UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Placer-gold Deposits of the Las Animas District, Sierra County, New Mexico

By

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This report is preliminary and has not been edited or reviewed for conformity with U.S. Geological Survey standards and nomenclature.

Contents

Illustrations

Introduction

Investigations of the placers of the Las Animas district have shown that the gold occurs in four gravel units ranging in age from latest Miocene(?) to Holocene. The three oldest units, though unnamed locally, can probably be assigned to the Santa Fe Group. The gold appears to have been derived chiefly from hydrothermal deposits in veins and dikes radiating outward from the Copper Flat monzonite stock, which intrudes andesite and very minor amounts of sandstone of Late Cretaceous age. The gold placers, which have been the most productive in New Mexico, still retain a potential for limited future production.

Location, access, and population

The Las Animas placers occur in Sierra County, southwestern New Mexico, in the vicinity of lat. 33° N., and long. 107°30' W. (fig. 1), in part of T. 15 S., R. 6 W., and in adjacent townships to the west, southwest, and south. The area is approximately 95 miles (153 km) northwest of El Paso, Texas, and about 20 miles (32 km) southwest of Truth or Consequences, the county seat of Sierra County. The nearest town, Hillsboro, immediately southwest of the placer area, gives the name to the mining district, but inasmuch as the vicinity of Hillsboro is more of a lode-mining area than a placer-mining area, the name, Las Animas, is usually applied to the placer district.

State Highway 90, an asphalt-surfaced road that leads westward from Interstate Highway 25 to Silver City, bisects part of the Las Animas placers. El Oro Mining, Ltd. and Quintana Minerals Corp. had thriving camps at Pague Ranch and Golddust in the spring of 1975 (fig. 1). Hillsboro is the only permanent settlement in the area.

Topography, drainage, and water supply

The gold-placer deposits occur east of the Animas Hills in the upper part of a broad alluvial apron that extends eastward about 10 miles (16 km) to Caballo Reservoir (fig. 1). Las Animas Creek to the north and Percha Creek to the south are incised 250-300 feet (80-100 m) into the apron. The Animas Hills form a ring, with a diameter of about four miles (6.4 km) and a maximum altitude of 6,280 feet (1,915 m) above sea level, or about 1,000 feet (300 m) above the gently sloping ground to the east. Copper Flat, in the middle of the ring, is about 5,500 feet (1,700 m) above sea level.

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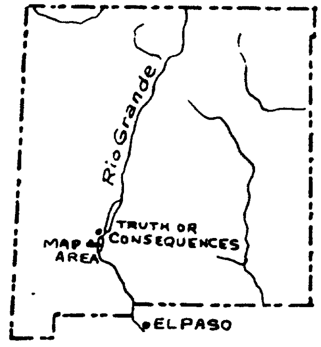


INDEX MAP O
GREENHORN

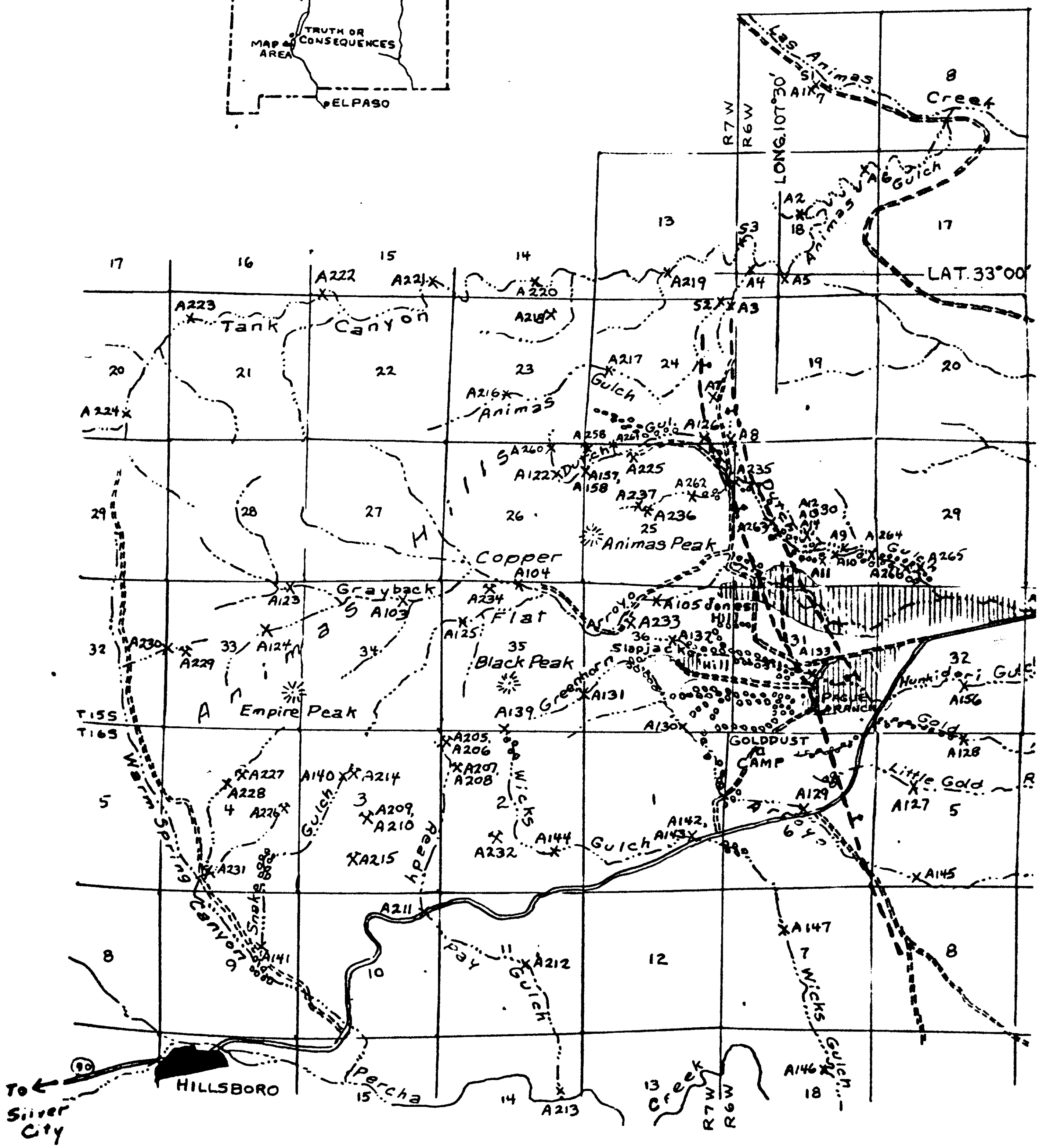
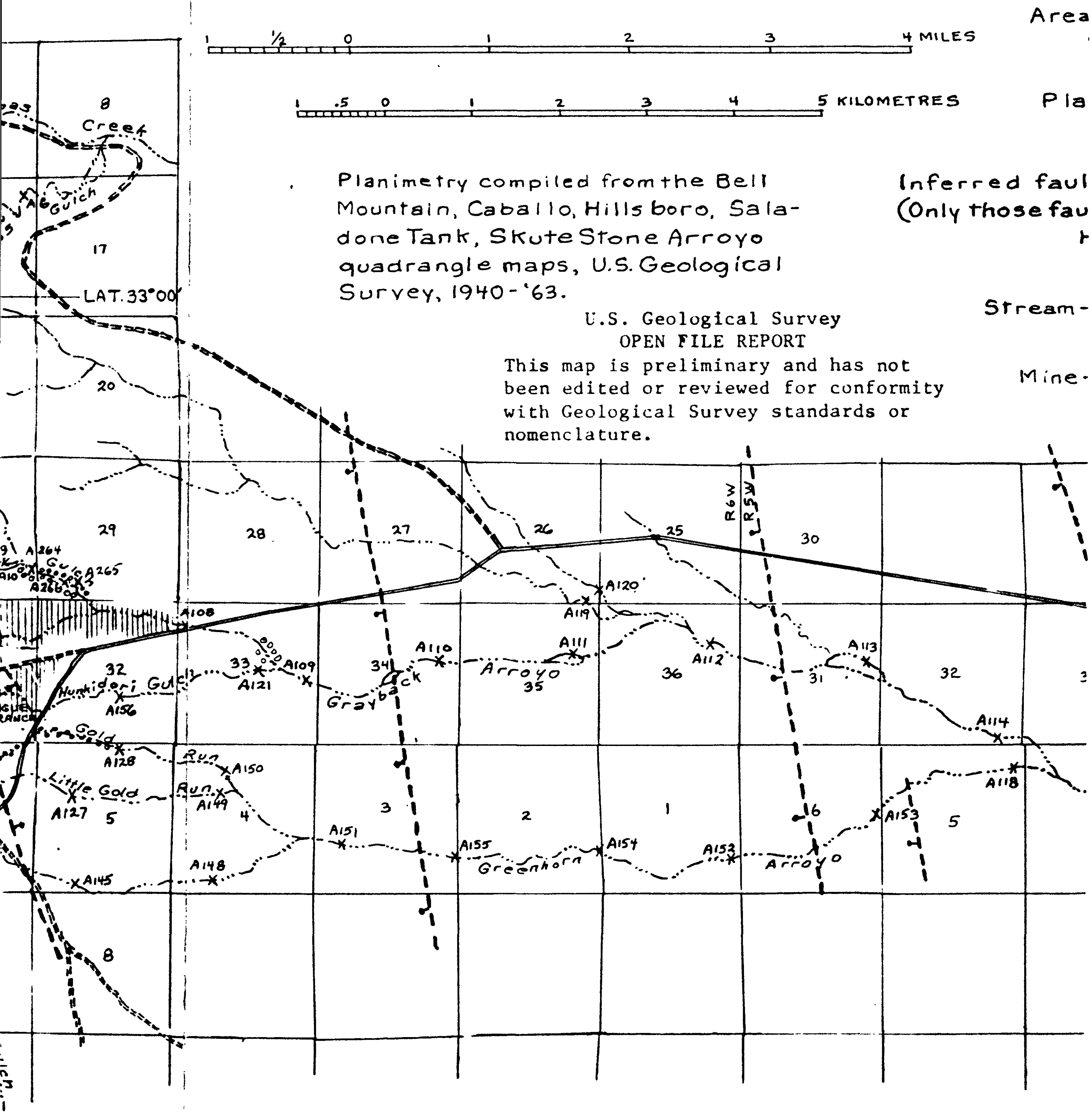


