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No. 16

GEOLOGIC HISTORY OF BLACK HILLS GOLD PLACERS

By

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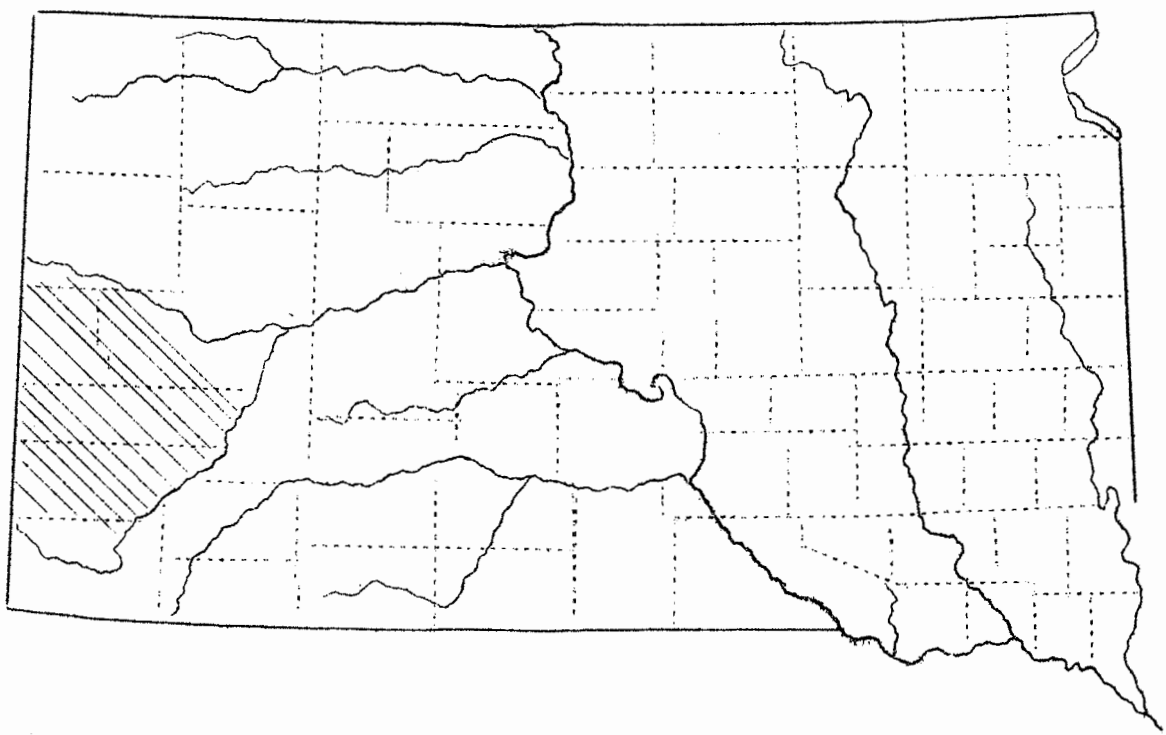
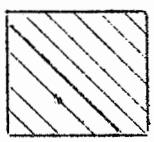
GEOLOGIC HISTORY

OF

BLACK HILLS GOLD PLACERS

INDEX MAP





Diagonal ruling indicates area covered by this report.

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PRINCIPAL DIVISIONS OF GEOLOGIC TIME

In Chronological Order with Oldest at the Bottom

Era	Period	
Cenozoic	Quaternary	Recent
		Pleistocene
	Tertiary	
Mesozoic	Cretaceous	
	Jurassic	
	Triassic	
Paleozoic	Permian	
	Pennsylvanian	
	Mississippian	
	Devonian	
	Silurian	
	Ordovician	
	Cambrian	
Pre-Cambrian Time: Proterozoic or Algonkian		
Pre-Cambrian Time: Archeozoic		

GEOLOGIC HISTORY OF THE BLACK HILLS GOLD PLACERS

INTRODUCTION

The economic conditions of the past few years have stimulated the general interest in gold and brought about renewed activity in prospecting and mining. Because of the comparative ease and small cost with which placer gold is recovered, this type of deposit has attracted more attention than the vein or lode type, particularly from people of somewhat limited experience.

"Gold is where you find it." This ancient axiom of the prospector is of course eminently true. But the implication in that statement that the occurrence of gold is haphazard, accidental, is not true. The origin of gold deposits, or of any type of geologic body, is the result of the combination of certain conditions governed by definite laws of physics and chemistry. A proper understanding of those laws and conditions has in many instances led directly to the discovery of valuable metalliferous deposits.

A previous report of the Survey outlines the general conditions controlling the origin of placer deposits of different types, lists some of the principal districts of the Black Hills, gives a resume of the laws governing the location and holding of claims and offers some suggestions as to methods of mining and recovery of the gold.[1] It is the purpose of the present paper to give in somewhat greater detail the history of the particular set of the geological conditions that have resulted in the formation of the placers of the Black Hills, and thereby offer some suggestions as to the areas that may warrant investigation by the prospective miner. The question has frequently been asked, "Where can I go to find gold in paying quantities?" It is, of course, impossible to answer that question definitely. But it is hoped that a non-technical account of the events that have brought about the accumulation of Black Hills placer gold may lead to more intelligent search in those areas where the conditions appear to be favorable, and on the other hand, may save some useless prospecting over ground whose geological history makes it very unlikely that profitable results can be obtained. This paper is directed to the prospector and miner. The professional geologist seeking information on Black Hills geological history will find this treatment altogether too brief and lacking in many details. He is referred to the many more technical treatises on Black Hills geology that are readily available to him.

