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AURIFEROUS CONGLOMERATE IN CALIFORNIA.

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Three distinct classes of gold-bearing deposits, geologically considered, have been well known and mined in California. These are, first, the auriferous quartz veins, and most naturally classifying with them, the slates and other metamorphic rocks containing gold associated with pyritous minerals. These deposits are the primary matrix and original source of the gold found in the second and third classes. The second class is that of the Neocene (Pliocene and Miocene) river gravels, auriferous from the erosion of the gold-bearing quartz veins and auriferous metamorphic rocks of the first class. These gravels are found in the channels of the Neocene rivers which became obliterated and destroyed as drainage conduits in the latter part of the Tertiary period by the lava-flows and accompanying geological phenomena of that time. They are frequently referred to as the "buried rivers" or as the "ancient rivers" of California, and they constitute the hydraulic and drift mines, the principal source of the yield of placer gold at the present time. The third class comprises the placer deposits of the Quaternary and the recent erosion and formation of the beds, bars, and benches of existing stream channels, and generally speaking, the shallow surface placers. The source of the gold of this last class is in either or both of the preceding. Though some of these latest placer deposits are locally of some importance considered as a class with regard to the total gold yield of the State annually, they are now of little and diminishing consequence.

In the summer of 1892 the writer, reporting on the mines and mineral resources of Siskiyou County for the State Mineralogist, made a superficial examination of an auriferous deposit which appeared to have peculiarities that suggested the possibility of its being unique. (See our XIth Report, pp. 420, 448.) During the past summer, 1893, under the direction of the State Mineralogist, he has made a much more detailed examination and topographical survey of the deposit. Briefly stated, this later investigation established the surmised unique character of the deposit, though some of the qualified conclusions of the preceding examination were not verified. Considered with reference to the preceding classification of the California gold-bearing deposits, its place is between the class of the lodes and that of the Neocene gravels. Like the latter it is a gravel-filled stream channel, the accumulations of erosion; like the former it is a rock in place bearing gold. Its auriferous character has clearly resulted from the action of mechanical forces in the breaking out and re-concentration of the gold of older formations, as distinguished from the action of chemical forces in the distribution of gold in quartz, and associated with the pyritous minerals in the metamorphic rocks. Comprehensively, it is an auriferous gravel bed compacted by age and some metamorphism into a conglomerate. This conglomerated condition exists occasionally in the Neocene gravels, but is not charac-

teristic of them; when it does occur being more often the result of a cementing of the mass by the chemical changes of some of its constituents than a blending and coherence as a result of pressure and age. The distinctive and unique difference is, however, age rather than physical condition. It is a much older deposit than the auriferous Neocene gravels, being a Mesozoic formation—secondary in geological age as compared with the Neocene, which is Tertiary. In the order of the succession of the rocks it rests unconformably in an eroded depression in the metamorphic Mesozoic or Pre-Mesozoic rocks. It is directly overlaid by another Mesozoic formation, the Cretaceous (Chico) sandstone. In the writer's opinion the difference of geological age seems sufficient to support a distinctive name, as it is to be presumed that other deposits will be discovered, or identified among those already known. Requiring practically the same methods of mining and treatment to obtain the contained gold as the South African Transvaal conglomerate deposits, the name "Auriferous Conglomerate" is suggested. For the purpose of description the deposit will be so referred to in this paper.

The map accompanying it is compiled from the writer's special surveys of the deposit, the U. S. Public Land Survey, and the topographical sheet of the U. S. Geological Survey. As to the general details of the locality, it is self-explanatory.

GEOLOGICAL.

The richness in gold of the "Auriferous Conglomerates" where exposed by the Quaternary and recent erosion, gives to the geological conditions of its existence unusual interest, both as being in a measure determinative of the probable location and gold-bearing value of the vastly greater extent of the deposit buried, and as suggesting and directing exploration for similar deposits elsewhere in the State. Accentuating this specially local scientific interest and economic importance, is the fact that there are many geological phenomena connected with this deposit that associate it with the so-called "Reef" gold-bearing deposits of the Witwatersrand, near Johannesberg, in the Transvaal, South Africa.

