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Parker, Ben H., Jr.
1968, pp. 168-184. https://doi.org/10.56577/FFC-19.168

in:

San Juan, San Miguel, La Plata Region (New Mexico and Colorado), Shomaker, J. W.; [ed.], New Mexico Geological Society 19th Annual Fall Field Conference Guidebook, 212 p. https://doi.org/10.56577/FFC-19

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PLACER GOLD IN SOUTHWESTERN COLORADO

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Editor's note: The text below is excerpted from THE GEOLOGY OF THE GOLD PLACERS OF COLORADO, *by Ben H. Parker, Jr., 1960, an unpublished doctoral dissertation of the Colorado School of Mines.*

THE PLACERS OF OURAY COUNTY

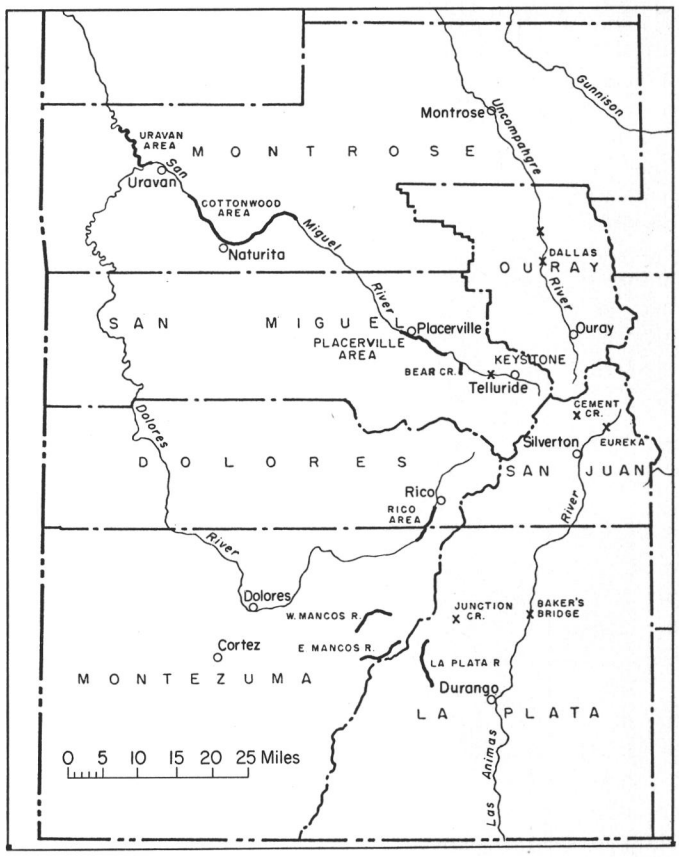
The only placer deposits in Ouray County are the Dallas placers on the Uncompaghre River; they extend downstream nearly 6 miles from a point 2 miles downstream from Ridgway. They have been worked at two places, in sec. 4, T. 45 N., R. 8 W., and in NE¼ sec. 17, T. 46 N., R. 8 W., on the east side of the river. The first, more extensive workings are south of the mouth of Dallas Creek and the second are south of the mouth of Cow Creek. U. S. Highway 550 parallels the river between Ridgway and Montrose, and the placer sites are easily reached from it or on county and ranch roads. The placers range in elevation from 6,675 to 6,950 feet elevation. The climate is fairly mild and placering could be conducted here nearly year-round. The placer areas are covered only with small brush and willows.

April 19, 1878, the *Denver Rocky Mountain News* (p. 4) reported several hundred men had left Lake City to locate claims on Dallas and Cow Creeks and April 28 (p. 4) another article stated that the placer diggings were first visited in 1860 by Abe Lee and added the comment "The area has been well guarded by the hostile Indians." Smith (1883, p. 67) wrote for the period 1880-82, ". . . Beside the lode mines there are some valuable and productive placers on the San Miguel and its tributaries, and on the Uncompaghre, which have been worked for several years, yielding, according to the best information obtainable, $10,000 to $30,000 per annum." In his report for 1884 Burchard (1885, p. 177, 232-233) stated

> The Dallas Placer Mining Co. was organized in 1883 to work the extensive gravel deposits supposed to exist on the Uncompaghre River, at a point below the mouth of the Dallas. A hydraulic elevator capable of handling 2,000 cubic yards of gravel per day with a pressure of 300 feet has been erected, and work was commenced in October, 1883. The company is actively at work, although with what success is not known.

This placer was at the second location mentioned above, near the mouth of Cow Creek. The *Engineering and Mining Journal* reported two placer companies in 1884, this one and another which was erecting a hydraulic plant at Dallas, a section point on the railroad in the NE¼ of sec. 3. In the late 1890's the placers near the mouth of Dallas Creek were worked for a time by Chinese miners, according to local residents. In 1916 the *Engineering and Mining Journal* reported that small-scale sluicing was done here and in 1917 it announced that a dredge was proposed to work the bed of the Uncompaghre River between Ridgway and Cow Creek; the dredge was never built, however. Minerals Yearbook reported placer gold production in Ouray County in 1931-1936, 1938, and 1939. In 1934, the peak year, 11 operations produced 42.43 oz. gold. Most of the placering done must have been in the Dallas placer area. Henderson (1926, p. 186) does not credit Ouray County with any placer gold production in the period 1878-1923, but it is probable that the county's production during that time exceeded the county's $4,299 production since 1931 several fold.

Within the placer area the Uncompaghre valley is steep-walled and youthful. It was aggraded with outwash in Pinedale times forming terraces locally more than ½ mile broad which the river is now incising. The terminal moraine of the Uncompaghre valley's Pinedale glacier is



"Locations of placer gold operations in southwestern Colorado."

northeast of Ridgway (Atwood and Mather, 1932, pl. 1, shown as "Wisconsin" moraine, but see Richmond (1954, p. 615) for later correlations.) at the south end of the placer area. These outwash gravel terraces are 65 feet above the level of the river in sec. 4. A number of lower terrace surfaces have been incised in the outwash material as the river has cut its modern channel. In sec. 4 such terraces are 13, 17, and 24 feet above river level. All the placer workings seen were in the gravels beneath these lower terraces or along their river edges. This does not appear to be related to any difference in gold content of the gravels beneath the various terraces but rather is because water could be brought more easily to the lower terraces, which are also closer to the false bedrock. The pit in sec. 17 is also in the low terrace.

Atwood and Mather (1932, pl. 1) show remnants of the outwash gravels of the Durango stage (Bull Lake stadial of Richmond) and remnants of the Florida gravels (which were deposited at the end of the Cerro glaciation) on the mesas overlooking this part of the Uncompaghre Valley. There are no reports of placers having been found in them, however.

The gravels exposed in the placer cuts are conspicuously stratified—the size of the large fragments and the proportion of sand to gravel varying from layer to layer. No pure sand or clay strata were observed. The coarse fragments arc angular to sub-rounded; the largest boulder seen was 3.5 feet in diameter, but boulders more than 1 foot across are uncommon. Volcanic rocks predominate in the gravels; sandstone and quartzite make up less than one-third of them. Precambrian quartzite is uncommon. The gravels worked appear to have contained little clay.

The thickness of the gravels is unknown, for bedrock has not been explored. At Ridgway, on the south side of the terminal moraine, wells have been drilled 108 feet without encountering bedrock, and the outwash below the moraine could easily be nearly as thick. In the placers in sec. 4 the gravels beneath the low terrace surfaces were mined in many cuts while a number of drifts from the river bank followed a bed of coarse gravel which contains little sand just a few feet above river level. Cranston (1909, written communication, furnished by Mr. Franklin Bell) wrote "In places the lower benches show evidence of considerable work having been done down to a clay streak which appears a little above creek level."

No information is available concerning the nature of the gold produced here. In 1933-35 and 1938, the years of largest recent placer production in Ouray County, the placer gold produced averaged 760 fine. If all this gold was placer gold, this figure approximates the fineness of the Dallas placer gold. The source of this gold is the veins of the Ouray area.

The small amount of work which has been done here has not exhausted the gravels. This indicates that they are of low grade. Cranston wrote that his testing did not indicate any values greater than 5 to 10 cents per cubic yard, except in small areas. Because of its low grade, although considerable gravel remains here, it is unlikely that anything more than occasional small-scale mining by individuals will ever be done. There is ample water and dump space for such operations, which would be so small that pollution would present little problem.

Good concentrations of gold on bedrock may exist along the Uncompaghre River downstream from the moraine at Ridgway. The probable great depth of bedrock, and the almost certain presence of large boulders in the short distance downstream where values would be best, would make the mining of such deposits uneconomic, if not impossible. Cuttings from wells drilled in the broad valley flat above the moraine near Ridgway are reported to have contained traces of gold. However, the valley between the moraine and Ridgway and upstream toward Ouray is not an attractive placer prospect either, since depths to bedrock for much of the distance would be prohibitive.

Cross, Howe, and Irving (1907, p. 19) gave a detailed discussion of the reported occurrence of gold in fossil placer deposits in the Telluride Conglomerate in the upper part of the valley of Cow Creek in the southern part of T. 45 N., R. 7 W. The Telluride Conglomerate, considered by Larsen and Cross (1956, p. 60) to be of Oligocene age, lies unconformably upon Cretaceous rocks and Paleocene tillites and beneath the volcanic rocks of the San Juan and San Miguel Mountains. Cross, Howe, and Irving found no evidence of placer gold in these conglomerates, or indeed of any gold in significant quantities. The supposed placer deposits must be considered spurious. So far as is known, fossil placers have not been reported in this formation elsewhere in the San Juan area.

During 1951 and 1952 attempts were made to recover gold supposed to have been concentrated in the plunge basin of Box Canyon Falls immediately southwest of the town of Ouray. This gold was supposed to have been derived from stream reworking of the tailings of the stamp mills of the Camp Bird Mine, a famous producer of free-gold ores. The U. S. Bureau of Mines reports no production of placer gold from Ouray County during these years. It is presumed that the operation failed, and it is unlikely that any significant concentration of placer gold existed here.

THE PLACERS OF SAN MIGUEL AND MONTROSE COUNTIES

Introduction

The placers of San Miguel and Montrose Counties have not been prolific—their production from their discovery in 1875 through 1957 amounts to about $285,000—and it is probable that most of the large operations were unprofitable. Although some reserves of gold-bearing gravel remain, they are as inaccessible as the gravels worked in past abandoned operations and there is little reason to suppose that they are any richer. Nevertheless, these placers are of particular interest because of the engineering difficulties which were overcome in working them and because of the extravagant promotions which were based on them in the 1880's and 1890's.

