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Drilling and Sampling Tertiary Gold-Bearing Gravels at Badger Hill, Nevada County, Calif.

UNITED STATES DEPARTMENT OF THE INTERIOR

Report of Investigations 7935

Drilling and Sampling Tertiary Gold-Bearing Gravels at Badger Hill, Nevada County, Calif.

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DRILLING AND SAMPLING TERTIARY GOLD-BEARING GRAVELS AT BADGER HILL, NEVADA COUNTY, CALIF.

by

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and Robert L. Stahl[2]

ABSTRACT

As part of an effort to develop new or improved placer mining technology in the Tertiary gold-bearing channel gravel of northern California, the Bureau of Mines conducted investigations at the old Badger Hill placer mine in Nevada County, Calif., to collect data and information regarding drilling and sampling methods and deposit characteristics.

Sampling studies involved the collection and processing of 400 tons of large-and small-volume samples from drill holes, underground workings, surface pits, and blasthole rounds. A total of 355 samples averaging 2,296 pounds per sample provided reasonably accurate data for analysis of the gold distribution. These studies indicated that the bulk of the gold is within 40 feet of bedrock in stacked, lenticular zones of cemented gravel that are largely confined to the relatively narrow, meandering course of the deepest portion of the bedrock channel.

Drilling studies involved the testing of truck-mounted rotary, bucket, and vibratory drills, none of which proved to be a completely versatile tool for sampling quickly and reliably both consolidated and unconsolidated gravel.

INTRODUCTION

To meet the national requirements for increased domestic gold production, the Bureau of Mines, under the aegis of the Heavy Metals Program of 1966-70, conducted a nationwide search for favorable gold-bearing deposits. Preliminary investigations indicated that the immense Tertiary channel gravel deposits of California (1, 8) contain one of the largest reserves of gold in the United States; reserves that might be developed rapidly with the application of new or improved placer mining technology. The Badger Hill Deposit in Nevada County, Calif., was selected as a typical and convenient site for Bureau of Mines research groups to conduct surface and underground investigations in the Tertiary channel environment.

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[3]Underlined numbers in parentheses refer to items in the list of references preceding the appendix.

Five Bureau of Mines research centers and laboratories participated in mining subsystem studies at the old Badger Hill hydraulic mine, Nevada County, Calif., to identify the problem areas requiring immediate solution to stimulate gold mining in these extensive gravel deposits. The original objective of the program was to delineate a segment of a typical Tertiary channel and then conduct intensive mining research, followed by demonstration mining. Reduced funding and subsequent reorientation of the work resulted in the emphasis being shifted towards research within the problem areas that were encountered for each mining subsystem. The demonstration mining stage of the project was eliminated.

Deposit delineation activities under the Denver Mine Systems Engineering Group were oriented to accomplish the following objectives: (1) Determine the vertical and horizontal distribution of the gold particles; (2) test and improve drilling and sampling equipment and techniques; and (3) provide drilling support for geophysics studies.

Sufficient sampling data were obtained to verify that a relatively normal placer gold distribution exists in the Badger Hill segment of the San Juan Ridge channel. The drill-sampling investigation indicated that the drills tested by the Bureau of Mines were incapable of providing reliable samples of the deep, cemented gravels; however, the rotary drill was found to be essential for rapid probing to bedrock in support of the seismic technique that was developed to establish bedrock configuration.

Throughout this report, sample results are presented in terms of milligrams of gold per cubic yard (mg/cu yd) of in-place gravel and milligrams per ton (mg/ton) of dry gravel. Density tests place white gravel at 2,700 pounds per cubic yard (lb/cu yd), red gravel at 3,570 lb/cu yd, and blue gravel at 3,900 lb/cu yd. To assist with the task of converting from milligrams to the currently fluctuating value of gold, the following items of information are presented:

1. 31,103 mg is equal to 1 troy ounce.

2. Current price of gold per troy ounce divided by 31,103 is equal to the current value of 1 mg of gold at 1,000 fine.

3. The value in item 2 multiplied by 0.9 is equal to the value of 1 mg of gold at 900 fine.

All Badger Hill sample results are presented in milligrams of gold at 900 fine unless otherwise stated.

ACKNOWLEDGMENTS

The Bureau of Mines wishes to thank San Juan Gold Co. for cooperating in this study and for allowing the drilling and sampling to be done on their property. The U.S. Forest Service, the Bureau of Land Management, and property owners in the area aided the study by their interest and cooperation.

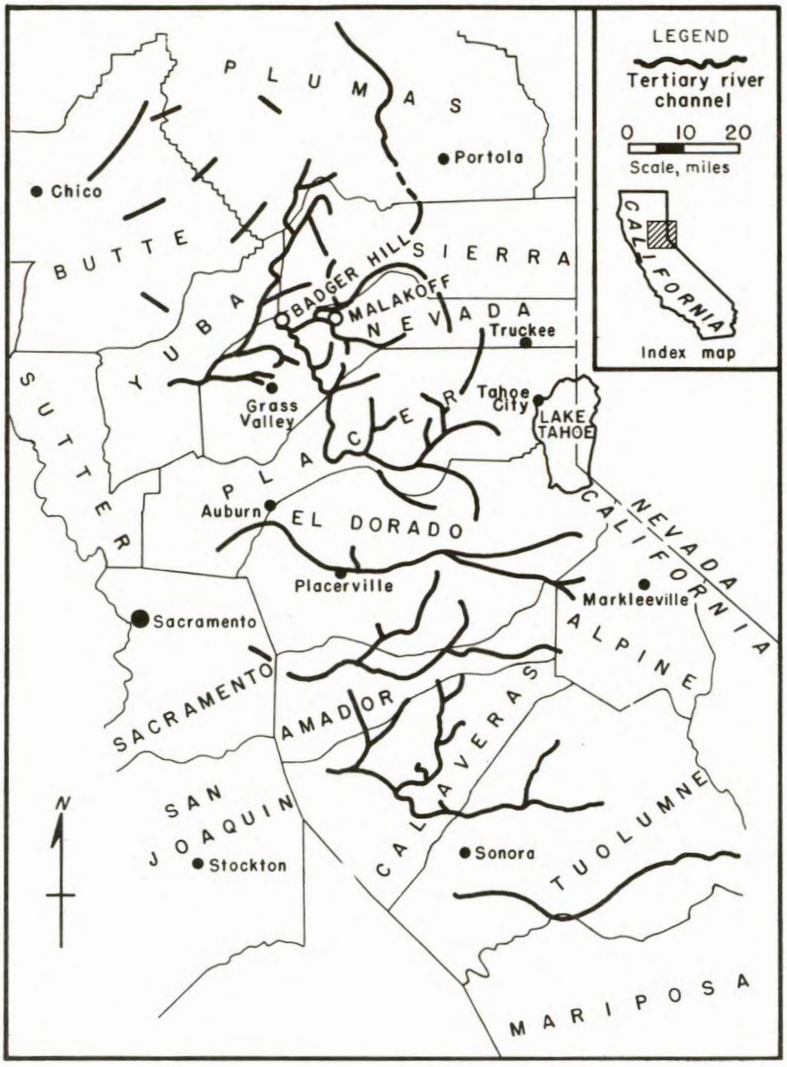

FIGURE 1. - Location of Badger Hill and Malakoff pits, San Juan Ridge, Nevada County, Calif.

DESCRIPTION OF BADGER HILL SITE AND DEPOSIT

The Badger Hill deposit is on the west slope of the Sierra Nevada Mountains, in Nevada County in northern California, approximately 12 miles due north of the town of Grass Valley and 6 miles west of the huge Malakoff pit (fig. 1). The area may be reached by traveling northwest from Grass Valley on State Highway 49 for approximately 20 miles, then northeast on Tyler Road for 5 miles, then north on a dirt road about 1-1/2 miles to the project site, located in sec. 36, T 18 N, R 9 E. The famous hydraulic pits of North Columbia and Malakoff (5-6), among the largest in the Sierra Nevada, are located a few miles to the east (fig. 2). In dry weather, access to the area is excellent; however, during the rainy season the dirt road leading to the site often is excessively muddy.

The deposit is perched on San Juan Ridge from 700 to 900 feet above and between the Middle and South Yuba Rivers. Approximately 5,000 feet of the north end of the deposit was mined hydraulically (3) in two benches prior to 1884, creating a mile-long pit known as the Badger Hill diggings. A vertical bank of gravel approximately 120 feet high separates the lower from the upper workings. The lower pit was hydraulicked to bedrock, laying bare about 2,000 feet of the channel bottom. Total relief in the pit area is about 360 feet; the altitudes range from 2,340 feet in the lower pit to about 2,700 feet on the high point of the upper bench (fig. 3, in pocket).

Exploitation of the Badger Hill deposit and of all other similar deposits in northern California by large-scale hydraulic mining ceased in 1884 because of legal restrictions placed upon the disposal of debris (4). Production figures are not available for the Badger Hill diggings, although the pit size indicates that several million cubic yards of gravel were removed prior to

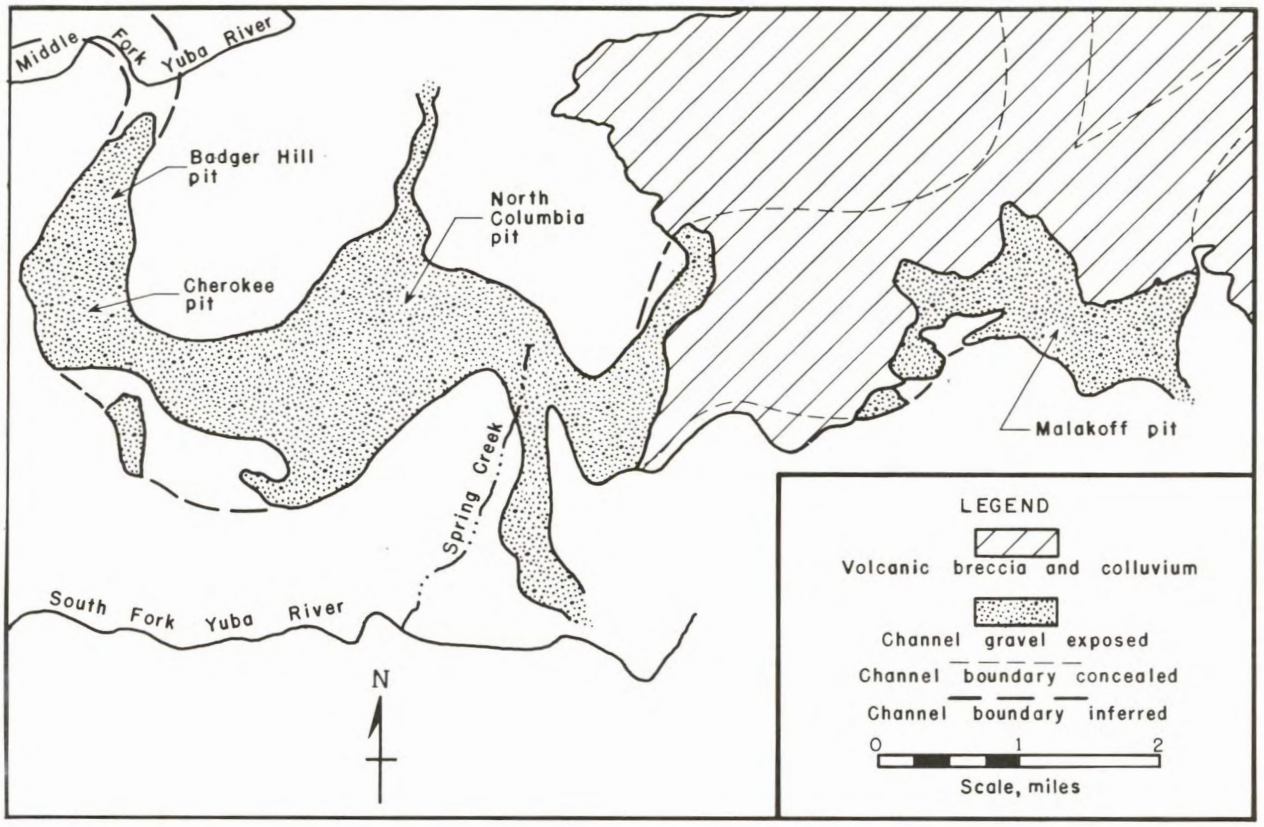

FIGURE 2. - Tertiary channel and major hydraulic pits on San Juan Ridge, Nevada County, Calif.

1884. According to a summation of several earlier reports (5), a reserve of 7,700,000 cubic yards of red and blue gravel is exposed in the pit area at Badger Hill. The total Badger Hill deposit is estimated to contain approximately 76,900,000 cubic yards of gravel. Detailed information concerning the Badger Hill deposit is lacking, although early engineering reports (5, 7, 9, 11) are available describing the mining, sampling, and reserves of the bulk of the channel on San Juan Ridge.

The Badger Hill test site is at the west extremity of a 6-mile-long segment of Tertiary channel fill that ranges in depth from about 250 feet at Badger Hill to about 500 feet at the eastern end of the segment. The channel width ranges from 1,200 feet at Badger Hill to approximately 7,000 feet about 3 miles to the east.

The fill is classified into upper and lower gravels. The upper gravel contains abundant milky-white quartz pebbles interbedded with large amounts of sand and clay. This material is well exposed in the walls of the hydraulic pit and normally comprises the bulk of the channel fill in undisturbed areas. See figures 4 and 5 (fig. 5 in pocket) for geologic cross sections through the Badger Hill pit. For explanation of profiles AA', BB', CC', and DD', see figure 3 (in pocket). Within the lower gravel, two units are recognized as

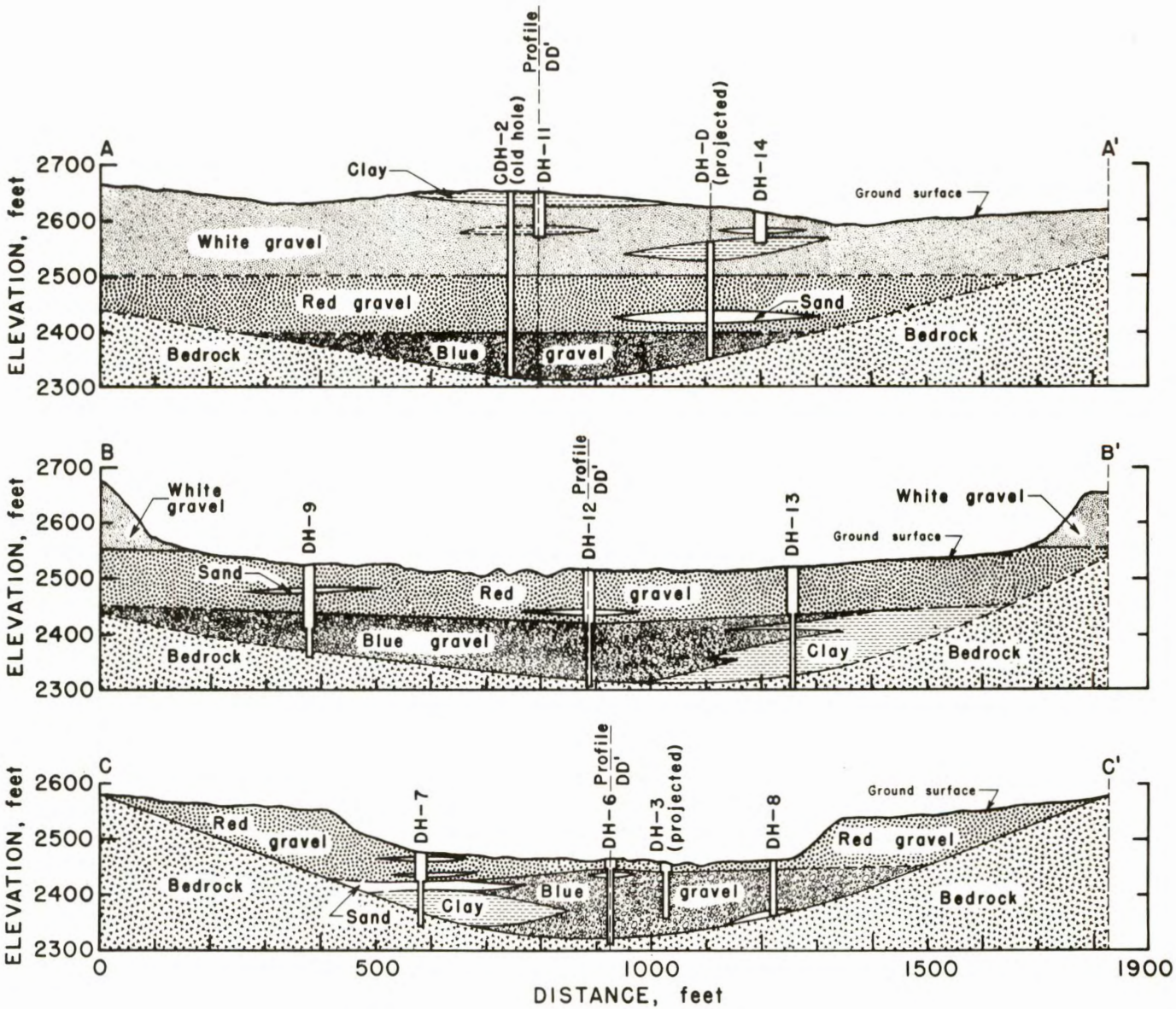

FIGURE 4. - Cross sections through Badger Hill hydraulic pit.

blue gravel and red gravel. The coarse, poorly sorted blue gravel that commonly fills the bottom of the channel is blue-gray in color below the water table, carries secondary sulfides, and normally is cemented. The overlying red gravel contains few boulders, is better sorted, is stained reddish-brown by iron oxide, generally lacks sulfides, and is well compacted but not cemented.

Approximately 80 percent of the gold occurs in the blue gravels near bedrock. The remaining 20 percent is distributed erratically throughout the red and white gravels from the ground surface to the blue gravel contact and from bank to bank in the channel fill.

DRILLING AND SAMPLING DELINEATION COMPLETED BY THE BUREAU OF MINES

The original drill-sampling and trench-sampling projects were designed to determine the suitability of the Badger Hill deposit for demonstration mining. If results were favorable, the drilling and sampling projects were to provide sufficient delineation data (vertical and horizontal distribution of gold and material types, bedrock configuration and depth, and accurate topographic control) to develop a detailed three-dimensional physical model of the deposit, which would be used to develop an optimum mining system.