There are in Northern California two distinct groups of rocks, or preferably stated the rocks of Northern California are divisible into two distinct groups. These are, first, the highly metamorphic and altered sedimentary, crystalline, and eruptive rocks; and second, the occasionally metamorphic, but ordinarily unaltered sedimentary and eruptive rocks and unconsolidated formations. The first described group comprise the older formations, and compose the mass of both the Sierra Nevada and Coast Range, and the floor on which rest the formations of the second group in the region between the ranges. The auriferous quartz veins and pyritic rocks all belong to the first group, and the placers are part of the second. The first group is indifferently designated as the "Metamorphic Series" or the "Auriferous Series," but there is no distinctive group name for the second group. Stratigraphically, the Metamorphic Series includes, doubtfully, some Archæan rocks, definitely the Carboniferous and probably other Palæozoic formations, and the Mesozoic, Triassic, and Jurassic. The other group includes the later Cretaceous of the Mesozoic period, the Tertiary, Pliocene, and Miocene (Neocene), Quaternary, and recent formations. In the orderly stratification of the rocks there is a clearly marked break between the two groups. The rocks and formations of the second group rest unconformably on the Metamorphic Series at every point at which their contact has been observed and examined. This unconformability is conclusive geological evidence of a period of regional elevation above the sea subsequent to the formation under the sea of the older group of rocks and prior to the formation of the rocks of the younger group; also under the sea except as to the eruptives which may be deposited either on the land surface or under water, and further excepting the noted "Auriferous Conglomerate." The formation of this latter in place is, in the writer's opinion, assignable to the period of regional elevation, while the dynamical conditions that consolidated it into its present form existed during the subsequent period of regional subsidence below the sea when the Cretaceous strata were being formed. A period of regional elevation as a period of sub-aërial erosion, during which air, rain, and running water break up and carry back into the sea enormous quantities of the uplifted rock-masses to ultimately form of them other rocks. These eroding activities of air and water are observable and measurable at the present time everywhere on the land surface of the earth. Their energy in the Tertiary period is shown in the eroded river-channel depressions and their gravel-filled beds so extensively exposed by drift and hydraulic mining in the Sierra Nevada Mountains. The Siskiyou County deposit of "Auriferous Conglomerate" is the existing result of the action of the same forces in the early Cretaceous, the deposit certainly being the gravel-filled channel of a Mesozoic river. This, although its position under the Cretaceous (Chico) sandstone, adjacent to the shore-line of the Cretaceous sea, quite naturally has suggested that it might be a sea-beach-formed conglomerate and not accumulated river gravels in place. Such sea-beach or near-shore conglomerate deposits would be formed by the direct wave erosion of the solid rocks; by tidal and current distribution of originally river gravels which have been discharged by torrential streams into the sea at their mouths; and third, by the erosion and redistribution of the channel accumulations of submerged rivers, such a phenomenon, for example, as is now presented at Gold Bluffs on the coast of Northern California. The rocks of the Metamorphic Series on which the "Auriferous Conglomerate" rests unconformably form the northern portion of the main auriferous mineralized belt of Siskiyou County (see our XIth Report, p. 421), and are markedly auriferous in the immediate locality of the conglomerate. Gold-bearing quartz veins are numerous, and the rocks themselves are highly quartzose and mineralized with pyritic minerals. Still there are no workable veins known; only small seams and occasionally a rich pocket. The recent placers exclusively formed from their recent erosion are insignificant in extent, and have never been profitably mined. The wave erosion of these hard rocks, limited as such erosion would be to the cutting edge of the wave crest, and by the protection against even that cutting afforded by the accumulation of eroded fragments, cannot account for the enormous mass of the conglomerate. The linear extent of the latter is certainly 10 miles, possibly more than double that additional, its width where measurable about 1,500 ft., and thickness an average of 100 ft. The rocks are not sufficiently auriferous for their direct erosion to account for the relatively much greater auriferous value of the conglomerate, nor can wave energy account for the concentration of the gold at the bottom on and near the bedrock. The preceding stated conditions are equally conclusive against the possibility of the formation of the deposit by tidal and current dis-

tribution of the discharged gravels of torrential streams. In addition, the topography of the section is such that the inference is against the existence of any such streams. It is, however, possible that the regional subsidence preceding the formation of the overlying Cretaceous sandstones for a period brought within the range of action of the sea waves the gravel-filled river channel. It is possible that some erosion of the upper portion of the original mass took place, but it is evident that the erosion did not extend to the bed of the old river and that the conglomerate is in fact the river gravels in place so far as sea erosion is concerned. A condition of regional subsidence in which the rate of sinking exceeded the rate of the erosion by the rising wave edge, explains the preservation in place of the old channel gravels. Precisely this phenomenon is presented by Gold Bluffs. There the ocean is cutting into the gravel- and sand-filled channel of the ancient Klamath River. But the drift accumulations now being cut away must have been made above the sea-level, necessarily inland, and probably during a period of local uplifting, which ultimately, by its obstruction to drainage, diverted the river into its present channel. As a consequence of subsequent regional subsidence (continuing down to the present time, if indeed it is not now going on), this ancient river channel is disappearing beneath the sea at a rate which has prevented its complete obliteration by wave erosion. The latter is only cutting away and redistributing the upper portions of the old debris-filled channel. The bed, and likely several hundred feet depth of sands and gravels, are sinking beneath the sea surface undisturbed by its waves.

