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Long-winded report which nobody
will Read

Yellow available Now
Blue – may be next week
~~week~~

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Report on the

MELLGREN MINES

TOMBSTONE
MINING DISTRICT
Cochise County,
Arizona

By
C. J. SARLE, Ph.D.
Mining Geologist*
Tucson, Arizona

———oooOooo———

With contributions by
V. G. MELLGREN, B.S., E.M.
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Tombstone, Arizona

Sept. 5, 1928.

*For eight years Professor of
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Tombstone, Arizona
Sept. 4, 1928

FOREWORD.

The breadth of field covered in the following report on the Mellgren Mines—including as it does: a brief sketch of the formations, structures and geologic history of the "Tombstone-Mule Mountain Range"; a correlation of the ore deposits and including formations of the Bisbee Mining District, in the southern end of the range, with these of the Tombstone Mining District in the northern: a general discussion of the Tombstone District as a whole, with comparisons between the Eastern area of the District, principally held by the Bunker Hill Mines Company, a subsidary of the Phelps Dodge Corporation—and where the ore bodies have been opened up to greater depth and more extensively, and the Western area, of which the Mellgren holdings form the larger part—has been, for the purpose of giving a general perspective, by which the conditions which mining operations have revealed in the Western area may be judged and by which the predicted ore possibilities, with depth development, in the Mellgren Mines may be appreciated and estimated.

My acquaintance with the Tombstone Mining District, it must be explained, though extending over a period of years, may be summed up as the result of actual intensive work, at intervals, amounting all told to a few week's time only. The breadth of field, the number of mines, many of them at present practically inaccessible, and the limited time at my disposal, has precluded of necessity, my acquiring much information which must constitute therefore an important omission in the discussion of this noted mining district, and which doubtless would have been very helpful also in the exposition of the Mellgren property.

It is very fortunate therefore, that Mr. V. G. Mellgren, a qualified graduate Mining and Metalurgical Engineer, with long practical experience in the Tombstone Mining District, a detailed knowledge of the various mines, and accumulated fund of information on past production of the District,—giving him an extensive and detailed knowledge of the District and its possibilities—has contributed the valuable data on pages ..... to ..... inclusive, in this report.

In my work I have had opportunity to confirm, in general, the facts which he has set forth and I have used them freely in the following Pre-Summary and elsewhere as needed to supplement my own investigations.

(Signed) C. J. SARLE,
Tucson, Arizona
Sept. 4, 1928.

PRE-SUMMARY.

The Mellgren Mining Property consists of 56 lode claims and fractional claims, in contiguity, covering an area af about 1050 acres. (See appended Topographical and Geological Map of Western Tombstone). From the center of this property it is 2 miles by the Charleston highway, northeasterly, to the Court House in the City of Tombstone, County Seat of Cochise County, Arizona. Tombstone is the terminus of a branch of the Southern Pacific Railroad, which leaves the main line at Fairbank, 9 miles to the westward. From Tombstone by rail, the Smelter at Douglas, Arizona, is 60 miles and to that at El Paso, Texas, 315 miles. (See Areal Geological Map of Tombstone Mountains).

The Mellgren property with several smaller adjoining properties, variously owned, comprise what is locally known as the West District, in distinction from the eastern portion of the Tombstone Mining District, the major part of which is owned by the Bunker Hill Mines Company, a subsidiary of the Phelps Dodge Corporation, having been purchased from the Tombstone Consolidated Mining Company in 1912. Among the Tombstone consolidated holdings were also the State of Maine, Chance and San Pedro Mines, in the Western area, patented properties, closely adjoining the Mellgren Mines.

The Tombstone Mining District is coextensive with the Tombstone Hills. The Tombstone Hills are the deeply eroded and subdued northerly end of a northwest-southeast trending mountain structure, some thirty odd miles in length, which has for its southerly end, the higher and broader Mule Mountains, and for its intermediate portion the Little Mule Mountains. This structure, for convenience in this report, has been designated the Tombstone-Mule Mountain Range. This range was formed in the Late Tertiary time; by block-faulting, accompanied by extensive igneous invasions, which formed large deep seated granitoid batholiths beneath the structure and more superficial porphyritic dikes and stocks and extensive surface flows. The older crustal rocks thus broken up and invaded by superheated solutions of mineral matter, or lavas, became the depositories for large and valuable deposits of ore minerals. These were formed by volatile constituents given off from reservoirs of molten rock cystallizing and congealing beneath; forming the great copper deposits of the Bisbee District, 25 miles south of Tombstone in the southern end of the Range, and probably simultaneously the high grade, silver-gold, silver-lead-gold and silver-lead-zinc ores of the Tombstone District, in the northern.

The rocks involved in copper deposition in the Bisbee end of the Tombstone-Mule Mountain Range, are mainly the lime-stone members of the upper Paleozic series of sedimentary formations; the Abrigo (Upper Cambrian) Limestone, the Martin (Devonian) Limestone and Escabrosa (Lower Mississippian) Limestone. In the southeastern part of this area, occur however, some lead and gold in the overlying Mesozoic or Bisbee (Lower Cretaceous) series. Copper occurs also in granite porphyry, in Sacremento Hill, Bisbee. The copper ore restricted to horizons just mentioned has a proven zone of deposition ranging to 1400 feet in thickness.

In the Tombstone area, the ores thus far developed occur principally in the Mesozic (Bisbe Series) strata, but there are numerous occurrences in all of the underlying Paleozoic limestones, enumerated above as ore horizons of the Bisbee District, here including also the Naco (Pennsylvanian) Limestone, at the top of the Paleozic series. While stratigraphically this would appear to give the ores a vertical range thru several thousand of feet of formations, it is certain that the actual thickness of the ore zone, exclusive of a possible copper zone beneath, is very much less, probably in the neighborhood of two thousand feet.

That rocks of all horizons in such a thick series of strata should become involved as controls in the deposition of ore, it would seem, might be reasonably explained

as due to their chance position within a certain depth or temperature zone and, within a certain distance of the source of mineralization; determined by fault displacements and the variable height of magmatic ascent or wedging. That the silver-gold, silver-lead-gold and zinc zones of the Tombstone District have this assumed approximate, combined thickness of 2000 feet, is based upon an observed and indicated descending zonal arrangement of the metals, which has been brought out thru mining operations. Thus, the depth of 400 feet, with lead beginning to appear at water level, the silver-lead-gold ores of the Eastern area, proven to a depth of 700 feet, and; zinc beginning to appear prominently at a depth of between 700 feet and 800 feet, and to which, it is thought reasonable to ascribe a zone thickness—allowing for a lead-zinc transition above and a zinc-copper below—of 800 feet to 900 feet, together giving the above estimated 2000 feet depth-range to that portion of the Tombstone ore column above the zone of copper ores.

Moreover in strong conduit structures, where erosion has not removed the upper part of the ore zone, it may be expected that mining operations may be carried to such depths as indicated above, or even greater and as in the Western area, in some portions of which, Paleozic strata underly Mesozoic, in their original relations, beginning with lead-gold ores, the whole gamut of ore zones may be run, as depth development in mining goes on.

The ores of the Western Tombstone area are not confined to the sedimentary rocks however, but occur also in a widespread quartz monzonite porphyry. Although there are many exceptions, the greater number of the fissure veins in both the Eastern and Western area have a roughly north-south strike and steeply dip to the west. Where folds occur in the Eastern area they have been found in many cases to be the loci of interbedded deposits, or saddle reefs, and this may well prove to be the case in the Western area, should such structures be encountered.

In the Bisbee area the magmation which introduced large dikes of granite porphyry into the Paleozoic sediments, appears to have been the phase which produced the ore deposits. In the Tombstone area it appears to be connected with the slow upward advance of lava in great volumn, of monzonitic composition, which from observed croppings of the monzonite described in the body of this report, must underly a large part of the Tombstone Hills at depth. Many dikes of similar composition may be genetically connected. This intrusion profoundly altered the Paleozoic limestone in places, where directly in contact with them, and, in a late phase of cooling, furnished the ore forming solutions. (See Areal Map of Tombstone Mountains, Appended).

The ores throughout the Tombstone District appear to have the same general source and are in all essentials the same, variations observed in mining being attributable to difference in position in the zone of ore deposition and degree of secondary alteration.

It appears to be the concensus of opinion among Geologists and Mining Engineers, who have made a study of conditions in the Tombstone Mining District, that the mining of ore deposits has scarcely begun. The reserves of milling and high grade ores indicated, are very large. This applies not only to ores below water level, which are yet practically untouched, but there is a large tonnage remaining above. Moreover there is much virgin ground in both the Eastern and Western areas of the District which promise when explored and developed to greatly extend mining operations.

To-dat mining in the District has largely been, a selection of the high grade portions of the ore bodies, leaving the lower grade or milling ores, and these operations have been limited almost wholly to that portion of the secondary or oxidized ores, above the water table. The depth to permanent water varies, being relatively

greater at points of greatest relief. Thus in the Eastern portion of the District it ranges from 432 feet to 630 feet and in the Western, from 200 feet to 400 feet.

The Tombstone Consolidated Mining Company in sinking a 1000 foot shaft, known as the Boom shaft, in the Eastern area, established three favorable factors, vital to the economic life of the Tombstone Mining District. One is, that contrary to a persistent general misapprehension, the water in the Eastern area, can be controlled and is actually much less than now being handled by many mining companies. (See pages.....). The second is that the ores maintain their volume and values below the permanent water level. (See page.....). The third is that the silver-lead-gold ores of the Tombstone District, eventually, in depth, will give place to zinc-lead-silver-gold ores. (See page.....).

Water in the Western part of the District as shown in the body of this report, though lying at a shallower depth than in the Eastern, can easily be handled, the volume being about ample for milling purposes. (See page .....).

In the ores of the Tombstone District thus far mined, silver values predominate and gold has been consistently important, and likewise, lead in the Eastern part, tho in the Western or Mellgren area,—due it is believed to the higher horizon in the zone of ore deposition, at which mining, so far, has been carried on,—lead is only just beginning to come in at water level. The ratio of these metals in the ores mined has varied widely however. In some instances the gold value has nearly equalled that of the silver; and this has been true of the fluctuating lead content of the ores of the Eastern District. The ores of the whole Tombstone Mining District may be classified as high grade. The earlier operators shipped and milled ore having an average value of $100 per ton, or better and hundreds of tons were shipped from Tombstone running a thousand dollars or more.

During the 50 years, which have elapsed since 1878; when Edward L. Schieffelin made the discovery of ore in the Tombstone Hills, and located his claim the "Toughnut," the first in the Tombstone Mining District,—mining has moved with pulsations. From 1880 to 1890 the greatest activity prevailed: the City of Tombstone sprang up, water was piped in a distance of 30 miles from the Huachuca Mountains, to the southwest; Mining Companies were formed and mining of the rich silver-lead-gold ores was carried on with utmost vigor and, mills for the handling of the ores were built on the San Pedro River at both Fairbank and Charleston.

It was during this period that the State of Maine, Merrimac, Free Coinage, Junetta, San Pedro, Chance and Louise Mines, contiguous to the Mellgren Holdings, and the Joseph No. 1, Joseph No. 2, Anex No. 40, Anex No. 41 and Bonanza Mines of that group were worked. (See position of these on, Vein Map of Western Area, Appended).

The demonitization of silver in 1890 and strike brought this first period of great prosperity, in the Tombstone District to a close.

Thru 1890 to 1900 was a period of small mining operations, mainly by leasing.

From 1900 to 1912 marks a second period of great activity and large production, in the Tombstone Mining District, tho little effecting its Western portion. It spans the existence of the Tombstone Consolidated Mining Company, created by the consolidation of the older companies of the Eastern District, in 1900 and ended in 1912, when the interests of that company were taken over by the Bunker Hill Mines Company, a subsidiary of the Phelps Dodge Corp.

Tombstone Mines were then closed down, and have remained so ever since; excepting for a short period during the late War, when two or three of the mines were worked on a small scale. The Bunker Hill Company, however has held to a policy of giving short term leases, for operations on a small scale, and sums up to $150,000 are said to have been made by some of the leasors, mainly by chloriding,—

mining the lower grade ores in search of high grade chutes.

The laying of the Tombstone branch of the S. P. R. R. from Fairbank in 1902, greatly improved transportation conditions. But until about five years ago, the Smelters only paid for 50% of the value of the silver chloride and, until about a year and a half ago, placed a penalty of 10 to 12 cents a unit on the silica content of ores, —penalties, deductions and charges, sometimes running as high as $25.00 a ton on some ores shipped.

In 1904 the Mellgerns began acquiring their present holdings in the Western District, which they have been working continuously since. Work started by them in 1908, on the Joseph No. 1 claim, was continued for several years. The north shaft in this time was sunk from the surface to a depth of 220 feet; and a drift was run at the 100 foot level, 100 feet south. The ore taken out and shipped, in sinking, varied from $12.00 to $40.00 per ton, and, one small shipment of 4½ tons, from a pocket, assayed 5005.0 oz. silver and 5.01 oz. gold per ton. In 1923 the Mellgrens sank the south Bonanza shaft 34 feet below water, to test the flow, which proved to be 40 gallons per minute. Surficial work has been done on Joseph No. 2 vein, from time to time, and other of their properties, off and on for years.

Surficial mining on the Free Coinage vein, parallel and about 2000 feet to the west of the Bonanza vein, began by leasers in 1920, continued to 1924.

The Pittman Act, effective from 1920 to 1923, stimulated, to a minor degree, activities in the Western area. From the Bonanza dump 50 to 60 cars of ore were shipped running from $3.00 to $33.00 per ton and screenings from the mine dump and gob were cyanided. The results proved to the complete adaptability of these ores to this class of treatment. Leases have been given by the Mellgrens, on various of their properties, off and on for years.

In 1922 and 1923 Herman Trappman, a leasor, mined 30 feet below water level in the San Pedro mine, handling the water with a bailer; and removed ores to the value of $9,000 to $10,000, the ore running from 100 to 200 ounces in silver.

In 1923 the Old Puebla Leasing Company cyanided the State of Maine dump and mine gob—to a profit—although the ores had been mined by stripping and often taken down "clean" on canvas.

In 1922 a leasor sank a winze, from the north drift on the 200 foot level in the Chance Mine to a depth of 22 feet below permanent water and drifted 18 feet and stripped the ore for this distance to the 200 foot level above. Before the ore could be removed however, the upper part of the shaft caved in. Assays showed the ore ran from 100 to 1200 ounces in silver.

In 1923, as already mentioned, the Mellgrens, as a test; mined, by the filled-stope method, and cyanided 920 tons of ore, from above the 100 foot level, in the north end of the Bonanza vein which yielded a bullion return of $44,000.

Work is now being carried on in the Bonanza Mine, off the north shaft.

Since the early day operations portions of probably every dump in both the Eastern and Western area have been shipped, sorted and shipped, or milled.

The Tombstone Mining District has had a known production of ore totalling $85,000,000.00 gross value. Of this sum approximately $79,000,000.00 was contributed by twenty-odd mines in the Eastern or Bunker Hill area and $6,000,000.00 by a dozen or more in the Western or Mellgren area. Of the $6,000,000.00 produced in the Western area, the major part is accounted for as follows: Anex No. 40 and 41 veins, produced $60,000.00; Bonanza-Chance vein, $1,000,000.00; Junetta, $100,000.00; Louise $100,000.00, Joseph No. 1, $60,000.00; Joseph No. 2, $150,000.00; San Pedro, $150,000.00; Solstice, $75,000.00; and State of Maine $3,500,000.00.

It seems quite probable that the yield of some of the above mines was considerably larger than the above figures show, and moreover, it is, the general opinion of

"Old Timers" of the District, that the actual output from these and other properties of the Western area has been between $7,000,000.00 and $8,000,000.00.

The Western area of the Tombstone District should be described as rolling, to hilly. From the lowest to the highest point in the mined area, is approximately 450 feet. All parts have been made accessible by mine roads, which connect with the Charleston-Tombstone highway. (See Topographical and Geological Map of the Western Tombstone District, appended to this report).

As to the Geology:—The western and southwestern part of this area is underlain by a quartz monzonite porphyry. The north-eastern is floored and flanked by a granitoid rock, classified as monzonite. Between these two areas is a belt of sedimentary rocks—surficially mostly Mesozoic; standstones—with two or more belts of shale interbedded with thin sandstone platten,—and with one exposed zone of limestone. Two outcroppings of Paleozoic limestone occur, one Pennsylvanian (Naco) in age, to the north; the other Mississippian (Escabrosa) in age, to the east. A small area of Mesozoic, not indicated on the map, also occurs, just north of Uncle Sam Hill, surrounded by the quartz monzonite porphyry. Paleozoic rocks are believed to underly, in their natural relation, the major portion of the area covered by the Mesozoic sediments. The Mesozoic strata have a generally gentle and rolling dip to the northward. The Paleozoics are slightly at variance in dip.

Several north-south dikes, appearing to be a little more basic than the quartz monzonite porphyry, the largest reaching 20 feet in width, cut the sedimentaries, and one observed continues northward into the granitoid monzonite for some distance. In a single known instance, in this area, one of these dikes follows a fissure occupied by a vein, but does not appear to be genetically connected with it.

The dikes show off-setting by cross-faulting and may well be studied for the light this may throw upon the displacements of veins, which likewise show some faulting. For example, the general opinion is that the Merrimac and Free Coinage veins are part of the same north-south ore body, displaced by faulting.

The contact betwyen sedimentary and igneous rocks, from surface examination, where observed, appear to be intrusive, tho it seems highly probable that later movements, such as would produce the fissure system, containing the veins, must have cause some displacements, probably resulting in fracturing and brecciations along them. It would be well to determine this fact in connection with the north-south, main contact, between the quartz monzonite porphyry and sedimentary formations, on the Mellgren ground.

The ores occur mainly in master fissure or shear zones, roughly in common north-south strike, with a decided tendency to northeasterly departures. This likewise is true of the trend of most of the vein fissures in the Eastern area of the District. Their dip varies from 90 degrees to as low as 60 degrees westward. Cross-veins likewise occur, in which there is less regularity in direction and dip, and less persistence. The veins occur in both the sedimentary formations and the quartz monzonite porphyry. (See attached map showing the veins of the Western Tombstone District).

