GOLD-BEARING GRAVELS NEAR MURRAY, IDAHO

By

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MOSCOW, IDAHO
FOREWORD

Geomorphology, as Dr. Dort points out in the present report, is the study of the origin and modification of landforms or landscape features. It is becoming more and more apparent that a knowledge of geomorphology as applied to the origin of river valleys and intermontane basins is essential to an understanding of the factors which controlled deposition and concentration of valuable minerals in the placer sands and gravels of northern and central Idaho.

With the publication of this pamphlet Dr. Dort, who teaches geomorphology at the University of Kansas, has added another link to our growing chain of knowledge of the conditions under which Idaho's placer deposits have formed—knowledge which can be put to good use in exploration and development of such deposits.

E. F. COOK  
Director
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INTRODUCTION

The first placer mining claims were staked on the gold-bearing gravels of Prichard Creek at the site of Murray, Idaho by A. J. Prichard in 1883. During the following two years there was feverish activity along Prichard Creek, Beaver Creek to the south, and their tributaries, and more than half a million dollars worth of gold was recovered from gravel deposits along the valley floors and on terraces on the valley sides. The most readily discovered gold was soon removed and placer mining decreased. Search for the mother lodes led to the opening of several bedrock mines, with less spectacular success. Nevertheless, by 1900 more than $4,000,000 worth of gold and associated silver had been produced from placer and lode workings in the Murray area. Profitable exploitation of gravels underlying the bed of Prichard Creek was accomplished between 1917 and 1926 by a dredge brought in from the Yukon. Similar efforts along Trail Creek, using three smaller dredges, were failures. However, the Trail Creek gravels were worked with some success in the 1950's by use of a dragline and washing plant.

Throughout the entire history of the Murray area there have been sporadic attempts at working placer deposits along most of the smaller creeks and gulches. At present the only activity involves individuals or small groups. Total production of gold and associated silver from the Murray area now exceeds $6,000,000, of which about two-thirds came from placer ground. Future operations at any increased rate will be dependent on an increase in the legal price of gold or a decrease in the costs of labor and materials.

PREVIOUS WORK AND ACKNOWLEDGMENT

The first detailed accounts of the geology of the Murray area were included in regional studies of the large Coeur d'Alene District made by Ransome (1904) and by Ransome and Calkins (1908). Additional information, pertaining strictly to the lode deposits of the Coeur d'Alene District, was supplied by Umpleby
and Jones (1923), Shenon (1938) and Hosterman (1956) published reports dealing with the bedrock geology and lode deposits in the Murray area specifically. Studies made along the South Fork of the Coeur d'Alene River by the present author between 1949 and 1954 have provided important background material.

The purpose of the present investigation, made during the summer of 1957, is to expand knowledge of the placer deposits in the Murray area. By compilation of the regional geomorphic history, an understanding of the geological controls which caused accumulation of these deposits can be achieved. This information can then be used as a guide for assessing the possibilities of future production of placer gold.

The author is indebted to Dr. Earl F. Cook, Director of the Idaho Bureau of Mines and Geology, for his enthusiastic support of this project. The study was aided by discussion with members of the geological staff of The Bunker Hill Company and with S. Warren Hobbs of the U. S. Geological Survey. William Wylie, Jr., and Frank Schamel provided some of the historical information about the early days of placer mining in the Murray area.

LOCATION AND TOPOGRAPHIC SETTING

The town of Murray is located on Prichard Creek, a major tributary of the Coeur d'Alene River in the panhandle of northern Idaho (see Fig. 1). Gold-bearing gravels occur along valley sides and beneath floodplains in an area roughly six miles square which may be conveniently designated as the Murray area on the basis of the nearly central location of that town. As thus defined, the Murray area encompasses parts of the Beaver, Coeur d'Alene, Eagle, and Summit mining districts. The most recent topographic map to include the area is the quadrangle issued by the U. S. Geological Survey under the advance print designation of Trout Creek #3.

Murray is approximately 30 miles northeast of Kingston and U. S. Highway 10 by way of gravel roads along the Coeur d'Alene River. It can also be reached by 20 miles of gravel road north from Wallace, which also is located on U. S. Highway 10. Several logging roads and bulldozer trails permit ready access into most parts of the area.

The Murray area is situated in the western foothills of the Bitterroot Mountains, along the crest of which is located the Idaho-Montana boundary. The terrain is in an early mature stage of regional development and is comprised entirely of sharp hills and narrow valleys. The elevation of Prichard Creek at Murray
Fig. 1.— Index map of northern Idaho showing location of Murray area and limits of Glacial Lake Coeur d'Alene.
is approximately 2,800 feet above sea level. Murray Peak, two and one half miles northeast, attains an elevation of 5,934 feet. Nearby peaks exceed 6,500 feet. These peaks are sharply rounded, ridgecrests are narrow, and slopes are almost universally steep. Declivities of 30° or greater are not uncommon, and occasional vertical cliffs are present. North-facing slopes of peaks exceeding 5,800 feet in elevation have been subjected to alpine glaciation and small cirques have formed in localities favorable for the catchment of sufficient quantities of snow. The lower reaches of the major streams have small floodplains developed on valley-fill alluvium. The small gulches are still in youth and show no development of valleyfloor flats. Virtually the entire area is covered by a thick forest growth.

When viewed from a vantage point on one of the higher peaks, the regional terrain exhibits a marked accordance of nearly level ridgecrests above which sharply rounded peaks rise an additional few hundred feet. This preponderance of nearly equal summit elevations over large parts of northern Idaho has led some geologists to postulate the former existence of a vast erosion surface of low relief, the "Idaho penplain", which was uplifted and has since been almost completely destroyed by erosion. This interpretation of the topography is open to some debate.