FIGURE 1.--

DEX MAP OF THE ANIMAS HILLS AND GRAYBACK-EENHORN ARROYOS, SIERRA COUNTY, N. MEX.



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BACK-
MEX.

4 MILES

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EXPLANATION

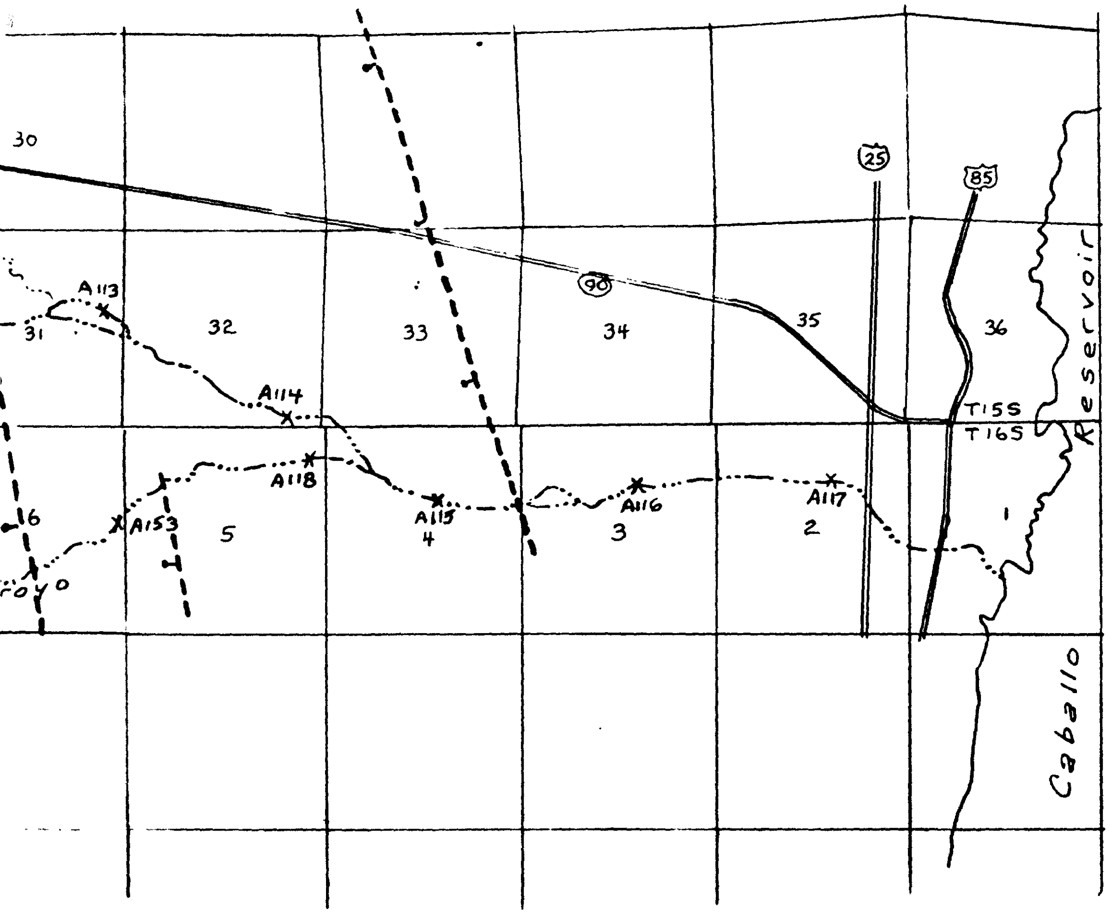
Areas mapped in detail
(Plates 1, 2, 3)

Placer-mine tailings

Inferred fault, showing downdropped block
(Only those faults which are east of the Animas Hills are shown)

X A154
Stream-sediment sample locality

A205
Mine-dump sample locality



Grayback Arroyo descends from the inner slopes of the ring of hills through Copper Flat and eastward across the alluvial apron to Caballo Reservoir (fig. 1). Most of the gold placers of the Las Animas district are in Grayback Arroyo, Greenhorn Arroyo (the next drainageway to the south), or in their tributaries. Dutch Gulch and Hunkidori Gulch to the north, and Gold Run and Little Gold Run to the south, are the principal tributaries with placer-gold deposits. Some of the placers are on interfluves between the tributaries. All of these watercourses are dry most of the year.