The average width of the veins mined in the Western area, so far, has been about 4 feet, tho, sometimes in places, widening to as much as 10 or 12 feet. The walls within the comparatively shallow depths to which the veins have been mined, are neither sharply defined by slickensiding nor by gouges. This is also true of some of the veins of the Eastern area.

The ores as deep as mined, or to water level, and to a proven depth of 34 feet below, are oxidized or secondary silver-gold ores. The silver occurs in the ore as a chloride, iodide, bromide and occasionally a small amount of sulphide, usually 40% as chloride. Vanadium is sometimes noticeably present; iron and manganese oxides

occur, rarely amounting to more than 5 to 8 per cent generally merely stains. Some traces of lead in the form of Mimetite, (Lead Chloro Arsenate); Cerussite; (Lead Carbonate); Anglesite, (Lead Sulphate) and, Pyomorphite, (Lead Chloro Phosphate), are occassionally observed, and near water level, small bunches of ore running as high as 9% in lead have been encounted.

The gangue is altered country rock, quartz and sometimes, barite or heavy spar in appreciable amounts. The average silica content of ores shipped has been about 74%.

Many of the shallow gulches, or washes, of the area appear to owe their rectilinear courses to lines of weakness determined by the position of such structure as fault, shear and breccia zones and to interformational contacts. The formations and structures in such positions are usually more or less obscured by alluvium and they should be prospected carefully as likely places for veins, chutes, or less regular ore bodies.

The Western portion of the Tombstone District is largely undeveloped. There has been no systematic development of the ore bodies and no deep mining: No centralized workings for large scale operations, such as, cross-cutting the country at depth, from a main working shaft, to transect the parallel north-south vein system and the development of these veins along their entire strike.

There is little doubt, that blind veins, will be encountered, when cross-cutting at depth is done.

Mining in the Western area has always been handicapped by the lack of capital and has been carried on with very poor facilities. The early work done on the State of Maine, San Pedro and Chance Mines, was with no better equipment than a steam hoist and hand steel. In this way silver-gold ore, as earlier stated, to the gross value of $3,500,000.00 was taken from the State of Maine. The block mined was 600 feet long, 400 feet deep and averaged 4 feet mining width. Operations extended nearly to water level and values apparently as good as those mined, were still going down, when the mine was closed, because of the demonitization of silver and a general strike.

The $150,000.00 given as the output of the San Pedro Mine was taken in places, from a section of the vein about 300 feet long and above the 160 foot, or water level. It will be recalled that it was from this mine that Trappman, later, mining 30 feet below water, extracted ore to the value of $9,000.00 to $10,000.00, which ran from 100 to 200 ounces in silver.

Aside from the operations of the three properties mentioned above, in the manner described and the one cited case, when with standard drills and hoist, the Mellgrens, extracted by the filled stope method, from above the 100 foot level, in the north end of the Bonanza vein, 920 tons of ore, which cyanided gave a bullion return equivalent at present market prices to $34,000.00, all the mining done in the Western area has been with single-jack and hand steel, hoisting by windless or whim.

Handicapped by such primitive and inadequate equipment, it is natural, that with veins known to contain lenses and pockets of high grade, that mining in the Western area, has always been in the nature of chloriding or gophering, as the miners would express it, and that whenever ores too persistently low to ship were encountered, work was abandoned at that point and started in another, it usually in such cases being said that the ore had "pinched out". This was far from being true, for in practically all cases, ore of a milling grade may be found in the faces of these workings and ore is still going down. In depth water stopped them. The ores below water, therefore, constitutes a reserve wholly untouched.

In the Bonanza-Chance vein, opened up for 1200 feet of its length, the northern 1000 feet of it, on Mellgren holdings, has yielded ore to the value of $1,000,000.00

gross, principally in high grade, about 2/3 of the vein above water still remaining to be mined. The gross return for the northern or Bonanza portion of this vein was $400,000.00; and, the unmined ore left above water is estimated to be 60,000 tons. (See Verticla Longitudinal Section of Bonanza Vein, appended to this report).

Under Estimate of Tonage, page....., it is shown that of the 23 known veins on the Mellgren property, in but five of them, Bonanza, Joseph No. 1, Joseph No. 2, Anex 40 and Anex 41 claims, chosen because they have been most extensively worked and opened up, there are above the 500 foot level, and in a combined total strike distance of 4000 feet, along which they have been opened up, with the average mining width of 4 feet; 631,000 tons of ore available for mining—enough to run a 200 ton per day plant for 9 to 10 years. (see pages.....)

Under the description of Individual Claims, page....., in the body of this report, the principal veins and workings of the Mellgren property have been gone into in considerable detail. There are other veins on this property on which little work has been done, because the ores, tho of milling grade, proved too low to ship; and there are veins also, which have been neglected because the work done on them, indicated that ore of commercial milling grade only, could be developed, within the depths practicable with the equipment in use. There are also known veins on the property which have never been worked. The northern end of the Bonanza vein was blind and was only picked up by trenching.

Further, as stated, many of the washes, judging from their trend, may have developed upon structures which will prove to have been extensively mineralized; and it is expected, that when cross-cutting at depth is once undertaken, that veins, not showing at the surface, will be encountered.

A number of the Mellgren claims have had no work done on them, other than that required for location and assessment—yet there are few if any, of the 56, which do not hold forth a potential chance—so generally and heavily mineralized has the Western area been proved, by the comparatively limited mining so far done.

On page....., under the description of the "Zonal Arrangment of the Metals", reasons are given for the assumption, that mining in the Western area of the Tombstone District, has been carried on at a higher horizon, the silver-gold, in the zone of metallization, than that worked in the Eastern area, and that therefore the veins in the Western area may be expected to extend to greater depth and, downward to take on the lead phase, accompanied by the silver and gold values, of the Eastern, which in turn will give place to ores containing zinc.

There also remains the possiblity of the unexplored Paleozoic limestone beneath the Mesozoic series, which have been productive horizons in the Eastern area; and, that arched structures, when encountered, will contain saddle reefs and breccia ores, as proved in the Eastern area.

As has been shown, values, on the Mellgren properties persist to the deepest point explored, that is, whenever operations have been carried to water level, or opened below, they are still going down. Gold if anything has increased a little with depth; lead appearing at water level, will increase in depth, and become a substantial value, as seen in the Eastern District, and with the persistent silver and gold, raise the tenor of the ore. Moreover the values below water should become more uniform.

It is manifest that the water-table was once much lower than at present. How much is uncertain, in face of the shallow depth to which mining has been carried, therefore, the depth to the primary sulphides is unknown. It may, as in the Eastern area, exceed 700 feet, but topographically it should be above 500. It would be well to select one or more of the veins and to drill off-set angle drill holes, to cut the vein at various computed depths and determine the depth to the primary sulphides, their

strength and values.

The circumstances of shallow mining, ores largely unmined above water, many veins practically unworked, ore still going down in the deepest workings, all below water practically virgin ground, the depth in the ore zone, to which mining has been carried in the Eastern area, on the same general vein system, but starting lower, means in aggregate an immense tonage of unmined ores on the Mellgren property.

The 631,000 tons of ore, estimated for a portion of five of the veins on this property, are figures which of course must be regarded merely as an approximation, but serve to give some conception of the order of magnitude in which the probable total unmined tonage of this property, could it actually be estimated, would be expressed.

The method by which the average value per ton of ores mined from various properties in the Western area, given in the body of this report, were computed, was; to take the total tonage mined, total tonage of ore shipped and total smelter returns; total tons thrown on the dumps, and calculate total dump values, based upon assay; add these values; and divide their sum by the total tons mined.

In making estimates of value of unmined blocks of ore, in the various properties, the procedure followed was to ascertain, by the above method, the average value per ton of the ores already mined and to assume this value per ton to be the average value per ton of the ore in situ.

This method of estimating the values of ores en-block, when the continuity of the ore, to a reasonable certainty, has been proven, gives results fairly reliable, and, probably in the present case as accurate as could be obtained by any method. The reason for this is that the ore, above water level, that mined so far only, and the ore below water level, as deep as it has been penetrated, is oxidized, and as is usual with this class, the values are spotted, in this case varying from low to high grade. It will probably be agreed that in such ores, mine sampling would not give estimates as dependable or safe. Moreover these properties sampled, today, on ore faces left in past mining, which as has been stated, was solely for the high grade ores, would give results wholly misleading. Ores of exceptionally high grade have been encountered repeatedly and this fact must not be overlooked in estimating the general average of the ore to be mined, as these occurences may be expected to raise the value of the mine run. Lenses of high grade have been encountered in the Joseph No. 1, Joseph No. 2, Junetta, Merrimac, State of Maine, San Pedro, Chance, Mamie and Solstice workings. One lot of 22 tons of silver-gold ore, shipped from the Bonanza vein brought $40,000.00, which allowing for present lower market value of silver and deducting 1-5, would be about $32,000.00. Mention was made earlier of 920 tons of ore stoped from the north Bonanza workings, which yielded $44,000.00—which at present prices would be equivelent to something like $34,000.00.

The computed general average value per ton of ores mined in the State of Maine, present market, was about $60.00; of the Chance $50.00; North Bonanza $27.00; Joseph No. 1 $27.00; etc. Accepting these values, (a very low estimate of the probable average value per ton of ore which have been mined in the Western Tombstone area, inclusive of the Mellgren property, would be, say $25.00.)

Two alternative plans for the development, equipment and operation of the Mellgreen property, have been outlined. (See page .....).

One plan calls for a capital outlay of $225,000.00—and the placing of the property on a 100 ton daily production basis. It includes the sinking of a development shaft to cut the Bonanza vein at a dept of 500 feet and its development from that level. Then from this depth the gradual development of the property could be carried on, by cross-cutting to other veins. It would provide also for the repair of shafts, installation of pipe lines, erection of central power plant, and the installation of a hundred ton combination cyanide and floatation plant. It contemplates development

and operation by the company, in conjunction with leasing of portions of the mines; the company supplying power and equipment and receiving a royalty on ores mined by lessees, and a profit for the milling of such ores. Under this plan of combined company and leasing operation—mining and milling 100 tons a day—assuming the average value of the ore to be as low as $10.00 per ton, with a net profit of $5.00 per ton, it is expected that an annual profit of at least $115,000.00 could be made.

The other plan proposes a more extensive development of the property with a veiw to mining and milling 200 tons a day and would require a capital outlay of $500,000.00. This advises the immediate sinking of 2½ compartment shaft, to cut the Bonanza vein at the 800 foot level, and the development of the vein system from that depth; cross-cutting easterly and westerly to cut 12 veins, (See Verticle Section along the line A ¾ B, on the Vein Map—in back of this report.); drifting to commence on each vein as soon as reached, the raising of air shafts being included. The policy of leasing portions of the mines would be adhered to, as in the first plan. Assuming roughly the same mining and milling costs and value of ore, a yearly return of $360,000.00 is estimated.

It is also recommended as a part of this plan, for a more extensive development of the property, that a portion of the reserve fund be used to purchase the isolated, adjoining claims; Red Top, Merrimac, Clipper, Free Coinage, Bay, Louise, Mamie and Juaetta, (See attached Claim Map of Western Tombstone area.) as advantageous in a plan for larger development.

Under this plan the power plant would cost double that in the preceeding outlined plan, i.e.; $50,000.00 and, the development work, cost $250,000.00. The reserve fund in both cases being $50,000.00.

The Mellgren property, well within the minerized area of the Tombstone Mining District—a District proven to be widely and heavily mineralized, and with ores exceptionally high in grade, and very persistent in depth, is exceedingly well sponsored by its associations. The formations are the same, the ores occur in the same master system of parallel fissures as in the rest of the District and the character of the ores are the same because formed from a common sourse in an underlying deep seated monzonitic magma. Moreover development has been sufficient to indicate the large ore reserves, prove the relatively high grade of the ore, and shows its amenability to standard methods of treatment.

The Eastern Tombstone area, ~~covered by the~~ Bunker Hill Mines Company holdings, which has had proper financing, has yielded $79,000,000.00 gross value in silver-lead-gold ores, and have assured enormous unmined tonages. The Western area of the District, of which the Mellgren claims cover the greater part, unfinanced and without proper equipment, has had a known production of $5,545,000.00 in silver-gold ore —from the shallow development of 14 of its mines,—probably all told between $7,-000,000.00 and $8,000,000.00, and has, as shown, a reserve of unmined ores, above and below water, and in undeveloped veins that can only be estimated as, large.

Mined high in the ore column, the silver-gold ore of the Western area will give place, with depth, to ores containing lead, as in the Eastern area, and should become more uniform in value and of a higher tenor below water.

Conditions for mining, such as character of formation, size and form of ore bodies, water, labor, accessibility, transportation, climate and other factors are probably as favorable as in any mining camp in the country.

From the amount of development work done, few properties, under similar methods of operation, have yielded larger returns, or promise more, if adequately financed, developed, equiped and efficiently operated. Under these optimum conditions, in my opinion, the Mellgren Mines may be worked for many decades and with gratifying results.

But, any one with less than $225,000.00, on hand, to put into development and equipment, should not think of attempting to operate this property; for they will fail of the exceedingly satisfactory results otherwise to be expected.

MELLGREN HOLDINGS.

The MELLGREN MINING PROPERTY consists of 56 unpatented lode claims, all inter-connected, which together cover an area of about 1050 acres. (See position of Mellgren property, traced in heavy lines, on accompanying Geological and Topographical Map, of the Western part of the Tombstone Mining District. Also, see claim map of the Tombstone Mining District, on which the Mellgren claims are indicated by red shading).

As the several claims comprising the MELLGREN GROUP are contiguous, the required annual assesment work may be done at any one point on them for the entire property. The assesment work for the year 1928-1927 has been done.

TITLE.

The property is owned by V. G. Mellgren and Anna Mellgren, and an Abstract of Title is on deposit in the Cochise County State Bank of Tombstone.

LOCATION.

The MELLGREN GROUP of Mining Claims is situated in the western part of the Tombstone Mining District, southwesterly from Tombstone, County Seat of Cochise County, Arizona, it being about 2 miles from the Court House to the center of the property.

ACCESSABILITY.

Tombstone is the shipping and supply point. The Tombstone-Charleston County Highway, a good auto road, crosses the property nearly centrally. A branch line connects Tombstone with the main line of the Southern Pacific Railroad at Fairbank, 9 miles to the westward. On a siding at Tombstone are loading platforms for ore. The accessability of all parts of the property, is an important asset in development and operation.

HISTORY OF THE TOMBSTONE DISTRICT.

A brief sketch of the history of the Tombstone Mining District may be of interest. Up until the years 1877 and 1878 the Tombstone District was a comparatively unknown and unexplored region. It was infested with the murderous Apache Indians, and few prospectors dared go there. Being thought in the center of promising mineral bearing sections, it excited the hopes and expectations of prospectors, but was not explored until Edward L. Schieffelin, braving the dangers from the Indians, penetrated to its center, and discovered its hidden riches.

Schieffelin had discovered evidences of mineral in a remote portion of the region as early as 1877 and in the Spring of 1878 he started from Tucson, with the intention of thoroughly prospecting the Mule Mountains, in which he felt certain, great deposits of mineral wealth would be found. His expedition was considered a very hazardous one and he was advised by his friends to take his tombstone with him. His enterprise and courage were rewarded by finding a heavy outcrop of rich ore at the very surface of the ground. The profusion of ore, lying nearly flat, showing no well defined linear outcrop, was somewhat puzzling to him, it would appear, as he located a claim transverse to the trend of the vein, and called it the TOUGHNUT; and, to the District he gave the name TOMBSTONE, remembering the advice of his friends to take his tombstone with him.

Returning to Tucson with his samples, he persuaded his brother Albert and

Richard Gird to join him in locating other claims. News of the discovery and of the splendid results of mining operations soon spread over the country. Mines were opened up in all directions, the hills were dotted with hoisting works, mills were erect- on the San Pedro River, a city of thousands of inhabitants quickly sprang up, water was piped in a distance of 30 miles, from the Huachuca Mountains, and the greatest activity in mining prevailed and mining has continued since.

In 1900 the numerous companies in the eastern part of the District were consolidated into one company, known as THE TOMBSTONE CONSOLIDATED MINING COMPANY and they operated until 1912, when these properties were taken over by the PHELPS-DODGE interests and is now known as THE BUNKER HILL MINES COMPANY, which controls the eastern portion of the District, while the MELLGREN MINES cover the greater part of the western.

TOPOGRAPHY AND GEOLOGY OF THE TOMBSTONE HILLS.

An imaginary square 16 to 18 miles on a side and having its western edge in line with the San Pedro River, would roughly enclose the TOMBSTONE HILLS and delimit the Tombstone Mining District. (See accompanying "Areal Geological Map of Tombstone Mountains"). These so called hills are, as are also the intervening "Little Mule Mountains", structurally an erosional remnant of the northerly end of the northwest-southeast trending Mule Mountains, in which the enormous copper deposits of Bisbee, 25 miles to the southeast are being mined.

The region thus defined is one of relatively moderate relief. From the San Pedro Valley, elevation approximately 3900 feet above tide, the country rises rapidly over a partially developed erosional, pedimentary slope. On this slope stand a few groups of hills, among the highest of which are UNCLE SAM HILL, summit 4831 feet, THE DOME, 5091 feet and MAYS HILL, 5732 feet. The eastern portion of Tombstones Hills, rising more enmass, from a relatively abrupt western face, has among its more noticeable eminences, NO-ACCOUNT HILL, elevation 5247 feet, MILITARY HILL, 5301 feet and AJAX HILL, 5315 feet.

Washes and open passes make even the rougher portions of these mountains comparatively easy of access, and the District is traversed by a system of mine roads, connecting either with the TOMBSTONE-BISBEE, (BANKHEAD U. S. ROUTE 80), TOMBSTONE-CHARLESTON or TOMBSTONE-FAIRBANK highways. Drainage from all sides of the Tombstone Hills is by dry washes to the San Pedro river.

The Geological Map accompanying this report, shows the distribution, class and age of the rock formation involved in the structure of the Tombstone Mountains, tho in a somewhat generalized manner, owing to the small scale to which it is drawn.

