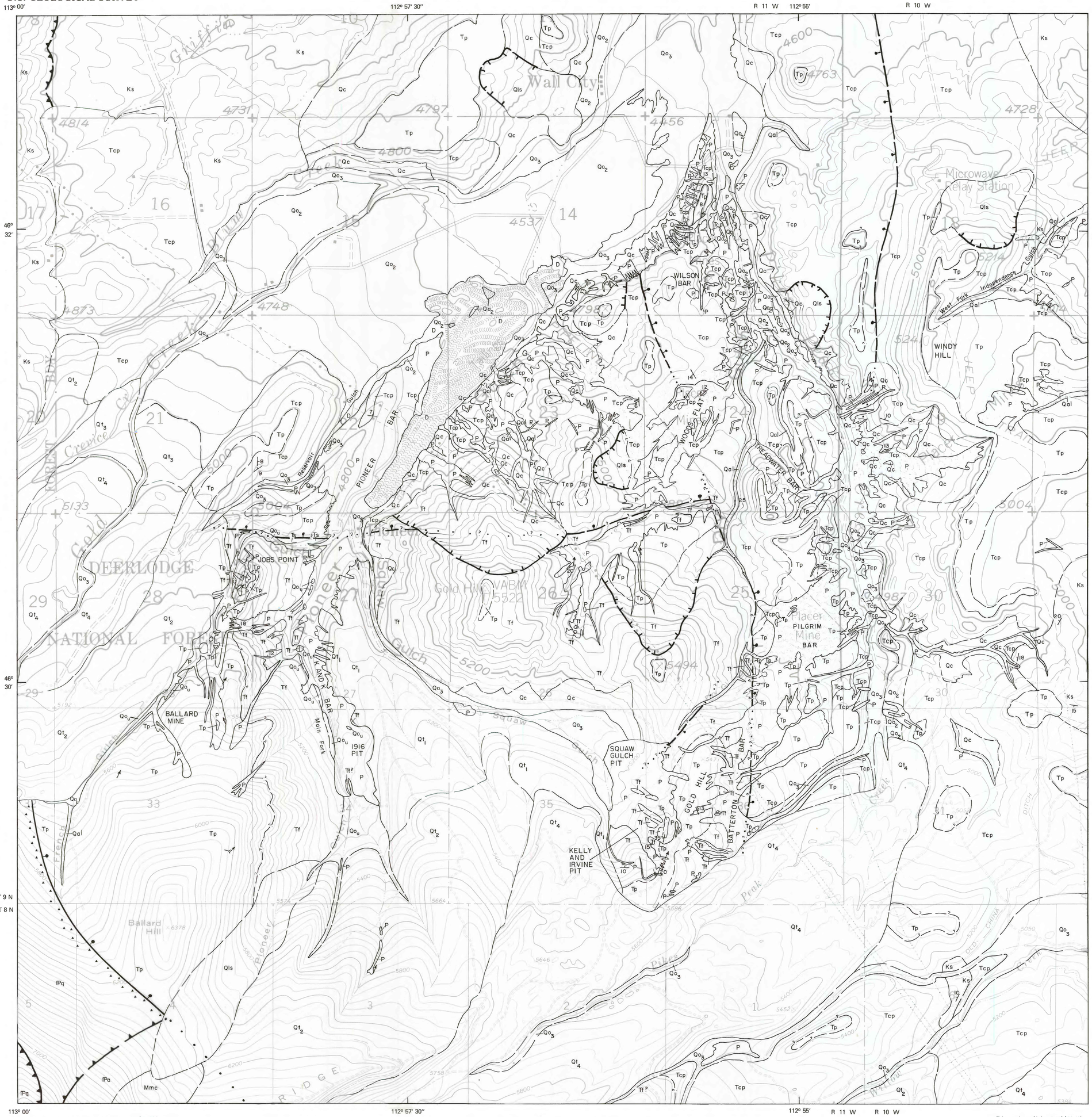


Base from U.S. Geological Survey; 1:62,500, Garrison, 1952; 1:24,000, Rock Creek Lake, 1967

SCALE 1:12 000

½ 0 1 MILE

.5 0 1 KILOMETER

CONTOUR INTERVAL 40 FEET
DATUM IS MEAN SEA LEVEL

N
19° MN

MONTANA

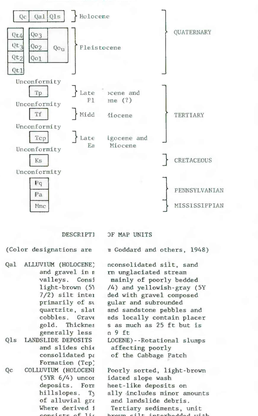
This map is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature.