Las Animas and Percha Creeks parallel Grayback Arroyo to the north and south, and follow independent courses eastward to the Rio Grande. These streams drain from the high Black Range to the west, and, as contrasted with the relatively dry Grayback Arroyo, they have surface flow part of the year. The dry Tank Canyon and Animas Gulch, tributaries of Las Animas Creek, drain the north slopes of the Animas Hills. Warm Springs Canyon, Snake, Ready Pay, and Wick Gulches, also dry, are tributary to Percha Creek, and they drain west and south slopes of the hills. All of these drainageways contain auriferous gravels except possibly the upper reaches of Tank Canyon, where we found very little gold.

The Animas Hills provide very limited amounts of water, for the local precipitation is meager and groundwater recharge from the well-watered Blank Range, to the west, is diverted from the ring of hills by the deeply incised Warm Springs and Tank Canyons. Windmills at Pague Ranch and in Grayback Arroyo (T. 15 S., R. 6 W., sec. 31, pls. 1 and 2) have pumped water from wells 85 feet (26 m) deep, but the amount has been less than 100 gallons (400 litres) per minute (Harley, 1934, p. 168). Two deep wells were drilled in 1974 by Inspiration Copper Corp. in the same section (pl. 1). The northernmost of these wells, in Grayback Arroyo about 600 feet (180 m) south-southeast of 1/4 cor. secs. 30 and 31, is 860 feet (262 m) deep and does not reach bedrock; it yielded about 250 gallons (1,000 litres) per minute in March 1975 (Shell Denison, El Oro Mining, Ltd., oral commun., 1975).

Climate and vegetation

The climate is semi-arid. At Hillsboro the average annual precipitation for 48 years through 1970 was 10.98 inches (280 mm) (U.S. Dept. Commerce, 1970, p. 220). In common with other arid regions, the amount of precipitation varies greatly from year to year, but half or more of the annual total occurs during the summer months. Some of the generally light winter precipitation is in the form of snow. Temperatures are hot in the summer, generally mild in the winter, but short cold spells may occur in December through March.

Hilly areas are grassy, and virtually treeless. Flatter areas to the east are mostly covered with creosote bush.

Previous geologic studies

Detailed geologic studies have not been made of the Las Animas placers. Previous reports of the area are listed by M. G. Johnson (1972, p. 25-26). D. C. Hedlund, of the U.S. Geological Survey, mapped the Hillsboro quadrangle in 1973-1974. His open-file map and report of the area (Hedlund, 1975) were available at the time the present study was made.

Field and laboratory work

The authors spent 6 weeks in the field from October to December 1974, and Segerstrom returned for a short period in March 1975. Channel samples were cut vertically from the walls of trenches 5-17 feet (1.5-5 m) deep. Plane-table maps at 1:2,400 scale and 5-or 10-foot contour interval were made of three areas (plates 1-3) with a total area of about 1.1 mi^2 (4 km^2). The trenches that were sampled, as well as other sample localities, were plotted on these maps. In addition, samples were taken from stream beds outside the areas of planetable mapping and from mine dumps in the Animas Hills. Grayback Arroyo was sampled at one-mile (1.6 km) intervals from its source to Caballo Reservoir, and most of its tributaries, as well as principal gulches to the north and south, were similarly sampled.

In all, 265 samples were taken and concentrated by panning. All visible gold was separated from the black-sand concentrates and weighed, and atomic absorption analyses were made for gold on the black-sand residues.

Acknowledgments

C. H. Maxwell, of the U.S. Geological Survey, made many helpful comments on the regional geology. J. C. Antweiler II, of the Geological Survey, shared his vast experience in placer gold deposits with us. J. W. Hawley, of the New Mexico Bureau of Mines and Mineral Resources, shared his knowledge of Cenozoic stratigraphy of the region with us in the field. Shell Denison, of El Oro Mining, Ltd., permitted us to use his test pits (trenches), and Earl Burke, of Inspiration Copper Corp., gave us information on the two deep wells in sec. 31.

Geology

Animas Hills

The oldest rocks, Precambrian to Pennsylvanian, are limited to the lower, outside periphery of the Animas Hills. They may be summarized as follows (Hedlund, 1975):

Age	Formation	Lithology	Thickness
Precambrian	----	quartzofeldspathic gneiss	----
Cambro-Ordovician	Bliss Sandstone	quartzitic sandstone	110 ft (34 m)
Ordovician	El Paso	limestone	470 ft (143 m)
Ordovician-	Montoya	dolomite	195 ft (60 m)
Silurian	Fusselman	dolomite	114 ft (35 m)
Upper Devonian	Percha	shale	162 ft (50 m)
Mississippian-	Kelly	limestone	7 ft (2 m)
Pennsylvanian	Lake Valley	limestone	194 ft (59 m)
	Magdalena	limestone, shale	720 ft (220 m)

The Animas Hills consists predominantly of andesite flows and breccias of Late Cretaceous age. Minor interbeds of sandstone occur. The maximum thickness is about 2,732 feet (833 m) (Hedlund, 1975, p. 10). The andesites and sandstone are intruded by a stock of quartz monzonite of Late Cretaceous age (73.4±2.5 m.y.) apparently centered near Copper Flat, and by quartz latite dikes radial to the stock. A low-grade disseminated copper deposit is related to the Copper Flat stock (Kuellmer, 1955), the quartz latite dikes are mineralized, and veins radial to the stock are gold-bearing (Hedlund, 1975, p. 16). Many mine dumps were sampled and the analytical results for gold are shown in table 1. Sample localities are shown in figure 1.

The rocks of the Animas Hills are the chief source and perhaps the only source of the gravel in the placer deposits, although it is conceivable that reworked older gravels may have been minor contributors. The gold was derived mainly from the dikes and veins radial to the stock. Some gold came from disseminated sulfides in the quartz monzonite, but inasmuch as the stock is barely unroofed by erosion, this source is probably minor. Judging from the paucity of mineralized rock in the formations that predate the andesites it is doubtful that the Precambrian-to-Pennsylvanian units could have contributed gold to the placer gravels.

Placer deposits

The placer deposits of the Las Animas district consist of four gravel units, three of which are shown in plates 1, 2, and 3: (1) A calcite-cemented deposit (Tsfc) that occurs in the subsurface east of the hills and in eroded remnants on the flanks of the hills. On Slapjack Hill the probable age is 7-9 m.y., latest Miocene or earliest Pliocene (J.W. Hawley, oral commun., December 1974). (2) An overlapping gravel that mantles long, gentle slopes descending eastward toward the Rio Grande and contain as many as four or five soil-caliche layers. This fill deposit (Qsfm), hundreds of feet thick in the placer district, perhaps thousands of feet thick farther east, is about 500,000 years old (mid Pleistocene) at or near the surface, according to Hawley. (3) A gravel unit (Qsfv) lenticular in cross section, and with one or two buried soil-caliche layers, that partly fills shallow valleys cut in the No. 2 deposit. This unit is probably of late Pleistocene and/or early Holocene age. (4) Modern stream deposits. Unit 4 is combined with unit 3 in pls. 1-3 to avoid cluttering the map with a contact drawn along the present stream channels. All three units are weakly stratified and poorly sorted, for the most part, but lenticular beds of well sorted gravel and sand occur in them. The units contain cobbles, pebbles, and boulders of andesite, quartz latite, quartz monzonite, vein quartz, jasper, and chalcedony. The boulders are as much as 30 inches (75 cm) in diameter. Most of the clasts are hard, but some of them can be sliced with a shovel, even in the youngest unit. A basalt flow vesicular in part, overlies Unit 1 on Jones Hill, and the same or other flows overlie or are enclosed in unit 2. Basalt dikes cut units 1 and 2 in E. 1/2 sec. 7, T. 16 S., R. 6 W., and in SW 1/4 sec. 19, T. 15 S., R. 6 W. The entire package of gravel units and associated lava is tentatively assigned to the Santa Fe Group, of Tertiary and Quaternary age (Hawley and others, 1969). Its thickness ranges from about 12 feet (4 m) on Slapjack Hill to an unknown amount greater than 860 feet in the well near 1/4 cor. secs. 30 and 31, T. 15 S., R. 6 W.