The Tombstone-Mule Range, a term it may be permissable to use for its convenience here, is of the type commonly designated, "Fault Block Mountains": that is to say it is a structure composed superficially at least of raised and tilted "Earth Blocks", although a considerable part of the relief and bulk, as usual with this type of mountain structure, is due to granitoid rocks, introduced at the time of uplift, as upwelling lavas beneath and into the structure.

FORMATION OF THE TOMBSTONE MOUNTAINS BY BLOCK - FAULTING AND BATHOLITHIC INVASION.

The history of the formation of the Tombstone Hills or rather of the Tombstone-Mule Mountain Range is generically a part of happenings affecting a wide area, and a clearer perspective of its specific details may be gained by a consideration of it in its broader or regional setting.

The Tombstone Mountain Range, as stated earlier, stands on the site of an older range which was formed in Permian, or closing Paleozoic time. By Mid-Mesozoic time, erosion had reduced these mountains practically to base level. Southern Arizona and the region to the east and south, then subsided and a thick series of Comanchean

sediments were deposited, which, in the Tombstone-Bisbee area covered the planed base of the first or Permian Range, under 5000 feet or more of strata. In closing Mesozoic time, a slow upward warping of the broad region of Northern Mexico, and the region to the northward, including Arizona, began. In Early Tertiary time great fissure eruptions occured over the region and covered thousands of square miles of country under a thick mantle of acidic and sub-acidic lava flows and tuffs, the latter formed by explosive eruptions. This was followed in Mid-Tertiary time, by a collapse as it were, of a considerable part of the arch, including the area of the Great Basin Region, and of an eastward trending extension which stretches across Southern Arizona, between the Plateau region of Northern Sonora and the Colorado Plateaus Region to the north.

In the collapse, the Early Tertiary volcanic covering and underlying older rock formations were broken up, producing a topography in which the salient features, as seen today, are the long northwest-southeast trending fault block mountains and intakmont valleys or plains.

This change was not cataclysmic, but evolved slowly, tectonic movements and volcanism continuing more or less intermittently to the close of the Tertiary time. For that matter, movements or minor readjustments may be expected to occur over a long period of time to come.

A phenomenon seemingly genetically connected with the formation of these fault-block ranges was batholithic invasions. This was a upward movement, from deep seated reservoirs beneath, of magmatic material in great volume along their axes, these slowly crystallizing into granite, monzonite, diorite and other granitoid rocks. The presence of such large masses of coarsely crystalline rocks is revealed in the bases of nearly all of the mountains of this type, which have been deeply eroded; and in most cases they are seen to have played an important part in the shaping of these mountains, at least in the position taken by the various fault-blocks, comprising them. Compression and tension were likewise important factors.

In connection with their invasion, these batholiths, in another respect, played an important role. In many cases by latter differentiation they were metal rich, and their residual and volatile constituants, escaping from them; or being forced out, as the magma crystallized, from a state of mineral solution, made their way into the overlying older rocks thru fissures, shear zones and fault planes, and formed large and valuable ore deposits.

Active erosion, started by uplift, has since greatly modified the shape of these mountain masses, by carving them into rugged superfices of canyons, divides and peaks. Under the attacks of the elements their flanks have retreated in irregular outline, giving place to progressively extending outwardly sloping, rock-carved floors or pediments; the tendency being, to reduce these mountains to rounded hills and replace in the end by outward sloping, flat-conical surface or plains.

In the process of denudation and dissection of these mountains, enormous thinknesses of rock have been removed, in some cases reducing their original volcanic and sedimentary coverings to mere isolated patches, or to foot hill remnants. Thus have the deep seated batholiths and inermost structure of these mountains been revealed, and their contained ore deposits, brought within reach of the prospector.

The debris from the wasting mountain slopes, transported from the canyon mouths, by debouching streams, in times of seasonal freshets, and carried to the intervening lowlands, have built up thick alluvial deposits, whose long water-laid slopes have crept back over the pedimentary areas, burying the mountains seemingly to their necks in their own excoriations.

A late phase in the cycle of erosion, transportation and deposition of debris over Southern Arizona—possibly resulting from climatic changes, but more probably

due to a later stage in the maturation of the head-water tributaries of many mountain canyons and, possibly a result of general elevation of the region quickening the discharge of the waters of the ephemeral mountain streams—has led to theentrenchment of the axial intermont streams, such as the San Pedro River, and to a corresponding dissection of the converging alluvial slopes fronting the mountains or either side, and in places has denuded large areas of the rock floored pediment: of the mountains.

The above sketch of Teriary Mountain making, in the Southern Arizona region, and subsequent slow wasting away of these mountains, portray the evolutionary history of the Tombstone Hills, formerly mountains, with flanks greatly extended beyond their present limits; now in their much denuded and reduced condition, they present a constrast to many of their loftier and more massive neighbors, which has led to their being called, quite consistantly, the "Tombstone Hills."

In their present state, the Tombstone Hills have been stripped of their original covering of Early Teriary volcanic rocks; the Mesozoic strata have been removed from the top of the more elevated Paleozoic fault-block and higher extending portions of the Late Teriary monzonite batholith, and uncovered the quartz monzonite porphyry dome, exposed in the western part.

The position of the various rock formations, as shown on the Areal Geologic Map of the Tombstone Mountains, suggests a complex of fault-blocks. Had the mapping of the area been drawn to a larger scale and therefore less generalized, this block structure would be much more evident.

E. L. Jones and F. L. Ransome, in U. S. G. S. Bulletin 710 D, Pl. 5, Seq. page 102, have shown the faulting for the northern area of the Tombstone District. Centrally is an eastwardly up tilted block, with scarp-like western front—high points in which are Military and Ajax Hills, the whole raised between master fault planes on the north and south and along its western side. To the northward and westward is an intricate system of fault blocks which from their fosition appears to have fallen away from the central block, so that while the central block is a mass of Paleozoic strata stripped of its former Mesozoic sedimentary and Tertiary volcanic coverings, the area to the north and west is mainly surfaced by Mesozoic strata and areas of quartz monzonite and quartz monzonite phorphyry.

GEOLOGY AND ORE DEPOSITS OF THE EASTERN (BUNKER HILL) AREA OF THE TOMBSTONE DISTRICT

As has been stated the principal surfacing formation of the northern part of the Eastern area of the Tombstone District is the Mesozoic series. These sandstones, or quartzites, argillaceous sandstone, shales and interbeded blue to black limestones have in general a northeasterly to easterly dip—to the south and west of U. S. Min. Mon. No. 2, the underlying Paleozoic formation come to the surface and supplant the Mesozoic strata.

As determined by the early investigations of William P. Blake ("Tombstone and its Mines") a report to the Development Company of America, 1902, John A. Church (Trans. A. I. M. E., XXXIII, p 14) and others, the Mesozoic strata of the northern part of the Eastern Tombstone area are in a flexed and crumpled condition, forming a series of parallel anticline and synclines; the long axes of the 4 principal saddles or rolls as pointed out by them, having a trend of 60-80 degrees north of west and a pitch to the west of 10-15 degrees. They also recognized, that these sedimentary folds are cut by a succession of "5 nearly verticle plutonic dikes", striking a few degrees east of north and west of south. These dikes fill, in part, a series of fissures. Church also shows fissures with a northeasterly trend, without dike fillings, cutting the dikes and anticlines. The dikes or veins, terms often used interchangeably by these writers, of which 5 are recognized, are considered as the principal channels thru which the ore forming elements were introduced, and themselves constitute

lode deposits. The dikes are described by Blake as often bearing gold, silver and ores of other metals, and containing much quartz; or the quartz formed in distinct and parallel veins or forming an acute angle with the trend of the dikes. Blake concludes that the dikes or veins were formed together, or in near sequence of time, and that the silicious deposits represent emanations from deep seated, probably thermal sources. Cutting indiscriminately, shales, quartzites and limestones, ores are found in sheared and brecciated portions of the dikes, alongside of the dikes dikes in all of these formations, tho limestones are favoring formations. Where these fissures cross the anticlines, interbedded deposits often occur in the limestone strata in the folds, either in the apex or axis of the folds, or on the limbs of the folds as saddle reefs. It was observed, moreover that mineralization is more extensive downward with the pitch from the dikes, than up slope in the saddles. Frequently mining operations have opened up several of these saddle reefs, one above the other, usually interconnected by longitudinal, verticle fissures or veins, in, or near, the axis of the folds. Considerable oblique cross-faulting, tho of comparatively small displacement, occurs.

In the southern part of the Eastern area, in the Paleozoic limestones, the ores occur in the north-south fissure system, as lodes, and less regular bodies in brecciated portions of the limestone, and often as irregular and branching descending pipes, or "chimneys", many of which have been mined to a depth of several hundred feet —some to water-level.

To date mining in the Tombstone District has been largely a selection of the high-grade portions of the ores, leaving the ores of low or milling grade. And, these operations have been limited almost wholly to that portion of the secondary or oxidized ores which lie above the level of permanent water.

The depth to the water table varies, being relatively greater at points of greatest relief. Thus in the Eastern part of the District it varies from 432 feet to 630 feet in depth and, in the Western from 200 to 400 feet. (See later discussion of water).

In the ores of the Tombstone District thus far mined, silver values, predominate and gold has been consistently important; lead is likewise important in the Eastern area, tho in the Western, or Mellgren area—due it is believed to the higher horizon in the zone of ore deposition—lead is only just beginning to come in at water -level. The ratios of these metals in the ores of different mines however have varied widely.

Blake (Opus. Cit.; p. 72-74) showed that there is a marked increase of gold relative to silver in depth, citing from mines in many of which operations had been carried to water-level.

The ores of the whole Tombstone Mining District may be classified as high grade. The earlier operators shipped and milled ores having an average value of $100 per ton, or better and, hundreds of tons were shipped from Tombstone running a thousand dollars or more. Blake, in the above cited report, quotes J. W. Dean, an operator, as stating that the smelting ores shipped from Tombstone in 1899, averaged in value from $200 to $300 per ton—he says—"Such ores were selected so as to justify the great cost of hauling and transportation, but with a railway connection, and possibly a smelter in the camp, ores of a much lower average would be worked profitably.

And again quoting Blake from the same report (page 71):—"There are two classes of ores produced at the Tombstone mines—the milling ores and those best adapted to smelting. Both classes are high grade. They yield gold, silver and lead. The average value of ore worked by milling in 1881 was reported as $70 per ton. It is said and believed by competent judges familiar with the yield of ores of the Tombstone District, that the general average value was $45 per ton, being the highest

average value ever reached in any important district on the Pacific coast. Averages of samples and certificates of returns from the Smelters sustain this claim******"

The oxidized ores thus far mined in the Eastern area, admit of a rough three-fold classification, as:—highly silicious ores, silical 50-70 per cent; manganese and iron low to nil; silica low ores, silica 15-30 per cent, manganese variable, averaging from 0-5 per cent, iron 4-5 per cent, tho sometimes reaching 10-12 per cent, and lime as high as 35 per cent; and manganiferous ores, silica low, little lime or iron and some fluorite, other metals variable but generally low.

"The first two of the above types of ore typify the oxidized ores of the northern part of the Eastern area and the third are found in a few mines in its southern part."

In all these ores the common silver mineral is the chloride (Cerargyrite) tho the bromides (Embolite and Bromyrite) and iodide (Iodiyrite) are important as is also the sulphide (Argentite) in some of the higher grade ores; other forms occurring are the antimonial sulphide of silver (Pyrargyrite) and the silver arsenide (Ruby Silver or Proustite). Some of the ores with the highest lead content have assayed tellurium, indicating the presence of the telluride of silver and gold. Copper, usually in traces, occurs in the carbonate and silicate form, in the northern ores and tends to run higher in the southern ores. The invariable form of the secondary lead is the carbonate (Cerusite), but the lead molybdate (Wulfenite) and the lead sulphate (Anglesite) are not uncommon.

Typical of secondary ores, the values are bunchy and the ores are apt to be cellular and friable, and, in the more silicious ores, the high grade screenings indicate that a considerable part of the values are contained in the fractures. Pyrite sometimes encountered is rarely peripheral in position and unaccompanied by copper.

The third type of oxidized ores, the Manganiferous ores of the southwestern part of the Eastern district, occur in the Paleozoic limestones. These ores vary from manganiferous silver ores to argentiferous manganese ores. They are found in the Oregon, Lucky Cuss, Lucksure and Bunker Hill mines. They usually occur in the plane of along fissures, at the point of intersection of less distinct cross-fissures and are ores of the irregular pipes or "chimneys", enumerated in the preceding discussion of the forms of Tombstone ore bodies. They also occur as isolated small bodies and in the Prompter workings, the eastern end of the Oregon mine, as long narrow ore chutes, in the plane of the east-west striking Prompter fault.

The manganese occurs in a variety of forms, Pyralusite, Wad and Psilomelane; principally as the latter. The gangue is quartz, calcite, some fluorite, silver chloride, lead carbonate and silicate of copper. (The latter formed from tetrahedrite).

During the late war these mines are said to have produced 40,000 to 50,000 tons of manganese; the fines being shipped for their silver values. It is not known that any large amount of manganese ores remain. But, were it not for the silver values it is doubtful if they could be mined at a profit, under ordinary conditions. It is said that many of these manganese pipes were mined to water level—in the Oregon 630 feet.

The ores were shipped as non-lead ores. In the main Prompter ore chute, lead values, however, increase noticeably below the 360 feet and, there is little doubt that with depth that manganese will decrease and there will be a strong increase in silver, lead and gold.

In the Emerald and Silver Plume mines, in the same neighborhood, manganese decreases rapidly from the surface. Smelter returns of leasors now shipping the gob or stope fillings on the 200 level from the Emerald indicate this decrease. Present shipments are running 50-60 cents in gold, 6-8 oz. silver, 2-3 per cent lead, 0.20-0.50 per cent copper, 5-7 per cent manganese, 3-4 per cent iron and 50 per cent silica. A pillar on the 200 level, now being shipped, assays seventy-five cents to a dollar in

gold, 30 oz. silver, 6 per cent lead and 4 per cent copper. A 50 to 60 foot verticle winze, sunk from the 900 level, is said to have encountered a large body of ore high in lead.

The ores of the Emerald and Silver Plume mines are interpreted as being zonally a little lower in the ore column than the manganiferous ores just discussed.

There has been much speculation as to the origin of the bodies of manganiferous ore. Some have advanced the suggestion that, at least in part, they are segregations, by wandering meteoric water, of manganese originally distributed, in small amounts, thru the Paleozoic limestone. But a discovery of a considerable body of ore, rich in the manganese sulphide(Alabandite), in the Lucky Cuss mine would indicate that these manganese oxides form an original part of the ore column beneath, deposited as a primary ore syngenetically with those of the other associated metals. There seems no reason to doubt, however that there has been a considerable downward segregation of the manganese from higher levels, now eroded, brought about by oxidation and descending ground water.

It appears to be the concensus of opinion among Geologists and Mining Engineers, who have made a study of conditions in the Tombstone Mining District, that the mining of the ore deposits has scarcely begun. The reserves of milling and high grade ores indicated are very large. This applies not only to ores below water level, which remain practically untouched, but there is a large unmined tonnage above. Moreover there are a considerable number of properties with excellent showings on which very little work has yet been done and there is much virgin ground in the Eastern area and in the Western as well, which promises when explored and developed to greatly extend mining operations.

The formation of the Tombstone end of the Tombstone-Mule Mountain Range, in age and character, duplicates in all important essentials the series found in the Bisbee end.

The oldest rock formation exposed in the Tombstone Mountains are a fine-grained schist, referable to the Pinal Schist, also exposed in the Bisbee District, and an intrusive gneissic granite, both of Pre-Cambrian age. These by up-faulting and erosion, are exposed in a limited area, as indicated on the geological map, above referred to, near its center. These rocks, because of their deep lying position and great age, together with, later intruded, extensive masses of granitoid rocks, may be regarded as the basement foundations of the Tombstone region.

Resting, by sedimentary-overlap, upon the Pinal Schist and intrusive gneissic granite, and upon what was once part of the old land-surface, produced by erosional-bevelling of these older basement formations, in Pre-Cambrian time, is a thick series of marine strata of Paleozoic age. This series includes sediments, now lithified, representing portions of Upper Cambrian, Devonian, Mississippian and Pennsylvanian times.

The Upper Cambrian strata exposed in the Tombstone area, represents two distinctly contrasting phases of sedimentation, and possibly in part, a third. The first took place close in the wake of an advancing strand line, which hesitantly moved across the old Pre-Cambrian land surface; due to its down-warping to and below sea level, until the region of Tombstone and all the country for hundreds of miles around lay beneath a vast, open, shallow, salt-water sea. With this sea came the life of the shoal-waters of the great extra-continental oceanic realm of which it was an extension. The second phase of sedimentation, began with the advent of open sea conditions over the region—and lasted for several millions of years. The third phase represents sedimentation which took place under shoaling water conditions and deposition of sediments off-shore just ahead of a retreating strand line, due either to cessation in subsidence and sedimentary fill, or to the gradual up-warping of the bottom-

the region in the end again becoming land.

The first of the above phases of sedimentation was the formation of a beach and off-shore, shoal and bar series of deposits, made up wholly of the coarser wave-worked, beach-ground waters-sorted and, current distributed materials. This portion now lithified, by the addition of a cement of silica, is known as the Bolsa Quartzite. Its thickness, 740 feet in the Tombstone section, represents a gradual subsidence of the region, and the laying down of land derived sediments, amounting to that number of feet—and more, for the rate of subsidence, end of the advance of the strand-line into remoter regions was slightly exceeding the rate of up-building, by sedimentation, and the water was deepening the while. Thus, the Bolsa Quartzite, in the Tombstone Hills, has a basal conglomerate 6 inches to 3 feet in thickness, composed of well rounded, white vein-quartz pebbles, imbedded in quartz sand, formed by beach sorting of the old residual soil, made by the weathering of the Pinal Schist and intruding gneissic granite.