GEOLOGIC MAP OF THE PIONEER DISTRICT, POWELL COUNTY, MONTANA

By
Jeffrey S. Loen and Michael R. Waters
1988

EXPLANATION

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

(Color designations are from Goddard and others, 1948)

Qal ALLUVIUM (HOLOCENE)--Unconsolidated silt, sand and gravel in stream valleys. Commonly light-brown (5Y 7/2) silt interbedded with gray (5Y 6/1) sand primarily of stream-worked quartzite, slate, and sandstone cobbles. Gravel locally contains placer gold. Thickness is generally less than 5 ft

Qls LANDSLIDE DEPOSITS (HOLOCENE)--Rotational slumps and slides consisting of poorly sorted, unconsolidated silt, sand, and gravel derived from the Cabbage Patch Formation (Tcp).

Qc COLLUVIUM (HOLOCENE)--Poorly sorted, light-brown (5YR 6/4) unconsolidated silt and sand. Colluvial deposits form gentle slopes on hillslopes. Thickness is generally less than 5 ft. Where derived from alluvial gravels, colluvium consists of light-brown silt and sand with a few pebble- and cobble-size clasts of quartzite, slate, and sandstone. Where derived from Mesozoic and Paleozoic units, colluvium consists of light-brown silt and sand with a few pebble- and cobble-size clasts of quartzite, slate, and sandstone derived from Mesozoic and Paleozoic units. Locally contains placer gold. Thickness is generally less than 5 ft

Qo3 YOUNG OUTWASH--Poorly sorted, unconsolidated fluvial gravel in stream valleys approximately 5 ft above the level of the modern streams. Typically consists of gray (N7), well-stratified, poorly sorted, subrounded pebbles, cobbles, and boulders of Cretaceous granodiorite in a sandy matrix. Locally contains placer gold. Terraces are identified above modern streams and dominantly of weathering of included clasts.

Qo2 INTERMEDIATE OUTWASH--Poorly sorted, unconsolidated fluvial gravel in stream valleys approximately 9 ft above the level of the modern streams. Terrace surface is generally unweathered and locally contains placer gold. Siltstone forms massive beds ranging in thickness from 3 in. to 2 ft. Reddish-brown, clay-rich paleosols as much as 4 ft thick are developed in unit on Gold Hill and Ballard Hill. Unit is typically 10 to 20 ft thick in the central and northern map area; however, as much as 650 ft of conglomerate may be present on Ballard Hill in the southwestern part of the map area.

Tf FANGLOMERATE (MIDDLE MIOCENE)--Interstratified deposits of reddish-brown pebble and cobble-sized conglomerate and yellowish-gray (5Y 7/2) to grayish-orange (10YR 7/4) clay-rich, weakly consolidated siltstone and sandstone. Conglomerate consists of poorly to well-cemented gravel made of well-rounded clasts of quartzite, slate, and sandstone. Conglomerate locally contains placer gold. Siltstone contains Barstovian land-mammal age vertebrate fossils (C.A. Repenning, written commun., 1986) and wood. Maximum thickness of unit is approximately 600 ft

Tcp CABBAGE PATCH FORMATION (EARLY MIOCENE AND OLIGOCENE)--Interbedded tuffaceous gray (N7) to pale-yellowish-brown (10YR 6/2) mudstone, siltstone, arkosic sandstone, shale, marl, diatomite, and lignite. Interbedded mudstone and siltstone are the most abundant lithologies. Contains Oligocene and early Miocene freshwater invertebrate fossils (R.M. Forester, J.P. Bradbury, written commun., 1986). Forms round-topped hills in northern and eastern part of map. Maximum thickness is probably greater than 2,000 ft

Ks SEDIMENTARY ROCKS, UNDIVIDED (CRETACEOUS)--Includes sandstone and conglomerate belonging to the Colden Spike and Kootenai Formations, and the Colorado Group. Maximum thickness of total sequence in Drummond-Garrison area ranges from 21,280 to 24,080 ft (Ruppel and others, 1981, table 7)

PzQ QUADRANT FORMATION (PENNSYLVANIAN)--Ridge-forming, angular to subangular, well-sorted, medium- to fine-grained quartzite. Strongly brecciated, isoclinally folded, and cut by thrust faults and fractures southwest of Ballard Hill. About 85 ft thick (Elliott and others, 1984)

PzA AMSDEN FORMATION (PENNSYLVANIAN)--Red, silty mudstone and shale, and red siltstone interbedded with sandstone and gray limestone. Tightly folded and cut by thrust faults southwest of Ballard Hill. About 300 ft thick (Elliott and others, 1984)

Mmc MISSION CANYON LIMESTONE (MISSISSIPPIAN)--Richly fossiliferous, well-bedded biosparite and biopsparmicrite that locally contains black chert concretions. Contains paleokarst features including caverns and breccias. About 900 ft thick (Elliott and others, 1984)

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DISTURBED SURFACE MATERIALS

Areas mined by ground sluicing and hydraulic mining. Includes mine tailings

Areas mined by dredging. Includes mine tailings.

