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531	20,000 ✓	Richard McGee ✓	577 - 10,000
532	7,331 ✓	Wm. R. Noack ✓	578 - 25,000
533	2,500 ✓	alg. Taggart ✓	579 - 10,000
534	2,500 ✓	M.D. Disney ✓	580 - 14,000
535	25,000 ✓	Norman Jensen ✓	581 - 100,000
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The Engineering and Mining Journal

VOLUME 98

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BY FRED A. HALE, JR.*

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Upper workings of Boss mine



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The country rock in the vicinity of the Boss property consists of thick-bedded limestones, probably of upper Mississippian age, dipping about S 60° W at an angle of 10° to 20° from the horizontal. These limestones are cut by a large batholithic intrusion of acid porphyry, which has been identified as a quartz monzonite, showing large phenocrysts of orthoclase feldspar and occasional quartz crystals in a fine-grained ground mass, the whole presenting a facies almost identical with the numerous porphyry intrusions throughout the Yellow Pine district.

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largest outcrop occurred; at lower levels, two other tunnels have been driven, the first of which, about 30 ft. lower than the upper tunnel, has encountered the main ore zone. The lowest tunnel is being driven at an elevation several hundred feet lower than the upper workings, and has not yet reached the main ore zone.

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First-Aid Instruction in California

By LEWIS J. EDDY

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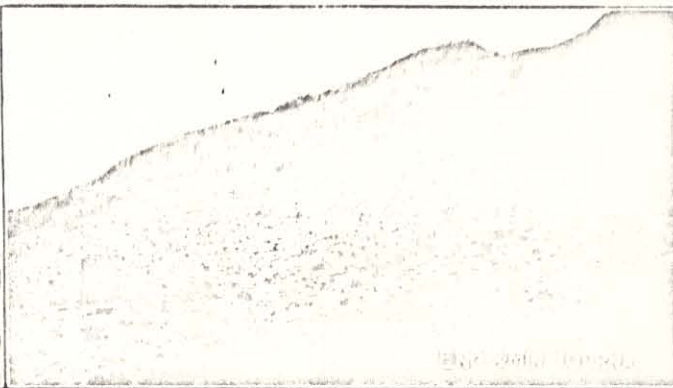
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volumes for 1906, 1907, 1908, 1909, 1910, 1911, 1912, and 1913 are Bulletins 316, 341, 381, 431, 471, 531, 541, and 581. Bulletin 621 forms Part II of the "Contributions" for 1915.

The reports on work in Alaska have been printed in a separate series since 1904, the volumes so far issued being Bulletins 259, 284, 314, 345, 379, 442, 480, 520, 542, 592, and 622.

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A GOLD-PLATINUM-PALLADIUM LODE IN SOUTHERN NEVADA.

By ADOLPH KNOPF.

INTRODUCTION.

The discovery of platinum-bearing gold ore at the Boss mine, in southern Nevada, was brought to the attention of the Geological Survey by Mr. F. A. Hale, jr., in September, 1914. Some samples of the ore were submitted at the same time. These were assayed and found to be extraordinarily rich in gold, platinum, and palladium. A brief announcement of the discovery, based on the returns of these assays and on information courteously supplied by Mr. Hale, appeared on October 3, 1914, in an advance chapter of Mineral Resources¹ for 1913. Early in October an examination of the deposit was made by the writer, the results of which are here given.

LOCATION.

The Boss mine is situated in the Yellow Pine mining district, Clark County, Nev., near the extreme southern part of the State. The main settlement of the district is Good Springs, distant 8 miles from Jean, a station on the San Pedro, Los Angeles & Salt Lake Railroad. Good Springs lies on the east side of a desert range known as Spring Mountain, but the mine is situated on the west slope, 12 miles from Good Springs, by a road which crosses the range through a low pass. A few miles from the mine is the abandoned settlement known as Sandy (Ripley post office), at which was situated the cyanide plant of the Keystone mine. From a well at this place water of good quality is obtained for domestic use at the Boss mine and neighboring prospects. An ample supply is said to be available for milling purposes.

HISTORY.

The deposit on the Boss claim was discovered some 30 years ago, having been located for copper, the presence of which is plainly indicated by chrysocolla and other oxidized copper minerals. In

¹ Day, D. T. The production of platinum and allied metals in 1913. U. S. Geol. Survey Mineral Resources, 1914, pp. 149, 448, 464-65. A more detailed account was published by Mr. Hale (the mine is in southern Nevada) and Mr. Zentgraf, vol. 68, pp. 641-65, 1914.

the nineties the property was bonded and a leaching plant was built at Good Springs to treat the oxidized copper ores, but, the process proving a failure, the property reverted to its original owners. Not until recently has the gold and platinum content of the ore been recognized. The owners, Messrs. Yount & White, discovered the high gold content by sampling and assaying, and the Boss Gold Mining Co. was organized in March, 1914.

The failure to recognize previously the auriferous character of the ore needs explanation. It seems to have been due in part to the fact that, although the ore can be shown by assays or chemical means to carry considerable gold, the presence of the gold, as the writer has verified personally, is not evident on panning. Moreover, some extraordinarily rich material (the plumbojarosite, described on p. 8, assaying as high as \$6,000 to the ton in gold) yields when panned a black residue which might easily be thrown away as worthless black sand. This unpromising-looking black residue when strongly scoured by rubbing it in the pan with a piece of iron rolls out into yellow flakes and quills, and its identity as gold becomes manifest. The discovery of the platinum content of the ore is due to the acumen of Mr. H. K. Riddall, chemist for the Yellow Pine Mining Co. In running assays of the Boss ore he noticed that the gold buttons, instead of being smooth, had rough, cauliflower-like surfaces. He suspected that the buttons might contain platinum, and this suspicion was strengthened by the fact that solutions obtained on parting, instead of being colorless as is the rule when the gold is alloyed with silver only, showed yellow and brown tints, indicating the presence of platinum and palladium. By systematic tests these metals were then proved to be present. This result was soon verified by a number of other assayers, although one supposedly reliable assaying firm in Los Angeles reported that the ore contained no platinum. Two samples sent to the Geological Survey by Mr. Hale were submitted for assay to Ledoux & Co., of New York, who reported on September 9, 1914, as follows:

Assays of ore from Boss mine.

	1	2
	Ounces.	Ounces.
Platinum.....	7.38	99.08
Gold.....	11.55	111.00
Palladium.....		16.00

NOTE.—Concentration by panning shows that the metals are in the free state, being apparently alloys of gold and platinum metals. Owing to uneven distribution, assaying is very difficult and the above results can only be considered as approximately correct. Assay for palladium was omitted on No. 1, but the sample contains 1 or 2 ounces of this metal. A little iridium is present in No. 2.

Prior to the discovery of the platiniferous character of the ore some small shipments of high-grade copper ore and of high-grade

gold ore had been sent to the smelter at Salt Lake City, but after the platinum content was recognized production was suspended, pending arrangement for the advantageous disposal of the platinum and allied metals.

In October negotiations were under way for the treatment of certain lots of high-grade ore by the Pacific Platinum Works, of Los Angeles, whereby this firm agreed to pay \$46 an ounce for the combined platinum and palladium content, after deducting a treatment charge of \$300 a ton.

Late in the year the mine was sold by the Boss Gold Mining Co. to W. C. Price and associates for \$150,000, according to O. J. Fisk, former manager of the company.

The great interest that attaches to so unusual and remarkable an occurrence of platinum and palladium in a gold-bearing lode hardly needs comment. As is shown on pages 13–17, in the review of the known distribution of platinum in veins, the Boss vein is one of the few primary deposits in which metals of the platinum group occur in more than traces and, with one possible exception (the New Rambler mine in Wyoming), is the only primary deposit of economic importance in which these metals are the constituents of predominant value.

