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SR-7

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A BRIEF HISTORY AND REVIEW OF ORE GRADES AND PRODUCTION IN THE TOMBSTONE MINING DISTRICT WITH EMPHASIS ON THE CONTENTION MINE AREA

BY

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June 1984

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PREFACE

Accelerated interest in precious-metal occurrences in Arizona prompted the review of production records of the Tombstone mining district. The Tombstone area was, and continues to be, the largest producer of primary silver in the state. A significant amount of "by-product" gold has also been produced. At present two producing companies are active in the district.

This report represents an attempt to gather data from several sources and tabulate the annual production of each mine, beginning with the Tough Nut in 1879. The production tables generally give the tons of ore, or other material, treated and the amount of precious and base metals recovered. Based on this information, average (recovered) grades have been calculated and added to the tables.

Two final compilations of the annual grade of gold and annual grade of silver are given for each mine at the end of the report. Since the earliest precious-metal production was reported as doré or precious-metal bullion, with no separation of silver and gold, the amount of silver produced during the early years and the corresponding silver grade are exaggerated. Gold is included with the silver in these early production and grade figures.

The strongest zone of metallization exploited in the Tombstone district was the Contention-Head Center-Grand Central area. Although this zone is emphasized in this report, production figures and calculated ore grades are tabulated for most of the other major district mines. The western-most deposits are not discussed.

This report should be viewed as a base of information that can be expanded and improved as more data is obtained. The interested reader is encouraged to review individual mine files, maintained by the Department, for other engineering and geologic reports.

Attached are tables of production of the Tombstone mining district and tables showing yearly precious metal grades of ore treated. The grades are based on recovered metal only. Silver production figures for the earliest years were obtained from U.S. Bureau of Mines data. These "silver" figures probably represent troy ounces of precious metal bullion, or doré, containing both silver and gold, shipped to the U.S. Mint for refining. Whenever gold production is not shown, therefore, it may be generally assumed the amount of silver and the recovered grade of silver are erroneously high.

Although the production figures are not complete, they probably do represent some 90 to 95 percent of the total ore produced from the heart of the district. Much of the production since the early 1930's is not tabulated because it has not been segregated according to mine or operating entity. This later production includes that of the Tombstone Development Co., the Tombstone Mining Co., and other companies and leaseholders. In addition to the production-grade tables, there are several smaller tables showing metal produced from non-ore sources such as mill tailings and smelter slag.

The Contention--Head Center--Grand Central area is the strongest metallized zone exploited in the district. Since startup in 1880, production from this zone was nearly continuous for about fifty years, and intermittent for another twenty-five years. Recently, significant production from this zone is attributed to the mining and heap leaching operation of Tombstone Exploration, Inc.

The Contention--Grand Central ore zone is about 3,300 feet long. Within this zone the richest ore bodies occurred between the surface and the

fourth level. Generally, the rock was soft and the mining costs were low (Butler and others, 1938, p. 69-70).

Development of the Contention, Head Center, and Grand Central mines was rapid during the earliest years. By July, 1881, mine workings had reached the water table at a depth of 560 feet. Although ore extended at least 100 feet below the water, pumping was not sufficient to allow extensive drifting or stoping in this region. Fire destroyed the hoist house and pumping facility at the Grand Central mine in 1886 and later that year the Contention works were also destroyed.

Much of the production by the Grand Central Mining Co. from 1884 to 1888 was actually from the Emerald mine. The Emerald is approximately 4,000 feet to the southwest of the Grand Central shaft. Like the Contention--Grand Central deposits, the Emerald is associated with a north-trending fissure.

Between startup and 1887, the Contention, Grand Central (and Emerald), and Head Center mines had reportedly treated 272,545 tons of ore, yielding 10,969,929 ounces of silver and 6,092 ounces of gold. Using these figures, the recovered grades were about 40.25 oz Ag/ton and 0.022 oz Au/ton.

Although usually not specific, early written accounts of ore grade in the district suggest that gold assays were significantly higher than 0.022 oz/ton. Church (1903, p. 34) states the proportion of gold was 0.827%, by weight, of the precious metals (district-wide) and the Contention--Grand Central zone produced about 1 ounce gold to 80 ounces silver. Extraction rates for near-surface, or chloride ores throughout the district were about 85% silver and 45% gold (Church, 1887, p. 602).

Combining all silver (doré) and gold reported from the Contention--Grand Central zone, between 1880 and 1887, gives a total of 10,976,021

ounces of bullion. Assuming an original ratio of 80 ounces of silver to one ounce of gold in the ore and recoveries of 85% and 45% respectively, there would be approximately 84.51% of the available precious metal extracted. The total amount of gold and silver in the ore, therefore, may have been about 12,987,836 ounces.

Applying the 80:1 ratio to the total precious metal content indicates 12,825,488 ounces of silver and 162,348 ounces of gold were sent, in 272,545 tons of ore, to the company mills. The tenor of the ore, therefore, may have been about 47.06 oz Ag/ton and 0.596 oz Au/ton. It should be emphasized that several assumptions have been made in deriving these figures. The ore grades, though reasonable approximations, may not be completely accurate.

During the period, 1899-1914, most of the district mines were operated by lessees or by the Tombstone Consolidated Mines Co. Individual mine production is not given in the records studied. A majority of the ore produced, however, probably came from the Contention--Grand Central area. Certainly the bulk of the production originated above the water table even though significant development was made down to the 1,000-foot level during the more successful years of dewatering. The average recovered grade was 10.90 oz Ag/ton and 0.140 oz Au/ton. The silver to gold ratio (recovered) was approximately 79:1.

Between 1915 to 1918 the Bunker Hill Mines Company, a subsidiary of the Phelps Dodge Corp., operated the defunct Tombstone Consolidated Mines property. On April 1, 1918, the property was turned over to lessees. The mines were managed in this manner until the end of 1931.