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1. Anderson, Doris L. M., Prospecting for Placer Gold in South Dakota. S. D. State Geological Survey, Report of Investigation No. 15, March, 1933.

SOURCE OF THE PLACER GOLD. PRIMARY DEPOSITS.

All placer gold is "secondary", because it is derived ultimately from vein or lode deposits which are "primary". The primary gold deposits which could have given rise to placer deposits were all formed in that ancient era known to geologists as the pre-Cambrian. (See table of eras and periods of geologic time.) These pre-Cambrian primary deposits have been described in detail in other publications and only brief description of them is necessary here for the purposes of this paper. They consist of lodes or veins cutting the slates, quartzites, schists, and other metamorphic rocks of pre-Cambrian age. There are no gold veins of importance cutting the pre-Cambrian granite of the Black Hills, although most students of the region consider that the granite was the source of the primary solutions that deposited the gold ores in the metamorphic rocks. The lodes vary in width from a fraction of an inch to (in the case of the greatest of them all, the Homestake lode) several scores of feet. Most of them are short, a few feet or a few tens of feet long, but some of the greater ones attain lengths of several thousands of feet.

The chief minerals of the deposits are quartz, chlorite, amphibole, various carbonate minerals, and the sulphides, pyrite, pyrrhotite, and arsenopyrite (white iron). In these primary deposits the gold occurs as free native gold in the quartz or other gangue mineral, or as fine particles of metallic gold imbedded in the sulphide minerals, particularly pyrite and arsenopyrite. Shattering and chemical decomposition of the outcrops of these lodes, followed by erosion, have freed the gold from its closely associated minerals, and brought about its accumulation in placers in the manner described in the earlier report of the Survey.[1]

The deposition of the primary gold deposits of the Black Hills did not take place uniformly over the entire area of pre-Cambrian rocks, but was confined chiefly to a few localities. Some of the principal deposits may be mentioned here. In the northern Black Hills is the great Homestake lode which was undoubtedly the source of most of the placer gold in the vicinity of Lead and Deadwood, mined so extensively in the earlier days of Black Hills history. There are also many smaller veins and lodes, such as the Cloverleaf (Uncle Sam), and others, which contributed their share of gold to northern streams. In the vicinity of Tinton on the Wyoming border is a somewhat limited area of pre-Cambrian rocks containing numerous small lodes which have probably been, in part at least, responsible for the placers of that area. In the central and southern Hills the placers have been formed through the erosion of many gold-bearing veins, such as the Summit, Forest City, and St. Elmo near Hill City; the Holy Terror, Bullion, Columbia, Egyptian, Bismark, and other

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1. Anderson, Doris L.M. Report of Investigations No. 15.

at Keystone; and similar veins near Rochford, Silver City, and Custer. In addition to these and many other scattered primary deposits that have been large enough and rich enough to receive attention from lode miners, there are in many parts of the Hills numerous veins and lodes too small or of too low grade to be mined, but which through long continued erosion and concentration, have contributed a very considerable amount of gold to the streams.

There are also primary gold deposits in the northern part of the Hills that were formed in a much later geological period (Tertiary), but these have probably given rise to no placer accumulations of importance. In these Tertiary primary deposits the gold occurs partly as a telluride mineral, partly associated with extremely fine-grained pyrite.[1] On the weathering and erosion of these deposits the gold was set free in such a fine state of sub-division that it was dissipated in the flushing action of the streams instead of sinking readily through the current to be concentrated in the gravels.

It necessarily follows from this discussion of the source of the placer gold that there is little use in prospecting the streams in the Black Hills that do not head back or run through a considerable area of pre-Cambrian metamorphic rocks. Some possible exceptions to this statement will be made later. (Page 11.)

1. Connolly, J. P. Tertiary Mineralization of the Northern Black Hills. S. D. State School of Mines, Bulletin 15, 1927.

FIGURE 1.