The fluviatile origin of the conglomerate deposit is further established by its appearance in sections afforded by the existing stream cuts and by mining excavation. On the map is shown a cross-section of the "Auriferous Conglomerate" and associate formations made by the Klamath River. It distinctly shows the bedrock bottom and limiting rims of the old channel. The Tertiary and Quaternary uplift (probably the latter, as the tilting seems to extend to the capping Tertiary lava) has tilted the Cretaceous beds so that though originally deposited approximately level they now have a mean dip of 17°, in direction about N. 55° E. Restoring the section by eliminating the dip of 17°, the bedrock under the middle of the deposit of conglomerate becomes level for a distance, as determined, of about 800 ft. This would then be the width of the bed of the old channel at this particular point. The southwest rim, in the section as existing rising with 24° of slope from level, in the restored section rises with only 7° of slope from the bed of the old river. The northeast rim, in the existing section appearing nearly level, in the restored section rises with 17° of slope from the bed of the old river channel. This northeast rim limits the downward extension of the "Auriferous Conglomerate." Farther to the northeast the sandstone rests directly on the metamorphic rocks, the contact disappearing under the Klamath River. Correspondingly the upward extent of the conglomerate is limited to the southwest rim. Beyond it the sandstone rests directly on the metamorphic rocks. Not shown on the Klamath section, this appears in plan on the main map.

The tributaries of Cottonwood Creek do not cut through the conglomerate, but the partial sections made by their erosion show the distinctive individual slopes of southwest rim and channel bed.

The principal section afforded by mining excavation is the bank face

in the hydraulic pit of the Blue Gravel Mine on the right bank of Klamath River. Its appearance is similar to the sectional exposures of gravel banks in the hydraulic mines in the Neocene river deposits. As far down as the action of the atmosphere and surface water extended the color of the deposit is red, and it is more or less decomposed. The balance of the deposit is dark blue in color, suggesting the name "blue gravel." The conglomerate is composed of water-worn rounded pebbles, cobbles, and large bowlders, derived from the metamorphic and crystalline rocks, quartz, granite porphyry, limestone, and diabase, the latter the immediately underlying bedrock. The cementing material consists of sands and clays, the finer fragments and sediments of the same rocks. Streaks and beds of sandstone and a soft red rock appear in the body of the conglomerate, corresponding to the sand and pipe-clay streaks of the Neocene gravels. Other constituent parts of the conglomerate in small quantities are gold, magnetite, hematite, pyrite, chalcopyrite(?), garnet, ruby, and sapphire, all (except the gold and hematite) in small water-worn grains. Some of the hematite appears in pseudomorph crystals apparently after calcite. The gold is generally of the description known as channel gold, occurring in nuggets, coarse and fine grains, scales, and flour gold. Its distribution is similar to the observed distribution of the gold in the gravels of the Neocene and existing streams. It is largely concentrated near the bedrock, on and even in it, in pay streaks or leads. These seem to follow the longitudinal direction of the channel.

The irregular, meandering line of the old channel adjacent to Klamath River is displaced by the tilting of its plane, and subsequent erosion has left it in relief, so far as some of the adjacent region is relatively situated. The continuity of the conglomerate deposit is inferable through this section from the exposures which are numerous and not widely separated. Its location is determinable with a fair approximation to accuracy from these same erosion exposures. Northward from the Klamath a distance of 5 miles, it is so located and delineated on the map. Southward 7 miles it is indicated, but with a less degree of exactness toward the southern end, as the conglomerate exposures are less conclusive. Both northward and southward from the determined section the displacement has left the old channel deeply buried. Excepting an exposure of the conglomerate for a distance of about a mile near Yreka, there is no surface indication from which the buried portion of the old channel can be located.