GENERAL GEOLOGY OF THE DISTRICT.¹

SEDIMENTARY AND IGNEOUS ROCKS.

The prevailing rocks of the district are stratified dolomites of middle Carboniferous age. (See Pl. I.) They are considerably though not acutely folded and are broken by faults. This formation is economically the most important assemblage of rocks in the district, as all of the ore deposits occur in it or in the dikes cutting it.

Limestones of Pennsylvanian age and red sandstones and shales of probable Mesozoic age are also present in the district, but they are of no special concern here, as they lie at a considerable distance from the area in which the Boss mine is situated.

Intrusive igneous rocks are not common in this district; in fact, the areas occupied by them are so small as to be barely perceptible on the geologic map. They consist of sills and short dikes of quartz monzonite porphyry and granite porphyry, as a rule considerably altered. The age of intrusion has not been established, but is thought to be at least as recent as post-Jurassic.

Some horizontal sheets of biotite andesite cap the summit of Table Mountain, southwest of Good Springs. This is the only noteworthy occurrence of extrusive rocks in the district.

¹ A more extended discussion of the geology is given by J. M. Hill: The Yellow Pine mining district, Clark County, Nev.: U. S. Geol. Survey Bull. 540, pp. 228–240, 1914.

METALLIFEROUS FEATURES.

The principal metalliferous deposits of the district are bodies of lead-zinc ores inclosed in dolomite or limestone. The prevailing minerals are smithsonite and cerusite; galena occurs to some extent, but zinc blende, presumably the parent of the oxidized zinc ores, is present in only one mine. The genesis of the primary minerals of these deposits is as yet unknown.

Gold deposits were formerly of some importance in this district, the Keystone mine, the most productive, being credited with an output of \$1,000,000. At this mine the gold is disseminated through quartz monzonite porphyry, which has been highly altered by the development of sericite and siderite. In general the deposits are closely associated with the porphyry dikes and may stand in genetic relation to them. Certainly the chemical alteration produced in the porphyry dikes indicates that the ore-forming solutions were ascending thermal waters.

Some copper deposits have also been developed. They consist predominantly of oxidized copper minerals forming irregular replacement bodies. Tetrahedrite, which has been recognized in the gold ore of the Lavina mine, and chalcocite are the only copper-bearing sulphides found in the district.

Finally, brief mention should be made of the so-called vanadium deposits. On the Bill Nye claim, for example, a dolomite breccia cemented by a copper-bearing lead vanadate, probably cuprodesclowitzite, forms a tabular deposit 18 to 24 inches thick, which has been exposed by an incline to a depth of 12 feet.

The Yellow Pine district is the most productive zinc and lead district in Nevada. In 1913 it yielded 29,060 tons of ore, containing \$1,268 in gold, 192,339 ounces of silver, 283,592 pounds of copper, 6,204,065 pounds of lead, and 14,369,709 pounds of zinc, valued in all at \$1,239,081.¹

THE BOSS MINE.

GENERAL GEOLOGIC FEATURES.

The country rock at the Boss mine consists of dolomite in beds ranging from a few inches to several feet thick. The beds comprise a dark-gray or black variety, fetid with hydrogen sulphide on fresh fracture, and a more prevalent pale-buff variety. They not uncommonly carry crinoid fragments and are of late Mississippian or early Pennsylvanian age—that is, middle Carboniferous.

The rocks strike east and dip gently to the north. The structure is that of a broad anticlinal arch, whose crown has been more or less

fractured and broken by faults. In the immediate vicinity of the mine the rocks are practically horizontal.

A small mass of granite porphyry or dike of no great linear persistence occurs 600 feet north of the mine. This rock is characterized by numerous large corroded phenocrysts of quartz and kaolinized feldspars embedded in a fine-grained groundmass. It accordingly resembles the small masses of intrusive granite porphyry and quartz monzonite porphyry scattered throughout the district. The porphyry is highly altered and has been considerably prospected for gold, but has proved of too low grade to be profitable, carrying at best only a few dollars in gold to the ton.

The ore bodies so far developed may be briefly characterized as oxidized copper shoots and gold-platinum-palladium shoots. The copper ores consist largely of chrysocolla and colloidal complexes of chrysocolla and limonite; these ores are reported to carry only minor amounts of the precious metals. The gold-platinum-palladium shoots consist of fine-grained siliceous ore carrying a small quantity of a bismuth-bearing variety of plumbojarosite (a hydrous sulphate of iron and lead). There is no fixed ratio between the content of gold and the platinum metals, nor between the content of platinum and palladium. This variability seems to be a result of the prevailing oxidized condition of the ore. The palladium, according to reliable figures furnished to the writer, is probably in excess of the platinum.

The copper shoots and the precious-metal shoots can be mined separately, it is said. The segregation of the metals into separate shoots that makes this feasible will assuredly be found less and less complete as depth is attained on the deposit.

The ore bodies of the Boss mine occupy a nearly vertical zone of fracturing in the horizontal strata of dolomite. At the surface this zone is 30 feet wide, but the precious-metal shoots are confined to the 12 feet resting on the footwall. The length of the mineralized zone exposed on the surface is about 100 feet, but the ore bodies do not extend continuously over this distance. At the portal of the upper tunnel the footwall strikes N. 5° E. and the hanging wall strikes N. 25° E. The principal ore shoot, so far as the present workings disclose, forms an irregular pipe pitching at a low angle to the northeast.

The dolomite within the zone of fracturing has recrystallized to a coarse white spar, and this dolomite spar makes up the rock inclosing the ore shoots.

DEVELOPMENT.

The principal development consists of three tunnels driven along the zone of mineralization. (See fig. 1.) They are known as the upper, middle, and lower tunnels. The middle tunnel is about

¹ U. S. Geol. Survey Mineral Resources, 1913, pt. 1, p. 818, 1914.

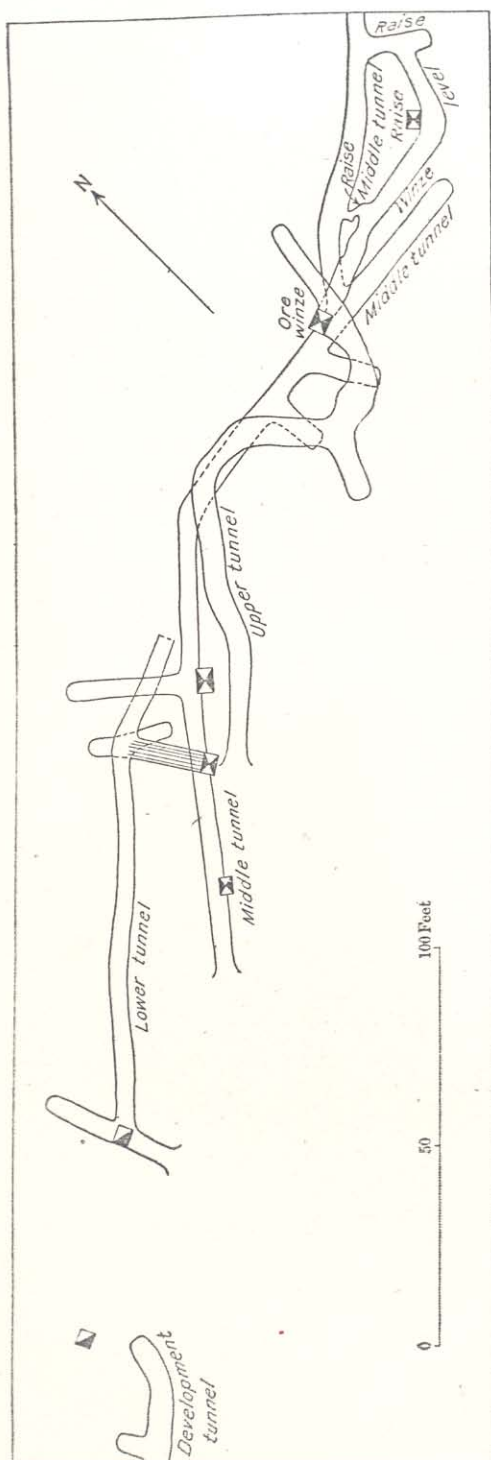


FIGURE 1.—Plan of the workings of the Boss mine, Clark County, Nev.

