferrimagnetic minerals present such as magnetite, pyrrhotite and ilmenite. Data collected with the magnetic susceptibility tool are currently being processed.

SEISMIC SURVEYS

Expanding-spread seismic refraction and/or common offset seismic reflection surveys were conducted by the Geological Survey of Canada at the following sites: Ballarat mine near Barkerville, Alice Creek property, Sovereign Creek area, Fontaine Creek mine, Reddish Creek area, Golden Bench mine on the Cottonwood River and Corless Tertiary mine on the Quesnel River. The surveys can be efficiently conducted with a two-person line crew and one person operating the seismograph (Plate 4-8-4). A portable, gas-powered auger drill was used to drill shot holes to a depth of about a metre and shotgun explosives were used as the signal source (Plate 4-8-4). For comparison purposes, shallow hammer-seismic refraction surveys were also conducted at two sites (Gallery Resources and Golden Bench mines) using hammer blows on a steel plate as the signal source. All refraction and reflection surveys were located near holes drilled during this program (VL92-4, VL92-6, VL92-7, VL92-9 and VL92-10) or near industry drill holes at the Gallery Resources Ltd., Ballarat, Corless Tertiary and Sovereign Creek mines. The drill-hole results will provide stratigraphic control and reference data for evaluation of the seismic results.

The purpose of the seismic surveys was to map the subsurface stratigraphy, in particular the thickness and lateral extent of gravel horizons that are known or believed to contain placer gold, and to evaluate the applicability of the various methods in different geologic conditions. Many buried auriferous gravel units pose a problem for interpretation because their acoustic velocity is lower than that of till units which they commonly underlie. These deposits constitute what is known as a 'hidden' layer. The preliminary



Plate 4-8-3. Geonics EM-39 logging system for apparent conductivity, naturally occurring gamma radiation and magnetic susceptibility. The apparent conductivity probe has been partially inserted into plastic (PVC) casing in the drill hole.

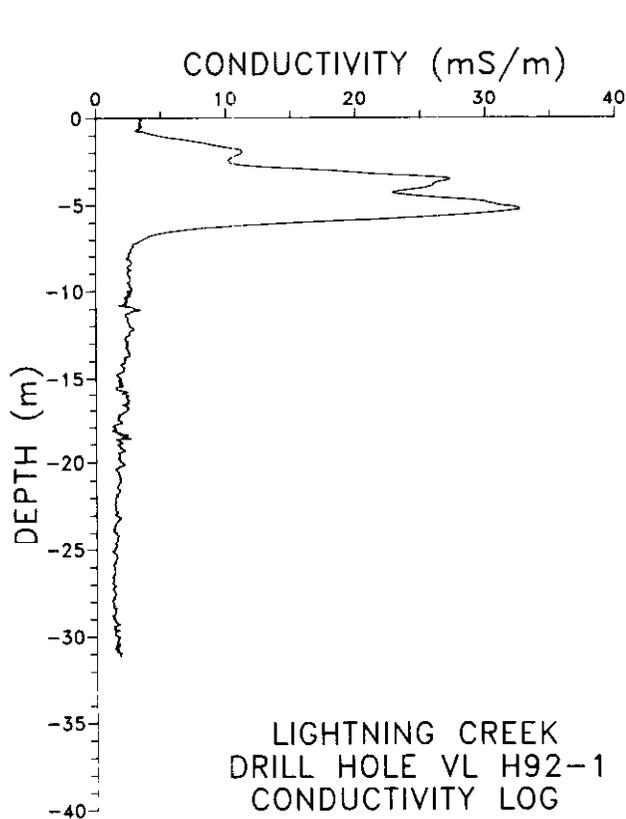


Figure 4-8-2. Conductivity log of drill hole VL92-1 at the Gallery Resources mine on Lightning Creek. High conductivity in the upper several metres of the hole reflects high silt and clay contents whereas low conductivity is indicative of gravelly deposits. (mS/m = millisiemens/metre).