The data on which is based the conclusion of the writer, that the conglomerate is an old river channel deposit, has been here presented in considerable detail by reason of its particular pertinence to the occurrence of the gold. If the conglomerate were a beach deposit formed from direct erosion, its gold-bearing character would be limited and local to points adjacent to where auriferous quartz veins were cut down and broken up, and there could be no presumption of gold-bearing value as an incident of the linear extent of the deposit. On the other hand, the certainty that the conglomerate is an old river bed accumulation in place, establishes a presumption of average gold content per unit of weight, volume, or bedrock area, for the buried and uneroded portion of the conglomerate, equal to the average gold content per corresponding unit of the naturally eroded or mined portion; that is, the

conditions of gold distribution and gold content per unit are precisely those of the Neocene river gravels, and may be similarly estimated.

The direction of the flow of the old river was most probably southward, the writer's opinion being based on its location with reference to the Coast and Sierra Nevada ranges, and on the assumption of the Mesozoic regional elevation during which the river existed, being the resultant of geological activities, the recurrence of which has produced the present relief of the region. Also cumulative of this, the exposed area of the rocks of the Metamorphic Series adjacent to the conglomerate does not seem sufficiently extended and auriferous to account for the gold accumulation in the conglomerate. Yet it is from this area that all the gold must have come if the flow of the old river was northward. There is no other possible source for it on the assumption of a northward flow. With a southerly flow, however, the old river had the erosion of the indefinite northward extent of the main mineralized belt of Northern California, which is now buried underneath the Cretaceous and later formations, from which to concentrate gold.

The geological phenomena that associate this California "Auriferous Conglomerate" with the so-called "Reef" (conglomerate) deposits of the Witwatersrand, Transvaal, in South Africa, are particularly connected with the overlying Cretaceous strata, and not with the conglomerate itself. These strata consist of sandstones mainly, but stratified conformably in their mass are shales (locally termed "mud slates") and seams of conglomerate similar in composition and appearance to the main underlying bed. The shales are also associated with a greater or less development of lignite in seams and beds; at one point, designated on the map, three miles southwest of Ager, a vein 3 ft. thick is being mined. Excepting the lignite, the structural formation of the "Reef" deposits is identical. The South African formation is, however, much the older, being carboniferous, and metamorphism has altered the sandstone into quartzite, the shale into a schist, and has tilted and faulted the strata. The conglomerate is identical in appearance with the South African. No examination has been made to determine if they are equally auriferous. It is suggested that a more thorough study of the Siskiyou County formation and the phenomena presented at Gold Bluffs may tend to solve the problem of the occurrence of the gold in the South African conglomerate.

TOPOGRAPHICAL.

The drainage of the region of the "Auriferous Conglomerate" is through Klamath River and some of its tributaries. The surface of the country west of the deposit is broken and mountainous. North of Klamath River, Cottonwood Creek has made two narrow valleys, the lower one just east of the deposit. South of Klamath River the middle drainage basins of Shasta River and Willow Creek merge into each other and together form Shasta Valley. Between the valley and the river is Black Butte, a lava-capped mountain 5,270 ft. high. The conglomerate deposit is close to the western rim of Shasta Valley, as far as traced, and it passes beneath the southern and western edges of Black Butte. The mean elevation of Cottonwood Valley is 2,200 ft., and of the portion of Shasta Valley adjacent to the conglomerate deposit about 2,700 ft. The

latter, north of Klamath River, is between 2,100 and 2,800 ft., and south of it between 2,100 and 3,500 ft. in altitude.

The Klamath River in this locality is a large torrential stream. Flowing southwesterly it crosses the contact of the Metamorphic Series and the Cretaceous sandstone nearly at right angles. The section across the conglomerate has already been described. Longitudinal exposures of the conglomerate have been made on both sides of the river by small tributaries. On the northern side Rancheria Gulch is a small depression, scarcely a mile in length. Its bed follows closely the existing line of contact of the formations, and to its erosion is clearly due the existing adjacent portion of this contact line. Adjacent to the river it has eroded its channel diagonally across the old river channel bed, cutting away and carrying off into the Klamath River a considerable area of the conglomerate. Its particular interest is in its shallow placers, which, though limited in area, were extremely rich, and unquestionably derived their gold from the erosion of the conglomerate. On the south side of the river Carson Gulch has exposed the edge of the conglomerate deposit for a considerable distance, but apparently has not cut as deeply into it as Rancheria Gulch. The gold of its placers seems to have come almost entirely from the erosion of small auriferous quartz ledges in the hard metamorphic rocks. These placers were noticeably not as rich as those of Rancheria Gulch.

