Platinum in Southern Nevada

By ADOLPH KNOPF

*INTRODUCTORY. The discovery of platinum-bearing gold ore at the Boss mine was announced in October 1914. Early in that month an examination of the deposit was made by me, the results of which are here given.

The Boss mine is situated in the Yellow Pine mining district, Clark county, near the extreme southern part of Nevada. 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 that crosses the range through a low pass.

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 the nineties the property was bonded and a leaching plant was built at Good Springs to treat the oxidized copper ore, 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 and 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 I have verified personally, is not evident on panning. Moreover, some extraordinarily rich material (the plumbojarosite, assaying as high as $6000 per ton in gold) yields when panned a black residue that might easily be thrown away as worthless black sand. This unpromising 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 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:

	1. Oz.	2. Oz.
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 oz. 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 per ounce for the combined platinum and palladium content, after deducting a treatment charge of $300 per 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. 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. The prevailing rocks of the district are stratified dolomites of middle Carboniferous age. 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.

*Abstract from Bulletin 620-A, U. S. Geological Survey, entitled 'A Gold-Platinum-Palladium Lode in Southern Nevada.'

cost of $136,772. The average cost of the dredging operations was 4.27c. per yard, including depreciation. The dredge on Butte creek began work on October 3, so that only three months are included in these figures.

A total of 3,241,641 cu. yd. was moved at the hydraulic mines. This produced $544,262, at a cost of $245,686. The working cost was 7.6c. per yard, exclusive of depreciation of the main ditch, a decrease of 2.1c. compared with 1913. The total water used amounted to 519,834 miner's inches, compared with 406,135 in 1913, a gain of over 25%. The duty of the water was 6.02 cu. yd. per inch.

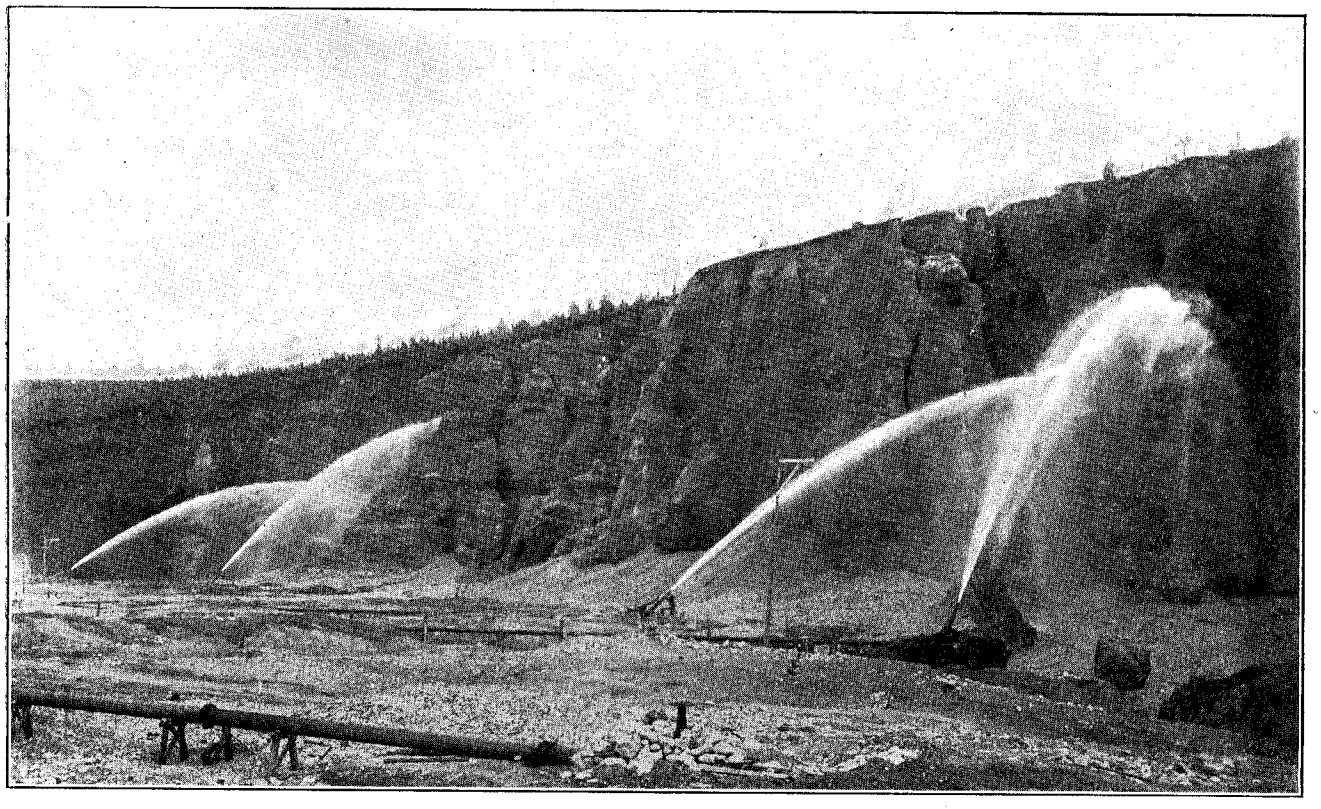
The Twelve-Mile water system was operated from May 8 to September 30, inclusive, a total of 146 days. The average daily delivery was 3561 miner's inches. The ditch was operated for 96.4% of the possible time. Severe frosts early in September caused considerable difficulty in keeping the ditch open, otherwise the system gave excellent service.