More outstanding in the Murray area are lower accordant ridgecrests which indicate the former presence of a gently sloping erosion surface, the remains of which are now about 800 feet above the valley floors. Some portions of this surface are underlain by gravels, others expose only bedrock.

**BEDROCK**

Bedrock outcropping in the Murray area consists almost entirely of slightly metamorphosed sedimentary strata belonging to the Precambrian Belt series. Calkins (1908, p. 23) in his regional study of the Coeur d'Alene District, divided these rocks into six formations. In order of decreasing age these are the Prichard, Burke, Revett, St. Regis, Wallace, and Striped Peak formations. Quartzites, argillites, and mixtures of the two lithologies predominate, with some impure carbonate horizons present. The vari-colored strata range from thin- to thick-bedded and the low grade of metamorphism has not obliterated such primary sedimentary features as ripple marks, mud cracks, and raindrop imprints. Neither the top nor the bottom of the complete stratigraphic section is exposed. The thickness of strata present in the Murray area is estimated by Hosterman (1956, p. 727) to be 25,000 feet. Contacts between formations are gradational and there are frequent repetitions of lithologic
types both within single units and throughout the entire column. It is therefore difficult to identify the source of rock fragments freshly broken from outcrops and almost impossible after these fragments have been transported some distance by streams.

Also present in the Murray area are two groups of igneous intrusives of relatively minor areal extent. Several stocks form outcrops, ranging in longest dimension from a few hundred feet to almost three miles, along a northeasterly-trending zone which crosses the southeastern corner of this study. The prevailing composition of these small intrusives is monzonitic, but intricate patterns of gradation into syenitic and dioritic zones are present. The texture varies from fine-grained, equigranular masses to markedly porphyritic phases in which the euhedral phenocrysts may exceed five centimeters in length.

A second group of intrusive bodies, more widespread though less well known than the monzonite stocks, consists of small dikes of diabase, lamprophyre, and monzonite. These dikes are almost always less resistant to erosion than are the strata of the Belt series countryrock. Consequently, most outcrops are effectively concealed by soil and vegetation.

The rocks of the Murray area have been deformed by a series of irregular north-south trending folds which have in turn been broken by numerous high-angle normal and reverse faults. Many of these faults have a general north-south orientation, but a few strike somewhat north of west, parallel to the grain of regional structure. Intersection of the various structural elements creates a rather intricate outcrop pattern and, although strata of the Prichard formation outcrop over considerably more than half of the area, continuous sections are rare, (Hoserman 1956, Pl. 57).

UNCONSOLIDATED SEDIMENTS

GENERAL FEATURES

Deposits of unconsolidated sediments in the Murray area are broadly divisible into two groups, bench or terrace gravels and valley-floor alluvium. This division is made largely on the basis of present topographic position of the debris, but two distinct episodes of deposition are represented and two periods of geomorphic history are indicated.* The material contained in the two groups is lithologically indistinguishable, and considerable difficulty is encountered in applying the two categories where the bench gravels have been washed downslope subsequent to their original deposition and now mingle with younger gravels on the present valley floors. In addition, the valley-floor alluvium has been slightly dissected since its

* As recognized by Ransome and Calkins.
deposition and remnants of that debris now occupy positions up to twenty feet above present stream levels. Furthermore, as the present valleys were eroded, small patches of gravel were left on the valley sides at elevations equal to or above those of bench gravels deposited during the preceding cycle of valley filling (see Fig. 2).

BENCH GRAVELS

The bench gravels occupy positions which are located outside of the present stream valleys and are, in general, above the level of the present drainage system. Only where minor gulches cross the area underlain by bench gravels do the two levels locally coincide. These gravels were deposited by creeks which existed during a previous cycle of erosion when drainage levels were at higher elevations than at present. The valleys of this previous cycle were partially filled with alluvial debris before renewed downcutting by the streams excavated new valleys or, in some places, reopened the old ones. The valley fill is now present as bench gravels in isolated remnants on ridges and spurs.

The largest area of exposed bench gravels is southwest of Murray Peak at the confluence of Prichard and Eagle Creeks. Here remnants of a dissected, gently sloping surface are underlain by cobble to boulder gravels for a distance of 9,000 feet in a northwest-southeast direction parallel to and from one-half to one mile north of the present course of Prichard Creek. The upper limit of these gravels is at an elevation of approximately 3,500 feet, or about 900 feet above the adjacent reaches of Prichard Creek. Determination of the lowest limit of bench gravels in place is difficult because erosion of new valley systems subsequent to deposition of these gravels has produced slopes down which the gravels move readily by gravity. However, more definitive evidence is provided by certain mine workings.

Approximately 3,000 feet upstream in McComber Gulch from its confluence with Prichard Creek a horizontal drift mine explored a fracture system in strata of the Prichard formation. The drift has a strike of N 15° E, which is approximately at right angles to the trend of Prichard Creek to the south and the long axis of the bench gravels to the north. At a distance of 770 feet from the portal, this drift encountered boulder gravels. The elevation of these gravels is about 2,800 feet, 200 feet above the confluence of McComber Gulch and Prichard Creek and 700 feet below the highest occurrence of bench gravels on the southwestern slopes of Murray Peak. The bedrock-gravel relationships indicate that an old, gravel-filled valley passes across the headwaters of McComber Gulch. Because the
Fig. 2 — GOLD-BEARING GRAVELS, MURRAY AREA, IDAHO

SCALE

CONTOUR INTERVAL: 400 Feet

Base map from U.S. Geological Survey
Trout Creek 3, Idaho Quadrangle
advance print, 1957.