The lower Cottonwood Valley is the most interesting topographical feature of the district. Cottonwood Creek, flowing through it, is a large stream which rises in the Siskiyou Mountains in Oregon, and with numerous small tributaries drains a large area of country lying partly in both States. The valley is clearly the result of the erosion of the creek in the comparatively soft sandstones and shales lying between the hard metamorphic rocks and the equally hard lava. More particularly, it is the cumulative effect of a number of channels successively eroded by the same stream at different periods in its history, the process of its action being that described in our XIth Report (Siskiyou County) as the cause of bar and bench formations on the Klamath River, namely, the greater rate of channel-bed cutting of a running stream in soft rocks as compared with hard rocks. The first drainage channel of Cottonwood Creek probably formed on the contact of the lava and the metamorphic rocks subsequent to the Quaternary tilting, and ultimately cut below the lava into the softer sandstones and shales. In these the rate of cutting was much more rapid than that of the Klamath River in the hard metamorphic rocks below the junction of the two streams, until a base level determined by the Klamath erosion was approximated. The creek then losing its carrying power through diminished velocity of flow, ceased cutting and commenced accumulating sands and gravels, raising the bed of the water flow until the obstruction to drainage diverted it into a new line of depression, to be by it eroded into a second channel. In turn the second channel, and successive channels subsequently, went through the same process of formation and obliteration, each working its cut a little deeper than the immediately preceding one, and a little farther to the northeast—the greater depth to bring it to the new base level of the Klamath determined by its erosion between the periods of two successive channel formations, and the northeastward tendency caused by the relatively larger quantities of debris brought in by the tributaries from the southwest, which, accumulating, maintained that side

of the channel higher than the other, which then became the depression for the water flow and erosion. Extensive remains of the detrital accumulations of one of the first of these channels, if not indeed the first, exist in a range of low hills lying on the base of the mountains on the southwestern edge of the valley. They are composed of clean-washed and water-worn gravels and cobbles, and a soft, sandy clay. The rock is so largely quartz that the deposit is locally known as the crystalline wash. Between the remains of this old channel and the present channel of the creek, there are the fragmentary eroded depressions and drift accumulations of the several channels of the intervening period, and also the remains of one or more old channels of each of the tributaries, the latter making cross erosions. All of these channels are merged and obliterated more or less, one by the other, and by the present channels of the tributaries, so as to be indeterminate as to individuality. It is, however, their cumulative effects which are significant and most appreciable, namely, the formation of the valley, and the accumulation and concentration in it in shallow placers of an enormous quantity of gold.

ECONOMICAL.

In 1852 the shallow placers of the Cottonwood Valley were discovered. Limited in extent to a district not over 3 miles long by 1½ wide, they have yielded in the forty-two years elapsing since the date of their discovery an immense amount of gold. Nearly all of the mining was done in the "fifties" by individual miners or small companies, using only the simplest appliances—pan, rocker, and sluice. Anything more than an approximate to the aggregate value of the gold taken out since their discovery can never be known. The best informed of the old residents estimate that $4,000,000 has been taken out, including in this the yield of Rancheria Gulch. The basis of their estimate is the number of miners engaged in the several years and the daily gold yield to each miner. The town of Cottonwood, now Henley, built and supported entirely by these mines, at one time in the early "fifties" had a voting population of 700, and a Chinese population of 500. In 1854 one of the storekeepers is said to have sent a mule load of gold every week to Yreka, the supply point for the district. One of the claims, the Brass Wire, in Rocky Gulch, is known to have yielded over $250,000. As a whole the placers were considered rich, even for early days, and quite generally are said to have paid miners more than the then ruling rate of day wages. Confirming this reputed richness, the occasional discovery and working of small areas overlooked by the old miners or covered by their tailings piles, pays the miners from $6 to $20 a day.

Almost exclusively all of the mining has been in the fragmental remains of the old channels lying in the valley between the channel known as the crystalline wash and the present channel, and in the channels of several of the tributaries. No gold has been found in the crystalline wash, and the present bed of the creek was not especially productive. Rancheria Gulch contained a small area of exceedingly rich placers, and became the site of a small mining hamlet for several years. The largest nugget found in the district came from these placers. It was valued at $1,900.