CONTACT--Dashed where approximately located or inferred; dotted where concealed. Queried where location uncertain

NORMAL FAULT--Dashed where approximately located or inferred; dotted where concealed. Queried where location uncertain. Bar and ball on downthrown side

FAULT BRECCIA

THRUST FAULT--Dashed where approximately located or inferred; dotted where concealed. Queried where location uncertain. Sawteeth on upper plate

LANDSLIDE SCARP--Dashed where approximately located or inferred. Hachures point towards landslide

15 STRIKE AND DIP OF BEDS

PALEOCURRENT DIRECTIONS OF IMBRICATED CLASTS IN PEDIMENT GRAVEL (Tp)

ADIT

INTRODUCTION

The first discovery of placer gold in Montana was made along Gold Creek in 1852. Mining of placers in the Pioneer district between 1862 and 1959 produced approximately 300,000 ounces of gold (Loen, 1986). The placers occur both in Quaternary stream valleys and on Tertiary geomorphic surfaces lying hundreds of feet above the present floodplains.

Previous studies by Lyden (1948) and Pardee (1951) determined that the oldest gold-bearing unit in the district was glacial drift deposited by an ice sheet during the first of three Pleistocene glaciations. The early drift was presumably reworked into fluvial placers that occurred as terraces and along valley bottoms by stream downcutting during Pleistocene interglacial intervals and the Holocene. An alternate interpretation to this hypothesis was presented by Loen (1986) who emphasized the influence of Tertiary geologic events on the formation of the placers. This map shows the locations of placer mines in the Pioneer district and the types and ages of the host rocks for the placers.

GEOLOGIC SETTING

The Pioneer district occupies piedmont slopes extending northeast from the Flint Creek Range. The Flint Creek Range is underlain by a folded and thrust-faulted sequence of sedimentary rocks that range in age from Middle Proterozoic to Late Cretaceous. Granodiorite of the late Cretaceous Royal stock (67 m.y. old by fission-track dating) (Baty, 1976) intruded the sedimentary rocks after thrusting ceased. The stock and surrounding sedimentary rocks in the contact aureole are cut by abundant quartz veins, many of which contain anomalous base and precious metal values (Elliott and others, 1984).

The district is underlain principally by Tertiary age strata of the Bozeman Group. These strata represent a disjunct remnant of basin-fill strata originally deposited within a single large basin and greatly modified by later erosion and structural movements (Rasmussen, 1977). The present basin, the Gold Creek basin, probably developed in response to uplift and block faulting mainly during the Miocene and Pliocene.

The present drainage system developed during regional stream incision between the Pliocene and middle Pleistocene. In the middle Pleistocene, glaciers developed in the mountains of the Flint Creek Range and flowed down valleys to the southern portion of the study area. During the Holocene, colluvial aprons formed along stream valleys and the poorly consolidated Tertiary units slumped and landslides extended into the adjacent valleys.

TERTIARY SEDIMENTATION

Valley fill of the Bozeman Group in the district is divided into three sequences that represent two distinct sedimentation styles. The oldest unit, the Cabbage Patch Formation (formerly the Cabbage Patch beds of Konizeski and Donohoe, 1958), consists dominantly of tuffaceous mudstone and siltstone deposited under low-energy conditions in stream channels and lakes occupying a single broad basin (Rasmussen, 1977). A younger group of rocks, represented by fanglomerate and pediment gravel, consists principally of siltstone, sandstone, and conglomerate deposited under relatively high-energy conditions along the margins of an active fault-block uplift (Loen, 1986). The Cabbage Patch Formation is separated from these younger units by a regional unconformity of Early to Middle Miocene age (21-17 m.y.) that may represent the beginning of block faulting in western Montana (Rasmussen, 1973).

GLACIAL HISTORY

Alpine glaciers moved down the Pikes Peak and Gold Creek valleys during the late Pleistocene and deposited till that is subdivided into four principal ages on the basis of relative weathering criteria. The deposits blanket the upper valleys of Pikes Peak Creek and Gold Creek, and parts of the valleys of Pioneer Gulch and French Gulch in the map area. The first glacier deposited a large amount of till in Pioneer Gulch, diverting later glaciers and streams to the Pikes Peak Creek valley. Locally, the latest glaciers overrode earlier till and covered small areas underlain by Tertiary sediments, such as at Gold Hill and Reservoir Hill. During each advance, large quantities of meltwater transported outwash gravels consisting predominantly of granodiorite detritus down the valleys. Much of the outwash was deposited in Pioneer Gulch and the Gold Creek valley.