Undoubtedly numerous mines throughout the district frequently contributed to the total production credited to Bunker Hill Mines. As many as 60 lessees operated the company mines in one year. In general, therefore, no specific sources of ore have been identified with the exception of that mined during 1930 which, according to a Phelps Dodge annual report, came chiefly from the Contention--Head Center area, a "high" gold zone. The recovered grade, 0.274 oz Au/ton, that year was the highest on the company property since 1916. No ore was produced from below the water table during the Bunker Hill Mines management.

Several observations taken from the literature may be made concerning the changes in character of the ore, grade, and precious metal ratios occurring with depth in the Contention--Grand Central ore zone. No attempt is made to predict actual grades of mineralization remaining in the ground.

Ore occurs (1) in the faulted segments of the Contention dike, (2) in brecciated footwall zones of these segments, and (3) in limestone beds of the shaley Bisbee Group. Where the dike is in place and unfaulted, very little ore has been found (Butler and others, 1938, p. 70). In general, the ore bodies appear to be genetically related to northeast fissures. Though not well documented, Church (1903) shows that some of the deposits in the Contention--Grand Central zone are associated with anticilinal flexures in the sediments.

The ore of the upper levels of the zone was rich in silver, gold, and lead. Most of this ore was strongly oxidized. Church (1887, p. 601) describes the mineral suite as one comprised chiefly of horn silver (probably also bromyrite--AgBr) enclosed in a gangue of quartz, iron and manganese oxides, with lead carbonate and some sulfides of silver, iron, copper, lead and zinc. Gold occurred in the native form as well as in various sulfide

minerals where, according to Butler and others (1938, p. 51), it may be present as a telluride.

With increasing depth in the mines, the proportion of silver sulfide increased and the silver haloid decreased. Fissure-veins usually had a higher gold value than the anticlinal deposits, and Church (1903, p. 34-35) believed that the gold content increased with depth in all occurrences. He reports an anticlinal deposit located in the Contention mine that was drifted on 90 feet below the water table. The drift, 140 feet long, assayed more than 4.8 ounces per ton in gold. It is not known if this deposit was chiefly oxide or sulfide in character.

Only very general comments may be made concerning distribution trends of other metals. Lead is widely distributed but its presence does not necessarily indicate high silver values. It is generally low in deposits that are high in manganese.

Distribution of copper and zinc is not well known. Copper appears to be most abundant in and near strong northeast fissures, according to Butler and others (1938, p. 104), and the largest body of copper ore probably occurred deep (9th level?) in the Emerald mine. The largest deposit of zinc ore was probably mined in the Silver Thread area north of the Contention--Grand Central zone.

Although manganese is widely distributed it is most abundant on the margins of the more productive parts of the district. The Prompter fault area, south of the Contention--Grand Central ore zone and between this zone and the Emerald mine, is noted for its manganiferous silver occurrences. The Bunker Hill--Rattlesnake property, south of the Grand Central mine and associated with the Prompter fault, had abundant manganese ore. High gold areas generally carry small amounts of manganese.

For the most part oxidation has improved the grade of the ores, and oxidation is known to extend below water level. The water table may have been lower at some time before the Tombstone district was discovered. The deeper ores, however, are generally less altered and Butler and others (1938, p. 107) suggest the probability that the deeper ore, on the average, will be of lower grade than that above the water level.

SELECTED REFERENCES

Austin, W.L., 1883, Silver Milling in Arizona: Trans. AIME, v. 11, p. 91-106.

Blake, W.P., 1882, The Geology and Views of Tombstone, Arizona: Trans. AIME, v. 10, p. 334-345.

Butler, B.S., Wilson, E.D., and Rasor, C.A., 1938, Geology and Ore Deposits of the Tombstone District, Arizona: Az. Bur. Mines Bull. 143, 114 p.

Church, J.A., 1887, Concentration and Smelting at Tombstone, Arizona: Trans. AIME, v. 15, p. 601-613.

Church, J.A., 1903, The Tombstone, Arizona, Mining District: Trans. AIME, v. 33, p. 3-37.

Goodale, C.W., 1889, The Occurrence and Treatment of the Argentiferous Manganese Ores of Tombstone District, Arizona: Trans. AIME, v. 17, p. 767-777.

Staunton, W.F., Personal Papers, Special Collections, Univ. of Az.

Tenney, J.B., 1927-29, History of Mining in Arizona: Unpublished manuscript, Special Collections, Univ. of Az., 401 p.

ORE

Contention	Tons	oz Ag	oz Au	lbs Cu	lbs Pb	lbs Zn	Reference
1880	15,000	1,055,630					USBM
81	20,000	1,317,848					"
82	22,390	1,474,160					"
83	26,107	890,050					"
84	8,720	297,300					"
85	6,035	205,733					"
1910	1,640	42,976		9,222	125,312		"
11	5,265	150,119	1,313	45,479	694,563		"
1928	16	64	1	74	1,211		"
	105,173	5,433,880	1,314	54,775	819,875		
Average		51.67	0.012	0.03%	0.39%		
Grand Central							
1881	18,000	929,978					USBM
82	34,180	1,191,947					"
83	29,240	769,840					"
84	16,560	465,930					"
85	22,650	596,334					"
86	20,675	500,000					"
87	14,500	518,360	4,777				J B Tenney
88		(212,766)					"
1917	74			11,862			USBM
29	45	510	1	182			"
1956	15	9		200	2,400		"
	155,939	5,185,674	4,778	12,244	2,400		
Average		31.89	0.031	0.004%	0.0008%		
Head Center							
1881	5,878	169,487					USBM
82	3,800	109,718					"
83	1,200	48,650					"
84	555	22,520					"
1893-96 (?)							J B Tenney
	11,433	350,375					
Average		30.65					

Feb. '84

MISCELLANEOUS

Contention	Material	Tons	oz Ag	oz Au	lbs Cu	lbs Pb	lbs Zn	Reference
1940	AuAg tails	1,337	4,533	94	4,950			USBM
Average			3.39	0.070	0.19%			
Grand Central								
1924	Pb tails	15,000	30,000	484	15,000	1,000,000		J B Tenney
25	Pb tails	10,575	37,463	506	17,344	1,170,286		"
1926	Pb tails	25,923	44,146	543	17,304	1,104,160		"
		51,498	111,609	1,533	49,648	3,274,446		
Average			2.17	0.030	0.05%	3.18%		