The succeeding 120 feet of the quartzite is exceedingly massive, in its outcroppings forming nearly vertical escarpments, the rock under weathering, falling away in smooth joint planes. In the main, it is comparatively coarse-grained sand. The next 75 feet are less heavily bedded and, upwards the layers average about 14 inches in thickness, and are of finer textures; but cross-bedding and cross-lammanations, produced by drifting of the sand into off-shore bar structures, are typical. About 65 feet from the top of the quartzite beds is a heavy stratum, 10 to 11 feet in thickness of dirty yellowish-brown weathering quartzite, filled with lighter colored, slender, vertical, pencil-like, sandstone cylinders (Scolithus), representing the living-burrows, of myriads of sedentary marine worms, which lived in the outer bar region of this sea. These fossils and many other molds of various forms, of similar origin, furnish a Bertillion record, as it were, of the existence and activities of organism living in the shallow shore waters of this sea in Upper Cambrian time.

Beyond the zone of beach-slopes and bars, in the region of deepening waters and weakening currents, the finer land-derived sediments, including the easily rafted fine mica flakes, derived from the pre-Cambrian schists and gneisses were deposited. This, the upper part of the Bolsa Quartzite grades, interruptedly from relatively pure quartzites, into micaceous, arenaceous shales and shaly-micaceous sandstones. Finally, some of the layers become somewhat calcareous. Often the flaggy, or thin-splitting, sandstones of this horizon have a greenish cast, because of contained glauconite (A hydrated silicate of iron and potassium) precipitated by activity of micro-organism, at the upper edge of the fore-slope of the transition zone, between shallower and deeper waters.

These micaceous shaly and flaggy beds are transitional from the Bolsa Quartzite to the succeeding Abrigo Limestone, but have been included with the former, in the measured thickness given for that member for they are composed of strickly terrigenous, or land derived materials. As a whole this zone is very weak under the attack of weather and erosion and its position is marked by a depression along its outcrop in line with the strike of the beds.

While viewed from close up the layers of the Bolsa Quartzite on the surfaces of fresh fractures are gray in coloring, yet, viewed ensemble and from a distance, the weathered surface of the quartzite appears a light rusty-brown.

So with the subsidence and landward advance of the strand-line, zones of sedimentation shifted and, over the Tombstone region, with deepening water and with increasing distance from shore and it shore-currents, drag of waves, undertows and beat of surf, finer sediments were next laid down. Thus were initiated, over the spot where coarser beach and shoal-water deposits formerly had been laid, finer deposits representing the second phase of sedimentation, already referred to—and following

in this manner we have the deposition of the Abrigo Limestone, 740 feet in thickness, where measured near the Emerald Mine—a mile and a half south of Tombstone.

Fine, greenish, micaceous shale, and fine sandy shales, with thin platten of fine grained sandstone now appear, with included thin layers of impure, often arenaceous, magnesian limestones. The limestone layers become more numerous and generally purer upward, but are separated by shaly partings. Two or three heavy massive benches of limestone of blue-gray color occur—and many of the weathering edges of limestone layers are ribbed with narrow, parallel flat bands of brown-weathering, impure chert, which contrast strongly with the gray color of the including planes of limestone. Two prominent zones of shale and sandstone platten separate these limestone beds. The shales usually weather a light rusty-brown.

This portion of the upper Cambrian strata for the major part, represents a period of comparatively slow sedimentation. The sands, now quartzites, which make up the Bolsa, were deposited in a comparatively narrow off-shore belt of relatively rapid sedimentation. The fine sand and mica flakes, argillaceous matter, of which the shales of the Abrigo were formed, accumulated in inches, while the sands of the Bolsa, relatively speaking, were built up by the yard.

The many feet of limestone included in the Abrigo probably represent a much slower accumulation than either the sandstones or shales, made up, as they are, of lime secreted by small marine organisms, both as shell-armor and skeleton, from the waters of the sea. These layers either composed of finely fragmented or comparatively complete test of organism, collected by current sorting as shell-marl were cemented by interstitial lime and magnesia, into limestone.

Prominent among organisms contributing to these deposits, were small lime-secreting algae or marine plants. Many of them must have been so delicate that on decay of the organic matter of the plant, a residue of lime-mud only was left, or crumbled under the slightest trituration, destroying their form. But, one small form (Solenopora), whose calcareous skeletal remains resemble small, oblong, black concretions, having a concentric inner structure, makes up, almost wholly, many of the thin layers of limestone and the bulk of one of the thicker massive beds. Many forms of animal life contributed lime to these deposits. Brachiopods which in later Paleozoic times, with lime carbonate shells forming one of the most important contributions in limestone formation, are represented, but here mainly in the fine shales, by their minute two valved shells, circular or oval in outline, composed of phosphate of lime. Important possibly as plants, in the formation of the Abrigo limestone, particularly the upper beds, were, tho now extinct, Trilobites, representing several genera and species. These little marine creatures were Crustaceans, with a phosphate-of-lime covering, composed of many overlapping bands and rings, forming an armor, as in the case of the living members of the family, such as the lobsters and shrimps. The Tribolite body was compressed and in outline oval, and with median-longitudinal ridge along the back, making with either side three lobes, signified by the name Tribolite. These crustacians living in countless numbers, contributed, by their moultings and death, the bulk of the material comprising many of the limestone layers in the upper part of the Abrigo.

Thus the Abrigo, the second phase of Upper Cambrian sedimentation in the region of Tombstone, that of shallow open sea conditions, judged by the nature of its deposits and thickness, represents a period whose duration was vastly longer than that of the transitory, first phase of sedimentation, when the Bolsa beach and near-shore, shoal-water sands were deposited. The latter represents the time of transition and formation of strand deposits across hundreds of miles of submerging land-surface, for there is no evidence that any material part of the deposits of this second phase were removed from the series by erosion. The conditions indicated are quite

to the contrary.

For, resting upon the argillaceous and calcareous part of the Abrigo, occurs some fifty feet or more of white, relatively thin-bedded, fine grained, pure quartzites, with some intercalated sandy shales. Layers of similar quartzite however, first appear among the upper layers of limestone beneath. Theres 50 odd feet of quartzites, it is believed, represent the third and last phase, deposited during the time of withdrawal of th esea across the Tombstone area. These quartzites may, therefore, represent material derived by reworking top beds of the Abrigo, deposited off-shore, ahead of the retreating wave line.

The relatively weak resistance offered by the Abrigo Limestone to the attack of the agencies of weathering and erosion, makes its line of outcrop—between the more resistent Bolsa Quartzite, beneath, and the more massive limestones, immediately overlying—either a depressed belt or floor of a terrace. Viewed from a little distance, the color of the Abrigo as a whole varies from a dark greenish-yellow to a dark rusty-brown.

No strata representing either succeeding Ordovician or Silurian times, are known in the Mule-Tombstone Mountain Range, although it is probable, from the occurrences of the Lower Ordivician (Beekmantown age) Longfellow Limestone, in the neighboring ranges, northeast and east, that deposits which then may have formed within the Tombstone area, were later removed, before being incorporated in the sedimentary succession. So it is to be inferred that for the greater part of the many succeeding millions of years, and until Devonian time, the region remained above the sea.

In Devonian time the sea extended its realm into the region again and the 300 or 500 feet of sediments now designated the Martin Limestones, were then laid down. A gray sandstone often weathering friable and in thickness at no point observed exceeding 5 or 6 feet, probably represents the strand-deposits and basal-conglomerate of this series of sediments. Considerable shale and some sandstone occur in the basal portion, above the gray sandstone sill, but limestone predominate and the bedding becomes progressively thicker toward the top of the formation. These limestones are dense, mainly pure lime; containing only little magnesia, and generally dark in color, and next to the limestone in the higher Mesozoic series, the darkest in the Tombstone series of sedimentary rocks. Tho the general color is bluish gray some of the strata are gray.

Fossils are abundant in a number of the upper limestone beds and usually are silicified, so that etching of the limestone by carbonated rain water, brings the fossils into relief on the exposed edges of the strata. Some layers are largely composed of little two-valved, lense-shaped, fan-ribbed shells of a little Brachipod (Atrypa Reticularis) species; other layers, made up of coral mud, contain large numbers of beautifully preserved branched, hemi-spherical anl lamellar forms of compound corals.

The base of the Martin Limestone, thinner bedded and with included shales, is a weak member as compared with the capping quartzite of the underlying Abrigo Limestone, and so is often eliminated, along the strike, by being thrust back under the heavier more competent upper beds of the Martin, which are also reinforced by the still more massive basal portion of the overlying Escabrosa strata.

Escabrosa Limestone, of Mississippian (Lower Carboniferous) age, is approximately 500 feet in thickness. It rests with such apparent conformity upon the Martin Limestone and with so little contrast between the rocks of the two formations, that the exact line of demarkartion is often difficult to fix, except by fossils. But, the Escabrosa limestone is to be distinguished otherwise from the Martin limestone by its general lighter color and the remarkable massiveness of its basal 75 or 100 feet.

In all outcroppings this portion appears as a ledge forming member in the series of sedimentary formations, and has a face decidedly steeper than that which marks the Devonian limestone beneath. Moreover a short distance above its basal plane, large, flat, lenticular, black chert concretions show in the limestone and crinoidal fragments and small conical Zaphrentoid corals are usually in evidence. Above the basal 100 feet or so the layers of the limestone become much thinner and in uptilted blocks, which usually outcrop in an erosion-bevelled plane on the dip slope of the block. Some of the middle beds of the Escabrosa limestone, viewed from a distance, have a distinctly bluish-gray cast, but as a whole they appear light gray in color. Altogether they appear darker than the main body of the Escabrosa in the Bisbee area and are not so coarsely crystalline in texture nor so distinctly crinoidal and are, as the capping portion of the formation at that locality, harder and less easily broken. Fossils are fairly abundant and usually silicified.

The Naco Limestone, of Pennsylvanian (Upper Carboniferous) age, in turn rests upon the Escabrosa Limetone. Resting, as it does with no apparent unconformity upon the latter and with no obvious change in the appearance of the rock, also light gray in color, tho as a whole thinner bedded, the transition from one to the other is, except on fossil evidence, rather difficult to establish. There are, however, distinguishing features, such as, the rock in general being thinner bedded, of finer, denser texture, more brittle, often breaking under the hammer with a ringing sound, the occurrence of a few thin layers of pinkish, weathering, impure laminated limestone and a few zones of impure thin splitting limestone.

But part of this enormously thick (probably regionally 3500 feet or more) series of limestone beds is exposed, but makes up the visible portions of the fault blocks in the southern and southeastern part of the Tombstone Hills.

Two faunas are represented by the fossils, an earlier and lower, with eastern affinities and a later, with western,-and also with some Permian aspects.

Recalling the figures which have been given for the thicknesses of the various Paleozoic formations, the total original thickness of the reconstructed Paleozoic series would be something like 5700 feet. Of all this but the Bolsa, 740 feet was limestone. But, much of the upper Naco apparently was destroyed during early Mesozoic times by erosion.

It has been stated that the Tombstone-Mule Mountain Range had its inception by warping and faulting in Permian or closing Paleozoic time. During millions of years following the first uplift, the agencies of weathering and erosion were busy bevelling and grading down the relief. At one known point, the Escabrosa Limestone was uncovered by these processes, as proven by the direct sedimentary contact, which the basal conglomerate of the overlying Mesozoic series makes with it. This occurrence of Mesozoic (Comanchean) strata, resting by sedimentary overlap, upon Mississippian (Paleozoic) strata, without the intervention of the Naco limestone, is found about one mile, airline, south of Tombstone, along the crest and side of the ridge on which U. S. Min. Mon. No. 3 stands, the monument itself being on the conglomerate.

Resting uncomfortably upon the deformed and eroded surface of the Paleozoic formations, in the Tombstone Area, as just shown, and beginning with the conglomerate referred to, is a thick succession of essentially arenaceous and argillaceous strata. This assembly from its similar stratigraphic position and its showing the same general lithologic characteristics, clearly, should be corellated with a sedimentary series occurring in the Bisbee section, to the south, which has been designated the Bisbee Group and from the marine fossils abundant in its mid-section known to be of Comanche or Lower Cretaceous age. Moreover, this basal-conglomerate member, upward of 100 feet in thickness, in the Tombstone section, is the homologue of

the similarly positioned conglomerate found at the base of the Bisbee Group and known as the Glance Conglomerate. It is a thick irregular-bedded deposit, composed of sub-angular, poorly assorted pebbles and cobbles, the latter sometimes reaching six inches or more in diameter.

From the nature of the material it is apparently a composite of all of the older formations of the immediate vicinity, ranging from the basal conglomerate of the Bolsa to and including the Naco limestone—tho preponderatingly composed of fragments from the latter.

This conglomerate probably represents a beach deposit formed at the edge of a rapidly advancing strand, by reworking of the surficial litters or soil which mantled the nearby base-levelled surface, formed by planing away of the old Permian Mountains, predecessors of the Tombstone-Mule Mountain Range.

With such an origin it would seem probable that any exposed igneous formations within the area would be represented by pieces in this conglomerate, but in a comparatively brief search none were found.

Immediately overlying the basal conglomerate just described, is a zone, about one-fourth its thickness, of massive reddish-purple, sandy mud-rock. The succeeding beds are an endless repetition of sandstones, sandy-shales, shales, benches alternating in darkness and great variability in textures. Some of the sandstones are arkosic, some are of pure well-sorted sand and others are conglomeritic. Colors are variable, tho in general the beds weather a light-yellowish-brown cast, but individual beds may be gray, buff, pale terra-cotta to light rusty-brown. The shales in color vary from yellowish, green, black, reddish to varicolored shades. There are some included thin limestones, mostly dark blue to black in color.

A log given by William P. Blake—in a publication hereinafter referred to—of a hole drilled, near the present site of the Tombstone Grammar School, shows that after passing through 60 feet of recent, cemented-detritus, penetrated 396 feet of these Mesozoic strata, five black limestones, one of them 10 feet thick, the others 2 or less, the bottom of the hole being in a "white limestone." Six black shales, 2 to 12 feet in thickness were also encountered.

The blue limestones contain an abundance of marine fossils and, tho poorly preserved, clearly show their age to be lower Cretaceous and their horizon probably corresponds, therefore, roughly to that of the "Mural Limestone," in the Bisbee section, where the marine facies of sedimentation is much more strongly displayed. This limestone zone outcrops in both Eastern and Western areas of the Tombstone District and in the weathering slopes, above and below, fragments of black silicified trunks of trees are common, as at Bisbee.

Comstock Hill, an eminence between the highway and railroad, just beyond the western edge of Tombstone, is a much reduced fault-block, composed of higher Mesozoic (Comanche) sediments, which rests upon a basement of quartz monzonite. Here a thousand feet, or better, of steeply northward dipping, thin to thick-bedded limestones, many ribbed with prominent-weathering bands of brown chert occur. Apparently the original coloration of the limestone, as seen where least altered, was dark gray to bluish, but now is in a large part whitened by marbleization or given a yellowish color by garnetization. Near the top of this series of strata, where the railroad cuts around the northern flank of the hill, sandy and shaly layers are interbedded with the beds of limestone.

A number of less altered limestone layers, in the lower and mid-section of this series, are largely made up of small Lamellibranch (Clam family) shells, few over an inch in length. At first with Blake, Ransome and others, these beds were thought to belong to the lower part of the Paleozoic series, but the fossils relate it to similar limestone strata occurring in the Mesozoic section, in the southern end of the Whet-

stone Mountains, some twenty miles to the westward.

Metamorphism has in many places altered these Mesozoic strata to quartzites hornfelsitised shales, marbleized the limestone, converted finely silicious layers into novaculites, and even epidotized and garnetized portions.

Probably the most complete and least interrupted exposure of these Comanche strat (See Areal Geological Map of tthe Tombstone Mountains), in the Tombstone area, extends with northeasterly dip, northward from the above located outcrop of the Glance Conglomerate—to and including the most intensively mined portion of the Eastern Tombstone District. Rocks of this age, surface more territory, however, in the Western area.

Of the 5000 feet of Mesozoic strata. recognized in the Bisbee section, presumably all of Comanche age, it is doubtful if more than a corresponding 3500 feet can be differentiated in the Tombstone region. This is due, it is believed, to the manner in which these rocks have been mutilated by faulting and erosion, rather than that they originally had a lesser thickness.

In Plate ....., in the back of this report is a panoramic view, taken from U. S. Min. Mon No. 3, looking southerly, sweeping the Tombstone Hills from southwest to northeast, and shows, as annotated on the picture, the stratigraphic series, ranging from the Bolsa Quartzite to, and including the Mesozoic (Bisbee) series.

While no igneous rocks were found in the material comprising the basal conglomerate of the Mesozoic sedimentary series, the brief time spent in seach and the limited extent of the outcrop examined. by no means should be considered as conclusive evidence that they are not represented. Such igneous intrusives as have been found in the Tombstone area, however, are all of types such as have been observed at one point or another cutting the Mesozoic strata, and probably, therefore, should be considered as post-Cretaceous in age.

Extensive outcroppings of dark-gray, rather fine grained granitoid rock, by field determination judged to be a granodiorite or quartz monzonite, occur just west and southwest of Tombstone and reappears in a restricted area in the southwestern part of the region. Its extent to the northward is unknown as it there disappears beneath the alluvial plain. This batholithic body cuts all the sedimentary formations and at Comstock Hill, which is part of a fault block which formed a roof-pendant, into the quartz-monzonite batholith, tongues and dikes of it extend into the Mesozic beds and similar occurrences are known in the Western area of the District. At the southern end of the outcrop of pre-Cambrian basement rocks, mentioned, it is in intrusive contact with them. Aplytic dikes and some small ones of pegmatite, probably differentiates in the final cooling of the mass, cut it at many points and in all directions. Large inclusions or xenoliths, of a dark, fine-grained diorite occur in it. But from its known field relations little more can be said of the age of this quartz monzonite than that it is post-Cretaceous, probably Tertiary, and that it was connected with the initial disturbances which produced the present Tombstone Mountains, raising and displacing the overlying fault blocks in its slow ascent.

Its contact with the limestones is marked by their marbleization and garnetization. The indications are that it underlies a considerable part of the Tombstone uplift at depth.

