UTAH GEOLOGICAL AND MINERALOGICAL SURVEY
affiliated with
THE COLLEGE OF MINES AND MINERAL INDUSTRIES
University of Utah, Salt Lake City, Utah

GOLD PLACERS IN UTAH

A COMPILATION

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UTAH GEOLOGICAL AND MINERALOGICAL SURVEY

103 Civil Engineering Building
University of Utah
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DIRECTORS:

William P. Hewitt, 1961-
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GOLD PLACERS IN UTAH

Compiled by the Utah Geological and Mineralogical Survey
from United States Geological Survey Bulletins and Professional Papers

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GOLD PLACERS IN UTAH

Introduction

Only a small amount of material has been published concerning placer mining in Utah, most of which is now out-of-print and available only in libraries. There are seven bulletins and professional papers that contain sections dealing with Utah placers. (These are listed below.) Only one publication, Utah Geological and Mineralogical Survey Bulletin 62, is still available.

Boutwell, J.M., 1905, Economic Geology of the Bingham mining district: U.S. Geol. Survey Prof. Paper 38.

Butler, B.S., et al, 1920, The ore deposits of Utah: U.S. Geol. Survey Prof. Paper 111.

Gehman, H.M., 1958, Notch Peak intrusive: Utah Geol. and Mineralog. Survey Bulletin 62.

Gregory, H.E. and Moore, R.C., 1931, The Kaiparowits region: U.S. Geol. Survey Prof. Paper 164.

Gregory, H.E., 1938, The San Juan country: U.S. Geol. Survey Prof. Paper 188.

Hill, J.M., 1913, Notes on the northern La Sal Mountains, Grand County, Utah: U.S. Geol. Survey Bulletin 530a.

Hunt, C.B., et al, 1953, Geology and geography of the Henry Mountains region, Utah: U.S. Geol. Survey Prof. Paper 228.

Most of these bulletins and professional papers discuss placer operations on the Green, Colorado, and San Juan Rivers, and adjacent areas around the Henry and La Sal Mountains. One professional paper, "Economic Geology of the Bingham Mining District", covers placer mining in the Bingham district. Except for photographs, charts and maps, those sections that describe Utah gold placers are herein reproduced in their entirety.

Commercial placer operations in Utah have been generally unsuccessful or discouraging. However, in many parts of Utah there are extensive areas of stream and terrace gravels that have not been thoroughly prospected for gold. Some are along stream courses draining major mining districts. Possible auriferous gravels exist in the vicinity of the Tintic, Marysvale-Tushar, San Francisco-Milford, Park City, and other mining districts. In many areas of Utah, lack of water imposes a serious handicap for the utilization of the more commonly accepted placer mining methods.

For information concerning placer mining equipment, laws, methods, and techniques, the reader is referred to the following publications:

Boericke, W.F., 1941, Prospecting and operating small gold placers: John Wiley and Sons.

California Div. of Mines and Geology, 1963, Basic placer mining: Mineral Information Service, v. 16, n. 12 (December).

Gardner, E.D., and Johnson, C.H., 1934, Placer mining in the western United States, I: U.S. Bureau of Mines Information Circ. 6786.

Gardner, E.D., and Johnson, C.H., 1934, Placer mining in the western United States, II: U.S. Bureau of Mines Information Circ. 6787.

Gardner, E.D., and Allsman, P.T., 1938, Power shovel and dragline placer mining: U.S. Bureau of Mines Information Circ. 7013.

Jackson, C.F., 1938, Small-scale placer mining methods: U.S. Bureau of Mines Technical Paper 591, with a section on Federal placer mining laws and regulations, by F.W. Johnson.

Other publications concerning placer mining in the western United States may be found in local libraries and bookstores.

Butler, B.S., 1920, The Ore Deposits of Utah: U.S. Geol. Survey Prof. Paper 111, p. 150-151.

CLASSIFICATION

The ore deposits of the State may be classified according to age, form, or genesis. For the purpose of comparison of the various deposits, which is one of the main objects of the general discussion, a genetic classification has numerous advantages and is used in this paper as the basis for the main divisions, further subdivision being made on the basis of the metal content. In the discussion of individual districts use is made of such other characteristic features as seem best to bring out the relations in the particular area.

The classification adopted is based on that proposed by Lindgren.1/

ORIGIN

Deposits Due To Mechanical Concentration

Gold placers

Gold placers within the State are neither numerous nor of great importance. The only ones that have contributed largely to the gold output are those of the Bingham district, though others have been worked in the La Sal Mountains, the Henry Mountains, near Marysvale, and on Colorado River and its tributaries, Green, Grand, and San Juan rivers. The total output probably has not exceeded $1,800,000 in value.

The deposits in the Bingham district are in the bench gravels of Bingham Canyon and its tributaries and in stream gravels that have been largely derived from the reworking of the bench deposits.

The occurrence of the gold is typical. In general, the richest deposits are near bedrock though some are in pay streaks higher in the gravels. The gold is rather coarse, especially near the heads of the canyons, and finer farther downstream. The canyons drain a mineralized area and there can be little doubt that the gold was freed and concentrated through the weathering and erosion of the neighboring rocks.

The deposits in the La Sal Mountains occur on a high bench or mesa that marks the level at which the mountain streams flowed out on a plain surrounding the mountains at an earlier period in the physiographic development of the region. Later an uplift of the region caused the streams to cut canyons in the mesas surrounding the mountains. The weathering of the material in these deposits has not been very complete and the short distance that the gold has been transported has not entirely freed it from gangue minerals, so that its recovery is difficult. The associated rocks and minerals indicate that the gold has been derived from the gold-copper veins of the La Sal Mountains.

The deposits of the Henry Mountains are apparently in general similar to those of the La Sal Mountains, though gold has been recovered from stream beds as well as from gravels on benches and mesas. As in the La Sal Mountains the gold has been derived from the neighboring gold-copper veins.

The deposits near Marysvale are at the base of the range on a bench that marks the level at which the streams once flowed. The principle deposits are near the mouth of Bullion Canyon, and there is little doubt that the gold was derived from gold-bearing veins cut by the stream flowing therein.

A little gold has been recovered from placers below the outcrop of the Annie Laurie vein in the Mount Baldy district. Gold is also reported in the gravels on the west side of the Tushar Range, but none has been produced.

Some of the gold-bearing districts, notably the Mercur and the Tintic, contain no placer deposits. In the Mercur, and possibly in the Tintic, this is attributable to the finely divided condition of the gold, which does not favor its concentration in placers.

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1. Lindgren, Waldemar, Mineral deposits, p. 188, New York, McGraw-Hill Book Co., 1913.

In the Tintic district the small amount of the deposits that have been removed by erosion may also be a factor.

Numerous river placers, both bench and stream, occur along Colorado River and its principal tributaries. The gold is very finely divided and shows little tendency to form rich pay streaks. A little platinum has been found with the gold. The deposits have been worked to some extent at numerous localities, but recovery of the fine gold has everywhere been difficult and the operations have not been very successful. Dredging has been tried on Green and Colorado rivers but has not proved successful.

The gold has possibly been derived from the sedimentary rocks of the region, which are known to contain the metal in small amounts, or from gold-bearing deposits near the headwaters of the streams. The bench placers were formed in the river channels during earlier stages in the physiographic development of the region, and modern stream placers are now being formed by a concentration of the gold brought into the rivers by the weathering and erosion of the rocks of the adjacent areas and of the earlier deposits.

The black sands that accompany the gold might be of commercial value under favorable conditions. These black sands are composed mainly of magnetite with lesser amounts of ilmenite and chromite and of heavy silicates, such as garnet and zircon. In some placers they are said to constitute 7 to 8 per cent of the gold-bearing material, and to contain, after amalgamation treatment, as much as $3 to $4 in gold to the ton, but they doubtless average much less. If such material could be shipped cheaply to the smelters, the value of its iron for fluxing might pay a large part of the cost, leaving the gold as a profit. Under present transportation conditions, however, the black sands probably have no value.

Butler, B.S., 1920, The Ore Deposits of Utah: U.S. Geol. Survey Prof. Paper 111, p. 630-632: Henry Mountain region (in part).

PLACER DEPOSITS

Placer gravels occur in the bed of Crescent Creek and on benches at higher levels. In 1914 the gravels in the bed of the creek were being sluiced and some dry washing was being done on the higher benches. The presence of gold-bearing gravels in this locality has been known for several years but they have yielded in all only a few hundred dollars in gold.

The gravel on the benches apparently accumulated from the material coming from the mountains before the present canyons were cut.

When the streams renewed their downcutting the bench gravels were in part reworked and formed the the channel gravels. Barite sand is abundant in the placer gravels and is believed to be derived from veins in the mountains at the head of Crescent Creek. The placer gravels, so far as known, are confined to Crescent Creek, near whose head the most important gold-bearing veins occur. This relation naturally leads to the belief that the gold of the placers was derived from the gold-bearing veins in the mountains.

Butler, B.S., 1920, The Ore Deposits of Utah: U.S. Geol. Survey Prof. Paper 111, p. 636-640: Paria region (in part).

GOLD DEPOSITS

Disseminated Deposits In Consolidated Sedimentary Rocks

Character of the sediments

Finely distributed gold is reported to occur in the sedimentary rocks over wide areas in the Plateau region in formations ranging from Permian to Jurassic and possibly in still younger rocks. Considerable money and time have been expended on this class of deposits, but there had been no known production. Nevertheless the occurrence is of much geologic interest.

The gold occurs in sediments ranging from moderately coarse sandstone to extremely fine clay. It is all very finely divided and, it is said, can not be collected by panning, a fire or amalgamation assay being necessary to determine the tenor of the rock.

An attempt to extract the gold on an industrial scale has been made at Paria, on Paria River, in Kane County, about 15 miles north of the Utah-Arizona boundary, and at Spencer Camp, on lower San Juan River.1/

Paria area

At Paria the gold is contained in part in an extremely fine clay of rather unusual character, which it was once thought might be treated by hydraulic methods. In the fall of 1911 considerable machinery for this purpose was freighted to the camp from Marysvale. So far, however, no method of profitable treatment has been devised.

Lawson discusses the gold deposits of the clay as follows:

1. Gregory, H.E., Geology of the Navajo country: U.S. Geol. Survey Prof. Paper 93, p. 40, 1917.

"The purpose of my examination of the sections at Paria was in part to determine the quantity of gold present. * * * The nearly horizontal attitude of the beds made it possible to sample the clays by vertical cuts on the face of the bare hill slopes. The cuts were made deep enough to get beneath the veneer of slacked pulp which covers the unweathered clay. A sample of from 25 to 30 pounds was taken every 10 feet measured vertically by leveling. The sampling was done on the assumption that whatever gold the clay might contain was all very fine, and practically uniformly disseminated in any given stratum. The lower part only of the formation was sampled, comprising from one-half to two-thirds its entire thickness. The samples, after careful crushing and quartering, were submitted to Mr. E.H. Simonds, of San Francisco, for assay. This he did with the utmost care, in quadruplicate for each sample.

"The first series of 18 samples was taken from a trench 174 feet high on the southwest side of the Paria River. Of these one was found to contain 10 cents per ton, nine 5 cents per ton, two $2\frac{1}{2}$ cents per ton, four contained a trace, and one contained none. These results were checked by taking an aggregate made up of equal weights of every one of the 18 samples. The assay of this aggregate sample was 5 cents per ton. It is worth noting that the sample which yielded 10 cents per ton was taken from the 15-foot bed of sandstone described as occurring in this section.

"The second series of 22 samples was taken from a trench 210 feet high on the northeast side of Paria. Of these, one yielded $12\frac{1}{2}$ cents per ton, two $7\frac{1}{2}$ cents, eight 5 cents, five $2\frac{1}{2}$ cents, five a trace, and one none. The average of the entire cut is about 4 cents per ton.

"The third series of samples was taken from a trench 240 feet high, beginning at the top of the Shinarump sandstone on the southwest margin of the formation. Of these one yielded $7\frac{1}{2}$ cents per ton, five yielded 5 cents, one $2\frac{1}{2}$ cents, sixteen a trace, and one none. Confirming these results, an aggregate of equal amounts of 13 samples from the first series of 18 yielded to assay by Mr. W.S. Morley 4 cents per ton. A similar aggregate of 16 samples from the second series yielded Mr. Morley 2 cents per ton, and an aggregate of 20 samples from the third series yielded also 2 cents per ton. Comparable results are obtained by amalgamation assays on large samples, using chemically pure mercury.

"To those unfamiliar with the hydraulic method of mining, the gold content of the Shinerump clays may appear to be so small as to be insignificant and unworthy of attention from a practical point of view. But under the most favorable conditions gravel containing 5 cents per yard, or $2\frac{1}{2}$ cents per ton, may be worked at a profit. The peculiar way in which the Shinarump clay slacks and runs with water suggests that it may be no less susceptible of hydraulicking than banks of gravel. This suggestion, coupled with an exaggerated notion of the amount of gold contained in the clays, has led to various attempts to exploit them for gold. The ground has been staked out in hundreds of placer claims and these have been offered for sale at large figures. The value of the ground is, however, very problematical. If a method of successful hydraulicking and recovery of the gold be developed, it will only be after a long period of experimentation, at large expense, at a few favored localities where a vast yardage of the clays is free from overburden and where abundant water may be had cheaply. No large expenditure for the method of winning the gold has been demonstrated.

"At present, the occurrence is interesting from a geological rather than a practical point of view. We may safely assume, on the basis of the sampling at Paria, that the Shinarump clay there contains on the average 5 cents per cubic yard. The same formation appears to be similarly auriferous at Lees Ferry and at San Juan, and it is probable from the extreme uniformity in the physical characteristics of the formation wherever it has been observed, that it is similarly auriferous throughout its extent."

The gold is not confined to the Shinarump clays in the Plateau province. A cut 140 feet high was made in the underlying Permian shales and 14 samples secured for assay. Of these, two yielded 10 cents in gold to the ton, five yielded 5 cents, six a trace, and one none. An aggregate of equal parts of these 14 samples yielded to an amalgamation assay 4 cents per ton. This result is probably representative of the gold content of the entire thickness of the Permian, since the conditions of sedimentation appear to have been very uniform throughout. The Permian beds do not, however, slack in water, and there is no prospect of their being susceptible of hydraulic mining. They are, however, quite as interesting as the Shinarump as an instance of the occurrence of gold in fine-grained sedimentary rocks.1/

San Juan River region

Gold was first reported from San Juan River by an Indian trader named Williams in the fall of 1892. Tales of fabulously rich deposits, both in river placers and in sandstones adjacent to the river, spread through the West, and several hundred men "stampeded" to the region in midwinter (1892-93) and suffered great hardships. The river and its tributaries were staked for many miles. After fighting and

1. Lawson, A.C., The gold of the Shinarump at Paria: Econ. Geology, vol. 8, p. 434-446, 1913.

bloodshed it was found that the gold was too fine to be worked on a small scale, and in a few months the region was practically abandoned.