Reduction of funding resulted in the elimination of detailed drilling that would more firmly establish the distribution of the gold; however, sufficient drilling and sampling were accomplished throughout the deposit to determine the various weaknesses and advantages of the equipment and techniques employed and to verify certain concepts regarding the distribution of gold.

Sample processing facilities were established at Badger Hill to concentrate large- and small-volume gravel samples at the site. Equipment included a large-volume sample concentration plant designed and built by the Bureau (figs. 6-7), and complete ancillary power, loading, pumping, sampling, and transportation equipment and facilities. Large-volume samples from the upper gravels were obtained with a bucket drill equipped with a 30- or a 36-inch bit. Small-volume samples from the cemented gravels were obtained with a standard-type rotary drill equipped with 4- to 5-inch button bits. The most significant use of the rotary drill was to quickly determine the depth to bedrock in support of the geophysics portion of the delineation studies.

Samples not classified as drill hole samples were collected from hand-dug pits or selected from batches of cemented gravel that was fragmented by blasting at underground and surface test sites.

Samples were comprised of hundreds or thousands of pounds of gravel, and normally produced up to 25 pounds of concentrate that might contain from a few dozen to many hundreds of gold particles or colors ranging in size from microscopic specks to flakes 3 mm or more in diameter. The relatively large amounts of concentrate and gold per sample required the adaptation of field evaluation and recording techniques that differed from those employed for

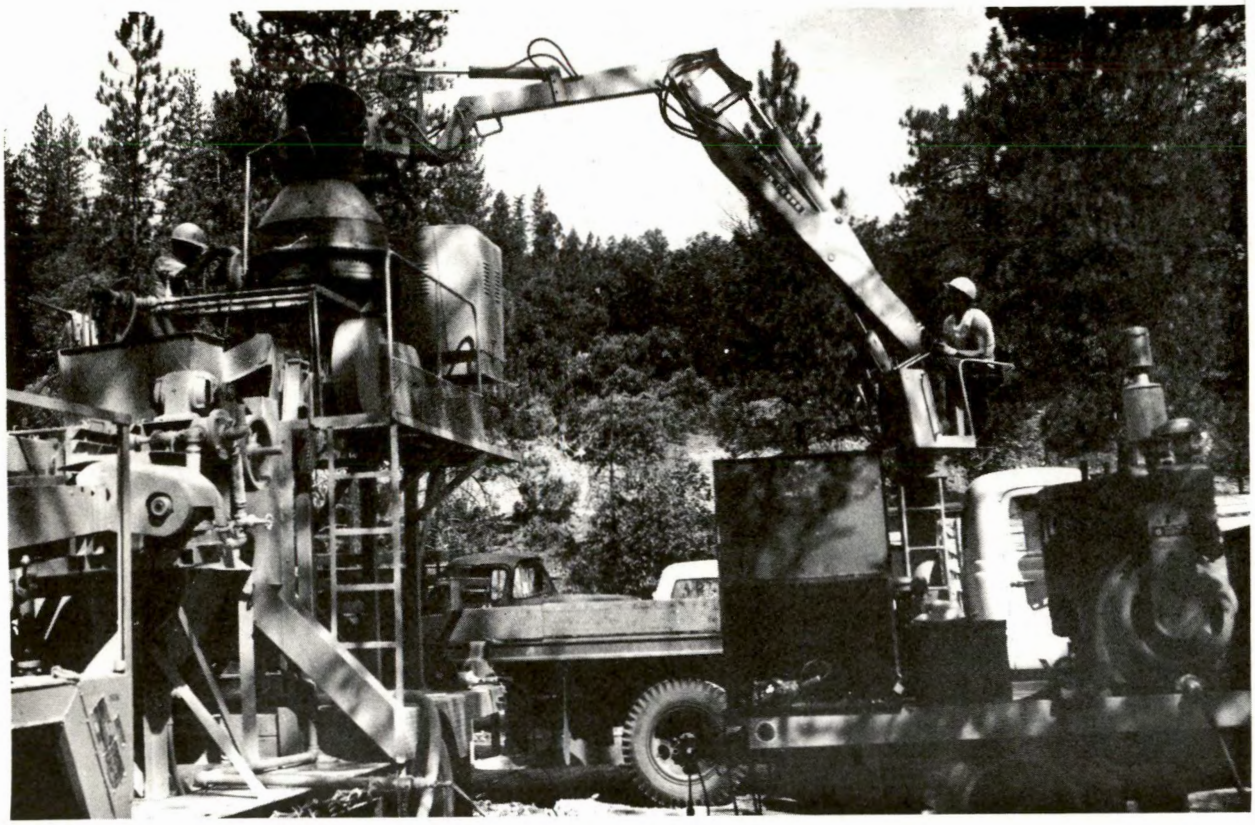

FIGURE 6. - Loading gravel into sample plant.

standard churn drilling samples (2), which normally produce a few ounces of concentrate and a few easily counted particles of gold.

Concentrates from Badger Hill were panned down to an average of 2.5 pounds per sample, from which all but the smallest particles of gold (minus 100 mesh) were removed for counting prior to amalgamation. Often large numbers of the smaller particles could not be included in the color count, thus explaining some apparent discrepancies between the color count and the total weight of the gold recovered by amalgamation. For examples of such discrepancies in the drill hole sample data, see appendix table A-4.

Another apparent discrepancy will be noted in the comparison of sample volumes and sample weights as recorded in table A-1. For a constant sample volume, the sample weights often vary considerably as a result of the relative amounts of clay, sand, gravel, and cobbles in each sample. Samples that contained a high percentage of clay and sand invariably were many pounds lighter than samples of equal volume that contained a high percentage of gravel and cobbles.

FIGURE 7. - Washing concentrate from tilting riffle box.

An automatic tailings sampler was an integral part of the concentration plant. Except for isolated instances, gold loss in the tailings was found to be negligible. Processing of tailing samples also indicated that flour gold was not adhering to the black sands and that gold was in no way chemically associated with the heavy waste materials.

Table 1 presents a resume of all types of drilling and sampling completed within the scope of the delineation studies. The drill holes and corresponding samples are classified according to type, location, or task. Bucket drill sample numbers are prefixed with the letter B and rotary drill sample numbers are prefixed with the letter C in table A-1. As indicated in table A-1, several holes were started with the bucket drill and samples were collected to the cemented gravel, from which depth a rotary drill was used to penetrate to bedrock. Hole locations are indicated in figures 3-5 (figs. 3 and 5 in pocket).

TABLE 1. - Resume of drilling and sampling at Badger Hill

Sample type	Number of holes	Number of samples	Total dry weight, lb	Total footage	Average weight per sample, lb
Bucket drill	16	160	601,744	760.9	3,760.9
Rotary drill	11	21	30,069	1,171.0	1,431.8
Blasthole	12	11	11,031	431.1	1,002.8
Hydrology hole	5	10	27,538	962.0	2,753.8
Measured pit:					
"A" series	([1])	5	13,675	([1])	2,735.0
"P" series	([1])	15	1,568	([1])	2,104.5
Stratigraphic	([1])	13	2,084	([1])	173.6
Adit round	([1])	38	91,122	([1])	2,398.0
Toe bulk	([1])	7	20,292	([1])	2,898.8
Bedrock drift (winze)	([1])	3	302	([1])	100.6
Upper level drift (raise)	([1])	9	428	([1])	47.5
Face:					
Lower bench	([1])	55	440	([1])	8.0
Lower bench select	([1])	2	1,022	([1])	811.0
Core (bedrock)	([1])	6	([3])	45.9	([3])
Vibratory drill holes	13	([2])	([2])	180.0	([3])
Total	57	355	801,315	3,550.9	2,296.0

[1] Samples were obtained by means other than drilling.
[2] No samples were collected.
[3] Weight not recorded.

Blasthole samples were obtained from two rows of surface holes (fig. 3) that were drilled in a prepared bench of blue gravel. The sample numbers correspond to the hole numbers and have a prefix of BL in table A-1.

Five hydrology test holes were rotary drilled and two samples were collected from each hole. The holes are listed as A, B, C. D, and E (fig. 3) and the corresponding samples are prefixed with the letters HH in table A-1.

One ventilation hole, VH-1 (fig. 3) was rotary drilled from the surface to the depth of the underground workings to provide additional air to the test rooms. One sample was collected and is recorded as C-14 in table A-1.

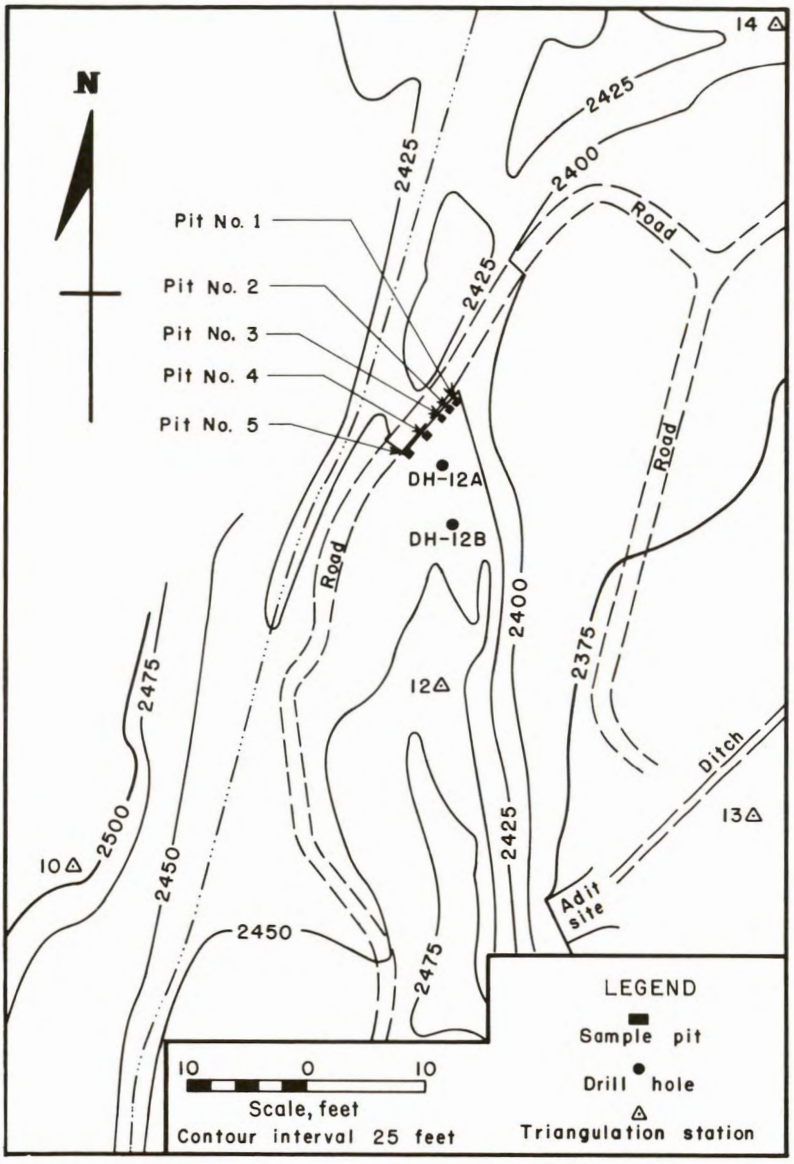

FIGURE 8. - Location of large- and small-volume pit samples and holes 12A and 12B prior to surface blasting.

Measured pit samples from pits 1-5 (fig. 8) were cut at the start of a sampling project to test statistically the reliability of large-volume samples versus small-volume samples. Early termination of the program prevented completion of this project; however, the sample results of five 1-cubic-yard samples (A samples) and 15 0.75-cubic-foot samples (P samples, fig. 9) are presented in table A-3 according to pit number and sample number.

A series of stratigraphic samples (figs. 3 and 10) were cut in a vertical face of red gravel near the edge of the lower bench. The results, prefixed with the letter T, are given in table A-3.

Adit round samples are bulk grab samples that were collected underground after blasting each drill hole round while driving the test rooms (fig. 11). The samples are prefixed by the letters AR in table A-2.

Toe bulk samples are bulk grab samples that were obtained from the toe of each of the two masses of fragmented blue gravel produced by surface bench blasts (fig. 12). The samples are prefixed by the letters TB in table A-3.

Bedrock drift samples (fig. 11) were cut from blue gravel in the floor of the southeast-trending drift at the bottom of the winze in the Badger Hill adit. The samples are identified in table A-2 as bedrock drift samples 1-3.

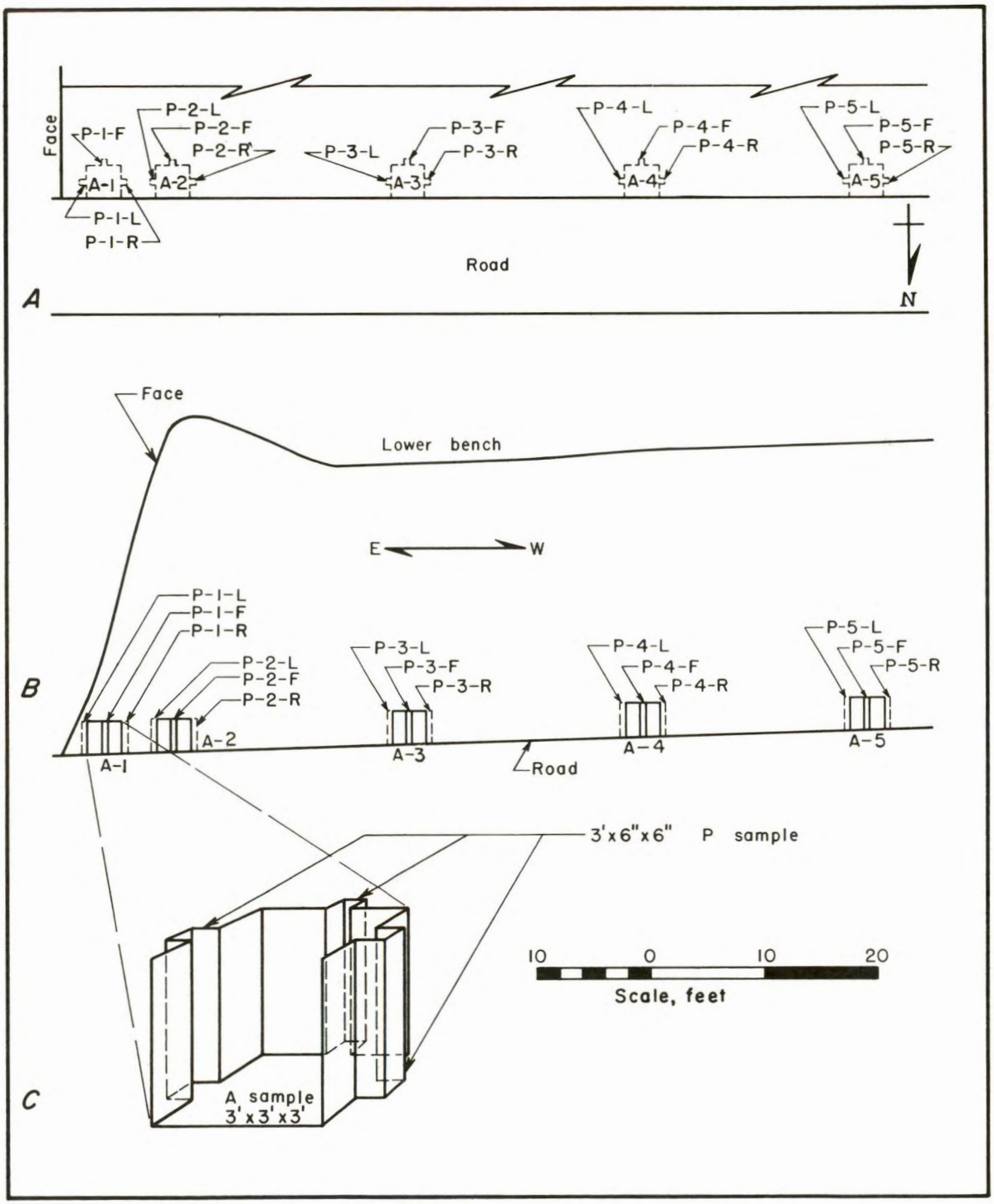

FIGURE 9. - Detail of large- and small-volume pit samples.

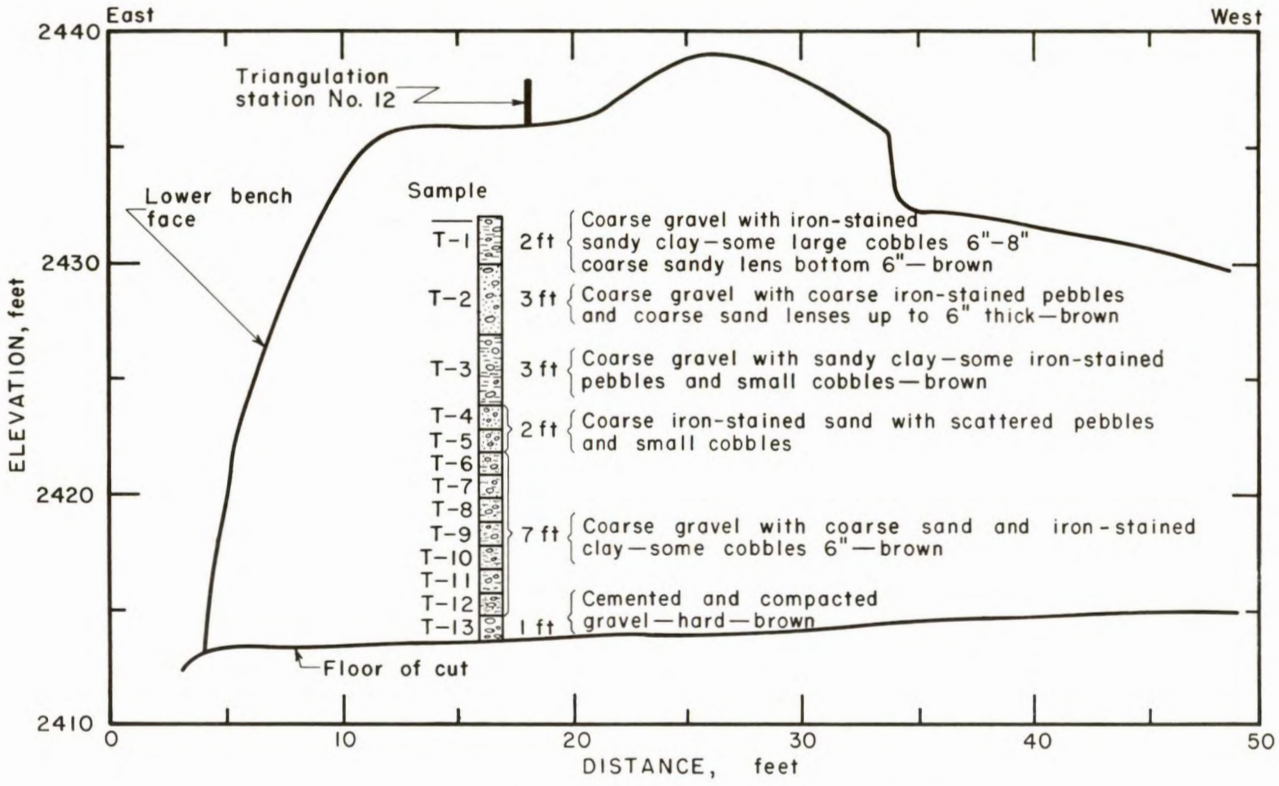

FIGURE 10. - Location of stratigraphic samples.