Leases on claims owned by the company in the Yukon and Iditarod carried under the head of 'lay operations,' yielded a total of $135,897, at a cost of $6525. As mentioned in the last report, expired leases, where they are in line of dredging, have not been renewed.

All operations yielded gold worth $4,345,046. Operating charges totaled $2,050,889. The net profit was $1,184,819. Dividends amounted to $1,050,000.

The "lay operations" mentioned in this report refers to an important feature of mining in the North. Small parties or partnerships of working miners will take a lease or 'lay' on an alluvial claim, paying the owner a royalty up to 50% on the gross output. For this rich tribute the claim-holder may have done nothing beyond locating the ground or having it located for him. In the case of a company like the Yukon Gold, the ground will have been purchased and the leasing of it means that it is not suitable for large-scale operations on company account.

The photograph of hydraulic mining on this page illustrates operations on the big alluvial deposit known as the White Channel, thus named on account of the preponderance of white quartz pebbles in the gravel. This is a mass of Pliocene drift, as much as 200 ft. thick, but much thicker before it was eroded. From this erosion the creeks of the Klondyke were enriched, more particularly Bonanza and Eldorado, famous during the great rush 17 years ago. Indeed, nearly all the gold of the present low-level valleys is of secondary origin and derived from the re-distribution of the older gravels. This applies also to the flats now being dredged so successfully. These flats are frozen to bedrock except where the live water of the present creeks passes, so that artificial thawing has been necessary. The cost of the thawing has been decreased gradually to one-half what it was, say, seven years ago, but it is still a heavy tax. To decrease this item, it is customary now to strip the moss and frozen mould covering the gravel, so as to expose it to the natural thaw under the sun during summer. In this way the gravel becomes loosened as much as 12 to 16 feet in a single season, as against the maximum penetration of the winter frost to 6 or 7 feet.



HYDRAULICKING THE WHITE CHANNEL DEPOSIT NEAR DAWSON.