30 feet below the upper, and the lower is about the same distance below the middle tunnel. The richest ore is exposed in the "ore winze," which was sunk from the upper tunnel and is connected with the middle tunnel. Estimates of the total amount of ore exposed in the mine range from 1,000 to 2,000 tons, but at the time of visit an accurate estimate was not possible.

A development tunnel was started some years ago several hundred feet below the upper group of tunnels, but no work has been prosecuted on it recently.

MINERALOGIC FEATURES.

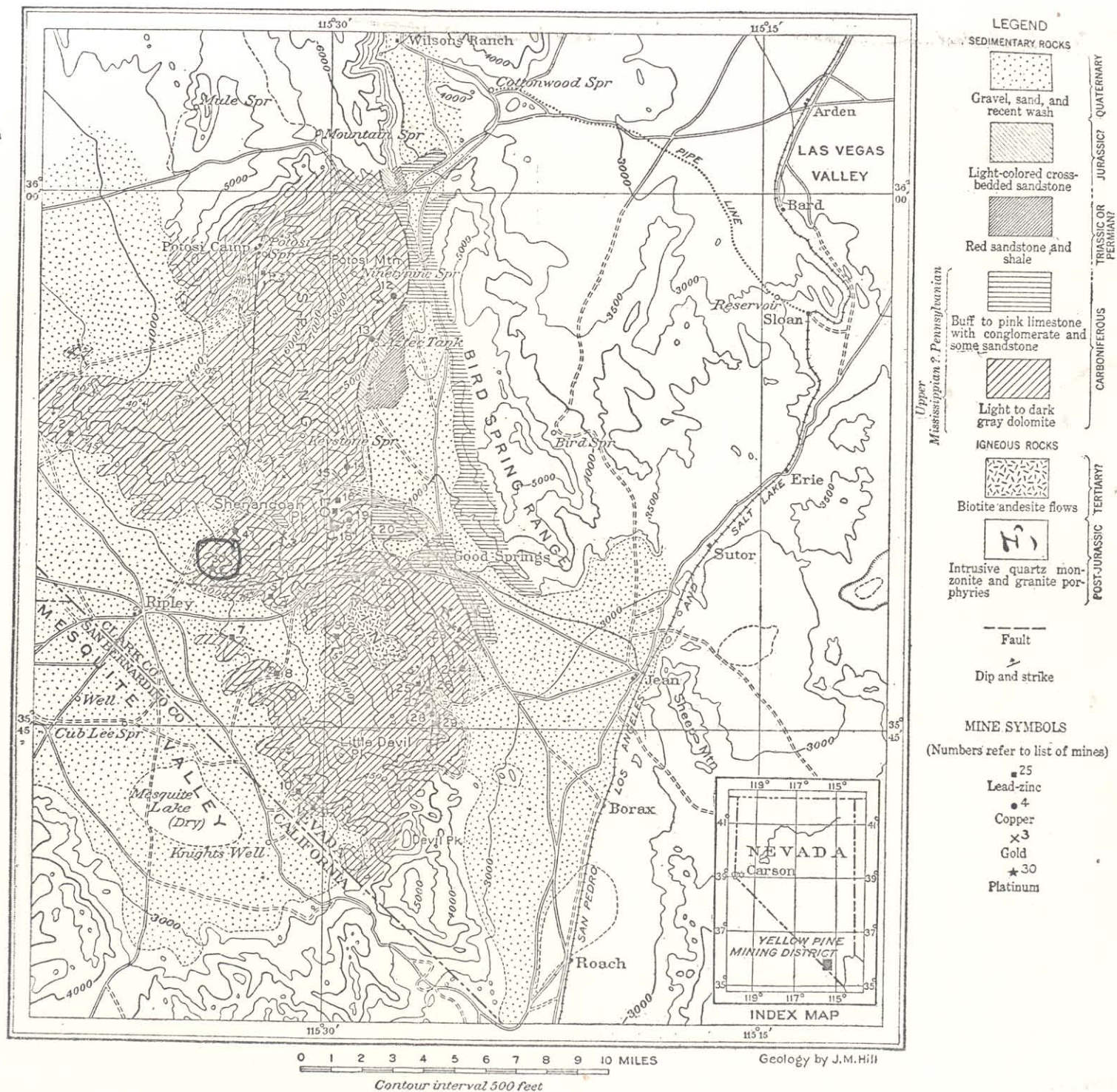
The essential features of the deposit are well shown in the irregular open cut at the portal of the upper tunnel. Here there is a considerable mass of somewhat cupriferous gossan. Below it, at about the tunnel level, is an irregular pocket of light-gray material, which crumbles to a fine gray sand; and beneath this sandy material is a porous dark-gray to blackish siliceous rock. The ore carries gold and platinum metals, and a winze was sunk

LIST OF MINES

1. Potosi
2. Green Monster
3. Keystone
4. Oro Amigo
5. Whale
6. Bill Nye
7. Hoodoo
8. Springer and Tiffen
9. Hoosier
10. Milford
11. Addison
12. Ninety-nine
13. Contact
14. Ninety-three group
15. Red Cloud
16. Prairie Flower
17. Yellow Pine
18. Alice
19. Porphyry Canyon
20. Lavinia
21. Columbia
22. Frederickson
23. Monarch
24. Lincoln
25. Porter
26. Monte Cristo
27. Accident
28. Bonanza
29. Anchor
30. Boss

GEOLOGIC FEATURES.

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SKETCH MAP OF YELLOW PINE MINING DISTRICT, CLARK COUNTY, NEV.

here to the tunnel below, but the ore shoot is reported not to have persisted to the lower level. About 6 feet farther in toward the mouth of the tunnel, lying under a mass of earthy red hematite, is another streak of gray sandy material, containing a middle band, three-fourths of an inch wide, of a soft greenish-yellow powder. This greenish-yellow mineral, identified as a new variety of the rare species plumbojarosite, is extraordinarily rich in gold and platinum metals; in fact, the evidence indicates that the distribution of the precious metals, especially of those of the platinum group, is dependent on the presence of this mineral.

A sample of the gray sandy material essentially free from admixed plumbojarosite, taken by the writer from a point near the winze mentioned above, was submitted to the Bureau of the Mint and assayed by F. P. Dewey, who reports as follows: Gold, 0.44 ounce to the ton; platinum metals remaining insoluble on boiling the silver lead in strong sulphuric acid, 0.01 ounce to the ton. If palladium was present it was not determined.