Most of the placers are on terrace-gravel remnants along the San Miguel River from near the village of Sawpit downstream to the river's junction with the Dolores River and along the Dolores downstream to its junction with

Roc Creek, a total distance of 75 miles. These placers are discussed together. A large placer was worked at Keystone, on the San Miguel about 5 miles above Sawpit; it is geologically different from the others and is discussed separately.

Various reports state that placers were worked on Big Bear Creek and Fall Creek, and the Engineering *and Mining* Journal reported small scale placering operations on Big Bear and Elk Creeks in 1894. The present author was unable to get any information about them or to find any evidence of placering on Big Bear Creek. Local residents say that showings of placer gold have been found on the upper part of Mesa Creek on the Uncompaghre Plateau.

SAN MIGUEL-DOLORES RIVER PLACERS

Location and Geography

The principal placers along the San Miguel and Dolores Rivers are in three areas. One extends downstream for 9 miles from Sawpit, one downstream for about 22 miles from Cottonwood Creek, and the third upstream from Roc Creek for about 6 miles. The first area is in San Miguel County; the others are in Montrose County. Placerville is near the center of the first area, and Naturita near the center of the second; Uravan is about 9 miles upstream from the third.

The placers range from 7,700 feet elevation near Sawpit to 4,744 feet below Rock Creek. They lie in a usually narrow, steep-walled canyon cut in the mesas between the northwest flank of the San Juan Mountains and the southwest flank of the Uncompaghre Plateau. The canyon walls are broken by a number of bedrock benches on which the placer gravels have been deposited. They are locally covered with pine and juniper trees and small brush.

State and county highways parallel the rivers through most of the placered areas. Upstream from Cottonwood Creek for 16 miles to Norwood Hill, the San Miguel can only be reached on a few private roads; and from the junction of the San Miguel and the Dolores Rivers to the mouth of Mesa Creek some of the placers on the Dolores are inaccessible by car. Elsewhere the rivers can be reached on private roads passable by passenger cars.

History

The first prospectors entered the headwaters of the San Miguel in 1875, according to Purington (1898, p. 752-753), and the first placer discoveries probably were made in that year. July 22, 1876, the Denver Rocky Mountain *News* (p. 4) described the placers of the San Miguel River as follows:

> San Miguel—A region 35 miles due west of Silverton, on the west side of the mountains, .. . is reporting very favorable yields. Ten cents to $1 is reported to the pan; for a distance of 30 miles the river banks are being worked. A 31/2 mi ditch is planned to provide ample water.

In 1878 the Engineering *and* Mining Journal reported that 5 companies planned to work the mines near Placer ville that season. In his report for 1881, Burchard (1882, p. 420) wrote

> . . . On Bar No. 1 [near Placerville], the St. Louis Co. ran three weeks and cleaned up about $1,500 gold. A few other groups of men working in a small way with toms, rockers, and sluices obtained lesser amounts.

In his report for 1882, Burchard (1883, p. 521) stated

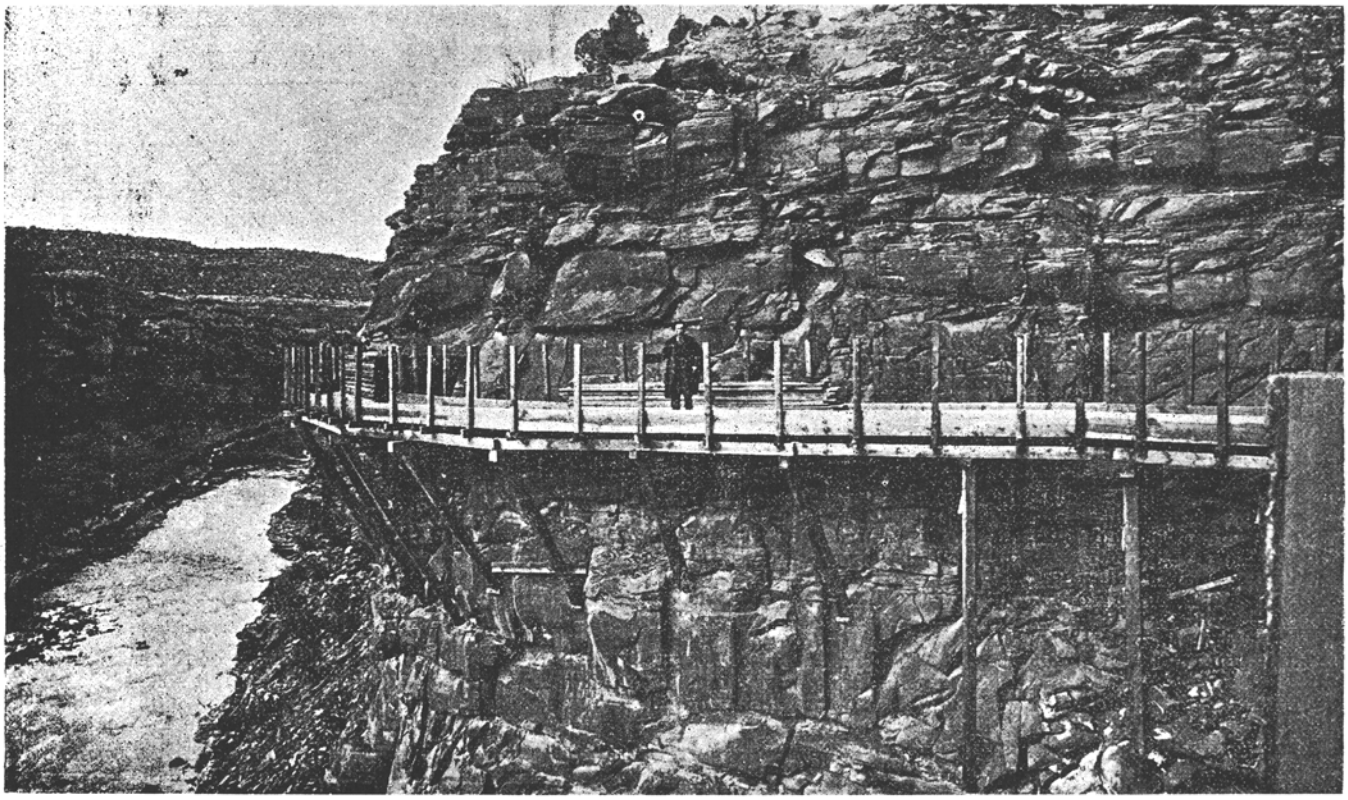
> The St. Louis and Lower San Miguel Placer Mining Co., after expending $30,000 and making a trial run, with the result of cleaning up $1,300 from 2,200 cubic yards of gravel, became involved in litigation and suspended operations.
>
> The Keokuk Hydraulic Mining Co., purchased during the past 18 months the large bodies of gravel known as the Kansas City and Montana Bars [probably near Placerville] and proceeded to develop them by a ditch 11 miles in length, which they have recently completed.
>
> Four miles above Leopard Creek [which joins the San Miguel at Placerville] are situated the Wheeler Bars, upon which a tunnel 8 feet high, 5 feet wide, and 96 feet long produced over $4,000. The Willow Creek bar, owned and operated by a party of Pennsylvania capitalists, has produced an average of 75 cents per cubic yard of gravel for all washings upon their claim.

In 1883 Burchard (1884, p. 417) said that most of the placers were not worked.

Deposits of gravel to which water could be brought cheaply and bedrock channels of high bars which could be exploited by drift mining were worked over a long period of time after 1875, but most such operations probably had been abandoned by the 1890's, for Purington (1898) makes no mention of them.

In 1886 several companies were formed to work placers at Mesa and Cottonwood Creeks. The following year the Mesa Creek placer properties came into the possession of the Montrose Placer Mining Co., capitalized at $5,000,000. According to the Engineering and Mining Journal (1887, v. 44, p. 263), this company claimed to have 600 acres of placer ground underlain by gravels 12 to 115 feet deep worth from 50 cents to $7 per cubic yard. In a feature article on the company's operations the Engineering *and* Mining Journal (1890, v. 49, p. 563-565) reported

> . . . In the spring of 1888 the ground was prospected by the aid of the streams of melting snow and the trifling amounts of water afforded by the Mesa Creek, quite a small stream. The result, however, was so satisfactory that the company decided to build a ditch and flume to a point 10 miles above [on the] San Miguel River.
>
> There is about half and half ditching and fluming . . . The total cost will be about $75,000 when finished, and it is expected to be completed within a few months. . . . This work was commenced at the lower end where the greater part



"Dolores Canyon flume of the Montrose Placer Mining Company. At this point the flume was 400 feet above the river."
Engineering and Mining Journal, 1890

> of the flume is [because] the forest from which the lumber was obtained is located nearest that point. Now work is going on at the upper end. . . .
>
> The flume traverses the whole length of the Dolores Canyon, which is about four miles. It is fastened to the walls of the cliff . . . and for a long distance is at an elevation above the river of 300 to 400 feet. It is very firmly built and has been fully tested to carry the volume of water which will pass through it when finished. .. . In getting the levels the work was very dangerous, the man being lowered down over the cliff . . . , marking in red paint the line to be followed by the construction gang. As the supporting timbers were put in place, the floor of the flume was laid and the derrick pushed out ahead, from which other supporting timbers were raised and secured to their places. Under favorable conditions and with a gang of 12 men, 250 feet per day have been erected. At one point on the line, nearly 200 feet long, the rock projects out, forming a sort of canopy, and is so shaped that it was impossible to support the flume on brackets, and it is hung from bolts, driven in overhead, on which the flume swings .. .

(This article contains two photographs of the flume and diagram showing its construction.)