Southward from the main exposures of this quartz monzonite, and along the whole western slope of the Tombstone to Charleston and thence northward in the San Pedro valley is an area of quartz monzonite porphyry (possibly thin section may prove it a quartz porphyry), a little more acidic in composition than the quartz monzonite. Exposed by erosion it now forms a part of the pedimentary-slope and constitutes groups of hills among which occur the more prominent peaks mentioned earlier—Uncle Sam Hill, The Dome, Mays Hill etc. As indicated on the Geologic

Map it intimately cuts the Mesozoic sedimentaries. This quartz monzonite porphyry is apparently the de-roofed and much dissected remnant of a large dome-shaped intrusion, which raised and widely displaced by magmatic wedging the surrounding formations, and most certainly must have contributed to still further deform the older rocks in the Eastern part of the Tombstone area.

At one point in the Western Tombstone District, where its contact with the Mesozoic beds is clearly exposed by stream action, it includes many quartzite fragments and the Mesozoic beds in places are epiodotized and garnetized. Blocks of Naco limestone brought up from depth, on the contact, are marbelized, silicified and garnetized.

At no point has this quartz monzonite porphyry been observed in direct contact with the quartz monzonite nor have xenoliths of the latter been found in it. However, dikes, a little more basic, but very similar in character cut the quartz monzonite and are of frequent and widespread occurrence in the sedimentary areas. It is probably a differentiate from the same deep-lying magmatic reservoir which furnished the material for the quartz monzonite; owing its difference in texture, most likely, to more rapid cooling at a higher level in the older formations.

Most of the dikes observed in the Tombstone area have roughly north-south strikes and as stated appear to be related to the stage of magmation which produced the quartz monzonite porphyry. Moreover, the fissure system which determines the course and position of these dikes, as will presently be seen, also later acted as controls which determined the position of most of the metalliferous veins of the Tombstone District.

The dikes of more acidic type occur cutting the Upper Cambrian formation in the vicinity of the Emerald and Silver Plume mines, about 2 miles south and east of Tombstone. One of these tho not traced out, should pass close to the shaft of the Prompter Mine.

A large oblong rhyolitic porphyry stock appears just east of the Tombstone-Bisbee highway in the southern part of the Tombstone Hills.

Felsitic or rhyolitic porphyries appear along the highway near Charleston, but neither these nor the preceding acidic intrusions have been determined in age, tho evidently post-Mesozoic, and all appear older than the quartz monzonite porphyry dikes.

In the last named locality dikes, sills, flows and agglomerates, mostly acidic, tho some are dioritic and andesitic, therefore intermediate, occur in disconnected exposures, suggesting by their position and relations, that they are remnants of an older Tertiary series, and antidating the nearby quartz monzonite porphyries which appear to cut them. These last may be, therefore, remnants of extensive sheets which once covered the region.

Such flows dissected into remnant hills lie a few miles north and east of the Tombstones, and well may represent outliers of formations once overlying the Mesozoic beds, now uplifted in the body of the Tombstone Hills, from which they were stripped by erosion.

A small area of Quarternary basalt occurs about 2 miles east of Tombstone on the highway to Gleeson, a copper camp in the Dragoon mountains about 16 miles east of Tombstone.

A detailed study of the relative ages of these igneous rocks, and a comparison of their petrographic characters should throw much valuable light upon the Tertiary history of the Tombstone region and the formation of the ore deposits.

GEOLOGY AND ORE DEPOSITS OF THE WESTERN (MELLGREN) AREA OF THE TOMBSTONE DISTRICT.

The Western area of the Tombstone District is rolling to hilly and between the

lowest and highest point within the mined area is a difference of approximately 450 feet. Except for occasional patches of detrites along the foot of slopes and in the bottoms of draws the rock formations are well exposed. All parts of the area have been made accessible by mine roads, which connect with the Charleston-Tombstone highway. (See Topographical and Geological Map of the Western Tombstone District, appended to this report).

The western and southern part of this area is underlaid by a quartz monzonite porphyry. The northeastern is floored and flanked by a granitoid rock, classified as monzonite. Between these two areas is a belt of sedimentary rocks—surficially mostly Mesozoic; sandstones—with two or more belts of shale interbedded with thin sandstone platten,—and with one exposed zone of limestone. Two outcroppings of Paleozoic limestone occur, one Pennsylvanian (Naco) in age, to the north; and the other Mississippian (Escabrosa) in age, to the east. A small area of Mesozoic, not indicated on the map, also occurs, just north of Uncle Sam Hill, surrounded by the quartz monzonite porphry. Paleozoic rocks are believed to underly, in their natural relation, the major portion of the area covered by the Mesozoic sediments. The Mesozoic strata have a generally gentle and rolling dip to the northward. The Paleozics are slightly at variance in dip.

Several north-south dikes, appearing to be a little more basic than the quartz monzonite porphyry, the largest reaching 20 feet in width, cut the sedimentaries, and one observed, continues northward into the granitoid monzonite for some distance. In a single known instance, in this area, one of the dikes follows a fissure occupied by a vein, but does not appear to be genetically connected with it.

The dikes show off-setting by cross-faulting and may well be studied for the light this may throw upon the displacements of veins, which likewise show some faulting. For example, the general opinion is that the Merrimac and Free Coinage veins are part of the same north-south ore body, displaced by faulting.

The contact between sedimentary and igneous rocks, from surface examination, where observed, appear to be intrusive, tho it seems highly probable that later movements, such as would produce the fissure system, containing the veins, must have caused some displacements, probably resulting in fracturing and brecciations along them. It would be well to determine this fact in connection with the north-south, main contact, between the quartz monzonite porphyry and sedimentary formations, on the Mellgren ground.

The ores occur mainly in master fissures or shear zones, roughly in common north-south strike, with a decided tendency to northeasterly departures. This likewise is true of the trend of most of the vein fissures in the Eastern area of the District. Their dip varies from 90 degrees to as low as 50 degrees west-ward. Cross-veins likewise occur, in which there is less regularity in direction and dip, and less persistence. The veins occur in both the sedimentary formations and the quartz monzonite porphyry. (See attached may showing the Veins of the Western Tombstone District).

The average width of the veins mined in the Western area, so far, has been about 3 to 4 feet, tho, sometimes in places, widening to as much as 10 or 12 feet. The walls within the comparatively shallow depths to which the veins have been mined, are neither sharply defined by slickensiding nor by gouges. This is also true of some of the veins of the Eastern area.

The ores as deep as mined, or to water level, and to a proven depth of 34 feet below, are oxidized or secondary, silver-gold ores. The silver occurs in the ore as a chloride, iodide, bromide and occasionally a small amount of sulphide, usually 40% as chloride. Vanadium is sometimes noticeably present; iron and manganese oxides occur, rarely amounting to more than 5 to 8 per cent, generally merely stains. Some

traces of lead in the form of Mimetite, (Lead Chloro Arsenate); Cerussite, (Lead Carbonate); Anglesite, (Lead Sulphate); and Pyromorphite, (Lead Chloro Phosphate), are occasionally observed, and near water level, small bunches of ore running as high as 9% in lead, have been encountered. Copper carbonates and silicates occur in traces.

The gangue is altered country rock, quartz and sometimes barite, or heavy-spar, in appreciable amounts. The average silica content of ores shipped has been about 74%.

Many of the shallow gulches, or washes, of the area appear to owe their rectilinear courses to lines of weakness determined by the position of such structure as fault, shear and breccia zones and to interformational contacts. The formations and structures in such positions are usually more or less obscured by alluvium and they should be prospected carefully as likely places for veins, chutes, or less regular ore bodies.

The Western portion of the Tombstone District is largely undeveloped. There has been no systematic development of the ore bodies and no deep mining. No centralized workings for large scale operations, such as, cross-cutting tthe country at depth, for a main working shaft, to transect the parallel north-south vein system and the development of these veins along their entire strike.

There is little doubt that blind veins will be encountered, when cross-cutting at depth is done.

CONTINUATION OF TOMBSTONE ORES BELOW THE LEVEL OF PERMANENT WATER.

At the time of the sinking of the Boom shaft to the 1000 foot level (See particulars under discussion "Water in the Tombstone Mining District"), active work in opening up and mining of the ore below water-level was in progress. Extensive bodies of ore of good grade were found and shipments were being made from these ores below water, at the time of the last pumping operations, 1906-1910.

A review (E. and M. Jour., June 15, 1910; page 161) of the annual report of the Tombstone Consolidated Mines Company, Tombstone, Arizona, for the year ended Sept. 30, 1909, sets forth the results of mining below water-level for the year. Development to the extent of 4543 feet was done, mostly on the Contention Group, the mill operated and ores and concentrates shipped from 700-800 foot levels. "During this period were produced and treated 15,070 tons of ore of which 10,670 tons were milled and 4,400 tons were smelted. Of the milling ore 4443 tons were zinc ore and averaged 0.04 oz. gold, 10.5 oz. silver, 13.3 per cent lead and 22.6 per cent zinc.*****". The bulk of the zinc ore was mined between the 700 and 800 foot levels, in tthe Silver Thread mine and was sulphide.

It is reported that in the Lucky Cuss mine, one chute of ore, in tight ground, was mined to a depth of 200 feet below water, operations ceasing at that point when loose ground, admitting the water, was encountered.

Present development likewise shows ore bodies to and into the water, in many of the mines in both the Eastern and Western parts of the District, the following being some of them:—Contention, Grand Central, Luck Sure, Emerald, West Side—Eastern area: State of Maine, San Pedro, Louise (Randolph), Fox, Bonanza, Joseph No. 1, etc.—Western.

The following excerpts from the report of W. P. Blake, (Opus. Cit. "Tombstone and its Mines") furnish very conclusive evidence of the persistence of Tombstone ores with depth and into the water table.

Under the caption the "Contention Mine," Blake states:—

"In the winter of the year 1882 I made an extended and careful study of the workings of tthe Contention, Head Center and Tranquility Mines in company with

the late Mr. Isaac E. James, the engineer and surveyor, and have notes of the lode and ore bodies and stopes. I was able to trace these ore bodies from the surface to the 600 foot level, just above the water line, and to note their continuity and satisfactory evidence of the downward extension of the lode and its ores into and below the water. I was not present when the water was lowered by pumping, but in company with Mr. James had previously been to the lowest winze on the lode and saw a strong lode of quartz extending into the water. It had the appearance of being leached out at water level and for a few feet above it, as if by seasonal changes of the water level, the ores had been removed, leaving a cellular skeleton-mass of white quartz. The inference was unavoidable that greater depth under the water would show good ore in the lode."

The concensus of opinion and statement by competent observers and judges at that time and since is that ore values will be maintained in depth. This is my belief also. It is based upon the knowledge gained as above stated and upon the fact that I have recently visited different parts of the 600-foot level of the mine, where winzes have been sunk to and into the ground now covered by water and have seen good ore there.

Other points at which ore has been shown to extend to and below the water were visited by me in the extreme east workings of the Contention on the 600 foot level, where two winzes show good ore.

At several points where mining operations on ore-bodies have reached water level, the evidence of continuity have been highly satisfactory. It would be an anomaly in mining if the ores so liberally formed above water did not extend with equal value below its level. It is geologically certain that the present surface level of the country is much lower than it formerly was, this lowering or cutting away being the result of the mighty erosive agencies to which Arizona has been subjected. The ancient surface was probably some hundreds of feet higher than now, so that the ore deposits we have been able to mine were once below the water. And if we lower the water artificially we may expect to uncover ores as rich or richer than those uncovered by the gradual subsidence of the water from natural causes.

This question of continuity of ore below water has been much discussed. That the ore should so continue, theoretically has been sufficiently stated and shown. But it is now a matter of fact rather than theory. While not present when the two great pumps were in action, one at the Grand Central, and the other at the Contention, I am most creditably informed that the water was drawn out enough to permit of winzes being sunk at intervals below the 600 foot mark for the purpose of testing the lode. Owing to the broken character of the ground, the water receded at points quite remote from the shafts almost as fast as in the shafts.

High grade gold ore was found in the winze upon the east ledge, about 400 feet north of the Contention pump shaft. A letter from the then president of the Contention Company stated that at a depth of 75 feet in this winze, "a drift was run for a distance of 140 feet, and that the ore taken therefrom averaged over $100 in gold per ton." Ore of excellent grade was found in other winzes but this winze was the only one in which considerable drifting was done.

Another letter: "We are running a drift on this west ledge northward from the bottom of the winze on the 600 foot level, and are getting a good showing of ore, an assay from which, received that morning showed 22.6 ounces silver and 2.9 ounces gold, or a total value of $71.24, figuring silver at 50 cents per ounce. Another assay received today also shows the same striking high proportion of gold to silver, which we are finding to be the rule on water level."

Referring to the "Grand Central Mine"—he gives the following important facts in regard to the extreme southern portion of the Contention lode:—"Mr. Gage, as

ly established by the dikes, apparently very closely related to the quartz monzonite porphyry, which not only cut the Mesozoic strata, but also the quartz monzonite, that the quartz monzonite porphyry is younger. This would then connect the formation of the Tombstone ores with magmatic surgence which placed the quartz monzonite porphyry and, therefore, occurred as a late phase in the formation of the Tertiary, Tombstone-Mule Mountain Range. Furthermore that it was very late, is indicated by the small amount of deformation found in the Tombstone ore bodies.

The formation of the north-south system of vein-fissures is attributed to loss of volume with the mass of quartz monzonite porphyry, due to loss of gaseous turgidity and shrinkage in cooling, resulting in settling and cracking in the upper zone, in adjustment; effecting not only the upper already congealed part of the quartz monzonite porphyry but extending to the including sedimentary formations and the quartz monzonite. Later a momentary resurgence led to the upwelling of fresh lava and the filling of many of these shear or fissure planes and some of the older fault planes and the formation of dikes of very similar composition to the quartz monzonite porphyry.

Following very close in sequence upon the formation of these dikes, a final depth differentiation of the monzonitic magma led to an upward migration of solutions rich in metals, and ores were deposited on the walls of fissures, in part already occupied by dikes; in the dikes where fractured, sheared or brecciated; in replaceable beds, in breccia zones along the fissures, and in the anticlinal structures.

ZONAL ARRANGEMENTS OF THE METALS AND POSITION OF THE MELLGREN VEIN IN THE ORE COLUMN.

Four widely spaced, great metallogenic periods, the results of as many distinct regional magmations, are recognized in the geologic history of Southern Arizona. These magmas were copper rich and the source of the deposist of the noted camps of the great "Copper Belt of Southern Arizona." They also produced rich and sizeable deposits of gold, silver, lead and, in certain phases, considerable deposits of the rarer metals, such as vanadium, molydenum and tungsten.

The prediction "She'll go to copper with depth," often heard expressed by mining men, in discussing properties in Southern Arizona, when ores in surface showings and in mine developments are gold, silver, lead or zinc, or combinations of these in value, is a recognition, based upon many observations thruout a wide extent of country, of the almost invariable occurrences of copper, where conditions for ore formations have obtained—most important in its bearing on the matter in hand—andalso, implies a clearly marked tendency in the deposition of the ore minerals to form a zonal arrangement of the metals. In this arrangement of the metals, that of lead, zinc and copper usually are the most definite. These zones are gradational or overlapping however, and sometimes apparently there has been a telescoping of the zones of deposition. This tendency to the segregation of the metals in sequence of depth-zones, may be explained, if it is assumed that the compounds of the several metals took place under different, but more or less critical temperatures and pressures. While the graduation in temperature and pressure required to bring about this zonal disposition, most naturally should be a factor of depth, leading to the super-imposing of one metal zone upon the other; the same graduation in temperature and pressure, it appears, may take place laterally, or ex-centrically, judging by the peripheral position of the ores of other metals, to those of copper, often observed.

Under a covering of rock, sufficient in thickness to furnish ample vertical range in which to develop and to sustain a gradual gradation in temperature and pressure the outwardly diffused or migrating mineralizing products form a differentiated ore magma, would find most perfect adjustments in zones—and most definite and clearly

recognized expression in fissures with definite controlling walls. In such a case, if the upper portion of the ore zone has not been destroyed by erosion, the sequence of metals, as depth development in mining is carried on, will be roughly as follows:—uppermost a residium of quartz and gold, or gold and silver; changing downward to silver-lead-gold, usually with some antimonial (gray) copper and sometimes with considerable manganese; then to lead, with decrease of associated silver and gold values; next to lead-zinc; then to lead-zinc-copper and finally to copper iron ore. The primary form of these ores is the sulphide. The serial succession of metals in depth could be carried farther, but has no special application here. Erosional stripping, post-metal faulting and erosion, may have brought any of these zones to the surface.

This zonal arrangement of the metals may have been in a large part obscured by the destruction, leaching and downward migration and reconstruction of the ore, under the oxidizing action of descending ground waters.

The tendency to zonal arrangement of the metals also may be interfered with, due to the rapidity of ascent of the magma and near approach to the surface before deposition in a restricted horizon, leads to a telescoping of the zones of metals.

And again, the zones of metals may be established in a lateral or peripheral position, in approximately the same depth plane, due to the varying position of conduits controlling the ore forming solutions, relative to the source of mineralization.

Moreover conditions are sometimes observed which seem best explained as due to a shifting and descent of the zones of deposition by overlap of higher upon them. Also, a reverse condition is sometimes observed, seemingly produced by magmatic re-surgence and ores of a lower zone thus lap upon ores of a higher zone.

These observed facts, despite recognized departures from the normal sequence in the zonal arrangement of the metals, explained by more or less theoretical deductions, find valuable application in many cases and often provide criteria by which the persistence of ore and values in depth may be judged and indices as to what changes in the metals may be expected to take place, as mining is carried deeper.

As stated before, changes of primary ores connected with weathering and erosion; the decomposition, leaching and recomposition of ores, may obscure the original zonal sequence of the metals, leaving the oxidized products of some ores perched, while concentrating others at lower levels.

It is, therefore, in no way surprising to find—reviewing the facts set forth in the discussion of genesis of the Tombstone ores, indicating a single metallogenic episode, and ores related mainly to one common system of north-south fissures, ores the result of a culminating sequence of differentiations in a single large, deep-lying magma, in sub-acidic phase, and comparing the described ores of both the Eastern and Western areas, and finding them essentially similar or gradational—tho disguised by secondary alteration, as noted, to find that there is a clear and definite zonal sequence of the metals and that the zone of ore deposition is of great vertical thickness—and moreover that the ores may be expected to continue far below any depth explored either by erosion, or the lowest level to which mining in the District has yet penetrated.