The possibility of working the sandstone deposits has been investigated several times since. As late as 1910 machinery was taken into the region to crush and treat the rock but was never operated. The sandstone is said to contain 20 to 40 cents, or even more, per ton, in gold. The writer has not visited the district and has no reliable data pertaining to the gold content of the sandstones. It may be recalled, however, that apparently reliable reports stated that the deposits at Paria contained from 30 to 65 cents per yard in gold, and considerable money was spent on this assumption, whereas Lawson found that the average for those deposits is about 5 to 10 cents per cubic yard. It is possible that a more careful sampling will show a much lower content for the sandstones of San Juan River region than is commonly reported.

Other deposits

The Triassic sandstones in the vicinity of the Henry Mountains are said to carry gold, assay values exceeding $1 per ton being reported. However, anyone considering working these sandstones should remember the Paria experience, and make careful investigation before attempting to treat them. Assays of sandstone from the La Sal Mountain region show gold and silver present. Ash from the Pleasant Valley coal is said to have yielded 60 to 80 cents per ton in gold.[1]

It is evident, as pointed out by Lawson, that the gold is widely distributed, but thus far it has not been found possible to extract it profitably. The widespread occurrence of the gold is of interest, however, as indicating that the sediments were derived from a rather highly mineralized area, and further, as furnishing a possible source for the placer gold of Colorado, San Juan, Green, and Grand rivers.

Placer Deposits

General features

Placer gold has been known for a number of years in the rivers of eastern Utah, including the Colorado and its main tributaries, Grand, Green, and San Juan rivers. The deposits have been worked sporadically and numerous devices have been tried for saving the very fine gold.

The richer gravels have been worked in a small way, some probably at a profit, but attempts to operate on a large scale have not met with success. The total production has been only a few thousand dollars, of which Colorado and Green River deposits have furnished the greater part.

The gold-bearing gravels are found at intervals from Wyoming to Arizona. They are most extensive, however, on Colorado River, between the mouth of Fremont (Dirty Devil) River and the southern boundary of the State, on Green River, above the mouth of the Duchesne, and on San Juan River near Bluff. Few of the river placers were visited by the writer, and little concerning them is to be found in the literature.

Colorado River

Development

The most active operations on Colorado River have been carried on from about the mouth of Crescent Creek southward to a few miles below the mouth of San Juan River. Attempts at dredging and other placer operations were carried on farther south. The region has little rainfall and the tributary streams normally carry little water, and many of them are dry for a large part of the year, preventing large hydraulic or sluicing operations with water from a source above the river. Pumping from Colorado River for sluicing is expensive. A water wheel was tried at the Good Hope bar and was later set up at the Gold Coin placer, but was not notably successful. Dredges were used a short distance above the mouth of Pine Alcove Creek and farther south toward Lees Ferry, but neither was successful. Moreover, the very fine division and flaky character of the gold make it hard to save, and the percentage recovered by the methods so far employed is said to be very low. In view of these difficulties and the remoteness of the region, and the consequent high cost of supplies, it is not surprising that the efforts to work the placers have not met with marked success.

Occurrence

Gold is present in the river bed, in bars a few feet above the river, and in benches many feet higher. At the Gold Coin placer, according to Frank Bennett, the upper bench is 197 feet and the lower bench 65 feet above low-water mark. Other benches, said to be gold bearing, are estimated to be 1,000 feet above the river. These benches are remnants of old canyon bottoms in which lower channels have been progressively cut. The bench gravels examined are rather fine, few of the pebbles measuring more than 6 inches, and probably 50 per cent being less than 1 inch.

On some of the river bars coarser material was present and the relative proportion of coarse material

1. Jenney, W.P., The chemistry of ore deposits: Am. Inst. Min. Eng. Trans., Vol. 33, p. 461, 1902.

was somewhat greater than on the benches. The fine material consists mainly of quartz sand but contains a large amount of heavy sands. The heavy sand consists mostly of magnetite, which can be readily removed by an ordinary hand magnet. A considerable portion of the remainder, consisting largely of hematite and ilmenite, can be removed with an electromagnet. The remainder is principally garnet, a black mineral that is probably chromite, zircon, and small amounts of rutile. Pebbles of hematite, the largest an inch in diameter, were noted, especially on the Gold Coin claim.

Many of the mineral grains composing the heavy sands are well rounded. Others, notably those of zircon and chromite, show nearly perfect crystal outlines. The heavy minerals are abundant in the gravels. Mr. Bennett states that the gravels of the Gold Coin placer contain as high as 6 per cent of "black sand," and other deposits probably contain about the same proportion.

The gold is in small flakes; the largest seen (in a sample panned from the Gold Coin placer) was 0.36 millimeter long and 0.26 millimeter broad. The average dimensions, however, are much less, the greatest diameter not greatly exceeding 0.10 millimeter. Flakes with a diameter of 0.05 millimeter are not uncommon.

Most of the gold from the Gold Coin placer is very clean and has the color of very pure gold. Some flakes, however, are yellowish green and are evidently not so pure. The gold is about 0.960 fine, but it is said to vary somewhat on different bars. The records of output from several bars show about 12 parts of gold to 1 part of silver. Three small colors of a gray metallic material, found in a pan from the Gold Coin placer, show the same rounding and pitting as the gold colors, and are believed to be platinum, which is known to be present in the deposits.

The gold content of the gravels is said to be rather uniformly distributed vertically instead of being concentrated on bedrock. The richest ground is said to contain considerable clayey material. The gold gravels are commonly covered by sand, in places several feet thick, that has been derived from the adjacent cliffs. Gravels at the upstream end of bars are said to contain more gold than those lower down; and the high benches are said to be commonly richer than the lower ones; but there are exceptions to both these rules.

The gold content of the gravels, of course, varies from place to place and to obtain an average would require very extensive sampling. Some of the results of operations are available, but it is reasonable to suppose that only the richer gravels were treated. Mr. Bennett states that about 1,000 yards of gravel from the upper bar of the Gold Coin claim yielded gold to the value of $730, or about 73 cents per yard. Gravels from a bar near the mouth of Red Creek are said to have yielded from 70 cents to more than $1 per yard. The "black sands" are said to contain considerable gold that is not recovered.

Very few data are available as to the platinum content of the gravels. A sample of "black sand" examined by D.T. Day and R.H. Richards[1] yielded 6.36 ounces gold and 0.15 ounce platinum per ton, and some high-grade gold concentrates are said to have assayed 1 part of platinum to 9 parts of gold.

Bert Seaboldt has kindly furnished estimates made by several men who have examined the gravel bars along the river. These estimates are based mainly on the results of panning and show a variation from 25 cents per cubic yard to double or triple that amount. The writer has heard other estimates as low as 5 cents per yard for the general run of the river sands. It is probably needless to say that great caution and skill are required in estimating the gold content of the gravels, and one accustomed to coarse gold is likely to be misled by the very fine and "flaky" gold of Colorado River.

San Juan River

The placer deposits of San Juan River were not examined by the writer but have been described by Gregory,[2] who states that reports of rich deposits of gold in gravel bars and terraces of the San Juan, below the mouth of Montezuma Creek, caused the "Bluff excitement" of 1892, when 1,200 people rushed to the river and went away empty handed.

Several plants have been installed along the river, notably that of the Oregon Gold Mining Co., near the mouth of Montezuma Creek; at Zana Camp, 3 miles below the mouth of Nakai Canyon and about 20 miles above the junction of the San Juan and the Colorado; at Spencer Camp, in the Great Bend in the San Juan 6 miles below Zana Camp; and 4 miles below Nakai Canyon. Minor operations have been carried on at other localities.

The output from these operations has been small, and the larger undertakings, at least, have been failures. Gregory says: "That gold is widely distributed in the San Juan Valley is indicated by the fact that nearly every pan from the bars shows a color." The metal, however, is in excessively fine flakes. The cost of transportation is too great to justify operations without a yield larger than has been reported.

1. U.S. Geol. Survey Bull. 285, p. 159, 1905.
2. Gregory, H.E., Geology of the Navajo country: U.S. Geol. Survey Prof. Paper 93, p. 139, 1917.

Green River

Gold has been found and some prospecting done on Green River at numerous points from the Wyoming line southward. Gravels in Browns Park are said to contain gold, and some prospecting has been done, though there has been little production. Near Jensen attempts have been made to recover the gold by both dredging and sluicing, but neither method has been very successful in recovering the fine gold. Considerable prospecting has been done in the vicinity of Jensen, where large bodies of gravel are reported to contain gold in small amount. According to Newton Stewart, of Jensen, the gravels capping the mesas bordering Green River in that vicinity also contain gold in small amount.

At the Horseshoe Bend of Green River, about 15 miles a little west of south from Vernal, considerable placer mining has been done. This was the only locality where operations were being carried on at the time of the writer's visit, and circumstances permitted only a very hasty examination.

The gravels are on the inner side of the great oxbow curve made by the river. Where they occur, near the "top" of the bow, the river is cutting against its outer bank and has gradually receded from its inner bank. The gold-bearing gravels, which rise several feet above high-water mark, have been prospected along the river front for upward of a mile and are said to extend a quarter of a mile back from the river, though sufficient prospecting has not been done to outline their areas.

The pay gravel is said to rest upon clay, which is underlain by the decomposed sandstone of the region. The deposits are covered by sand that has drifted over them, in places to a thickness of 5 feet or more. The gravel contains many pebbles 2 to 4 inches in diameter or even larger but few boulders that exceed a foot in diameter. The gold is reported to be rather uniformly distributed vertically; at least it shows no marked tendency to concentrate at the base. There are evidently rich streaks horizontally and the same is probably true vertically.

The mineralogy of the fine material is similar to that of Colorado River. Magnetite is abundant, as are also garnet, hematite, ilmenite, chromite, and zircon. The gold is almost identical in appearance with that of Colorado River in color, size, and shape, except that the sample examined contained fewer of the greenish-yellow "colors". Two flakes of a gray metallic mineral collected in a pan are believed to be platinum.

The gravels vary in gold content from place to place, and it is difficult to determine their average tenor. Some of the gravel worked is said to have yielded $1 per yard. In these operations, however, the better ground was selected, and it is safe to say that in any large operations the average would be very much lower.

The only water supply is Green River and in working the ground it is necessary to elevate both the gravel and the water.

As in other places in eastern Utah difficulty has been experienced in recovering the fine gold. In the fall of 1913 the Fine Gold Placer Mining Co. has nearly completed a plant designed especially for recovering the fine gold, but to the present time (1917) it has made no important production.

Grand River

A small amount of placer gold has been recovered from the bars of Grand River. The writer did not see these deposits, but they are said to be similar to those of Green and Colorado Rivers.

The source of the gold in the placers has never been definitely ascertained and has been much disputed.

It is, of course, recognized that the gold-bearing veins of the La Sal, Abajo, Henry, and possibly Uinta mountains may have and propably did furnish a portion of the gold, though the gold of the Henry Mountains at least is said to differ considerably from the river gold. Moreover, so far as known at present, the veins in these mountains do not seem adequate to account for the gold along the rivers.

It seems to be the prevailing opinion among men who have worked the river deposits that the gold in the sedimentary rocks has been concentrated to form the auriferous gravels of the rivers.

Schrader[1] has described very similar deposits from Wind and Big Horn Rivers, Wyo., and considers their most probable source to be the lodes in the pre-Cambrian rocks. Green River heads in essentially the same region, and it is entirely probable that at least part of its gold has been derived from a similar source and has been concentrated by repeated reworkings. In like manner it is possible that the gold of the San Juan placers was derived from the lode deposits near the headwaters of that stream.

Boutwell, J. M., 1905, Bingham mining district, Utah: U.S. Geol. Survey Prof. Paper 38, Pt. 2, p. 331-360.

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1. Schrader, F.C., Gold placers of Wind and Big Horn rivers, Wyo.: U.S. Geol. Survey Bull. 580, p. 127-145, 1914.

PLACERS

Introduction

Bingham is the only locality in the State where placer mining has been successfully prosecuted.1/ It reached its greatest development during the years 1868-1872, and since then has steadily waned until at present only a few scattered creek deposits are operated. The deposits which are known to carry gold have been practically worked out with the exception of an extensive body of gold-bearing gravels that cover the bottom of lower Bingham Canyon to a considerable depth.

Auriferous gravels occur on the walls and bottoms of Bingham Canyon and its tributaries through a vertical range of several hundred feet, in bench, rim, and creek deposits. The bench deposits have been opened in middle Bingham Canyon on Argonaut, Dixon, Cherikino, and upper Clays ground: in Carr Fork at the Gardella pit: and in lower Bingham Canyon on the St. Louis, Lashbrook, and Schenk ground. Rim deposits were best developed in lower Bingham Canyon, where they have been opened by the Old Channel, Clays, and Mayberry workings. Shallow creek deposits have been worked at the Castro placer, in Bear Gulch; at the junction of Bingham Canyon and Carr Fork, and at other scattered localities. Deep creek gravels have been worked on West Mountain placer and Bingham placer ground in lower Bingham Canyon. Some of these deposits may be correlated in distinct channels. They indicate deposition at successively later and later periods during a general cutting of the valley down to lower and lower levels through five distinct stages of dissection.

Most of the gold has been derived from croppings of ore-bearing limestone; some has undoubtedly come from auriferous copper-bearing monzonite and croppings of veins and lodes, and some possibly from quartzite. Far the greater portion lies in the lowest 5 to 6 feet of uncemented gravel immediately above bed rock, though a little flour gold has been found in a few upper leads. The pay gravel was worked by tunnels in bed rock by lateral drifts from the bottom of shafts to bed rock, and in a few places by hydraulicking. The gold was usually recovered by ordinary sluicing. It is medium coarse, well waterworn, and battered. Values were variable, averaging 6 to 10 cents per yard in some bench deposits, over $2 a day in some rim deposits, over $2.75 in the Mayberry rim deposits, and about 10 cents a pan in some of the deep creek gravels. The fineness is reported to be between 0.850 and 0.950. The total known output amounts to about $1,500,000.

1. Tenth Census, vol. 13, p. 419.

History and Development of Placer Industry in Bingham

Discovery: The date of the discovery of placer gold in Bingham has been differently reported. One author states that placers were discovered in 1864.1/ Some pioneers maintain that gold was first discovered in the gravels of this canyon in the fall of 1866,2/ and was actively exploited by Peter Clays and G.W. Crowley3/ in the spring of 1867. Others hold that "free gold was first discovered in Bingham in 1864 by a party of old Californians, who, returning from Montana to pass the winter in Salt Lake City, prospected the canyon in the early part of that year. It was not, however, until the spring of 1865 that much work was done in prospecting for gold in the gravels."4/ Placer gold was not, however, the scent which led to the development of the camp, as has been the case with so many other camps of the West, for carbonates and sulphides of lead and copper had been discovered about two years before (see p. 81). The first successful operation upon high-level gravels was carried on in 1868, at a point about 1,000 feet above Myers' Hotel.

Early activity: The discovery that the Bingham gravels carried gold in pay quantities aroused great enthusiasm, and prospecting was thereupon actively taken up. The results were satisfactory beyond expectation, for it appears that by 1870, despite the powerful opposition of Brigham Young, a million dollars in stream gold has been recovered from the gravels in this district. In fact, this early period, from 1868 to 1872 proved to be that of maximum activity in gravel mining.