The flume was 6 feet wide and 4 feet deep; it was set on sills fastened to the cliff with iron pins and supported on the hanging end by posts or inclined timbers pinned to the cliff beneath. Hall (1895, v. 4, p. 235) wrote

> . . . The operative plant of the Montrose Placer Mining Company, formed of St. Louis capitalists, and managed by Col. N. P. Turner, an experienced California miner, is one of the remarkable triumphs of engineering in our state. . . . The company owns six and a half miles of mining ground on the Dolores river. To successfully work them by hydraulic process it was found necessary to tap the stream thirteen miles above, and carry the water by ditch and flume the entire distance. For more than six miles this flume is supported on brackets from an overhanging cliff, ranging from 100 to 150 feet above the river and from 250 to 500 feet below the summit of the gorge. In places the cliff hangs over at an angle of fifteen degrees and such water as escapes the flume strikes on the opposite side of the river 100 yards from its base. A wagon road was constructed along the cliff at the apex, from which workmen were let down by ropes for the purpose of drilling into the face of the cliff, inserting the iron brackets [pins] and setting the flume thereon. The flume is six feet wide and four feet high, and 1,800,000 feet of lumber was consumed

> in its construction. Col. Turner was engaged more than two years in perfecting this wonderful enterprise. It carries 80,000,000 gallons of water each twenty-four hours. Its grade is 6 feet 10 inches to the mile, and its cost is something over $100,000. At the placers the latest improved hydraulic machinery is employed, and the work of cutting the sluicing began in the early summer of 1891. Col. Turner's lowest estimate of the gold contents of the ground is 25 to 30 cents per cubic yard, and he washes down into the great main sluice from 4,000 to 5,000 cubic yards daily. The gold is extremely fine, and can only be saved by the liberal use of quicksilver. At the time of my interview with him at Ouray, and afterward at Montrose in September, 1891, he had made no general "clean up" of the sluices, but had taken from the head four or five balls of amalgam about the size of hen's eggs, as a partial indication of the precious metal being saved. It was, of course, wholly impossible to determine the results of the season until the final investigation to occur at the close of operations for the year, but he was very confident that large profits would accrue to the company for many years to come.

August 8, 1891, the Engineering and Mining Journal (1891, v. 52, p. 170) quoted local newspapers as reporting that the company had just made a cleanup of $80,000 after a run of 6 weeks with 1 giant. (This conflicts with Hall's report, however.) The present author has found no subsequent reports of operations or production by the Montrose Company except for a short news item in the *Engineering and Mining Journal* (1897, v. 64, p. 345) which stated that the operations were suspended in 1893. The gravel deposits below the mouth of the flume are much less extensive than the company's reports indicated and their value probably proved to be only a fraction of the company's estimates.

In 1888 the Engineering *and Mining Journal* reported on the operations of five placer mining companies—the San Miguel Gold Placer Co., which operated bars between Placerville and Telluride, and four English companies which controlled placers along 10 miles of the River in the vicinity of Cottonwood Creek. The San Miguel Gold Placer Company, capitalized at $3,000,000, announced in its prospectus that its placers contained some $5,700,000 in gold which could be mined at a cost of $1,600,000. The company owned some 900 acres of placer ground reported to contain 14,000,000 cubic yards of gravel worth 41 cents per cubic yard. In the season of 1889 the company washed 5,000 to 8,000 cubic yards of gravel daily; in 1891 the company was defunct. Among the English companies the U.S. Gold Placers Company was the most active. The end of 1888 the Engineering *and Mining* Journal stated that the company had been in existence for 2 years; in this time it reportedly had spent $150,000 for land and the construction of 91/2 miles of ditch which brought water to the high bars in sec. 9, T. 46 N., R. 9 W. Only 40,000 cubic yards had been washed as a test and $10,000 was reportedly produced. The company operated the placers in 1889, in early 1890 faced bankruptcy, and in 1892 was in liquidation.

These companies were the largest placer operations along the rivers at the time, but not the only ones. The English companies were capitalized at £830,000 (approximately $4,000,000), the San Miguel Company at $3,000,000, and the Montrose Company at $5,000,000. The expenditures of the companies aggregated several hundred thousand dollars. The placer production of San Miguel and Montrose Counties to the end of 1907 was $208,000 and probably half of this came from the Keystone placer. Poor sampling, unrealistic financing, and occasionally extravagant management were not uncommon in the mining promotions of the time, but these appear to have especially flourished along the San Miguel River.

During the 1930's there were many small-scale operations along the rivers. According to U. S. Bureau of Mines reports, in 1930 there was only one placer operation (which produced 1.5 oz. gold), but from 1932 through 1941 there were 20 or more operations each year. In the peak year, 1935, 181.65 oz. gold was produced in 81 operations.

Geology

REFERENCES

The bedrock geology of parts of the placer areas has been described by Purington (1898), Cross and Purington (1899a), Cater, Butler, and McKay (1955), and Bush, Bromfield, and Pierson (1959). The physiography and glaciology of the headwaters of the San Miguel River, immediately above the Placerville area, have been described by Hole (1912) and Atwood and Mather (1932).

PHYSIOGRAPHY

The mesas into which the canyon is cut are rolling surfaces of considerable relief; most of them are capped with Dakota sandstone. The valley slopes are either a succession of cliffs and benches or gentle slopes. The valley is narrow and youthful, except in the section from near Naturita to Uravan, which is approaching maturity. Notable incised meanders between Uravan and Gateway attest to the intermittent rejuvenation of the river.

There are many remnants of gravel terraces along the rivers. The following descriptions are of the remnants within the placered areas.

In the vicinity of Placerville, between 8 and 17 miles downstream from the junction of the San Miguel with South Fork, there are two terraces preserved in many remnants—one 150 to 185 feet above creek level, and the other 210 to 270 feet above. In addition, there is one terrace-gravel remnant 385 feet above creek level 2 miles downstream from the mouth of Specie Gulch. Exposures of bedrock beneath the more extensive terrace surfaces range from 90 to 150 feet above creek level. The variation probably reflects the exposures' different distances from the main channel of the river at the time the gravels were deposited, since the bedrock beneath the upper terrace is not consistently above that of the lower terrace. This suggests that there was little canyon deepening between the times of deposition of the two terraces. Near Placerville, bedrock surfaces beneath the terraces are exposed 22 feet

above river level. It is probable these are surfaces cut after the deposition of the terraces and the terrace gravels have subsequently slumped into them; however, their relationships could not be determined from the few exposures available. Bedrock beneath the 385-foot terrace surface is 215 feet above river level.

There are two terraces near the mouth of Cottonwood Creek. The surface of one is 27 to 45 feet above river level and its bedrock is 12 to 20 feet above the river on the river edge. The other terrace is approximately 190 feet above river level and its bedrock is 140 feet above the river.

In the SW part of T. 47 N., R. 16 W., there are terraces 37 to 53 feet above the river; their bedrock is 20 to 50 feet above river level. Several terraces occur in the section between Uravan and the mouth of Roc Creek. The principal placers are in a terrace from 60 to 85 feet above creek level beneath which the bedrock is 20 to 40 feet above the river. There are, however, terrace remnants 25 to 30 feet above the river and others 120 and 180 feet above the river. Bedrock beneath the 120-foot terrace is 35 feet above creek level, but beneath the 180-foot terrace it is 160 feet above it.

These terraces cannot be correlated between the placer areas with the information available because of the great distances between the areas and the differences in gradient along them and because of the influence of hard strata in bedrock on the terrace positions.

Atwood and Mather's (1932) studies along the San Miguel River did not include the terrace gravel remnants. Near the junction of the San Miguel and South Fork they show (1932, pl. 1) drift of the Durango stage of glaciation on the edge of a mesa overlooking the 1,100-foot-deep canyon of the San Miguel. They state that there is no Durango till preserved within the canyon. Moraine of their "Wisconsin" stage of glaciation fills the valley of the San Miguel east of the junction and lies on the canyon floor at the junction. They concluded that the canyon was considerably deepened during the interval between the Durango and "Wisconsin" glaciations.

Hole (1912, p. 514) concluded that the gravels in the canyon up to 100 feet above its floor are outwash of the "Wisconsin" stage of Atwood and Mather; and Bush, Bromfield and Pierson (1959, p. 345) concluded that all the terrace remnants in the Placerville quadrangle are probably of the same age.

In the Placerville area, since all the terraces lie in the lower part of the canyon, they must be of post-Durango age. Atwood and Mather (1932, p. 145) state that elsewhere in the San Juan Mountains

> . .. The Wisconsin outwash terrace, however, is ordinarily 20 to 30 feet above the modern alluvium, and in some valleys it is 50 to 60 feet high. Nevertheless, it is extremely rare for solid rock to be exposed in the post-Wisconsin [slopes cut into] the terraces.

They did not study the gravel terraces of the upper San Miguel, whose canyon is narrower in relation to the river volume than most of the valleys in which they mapped "Wisconsin" outwash. Since the valley is narrower, and yet contained large and vigorous glaciers at its head, outwash trains within it might well have been thicker than elsewhere in the San Juan area. The elevated bedrock levels beneath the terraces, on the other hand, suggest two alternatives—that the San Miguel valley has experienced a moderate post-"Wisconsin" uplift that has not affected the rest of the San Juans or that the terrace gravels near Placerville are of Post-Durango-pre-"Wisconsin" age, perhaps corresponding to Atwood and Mather's (1932, p. 133) Oxford and other gravels. On available evidence, the author is inclined to believe the latter.

Both Ray (1940) and Richmond (1954) have tentatively correlated the glacial stages which Atwood and Mather recognized with those recognized in the Front Range and at Twin Lakes. Neglecting differences in terminology, they are in substantial agreement. Richmond correlates the Durango stage with the Bull Lake stadial and the "Wisconsin" stage with the Pinedale stadial. Thus the "post-Durango-pre-Wisconsin" terrace gravels near Placerville are probably of middle to late Wisconsin age. The lower terraces in the two downstream placers areas are almost certainly of the same age, but the upper terraces may be somewhat older.

BEDROCK

The streams are underlain by sedimentary rocks ranging in age from Permian to Upper Jurassic. Rocks of the Permian Cutler Formation are exposed in the canyon from near Sawpit to about 5 miles below Placerville, and rocks of the Triassic Dolores Formation extend upstream from Sawpit to the mouth of Howard's Fork and downstream approximately from sec. 24 to sec. 3, T. 44 N., R. 12 W. The Triassic Chinle Formation is exposed on the Dolores at the mouth of the San Miguel. Elsewhere, rocks of Jurassic age form the bedrock of the streams and lower valley slopes. These rocks include sandstones, shales, and a few limestones. They form a mall part of the coarse fraction of the gravels which immediately overlie them, but most of the rocks are so soft that they do not persist far downstream.

The bedrock floors beneath the placer terrace gravels are usually developed on hard layers and consequently drop abruptly where the river breached a hard layer and the soft rocks underlying it, developing a floor on the next hard layer beneath. These rocks have made favorable bedrock for placer mining. Thin and slabby sandstones and soft shales have been easily cleaned; the more massive sandstones have formed bedrocks which gold did not penetrate.