The gray sandy material proves to consist largely of perfectly formed crystals of quartz, averaging 0.1 millimeter in diameter; doubly terminated crystals are common. Some of this quartz sand, after repeated evaporation with hydrofluoric acid, left a small residue consisting of minute crystals of adamantine, almost metallic luster. These crystals comprised octahedrons and square tabular forms, averaging a few hundredths of a millimeter in size. Their crystal habit, together with the fact that they gave a strong titanium reaction after fusion with potassium bisulphate, suggested that they were octahedrite (anatase), and their identity as octahedrite was conclusively established by Dr. H. E. Merwin by the determination of their optical properties. Dr. Merwin reports as follows:

The grains are mostly single crystals, slightly tabular normal to an optic axis (uniaxial, negative). The refractive index ω was found to be 2.51 ± 0.01 for lithium light. Measured on six crystals, $\omega - e$ is 0.070 ± 0.003 . The value for ω is the same as all observers have found for anatase (ranging between 2.515 and 2.521) and $\omega - e$ is the same as later investigators have found for this mineral ($0.066 - 0.073$).

A few prisms and knee-shaped twins of rutile occur with the octahedrite. The octahedrite and rutile are subordinate constituents, but they are the only gangue minerals in the deposit other than quartz.

A particularly rich shoot of ore has been developed by a winze sunk from a point near the end of the upper tunnel. In this shoot are small masses of what is locally known as greenish talc.¹ Some of these were mined separately and two shipments aggregating about 1 ton were sent to the smelter at Murray, Utah. On a control sample of this ore Ledoux & Co. report as follows: Gold, 111 ounces to the

¹ Hale, F. A., Eng. and Min. Jour., vol. 98, p. 642, 1914.

ton; platinum, 99.08 ounces to the ton; palladium, 16 ounces to the ton; iridium, trace.

The "greenish talc," determined chemically and microscopically, proves to be a bismuth-bearing variety of the rare mineral plumbojarosite. It is a greenish-yellow mineral of smooth, unctuous feel, which under the highest power of the microscope is seen to consist of perfect hexagonal tablets averaging 0.01 millimeter in diameter. It carries considerable mechanically admixed gold and platinum metals. An analysis of the purest obtainable material was made in the laboratory of the United States Geological Survey by R. C. Wells, with the following results:

Analysis of bismuthic plumbojarosite from the Boss mine.

Fe ₂ O ₃	32.24	CaO	0.06	TiO ₂	0.37
Al ₂ O ₃.....	.14	MgO .....	.14	Au .....	.79
SO ₃	24.08	K ₂ O .....	.22	Pt .....	.05
PbO.....	16.75	Na ₂ O.....	.52	Pd .....	.22
H ₂ O.....	.02	CO ₂.....	.43	Ir	Trace.
H ₂ O+.....	8.55	As ₂ O ₅.....	.09	Ag	Trace.
CuO.....	1.97	P ₂ O ₅	Trace.		
Bi ₂ O ₃	6.34	SiO ₂	6.90		99.88

Reduced to ounces a ton, the analysis shows gold to be present to the extent of 234 ounces, platinum 15 ounces, and palladium 64 ounces. Assays of similar material are reported to show as high as 575 ounces of gold, 230 ounces of platinum, and 30 ounces of palladium. The silica and titania shown by the analysis represent an admixture of quartz and octahedrite.¹

The gold and platinum metals can be partly separated from the plumbojarosite by panning, but long before a clean separation can be effected fine gold and especially platinum pass into the tailings, in spite of the utmost precaution. The gold is extraordinarily rough and spongy; delicate platy forms are common, and some is intergrown with quartz and plumbojarosite or is molded around minute quartz crystals. It is more or less blackish, and aggregates of the finer particles look like so much black sand. Treatment with hydrochloric acid and annealing, however, bring out the normal yellow color of gold. Some of the larger particles after being treated thus were analyzed by R. C. Wells, as follows:

Analysis of gold from the Boss mine.

Gold.....	97.8
Silver.....	2.2
Platinum metals.....	Trace.
	100.0

¹ Further study of the material analyzed shows that it contains 20 per cent of beaverite, CuO.PbO. Fe₂O₃.2SO₃.4H₂O. (See Knopf, Adolph, Plumbojarosite and other basic lead-ferric sulphates from the Yellow Pine district, Nev.: Washington Acad. Sci. Jour., vol. 5, pp. 497-503, 1915.)

Qualitative tests on other gold particles always showed the absence of platinum metals, and the inference of Ledoux & Co. that the metals are present "apparently as alloys of gold and platinum metals" is therefore not borne out. The platinum and palladium occur in extremely small particles, which even at high magnification under a binocular microscope are indistinguishable from the dull blackish particles of gold; in all material examined by the writer chemical tests were necessary to establish the presence of the platinum and allied metals. By cleaning the precious metals in molten sodium carbonate, particles of gray metal (platinum and palladium, or an alloy of these) become distinguishable from yellow gold. The possibility was entertained that sperrylite might be present in the residue of the pannings from the plumbojarosite or elsewhere in the ores of the Boss mine, but no trace of this mineral, which, according to its discoverer, is characterized by a wonderfully brilliant luster, was found.

The pockets of plumbojarosite occur in a porous, fine-grained siliceous gangue, which is a replacement of the dolomite country rock. The pores and cavities evidently resulted from the leaching of sulphides formerly present; they are now partly filled with malachite in small botryoidal groups, or more commonly with powdery plumbojarosite. A thin section cut from a specimen selected for assay shows quartz, commonly euhedral, and plumbojarosite scattered throughout the material, perhaps to the extent of 10 per cent. This specimen was submitted to the Bureau of the Mint for assay, and F. P. Dewey reports as follows:

Gold, 4.12 ounces to the ton; platinum metals remaining insoluble on boiling the silver bead in strong sulphuric acid, 3.35 ounces to the ton. I made no determination of palladium, but the sulphuric-acid solution was strongly colored, indicating that much palladium had gone into solution.

This determination of the platinum metals (mainly platinum with some iridium) is therefore a minimum for this particular sample. The ore, despite its extreme richness, shows no free gold or platinum metals. The writer was unable to pan any precious metal from this ore, or to separate any with heavy solution, but on evaporation with hydrofluoric acid an extremely fine black residue remained, containing gold, platinum, palladium, and octahedrite.

A composite of 22 samples taken in the winze connecting the upper and middle tunnels and on the intermediate level yielded the following return, in ounces to the ton: Gold, 3.46; silver, 6.4; platinum, 0.70; palladium, 3.38.¹ It is probable that there are several hundred tons of ore of this grade, which, with platinum and palladium at \$45 an ounce, has a value of \$256 a ton.

¹ Data furnished to the writer by a mining engineer who examined the mine under an option that was not exercised.

The only sulphide-bearing ore exposed in the mine at the time of visit was in the sublevel below the upper tunnel. Here, in particularly tight ground, about 3 feet of copper ore rich in chalcocite had been opened. An average sample of this ore, as reported by the management, showed copper 15.1 per cent and platinum metals 0.40 ounce, gold 0.13 ounce, and silver 1.2 ounces to the ton.

The chalcocite, which is of the steely kind and shows conchoidal fracture, occurs as small blebs and finely disseminated particles embedded in a close-grained siliceous gangue. It is partly altered to brochantite, the basic sulphate of copper, which forms small glassy emerald-green prisms implanted on the sulphide from which it was derived. Examination of this ore under the microscope shows that it is an aggregate of quartz, chalcocite, and brochantite, with octahedrite present as a rare accessory mineral; the brochantite occurs in partial replacement of the quartz and is somewhat more abundant than would be estimated from inspection by the unaided eye. An oxidized bismuth compound, whose identity was not established, is associated with some of the chalcocite.

GENESIS OF THE ORE.

