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ELKO COUNTY

JARBIDGE DISTRICT

SALT LAKE MINING REVIEW

vol. 12, no. 8, p. 38, July 30, 1910. by Winthrop W. Fiske, M.E (reference - Bull 497)

Jarbridge continues to improve slowly and is steadily gaining in area of proven mineralized ground. The Riddle-Buys lease, on the North Star has 6' of \$12 ore in the lower tunnel. The Buster Co. is drifting on a spur vein. The Amazon Co. has the best looking portal in the camp. The Riddle-Corriigan lease on the Pavlak, is drifting on one vein and cross-cutting for the next one. The present vein has 7' of milling ore with spots of "picture ore." The "4-M" lease on Pavlak is taking out considerable milling ore and has a streak about $\frac{1}{2}$ " wide of \$5,000-\$10,000 ore. The Winkler strike on the Bluster claim continues to make the best showing thus far. The vein has been opened for about 8' wide and free gold can be seen in the quartz. The cross-cut tunnel on the Pavlak is entering a change of rock which indicates that it has a greater dip to the west with depth and it is believed that the tunnel will encounter the vein sooner than expected.

vol. 12, no. 10, p. 30, September 15, 1910.

The 4-M leasers have a carload of rich ore sacked ready to ship. They have been sinking on the vein for the past 2 weeks and have found more of the rich ore. The tunnel on the Good Luck is in about 30' and is all in ore, with spots of high grade. The latest strike was made recently in the Fifth Crater; a 5' vein with a streak of quartz on the hanging wall produces some very handsome specimens of free gold. Miners are developing the other mines in the district.

vol. 12, no. 12, p. 29, September 30, 1910.

The freight rate in and out of Jarbridge is $2\frac{1}{2}$ ¢ per pound and ore haulage per ton to the railroad is \$50/ton. The local ranchers are out to get what they can.

Besides the 4-M lease there are several other properties which have shipping ore: the Bluster, Rock Creek and Success claims; the Altitude, Windy and Victoria claims in the Second Crater; the Arkansas in the Third Crater, and the Windy Point in the Fifth Crater. The Good Luck tunnel is in about 50' running along the hanging wall of the vein.

The Amazon-Rainbow tunnel is in about 80'. The Pavlak tunnel is in about 380' and hasn't hit the vein as-yet. Work on other claims continues.

verage ore delivered to the concentrator carries 40 ounces of silver per ton, whereas the narrow ore seams, averaging 1.7 feet in width, usually carry 73 ounces per ton.

The mine and methods of sampling and estimating have been described in detail by Mishler and Budrow.¹⁰

The following notes on sampling are excerpts from this article:

In sampling development work, dilution in mining is accepted as unavoidable. Samples are cut over the full stoping width (3½ or 3 feet); if the vein is over stoping width the full vein is sampled. Each sample across the back is divided into as many samples as there are varieties of ore and waste, and the exact width of each is noted. Where the ore is rich and easily recognized underground, it is believed that this method gives a more dependable average assay than is possible when a single sample is cut across both ore and waste.

All drifts, raises, and winzes are sampled at 5-foot intervals. The samples are cut from the backs of the drifts and from alternate sides of the raises and winzes. The backs of stopes are sampled in the same manner wherever the chute samples show that the ore is lower than milling grade. In shrinkage stopes weekly samples are taken across the broken ore at 10-foot intervals. The width and distance from the end of the stope are recorded for each sample. The samples corresponding to the same distances are combined for the entire month and assayed. Grab samples, consisting of two double handfuls, are taken from each car of ore as it is loaded at the chute. Composites from important chutes are assayed daily. From chutes producing small tonnages and from development faces the samples are closely watched in order to maintain the grade of ore sent to the concentrator.

The following tabulation illustrates the accuracy of sampling. Odd-numbered samples were taken on one side of the drift and the even numbered on the other side. Samples were cut at 10-foot intervals.

Averages of alternate assays along Tigre vein

Level	Number of assays	Average of assays, ounces silver per ton		Error, per cent
		Odd numbers	Even numbers	
7-----	428	35.4	41.4	38.4
8-----	368	34.4	31.9	33.1
9-----	288	36.0	42.3	39.2
10-----	232	32.0	39.7	35.9
Total-----	1,316	34.7	38.6	36.6
				6.3

Grab sampling of cars shows an error of 9 per cent, the grab samples being high.

CRIPPLE CREEK DISTRICT, COLORADO

Jones¹¹ states that samples are taken by shift bosses. Streaks of ore are usually sampled together with a couple of grabs from the muck pile. Ore drawn from chutes is sampled by taking a handful from each car trammed. These grab samples will run 20 per cent higher in value than the settlement value of the ore.