Upper-level drift samples (fig. 11) were cut from blue gravel in the walls of a short drift off a 20-foot raise in the right wall of the Badger Hill adit. The samples are identified as upper level samples 1-9 in table A-2.

A total of 55 samples were cut at intervals of from 10 to 20 feet along 700 feet of the old working face of the lower bench to provide a reconnaissance-type evaluation of the distribution of gold near the contact of the red and blue gravels. The samples were approximately 1/10 cu ft in volume and averaged 8 pounds in weight. Ten samples contained no visible gold and were scattered at random along the face. Forty-five samples contained color counts ranging from 1 to 17 per sample with two zones of higher gold concentration appearing 100 feet and 200 feet north of the adit site (fig. 3, in pocket).

Two select samples were cut from the face of the lower bench. The first was cut about 10 feet above the portal of the adit to check the surface exposure of a zone corresponding to that sampled in the upper-level drift (fig. 11). One cu ft of gravel contained 65 mg of gold. The second select sample was cut to check one of the zones of high gold concentration detected by the reconnaissance sampling along the face. One-third cu yd of gravel contained 45 mg of gold.

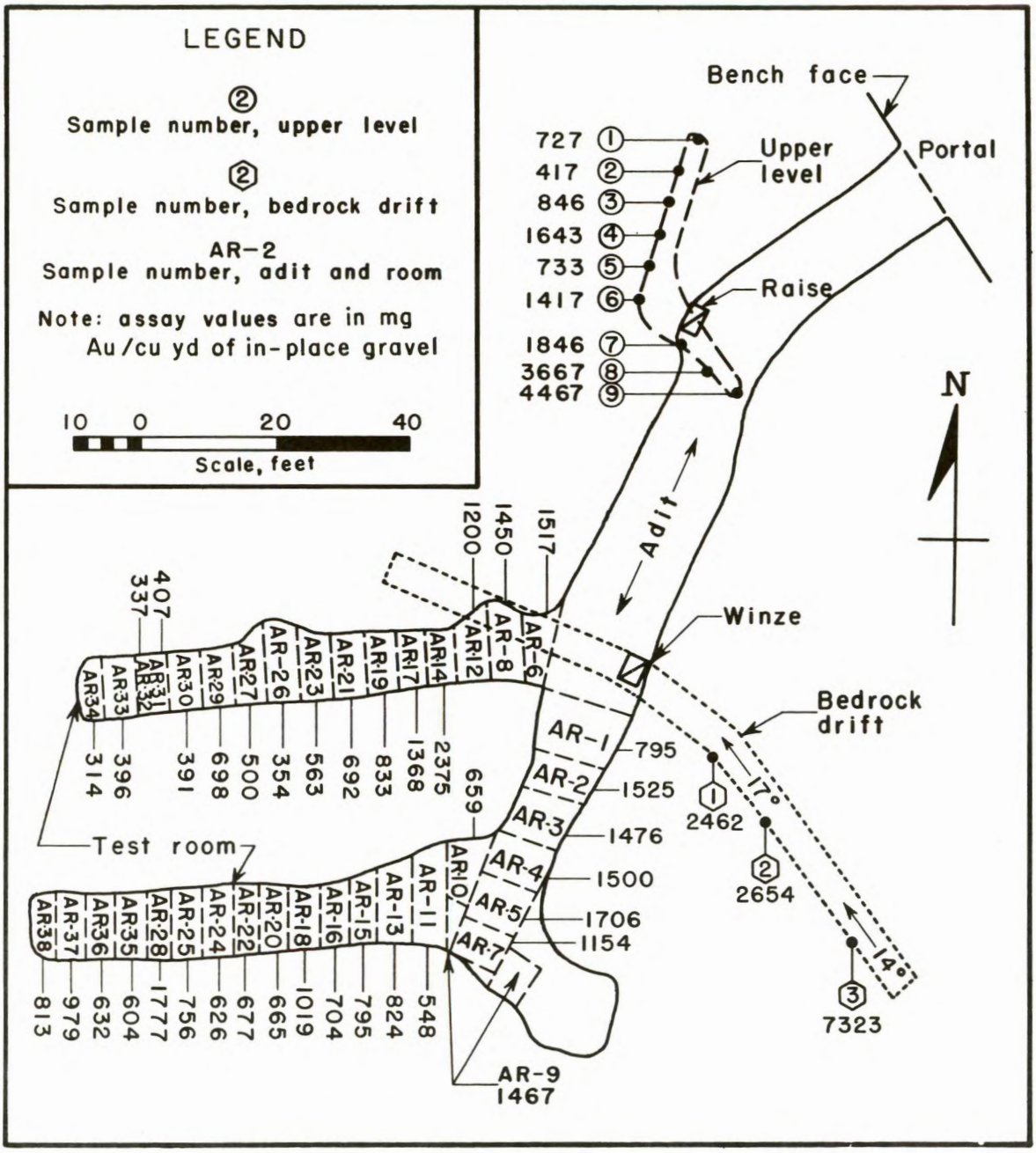

FIGURE 11. - Location of underground samples, Badger Hill adit.

Six short core holes were drilled into bedrock from the bottom of six rotary drill holes to provide core samples of rock types for the geophysics studies conducted by the Bureau of Mines (13) and the Geological Survey (10).

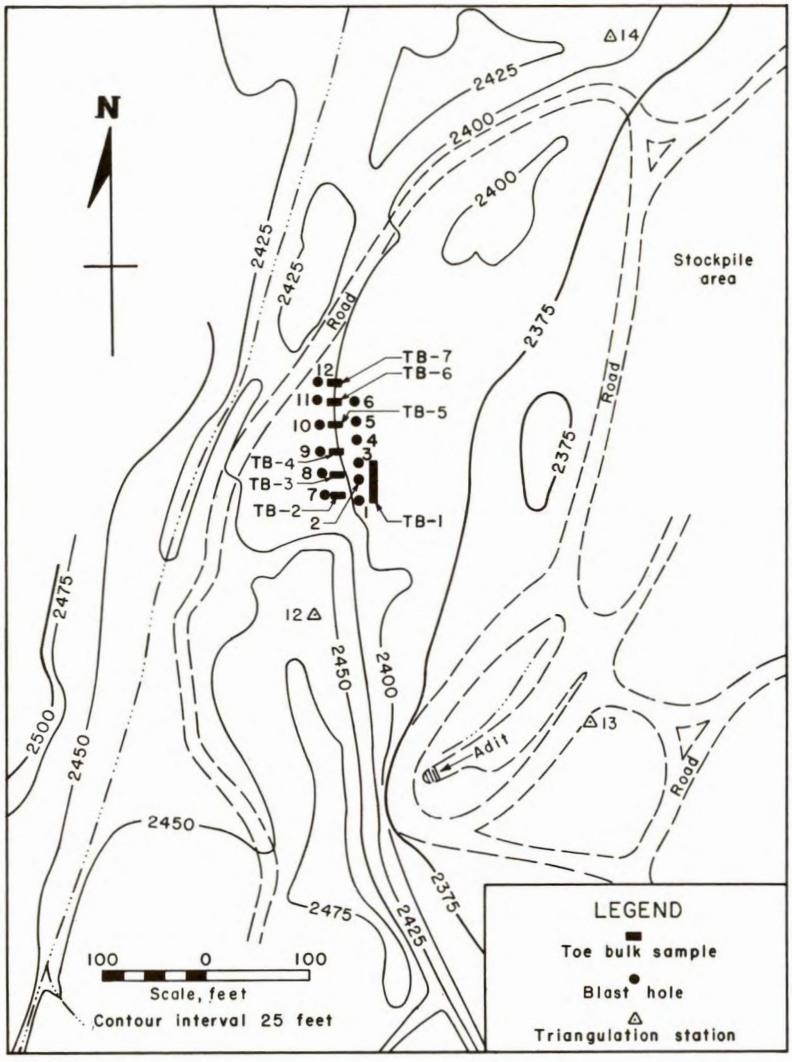

FIGURE 12. - Location of toe bulk samples and blast holes, open pit test area.

An experimental vibratory drill was utilized to drill 13 shotholes for seismic measurements (13). No samples were collected from this drilling.

All concentrate from the above-described samples (table 1) was processed by amalgamation and cyanidation at the Bureau's Salt Lake City Metallurgy Research Center, and the recovery of gold at 900 fine is presented in tables A-1 through A-4. As indicated in the total gold column of tables A-1 through A-4, the amount of gold recovered during amalgamation can be increased by cyanidation of the amalgam residue.

DISTRIBUTION OF GOLD

A systematic study of the distribution of gold in the Tertiary channel from the Badger Hill pit to the North Columbia pit is incomplete because of the lack of churn drill holes at Badger Hill; however, the several types of samples taken at all depths by Bureau personnel in 1968-69 provide sufficient data to establish several general conclusions concerning the vertical and horizontal distribution of gold and the physical characteristics of the gold particles within the three readily identified zones known, from upper to lower, as the white, red, and blue gravels.

White Gravels

An indication of the distribution and size of the gold particles found in the uppermost 90 feet of the white gravels at Badger Hill was determined from 33 samples obtained from bucket drill holes 10, 11, and 14 (fig. 3, in pocket). The samples were cut at 5-foot intervals and totaled 11,528 pounds of gravel for an average of 3,379 pounds per sample (table A-1). Twelve stratigraphic samples cut from the upper 100 feet of white gravels at the North Columbia pit

provided a preliminary check of the gold distribution for that section of the channel.

The 111,558 pounds of upper white gravels contained only 5.5 percent of plus 1/8-inch material, mostly quartz pebbles, and contained an average of 22.2 mg/cu yd of gold. Gold content of the samples ranged from 3.2 to 89.1 mg/cu yd (2.4 to 64.8 mg/ton). The following sieve analysis is believed to be representative of the gold particle size distribution in the upper 100 feet of white gravel at both the Badger Hill and North Columbia deposits:

Particle size	Weight-percent
Minus 20 mesh.....	0
Minus 20 plus 40 mesh.....	2
Minus 40 plus 60 mesh.....	5
Minus 60 plus 80 mesh.....	11
Minus 80 plus 100 mesh.....	12
Minus 100 mesh.....	70
Composite.....	100

Under the microscope, the gold particles from the white gravels (fig. 13) appear to be clean and have a high percentage of slightly flattened particles rather than a predominance of flakes battered to paper thinness as characterized by the gold found deeper in the channel. Many particles appear to be remnants of wire gold, and some are nearly spherical. The gold is not sufficiently worn to have acquired the smooth, dull patina that is noticeable on flakes from the blue gravels.

All of the gold from the white gravels exhibited a marked tendency to float if briefly exposed to air while panning. The addition of a small amount of detergent to the water while concentrating these gravels was essential to prevent a loss of gold. As noted by the sieve analysis, 70 percent of the gold passed through a 100-mesh screen, thus approaching flour gold particle size, which is a difficult product to recover in a large-scale placer operation.

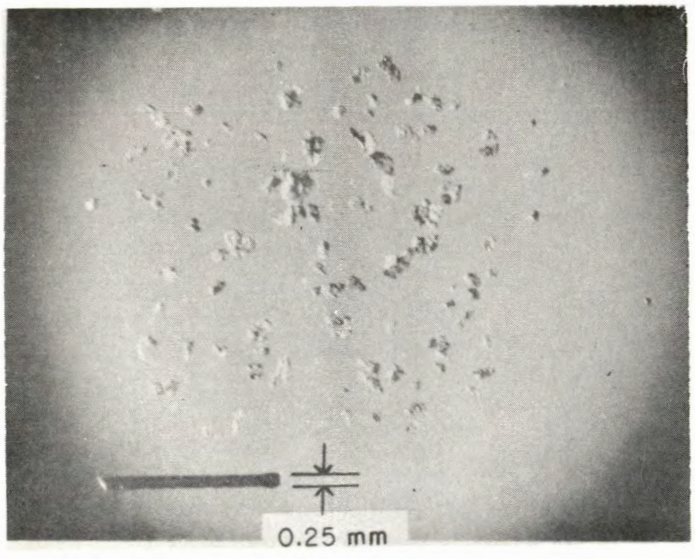

FIGURE 13. - Gold particles from white gravels, Badger Hill.

Clay and sand lenses within the white gravel zone contain the smallest amount of gold. The concentrates of some samples from these lenses contained no visible gold. This occurrence appears to be uniform throughout the deposit and is indicative of a low-velocity current from which even the smallest particles of

gold normally are dropped prior to the deposition of the sand and clay. Table 2 contains analyses of twelve 10-pound samples from a vertical section of the upper white gravel zone at North Columbia, illustrating the influence of an abundance of sand and clay on the gold particle or "color" count per sample.

TABLE 2. - Analyses of 12 white gravel samples

Sample	Estimated composition, percent			Number of gold particles	Gold weight, mg
	Clay	Sand	Gravel		
1	80	20	0	0	0.0
2	70	30	0	2	Trace
3	25	70	5	6	.4
4	10	85	5	5	.3
5	15	75	10	2	.9
6	10	90	0	0	.0
7	5	80	15	1	.5
8	40	60	0	0	.0
9	10	80	10	1	.4
10	10	80	10	2	1.1
11	30	70	0	0	.0
12	40	58	2	3	Trace

Of the four samples in the above series that contained no visible gold, none contained gravel. Of five samples that contained no gravel, only one contained visible gold. This relationship is further exemplified by the gold-sand-clay ratio in the bulk samples. Samples having a high percentage of minus 1/8-inch material generally contained less gold than those having a relatively low percentage of minus 1/8-inch material, providing that the samples all are from the same stratigraphic zone. Such comparisons must be made within one of the three zones and not between zones, as a sand or clay lense near bedrock possibly will contain several cents in gold per cubic yard--an amount that might equal or exceed that of the most favorable material high in the white gravel zone.

Horizontal distribution of the gold is highly erratic in the white gravels. Sampling by the San Juan Gold Co. (12) and the Bureau of Mines indicates that minor concentrations of gold exist across the entire width of the areas tested, as might be expected from deposition in a braided stream environment. A red clay zone forming the original ground surface provided the most difficult samples to concentrate in the Bureau sample plant. The addition of a measured weight of cobbles to a sample normally weighing from 800 to 1,000 pounds reduced the scrubbing time from 60 or more minutes to about 30 minutes to free most of the gold from the clay.

Red Gravels

A total of 192 samples from 13 bucket drill holes and 32 pits provided 508,143 pounds of gravel from the central or red gravel zone at Badger Hill. The bucket drill holes were spotted in the floor of the middle bench (fig. 3, in pocket) and were extended to the contact of the highly compacted blue

gravel that usually stopped the drilling advance after a few inches of penetration. A perched water table rests upon the contact of the red and blue gravels. The thickness of the red gravel zone ranges from 20 to 80 feet in the area tested.

Gold particle size and the amount of gold per cubic yard increased noticeably from the white to the red gravels, although the changes probably are gradational. In the white gravel zone, bucket drill hole samples yielded an average of 22.2 mg/ton of gold (30 mg/cu yd) at 900 fine; and in the red gravel zone, 490,816 pounds of bucket drill hole samples yielded an average of 43.5 mg/ton (58.8 mg/cu yd) at 900 fine. Plus 1/8-inch material increased from 5.5 percent in the white gravel to 46 percent in the red gravel.

The following sieve analysis is believed to be representative of the gold particle size distribution for the red gravels at Badger Hill:

Particle size	Weight-percent
Plus 20 mesh	0
Minus 20 plus 40 mesh	36
Minus 40 plus 60 mesh	38
Minus 60 plus 80 mesh	17
Minus 80 plus 100 mesh	5
Minus 100 mesh	4
Composite	100

Approximately 20 percent of the gold particles observed from the red gravels were coated with iron oxide or with an unidentified translucent material that sometimes completely encased the flakes. Both types of coatings will influence the efficiency of recovery by amalgamation unless scrubbing is employed ahead of the recovery unit. Ten minutes of scrubbing in the Bureau sample plant normally was sufficient to remove the coating and to brighten most of the rusty gold. Much of the gold will float readily if allowed to become dry or greasy at any stage of the recovery operation.

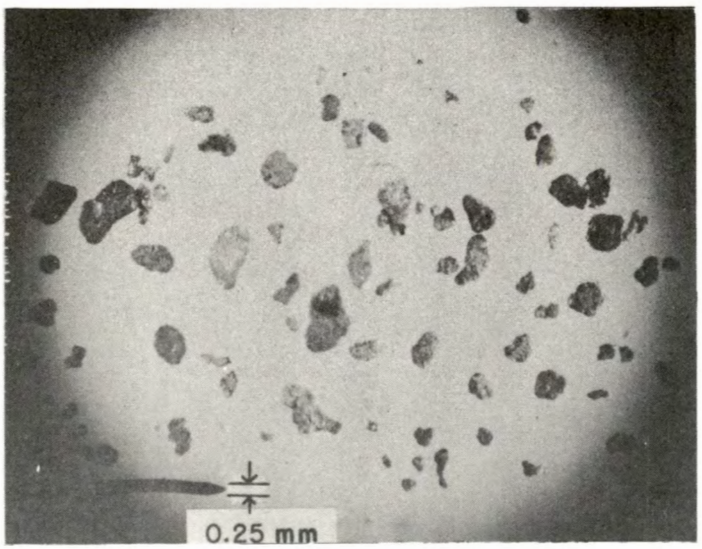

FIGURE 14. - Gold particles from red gravels, Badger Hill.