Beach gravels (including some gravels in present valleys, but above valley-fill alluvium)
Major gold-producing lode mines
Main roads
position of the McComber Gulch mine relative to the bottom of this filled valley is not known, it is not possible to compute the original maximum thickness of the gravel fill at this point.

On a slope above Fancy Gulch, about a mile from Eagle Creek, there are some caved adits and a recently worked hydraulic face. The contact between bedrock and overlying boulder to cobble gravels is at an elevation of about 3,100 feet. At the 2,800-foot contour in Daisy Gulch there is another small group of caved adits. At this locality some of the dumps are covered with angular fragments of the local bedrock, but others appear to contain only gravel debris, indicating the presence there of the gravel-bedrock contact. Bedrock is exposed along the southern side of Daisy Gulch below these adits, but on the northern side only thick soil and gravel float are visible. Therefore, the location and elevation of the lowest part of the gravel-bedrock contact is again unknown. However, the continuation to Daisy Gulch of the gravel-filled valley encountered by the McComber Gulch mine is indicated.

Near the eastern end of the large area of bench gravels described above is Dream Gulch, a short, steep-sided valley considerably modified by hydraulic placering. Outcrops of Prichard strata are present along the sides of the lower part of this valley, near its confluence with Prichard Creek. Bedrock also outcrops in the upper portions of the valley, where the old gold-producing Buckeye Boy Mine is located. In the middle reaches of the gulch, however, only gravels are exposed. On the eastern side of the gulch there is a scarp approximately 100 feet high left by hydraulic placering operations. Smaller scars are present on the western side. Here again the gravel-bedrock relationships clearly indicate the presence of a gravel-filled valley transecting existing spurs which have high bedrock tips. Piles of placering debris cover the floor of the valley and effectively conceal the location of the gravel-bedrock contact.

East of Dream Gulch there is a small, unnamed gulch, also heavily placered, and then a broad spur on the west side of Buckskin Gulch (see Fig. 3). The crest of this spur, about 150 feet above Prichard Creek, has been scalped by placering and now exposes bedrock on which rest scattered piles of stream-worn boulders. In back of a flat bedrock bench, some 100 feet wide, is a 30-foot scarp and a second, narrower bench, also covered with piles of boulders. The details of the present configuration of this spur are undoubtedly the result of the placering of the former gravel cap. It is probable, however, that the lower bench represents the approximate base of the gravel deposits and, therefore, the bottom of the old gravel-filled channel. Its elevation is about 2,900 feet.
Figure 3. Prichard Creek Valley west of Murray.

Scars of placer operations in bench gravels by Alder Gulch in left foreground, by Buckskin Gulch in center, and by Dream Gulch toward right background. Old, gravel-filled valley of Prichard Creek continues beneath flat-topped spur beyond Dream Gulch. Dredge tailings piles floor the present valley. The Mountain Lion Mine and Beehive workings are located near the projecting group of trees on the left side of the valley floor. Kings Pass in center background.
Gravels form a thin veneer on the spur between Buckskin Gulch and Alder Gulch at elevations between 3,200 and 3,400 feet. The spur between Alder Gulch and Gold Run has a prominent conical hill at the outer end overlooking the town of Murray. Beneath the col in back of this hill a hydraulic placering scar exposes gravels to a depth of about 60 feet on the eastern side of the spur. A bulldozer road on the western side exposes bedrock at a slightly lower elevation, thus bracketing the position of the base of the gravel-filled valley at a little less than 3,350 feet. Small patches of gravel higher on this spur appear to mark the location of small filled valley segments originally tributary to the main valley. The spur separating Gold Run from Cougar Gulch, and that between Cougar Gulch and Wesp Gulch show similar although not as prominent cols, also underlain by gravels. The old valley remnant between Gold Run and Cougar Gulch has been almost completely excavated by placering. The bedrock floor is exposed at an elevation of about 3,350 feet.

The present floor of Prichard Creek, considerably modified by dredging operations, has a gradient of about 80 feet per mile. The gradient of the gravel-filled valley, computed on the basis of the inexact data available from remnants exposed along a distance of three miles, is about the same. The width of the filled valley, clearly indicated on the sides of several of the spurs south and southwest of Murray Peak, is less than that of the present valley of Prichard Creek. The present floor of this latter valley is on top of gravel fill. However, the bottom of the bedrock channel, as indicated by exploratory drilling and excavations for placer operations is also larger than the old filled channel.

The large area of bench gravels extending from Dream Gulch to Daisy Gulch is continuous with a broad gravel cap on the spur between Daisy Gulch and Fancy Gulch. A smaller, isolated gravel cap is present on the spur between Fancy Gulch and Bedrock Gulch. The presence of these bench gravels along the eastern side of the valley of Eagle Creek suggests that there may be an old, gravel-filled channel cutting through spurs there in a manner similar to the situation along the northern side of the valley of Prichard Creek. Relationships are not certain, however, because exposures are smaller and less numerous.

Scattered patches of bench gravels are present on spurs along the western side of the valley of Beaver Creek, a tributary of the Coeur d'Alene River which flows essentially parallel to and south of Prichard Creek. The largest such occurrences are located between White and Scott Creeks, between Scott and Missouri Creeks, and north of Missouri Creek. These remnants, as exposed in bulldozer cuts, are thin and
discontinuous. No gravel-filled remnants of a former valley are present. The largest patches form veneers at elevations of 2,800 to 3,100 feet.