The Boss deposit represents in the main an irregular siliceous replacement of dolomite along a series of vertical fractures. On account of the prevalent oxidation and the inconsiderable depth to which the workings have penetrated, primary sulphides have not yet been reached. The chalcocite, the only sulphide so far found, most probably originated as a precipitate from downward-moving solutions whose copper was derived from primary sulphides formerly exposed to oxidation near the surface.

The deposit yields as yet no especially strong evidence concerning the genetic conditions that prevailed at the time it originated. Some clue is perhaps afforded by the presence of the titanium oxide minerals, octahedrite and rutile. Both of these are rather uncommon in metalliferous deposits. Of the two rutile is the more common. It is, for example, somewhat abundant in certain of the auriferous deposits of the Juneau gold belt, which are veins that originated at high temperature; in fact, according to W. H. Emmons,¹ rutile is restricted to high-temperature veins. Octahedrite occurs in the tourmaline-bearing copper veins of Las Condes, Chile;² in tin veins of Saxony associated with apatite, fluorite, and chlorite; and in fissure fillings in the Alps,³ but these veins are not notably metalliferous. The Alpine veins are thought to have formed at tempera-

tures between 250° and 400°. In view of the affiliation generally shown by the octahedrite and rutile with deposits of high-temperature origin, the suggestion is advanced that the primary ore of the Boss deposit was formed under conditions of moderately high temperature.

The facts at hand can not of themselves be held to prove that the ore deposition was genetically connected with the intrusion of any particular dike or igneous mass now visible at the surface. It is probable, nevertheless, that the mineralization followed as a sequel to the intrusion of the magma from which the granite porphyry dikes were derived, for these are the only intrusives that penetrate the rocks of the district.

The deposit, as already described, is highly oxidized and contains abundant oxidized copper compounds and plumbojarosite. These minerals indicate that the primary sulphides will be found to carry copper, iron, lead, bismuth, and precious metals. The extraordinary richness in gold, platinum, and palladium of ore containing notable quantities of plumbojarosite raises an important problem. It is of course not impossible that the plumbojarosite may have originated essentially in place by simple oxidation of sulphides that were extremely rich in precious metals. A partial analogy for this supposition is furnished by the development of the brochantite in the chalcocite-bearing ore; the brochantite appears to have formed in place from the chalcocite without any important migration of copper. For the origin of the plumbojarosite, however, the following explanation appears to fit the known facts more closely. B. S. Butler,¹ who has recently shown that in the oxidized ores of Utah plumbojarosite is rather common, although heretofore unrecognized, believes that in the occurrences studied by him the plumbojarosite was produced by the action of ferric solutions on galena; the lead has remained essentially in place, but the iron may have come from some distance. It is therefore suggested that in the Boss ore body descending solutions rich in ferric sulphate attacked primary galena, forming the plumbojarosite, and that this reaction caused the concomitant precipitation of the gold, platinum, and palladium. According to this explanation an efficient solvent for the precious metals was active and in this connection the fact established by R. C. Wells, during the chemical investigation of the plumbojarosite, that the precious metals are rather soluble in hydrochloric acid in the presence of plumbojarosite is highly suggestive.

On the whole, then, it is likely, in view of the probable mode of origin of the plumbojarosite and of the evidence of leaching indicated by the porous nature of the siliceous ore, that a certain amount of redistribution of gold, platinum, and palladium has taken place by

¹ A genetic classification of minerals: *Econ. Geology*, vol. 3, p. 625, 1908.

² Lindgren, Waldemar, *Mineral deposits*, p. 655, 1913.

³ Koenigsberger, Johann, *Transformations and chemical reactions in their application to temperature measurement of geologic processes*: *Econ. Geology*, vol. 7, p. 697, 1912.

¹ Occurrence of complex and little-known sulphates and sulpharsenates as ore minerals in Utah: *Econ. Geology*, vol. 8, pp. 315-316, 1913.

the action of descending surface solutions. It would follow, then, that in depth, below the zone of oxidation, the pockets of extremely high-grade ore, such as are now being extracted, will be found to give way to ore of moderate grade.

AZURITE MINING CO.'S CLAIMS.

The claims of the Azurite Mining Co. adjoin those of the Boss group, and some work is in progress here. The Rosella prospect, situated several hundred feet north of the Boss mine, is in a coarsely crystalline white dolomite; the metalliferous deposits consist of small irregular bodies of oxidized lead-zinc ore. Of interest is the occurrence of pure lumps of the rare mineral plumbojarosite, consisting of minute hexagonal tablets, having a maximum refractive index of 1.83, and reacting for lead, ferric iron, water, and sulphate. Curiously enough the plumbojarosite is not a bismuth-bearing variety, as at the adjoining Boss mine. In places a porous siliceous gangue is found, but this has not been shown to be platiniferous.

On the Azurite claim a body of oxidized copper ore inclosed in coarsely crystalline dolomite has been opened. The gangue is siliceous and, in addition to carrying the oxidized copper minerals, locally contains chalcocite.

ORO AMIGO MINE.

At the time of the writer's visit to the Yellow Pine district, metals of the platinum group were known to occur only at the Boss mine. Since then they have been found in the ore of the Oro Amigo mine, the property of the Oro Amigo Platino Mining Co., which is situated between 1 and 2 miles northeast of the Boss mine. Mr. H. K. Rid-dall, to whom the writer is indebted for specimens of the ore, reports as follows:

Assay of ore from Oro Amigo mine.

[Ounces to the ton.]

	Gold.	Plati-num metals.
Sample No. 1, width 3 feet.....	0.11	0.10
Sample No. 2, width 6 inches.....	.51	Small.

Sample No. 1, as examined by the writer, consists essentially of limonite; it carries no bismuth nor admixed plumbojarosite and is therefore quite unlike the ore of the Boss mine. This may indicate that the distribution of the platinum metals is more widespread in the Yellow Pine district than is now known and that it is not restricted to the peculiar mineral association shown by the Boss deposit. Sample No. 2 is a siliceous rock, holding numerous small angular fragments of chert, and is coated and permeated with limonite.

GEOLOGIC OCCURRENCE OF PLATINUM.

REVIEW OF KNOWN LODE OCCURRENCES.

To afford a basis for comparison of the platiniferous deposit at the Boss mine with other occurrences of platinum in lodes, a short summary is given in the following pages, describing, so far as they are known, the geologic features of some of the more important occurrences of platinum in lode deposits.

The bulk of the world's supply of platinum, as is well known, is obtained not from lodes but from placers, those in the Ural Mountains of Russia alone furnishing 95 per cent of the entire annual production. Minor quantities are derived from Colombia, California, and New South Wales. In the Ural Mountains the platinum-bearing gravels have resulted from the erosion of a broad belt of basic plutonic rocks trending parallel to the axis of the range.¹ The platinum, traced to its bedrock source, is found as an original constituent of dunite, or rarely of pyroxenite, and as such has crystallized from a molten state, most commonly in association with chromite. The metal occurring thus, however, is too dispersed to be economically valuable. Certain segregations of chromic iron in the dunite contain considerable amounts of platinum, but even these are so small and irregularly distributed that they do not admit of profitable exploitation. The output of platinum in the Ural region is therefore derived solely from the placers. These are now worked mainly by dredges, and this industry is regarded as likely to show an expansion in the future.²

The platiniferous gravels of other districts, such as those of Colombia, have essentially the same geologic relations as those of the Ural Mountains. The platinum obtained as a by-product of the gold-dredging industry of California is shown by Lindgren³ to be derived from the erosion of the serpentine, peridotite, and gabbro masses occurring in the auriferous region.