As indicated by the sieve analysis, the gold flakes generally are larger in size than those from the white gravels and are characterized by a thin, flat, pancake appearance (fig. 14). A few rough and sometimes spherical particles were observed in most of the samples, possibly indicating more recent liberation and less battering through transportation.

Sample data (table A-1) indicate that no concentration of gold exists at the contact of the unconsolidated red gravels and the highly compacted or cemented blue gravels. Although the transition from one zone to the other often is sharply defined, the contact apparently did not materialize in time to serve as a false bedrock.

As noted in the white gravels, the least favorable zones for the concentration of gold are those having a high content of clay and sand. The stratigraphic section (fig. 10, table A-3) illustrates the selective occurrence of gold in several feet of red gravel, sand, and clay. The horizontal distribution also appears to be similar to that in the white gravels whereby minor concentrations of gold were found across the full width of the areas tested.

Blue Gravels

Unoxidized or blue gravels cover the deepest portion of the channel to known depths ranging from 118 to 138 feet along the trough at Badger Hill and from 100 to 250 feet along the trough at North Columbia. This zone is characterized by a distinctive gray-blue color, high density, and a relatively high percentage of large boulders within 20 feet of bedrock. The material is highly compacted and usually is tightly cemented, requiring drilling and blasting for primary fragmentation.

Approximately 80 percent of the total gold content of the channel deposit is believed to be confined to the blue gravels. Sampling data developed by the Bureau of Mines tend to confirm the earlier work at the North Columbia deposit (12), which indicate that most of the gold is concentrated to the lower 40 feet of blue gravels, but not necessarily resting directly upon bedrock. Approximately 50 percent of the richer concentrations of gold in the tested areas at North Columbia are from 5 to 30 feet above bedrock. Figure 15 illustrates the tendency for the gold sometimes to concentrate in multiple lenses above bedrock. This type of occurrence was noted and described by Lindgren (8, p. 66) and Munro (9, p. 28) at the time that many of the deposits were being mined.

The Bureau of Mines collected 154,266 pounds of blue gravel comprising 92 samples from 33 drill holes, from 38 adit blast rounds, and from 20 pits and cuts. Seventy-seven percent of this material was retained on the 1/8-inch screen of the sample plant, indicating a 31-percent increase of coarse material over that of the red gravels.

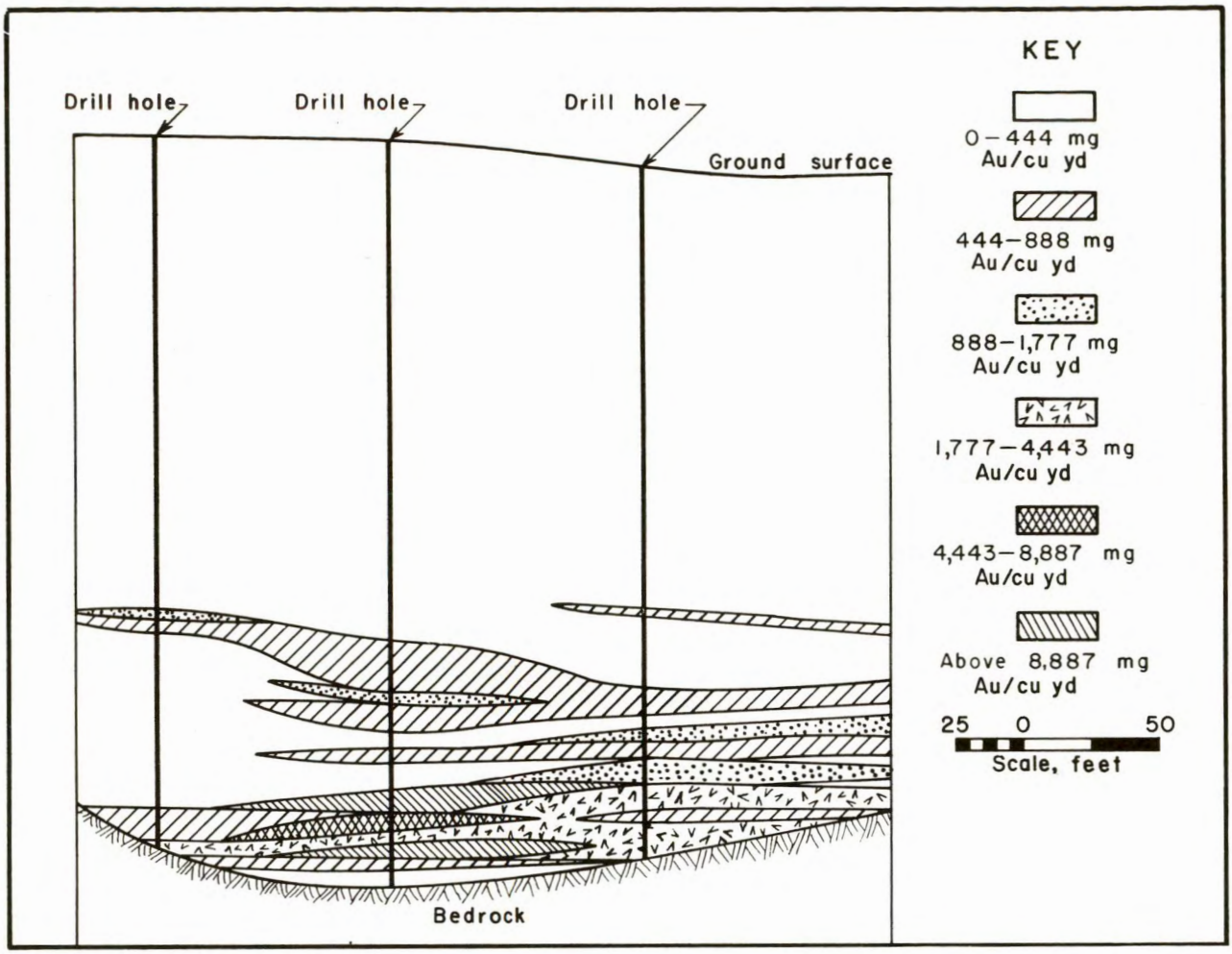

FIGURE 15. - Portion of drill hole fence illustrating occurrence of multiple zones of high gold concentration above bedrock, North Columbia pit, Nevada County, Calif.

The average gold particle size and value per unit of gravel increased noticeably in the samples of blue gravel. The following sieve analyses are believed to be typical for gold from the blue gravel zone at the Badger Hill deposit:

Particle size	Weight-percent
Plus 20 mesh.....	24.7
Minus 20 plus 40 mesh.....	48.2
Minus 40 plus 60 mesh.....	19.2
Minus 60 plus 80 mesh.....	7.7
Minus 80 plus 100 mesh.....	.2
Minus 100 mesh.....	.0
Composite.....	100.0

Approximately 50 percent of the gold particles still were coated with varying amounts of blue-black material after from 5 to 10 minutes of scrubbing

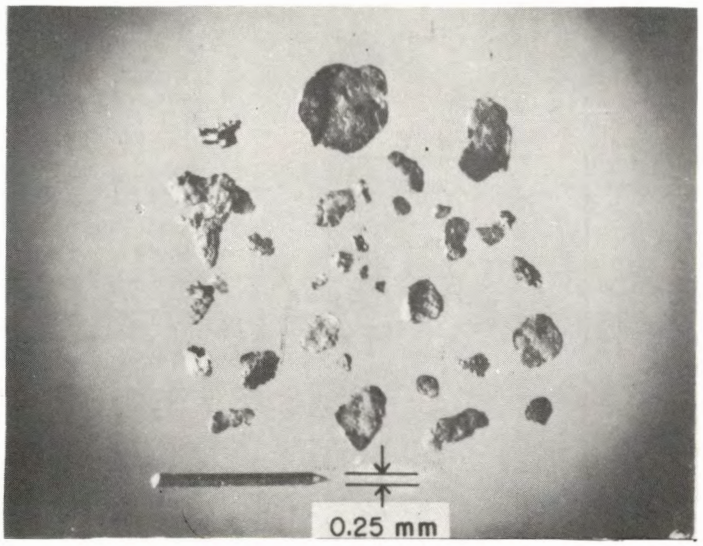

FIGURE 16. - Gold particles from blue gravels, Badger Hill.

in the Bureau sample plant. This amount of scrubbing time was sufficient to separate the gold from the pulverized gravel, but insufficient to thoroughly clean the gold flakes.

Gold particles at this depth normally are flat, relatively smooth flakes, often of irregular shape and having a noticeably dull luster (fig. 16). An occasional rough or nearly spherical particle was observed among the minus 40-mesh sizes, which generally contain the cleaner, less flattened particles. Nuggets were not found in any of the blue gravel samples that were concentrated by the Bureau at Badger Hill; however, coarse colors weighing from 10 to 15 mg each were plentiful. The largest particle found weighed approximately 30 mg and was obtained from a blast round sample about 15 feet above bedrock.

Distribution of gold in the blue gravels at Badger Hill was found to be erratic vertically and horizontally; however, the lenses or gravel that contain the richest concentrations of gold appear to be confined to the bottom 40 feet in the vicinity of the deepest part of the bedrock trough. A study of the Bureau's underground sampling results tend to confirm the occurrence inferred by the North Columbia drill-sampling results (12) of elongate, meandering lenses of richer gold-bearing gravels on and above bedrock, but confined to the 40-foot-thick zone described above. Systematic drilling completed in 1938 (12) at North Columbia indicates that the richest gravels within the zones tested are in elongated pods up to 10 feet in thickness, up to 300 feet in width, and up to 3,000 feet in length that reflect the meandering course of the deepest parts of the channel.

The Bureau of Mines drill-sampling project was too limited to determine the approximate length and width of the richer concentrations of gold at Badger Hill; however, the underground sampling confirmed the existence of multiple zones on and above bedrock.

Fifty samples totaling 91,852 pounds of blue gravel were collected from the underground workings in the lower bench. They contained gold ranging in value from 177.7 to 3,752.0 mg/ton (313.7 to 7,322.6 mg/cu yd) and averaging 431.2 mg/ton, or 761.8 mg/cu yd. Collection points ranged from a few inches to 25 feet above bedrock. Table A-2 gives winze, raise, and adit blast round sample data, and figure 11 gives the sample location map.

Three obvious zones of gold concentration were noted in the underground workings, although the extent of each zone only can be inferred because of the limited horizontal and vertical range of the crosscuts and drifts. The original underground workings that were rehabilitated by the Bureau consisted of 100 feet of main drift commencing on bedrock at the deepest part of the channel in the lower bench, 20 feet of raise, 42 feet crosscut from the top of the raise, 15 feet of winze at the face of the main drift, and approximately 100 feet of crosscut from the bottom of the winze. Sample results indicate that the three sets of workings are in three different zones of gold deposition (fig. 17).

Adit samples and blast round samples collected from the test rooms contained an average of 422.2 mg/ton (747.0 mg/cu yd); those from the crosscut off the winze contained an average of 2,145.7 mg/ton (4,337.3 mg/cu yd); and those from the crosscut off the raise contained an average of 981.3 mg/ton (1,779.6 mg/cu yd); thus indicating that most of the Bureau's underground testing was done between two zones of higher grade gold-bearing gravel.

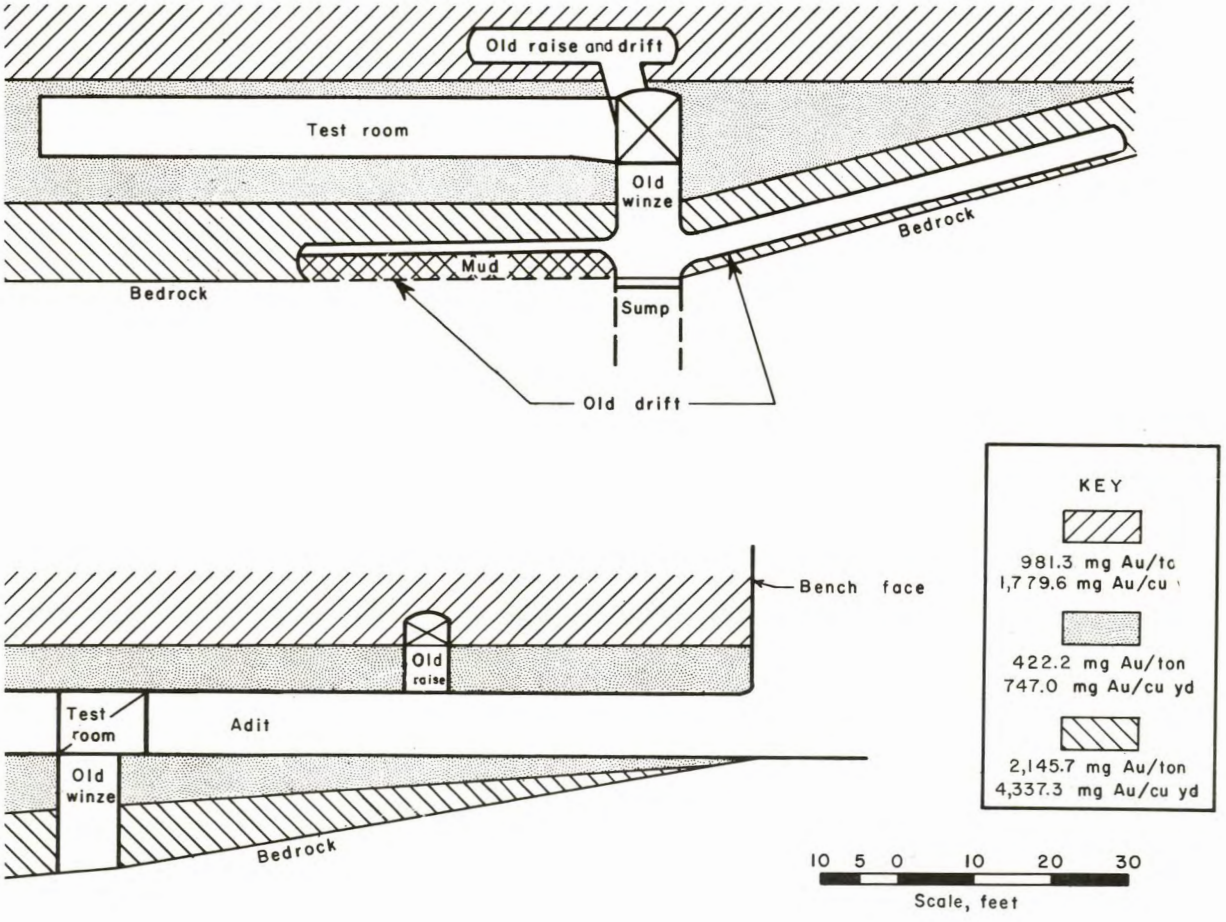

FIGURE 17. - Cross section (top) and longitudinal section (bottom) through Badger Hill adit showing zones of gold-bearing gravel.

Cemented gravel resting on bedrock at the portal of the adit contained little more than a trace of gold from repeated tests; however, samples of bedrock gravels taken from the crosscut off the winze about 100 feet in from the portal contained gold values ranging from 1,243 to 3,752 mg/ton (2,461 to 7,323 mg/cu yd). As indicated on the sample location map (fig. 11), the richest sample, containing 7,323 mg/cu yd, is up slope to a point where it is at the same elevation as the floor of the adit, and the lowest grade sample is at the deepest end of the crosscut.

The horizontal extent of the highest concentrations of gold in the blue gravels was not determined at Badger Hill; however, 31,528 pounds of blue gravel obtained from 11 drill holes and 7 pits ranging in distance from 250 to 400 feet from the underground workings contained an average of 186.3 mg/ton or 340.1 mg/cu yd. This is a drop of 244.9 mg/ton or 421.7 mg/cu yd from the underground sample average, indicating that the gold content of the blue gravels decreases sharply as sampling progresses away from the deepest portion of the bedrock trough.

EVALUATION OF DRILLING METHODS

One of the primary objectives of the delineation study was to test and, if possible, to improve drilling and sampling equipment and techniques for the Tertiary channel placer environment. The project plans required a comparison of placer sampling by churn drilling, bucket drilling, rotary drilling, and vibratory drilling. The program was terminated before the churn drilling phase of the project was started; consequently, a direct comparison of results cannot be made. Although churn drilling is the accepted method of sampling deep placers (2), it is slow, costly, and sometimes not too reliable, particularly where cemented gravels are found, as in the Tertiary channels of California. Regardless of the lack of churn drilling data, certain advantages and disadvantages were obvious in the drills that were tested.

Bucket Drill

In the upper gravels where clay is a major binding constituent and where boulders are not present, the bucket drill fitted with a 30- or 36-inch bucket-type bit proved to be an outstanding sampling unit (fig. 18). The high clay content prevented sloughing of the walls, and the lack of cobbles and boulders lessened the overbreak to a minimum. Samples were restricted to a maximum of 5 feet of hole depth, thus providing at least 1.5 cubic yards of material per sample. In general, bucket drill sampling of the white gravels is considered to be reliable with respect to lack of hole overbreak and sloughing; however, drilling of this zone without the use of casing is not feasible during the rainy season, as the ground becomes saturated and tends to flow into the large-diameter holes as a semifluid mass.

In the central or red gravel zone of the channel, where lenses of loose sand and gravel up to several feet in thickness occur, 32-inch casing was forced through the thicker sections of loose material using high drillhead pressure. Some dilution was noted in this zone caused by sloughing of the thinner lenses of loose gravel and by tearing of the walls by cobbles;

FIGURE 18. - Loading bucket drill samples.

however, the accuracy of the samples is believed to compare well with that of churn drilling as a result of the large volume involved per sample.

Water usually appeared in the bucket drill holes at a depth of approximately 18 feet and caused minor amounts of dilution by agitation of water against the walls of the uncased holes as the bucket was raised and lowered during pulls. Normally the high clay content prevented sloughing even under water.

Bucket drill progress normally was stopped at or shortly below the contact of the blue gravel, depending upon the degree of cementation or compaction of the gravel. On two occasions large boulders stopped the drill at the upper contact. To avoid excessive wear and tear on the equipment, no attempt was made to force the penetration into the blue gravels.

In general, the bucket drill proved to be an outstanding large-volume sampling tool for the white and red gravels. It has little or no application in the highly compacted and cemented blue gravels. If sample volume and time

are essential factors, the bucket drill has an advantage over the churn drill; however, it is not able to penetrate the cemented gravel and it requires the availability of large-scale processing equipment to concentrate the high-volume samples.