The only localities within the watershed (excepting that of the upper Dolores River) in which Precambrian rocks occur is in the crest of the Uncompaghre Plateau. Igneous rocks are exposed in the drainages of streams upstream from Norwood Hill in the San Miguel and San Juan Mountains. Phaneritic rocks ranging from diorite to monzonite in composition are exposed in the San Miguel Mountains; on the South Fork and at Sawpit there are intrusives of granite porphyry and monzonite-diorite. The San Juan and San Miguel Mountains are themselves volcanic piles of andesitic and rhyolitic debris.

In the upper San Miguel area the bedrock beneath the terraces is well exposed in many drift mines. Here the bedrock is commonly massive sandstone which the stream has sculpted into very irregular forms. Grooves or channels in the bedrock floor are common. Some drifts expose parallel benches, apparently not related to hardness of various strata, which must have been formed as curved river channels "slipped" laterally. Abrupt changes of 5 to 10 feet in elevation along bedrock channels and potholes in the channel floors are not uncommon. One abandoned channel 117 feet above the present river level is separated from the present channel by a bedrock ridge which rises 160 feet above the present river level. At this place talus covers both terrace and bedrock ridge so that there is no break in the slope of the canyon wall.

From Cottonwood Creek downstream, the bedrock floors of the terraces where exposed in the pits show little relief. Here hard layers have been stripped to near-dip slopes and more than a few feet relief from the bedding planes is uncommon. At the lower Cottonwood placers some gold appears to have been recovered by lifting slabs of bedrock, but in general this has not been done.

TERRACE GRAVELS

The terrace gravels vary greatly in thickness. Near Placerville the gravels beneath the 210-to-270 foot terrace are 100 to 160 feet thick; those beneath the 150-to-185-foot terrace are 70 to 100 feet thick, and those beneath the 385-foot terrace are 170 feet thick. Near Cottonwood Creek the gravels of the upper terrace are 50 feet thick and those of the lower terrace are 15 to 25 feet thick. Further downstream the gravels beneath the 35 to 53 foot terraces are 7 to 30 feet thick, and those beneath the higher terraces are 30 to 85 feet thick.

Particularly in the Placerville area, the terrace gravels are covered with considerable thicknesses of talus.

The composition of the terrace gravels changes greatly along the river, as might be expected. Near Placerville, lava boulders make up one-third to one-half of the coarse fraction and locally-derived sandstones, about one-third. Boulders of San Juan Tuff, phaneritic igneous rocks, vein quartz, and conglomerate make up the remainder. Greenstone pebbles are fairly common in the gravels near Placerville—these are derived from the Cutler conglomerates which outcrop in the lower canyon walls. The occasional schist boulders were derived from the conglomerates of the Telluride Conglomerate or the Cutler Formation. The coarse fraction is angular to rounded; most of the boulders are sub-angular. There are few boulders more than 2 feet in long dimension and most are smaller, but a 5-foot boulder was seen in one of the drift mines. The gravels of the modern stream floor differ from these in containing much more lava and San Juan Tuff.

Downstream, igneous rocks from the headwaters of the San Miguel make up a progressively small proportion of the total gravels but become increasingly abundant in the smaller, better rounded fraction.

At Cottonwood Creek the coarse gravels contain much angular sandstone and quartzite, together with sub-rounded pieces of lavas and aphanoporphyries, San Juan Tuff, and phaneritic igneous rocks. The gravels of the high terrace here contain less tuff and phaneritic igneous rocks than do the lower gravels. Below Uravan the gravels contain more metamorphic rocks and, for a short distance below the mouth of Mesa Creek, coarse-grained hornblende-rich metamorphic rocks and pink granite predominate.

The gravels are well indurated, but not cemented. Large chambers in the drift mines have remained open for many years with little caving and there are many near-vertical faces 50 to 100 feet high in the old hydraulic cuts. The gravels contain little clay and are easily washed.

Character and Distribution of Gold

Very little information is available concerning the character and distribution of the gold in the gravels along the San Miguel and concerning the values of the gravels. Some gravel values reported in the hydraulic mines have been quoted in the history section, but most of these are high, and, since the gravels were not mined out in the principal hydraulic cuts, the values must not be representative of the remaining gravels nor probably of the gravels which were worked. Many drift mines have been worked beneath the terraces in the Placerville area. Some of these are very extensive, suggesting profitable operations. These indicate that the gravels immediately overlying bedrock channels were of good grade. Placerville residents report that the gold in these bedrock channels was fine and hard to save.

Purington (1898, p. 830) described the placers of the Placerville area as follows:

> . . . the auriferous gravels are not found at the level of the present streams, but as local small areas at a greater or lesser distance above. There are three levels at which these gravels occur—one 30 feet, one 75 feet, and one above 200 feet above the present drainage. One of the causes of difficulty [of mining] is the getting of water up to the banks. Another is the weight of gravel, one cubic yard sometimes weighing 4,500 pounds. The third difficulty experienced is the great size of the boulders which have to be handled. The gold itself is easily saved, and its yield is from 10 to 20 cents to the cubic yard [old price], the amount lessening as the distance from the source increases.

Bush, Bromfield, and Pierson (1959, p. 379) state

> Information from local miners indicates that the gold was for most part of fine-grain size and that very few nuggets were found. Most of the gold is reported to have been in the base of the gravels . . .

Burchard (1882, p. 521), in the Director of the Mint's report for 1882, states that the Willow Creek Bar, located on the north bank of the San Miguel River between Keystone and Sawpit, produced an average of 75 cents per cubic yard, old price.

Dr. Ben H. Parker (1935, written communication) reported that the gold found in the lower terrace and on the

surface of modern stream bars along the San Miguel about 3 miles northeast of Naturita was extremely small and well flattened. The coarsest particle of gold recovered from 21 samples of 150 to 250 lb. of gravel each weighed 0.25 mg. Mr. Clarence E. Manion (1958, oral communication) estimated the gold in the same area to be 750 fine. The results of Manion's testing showed the gold to be concentrated in the top 2 to 3 feet of the modern bars, with the best values frequently on the inside banks of sharp river bends. The gold values of the top gravel layer ranged from nil to more than $1 per cubic yard, but the gravels immediately beneath were practically barren. Parker's tests of the terrace gravels, at sites said to be of good grade, showed values of less than 10 cents per cubic yard. Mr. Kip Wood, who has lived in the area since the English companies worked the terrace gravels at Cottonwood, stated (1956, oral communication) that during the 1930's two men worked the low-terrace gravels near the English company's cut for 2 months by hand methods. They made $300 during that period, producing from 10 cents to $5 per man per day. Production figures quoted in the history section indicate gravel values of 25 cents per cubic yard in gravels worked by the English company in this same area, but these values, if true, must have presented an unusually rich local deposit.

The gravels on bedrock beneath the modern stream channel have never been tested.

The distribution of the placer mines, and the methods and extent of mining in them, suggests that within the terrace gravels most of the gold was concentrated immediately above bedrock channels, whereas the remainder of the thick gravel deposits was of very low grade. The gravels appear to have been richer in the Placerville area.

More work has been done in the 1930's, and subsequently, on the lower placers in Montrose County than in the Placerville area. This is probably related less to better gravels there than to greater ease of working, for most of these gravels are relatively thin and lie nearer river level here than upstream.

Source of the Gold

These placers contain gold which was undoubtedly derived principally from the mineralized areas at the heads of the San Miguel and South Fork. A minor contribution of gold may have been made from the ore deposits of the Mt. Wilson district at the head of Big Bear Creek and perhaps from those near Sawpit. The San Miguel watershed was the source of the placer gold on the Dolores River below the mouth of the San Miguel, for there are no placer deposits on the Dolores for many miles upstream from the junction.

Reserves and Future Placer Operations

Along the San Miguel and Dolores Rivers from place to place there are unworked elevated terrace-gravel deposits, a few of which are extensive. There is no reason to suppose, however, that they are of any better grade than those previously worked. From sec. 3, T. 44 N., R. 12 W., upstream to Keystone there are probably a number of bedrock channels containing gravels of good grade which have not yet been discovered. Systematic prospecting for these would be expensive, and probably the cost would not be repaid in mining the channel gravels discovered.

The gravels beneath the modern stream channels of the San Miguel and Dolores Rivers have not been tested to bedrock and may contain some bodies of gravel suitable for dredging. Drilling on the upper San Miguel in areas where the topography is suitable for dredging, sufficiently far downstream to avoid large glacial outwash boulders, but remaining upstream to be in the area of the coarsest gold, might disclose such dredging gravels.

Bringing water to the level of the elevated terraces has presented difficult problems since these placers were first worked. It is likely that since the time of major placer mining, the waters of the San Miguel River, particularly downstream from Cottonwood Creek, have been appropriated for other purposes, and that little water is now available. In the Placerville area there is almost no ground available for settling ponds and tailings disposal. This problem is less critical downstream.

In view of the probable value of the elevated terrace gravels, the distribution of the gold in them, and the water supply and pollution problems, it is extremely unlikely that these deposits will ever again be worked on a large scale. From time to time drift mining may profitably be done, but these operations probably will be small.

KEYSTONE PLACER

Location

The Keystone placer extends along the San Miguel River immediately above its junction with South Fork for approximately 0.6 miles. It lies in the NW1/4 sec. 33 and the northeastern part of sec. 32, T. 42 N., R. 9 W., and is approximately 41/2 miles downstream from Telluride. At the placer area, in less than a mile the San Miguel rises from its valley floor at the junction with the South Fork at 8,080 feet elevation to the level of the long flat on which Telluride is built at 8,600 feet. Colorado Highway 145 parallels the river on the north hill slopes above the placer and a jeep road follows the river to the center of the placer cuts. Large slumps have developed at several places on both sides of the river adjoining the cut, and one threatens to destroy the highway.

History

The first record of mining at the Keystone placer is in Burchard's report for 1881 (1882, p. 420). He says

> In the valley of the San Miguel, the Keystone Co. was engaged most of last season in erecting flumes and other preparations for washing on an extensive scale. They ran just a month before closing down and cleaned up about $3,500 in gold, worth about $16 per ounce.

Burchard (1883) reported that the placer was worked with successful results the following year, as well.

The Engineering *and* Mining Journal reported in the spring of 1889 that the placers were to be worked that year; and in 1890, $18,000 was produced from them, ac-

cording to Henderson (1926, p. 219). According to the *Engineering* and *Mining* Journal the mine was worked successfully throughout the 1891 season; and the following winter the mine crew was employed in prospecting by drifting, as well as repairing. These early operations at the Keystone mine apparently were near the mouth of the South Fork.

