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James Doyle Sell Mining Collection

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JDS

9/11/92

FROM: W. L. KURTZ

TO: Bill Gray

We will not go ahead with Harold Downey's Tombstone Property.

At AGS meeting July 11, 1995 H Downey verbally reported that BHP drilled a hole south of the wash, south of his drilling, along the anticlinal axis. No report yet.

However, a sludge sample collected by Downey returned 10% Pb - 10% Zn & 100's oz Ag

Don't remember actual values — but very interesting.

JDS

ASARCO

Southwestern Exploration Division

June 11, 1991

W.L. Kurtz

Tombstone South Property
H.J. Downey, Inc.
Cochise County, Arizona

Mr. H.J. Downey has drilled a significant intercept of silver-lead-manganese (30' of 4.56 opt Ag, 0.88% Pb, and 2.45% Mn) at the inclined (-60° hole) depth of 385'-415'.

The intercept was within a breccia mass along a vertical fault zone, but undoubtedly represents the type and style of mineralization which should be found at the top of the NACO Group limestones under an impervious red mudstone cap of probable Permian age.

As mapped by aerial photos, a zone of favorable target stratigraphy is plus 800 feet wide between the two breccias shown in Figures 2 & 3, and the syncline structure is noted for several thousand feet to the southeast. The depth to the target manto-style Ag-Pb-Mn mineralization is 350'-400' below the surface.

To the north, the syncline has been dropped down across a N70°E fault connecting the two breccia zones. The target zone is much deeper since the surface units and the cored units at the bottom of the hole are Cretaceous Bisbee Group. The drill hole TS-1 is located 500 feet south of the north line of State Lease Section 32 (T20S, R22E) and the prospective target area to the southeast is mainly on the same State Lease Section 32.

Several other target areas have been outlined in the land package.

I recommend that SWED continue the Downey drilling to outline the extent, tonnage and grade of this potentially significant zone, even though it is on State Lease land.

James D. Sell

James D. Sell

JDS:mek
Attachment

COMMENT

June 11, 1991

Tombstone South Property
H.J. Downey, Inc.
Cochise County, Arizona

Mr. H.J. Downey, H.J. Downey, Inc., controls some State land in Section 32 (all), T20S, R22E, and Section 4 (N½), T21S, R22E, southwest of Tombstone, Arizona, along with Federal mining claims in adjacent Sections 29 and 33 (Figure 1).

Mr. Downey presented Asarco with a conceptional idea of silver-rich mantos lying in a syncline in a structural complex area of faulting and brecciation.

As the land package is State land, I had elected not to pursue the project when presented last year, even though a relatively shallow target area was envisioned.

Mr. Downey has now completed his proposed drill hole and has submitted the attached report, drill section, plan map, drill log with assays, and several photos of his model. The best interval in TS-1 was 30' (385'-415') with 4.56 oz. Ag, 0.88% Pb, and 2.45% Mn.

TS-1 was collared in early May 1991, being drilled N77°W at an inclination of -60°.

Synopsis of Hole TS-1

Surface - 255'.	Limestone and siltstone, red and purple mudstones. Possibly Permian age.
255'-420'	Breccia, of mudstone, siltstone, sandstone and quartzite, at junction of faults trending N30°E and N70°E. The entire breccia intercept contained abundant manganese (averaging over 1% Mn). At the north (bottom) contact a mineralized zone was cut from 385'-415' where individual 5' assays had highs of 0.110 ppm Au, 12.6 opt Ag, 0.13% Cu, 2.70% Pb, 0.12% Zn, and 5.3% Mn. The best 30' (385'-415') averaged 0.001 opt Au, 4.56 opt Ag, 0.06% Cu, 0.88% Pb, 0.06% Zn and 2.45% Mn.
415'-598' T.D.	Conglomerate limestone, shaley siltstone, limestone, mudstone, and quartzite of the Bisbee Group sequence (Cretaceous age).

As shown in Downey's cross section, he believes that the syncline structure is correct and that an unconformity exists between the cored red/purple mudstones (Permian?), and the underlying replacement-type limestones of the NACO Group (Pennsylvanian), with the manto silver-lead-manganese mineralization lying at the contact.

The breccias are tectonic and thus have little vertical transport of fragments, and this would suggest that the target manto mineralization would lie between 350'-400' below the surface.

Additional thickness of mineral might be available in the NACO Group stratigraphy, since the drill hole passed out of the permeable breccia and into an unfavorable tight limestone/quartzite Bisbee Group sequence.

The intercept of multi-ounce silver of the typical Tombstone silver-lead-manganese suite is an important intercept and with the probable shallow depth to the productive horizon and the extent of the possible mineralized block, I recommend that Asarco rethink this taboo on Arizona State lease land and test this target for important silver-lead tonnage and grade.

James D. Sell

James D. Sell

JDS:mek
Attachments

Tombstone South Property

An Update of Concepts; Recommendations

H. J. Downey, Inc.

With the drilling of the first hole, TS-1, in early May, 1991, some of the geolological/structural concepts relating to the northern breccia areas (Bx #3 & Bx #4) are becoming more fully understood. Furthermore, the well mineralized intercept encountered from 390' to 415' as well as other intercepts within the Bx #3 zone have shown that ore grades of silver with associated base metals are possible.

DDH TS-1 was designed to intercept three structural elements defined by surface observations, a northeasterly trending vertical shear, a southwesterly probable fault, and a flexure of the bedding of sediments of the Lower Bisbee Formation, all of which intersect at the Bx #3 area. The hole was collared 125 feet easterly from the control point 0+0 on the IP grid and drilled at -60° at a bearing of N 77 W.

Rock at the drill site is a dense maroon/purple mudstone which was drilled to a depth of 254 feet (220 vertical) where contact with breccia was made. This contact was about 50 feet further west than anticipated indicating the mudstone beds are probably slightly rolled back easterly from vertical (refer to attached X-section). Because the breccia is dramatically more altered and mineralized (although oxidized) than the mudstone it is very likely the mudstone has acted as an impervious cap during the mineralizing periods.

The previous concept of a synclinal roll between the two breccia areas can be further modified to state that this roll lies in a block some 800 to 1,000 feet across which is bounded by and has been compressed between two high angle faults all of which are cross-cut by a vertical shear zone. Pipe-like breccia zones have been formed at the fault/shear intersections (refer to attached vertical section). It is further surmised that low angle, possibly multiple, manto deposits are located between the two breccia zones beneath the mudstone cap at a depth somewhere between 200 and 400 feet. This concept is substantiated by the IP response on Line 4E of the 1988 Geophynque survey (James Fink comment and pseudosection attached).

B. J. Devere, Jr. (1978) and others have noted that manganese mineralization in the Tombstone district is probably a later stage event following the sulfide ores but probably before the oxidation and enrichment period. At Tombstone South, it is not yet clear whether the manganese/silver mineralization is dominant or if it represents a separate phase in breccias adjacent to enriched sulfide deposits.

Recommendations: A new IP survey of line 4E utilizing a 500 foot dipole spacing should give a better definition of the anomaly found in the 1988 survey. A vertical drill hole on this anomaly is warranted at this time. Angle drilling from outside the breccias into the center block would further define extent and grade of mineralization indicated by that found in the TS-1 hole.