The first unit (Tsfc) is strongly indurated with calcite cement precipitated from ground water and locally laced with calcite veins. In contrast, the second (Qsfm) and third (Qsfv) units are well indurated only in caliche zones a few inches to several feet (0.1-1.0 m) thick which underlie soil zones. Basalt clasts are absent in the first unit, but are present in units 2 and 3. A lens of reddish silt and clay (Qsfr) of probable lacustrine origin is interbedded with unit 2.

The contact between units 1 and 2 (Tsfc and Qsfm), as shown in plates 1 and 3, represents the lithologic change from gravel without clasts of basalt to gravel with such clasts. Because of its concealment by slope-wash deposits this contact is largely hypothetical. On the other hand, the contact between units 2 and 3 (Qsfm and Qsfv), as shown in plates 1, 2, and 3, is fairly well defined by a prominent and very well indurated caliche layer and by topography. Many of the trenches depicted in plates 1 and 2 are floored with this "false bedrock" (the term applied by local placer miners) at about 5-15 (1.5-5 m) below the surface of the valley-fill deposit (Qsfv). This layer was not encountered, however, as deep as 17 feet in some trenches. In the trenches at the sides of Grayback Arroyo (pl. 1) the "false bedrock" rises to within a foot (0.3 m) of the surface; at such places, the slope of the ground generally steepens and here the margin of the valley-fill deposit (Qsfv) is placed on the map. Although "false bedrock" is not as well exposed in Hunkidori Gulch (pl. 2) and other drainageways, it is assumed that the change of slope marks the contact there just as it does in Grayback Arroyo.

Most, if not all, of the gold placers in the Animas Hills, occur along the floors of narrow, steep-walled valleys, and are not over a few tens of feet (about 30 m) wide and 5-10 feet (1.5-3 m) deep. These deposits, which are locally well cemented with calcite, were not mapped, but were sampled (fig. 1).

Structure

The Las Animas placer-gold district lies in the western part of the Rio Grande trench, which extends roughly north and south along the entire length of New Mexico, and extends into southern Colorado. The exact location of the western boundary fault of the trench at the latitude of the Las Animas district, _ca_. 33°, is controversial, but it is somewhere between the Animas Hills and the Black Range, west of the placer district. The Animas Hills occupy a horst which rises out of the trench (C. H. Maxwell, oral commun., March 1975). There is no doubt, however, that most of the downdropping of the trench progressed along more than one major fault, and that one of these faults strikes north-northwest along the eastern base of the Animas Hills (fig. 1, pl. 1). This fault, which is shown with a "concealed" symbol in pl. 1, is covered by the Nos. 2 and 3 gravel units (Qsfm and Qsfv). The existence of the fault is proved by outcropping andesite (Kcfa) on the lower slope of Jones Hill and the same andesite buried by more than 860 feet (262 m) of gravel at the well site near 1/4 cor. secs. 30 and 31, T. 15 S., R. 6 W. Part of this depth to bedrock may be due to later faulting which displaced the younger gravel units along north-striking splays.

Other north-striking faults shown in figure 1 are discernible as faint, discontinuous lineaments on Skylab 3 photo images at 1:250,000 scale, taken Sept. 7, 1973, from a height of 232 nautical miles (430 km). Identification numbers of the images are G30B086057, 058, and 059; they can be ordered from the EROS Data Center at Sioux Falls, D. C. In some places the lineaments follow swales across the interfluves on either side of Grayback Arroyo. These swales show that the relative displacement was upward on the east side of the fault block, for they contain accumulations of silt presumably resulting from catchment of runoff and slope wash from the west. Grass grows in the swales, in striking contrast to the creosote bush that grows elsewhere on the interfluves. In other places the lineaments follow bends in the arroyos; a good example is Grayback Arroyo a little east of 1/4 cor. secs. 30 and 31, T. 15 S., R. 6 W.

Geologic history

The Animas Hills were a center of volcanic activity, and a thick sequence of andesite was deposited. Emplacement of the quartz monzonite of Copper Flat, radial fracturing in the andesite country rock and emplacement of the quartz latite dikes occurred in Laramide (Late Cretaceous-Paleocene) time. The stock and some of the dikes were mineralized with disseminated sulfides. The fractures which were not filled with dikes were then occupied by hydrothermal vein deposits, chiefly of quartz and sulfides, some of which were gold-bearing. The age of mineralization is unknown; it was probably early Tertiary.

The Rio Grande trench went through a complex history of recurrent faulting, possibly beginning as early as Laramide, and continuing to the present. Post-Laramide erosion of the Animas Hills was accelerated by the faulting, due to greatly lowered base level on the east side. As a result, the quartz monzonite stock was unroofed and the coarse, poorly-sorted debris derived from the andesite and intrusives was spread out in an apron of coalescing alluvial fans to the east. The greatest amount of erosion occurred in the zone which is now Copper Flat, where the andesite flows and breccias were most intensely fractured. The ring of hills that nearly encircles Copper Flat today is held up by the less fractured, more resistant andesite that was not flushed out during unroofing of the stock.

As erosion and redeposition progressed, the early debris fans were covered by later fans, and newer fill deposits partly overlapped the debris-covered apron to the west. In addition, there was local ponding, especially in areas of renewed faulting with the east sides up.

Finally, the basin-fill deposits were dissected by valleys tributary to the Rio Grande. Some of these have been partly filled with clastic sediments derived mostly from reworking of the debris apron and of the overlapping fill deposits during late Pleistocene and Holocene time.

Placer deposits

History and production

The first discovery of placer gold in the Las Animas district was in November 1877, in Snake and Wicks Gulches. During the winter of 1877-78, $90,000 was taken from Wicks Gulch. The discoveries quickly spread to other gulches and to Slapjack Hill (Jones, 1904, p. 81-82). In 1910, it was stated that the placer deposits of the district were practically exhausted (sic) (Lindgren and others, 1910, p. 275).

From 1877 to 1931, Snake and Wicks Gulches produced gold valued at $140,000 (7,000 oz at $20/oz), and the upper part of the alluvial fan drained by Grayback, Hunkidori, and Greenhorn Gulches produced gold valued at $2,000,000 (100,000 oz). The production of miscellaneous placers during this period was valued at $60,000 (3,000 oz) (Harley, 1934, p. 141, p. 167).

Production during succeeding years, as reported in the Minerals Yearbook (U.S. Bureau of Mines, 1933-43) is as follows:

	fine oz.
1932	196
1933	221
1934	1,139
1935	2,910
1936	1,716
1937	1,369
1938	2,073
1939	2,271
1940	1,688
1941	989
1942	582
1943	2
Total for 12 years	15,201

In 1934 and during the period 1936-1942, almost all of the gold was produced by the J. I. Hallett Construction Co. operating at a capacity of 1,000 to 1,200 yd^3 of gravel per 24 hours in the upper part of the alluvial apron that fans eastward from the Animas Hills. During most of this period Hallett was the chief gold producer in the State. In 1935, nearly half of the production was by William Little who operated in Gold Run. During 9 years of operation, Hallett washed 70,000 to 100,000 yd^3 per year and during 1935 Little washed 70,000 yd^3. In 1936-1937, 200,000 yd^3 of gravel yielded about 3,000 oz. of gold at an average grade of 0.015 oz per yd^3, worth about 52 cents at that time, and about $2.60 at the 1975 gold price ($1 75/oz). All gold-placer operations ceased in 1943 and from then through 1974 only very sporadic and small scale placer-mining was conducted in the district.