The situation of Rancheria Gulch with reference to the "Auriferous Conglomerate," the absence of quartz veins within its drainage area

sufficiently numerous and rich to have been the source of the gold found in its placers, the identity of the gold found in the placers with gold found since in the adjacent conglomerate, are conclusive in establishing the "Auriferous Conglomerate" as the source of the gold of the shallow placers to which reference has been made. As a physical necessity resulting from the occurrence of the gold in Cottonwood Valley in placers demonstrably formed by existing streams, the source of the gold, so far as those placers determine it, is within the drainage area of Cottonwood Creek as it now exists. East of Cottonwood Creek no trace of gold has ever been found. West of it, above what is designated on the map as "Cañon," being the channel of the creek in the hard metamorphic rocks, only the deposits at Soda Bar and in the West Branch contained any gold. These placers are limited in extent and have never been particularly rich. The source of their gold is clearly determinable as being in the small quartz veins in the upper portions of the drainage area of the West Branch. The tributaries of Cottonwood Creek, Kanaka Gulch (now discharging directly into the Klamath, but at an earlier period in its history into the creek), Rocky Gulch, Rancheria Creek, and Ditch Creek, all contained placer deposits and all have been mined. From the placers in the main valley up to where the "Auriferous Conglomerate" is cut through, these placers have been uniformly rich. Above the conglomerate, except in Rocky Gulch, they cannot be mined profitably, and are very limited in extent. Noticeably the gold obtained from them is different in description and fineness from the gold of the lower placers. It is, as a rule, little washed, and undoubtedly derived directly from the small auriferous quartz veins of the metamorphic rocks. The auriferous character of the conglomerate, determined directly from mining it, makes conclusive the evidence establishing it to be the immediate source of the gold of the Cottonwood Valley placers.

Klamath River, receiving the erosion of Cottonwood Creek as well as its own direct erosion, derived from the "Auriferous Conglomerate" a very large amount of gold. No gold at all is found in its bed, bench, or bar formations above the junction of Cottonwood Creek. Nugget and coarse gold has only been found in the section of the river from Cottonwood Creek downward to about Honolulu. Above this last noted place there is only one area, other than the conglomerate section, which has contributed any large amount of gold to the river. This is the drainage basin of Humbug Creek discharging into the river 2 miles above Honolulu and 15 miles below Cottonwood Creek. At Honolulu, the writer is informed, pieces of the conglomerate are found in the river mines containing gold, also coarse gold that probably came from it. Above Humbug Creek it is probable that by far the largest portion of the gold in the river bed was derived from the conglomerate. How much has been mined from this section of the river is not known. So far as known, river mining in this section has been profitable. It has been as extensively carried on as in any other portion of the river, employing as many companies and men, and as continuously. The total of yield in the forty years of its mining can be certainly estimated in the millions.

The contacts of the conglomerate and bedrock where exposed by erosion have been determined and surveyed. From them the superficial areas of erosion of the old channel bed and rims have been computed

with a fair approximation to accuracy. The figures so determined are as follows:

For Klamath River	3,500,000 sq. ft.
Rancheria Gulch	1,000,000 sq. ft.
Kanaka Gulch	100,000 sq. ft.
Rocky Gulch	200,000 sq. ft.
Rancheria Creek	700,000 sq. ft.
Ditch Creek	400,000 sq. ft.
Bushy Gulch	200,000 sq. ft.
Total	6,100,000 sq. ft.
Or excluding Klamath River, the total is	2,600,000 sq. ft.

This last total being the superficial area of the old channel, the erosion of which has directly contributed to the formation of the Rancheria Gulch and Cottonwood Valley placers. Considerable of the gold of this area has undoubtedly been carried into Klamath River, and another large amount is still in unworked shallow placers. The sum of these two amounts is assumed to be at least an equal offset for the gold that has been mined in these shallow placers, the source of which, could it be known, would be in the metamorphic rocks above the conglomerate. The total yield of these placers being estimated at $4,000,000, and the area of eroded conglomerate being 2,600,000 sq. ft., the yield has been at the rate of $1 54 per square foot for both channel bed and channel rim areas.