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ORE

Tough Nut	Tons	oz Ag	oz Au	lbs Cu	lbs Pb	lbs Zn	Reference
1879	5,210	213,875					USBM
1880	19,350	794,298					"
81	33,435	1,372,572					"
82	30,800	1,263,942					"
83	16,322	550,526	2,918		747,200		"
1892	1,102	97,455	603		248,956		W F Staunton
93	2,096	116,201	1,289		541,208		"
94	1,671	105,014	1,687		582,731		"
1935	1,833	36,079	643	22,000	340,000		USBM
36	1,747	28,820	445	10,850	135,200		"
53	65	1,927	20	440	3,560		"
1957	565	6,994	98	3,220	60,000		"
	114,196	4,587,703	7,703	36,510	2,658,855		
Average		40.17	0.067	0.02%	1.16%		

Vizina							
1880	1,906	40,543					USBM
81	2,725	57,941					"
1886-88(?)							J B Tenney
	4,631	98,484					
Average		21.27					

Way Up							
1883	550	5,631					J B Tenney
Average		10.24					

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ORE

Lucky Cuss	Tons	oz Ag	oz Au	lbs Cu	lbs Pb	lbs Zn	Reference
1888	2,566	107,979	1,519		68,501		W F Staunton
89	687	25,707	356				"
1890	2,488	110,954	1,162		61,193		"
91	2,271	124,682	1,682		145,313		"
92	2,684	116,973	1,254		280,606		"
93	3,729	93,802	431		193,328		"
1894	31	1,708	52		1,283		"
	14,456	581,805	6,456		750,224		
Average		40.25	0.447		2.59%		
		[90Ag : 1Au]					

West Side							
1888	481	40,674	893		70,298		W F Staunton
89	151	12,664	241		13,980		"
1890	500	42,411	966		44,828		"
91	1,105	81,005	1,527		316,136		"
92	1,490	99,026	1,689		318,912		"
93	1,184	57,548	971		179,659		"
1894	246	14,362	279		66,383		"
	5,157	347,690	6,566		1,010,196		
Average		67.42	1.273		9.79%		
		[53Ag : 1Au]					

Northwest							
1890	274	23,895	39		58,674		W F Staunton
91	458	30,751	99		116,836		"
92	1,413	124,062	501		262,407		"
93	1,427	124,253	257		288,990		"
1894	310	29,730	2		51,960		"
	3,882	332,691	898		778,867		
Average		85.70	0.231		10.03%		
		[370Ag : 1Au]					

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ORE

Good Enough	Tons	oz Ag	oz Au	lbs Cu	lbs Pb	lbs Zn	Reference
1884	10,610	357,951	1,875				USBM
85	11,900	401,630	111		1,108,600		"
86	12,000	400,000					"
87	11,750	396,139	1,713		451,500		"
88	9,500	319,150					"
89				SHUT DOWN			J B Tenney
1890	20,000	571,430					USBM
91	16,500	465,647	3,861				"
92	19,600	563,218					"
93	19,500	517,240					"
94	13,600	471,900					"
95	14,300	461,540					"
1896	15,000	441,175					"
1913	187	27		14,503			
	174,447	5,367,047	7,559	14,503	1,560,100		
Average		30.77	0.043	0.004%	0.45%		

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MISCELLANEOUS

	Tons	oz Ag	oz Au	lbs Cu	lbs Pb	lbs Zn	Reference
Tombstone Mill & Mining Assay Office Dump							
1891	17	899	9		2,476		W F Staunton
Average		52.88	0.529		7.28%		
Tombstone Mill & Mining Charleston Slag Dump Cleanings							
1891	42	2,590	24		6,066		W F Staunton
92	323	22,090	152		86,469		"
93	17	362	3		1,824		"
	382	25,042	179		94,359		
Average		65.55	0.469		12.35%		

ORE

Bob Ingersol	Tons	oz Ag	oz Au	lbs Cu	lbs Pb	lbs Zn	Reference
1881		(13,274)					J B Tenney
82(?)							"
1883	950	23,874					"
1884(?)							"
1922	190	2,899	14	2,069	8,530		USBM
23	220	3,166	22	1,158	12,433		"
29	51	270	2	257			"
1930	379	16,121	124	3,181	118,996		"
31	293	10,051	137	2,697	73,739		"
1932	226	6,766	79	2,327	13,695		"
	2,309	76,421	378	11,689	227,393		
Average		27.35	0.164	0.25%	4.92%		

Herchel							
1903-04(?)							J B Tenney
1905	1,800	90,000			900,000		USBM
06	367	30,276	170		13,680		"
07	201	25,934	174	3,045	19,075		"
08	955	54,440	292	7,461	45,761		"
1910	2,636	41,768	551	10,282	60,424		"
11	2,701	50,886	640	10,060	120,165		"
13	77	1,257	15		3,285		"
19	80	2,098	9	340	1,796		"
1920	27	1,126	9	582			"
1933	280	5,292	42	300	1,200		"
34	597	5,492	36	279	1,134		"
1935	680	652	4	328	750		"
	10,401	309,221	1,942	32,677	1,167,270		
Average		29.73	0.187	0.16%	5.61%		

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MISCELLANEOUS

Herschel	Material	Tons	oz Ag	oz Au	lbs Cu	lbs Pb	lbs Zn	Reference
1919	Ag tails	777	5,781	34	2,998			USBM
Average			7.44	0.044	0.19%			

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ORE

Old Guard	Tons	oz Ag	oz Au	lbs Cu	lbs Pb	lbs Zn	Reference
1903-04 (?)							J B Tenney
1905	320	16,000			160,000		USBM
1910	381	18,877		54,086			"
11	63	1,348	26	504	6,549		"
14	154	2,736	32	240	4,476		"
15	105	291	33	580	599		"
16	168	1,928	21		1,033		"
17	52	24	18	494	7,684		"
1920	69	1,900	30	320	6,912		"
22	383	4,155	46				"
23	65	830	17				"
26	376	4,938	72	2,158	4,422		"
27	262	2,051	38	1,700			"
28	107	1,074	19	806			"
1929	32	704	11	381	592		"
1933	52	751	13	359	724		"
34	67	1,499	19	279	1,026		"
1935	40	434	6	161	554		"
	2,696	59,540	401	62,068	194,571		
Average		22.08	0.149	1.15%	3.61%		