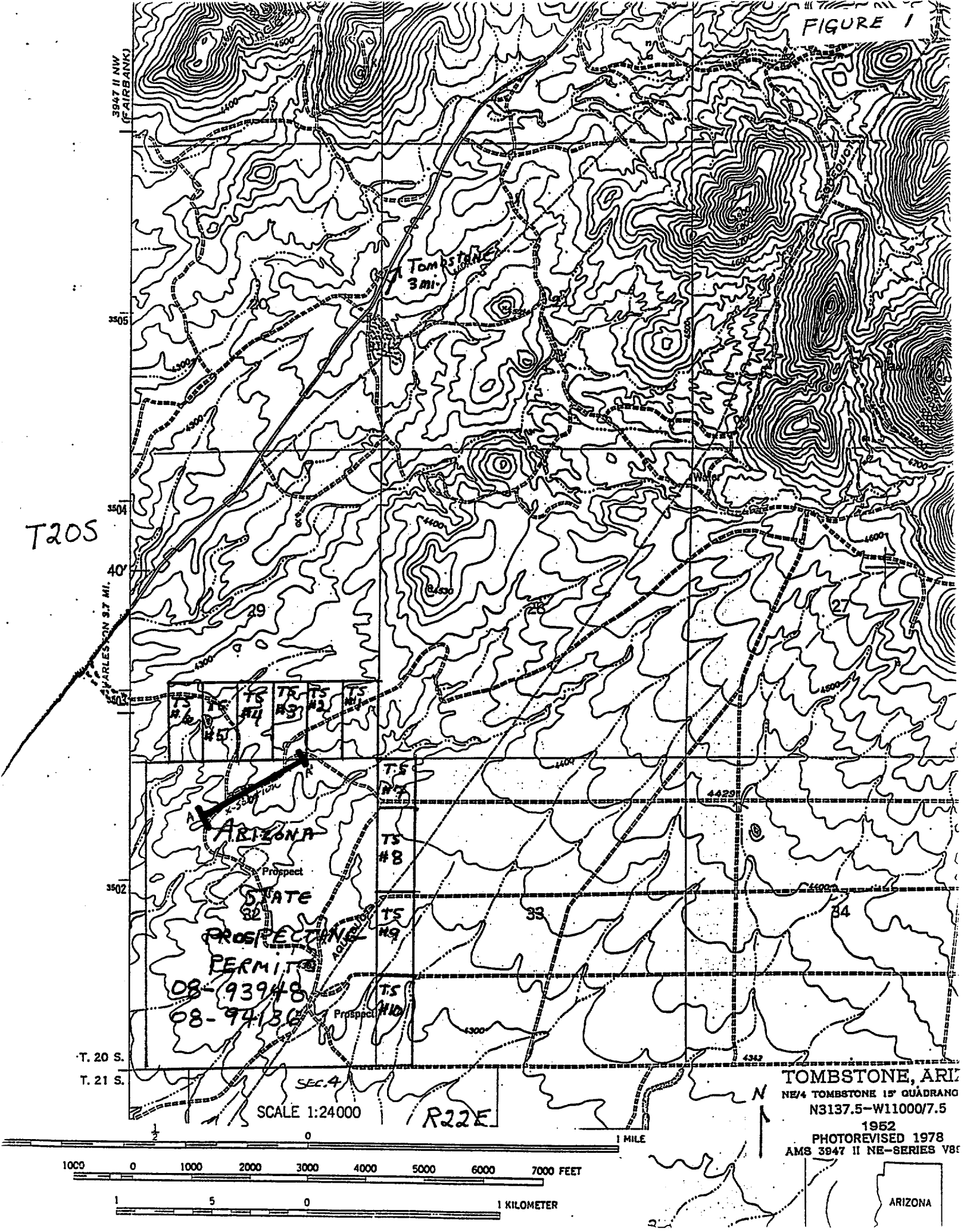
Harold J. Downey

Harold J. Downey

6/5/91

Date

FIGURE 1


3947 II NW (FAIRBANK)
Tombstone 3 mi.
Water
T20S
TS #1
TS #2
TS #3
TS #4
TS #5
TS #6
TS #7
TS #8
TS #9
TS #10
ARIZONA STATE PROSPECTING PERMIT
08-93948
08-94136
Prospect
Prospect
29
28
27
32
33
34
T. 20 S.
T. 21 S.
SEC. 4
R22E
SCALE 1:24000
1 MILE
7000 FEET
1 KILOMETER
N
TOMBSTONE, ARIZ
NE/4 TOMBSTONE 15' QUADRANG
N3137.5–W11000/7.5
1952
PHOTOREVISED 1978
AMS 3947 II NE–SERIES V8
ARIZONA

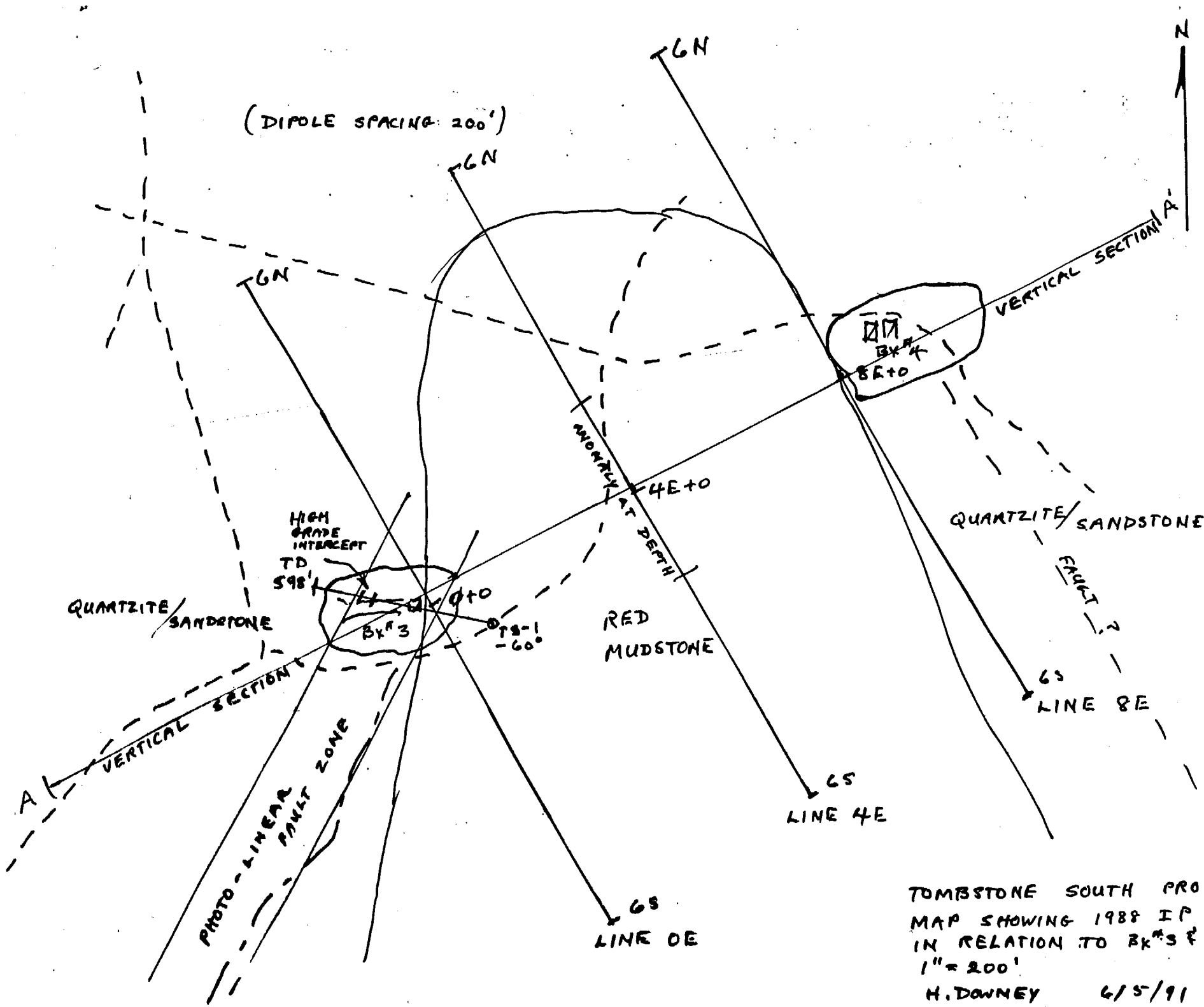
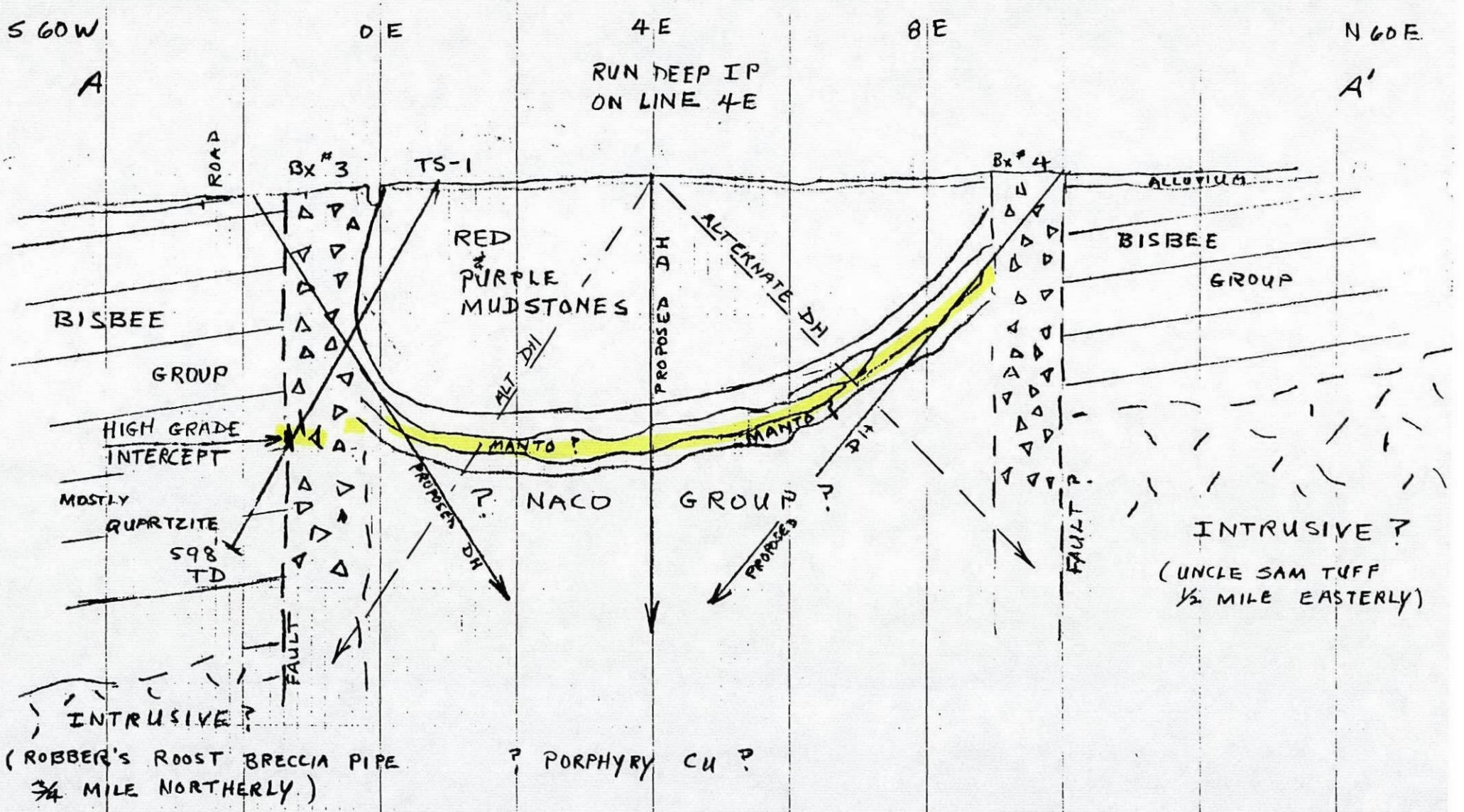