Present condition: Since that time, so far as may be learned from incomplete records, except during a slight revival in 1881, the placer output has steadily declined. Some gravel mining has been intermittently carried on. As late as 1898 the Argonaut was hydraulicked. In December, 1902, Bartholomeo Gardella, a veteran gravel miner, was working the Dixon bar on its southern portion in the north slope of Dixon Gulch. And in recent years some sluicing has been conducted in Bear Gulch. The latest extensive operations in gravel mining, and perhaps the most expensive single piece of work ever undertaken in this line in the State, was the exploration of West Mountain ground toward the close of the nineties. Regarding this work, which is described in some detail in the general consideration of the

1. Huntley, D.B., Tenth Census, vol. 13, p. 419.
2. Personal communication from Daniel Clays.
3. Personal communication from Isodore Morris, one of the original locators of Old Jordan claim, the oldest in the State.
4. Murray, J.R., Mineral Resources of the Territory of Utah, 1872, p. 5.

property, it is sufficient in this connection to state that it was eventually abandoned without having added significantly to the output. Recently the water-filled shaft and connected workings of this company have been secured by mill operators for the purpose of supplying water for use in wet concentration. Placers in Bingham have now ceased to be an important source of ore.

Character of gold: The detrital gold obtained from Bingham gravels is coarse, ranging from one-half an ounce downward. It is reported to have shown typical facies, being pounded and flattened into flakes and scales which show puncturing and indenting by gravels. Some valuable nuggets have been found.1/

The fineness of Bingham placer gold has been reported by two authors, and considerable difference appears. Egleston gives the pay contents of Utah (Bingham) gravel as follows: fine gold, 967.5; fine silver, 132.5 (estimated); base metal, 4.4; total crude metal, 1,104.4.2/ Huntley states that the fineness averages about 0.852 gold and 0.140 silver.3/

Occurrence of pay: The general occurrence, so far as can be judged from information obtained from various sources, is like that characteristic of placer gold in old stream beds in various parts of the world. That is, pay occurs highest over bed rock or in the case of upper leads, over a relatively dense member, and best in the main channel, thinning outward toward the rims. This seems to have been found true in the gravel of various channels, whether high-lying patches, intermediate channels, or deep-lying gravels.

In these gravels the values have been found to lie at two general horizons, namely, in upper leads and immediately overlying bed rock. (Pl. XLVI.) Thus, in the so-called channel deposits, low values averaging $1 to $2 per day were found in a "gray wash" 8 to 10 feet in thickness, which lies 15 to 18 feet above bed rock upon 8 to 12 feet of waste, including poorly sorted soil, rock, and vegetable debris. But the principal source of pay was the "red gravel" which immediately overlies bed rock to a thickness ranging from 3 to 8 feet. Similarly, in the gravels as a whole, including this channel and all others thus far discovered in this locality, the bulk of the gold has been taken from the portions immediately overlying bed rock.

The broad features of occurrence are illustrated by the following examples: In the exceptionally rich stretch adjacent to Damphool gulch, opened by the Clays Brothers, pay was taken from the lowest 5 or 6 feet of gravel and the highest values from the lowest portion. Although gold is said to have been most abundant in the high-lying remnants, worked at various points along the canyon wall, it has also been found to occur at higher levels, in that portion of the gravel which immediately overlies bed rock. Thus, in the ground explored by the Bingham Placer Company, in lower Bingham Canyon, some pay, composed chiefly of flaky gold, with some magnetic (?) iron, lay upon a firm floor of "cement" gravel, at a depth of 115 feet beneath the present stream level and at an elevation of at least 135 feet above bed rock. This was probably one of the best-defined upper leads developed in the history of placer mining in Bingham. Another instance is furnished by recent sampling of the face of gravels exposed in the Argonaut cut. From this it appears that the lowest 30 feet of gravel carries low values throughout, although the lowest 5 feet yielded considerably higher values.

The occurrence in narrow channels on the rims of major channels is admirably illustrated by the rim benches on the Mayberry and the Clays ground. Thus the Mayberry bar was a deposit of pay gravel filling an early high channel 75 feet below the present surface. The width developed between the rims is about 50 feet, and the length from a point where it leaves the present rock wall to that where it reenters the main channel is about 150 feet. Extensive exploration of the Clays bar adjacent to Damphool Gulch proved that the benches on which pay occurs there were remnants of channels cut in bed rock at three distinct levels during the general epoch of degradation. The upper bench lay 30 feet below the present level of the valley bottom, and was 60 feet in width. This fell off to a bench 20 feet wide at a depth of 20 feet below (250 feet below the surface), and that gave way to a third and probably later narrow channel 15 feet lower and 30 to 50 feet wide. Gold occurred in the gravel upon each of these benches, but the highest values occurred on the highest bench.

As regards the distribution of gold longitudinally along the course of the streams, there appears to have been some localization of values in that direction also. Thus the occurrence of the richest stretches appears to have been in general in the upper or headward portion of stream deposits. In certain instances, as in upper Bingham Canyon and Carr Fork, the position of these richer bars was clearly determined by the position of the source of their gold, for in these localities pay occurred a short distance downstream from the points where the stream crossed ore-bearing limestones. The occurrence of nuggets in the ground worked by the Clays Brothers,

1. See values, p. 11.
2. Egleston, Thomas, Metallurgy of silver, gold, and mercury in the U.S., 1890, vol. 2, p. 261.
3. Huntley, D.B., Tenth Census, vol. 13, p. 419.

near Damphool Gulch, however, is not so readily understood, for gold-bearing members are not known to occur in that immediate vicinity. Its deposition in its present position may have been due to repeated reworking of gravels far upstream, or it may be ascribed to unusual flow of water after extremely heavy spring storms. It is, of course, possible that it was derived from an adjacent gold-bearing ore body which is still unknown. In a broad way, just as the size of gold particles is found to decrease from their parent ledge downstream, so it appears to grow finer from the upper to the lower portion of the Bingham Canyon.

The nature of the association of gold with its inclosing gravel is in general that which is characteristic of unconsolidated materials. The gravel which was mined from the surface of bed rock at the extreme lower portion of the spur between Bingham Canyon and Carr Fork, however, unlike the bulk of Bingham gravels, is reported to have been cemented, and to have required special treatment before the gold contents could be extracted.

Exploitation: The method of opening the pay areas and of extracting and removing the gold varies according to the location of the individual occurrences. Some deposits were hydraulicked, others were reached through shafts and lateral drifts off from their bottoms, a very few were so exposed as to permit working immediately on surface, and a number were operated through bed-rock tunnels. Thus, the Gardella and Argonaut were hydraulicked, the former in 1872 to a considerable depth and over a circular area, and the latter in a cut in gravels 200 feet long, 50 feet wide, and 50 feet high. The Argonaut hydraulicking was conducted under a head pressure of 100 feet, through a pipe 10 inches in diameter and three twenty-seconds inch in thickness,[1] which carried from 300 to 400 miner's inches of water and threw a stream 80 feet in length from a 3-inch nozzle. In early times a part of this ground is reported to have been drifted.[2]

In exploiting the deposits at the mouth of Damphool Gulch the Clays Brothers sunk round shafts to bed rock and stoped out the lowest 5 or 6 feet of gravel for a distance of from 6 to 20 feet from the bottom of a shaft. Two days usually sufficed for sinking one of these shafts. The method was safe and cheap, because drifting was not carried far from the bottom of the shaft. The situation of the upper Clays bar in Bingham Canyon, above the mouth of Carr Fork, and of Dixon bar, permitted drifting in pay along bed rock from the surface upstream. In a similar way, the bottom gravels in West Mountain ground are said to have been opened by a bed-rock drift off from the base of the drainage shaft along the channel. In upper Bingham and Bear gulches the pay portion is exposed along its source directly today, so as to allow open-cut working.

The pay gravel was removed in various ways. In hydraulicking the washings were, of course, led through sluices. In drift mining, the usual method - crosscutting and stopping - was followed. In the Clays lower workings the gravel was hoisted in rawhide buckets by windlass.

As to the early methods of saving the gold very little information could be obtained. Evidently they were very primitive. It is reported that in 1874 goldbearing gravel was drifted out and "washed in sluices on the surface".[1]

At present in Bear Gulch water is ponded and led through a short flume or sluiceway over the gravels and the gold is caught by California riffles. Sluices and riffles were undoubtedly utilized in saving the gold from the hydraulicked gravels, and a similar method seems to have been followed at the West Mountain placer.

The problem of suitable water supply has ever been a serious one in working the auriferous gravels of Bingham. The usual scarcity of water for washing has been experienced about the heads of canyons, while the gravels which occupy the deepest channel in lower Bingham Canyon contain such an abundant supply of water as to interfere with underground work.

It has been said that from the earliest days to the present washing has been hampered by an insufficiency of stream water. In 1870 it was stated that "owing to the scarcity of water, it (placer mining) could not be successfully followed except in the early part of the season, when the melting snow furnished plenty of water."[1] At the present day the preparations for working the gravels in Bear Gulch are timed so that the spring waters may be utilized. Although it may be that insufficient water supply might render profitable washing at the upper portions of the canyon and its forks uncertain, utilization of the present supply could be far more economically conserved. Nor should it be felt that Bingham is less fortunate than many other placer localities in this respect. From replies to queries sent out by mining specialists engaged in the collection of data for the Tenth Census as to source of water utilized for placer mining, it appears that 82.93 per cent of the parties gave snow as the original source of their supply, 15.45 per cent rain, and 1.62 per cent both snow and rain. At Bingham there are heavy

1. Egleston, Thomas, Metallurgy of silver, gold, and mercury in the U.S., 1890, vol. 2, p. 176.
2. Tenth Census, vol. 13, p. 196.

1. Huntley, D.B., Tenth Census, vol. 13, p. 420.

snows which last from early in the fall to late in the spring, and it would seem entirely feasible to collect the snow water in a cheap but adequate reservoir and to economize its use by sluicing.

On the other hand, an obstacle to the successful exploitation of the deep-lying gravels, which has long proved insurmountable, has been the excess of water. Accordingly, when the West Mountain Placer Company was organized in 1898 this difficulty was considered and development was undertaken with this in mind. It was proposed to extend a system of drifts and shafts across the channel from rim to rim on the upstream side of the workable ground, to collect therein the subsurface flow of water, and to pump it thence to the surface, thus leaving the region below accessible for thorough exploitation. That this method has not succeeded is said to be due to insufficient pumping capacity. The present superintendent states, however, that the capacity is sufficient to manage the main flow from upstream and that the uncontrolled flow enters below the drainage cross section by seepage downward from the overlying creek, from side streams, or from bed rock. It was afterwards proposed to govern this flow, which amounts to 100 gallons per minute, by operating an electric pump of 900 gallons power at a lower shaft. It seems probable that the entire drainage problem might have been solved more satisfactorily by leading the excess water out through a long drainage tunnel driven from below on bed rock.

Values: The values in Bingham gravels, so far as may be judged from the meager data at hand, have not been high. The lowest 30 feet in the Argonaut cut are reported to have averaged 6 cents per cubic yard, and the lowest 5 feet to have averaged 18 cents. The Mayberry rim channel is said to have averaged $2.93 a pan. The lower rim channels worked by the Clays in the lower canyon are stated by Mr. Clays to have run fairly high - 6 pans it is said averaged $5, and in places the gravel ran $18 to $20 a yard. The gravel lying deep beneath the present stream level, upon the lowest bed rock, was found in the West Mountain workings to average 8 to 10 cents a pan. In one instance it gave $1.56 from a single pan; and yielded several nuggets valued at from 40 to 50 cents, and one amounting to $1.66. The largest nugget known to have been taken from Bingham gravels is that found in August, 1876, near Damphool Gulch, by Mr. Daniel Clays, which is reported to have weighed 7 ounces and 15 pennyweights and to have been valued at $128. It has ranked since that date (so far as known without contradiction) as the largest single piece of gold ever found in Utah.

Output: The total value of gold produced by the Bingham placers can not be stated with exactness. Precise returns were made for only a few years; general averages were stated for others, and no figures whatever were furnished for the greater portion of the period of operation. Thus many small amounts which have been taken out intermittently for the last nine years, but apparently not reported, must be omitted. The Argonaut is reported to have produced $100,000, and the Clays diggings in the lower canyon, $175,000. A single clean-up at the West Mountain is said to have yielded $500. The following summary is based almost entirely upon the Mint reports, the best available data, but the resulting total is necessarily below rather than above the true total:

Known Output of Placer Gold from Bingham, Utah

1869-70	1,000,000-600,000
1871	100,000
1872	100,000
1873 (From Bear Gulch)	27,000
1874	85,000
1875	30,000
1880	1/20,000
1881	116,300
1890	10,000
1891	2,600
1892	6,000
Total	1,496,900 or 1,096,900

Future of the industry: The only considerable body of gold-bearing gravels in Bingham remaining unworked is that which fills the bottom of lower Bingham Canyon. Judging from all that can be ascertained regarding the facts brought out by its exploration and from the opinions of intelligent, trustworthy miners of extended local experience, detrital gold occurs there in paying quantities.

In placer gold deposits, as in case of ore bodies in place, the most inaccessible, which are often those at depths, await the exhaustion of superficial and more accessible occurrences. Success in these gives confidence and draws capital to wider undertakings. Superficial pay gravels appear to have been worked out. Numerous isolated remnants of high-level channels have been explored from Upper Bingham to the Lead Mill station. Some of these paid well while they lasted; many proved unprofitable. The detrital gold which lies deep beneath the present stream upon bed rock in the lower canyon awaits practical exploitation on a large scale. Upon the outcome of such operations on these deposits rests the future of placer mining in Bingham.

History of Auriferous Gravels

In the following section some of the more important factors that were apparently involved in the deposition of gold-bearing gravels at Bingham are briefly considered. These include the development of the present topography, the distribution and sources of the gravels and of their included pay, the deposition

1. Tenth Census, vol. 13, p. 318.

of the placers, the correlation of the placers, and a resumé of the history of the placers.

Present topography: The Oquirrh Range rises steeply from elevations on the surrounding desert of about 5,000 feet to elevations on the main divide of over 9,000 feet at the northern and over 10,000 feet at the southern portion of the range. Its actual lower slopes are buried beneath many hundred feet of relatively recent unconsolidated deposits, so that it is only the upper portion of the entire mountains which appears above this blanket of waste and is today considered the range. The eastern slope of the actual range probably descends beneath Salt Lake Valley on roughly the same general inclination as is exposed in its upper portion, passing deeper and deeper until, well toward the eastern side of the area, it meets the much steeper western slope of the Wasatch. The variations in the local base-level determined by this heavy blanket of waste, and earlier by the inland sea which occupied this area, have played an important part in the development of the present topography of the range. A thorough consideration of these problems requires more complete evidence than is now at hand and would lead far away from the more directly economic purpose of the present volume. The purely physiographic questions involved, including the main conclusions regarding this area, those regarding the Wasatch, and the correlation of the two, may be presented in a separate paper.