In February 1975, a new operation was started by El Oro Mining, Ltd. in Grayback Arroyo, NE 1/4 sec. 32, T. 15 S., R. 6 W. The operation centers around a "portable" placer mill 230 feet long and 45 feet wide designed to process 12,000 short tons (8,500 yd^3) of gravel each 24 hours of continuous operation. The mill will move ponderously on its 48 wheels so that it can be near the digging operation at all times.

Occurrence and grade

Gold was detected throughout the thick gravel section that was perforated by the two wells in and adjacent to Grayback Arroyo, in N. 1/2 sec. 31, T. 15 S., R. 6 W., by Inspriation Copper Corp. (pl. 1). Drill cuttings were analyzed for gold, with these results: In the south well, 0.005 oz per ton was detected at several intervals down to 80 feet (24 m). At various levels from 80 feet (24 m) to bedrock, at 765 feet (233 m) below the surface, values of 0.01 oz per ton showed up. In the north well, which did not reach bedrock, gold values of 0.01 oz per ton were fairly common between 515 feet (175 m) and 860 feet (262 m) below the surface (Earl Burke, oral commun., Dec., 1974).

Gold is distributed broadly throughout the apron of coalescing alluvial fans at shallow depths to as far as 0.5 to 1 mi. east of the base of the Animas Hills, and is especially common in and near the gulches that dissect the fans. Farther away out from the hills where the values are leaner, the distribution of gold is not as broad, and the values within about 16 or 17 feet (5 m) of the surface tend to be restricted to the valley-fill deposits of unit 3 (Qsfv). Exceptionally, as near sec. cor. 29, 30, 31, and 32, T. 15 S., R. 6 W., the presence of gold in unit 2 (Qsfm) suggests that a buried valley favorable to the accumulation of gold existed there (pl. 1).

The most systematic sampling by the authors was done in and adjacent to short stretches of Grayback Arroyo and Hunkidori Gulch, where about 100 test pits (trenches) were avilalbe for sampling (pls. 1 and 2). These trenches, made with a backhoe by El Oro Mining, Ltd., in 1974 are as much as 100 feet (30 m) long and 17 feet (5.2 m) deep. Most of them are in the valley fill gravel unit (Qsfv).

Cut-and-fill structures seen in the walls of the trenches show that this valley-fill unit is a composite of lesser cut and fill units as small as a few feet (1 m) wide and a few feet (1 m) deep. Many of the fill deposits are lenses of well-sorted gravel where gold might tend to be concentrated, as contrasted with the expectably less auriferous mass of unsorted detrital material exposed across most of the trench walls. In cutting vertical channel samples from the walls an effort was made to collect "random" material, lean and rich gravel representative of the mineable whole. Hence the values plotted in trenched areas of plates 1 and 2 are probably realistic.

The analytical results of "random" sampling are shown in table 2. These values, ranging from \$9.32 per yd^3 to less than one cent, based on gold price of \$175/oz., are "combined" values; that is, they represent visible gold plus gold determined by atomic-absorption analysis of the black-sand residue. The best values are around the mouth of Dutch Gulch, where the patterns drawn on plate 1 portray relatively large areas of greater than \$1.00 and \$2.00 gold values. The trenched area of Hunkidori Gulch (pl. 2) is generally leaner in gold values than that of Grayback Arroyo.

Most random samples from outside the trenched areas were cut from vertical channels in the edges of pre-World War II placer diggings, as on Slapjack Hill (pl. 3), Jones Hill (pl. 1, near west edge), and along Grayback Arroyo just east of Jones Hill. The spacing of these sample localities was not of sufficient density to make areal evaluations as in the trenched areas farther east. Analytical results from the areas of old workings are erratic because some contaminated samples could not be avoided. For example, analysis of a sample of Upper Cretaceous sand (Kcfs) from the west side of Slapjack Hill (locality A163, pl. 3) indicated a value of \$199.66 per yd^3, yet the sample contained only two nuggets and one small gold flake; the gold was dropped down on the sand during strip mining of gravel which once overlay the area.

On the other hand, some samples from in and around the diggings contained gravel that had been impoverished by placer mining, although an effort was made to avoid sampling reworked material. Despite deficiencies of sampling on Slapjack and Jones Hills and in the nearby Grayback Arroyo, it is evident that the diggings at those places were in richer gravel than most of the unworked areas farther east.

Outside the areas which were mapped by plane table, "intuitive," rather than "random" samples were taken. "Intuitive" means that the sample was taken at favorable places in stream beds: from under boulders, in plunge pools below waterfalls, along stretches where there are layers rich in black sand, etc. "Intuitive" sample localities are shown in figure 1. They are generally spaced at one-mile (1.6 km) intervals along the gulches and arroyos, but spacing is closer within Dutch Gulch. The results are shown in table 3.

The distribution of gold values at $175/oz along Grayback Arroyo from near the head to near the mouth, a distance of about 17 miles (27 km) follows: In the headwaters area, west (upstream) from Copper Flat, the values are low, ranging from 1 cent$/yd^3$ (A123) to 5 cents$/yd^3$ (A103). A good value, $1.61, was obtained from a tributary on the south side of Copper Flat (A125). East of Copper Flat for about 5 miles (8 km) the values were spotty, ranging from $0.98 (A107, pl. 1) to zero. East of the fault that crosses sec. 34, T. 15 S., R. 6 W. and sec. 3, T. 16 S., R. 6 W. the gold values show a sudden upsurge to $1.33 (A110), then in the next 5 miles (8 km) values range from ten cents to one cent. Samples A116 and A117, at the lower end of Grayback Arroyo, had no detectable gold.

Greenhorn Arroyo showed only 5-cent gold near the head, but shortly downstream from old placer workings on the west side of Slapjack Hill, a $6.50 gold value showed up (A130). Farther downstream, below other placer diggings, $1.15 showed up (A129). The eight samples that were taken farther downstream, nearly to the junction of Greenhorn and Grayback Arroyos showed values of three cents to zero with the exception of 34 cents in sample A155. This sample was taken a little east of the same fault that marked a change from lean to richer gravel in Grayback Arroyo. A possible explanation for the change in both gulches is that preexisting auriferous gravel was buried by barren sand deposited as a result of uplift of the east side of the fault.

The relatively short Hunkidori Gulch, from near its head to near its junction with Grayback Arroyo, showed sequential gold values as follows: \$1.57, zero, 0.03, and 0.01. Gold Run and Little Gold Run were not sampled at their heads because the ground there had all been reworked by placer-mining operations. Values from these two gulches ranged from zero to 3 cents except for A127, which showed \$2.26 oz./yd^3; this sample locality was closer to the head than the others on Gold Run and Little Gold Run.