The placer was idle from 1892 until 1898 when a shaft was being sunk to bedrock. In 1901 the Keystone Hydraulic Co. began construction of the hydraulic plant with which the large cut was made. Hodges included the following description in his report for 1901 (1902, p. 140)

> The Keystone Hydraulic Mining Co. is prepared to begin extensive operations on San Miguel River in the spring of 1902. It has under construction a dam across East Fork of San Miguel River, a 2,500 ft. flume 6 by 12, and is installing an adequate pipe line. Two 10-inch giant nozzles will be placed, capable of washing 12,000 to 20,000 cubic feet [cu yd?] of gravel daily, which has been sampled and shown to carry from 10 cents in surface dirt per yard to $1.50 in bedrock . . .

October 5, 1901, the *Engineering and* Mining Journal (1901, v. 72, p. 424) published an article on these placers. In addition to the above information it stated that many 50-cent to $5 nuggets had been recovered during testing, and that hydraulicking was begun in September, 1901. In another article it stated that the giants operated under a head of 650 feet and threw a jet 450 feet long. During the season of 1902 most of the work at the placer was directed to making a bedrock cut for the sluice boxes. Huge boulders presented many difficulties and at the end of the season a tunnel to carry the sluices was begun. The property was worked in 1903, but mining operations were interrupted by flood and tailings damage to the dam and flume. The placer was worked in 1904 and 1905, producing the bulk of San Miguel county's production of $44,957 and $21,587 in those years. The Engineering and Mining *Journal* reported that work was stopped at the mine in 1906 after large landslides of "surface material" into the pit occurred.

Geology

The Keystone placer is in morainal material of "Wisconsin" (Pinedale) age, just upstream on the San Miguel from its junction with the South Fork. Hole (1912, p. 515-516) described this moraine as follows:

> The moraines below Keystone are formed from material brought partly by ice advancing down Lake [South] Fork, partly by that coming down the main valley from the east. San Juan [Tuff] bowlders up to 15 feet or more in diameter characterize the drift from the east; granite or diorite-monzonite in bowlders up to about 3 feet in diameter, that from the south. The mesa lying in the angle between the main valley and the Lake Fork is covered with drift brought from the south; this drift extends eastward more than half a mile from the nearly perpendicular rock face which at this point forms the upper part of the east wall of the canyon of Lake Fork. While there is more or less commingling of drift from the two sources, yet, speaking generally, the small tributary of the San Miguel River, which enters from the south about one mile east of Lake Fork is the dividing line between drift from the east and drift from the south. Half a mile west of this tributary and between the railroad and the San Miguel River, [east of the W1/4 cor. sec. 33], the moraines take the form of low ridges extending in a northeast-southwesterly direction. On the north side of the river, and extending one-fourth to one-half a mile up the valley from this point are glacial deposits which are being treated by hydraulic process to recover the gold they contain. These deposits, as well as those extending eastward for half a mile from the small tributary referred to, lying chiefly on the south side of the river, show in places layers of stratified silt, sand, and gravel; the greater part of the deposit, however, is unstratified.
>
> The drift in the vicinity of Keystone constitutes by far the largest accumulation of glacial debris to be found in the canyon of the San Miguel; judging from the comparatively small number of large San Juan bowlders found farther down the canyon, the Keystone drift is in the nature of a terminal moraine for the glacier which advanced from the east. On August 1, 1904, drift in the form of a ridge transverse to the stream at a point about four-fifths of a mile east of the mouth of Lake Fork was being washed down in the process of hydraulic mining; the work showed that the pre-glacial channel of the San Miguel River at this point was about 100 yards farther north than at present, and approximately parallel to its present course, and that the pre-glacial channel had a depth of bed as much as 30 feet lower than the bottom of the present channel. It appears, therefore, that the pre-glacial channel was filled to such an extent as to displace the stream and to cause it to flow at a higher level along the south wall of the valley where it has in post-glacial time eroded a new channel not more than 10 to 20 feet in depth.

Bedrock beneath the placer is Morrison Formation, which dips 3° to the north. It is exposed at the western end of the hydraulic pit near the head of the sluice. The highest point of the pit face is a few hundred feet north of the center of sec. 33. It is 420 feet above the highest bedrock exposure on the river bed in the cut; the gravel face beneath this point is 330 feet high, but the floor of the cut here is covered with debris and may be deeper.

The boulders exposed in the placer-tailings dumps include all varieties of sedimentary rock outcropping in the Telluride district as well as lavas and San Juan Tuff and coarse diorites and monzonites. The boulders are angular; very few are rounded. The cobbles are distinctly more

rounded, however. In the pit there are many huge boulders; the largest observed is 18x18x10 feet. According to common reports, the placer operation failed chiefly because of these giant boulders which the miners could not dispose of and which soon filled the working area. Few of these large boulders are exposed in the present pit banks, suggesting the huge boulders were concentrated near bedrock.

Purington (1898, p. 831) stated most of the gold in the gravels is very fine, and in rounded grains, but was easily recovered. There is some coarse gold. There is a great deal of fine magnetite in the gravels, and some grains of native copper were occasionally found during the placering.

Although the more extensive placer workings are on the north side of the river, at the time the placer was worked the railroad ran above the placer area on the south side and less work may have been done here for fear of undermining the right of way. Consequently, the gravels may not have been especially richer on the north side of the valley than on the south. On the other hand, moraines on the north side of the San Miguel glacier received debris from Marshall and Ingram Basins and should have been richer in gold than the moraines on the south side of the valley and from South Fork.

Classification and Geologic History

The fact that the gold was concentrated on bedrock and the apparent concentration of boulders there suggests that the deposit may be in part caused by stream concentration. It is suggested that as the San Miguel glacier advanced downstream its terminal moraine tended to override outwash and previous stream deposits, for ice movement is upward at the snout of a glacier, and scouring takes place upstream from it. Following Hole's interpretation, at the junction of the valleys of the San Miguel and South Fork, just below the placer, the advance of the San Miguel glacier was blocked by the South Fork glacier. The terminal moraine and the stream gravels beneath it were protected from removal by the South Fork glacier by the ridge between the two valleys and were perhaps overridden by the ice of the San Miguel glacier. Thus this placer deposit is of Pinedale and perhaps slightly earlier age, the product of alluvial, glaciofluvial, and glacial action.

Reserves and Future Placer Operations

There is no reason to presume that the placer gravels here have been exhausted. There is no economic mining method available, however, by means of which the difficulties presented by the huge boulders can be overcome to permit hydraulicking (which probably would not be permitted now because of the pollution problems involved.) No other surface placer-mining method would permit cleaning bedrock, and apparently the surface gravels, apart from those worked at the toe of the moraine (gravels reconcentrated since the retreat of the South Fork glacier), are not rich enough to mine. Drift mining here would be very expensive, for an Engineering *and Mining Journal* article reported that the tunnel driven for the sluice had to be very heavily timbered, and the reported grade of the gravels on bedrock is not nearly sufficient to repay the cost of such mining.

SAN MIGUEL VALLEY BETWEEN KEYSTONE AND PANDORA

The long flat valley between the Keystone moraine and the head of the valley at Pandora is floored with lacustrine beds deposited in a glacial lake dammed behind the Keystone moraines. It has frequently been suggested that there might be placer deposits beneath these beds in the bedrock canyon of the San Miguel. The depth to bedrock beneath the valley floor is unknown, but through most of the valley's length it is probably 200 feet or more. In this area, the glacier had the power to scour its floor, cleaning the bedrock or at least thoroughly mixing the gravels on it. As a consequence it is unlikely that placer gravels lie buried beneath the valley floor, and certainly bedrock is too deep to permit mining. Neither is it likely that placers were formed by Marshall and Ingram Creeks, which drain the areas of the rich gold veins, in their deltas or fans on the margins of the lake, for such an environment is not usually suitable for placer accumulation.

These lacustrine beds contain low gold values at the surface from place to place, and were worked for a short time in the 1880's. Corregan and Lindgane (1883) list several placers near Telluride on which a little work had been done and at which low values, generally of only a few cents a yard, were reported.

In 1927 a number of holes were drilled in the lake beds downstream from Telluride under the supervision of Mr. Robert Livermore, who reported (1938, written communication), ". . . none of the holes showed appreciable value, and no bedrock was found in any of them." The sites and depths of these holes is unknown.

TAILINGS DEPOSITS BETWEEN PANDORA AND TELLURIDE

During the early active period of mining in the Telluride area the ores of many of the mines were treated in stamp mills located near Pandora. These mills lost considerable gold in their tailings, which were discharged into the San Miguel. From place to place these tailings accumulated, reportedly to depths of as much as 50 feet. They contained $5 to $8 per ton in gold. In the late 1890's the first of a series of cyanide mills was built to treat these tailings. These deposits are not placer deposits since, during their transportation and deposition, little if any concentration of gold apparently took place. This lack of concentration was caused by the streams having been overloaded with the tailings. At other places, such as near Gladstone, in San Juan County, placers developed from mill tailings where the stream's power was sufficient to transport and classify them.

THE PLACERS OF DOLORES, LA PLATA, AND MONTEZUMA COUNTIES

Placers have been worked at a number of places in Dolores, La Plata, and Montezuma Counties. Although their production has been small, the counties' recorded production of $2,245 represents only a part of the total.

The placers are located in three areas, each of which is

discussed separately. On the Dolores River, placer gravels have been worked from place to place for 7 miles downstream from Rico. Some placers have been worked on the East and West Mancos Rivers, on the La Plata River, and on Junction Creek, all of which head in the La Plata Mountains. At Baker's Bridge, on the Animas River, stream and terrace gravels contain considerable placer gold.

The placer deposits near Rico and at Baker's Bridge contain some unworked gravels of good grade. Those near Rico may be worked in the future by small-scale methods, but surface-land values near Baker's Bridge are such that little placering is likely to be done there. The remaining areas include some large, untested placer deposits, but they are probably of too low grade to be worked.

UPPER DOLORES RIVER

There are small placer workings from place to place in the Dolores River valley from the mouth of Burnett Gulch, 1¼ miles downstream from Rico, to the mouth of Tenderfoot Gulch, 7 miles below Rico. Gold-bearing gravels have been found upstream to Rico and extend for more than 1 mile below Tenderfoot Gulch. Montelores, once a station on the now abandoned Rio Grande Southern railroad line, is 3¾ miles below Rico. The boundary between Dolores and Montezuma Counties crosses the valley at Montelores; Dolores County includes the valley above the boundary and Montezuma County the valley below. State Highway 145 parallels the river through the placer area, and all the placers are within a short distance of it. The placers are between 8,250 and 8,650 feet elevation. The winters in the district are severe and the placer working season is short.