FIGURE 2

TOMBSTONE SOUTH PROPERTY
MAP SHOWING 1988 IP LINES
IN RELATION TO Bx#3 & Bx#4
1" = 200'
H. DOWNEY 6/5/91



INTERPRETIVE VERTICAL SECTION A-A' ALONG
SHEAR/FISSURE CONNECTING Bx #3 & Bx #4

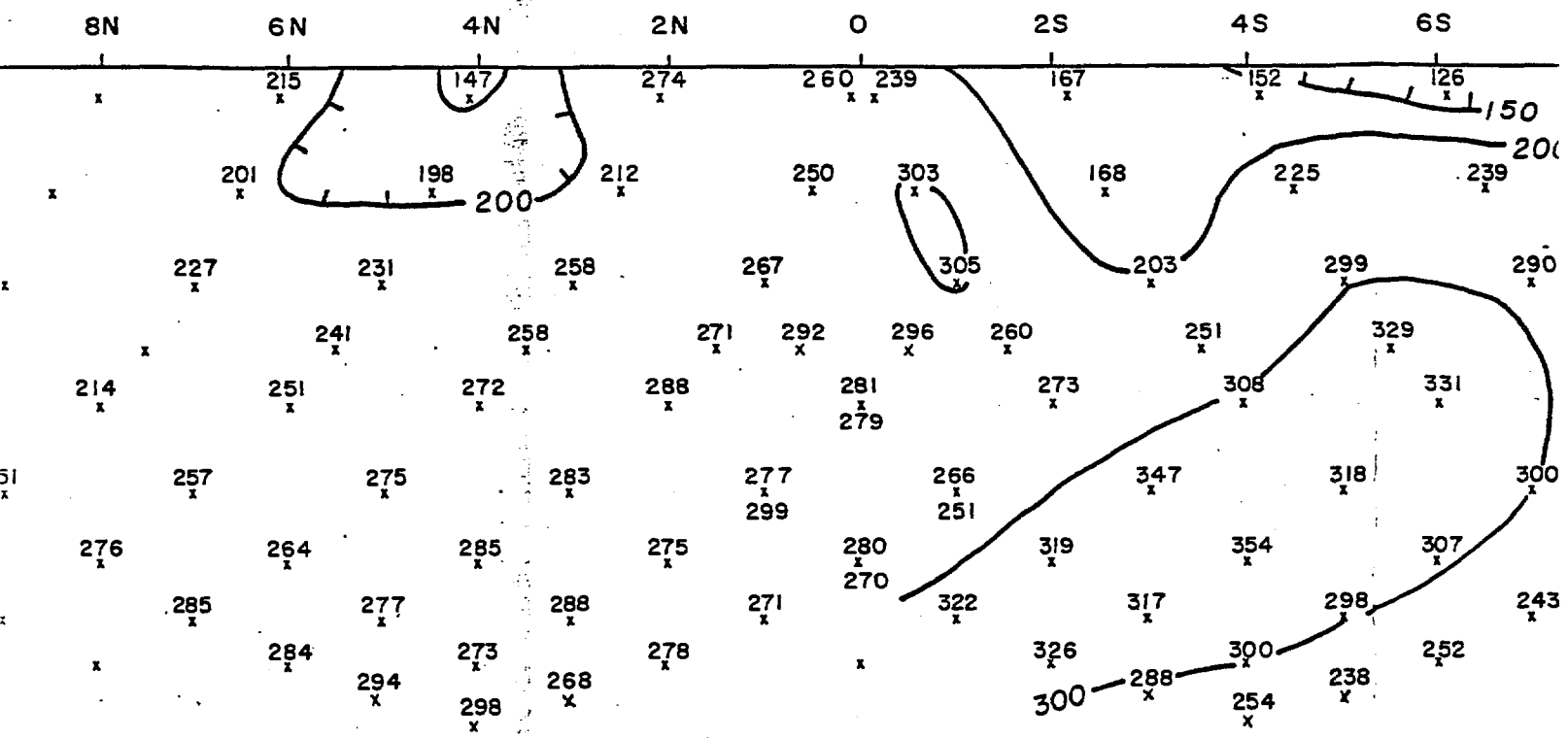
Looking Northwesterly

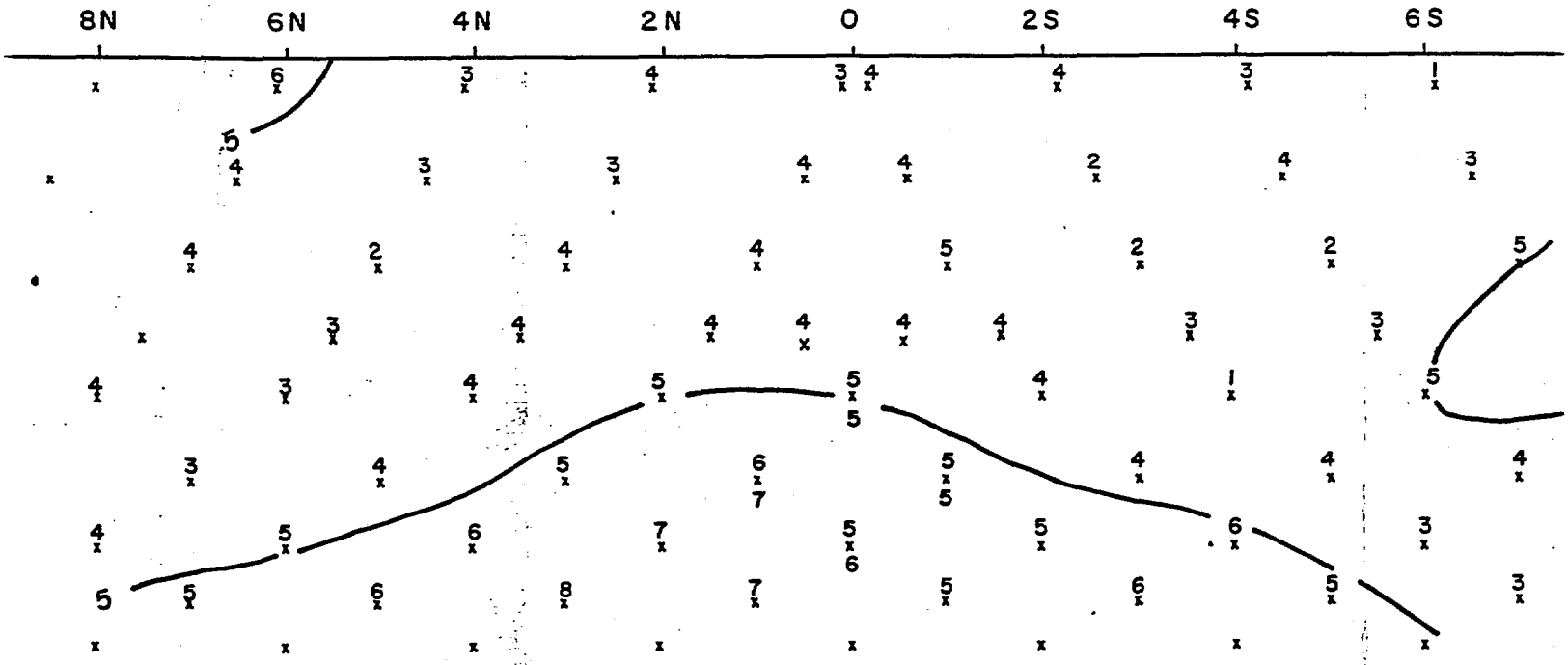
TOMBSTONE SOUTH PROPERTY

SCALE: 1" = 200'
H. DOWNEY 6/5/81

FIGURE 3

LINE 4E





Refer to Report, Pg 3 (Next sheet)

shearing, a short-wavelength magnetic anomaly would be anticipated. Furthermore, magnetics and gravity may indicate deeper lithologic or structural changes related to the shear zone. With these considerations in mind, electric, magnetic, and gravimetric methods were tested at the prospect.

IP and Resistivity

Line 0

The apparent resistivity data for Line 0 are presented in pseudosection format in Figure 1 and range from 130 to 600 ohm-meters. The low apparent resistivities appear to be correlated with the known brecciated zone at the center of the line. The apparent resistivity contour pattern suggests a northerly dip and the IP data tend to support this. The appearance of the anomaly in pseudosection is very typical for dike-like bodies, but a quantitative dip cannot be estimated. Background apparent chargeabilities are approximately 4 milliseconds and the estimated true chargeability of the brecciated zone is approximately 20 to 25 milliseconds. Oxide staining and casts are seen in the vicinity of the prospect shaft near the center of the line. Clays are also present. The observed IP response may be due to the presence of both clays and unaltered sulfides.