Wicks Gulch showed several good values. Sequentially from the very head to near the junction with Percha Creek, these are \$0.60, 1.53, 0.01, 3.45, zero. A142, taken from the stream bed, showed only one cent, but A143, taken nearby from an old mine working in calcite-cemented gravel 12-18 feet (3.6-5.5 m) above the stream bed, showed a gold value of \$5.65. Ready Pay Gulch showed values of \$0.03, \$1.65, and \$0.05 in downstream sequence; the head was not sampled. Snake Gulch had gold values of \$0.11 and 0.07. Samples A228, A230, and A231, from other tributaries of Warm Spring Canyon, showed \$0.24, \$0.11, and \$0.23, respectively. Tank Canyon was virtually barren.

Animas Gulch showed \$0.72, 0.80, 0.09, 1.03, and zero, in downstream sequence.

Dutch Gulch, where the spacing of sample localities is closer than the one-mile (1.6 km) spacing along other watercourses, showed the following sequence of gold values from near the head to near the junction of Dutch Gulch with Grayback Arroyo: \$0.68, 0.02, 7.50, 0.09, 0.03, 0, 1.46, 0.34, 1.86, 0, 2.81, 0.01. The \$7.50 value was obtained by averaging 4 values from A157 (2 samples) and A158 (2 samples) taken within a few feet (1 m) of each other. The \$1.46 value was obtained by averaging 3 values from a single channel cut in the stream bank. The top sample showed \$4.39 in gold values, whereas the two lower samples showed no detectable gold.

Amount of placer gold; conclusions

The placer ground along Grayback Arroyo in the northern part of sec. 32, T. 15 S., R. 6 W., shown by crosshatching to contain >$0.25/yd^3 but <$1.00/yd^3 in gold values (pl. 1), totals about 36 acres. Assuming an average depth of 15 feet (5 m) to "false bedrock," below which the values tend to fall off, the area has 860,000 yd^3 of gravel. With an average value of $0.50/yd^3, this volume of gravel contains $430,000 in gold (at $175.00/oz.). Similarly, the area containing >$1.00 but <$2.00 totals about 10 acres, which to a depth of 15 feet (5 m) represents about 236,000 yd^3 of gravel. With an average value of $1.50/yd^3, this volume of gravel contains $354,000 in gold. Similarly, the area containing >$2.00 totals about 5.3 acres, which to a depth of 15 feet (5 m) represents about 151,000 yd^3 of gravel. With an average value of $3.00/yd^3 this volume of gravel contains $453,000 in gold. The total value in gold of the approximately 52 acres along Grayback Gulch, as shown above, is about $1,200,000, an average of about $1.00/yd^3.

The placer ground along Hunkidori Gulch in SE 1/4 sec. 31, T. 15 S., R. 6 W., shown by crosshatching to contain >$0.25 but <$1.00 in gold values (pl. 2) totals about 13 acres, which to a depth of 15 feet (5 m) represents about 350,000 yd^3. With an average value of $0.50 this volume of gravel contains $175,000 in gold.

The total amount of one-dollar-per-yard gravel in the area of plate 1 where there is insufficient sampling (west of sec. 32) is about the same as that of the trenched area of sec. 32, judging from distribution of the valley-fill deposit (Qsfv) and the analytical data obtained.

Slapjack Hill (pl. 3) has an area of about 15 acres that is underlain by calcite-cemented gravel (Tsfc) with an average thickness of 7 feet. About 2 acres are covered with tailings piles, and an unknown acreage honey-combed with underground workings. Thirteen samples of the gravel showed an average grade of only 36 cents per yd^3, but a fourteenth sample (A138) showed a value of $27.66. Part of this sample was scraped from bedrock at the base of the gravel, and the other samples were not, so it seems irrelevant to estimate the amount of gold remaining on the hill.

Estimation of amounts of gold in other areas of the district is extremely tenuous, because of insufficient sampling and analytical data. The amounts of gold east of sec. 32, T. 15 S., R. 6 W., are probably much too low to warrant attempts at exploitation, with the possible exception of a few acres in Grayback Arroyo and Little Gold Run. However, large amounts of gold have been obtained in the past from areas of intensive placer mining along the eastern base of the Animas Hills. The innumerable tailings piles in secs. 29, 30, and 31, T. 15 S., R. 6 W., in secs. 24, 25, and 26, T. 15 S., R. 7 W., and in sec. 6, T. 16 S., R. 6 W., occupy a total area of approximately 280 acres, including about 20 acres in the area of plate 1. The areas of tailings piles are shown in fig. 1.

A few tailing piles were sampled with erratic results ranging from 2 cents to \$1.77/yd^3. Tailings from 4000 yd^3 of gravel run through a screening and washing plant in Dutch Gulch "ran over 10 cents/yd^3" with gold at \$35/oz, which would be over 50 cents with gold at \$175/oz. The average ~~grade~~ value of gold recovered in this operation was 43 cents/yd^3 (now \$2.15) (Harley, 1934, p. 167). An average value of 50 cents/yd^3 thus seems realistic in calculating the total amount of gold in the 280 acres of tailings piles. Estimating that the piles are equivalent to an average thickness of 15 feet (3 m) of reworked gravel the total volume of tailings is about 6.8 million yd^3. The amount of gold in this volume of gravel would then be worth 3.4 million dollars (gold at \$175/oz).

The big unknown in estimating the amount of gold remaining in the district is in the large areas underlain by mantling gravel (Qsfm). These include areas between the diggings along the east base of the Animas Hills. The road from Pague Ranch to Slapjack Hill (fig. 1) traverses the largest of such areas--partly on a basalt flow (Qsfb). Even larger areas of no placer workings are on interfluves between arroyos farther downstream (east). As stated before, well cuttings show gold values to great depths below the surface, hence there is a gold resource of unknown magnitude below the basalt and below the "false bedrock" that overlies "Qsfm." The amount of this gold that is mineable at present prices or at any conceivable future price is believed to be minimal.

No attempt was made to estimate the volume of gold remaining in the gulches of the Animas Hills themselves. Judging from the amounts of gravel in these gulches and the analytical data from our sampling, the largest amounts of placer gold in the Animas Hills are in Dutch and Wicks Gulches, but at best these are amenable only to small operations of a few tens of yards per day.

It is hard to escape the conclusion that much less gold mineable at a profit remains in the Las Animas district than the 125,000 oz (about 4,000 kg) reported as taken out.

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Table 1.--Gold content of samples from mine dumps in the Animas Hills, Sierra County, New Mexico. [Sample is a rounded pan-full of standard diameter (14 in = 35.6 cm).]

Sample no.	Location T. R. S.	Gold Free (mg)	Gold After HNO_3 (mg)	Total gold oz/yd^3
A205	16-7-2	0	16.4	0.1053
A206	16-7-2	7.1	3.3	0.0668
A208	16-7-2	6.8	7.1	0.0892
A210	16-7-3	2.1	7.9	0.0642
A214	16-7-3	0	0.4	0.0026
A215	16-7-3	0.3	1.3	0.0103
A218	15-7-23	0	0	--
A225	15-7-25	0	0.5	0.0032
A226	16-7-4	5.1	29.4	0.2215
A227	16-7-4	11.8	68.4	0.5149
A229	15-7-33	0.95	4.2	0.0331
A232	16-7-2	1.3	1.6	0.0186
A233	15-7-36	0.6	0.34	0.0060
A234	15-7-35	0	0.5	0.0032
A236	15-7-25	6.0	9.0	0.0963

Table 2.--Gold content of "random" (unbiased) samples from gravel in the Las Animas placer-mining district. [Sample is a rounded pan-full of standard diameter (14 in = 35.6 cm).]