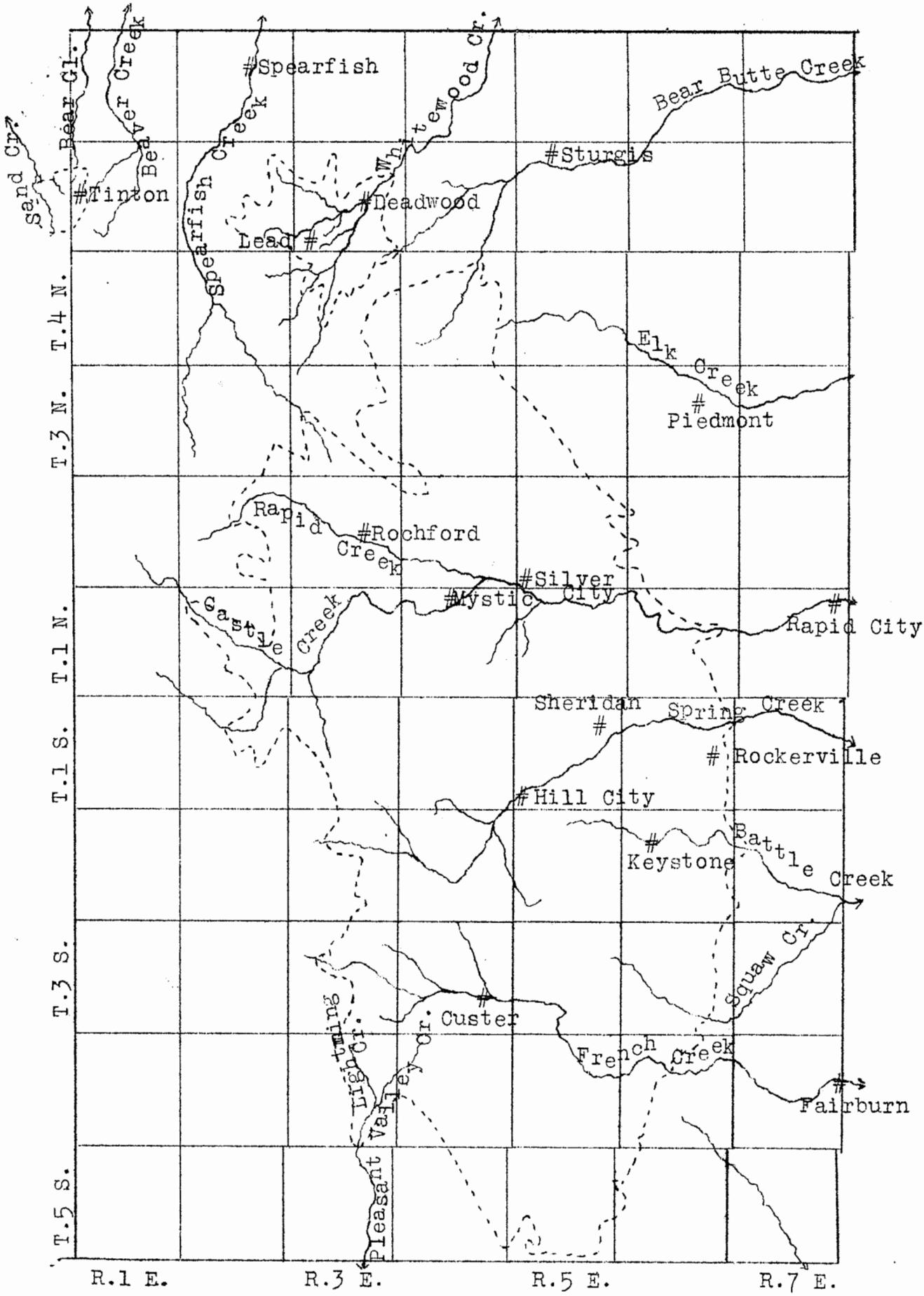
INDEX MAP OF CENTRAL BLACK HILLS

Principal towns and main streams are shown. Many small gulches tributary to main streams and which carry placer gold are not shown. The dotted lines delimit the outcrops of pre-Cambrian rocks, within which are the primary veins and lodes that were the ultimate source of the placer gold. Placer gold will not be found in commercial quantities very far outside of the areas enclosed by the dotted lines.

Data compiled from maps of the Forest Service and the U. S. Geological Survey.

Scale indicated by the squares, which are townships.

FIGURE 1. INDEX MAP OF THE CENTRAL BLACK HILLS



HISTORY SUBSEQUENT TO PRIMARY MINERALIZATION

At the close of the pre-Cambrian eras, after all the slates, schists, quartzites, and other rocks composing the central shield of the Black Hills had been formed, and after the primary gold veins had been deposited, a long period of weathering and erosion followed. The rocks and the outcrops of the veins were decomposed by weathering, and much gold was set free.

Cambrian Placers

In the Cambrian period of the Paleozoic era a great inland sea spread over this area, a sea which at first was shallow, and above the level of which jutted many rocky reefs and islands. The waves and currents of this shallow sea washed the sand and gravel back and forth, and concentrated such gold as had been previously freed from the vein outcrops. This gravel, with the gold concentrated at or near the bottom, was later cemented together into firm rock, conglomerate. This constitutes the "cement ore" of Black Hills mining history. This cement ore is thus a very ancient "fossil" placer deposit. Quite large bodies of this ore were formed in the vicinity of Lead and Deadwood, the gold evidently derived chiefly from the Homestake ledge. See Fig. 2. These deposits, although of placer origin, have not been worked by placer methods, owing to the firm, hard nature of the rock, but by the usual methods of underground mining. Similar ancient placers of Cambrian age were also formed in the southern Hills in the vicinity of Rockerville, Hayward, and to the northwest of Hill City, but they have not proven of sufficiently high grade to be mined profitably. There was undoubtedly much more placer ore of this nature formed in the Black Hills in Cambrian time. Some of it is possibly undiscovered as yet, but most of it probably has been eroded away, yielding its gold to the placers that were formed much later.