¹⁰ Mishler, R. T., and Budrow, L. R., Methods of Mining and Ore Estimation at Lucky Tiger Mine; Trans. Am. Inst. Min. and Met. Eng., vol. 72, 1925, pp. 468-483.
¹¹ Jones, Fred, Mining Methods of the Cripple Creek District; Trans. Am. Inst. Min. and Met. Eng., vol. 72, 1925, pp. 512-517.

Park¹² has written of the sampling practice in this district as follows:

The wall rock is investigated by means of crosscuts and by holes drilled by ordinary drifting machines using extension bits. These holes may be quickly and cheaply drilled to depths of 50 or 60 feet and the sludge samples obtained show the presence of any values equally as well as the more expensive diamond-drill hole. Drifts driven on the vein are sampled at intervals of from 3 to 5 feet. The face is sampled in sections, usually three or more samples being taken in one cut across the width of the drift, one sample representing the main vein material and the other stringers or wall rock included in the opening. A further sample is taken of the muck removed from each round; this serves as a rough check on samples cut from the face.

MOGOLLON DISTRICT, NEW MEXICO

The gold-silver ore occurs in veins in igneous rocks in a gangue of quartz, calcite, wall-rock fragments, and some fluorite. Argentite and auriferous pyrite are the principal valuable minerals. In high-grade ore, native silver and free gold are often observed and frequently cerargyrite and bromyrite. According to Kidder¹³—

Underground samples are taken by trammers on each shift from every development face. Later, for purposes of preparing assay plans and estimating reserves, mull samples are cut, usually at intervals of 10 feet, and in spotted or ordinarily cut at intervals of 5 feet. In winzes and raises the samples are raised or "winze." Backs of stopes are cut at intervals of 5 feet, but on alternate sides. Successive slices of the samples are cut halfway between those on the previous slice.

In addition to the sampling of development faces for estimating the mineral content of ore bodies chute samples are taken, and the tonnage drawn from each chute is estimated by the number of cars trammed. The average assay in ounces of gold and silver is calculated for each chute at the end of the month. As the ore is trammed to the mill the cars are weighed, and a grab sample is taken from the top of each car and a composite sample made for each shift. At the end of the month the calculated average of the scale samples is checked against the chute samples taken underground and against the average mill rates, and tailings (production plus tails). On account of the slightly higher assay of the fines in the ore the average mine sample and the scale sample are usually slightly higher than the mill-head sample. The yearly average, however, seldom shows a variation of more than 10 per cent compared with the mill heads and generally agrees within 3 or 4 per cent. On spotty and high-grade ore the underground car samples are very unreliable. To be used at all, lots of ore after being sampled underground should be crushed and checked in a Snider, Venzin, or other automatic sampler.

¹² Park, John Furness, Mining Methods of Jarbridge District; Trans. Am. Inst. Min. and Met. Eng., vol. 72, 1925, pp. 518-528.
¹³ Kidder, S. J., Mining Methods in Mogollon District, New Mexico; Trans. Am. Inst. Min. and Met. Eng., vol. 72, 1925, pp. 529-549.

and value of the ore mined. These figures, obtained from stoped areas above and below an unstopped block of ore, are averaged, and the resulting factors are applied to the unstopped block.

LUCKY TIGER MINE, SONORA, MEXICO

Mishler and Budrow⁷ have described the methods of calculating ore reserves, and the following is abstracted from their paper.

The assays, figured to stoping width are plotted on longitudinal sections and plans drawn to a scale of 1 inch = 40 feet. Ore reserves are estimated as of January 1 and July 1 each year. Backs of old stopes are surveyed and plotted on the assay maps as of those dates. If the back has not been sampled, the average assays along the levels above and below are weighted inversely to their distance from the back, and the average thus obtained is taken as the assay value of the back. If all the assays surrounding a block represent stoping width, their arithmetical average is taken as the assay of the block. The tonnage is figured by multiplying the area of the block by the stoping width and dividing by a cubic-feet-per-ton factor of 11.5. When any of the assays around the block represent more than stoping width, the excess width must be considered in figuring the average assay and tonnage.

If blocks are developed on less than four sides, it is customary to figure that one extends 30 feet from the drifts and raises, or below the lowest level. The full assay value of each sample is employed. The modification of high assays is warranted when the estimates are based upon only a few samples, but when several thousand samples are available, abnormally high assays will be offset by abnormally low ones.