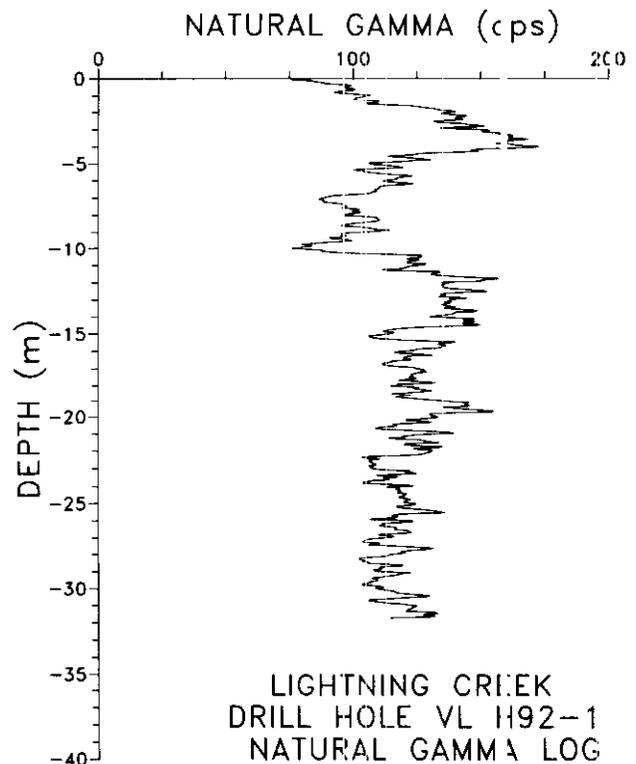


Figure 4-8-3. Natural gamma log of drill hole VL92-1. The natural gamma peak at 5 metres depth corresponds well with a similar peak in the conductivity log at the same depth (see Figure 4-8-2). Fluctuating values in the natural gamma log may reflect textural changes such as variations in sand and silt content in the gravels. (cps = counts per second).



Plate 4-8-4. Field crew conducting an expanding-spread seismic refraction and reflection survey on a high terrace of the Quesnel River above the Corless Tertiary mine site. The person on the left is operating the seismograph and the person on the right is releasing the firing pin into a shot hole. Geophones are spaced at equal intervals along the cables on the right. Note the portable, gas-powered auger drill in the middle of the road, used to drill shot holes.



Plate 4-8-5. Equipment used for ground-penetrating radar surveys. Transmitting and receiving antennas, in the foreground, are connected by fibre-optic cables to the data collection and processing equipment in the background.

seismic surveys conducted during this study will attempt to determine the potential of these techniques for locating these hidden layers. The seismic data are currently being processed and analyzed. The results of these analyses will indicate the potential for future studies.

GROUND-PENETRATING RADAR STUDY

Ground-penetrating radar surveys were conducted by Jean Pilon of the Geological Survey of Canada at six different mine sites (Gallery Resources Limited, Ballarat, Golden Bench, Pawnee, Tregillus Lake and Corless Tertiary mines). The survey equipment consists of two hand-carried antennas, one for transmitting and one for receiving the radar signals, connected to the data collection and processing equipment by fibre-optic cables (Plate 4-8-5). Data were collected from a total of 25 lines up to several 100 metres in length. The results of drilling data from these sites, collected during the 1992 program and by industry, were compiled in order to test the accuracy of the ground-penetrating radar data. Preliminary results indicate that the method is an excellent tool for determining depth to bedrock, water table level and major stratigraphic breaks and for investigating channel geometry in gravelly placer deposits. The main limitation of the method appears to be caused by the presence of clay-rich sediments that may overlie or be interbedded with auriferous gravel units.

FIELD CONFERENCE

A field conference on the geology of placer deposits in the Cariboo region was held for the mining and exploration industry as part of this program. The following topics were discussed: the bedrock geology of the Cariboo and relationships of lode gold and placer deposits (Chris Ash, B.C.