The visible slopes of the range are cut by numerous canyons trending roughly transverse (east-west) to the range. Bingham Canyon, the master stream of the region under special consideration, maintains a generally northeast course from the main divide to Salt Lake Valley, cutting obliquely across the eastern portion of the range. Short, deep, narrow, and steep-sided canyons head on the main divide and drain into Bingham Canyon from the west. The bottoms of the master canyons rise with comparatively gentle, regular, slopes, from the deserts far into the range, nearly to the main divide. Thus they have reached that state of balance between erosion and deposition known as graded, when, by duly wearing their slopes down or building them up with respect to the base-level of their basin, their capacity to do work becomes equal to the quantity of work they have to do.1/ Their headward portions, however, rise from the partially graded stretch to the crest of the main divide by exceedingly steep slopes. The side canyons draining into these masters are, like them, narrow and steep, but differ in having less graded, more steeply sloping bottoms. Thus the main streams have cut deeply far toward their heads; the chief laterals have done the same to a less extent, but the numerous side gullies rise abruptly.

1. Davis, W.M., Jour. Geol., vol. 10, p. 86,87.

As a whole the master streams are fairly graded, and the principal side streams are partially graded in their lower and upper courses, and their side gullies are not graded. Thus, while all the canyons are narrow, the masters exhibit very narrow flat bottoms which extend short distances up the larger tributaries.

The general eastern and western slopes of the range, the major divides between master streams, and the minor divides exhibit definite systematic modifications in form. In general the profiles of divides between streams draining eastward show a generally even, gradual, decline to the Jordon Valley, with accented departures at top and bottom. Thus above this prevailing slope rise the peaks along the main divide; below it descends the sudden pitch-off eastward to the desert. In the region about Bingham Canyon the land form appears to comprise five elements. The prevailing slope is a moderately inclined, partially graded surface, above which rise precipitous ledgy peaks on the main divide, and below which abruptly descend the steeper slopes of the present canyon. Farther downward these slopes give way to flat valley bottoms, beneath which narrow steep-sided trenches have been cut. These several elements appear in fig. 9, which was prepared from an exact tracing from a photograph of the essential topographic features. In brief, the present topography, comprising several types of form, is composite. The production of this composite topography as a factor which influenced the deposition of auriferous gravels is briefly described under the heading "Stages of erosion," page 14.

Distribution of gravels: Stream gravels occur in Bingham Canyon and adjoining canyons in two forms, (1) as channel fillings covering the main bed rock bottoms, under present streams, creek gravels; and (2) as deposits on earlier stream beds now left as isolated remnants upon canyon walls above present streams, bench gravels.

The creek gravels include those lying in the immediate bed of the present creek (creek gravels proper), those lying on the rock walls (rim gravels), and those lying below the present creek level immediately upon the lowest bed rock (deep creek gravels).

The creek gravels cover the bed of Bingham Canyon from the Jordan Desert well toward the head of the main canyon, and extend up Bear Gulch almost to its head, as well as up the other main forks of the canyon. Although interrupted locally by bed rock, they are practically continuous along these stretches. Their thickness decreases upstream. Thus near the mouth of the canyon, on the Bingham ground, a shaft that is reported to be down 250 feet has not reached bed rock. Farther upstream, at West Mountain shaft, the thickness of the gravels is about 150

feet; still farther above, at the mouth of Carr Fork, the thickness, it is understood, is about 60 feet; in upper Bear Gulch the thickness is about 15 to 20 feet, and thence headward, as well as in upper Bingham Canyon and Carr Fork, the thickness decreases. In short, the deposit of creek gravels as a whole has the form of a wedge, with the thick end downstream.

Deep creek gravels have been explored in lower and middle Bingham Canyon. Rim deposits have been opened in lower Bingham Canyon at a depth of 90 feet below the present creek level, and from Damphool to Markham gulches at depths varying from 60 to 10 feet below the surface. And shallow creek gravels, or creek gravels proper, have been worked in the bed of the present creek, principally in upper Bingham Canyon and its headward branches, Carr Fork and Bear Gulch. In general the inclination of the rims appears to be steeper than that of the present stream, so that downstream they appear to descend deeper and deeper beneath the present creek level.

Bench gravels are distributed in isolated patches at numerous points along the main canyon, in its middle and lower portions, at elevations ranging from 20 to 375 feet above the present stream. Regarding certain of the higher patches it may only be said that they now occupy rock shelves carved by early streams. Similarly some of the lower ones, like the rim deposits, fill remnants of old channels, but a number of the deposits at intermediate elevations clearly lie upon a distinct bench. A comparison of transverse profiles (Pl. XLVI) of the canyon, at points where these deposits occur, with the tracing showing the prominent topographic points on the canyon walls (fig. 9) shows that the bench is the old prevailing graded slope of the region, upon which, before the cutting of the late canyon began, extensive deposits of gravel were laid.

The relations between these several bench deposits may in some instances be recognized; in others they are doubtful. The evidence of various kinds upon this problem is discussed under the heading "Correlation of placers," page 16.

Sources of gravels and gold: Evidence as to the sources of the gravels is found in their distribution, composition, association, and form. The occurrence of the gravels in the form of stream deposits indicates their derivation from sources upstream from their present position. In all observed instances the grades of the former stream courses, allowing for subsequent tilting, show that their directions of flow were in general the same as those of present-day streams. The gravels therefore reached their present position from points farther up the present valleys.

The gravels include fragments of rocks of the principal types found in the district, but predominantly the more resistant ones, as quartzite, quartzite breccia, chert, monzonite, and porphyry. As these occur generally throughout the district, and the drainage comprises only a single basin, the sources of any particular deposit can not be definitely assigned to a single locality. The apparent restriction of the coarse granular rock (monzonite) found in the lower workings of the Highland Boy to that general locality in Carr Fork affords an exception. Boulders of that rock are found in the gravel exposed in the Gardella pit, indicating their partial if not complete derivation from Carr Fork. Although other distinctive types are wanting, it was noted that the types represented in the various deposits occur in place upstream. Thus the association of rocks in the gravels, allowing for the omission of those which do not well resist erosion, is the same as their association in place.

The form of the gravels affords a rough key to their source, on the basis that the most perfectly rounded and waterworn boulders have traveled farthest. In general the lower (both downstream and on the canyon walls) that gravels occur, the more perfectly rounded and waterworn they are. Exceptions to this are seen in the intercalated beds of sharply angular material, but this was undoubtedly of immediately local derivation. Thus the high bench gravels exposed in the St. Louis workings appear only partially worn, while those taken from the Clays rim are reported to have been very thoroughly rounded.

The sources of the gold in these gravels is partly indicated by similar criteria. In gravel lying in the headward portions of the canyon and its forks comparatively coarse gold has been reported. In that deposited far out, at the mouth of the main canyon, the gold is reported to have been very fine. Similarly, the gold in the high bench gravels is said to have been rough, as distinguished from that in the creek gravels, especially in the lower canyon, which is reported to have been rounded, worn, and battered. Detrital gold in high values occurs in creek gravels immediately downstream from the croppings of the so-called "oxidized gold ores," and these were doubtless the principal sources of placer gold. The pay gravel of certain placer deposits, however, can hardly be assigned to that source. In upper Bear Gulch no ore-bearing limestone crops upstream from the auriferous gravels, and reconstruction of topography does not make the derivation of all the gold from oxidized ore in limestone seem more probable. Some of it may have come from croppings of ore on the Bazouk property, but the main source of the gold in this locality was more likely mineralized porphyry. Again, the occurrence of the largest single piece of gold known to have been found in Utah, adjacent to Damphool Gulch, far from the known

croppings of any highly mineralized limestone, calls for further explanation. This and associated coarse gold may have come from an adjacent ore body which still remains undiscovered, but it is more likely to have been derived from some fissure or lime cropping at a more distant point and to have reached its present position by migration downstream.

Some of the gold in this section has doubtless reached its position by oft-repeated transportation from some distance upstream. Some probably came from gold- and copper-bearing porphyries. Numerous assays of the Bingham monzonite on the Wall and Boston Consolidated properties indicate a constant though low content of gold. Furthermore, extensive observations on the Alaskan placers, now borne out by detailed studies, tend to show that the pay in those rich gravels is not so largely derived from strong quartz veins as from innumerable minute veinlets and impregnations that are generally disseminated throughout entire formations.1/ In a similar manner it is not improbable that not only the intrusives carry fine gold, but also sedimentary formations, such as the great Bingham quartzite. In brief, the pay in the Bingham placers was derived from the replacement and fissure ore bodies, from impregnated intrusives, and possibly in minor amounts from impregnated sediments.

Stages of erosion: The date of the initiation of erosion on the present Oquirrh Range can not be precisely stated. The lowest as well as the highest known sediments outcropping in the Bingham area have thus far been found to include only upper Carboniferous faunas. No visible paleontologic or stratigraphic record of the geologic history of the area from that time until Quaternary is known. If such record was written it lies hidden beneath the desert.

Something may be determined regarding this area, however, by comparison with the history of adjoining regions. Regarding the history of the Tintic Mountains, the southern extension of the Oquirrh Range, it has been stated that "the southeastern shore of the Mesozoic continent was not far from the southern end of the Tintic Mountains. In post-Jurassic time the young continent received an important addition on its western edge - an uplift which was accompanied by a marked plication, producing folded ranges."2/

1. Brooks, A.H., Richardson, G.B., Collier, A.J., and Mendenhall, W.C.: Reconnaissances in the Cape Nome and Norton Bay Regions, Alaska, in 1900: U.S. Geol. Survey, 1901, p. 142.
2. Smith, G.O., and Tower, G.W., Geology and mining industry of Tintic district, Utah: Nineteenth Ann. Rept. U.S. Geol. Survey, Pt. 3, p. 671.

The same writer continues: "This post-Carboniferous uplift inaugurated a decided change in the history of the area. Erosion was substituted for sedimentation and the new land area immediately began to have its surface wasted away. It appears probable that many thousand feet of Carboniferous strata have wholly disappeared from the Tintic region, and their erosion was pre-Tertiary."1/

In view of the probable bulk of this range at this time to the south, and of the present maximum depression in the Great Basin (Great Salt Lake) to the north, it is not unreasonable to suppose that the range grew northward. The Mediterranean of that period, now Great Salt Lake, grew shallower and shallower as the elevation extended northward. Down the north-northeast consequent slope flowed initial consequent streams, whose course is preserved today only by such master streams as Bingham Creek.

The dissection which began at that time is still in progress. It has not proceeded regularly, but by stages of greater and less intensity. During some of the less active stages cutting down gave way to filling up, and these gravels were deposited.

Complete treatment of this problem involves thorough consideration of such factors as climatic variations, orographic and epirogenic movements, and factors determining synchronous degradation and aggradation. The field study has not been sufficiently wide to afford data required for the adequate consideration of these factors. Some evidence, however, has been obtained, and that must suffice for the present. In a broad way it is evident that general increase or decrease in precipitation would produce a corresponding change, other factors being constant, in stream degradation and aggradation. Ice erosion might produce characteristic topography. Broad land movements, either orographic or epirogenic, might produce similar results, according as the tilting hastened or retarded degradation. Differential tilting along axes athwart stream courses - stream capture and diversion, etc. - are factors in synchronous degradation and aggradation. Finally, if Lake Bonneville had extended high enough on the eastern slope of the Oquirrh Range it might have caused the deposition of such deposits of detrital material as the gravels in lower Bingham Canyon.

In general, records of precipitation in this region extend back only to about 1863, a period covering not even the deposition of the latest creek gravels, and are accordingly valueless in interpreting the great stages of erosion. Evidence of glaciation has not been found. In his study of Lake Bonneville history Gilbert described a fault along the west base of the Oquirrhs, on which he believed the range to

1. Ibid., p. 672.

be relatively rising on the east. Further, he determined a broad epirogenic movement of the same phase which, like that on the fault, tends to tilt the range in post-Bonneville time toward the east. Such a movement, even of that recent date, would not affect the great erosion stages, and it is believed the movements began at a much earlier period. As regards the influence of Lake Bonneville upon the deposition of the latest thick gravel deposits in lower Bingham Canyon, it is to be noted that the general upper limit of that water body assigned by Gilbert is 5,200 feet, while the present elevation of the surface of the gravels on West Mountain placer ground is 5,500, and their base at that point about 5,250, and that the Bonneville bench on the eastern slope of the range within the Bingham area was not noted at or above the 5,250 level. These evidences are in accord with Gilbert's opinion of the extent of Lake Bonneville in this locality as depicted on his map, which shows the upper limit of the lake extending considerably to the east of the eastern foothills of the Oquirrhs, and thus below Bingham Canyon. Although this would appear to eliminate this factor in the deposition of even the most recent gravels, the question is a broad one whose final solution must await more extended study of recent land movements and of the eastern continuations of the Bingham Creek gravels than was practicable during the present survey. Lithologic differences and geologic structures fail to explain the systematic topographic features. The land forms themselves can best tell their history.

The present topography of the Bingham region is composite (see fig. 9). As above stated, it indicates that at one time dissection advanced well beyond maturity (when the relief began to decrease) and produced a surface of moderate relief. The main slopes were fairly graded, a few ungraded ledgy remnants only remaining. Succeeding the long quiescence required for such denudation, an elevation of several hundred feet ensued, and another cycle was inaugurated. This elevation revived the streams, enabling them to cut actively, as is shown by the topography of the present master canyons and their forks. Their narrow, steep-sided walls are proof of their youthful character and show that the dissection which produced them has not advanced far. In fact it appears to have been early interrupted by another land movement, which was probably in its broad effect a depression or, more precisely, a tilting eastward. In consequence of this interruption and loss of energy the streams were forced to lay down their loads, and thus fill up the lower portions of the master canyon and its main adjoining canyons with a heavy deposit of gravel. This aggradation appears to have given way at the present date to a slight dissection (Pl. XLVII). This is most marked in the headward portions of the gravel filling, and gradually decreases out toward the mouth of the main canyon, though even there high gravel terraces show it to be pronounced. These last two stages, filling and subsequent cutting, are assigned to corresponding land movements only tentatively, as further study might show that the elevation which initiated the canyon stage is still in progress and that the recent minor aggradation and dissection are due to other causes.

In brief, the topography of Bingham Canyon appears to have been produced during at least four cycles, which were initiated by two positive geographic interruptions and one negative interruption. An early cycle of unknown extent was interrupted by a considerable elevation, succeeded by reduction to maturity, followed by pronounced uplift initiating dissection which in early youth was terminated by an uneven east-westerly depression which at a comparatively recent date may have given way to a slight uplift.

Deposition of gravels: Dissection and denudation imply reciprocal deposition. The stages of erosion are not conceived as comprising continuous erosion alone, for erosion in one part of a canyon was doubtless contemporaneous with corresponding deposition in other parts. Furthermore, it is not improbable that during epochs that were characterized as a whole by degradation there were transient periods characterized by aggradation. Such general aggradation is exemplified on a more extensive scale by that which marked the physiographic cycle next to the last and which was recorded by the gravels blanketing the bottom of the present Bingham Canyon.

The preservation of gold in the gravels is immediately due, then, to deposition. The most widespread period of deposition recorded was that just mentioned, during which a heavy deposit of gravel, over 250 feet in thickness, was laid down in lower Bingham Canyon and a conterminous though gradually thinning deposit was laid down in middle and even upper Bingham Canyon. Deposition at other periods is marked by the bench-gravel deposits. The possibility that all the gravels were deposited during a single long period of deposition that lasted until the filling reached the highest point at which gravels occur, and that in the course of their removal down to their present level the benches escaped as remnants, appears highly improbable.