In the Bisbee region the Paleozoic limestones— Abrigo, Martin, Escabrosa — are the horizons thus far shown to carry the copper ores. The copper zone to date, has a proven vertical thickness of 1400 to 1500 feet. Some gold and silver ores, however, occur in the overlying Mesozoic strata in the southeastern part of the area.

While Bisbee is known as a copper camp, thousands of tons of lead-silver ore, with some zinc, are mined annually. The ores of the Bisbee District do not occur in fissures or in bedding-plane deposits, as at Tombstone, but as metasomatic replacement bodies. The relation of the lead ores to the copper ores, so far as known to the writer, appear to be distal or peripheral.

In the Tombstone District, as previously shown; all horizons from the Bolsa Quartzite thru the Naco Limestone, the upper member of the Paleozoic series and including the Mesozoic (Comanche) strata at the top, are repositories of ore.

It is exceedingly improbably, too, that the actual vertical range of the hyper-copper ores in the Tombstone area should be as great as the known combined thickness of the sedimentary series. It may be, exclusive of the deep lying copper zone, approximately a half of that thickness, say 3000 feet. That it should include formations representing the entire stratigraphic succession, however, may be explained if account is taken of the different positions the various fault-blocks hold in relation to the source of mineralization and the variable height of magmatic ascent or wedging—and within a critical range or zone of temperature.

Erosion in the northern part of the Eastern (Bunker Hill) area of the Tombstone District has, it is interpreted, stripped away a considerable part of the ore zone, so that the ores begin with the silver-lead-gold zone—and roughly between 700 and 800 feet in depth, enter upon the lead-zinc transition, or next lower metallic zone.

In the Western (Mellgren) area, the 400 feet of gold-silver ores, taking the deepest mine, the State of Maine, as type, shortly below water level, are in transition to the silver-lead-gold ores, equivalent of the upper 700 or 800 feet in the northern portion of the Eastern area.

Some of the veins of the Western area show considerable perched secondary manganese ores, manifestly brought downward and concentrated from a higher eroded level in the metal zone. The manganiferous silver and argentiferous manganese ores of the southern part of the Eastern area, represent a still higher horizon, in sequence, lying above the silver-gold ores of the Western area. As proved in several mines this manganiferous zone is at least 600 feet thick.

Considering the thickness of the several other zones, brought out by mining development, it probably is reasonable to assume a thickness of 700 to 800 feet for the zinc zone; allowing for a lead-zinc transition at the top and a zinc-copper transition below.

The above thicknesses of course are only approximations and there is much overlapping due to secondary changes. Summed up: beginning with the manganiferous zone, 600 feet thick; silver-gold zone, 400-500 feet; lead-silver-gold, 800 feet; zinc 700-800 feet, gives the total thickness of the ore zone, or depth of ore column, not allowing for copper ores below, in the Tombstone section, as 2700 to 3000 feet—all told—and it may be found to be greater. 32

The Mellgren property viewed in the light of this zonal thickness of the hyper-copper metallic zones and placed in its proper position in the ore column, on strong persistent structures, should have below its surficial zone of 400-500 feet of silver-gold ores, a zone of lead-silver-gold, 800 feet in thickness, followed by complex ores to a surmised thickness of 700 to 800 feet.

Downward leaching of the upper part of the lead zone should produce an enrichment of the ore body some short distance below the present level of ground-water.

The depth, in the Western area, to which oxidization has extended is unknown, if it is the same as in the Eastern area of the District, it is at least 700 to 800 feet; but it is assumed to be at least 500 to 600 feet to persistent primary sulphides.

WATER IN THE TOMBSTONE MINING DISTRICT.

A much discussed question when Tombstone Mines are mentioned is water. In the Eastern area, pumping is a big item, as in sinking the Boom shaft to the 1000 foot level, which is approximately 400 feet below water level, a pumping capacity of about 4000 gallons per minute, was necessary under peak load.

WATER IN THE EASTERN AREA.

Some past history of water in the Eastern area, with extract from the report of W. P. Blake, will be of interest.

EXTRACT: The camp was at first a dry one, and mills were located on the river, thus involving the necessity of an expensive wagon haul. There was little in the appearance or the surroundings of the camp to suggest the existence of water, and when it was struck in the Sulphuret shaft, at a comparatively shallow depth of 500 feet, it was a surprise to all. Other shafts, including the Contention, Grand Central, West Side, Head Center and Empire reached water soon after, and demonstrated that it was to be found at practically the same level throughout the District. The mines at this time were working in high grade ore bodies far above water, and no doubt was felt as to easily pumping it out and continuing down when it should become necessary. The Grand Central Company installed a line of direct acting steam pumps capable of raising 500,000 gallons in 24 hours, but, to the surprise of all, the withdrawal of this amount of water produced no appreciable effect. The Contention Company then put in a plant of 12 inch Cornish pumps at an expense of about $150,000 and capable of raising 1,000,000 gallons in 24 hours, and again pumping began, and an attempt made to sink, but it soon became evident that the combined capacity of the pumps was inadequate. The Grand Central then put in a line of 14-inch Cornish pumps of 1,500,000 gallons capacity, and at a cost of in the neighborhood of $200,000.00 and together the two Cornish plants gained steadily on the water and sinking below began. But much valuable time had been lost and from a lack of appreciation of the seriousness of the problem, the rate of dividends had gone on undiminished, without retaining an adequate reserve for contingencies. Furthermore, there was a lack of harmony among those concerned which prevented the attainment of the best results.

THE WATER CONTROLLED.

A depth of 100 feet below water level was reached, and it was demonstrated that the water could be controlled; that it was in fact, a basin which, once exhausted, could be held in check with a moderate expenditure for pumping. Other mines than the Grand Central and Contention took advantage of the recession of the water and began pushing down, proving the continuance of the ore below water and its excellent grade. Both the Grand Central and Contention shafts were vertical, and it was necessary to cross-cut for their ore bodies. This was going on and very rich ore found that in the Contention assaying about $100.00 per ton in gold. Up to this point (May, 1886) the situation was good. The mines were still working in ore above the water, and it had been conclusively shown that the water could be controlled and mining go on indefinitely, when a disastrous fire utterly destroyed the fine Grand Central hoisting works and pumping plant. There is no doubt that the Contention pumps could have held the water in check alone after this disaster, until other machinery could have been put on the Grand Central, but differences arose between the companies and pending a settlement of these the pumps were stopped and the shafts allowed to fill. Finally, through the carelessness of a watchman, the Contention plant took fire, and its complete destruction postponed indefinitely, the working of the mines below water.

After this succession of disasters several unsuccessful attempts to effect the consolidation of the various interests were made, and in the meantime deep mining at Tombstone was suspended. (END OF EXTRACT)—Insert:—In 1900 a consolidation of most of the properties in the Eastern area was effected, known as the TOMBSTONE CONSOLIDATED MINING COMPANY, and again sinking was started. EXTRACT FROM REPORT OF W. P. B. CONTINUED, BELOW.

NEW SHAFTS AND PUMPS.

The company has already located a new shaft and has completed it to water level. This shaft measures 7 feet by 22 feet in the clear and has four compartments, two for hoisting and two for pumping.

The pumps are supplied by the Prescott Steam Pump Company of Milwaukee. They are the direct acting type, triple expansion, with steam cylinders in pairs, of 39 inches and 23 inches, and 15 inches in diameter. Diameter of water plunger 13 inches, stroke 24 inches. These pumps are 33 feet 7 inches in length, 9 feet 8 inches wide and more than 6 feet high. These powerful pumps will throw 1750 gallons of water per minute, which is nearly 60 per cent more than the combined pumping capacity of the old Grand Central and Contention pumps. They will be placed at the water level in chambers excavated for them, and two will be laid down there, one in reserve.

Other pumps of the same type have been ordered and are under construction, that are proportioned to a 1000 foot lift and will be ready to install when that depth is reached. All of the above will be stationary, and the falling water level will be followed down by four movable pumps called sinkers. These will have 14 inch steam cylinders, water cylinders 8 inches and a stroke of 12 inches. Each pump will throw 800 gallons per minute, an excess that is necessary to provide for moving them in succession without stopping the discharge of water.

There will be four 200 horsepower boilers of the Morrison corrugated internal furnace type, each 10 feet in diameter and 15 feet long. Crude oil will be used for fuel. (END OF EXTRACT).

Following the above data, a resume of the history follows. The Tombstone Consolidated Company, with the above equipment commenced sinking and a depth of 1000 feet was reached. Three breakdowns during sinking caused delays and great expense. A cross-cut from the 1000 foot level to cut the ore deposits at this depth was in progress, but the distance necessary to reach them had not been reached at the time of the last breakdown, when the shaft was again allowed to fill with water. The ground through which the shaft was sunk was of a very loose material and during the pumping operations, it was necessary to keep almost constant work in the shaft, owing to the continual loosening of the wall blocks, causing the timbers to get out of line. Sometime after the last breakdown of the pumps, the Tombstone Consolidated Company was taken over by the Phelps Dodge interests and is now known as the Bunker Hill Mines Company. The Boom shaft later caved in and to-date there has been no other work done below water level since the Tombstone Consolidated operations. With modern electric pumps as compared to the old steam pumps, unwatering of the mines, in the Eastern Tombstone area is but a question of proper financing. I have gone into the pumping data at some length, in view of the fact that there is an unwarranted opinion throughout mining circles that the Tombstone water could not be handled.

WATER IN THE WESTERN (MELLGREN) AREA.

Now as to water in the Western part of the District and at the Mellgren Mines. The water level at the Bonanza shaft (One of the Mellgren Mines) is at a depth of 190 feet. The water level at the Boom (Eastern area) shaft is approximately at the 600 foot level. The elevation of the Bonanza shaft is approximately 120 feet lower than the Boom shaft. This then gives an approximate of 290 feet difference in elevation between the water level of the Eastern and Western areas, the Western water level standing 290 feet higher than the Eastern water level.

The monzonite batholith mentioned under geology here becomes important, and a sketch, which is a part of this report will graphically illustrate the point I am outlining. (See page.....). The monzonite runs northerly and southerly and near-

ly separates the Eastern and Western areas. It is self evident that this granitoid rock is deep seated and impervious to water, and in connection with the Western structures has a direct bearing on the water.

To determine an approximate flow, I commenced sinking in the south Bonanza shaft at water level, with a small Snow boiler feed pump, run by air furnished by a one drill compressor. In this manner I reached a depth of thirty-four feet below water with a computed flow of 40 gallons per minute. As a further check on the water flow I ran levels to the old Manilla Mine, which shows the same water level as the Bonanza. This shaft was sunk 500 feet below with an estimated flow of 100 gallons per minute. Work below water in the Chance and San Pedro mines (of the Western area) likewise show the same relatively small flow. From this data it is safe to draw conclusions, that water will be no draw back for at least 500 feet below the present water level at the Mellgren Mines, with a probability of a much greater depth without a large pumping plant. This water will be a decided asset to mining and milling operations.

THE MELLGREN GROUP IN GENERAL.

The portion of the Tombstone District covered by this group is to some extent undeveloped as a whole, a number of the claims having but little work done upon the veins and ore chutes exposed on the surface. There has been no attempt made at deep mining, the deepest workings being at the south Bonanza shaft, which is down 34 feet into the water; the total depth being 230 feet from the collar of the shaft.

There has been no systematic development of the ore bodies or centralized workings for large scale mining operations; such as cross-cutting the country, to cut the parallel north-south trending vein system, and the development of these veins along their entire strike, the work so far done being more in the form of what miners call chloriding, that is, the gophering out of the high grade lenses. The exception to this rule is seen in the North Bonanza stope. This block of ground from the 100 foot level to the surface and for a distance of 160 feet north of the shaft, was mined by the filled stope method, the vein being mined as a whole, taking the lower grade and high grade portions together, which furnishes some very interesting data as to vein valuation, in taking out the ore en-block, such as would be followed in large scale operations for milling.

There appears to be little doubt that at such time as cross-cutting at depth is done, blind veins now covered, will be encountered. This supposition is strengthened by the general topography of the surface, it being quite evident that many of the gulches or washes are formed on vein or shear zone fractures, these structures producing the depressions by erosional agencies. The probability of a general mineralization in shear zones and brecciated areas near faults and contacts is exceptionally good.

It has been shown in the geological discussion that the great depth and the number of the parallel and cross-veins makes the potential ore reserves very large, when considered collectively. There is in addition to the vein system, the probable and unexplored Paleozoic formations underlying the Mesozoic, which in the Eastern area produced large ore bodies.

There are many veins cropping on the surface, which are undeveloped and no attention has been paid to contacts. Work on these contacts should be done, as it is to be expected that ore bodies will be found at or near some of them. The ore so far worked, has been in the form of fissure veins, these veins having, in the process of development, yielded very high grade ore. This however will be gone into more fully under Description of Individual Claims.

Of the many thousand feet of work done, all has been accomplished under a great

handicap, most of it being done by hand steel and whim or windlass hoisting. Working in this manner it has yielded a good profit, the development being more than paid for by ore extraced. Very little attention has been paid to the lower grade or milling ores. In the past when the values dropped below a shipping grade, it was considered that the ore had pinched out, this being far from the case as a milling grade of ore was usually left.

An interesting feature of the ore at water level where it has been encountered is the fact that lead values commence to show up, and it is reasonable to expect a lead content below water. From indications of the veins at the water level I believe that larger and more uniform values will be encountered below water. Gold values increase slightly with depth. The principal values so far extracted have been gold and silver, with silver predominating, all in the oxidized zone above water.

A very interesting condition in connection with work done by the later Herman Trappman, in the San Pedro Mine, (One of the Bunker Hill Mines Company claims in this area) was the presence of Chalcosite (Copper Sulphide) in the dike rocks, in the working below water. The copper content was not of commercial value, it occurring very irregular and spotted. Whether this will with depth lead to copper deposits, only future work will tell, but there is to my theory the possibility of copper ores with depth.

DESCRIPTION OF INDIVIDUAL CLAIMS.

BONANZA.

This is one of the early day locations of the District, having been located in 1880. The first work done was upon the extreme south end of the claim. An incline shaft was sunk to a depth of 200 feet and at an angle of about 70 degrees, following the dip of the vein. Very high grade ore was encountered, values up to $3,000.00 per ton being mined. I was shown the smelter returns from the settlement sheets, from the files of Col. Wm. Herring, (now deceased) showing ore of value in excess of $2,000.00 per ton, one shipment being for a lot of 22 tons, with a value of $2273.00 per ton. (Figured on value of silver at that time). Working in a small way this mine has produced about $290,000.00 in high grade ore, high grade lenses having been encountered in workings off of the south shaft and off of workings in the north shaft, which is at a point on the vein 1,000 feet north of the south shaft.

The vein having a strike of N 20 E outcrops from the south end line for a distance of 1,000 feet north, ore having been taken out along practically the entire distance, as shown by Longitudinal Section of Bonanza workings, attached to this report. Crossing the south end line this vein runs into the Chance claim, and from this mine there has been about $600,000.00 produced. Attention is here called to Bonanza Mine "Longitudinal Section," showing ore going down into the water. On the Chance side, near the Bonanza south end line, values from 100 to 1200 ounces in silver per ton and on the Bonanza side up to 800 ounces.

Work is now in progress off of the 100 foot and 200 foot levels of the north Bonanza shaft. From the stope marked North Bonanza Stope, on Longitudinal Section, above the 100 foot level and north of the shaft 160 feet in length, $166,000.00 has been shipped. About 920 tons of ore were put through a test cyanide plant for the purpose of collecting data as to cyanidization, which gave a bullion return of $14,000.00, based on $1.00 per ounce silver. This and numerous other tests made prove that the ore is ideal for cyaniding.

The average width of the ore as mined, shown by stopes in the mine, is about 4 feet. The value of the ore is very irregular, but from ores so far extracted in the development of the vein, has averaged above $25.00 per ton, (at the varying prices of silver as mined) this figure not including some of the real high grade lenses which have been encountered. In stoping operations in the north Bonanza stope, I have had

assays up to 3,000 ounces in silver and 4.00 ounces in gold per ton, over a width of 30 inches. It has been the history of the vein from the south workings to those off of the north shaft, that high grade lenses would be encountered in mining the vein, and probability of encountering further high grade chutes in future operations seems almost certain.

Two undeveloped veins crop on this claim, one to the East and a cross-veing running into the main vein.

An examination of the Longitudinal Section will show ore developed. Where the vein is exposed going down into the water the condition of the vein is as strong as above water level.

ANNEX 40 AND 41.

These claims, formerly the property of the Yellow Jacket Mining Company, have produced about $60,000.00. The present owners have confined themselves to surface work. Two parallel veins are opened up and crop on these claims, one for a distance of 1900 feet and the other for 1100 feet. The work on this property like the Bonanza was in search for high grade ore, and development has been in the form of scattered workings, the deepest point to which mining was done is 250 feet. These veins properly developed will add greatly to the group tonnage.

JOSEPH NO. 1.

The present owners sank one shaft from the surface to a depth of 220 feet on the vein, at a point about 400 feet north of old workings from which $60,000.00 was mined by lessees, in high grade ore; the vein was irregular as to value in sinking, a number of cars shipped during the sinking operations giving a return of from $12.00 to $10.00 per ton, (silver at the period of mining being around 0.50c per ounce) while on the 100 foot level one small pocket of 4½ tons gave an assay of 5005.0 ounces silver and 5.01 ounces gold per ton. Lead in the form of Galena (Lead Sulphide) was coming in at the bottom of the shaft, the last assay running 90.00 ounces in silver and 0.41 ounces gold per ton. Still there

All work here was with hand steel and whim hoisting. Mining being very slow at this depth under these conditions, operations were suspended, and no work has been done in this shaft in the past 12 years.

This vein like the Bonanza has a strike of N 20 E, dip 70 West. It is on this claim that the shale occurs. To the east of this vein about 150 feet lies the Mamie mine, which produced $250,000.00 from another of the parallel vein system.