Later Paleozoic and Mesozoic History

Following the Cambrian period there were two long eras of geologic time, the events of which are of little interest to us from the standpoint of mineral deposits. During the Paleozoic and Mesozoic eras this area was under water, arms of the sea that at various times came in from the Arctic or Pacific, or great inland bodies of water not connected with the oceans. Gravel, sand, mud, and lime were deposited in thick sheets in these bodies of water, later solidified into the equivalent conglomerate, sandstone, shale, and limestone. The ancient pre-Cambrian rocks, with their outcropping veins of gold ore, and the

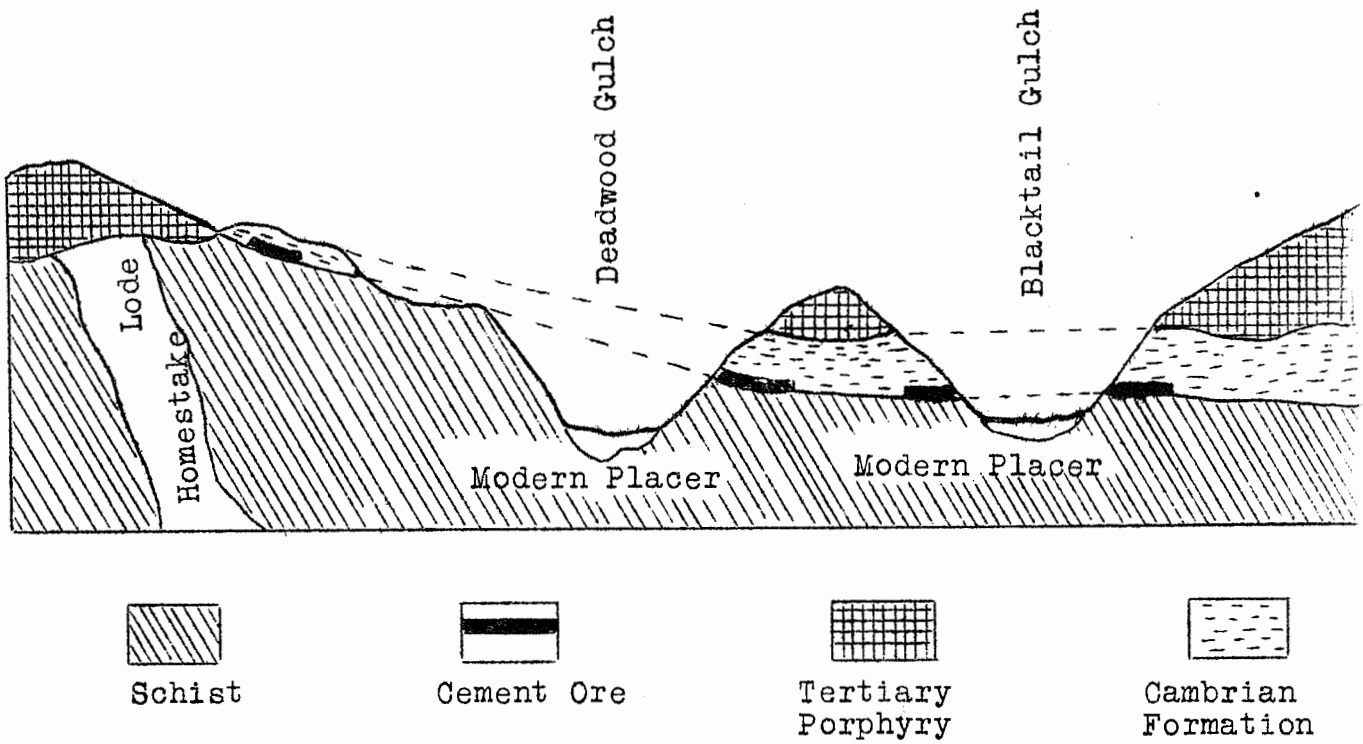


FIGURE 2.

GENERALIZED EAST-WEST CROSS SECTION OF THE HOMESTAKE DISTRICT

After W. B. Devereaux, 1882

More recent geological work has shown that this drawing is inaccurate regarding the structure of the Homestake lode and the enclosing schists, and in the complete covering of the outcrop by prophyry. It shows in a remarkably fine way, however, how the Cambrian cement ores, "fossil placers", were formed from the erosion of the Homestake lode, and the derivation of the modern placers from both the Homestake lode and the cement ores.

very old Cambrian "fossil" placers, were buried beneath thousands of feet of such sediments.