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ORE

Oregon	Tons	oz Ag	oz Au	lbs Cu	lbs Pb	lbs Zn	Reference
1882	4,450	223,300					USBM
83	2,250	128,245					"
84	1,210	60,520					"
1885-90(?)							J B Tenney
1891	185	6,530					USBM
	8,095	417,595					
Average		51.59					
Bunker Hill							
1883	1,980	88,297					J B Tenney
88(?)							"
89	7,000	230,000					USBM
1890-92(?)							J B Tenney
1903	100	7,500	10	12,000	66,000		USBM
1910	450	6,541	15	4,856	48,718		"
	9,530	332,338	25	16,856	114,718		
Average		34.87	0.003	0.09%	0.60%		
San Diego							
1883	415	10,698					J B Tenney
1918(?)							"
1934	80	323	3	306	11,715		USBM
1943	60	34			1,833		"
	555	11,055	3	306	13,548		
Average		19.92	0.005	0.03%	1.22%		

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Tombstone Consolidated	Tons	oz Ag	oz Au	lbs Cu	lbs Pb	lbs Zn	Reference
1899-1902	967	105,077	1,062		190,869		W F Staunton
1903	11,295	189,744	3,750		291,972		"
04	35,720	491,871	8,140		699,174		"
05	31,508	420,712	6,523		1,748,887		"
06	67,121	586,804	7,143		2,142,748		"
07	71,477	506,455	5,818	10,780	2,509,215		J B Tenney
08	51,266	357,414	4,106	7,608	1,770,794	173,313	"
09	27,123	201,700	2,280	27,706	1,535,637	713,716	"
1910	5,249	116,520	1,062	31,163	305,876		"
11	8,797	224,098	2,155	68,209	982,010		"
12	7,405	158,377	1,363	27,723	617,820		"
13	5,760	126,392	1,230	10,657	334,923	36,503	"
1914	6,093	108,868	1,380	14,217	234,345	39,324	"
	329,781	3,594,032	46,012	198,063	13,364,270	962,856	
Average		10.90	0.140	0.03%	2.03%	0.15%	

Bunker Hill Mines (PD)							
1915	9,003	100,115	1,216	36,075	164,135	63,386	J B Tenney
16	57,200	435,931	3,950	131,546	983,983		"
17	42,837	330,354	3,119	142,482	1,278,754		"
18	19,507	283,412	1,389	41,503	457,183		"
19	27,445	450,366	1,946	209,182	289,424		"
1920	28,980	446,721	1,788	144,010	243,946		"
21	18,594	409,234	1,503	132,688	678,946		"
22	44,347	613,700	2,322	196,740	744,529		"
23	32,770	495,943	3,093	195,485	465,914		"
24	15,448	247,642	2,459	72,836	465,323		"
25	17,185	203,918	2,171	57,996	356,733	32,592	"
26	21,785	176,433	2,446	96,172	866,826		"
27	9,831	95,688	2,169	36,098	134,240		USBM
28	21,452	151,400	2,200	1,316,373	155,840		"
29	6,947	60,569	1,082	27,180	135,425		"
1930	5,570	35,061	1,528	780	42,440		"
1931	5,728	52,051	1,384	21,564	3,407		"
	384,629	4,588,538	35,764	2,858,710	7,467,048	95,978	
Average		11.93	0.093	0.37%	0.97%	0.01%	

Feb. '84

MISCELLANEOUS

Bunker Hill Mines (PD)	Material	Tons	oz Ag	oz Au	lbs Cu	lbs Pb	lbs Zn	Reference
1917	Ag tails	14,637	113,785	254	87,006			J B Tenney
18	AgMn tails	3,952	34,971	2	5,526			Phelps Dodge
19	AgMn tails	1,117	5,853	31				"
1920	Mn tails	2,027	10,134	54				"
26	Ag tails	376	3,292		4,148	28,589		USBM
27	Pb tails	11,460	18,667	201	1,000	70,300		"
28	Pb tails	2,500	2,762	51	1,202	71,755		"
1929	Pb tails	8,155	35,331	570	48,434	695,098		"
1931	Pb tails	9,139	32,746	635	37,221	190,687		"
Tombstone Development Co. (?)								
1932	AuAg tails	2,286	7,118	131	12,765	42,730		USBM
		55,649	264,659	1,929	197,302	1,099,159		
Average			4.76	0.035	0.18%	0.99%		
71 Minerals								
1974	Dump	5,000	2,240					USBM
75	"	293,276	60,436	2,591				"
76	"	940,000	124,700	3,661				"
1977		-	77,000	1,900				"
		1,238,276	187,376	8,152				
Average			0.15	0.007				

Feb. '84

ORE

Tombstone Extension	Tons	oz Ag	oz Au	lbs Cu	lbs Pb	lbs Zn	Reference
1930	2,760	21,997	205		887,952		B S Butler
31	5,801	5,801	44		232,099		"
32	3,096	41,485	286		1,563,532		"
33	2,819	37,840	224		1,145,565		"
34	3,129	35,632	196		1,280,550		"
35	2,458	30,439	90		970,857		"
36	222	2,860	10		87,228		"
37	412	4,437	28		167,949		"
1938-49(?)							USBM
1950	160	2,134	13		65,600		"
1951-52(?)							"
1954(?)							"
	20,857	182,625	1,096		6,401,332		
Average		8.76	0.053		15.35%		