Line 4E

Apparent resistivities are presented in pseudosection format in Figure 2 and range from 120 to 350+ ohm-meters. The apparent resistivity pseudosection shows no particular contour pattern suggestive of the breccia zone seen in Line 0. The IP response does however show a broad, weak, buried response in the middle of the line. The apparent IP response is barely twice background, but if it is due to a polarizable body (or dike-like feature), the volume contribution of the body is quite low suggesting a small body. However, the response is so weak that this interpretation is tenuous at best.

Line 8E

Apparent resistivities are presented in pseudosection format in Figure 3 and range from 75 to 300+ ohm-meters. The apparent resistivities show only a very weak contour pattern that may be related to the breccia zone mapped in the immediate vicinity. Average apparent resistivities for the line are 150 to 200 ohm-meters. The IP data show a peculiar "half-pantleg" shaped anomaly centered on the line. This may be an indication of the breccia

The sulfide ore oxidized to limonite and cerussite that contained considerable bromyrite and cerargyrite with minor amounts of smithsonite, malachite, native gold and silver. In a few phases, chalcocite and argentite were found with the oxides.

The later manganese-silver ores occur mostly in the southern and western parts of the district principally in orebodies associated with the Prompter and Lucky Cuss faults. Most of the manganese occurs as psilomelane; however, a mass of alabandite was mined from the 350-ft level of the Lucky Cuss mine. The alabandite occurred in a replacement deposit in crystalline Naco limestone adjacent to the Lucky Cuss fault and was surrounded by pyrite, galena and sphalerite, which it in part replaced (Butler and others, 1938). The manganese ore generally contained less silver and lead and more copper than the oxidized sulfide ores, with the silver content usually being less than 20 ounces per ton. Typical manganese ore from the Dry Hill mine assayed 17 ounces per ton silver, 0.04 ounces per ton gold and 0.17% copper (Butler and others, 1938). However, some of the manganese ores from the Prompter mine averaged 35 ounces per ton silver from production in 1883 (Buchard, 1884). Ransome (1920) concluded that there was little doubt that the manganese-silver deposits occurred, at least in part, due to the reaction between the carbonate host rocks and the oxidizing sulfide deposits. However, the much lower silver and lead, and the higher copper content of the manganese-rich ores compared to the low-manganese sulfide ores suggests a separate, distinct phase of mineralization.

Silver was the most economically important metal produced, but gold and lead were also significant. The silver to gold ratio for ores produced was 6:1 in dollar value. The district has produced 45,000,000 pounds of lead (Keith, 1973, p. 13), an average of approximately 45 pounds of lead per ton of ore mined.

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Tombstone South Property

Summary Geologic Log TS-1

Bearing: N 77 W Inclination: -60

0--254: Alternating sequences of maroon, calcareous, shaly mudstone and siltstone with a few short sections of pale green limestone. Varying degrees of carbonate reaction with acid; may be indicative of introduced calcite. No ore minerals identified.

254--420: Structural Breccia-- probably resulting from intersection of a N 70 E vertical shear with a S 30 W major fault zone and complicated by a flexure of bedding in the Bisbee Group. Lithologies include mudstone, siltstone, quartzite, and a few fragments of limestone. Veinlets are mostly quartz- very minor calcite as veins or in fragments. Predominant fracture and vein orientation is 30 to the core axis. Matrices are composed largely of manganese oxide minerals with some red hematite and lesser goethite and jarosite. Water table may be at 400 feet (drill hole depth). Rock from 390 to 425 is drusy/vuggy with considerable manganese oxide flooding. Best grades of silver, copper, lead, zinc, and manganese are in this zone (refer to grade log) although their mineral compositions have not been identified.

420--598 (TD): Alternating sequences of sandstone and quartzite with short sections of calcareous maroon mudstone and conglomeritic limestone. The last 22 feet is massive, light tan quartzite; very fresh with only minor manganese oxides on fractures.

GEOLOGIC LOG

PROJECT TOMBSTONE SOUTH

PROJECT TS — HOLE NO. TS-1
Collar elev. — Final depth 598
Coord N. — Coord E.
Inclination -59° N77W — Page 1 of 3
Logged by H. DOWNEY
Date start 4/30/91 — Date finish 5/8/91

DEPTH from	DEPTH to	int'vl	% CORE RECOV.	SPLIT	ALL ASSAY IN PPM Au	Ag	Cu	Pb	Zn	Mn	ORE MINERALS: MANGANESE (GENERAL)	GANGUE (%) MINERALS: QUARTZ-VEIN	QUARTZ-SILIC.	CALCITE DISS	CALCITE VEIN	GOETHITE	JAROSITE	RED HEMATITE	ALUNITE	STRUCTURE % RQD	FAULTS	FRACS/FT	ROCK TYPE and REMARKS
0	2	2																					OVERBURDEN
2	5	3	20								TR			.5						0			2-20 LIMESTONE SILTY Dark maroon to dark gray - calcite (later)
5	10	5	30								TR			.5						0			coating fracture, white calcite stringers - limonite
10	15		90								TR			.5						0			jarosite coatings @ 16'. Core is quite crushed and
15	20		100								TR			.5						0			broken.
20	25										0.1			1									20 - 50.5 Becomes less calcareous 20' - 50'. (calcareous siltstone)
25	30										0.1			1									Dendritic manganese coating calcite veinlets
30	35										0.2			1									Limestone effect may be due to secondary
35	40										0.2			2									calcite flooding (silicing)
40	45									Mo	0.2			2		TR				20		BRKN	
45	50			45-50	.004	<.2	6	14	40	<2	0.2			2						0		BRKN	
50	55			50-52	.004	<.2	26	10	36	<2	0.2			2		TR				30	2" @ 52	7	50.5 - 52 LIMESTONE - Pale green - top contact irregular
55	60			52-55	.002	<.2	12	16	65	<2	0.2			2				TR		10		2	31° - 45° - bottom in small slip (2" crushed)
60	65										0.3			2						10		3	
65	70										0.3			2						40		2	52 - 93 CALCAREOUS SILTSTONE - Dark maroon - calcite veining
70	75										0.1			2						10		2	30° to core axis predominant.
75	80										TR			2						20		2	
80	85										TR			2						50		1	
85	90			85-90	<.002	<.2	8	16	44	<2	TR			5						20	86-90	3	gouge & broken - abundant calcite veining
90	95			90-95	.002	<.2	8	14	42	<2	TR			5						0		5	93 - 101 Rock becomes spotted below 95 with irregular
95	100			95-100	.002	<.2	16	12	38	<2	TR			2						10		3	rounded blebs to ½" dia. calcite rich
100	105			100-105	.004	<.2	34	12	65	<2	TR			2						10		3	101 - 103 CONGLOMERITIC LIMESTONE - Poorly sorted, rounded
105	110										0.1			2						20		2	pebbles & cobbles of maroon/purple calcareous
110	115										0.1			2						40		2	limestone in carbonate matrix. A few fragments
115	120										TR			2						40		2	of black siltstone.
120	125										0.1			2			2			10		2	103 - 121 LIMESTONE - Pale green - similar to 50.5-52
125	130			125-130	.002	.10	4	44	10	510	0.1			2						10	124.5 2" gouge	1	Massive with a few calcite veinlets. Massive
130	135			130-135	<.002	.40	18	22	14	2,350	0.1			2						50		2	fracture cemented. "Blue"?
135	140										0.1			3						20		2	
140	145													3						20		2	CALCAREOUS SILTSTONE - Similar to above similar
145	150													3						30		1	spotted texture
150	155													3						70		1	
155	160													3						10		3	121 - 135 SHALY MUDSTONE - Pale green - laminae @ 70°
160	165													3						10		3	to axis. Orange/red hematite coating fracture
165	170													3						10		3	and filling seams.
170	175													3						10		3	
175	180													5						60		1	135 - 216 CALCAREOUS SHALY SILTSTONE - Maroon to
180	185													5						60		1	purple, spotted with calcite blebs
185	190													5						70		1	and inclusions to 1" diameter
190	195													5						70		1	
195	200													5						70		1	
200	205													5						70		1	
205	210													5						70		1	