Sample no.	Location T. R. S.	Visible gold No. of particles	Visible gold Weight (mg)	Weight of gold from atomic absorption analysis of concentrate (mg)	Total gold $/yd^3 (gold at $175/oz)
A1	15-6-7	0	0	.0022	<.01
A7	15-7-24	3	0.08	.2861	0.41
A12	15-6-30	8	3.9	.0004	4.39
A13	15-6-30	0	-	0	<.01
A14	15-6-30	0	-	.0006	<.01
A15	15-6-33	2	-	.0330	0.04
A16	15-6-33	16	0.6	.0320	0.71
A17	15-6-32	10	0.7	.0180	0.81
A18	15-6-32	4	-	.0209	0.02
A19	15-6-32	2	-	.0190	0.02
A20	15-6-32	2	-	.0550	0.06
A21	15-6-32	5	-	.2800	0.33
A22	15-6-32	2	0.45	.0032	0.85
A23	15-6-32	8	0.3	.0022	0.34
A24	15-6-32	4	-	.1111	0.12
A25	15-6-32	5	0.4	.0073	0.46
A26	15-6-32	5	-	.0434	0.05
A27	15-6-32	1	-	.0228	0.02
A28	15-6-32	1	-	.0369	0.04
A29	15-6-32	1	0.5	.0079	0.57
A30	15-6-32	2	-	.0396	0.04
A31	15-6-32	5	1.0	.0086	1.14

Table 2.--cont.

Sample no.	Location T. R. S.	Visible gold No. of particles	Visible gold Weight (mg)	Weight of gold from atomic absorption analysis of concentrate (mg)	Total gold $/yd³ (gold at $175/oz)
A32	15-6-32	1	-	.0050	<.01
A33	15-6-32	7	0.2	.0165	0.26
A34	15-6-32	9	0.05	.0160	0.60
A35	15-6-32	2	-	.3322	0.37
A36	15-6-32	0	-	.0088	0.01
A37	15-6-31	8	0.8	.0092	0.91
A38	15-6-31	0	-	0	<.01
A39	15-6-31	17	2.2	.0660	2.55
A40	15-6-31	7	0.4	.1936	0.67
A41	15-6-31	0	-	.0012	<.01
A42	15-6-31	1	-	.0053	<.01
A43	15-6-31	1	0.64	.0019	0.72
A44	15-6-31	0	-	.0146	0.02
A45	15-6-31	2	-	.0083	0.01
A46	15-6-31	4	-	.0170	0.02
A47	15-6-32	32	0.75	.0399	0.94
A48	15-6-32	5	-	.0814	0.09
A49	15-6-32	6	0.3	.0200	0.36
A50	15-6-32	6	0.5	.0726	0.64
A51	15-6-32	8	1.4	.0124	1.60
A52	15-6-32	4	-	.1155	0.13
A53	15-6-32	14	0.9	.0067	1.03
A54	15-6-32	17	1.1	.0053	1.25
A55	15-6-32	2	0.6	.0194	0.70
A56	15-6-32	8	0.8	.0010	0.90
A57	15-6-32	2	-	.1034	0.12

Sample no.	Location T. R. S.	Visible gold No. of particles	Visible gold Weight (mg)	Weight of gold from atomic absorption analysis of concentrate (mg)	Total gold $/yd^3 (gold at $175/oz)
A84	15-6-31	5	-	.0814	0.09
A85	15-6-31	3	-	.0198	0.05
A86	15-6-31	9	1.4	.0007	1.58
A87	15-6-31	6	1.3	.0748	1.55
A88	15-6-31	3	-	.0506	0.06
A89	15-6-31	10	0.22	.0066	0.26
A90	15-6-31	4	-	.0363	0.04
A91	15-6-31	19	1.1	.0132	1.30
A92	15-6-31	0	-	.0308	0.03
A93	15-6-31	3	0.3	.0522	0.40
A94	15-6-31	0	-	.0006	<.01
A95	15-6-31	1	-	.0170	0.02
A96	15-6-31	3	-	.0660	0.07
A97	15-6-31	2	-	.0014	<.01
A98	15-6-31	1	-	.0020	<.01
A99	15-6-31	2	0.7	.0286	1.05
A100	15-6-31	1	-	.0418	0.05
A101	15-6-31	0	-	.0030	<.01
A102	15-6-31	1	-	.0050	<.01
A134	15-7-36	3	0.56	-	0.63
A135	15-7-36	1	-	.0130	0.01
A136	15-7-36	0	-	.0013	<.01
A137	15-7-36	7	1.7	.0305	1.95
A138	15-7-36	33	24.5	.0682	27.66
A159	15-6-32	2	-	.0946	0.11

Table 2.--cont.

Sample no.	Location T. R. S.	Visible gold No. of particles	Visible gold Weight (mg)	Weight of gold from atomic absorption analysis of concentrate (mg)	Total gold $/yd^3 (gold at $175/oz)
A160	15-6-32	1	-	.0700	<.01
A161	15-6-32	12	0.92	.0035	1.04
A162	15-6-32	5	0.20	.1826	0.43
A163	15-7-36	3	177.3	.0164	199.66
A164	15-7-36	0	-	-	<.01
A165	15-7-36	0	-	.0014	<.01
A166	15-6-29	6	1.0	.0422	1.17
A167	15-6-32	4	-	.0325	0.04
A168	15-6-32	12	1.5	-	1.69
A169	15-6-31	4	-	.0484	0.05
A170	15-6-31	1	-	.0318	0.04
A171	15-6-31	1	-	.0253	0.03
A172	15-6-31	7	0.45	.0061	0.51
A173	15-6-31	1	-	.0177	0.02
A174	15-6-31	0	-	.0229	0.02
A175	15-6-31	4	0.6	.0016	0.68
A176	15-6-31	6	0.2	.0073	0.24
A177	15-6-31	3	1.26	-	1.42
A178	15-6-31	2	0.6	.0270	0.71
A179	15-6-31	3	-	.1595	0.18
A180	15-6-31	1	-	.0239	0.03
A181	15-6-31	0	-	.0116	0.01
A182	15-6-31	0	-	.0099	0.01
A183	15-6-31	0	-	.0014	<.01
A184	15-6-31	2	-	.0748	0.08

Table 2.--cont.

Sample no.	Location T. R. S.	Visible gold No. of particles	Visible gold Weight (mg)	Weight of gold from atomic absorption ~~AA~~ analysis of concentrate (mg)	Total gold $/yd³ (gold at $175/oz)
A185	15-6-31	1	1.0	.0046	1.13
A186	15-6-31	4	-	.2530	0.28
A187	15-6-30	3	-	.3432	0.39
A188	15-6-30	1	-	.1925	0.22
A189	15-6-31	4	2.8	.0253	3.21
A190	15-6-31	1	-	.0025	<.01
A191	15-6-31	4	-	.1023	0.12
A192	15-6-31	3	0.13	.0180	0.17
A193	15-6-31	1	-	.0162	0.02
A194	15-6-31	0	-	.0049	<.01
A195	15-6-30	3	-	.0380	0.03
A196	15-6-30	10	1.51	.0657	1.77
A197	15-6-31	1	-	.0319	0.03
A198	15-6-31	3	-	.1078	0.12
A199	15-6-31	0	-	.0082	0.01
A200	15-7-36	1	-	.3608	0.41
A201	15-7-36	0	-	.0016	<.01
A202	15-7-36	2	2.74	.0076	3.09
A203	15-7-36	4	0.3	.0583	0.40
A204	15-7-36	0	-	.0814	0.09
A238	15-7-36	0	-	.0014	.01
A239	15-7-36	2	-	.0278	0.03
A241	15-7-36	4	0.7	.0203	0.81
A242	15-7-36	0	-	.0012	<.01

Table 2.--cont.