Tertiary Uplift and Erosion

Then finally there came a great change. At the end of the Mesozoic era, or in the early part of the modern Cenozoic era in what is known as the Tertiary period, this thick accumulation of sedimentary rocks began to suffer a great slow uplift. They were elevated into a great dome, like an inverted saucer. This doming in the Black Hills area was a minor accompaniment of the much greater folding movements in the Rocky Mountain region to the west. Naturally the seas were drained and the sedimentary rocks were exposed to the action of the elements. As the rain waters fell upon the dome they were congregated into streams with high erosive power. The comparatively soft sedimentary cover of the central part or top of the dome was stripped away, the pre-Cambrian basement rocks were again exposed, and the streams cut deep canyons into them. Following the usual course of river history, as the gradient of these streams gradually lessened, the larger canyons changed into broad open valleys, within which the streams meandered from side to side. At this stage in the development of a stream the valley is said to be mature in age. In these mature valleys and in their more youthful tributaries sand and gravel were deposited by the streams. Accompanying this deposition, placer gold, weathered and eroded out of the pre-Cambrian veins and also in part out of the old Cambrian fossil placers, was concentrated in the channels and bars, usually close to bed rock or sometimes just above a seam of clay which constituted a "false" bed rock. This happened in late Tertiary or early Quaternary (Pleistocene) time.

Formation of High Level Bench Placers

Then came a renewed uplift in the Black Hills, steepening the gradient of the streams and causing them to erode rapidly in their old bottoms. The larger streams cut new, steep-walled, youthful valleys within their earlier mature valleys. This process is called rejuvenation of streams. The result was that parts of the early Pleistocene river bottoms now were left as terraces or benches high up on the sides of the rejuvenated valleys. In some cases the streams were caused to change their courses entirely, and in places these older gravels, once deposited on the early stream bottoms, now occupy "saddles" on the ridges, or cap the buttes and mesas now left as remnants of erosion. By reason of minor fluctuations of level or in the velocities of the streams, more than one series of high level benches have been formed. As many as five such series of early terrace deposits have been reported from some streams.

Formation of Low Level Benches and Stream Placers

Naturally much of the gold that had been deposited on the mature valley bottoms was again eroded out, reworked, and concentrated on the bottoms of the rejuvenated valleys. But much still remained on the terraces or benches. By late Pleistocene time the rejuvenated valleys were again beginning to widen, due to decreasing gradient, and reached the stage of late youth or very early maturity. Another slight uplift took place toward the end of Pleistocene time or in the beginning of Recent time, again rejuvenating the streams. In similar manner they began to cut new channels in the old bottoms, leaving a second series of benches or terraces, with their placer gold, at a lower level than the first. Again there was a re-working of the gold, and deposition in the present stream channels, gold derived from the primary deposits, from the Cambrian fossil placers, the early Pleistocene terraces, and the late Pleistocene benches. This history is shown in the dravings of Figure 3. Usually well developed benches are to be found along the major streams only. In many places they are absent along parts of the valleys, as they were cut out in part by the erosive action of the rejuvenated streams. It is a very common thing to find remnants of terraces on one side of the stream in a given place, then further along the valley the terrace will be on the opposite side. They thus alternate from side to side along the course of the valley, corresponding with the meanderings of the stream itself. The high level terraces, being the older, are more likely to have been eroded away than those at low level, but remnants of them are found along many of the larger streams. Where these are large enough to promise sufficient volume of gravel they should be tested, as some of them, particularly in the northern Hills, have yielded profitable amounts of gold. The low level benches are quite numerous and today are yielding the larger volume of placer gold being produced in the Hills.

Summary of Placer Formations

It will be seen from this brief sketch of part of the geological history of the Black Hills that there are at least three different periods of fairly recent time when placer gold was accumulated in the stream bottoms, and thus, in a general way, three different levels where prospecting should be done,--the late Tertiary or early Pleistocene benches, "high level", now lying one hundred to three hundred feet above the streams; the late Pleistocene or Recent benches, "low level", five to ten to fifteen feet above the streams; and the present stream beds. The very early, Cambrian, fossil placers or cement ores, may still be found to yield gold in paying quantities, but because of the firmly cemented nature of the material, this ore cannot be worked as a placer. It will interest the hard rock miner only.