GEOLOGIC LOG

PROJECT TOMBSTONE SOUTH

PROJECT TS
Collar elev
Coord N
Inclination
Logged by H. DOWNEY
Date start

HOLE NO. TS-1
Final depth
Coord E
Page 2 of 3
Date finish

DEPTH from	DEPTH to	int'vl	% CORE RECOV.	SPLIT	ASSAY ppm ALL IN Au	Ag	Cu	Pb	Zn	Mn	ORE % EST MINERALS	MANGANESE (GENERAL)	GANGUE % EST. MINERALS QUARTZ VEIN	QUARTZ SILIC. DISS.	CALCITE VEIN	GOETHITE	JAROSITE	RED HEMATITE	ALUNITE	FLUORITE	PYRITE (D)	STRUCTURE % RQD	FAULTS	FRACS/FT	ROCK TYPE and REMARKS
210	215	5	100									0.1			5							20		2	
215	220														5			1	TR			30		1	216-236 BRECCIATED CALCAREOUS SILTSTONE - Fragments of
220	225														7			2	TR			20		3	unit above in similar matrix. There is a general
225	230														7			2	2			10		3	increase in clastic flake. Hematite veining on
230	235														7			2				60		1	fractures & bleeds? blebs 226-228.
235	240														10			3				60		1	236-254 CALCAREOUS SHALY SILTSTONE - MAROON/PURPLE AS ABOVE
240	245														5			1				10		2	Brownish lim colorations below 240
245	250														5	3	5	5				10	245.5-247	3	Broken - brecciated - bleached - may be fault 245.5-247
250	255											3			1	3	5	5				10		7 5	
255	260			F. ERY	.008	.20	55	20	690	3350		4			1	3	5	5				5	BRECCIA	1	254-304 BRECCIATED MUDSTONE - Multi colored, soft, dense
					.006	.80	46	34	800	3400															
260	265			2.5'	.004	.40	14	34	335	1830		5			1	3	5	5				5	(STRUCTURAL)		fragments in manganese (pyrolusite?) matrix.
					.016	2.40	44	165	1100	11,000															
265	270				.030	26.00	190	1150	2150	56,500		10			1	3	5	5				5			Red hematite and jarosite form alteration rims
					.03	22.00	140	600	1700	32,500															
270	275				.022	4.40	28	155	1100	18,500		7			1	3	5	5				0			on fragments, fractures / hematite after (pyrite)
					.020	.80	19	158	440	6,050															
275	280				.018	.80	12	65	265	3,700		7			1	3	5	5				0			pyrite, rubber disseminated in spots.
					.022	.60	12	16	275	2,600															
280	285			280-285	.006	.60	10	18	290	4,250		7			1	3	5	5				10			
285	290			285-290	.018	1.10	14	50	265	4,750		7			1	3	5	5				10			
290	295			290-295	.016	1.00	14	48	290	3,700		5			1	3	5	5				0			
295	300			295-300	.028	.90	18	32	405	9,200		5			1	3	3	3				0			
300	305			300-305	.008	6.30	8	95	650	4,150		5			1	1	1	1				10			304-326 SANDSTONE - Grey, fine grained, soft - Sotty,
305	310			305-310	.010	6.50	12	110	780	8,250		5			1	1	1	1				0			manganese coating, fractures and in veinlets
310	315			310-315	.014	6.50	10	80	570	11,500		5			1	1	1	1				10			
315	320			315-320	.020	7.70	18	100	790	8,950		3			1	1	1	1				10			
320	325			320-325	.022	3.20	14	60	210	4,000		3			1	1	1	1				0			
325	330			325-330	.022	15.00	60	340	510	5,550		5			1	1	1	1				0		V	326-330 QUARTZITE - grey, dense, pale white - may
330	335			330-335	.026	12.00	80	430	610	7,800		5			1	1	1	1				10		4	be bleached due to alteration.
335	340			335-340	.034	8.20	55	405	200	5,550		5	1		1	1	1	1				0		5	330-361 SANDSTONE - grey, fine grained - same as
340	345			340-345	.022	27.00	50	320	600	13,500		5	1			2	2	2				0		5	304-326 - however bleached & dusted to
345	350			345-350	.044	12.00	60	258	540	11,000		7	1			2	3	3				20		3	FeOx at 350
350	355			350-355	.010	6.90	32	680	440	6,250		5	1			2	3	5				40			
355	360			355-360	.006	1.50	10	280	180	250		10	1			1	1	5				80			
					.006	37.00	38	400	770	29,500															
360	365			360-365	.006	5.70	38	230	230	4,400		20	2			1		5				50			361-359 MUDSTONE - Soft, pale green - a few hematite
365	370			365-370	.028	3.70	28	95	200	660		3	2			1		5				30			veins after pyrite
370	375			370-375	.026	3.10	40	90	220	290		3	2					3				20			359-362 - Marine manganese 359.5-361.5
375	380			375-380	.008	2.60	60	24	265	200		3	2				1	3				30			362-385 SANDSTONE - Light grey - Stockwork of
380	385			380-385	.008	4.50	30	110	130	470		3	2				2	3				10			hematite veinlets 1 mm thick.
385	390		MISLATCH 20% 100	385-390	.012	29.00	50	730	85	3,000		5	3			1	1	1				0	FAULT?		385-391 QUARTZITE - Brecciated -
390	395			390-395	.008	4.30	820	4200	1250	45,000		10	3			1	1	1		1		0			391-485 SANDSTONE - grey to brown, fine grained
395	400			395-400	.030	210	1,300	21,500	920	53,000	Pb 2.70%	15	3			1	-	1		1		WATER	TABLE ?		with siliceous (quartzite) sections. Drusy/
400	405			400-405	.022	21.00	155	1,900	210	380		10	3			1		1		1		10			sugary through 420'
405	410			405-410	.110	75	170	2,800	165	1,200		10	3			1		1				10			Many fault 385-390 - may have caused
410	415			410-415	.090	165	1,250	21,500	760	44,500	Pb 2.39%	10	3			1		1				0			Mislatch & core loss. Recovered 1½' rubble
415	420			415-420	.010	7.20	75	960	180	6,580		5	3			1		1				0			Also 1.5' gouge 415-416.5
420	425			420-425	.006	22.00	44	485	75	350		5	3			1		1				0			End of Bx-420

GEOLOGIC LOG

PROJECT TOMBSTONE SOUTH

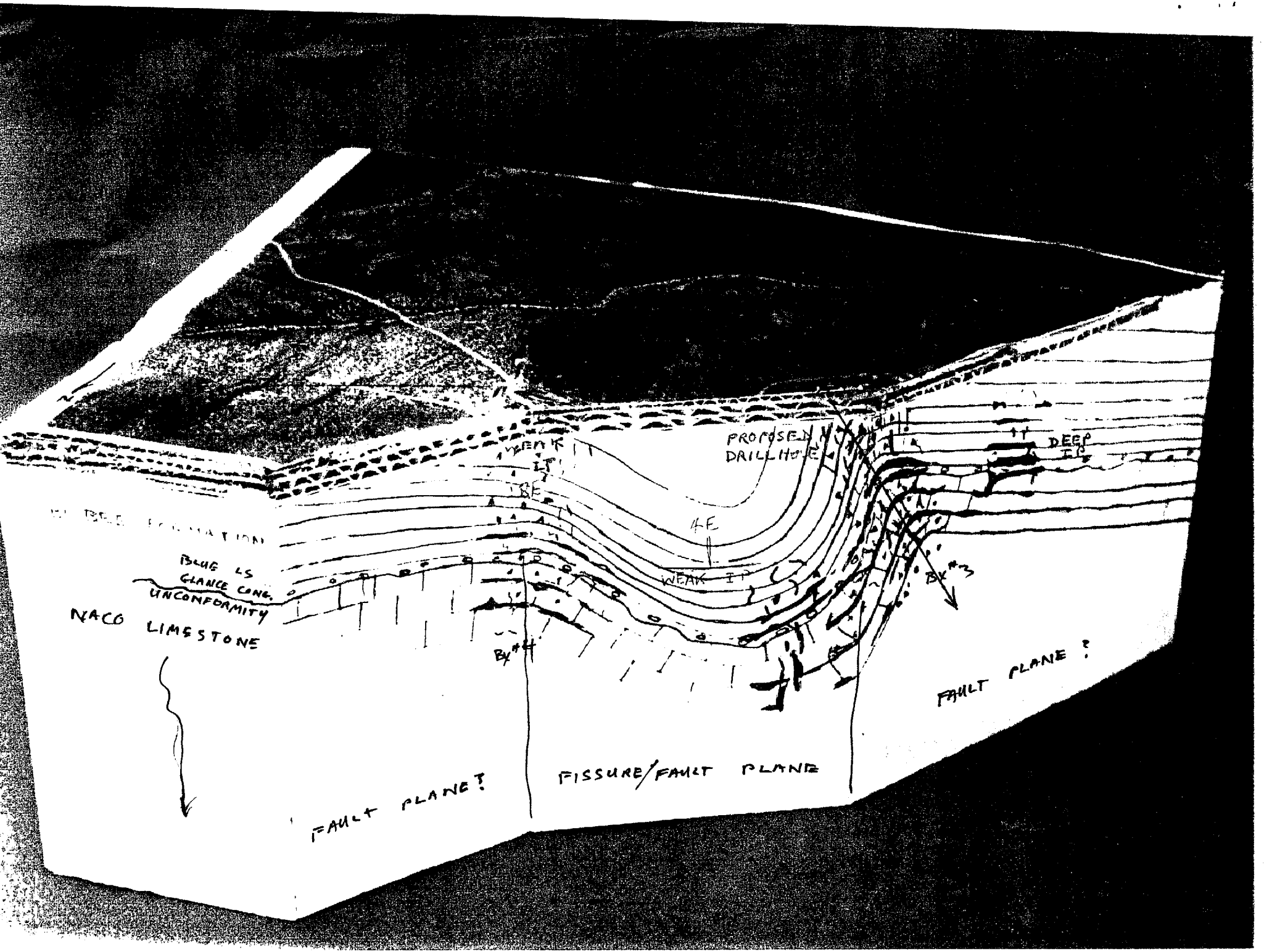
PROJECT TS
Collar elev.
Coord N.
Inclination
Logged by H. DOWNEY
Date start