Sample no.	Location T. R. S.	Visible gold No. of particles	Weight (mg)	Weight of gold from ~~AA~~ atomic absorption analysis of concentrate (mg)	Total gold $/yd^3 (gold at $175/oz)
A243	15-7-36	0	-	.0065	0.01
A245	15-7-36	0	-	.0018	<.01
A247	15-7-36	1	-	.0638	0.07
A248	15-7-36	3	-	.0462	0.05
A249	15-7-36	1	0.4	.0028	0.45
A250	15-7-36	2	-	.0396	0.04
A251	15-7-36	4	1.2	.0119	1.36
A252	15-7-36	0	-	.0013	<.01
A253	15-7-36	0	-	.0167	0.01
A256	15-7-36	0	-	0	<.01
A257	15-7-36	0	-	0	<.01
A263	15-6-30	0	-	.0009	<.01
A264	15-6-30	6	2.5	0	2.81
S1	15-6-7	0	-	0	<.01

Table 3.--Gold content of "intuitive" (biased) gold samples taken chiefly from stream beds in the Animas Hills and in and around the Las Animas placer-mining district. [Sample is a rounded pan-full of standard diameter (14 in = 35.6 cm).]

Sample no.	Location T. R. S.	Visible gold No. of particles	Visible gold Weight (mg)	Weight of gold from ~~AA~~ atomic absorption analysis of concentrate (mg)	Total gold $/yd³ (gold at $175/oz)
A2	15-6-18	0	-	0	<0.01
A3	15-7-24	0	-	0	<0.01
A4	15-6-18	11	0.9	.0160	1.03
A5	15-6-18	1	-	0	<0.01
A6	15-6-18	0	-	0	<0.01
A8	15-7-24	2	0.14	.0065	0.16
A9	15-6-30	0	-	.0024	<0.01
A10	15-6-30	78	1.6	.0124	1.86
A11	15-6-30	3	0.3	.0048	0.34
A103	15-7-34	0	-	.0484	0.05
A104	15-7-35	0	-	.0085	0.01
A105	15-7-36	0	-	.0008	<0.01
A107	15-6-32	5	0.8	.0367	0.98
A108	15-6-33	0	-	.0038	<0.01
A109	15-6-33	4	0.20	-	0.23
A110	15-6-34	12	1.1	.0840	1.33
A111	15-6-35	1	-	.0077	0.01
A112	15-6-36	1	-	.0160	0.02

Table 3.--cont.

Sample no.	Location T. R. S.	Visible gold		Weight of gold from ~~AA~~ atomic absorption analysis of concentrate (mg)	Total gold $/yd^3 (gold at $175/oz)
		No. of particles	Weight (mg)		
A113	15-5-31	2	-	.0924	0.10
A114	15-5-32	5	-	.0605	0.07
A115	16-5-4	1	-	.0064	0.01
A116	16-5-3	0	-	.0001	<0.01
A117	16-5-2	0	-	.0007	<0.01
A118	16-5-5	1	-	.0092	0.01
A119	15-6-26	0	-	-	<0.01
A120	15-6-26	1	-	.0022	<0.01
A121	15-6-33	7	-	.0105	0.01
A122	15-7-26	34	12.8	.0210	14.43
A123	15-7-33	1	-	.0082	0.01
A124	15-7-33	0	-	.0252	0.03
A125	15-7-35	16	1.4	.0268	1.61
A126	15-7-24	10	-	.0395	0.09
A127	16-6-5	14	2.0	.0053	2.26
A128	16-6-5	0	-	-	<0.01
A129	16-6-6	4	1.0	.0107	1.15
A130	15-7-36	4	5.7	.0214	6.50
A131	15-7-36	1	-	.0420	0.05
A132	15-7-36	20	1.3	.0935	1.57
A133	15-6-31	1	-	.0072	<0.01
A139	15-7-35	6	0.5	.0330	0.60
A140	16-7-3	0	-	.0979	0.11

Table 3.--cont.

Sample no.	Location T. R. S.	Visible gold No. of particles	Visible gold Weight (mg)	Weight of gold from atomic absorption analysis of concentrate (mg)	Total gold $/yd³ (gold at $175/oz)
A141	16-7-9	3	-	0605	0.07
A142	16-7-1	1	-	.0133	0.01
A143	16-7-1	18	5.0	.0179	5.65
A144	16-7-2	18	1.1	.2558	1.53
A145	16-6-5	0	-	.0075	<0.01
A146	16-6-18	0	-	.0030	<0.01
A147	16-6-7	20	2.7	.3608	3.45
A148	16-6-4	0	-	-	<0.01
A149	16-6-4	1	-	.0242	0.03
A150	16-6-4	2	-	.0208	0.02
A151	16-6-3	0	-	.0006	<0.01
A152	16-6-1	1	-	.0249	0.03
A153	16-5-6	0	-	.0024	<0.01
A154	16-6-2	1	-	.0019	0.01
A155	16-6-3	6	0.3	.0004	0.34
A156	15-6-32	7	-	.0235	0.03
A157a	15-7-25	6	21.5	.0016	24.21
A157b	15-7-25	15	0.9	.0072	1.02
A158a	15-7-25	35	2.8	.0030	3.16
A158b	15-7-25	22	1.2	.1782	1.55
A207	16-7-2	6	1.1	.0832	1.33
A209	16-7-3	0	-	.0104	0.01
A211	16-7-10	0	-	.0242	0.03
A212	16-7-11	35	1.40	.0675	1.65
A213	16-7-14	1	-	.0484	0.05

Table 3.--cont.

Sample no.	Location T. R. S.	Visible gold		Weight of gold from ~~AA~~ atomic absorption analysis of concentrate (mg)	Total gold $/yd³ (gold at $175/oz)
		No. of particles	Weight (mg)		
A216	15-7-23	9	0.6	.0402	0.72
A217	15-7-24	3	0.7	.0116	0.80
A219	15-7-13	1	-	.2827	0.32
A220	15-7-14	0	-	.0242	0.03
A221	15-7-15	0	-	-	<0.01
A222	15-7-22	0	-	.0005	<0.01
A223	15-7-21	0	-	-	<0.01
A224	15-7-22	0	-	.0010	<0.01
A228	16-7-4	9	0.14	.0716	0.24
A230	15-7-33	1	-	.0979	0.11
A231	16-7-7	1	-	.2048	0.23
A235	15-7-25	6	-	.0266	0.03
A237	15-7-25	6	0.6	.0375	0.72
A240	15-7-36	0	-	.0157	0.02
A244	15-7-36	1	5.7	.0074	6.42
A246	15-7-36	1	-	.0231	0.03
A254	15-7-36	3	1.4	.0052	1.58
A255	15-7-36	0	-	0	<0.01
A258	15-7-25	2	-	.0396	0.04
A260	15-7-26	9	0.6	0	0.68
A261	15-7-25	0	-	0	<0.01
A262	15-7-25	26	2.5	.0135	2.83

Table 3.--cont.

Sample no.	Location T. R. S.	Visible gold No. of particles	Visible gold Weight (mg)	Weight of gold from ~~AA~~ atomic absorption analysis of concentrate (mg)	Total gold $/yd^3$ (gold at \$175/oz)
A265	15-6-29	0	-	.0096	0.01
A266	15-6-29	26	1.3	.0286	1.48
S2	15-7-24	5	0.05	.0050	0.09
S3	15-6-18	3	0.05	.0010	0.07