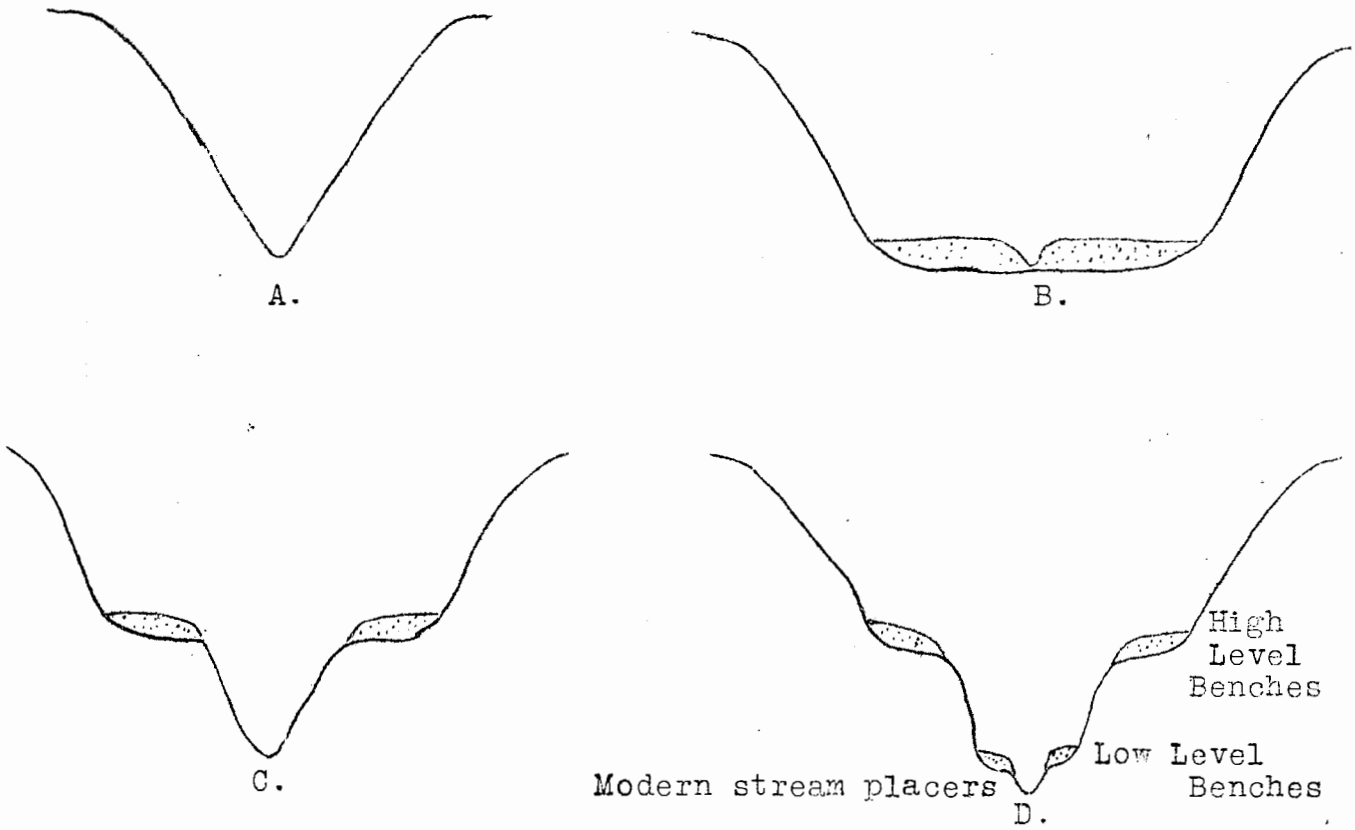


FIGURE 3

CROSS SECTIONS TO SHOW VARIOUS STAGES IN STREAM DEVELOPMENT IN THE BLACK HILLS

A. Steep walled, youthful, V-shaped valley of Tertiary time.

B. Broad, U-shaped, mature valley of early Pleistocene time, with gravel deposits containing placer gold.

C. Rejuvenated, V-shaped valley cut into the bottom of the older, mature valley, leaving sand and gravel with placer gold in the form of terraces or benches.

D. Late Pleistocene and modern valley, showing two ages of terraces, with sand, gravel, and gold, the "high level", early Pleistocene benches, and the "low level", late Pleistocene or modern benches.

It was stated earlier in this report (page 3) that little or no placer gold would be found in stream beds that did not traverse an area of pre-Cambrian metamorphic rock, the ultimate source of practically all of the placer gold. Possibly a little of the re-worked placer gold from some of the higher benches may find its way into the smaller streams that do not reach back to the pre-Cambrian areas. Streams that cut back to the cement ores only, or those that traverse areas of certain types of the primary ores of Tertiary age may contain a little placer gold. But it is probable that such occurrences of placer gold are exceptional and very rarely will they be found rich enough to be profitably worked.

OTHER MINERALS ASSOCIATED WITH PLACER GOLD

It is a matter of common knowledge that certain other heavy minerals are usually associated with gold in placer deposits, and accompany the gold during the mining and concentrating operations. In the Black Hills such associated minerals are: cassiterite (tin stone), columbite, tantalite, wolframite (tungsten), sheelite (tungsten), zircon, beryl, monazite, garnet, magnetite, hematite, ilmenite, tourmaline, and barite.[1] All of these minerals have some commercial uses, but are usually found in such small amounts in Black Hills placers as to be merely a nuisance in the recovery of the gold. However, under suitable market conditions, and if found in abundance, certain of them, particularly cassiterite, columbite, tantalite, and the tungsten minerals, might become worthwhile by-products.

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1. Lincoln, F. C. Unpublished manuscript, book on "Placer Mining", in press.