Their positions and the character of their rock bottoms make it probable that the bench gravels were laid down on beds of early streams which then flowed at the elevations of the benches. The lack of data on various bench deposits and their comparative isolation and scantiness renders knowledge of their relationship, of their possible continuance, and thus of their extent, very imperfect. Accordingly, it can not be positively known whether they were

deposited during periods of general deposition throughout the canyon or were of only local deposition. It seems probable, however, that the high benches are merely remnants of local deposits which escaped removal during subsequent erosion by virtue of their isolation beyond the course of later streams. Lower bench gravels, as in the Dixon and Argonaut, show more continuity and so far suggest more extensive deposition. Their origin, however, appears to have been like that of the higher benches.

The rim gravels, so far as position on inclosing rock walls is concerned, are genetically like the bench gravels. Their position with regard to the creek gravels, however, suggests the alternative possibility that they may have been deposited during the period of the general deposition of creek gravels. The relative dates of the deposition of the rim and the adjacent creek gravels are indicated by several features. A section across the gravels will show the relation of the rim gravels and the beds overlying those at a corresponding elevation in the main channel. Again, a vertical exposure of the members composing the bedding of the main channel, as in a shaft, will prove the presence or absence of an upper lead in the main channel at the elevation of the rim pay. Further, the general character of the rim gravels as regards decomposition, rock association, consolidation, etc., as compared with that of possibly contemporaneous gravel in the main channel, is often sufficient to prove their relative age. These criteria have not been developed in Bingham, and accordingly the relative ages of rim and creek gravels can not be stated with certainty. The fact, however, that rich gravel has not been found at corresponding heights in the main channel, that rim gold differs in character, and that in some instances deep-creek gravel is reported to have yielded extra high values on bed rock immediately downstream from the rim deposit, strongly suggests that the Clays, and probably Old Channel rim deposits, are older than the creek gravels in their vicinity. If this be true, they would be older than the creek gravels, and thus would be genetically related to the bench gravels.

It is thus evident that the deposition of the gold in these gravels takes place by a double process of repeated natural concentration. On being released from bed rock by erosion, gold is shed into streams, and by being successively transported down the stream and deposited becomes concentrated. Gold-bearing gravels were early deposited on the bed of streams long before the present canyon assumed its present form. Subsequently, streams cut down through those gravels, left portions lying on the walls as benches, and carried other portions, with the included gold, down to its deeper bed. By many repetitions of this process, shown by the increased rounding of the gravel and gold in the deeper later deposits, the gold has been lowered from higher to lower and lower levels and thus concentrated again and again.

Correlation of placers: In some placer districts only certain channels are worth working. The correlation of channels, especially when they are numerous, then becomes of prime importance. The valuable and worthless ores are thus distinguished with a view to concentrating work on those which are most likely to yield a profit.

At Bingham the several placers have all yielded pay and belong to a single drainage system. Their correlation is not, therefore, of much practical importance. The principal value arising from such correlation would be for the information afforded regarding changes in grade of stream beds from earliest to latest ones and thus regarding broad earth movements.

The data required for such close correlation is not to be obtained. Comparative sections of capping, alternation of sediments with volcanics, grades of channel intersections, etc., all of which may be so clearly determined elsewhere, are not present or accessible in this region. General observations have been made on such features as elevations and general character of gravel.

A few broad probabilities may be stated. The correlation of the high benches offers the greatest difficulty. In view of the agreement in elevation, width of channel, value of pay, and character of gold, there seems no reasonable doubt that the Argonaut and Dixon are portions of the same channel. The view entertained by some that the Gardella is also to be correlated with this channel is controverted by the wide discrepancy in elevation. This objection can be removed only by hypothecating a strong fault, for which no visible evidence has been found. Neither does a comparison of the elevation of the St. Louis pit with the elevations of the pits of the Dixon and Argonaut appear to warrant its correlation with this channel. For that channel to reach the St. Louis would require a grade that was not only flatter than main bed rock, but even flatter than the present graded valley bottom. As regards the relation of the Clays and Old Channel rim deposits, it is to be noted that their elevations agree, but some of the Clays gravel was cemented, while that of the Old Channel was not, and the Clays rim showed three Channels, while the Old Channel was not so reported. Accordingly it is uncertain whether these are the same or whether one is later and cut out the other. Although not yet proved, it is not improbable that upper leads in West Mountain ground will prove to be continuous with that of the Bingham placer.

The profile of the present creek showing bed rock where encountered affords a suggestive comparison. Bed rock appears to descend deeper and deeper beneath the surface of the gravels downstream. Or the gravels may be said to thicken downstream. In

other words, the slope of the present stream bed is less than that of bed rock. This may indicate either more perfected grading at present or a tilting toward the east. The tilting seems somewhat more probable in view of the fact that in recent time the present stream has dissected the bottom gravel deeper in the upper portion of Bingham Canyon than in the lower or outer portion. That is, three known stream grades appear to indicate a tilt eastward along a north-south axis located toward the head of the canyon.

Resume of history of gravels: In post-Carboniferous time the Oquirrh Range gradually emerged above water level and grew northward. Streams flowed northward down its slopes and began the work which Bingham Creek and its tributaries are today carrying on. That work consisted of wearing down the surface, cutting valleys, and transporting downstream the product of that erosion - that is, developing the present topography. Although the general action has been dissection, this has been interrupted for relatively short periods at local points or in special instances throughout the length of the canyon by deposition. The removal of the various rocks and of their included gold values from their positions in placers, and their subsequent deposition as placers, constitutes the history of the auriferous gravels.

This generally continuous dissection has been made possible by a broad uplift with slight eastward tilting of the entire region, accomplished during definite stages which were characterized by elevation followed by quiescence and degradation, and by subsequent aggradation which may be due to slight depression. Thus the present topography indicates that a long early cycle was interrupted by an elevation of many hundred feet, introducing reduction of that land surface to maturity, then succeeded by a pronounced uplift initiating dissection, which was interrupted in early youth by aggradation. This deposition and succeeding slight dissection of gravels may have been due to minor depression and elevation successively in the course of general elevation.

During these land movements the activity of the erosive agents has varied accordantly. At an early date auriferous gravel was formed by the erosion of gold-bearing ore shoots in limestones and of igneous and probably sedimentary auriferous rocks. Portions deposited in stream beds were subsequently left as benches by further stream incision. Repeated deposition and subsequent dissection have produced a series of high bench and rim deposits of auriferous gravel. The principal deposits of auriferous gravel were laid down (1) at the close of the erosion stage, marked by the mature slopes, and (2) after the close of the cutting of the recent canyon and the succeeding depression. The former is recorded by the Argonaut and Dixon bench gravels, and the latter by the wedge of creek gravels. Each removal of gravel and its included pay from higher to lower levels, as well as each transportation downstream, has acted further to sort and to concentrate the gold. Thus the present creek gravels, including their eastern continuation, include all the gold released from bed rock from earliest to latest time, except the relatively small per cent left on the benches and that removed by man. The present recent dissection of the creek gravels and any normal succession of activities which may follow will continue this process of natural concentration of the placer gold.

Descriptions of Placer Mines

The placer mines of Bingham are in a condition that is unfavorable to critical study. The principal workings are inaccessible, reliable information is scarce and detailed facts of occurrence required for adequate correlation can not be obtained. Yet certain broad features of location, development, occurrence, values, etc., have been learned by conversation with operators and by observation, and these features afford a basis for general descriptions of the principal workings.

The several productive areas will be described in the following geographic order: upper Bingham Canyon, Bear Gulch, middle Bingham Canyon, Carr Fork, and lower Bingham Canyon. The deposits in each of these localities will be considered roughly in the order of their occurrence on benches, on rims, and on the canyon bottom at or below the present creek level.

Upper Bingham Canyon

Creek gravels: The gravels in upper Bingham Canyon which have yielded gold are the deposits filling the main valley bottom. They are recent shallow deposits of waterworn subangular gravel, including quartzite, porphyry, and limestone. Pay is reported to have occurred in the base of these gravels upon bed rock.

In general, the gold occurred just downstream from the points where ore-bearing members are crossed by the creek. Thus, large nuggets are said to have been found near the present Niagara mine, and in the early days it is reported that rich gravel was found in the main canyon from the point where the stream crosses the Old Jordan limestone down to and below its junction with Bear Gulch.

Bear Gulch

Creek gravels: The chief locality in Bear Gulch where gravels are now worked lies about 1,500 feet upstream from the Telegraph mine. Interbedded angular quartzite and subangular fragments of intrusives

occur here to a depth of 10 to 15 feet (see Pl. XLVIII). Recent stream cutting has exposed at the base of these deposits, immediately upon bed rock, a fine, poorly washed gravel which bears gold. This was worked from 1868 to 1872 by an experienced placer miner named Castro, and is still exploited annually on a small scale. At time of visit (1900) preparations were being made to work this deposit during the spring, when melting snows sufficiently augment the weak stream to permit sluicing and washing over California riffles.

Middle Bingham Canyon

In Bingham Canyon, between Bear Gulch and Markham Gulch, were worked the most extensive and valuable bench gravels in the district and some creek gravels. The bench deposits include, in the order of their elevation above the present stream, the following: Argonaut pit, Dixon channel, Cherikino bar, and Clays bar. Creek placers which were worked include the Heaton & Campbell placer and surface workings on recent deposits. The general features of each of these workings will be briefly described in the order given above.

Bench gravels

Argonaut pit: The Argonaut deposits extend across the end of the spur between Carr Fork and Dixon Gulch, at an elevation of 375 feet above the present level of Bingham Creek (see Pl. XLIX, A). They appear to fill a well-defined old channel or bench to a thickness of at least 60 feet (see general section on Pl. XLVI). An excellent exposure shows the deposit to be made up in general of a capping of fine sand and gravel underlain by cross-bedded lenses of sand: black, carbonaceous detrital deposits; ferruginous subangular material, becoming finer downward; carbonaceous material; coarse subangular material from 1 to 6 inches in diameter; a lower carbonaceous bed, and a base hidden by talus. The bed rock is smoothly waterworn. The correlation of this gravel with that in the Dixon channel to the north and the Gardella pit to the south is considered under the descriptions of those respective properties.

In the early days the base of this bank of gravel was explored by small open cuts along the exposures of the channel bottom in Carr Fork and Dixon Gulch. These developments apparently warranted more extensive work. A hydraulic plant was installed, capable of throwing an 80-foot stream through a 3-inch nozzle, and the deposit has been piped from Carr Fork to Dixon Gulch from surface to bed rock. The resulting cut is about 200 feet long by 50 wide and 60 high. The flowage was led eastward by channel cut in bed rock and sluiced in Dixon Gulch. The values contained in this deposit were recently carefully sampled in connection with a lawsuit. It appears that the lowest 30 feet of gravel now exposed in the face of the main cut averaged 6 cents per cubic yard, and that the lowest 5 feet averaged 18 cents. The total output from these workings can not be stated with certainty, but it is generally held that it is approximately $100,000.

Dixon channel: The Dixon channel is located on a bench in the southern wall of Bingham Canyon, on the spur between Dixon and Markham gulches, at an elevation above Bingham Creek of about 350 feet at its upper end and about 300 at its lower end. The bed rock on rims and channel was not accessible for determination of present elevation and grade. The upstream end of this deposit lies just across Dixon Gulch and only 125 feet north from the Argonaut. The accordant elevations of bed rock in these two workings, as well as the general character of the channel, seem to substantiate the general belief that the Argonaut and Dixon workings are on portions of the same bench or channel.

This channel was worked in 1868. The exposure on the wall of the canyon of the downstream portion of this deposit has been worked by an open cut; two shafts 40 and 50 feet deep have been sunk, a bed rock tunnel was run by the Dixon Brothers upstream for a distance of 80 feet, and in 1902 Gardella was working the upper portion of this deposit. This thorough exploration proves the deposit to be a filling of gravels in a stream channel to a depth of approximately 50 feet. The channel is stated to be 25 to 100 feet wide, with a flat stretch, some irregular steep portions, and a notable pothole. Rims 15 to 50 feet wide have been found.

Information as to the character of gold and average value of pay is scarce. In general the gold is said to have been of medium size, and evenly rather than thickly distributed, so that a moderate and constant rather than a high saving was effected. No figures on output could be obtained.

Cherikino bar: Lower bench gravels have been worked in middle Bingham Canyon at several points. On the northeast side of the canyon, in the rear of Rogers's custom concentration mill, or about 4,000 feet upstream from the mouth of Carr Fork, is a deposit which appears to be one of the most extensive masses of gravels known above the extreme outer portion of the canyon. Its general appearance is that of a shelf or bench of solid gravel, approximately 250 feet in thickness, 1,500 feet in length, and 500 feet in breadth. Waterworn gravels cap this bench, are plentiful on the slopes below, and appear interbedded with waterworn sand and subangular float along the railroad. They have been insufficiently explored underground, however, to prove

their true character and extent. A tunnel has been run into the base of these gravels about 50 feet above the creek level, but the results obtained were not to be learned. It is reported that considerable work was done here in the early days by two Italians, Cherikino and Bretano, and that they developed a well-defined channel at an elevation somewhat above the present creek level.

Clays bench: At the junction of Carr Fork and Bingham Canyon, overlying the lower portion of the intervening spur, occurs one of the largest and richest deposits of gravel in this region. It lies upon quartzite about 50 feet above Carr Fork Creek on the west and about 30 feet above Bingham Creek on the southeast. Its maximum dimensions are 1,000 feet in north-south and east-west directions, and 150 to 200 feet in thickness.

The gravel composing this mass includes angular and subangular quartzite, granular fine-grained monzonite (found in main Bingham Canyon), coarse porphyry (found in Carr Fork), and quartzite breccia. The base of the deposit is made up of well-rounded, fairly coarse fragments of fine-grained intrusives, quartzites, and cherty limestones, which are cemented by coarse waterworn quartz sand. Between these basal cemented gravels and the quartzite intervenes a layer of smoothed and polished ferruginous breccia, reaching in places a thickness of 6 inches.

Development work in the base of this mass comprises numerous short bed rock tunnels from Bingham Canyon, the Gardella hydraulic pits, and a long tunnel on bed rock in Carr Fork. This tunnel was driven from the north end of the deposit, under the center of the spur, for 800 feet, whence a fork to the south connects it with Gardella pit and with Bingham Canyon. It proves the presence here of a narrow channel.

The gold found here was, as a whole, coarse. The best values occurred in the base of the gravels upon bed rock, but some gold was taken from an upper lead 150 feet above bed rock. It was in this deposit, at a point about 1,000 feet above Myers's Hotel, that the first successful operations (1868) on bench gravels in this district were conducted. Later the Clays Brothers worked here with great success. A little mining, screening, and washing is still carried on. Although no definite estimate of values nor output was obtainable, it is reported that a large amount of coarse gold was richly distributed in the basal gravel and was saved at considerable profit.