Rotary Drill

A standard, truck-mounted rotary drill (fig. 19) used by the Bureau and a second similar drill used by a contractor for the hydrology study were of greatest value in drilling rapidly to bedrock through the cemented blue gravels. The delineation holes were drilled using mud as a circulation fluid. The hydrology holes were drilled using large volumes of compressed air to remove the saturated cuttings. Compressed air would not remove thick mud, but with the addition of sufficient water to produce a loose mixture, both the cuttings and water were blown from the hole as a slurry.

FIGURE 19. - Rotary drilling in cemented gravel.

Casing was not required to hold the walls of most of the holes that were drilled in the blue gravel; however, one hole was lost as a result of penetrating a zone of loose sand near bedrock. With the use of mud or air as a circulating agent to remove cuttings, the value of the rotary drill as a relatively precise sampling tool for the Tertiary channel gravels is nil. The use of heavy mud and slow penetration rates did not prevent excessive dilution of the samples. Water alone or water and compressed air used as circulating agents tend to produce more dilution than occurs when the holes are coated with drilling mud.

Because of the high dilution factor, which often approached and sometimes exceeded 100 percent, no attempt was made to sample the holes at closely spaced intervals. Cuttings were collected as a single sample from the upper contact of the blue gravels to an estimated depth of 20 feet above bedrock. A second sample was collected from this point to bedrock. The two samples were collected primarily to determine whether or not a sharp increase of gold occurs from the upper to the lower zones of the blue gravel section and to obtain a full thickness sample of gold from the blue gravel.

With additional experimental work utilizing casing and short runs, a fairly reliable sampling procedure possibly could be devised for rotary drilling in the cemented gravels. Under this program, the rotary drill's principal value was found to be in providing rapid penetration to bedrock for a specific purpose, such as verification of geophysical work or to provide holes for hydrology studies. One hole was drilled quickly from the surface to the level of the bedrock drift for ventilation purposes.

Vibratory Drill

The vibratory drilling concept has been utilized successfully in the construction business for driving heavy steel piling using high-frequency vibrations transmitted through the piling to literally fluidize the surrounding soil and allow the piling to sink rapidly to the desired depth. A truck-mounted experimental drill (fig. 20) using the vibratory concept was tested by the Bureau in many types of material to determine the potential of the drill for capturing samples; however, the result was persistent and almost immediate blocking of the core barrel. Extensive experimental work was performed in an effort to overcome this deficiency, but the Heavy Metals Program was terminated before the work was completed.

At Badger Hill, the vibratory drill performed exceptionally well in the white and red gravels to drill seismic shotholes to required depths ranging from 10 to 15 feet. A drilling time of from 1 to 2 minutes per hole was adequate for these depths. Although clay immediately blocked the drill pipe, the penetration rate was not slowed. Until a core barrel or tube is designed that will allow the clay and gravel to enter without blocking, the drill will be of little utility for sampling purposes in the Tertiary channels.

FIGURE 20. - Vibratory drill placing shotholes.

DISCUSSION OF DELINEATION COSTS

Drilling and sampling costs incurred by the Bureau of Mines at Badger Hill have little direct application to the estimation of actual delineation costs because of the research orientation of the Bureau activities. As no tool was tested or developed by the Bureau that is superior to the churn drill for penetrating and sampling the blue gravels, this type of drill is expected to be utilized at least in part by any company that might consider conducting additional delineation work in the channel.

The most recently completed churn drilling on San Juan Ridge was contracted by the U.S. Geological Survey in the summer of 1968 at a cost of approximately $25 per foot. Considering the scarcity of experienced gold placer churn drillers, even a relatively large drilling contract probably would fall into the range of at least $25 per foot as of yearend 1973.

Realistic cost estimates for additional delineation on San Juan Ridge will be controlled by the system of mining that is proposed. If the entire deposit is to be mined for various byproducts as well as for gold, widespread

sampling of at least two types will be required to investigate the entire thickness of the channel fill to supplement the available sampling data and to generate new data concerning the amount and distribution of the potential byproducts. Ilmenite, zircon, chromite, garnet, and rutile were identified in the concentrate from Badger Hill. Trench sampling of the old working faces can be accomplished quickly and economically to determine the amount and distribution of the byproduct materials in the white gravels. Trench sampling sites are accessible at the Badger Hill, Cherokee, North Columbia, and Spring Creek pits that would provide adequate sample control for the entire 6-mile segment of lava-free channel.

Approximately 50 channel samples averaging 40 cubic yards per sample strategically spotted among the old pits should provide reasonably accurate data with regard to the amount and distribution of the potential byproducts. The cost of a sampling program as of 1971, including equipment, labor, and operating costs, will range from $45,000 to $50,000 for a period of from 4 to 6 months on a 3-shift basis during the dry season. Most of this time will be spent in setting up, in gaining access to sample sites, and in the actual digging of the samples. To process approximately 2,000 cubic yards of gravel with a relatively small and simple trommel-type concentration unit will require little more than 30 operating days.

Regardless of the decision to process or to waste the white and red gravels, additional delineation data will be required concerning the position and extent of the deepest and most favorable portion of the blue gravels. On the basis of drill-sampling data presently available, this zone is expected to be confined to a band seldom exceeding 500 feet in width and 40 feet in thickness that follows the configuration and meanders of the deepest portion of the bedrock trough. Drill sampling should be confined to this zone as closely as possible to reduce the high cost of penetrating and recovering samples in the tightly compacted and cemented blue gravels.

The deepest portion of the channel can be determined by geophysical techniques to reduce the target area to a minimum prior to drilling (10, 13). With the proper and successful utilization of geophysics, the fences of drill holes can be reduced to three or four holes in possibly five fences spotted along the least-explored portion of the channel from the North Columbia pit to the lava capping about 2 miles to the east. An additional three to four fences might be required between the Badger Hill and North Columbia pits to provide more detailed data than presently is available from the old records.

The cost of preliminary delineation (as of 1971) of the deepest portion of the trough along the entire channel is estimated to be $25,000. Such a study would utilize seismic and gravity methods and would require three men for a period of from 5 to 6 months including interpretation time. A drilling program based upon the geophysics data and ranging from 24 to 26 holes averaging 300 feet in depth will cost from $110,000 to $160,000 including access.

CONCLUSIONS

Bureau of Mines sample results from the Badger Hill deposit supplemented by invaluable drilling and sampling data provided by the San Juan Gold Co. (5, 7, 9, 11-12) indicate that the gravels containing the greatest concentrations of gold are confined to the blue zone within 40 feet of bedrock in the deepest part of the channel. The width of the most favorable zone is estimated to vary from 100 to 500 feet; however, the actual width, thickness, and direction of the zone will be determined by the configuration, slope, and meanders of the original bedrock trough. The richest concentrations of gold within the zone are expected to occur in isolated, elongated lenses of gravel that may or may not be on bedrock. Two or more rich lenses may occur one above the other from 5 to 40 feet above bedrock, creating additional exploration and mining problems for maximum recovery by underground methods. A rapid, inexpensive drill-sampling technique will be essential for underground use to probe for multiple lenses of rich gravel unless a full mining height of 40 feet is maintained along bedrock.

Gold was found to be universally distributed in irregular amounts throughout the white and red zones. The quantity and particle size of the gold increased progressively with depth in all three zones. Lenses of sand and clay contained the least amount of gold regardless of location.

None of the three drills that were tested proved to be an all-purpose tool that can compete with the standard placer-type churn drill. Each of the three drills has a limited use for special conditions and each in its restricted capacity provides satisfactory results; however, the data provided by earlier drilling records (12) indicate that in the blue gravel the churn drilling technique continues to have superior capability for providing significantly reliable samples. Additional work is needed towards the development of a cheaper, quicker, and more reliable method to drill and sample the cemented gravel, as even the reliability of the churn drill sample is greatly lowered when the casing cannot be driven ahead of the bit.

In providing drilling support for the geophysics studies, a standard, truck-mounted rotary drill was found to be essential to quickly penetrate the cemented and highly compacted gravels to precisely identify the depth of bedrock.

Large-volume samples were difficult to handle and required specialized equipment for processing, but the relatively large quantities of gold and concentrate that were recovered from each sample provided additional reliability for the determination of the quantity and size distribution of the gold.

REFERENCES

1. Clark, W. B. Tertiary Channels. Miner. Inf. Service, Calif. Div. Mines and Geol., v. 18, No. 3, March 1965, pp. 39-44.

2. Daily, A. Valuation of Large, Gold Bearing Placers. Eng. and Min. J., July 1962, 9 pp.

3. Egenhoff, E. L. The Giants. Miner. Inf. Service, Calif. Div. Mines and Geol., v. 18, No. 3, March 1965, pp. 47-50.

4. Gilbert, G. K. Hydraulic Mining Debris in the Sierra Nevada. U.S. Geol. Survey Prof. Paper 105, 1917, 155 pp.

5. Hoffman, R. B. Appendix to Report of Ross B. Hoffman. January 1935, 90 pp. Available for examination at office of San Juan Gold Co., Oakland, Calif.

6. Jackson, W. T. North Bloomfield Mining District. Division of Beaches and Parks, California Department of Parks and Recreation, 1967, 134 pp.

7. Lanier, M. B. San Juan Ridge and Smartsville Placers. Report No. 2, May 1935, 233 pp. Available for examination at office of San Juan Gold Co., Oakland, Calif.

8. Lindgren, W. The Tertiary Gravels of the Sierra Nevada of California. U.S. Geol. Survey Prof. Paper 73, 1911, 226 pp.

9. Munro, C. H. Report on River Mines Company. January 1932, 58 pp. Available for examination at office of San Juan Gold Co., Oakland, Calif.

10. Petersen, D. W., W. E. Yeend, H. W. Oliver, and R. E. Mattick. Tertiary Gold-Bearing Channel Gravel in Northern Nevada County, California. U.S. Geol. Survey Circ. 566, 1968, 22 pp.

11. Read, W. Report on California Mines. August 1928, 16 pp. plus drill hole logs. Available for examination at office of San Juan Gold Co., Oakland, Calif.

12. San Juan Gold Company. Drill hole records on file at office of San Juan Gold Co., Oakland, Calif.

13. Tibbetts, B. L., and J. H. Scott. Geophysical Measurements of Gold-Bearing Gravels, Nevada County, Calif. BuMines RI 7584, 1971, 32 pp.

APPENDIX.--DRILLING AND SAMPLING DATA

TABLE A-1. - Drill hole sample data

Hole	Diameter, inches	Sample	Sample interval, feet	Net weight, pounds	Dry weight, pounds	Plus 1/8-inch fraction, percent	Approximate volume, cubic yards	Gold recovery, milligrams	Total gold,[1] milligrams	Type hole
1....	36	B-1	2 - 7	6,333	5,700	51.2	1.68	72.50	82.65	Bucket.
	36	B-2	7 - 12	6,127	5,514	49.0	1.68	85.64	91.34	Do.
	36	B-3	12 - 17	5,420	4,878	49.2	1.68	63.43	66.30	Do.
	36	B-4	17 - 22	7,096	6,244	60.1	1.68	47.87	51.18	Do.
	36	B-5	22 - 27	8,131	7,074	64.6	1.68	113.73	120.54	Do.
	36	B-6	27 - 32	6,589	5,798	46.7	1.68	121.19	127.10	Do.
	36	B-7	32 - 34.7	3,953	3,479	50.7	.91	Sample	Lost	Do.
	5	C-10	34.7-109.3	1,516	1,410	38.1	.38	57.00	61.40	Rotary.
	5	C-11	109.3-129.3	514	478	12.8	.10	4.50	4.50	Do.
2....	36	B-8	2 - 5	6,309	5,867	51.2	1.01	265.04	284.04	Bucket.
	36	B-9	5 - 10	8,867	7,803	50.2	1.68	265.10	282.01	Do.
	36	B-10	10 - 15	6,411	5,770	57.5	1.68	79.69	86.34	Do.
	36	B-11	15 - 20	6,533	5,880	58.7	1.68	136.15	151.57	Do.
	36	B-12	20 - 25	7,651	6,733	57.4	1.68	251.09	276.36	Do.
	36	B-13	25 - 25.4	635	559	68.2	.13	43.71	44.46	Do.
3....	36	B-14	0 - 5	5,609	5,048	47.6	1.68	184.79	196.28	Do.
	36	B-15	5 - 10	5,329	4,690	62.7	1.68	17.16	18.72	Do.
	36	B-16	10 - 15.2	4,838	4,354	67.5	1.75	62.35	66.60	Do.
	5	C-3	15.2-106.2	2,760	2,567	36.1	.46	200.00	206.80	Rotary.
4....	36	B-17	0 - 5	5,868	5,457	42.1	1.68	22.40	22.60	Bucket.
	36	B-18	5 - 10	5,984	5,565	43.6	1.68	222.15	227.83	Do.
	36	B-19	10 - 15	5,776	5,372	44.0	1.68	508.38	527.84	Do.
	36	B-20	15 - 20	5,640	5,189	47.6	1.68	121.37	124.74	Do.
	36	B-21	20 - 25	6,186	5,567	47.3	1.68	112.49	120.56	Do
	36	B-22	25 - 30	7,876	6,931	48.3	1.68	128.74	133.53	Do.
	36	B-23	30 - 35	6,894	6,205	48.7	1.68	121.35	126.28	Do.
	36	B-24	35 - 40	7,713	6,787	60.4	1.68	153.40	156.40	Do.
	36	B-25	40 - 41.4	2,102	1,829	63.6	.47	57.82	61.62	Do.
5....	36	B-26	0 - 5	5,888	5,476	47.9	1.68	306.92	319.66	Do.
	36	B-27	5 - 10	6,421	5,650	59.4	1.68	60.50	73.10	Do.
	36	B-28	10 - 15	6,141	5,527	56.8	1.68	45.50	70.90	Do.
	36	B-29	15 - 20	6,649	5,984	63.5	1.68	43.50	62.50	Do.
	36	B-30	20 - 20.3	645	568	62.8	.10	8.00	8.40	Do.
	5	C-1	22 -112	2,799	2,603	33.0	.46	264.00	268.50	Rotary.
	5	C-2	112 -133	536	498	23.9	.11	185.00	189.30	Do.
6....	36	B-31	0 - 5	5,789	5,210	60.3	1.68	95.50	112.80	Bucket.
	36	B-32	5 - 10	7,039	6,194	53.7	1.68	230.00	347.44	Do.
	36	B-33	10 - 12	972	875	70.2	.67	28.00	41.11	Do.
	5	C-4	12 -122	3,257	3,029	36.4	.56	177.50	183.30	Rotary.
	5	C-5	122 -142	744	692	31.7	.10	200.00	234.60	Do.

See footnotes at end of table.

TABLE A-1. - Drill hole sample data--Continued

Hole	Diameter, inches	Sample	Sample interval, feet	Net weight, pounds	Dry weight, pounds	Plus 1/8-inch fraction, percent	Approximate volume, cubic yards	Gold recovery, milligrams	Total gold,[1] milligrams	Type hole
7....	36	B-34	0 - 5	4,653	4,188	33.4	1.68	14.5	37.5	Bucket.
	36	B-35	5 - 10	4,468	3,798	23.8	1.68	20.0	20.4	Do.
	36	B-36	10 - 15	4,564	3,971	29.6	1.68	33.0	36.0	Do.
	36	B-37	15 - 20	4,806	4,085	36.4	1.68	97.5	109.1	Do.
	36	B-38	20 - 25	5,053	4,295	36.1	1.68	39.5	41.1	Do.
	36	B-39	25 - 30	7,408	6,519	37.8	1.68	27.8	29.7	Do.
	36	B-40	30 - 35	5,957	5,242	38.7	1.68	60.0	62.2	Do.
	36	B-41	35 - 40	6,423	5,781	40.0	1.68	88.5	91.2	Do.
	36	B-42	40 - 45	6,593	5,802	32.8	1.68	356.0	363.0	Do.
	36	B-43	45 - 50	5,999	5,399	38.1	1.68	356.5	365.3	Do.
	36	B-44	50 - 55	6,388	5,621	33.3	1.68	150.0	153.9	Do.
	36	B-45	55 - 56	764	649	25.1	.34	15.6	16.3	Do.
	5	C-6	56 - 92	721	671	15.8	.18	22.0	23.4	Rotary.
	5	C-7	92 -113.7	799	743	4.0	.11	4.6	4.8	Do.
8....	5	C-8	0 - 81.8	2,647	2,462	37.8	.41	53.3	55.5	Do.
	5	C-9	81.8-101.8	605	563	31.9	.10	134.0	134.0	Do.
9....	36	B-74	0 - 5	1,958	1,821	33.2	1.68	16.0	16.3	Bucket.
	36	B-75	5 - 10	5,918	5,196	34.8	1.68	392.0	395.8	Do.
	36	B-76	10 - 15	3,915	3,328	30.0	1.68	300.0	301.7	Do.
	36	B-77	15 - 20	4,141	3,661	29.1	1.68	76.0	76.9	Do.
	36	B-78	20 - 23	1,669	1,441	26.7	1.01	120.0	120.5	Do.
	30	B-93	23 - 25	1,358	1,188	14.7	.31	23.1	23.6	Do.
	30	B-94	25 - 30	4,187	3,588	15.3	.78	25.6	26.3	Do.
	30	B-95	30 - 35	3,844	3,267	26.3	.78	48.0	48.3	Do.
	30	B-96	35 - 40	5,795	4,932	26.0	.78	126.0	128.5	Do.
	30	B-97	40 - 45	3,181	2,704	13.5	.78	59.0	59.2	Do.
	30	B-98	45 - 50	4,896	4,162	29.1	.78	58.0	59.6	Do.
	30	B-99	50 - 55	4,833	4,108	31.9	.78	31.0	31.6	Do.
	30	B-100	55 - 60	3,939	3,348	34.3	.78	32.0	32.6	Do.
	30	B-101	60 - 65	4,634	3,939	34.7	.78	23.2	24.6	Do.
	30	B-102	65 - 70	4,431	3,766	11.4	.78	33.0	33.8	Do.
	30	B-103	70 - 75	3,234	2,749	26.3	.78	27.0	28.9	Do.
	30	B-104	75 - 80	5,064	4,305	25.7	.78	92.0	93.5	Do.
	30	B-105	80 - 85	4,002	3,406	25.1	.78	91.0	94.2	Do.
	30	B-106	85 - 90	4,472	3,850	43.4	.78	27.8	30.4	Do.
	30	B-107	90 - 95	3,814	3,242	36.1	.78	27.2	30.3	Do.
	30	B-108	95 -100	4,279	3,637	37.2	.78	69.0	72.5	Do.
	30	B-109	100 -105	3,479	2,957	38.5	.78	43.0	44.3	Do.
	30	B-110	105 -109	2,872	2,599	44.3	.62	49.0	51.4	Do.
	5	C-15	111.2-137	1,059	985	32.7	.13	68.0	70.2	Rotary.
	5	C-16	137 -160	676	629	21.9	.12	8.2	9.3	Do.
10...	36	B-46	0 - 5	4,382	3,970	29.3	1.68	63.0	66.2	Bucket.
	36	B-47	5 - 10	5,471	5,060	32.8	1.68	79.0	80.7	Do.
	36	B-48	10 - 15	4,849	4,466	9.6	1.68	6.3	6.7	Do.