HOLE NO. TS-1
Final depth
Coord E.
Page 3 of 3
Date finish

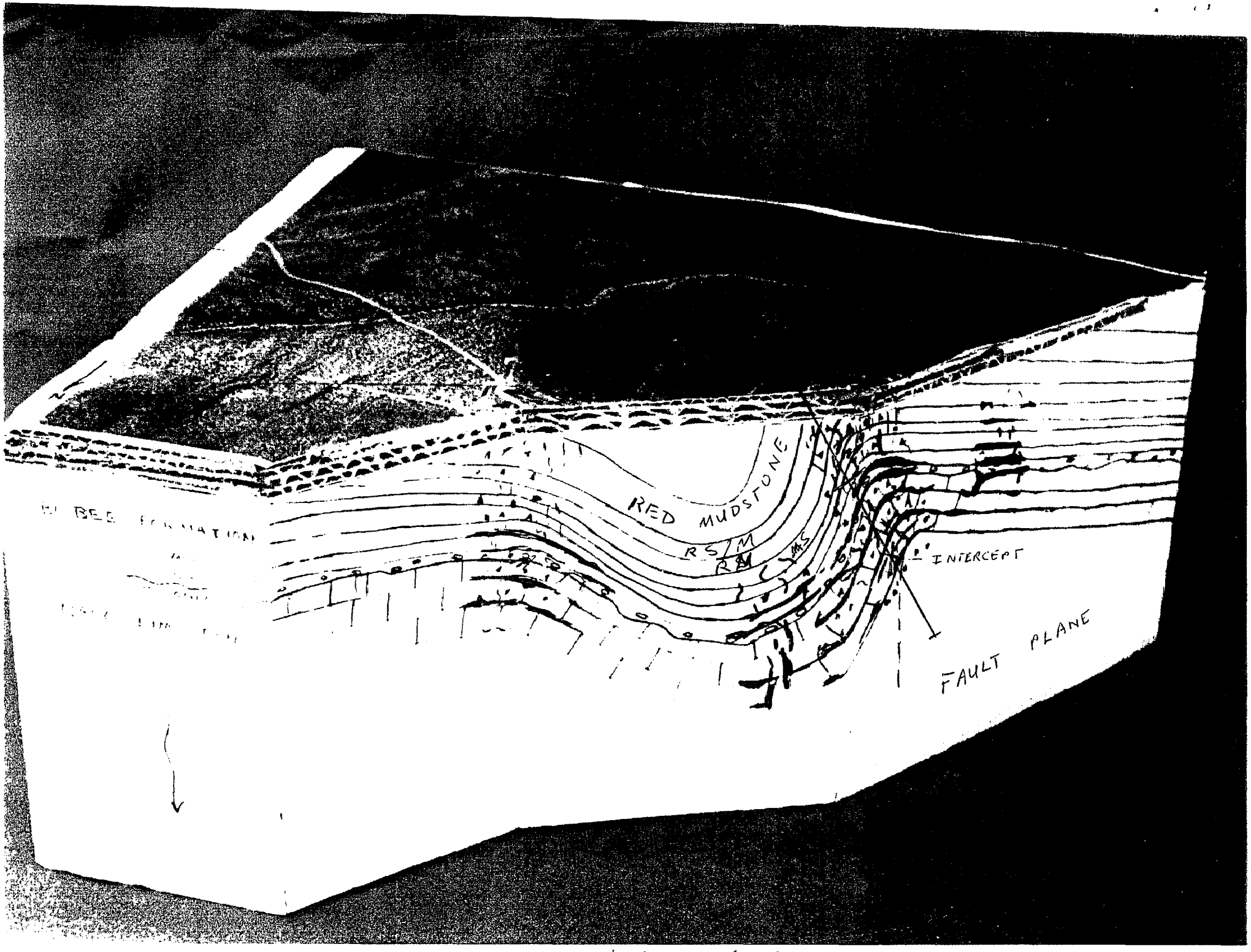
DEPTH from	DEPTH to	int'vl	% CORE RECOV.	SPLIT	ASSAY ALL IN PPM Au	Ag	Cu	Pb	Zn	Mn	ORE MINERALS MALACHITE (GEOCHEM)	GANGUE MINERALS QUARTZ VEIN	QUARTZ SILT	CALCITE	GOETHITE	JAROSITE	RED HEMATITE	AZURITE	FLUORITE	PYRITE	STRUCTURE % RQD		ROCK TYPE and REMARKS
425	430			425-430	.008	15.00	70	255	305	1,550	10					1					0	BX	391-455 - CONT. BRECCIATED SANDSTONE - continues to 455
430	435			430-435	.006	6.40	70	16	475	3,400	10					1					10		
435	440			435-440	.006	14.00	42	220	435	7,550	5					1					10		Major BX zone ends @ 420
440	445			440-445	.006	14.00	70	65	620	5,250	5					1					20		
445	450			445-450	.014	22.00	85	150	860	9,650	5					2	3				10		
450	455			450-455	.002	3.00	70	36	1,250	1,400	5					2	3				20		
455	460			455-460	<.002	2.00	28	26	780	2,900	5					2	2			1	30	BX END OF BX	455-469 CONGLOMERITIC LIMESTONE - Mottled brown to pale green
460	465			460-465	<.002	1.60	28	16	330	990	5					2	2			2	30%		
465	470			465-470	.002	.80	24	16	340	800	5					2	2			2	AV		469-482 SANDSTONE - grey, medium grained - hematite coats after pyrite
470	475			470-475	.004	4.40	12	28	380	1,300	5				1	2	2			2			
475	480			475-480	.006	.60	<2.	20	135	660	5					2	2			2			
480	485			480-485	.006	1.20	12	38	1,050	3,300	2					1	1						482-509 CALCAREOUS SHALY SILTSTONE - Maroon/purple, spotted with calcite blebs. Similar to unit above 250
485	490			485-490	.004	1.40	8	16	410	1,100	2					1	1						
490	495			490-495	.004	.80	16	16	130	690	2			1	1	1	1						
495	500			495-500	.030	1.20	12	14	32	520	2			1	1	Tr	Tr						
500	505			500-505	<.002	1.10	4	12	20	490	2			1	1	Tr	Tr						
505	510			505-510	<.002	.20	6	10	24	830	3			1	1	Tr	Tr						509-518 LIMESTONE - Pale green, mottled to purple - may be alteration (baking) of above unit
510	515			510-515	<.002	.80	4	6	110	510	3			1	1	Tr	Tr			2			
515	520			515-520	.002	.40	6	20	380	1,050	3			1	1	Tr	Tr			2			518-557 SANDSTONE - grey, medium grained - a few calcareous zones, calcite stringers - siliceous zones could be considered quartzite
520	525			520-525	.006	.70	14	205	530	1,100	2			1	1								
525	530			525-530	.006	.40	12	95	305	930	2			1	1								
530	535			530-535	.002	1.40	14	26	115	470	2			1	1								
535	540			535-540	.004	.20	6	20	180	950	2			1	1	1	Tr						
540	545			540-545	.012	.85	6	185	458	6,250	5			1		1	Tr						
545	550			545-550	.006	.25	8	75	630	2,800	3			1									
550	555			550-555	<.002	.30	10	22	165	990	2			1						1			
555	560			555-560	<.002	.15	8	24	60	570	2			1						1			557-573 CALCAREOUS MUDSTONE - Soft, green-grey - fine banding, hematite stringers - near upper contact. Mottled green 560-564 - purple 564-566 - may be altered. Numerous carbs to 3/4" dia 567-570. Abundant tan grained dia. pyrite 560-570
560	565			560-565	.002	.05	10	28	70	480	1			1						1			
565	570			565-570	.012	2.20	20	285	510	5,700	1			1						3			
570	575			570-575	.008	1.00	12	270	520	4,100	1			1						1			573-577
575	580			575-580	<.002	.15	12	10	105	1,000	1									.5			
580	585			580-585	<.002	.25	6	14	75	970	TR									.5			
585	590			585-590	.004	.30	6	60	145	4,400	TR									TR			CONGLOMERITIC CALCAREOUS SHALE - Purple - contact @ 30° to core axis.
590	595			590-595	<.002	.25	6	18	70	830	TR									TR			SANDSTONE / QUARTZITE - Similar to 518-557
595	598			595-598	.002	.20	10	14	50	890	TR									TR			577-598 QUARTZITE - Light tan, massive, minor dendritic MnO2 on fractures.
	598	BOTTOM OF HOLE																					

INCLINATION @ BOTTOM: -65°

BEARING: N 80 W



Looking Southeasterly



Looking Southeasterly

TRANSACTIONS

OF THE

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1903.

The Tombstone, Arizona, Mining District.

BY JOHN A. CHURCH, NEW YORK CITY.

(New York and Philadelphia Meeting, February and May, 1902.)

TWENTY years ago Tombstone was the most noted mining camp in Arizona. It presented a combination of fissure-veins and bedded deposits in relations which were most puzzling, and impossible to make out until the extensive development of the mines permitted every detail of the structure to be observed. These details have been studied with great success by W. F. Staunton, now Manager of the Congress mine, in Arizona, and subsequently by H. J. Gray, and the facts upon which the following description is based are mostly the discovery of Mr. Staunton, though confirmed by my own examination.