Feb. '84

WEIGHTED AVERAGE RECOVERED SILVER GRADE (oz/short ton) ORE

Year	Tough Nut	Contention	Vizina	Grand Central	Head Center	Bob Ingersol	Oregon (Knoxville)	Luck Sure	Bunker Hill	San Diego	Way Up	Good Enough	Lucky Cuss	West Side	North West	Tombstone Consolidated	Tranquility	Herschel	Old Guard	Tombstone Extension
1879	41.05																			
1880	41.05	70.39	21.27																	
81	41.05	65.89	21.26	51.67	28.83	?		46.82												
82	41.04	65.84		34.87	28.87	?	50.18													
83	33.73	34.09		26.32	40.54	25.13	57.00		44.59	25.78	10.24									
84		34.09		28.14	40.57		50.02					33.74								
85		34.09		26.33			?					33.75								
86			?	24.18			?					33.33								
87			?	35.75			?					33.71								
88			?	?			?		?			33.59	42.08	84.56						
89							?		32.86				37.42	83.87						
1890							?		?			28.57	44.60	84.82	87.21					
91							35.30		?			28.22	54.90	73.31	67.14					
92	88.43								?			28.74	43.58	66.46	87.80					
93	55.44				?							26.53	25.15	48.60	87.07					
94	62.85				?							34.70	55.10	58.38	95.90					
95					?							32.28								
96					?							29.41								
97																				
98																?				
99																?				
1900																?	121.66			
01																108.70				
02									75.00(?)							16.80		?	?	
03																13.77		?	?	
04																13.35		50.00	50.00	
05																8.74		82.50		
06																7.09		129.02		
07																6.97		57.01		
08																7.44				
09																22.20		15.85	49.55	
1910		26.20(?)							14.54							25.47		18.84	21.40	
11		28.51(?)														21.40				
12												0.14(?)				21.94		16.32		
13																17.87			17.77	
14																11.12			2.77	
15																7.62			11.48	
16																7.71			0.46	
17																14.53				12.08
18																16.41		26.23		
19																15.41		41.70	27.54	
1920																22.01				
21						15.26										13.84			10.85	
22						14.39										15.13			12.77	
23																16.03				
24																11.87				
25																8.10			13.13	
26																9.73			7.83	
27																7.06			10.04	
28																8.72			22.00	
29						5.29(?)										6.29				7.97
1930						42.54										9.09				19.36
31						34.30										?				13.40
32						29.94										?		18.90	14.44	13.42
33										4.04						?		9.20	22.37	11.39
34										0.57						?		0.96	10.85	12.38
35	19.68															?				12.91
36	16.50															?				10.76
37																?				?
38																?				?
39																?				?
1940																?				?
41																?				?
42																?				?
43																?				?
44																?	121.00			?
45																?				?
46																?				?
47																?				?
48																?				?
49																?				13.34
1950																?				?
51																?				
52																?				
53	29.65															?				
1954																				
1957	12.38																			
Average: 1879-1900	41.04	53.34	21.27	31.91	30.65	25.13	51.59	46.82	35.45	25.78	10.24	30.80	40.25	67.42	85.67	11.45	121.66	29.73	22.08	8.76
Average: 1901-1957	17.53	27.96				28.90			25.53	2.55										
Average: 1879-1957	40.17	51.67	21.27	31.91	30.65	27.35	51.59	46.82	34.87	19.92	10.24	30.80	40.25	67.42	85.67	11.45	121.66	29.73	22.08	8.76

Feb. '84

WEIGHTED AVERAGE RECOVERED GOLD GRADE (oz/short OF ORE

Year	Tough Nut	Contention	Vizina	Grand Central	Head Center	Bob Ingersol	Oregon (Knoxville)	Luck Sure	Bunker Hill	San Diego	Way Up	Good Enough	Lucky Cuss	West Side	North West	Tombstone Consolidated	Tranquility	Herschel	Old Guard	Tombstone Extension
1879-1882	?	?	?	?	?	?	?	?												
1883	0.179	?		?	?	?	?	?	?	?	?									
84		?		?	?	?	?					0.176								
85		?		?			?					0.009								
86			?	?			?					?								
87			?	0.329			?					0.146								
88			?	?			?		?			?	0.592	1.857						
89							?		?			?	0.518	1.596						
1890							?		?			?	0.467	1.932	0.142					
91							?		?			0.234	0.741	1.382	0.216					
92	0.547								?			?	0.467	1.134	0.355					
93	0.615				?							?	0.116	0.820	0.180					
94	1.010				?							?	1.677	1.134	0.006					
95					?							?								
96					?							?								
97																				
98																				
99																?				
1900																?				
01																?	?			
02																1.098				
03									0.100							0.332		?	?	
04																0.228		?	?	
05																0.207		?	?	
06								?								0.106		0.463		
07																0.081		0.866		
08																0.080		0.306		
09																0.084				
1910		?							0.033							0.202		0.209		
11		0.249														0.245		0.237	0.413	
12																0.184				
13																0.214				
14																0.226			0.208	
15																0.135			0.314	
16																0.069			0.125	
17				?												0.073			0.346	
18										?						0.071				
19																0.071		0.113		
1920																0.062		0.333	0.435	
21																0.081				
22						0.074										0.052			0.120	
23						0.100										0.094			0.262	
24																0.159				
25																0.126				
26																0.112			0.191	
27																0.221			0.145	
28		0.063														0.103			0.178	
29				0.022		0.039										0.156			0.344	
1930						0.327										0.274				0.074
31						0.468										0.242				0.008
32						0.350														0.092
33																		0.150	0.250	0.079
34										0.038								0.060	0.284	0.063
35	0.351																	0.006	0.150	0.037
36	0.255																			0.045
37																				0.068
38																				?
39																				?
1940																				?
41																				?
42																				?
43										?										?
44																				?
45																	?			?
46																				?
47																				?
48																				?
49																				?
1950																				0.081
51																				?
52																				?
53	0.308																			
1954																				?
1956				?																
1957	0.173																			
Average: 1879-1900	0.059			0.329								0.043	0.447	1.273	0.231					
Average: 1901-1957	0.286	0.012		0.022		0.164			0.003	0.038						0.057		0.187	0.149	0.053
Average: 1879-1957	0.067	0.012	?	0.031	?	0.164	?	?	0.003	0.005	?	0.043	0.447	1.273	0.231	0.057	?	0.187	0.149	0.053

Feb. '84

DRILLING OIL TOOLS PRODUCTION

CENTRIFUGAL PUMPS TURBINE

BYRON JACKSON CO.