Although platinum occurs in metalliferous lodes at a number of places in several parts of the world, no lode deposit is worked solely for its platinum content. In fact, the platinum in those deposits from which it is obtained forms but an insignificant fraction of the total metallic content, either in quantity or in value, and is recovered as a minor by-product. There are, however, a few platiniferous lode deposits which, under more favorable commercial conditions, may possibly become productive and in which the platinum is the metal of predominant value.

¹ Duparc, Louis, Le platine et les gites platinifères de l'Oural: Arch. sci. phys. nat., vol. 31, 1911; reviewed by E. S. Bastin in Econ. Geology, vol. 7, pp. 202-203, 1912.

² Hutchins, J. P., Dredging in the Russian Empire: Eng. and Min. Jour., vol. 98, p. 857, 1914.

³ Lindgren, Waldemar, The Tertiary gravels of the Sierra Nevada of California: U. S. Geol. Survey Prof. Paper 73, p. 74, 1911.

following notes, however, were made by the analyst, E. T. Erickson, of the United States Geological Survey:

This sample loses carbon dioxide somewhat rapidly, accompanied by precipitation of basic constituents when left open to the air. When first delivered to the chemical laboratory the sample contained a small precipitate of iron-like substance. This was initially filtered out and gave by analysis a total of 0.4 milligram of As_2O_3 , the volume of the sample being 2,530 cubic centimeters and nearly filling the container. The iron-like precipitate gave evidence of the presence of silica.

The initial carbon dioxide determination after the opening and filtration of the sample was 466 parts per million. On the second day this lowered to 396 parts per million, when the following analyses were conducted in order to represent the composition of the sample on that day:

Parts per million.		Parts per million.	
Ca	175	CO_2	396
Mg	96	Cl	82
Na	42	As_2O_3	4
K	Trace.		
SO_4	270		1,080
HCO_3	15		

Upon the third day of the opening of the sample the Ca determination gave 168 parts per million and the Mg 81 parts per million. After the fifth day, the Ca content lowered to 126 parts per million and the Mg to 70 parts per million. By this time the sample contained much visible precipitate. Sulphides are not appreciably present.

The presence of arsenic is accounted for by the alteration of realgar to orpiment, but it is surprising that water of this type should contain so little SO_4 and little or no iron. Nor can any explanation be offered of the relatively large sodium content. The precipitation of the lime and magnesia suggests that the dolomite crystals found in the cavities of the quartz in the lower levels may be of supergene origin.

Some of the stibnite specimens collected from the 100 and 200 foot levels show a partial alteration to valentinite (Sb_2O_3) and stibiconite ($H_2Sb_2O_5$). The stibiconite appears to have formed both directly from the stibnite and as an alteration product of the valentinite. Kermesite ($2Sb_2S_3 \cdot Sb_2O_3$) is rare but in places forms a reddish coating on stibnite crystals. Tufts of hairlike stibnite crystals, which are found here and there in the quartz vugs, probably represent deposition by supergene waters. It is also possible that the small stibnite crystals found in the fault gouge are of supergene origin.

RELATION OF ORE DEPOSITION TO FAULTING.

The productive mines of the district all lie in a belt extending about 10,000 feet from east to west and less than 2,000 feet from north to south. The overthrust fault marks the northern limit of

productive mineralization. This fault is older than the numerous faults that cut the ore-bearing limestone and is undoubtedly contemporaneous with the intense folding that preceded the intrusion of the granodiorite.

Movement on the normal faults may have begun at the time of the granodiorite intrusion, for an alaskite dike seems to follow one of the faults, and the coarse calcite of the limestone ores, which, as shown below, may be related to the granodiorite intrusion, follows the minor faults.

The Tertiary rocks to the north show faulting, both before and after the intrusion of the andesite porphyry. The faults of largest throw appear to belong to the earlier group.

Productive ore deposits occur only close to the overthrust fault, along the south side. Although the fault plane itself is nowhere mineralized, it is believed that the presence of this major fault was the determining factor in the localization of the deposits. The mines are all on the hanging-wall side of the overthrust, and most of the deposits are associated with the small normal faults of later date. It may be that the overthrust fault with its narrow zone of comparatively impervious gouge acted as a dam to prevent important migration of the mineral-bearing solutions to the north of the fault, and that the intersection of the overthrust with the minor normal faults determined the principal channels followed by the ascending solutions. If so, it is necessary to assume that the source from which the solutions were derived lay to the south of the fault. This hypothesis furnishes a possible explanation for the restriction of the limestone ores to the White Caps limestone, to the exclusion of the two similar beds at slightly lower horizons. The limestone beds at the White Caps mine and on Litigation Hill, though approximately parallel with the overthrust in strike, have, at least at the White Caps mine, a slightly steeper dip. Thus the White Caps limestone would be cut by the fault plane at a lower level than the two lower beds, and uprising solutions controlled on the north by the overthrust would tend to be diverted along the first soluble bed.

The White Caps limestone is cut out against the fault on April Fool Hill, and the next higher bed, which contains the Mustang ores, meets the overthrust on Mustang Hill 4,500 feet to the west. Between these limestones there are no soluble beds in which replacement deposits could be formed, but the schist offered channels in which vein minerals were deposited, either along the schistose cleavage planes and joints, as in the Big Pine, or along well-defined shear zones, as in the Union No. 9 and similar mines.

The earlier normal faulting is believed to have afforded the principal channels for the ore-bearing solutions, both in the lime-

2190 0143

PAUL BURKE

VICE PRESIDENT

SECURITY PACIFIC NATIONAL BANK

SECURITY PACIFIC PLAZA • (213) 613-5400

333 SO. HOPE ST., LOS ANGELES, CA 90071



P.O. Box 2097

TERMINAL ANNEX

LOS ANGELES, CA

90051

Dudley L. Davis

Mining Consultant

Registered Engineer

Arizona 3038 : Nevada 2546

Registered Geologist

California 2473

8023 Calle de la Plata
La Jolla, Calif. 92037
(714) 454-6988

337 Colorado Avenue
Grand Junction, Colo. 81501
(303) 243-2512

December 13, 1986

Paul Burke
Vice President
Security Pacific National Bank
Security Pacific Plaza
3333 South Hope Street
Los Angeles, CA 90071

Dear Mr. Burke:

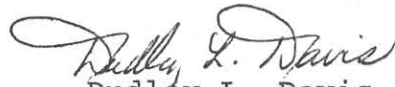
This letter of intent is written regarding a lease and option on the Boss mine in Clark County, Nevada. If terms are agreeable, we propose to write a final contract which will embody the following terms:

1. Payment of \$3,000 to the owners upon signing the agreement;
2. Commitment on our part to perform no less than \$25,000 worth of exploration on the property during the first year of the lease. This exploration to consist primarily, but not exclusively, of diamond drilling;
3. Results of our geologic investigations, assay returns, and other pertinent data developed by such exploration to be supplied to the owners.
4. A second year's option under the same terms for additional exploration.
5. Exploration will not be limited to the amount specified. If results justify, additional exploration will be at our discretion.
6. Purchase price shall be \$500,000.00, payable out of 5% net smelter returns from sales of mineral products from the property.
7. The usually "boiler plate" regarding workman-like operation, compliance with applicable laws, etc., will be embodied in the contract.

Paul Burke
Security Pacific National Bank
December 13, 1986
Page 2

Please let me know when we can meet with you and your partners to negotiate such a contract.

Very truly yours,



Dudley L. Davis

DLD/mam

Paul Burke
Security Pacific National Bank
December 13, 1986
Page 2

Please let me know when we can meet with you and your partners to negotiate such a contract.