Over a period of 14 years the estimated ore reserves have averaged 340 ounces of silver per ton; the ore mined during the period averaged 37.1 ounces, an error of 3.1 ounces or 8.4 per cent.

JARBIDGE DISTRICT, NEVADA

According to Park,⁸ raises are put up in ore, usually about 100 feet apart. The blocks between these raises are estimated from the average assay value and cubical contents. The tonnage figure for the ore is 18 cubic feet per ton in place and 23 cubic feet broken. The estimated tonnage in a block is generally within 10 per cent of the actual amount and is always low because of dilution in mining. The estimated grade runs about 17 per cent higher than the true grade, and this factor is taken into account when reports are prepared on newly blocked-out territory.

MOGOLLON DISTRICT, NEW MEXICO

According to Kidder,⁹ stope maps on a scale of 1 inch equals 10 feet show the width and value of ore where each sample was cut as well as the tonnage and value of ore broken in the stope during each month. The average grade of ore is calculated from the foot-ounces of gold and foot-ounces of silver, allowing 13 cubic feet per ton of ore in place.

The sampling of the smaller blocks of ore generally checks closely with the tonnage and grade of ore produced, but the larger blocks are rarely sufficiently developed ahead of mining to permit more than rough estimates of their probable production. As stoping proceeds

⁷ Mishler, R. T., and Budrow, L. R., work cited.

⁸ Park, John, work cited.

⁹ Kidder, S. J., work cited.

and the width and grade are more clearly established it has been found that the monthly estimates of ore broken, when finally checked against the ore drawn, agree closely as to tonnage and grade. The ore drawn, however, commonly exceeds the estimates of tonnage, while the grade of ore drawn will be correspondingly less.

CONSOLIDATED CORTEZ MINE, CORTEZ, NEV.

At Cortez, Nev., silver ore occurs principally in fissure veins and the ore bodies are irregular in dimensions and in grade. Hezzelwood¹⁰ states that these conditions have been responsible for evolution of the following practice:

The usual methods of blocking out the ore by measuring and sampling in making estimates of ore reserves has been found unreliable at the Cortez mine. The tendency of the ore to narrow or widen and the grade to change without apparent reason makes such methods inaccurate. A ratio between the number of feet of development work and the number of tons mined has been worked out for the operations on the lower levels which were started in 1926. This ratio furnishes a basis for estimating probable ore, particularly when development work is confined to the three known zones. This method of estimating, although not accurate, is probably as safe as any method for this form of ore deposit.

COPPER MINES

HUMBOLDT MINE, MORENCI, ARIZ.

Mosier and Sherman¹¹ write briefly regarding estimating practice as follows:

For the estimation of ore reserves a full knowledge of the ore deposits must be obtained. Caving stopes have reasonably regular outlines, and selective mining is therefore not practicable by this method.

Some material of a grade that will not pay to reduce must be mined, and some good ore on the boundaries must be left because its inclusion would bring in too much waste. The side boundaries, which are vertical or nearly vertical, are drawn as compromise planes to inclose as much ore as possible without too much waste.

Except for preliminary estimates, the volume of material within the stope cutting level, (2) the shrinkage side outlines, and (3) the leached gossan or a stope above as the case may be. Within these boundaries the grade of ore in place is calculated by combining assays in a rational manner.

RAY MINES, RAY, ARIZ.

The following is quoted from Thomas:¹²

In chum drilling, samples were obtained by the use of a split divider. A careful record was kept of the type of material being drilled through, the color of the sludge and the character of its various mineral constituents, the weight of material cut for each 5 feet of drilling, the size of bit, and the length and size of the casing in the hole. From the weight of the sample and the size of the bit it was possible to determine whether there was caving in the hole and to thus arrive at some conclusion as to the accuracy of each 5-foot sample. The samples were assayed locally by the iodide method, and the remainder of the pulp was sent away for determination of the copper by the electrolytic method.

¹⁰ Hezzelwood, George W., Mining Methods and Costs at the Consolidated Cortez Silver Mine, Cortez, Nev.; Inf. Circ. 6327, Bureau of Mines, 1930, p. 4.

¹¹ Mosier, McHenry, and Sherman, Gerald, work cited.

¹² Thomas, Robert W., work cited.