Within the area of this report, bench gravels are also present in two localities along the western side of the Coeur d'Alene River. The course of the river forms a U-shaped bend toward the southeast at the mouth of Beaver Creek. On the inside of this bend there is a bedrock terrace at an elevation of 2,800 feet, slightly more than 400 feet above the river. This small terrace is veneered with a thin deposit of cobble to boulder gravels. Three miles upstream, the river follows a larger bend toward the east, on the inside of which more bench gravels are present on remnants of a dissected terrace which has an elevation of about 3,000 feet. Cuts along logging roads indicate that this accumulation of gravel is at least 80 feet thick.

Bench gravels are present along the Coeur d'Alene River, its South Fork, and tributary creeks and gulches in many places outside the areal limits of this report. Height of these deposits ranges upward to as great as 1,100 feet above present drainage levels. The highest gravels are on spur crests east and west of Ninemile Creek near Wallace and on the crests of spurs and hills north and northeast of Enaville. The most widespread occurrences are present along the South Fork of the Coeur d'Alene River near Kellogg where remnants of a previous valley system are filled with cobble to boulder gravels attaining thicknesses as great as 600 feet.

Almost all of the constituent fragments in the bench gravels are derived from Belt Series strata outcropping within the drainage basins of the streams along which the deposits are located. However, it is rarely possible to identify fragments representative of specific formations. Most of the pieces are composed of quartzite, Argillite and argillaceous quartzite are present in minor amounts, especially in the upper reaches of streams or near downvalley outcrops where new debris is added to the stream load, but transportation of short duration has not brought about the complete destruction of the weaker fragments. Scattered cobbles or pebbles of the monzonitic rocks can occasionally be found, along with rare pieces of diabase or lamprophyre. The igneous rocks are especially susceptible to weathering and break up rapidly. Quartzitic rocks show only an external brown staining as a result of weathering attack.

The gravels display extreme variations in particle size. In general, maximum particle size and average particle size diminish with increasing distance from the headwaters of streams transporting the debris. However, an abrupt increase in these
parameters occur wherever a short, vigorous tributary enters a larger stream lacking the competence to move large fragments. It also appears to hold true, based on observations at the few localities where appreciable thicknesses of gravel are exposed, that particle size tends to increase toward the bottom of the deposit. At the hydraulic placer workings east of Dream Gulch, for example, the upper parts of the scarps show boulders 24 to 30 inches in greatest dimension. In contrast, near the base of these exposures, boulders four feet long are present. And the piles of boulders remaining from thorough cleaning of the bedrock surface west of Buckskin Gulch contain many fragments with greatest dimensions of between three and four feet.

The matrix material within which the cobbles and boulders are contained varies from sand to fine clay. The absence of good exposures renders percentage determinations unreliable. Where the gravels underlie a flat or gently sloping topographic surface, boulders tend to form a veneer which gives a visual impression of a high volumetric proportion of the coarser fragments. In such a position, however, rainwash is able to remove the fine-grained material, leaving a residuum of the larger fragments out of proportion to actual percentages. In contrast, where the gravels are exposed in an old, slumped hydraulic placering scarp, the face appears to be composed largely of fines, with only scattered boulders exposed. In a topographic position of this type the boulders roll to the bottom and tend to be covered by finer debris washed down the face and again a false impression of size percentages results. The only clear, undisturbed exposure of the bench gravels is in the McComber Gulch mine. Here boulders up to four feet in greatest dimension are so tightly packed as to be in contact with each other. The interstices between the boulders are filled with sand and clay. One lens of fine, well-sorted, very sticky gray clay was observed in a space separating some of the largest boulders present. In terms of volume, these fines constitute only a minor proportion of the deposit. Coarse sand and pebbles are notably absent.

VALLEY-FLOOR ALLUVIUM

After the old valleys of Prichard Creek, Eagle Creek, and other streams in the region were eroded and then partially filled with gravels which now constitute the bench gravels, drainage was rejuvenated and the streams resumed their downcutting activity. This erosion proceeded until the floors of the main valleys were at elevations below present drainage levels. There then followed a second cycle of deposition which caused partial filling of these new valleys. The debris which accumulated during this more recent episode of deposition is here termed the valley-floor alluvium.
The thickness of the valley-floor alluvium varies roughly with the size of the stream. In the smaller gulches the fill quickly decreases to zero in an upstream direction. Early reports of placer operations which involved the excavation of shafts to bedrock on the floor of Prichard Creek valley state that the average thickness of the gravels was about 35 feet. William Wylie, Jr., stated in a personal communication that dredging along Prichard Creek by the Yukon Gold Company encountered gravels 35 feet deep at Murray and 52 feet deep at the western end of the operation, a short distance west of the mouth of Dream Gulch. He also reported that in the same area there are actually two gravel-filled channels cut into the bedrock floor of Prichard Creek valley, separated by a low bedrock ridge and flanked by bedrock benches. These benches are approximately at the present creek level. The southern bench is exposed for a short distance in a modern flood-scour channel west of the Mountain Lion Mine.

Gravels are present 10 to 20 feet above Prichard Creek on the northern side of the valley at Murray and at the mouth of Accident Gulch, and on the southern side of the valley at the Beehive workings and the Mountain Lion Mine. These deposits are essentially continuous with and part of the valley-floor alluvium. Their presence indicates that the valley of Prichard Creek was filled to a level at least 20 feet higher than present and has been re-excavated by that amount. Many of the tributary valleys have small terraces 10 to 20 feet above their present floors. These are believed to be remnants of the original fill surface, although very extensive placer operations have so modified the original topography that there is cause for questioning which of the present surfaces are natural and which are manmade.