The Cottonwood Valley and Rancheria Gulch placers were the result of nature's hydraulic mining, or rather ground-sluicing, on an enormous scale, with time limits marked by the geological ages. Into them was concentrated gold, which in the conglomerate was distributed throughout its entire mass. There is no mining method by which it is possible to economically effect the same result; that is, to obtain by mining methods and appliances all of the gold in the conglomerate. In this the deposit is like some of the Neocene river gravels containing gold distributed throughout their entire mass, but which are either covered with too great accumulations of barren formations, or have not the necessary amount of dump for working on a large scale. Like these same Neocene gravels, the economic value of the deposit is restricted to the gold content of that portion of the mass in which it is most largely concentrated; this is the 4 or 5 ft. in depth of the conglomerate resting directly on the bedrock of the old channel bed, and including the softer superficial portions of the bedrock itself in which some of the gold is imbedded. In the Blue Gravel Mine a sufficient area of this channel bedrock has been worked for its yield to provide a safe basis for estimates of the gold content of the unbroken ground in the channel, and of the economical value of the entire deposit. This mine was discovered in 1887 by a Mr. C. B. Jillson, whose experience was obtained in the hydraulic and drift mines in the Neocene gravels in Sierra County. Prior to this discovery the auriferous character of the conglomerate does not seem to have been suspected. Proceeding on his former experience, and thus very naturally misconceiving the real character of the deposit, Mr. Jillson opened the mine and attempted to work it by hydraulicking, bringing in a supply of water from Ditch Creek for that purpose. At the date of the writer's examination 31,000 sq. ft. of the bedrock had been completely stripped, and had yielded in round numbers $20,000, an average of 60.6 cents per square foot. It is, however, known that a large amount of gold was swept into the dump, the Klamath River, in unbroken masses of

conglomerate, and that there was a further loss of gold in sulphurets. An additional area of hydraulic stripping was done, but the bottom conglomerate left. This at the time of examination was being taken up by hand and worked in an arrastra. This working, though by no means thorough, as the conglomerate masses were not pulverized, returned a larger unit yield for the bedrock stratum than the hydraulicking did for an average depth of 20 ft. washed. The yield for 420 tons worked was $1,489, an average of $3 52 per ton, or 88 cents per square foot of bedrock area. With proper appliances and methods, thorough pulverization, and the concentration and working of the sulphurets, the yield would safely have been $1 a ton, or 25 cents more per square foot. The arrastra tailings contained about 1 per cent of concentratable magnetite and pyrite, which assayed $101 per ton.

From the slope of the Black Jack Mine 100 tons of the conglomerate were worked in a stamp mill, returning $275, or at the rate of $2 75 a ton. It is known that all the gold was not returned, the milling not being thorough, and much fine gold being lost in the tailings. An assay of concentrates from this mine is said to show $590 to the ton. No determination was made of the percentage of concentrates, however.

At the Charter Oak Mine, in Ditch Creek, the tunnel had only cut through the rim into the conglomerate. Prospecting showed some fine gold and concentrates which assayed $120 a ton.

In the writer's opinion, the development of the Blue Gravel Mine is sufficient to make its figures of unit gold-content of actual return and safe estimate of avoidable loss, a basis of estimates. These figures are: actual return, $3 52 a ton, or 88 cents per square foot, and avoidable loss estimated $1 a ton, or 25 cents per square foot. The total of the two is $4 52 a ton, or $1 13 per square foot of bedrock area. To further assure safety of the estimate of available gold content of the entire deposit, these figures are reduced to $4 a ton, or $1 per square foot. Assuming a channel-bed width of 800 ft., as indicated by the survey of the Klamath section, the economically available gold content of the portion of the channel that can be located north of Klamath River is $21,000,000, and of the section south of the Klamath $22,000,000; in all a total estimate of $42,000,000.

In stating $1 as the writer's estimate of economically available gold content per square foot it is not to be inferred that each and every square foot of the channel bed contains an approximation to that amount of gold. As a practical fact, large areas likely contain no gold at all, their proportion being concentrated in pay leads or areas of higher unit yield. Further, much of the gold is coarse, nuggets ranging in value from $10 upward forming much of the total value of the deposit.

The conditions of existence of the gold necessitate drift mining as the method of exploitation of the conglomerate. For this the topography is specially favorable. Nearly the entire extent of the located channel is above the drainage level of Klamath River. The mining can be through tunnels, and the conglomerate is so compact as not to necessitate timbering the mining excavations other than may be required to facilitate working. Ventilation is possible by natural draughts. The conglomerate works well with powder. Power drills and traction can be economically used. An abundance of water power is available by electric transmission from Klamath and Shasta rivers and Cottonwood Creek. Economy of construction and maintenance of the necessary

mining and milling plants is assured by the near location of sawmills, direct railroad transportation to the centers of trade and population, and an adjacent agricultural country in Shasta Valley and Southern Oregon.

It is not to be lost sight of, however, that the deposit is distinctly a low-grade proposition. Its profitable working is only safely assured by operation on a very large scale with large plants, making every possible economy. Under the suggested favoring conditions of operation the cost of mining and milling should not exceed $1 50 a ton, or 37½ cents per square foot of area.