See footnotes at end of table.

TABLE A-1. - Drill hole sample data--Continued

Hole	Diameter, inches	Sample	Sample interval, feet	Net weight, pounds	Dry weight, pounds	Plus 1/8-inch fraction, percent	Approximate volume, cubic yards	Gold recovery, milligrams	Total gold,[1] milligrams	Type hole
10...	36	B-49	15 - 20	4,809	4,386	23.9	1.68	33.0	34.2	Bucket.
	36	B-50	20 - 26	4,953	4,606	28.8	2.02	142.0	143.0	Do.
11...	36	B-51	0 - 5	4,296	3,690	6.2	1.68	42.0	43.3	Do.
	36	B-52	5 - 10	5,102	4,337	1.5	1.68	17.0	17.5	Do.
	36	B-53	10 - 15	4,326	3,677	.1	1.68	26.9	26.9	Do.
	36	B-54	15 - 20	3,734	3,174	-	1.68	Nil	Nil	Do.
	36	B-55	20 - 25	3,924	3,335	10.8	1.68	49.0	50.6	Do.
	36	B-56	25 - 30	4,698	4,181	40.5	1.68	173.0	186.1	Do.
	36	B-57	30 - 35	4,794	4,406	22.9	1.68	68.0	69.4	Do.
	36	B-58	35 - 40	4,475	4,171	30.6	1.68	63.0	65.1	Do.
	36	B-59	40 - 45	4,319	3,969	23.6	1.68	30.0	30.0	Do.
	36	B-60	45 - 50	5,131	4,715	29.4	1.68	42.0	42.9	Do.
	36	B-61	50 - 55	4,413	4,033	22.1	1.68	56.0	57.7	Do.
	36	B-62	55 - 60	4,880	4,387	19.9	1.68	56.0	57.4	Do.
	30	B-63	60 - 65	2,839	2,467	13.2	.78	17.8	18.3	Do.
	30	B-64	65 - 70	3,465	2,994	6.5	.78	21.0	21.6	Do.
	30	B-65	70 - 75	4,228	3,640	2.0	.78	11.6	12.1	Do.
	30	B-66	75 - 77	2,131	1,811	4.9	.31	12.7	13.0	Do.
12...	30	B-130	0 - 5	2,589	2,382	30.4	.78	31.0	32.0	Do.
	30	B-131	5 - 10	3,630	3,220	28.8	.78	32.0	32.4	Do.
	30	B-132	10 - 15	2,794	2,442	34.1	.78	11.7	12.0	Do.
	30	B-133	15 - 20	2,799	2,390	34.2	.78	12.5	13.0	Do.
	30	B-134	20 - 25	4,444	3,782	32.0	.78	35.0	36.0	Do.
	30	B-135	25 - 30	3,351	2,848	40.6	.78	63.0	63.6	Do.
	30	B-136	30 - 35	3,454	2,946	35.6	.78	10.0	10.5	Do.
	30	B-137	35 - 40	3,742	3,181	30.9	.78	56.0	59.6	Do.
	30	B-138	40 - 45	3,887	3,304	29.8	.78	50.0	53.4	Do.
	30	B-139	45 - 50	3,862	3,283	36.9	.78	51.0	53.6	Do.
	30	B-140	50 - 55	3,476	2,955	29.5	.78	32.0	35.5	Do.
	30	B-141	55 - 60	4,415	3,753	37.6	.78	32.0	33.5	Do.
	30	B-142	60 - 65	4,319	3,671	37.6	.78	39.0	41.1	Do.
	30	B-143	65 - 70	3,441	2,925	36.3	.78	56.0	58.0	Do.
	30	B-144	70 - 75	4,190	3,562	33.0	.78	24.0	25.7	Do.
	30	B-145	75 - 80	3,746	3,184	15.3	.78	36.0	38.8	Do.
	30	B-146	80 - 85	4,631	3,969	37.2	.78	14.7	17.7	Do.
	30	B-147	85 - 90	3,625	3,128	42.0	.78	33.0	35.8	Do.
	30	B-148	90 - 94	4,018	3,468	46.2	.62	24.0	27.1	Do.
	5	C-20	94 -152	908	844	24.3	.29	15.2	([2])	Rotary.
	5	C-21	152 -208	1,086	1,010	20.0	.28	34.0	36.2	Do.
12A..	30	B-67	0 - 5	3,157	2,829	28.7	.78	97.0	98.4	Bucket.
	30	B-68	5 - 10	2,930	2,555	26.3	.78	160.0	161.6	Do.
	30	B-69	10 - 15	3,216	2,882	35.1	.78	105.0	107.9	Do.
	30	B-70	15 - 20	3,984	3,629	37.9	.78	30.5	31.8	Do.
	30	B-71	20 - 25	3,122	2,844	39.1	.78	53.0	53.8	Do.

See footnotes at end of table.

TABLE A-1. - Drill hole sample data--Continued

Hole	Diameter, inches	Sample	Sample interval, feet	Net weight, pounds	Dry weight, pounds	Plus 1/8-inch fraction, percent	Approximate volume, cubic yards	Gold recovery, milligrams	Total gold,[1] milligrams	Type hole
12A..	30	B-72	25 - 30	3,485	3,164	49.9	0.78	42.0	42.6	Bucket.
	30	B-73	30 - 35	4,504	3,968	48.1	.78	100.0	166.3	Do.
12B..	30	B-79	0 - 5	1,656	1,426	26.4	.78	42.0	43.0	Do.
	30	B-80	5 - 10	2,831	2,409	23.1	.78	105.0	111.2	Do.
	30	B-81	10 - 15	2,727	2,364	15.5	.78	66.0	67.4	Do.
	30	B-82	15 - 20	3,022	2,696	25.9	.78	90.0	91.8	Do.
	30	B-83	20 - 25	3,861	3,544	54.3	.78	([2])	([2])	Do.
	30	B-84	25 - 30	4,072	3,685	53.5	.78	417.0	418.0	Do.
	30	B-85	30 - 35	3,894	3,547	51.5	.78	59.0	62.6	Do.
	30	B-86	35 - 36.5	1,614	1,482	51.4	.23	65.0	68.8	Do.
13...	36	B-111	0 - 5	3,312	3,070	25.9	1.68	31.3	39.2	Do.
	36	B-112	5 - 10	4,283	3,799	15.4	1.68	57.0	128.7	Do.
	36	B-113	10 - 15	5,709	4,875	28.0	1.41	51.0	56.5	Do.
	30	B-114	15 - 20	4,463	3,843	24.5	.78	24.0	30.1	Do.
	30	B-115	20 - 25	3,225	2,806	33.1	.78	12.3	13.4	Do.
	30	B-116	25 - 30	4,819	4,154	37.4	.78	28.0	29.6	Do.
	30	B-117	30 - 35	3,479	3,065	34.6	.78	21.0	21.9	Do.
	30	B-118	35 - 40	3,919	3,464	32.2	.78	28.0	29.1	Do.
	30	B-119	40 - 45	3,074	2,681	23.0	.78	48.0	49.6	Do.
	30	B-120	45 - 50	3,333	2,853	17.9	.78	16.6	17.0	Do.
	30	B-121	50 - 55	3,492	2,993	29.0	.78	42.0	44.2	Do.
	30	B-122	55 - 60	5,529	4,722	26.1	.78	88.0	90.2	Do.
	30	B-123	60 - 65	3,292	2,821	31.5	.78	32.0	33.6	Do.
	30	B-124	65 - 70	4,844	4,166	28.4	.78	63.0	63.0	Do.
	30	B-125	70 - 75	3,437	2,925	30.2	.78	75.0	77.3	Do.
	30	B-126	75 - 80	4,210	3,646	25.2	.78	54.0	57.3	Do.
	30	B-127	80 - 85	3,955	3,378	29.7	.78	95.0	97.4	Do.
	30	B-128	85 - 90	4,492	3,917	49.3	.78	16.5	17.3	Do.
	30	B-129	90 - 91	1,303	1,144	57.9	.16	9.4	10.2	Do.
	30	C-17	91 -147	937	871	7.2	.28	12.3	12.6	Rotary.
	30	C-18	147 -167	654	608	.9	.10	1.6	2.0	Do.
	30	C-19	167 -222	222	1,120	5.8	.28	4.0	4.2	Do.
14...	30	B-149	0 - 5	2,401	2,187	27.4	.78	27.0	28.4	Bucket.
	30	B-150	0 - 10	2,629	2,487	23.0	.78	12.3	12.8	Do.
	30	B-151	10 - 13	3,057	2,877	19.9	.47	27.0	28.4	Do
	30	B-152	13 - 20	2,476	2,273	5.9	1.10	19.5	19.8	Do.
	30	B-153	20 - 25	2,892	2,643	10.0	.78	22.5	22.7	Do.
	30	B-154	25 - 30	2,258	2,037	7.1	.78	29.0	29.3	Do.
	30	B-155	30 - 35	2,960	2,697	3.8	.78	15.2	15.5	Do.
	30	B-156	35 - 40	2,703	2,454	10.0	.78	5.7	6.1	Do.
	30	B-157	40 - 45	2,800	2,484	12.2	.78	23.0	23.5	Do.
	30	B-158	45 - 50	3,086	2,666	9.7	.78	17.1	17.5	Do.
	30	B-159	50 - 55	4,893	4,159	3.8	.78	15.8	16.1	Do.
	30	B-160	55 - 60	1,316	1,119	1.6	.16	7.0	7.2	Do.

See footnotes at end of table.

TABLE A-1. - Drill hole sample data--Continued

Hole	Diameter, inches	Sample	Sample interval, feet	Net weight, pounds	Dry weight, pounds	Plus 1/8-inch fraction, percent	Approximate volume, cubic yards	Gold recovery, milligrams	Total gold,[1] milligrams	Type hole
15...	30	B-87	0 - 5	3,339	3,002	43.5	0.78	95.0	101.9	Bucket.
	30	B-88	5 - 10	3,586	3,288	63.1	.78	50.0	50.9	Do.
	30	B-89	10 - 15	3,641	3,372	57.8	.78	52.0	54.0	Do.
	30	B-90	15 - 20	4,095	3,817	64.0	.78	85.0	86.1	Do.
	30	B-91	20 - 25	3,802	3,528	67.5	.78	182.0	183.9	Do.
	30	B-92	25 - 29	3,681	3,375	62.3	.62	230.0	232.6	Do.
	5	C-12	31.5-111.5	2,341	2,177	42.2	.40	180.0	185.0	Rotary.
	5	C-13	111.5-133.0	707	658	30.0	.11	152.0	154.9	Do.
VH-1..	5	C-14	0 -121	5,910	5,142	27.8	1.37	640.0	642.2	Ventilation.
A.....	7	HH-1	0 -120	4,695	4,287	29.9	1.19	121.58	([3])	Hydral.
	7	HH-2	120 -140	682	634	28.3	.20	60.34	([3])	Do.
B.....	7	HH-3	0 -120	([2])	([2])	([2])	([2])	([2])	([3])	Do.
	7	HH-4	120 -143	875	814	41.7	.23	156.96	([3])	Do.
C.....	7	HH-5	0 -120	2,173	1,984	34.8	1.19	36.92	([3])	Do.
	7	HH-6	120 -145	686	638	43.3	.25	47.68	([3])	Do.
D.....	7	HH-7	0 -190	8,509	7,556	11.9	1.88	27.45	([3])	Do.
	7	HH-8	190 -212	864	804	33.7	.22	11.00	([3])	Do.
E.....	7	HH-9	0 -260	6,516	5,786	11.1	5.25	10.39	([3])	Do.
	7	HH-10	260 -295	547	509	11.0	.71	41.09	([3])	Do.
BL-1..	5	1	0 - 57	([2])	([2])	([2])	([2])	([2])	([3])	Blast.
BL-2..	5	2	0 - 32	1,097	976	23.9	.16	79.90	([3])	Do.
BL-3..	5	3	0 - 32	1,049	1,020	27.4	.16	73.00	([3])	Do.
BL-4..	5	4	0 - 32	638	593	32.6	.16	38.38	([3])	Do.
BL-5..	5	5	0 - 32	709	659	38.5	.16	57.84	([3])	Do.
BL-6..	5	6	0 - 48.5	1,418	1,319	48.6	.16	126.90	([3])	Do.
BL-7..	5	7	0 - 35	1,273	1,184	37.2	.24	83.56	([3])	Do.
BL-8..	5	8	0 - 35	1,348	1,254	37.9	.18	64.65	([3])	Do.
BL-9..	5	9	0 - 35	1,150	1,070	36.8	.18	76.75	([3])	Do.
BL-10.	5	10	0 - 31.8	994	924	39.0	.16	81.85	([3])	Do.
BL-11	5	11	0 - 31.8	1,080	1,004	43.9	.16	66.94	([3])	Do.
BL-12	5	12	0 - 29	1,105	1,028	40.6	.15	140.20	([3])	Do.

[1] Includes gold recovered by cyanidation of amalgam residue.
[2] No data.
[3] Cyanidation not conducted on samples from holes A through BL-12.

TABLE A-2. - Underground sample data

Location	Sample	Net weight, pounds	Dry weight, pounds	Plus 1/8-inch fraction, percent	Approximate volume, cubic yards	Gold recovery, milligrams	Total gold,[1] milligrams	Type sample
Adit rooms.....	AR-1	2,588	2,347	59.7	0.66	520.0	535.9	Blast round
	AR-2	641	571	53.8	.16	244.0	248.5	grab.
	AR-3	819	753	83.9	.21	310.0	311.6	Do.
	AR-4	545	494	56.9	.14	210.0	212.1	Do.
	AR-5	650	590	51.4	.17	290.0	290.9	Do.
	AR-6	912	827	54.6	.23	349.0	354.0	Do.
	AR-7	507	468	59.0	.13	150.0	154.5	Do.
	AR-8	775	704	59.4	.20	290.0	291.3	Do.
	AR-9	1,752	1,545	60.0	.45	660.0	663.1	Do.
	AR-10	1,729	1,568	61.1	.44	290.0	293.1	Do.
	AR-11	1,625	1,474	42.5	.42	230.0	231.0	Do.
	AR-12	611	554	54.3	.16	192.0	194.4	Do.
	AR-13	654	593	59.2	.17	140.0	154.3	Do.
	AR-14	642	582	60.6	.16	380.0	381.1	Do.
	AR-15	868	787	56.3	.22	175.0	176.8	Do.
	AR-16	948	860	57.5	.24	169.0	171.9	Do.
	AR-17	750	680	61.5	.19	260.0	276.3	Do.
	AR-18	7,587	6,881	60.1	1.95	1,987.77	([2])	Do.
	AR-19	3,776	3,425	73.5	.96	800.0	830.3	Do.
	AR-20	3,817	3,462	74.6	.98	652.0	652.8	Do.
	AR-21	3,839	3,482	73.4	.98	678.0	682.1	Do.
	AR-22	3,638	3,300	77.1	.93	630.0	654.4	Do.
	AR-23	3,389	3,074	73.5	.87	490.0	604.0	Do.
	AR-24	3,320	3,011	73.5	.85	532.0	545.3	Do.
	AR-25	3,325	3,016	85.9	.85	643.0	655.6	Do.
	AR-26	3,554	3,223	67.8	.91	322.0	326.3	Do.
	AR-27	3,826	3,432	72.2	.98	490.0	509.0	Do.
	AR-28	3,600	3,258	72.6	.92	1,635.0	1,640.8	Do.
	AR-29	3,358	2,965	73.3	.86	600.0	604.0	Do.
	AR-30	3,413	3,171	76.5	.87	340.0	344.8	Do.
	AR-31	3,554	3,202	73.0	.91	370.0	376.2	Do.
	AR-32	7,048	6,364	72.5	1.81	610.0	640.6	Do.
	AR-33	3,565	3,219	70.4	.91	360.0	377.6	Do.
	AR-34	3,706	3,354	72.6	.95	298.0	304.2	Do.
	AR-35	3,739	3,496	78.6	.96	580.0	587.4	Do.
	AR-36	3,713	3,397	80.3	.95	600.0	615.3	Do.
	AR-37	3,784	3,421	77.0	.97	950.0	955.8	Do.
	AR-38	3,878	3,572	76.3	.99	805.0	817.2	Do.
Upper level....	1	42.5	39.5	89.4	.011	8.0	([2])	Channel.
	2	48.0	44.6	96.9	.012	5.0	([2])	Do.
	3	50.0	46.5	91.0	.013	11.0	([2])	Do.
	4	56.0	52.1	92.0	.014	23.0	([2])	Do.
	5	60.0	55.8	86.7	.015	11.0	([2])	Do.
	6	45.5	42.3	87.9	.012	17.0	([2])	Do.
	7	51.0	47.4	72.5	.013	24.0	([2])	Do.
	8	47.5	44.2	94.7	.012	44.0	([2])	Do.
	9	59.5	55.3	74.8	.015	67.0	([2])	Do.
Bedrock drift..	1	103	95.8	68.9	.026	64.0	([2])	Do.
	2	100	93	63.0	.026	69.0	([2])	Do.
	3	121	113	48.8	.031	227.0	([2])	Do.

[1] Includes gold recovered by cyanidation of amalgam residue.
[2] Samples not amalgamated.