At a few localities, small patches of gravels are exposed higher on the sides of the present valleys. The most notable examples are on the spur east of Accident Gulch at a height of 400 feet above Prichard Creek and on spurs both north and south of Fancy Gulch at heights of about 250 feet above Eagle Creek. These gravels are located on slopes which are parts of the present stream valleys, as opposed to slopes which were parts of the former, gravel-filled valleys. It is apparent that these gravels were deposited during the cutting of the present drainage system, and so do not constitute part of the bench gravels. On the other hand, they were not deposited during the second episode of valley filling and are, therefore, not part of the valley-floor alluvium as herein defined.

Valley-floor alluvium above the present level of Prichard Creek is exposed in a fresh cut at the Mountain Lion Mine west of Murray (see Fig. 4). The eroded surface of Prichard strata is highly irregular. Resistant layers form bosses and ridges,
Figure 4. Contact between upper part of valley-fill alluvium and bedrock at the Mountain Lion Mine. Note the extreme irregularity of the bedrock surface.
weak layers have been etched away to form low places and even narrow slots a foot or more deep. The edges and corners of the projections have been somewhat rounded and smoothed by water. Directly above the bedrock is a zone of large, subrounded to subangular boulders of quartzite, the largest of which have a long dimension of about four feet. Sand and clay fill the spaces between these boulders. Particle size decreases rapidly upward so that within four feet only cobble-sized debris is present, and this grades upward within another four feet into coarse pebble gravel, sand, and sandy clay. On top is a varying thickness of angular slopewash debris.

It is reported by Shenon (1938, p. 14) that Beehive workings in the vicinity of the Mountain Lion Mine encountered a layer of peat which ranged from one to three feet in thickness. The presence of such a layer of plant remains and fine-grained debris indicative of a quiet water, swampy environment would have a strong bearing on the interpretation of the geomorphic history of the region. It also would exert a strong influence on the occurrence of placer gold in the valley-floor alluvium. However, the present writer could find no exposure of peat in the few Beehive workings that were still open, nor any person who remembered having seen any peat.

No exposures of valley-floor alluvium below present stream level are available, but some information can be obtained by study of the spoil piles left by dredging of Prichard Creek for about two miles each side of Murray. It is readily apparent that the angularity of the debris decreases downstream. There is also a slight decrease in average size of the fragments in a downstream direction. However, the addition of boulders from the bench gravels, both by placer operations and by natural erosion, has resulted in a mixing of this debris with fragments brought directly from bedrock erosion. The debris is composed almost entirely of quartzite fragments. Pieces of igneous rocks, especially the monzonitic varieties, are more numerous than in the bench gravels, but still constitute less than 1% of the deposit.

**GEOMORPHIC HISTORY**

Geomorphology is the study of the origin and modification of landforms or landscape features. Therefore, the geomorphic history of an area is a compilation of the more recent geologic events which, in aggregate, effected development of the present topography.
A complete discussion of the geomorphic history of the Murray area might begin with the development of a surface of low relief not far above sea level, the "Idaho peneplain", and its subsequent uplifting to elevations of 5800 to 6500 feet. However, the very existence of this extensive erosion surface is a highly controversial subject and sufficient evidence is not now available for satisfactory evaluation of the arguments for and against it. Furthermore, the development of this erosion surface, if indeed it occurred, did not affect the accumulation of gold in the bench gravels and valley-floor alluvium, which were formed much later in geologic time.

Deposition of the older group of gold-bearing gravels in the Murray area was immediately preceded by a lengthy episode of erosion during which the major landscape features now existing were given their broad outlines. All major drainage lines were established and the larger valleys were eroded. There were, however, some differences in pattern and location. The best preserved of the old valleys not now occupied by a stream is the former course of Prichard Creek. The former valley deviates from the present valley at the mouth of Butte Creek, and follows a more northwesterly course which is marked by gravel-filled cols between that point and Murray. From there it curves slightly west, crosses Buckskin Gulch and Dream Gulch, and joins Daisy Gulch. The old valley then followed the lower course of Daisy Gulch to Eagle Creek and thence to the present lower part of Prichard Creek and the Coeur d'Alene River. The existence of this abandoned valley is readily observable where more recent gulches have been eroded across its course, exposing the gravel fill flanked by bedrock. The best exposures are between Dream Gulch and Buckskin Gulch and in the col on the divide between Gold Run and Cougar Gulch. The fact that the McComber Gulch Mine cut through 770 feet of bedrock and then penetrated boulder gravels at least 400 feet lower than bedrock exposures on nearby spur-points also clearly illustrates the presence of the old, gravel-filled valley. Erosion of this former valley system proceeded rapidly until the main valley floors were about 150 feet above present drainage levels. Cross-sections of the gravel fill visible along the sides of recent, transecting gulches show that at that time even Prichard Creek occupied a narrow, steep-sided youthful valley.