BLACK HILLS PLACER DISTRICTS

A list of the principal placer districts of the Black Hills was published in the earlier report of the Survey.[1] With some additions and rearrangement, the list is repeated here.[2]

County	District	Subdivisions
Custer	French Creek (Custer)	
	Lightning Creek	
	Pleasant Valley Creek	
**	**	**
Lawrence	Deadwood	Blacktail Gulch
		Bobtail Gulch
		Deadwood Creek
		Gold Run
		Sawpit Gulch
		Whitewood Creek
	Galena	Bear Butte Creek
		Ruby Gulch
		Strawberry Creek
	Nigger Hill (Tinton)	Bear Gulch
		Beaver Creek
		Iron Creek
		Mallory Gulch
		Nigger Gulch
		Poplar Gulch
		Potato Gulch
		Sand Creek
	Spearfish Creek	
	Two Bit	Spruce Gulch
		Two Bit Creek
**	**	**
Pennington	Battle Creek	Harney
		Hayward
		Iron Creek
	Castle Creek	Cheese Hill
		Crooked Gulch
		Hoodoo Gulch
		Mystic
	Hill City	Newton Fork
		Palmer Gulch
		Upper Spring Creek

1. Anderson, Doris L. M.
2. Lincoln, F. C.

Black Hills Placer Districts (Cont.)

County	District	Subdivision
Pennington	Junction	
	Little Rapid Creek	
	Rapid Creek	Bear Gulch
		Big Bend
		Nielsens
		Nugget Gulch
		Pactola
		Placerville
		Victoria Creek
	Rockerville	
	Sheridan (Lower Spring Creek)	
	Slate Creek and Skull Gulch	

It will be seen by reference to the map, Figure 1, that all of these districts lie within the outer margin of pre-Cambrian rocks, in stream beds that run for considerable distances through such rocks. There are many small gulches, not named in the foregoing list, which drain into the larger gulches in the regions mentioned. These frequently carry placer gold and may offer some reward for prospecting. Most of the streams mentioned carry gold in the present stream bed along the adjacent low level benches. The larger streams, such as Rapid Creek, French Creek, Spearfish Creek, Spring Creek, Battle Creek, and the areas about Rockerville and Tinton, show many remnants of high level gravel deposits.

GENERAL SUMMARY AND APPLICATIONS

The placer deposits of the Black Hills are derived originally from the primary gold deposits of the lode or vein type which were formed in pre-Cambrian times. There have been at least four periods of placer gold accumulation from these primary deposits, namely, the Cambrian or ancient "fossil" placers, the late Tertiary or early Pleistocene, the late Pleistocene, and the Recent accumulations. Each type of placer has derived its gold from the primary deposits in part, and also, in the case of the last three mentioned, from the re-working of the earlier formed placers. The Cambrian placers, (cement ores), are not now of interest as such, but, if worked at all, must be operated as hard rock mines. The three later types of deposits are found in (1) high level terraces, saddles, or gravel capped buttes or mesas

lying one hundred to three hundred feet above present stream levels, (2) low level benches lying five to fifteen feet or more above stream levels, and (3) present stream beds. See Fig. 4.

Only stream systems draining areas of pre-Cambrian slates, schists, and quartzites offer much promise of profitable placer accumulations, and the best of such streams will be those which drain the districts of primary mineralization mentioned previously. Streams cutting through areas of granite only, of later sedimentary rocks, or even through the districts of primary Tertiary mineralization, may show some gold in the gravels, but they should be regarded for the most part as not favorable.

The miner with little equipment, who expects to work on a small scale, will perhaps find the present stream beds and parts of the low level terraces the easiest places to work. The larger low level terraces at the present time are yielding returns to the groups or companies equipped with machinery for operating on a greater scale, with power shovels, scrapers, drag lines, dredges and concentrating machines. The high level terraces have not received much attention in recent years, possibly not as much as they deserve, Because of their situation so far above stream levels, the usual scarcity of water in those positions, and the amount of overburden generally present, they will interest only the larger, well equipped companies having capital for considerable development work.

It is obvious that before any actual mining is attempted the prospective ground should be thoroughly investigated, and yet this necessary precaution is too frequently neglected. A number of test pits should be sunk through the gravel to bed rock, and sufficient panning samples obtained to yield a fairly accurate estimate of the average amount of gold present in a given amount of "dirt". A careful calculation of the total amount of gravel present should also be made. Thus some idea of the total possible yield of gold may be obtained to be checked against the costs of operation. If possible, the nature of the bed rock surface should be determined, as this may make a difference in the method of mining to be employed. If that surface is very irregular and hard it is almost impossible to "clean the bed rock" with a power shovel, clam-shell, or scraper, and inasmuch as the richest and coarsest gold is likely to occur very close to bed rock, serious losses will result from the use of such mining methods. Many other factors should also be investigated; the depth of the valueless oberburden to be removed; the amount of water available for operations, and, in the case of some of the low level benches and stream placers, the amount of troublesome water to be eliminated by draining or pumping; title to land; and regulations regarding water rights, cutting of timber, and pollution of streams