Very truly yours,


Dudley L. Davis

DLD/mam

THIS IS A COPY OF YOUR 1986-87 TAX BILL AS OF 11/10/86 580 420 003 87
TAX RATE 2.0875 TAX DISTRICT 100

VALUATIONS:

LND: 2800 IMP: PP: LV: EX: NET: 2800
NAME -- ADDRESS LEGAL DESCRIPTION ACRES:
BANK SECURITY FIRST NATL LA MS#4371 89.74
ELLIS LUETTA FLORENCE BOSS, BOSS #2, #3, CAMPO, MANSE
%A CORNELL PT SECS 26, 27, 34-24-57
BOX 2097 TERM ANNEX 10-115
LOS ANGELES CA 213-556-1811
90051

INSTALLMENT	TAXES	PENALTY	INTEREST	INSTALLMENT	TOTAL PAID-DATE	ADJ.	REFUND
1ST:	16.45				16.45	07/17/86	
2ND:	14.00				14.00	09/30/86	
3RD:	14.00				14.00		
4TH:	14.00				14.00		

TOT-TAX: 58.45 1ST HALF: 30.45 2ND HALF: 28.00 FEES PD:
INSTALLMENTS PAID BY:
1ST: S/PAC 2ND: BANK SECURITY 3RD: 4TH:

INSTALLMENT DUE DATES: 3RD MONDAY IN JULY, 1ST MONDAY IN OCTOBER, JANUARY, MARCH

2190 0143

December 13, 1957

AIRMAIL - SPECIAL DELIVERY

Mr. Thomas L. Moran
Hartley Route
Dumas, Texas

Re: Zanzibar stock interest to Thomas L. Moran

Dear Tom:

Yesterday in the three-way telephone conversation between you, Mr. Davis and myself, we discussed the relative interests of you and Mr. Gill in the Zanzibar Mining Corporation. At that time, I mentioned the fact that the success of the corporation may be hampered in the eyes of the S. E. C. and the public should a controlling individual be under scrutiny by the S. E. C. or in litigation (however unjust). Therefore, it is my suggestion that we do the following:

1. The two trusts that were created for your children with the Bank of Amarillo as Trustee be made into irrevocable trusts.
2. That the present stock which you control in the Zanzibar Mining Corporation be given equally to those two trusts.
3. That in the future any large blocks of stock which may accrue to you be given to the trusts.
4. That smaller blocks of stock could be picked up as long as you remain in the position of a minority stockholder.

In the future, the following blocks of stock may come into your hands:

1. 1/2 of 271,500 shares at this time under purchase from Mr. Burfening.
2. 1/2 of 119,250 shares which are yet to be purchased from the Kirman estate.
3. 1/2 of stock exchanged for the Thumb Butte property.
4. Possible stock exchanged for the Black Prince and the Black Jewel property.
5. Possible purchases of stock at the assessment sale.

Sincerely yours,

HCT:dh
cc Bayshore

Hale C. Tognoni

C
O
P
Y

Minutes of Special Meeting of Stockholders
of

ZANZIBAR MINING COMPANY OF NEVADA

A special meeting of the stockholders of Zanzibar Mining Company of Nevada was held in Phoenix, Arizona at 721 First National Bank Building on the 20th day of August, 1958 at 2:00 o'clock p.m.

Mr. Hale C. Tognoni, General Counsel of the Corporation, presided at the meeting and Mrs. Lois S. Moore, Secretary of the Corporation, acted as Secretary of the meeting.

The Secretary called the roll of stockholders and determined that the following stockholders were present in person and with proxies:

	<u>Number of Shares</u>	
	<u>In Person</u>	<u>By Proxy</u>
William G. Gill	160550	1000
Thomas L. Moran	160550	3000
Dudley L. Davis	100	21243
Hale C. Tognoni	1000	26725
William G. Gooding	100	100
Lois S. Moore	1000	48553
Hubert Merryweather	-	1350
Margaret J. Kelleher	300	1000
Joseph A. Birchett	-	1000
Sub Totals	323600	103971

TOTAL SHARES REPRESENTED: 427,571

Minutes of Special Meeting of Stockholders
of

ZANZIBAR MINING COMPANY OF NEVADA

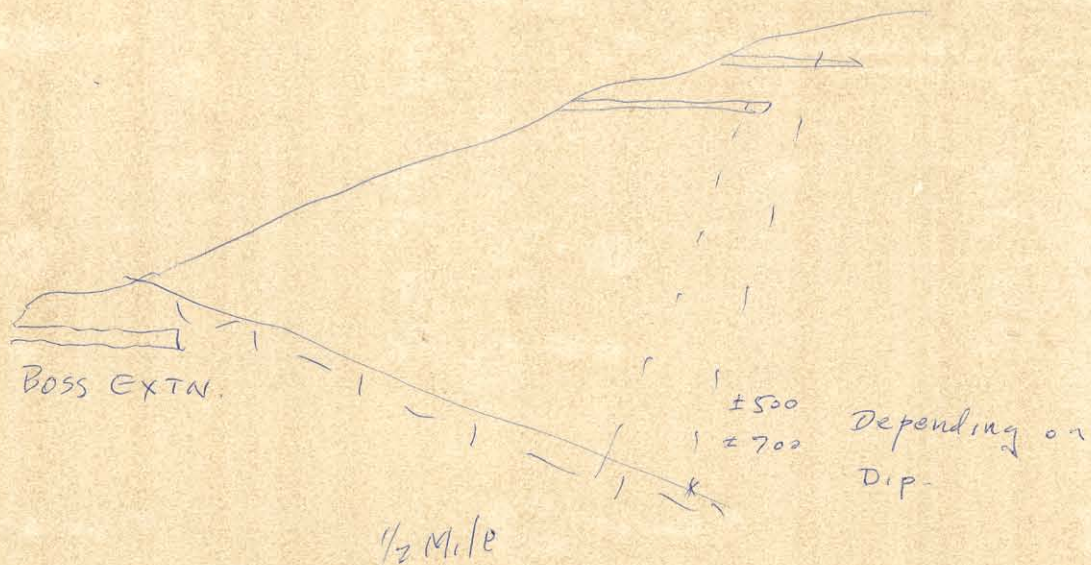
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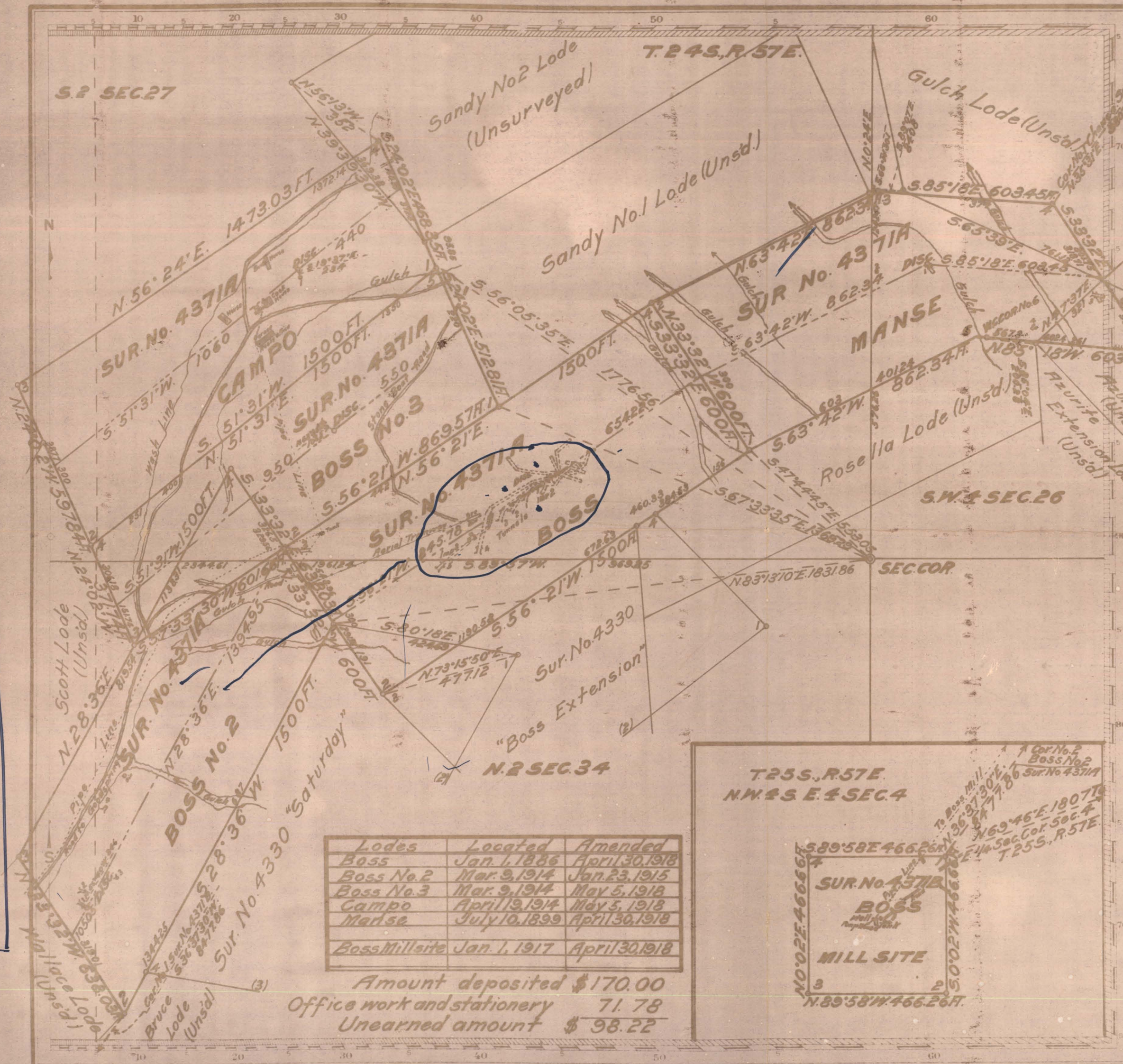
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Joseph A. Birchett	-	1000
Sub Totals	323600	103971