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

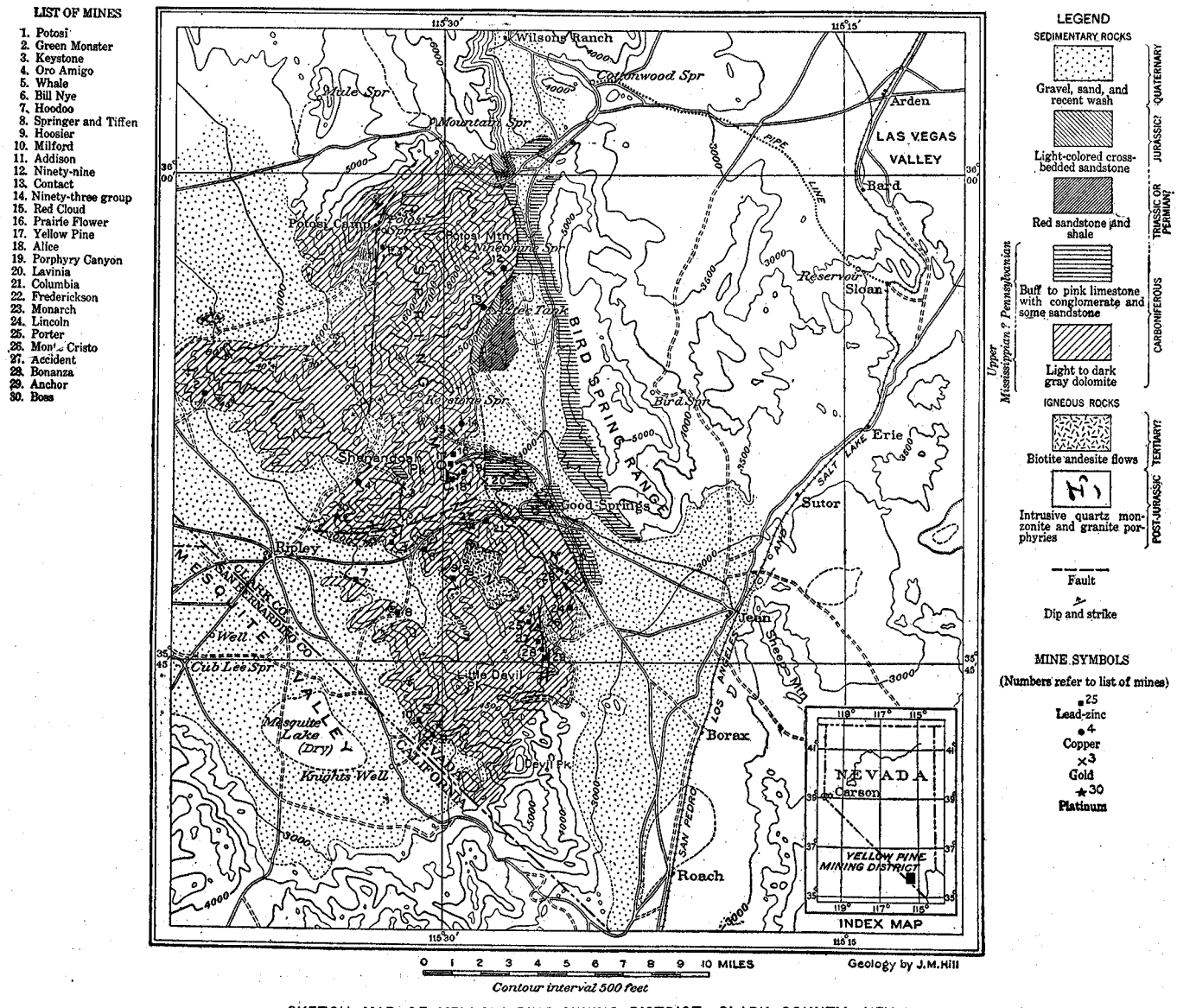
Gold deposits were formerly of some importance in this district, the Keystone mine, the most productive, being credited with an output of $1,000,000. At this mine the gold is disseminated through quartz-monzonite porphyry, which has been highly altered by the development of sericite and siderite. In 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 replacements. 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 cupro-descloizite, 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, in which the Boss mine is situated, is the most productive zinc and lead district in Nevada. In 1913 it yielded 29,060 tons of ore, containing $1268 in gold, 192,339 oz. silver, 283,592 lb. copper, 6,204,065 lb. lead, and 14,369,709 lb. zinc, valued in all at $1,239,081.

The 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



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

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 north. The structure is that of a broad anticlinal arch, whose crown has been 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 linear persistence occurs 600 ft. 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.

The orebodies so far developed are characterized by oxidized copper and gold-platinum-palladium. 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 ore consists of a fine-grained silicious matrix containing 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 is probably in excess of the platinum.

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

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

PLUMBOJAROSITE. A particularly rich shoot of ore has been developed by a winze sunk from a point near the end of the upper adit. In this shoot are small masses of what are locally known as greenish talc. 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. reports as follows: Gold, 111 oz.; platinum, 99.08 oz.; palladium, 16 oz. per 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 millimetre 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:

Fe_2O_3	31.80	CO_2	0.43
Al_2O_3	0.14	As_2O_5	0.09
SO_3	24.08	P_2O_5	trace
PbO	16.75	SiO_2	6.90
H_2O-	0.02	TiO_2	0.37
H_2O+	8.55	Au	0.79
CuO	1.97	Pt	0.05
Bi_2O_3	6.34	Pd	0.22
CaO	0.06	Ir	trace
MgO	0.14	Ag	trace
K_2O	0.22		
Na_2O	0.52		99.88

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

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 tailing, 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.

The pockets of plumbojarosite occur in a porous, fine-grained silicious gangue, which is a replacement of the dolomite. The pores and cavities evidently resulted from the leaching of sulphides; they are now partly filled with malachite in small botryoidal groups, or more commonly with powdery plumbojarosite.

The only sulphide-bearing ore exposed in the mine at the time of visit was in the sub-level below the upper adit. Here, in particularly tight ground, about 3 ft. of copper ore rich in chalcocite had been opened. An average sample of this ore, as reported by the management, showed copper 15.1% and platinum metals 0.40 oz., gold 0.13 oz., and silver 1.2 oz. per 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 silicious 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 micro-