Tombstone is situated in a country that contains several important mines. On the south, at Bisbee, are the Copper Queen, which Prof. Douglas has described in our *Transactions*,* and other valuable mines; on the east the Commonwealth gold-mine and the recently opened copper-mines at Turquoise, or Gleeson, and the older Middlemarch and Black Diamond. Northeast are the Peabody copper-mines. The wolfram discoveries of two years ago were in the Dragoon mountains, towards which Tombstone looks on the north and east.

Though the town has no railroad at present, it lies but ten miles from Fairbanks, through which place both the Southern Pacific and the El Paso and Southwestern railways run, and it is expected that in a few months a cut-off on the latter road, between Fairbanks and College Peak, passing through Tombstone, will place the camp practically on the main line.

Its general situation is shown in the accompanying map. It lies on the Gadsden Purchase, and is in Cochise county, 25 miles from the Mexican line. The San Pedro river, at Fairbanks and Charleston, afforded an ample supply of water to

* *Trans.*, xxix., 511.

the old mills, and the water-supply of the town is drawn from the Huachuca mountains through a pipe-line about 25 miles long.

Considered as a whole, the formation consists of sedimentary beds in contact with an extensive eruptive mass of granodiorite; but with two exceptions (the Lucky Cuss and Knoxville) the best mines are not near the contact, and the eruptive rock does not underlie the productive part of the measures, unless at a depth greater than 3000 feet.

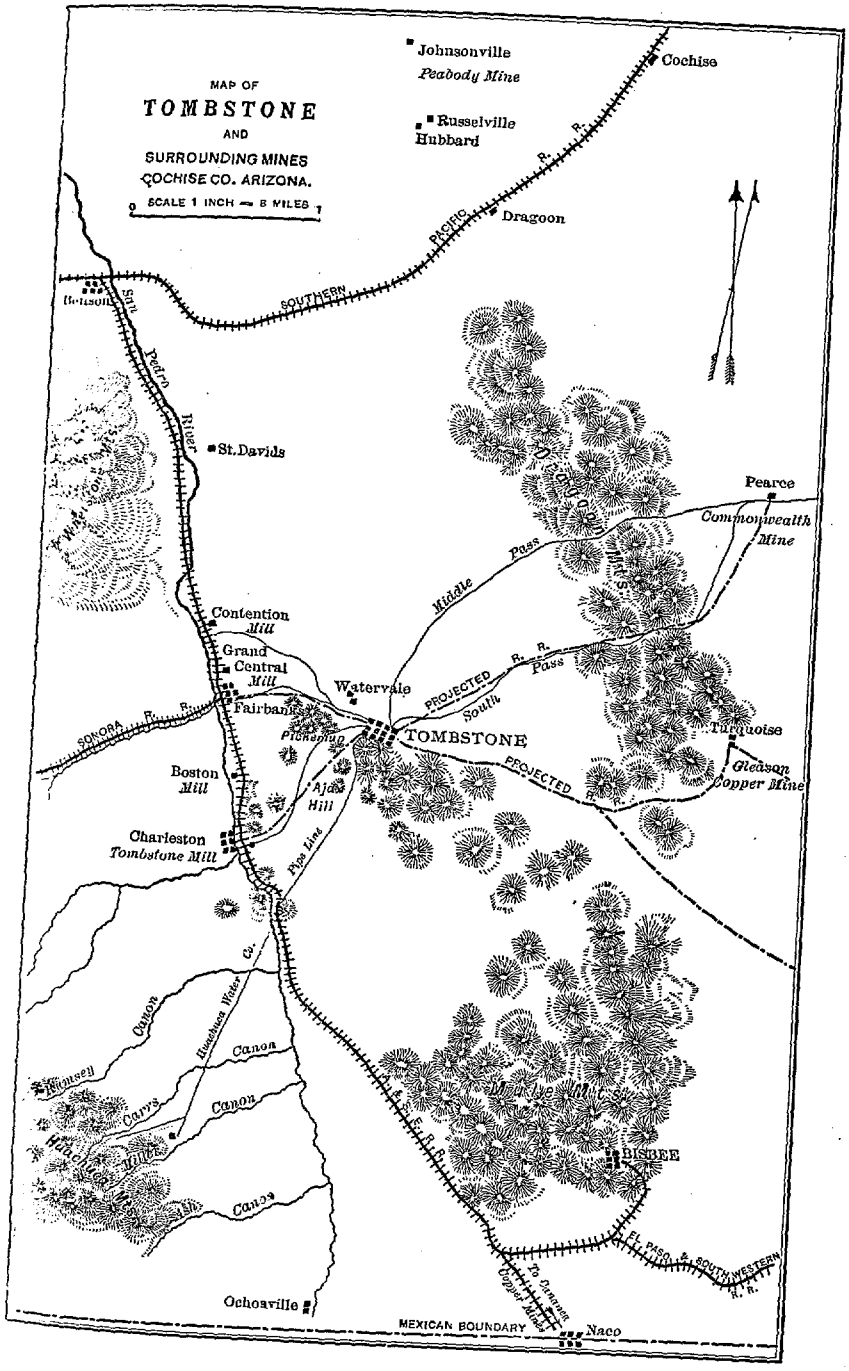
The Lucky Cuss claim has a fissure-vein within 300 or 400 ft. of the granodiorite, and has yielded nearly a million dollars; the West Side, another fissure-vein, is 2000 ft. from the contact, and has produced a million and a half; and the principal fissure of the district, which passes through the Grand Central, Contention and Head Center mines, and has yielded about twelve million dollars, is 4000 ft. from the eruptive rock. A few of the minor bedded deposits are 600 to 900 ft. from the contact, but their total product did not exceed $900,000, while the principal deposits of this type which have produced more than six million dollars are half a mile distant.

In a district like Tombstone, where surface-deposits of small extent have been opened at a great many points, exception can be taken to almost any statement that can be made, on the ground that ore has been found under conditions that do not agree with the general statement; but the preponderance which I have expressed in values could be given also in tonnage, if the books of all the mining companies had recorded the output by weight, and it is clearly shown by the comparative extent and permanence of the stopes and veins. It is by the study of the leading mines that the facts of the formation have been obtained. They show that the deposition of the ore has an intimate and interesting relation to the structure and dynamical history of the sedimentary rocks.

The observable measures of Tombstone consist of 2850 ft. of sedimentary strata, an intrusive mass of granodiorite and a surface-flow of rhyolite.

The Sedimentary Rocks.

At the bottom of the sedimentary series is the Randolph limestone, numbered I. in Fig. 1, so called from the mine of that name in the Charleston side of the district. A thickness


MAP OF
TOMBSTONE
AND
SURROUNDING MINES
COCHISE CO. ARIZONA.
SCALE 1 INCH = 8 MILES
Johnsonville
Peabody Mine
Cochise
Russelville
Hubbard
Dragoon
PACIFIC R. R.
SOUTHERN
Benson
San Pedro River
St. Davids
Pearce
Commonwealth Mine
Middle Pass
Contention Mill
Grand Central Mill
Fairbank
Watervale
PROJECTED R. R.
South Pass
SONORA R. R.
Pickaninny
TOMBSTONE
Turquoise
Gleason Copper Mine
Boston Mill
Ajax Hill
Charleston
Tombstone Mill
Pipe Line
Canon
Huachuca Water Co.
Canon
Hereford
Carr's Canon
Hilo Mill
Canon
BISBEE
E. & S. E. R. R.
EL PASO & SOUTHWESTERN R. R.
To Lavender Copper Mines
Ochoaville
MEXICAN BOUNDARY
Naco

of 300 ft. is allotted to it, as it is certainly more than 200 ft. thick. It has not been an important producer of ore.

Above it is the Ajax quartzite, II., a strong anticlinal in this rock forming Ajax hill, the highest elevation in the district, rising 900 ft. above the town. The Mamie and other mines have been producers from this rock, which is 500 ft. thick.

Over the quartzite is the Emerald limestone, III., 420 ft. thick. About the Emerald, the most important mine in it, this stratum consists of thin limestones interleaved with thinner shales. At other localities it is made up of thicker and purer limestones, with thicker beds of quartzite; but wherever seen it indicates variable conditions of formation. It contains several mines.

Next in the series is the Lucky Cuss limestone, IV., which has several productive mines besides the prominent one that gives it its name. Its thickness is taken at 400 ft., but in the southern part of the district it covers a great extent of country, and undoubtedly thickens rapidly, indicating steady and long continued subsidence. It is often fossiliferous, but metamorphism has made it difficult to obtain satisfactory fossils in any variety. It is full of crinoid fragments and imperfectly exposed corals, the crinoids being most abundant.

Upon this limestone rests the Herschel quartzite, V., which varies in thickness, but in the section given is taken at 270 ft., a minimum. At the surface it has a shaly structure, but in the East Side crosscut is found to be mostly a dense, fine-grained quartzite.

Above it is the first of the more important ore-strata, the White Lime, VI., 60 ft. thick. This rock, which has produced some of the most valuable ore-bodies in the district, has the usual appearance and softness of pure limestones, but in the ore-bodies and their neighborhood becomes very siliceous—so much so that Prof. Kemp, though deciding it to be limestone, found that the specimen sent him resembled a quartzite with lime intrusions. Its character as a limestone is undoubted; and the siliceous intrusion which characterizes it is probably to be ascribed to the solutions which brought in the ore, for it is not present away from the ore-bodies.