Creek gravels

Heaton & Campbell placer: No direct information was gained about drift workings in creek gravels in the upper and middle portions of the canyon. The following quotations indicate, however, that the gravel overlying the lowest portion of the main channel (supposed to be about 30 to 50 feet in thickness) has been profitably exploited.

In 1870 it was stated[1] that -

"The best-informed parties think that the bed rock of Bingham Canyon will prove equally as rich as the famed 'Alder Gulch' of Montana. ...Messrs. Heaton, Campbell & Co. are now working the bed rock of this gulch, near the mouth of Carr Fork, which they have reached after two years labor and the expenditure of $15,000 by a long drain tunnel. They informed me that they are averaging $12 per day to the hand, notwithstanding the imperfect manner in which they are at present obliged to work their ground. They have not as yet run any side drifts, and at present raise all their dirt by a windlass worked by two men. When we take into consideration the fact that from the pay dirt excavated by one drifter enough gold is washed to pay six hands $12 per day each, or a total of $72, abundant evidence is given that the gulch of Bingham is very rich in gold."

This early work is understood to have been accomplished through a tunnel, 1,000 feet in length, which extended up both Carr Fork and Bingham Canyon. It is reported to have paid well.[2] It is further stated that in 1880 another tunnel here had reached a length of 1,500 feet and that "every 250 feet a shaft is sunk through the 60 feet of overlying debris. The gravel drifted out is washed in sluices on the surface. The pay is found within 5 feet of the bed rock covered by a stratum of cement an inch or two thick. The channel here is about 60 feet wide and though rather spotted, owing to its steep grade, has paid good wages."[2]

Creek workings: In Bingham Canyon the recent gravels in the present creek bed have been worked from a point about opposite the old Rogers mill downstream for about 2,200 feet to a point about 1,600 feet above the mouth of Carr Fork. Recent stream cutting exposes a succession of fine gravel, sand, carbonaceous material, and fragments of roots, trees, etc. (See Pl. XLIX, B.) At the bottom of this cutting some work is said to have been done in sluicing gravel from the present stream bed, but nothing further has been learned.

Carr Fork

Bench gravels

Two bench placer deposits have been worked in Carr

1. Kelsey, E.B., Mineral Resources of the United States, 1871, R.W. Raymond, p. 219.
2. Tenth Census, p. 420.

Fork, both on the southeast wall of the canyon, one nearly opposite the mouth of Cottonwood Gulch, and the other downstream near the mouth of Carr Fork. The former lies at an elevation of 60 to 80 feet above the creek, and has been explored by a small open cut. No information was obtained about this deposit, and it is believed to have been unimportant.

Gardella pit: This pit is a portion of the extensive and rich body of gravels lying between the lower part of Carr Fork and Bingham Canyon. The workings on this deposit from Carr Fork include a number of short drifts extending southeastward in the base of the gravel and an extensive open cut. It is reported that this cut was hydraulicked in 1872 by Bartholomeo Gardella. A considerable circular area of bed rock and a face of gravel over 100 feet in height have been exposed. The general features of this deposit and of its included values are considered under the deposits of middle Bingham Canyon, in connection with the Clays workings. The opinion is held by some Bingham placer miners that the Gardella, Clays bench, and Argonaut placers are portions of the same deposit. A comparison of elevation, location, and gravel tends to show that the Gardella and Clays deposits are probably equivalent. That these deposits are also to be correlated with those on the Argonaut and Dixon placers, immediately to the north on the opposite side of Carr Fork, is, however, doubtful. The bed rock channel overlain by the Argonaut gravels, though barely 900 feet distant, stands at about the same elevation as the top of the Gardella open cut, or over 100 feet above the bed rock channel of the Gardella-Clays gravels. In explanation of this abnormal difference in elevations, clearly inexplicable on a basis of natural stream grades, those who believe in the unity of these deposits introduce a fault along lower Carr Fork with downthrow on the southeast. Faults of recent date are known to have dislocated gravels. Nearby examples are to be observed along the great Wasatch fault along the western foot of that range, notably adjacent to the mouth of Little Cottonwood Canyon, where a moraine and discrete material recently deposited in fans are distinctly faulted. Excellent instances of the faulting of auriferous gravels have been studied by Lindgren at Laport, in Plumas County, Cal. Although such faulting as is required by this explanation has been found elsewhere and may exist in Bingham, the concrete evidence of its existence here has not been found.

Creek gravels

Mixed gravel on the bottom of Carr Fork has carried high gold values. The principal pay portions occurred downstream from the Highland Boy and Stewart limestones, and the richest stretches reported were just below the Stewart mine and adjacent to the mouth of Cottonwood Gulch. One pioneer Bingham placer miner states that he saved $300 a day from creek gravels in Carr Fork. No details could be learned regarding exact position of pay, the character of gold, or the values saved.

Lower Bingham Canyon

In Bingham Canyon, between Markham Gulch and the mouth of the canyon, bench, rim, shallow, and the deep creek gravels have been worked, and the rim and deep-creek placers have been more extensively operated here than in any other part of the camp. The bench gravels, which are in this section of least importance, include (from highest to lowest) the St. Louis placer (Old Channel Company), Lashbrook bench, Howard hydraulic pit, and Schenk placer. Rim Gravels, which have probably afforded the best returns in both values and amounts known in the district, have been worked at various points on the "Old Channel," Clays rim, and Mayberry rim. And creek gravels have been extensively opened deep beneath the present creek in West Mountain and Bingham placer ground. These several placers will be briefly described in the order given above.

Placer mines in lower
Bingham Canyon
Bench gravels:

St. Louis workings: On the northeast wall of the main canyon, from a point about 300 feet above the Winamuck, remnants of bench gravels occur between 300 and 400 feet above the creek at intervals through a distance of about 2,000 feet. Gravels on the slope above the Winamuck include large well-rounded boulders of quartzite, quartzite breccia, porphyry, and cherty lime.

The principal work on this series of bench deposits has been done in the most northern body. This property, known as the St. Louis placer, also as the White channel, was exploited by the Old Channel Company, which excavated a pit that measured 75 by 35 feet, with a face about 60 feet in height. The face shows the following section (top to bottom): 8 feet red pebbly soil, including worn material; 25 feet bedded, fine, angular quartzite fragments, 2 to 4 inches in diameter; 25 feet coarse, waterworn boulders, 1 to 7 feet in diameter, including porphyry, quartzite, quartzite breccia; buff ferruginous basal portion densely compacted and partially cemented. The gold from these gravels is said to have been fine, flaky, and only slightly worn and smoothed. The pay obtained by these operations is reported to have been poor and the outcome financially to have been a loss.

Lashbrook workings: On the north side of the canyon, immediately upstream from the mouth of Dry Fork, are extensive deposits of waterworn gravels.

Three distinct classes of gravel may be recognized at this point, the extensive mass covering the bench 200 feet or more above the creek, irregular isolated patches on the steep slope below this capping, and the creek gravels. The capping bench deposits have been worked at intervals by Lashbrook and others, and it is stated that very little gold was recovered. Below this top level small patches filling channel remnants and inequalities in bed rock gravels have been found which carried high values. These, however, are rather limited in extent.

Howard pit: At the north side of the mouth of Dry Fork irregular patches of gravel lying below the bench level and on the slopes which descend thence to the present creek have been opened. Nothing is known of the results of the work at this point. Gravel of apparently the same class, lying on the north side of the canyon, between 2,000 and 3,000 feet north of Dry Fork and just north of the Live Oak shaft, was hydraulicked by one Howard. This work is reported to have been unprofitable.

Schenk placer: On the south side of Bingham Canyon, above halfway between the main West Mountain shaft and Lead Mine station, there is a long stretch of stream gravels. This deposit lies from 20 to 25 feet above the present creek level, and appears to be a remnant of the early stream bed. It has been opened in its basal portions by short tunnels on bed rock, and the gold-bearing gravel was worked by Schenk and others by a dry-washing process. These and other attempts to work this bench deposit at a profit are reported to have failed.

Rim gravels

Bench and rim gravels are both remnants of deposits in former stream beds left on the canyon sides by subsequent stream erosion. The distinction between the two is based on their positions relative to the surface of the stream deposits of the present creek. It is purely artificial and is made merely for convenience in description. Thus the deposits of lower Bingham Canyon, described above have been included under bench deposits because they occur on benches above the surface of the stream deposits of the present creek. Side rock benches that lie below the surface and higher than the base of the deposits of the present creek are commonly known as rims, and the pay gravels that lie upon such rims are accordingly termed rim gravels. Three rich rim deposits have been exploited in lower Bingham Canyon, known as the Old Channel, Clays rim workings, and the Mayberry rim.

Old Channel:[1] The longest, richest, and best-defined placer in Bingham, so far as may be judged from reports, was the "Old Channel," with its possible extention, the Clays Bar. This, although variously correlated with different gravels upstream, is best developed in lower Bingham Canyon. It lies on the north side of Bingham Canyon about 1,000 feet upstream from Freeman Gulch, and has been worked thence northeastward through a projecting spur, and thence beneath the mouth of Freeman Gulch and beyond, underground now occupied by dwelling houses, for about 260 feet, where it turns eastward into the main canyon. Downstream a rim that is generally considered the same has been explored from a point on the south side of the canyon, now under the Winamuck dump, in a crescentic eastward bend through low spurs, and northward to a point just beyond the base of the road to the upper workings of the Winamuck and Caledonia. Its northward bend has apparently been removed in the dissection of the present canyon. Below, from the base of the road to the Midland mine, near the slaughterhouse, it and the portion known as the Clays rim have been thoroughly explored along a general northeasterly course to the mouth of Damphool Gulch. Energetic and thorough prospecting through shafts on both sides of the canyon have failed to reveal its continuation beyond.

In general the upper portion of this deposit, lying above and adjacent to Freeman Gulch, appears to have been laid down in a narrow channel and locally forms a rim from 10 to 20 feet below the present creek level. The gold found in it is said to have been medium coarse and rounded. This upper portion yielded, it is reported, excellent returns, the stretch below the Winamuck having been lean. The stretch extending from the slaughterhouse to Damphool Gulch was worked by two parties, the upper 600 feet by one Crowley, the lower 600 feet by the Clays Brothers. The Crowley ground was not found to pay, but the Clays ground was exceedingly rich and was most thoroughly worked. Accordingly it was more thoroughly known than any other portion of these rim workings. The precise relation of the Old Channel to the Clays rim is in some doubt. Though they are commonly considered the same, Mr. Daniel Clays has noted that the form of the rim channel in his ground is quite unlike that of the Old Channel, and further, that while a portion of the basal gravel from his workings was somewhat cemented, so that it was frequently desirable to expose it to alternate freezing and thawing to break it up, the Old Channel basal gravel was unconsolidated. Inasmuch as the Clays ground is so well known as a separate successful working, it will be here described separately.

Clays rim: The rim gravels exploited by the Clays Brothers are located on the southeast side of Bingham Canyon, below the creek level, and extend from the mouth of Damphool Gulch upstream to a point nearly opposite the mouth of the next small gully, a distance of something over 600 feet.

1. Facts furnished by Mr. Daniel Clays.

Exploration has revealed a series of three side channels or rims, 30, 50, and 65 feet beneath the surface of the present creek gravels, averaging 60, 20, and 30 feet, respectively, in width (see fig. 10). The upper level is at this point at the level of the Old Channel bar, and, though the gravel upon it is partially cemented, the two are commonly considered portions of the same rim deposit. Bed rock in the Old Channel stretch is said to have been even and waterworn, with only one pothole. This feature of this and other lower rims is in notable contrast with the steep unevenly potholed beds of some of the high benches such as the Dixon and St. Louis.

The single rim of the Old Channel gives way at the head of the Clays workings to the composite three-channeled rim above described. And similarly, in the lower end of the Clays ground, at the point where these three channels swing northward, they are replaced by a single channel which enters the main canyon. As this lowest part carried especially high values, its continuation downstream was energetically sought. Shafts were sunk on both sides of the canyon, but no further trace of this rich rim was found beyond.

The Clays ground on this rim was thoroughly explored by sinking shallow shafts averaging 20 feet, to bed rock, and by stoping laterally from the bottom of the shafts for distances ranging from 6 to 20 feet, according to the character of pay and of the ground. This method was found more economical of time, money, and life than a system of timbered drifts and crosscuts. On the upper bench the lowest 5 to 6 feet of gravel was worth mining. Highest values occurred on bed rock. In general, pay was low in the upper 300 feet of the Clays workings, and low on the second and third channels (see fig. 10). The bulk of the gold recovered was taken from the top channel. Although the average value of this is unknown, it is reported that in some cases 6 pans yielded $6 and that a cubic yard gave 18.20. It was on this rim, about 150 feet from the head of the rich 300 feet, that Mr. Daniel Clays found the nugget which is generally admitted to be the largest single piece of gold ever found in Utah: This nugget weighed, it is said, 7 ounces 15 pennyweights, and was valued at $128. The output from the Clays workings includes $138,000 taken out by the Clays Brothers, and enough more by others to make an approximate total of $175,000.

Mayberry rim: Mr. A.P. Mayberry, working the lower portion of the West Mountain ground adjacent to the lower shaft, encountered a distinct rim on the north wall of the canyon, 75 feet below the surface. It appeared to be a remnant of a channel 50 feet in width, which, with the exception of this stretch 150 feet in length, was obliterated by later cutting of the main channel. This enters the north wall of the main canyon 75 feet below the present stream level, extends northeastward around a distinct quartzite ridge, and opens into the main channel 150 feet downstream. The basal gravel on this rim is reported to have averaged $2.93 to the pan.

Other subsurface exploration in West Mountain ground proved the existence at some points, 90 feet below the present surface, of a well-developed rock shelf, 12 to 15 feet in width.

Deep creek gravels

West Mountain placer:1/ This property includes the bottom of lower Bingham Canyon for about $1\frac{1}{4}$ miles, extending 1,800 feet above Dry Fork and 4,800 feet below. The main opening, West Mountain shaft, is situated 700 feet northeast of the mouth of Dry Fork, on the north side of the road. Shafts Nos. 1 and 2 have been sunk northeast of this main shaft, at distances of 1,000 and 4,550 feet, respectively, and shaft No. 3 has been sunk at a point still farther northeast beyond No. 2.