The youngest till displays weathering features similar to deposits that have been identified as late Wisconsin Pinedale age in other areas. The two intermediate tills are tentatively correlated with the early Wisconsin Bull Lake Glaciation. The oldest till may be of either early Wisconsin or Pre-Wisconsin age.

STRUCTURE

Structural features in the Pioneer district include a basin-margin fault, and numerous faults and fractures cutting the Tertiary sedimentary rocks. Evidence for block faulting at the southwest margin of the study area includes a breccia zone hundreds of feet wide occupying a linear northwest-trending valley parallel to the mountain front southwest of Ballard Hill. Tertiary age rocks in the Pioneer district show indirect evidence of several stages of faulting, including abundant small-scale fractures in mudstones and siltstones, diverse bedding attitudes as steep as 30°, major unconformities at stratigraphic intervals where thick sequences of rock are present in nearby areas, and rarely, faults exposed in mining cuts. The similarity of stratigraphic relationships exposed on Ballard Hill, Jobs Point, the hills in secs. 25 and 26, and Gold Hill suggest that this area forms a fault block that behaved as a reasonably coherent structural unit during late Tertiary deformation. Fanglomerate was removed from areas to the north and east of this block during relative uplift of the northern and eastern blocks in late Miocene or Pliocene time. Pediment gravel was then deposited on the truncated surface. Subsidiary faults offset the rocks within this block. Continued faulting during the Pleistocene combined with deep erosion and local slumping has left isolated remnants of the Tertiary units, capped by pediment gravel, at several topographic levels.

ECONOMIC GEOLOGY

Gold placers were discovered in 1852, and mining began in May 1862. The first mining was accompanied by a short-lived gold rush to the district. Later in 1862 most of the miners abandoned the Pioneer district to join gold rushes to Bannack and Alder Gulch, Montana (Lyden, 1948). After the richest placers had been mined in other districts, some miners returned to Pioneer and in 1869 began large-scale systematic mining using water brought in by ditches from surrounding areas. Hydraulic mining and ground sluicing were done sporadically until the 1940's, although the greatest production occurred during the 1870's and 1880's. Pilgrim and Pioneer bars were reportedly the richest deposits worked (Pardee, 1951). During 1903-1906 and 1933-1940, dredges worked the outwash in Pioneer Gulch. The first dredge produced an unknown amount of gold in 1905 and 300 oz in 1906 (Lyden, 1948). The second dredge, "the Moeier", produced 43,600 oz of gold and 4780 oz of silver ($1,526,190) from about 930,000 yd³ of gravel (U.S. Bureau of Mines Minerals Yearbook, 1933-1940; Pardee, 1951). In 1955, 1956, and 1957 a dredge mined outwash in Reservoir Gulch, producing 2,600 oz of gold, then worth $91,100 (U.S. Bureau of Mines Minerals Yearbooks, 1955-1957).

The only dependable records for production in the district are for the years 1906 to 1959, when gold and silver valued at $2,052,000 was produced (McClernan, 1976, Table P-1). In 1897 the director of the U.S. Mint estimated the value of early gold production at $4,000,000 (Pardee, 1951, p. 96). Based on these figures, total production from the district is estimated at about $6 million.

The average gold grade of material mined in the district, excluding dredging, was probably about 0.02 to 0.04 oz per cu yd (Loen, 1986). The average grade of the richest mines in the district (Pioneer and Pilgrim Bars) probably ranged from 0.1 to 0.15 oz per cu yd (Loen, 1986). The average grade of outwash dredged in Pioneer Gulch during 1933-1940 was 0.005 oz per cu yd (Pardee, 1951, p. 78).

Placers in the Pioneer district were apparently derived from base- and precious-metal-bearing quartz veins in and on the margins of the Royal stock. The placers are classified into three main types: (1) Tertiary conglomerate, (2) Pleistocene glacial deposits, and (3) Holocene alluvium and colluvium (Loen, 1986). The oldest placers apparently served as the principal gold sources for the two younger types.

Gold was released from the veins during deep weathering under moist, warm climatic conditions in the early Miocene. Miocene mountain uplift and the accompanying arid climate triggered erosion of gold-bearing hillslope colluvium that was reworked into fluvial gold placers on mountain-front flood-plains. As uplift subsided, braided streams flowing on pediment surfaces reworked the gold-bearing gravels, forming the richest placers.

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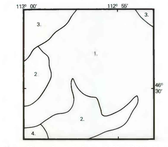

Mapping credits: 1. J.S. Loen, 1985 (1986); 2. M.R. Waters, 1984-1985; 3. C.A. Wallace, unpublished data; 4. Elliott and others (1984)