Since the preceding was written the writer has had an opportunity to examine some other Cretaceous and Pre-Cretaceous auriferous placer deposits. The Chico beds, sandstones and shales, which overlie the "Auriferous Conglomerate" in Siskiyou County, extend far southward into Shasta County, in California, and far northward into Oregon. Four miles southwest of Redding, in Shasta County, the Chico sandstone is found resting unconformably on the metamorphic Pre-Cretaceous rocks precisely as it does in northern Siskiyou County. In what is locally known as Oregon Gulch, close to the contact of the sandstone and metamorphic rocks, a shaft was sunk through 40 ft. of sandstone to the metamorphic rock (slate) which dipped eastward on about the same pitch as the bedding of the sandstone. Following the contact downward on the pitch the shaft opened up a small bed of auriferous gravel lying in a depression of the slate underneath the sandstone. This gravel bed where cut was 2 ft. deep in the middle and about 40 ft. across. Singularly enough, it was neither cemented nor conglomerated, though it contained considerable amounts of oxide of iron, and must have been subjected to enormous pressure from the mass of consolidated sediments overlying it. The gravel is smooth and stream-washed, but contains marine shells too much broken to be identified. The gold is very fine, and is found in the fine pyritic matter. On a smaller scale, the deposit is a copy of the Siskiyou deposit. It probably belonged to the tributary system of the larger channel. In this connection it is noteworthy that Mr. J. S. Diller, of the U. S. Geological Survey, has found the fragmentary remains of Cretaceous stream channels a few miles still farther to the southwest of Redding.

Just across the State line in Jackson County, Oregon, is the valley of Bear Creek, a tributary of Rogue River. The contact of the sandstone and granite traced northward from the State line after crossing the summit of the Siskiyou Mountains close to the railroad tunnel, crosses the head of Bear Valley east of the railroad, then turning more northwesterly recrosses the valley just north of the town of Ashland, and thence runs through the foothills flanking the valley between Ashland and Jacksonville, and comes out into the valley again just east of Jacksonville. The valley itself between these places is eroded out of the sandstones, but the erosion at no place exposes the conglomerate seen in California at Henley. However, on the hill slopes between Ashland and Jacksonville are exposed some very much decomposed conglomerates bedded in the sandstone. Whether one bed or several of this conglomerate exist, the exploration made is not sufficient to determine, but the conglomerate wherever exposed is auriferous. In superficial appearance the conglomerate is an ocherous-looking decomposed rock. On

closer examination it is found to contain considerable quartz, a portion of it distinctly water-worn and rounded. The other prominent constituents are feldspar and mica. It is evidently the resultant of the erosion of the adjacent granite. The gold is very fine, free in large part, but blackened and coated. Associated with the gold are found magnetite, pyrite, cinnabar, natural amalgam, and free quicksilver. What is known as the Golden Fleece Mine is located on this deposit, near Ashland. A pit has been excavated in the bed and some short drifts run, following the conglomerate into the hill. The bed rises with the hill slope, but at a less angle. On the mine is a 3 ft. Huntington mill, in which several runs have been made of the conglomerate, with more or less satisfactory results. Yields of from $1 to $5 a ton have been obtained in free gold. The concentrates are very high grade, containing gold too much coated to amalgamate, as well as that mechanically held by the sulphurets. The methods employed, it seems to the writer, can be considerably improved. Mining and crushing can be done very economically, but more effective appliances are needed for obtaining the gold that does not amalgamate either in the battery or on the plates.

The occurrence of gold in sufficient quantity in this Ashland conglomerate to admit of its economical extraction is suggestive of similar possibilities in conglomerates bedded with the sandstones and shales in the vicinity of Henley, in Siskiyou County. The Cretaceous sandstones that overlie the auriferous conglomerate, the old river channel deposit, in addition to beds of shale and occasional seams of coal, contain several conglomerate beds exposed by the ravine erosions. These have never been mined nor tested to ascertain whether or not they contain gold. Their exploration is, however, expedient under existing conditions of our knowledge of gold-bearing deposits.

In conclusion, the writer desires to express his obligations to Professors Joseph LeConte, Christy, and Lawson, of the University of California; Prof. Brander, of the Leland Stanford Jr. University; Mr. Jas. E. Mills, Mr. Waldemar Lindgren, Mr. Ross E. Browne, and Mr. J. S. Diller, for assistance and friendly criticism given him during the preparation of this paper.