TABLE 6.—*Typical test-hole drilling data*

Mine or district and State	Kind of rock	Type of drill ¹	Depth of holes, feet	Feet per drill-shift	Purpose of drilling	Results reported	Cost per foot	
							Labor	Total
Burra-Burra, Tennessee	Schists, graywacke, massive sulphide.	A	Up to 150	25	Outlining ore body.	Satisfactory; best on inclination +15° or over.		\$0.80
Acme, Tri-State	Cherty limestone	A			Prospecting walls.	Cuttings useful indicator, assays unreliable.	.64	
Do.					Testing bottoms.	Reliable samples.	.57	
Ray, Ariz.	Schist	B	17		Prospecting instead of raising +45°.	Satisfactory.		
No. 1, Menominee range, Michigan.	Hematite and iron formation.	A	Max. 90	23	Testing walls.	Good in soft ore; poor in hard chert.		
Morning, Idaho	Quartzite	A	{ Ave. 46 Max. 129 }	2 12	Testing vein walls.	Satisfactory.	\$0.92	1.10
Mascot, Tenn.	Dolomitic limestone	D			Sampling stope backs.	do.		
Cananea, Mexico	Porphyry and hard limestone.	A	{35 to 125 (Ave. 85)}	18 1/2	Flat holes to delimit ore bodies.	do.		
Engels, California	Diorite	D	7.7		Cuttings from 2 or 3 stope holes daily for samples.	do.		
Park-Utah, Utah	Quartzite	A	Max. 88		Prospecting 2 holes only.	Unsatisfactory; steel failed.		
Pilaras, Mexico	Brecciated volcanics	E			Sampling.	Satisfactory.		
Teck-Hughes, Ontario	Silicified syenite and porphyry, hard.	D	5		Testing vein walls every 10 feet.	Satisfactory; assays not used in reserve estimates.		
Fierro, N. Mex.	Hard magnetite and limestone.	F	20		Prospecting ahead. Assays used in grade estimates.	Very satisfactory.		
Do.	do.	A		8.84	Prospecting.	More costly, less accurate than diamond drilling.	1.217	2.821
Pecos, N. Mex.	Schist and diorite.	A	50 to 100		Prospecting for parallel ore bodies.	Satisfactory.	1.26	1.98
Black Rock, Butte, Mont.	Granite	A			Prospecting. Not now used.	Holes salted by soft-ore streaks.		
Page, Idaho	Quartzite	A			Prospecting walls. Not now used.	Not reliable for grade of ore.		
Spring Hill, Mont.	Hard contact met. ore and rocks.	A	Max. 35		Exploring to contact.	Limited range. Slow and costly in hard rock.		
Eagle - Picher lead, Oklahoma. ³	Chert and limestone	A	Max. 148		Exploration.	Unsatisfactory in hard rock.		
Evans-Wallower lead, Oklahoma. ³	do.	A			do.	Good ore found. Valuable for negative information.	1.69	
Federal M. & S. Co., Kansas ³	do.	A	Max. 147		do.	Eliminated much ground thought ore bearing.	1.00	
Canam Metals, Oklahoma ³	do.	A			do.	Located many new ore bodies.	1.90	
					do.	Several ore bodies found.	1.70	
						Cheaper than other methods.		

Missouri-Kansas Zinc Corporation.	Chert and limestone	A	Max. 152		Exploration often at steep plus angles.	Very satisfactory.		60-70
New Idria, California	Shale, sandstone, serpentine.	A	{ Ave. 99 Max. 228 }	30	Exploration.	do.		.75
Chief Consolidated, Utah ⁴	Limestone and ore	A	Max. 272	23	do.	do.	.44	.97
Southeast Missouri ⁵	Limestone	A	35 to 78	35	do.	75 holes drilled; satisfactory.	7.16	
Do	do.	C	Max. 22		Testing backs, floors, and walls.	Satisfactory.		
Tonopah, Belmont, Nevada. ⁶	Volcanics	A	Max. 256	34	Exploration, sampling walls.	Good.	(?)	
Jarbridge, Nevada ¹⁰	Zinc ore in dolomite	A	50 to 60		Exploration.	As good as diamond drills and cheaper.		
Edwards, N. Y.		A	Ave. 43		Testing walls.	25 per cent deducted from assays.	.99	

¹A, Heavy drifter with special independent rotation; B, piston machine on tripod; C, jack hammer with pneumatic feed; D, standard medium weight drifter; E, stoppers; F, jack hammer.

² For holes up to 100 feet deep.

³ Netzeband, W. F., Prospecting, with the Long-Hole Drill in the Tri-State Zinc-Lead District: Min. and Met., June, 1930, pp. 295-296.

⁴ Dobbel, Chas. A., Deep-Hole Prospecting at the Chief Consolidated Mines: Trans. Am. Inst. Min. and Met. Eng., vol. 72, 1925, pp. 677-689.

⁵ Year 1924.