There then followed a lengthy episode of deposition during which boulder and cobble gravels accumulated in the main valleys to depths of about 700 feet. Aggradation by streams can be caused by a drying of the climate, which reduces the volume and carrying power of the streams, by an addition of load, as from glacial outwash, or by a decrease in gradient, as from downstream damming. Although additional load may have been supplied to streams in the Murray area by glaciers active on nearby
peaks during one or more stages of the Pleistocene epoch, downstream blockage of drainage appears to best explain the episode of deposition which filled the old stream valleys here. Prichard Creek flows into the Coeur d'Alene River, which in turn enters Coeur d'Alene Lake, some 67 miles to the southeast. Coeur d'Alene Lake now drains westward to the Columbia River by way of the Spokane River. Lakes have existed in this general location at several times in the past as a result of successive dammings of westward drainage by at least two distinct episodes of lava outpourings on the northeastern edge of the Columbia Plateau and by at least two advances of continental glaciers from the north. Each of these events caused disruption of the westward flow of the ancestral Spokane River and aggradation along streams flowing to this point from the mountainous terrain of Idaho was a direct result.

Outpouring of the main mass of the Columbia Plateau lavas has been dated at Miocene on the basis of plant fossils contained in lake-bottom sediments of the Latah formation which are interbedded with flows along the northern and eastern margins of the volcanic area (Pardee and Bryan 1925; Knowlton 1925). The gravels which fill the old valley systems at Murray and along the South Fork of the Coeur d'Alene River show almost no alteration by weathering or cementation except at scattered localities near Kellogg and northeast of Enaville. It does not appear reasonable that the acid groundwater which is prevalent in this region as a result of weathering of sulphide ores could circulate through gravels since Miocene time without causing greater effects. It is believed, therefore, that these gravels were deposited during the Pleistocene epoch when westward drainage was blocked by an advance of continental ice sheets to the present northern end of Coeur d'Alene Lake.

Glaciially striated cobbles were found in the old gravels at several localities along the south fork of the Coeur d'Alene River (Dorr, in press) indicating that they consist at least partly of fresh or newly reworked glacial debris. In both the Murray area and along the South Fork of the Coeur d'Alene River it can be demonstrated that these gravels filled former valleys to depths of at least 700 feet and that later rejuvenation caused the streams to cut new valleys 900 or more feet deep in resistant quartzite strata before later accumulations of gravel were formed as a result of downstream blocking of drainage by continental ice of Wisconsin age. On the basis of these observations, the old gravels, which constitute the bench gravels in the Murray area, are believed to have been deposited during the Illinoian subdivision of the Pleistocene epoch.
After about 700 feet of gravels had accumulated, the main streams attained equilibrium and then wandered back and forth across the level surface of the deposits. Vertical variation in stream position became subordinate to lateral shifting. The migrating channel, or channels if the streams were braided, eroded the sides of the valleys, forming ever-widening flood-plain flats. Along Prichard Creek for three miles west of the site of Murray lateral cutting was concentrated against the southern side of the valley, perhaps because streamflow off the flanks of Murray Peak to the north was much greater and carried more debris to the main valley floor than came from the south. The broad, gently sloping surface which resulted from the southern migration of this portion of ancestral Prichard Creek is now represented by accordant ridgecrests at the confluence of Prichard Creek and Eagle Creek at elevations of about 3,200 feet. This lateral migration also caused a narrowing of the divide south of Prichard Creek and created a col where the divide was narrowest. This col is now known as Kings Pass.

Melting and failure of the ice dam to the west permitted at least partial drainage of Glacial Lake Coeur d'Alene and thus a lowering of the local baselevel which affected all streams draining into the lake. As a result, a wave of rejuvenation and renewed downcutting worked headward along all of these streams. The streams flowing on gravel valley fill began to cut down along the approximate courses they followed at that time. In some instances these courses were vertically above the pre-fill courses. In other places the course of a stream diverged considerably from the pre-fill channel. In the Murray area such divergence is especially noticeable in the reach of Prichard Creek which extends from the mouth of Butte Gulch to the mouth of Eagle Creek, about four and one half miles to the west. Here the new channel position is as much as half a mile south of the old position.

The renewed erosion continued downward until youthful valleys had been excavated to elevations somewhat below the present valley floors (see Fig. 5). The bedrock bottom of Prichard Creek at Murray is 30 to 50 feet below present stream level. This downcutting appears to have ended with some valley floor widening, at least by Prichard Creek west of Murray where two small channels are separated by a low, narrow bedrock ridge.

There then followed a second episode of deposition caused by downstream blockage of drainage. Advancing Wisconsin continental ice again formed a dam at the head of Coeur d'Alene Lake, eighty miles downstream from Murray. This ice dam impounded drainage from the Coeur d'Alene, St. Joe, and St. Maries Rivers and numerous smaller streams. Lake level rose until an overflow outlet was achieved across the plateau basalts along
Figure 5. Diagrammatic cross-section west of Murray.
Bench gravels fill the old valley of Prichard Creek and are intersected by the McComber Gulch Mine. Valley-fill alluvium underlies the present floor of Prichard Creek Valley and also extends slightly above stream level at some localities.
the southwestern side of the lake. The spillway is located near a railroad siding called Setters six miles east of Rockford, Washington. Here there is a low point in the divide between Lake Creek which flows eastward into Coeur d'Alene Lake and Rock Creek which flows northwest into the Spokane River. Lake level was stabilized by overflow across the spillway at approximately 2,580 feet above sea level. Arms of this lake extended long distances up the valleys of major streams entering from the east (see Fig. 1). In the valley of Prichard Creek lake-head was located near the present site of Murray. All streams flowing into this body of quiet water rapidly deposited the coarser-grained fraction of their load, causing filling of the lower parts of the valleys. At Murray about 70 feet of gravel accumulated on the floor of the valley of Prichard Creek.