Development work has been prosecuted chiefly from these three points, with a view ultimately to exploiting the basal portions of the gravels which overlie the bed of the rock channel, but with the immediate view of draining these gravels so as to permit such exploitation. West Mountain placer shaft descends to a depth of 160 feet in blue limestone on the north rim of the buried channel. Drifts extend southward at 90- and 150-foot levels into and across the old channel (valley) to the southern rim, and a 35-foot raise from the lower connects with an intermediate level which extends from rim to rim. Shaft No. 1 descends 175 feet southwestward at an angle of 35° through gravels to bed rock. From this point, which lies at a vertical depth of about 150 feet, a drift extends southwestward for 300 feet. Shaft No. 2 was excavated in the same direction on the same angle for 150 feet through gravels, but on striking water was abandoned. Shaft No. 3 also follows a course parallel to that of No. 1, striking bed rock at 170 feet. From its foot a vertical shaft connects through 125 feet of gravels with the surface, a drift extends northeastward on bed rock 100 feet, and another southwestward 80 to 90 feet, and one northward about 80 feet. From this development it appears that the present stream is underlain in this portion of the canyon by unconsolidated gravels to an average depth of about 150 feet. The rock bottom of the canyon underlying the gravels follows a course

1. At time of visit this property was not in operation; water filled the underground workings and stood in the main shaft only 60 feet below its collar. The statements in the present sketch are based upon information gained from various sources: But chiefly from Mr. F.C. Garland, superintendent of the mine.

in general parallel with the present creek. The descent of the walls to the bed rock bottom, however, is not constant, but is interrupted by a rock shelf (rim) 12 to 15 feet in width, about 90 feet below the present creek level. Its position suggests that it is to be correlated with the Mayberry rim, although its width is considerably less. The filling of the old channel is said to be practically all gravel, although published statements give additional material.1/ Thus, at the lower shaft, "at a depth of 125 feet, a streak of black loam with charred trunks of trees" was reported; and at the upper shaft "loose wash is 100 feet deep under creek bed, then there is a 7-foot stratum of cement."

Pay gravel has been found both on the upper rock bench and at the bottom of the main channel on bed rock. It is believed to exist at one if not at two other higher levels. Values average about equal from both. In the main West Mountain group, regular shipping has not been carried on. The known values were obtained in the general course of exploration and development. On the upper bench they are found through a thickness of 7 feet; on the main level in a similar thickness, with the richest portion at the base upon bed rock. It has been stated that the bed rock was taken up to a depth of 6 inches to 3 feet to obtain gold which it was anticipated had settled into cracks. The values were remarkably uniform not only on the two upper levels, but also along the course of the bottom placer. The average value of West Mountain gravel in minable limits is reported to have been 8 to 10 cents per pan, while one pan ran $1.56; a nugget $1.66, and many nuggets 40 to 50 cents. At one clean-up, on gravel taken in the course of running a drain level, $500 was reported to have been saved.

At present (1904) the attempt to work this property as a placer appears to have been abandoned, tentatively at least, and its main shaft is used by the Utah Copper Company as a source of water supply for a large concentrator.

Bingham placer: This property is situated in main Bingham Canyon, adjoining West Mountain placer on the east, and extends thence downstream for over 6,600 feet. It was not in operation at time of visit.1/ Development consists of a shaft down 250 feet and 200 feet of drifts on the 115-foot level. This shaft has reached a greater depth than that at which bed rock was found on the West Mountain ground, but is said to have encountered only stream gravels, no bed rock. If this be the fact, it proves that the rock or true bottom of Bingham Creek maintains to this point in its lower course at least as steep an inclination as that followed above, and thus throws important light on the relation of Bingham Canyon and similar side valleys to the main Jordan Valley.

1. Bingham Bulletin, May 5, 1899.

In 1899 work was devoted to exploring the pay gravels which overlie a firm floor of "cement gravel" that was encountered after passing down from the surface through 115 feet of loose wash gravel. The 6 feet of gravel which immediately overlies this stratum carries gold, often in form of thin flakes, and much magnetic iron. "The pay gravel is apparently as rich as West Mountain dirt."

Other placers: Above the West Mountain placer in lower Bingham Canyon no work was being prosecuted at time of visit. This area, however, is covered by numerous claims which would attract no little interest in event of the successful exploitation of the West Mountain ground. These include Hoffman, Charles Brink, M. Gibbons, May & Merrill, Remnant, McGuire & Co., and others. Some prospecting has been done on these, as well as on small gravel deposits in Bear Gulch, main Bingham Canyon, and Carr Fork. They are, however, with rare exception, only prospects and little is known as to their output and carry.

Hill, J.M., 1913, Notes on the northern La Sal Mts., Grand Co., Utah: U.S. Geol. Survey Bull. 530a, p. 114.

PLACER MINES

Wilson Mesa

Geology and mining conditions: The flat mesas south of Castle Valley are covered by a coating of gold-bearing gravel. This deposit is usually very thin, being indicated by scattered boulders and pebbles or by small flattened mounds of like material here and there on the sandstone bedrock. In a few places it attains greater thicknesses. Some of the larger deposits stand as low rounded knobs, but most of them seem to occupy reentrants in cliffs. The latter was apparently the position at the Point Lookout placer. A combination of the two forms is seen at the Black Cap workings. A third and much rarer occurrence is along what appears to be an old channel which runs northwestward from the Black Cap.

The gravels are the same throughout, consisting of subangular cobbles of igneous material similar to that seen in the La Sal Mountains to the east, with a relatively small proportion of sandstone fragments. They range in size from one fourth of an inch to 2½ feet, with an average size of about 10 to 12 inches. Fragments of monzonite porphyry cut by quartz stringers are fairly abundant and magnetite cobbles up to 4 or 5 inches in diameter are not at all rare. There seems to be a slight decrease in size of the boulders at the western edge of the deposits, but it is not everywhere the same and is rather doubtful. There is practically no stratification of these gravels except along the present drainage lines in reworked material.

The gold, said to be worth from $19 to $20 an ounce, occurs in small wires or flakes, and none of that seen appeared to be much waterworn. It is distributed throughout the thickness of the deposits, which are said to be of about the same grade from the surface to bed rock. Besides the gold that can be recovered by washing, it has been found that the "ribbon rock" (the monzonite porphyry cut by quartz stringers) contains a fairly large portion of the gold value of the gravels. Some of the miners assert that for every ounce saved by sluicing 10 ounces are lost in the ribbon rock which goes over the dump.

There is no natural water supply on Wilson Mesa. A ditch originally built for irrigation is said to supply about 12 cubic feet a second from the beginning of the thaw in April to the last of July, when the greater part of the snow has disappeared from the mountains. From then until October the supply is about 8 cubic feet a second, and it is further diminished during the winter. The water is all taken from Mill Creek, and considerable trouble has been experienced in obtaining enough for sluicing, as the town of Moab also takes its supply from this source and has a prior right to the water.

Prospects: The Black Cap placer (No. 12, fig. 16) is located in the cliff between the middle and upper mesas. The gravels here form a low knoll, and are also found below the general rim-rock level in what appears to be a cleft or reentrant from the face of the cliff. The maximum thickness above the true rim rock is about 50 feet, with possibly as much more below at one place.

Hydraulicking into sluice boxes located in the reentrant has opened a pear-shaped cut about 40 feet in maximum width by 60 feet long, with a face 40 feet high. The location is ideal for this sort of work, as there is plenty of ground for a dump much below the level of the gravels. It is said that some difficulty was experienced with the larger boulders and that considerable gold was lost in the ribbon rock.

At the Point Lookout placer (No. 13, fig. 16) the gravels clearly occur in a reentrant at the rim of a canyon leading into Mill Creek. This locality is also in the rim of the middle mesa, just above the lower mesa. A very thin veneer of gravels covers an area of 2 or 3 acres, with one deeper deposit just at the rim.

A shaft sunk in the deep deposit has gone down about 20 feet through gravel that contains a large amount of magnetite, usually as small pebbles, though some cobbles as large as 8 inches in diameter were noted. Very little water can be had here. The surface has been partly sluiced into a vibrating screen which allows only the finest material to pass. The fines were put through riffles and finally over a small amalgamation plate. Practically all the free gold was saved, but it was found that the tailings carried gold in the quartz ribbon rock.

At the Butterfly placer (No. 14, fig. 16) a low ridge running from the middle to the lower mesa is covered with gravel to varying depths, a knoll at the lower west end showing the greatest thickness. The main irrigation ditch referred to above passes this place and the gravels were handled by road scrapers, being carried upon a platform through which they fell into sluice boxes. The method was very cheap and it is said that with a team and scraper two men could make $16 a day.

Figure 16 shows prospects just northwest of No. 12 and east of No. 13. At the latter locality two shafts about 100 feet apart have been sunk; one to a depth of 40 feet is all in gravel, and the other, 10 feet deep, entirely in sandstone bed rock. This is on the relatively flat middle mesa, but in a depression that at present is a watercourse and seems to have been a channel at the time of the deposition of the gravels. Little work has been done on the prospect nearer No. 12, a low gravel knoll. The prospect southwest of Mesa post office is also a low knoll of gravel with bedrock outcropping just east of it. This is apparently a remnant behind a ledge of sandstone. The prospect just east of Mesa is a continuation of the Black Cap deposit. It is a relatively thin layer of gravels except in a few shallow reentrants.

Origin of the gravel: The material composing the gravels of Wilson Mesa is at least nine-tenths igneous. It occurs on flat-lying undisturbed sandstones which nowhere show any igneous rock in place. All the porphyry types represented in the main laccolithic mass of the La Sal Mountains are represented by pebbles or boulders in these gravels. Pebbles of monzonite porphyry cut by stringers of glassy quartz containing limonite, which resemble the ore of the Tornado and other places, are frequently seen. These, owing no doubt to their original altered condition, are softer and more weathered than the previously unaltered rocks. It can hardly be questioned that the gravels were very largely derived from the La Sal Mountains. Their present distribution is probably due largely to erosion since their deposition. In sheltered places such as reentrants the gravels have not been removed, but they have been largely eroded from the flat-topped mesas except for the remnants left in old channels or between the present drainage lines.

The method of deposition of the gravel on this mesa is open to question. That its deposition is not related to the most recent glaciation is clearly shown by the fact that the last glaciers were very small, rarely reaching below an elevation of 10,000 feet and never issuing beyond the high mountain valley. The material is subangular, no rounded pebbles be-

ing noted; it is fairly coarse for the most part with only a little sand; and it is so far as seen unstratified. Two hypotheses are suggested by its character. Both torrential flood and glaciers form such deposits. That one or the other of these agencies brought the material to its present resting place is fairly sure. In either event it is quite certain that the gravels were deposited at a time when the LaSal Mountains were higher than they now are, and either explanation presupposes a very much greater precipitation than there is at present in this region. It seems probable that the gravels were deposited prior to the establishment of the present drainage system, for deposits of this class are found only on flat-topped mesas, and if ever present have been entirely removed from the places now occupied by canyons. Similar gravels that were not visited are reported on the mesas north of the mountains.

If these gravels are glacier-borne deposits they must surely afford some evidence of this mode of transportation. The writer at the time of his visit did not fully realize the difficulty of proving this point, so did not spend sufficient time to collect conclusive evidence. One boulder of sandstone 10 feet in diameter on the upper mesa about half a mile east of Mesa post office showed marks that were thought to be striae.

Wallace W. Atwood, of the United States Geological Survey, who is making a study of the somewhat similar disposed gravels in the San Juan region, has come to the conclusion that they are the result of glaciation very much older than that which produced any of the Pleistocene drift heretofore found in the Rocky Mountains, and from his description of these deposits at the meeting of the American Association for the Advancement of Science held in Washington in December, 1911, the writer is inclined to attribute to a similar agency the deposition of the gravels of Wilson Mesa.

The question is, however, still far from solution, and more detailed study of the mesa will be necessary before a final statement can be made as to what brought the gravels to their present position.

Miners Basin

The town of Basin is located on a flat just above a very small, indistinct terminal moraine of the last glacial epoch. This moraine is composed entirely of angular igneous material, none of which has traveled over a mile and much of it a very inconsiderable distance. The moraine lies on the top of a debris-filled V-shaped valley. Both the glacial material and the debris contain a little fine free gold. The amount of material is, however, very small and hard to handle on account of the large angular talus blocks included in it.

Hunt, C.B., et al, 1953, Geology and geography of the Henry Mountains region, Utah: U.S. Geol. Survey Prof. Paper 228, p. 220-221.

PLACER DEPOSITS

Placer gold in the Henry Mountains region has been produced from fanglomerate near the foot of the mountains and from terrace gravels along the Colorado River.

Placer deposits in fanglomerate near the mountains are confined to stream courses that drain from the stocks. Thus, of the streams draining Mount Ellen, only Crescent Creek is known to have deposited valuable gold placers. No valuable placer deposits have been found around Mount Pennell although prospectors report finding gold in panning tests of the gravel near Straight Creek. Straight Creek drains part of the Mount Pennell stock, which is known to contain small, low-grade, fissure deposits of gold.

The gravel deposits on the north side of Trail Creek east of Mount Hillers, those along the South Fork of North Wash and the Poison Spring Benches, and along the north and west sides of Mount Ellen have been panned by several prospectors and they report no gold. Prospectors also report that there is very little gold in the gravels along North Wash and Hanson Creeks.

At the Lawler-Ekker placer deposit in sec. 28, T. 31 S., R. 11 E., flakes of gold are commonly half a millimeter in diameter but flakes 2 mm long and a millimeter thick are not uncommon. The gold occurs in black sand streaks at the base of the gravel. The black sand consists of magnetite, hematite, and probably ilmenite. Messrs. Ekker and Lawler estimate that the deposit worked thus far has produced somewhere between 50 and 75 cents in gold per cubic yard. Placering here is a seasonal operation, carried on only during the spring when sufficient water flows in Crescent Creek for hydraulic excavation. Total production since 1914, when the mining was started, has aggregated a few thousand dollars.

Gravel deposits along Glen Canyon have been extensively prospected but the gold, which is in tiny flakes - 0.05 to 0.10 millimeters in diameter (Butler and others, 1920, p. 638) - is so difficult to recover that the placer operations have not been very successful. Indeed, the surface tension of water suffices to float this flour gold. Most of the terrace gravels that have been worked are 175 ft. or less above the river. Higher terraces have been prospected but not worked. Most of the pebbles are small, an inch or less in diameter; 6 in. is the common large size.

The flour gold is not concentrated in black sand streaks but appears to be uniformly distributed in silty beds, or in gravelly beds cemented with silty matrix. This unusual distrubution of the gold occurs probably because the minute size of the individual particles offsets the high specific gravity.

Platinum also is present in the gravel deposits but the amount is very small. The gold is about 0.960 fine and commonly there are 12 parts gold to 1 part of silver (Butler and others, 1920, p. 638).

Mr. Frank Bennett reported that about 1,000 cu. yd. of gravel from the Gold Coin claim (Olympia Bar) yielded gold to the value of $730, or about 73 cents per cubic yard (Butler and others, 1920, p. 638). Mr. Bert Loper states that 138 cu. yd. of gravel from the Red Canyon (Castle Butte) Bar yielded gold to the value of $84, or about 61 cents per cubic yard. Other values ranging from a few cents to more than a dollar a yard have been reported. Data filed with the Bureau of Mines indicate that gold production from Glen Canyon has aggregated about $15,000 in the period 1904-38 inclusive.

A summary of the placer operations in Glen Canyon is given below.

Summary of the placer operations in Glen Canyon (Levels refer to the height above river level)

North Wash Bar; west side; 6- and 110-ft levels; small pits only.

Hite bars; west side; 55-, 75-, 110-, and 250-ft levels; small workings at the 75-ft level.

Grubstake Bar; east side; 15-ft level; gravel deposit 5½ ft thick buried by slides; several short adits and small rooms under slides. The following section was measured at these workings:

Top	Inches
Gravel with firm clay and sand cement; contains best gold value.....	14
Gravel with loose sand; soft unit, contains practically no gold.....	14
Gravel with firm clay and sand cement; contains moderate gold value.....	14
Gravel with soft sandy matrix; gravel content increases upward; contains minor quantity of gold.....	14
Base.	