Geological Survey), the geology of the Alice and Mary Creek placer deposits (Jack Wyder), the composition of lode and placer gold in the Cariboo (John Knight and Ken McTaggart, The University of British Columbia), the formation of placers, depositional processes, paystreaks and sedimentary traps (Ted Faulkner, B.C. Geological Survey), the geology of buried placer deposits, field criteria for recognizing different types of placers and ways of identifying potential geologic settings conducive to placer deposition (Vic Levson, B.C. Geological Survey), placer gold recovery technologies, ways of reducing gold losses and sampling methods (Randy Clarkson, New Era Engineering), geophysical and other methods of locating and investigating buried placer deposits (Marten Douma, Susan Pullan and Jim Hunter, Geological Survey of Canada). The conference included a field trip to study the geology of local placer operations (Plate 4-8-6). Buried Quaternary and Tertiary placers were examined at three sites: the Ballarat, Gallery Resources and Alice Creek mines. High attendance at the conference (100 people) indicates that this is an excellent format for the exchange of geoscientific information between researchers and industry.

SUMMARY

Subsurface placer deposits were investigated using a number of techniques including reverse-circulation drilling, ground-penetrating radar, borehole geophysics and seismic studies. The utility and limitations of these techniques in different geologic settings were also evaluated. The investigations were conducted in conjunction with industry and the Geological Survey of Canada at the Gallery Resources Limited property, the Ballarat mine, the Golden Bench mine, in the Alice Creek area, south of Sovereign Creek, near Fontaine Creek, in the Reddish Creek region, in the



Plate 4-8-6. Some of the field conference participants examining the geology of a buried placer deposit at the Ballarat mine.

Quesnel Canyon area and near the Tregillus Lake mine. The main results of this program include:

- The intersection of auriferous paleochannel gravels in eight of the ten reverse-circulation holes drilled.
- The discovery of previously unknown gold-bearing paleochannel gravels at two sites (near Alice and Reddish creeks).
- Completion of the first phase of a program to investigate the applicability of ground-penetrating radar, borehole logging and geophysical studies to determining the subsurface stratigraphy and geometry of buried placers in a number of different settings.
- Completion of a preliminary evaluation of gold recovery in reverse-circulation drilling.

At most of the drill locations, the presence of subsurface paleochannels was not indicated by surface geomorphologic features. In addition, the auriferous deposits were buried by a thick glacial overburden sequence at all sites (except at the two drill holes along the Cottonwood River). The identification of buried channel deposits must therefore rely on the interpretation of existing geologic data from the area of interest and extrapolation of information from adjacent areas. The most critical data for successful results include information on the paleogeomorphic setting, depositional environment, source proximity and paleoflow direction. Useful subsurface data, such as paleoflow records and information on stratigraphy and depth to bedrock, can be obtained from natural and manmade exposures and from drilling programs. In addition, bedrock geology controls such as the locations of potential source rocks and favourable geologic structures need to be considered. The results of the drilling program conducted during this study indicate that these sources of information can be successfully used to identify new paleochannel deposits. Targets for drilling should be based on correlations of stratigraphic data and paleogeographic reconstructions of the buried channel systems.

Reverse-circulation drilling can provide valuable geologic data, such as lithologic composition of gravel units, stratigraphy and depth to bedrock, but the method is not recommended for accurate determinations of gold content. Potential errors may be reduced by determining gold content on the basis of the actual amount of sediment recovered (rather than on theoretical calculations of sediment volume based on the drill bit diameter and sample interval). Modifications to the drilling techniques and equipment used may also help eliminate potential sources of error. Results are apparently more reliable in compact gravels not subject to caving. However, determinations of gold values from drilling data, regardless of the method used, must be interpreted with caution due to the typically small sample size and other factors. Qualitative records of gold content, such as notes on presence or absence of gold and relative abundance, are considered to be more reliable than quantitative determinations based on small samples.

The preliminary results of the borehole logging component of this study indicate that subsurface gravel units can readily be distinguished from units with high silt and clay contents. Geophysical logging of abandoned holes from previous drilling programs, common on many placer prop-

erties, may be an economic way of obtaining useful stratigraphic information. Other methods of determining subsurface stratigraphy such as refraction and reflection seismic surveys and ground-penetrating radar surveys may also be useful for locating buried placer deposits. Preliminary results indicate that ground-penetrating radar is a particularly good method for investigating buried channel gravels provided that they are not overlain by clay-rich sediments.

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