ESTABLISHED 1872

P. O. BOX 2017 TERMINAL ANNEX

LOS ANGELES 54, CALIFORNIA

U.S.A.

CABLE ADDRESS
"BYJAC"
ALL CODES

YOUR REPLY SHOULD BE MARKED
FOR ATTENTION OF

F.O.Bertelsen

14211-L

December 22, 1944

Department of Mineral Resources
State of Arizona
304 Home Builders' Building
Phoenix, Arizona

Attention: Mr. Charles H. Dunning, Director

Subject: Proposed Pumping Equipment
Tombstone Area Project

Gentlemen:

This is in reference to your letter of November 17th with which you enclosed Mr. Andrew Macfarlane's letter of November 15th, and a blueprint of his sketch showing a section thru' the vertical shafts and the existing as well as the proposed underground workings of the Tombstone Mines.

This is a decidedly interesting problem and we have given considerable thought to the pumping units that could be used to best advantage and that would prove most practicable for the job.

The ultimate objective is to provide pumps and motors capable of handling a total of 6000 GPM against the 1500' head, after the shafts havebeen extended below the existing 1000' level down to the proposed 1500' level.

We have noted that there are two vertical shafts, located approximately one-half mile apart, and that both of these shafts may be utilized. We also note that the present water level is a little below the 500' level, indicating to us that the initial pump or pumps may be installed on that level, should consideration be given to a scheme similar to that which we have in mind.

In order to pave the way for an intelligent discussion of this project, the writer has prepared a sketch, SK-14211-L, two prints of which we are enclosing herewith. We believe that the notations which we have made thereon are self explanatory, and after you and your engineers have reviewed same, it is very likely that you will have certain comments, criticisms or other suggestions

to offer, which we shall be very happy to receive, before we proceed with our estimates covering the respective units.

There will naturally be some differences of opinion regarding the size and number of the individual units that should ultimately be used. Whether large pumps and motors be used, or a proportionately greater number of smaller pumps and motors be installed to handle the ultimate capacity called for, we believe that the difference in the total horsepower requirements will be almost negligible. However, we are inclined to favor the use of a number of smaller units for underground service, to facilitate handling.

This is particularly true for the pumps that will be required to keep the shafts "dry" during sinking operations from the 1000' level down to the 1500' level. Furthermore, rather than furnish single units that would have to operate from zero feet to 500' head, during sinking operations, our scheme presupposes a vertical pump or pumps for zero feet to 125' to pump between the respective levels below the 1000' level. Our main reason for suggesting pumps to operate over a lesser range of head is that the units will be much less cumbersome in a shaft compartment where space limitations are important. Another reason is that pumps which are expected to operate against a maximum head of about 125' will be much more efficient throughout its entire range of performance than any pump that will be required to operate against a maximum head of 500'. In other words, good efficiency can be expected throughout a very limited range, and therefore would not be as economical as the lower head pumps.

Until such time that we are agreed on the size of the respective units that may ultimately be used, and some decision may have been reached regarding the generating equipment that will be installed - which of course establishes the electrical current characteristics - we will not be in a position to proceed with our estimating. We specialize only on pumping equipment and their drivers, and are not in a position to discuss or quote you on the generating plants nor on all of the piping and fittings that will be required,as this would all have to be handled by a different contractor. In order to start the ball rolling, we have taken the liberty of asking Westinghouse Electric & Mfg. Co. to contact you direct regarding the power plant, this being in their particular line.

Referring back to our sketch SK-14211-L, we have shown only one shaft and have used the word pump(s) regardless of whether only one or more than one pump will be used for the respective services for which they are intended.

It would seem to us that if space limitations do not prevent it, it might be more desirable and convenient to install most of the pumping equipment in one shaft only. We realize, however, that this scheme may not be practicable and that it might be necessary or advisable to install pumps in both of the shafts, this being one of the points on which your engineers will have to decide.

The units which we have designated on our sketch SK-14211-L as Pump(s)"A"to "F" are listed briefly hereunder and show the sizes which we have tentatively selected:

"A" Station Pumps to be installed temporarily on the 500' level, pumping from there up to the ground surface; later to be installed on the 1500' level, to pump up to the 1000' level. These are to have a combined capacity of 6000 GPM against 500' head and may consist of two station pumps equipped with 500 HP motors, each having a capacity of 3000 GPM.

An alternative wouldbe to use four station pumps, each operated with a 250 HP motor, each of these being designed to handle 1500 GPM against the 500' head.

"B" These are the vertical pumps that would be required for unwatering the shaft from the 500' level down to the 1000' level. This of course is temporary service and our idea is to later install these pumps after the shaft has been extended, to handle the water from the 1500' level up to the 1000' level.

The ideal pumps under this item would be our Submersible deepwell units, which, when ultimately installed at the bottom of the shaft, at which time either "A" or "B" would serve as a stand-by for the other. The Submersibles would be ideal at the bottom of the shaft, in that they would not be "drowned out" due to the water level rising, because of interruptions in power or anything of that sort.

Our suggestion is that four Submersibles be used, each handling 1500 GPM against 500' head, when equipped with a 250 HP Submersible motor. These motors have a nominal diameter of only 16", and therefore the space requirements in the shaft compartments are very nominal.

"C" This refers to the station pumps which are to be installed permanently on the 1000' level, after the mine has been unwatered to that depth. Our idea is to use four station pumps, each to handle 1500 GPM against 1000' head and operated with a 500 HP motor.

After pumps "C" have been installed, the use of pumps "A" and "B" would temporarily be discontinued.

"D" These would be the vertical pumps required to drain the shaft during sinking operations below the 1000' level and would be used first from the 1000' level down to the 1125; then from the 1125 down to the 1250; later from the 1250 down to the 1375; and finally from the 1375 down to the 1500 level.