Once again the continental glaciers melted, the ice dam at the north end of Glacial Lake Coeur d'Alene disappeared, and lake level declined. Stabilization was achieved at an elevation of 2,124 feet, controlled by the level of glacial outwash and a threshold at Post Falls, Idaho where the Spokane River is superimposed from the outwash gravels onto a buried spur of resistant basalt. As a result of the decrease in lake level, all streams entering from the east were again rejuvenated. Consequent regrading of Prichard Creek has removed about 20 feet of the gravel fill. During the last seventy-five years, placer operations have considerably modified the fine details of the landscape wherever gold-bearing gravels or slope-wash material were thought to be present.

**Placer Operations**

Placer operations in the Murray area have had a long and varied history. There is disagreement among historical accounts as to when gold was first discovered, but it is certain that there were no attempts at exploitation of deposits until the spring of 1883 when A. J. Prichard (sometimes spelled Pritchard) staked his Discovery Group of placer claims at the present site of Murray. His appearance in the trading center of Spokane, Washington with several sacks of nuggets and tales of valleys filled with gold-bearing gravel caused a general rush of prospectors to the area. The first settlement was Eagle City, located on the floodplain where Eagle Creek joins Prichard Creek. Attention was quickly concentrated in the vicinity of Prichard's Discovery Group, however, and by January, 1884, it is reported that there had sprung up the town of Murray consisting of tents and cabins occupied by 10,000 miners, businessmen, and hangers-on. As more discoveries of gold were made along Prichard Creek and its tributaries and along Beaver Creek
to the south, additional towns were formed. Chief among these were Butte City (later called Littlefield) at the mouth of Butte Gulch, Raven City at the mouth of Bear Gulch, Beaver City (later called Delta) at the confluence of Beaver Creek and Trail Creek, Myrtle (later called Thiard) at the head of Trail Creek, and Carbon City at the head of Beaver Creek. Large segments of the population shifted quickly from one discovery site to the next.

During 1884 the entire Murray area was the scene of feverish activity. Placer operations were undertaken on Prichard Creek and Beaver Creek and on most of their tributaries with varying success. The richest ground was located along Prichard Creek near Murray and on tributaries such as Alder, Buckskin, Dream, and Accident Gulches. Intensive work was also in progress on the lower reaches of Eagle Creek and its tributaries Daisy and Fancy Gulches and along the middle portion of Beaver Creek and its tributaries Pony and Trail Gulches. Because water in quantities sufficient for the placer operations was scarce, especially as exploitation of the bench gravels began, construction of ditches and flumes was planned to bring water from distant sources to points of greatest activity and need. Large cooperative ventures were initiated and during the following two or three years available creek flow was carried from watershed to watershed as one group of claims was worked and then another. Perhaps the most outstanding successful project of this type was the construction of a ditch and flume which brought water from the head of Prospect Creek in Montana across the Bitterroot Mountain divide by way of Thompson Pass and thence down Prichard Creek to Murray, a total distance of about 12 miles. A thirteen-mile flume was built to carry water along the northern side of Beaver Creek valley to Trail Creek and thence upstream to Potosi and Placer Gulches. An even more spectacular plan, to build a "bedrock flume" 16 feet wide to carry water from the Coeur d'Alene River upstream along Prichard Creek to Murray, ended in failure.

With so many miners at work during the height of the rush, the richer ground was quickly exhausted, operations gradually declined, and by 1890 the population of Murray was only 450 persons. Individual placer claims were worked at many localities, but in 1900 much of the Prichard ground was acquired by the Coeur d'Alene Mining Company, which devoted most of its activity toward further prospecting. In 1903 three small dredges began working the valley-floor alluvium near the confluence of Beaver Creek and Trail Creek. Success was slight and the attempt was soon abandoned. In 1917 a large dredge was brought from Alaska by the Yukon Gold Company and installed in a pond excavated in the valley-floor alluvium of Prichard Creek about a mile downstream from Murray. This dredge operated at a profit until 1926, working the valley-fill

* Historical data from Shiach et al (1903), Richard (1920), and Stoll (1932).
alluvium and portions of the bedrock floor of the valley from near the confluence of Accident Gulch upstream to the confluence of Bear Gulch, a total distance of approximately five miles.

The national depression brought renewed activity during the early 1930's when many individual claims were worked. During this period the rich Beehive ground was discovered along the southern side of Prichard Creek west of Murray where dissected remnants of the valley-floor alluvium are present ten to twenty feet above present stream level. Within the past decade placer operations have been conducted on a very sporadic and small-scale basis. The one exception was the working of the valley-floor alluvium along Trail Creek by a dragline and large washing plant.

At the present time placer operations are limited to scattered work by individuals or small groups. The McComber Gulch Mine is being worked occasionally in the gravels of the old filled channel of Prichard Creek. Surface operations are limited to desultory sluicing on small tributaries of Trail Creek, on Bedrock Gulch, and on Buckskin Gulch, and bulldozer exploration of the old Mountain Lion property west of Murray. At the latter location slopewash and landslide debris containing gold adjoins and partly overlies the highest portions of the valley-fill alluvium which was worked by the Beehive mines.