According to Mr. Robert Snyder, of Rico (1956, oral communication) the first of the placer deposits to be discovered was found by his father about ¼ mile upstream from the mouth of Tenderfoot Creek in 1882. The Engineering *and Mining* Journal (1882, v. 34, p. 190) reported that placer operations that year at "Snyder's Gulch" were crude but the results were successful. His father worked these placers on a small scale for some time until attention was attracted to the discovery, and for a brief period extensive placer prospecting was done here. The Rio Grande Southern railroad ran several excursion trains for placer prospectors from Cortez during this excitement, which appears to have been in 1894, when the Engineering and *Mining* Journal (1894, v. 58, p. 204) reported that about 50 men were prospecting for placers along the Dolores and its tributaries. Since this time the Snyder placers have been worked intermittently and a few placers have been worked upstream, but all these operations have been on a very small scale. During the 1930's there was little placering here; in 1934, the most productive year, "Minerals Yearbook" reported 7 placer operations which produced only 18.74 oz. gold and 2 oz. silver (one of these may have been in the La Plata Mountains).

Gold-bearing gravels have been found both along the bed of the Dolores River and on remnants of several terraces above the river, but placering has been limited to the terrace gravels. Downstream from Montelores the bedrock is the Pennsylvanian Rico and Permian Cutler Formations. These include predominantly red sandstones and conglomerates with intercalated shales and some limestones. The Dolores River has cut a late youthful valley with an open, V-shaped profile into these rocks. Placer prospects near Tenderfoot Creek show that the valley's bedrock slopes are not smooth, but from place to place there are remnants of benches underlain by hard strata. It is on these benches that the terrace gravels with their talus and soil overburden were deposited. In his prospect cuts within a mile upstream from Tenderfoot Gulch, Snyder has found terrace remnants 40 to 60, 100, 180, and 360 feet above the present river level. Remnants of the lowest terrace have been found upstream for several miles.

Between Burnett Gulch and the county line, the bedrock is sandstones, shales, and limestones of the Pennsylvanian Hermosa Formation and hornblende-monzonite porphyry. Within this section the valley walls are somewhat steeper than below and a single bedrock terrace, 70 feet above the river, has been found.

From Rico downstream the floor of the valley is covered with alluvium at all but the narrowest places. Locally the alluvial deposits are more than V2 mile wide. A terrace surface approximately 15 feet above the river level is locally developed in them along the valley.

The principal placer workings are at the Snyder prospect on the north side of the river from Tenderfoot Gulch for a mile upstream; just upstream from Montelores at the county line; and opposite the mouth of Scotch Gulch one mile below Burnett Gulch.

At the Snyder prospects the valley slopes have been dissected by tributary gulches from the north, so that the terrace gravels lie on the ends of spurs overlooking the valley. Several cuts have been made in the lower three terraces, but the uppermost one has not been prospected. These cuts are not large—at the largest cut, in the low terrace, less than 100 cubic yards of gravel has been worked. The cuts on the lower two terraces are ⅛ mile from the river; the cut on the 180-foot terrace is nearly ¼ mile from it. Gravel thicknesses exposed vary from a few feet to 15 feet.

There is little apparent difference in the gravels of the various terraces. The most abundant cobbles and boulders are of igneous rocks—hornblende porphyry makes up more than half of them. The porphyry rocks are angular to subangular and range up to 1.8 feet across. The sedimentary rocks are rounded to sub-angular and are made up of sandstones, arkose, and pebble conglomerate. Of these, the largest boulder seen was 4 feet across. However, few of the boulders of any rock type are more than 1 foot in diameter. In some of the cuts there is much magnetite, and cobbles of the mineral up to 4 inches in diameter are found; at other places there is almost none. There is little clay and the gravels are easily washed. At the large cut in the low terrace, the bedrock slopes away from the river; here bedrock relief amounts to 4 feet, but the bottom of the bedrock channel has not been exposed. In another cut in the low terrace, a bedrock channel 12 feet wide and 2 feet beneath the general bedrock level has been exposed.

Snyder reports that the gold is concentrated almost entirely on bedrock, and particularly along bedrock channels;

but, according to other reports, at some places the gold appears to be distributed throughout the gravel section. Several ounces of gold produced from the cuts was examined by the author. It is a uniform yellow color; a small part of the gold is rusty. The gold is coarse, in flakes and wires; some of the flakes are flat but most show rolled edges. The largest piece seen was a very thin, irregularly shaped flake nearly 1/2 inch long. No information is available concerning the fineness of this gold. According to Snyder, the gravels worked in the large cut averaged 80 cents per cubic yard.

Near Montelores there are a number of placer cuts aggregating less than 1,000 cubic yards in the terrace 10 to 15 feet above creek level. According to Mr. Snyder a thin layer of gravel, averaging about 11/2 feet thick, contained most of the values.

Opposite the mouth of Scotch Gulch there is a cut aggregating 700 cubic yards in the gravels upon a bedrock terrace about 70 feet above river level. Snyder reported that drift mines extend from it. The gravel worked in the cut is up to 7 feet thick on the upstream end but thins to less than 2 feet at the downstream end of the cut. These gravels are different in character from those of the Snyder prospects. Sedimentary rock varieties make up about half of the coarse fraction. The rocks are much coarser—a 5 x 6-foot rounded limestone breccia boulder and a 4-foot-diameter rounded sandstone boulder were observed in the boulder piles.

There are also a number of boulders containing considerable pyrite and sphalerite. At both ends of the cut the gravels lie beneath 10 or more feet of talus cover. The gravels were reported to be rich, but the grade is unknown.

Besides these three areas, from place to place along the river terrace gravels have been worked in small cuts, most of which are in the terrace 10 to 15 feet above river level.

The gravels of the modern river bed arc gold-bearing. At the mouth of Tenderfoot Creek several pans of gravel from the surface of the stream bars were washed and each contained a number of rather coarse colors. The river gravels have been drilled for about 2 miles along the river near the mouth of Tenderfoot Creek. In these tests the gravels ranged from 40 to 60 feet deep; the best hole showed gravel worth 50 cents per cubic yard. No work was done as a result of this testing, so it may be presumed that most of the testing showed gravels of much lower grade.

This gold was derived from the deposits of the Rico district, which have been described by Ransome (1901). These are fissure veins and blanket replacement deposits valuable chiefly for silver, lead, and zinc. Ransome (1901, p. 251) reported that free gold is uncommon in the ores of the camp, but stated it had been found in several veins and in float on Calico Peak and Horse Creek northwest of Rico and in one vein on Newman Hill southeast of the town.

The terrace-gravel remnants exposed at Snyder's prospects are small but apparently of good grade. Probably there are similar undiscovered terraces in the valley; these may prove attractive for future, small-scale mining operations if water can be brought to them economically. Downstream from Montelores the valley floor of the Dolores is suitable for dredging, and it is possible gravels of workable or near-workable grade can be developed there if the price of gold were increased. Ample water is available for dredging operations, and probably adequate settling facilities could be developed on the valley floor.

LA PLATA MOUNTAINS

The gravels of a number of streams which drain the La Plata Mountains,—West and East Mancos Rivers, La Plata River, and Junction Creek—contain placer gold and have been worked from time to time in the past.

Cross, Spencer, and Purington (1899, Economic Geology and Historical Geology Sheets) have mapped the gravels in the La Plata quadrangle (which includes all these placers except those on Junction Creek) and indicated those reported to be gold-bearing. On these maps "gold-bearing gravels" are shown along the West Mancos River for approximately 8 miles from the east side of T. 37 N., R. 12 W., to sec. 36, T. 37 N., R. 13 W.; along the East Mancos River for approximately 10 miles from its head in Rush Basin to its junction with the Middle Mancos River in sec. 24, T. 36 N., R. 13 W.; and along the La Plata River for approximately 8 miles from Bedrock and Boren Creeks (near La Plata City) in sec. 3, T. 36 N., R. 11 W., to sec. 11, T. 35 N., R. 11 W., 1 mile north of Hesperus. In addition they have mapped several remnants of terrace gravels reported to be gold-bearing—southeast of the junction of the East and Middle Mancos Rivers in secs. 19, 29, and 30, T. 36 N., R. 12 W., and sec. 24, T. 36 N., R. 13 W., and northwest of Hesperus, principally in secs. 3, 4, and 10, T. 35 N., R. 11 W.

County roads parallel the lower parts of the two rivers but at many places follow ridges 1/2 to 1 mile from them. The Colorado Highway Department atlas shows no roads or trails along the upper two miles of either placer area, where most of the old workings are reported to be. The lower ends of the placer areas on the West and East Mancos Rivers are 6 and 31/2 miles respectively from the town of Mancos. A county road follows the La Plata River from Hesperus to La Plata City, and lies within a short distance of all the placer areas on the river.

Junction Creek heads in the southwestern part of T. 37 N., R. 10 W., and the northwestern part of T. 36 N., R. 10 W. This area is approximately 10 miles from Durango; 6 miles of this distance is along a primitive road.

Elevations of the placer areas are as follows:

West Mancos River 7,850 to 9,700 feet
East Mancos River 7,400 to 11,400
La Plata River 8,150 to 9,900

The elevation of the principal lode mines at the head of Junction Creek is about 10,000 feet.

According to Hall (1890, v. 2,, p. 204)

> Captain Moss, with a party of Californians, in 1874 built a ditch on the La Plata River, to facilitate the workings of gold placers located there, but which were never very productive. .. . Parrott City . . . was founded a mile south.

According to the Engineering *and* Mining *Journal* (1885, v. 39, p. 250) placer gold was discovered at the head of Junction Creek in the Oro Fino district (T. 36 and 37 N., R. 10 W.) in 1885. In 1887 the Engineering *and* Mining *Journal* reported (1887, v. 44, p. 11)

> It is not generally known, that there are several placers being quietly though effectively and profitably operated on the East Mancos River, in this county, about 30 mi. west of Durango.
>
> For several years there has been a little prospecting in these placer fields, but until this summer there has been no active work for the development and profitable mining of the rich ores along that stream . . . The mining done there now is by panning and sluicing, and it is paying $4 to $10 a day a man, which is good pay.