If two units are used, each would be designed to handle 3000 GPM against the 125' head, requiring a 125 HP motor for each. The alternate would be to use four units, each to handle 1500 GPM against the same head, and requiring a 60 HP motor.

"E" We have in mind that after the 1125' level is reached, it would be advisable to install pumps "E" temporarily on the 1125 level with which to pump up to the 1000' level. We have in mind two units, each designed for 3000 GPM against 125' head, requiring a 125 HP motor; or as an alternate, four smaller units, each to handle 1500 GPM against the same head, and each requiring a 60 HP motor.

These pumps could later be installed on the 1375' level when that depth is reached.

"F" These are the station pumps which are to be installed on the 1250 level after the shaft has been sunk to that depth. These would consist of two units, each handling 3000 GPM against 250' head, when equipped with 250 HP motors; or as an alternate, four pumps each to handle 1500 GPM against 250' head when equipped with 125 HP motors. These would be capable of discharging the water from the 1250 up to the 1000' level, after which the use of pumps "E" on the 1125' level would be temporarily discontinued.

The foregoing comprises all of the pumps that would be required for the project. After the 1375' level has been reached, we suggest that pumps "E" be installed on that level, with which to discharge the water up to the 1250'. Whether or not this should be a permanent installation depends largely on the influx of water at this level.

After the final depth of 1500' has been reached, and pumps "A" and "B" are installed on that level, all of the above equipment, with the exception of the low head vertical pumps "D" and possibly pumps "E" will be in service. As a matter of fact, pumps "E" might even be installed to serve as stand-bys for some of the pumps on the lowest of the four levels.

December 22, 1944
14211-L

We know that exact capacities on a project of this kind cannot possibly be predetermined and this is one reason why we recommend the installation of a greater number of smaller pumps for the total capacity of 6000 GPM. We believe that a series of pumps, handling 1500 GPM or less, will provide for much greater flexibility than would be the case with pumps designed for 3000 GPM or more.

We have endeavored to point out that our suggested scheme is a tentative~~ly~~ one only and we invite your criticisms and suggestions before proceeding with our estimates.

Thus far, we have not taken into consideration what the possible inflow of water might be at the different levels, and therefore from your point of view, the installation of pumps on the 1000, 1250 and 1500 levels only, may not be the most advantageous. A greater inflow at any of the other levels would warrant trapping the water at those levels and pumping from there on up, rather than have it run down to lower levels and then be pumped back again. However, lacking any authentic information, we have purposely disregarded the matter of inflow at the different levels and have not taken same into consideration in our tentative scheme.

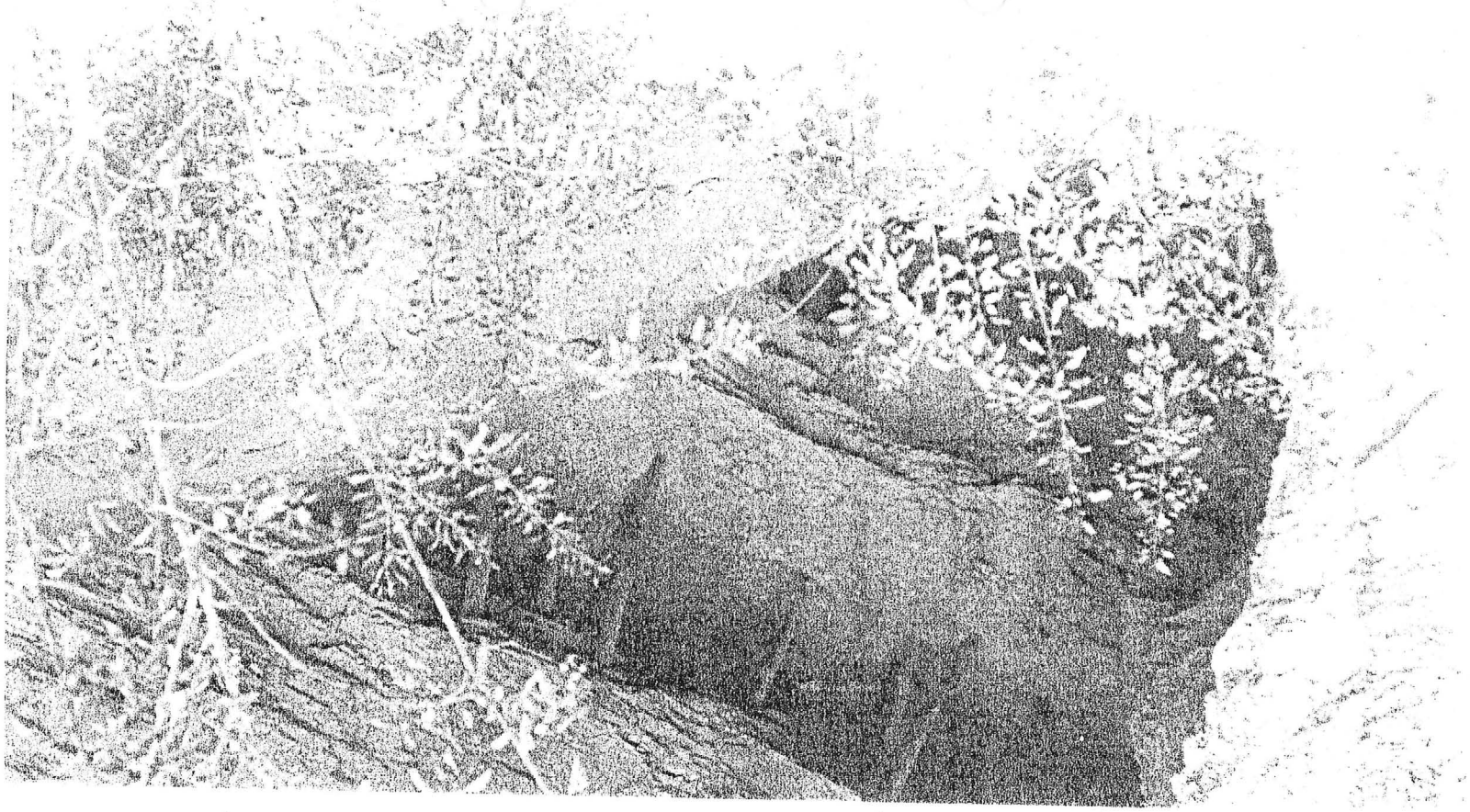
Awaiting your reply to this letter with a great deal of interest, we remain,

Yours very truly,

BYRON JACKSON CO.