**FUTURE OUTLOOK**

The gold which occurs in placer deposits was originally contained in veins or was disseminated through rock formed from or affected by igneous activity. Various processes of weathering and erosion break up the bedrock as it is exposed at the surface of the ground and the resulting loose debris is moved down the hillsides by gravity and rainwash. During this movement very little concentration of the gold occurs. Eventually, however, this material is carried into streams of flowing water in which sorting and classifying by particle size, shape, and weight quickly begins. The volume and velocity, and consequently the carrying power of streams undergoes rather continuous variation. During high water stages a stream is able to scour away loose valley-floor alluvium to depths as great as three feet for each foot the water surface rises. With the coming of low water stages, debris transported from upstream fills the valley to the original level. As water level fluctuates, there is, therefore, a more or less continual shifting of particles on the stream bed which, by a jiggling action, permits the heavier gold to work down through the lighter rock and mineral fragments
present. As a result, although the entire mass of valley-floor alluvium may contain small quantities of gold particles, the rich concentrations will form on the bedrock floor beneath the alluvium or on fine-grained layers within the alluvium, such as clay or peat, which are not susceptible to scouring by the stream and through which the gold cannot move. Such layers are called false bottoms by placer miners. Furthermore, any small depressions in the bedrock or false bottom surface will tend to trap even larger quantities of gold. This is especially true of long, narrow slots which trend at right angles to the direction of flow of the stream.

The sources of placer gold in the Murray area consist of mineralized shear zones that cut across the bedding and quartz veins which lie along the bedding. Some of the largest have been worked by lode mines, but most are too small for this exploitation and indeed remain undiscovered beneath the soil. The distribution of these primary sources is apparently not constant throughout the area. The comparatively great richness of placer deposits in gulches on the southern and southwestern slopes of Murray Peak near Murray and in gulches tributary to the east side of Trail Creek indicates that gold-bearing veins or shear zones are also especially numerous or rich in the drainage basins of those areas.

In the Murray area, gold was first concentrated in the alluvium which was deposited during a previous cycle of erosion and which now constitutes the bench gravels. Some of this gold was further concentrated when gulches of the present cycle cut through the former deposits and reworked those gravels. Therefore, as a result of the particular sequence of geomorphic events which transpired in the Murray area, the richest placer ground can be expected to occur in alluvium flooring present drainage lines close to and short distances downstream from the bench gravels. This fact was well recognized by the early placer miners and most of the gulches in this position have been worked down to or slightly into the bedrock floor. However, some unworked ground of this type does remain and is well worthy of further prospecting. Furthermore, some of the ground worked by the early, inefficient methods of placer operation undoubtedly contains more gold which could be obtained through use of modern methods of exploitation. In many of the smaller gulches it is extremely difficult to tell where early placer operations ceased and the ground is undisturbed. Detailed and careful prospecting will therefore be necessary if the overlooking of small but potentially rich pockets is to be avoided.

The rich Beehive workings, active in the early 1930s, were so named because remnants of dissected valley-floor alluvium 10 to 20 feet above present stream level were cut by numerous
small tunnels and stopes. No detailed information regarding
the extent and pattern of these workings is available and only
a few of the portals are open to even casual inspection. It
is certain, however, that some unworked ground remains.

The difficulties encountered in recovering all of the gold
lying on the bedrock floors of the valleys are well illustrated
by new exposures at the old Mountain Lion Mine west of Murray.
Current operations have cleared portions of the bedrock bench
present on the southern side of Prichard Creek. The surface
beneath the upper part of the dissected valley-floor alluvium
is highly irregular on a small scale. Thin-bedded argillites
and quartzites of the Prichard formation are steeply dipping
and are broken by numerous joints and shear zones, also tending
to have steep dips. Erosion by Prichard Creek at the time it
was flowing on this surface etched out the weaker layers and
zones, forming numerous small, irregular re-entrants into the
rock surface. In some instances, narrow slots less than two
inches wide have been eaten two feet or more into the bedrock.
These depressions in the stream bed act as natural riffles and
tend to catch all particles of gold being carried over the
position by the stream. A close and careful cleaning of these
pockets often yields small but rich concentrations of gold.

Dredging operations by the Yukon Gold Company along Pri-
chard Creek attempted to remove the upper few feet of the sub-
gravel bedrock in order to secure gold lodged in the slots and
crevices. That some bedrock was indeed brought up by the dredge
is attested to by the presence of angular fragments of rock in
the tailings piles. However, the extreme irregularity of the
bedrock surface as exposed at the Mountain Lion Mine, and the
presence of a deeper inner channel of unknown pattern and extent,
strongly suggests that considerable gold is probably still on
the floor of Prichard Creek valley. At the time of dredging
operations, company representatives stated that gold recovery
was at a very high rate, but local inhabitants insist that only
a small proportion of the gold content indicated by exploratory
drill holes ever was recovered. Drainage of the valley-floor
alluvium and methods of exposure of the bedrock surface present
major problems in working this ground.

Great volumes of unworked bench gravels remain in the
Murray area, especially at the confluence of Prichard Creek
and Eagle Creek. Gold is undoubtedly present in much of this
debris, but the quantities would be extremely small. Rich con-
centrations can be expected to occur along the bedrock floors
of the filled channels of Prichard Creek and its tributaries,
and on the upper surfaces of discontinuous clay lenses which may
be present. The removal of low-grade overburden to reach these
concentrations would be difficult and costly. Tunneling along the bedrock floor of the old valley would open only the potentially rich ground, but presents problems of drainage and heavy ground.

The profitable exploitation of placer ground is inevitably restricted not only by practical problems of mining mechanics, but also by the value of the ultimate product. The high costs of labor and materials at the present time, when coupled with a gold price set by law, make most of the placer ground in the Murray area either marginal or distinctly unprofitable to work. Persevering exploration will undoubtedly result in the discovery of small, rich pockets which can be worked to considerable profit by a single miner or a small group. Large scale operations must await a higher price for gold or lower costs for labor and materials. If either of these economic changes occurs, the Murray area can expect a resurgence of activity to occur at once.
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