TOTAL SHARES REPRESENTED: 427,571



(4-675)



Claim Located See Table

Mineral Survey No. 4371A AND B

Carson City

Land District

PLAT

OF THE CLAIM OF

The Boss Gold Mining Company
KNOWN AS THEBOSS, BOSS No. 2, BOSS No. 3,
CAMPO, MANSE LODES AND
BOSS MILL SITE
IN YELLOW PINE MINING DISTRICT,
Clark County, Nevada.

Containing an Area of 300 Acres

Scale of 300 Feet to the inch.

Variation 16° 20' East
SURVEYED July 10-22, 1918 BY

A. Homer Black U.S. Deputy Mineral Surveyor

The Original Field Notes of the Survey of the Mining Claim of
The Boss Gold Mining Company
known as the Boss, Boss No. 2, Boss No. 3,
Campo, Manse Lodes and Boss
Mill site

from which this plat has been made under my direction, have been examined and approved, and are on file in this Office, and I hereby certify that they furnish such an accurate description of said Mining Claim as will, if incorporated into a patent, serve fully to identify the premises, and that such reference is made therein to natural objects or permanent monuments as will perpetuate and fix the locus thereof.

I further certify that Five Hundred Dollars worth of labor has been expended for improvements made upon said Mining Claim, or for each location of improvements made upon said Mining Claim by claimant or its grantors and that said improvements consist of 4 Cuts and Tunnels; 2 Cuts, Tunnels and Crosscuts; 4 Cuts; 1 Shaft and Imp. No. 2 consisting of 4 Cuts and Tunnels with their workings Value \$56400.

that the location of said improvements is correctly shown upon this plat, and that no portion of said labor or improvements has been included in the estimate of expenditures upon any other claim.

And I further certify that this is a correct plat of said Mining Claim made in conformity with said original field notes of the survey thereof, and the same is hereby approved.

U.S. Surveyor General's Office

Reno, Nevada.

December 14, 1918 Nevada.

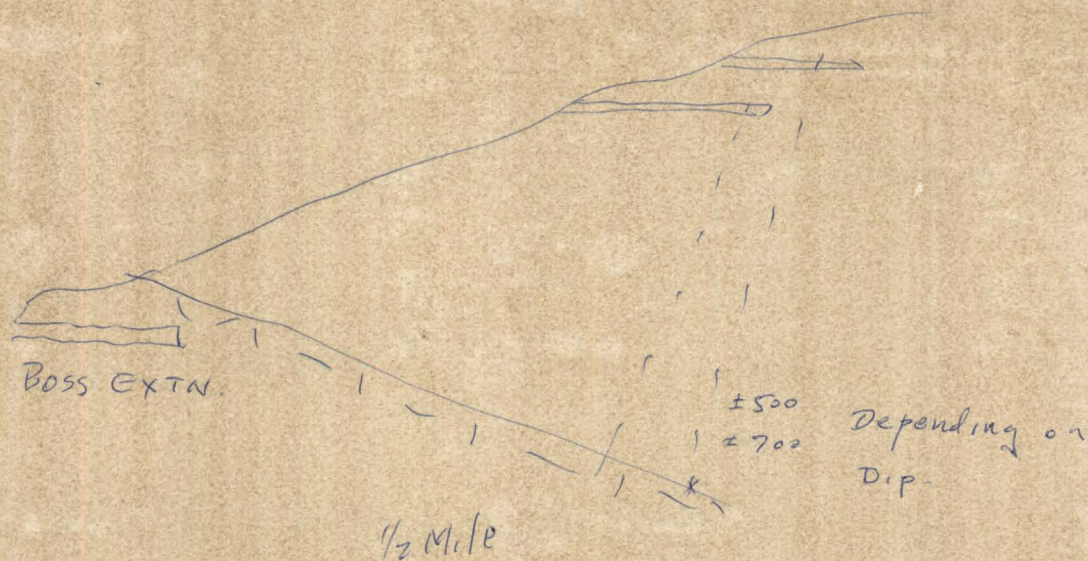
John B. Sullivan

U.S. Surveyor General for

204455

4371

2190 043



$$58 - 42$$

T. 25 S. T. 24 S.

(PROJECTED) 5290' ± (PROJECTED) 5260' ±

5280.00' 5277.36'

59 23

SEC. 34

616.50 Ac. Total

89.74 94.74 Ac.

BOSS NO. 2

MS 4371 CAMPO

BOSS NO. 3

BOSS NO. 1

SEC. 27

578.80 Ac. Total

(APPROX. LOCATION)

HWY

TO SANDY

TO GODSPRINGS

SEC. 26

MANSE

10.04

5300' ± (PROJECTED) 5240' ±

SEC. 26

47

1 - USA - 578.80 Ac. Total

2 - USA - 616.50 Ac. Total

SCALE

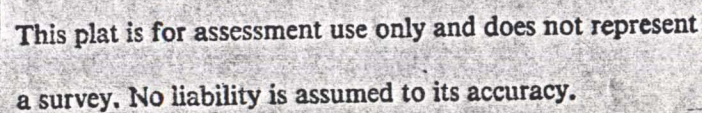
1" = 800'

CCA0 BJ 8-4-65

SCALE
1"=800'

2190 0143B

ED 2-100

$$58 - 42$$


2190 0143C

ED 2-100