By: F.O. Bertelsen

FOB/ms
encl.



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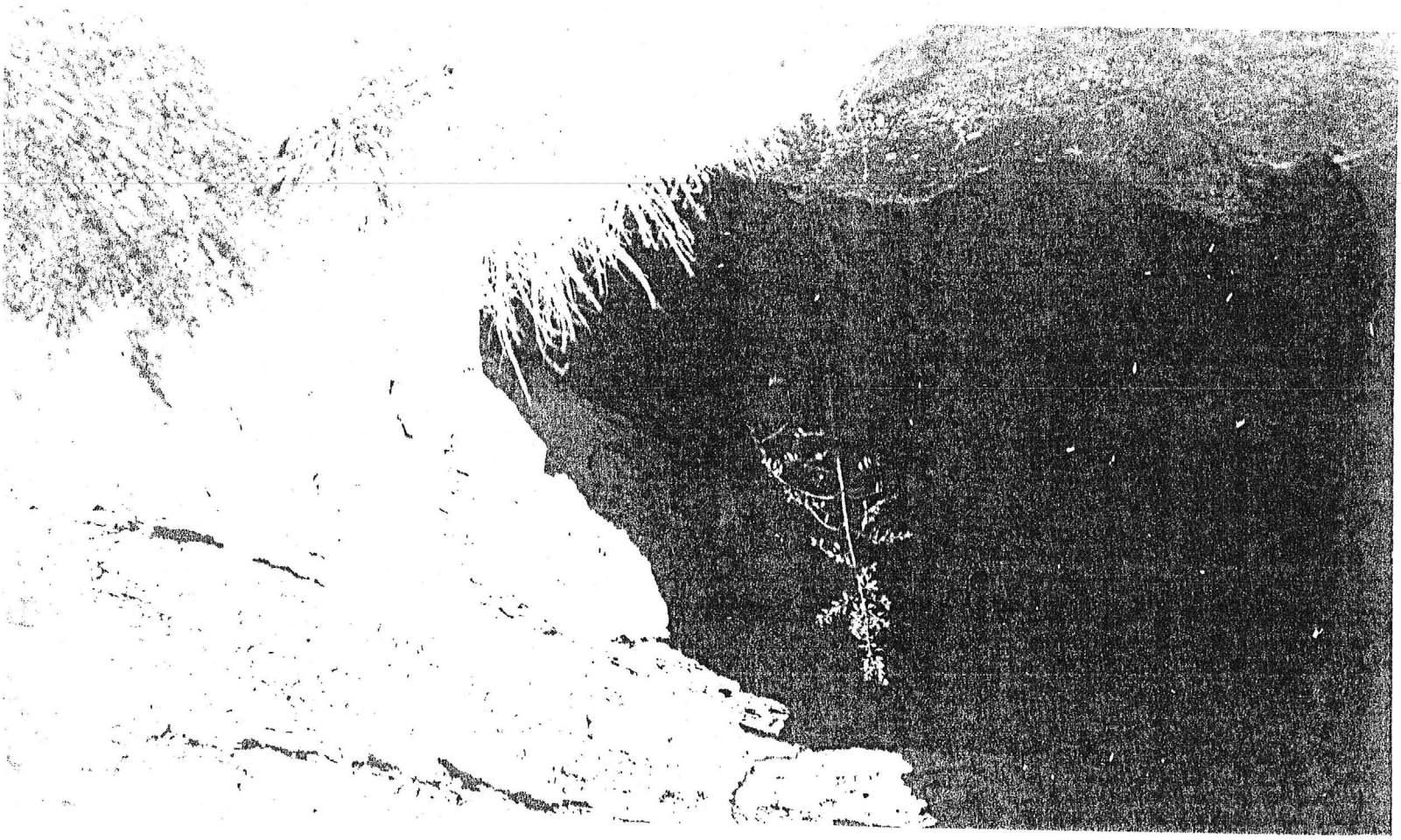
1954



A-24-2

1954

indicates that the basis for appropriations still must be discovery and location, and non-competitive leasing is not favored. Whether or not the opinion will be formally issued is uncertain because of its possible ambiguous interpretation.

ARIZONA

TOMBSTONE EXPLORATION CO. reports through Dusty Escapule, General Manager, the present processing rate is averaging 200 tons per hour of ores from the CONTENTION MINE. The crushing, pelletizing and leaching operation has a 60,000 ton capacity. Fifty personnel are currently employed at the operation out of Tombstone.

UNION MINE'S underground operation at the ORACLE RIDGE MINE is currently in the test mining and exploration stage. Surface and underground drilling is in progress on the copper/silver deposit in the OLD HAT DISTRICT of 1880's history. Ore grades of 2% copper and silver undisclosed occur in this scarn type deposit in the lower Paleozoic section, intruded by a Laramide quartz diorite. Mineralization appears to be controlled by bedding.

WALLABY ENTERPRISES President Richard Lundin reports WALLABY is finishing a milling study for LLC CORP. and is in the process of completing a placer potential study of Arizona, California, Nevada and New Mexico. A Michigan research study of base and precious metals has been completed and is available through the Tucson office.

BRITISH COLUMBIA

THE CANADIAN CHAMBER OF MINES and BRITISH COLUMBIA MINING ASSOC. are sponsoring a three-day mining seminar, entitled "Opportunities in Mining," for general industries supportive to the mining industry, to acquaint those industries with the needs of an anticipated multi-billion dollar mining boom in the province. The symposium, to be held April 27 through 29 at the Hotel Vancouver, is under the direction of Mr. Robert Haubower, President of the BC MINING ASSOC. Address inquiries to: "Opportunities in Mining," 201-321 Water Street, Vancouver, BC, V6B-1B8, or call 604-689-5540.