In this shaft Vanadinite (Lead Vanidate) is encountered associated with gold and silver, the vanadium which may develop on this group will, with proper milling facilities, be of commercial value. The Charleston vanadium belt extends north into this group, very little attention having been given to its possibilities until quite recently. Mention is here made of a vanadium content in some of the ores in the north Bonanza workings.

JOSEPH NO. 2.

This is the old Winfied mine and it is from these workings that some of the highest grade ore in the camp came from. (Having a high gold content). The value of the ore was very irregular, the high grade lenses coming in small. Approximately $150,000 was produced from the high grade ore from the mine. The vein had the same strike and dip as the other veins mentioned above.

PINTO NO. 3

Very little work has been done on this claim, but it is valuable in the undeveloped state. No high grade ore having been found at or near the surface, excepting one shipment of around 300 ounce silver ore, limited work has been done, but at such time as milling facilities are at hand or the cutting of the vein at depth, this vein will be another producer.

EMPIRE.

This one of the practically undeveloped claims, but I wish to mention it here, as I believe it will eventually become one of the largest producers. The contact cropping here is similar to the Oregon-Prompter contact, from which several million dollars has been produced. I highly recommend development along this contact at depth.

ANNEX NO. 12.

Another undeveloped claim, but being the east extension of the Junetta Mine, which has produced about $100,000.00 in high grade ore. Contact development is recommended. To the east of this property lies the Dry Hill Mine, a Bunker Hill claim, with a past production.

BILL B ETC.

The claims lying south of the State of Maine Mine are in the undeveloped stage, surface ore having been found in places but owing to their being in line with the strike of the State of Maine vein from which $3,500,000.00 was mined, they should be developed.

A discussion of each individual claim is hardly necessary, some of them having but little development on them, on veins and croppings exposed on the surface. Suffice it to say that the extent of the mineralized area, as shown by maps appended hereto, makes each and every claim a potential producer.

PAST WORK BY PRESENT OWNERS.

An explanation as to the scattered workings and development should be made here. The present owners having held this property for about twenty years, working the mines themselves, have confined their efforts to development on a small scale. All work done has been accomplished from the proceeds from ores extracted as they went along, they having in this way paid for all development work, gradually getting the property opened up. It speaks well for the mines that on this small scale method of operating, working without capital and under handicaps, that they have brought them to the present state of development.

SMELTER TREATMENT CHARGES.

Up until the last few years the smelter treatment charge on this class of ore was extremely high, a minimum base treatment charge of $4.50 per ton, with a 12c per unit charge on the contained silica content and but a 50% payment for the silver in the form of chloride. The average silica content of the ore is about 74.0% and approximately 40% of the silver value is as a chloride content, so from this data it can be seen that an exceptionally high grade of shipping ore was necessary to realize a profit under some of the past charges. It was not uncommon to have a combined treatment, penalty and freight charge in excess of $25.00 per ton. The smelters have now cut off the chloride penalty and likewise the silica charge on some classes of ore and treatment can be had at a much lower figure.

SUGGESTED METHODS DEVELOPMENT AND OPERATION MELLGREN MINES — CAPITALIZATION REQUIRED — OPERATION COSTS AND ESTIMATED PROFITS.

The ultimate question which arises, after a systematic study of the geology, ore possibilities on any property is:—what are its commercial possibilities.

From a very close study of the property, I am firmly convinced that operations on a large scale will open up very large tonnages of ore. The magnitude of the holdings and the number of separate veins, makes the development of the group as a whole a very slow process without sufficient capital.

Development of contacts, cross-cutting the various veins and a central working shaft are essential, as well as below water development. Immediate extraction of ores already developed could be commenced, but a systematic plan of development should be started at once.

On this property there are two methods for its operation open.

1. The operation of the mines as a whole by the operating company.
2. Operation by the company and leasing portions of the mines.

It is my belief that the second, or a combination of these two is the logical method to fellow; as the area covered by the entire holdings is so large that the simultaneous development is a matter of considerable capital outlay. The following plans are given as suggested methods.

PLAN NO. 1.—100 TON PER DAY BASIS.

At such time as this property is operating and milling on a 100 ton per day basis and likewise on a leasing basis—by leasing being meant, the non-operation of the mines as a whole by the operating company, but the leasing of portions of the different mines to individual lessees, on a royalty basis, and the operation of the mill, by the operating company, to handle the lease ore on a mill charge basis. The approximate costs and profits would be as follows.

The mill charge would run from $4.00 to $7.50 per ton on ore milled for lessees, and would be a direct charge paid by them. Figuring on a milling plant of the above mentioned 100 ton per day capacity, the actual cost of milling to the company should not exceed $1.75 per ton. From these figures a mill profit of $2.25 per ton would be made, or $225.00 per day. On mill charges and royalty from leases, I am confining myself to the lower grade ores that would come under the $4.00 mill charge.

Ore of $10.00 per ton recovery	$10.00
Mill charge	$ 4.00
Royalty (15% on $6.00)	$ 0.90

This then gives a royalty profit of $90.00 per day, on a 100 ton per day basis. The combined milling and royalty profit would be $315.00 per day or approximately $115,000.00 per year. Ores of a higher grade would run the profits greatly in excess of this amount and in addition to this there would be the profits from straight operation by the company, in milling or shipping the ores mined by them.

The approximate capital outlay would be as follows.

Mill (Equipment and Construction)	$100,000.00
Surface Plant	$ 25,000.00
Mine repairs and hoists	$ 20,000.00
Mill operating fund	$ 10,000.00
Pipe lines	$ 5,000.00
Supplies for lessees	$ 5,000.00
Trucks	$ 5,000.00
General development fund	$ 50,000.00
Total Initial Fund	$225,000.00

Under the leasing plan, lessees would be included the work done by the company in sinking a development shaft to the 500 foot level, at a point that would cut the Bonanza vein at this depth and the development of the Bonanza vein from this point.

Then the gradual development of the property can be carried on by cross-cutting to other veins.

Under the leasing plan, lesees would operate portions or blocks of individual mines, leased to them on such time and royalty basis as decided upon by the operating company. In figuring royalty profits I used a royalty basis of 15 %, which is rather low. Leasing operations upon the Bunker Hill Mines properties are on a 20% royalty. Following this plan all expenses incident to lease mining would be paid by the lessee. Air, powder and materials could be charged to them at a handling profit to the company. The operating costs of the central power plant would be covered by

the various leases, and would to a great extent lower the development costs of the company.

PLAN NO. 2 (200 TON BASIS).

Following a more extensive development plan, which calls for the development of the veins at the 800 foot level, a capital reserve of $500,000.00 will be necessary.

As illustrated on the Vertical Section along line A-B of the Vein Map, attached hereto, this plan calls for the sinking of a 2½ compartment shaft to the 800 foot level, on the Bonanza claim, at a point west of the main Bonanza vein, to cut it at 800 feet, and cross-cutting at this point, easterly and westerly to cut the 12 veins, which line A-B is indicated to cross, and the general vein development from this depth.

If this plan is adopted, mill construction should be so designed as to take care of a lead content by straight flotation, or a combination process, as well as the cyanidation of the siliceous silver-gold ores above water. A mill with a view of 200 tons per day or better should be provided for. Expenditures would be as follows.

Central Power Plant	$ 50,000.00
Mill	$150,000.00
Shafts, cross-cuts, drifts, etc.	$250,000.00
Reserve and outside claim purchasing fund	$ 50,000.00
Total	$500,000.00

The $250,000.00 would cover the sinking of the development shaft, cross-cutting as outlined, drifting on and development of veins as cut, and the development to lateral veins at their points of intersection, of their projected lines of strike with this cross-cut, the raising of air shafts being included in this development.

When milling on a 200 ton per day basis under this plan there would be, figuring on a net recoverable value of but $5.00 per ton, (using only $10.00 per ton recoverable mill value, and allowing $5.00 per ton for mining and milling) a net yearly return of $360,000.00.

As shown and proven by past general development, the vein values have been much in excess of this amount, as discussed later under Estimate of Value. There is little reason to believe that past general development will not be duplicated, which would give a low net value of $20.00 per ton, (allowing $5.00 per ton for mining and milling) and using this figure on a 200 ton basis, would show a net yearly return of $1,410,000.00.

Under this plant, a part leasing system could be carried on in connection with company operations, as outlined in Plan No. 1.

TOMBSTONE DISTRICT PRODUCTION.

When an analysis of production is made, on the output of mines in the Western area, where several million dollars has been produced in high grade ores, with no attention being paid to the low grade milling ores, and this taken in connection with the magnitude of the mineralized area, containing virgin and unblocked ore bodies, it becomes one of the most attractive commercial mining propositions possible.

They are not in an unexplored or unknown mineral bearing region, but a proven field. The Eastern area covered by the Bunker Hill Mines Company property, which has had proper financing, has yielded $79,000,000.00. The Western area, of which the Mellgren Mines cover the greater part, unfinanced, and without proper mining equipment, has yielded its owners a substantial profit, and paid for all development, which is exceptional in mining enterprises. The out-put of these Western area mines being about $6,000,000.00; bringing the Tombstone District production to about $85,000,000.00.

MILLING.

Numerous mill tests show the ore to be extremely well adapted to cyanidation. The values as a whole, (in the silver-gold oxidized ores so far developed) evidently not being finely disseminated throughout the rock, but occurring to some extent in the seams and fractures or brecciated zones, this permitting of a high per cent of recovery by straight leaching of the ores, ground to between 16 and 20 mesh.

In a mill design, it is advisable to draw plans for a probable change in the character of the ore below water, there being a probability of a lead content in the ore, and at greater depth, sulphides. These plans should therefore admit of the installation of concentrations or flotation units, to be operated in conjunction with the cyanidation plant.

The advisability of commencing mill operations by installation of a leaching or all slime plant, (following the cyaniding ores) are debatable questions. Naturally the leaching plant can be installed at less expense than the all slime plant.

PAST MILLING DATA ON TOMBSTONE DISTRICT ORES.

In the first days of milling in the early 80-s the old Pan Amalgamation process was used, several hundred thousand tons of ore being treated in this manner in the early Grand Central, Contention, Head Center, Girard, Corbin and Fisher Mills.

These were followed in 1900 by the old Tombstone Consolidated stamp mill, using a combination table concentration and cyanidation by leaching process. The crushing was done by 40 stamps, treating between 200 and 300 tons per day, and returned an exceptionally good profit per ton of ore milled.

The old Grand Central tailing dump at Fairbank has lately been reworked by the flotation process successfully, and proves conclusively that the silver-gold-lead ores can be commercially handled in this manner.

Likewise the State of Maine dump was put through a crude cyanide leaching plant a few years back, by the Old Pueblo Leasing Company, returning a good profit to them, even though the mill heads were exceptionally low, due to the fact, that in mining the State of Maine ore, nearly all of it was mined by the stripping method, taking out the ore clean, very often on canvas.

The cyanidation tests conducted on the Bonanza ore likewise demonstrate the adaptability of this ore to treatment by milling. Taking into consideration past milling experiences and mill tests, show there is no question as to the successfull milling of the ores.

ESTIMATE OF TONNAGE ON MELLGREN MINES.

The following figures have been arrived at assuming a 4 foot average mining width, and are computed on the theory that where work has been done at two points on a vein that the portions of the vein between these extremities is continuous.

Development having been extended to 200 feet in depth in many places, figures on ore, from the surface down 200 feet are given below; and then on an assumed depth of 300 feet below this point, is computed separately, 300 feet being a very conservative estimate on downward extension.

Insofar as the Tombstone Mining District is not an undeveloped or unproven field, but on past general development, is a known factor on proven ore bodies, it is safe to compare virgin ground in the District with proven development.

On tonnages here given, they have been confined to but 5 of the 23 known veins on this property. Veins being chosen on which the most development has been done, and including portions between two extremities on the vein, as example; work at the extreme south end and work at the northerly end of the Bonanza vein, of which a Longitudinal Section is appended, there being approximately 1200 feet between these points. In this manner no consideration is given to the probability of the extension of the veins along their strike.

BONANZA VEIN.

Block between the south shaft and north shaft, 1000 feet in length.
Surface to 200 foot level—60,000 tons.
200 foot level to 500 foot level—115,000 tons.

JOSEPH NO. 1 VEIN

Block between south workings and north workings, 400 feet in length.
Surface to 200 foot level—25,000 tons.
200 foot level to 500 foot level—35,000 tons.

JOSEPH NO. 2 VEIN

Block between north and south shafts, approximately 600 feet apart.
Surface to 200 foot level—30,000 tons.
200 foot level to 500 foot. level—60,000 tons.

ANNEX NO. 40, VEIN.

Block 1500 feet in length.
Surface to 200 foot level—92,000 tons.
200 foot level to 500 foot level—138,000 tons.

ANNEX NO. 41, VEIN.

Block 500 feet in length.
Surface to 200 foot level—30,400 tons.
200 foot level to 500 foot level—45,600 tons.

TOTAL TONNAGE IN THESE BLOCKS.

Surface to 200 foot level—237,400 tons.
200 foot level to 500 foot level—393,600 tons.

TOTAL TONNAGE FROM SURFACE TO 500 FOOT LEVEL.

631,000 tons.

ESTIMATE OF VALUES.

In arriving at an estimate of the value of the ore, it appears, that insofar as there are known mined tonnages, with known returns; it is a logical method to compute the value of the ore removed as a whole:—that is, the returns on tonnage shipped and tonnage remaining on the dumps, of a known value. In this way taking the value of the dump material and figuring it against returns on tonnage shipped, will give the general average en-block, thus giving an average value for the entire material removed.

Owing to the character of the vein material, in that it is ununiform throughout; containing low grade and high grade portions, this method gives an insight to the values as a whole.

In computing mill returns on a royalty and mill charge basis, a general value of $10.00 per ton was used; whereas in portions of the veins so far mined, the general average has been actually greatly in excess of this amount and it would seem that future development will duplicate past extractions.

Likewise in view of the fact that such exceptionally high grade ore has been encountered in the development so far done, it cannot be overlooked in estimating values; as the example of the high grade in the Bonanza, one lot of 22 tons returning over $40,000.00 (at the then silver price). From the Joseph No. 1 one small shipment running 5005.0 ounces in silver and 5.01 ounces in gold per ton. On the Joseph No. 2, Junetta, Merrimac, State of Maine, Chance, Mamie, San Pedro, Solstice, etc., high grade ores were encountered.

On the portion of the Bonanza vein between the north and south shafts, approximately 25% has been mined, yielding $100,000.00; this being from the surface to the 200 foot level and representing about 15,000 actually removed; part being shipped and the balance remaining on the dump as discarded low grade. Taking

into consideration the extension of this vein on the Chance side and considering the vein as a whole, from the surface to the 200 foot level, there shows approximately 1-3 of the vein within these limits has been mined and from this portion a return of about $1,000,000.00 has been realized.

CHANCE AND STATE OF MAINE MINES.

A short discussion in connection with the analysis of the group values of these mines; although outside of the Mellgren Group, will be of interest. The State of Maine Mine as stated in other parts of this report, produced $3,500,000.00 and the Chance $600,000.00. The ore occurs under similar conditions as the Bonanza, Joseph No. 1, Joseph No. 2, etc.; being of the same parallel vein system of this section.

STATE OF MAINE MINE.

In this mine the high grade ore lenses occurred in more uniform value than in some of the other veins mentioned, as shown by the out-put; which was confined between the approximate limits of 400 feet in depth, with lateral extensions of about 600 feet, all above water level.

With an estimated 40,000 tons mined from these workings, with no allowance made for a dump valuation, (not having information on dump values, it was given no value consideration) this would show a general average value of ore shipped and discarded dump material; of in excess of $80.00 per ton (at the price of silver when this ore was shipped and about $60.00 per ton at present market pricees) that is if the ore as a whole had been shipped.

CHANCE MINE.-(SOUTH EXTENSION OF BONANZA VEIN).

This property produced $600,000.00 from the surface to the 200 foot level, and in a lateral distance of a little over 200 feet. It was noted for its high grade ore; values of from $500.00 to $1,000.00 per ton often being mined in 3 to 5 foot widths.

Approximately 10,000 tons were mined, with possibly 7,000 tons of this amount remaining on the dump. Giving this 7,000 tons a valuation of $5.00 per ton; this then gives a general average of about $63.00 per ton, had this block been mined and shipped as a whole.

JOSEPH NO. 1.

In sinking the north shaft approximately 200 tons were shipped of about 35.0 ounce silver and 0.09 ounces gold per ton value, while 4½ tons of a value of 5005.0 ounces silver and 5.01 ounces gold per ton were mined. Of the 1000 tons mined, 800 tons remains on the dump (rejects from shipments) of a value of 5.0 ounces silver and 0.03 ounces gold per ton. This then gives a silver-gold content for this ore as a whole of 43.52 ounces silver and 0.08 ounces gold per ton.

BONANZA MINE. (NORTH WORKINGS).

Of the approximate 7,000 tons mined from this northerly portion of the Bonanza vein, about 3,000 tons have been shipped or cyanided, with a return of $166,000.00; or an average of $55.20 per ton. With the dump averaging at present market prices, $5.76 per ton, and with 4,000 tons remaining on the dump, this gives a general average of $27.00 per ton on the entire block of 7,000 tons. (Based upon present market price on the dump material and the varying silver prices, covering the range of these shipments). For further data, the following is given as another form of analysis on these workings.

ANALYSIS OF VALUE OF BONANZA VEIN, ON AN ASSUMED BLOCK 200x200x4 FEET, IN NORTH BONANZA WORKINGS.

Assuming a section of the Bonanza vein extending 100 feet north and 100 feet south of the north Bonanza shaft, and 200 feet in depth, or to water level, and using a 4 foot mining width, gives a block containing 12,000 tons.

Of this 12,000 tons, 7,000 tons have been mined, which leaves 5,000 tons unmined in this assumed block. Of the 7,000 tons mined, 3,000 tons have been shipped or

cyanided, and 4,000 tons of low grade thrown on the dump.

The 3,000 tons shipped or cyanided shows a return of $166,000.00, or an average value of $55.20 per ton. (The silver prices ranging from 0.46c to $1.00 per ounce, with an approximate average of 0.85c per ounce). The 4,000 tons thrown on the dump averages 8.0 ounces silver and 0.05 ounces gold per ton, or a total value for the dump of $33,040.00 at present market prices.