According to the Engineering *and* Mining Journal, an Omaha group purchased the Marshall placer on the East Mancos River, and installed a hydraulic plant in 1897, and proposed to work the property the following year. One of the articles credited this placer with a previous production of about $10,000. In 1898 it reported a company was hydraulicking at the Parrott Bar, presumably near Hesperus. Besides these activities there has been occasional small-scale prospecting and mining. In 1932 or 1933, placering on the East Mancos River led to the discovery of the Red Arrow mine, a notable free-gold producer, in sec. 11, T. 36 N., R. 12 W. The *Engineering and Mining Journal* (1934, v. 135, p. 130) stated that the four discoverers netted only $17 in 1 month's panning on the East Mancos prior to their find. Cross and others (1899, p. 5-6) describe the terrace gravels as follows:

> Terrace gravels—Well-marked deposits of gravel at a considerable height above the present drainage are found along the La Plata River in the vicinity of Hesperus and on the divide between East Mancos River and Cherry Creek. Since the deposition of the gravels erosion has taken such directions that they are now left upon the tops of ridges, but there can be little doubt that they were formed in the valleys of rather voluminous streams.
>
> The gravels in both these localities form a continuous wash over the areas represented on the map. They contain bowlders, always very smoothly rounded, a foot or more in diameter, but the thickness is not considerable, not more than 4 feet having been observed.
>
> All these high terraces are supposed to be auriferous, but have not yet been found rich enough to be of economic value.
>
> Beneath the high terrace and the present flood plain an intermediate bench is usually to be found. . . .

They describe the placer deposits as follows (1899, p. 13-14)

> Alluvial gold is very widely distributed in the La Plata district, and were it more concentrated, doubtless considerable quantities might be profitably extracted. The La Plata Valley has so far produced very little placer gold. In Bedrock and Boren Gulches [near La Plata City], as well as in the main valley, unsuccessful attempts at placer mining have been made. In the West Mancos Valley considerable work has been done, but, as the workings are now abandoned, it is to be inferred that they did not pay. In the valley of the East Mancos for a distance along the river of about 3 miles below Rush Basin, placer mining appears to have been the most successful. Here the gold is coarse, and nuggets of small size are not infrequently found. It is reported that considerable gold has been taken at a profit from the East Mancos. In general the gold is exceedingly fine, though not flaky. Its distribution is not confined to the area of the quadrangle, being found for many miles down the La Plata River, and down the Mancos to its junction with the San Juan. The gold is found also in gravels above the level of the present streams, such as the area north of Hesperus called "Gold Bar" and a small tract on the East Mancos River about 2 miles northeast of Menefee Mountain. The finely divided state of the gold and the difficulty of getting sufficient water to the deposits appear to be the principal impediments in connection with placer mining in this region.

ANIMAS RIVER

Introduction

Very little placering has been done along the Animas River. Downstream from the Silverton mining district for nearly 45 miles to Baker's Bridge, the river flows through a deep, narrow gorge which has undergone repeated, extensive glaciation. In this section no placers have been found, nor is it likely that there are any. Below Baker's Bridge the valley broadens to more than a mile in width and remains wide to the vicinity of Durango, where it narrows as the river flows between several hogback ridges. Atwood and Mather (1932, pl. 1) show terminal moraines of their Durango and "Wisconsin" stages of glaciation near the northern limits of the city of Durango. Upstream from the moraines to Baker's Bridge they have mapped remnants of drift of both glacial stages on the points of the mesas overlooking the valley; and on the valley floor they show alluvium, in part deposits in lakes which once lay behind the moraines. Downstream from the moraines, outwash deposits of Durango and "Wisconsin" age extend to the Colorado-New Mexico boundary. Southeast of Durango and Florida Mesa they have mapped a large area of Florida gravels, deposited shortly after the Cerro stage of glaciation, the earliest they have recognized in the San Juan Mountains. Near Ridgway, Richmond (1954) tentatively correlated deposits of the Cerro, Durango, and "Wisconsin" glacial stages with deposits of the Buffalo, Bull Lake, and Pinedale stadials, respectively, elsewhere. Both the latter stadials belong to the Wisconsin stage.

These correlations should be equally applicable to the Animas River valley.

No placer gold has been reported in the Florida gravels here or elsewhere in the San Juan Mountains. Presumably the gold veins of the principal mining districts had not yet been exposed to much erosion at the time of deposition of the Florida Gravels. The "Wisconsin"-Pinedale outwash is gold-bearing at Dallas and along the San Miguel River. Very probably the Durango-Bull Lake outwash is gold-bearing as well, but is so situated in the valleys that Pinedale and subsequent streams have removed or reworked the richer channels in it.

Consequently, it is probable that at Durango, immediately below the terminal moraines, gold-bearing gravels lie on bedrock, particularly beneath the "Wisconsin"-Pinedale outwash. However, the surface value of this ground is far greater than its possible placer value. It is also likely that upstream from the moraines, where the bedrock scouring power of the glaciers was very slight, the moraines lie upon placer gravels of good grade. In this area, besides the problem of quite high land-surface values, relatively barren moraine overlying these gravels may be very thick and it must contain many large boulders. Therefore it is unlikely this area will ever prove attractive for placer mining by any present mining method.

Baker's Bridge Area

Near Baker's Bridge, in portions of secs. 19 and 30, T. 37 N., R. 8 W., and secs. 24 and 25, T. 37 N., R. 9 W., placer prospecting supervised by Mr. H. W. C. Prommel (1938, written communications) disclosed a substantial body of high-grade placer gravel. The area is approximately 16 miles from Durango. U. S. Highway 550 crosses the west edge of the area and a good county road traverses it. Within the area the Animas River rises from 6,700 to 7,750 feet elevation. The highest gravels are at 7,000 feet. Within this area the Animas valley floor is a little more than 1/2 mile broad. It includes a number of terraces, whose surfaces are interrupted from place to place by rounded granite knobs. The terraces are covered with a light growth of pines. The climate is moderate, and the working season extends from March to December.

Apparently only prospecting and minor placering of the surface gravels has been done here. Prommel stated that an unsuccessful attempt was made years ago to divert the Animas River near Baker's Bridge and mine the gravels of the stream bed. A memorandum in the files of the Humphreys Gold Corporation states that two attempts to placer here in the late 1930's were unsuccessful. The nature or scale of these operations is not known to the present author.

A short distance downstream from Baker's Bridge the unconformable contact between the Precambrian basement rocks and the overlying Paleozoic sedimentary rocks plunges beneath the floor of the Animas River valley. Upstream from sec. 19, the Animas flows through a deep gorge cut in the Precambrian rocks, and below Baker's Bridge it flows in a broad valley which reflects the lesser resistance of the sedimentary rocks. North of sec. 19 the river flows southward, but in the NWN sec. 19 its course turns abruptly west-southwest for nearly 1/2 mile. In this section the river flows in an open basin nearly 1,000 feet wide. In the western part of sec. 19 the river turns southward and flows through a canyon cut 50 feet into the granite bedrock to Baker's Bridge, where it enters the upper end of its broad valley. Between Baker's Bridge and the mouth of the gorge several channels have been incised in the granite bedrock east of the present river channel. Prommel recognized a number of these abandoned channels, some of which can be seen at the surface and others which he found when sinking pits in the terrace gravels.

The highest of these channels trends nearly due south at the eastern edge of the placer area. He stated

> This old channel can be followed distinctly where it has cut a canyon into the granite basement rock, in places 30 ft. to 50 ft. deep. This oldest channel is fully 180 ft. above the water level in the present channel of the Animas River. . . . in its upstream part this oldest channel has been completely emptied of gravel by later erosion [but] here and there isolated patches of stream gravel remain on the hillside.

The other channels lie beneath the terrace gravels.

The gravels are found at two levels. The upper gravels are associated with the highest old channel already described and lie up to 180 feet above the level of the modern river. The lower gravels lie in the present valley floor; three terrace surfaces have been developed on this gravel. The highest of these terraces, which is about 60 feet above the river at its northern end near the mouth of the gorge and about 15 feet above it about 11/2 miles downstream, is the most extensive. The river's present flood plain is very narrow above Baker's Bridge but widens downstream.

There is little overburden upon the gravels. In one of the test pits 6 feet of loam, which proved to be gold-bearing, overlies the gravel. Elsewhere on the highest terrace the gravels are exposed at the surface. The upper and lower gravels are similar. They consist principally of well-rounded material. Prommel stated that 40 to 50 percent of the gravel is less than 1 inch in size; the remainder ranges up to boulders 4 to 6 feet in diameter; boulders 1 foot in diameter are common. Most of the rock types to be found in the watershed of the Animas River are represented in the coarse fraction. Precambrian rocks—granite, gneiss, and some schist—predominate, and fine-grained purple quartzite is common. The various volcanic rocks of the Silverton area are rare. Prommel reported that the material encountered in his prospect pits was well washed and loose, and all the pits had to be timbered. There is little or no clay in the gravels.

The material encountered in the test pits was not uniformly coarse. In several pits, at depths from 18 to 38 feet, a layer of fine sand and silt was encountered beneath the coarser material. In 2 pits which reached bedrock, 5 to 7 feet of red, clayey, fine gravel with some angular boulders was found immediately on bedrock and beneath the silt layer, but in other pits which reached bedrock this material was not found.

The granite bedrock surface beneath the gravels is very

irregular; Prommel estimates that gravels beneath the "highest terrace" may exceed 65 feet in thickness, yet bedrock projects above the terrace at a number of places. Depth to bedrock beneath the present flood plain is unknown, but near Baker's Bridge it is probably less than beneath the "high terrace" there.

Most of the gold recovered by Prommel in his testing was fine gold; however, he believed it could readily be recovered by sluicing and jigging methods. There were a few pieces of coarse gold, as well. Prommel states that 50-cent nuggets are reported to have been found in these gravels, but he found no such coarse gold. An average sample of the gold recovered from all the test pits was found to be 817 fine. Samples seen by the author included many thin flakes. The gold is of a number of colors: yellow, red-orange, and distinctly greenish; and some of the gold is rusty, although most is bright.

Testing showed the gold to be distributed throughout the gravels, but there is distinct concentration on bedrock. Gravel values found in the testing ranged from 1.59 to 121.59 cents per cubic yard. The values found in the pits which reached bedrock ranged from 2.9 to 37.0 cents per cubic yard.