TABLE A-3. - Surface pit sample data

Location	Sample	Net weight, pounds	Dry weight, pounds	Plus 1/8-inch fraction, percent	Approximate volume, cubic yards	Gold recovery, milligrams	Total gold,[1] milligrams	Type sample
Toe lower bench.	TB-1	4,510	4,194	57.1	1.16	846.09	-	Toe bulk.
	TB-2	2,930	2,930	74.2	.75	130.0	134.1	Do.
	TB-3	2,768	2,574	72.6	.71	280.0	291.4	Do.
	TB-4	2,742	2,550	77.8	.70	187.0	192.3	Do.
	TB-5	2,892	2,690	76.5	.74	260.0	266.4	Do.
	TB-6	2,979	2,770	75.4	.76	130.0	134.8	Do.
	TB-7	2,999	2,789	70.5	.77	214.0	217.5	Do.
Lower bench stratigraphic.	T-1	256	246	59.5	.065	16.2	17.2	Stratigraphic.
	T-2	426	409	51.9	.109	14.0	15.6	Do.
	T-3	396	380	59.3	.102	15.0	15.7	Do.
	T-4	118	113	11.9	.030	1.6	1.9	Do.
	T-5	122	117	36.1	.031	2.4	2.6	Do.
	T-6	122	117	42.6	.031	7.2	7.5	Do.
	T-7	120	115	51.7	.031	1.5	1.8	Do.
	T-8	125	120	52.8	.032	4.8	5.2	Do.
	T-9	116	111	52.6	.030	7.4	7.9	Do.
	T-10	127	122	63.0	.033	6.4	6.6	Do.
	T-11	127	122	75.6	.033	([2])	([2])	Do.
	T-12	123	118	72.4	.032	12.6	12.7	Do.
	T-13	121	116	63.6	.031	8.1	12.6	Do.
Pit 1.....	A-1	2,742	2,550	51.7	1.00	100.64	108.09	Measured pit.
	P-1-R	112	104	([3])	.03	3.80	4.10	Do.
	P-1-F	111	103	([3])	.03	5.30	5.90	Do.
	P-1-L	117	109	([3])	.03	3.90	4.20	Do.
Pit 2.....	A-2	2,662	2,476	44.2	1.00	121.48	125.62	Do.
	P-2-R	119	111	([3])	.03	1.50	1.60	Do.
	P-2-F	111	103	([3])	.03	4.00	4.30	Do.
	P-2-L	116	108	([3])	.03	5.30	5.30	Do.
Pit 3.....	A-3	3,289	3,059	44.7	1.00	90.00	109.00	Do.
	P-3-R	117	109	([3])	.03	1.60	1.80	Do.
	P-3-F	120	112	([3])	.03	2.60	4.00	Do.
	P-3-L	112	104	([3])	.03	.50	.50	Do.
Pit 4.....	A-4	3,025	2,813	52.6	1.00	37.50	39.00	Do
	P-4-R	107	100	([3])	.03	.70	.90	Do
	P-4-F	98	91	([3])	.03	2.80	2.80	Do.
	P-4-L	113	105	([3])	.03	3.20	3.70	Do.
Pit 5.....	A-5	2,986	2,777	58.1	1.00	15.50	16.20	Do.
	P-5-R	103	96	([3])	.03	Trace	Trace	Do.
	P-5-L	120	112	([3])	.03	1.90	2.10	Do.
	P-5-F	109	101	([3])	.03	3.30	3.30	Do.

[1] Includes gold recovered by cyanidation of amalgam residue.
[2] Sample lost.
[3] Oversize not collected in "P" series.

TABLE A-4. - Gold particle size distribution (color count)--drill holes and pits

Hole	Sample	Particle size, millimeters[1]					Gold weight,[2] milligrams
		+3	+2	+1	+0.5	-0.5	
1.....	B-1	-	-	3	14	29	72.50
	B-2	-	-	1	9	41	85.64
	B-3	-	-	-	12	38	63.43
	B-4	-	-	-	10	27	47.87
	B-5	-	-	7	23	32	113.73
	B-6	-	-	9	19	51	121.19
	B-7	-	-	-	-	-	-
	C-10	-	-	-	10	3	57.00
	C-11	-	-	-	-	3	4.50
2.....	B-8	-	-	11	42	110	265.04
	B-9	-	-	8	37	150	265.10
	B-10	-	-	-	7	53	79.69
	B-11	-	-	6	21	39	136.15
	B-12	-	1	5	37	127	251.09
	B-13	-	-	-	-	-	43.71
3.....	B-14	-	-	-	23	41	184.79
	B-15	-	-	-	3	22	17.16
	B-16	-	-	-	5	49	62.35
	C-3	-	-	6	14	28	200.00
4.....	B-17	-	-	-	2	12	22.40
	B-18	-	-	2	35	110	222.15
	B-19	-	-	10	63	240	508.38
	B-20	-	-	-	27	55	121.37
	B-21	-	-	-	35	49	112.49
	B-22	-	-	-	26	59	128.74
	B-23	-	-	2	23	30	121.35
	B-24	-	-	7	37	56	153.40
	B-25	-	-	-	8	26	57.82
5.....	B-26	-	-	7	52	160	306.92
	B-27	-	-	-	10	23	60.50
	B-28	-	-	-	3	25	45.50
	B-29	-	-	-	2	30	43.50
	B-30	-	-	-	1	14	8.00
	C-1	-	-	12	39	28	264.00
	C-2	-	-	5	11	19	185.00
6.....	B-31	-	-	-	7	55	95.50
	B-32	-	-	5	5	52	230.00
	B-33	-	-	1	4	12	28.00
	C-4	-	-	3	17	30	177.50
	C-5	-	-	6	8	6	200.00

See footnotes at end of table.

TABLE A-4. - Gold particle size distribution (color count)--drill holes and pits--Continued

Hole	Sample	Particle size, millimeters[1]					Gold weight,[2] milligrams
		+3	+2	+1	+0.5	-0.5	
7.....	B-34	-	-	-	-	-	14.5
	B-35	-	-	1	3	7	20.0
	B-36	-	-	1	3	1	33.0
	B-37	-	-	-	2	23	97.5
	B-38	-	-	2	3	10	39.5
	B-39	-	-	1	2	-	27.8
	B-40	-	-	3	8	30	60.0
	B-41	-	-	1	13	21	88.5
	B-42	-	-	3	-	54	356.0
	B-43	-	-	8	11	31	356.5
	B-44	-	-	4	10	56	150.0
	B-45	-	-	1	6	14	15.6
	C-6	-	-	-	5	16	22.0
	C-7	-	-	-	2	3	4.6
8.....	C-8	-	5	2	23	17	53.3
	C-9	-	-	4	-	20	134.0
9.....	B-74	-	-	1	1	6	16.0
	B-75	-	6	10	28	84	392.0
	B-76	-	2	3	50	36	300.0
	B-77	-	-	-	60	39	76.0
	B-78	-	-	2	23	59	120.0
	B-93	-	-	-	-	170	23.1
	B-94	-	1	2	-	52	25.6
	B-95	-	-	5	75	80	48.0
	B-96	-	-	-	2	200	126.0
	B-97	-	-	-	-	175	59.0
	B-98	-	-	-	10	210	58.0
	B-99	-	-	-	25	200	31.0
	B-100	-	-	-	-	135	32.0
	B-101	-	-	-	-	125	23.2
	B-102	-	-	-	-	110	33.0
	B-103	-	-	-	5	110	27.0
	B-104	-	-	20	100	200	92.0
	B-105	-	-	1	-	250	91.0
	B-106	-	-	-	10	120	27.8
	B-107	-	-	-	3	130	27.2
	B-108	-	-	-	-	240	69.0
	B-109	-	-	-	12	180	43.0
	B-110	-	-	-	-	125	49.0
	C-15	-	-	5	25	125	68.0
	C-16	-	-	-	-	30	8.2

See footnotes at end of table.

TABLE A-4. - Gold particle size distribution (color count)--drill holes and pits--Continued

Hole	Sample	Particle size, millimeters[1]					Gold weight,[2] milligrams
		+3	+2	+1	+0.5	-0.5	
10.....	B-46	1	-	-	6	-	63.0
	B-47	-	-	-	20	-	79.0
	B-48	-	-	-	-	24	6.3
	B-49	-	-	-	10	23	33.0
	B-50	-	-	-	60	72	142.0
11.....	B-51	-	-	5	15	21	42.0
	B-52	-	-	-	10	17	17.0
	B-53	-	-	2	5	13	26.9
	B-54	-	-	-	-	5	Nil
	B-55	-	-	20	-	-	49.0
	B-56	-	-	35	-	31	173.0
	B-57	-	-	5	-	19	68.0
	B-58	-	-	-	-	47	63.0
	B-59	-	-	5	-	23	30.0
	B-60	-	-	-	-	19	42.0
	B-61	-	-	-	8	30	56.0
	B-62	-	-	10	-	18	56.0
	B-63	-	-	-	-	3	17.8
	B-64	-	-	-	4	3	21.0
	B-65	-	-	1	-	3	11.6
	B-66	-	-	3	-	9	12.7
12.....	B-130	-	-	-	2	230	31.0
	B-131	-	-	7	10	120	32.0
	B-132	-	-	-	1	85	11.7
	B-133	-	-	-	15	80	12.5
	B-134	-	-	-	-	105	35.0
	B-135	-	-	-	-	130	63.0
	B-136	-	-	-	20	50	10.0
	B-137	-	-	2	5	110	56.0
	B-138	-	-	-	2	230	50.0
	B-139	-	-	-	5	135	51.0
	B-140	-	-	1	5	110	32.0
	B-141	-	-	-	10	250	32.0
	B-142	-	1	10	25	200	39.0
	B-143	-	-	-	5	104	56.0
	B-144	-	-	-	-	105	24.0
	B-145	-	-	-	-	220	36.0
	B-146	-	-	8	14	100	14.7
	B-147	-	-	1	-	160	33.0
	B-148	-	1	2	5	75	24.0
	C-20	-	-	2	25	-	15.2
	C-21	-	-	-	8	45	34.0

See footnotes at end of table.

TABLE A-4. - Gold particle size distribution (color count)--drill holes and pits--Continued

Hole	Sample	Particle size, millimeters[1]					Gold weight,[2] milligrams
		+3	+2	+1	+0.5	-0.5	
12A.....	B-67	-	-	10	30	-	97.0
	B-68	-	-	10	100	30	160.0
	B-69	-	-	-	-	100	105.0
	B-70	-	-	-	12	150	30.5
	B-71	-	-	20	70	45	53.0
	B-72	-	-	20	75	35	42.0
	B-73	-	-	8	75	130	100.0
12B.....	B-79	-	-	-	15	125	42.0
	B-80	-	-	10	40	225	105.0
	B-81	-	-	2	30	200	66.0
	B-82	-	-	3	40	180	90.0
	B-83	-	-	-	-	-	-
	B-84	-	-	25	100	550	417.0
	B-85	-	1	5	30	125	59.0
	B-86	-	-	6	10	150	65.0
13.....	B-111	-	-	-	10	150	31.3
	B-112	-	-	3	5	70	57.0
	B-113	-	-	3	25	150	51.0
	B-114	-	-	-	-	150	24.0
	B-115	-	-	-	10	50	12.3
	B-116	-	-	-	50	75	28.0
	B-117	-	-	2	75	50	21.0
	B-118	-	-	-	-	118	28.0
	B-119	-	-	-	1	185	48.0
	B-120	-	-	-	-	130	16.6
	B-121	-	-	-	5	145	42.0
	B-122	-	-	-	2	240	88.0
	B-123	-	-	-	5	90	32.0
	B-124	-	-	5	25	150	63.0
	B-125	-	-	-	10	200	75.0
	B-126	-	-	1	5	175	54.0
	B-127	-	-	-	10	150	95.0
	B-128	-	-	-	-	120	16.5
	B-129	-	-	-	-	80	9.4
	C-17	-	-	-	12	70	12.3
	C-18	-	-	-	-	8	1.6
	C-19	-	-	-	-	18	4.0
14.....	B-149	-	-	1	1	5	27.0
	B-150	-	-	-	-	170	12.3
	B-151	-	-	-	-	250	27.0
	B-152	-	-	-	-	200	19.5
	B-153	-	-	-	-	40	22.5

See footnotes at end of table.

TABLE A-4. - Gold particle size distribution (color count)--drill holes and pits--Continued

Hole	Sample	Particle size, millimeters[1]					Gold weight,[2] milligrams
		+3	+2	+1	+0.5	-0.5	
14	B-154	-	-	-	-	205	29.0
	B-155	-	-	-	-	126	15.2
	B-156	-	-	-	-	103	5.7
	B-157	-	-	-	-	260	23.0
	B-158	-	-	-	-	300	17.1
	B-159	-	-	-	-	75	15.8
	B-160	-	-	-	-	31	7.0
15	B-87	-	-	1	101	205	95.0
	B-88	-	-	3	10	150	50.0
	B-89	-	-	3	50	175	52.0
	B-90	-	-	2	10	175	85.0
	B-91	-	-	5	52	225	182.0
	B-92	-	-	12	120	130	230.0
	C-12	-	-	25	75	50	180.0
	C-13	-	1	35	50	100	152.0
VH-1	C-14	-	-	22	61	700	640.0
A	HH-1	-	-	5	109	290	121.6
	HH-2	-	-	6	35	89	60.3
B	HH-3	-	-	-	200	175	([3])
	HH-4	-	-	9	106	271	157.0
C	HH-5	-	-	1	29	74	36.9
	HH-6	-	-	5	33	99	47.7
D	HH-7	-	-	-	4	333	27.5
	HH-8	-	-	-	1	311	11.0
E	HH-9	-	-	-	5	63	10.4
	HH-10	-	-	-	15	80	41.1
BL-1	1	-	-	-	-	-	-
BL-2	2	-	-	5	79	273	79.9
BL-3	3	-	-	4	57	335	73.0
BL-4	4	-	-	-	24	224	38.4
BL-5	5	-	-	3	40	256	57.8
BL-6	6	-	-	2	111	334	126.9
BL-7	7	-	-	4	58	172	83.6
BL-8	8	-	-	4	30	231	64.7
BL-9	9	-	-	8	38	296	76.7
BL-10	10	-	-	4	43	270	81.9
BL-11	11	-	-	-	64	156	66.9
BL-12	12	-	-	7	96	348	140.2

See footnotes at end of table.

TABLE A-4. - Gold particle size distribution (color count)--drill holes and pits--Continued

Hole	Sample	Particle size, millimeters[1]					Gold weight,[2] milligrams
		+3	+2	+1	+0.5	-0.5	
Pit 1.....	P-1-L	-	-	1	4	3	3.9
	P-1-R	-	-	4	11	8	3.8
	P-1-F	-	-	2	8	11	5.3
Pit 2.....	P-2-L	-	-	2	6	2	5.3
	P-2-R	-	-	-	-	10	1.5
	P-2-F	-	-	3	-	6	4.0
Pit 3.....	P-3-L	-	-	-	-	9	.5
	P-3-R	-	-	-	1	8	1.6
	P-3-F	-	-	-	5	2	2.6
Pit 4.....	P-4-L	-	-	-	1	9	3.2
	P-4-R	-	-	-	-	9	.7
	P-4-F	-	-	1	2	6	2.8
Pit 5.....	P-5-L	-	-	-	-	4	3.3
	P-5-R	-	-	1	-	5	.6
	P-5-F	-	-	1	1	3	1.9
Stratigraphic channel..	T-1	-	3	2	25	124	16.2
	T-2	-	-	7	14	30	14.0
	T-3	-	4	10	16	72	15.0
	T-4	-	-	-	-	3	1.6
	T-5	-	-	-	2	3	2.4
	T-6	-	-	-	10	10	7.2
	T-7	-	-	-	1	10	1.5
	T-8	-	-	-	16	3	4.8
	T-9	-	1	9	25	-	7.4
	T-10	-	-	5	-	-	6.4
	T-11	([3])	([3])	([3])	([3])	([3])	([3])
	T-12	-	-	2	-	10	12.6
	T-13	-	2	2	15	-	8.1

[1] Does not include flour gold.
[2] Amount recovered from concentrate by amalgamation.
[3] Sample lost.

TABLE A-5. - Geologic logs--drill holes

Hole	Stratigraphic interval, feet	Distance, feet	Material	Color
1.....	0 - 7.0	7.0	Gravel.....	Brown.
	7.0- 9.0	2.0	Gravel, sand.....	Do.
	9.0- 27.0	18.0	Sand, clay, gravel, water at 19.0 feet.	Do.
	27.0- 33.0	6.0	Gravel, sand.....	Do.
	33.0- 34.7	1.7	Gravel.....	Do.
	34.7- 76.6	41.9	Cemented gravel.....	Blue.
	76.6- 81.6	5.0	Cemented gravel, clay, sand.	Do.
	81.6- 86.6	5.0	Cemented gravel, sand	Do.
	86.6- 91.6	5.0	Cemented gravel.....	Do.
	91.6-101.6	10.0	Clay, sand.....	Do.
	101.6-103.6	2.0	Cemented gravel.....	Do.
	103.6-128.6	25.0	Clay, sand.....	Do.
	128.6-139.3	10.7	Phyllite (bedrock)...	Gray.
2.....	0 - 25.0	25.0	Gravel, sand, water at 18.0 feet.	Brown.
	25.0- 25.4	.4	Cemented gravel.....	Blue.
3.....	0 - 7.6	7.6	Gravel, sand, clay...	Brown.
	7.6- 15.2	7.6	Gravel, water at 15.0 feet.	Do.
	15.2- 76.2	61.0	Cemented gravel, sand	Blue.
	76.2-101.2	25.0	Gravel, sand.....	Do.
	101.2-107.2	6.0	Sand, gravel, hole caved at 107 feet.	Do.
4.....	0 - 15.0	15.0	Gravel.....	Brown.
	15.0- 41.4	26.4	Gravel, sand, water at 17.5 feet, cemented gravel at 41.4 feet.	Do.
5.....	0 - 20.0	20.0	Gravel, sand, clay...	Do.
	20.0- 20.3	.3	Gravel.....	Do.
	20.3-132.6	112.3	Cemented gravel.....	Blue.
	132.6-138.2	5.6	Diorite (bedrock)....	Gray.
6.....	0 - 5.0	5.0	Gravel, sand, clay...	Brown.
	5.0- 10.0	5.0	Sand, clay, gravel...	Do.
	10.0- 12.0	2.0	Cemented gravel.....	Blue.
	12.0- 17.0	5.0	Cemented gravel, sand	Do.
	17.0- 22.0	5.0	Cemented sand, gravel	Do.
	22.0- 27.0	5.0	Cemented sand, clay..	Do.