As a margin of safety, I am giving the unmined 5,000 tons in this assumed block, a value no higher than that of the discarded dump material, or $5.76 per ton, or a total value of $28,700.00. As there have been 7,000 tons actually mined, with a known return and dump content of determined value, if we now revert this assumed block back to the virgin or unmined state, and as stated, to be within a safe margin, only allowing the 5,000 tons unmined, the same valuation as the rejected dump material, the block 200x200x4 feet, if mined as a whole, would have a general average value of $18.15 per ton, which is computed as follows.

12,000 tons in the assumed block.
7,000 tons of which have been mined.
3,000 tons of which have been shipped or milled.
4,000 tons of which remain on the dump.
5,000 tons of which represents computed unmined portion.
9,000 tons of which is the combined dump and unmined portions and giving this a $5.76 per ton valuation, gives a total of $51,840.00
3,000 tons shipped returned $166,000.00

12,000 tons total $217,840.00

RECOMMENDATIONS.

In the development of these mines, I would recommend the second or more extensive plan, as previously outlined under Plan No. 2. The advantages are a more rapid general development of the group, and with larger scale operations, a lower mining and milling cost, with corresponding increase in net returns.

In connection with this plan the leasing out of portions of the various mines of the group would be advisable. These leases covering ground that would not interfere with the general development plan, being confined to ground above water level. A partial lease operation in this manner would tend to lower mining costs to the company, due to the fact that lease operations would be contributing to the payment of the power plant operation costs, in addition to yielding royalty and mill profits.

It would likewise be advisable to determine the position or depth to the sulphide or primary ore zone, by diamond drilling. This could be accomplished by selecting one or more of the veins, and drilling offset angle drill holes, to cut the vein at computed depths; for example, the drilling of the Bonanza vein from the west, at angles to intercept it at 500 feet and 800 feet etc. This would also determine the strength and tenor of the primary sulphide ores.

CONCLUSION.

In closing I wish to say, that from all indications and from a very close study of this property, and the entire District in general; that I am firmly convinced of the development of large tonnages below water level. Insofar as the general mineralization factor of the District as a whole seems the same, a discussion of the geology and ore deposits of the entire District has a direct bearing on the Mellgren property, and for this reason I have gone into it in connection with data on this property.

The continuity of the ore bodies, to and into the water has been discussed on the Contention, Grand Central, Sulphuret, Silver Thread, Tranquility, Oregon-Prompter, Lucky Cuss, Emerald, West Side, Chance, Bonanza, San Pedro, Joseph No. 1, etc., is direct proof of their downward extension, and this taken in connec-

tion with the zonal arrangement of the metals, strengthens the argument for ores below water. The strictly primary ores as a whole not having been encountered, and the geological conditions, viewing the Tombstone District as a whole, makes me unhesitatingly say that ore bodies in the District and on this property, will without doubt be mined to considerable depth.

Of the many mining properties which I have examined, this one, taking all factors into consideration, is one of the best, from all general standpoints, as related to mining. Tombstone has been producing ore for the last 50 years and no doubt will be operating in the far future.

The water question has been described at some length, and on the Mellgern property, sufficient water for milling operations will undoubtedly be encountered, this water being in fact a decided asset for mining and milling.

The labor condition is exceptionally good. No camp or housing facilities are necessary; all employees can find accomodations in Tombstone. American and Mexican labor can be had at prevailing labor scale.

Accessibility as has been stated, is a very important factor, no road building being necessary, the property as a whole being easy of access.

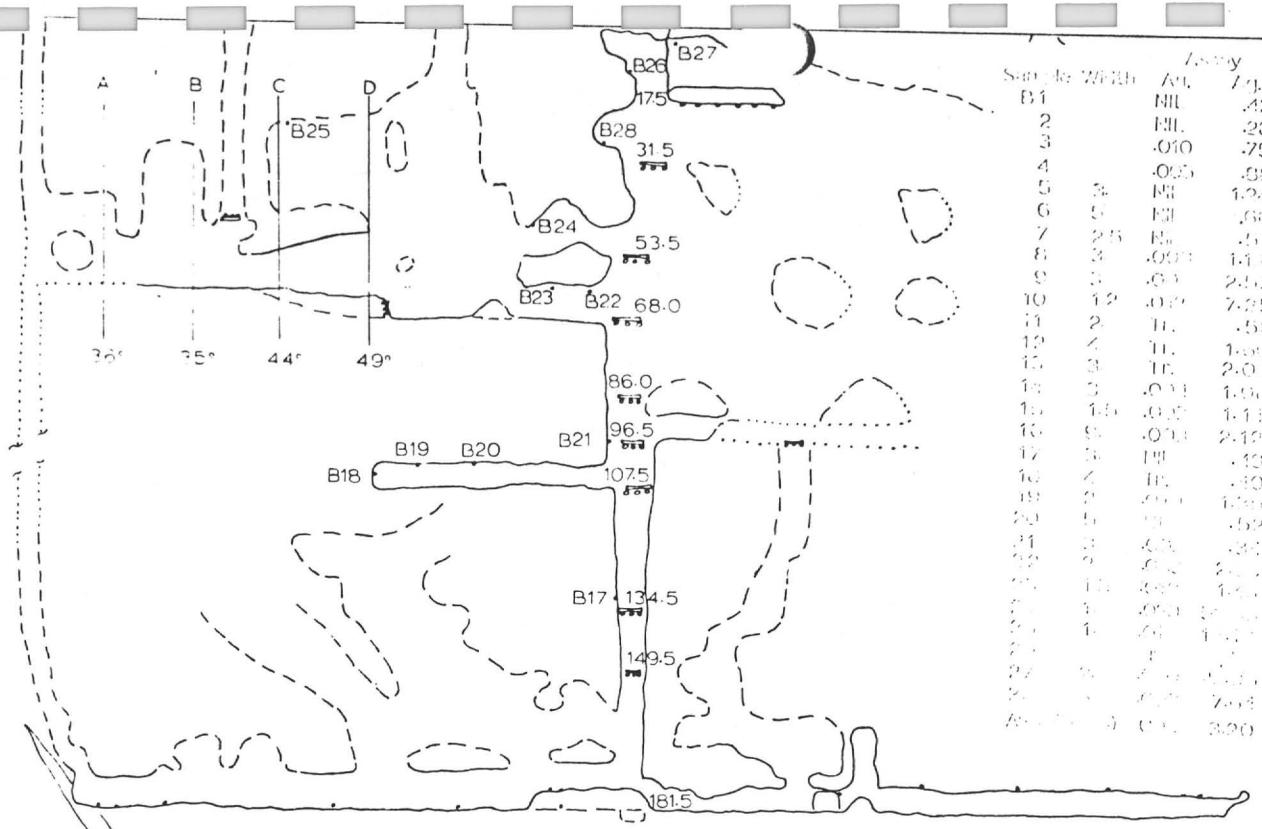
Transportation conditions are good. Hauling charges are reasonable, trucks being available on contract work at Tombstone. Freight is as near a minimum as can be expected on shipping ore. To the smelter at Douglas is about 60 miles and those at El Paso 315 miles.

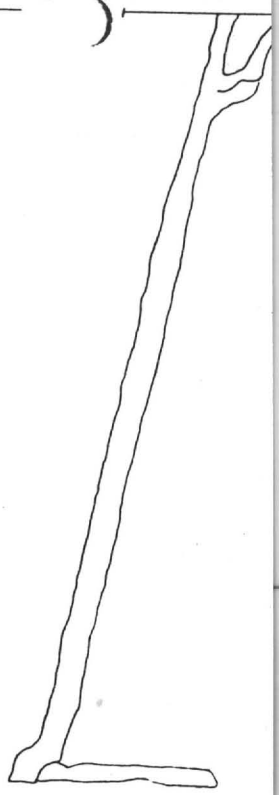
Climate like all southern Arizona, makes operating conditions exceptional, weather conditions at no time interfering with operations.

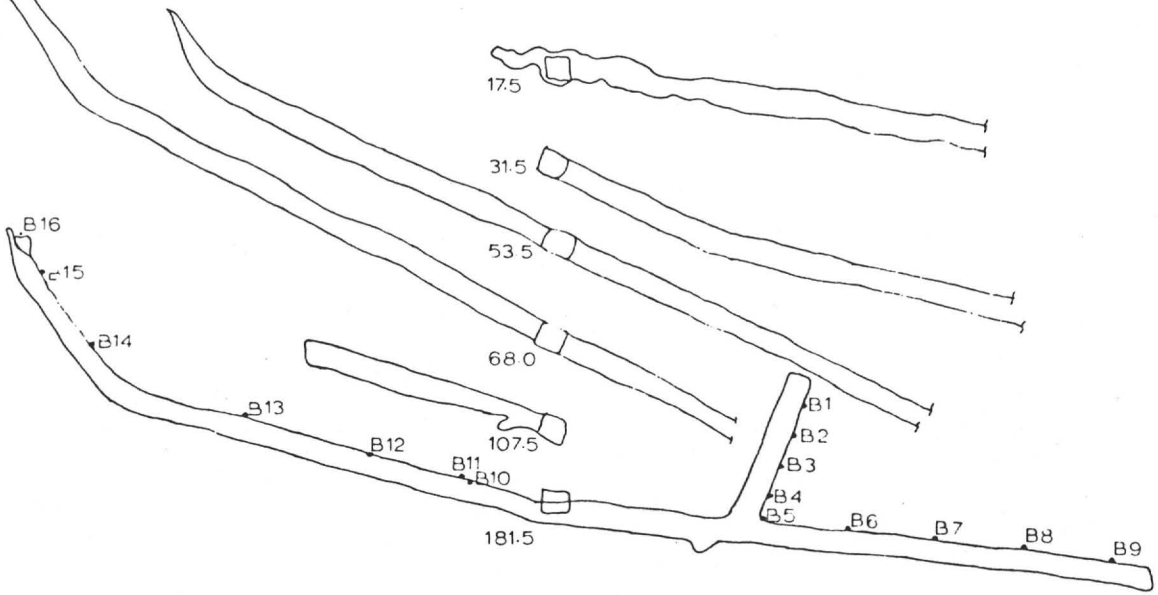
A word should be said in reference to leasing. In the event that an operating company should decide on a part-leasing basis of operations, there appears no question as to obtaining lessees at such time as equipment permits.

Many outlying properties would be worked, providing the company operating this property decided on taking custom ores, and a large tonnage could be confidently counted upon from this source. Ores available for treatment by milling in and near the "Tombstone Mining District," makes the plan of treating outside ores an attractive commercial asset and revenue from this source would add to the income of the company operating tthe "Mellgren Mines," in conjunction with a "Custom Plant.'

C. J. SARLE

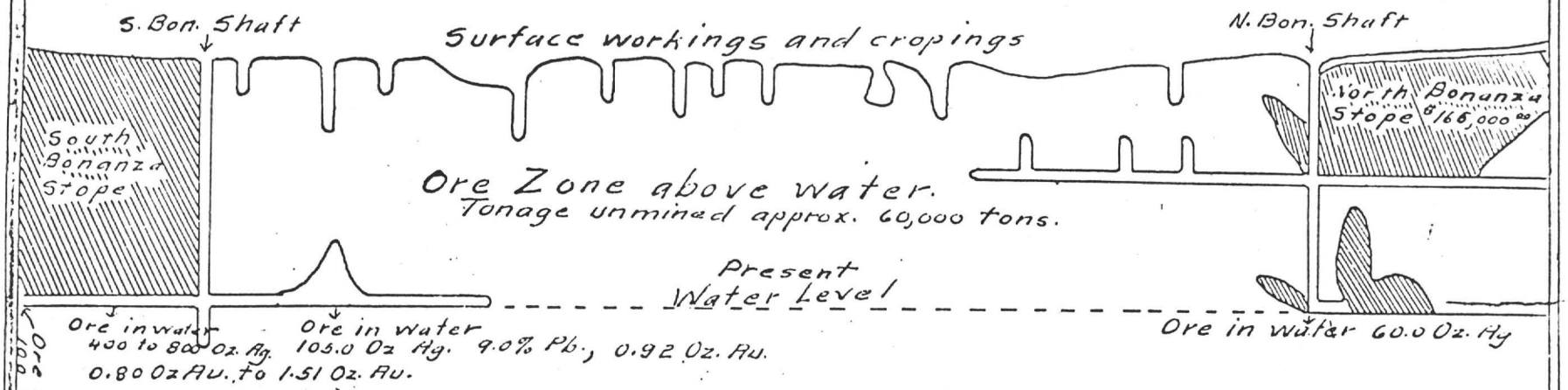






Sample	Width	Assay Au.	Assay Ag.
B1		NIL	.42
2		NIL	.28
3		.010	.75
4		.005	.88
5	3.	NIL	1.24
6	5	NIL	.66
7	2.5	NIL	.54
8	3.	.008	1.13
9	3.	.007	2.55
10	1.2	.012	7.25
11	2.	Tr.	.56
12	4.	Tr.	1.60
13	3.	Tr.	2.04
14	3	.004	1.08
15	1.5	.003	1.14
16	9.	.003	2.12
17	3.	NIL	.48
18	4.	Tr.	.40
19	2.	.010	1.35
20	5.	NIL	.52
21	3.	.003	.34
22	2	.003	2.86
23	1.5	.012	1.43
24	1.	.020	52.38
25	1.	.014	12.13
26		no sample	
27	2.	.020	23.08
28	3	.008	7.64
Avg (5-28)		.004	3.20

Longitudinal section of Bonanza Mine (One of the Mellgren Mines) Scale 1" = 1200' approx.



Ore Zone below water. level
Estimated tonage between 200 and 500 foot levels 115,000 tons.

This vein, including the Chance or southern portion, has produced, with but 1/3 of the ore mined, $1,000,000.00. These operations being above the 200 foot level, with the ore zone below, untouched.

Operations planed.

On the Bonanza Mine one of the 57 claims of the Mellgren Group, I am now extracting ore from above water level. The Chance-Bonanza vein has a past production record of a little under $1,000,000.00 over a period of 50 years. The bulk of the ore produced being classified as high grade. A longitudinal section of these vein workings is attached.

The water level stands at 200 feet and with the exception of winzes marked A-B and C, no work has been done below water.

At point marked "A" Mr. Emmit Finerty, a former Supt. of the Phelps-Dodge at Bisbee; obtained a lease and installed a pump-jack underground on the 200 level. This was powered by a gas engine with exhaust piped out. He sank on high grade ore a distance of 18 feet in depth with about a 20 foot winze length.

He contracted blood poisioning and had his leg amputated. The south shaft caved in and all tools, machinery etc are on the 200 level. No work has been done here since. Miners who worked in this winze are here and can be interviewed. I personally took samples and had assays as high as 1200 Oz. per ton in silver.

At point marked "B" my father sank in the water as far as he could without pumps and the ore here had values up to as high as 800 Oz. per ton in silver.

At the south Bonanza shaft I gave a lease to the Gorning Brothers. They had a small compressor and small boiler feed pump that they ran with air.

Doing all work themselves they sank 36 feet in the water. They had no capital and finally had to quit. Assays on the vein from the last round showed 94.0 Oz. in silver.

To the north at point marked "C" one half carload of ore was mined as far as they could under hand stope in the water. This was lower silver but higher lead, running 26.0% lead and 56.0 Oz. silver. A general average of gold values is about $1.50 for each 10.0 Oz. of silver and is a fairly consistant ratio over the property as shown by many thousands of assays.

From these pumping tests it was demonstrated that the water flow approximates 100 G.P.M.

My plan is to put down an off-set churn drill hole 300 feet to tap the Bonanza vein at this depth. As the vein dips at a 65 degree angle this will give a working back in excess of 100 feet.

A pumping plant to be installed on the surface, water to be drained as the south shaft is being sunk. At the 300 level drifting will be done north and south to get under the ore and then stopes started. By this method we would get under high-grade portions "A" and "B"

I have made a carefull estimate and put the cost at $15,000.00 I need this amount of capital to do this and know positively that the ore is there.

To parties putting up this amount I will enter into a lease on the South Bonanza for three years with the

usual 20% royalty; but in so far as I want to be a party to these operations I will stipulate that until the $15,000.00 is repaid that this 20% be credited to them.

My history is:—

University of Arizona, 1903-1907
Michigan College of Mines and Technology 1907-1908
Degress B.S. E.M.
Lt. Colonel, Chemical Warfare Res.
Operated on Mellgren Mines, off and on for thirty years.
Conducted Custom Assay Office here for 15 years.

I have my own assay equiptment which I will use and will actively work on these lease operations. It is due to my knoweldge of and experiance on the Mellgren properties that I wish to be associated with the operations.

This work is but a small part of development and operations of the entire holdings of the Mellgren Mines Corp. which takes in almost one half of the Tombstone District. To parties becoming interested in this small lease operation I will I will give an option that they can purchase a one half interest at any time within one year. This will give an opertunity to demonstrate the ore in this local section and allow time for a study of the group as a whole. From this they could decide if they would be interested in expansion and large scale development.

Memorandum B.

The Mellgren Mines Corporation holdings consists of approximately 1100 acres in the western portion of the Tombstone District. All claims are contiguous. For detail description see reports.

Memorandum "C".

The late J.L. Mellgren commenced aquiring what is now the Mellgren Mines Corporation holdings, in 1903. During his life time he worked the properties himself. No outside capital was ever raised.

After his death in 1929 operations continued as the Mellgren Group until 1934, when the property was incorporated with a view of raising outside capital for an extensive development program.

A tenative underwriting was arranged with A.J. Belfi & Co of New York. and a registration made with the S.E.C. After several months of red tape and delays I quit in discust and withdrew the application outright and since then have gone back to the old method of small operations. No stock has ever been sold.

During my fathers life time he at no time wanted or endeavored to interest out side capital, prefering to work in a small way himself and in this manner he did many thousands of feet of work. Ore produced at all times paying its way.

I have plans for extensive operations of the entire group that I can discuss with them.

From the date the churn drill hole is started we can almost certainly be mining or within 90 days. The south shaft already being down 236 feet and in fair condition