An interesting feature of these test results is the high-grade gravels found on the bars and the banks of the river, especially in the basin above Baker's Bridge. These ranged from 47.56 to 121.59 cents per cubic yard. Presumably, all these samples were from gravels well above bedrock. Although concentrations of fine gold in the upper gravels of river bars is common, these are exceptionally high and do not seem to be limited to the upper surfaces of the bars or banks. It seems very probable that these gravels should be of good grade to bedrock, and the values there might well be phenomenal.

The fine size of the gold particles and the thinness of the larger flakes indicate that the gold has been transported a great distance. The variety of colors of gold shows it was derived from a number of sources, which are undoubtedly the gold deposits of the Silverton and Needle Mountains areas.

According to Atwood and Mather (1932, p. 70) the lateral margin of the "Wisconsin" glacier was at 8,700 feet elevation, and they show "Wisconsin" till ranging in elevation from 7,800 to 10,000 feet elevation a short distance upstream from Baker's Bridge, where the Animas River now flows at 6,800 feet. Thus the ice at the time of maximum "Wisconsin" advance was 1,000 or more feet thick. Beneath such a mass of ice the valley floor must have been scoured clean and abraded.

Upon retreat of the ice, the Animas Valley in the placer area was dammed with moraine or outwash material to or above 6,850 feet, the elevation of the highest gravels in the old eastern channel. This dam was higher on the west side of the canyon and forced the Animas to flow over the granite outcrops on the east side of the valley and to incise the high channel there. As the dam was removed the Animas developed progressively lower channels across the bedrock.

It is concluded that the dam was of till rather than outwash material. Had it been outwash, deposited on a sur face with gradients such as outwash plains elsewhere in the San Juan display, an outwash plain would have stretched downstream for many miles and terrace remnants of it would remain along the valley. There are no such remnants. Atwood and Mather have mapped only a few morainal remnants within 200 feet vertically of the floor of the Animas valley. It does not seem reasonable that ground moraine nearly 200 feet thick should have been so completely removed from the valley floor; consequently it is suggested that the morainal dam was a recessional moraine. Their map suggests such a moraine or series of moraines may have existed between the mouths of Carson and Coon Creeks. As no outwash surfaces developed downstream from it, it must have been formed during a short stillstand.

Within the narrow valley near Baker's Bridge this morainal material was almost completely reworked by the streams. The "red clayey gravel" found on bedrock in some of the pits may be a remnant of this till. Unfortunately Prommel's test results do not indicate whether the gold found in these pits was concentrated on the granite bedrock or on the top of the clay.

According to this interpretation these are alluvial deposits formed since mid-Pinedale times. The gold in them was derived in two ways: first, from the reworking and concentration of a large mass of morainal material which dammed the valley here and, second, from gold being transported by the Animas River since the retreat of the glaciers and deposited here where the gradient of the river diminishes. Consequently, the placer gravels should not extend much below the mouth of Coon Creek (the south lines of secs. 25 and 30), and their grade should diminish rapidly downstream from Baker's Bridge.

This is one of the very few placer deposits remaining in Colorado with substantial proven reserves of good grade. Prommel has estimated that there are 200 acres of workable gravel beneath the "high terrace" between the center of sec. 30 and Baker's Bridge. He estimates this ground to contain more than 15,000,000 cubic yards of gravel which should average more than 26 cents per cubic yard. Gravels beneath the present river flood plain and the lower terraces should be of comparable grade.

Ample water could probably be obtained from the Animas River to work the placers, and there is suitable ground downstream for settling ponds. The operation of the placer would present several problems, however. The area in the vicinity of Baker's Bridge is gradually being developed for mountain home and resort sites. A few of these are in the placer area; others are in the immediate vicinity. Thus some of the placer area has a high surface value, and were the placer operated it might well be considered a nuisance by the neighboring surface owners. To overcome objections to the nuisance of placer operation, the placered area's surface might have to be restored after mining. The gravels are deep, bedrock is irregular, and the channls in it lie principally below water level. The gold is fine, and may require a somewhat more elaborate plant than ordinarily employed to make a satisfactory gold recovery. Some of these difficulties might be overcome by mechanized operations of moderate scale, working the upper

parts of the low-level gravels along the river in selected tracts.

THE PLACERS OF SAN JUAN COUNTY

But little placering has ever been done in San Juan County, however the county is of some interest to the placer miner.

In 1860 a party of seven men from California Gulch, under the leadership of Charles Baker, found placer gold near the site of Eureka. Extravagant reports of their discoveries reached the settled areas of Colorado and New Mexico. In December of that year a party, which from time to time had 100 to 300 members, set out from Denver for Baker's placer. In April, 1861, after an arduous trip, this group, called the "Baker Party," reached the Animas River and contacted Baker. In May this group established a town called Animas City, near Baker's Bridge in La Plata County. After considerable unsuccessful prospecting for gold placers and difficulties with the Ute Indians the party left in the late summer. This part of the San Juans was not again entered by prospectors until 1869. A detailed account of the Baker expedition and the 1869 group is contained in the Rocky Mountain Weekly News (Nov. 14, 1877, p. 5, and Nov. 21, 1877, p. 1). The following description of Baker's placers is given

> [Baker's] diggings were nine miles up the river [from Baker's Park] where is now Eureka. They had cut out lumber with whip saws and made some sluices, but had collected very little gold. A thorough trial for weeks after proved that the diggings would not pay for working, the best returns never exceeding fifty cents per day to the man . . .

A later account of "The San Juan Mines" in the Denver Rocky Mountain News (Aug. 13, 1873, p. 2) states

> Some little placer mining is being done on the head of the Animas River, parties interested claim to be making fair wages. Light prospects can be raised on many of the tributaries of this stream; they would hardly justify white labor in working them. Evidence of their having been quite well prospected are found in the shape of broken sluice boxes, abandoned tools, and fair sized pits that have been cleaned to bed rock. It is probably the work of the "Baker" party in 1860 and '61. There seems to be an impression with many outside of the district, and in fact throughout the territory, that rich gold placers are now being worked here; several parties have arrived fully outfitted to work in placers. Discoveries are reported to have been made in the vicinity of the Taylor, Uncompaghre and San Juan rivers, but no gold has been shown to evidence the fact .. .

It is not surprising that extensive prospecting has disclosed no placer deposits of importance on the headwaters of the Animas River and its upper tributaries. These val leys formed the gathering area of the ice of the Animas glacier. This ice was tremendously deep and must have filled these valleys until late in the Wisconsin stage. The valley's walls show abundant evidence of the erosive power of these glaciers, which not only scoured the valley floors but also stripped the upland areas of weathered debris from which placer deposits could later be concentrated. Because of this, in spite of the abundant gold deposits of the area, post-glacial streams here have concentrated very little gold along their courses. Interestingly enough, however, panning the gravels of Mineral Creek has led, within the last five years, to the discovery of a free-gold-bearing outcrop in the valley of South Mineral Creek. (Mr. Warren Prosser, 1957, oral communication, Mr. Charles 0. Parker, 1959, oral communication.) The deposit is now under development.

A placer deposit has been formed along Cement Creek downstream from the site of the Gold King mill. Rather extensive sampling done here by Mr. H. W. C. Prommel and Mr. Charles F. Johnson conclusively indicates that the gold in the placer was derived from concentration by Cement Creek of the tailings discharged from the mill. Prommel (1940, written communication) reported

> [The Gold King mill] was built in 1899 and has been in operation at various times up to 1918. . . . During its time the mill has produced about $17,000,000 (at present gold price of $35 per ounce) in gold bullion and concentrates from the ores of the Gold King mine. The recovery of the mill is said never to have exceeded 60% of the value of the ore.

Except for the area immediately below the mill the gold is concentrated entirely along the modern channel and adjacent flood plain of Cement Creek which ranges from about 40 to 75 feet wide for more than 1 mile below the mill. In this section Cement Creek has a 6-percent gradient. The gold is concentrated in the loose surface gravels. Test pits up to 600 feet downstream from the mill site have shown high gold concentrations to depths of 6.5 to 7.0 feet, but the average depth to barren "cemented gravels" in Johnson's sampling for 1 mile below the county road bridge at Gladstone was about half of this.

The gold-bearing gravel is comparatively fine—Prommel found that the bank run material is about 1/2 each —1 in., 3/8 to 6 in., and + 6 in. It is free from clay and easily washed. This gold-bearing gravel rests on compacted gravel which is barren. Above creek level this gravel is locally cemented with iron oxides forming a tough conglomerate, but Prommel states that the cementation has not taken place beneath permanent water level.

The gold in the placer, as might be expected of material passed through a stamp mill, is in very small particles. Four fineness determinations have ranged from 925 to 950 fine.

The grade of the gravels is phenomenal. Halfway between the county road bridge at Gladstone and the Gold King Mill eight test pits sunk to the barren gravel layer showed the gravels to average 6.5 feet thick and to run $1.95 per cubic yard. Individual pit values ranged from

$0.49 to $4.07 per cubic yard; 29 shallower test pits showed values ranging from $0.01 to $4.54 per cubic yard. The results show that the gold is slightly concentrated in the deeper gravel. The value of the surface gravels, decreases rapidly downstream from the mill site. Johnson (1938, written communication) sampled the gravels for 1 mile downstream from the county road bridge in 33 pits. He was not able to sample the deepest parts of the channel because of water problems, but estimated the gravel thickness to average 3.5 feet. The average value of the gravel sampled was 83 cents per cubic yard. The extent of the placer gold downstream is unknown.

As has been stated this placer gold has clearly been derived from the Gold King mill, although perhaps some gold was contributed from other, earlier stamp mills at Gladstone. In any event the placers have been formed since the 1870's and probably largely since 1899. A number of factors have combined to permit the formation of the placer. An inefficient mill treated large quantities of good-grade free-gold ores and discharged its tailings into a creek which not only had a suitable gradient but in which the relation between stream flow and tailings size and discharge was such that the tailings were washed along the creek rather than permitted to accumulate near the mill. The concentration process in the creek was rather inefficient. The data given by Prommel concerning the mill suggest that it must have discharged some $11,000,000 worth of gold and other metals into Cement Creek. A large proportion of this amount must have been gold. In the area tested, Prommel's and Johnson's estimates of the placer gold in the Cement Creek gravels aggregate less than $75,000.

The placers present several unusual mining problems. The gravel reserves are small; therefore, small-scale methods must be used. The thinness of the gravels and their narrow channels require a highly mobile excavating and washing plant. The working season is short-the road may be closed as late as June and the season ends in early November. Also, in this narrow valley the danger of slides and floods is great. Because of these factors and certain land ownership problems, these gravels have not yet been mined.

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