TABLE A-5. - Geologic logs--drill holes--Continued

Hole	Stratigraphic interval, feet	Distance, feet	Material	Color
6.....	27.0- 32.0	5.0	Cemented sand, gravel, clay.	Blue.
	32.0- 82.0	50.0	Cemented sand, gravel.	Do.
	82.0-107.0	25.0	Cemented gravel, sand	Do.
	107.0-122.0	15.0	Cemented sand, gravel.	Do.
	122.0-137.0	15.0	Cemented gravel, sand	Do.
	137.0-139.0	2.0	Cemented sand, gravel, clay.	Do.
	139.0-150.5	11.5	Phyllite, quartzite (bedrock).	Gray.
7.....	0 - 5.0	5.0	Clay, sand, gravel...	Brown.
	5.0- 10.0	5.0	Clay, sand.....	Do.
	10.0- 13.0	3.0	Sand.....	Do.
	13.0- 15.0	2.0	Clay, sand.....	Do.
	15.0- 35.0	20.0	Clay, sand, gravel, water at 20.0 feet.	Do.
	35.0- 40.0	5.0	Clay, gravel, sand...	Do.
	40.0- 44.0	4.0	Sand.....	Do.
	44.0- 50.0	6.0	Clay, sand, gravel...	Do.
	50.0- 55.0	5.0	Sand, gravel, clay...	Do.
	55.0- 56.0	1.0	Gravel, sand, clay...	Do.
	56.0- 72.0	16.0	Sand.....	Blue.
	72.0-111.0	39.0	Clay.....	Do.
	111.0-133.0	22.0	Quartzite (bedrock)..	Gray.
8.....	0 - 17.9	17.9	Sand, gravel, clay, water at 3.0 feet.	Brown.
	17.9- 41.8	23.9	Cemented gravel.....	Blue.
	41.8- 46.8	5.0	Cemented gravel, sand	Do.
	46.8- 61.8	15.0	Cemented gravel, sand, clay.	Do.
	61.8- 76.8	15.0	Cemented gravel, sand	Do.
	76.8- 81.8	5.0	Cemented gravel.....	Do.
	81.8- 94.8	13.0	Cemented gravel, sand	Do.
	94.8- 99.8	5.0	Clay.....	Green.
	99.8-101.8	2.0	Phyllite (bedrock)	Gray.
9.....	0 - 5.0	5.0	Gravel, sand, water at 5.0 feet.	Brown.
	5.0- 10.0	5.0	Sand, gravel, clay...	Do.
	10.0- 11.0	1.0	Sand, gravel.....	Do.
	11.0- 25.0	14.0	Clay, sand, gravel...	Gray.
	25.0- 30.0	5.0	Gravel.....	Yellow.
	30.0- 33.7	3.7	Sand, gravel, clay...	Pink.

TABLE A-5. - Geologic logs--drill holes--Continued

Hole	Stratigraphic interval, feet	Distance, feet	Material	Color
9.....	33.7- 35.0	1.3	Gravel.....	Pink.
	35.0- 37.0	2.0	Sand, gravel, clay...	Do.
	37.0- 40.0	3.0	Gravel.....	Gray.
	40.0- 45.0	5.0	Sand.....	Tan.
	45.0- 66.5	21.5	Gravel, clay, sand...	Tan-gray.
	66.5- 73.0	6.5	Sand, clay.....	Gray.
	73.0-109.0	36.0	Clay, gravel, sand...	Gray-blue.
	109.0-117.0	8.0	Cemented sand, gravel	Blue.
	117.0-137.0	20.0	Cemented gravel.....	Do.
	137.0-142.0	5.0	Cemented clay, sand, gravel.	Gray.
	142.0-143.0	1.0	Clay, sand.....	Do.
	143.0-146.0	3.0	Cemented gravel.....	Do.
	146.0-147.0	1.0	Clay, sand.....	Do.
	147.0-151.0	4.0	Cemented gravel.....	Do.
	151.0-152.0	1.0	Clay.....	Do.
	152.0-155.0	3.0	Cemented gravel.....	Do.
	155.0-165.0	10.0	Quartzite (bedrock)..	Do.
10.....	0 - 5.0	5.0	Clay, sand.....	Red.
	5.0- 17.0	12.0	.....do.....	Brown.
	17.0- 19.0	2.0	.....do.....	White.
	19.0- 20.0	1.0	Clay, sand, gravel...	Do.
	20.0- 26.0	6.0	Sand, clay, gravel (caved).	Do.
11.....	0 - 10.0	10.0	Clay, sand.....	Red.
	10.0- 22.0	12.0	Sand, clay.....	Tan.
	22.0- 28.0	6.0	Clay, sand, gravel...	Brown.
	28.0- 55.0	27.0	Sand, clay, gravel...	Tan.
	55.0- 56.0	1.0	Sand.....	Gray.
	56.0- 60.0	4.0	Sand, clay, gravel...	Do.
	60.0- 65.0	5.0	Clay, sand.....	Do.
	65.0- 75.0	10.0	Sand, clay, gravel...	Do.
	75.0- 77.0	2.0	Sand, gravel, water at 75.0 feet.	Do.
12.....	0 - 7.0	7.0	Gravel, sand.....	White.
	7.0- 24.0	17.0	Gravel, sand, clay..,	Buff.
	24.0- 50.0	26.0	Clay, sand, gravel, water at 20.0 feet.	Brown.
	50.0- 51.0	1.0	Gravel.....	Buff.
	51.0- 52.0	1.0	Clay.....	Do.
	52.0- 55.0	3.0	Sand, gravel.....	Do.
	55.0- 59.0	4.0	Gravel.....	Brown.
	59.0- 60.0	1.0	Sand.....	Do.

TABLE A-5. - Geologic logs--drill holes--Continued

Hole	Stratigraphic interval, feet	Distance, feet	Material	Color
12.....	60.0- 65.0	5.0	Gravel, clay.....	Buff.
	65.0- 72.0	7.0	Gravel, clay, sand...	Brown.
	72.0- 74.0	2.0	Sand.....	Buff.
	74.0- 75.0	1.0	Gravel.....	Do.
	75.0- 80.0	5.0	Sand.....	Brown.
	80.0- 81.7	1.7	Gravel.....	Buff.
	81.7- 83.0	1.3	Clay.....	Do.
	83.0- 94.0	11.0	Gravel, clay, sand...	Brown.
	94.0-107.0	13.0	Cemented gravel, clay, sand.	Blue.
	107.0-122.0	15.0	Gravel, clay, sand...	Do.
	122.0-152.0	30.0	Cemented gravel, clay, sand.	Do.
	152.0-167.0	15.0	Cemented gravel.....	Do.
	167.0-182.0	15.0	Cemented gravel, clay.	Do.
	182.0-197.0	15.0	Clay, gravel.....	Gray.
	197.0-199.0	2.0	Gravel, clay.....	Do.
	199.0-210.0	11.0	Quartzite (bedrock)..	Do.
12A.....	0 - 10.0	10.0	Sand, clay, gravel...	Brown.
	10.0- 20.3	10.3	Clay, gravel, sand...	Do.
	20.3- 28.8	8.5	Gravel, sand, clay, water at 28.0 feet.	Do.
	28.8- 34.4	5.6	Sand, gravel, clay...	Do.
	34.4- 34.6	.2	Cemented gravel.....	Blue.
12B.....	0 - 9.0	9.0	Sand, clay, gravel...	Brown.
	9.0- 14.0	5.0	Sand.....	Do.
	14.0- 16.5	2.5	Sand, clay, gravel...	Do.
	16.5- 19.0	2.5	Sand.....	Do.
	19.0- 26.5	7.5	Clay, sand, gravel...	Do.
	26.5- 31.6	5.1	Clay, gravel, sand...	Do.
	31.6- 33.5	1.9	Sand, gravel, water at 32.0 feet.	Do.
	33.5- 36.5	3.0	Cemented gravel.....	Blue.
13.....	0 - 7.0	7.0	Sand, gravel.....	Gray.
	7.0- 11.5	4.5	Clay, gravel.....	Do.
	11.5- 15.0	3.5	Gravel, sand.....	Brown.
	15.0- 17.0	2.0	Gravel, sand, clay...	Do.
	17.0- 18.0	1.0	Sand.....	Do.
	18.0- 33.9	15.9	Sand, gravel, clay...	Do.
	33.9- 35.0	1.1	Sand.....	Do.
	35.0- 47.0	12.0	Gravel, sand, clay...	Gray.
	47.0- 48.6	1.6	Clay.....	White

TABLE A-5. - Geologic logs--drill holes--Continued

Hole	Stratigraphic interval, feet	Distance, feet	Material	Color
13.....	48.6- 51.3	2.7	Clay, gravel.....	Gray.
	51.3- 69.0	17.7	Sand, gravel, clay...	Tan.
	69.0- 86.5	17.5	Gravel, clay.....	Brown.
	86.5- 89.0	2.5	.....do.....	Blue.
	89.0-102.0	13.0	Cemented gravel.....	Do.
	102.0-111.0	9.0	Clay.....	Gray.
	111.0-113.0	2.0	Cemented gravel.....	Blue.
	113.0-122.0	9.0	Compacted clay, gravel.	Do.
	122.0-127.0	5.0	.....do.....	Brown.
	127.0-162.0	35.0	Clay.....	Blue.
	162.0-167.0	5.0	Shaley clay.....	Green.
	167.0-198.0	31.0	Clay, shale.....	Do.
	198.0-222.0	24.0	Quartzite (bedrock)..	Blue.
14.....	0 - 10.0	10.0	Clay, gravel.....	Red.
	10.0- 25.0	15.0	Sand, gravel.....	Brown.
	25.0- 30.0	5.0	Clay, gravel.....	Do.
	30.0- 39.0	9.0	Sand.....	Do.
	39.0- 40.0	1.0	Gravel, sand.....	Do.
	40.0- 42.0	2.0	Sand, clay.....	Do.
	42.0- 47.0	5.0	Gravel, sand, clay...	Do.
	47.0- 48.0	1.0	Gravel.....	Do.
	48.0- 56.0	8.0	Clay, water at 49.0 feet.	White.
15.....	0 - 22.3	22.3	Sand, clay, gravel...	Brown.
	22.3- 59.5	37.2	Cemented gravel, water at 24.0 feet.	Blue.
	59.5- 61.5	2.0	Clay.....	Do.
	61.5- 66.5	5.0	Cemented gravel, clay	Do.
	66.5-138.0	71.5	Cemented gravel.....	Do.
	138.0-146.5	8.5	Talc (bedrock).....	Gray.
A.....	0 - 31.0	31.0	Sand, clay, gravel, water at 18.0 feet.	Brown.
	31.0- 39.0	8.0	Gravel, sand, clay...	Do.
	39.0- 40.0	1.0	Cemented gravel.....	Blue.
	40.0- 53.0	13.0	Gravel.....	Do.
	53.0- 54.0	1.0	Clay.....	Gray.
	54.0- 83.0	29.0	Loosely cemented gravel.	Blue.
	83.0-100.0	17.0	Clay.....	Green.
	100.0-139.0	39.0	Compacted gravel, clay.	Gray.
	139.0-146.0	7.0	Phyllite (bedrock)...	Do.

TABLE A-5. - Geologic logs--drill holes--Continued

Hole	Stratigraphic interval, feet	Distance, feet	Material	Color
B.....	0 - 18.0	18.0	Gravel, sand, water at 10.0 feet.	Brown.
	18.0- 23.5	5.5	Gravel, clay, sand...	Do.
	23.5- 25.0	1.5	Clay.....	Do.
	25.0- 40.0	15.0	Gravel.....	Do.
	40.0-140.0	100.0	Cemented gravel,	Blue.
	140.0-143.0	3.0	Andesite (bedrock)	Gray.
C.....	0 - 5.0	5.0	Gravel, sand.....	Brown.
	5.0- 20.0	15.0	Gravel, sand, clay, water at 12.0 feet.	Do.
	20.0- 25.0	5.0	Cemented gravel, sand, clay.	Do.
	25.0- 30.0	5.0	Sand, clay, gravel...	Do.
	30.0- 41.0	11.0	Clay, gravel, sand...	Do.
	41.0- 47.0	6.0	Gravel, sand, clay...	Blue.
	47.0- 50.0	3.0	Clay, sand.....	Do.
	50.0- 95.0	45.0	Cemented gravel, sand, clay.	Do.
	95.0-141.5	46.5	Cemented gravel.....	Do.
	141.5-145.0	3.5	Phyllite (bedrock)...	Gray.
D.....	0 - 2.0	2.0	Clay.....	Brown.
	2.0- 10.0	8.0	Clay, sand.....	Gray.
	10.0- 11.5	1.5	Gravel, clay, sand...	Do.
	11.5- 33.5	22.0	Clay, sand, water at 34.0 feet.	Do.
	33.5- 40.0	6.5	Cemented clay, sand, gravel.	Do.
	40.0- 45.0	5.0	Clay, sand.....	Do.
	45.0- 50.0	5.0	Cemented gravel.....	Do.
	50.0- 55.0	5.0	Clay, sand.....	Do.
	55.0- 64.0	9.0	Cemented clay, sand, gravel.	White.
	64.0- 72.0	8.0	Clay, sand.....	Brown.
	72.0- 75.0	3.0	Gravel.....	Do.
	75.0-125.0	50.0	Gravel, clay, sand...	Do.
	125.0-128.0	3.0	Sand.....	Do.
	128.0-130.0	2.0	Gravel.....	Do.
	130.0-150.0	20.0	Sand.....	Do.
	150.0-158.0	8.0	Gravel, sand, clay...	Do.
	158.0-180.0	22.0	Cemented gravel, sand, clay.	Blue.
	180.0-207.0	27.0	Cemented sand, gravel, clay.	Do.
	207.0-212.0	5.0	Phyllite (bedrock)...	Gray.

TABLE A-5. - Geologic logs--drill holes--Continued

Hole	Stratigraphic interval, feet	Distance, feet	Material	Color
E.....	0 - 46.0	46.0	Clay, gravel, sand...	Red-gray.
	46.0. 48.0	2.0	Clay.....	Gray.
	48.0-102.0	54.0	Clay, sand, gravel...	Do.
	102.0-122.0	20.0	Clay, gravel.....	Do.
	122.0-140.0	18.0	Gravel, clay.....	Do.
	140.0-153.0	13.0	Clay, gravel.....	Do.
	153.0-180.0	27.0	.....do.....	Yellow.
	180.0-218.0	38.0	Clay, gravel, sand...	Gray-tan.
	218.0-222.0	4.0	Cemented gravel.....	Blue.
	222.0-227.0	5.0	Clay.....	Do.
	227.0-273.0	46.0	Cemented gravel, clay	Do.
	273.0-318.0	45.0	Cemented gravel.....	Do.
	318.0-332.0	14.0	Granite (bedrock)....	Gray.
VH-1.....	0 - 32.0	32.0	Gravel, clay.....	Brown.
	32.0- 47.0	15.0	Cemented gravel, sand	Blue.
	47.0- 92.0	45.0	Cemented gravel.....	Do.
	92.0-104.0	12.0	Cemented clay, gravel	Do.
	104.0-112.0	8.0	Cemented gravel.....	Do.
	112.0-114.5	2.5	Sand.....	Do.
	114.5-121.0	6.5	Cemented gravel.....	Do.
BL-1.....	0 - 56.0	56.0	.....do.....	Do.
	56.0- 57.0	1.0	Phyllite (bedrock)...	Gray.
BL-2.....	0 - 16.0	16.0	Cemented clay, gravel	Blue.
	16.0- 32.0	16.0	Cemented gravel.....	Do.
BL-3.....	0 - 28.0	28.0	.....do.....	Do.
	28.0- 32.0	4.0	Cemented gravel, clay	Do.
BL-4.....	0 - 16.0	16.0	Cemented gravel.....	Do.
	16.0- 23.0	7.0	Cemented clay, gravel	Do.
	23.0- 27.0	4.0	Cemented gravel.....	Do.
	27.0- 32.0	5.0	Clay, gravel.....	Do.
Bl-5.....	0 - 28.0	28.0	Cemented gravel, clay	Do.
	28.0- 28.8	.8	Clay.....	Do.
	28.8- 32.0	3.2	Cemented gravel.....	Do.
BL-6.....	0 - 29.0	29.0	Clay, gravel.....	Do.
	29.0- 45.0	16.0	Cemented gravel.....	Do.
	45.0- 47.0	2.0	Cemented gravel, clay	Do.
	47.0- 48.5	1.5	Phyllite (bedrock)...	Gray.

TABLE A-5. - Geologic logs--drill holes--Continued

Hole	Stratigraphic interval, feet	Distance, feet	Material	Color
BL-7	0 - 13.0	13.0	Cemented gravel.....	Blue.
	13.0- 16.0	3.0	Cemented gravel, clay	Do.
	16.0- 35.0	19.0	Cemented gravel.....	Do.
BL-8	0 - 11.0	11.0	.....do.....	Do.
	11.0- 15.0	4.0	Cemented gravel, clay	Do.
	15.0- 25.0	10.0	Cemented gravel.....	Do.
	25.0- 27.0	2.0	Clay.....	Do.
	27.0- 31.0	4.0	Cemented gravel.....	Do.
	31.0- 35.0	4.0	Cemented gravel, sand, clay.	Do.
BL-9	0 - 32.0	32.0	Cemented gravel.....	Do.
	32.0- 35.0	3.0	Cemented gravel, clay	Do.
BL-10	0 - 31.8	31.8	Compacted sand, clay, gravel.	Do.
BL-11	0 - 27.0	27.0	.....do.....	Do.
	27.0- 31.8	4.8	Cemented gravel.....	Do.
BL-12	0 - 29.0	29.0	Compacted sand, clay gravel.	Do.
Stratigraphic channel:				
T-1	0 - 2.0	2.0	Gravel, clay, sandy, lens.	Red-tan.
T-2	2.0- 5.0	3.0	Coarse gravel, sand..	Brown.
T-3	5.0- 8.0	3.0	Gravel, sand, clay...	Do.
T-4	8.0- 9.0	1.0	Coarse gravel, sand..	Red.
T-5	9.0- 10.0	1.0	Sand, gravel.....	Brown.
T-6	10.0- 11.0	1.0	Coarse gravel, sand, cobbles.	Do.
T-7	11.0- 12.0	1.0	.....do.....	Do.
T-8	12.0- 13.0	1.0	.....do.....	Do.
T-9	13.0- 14.0	1.0	.....do.....	Do.
T-10	14.0- 15.0	1.0	.....do.....	Do.
T-11	15.0- 16.0	1.0	.....do.....	Do.
T-12	16.0- 17.0	1.0	.....do.....	Do.
T-13	17.0- 18.0	1.0	Cemented gravel.....	Do.

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