Dorothy Bar; island only slightly above flood level; not worked.

Monte Cristo Island; little higher than flood level; not worked.

Monte Cristo Bar; west side; 100- and 200-ft levels; small prospect pits.

Red Canyon Bar; (also known as Castle Butte Bar); east side; 145-ft level; one of the most productive bars; small open-pits in gravel 5-6 ft thick.

Ticaboo Bar (also called Bank of Ticaboo); west side 35- and 60-ft levels; small workings at lower level only.

Goodhope Bar; west side; 20-ft level; site of one of the largest early gold placer operations on the river. A water wheel 40 ft in diameter was built to lift water from the river into a flume that supplied a reservoir back of the gravel; several open-pit cuts, each of moderate size.

Ryan Bar; island below flood level; was seasonally prospected for a few years about 1900.

Olympia Bar; east side; 20-, 65-, 155-, and 175-ft levels; best values reported from north end of 175-ft level; extensive cuts at the 155- and 175-ft levels; smaller cuts at other levels; the water wheel built at Goodhope Bar was moved here in 1910.

Sundog Bar; west side; 40- and 155-ft levels; numerous small prospect pits.

California Bar; east side; north end is 75-ft level, south end is 50-ft level; three small sets of workings on the lower level; original workings that led to Glen Canyon gold rush are at north end of lower level; most extensive workings and reportedly the best values are at the south end; a talus cone overlies the south end of the gravel and adits extend into the gravel under the cone.

Smith Bar; west side; 4-ft level; largely buried by talus and sand; worked mostly by adit.

Moki Bar; east side; 60-ft level; small workings at north end; small workings at south end.

Ampitheater Bar; west side; 5-, 60-, and 120-ft levels; prospect pits.

New Year Bar; east side; 15- and 55-ft levels; prospect pits in upper level; small workings in west end of lower level.

Burro Bar; west side; 5- and 60-ft levels; upper level almost entirely cut away; prospect pits in lower level.

Boston Bar; east side; 60-ft level; several small pits.

Anderson Bar; west side; 8-ft level; prospect pits.

Shock Bar; east side; 50-ft level; open-cuts at south end only.

Klondike Bar; west side; 70-ft level; small pits.

Mescan Bar; island below flood level; no workings.

Wright Bar; island below flood level; no workings.

Bar above Sentinel Rock; west side; 12-ft level; small pits in gravel.

In 1939 only the Grubstake and Smith Bars were being worked.

It has been noted elsewhere that the gravel deposits in Glen Canyon are largely confined to the upper 75 miles of the canyon, so it is not surprising that 21 of the 26 gold placer bars listed are also in the upper part of the canyon. All except the last five listed above occur within the part of Glen Canyon shown on the geologic map.

The ill-fated attempt by the Hoskinini Company in 1900 to obtain gold by dredging the channel of the river has been described.

Gregory, Herbert E. and Moore, Raymond C., 1931, The Kaiparowits region: U.S. Geol. Survey Prof. Paper 164, p. 147-148: Economic geology (in part).

GOLD

Within the Kaiparowits region, as elsewhere in the plateau province, the Triassic and Jurassic rocks include widely distributed minute flakes of gold, and accumulations in gravel bars along the principal streams are sufficient to attract attention.

There are reports of prospectors along the Waterpocket Fold, in the Henry Mountains, and east of the Colorado River about Elk Ridge and the Abajo Mountains as early as 1870, and the finding of gold in sandstone and gravel of the San Juan River in the fall of 1892 led to the "Bluff excitement" of 1892-93.1/ Little prospecting seems to have been done along the Colorado River until the practicability of its traverse had been demonstrated by Powell. The wide desert stretches along the river, the difficulty of finding or making a feasible trail from the canyon rim to the stream below, and the ignorance of probable cateracts and whirlpools stood as discouragements. But the discovery in 1880 of the Dandy crossing (Hite) and of feasible routes leading to it resulted in the location of a working camp, to which supplies could be brought from settlements in both Utah and Colorado. The establishment of a miners' trading station at Hanksville in 1884 made conditions still more favorable. By using the Dandy crossing as a base the bars and alluvial gravel along the Colorado River between the mouth of the Fremont and Lees Ferry have been intermittently worked since 1883.

The following notes regarding placer mining in Glen Canyon were compiled from conversation and personal letters of Mr. Bert Loper, whose knowledge of the Colorado River between Hite and Lees Ferry is based on many years of experience.

Gold was discovered near the mouth of Trachyte Canyon by Cass Hite in 1883. Most of the mining in Glen Canyon was done during the years 1886-1889. A few men were at work during the following decade, and at least one man continued to pan gold until 1908. Doubtless in later years prospectors have worked here and there for short periods.

Beginning at the mouth of Crescent Wash, the larger bars explored for gold are North Wash, Hite, Grub Stake, Cape Horn, Monte Cristo, Red Canyon, Tickaboo, Good Hope, Sevenmile, Olympia, California, Moki, New Year, Burro, Boston, Anderson, Shock, Butler, Klondyke, Meskin, and Wright, the last of which is near the mouth of Navajo Creek. From all these bars enough gold to meet day wages was obtained. A good amount of gold was recovered at Boston, Red Canyon, Klondyke, Moki, Olympia, and Good Hope bars, and the California bar yielded more than $10,000. All the bars were located as prospects, except Good Hope, which is the only patented land within Glen Canyon.

Nearly all pay dirt is "wash gravel" that was deposited at high-water stages of the river, but tests showed gold in the Chinle shales and even in dune sands blown into the canyon from surfaces above the walls. The richest material mined is composed of streaks of adobe within the gravel - "powdery, sticky, mud, which quickly dissolves in water."

All the metal recovered was flour gold; there were no flakes or nuggets. Most of the gold came from the layers near the surface of the bars, "at grass roots" within the gravel, and at the contact of the gravel and bedrock. From Bedrock itself the yields were insignificant. Assays made for A.P. Adams of "red marl," "blue marl," "blow sand," and river silt showed from 20 cents to $1.20 a ton.

Frank Bennett, who has long been familiar with the placer deposits of Glen Canyon, says that selected gravel from the Gold Coin claim yielded about 72 cents a cubic yard and that a bar near the mouth of Red Creek yielded from 70 cents to more than $1 a yard.1/

Nearly all the mining was done with rockers, but where conditions were favorable home-made sluice boxes and quicksilver riffles were installed. Some shafts were sunk, and the tunnels in gravel banks a hundred feet or more above high-water level on the Loper claim near Tickaboo represent much hard work with pick and shovel. Lack of water from sources above the gold-bearing gravel and the expense of pumping from the river below have prevented large hydraulic operations. A water wheel was tried at Good Hope Bar, and in 1900 a power dredge was installed and operated for a few weeks near the mouth of Bullfrog (Hanson; Pine Alcove) Creek, but the flour gold recovered was insufficient to pay the cost of installation.

During the years 1910-1913 an ambitious scheme was developed for recovering gold from sandstone, shale, and silt on the Paria River at Lees Ferry and Paria. After preliminary study, including many assays, several hundred claims were located, assessment work was begun, and steam dredges and power

1. Gregory, H.E., Geology of the Navajo Country: U.S. Geol. Survey Prof. Paper 93, p. 139-140, 1917.

1. Butler, B.S., and others, the ore deposits of Utah: U.S. Geol. Survey Prof. Paper 111, p. 638, 1920.

shovels that were freighted from Marysvale were installed at the mouth of the Paria. To obtain fuel for operating the dredges a coal mine was opened in Warm Creek about 10 miles from its mouth, and a wagon road was constructed. From the end of the road a pack-horse trail was built through the narrow canyon portion of the Warm Creek Valley to the Colorado River, and a barge was constructed for carrying the coal to its destination. (See pl. 29,B.) The plan was to recover the gold known to exist in nearly all the beds of the Chinle formation, which is well exposed at the mouth of Glen Canyon and underlies thousands of square miles in Arizona and Utah with a thickness exceeding 500 feet.

Assays of 14 samples from Lees Ferry, received through the courtesy of Mr. C.H. Spencer, show an average of about 25 cents a ton for the "silts" derived from the Chinle beds. Analyses of three series of samples taken by Lawson[1] from equivalent beds at Paria showed an average of less than 5 cents of gold in a ton of shale and sandstone. The largest amount, 10 cents a ton, came from a bed of sandstone. Similar figures were obtained for the gold content of the Moenkopi formation immediately below the Shinarump conglomerate. Gold appears to be fairly evenly disseminated in the Chinle shales, and their composition and texture make them favorable for hydraulic mining. The metal occurs, however, as excessively fine flakes and dust and requires much skill for its recovery. Because of this difficulty and the isolation of the mining field, with the consequent enormous cost of operation, work at Lees Ferry was discontinued in 1913. A few years later an unsuccessful attempt was made to revive gold mining at Paria village in connection with an ill-starred irrigation project. (See p. 31).

The gold of Glen Canyon is accompanied by black sands, consisting of magnetite, hematite, ilmenite, garnet, and small amounts of chromite, zircon, and rutile. One analysis showed 0.15 ounce of platinum to the ton.[2] Obviously these minerals have originally come from mineralized rocks that were different from those now exposed in the Kaiparowits region. Some of the placer gold probably has been carried to Glen Canyon by streams from the Henry, La Sal, and Abajo Mountains, where gold-bearing veins are known, but it seems reasonable to assume that most of it has come from the disintegration of nearby Triassic sediments.

1. Lawson, A.C., The gold in the Shinarump at Paria: Econ. Geology, vol. 8, p. 446-448, 1913.
2. Butler, B.S., and others, The ore deposits of Utah: U.S. Geol. Survey Prof. Paper 111, p. 638, 1920.

Gregory, H.E., The San Juan Country: U.S. Geol. Survey Prof. Paper 188, p. 108: Economic geology (in part).

GOLD

In the San Juan country gold has been recovered from placers in the San Juan Valley, in Glen Canyon, and in Johnson Creek and from mines developed in the mineralized zone near the roof of the Abajo Mountain loccolith. In pioneer history the search for gold in the unexplored canyons far from sources of supply is a chapter of absorbing interest, but as a commercial enterprise it has led only to disappointment. With pan and sluice box many prospectors have made day wages, but mining companies whose operations call for the installation of machinery have failed. The value of the gold recovered is an insignificant fraction of the cost.

River Placers

The discovery of gold in gravel along the upper tributaries of the San Juan River led to a search for the metal throughout its course. Starting from Animas City, Colo., in 1879, E.L. Goodridge worked his way by boat to the mouth of the San Juan - the first known traverse of the river. He discovered flake gold at several places but gave discouraging reports regarding quantity and cost of recovery. After the settlement of Bluff (1880) some gold was panned by a Mr. Moss and others in sand bars above the mouth of Recapture Creek. Intermittent prospecting by local residents continued until 1891, when from unknown sources - chiefly, it seems, from the notorious Indian trader, Bill Williams - rumors spread that the gravel bars and terraces in the San Juan Canyon were rich in gold, particularly in the stretch below Clay Hill Crossing. Thus originated the "Bluff excitement" of 1892-93. A.L. Raplee reports that during these years some 1,200 men were working along the river between the mouth of Montezuma Creek and Glen Canyon. "Every sand bank and gravel bar was prospected and mud dipped out of the river's bed." To reach claims in the deepest part of the canyon the famous Honaker trail was built. Most of the prospectors returned empty-handed, a few obtained some gold, and it is reported that the Nephi claim yielded the equivalent of $3,000. Since 1893 the unprofitable search for gold along the San Juan has been continued at Zahns Camp, at Spencer Camp, near the mouths of Montezuma and Copper Canyons, and at other places thought favorable.

In Glen Canyon placer gold was discovered near the mouth of Trachyte Creek by Cass Hite in 1883, and

during the period 1886-89 mining was vigorously in progress at claims on 21 bars distributed along the river from the mouth of White Canyon nearly to Lees Ferry. Since that time the most promising claims have been worked intermittently. In 1927 the only man on the Colorado River in the San Juan country was a prospector at the mouth of Red Canyon.

In Glen Canyon all the gold obtained has the form of flour or microscopic flakes and when concentrated in the rockers and sluice boxes is accompanied by black sands - mostly magnetite and hematite but also garnet, zircon, rutile, and other resistant minerals. The tiny particles of gold are thoroughly disseminated within the bars exposed at high water and in those perched higher on the canyon walls. It seems equally abundant "at the grass roots", within the gravel, and just above bedrock but is most concentrated in thin short streaks of "blue marl" and "red marl" - impalpable sticky mud, readily disintegrated in water. Samples from this material showed as much as 0.06 ounce of gold to the ton.

The gold in the placers of the San Juan and Colorado Rivers is believed to have two sources. Some of it, doubtless, has been derived from areas of disintegrated auriferous rock in Colorado, transported and deposited by the present streams during their long life. The shape and size of the particles that make up the flour gold in Glen Canyon render them suitable for long transportation by streams of moderate volume and for deposition without marked sorting. Likewise the largest of the tiny flakes in the San Juan Canyon are like those mined along the Animas and other tributaries that rise in the gold-bearing San Juan Mountains. Probably most of the gold is derived from erosion of the Jurassic and Triassic rocks into which Glen Canyon, San Juan Canyon, and their many tributaries have been cut. These rocks, particularly the Chinle, Wingate, and Navajo formations, are known to contain gold in amounts that average something like 5 cents a cubic yard. Some dunes made of disintegrated sandstone are as rich in gold as some of the river silts and gravel. Placer mining in San Juan and Glen Canyons is further discussed in reports previously published by the Geological Survey.1/

1. Gregory, H.E., Geology of the Navajo country, a reconnaissance of parts of Arizona, New Mexico, and Utah: U.S. Geol. Survey Prof. Paper 93, p. 139-140, 1917. Butler, B.S., Loughlin, G.F., Heikes, V.C., and others: The ore deposits of Utah: U.S. Geol. Survey Prof. Paper 111, p. 152-158, 1920. Miser, H.D., The San Juan Canyon of southwestern Utah: U.S. Geol. Survey Water-Supply Paper 538, p. 21-22, 1924. Gregory, H.E., and Moore, R.C., The Kaiparowits region, a geographic and geologic reconnaissance of parts of Utah and Arizona: U.S. Geol. Survey Prof. Paper 164, p. 147-148, 1931. Gehman, Harry Merrill Jr., 1958, Notch Peak intrusive: Utah Geol. and Mineralog. Survey, Bulletin 62, p. 46.

PLACER GOLD DEPOSITS

The gold-bearing alluvium of Amasey Valley owes its existence to a resistant aplite sill that prevented the rapid downcutting of the Valley. Other valleys, such as Granite Canyon, have been deeply eroded; whereas Amasey Valley remains flat-floored down to the edge of the Quartz monzonite, where erosion is impeded by the aplite sill.

The source of the gold in the placers is not positively known. Crawford and Buranek (1941) state that the gold comes from quartz veins, but the only quartz is in the pegmatites and in the scheelite-bearing veins. No lode gold has been found.

INDEX TO SELECTED AREAS