⁶ Poston, Roy H., Leyner Drill in Underground Prospecting: Eng. and Min. Jour., vol. 118, Nov. 29, 1924, pp. 856-857.

⁷ Approximate.

⁸ Brown, R. K., Exploratory Deep-Hole Drilling: Comp. Air Mag., April, 1926, pp. 1593-1594.

¹⁰ Park, John Furness, Mining Methods in Jarbridge District: Trans. Am. Inst. Min. and Met. Eng., vol. 72, 1925, pp. 518-528.

mining the average grade of large tonnages of ore in place. It can not be argued from the law of averages that improper methods or carelessness will result in compensation of errors in individual samples if a large number of samples is taken, for in that event the errors will usually be cumulative in one direction or the other rather than compensating.

Even in ores in which the valuable minerals are uniformly distributed and with the most careful sampling, samples may consistently run higher or lower than the ore. One frequent cause of this is the difference in hardness or friability between the ore and the gangue minerals. At a given property experience factors can often be determined which, when applied to the sample assays, will give a correct estimate of the grade of the ore where samples run consistently high or low.

SUMMARY OF UNDERGROUND SAMPLING PRACTICE

Table 7 summarizes data on underground sampling practice by various methods under different conditions. These data are taken from previous publications in some instances and from special communications in others. Data on accuracy of sampling are not as voluminous as desired, but such figures as are available are believed worthy of tabulation.

District or mine and State	Character of ore	Sampling method	Indicated accuracy of sampling
GOOD AND SILVER			
Argonaut, Calif.	Gold in quartz, assuure vein.	Drill cuttings and grab samples; visual inspection.	Not reliable as to grade or ore.
Spring Hill, Mont.	Gold in quartz and sulfides; contact metamorphic deposit.	Chiley channelling.	Gold in quartz and sulfides in lenses in schist.
Mine 1	\$6 average value.	do.	Gold in quartz and sulfides in lenses in schist.
Mine 2	do.	do.	Channel samples and grab samples. Average grade .39.
Mine 3	do.	do.	Channel samples and grab samples from cars.
Kirkland Lake district, Ontario:	Gold in quartz, some tellurides and sulfides	Average grade .88.	Recoveries plus tailings loss.
Trek-Hughes	Gold in quartz zone in syenite porphyry and lamprophyre.	Channel samples and slides of drifts.	The average of channel samples usually about 10 per cent less than mill recoveries plus tailings loss.
Wright-Hargraves	Gold in quartz zone in syenite porphyry and lamprophyre.	Pick samples, each band in face sampled separately.	Pick samples to determine headages to mill samples.
Alaska-Juneau	Gold in ramifying quartz stringers in slate and metagabbro. Average ore \$0.89.	Gold with sulfides and quartz in dikes.	Settions 1. - Mill samples \$0.49, mill heads \$1.02, error +63.7 per cent. Mill samples \$0.93, mill heads \$0.99, error +5.4 per cent. Mill samples \$0.93, mill heads \$1.57, error +5.4 per cent. Mill samples \$0.93, mill heads \$2.33, error +4 per cent. Mill samples \$0.93, mill heads \$2.47, error +21.4 per cent.
Treadwell mine	Gold with sulfides and quartz in dikes.	Muck samples.	Settions 1. - Mill samples \$0.49, mill heads \$1.02, error +63.7 per cent. Mill samples \$0.93, mill heads \$1.57, error +5.4 per cent. Mill samples \$0.93, mill heads \$2.33, error +4 per cent. Mill samples \$0.93, mill heads \$2.47, error +21.4 per cent.
700 mine	do.	do.	Average 14 years, \$2.20, mill heads \$2.88, error +5.6 per cent.
Mexican mine	do.	do.	Average 16 years, \$2.28, mill heads \$2.83, error +5.6 per cent.
Ready Bullion mine	do.	do.	Average 17 years, \$2.20, mill heads \$2.83, error +5.6 per cent.
Mother Lode, California	Gold-quartz veins in states and greenstones.	Hand pick, 5 to 10 pound samples for sampling development.	Hand samples generally 20 per cent high.
Homestake mine, South Dakota	Gold-quartz replacements in folded dolomite beds.	Hand pick, 5 to 10 pound samples for sampling development.	Hand samples generally 20 per cent high.
Cripple Creek district, Colorado	Gold-quartz replacements in veins in tufts, breeches, and cardines.	Long holes for exploration.	Long holes for exploration.
Jarbridge district, Nevada	Native gold and silver; quartz veins in volcanic rocks.	Gold samples from chutes.	Gold samples from chutes.

TABLE 7.—Summary of underground sampling practice