FIGURE 4

CEMENT ORES AND "HIGH LEVEL" GRAVELS

of

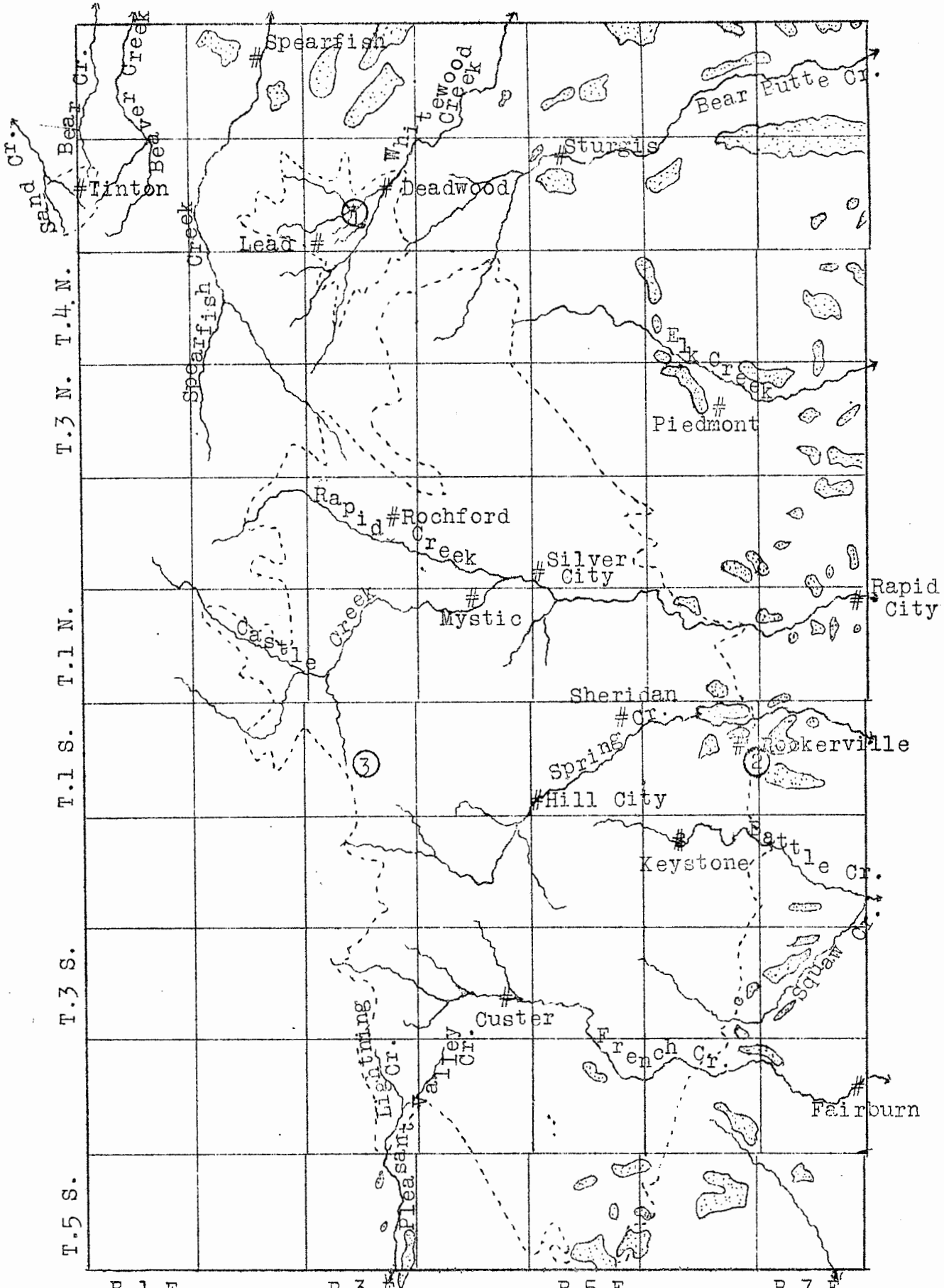
THE CENTRAL BLACK HILLS.

Numbered circles show location of Cambrian cement ores, "fossil placers". Stippled areas indicate the larger occurrences of the late Tertiary or early Pleistocene "high level" gravels. There are many occurrences of these too limited in extent to show on a map of this scale Not all such high level gravels will be gold-bearing, but those that lie within or not far outside of the dotted line (boundary of crystalline area) may be worth testing.

Geological data generalized from maps of the U. S. Geological Survey.

Scale: Squares are townships (6 miles square).

FIGURE 4. CEMENT ORES AND "HIGH LEVEL" GRAVELS
OF THE CENTRAL BLACK HILLS



N O T I C E O F L O C A T I O N
OF PLACER CLAIM

<u>To Whom It May Concern</u>:

NOTICE IS HEREBY GIVEN that the undersigned citizens of the United States, over the age of 21 years, under and in pursuance of and having complied with the Statutes of the United States and the laws of the State of South Dakota and the local laws and customs and regulations of this District, have this day located the following described Placer Mining Ground, situated in the _______________ Mining District, _______________ County, State of South Dakota, viz:

_ _

_ _

_ _

_ _

_ _

_ _

_ _

This claim is located upon a valuable deposit bearing gold and other precious metals, situated in _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

_ _

This claim shall be known as the _ _ _ _ _ _ _ _ Placer Mining Claim and we intend to work the same in accordance with the local customs and rules of miners in said mining district, and each of the undersigned have an undivided _________ interest therein.

Located this __________ day of _____________________, 19 _____.

_ _ _ _ _ _ _ _ _ _ _ _ _ _ _   _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

_ _ _ _ _ _ _ _ _ _ _ _ _ _ _   _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

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