Above the white limestone lies the Toughnut quartzite, VII., 120 to 140 ft. thick. It is one of the three rocks first recog-

with low vertical stopes in a crevice or crevices, and another that shows some limestone, and may have formed in a limited bed of this rock. Another, which unites the Quarry and Girard anticlinal ore-bodies, lies on the Quarry dike, and extends vertically for 40 ft. There are other small irregular stopes near the same dike. Thus, though ore can make in the quartzite, special preparation seems to be needed for it. Of occurrences where ore makes in it in contact with an ore-body in limestone it is not necessary to speak. Such exceptions occur in all mines.

Over the quartzite is the third of the original ore-series, the Blue Lime, VIII., 90 ft. thick. Unlike the white limestone, this is a soft, deep-blue rock, a typical limestone; and it is remarkable, considering the silica imported into the lower members, that this rock has been unchanged, except in definite lines like veins or in limited areas. In general, the rock is pure.

In the places excepted, there is a dark-blue silicified fossiliferous limestone, evidently an alteration of the parent rock, in which no original characteristic except hardness has been disturbed. The blue limestone has been one of the best ore-carriers in the district, as might be expected from its softness and purity.

Finally, we reach the highest stratum with which we have to deal, known in Tombstone as *the* shale, IX., to which I will add the name Contention, as that mine has been the principal producer from it. It contains a heavy bed of quartzite, and many thin limestones and thin quartzites; but the ore-bodies of the fissure-veins go down through all its constituents, and it is sufficient to regard it as a single, though a composite, member. The Grand Central pump-shaft has penetrated it vertically for 681 ft., and is supposed to be still 150 ft. above the blue limestone. It forms the surface over most of the productive area, and its thickness there may be taken as 700 ft.

These four rocks—the shale, blue limestone, quartzite and white limestone—will sometimes be spoken of as the Toughnut series, from the mine where these leading members of the Tombstone formation were first recognized.

The limestones are non-magnesian, and often fetid, even when bleached nearly white.

Few recognizable fossils were found, though all of the limestones are fossiliferous. *Fusulina cylindrica* was found in the

quartzite above the Lucky Cuss limestone and *Spirifer rocky-montanus* in the blue limestone. An undetermined *Chætetes* and a *Productus* were the only other fossils obtained. The indications are that the Tombstone beds belong to the higher measures of the Lower Carboniferous, and, perhaps, to the Carboniferous.

The sedimentary rocks are folded into a synclinal about 4000 ft. wide, measured on the center line of the Toughnut claim, with a nearly east and west axis, which pitches from the granodiorite eastward. The outcrops lie in an irregular horseshoe which has a deformation near the point of the curve that suggests pressure against the granodiorite. They have not been traced beyond a point east of the San Diego mine, but the Lucky Cuss limestone continues there in a line of prominent hills eastward. Except the three Toughnut rocks, this is the only one of the series that can be found near the town—Comstock hill, a mound 100 ft. high, being composed of it.

The composition of these rocks shows that the geologic history of Tombstone was mostly a very quiet one. There are two or three pebbly limestones, and two or three conglomerates with quartz pebbles like walnuts, but nearly all the other rocks are of extremely fine grain. The Ajax quartzite and the thick one included in the shale series are of ordinary visible grain, but the others are mostly of shaly fineness though siliceous in composition. The land mass which furnished the material for these rocks probably lay to the north and west, and sufficiently distant to send only fine sediments to the locality under consideration.

The massive fine-grained quartzites of Tombstone seem to be nearly pure silica, the coarser kinds often containing a large proportion of highly crystalline feldspar, opaque and pink in color. As the quartz grains of the granular quartzites are often perfectly limpid, the combination of these rounded glassy grains with well-developed feldspar makes a product that resembles closely one of the dike eruptives. Other quartzites, less frequently found, have much hornblende. These impure rocks resist erosion better than the pure. Sometimes they have a linear direction like dikes, and I suspect these are to be affiliated with the lines of silicified limestone as a result of the action of hot water or hot gases.

Elevation succeeded the formation of the rocks, and the steep dips in places where it can hardly be attributed to subsequent history indicate that this movement was not insignificant.

The Eruptive Rocks.

The next step in the process of preparing Tombstone for its mineral wealth was the intrusion of an extensive mass of granodiorite. It has a maximum width of about 10,000 ft., and a length of 15,000 from its contacts on the south to the line where it disappears towards the north, under the gravel of the 12-mile-wide valley which separates Tombstone from the Dragoon mountains. It may have some relation to the granitic rock which forms the front of Cochise's stronghold in those mountains, and reaches several miles out in the floor of the valley.

This mass intruded somewhere below the lowest of the known measures, and faulted the rocks at the southern contact, lifting a block from which the sedimentary rocks have been mostly removed by erosion; but patches of them, and in one case a considerable hill, are found scattered over its surface. These patches are mostly limestone which contained a decided proportion of silt, if we may judge from the products of contact-metamorphism. Sometimes quartzite is found, and the composition of these remnants recalls the Randolph and Emerald limestones.

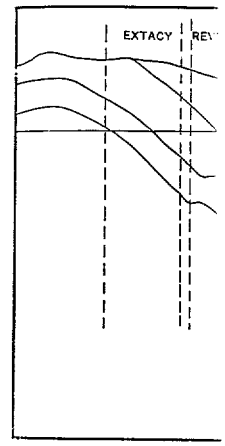
It is evident that the eruptive rock has suffered but little erosion except towards the valley. Near the southern contact it is possible often to walk on the original surface. This fact permits the minimum thickness to be calculated, for the upper surface is now on a level with the Herschel quartzite, and the granodiorite has risen 1600 to 1800 ft. above the level of its entrance, even if it intruded directly under the Randolph limestone.

The eastern face of this mass, on which the ore measures abut, is, so far as it can be observed, a sheer fault. At the Lucky Cuss a crosscut on the 140-ft. level reaches the granodiorite at a point vertically under the contact, and on the 340-ft. level a crosscut directly underneath failed to reach the eruptive rock, though pushed nearly to the same distance. The mine is nearly 700 ft. deep, but the dip of the vein takes the openings at the bottom about 600 ft. away from the granodiorite.

Northward from the Lucky Cuss the surface is covered by

gravel, and the e
eastern side; but
side, for a distai
presence of this
factors in Tomb
fault, and abuts
being about 4000

The surface-di
basin is shown i
SW. line throug
mine, on a line n
of the Lucky Cu



NE.-SW. Sectio

Grand Central a
their position in t

Fig. 3 shows t
to the Contention
that in Fig. 2. T
of the ore-bodies
the region of the
ture is exhibited
confined to the ro

The last additi
flow of rhyolite,
on the Charleston

f the rocks, and the steep
ttributed to subsequent
as not insignificant.

OCKS.

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on the south to the line
under the gravel of the 12
bstone from the Dragoon
on to the granitic rock
onghold in those moun
the floor of the valley.
v the lowest of the known
southern contact, lifting
rocks have been mostly
them, and in one case
over its surface. These
ntained a decided propor
products of contact-meta
und, and the composition
and Emerald limestones
k has suffered but little
ear the southern contact
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calculated, for the upper
schel quartzite, and the
above the level of its en
the Randolph limestone
which the ore measures
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evel reaches the grano
contact, and on the 340
failed to reach the erup
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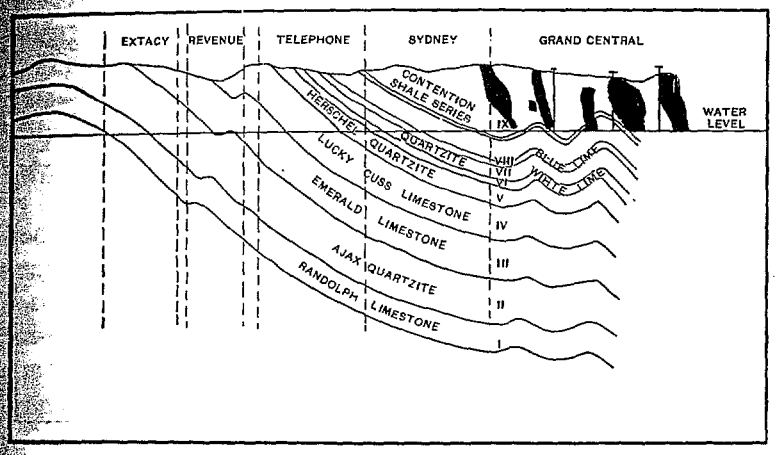
p of the vein takes th
away from the granodi

ie surface is covered by

gravel, and the eruptive rock is exposed only in gulches on its eastern side; but the conditions indicate that the whole of this side, for a distance of nearly a mile, is a fault-face, and the presence of this vertical face of rigid rock has been one of the factors in Tombstone's history. The western side is also a fault, and abuts on the Ajax quartzite, the width of the block being about 4000 ft., opposite the mines.

The surface-distribution of the rocks in the Tombstone basin is shown in Fig. 1. Fig. 2 is a section taken in a NE.–SW. line through, and nearly parallel to, the Grand Central mine, on a line north of the area where the extreme thickening of the Lucky Cuss limestone begins. The ore-bodies of the

FIG. 2.



NE.–SW. Section on Line Shown in Fig. 1, through Grand Central.

Grand Central are indicated in longitudinal section, to show their position in the so-called shales.

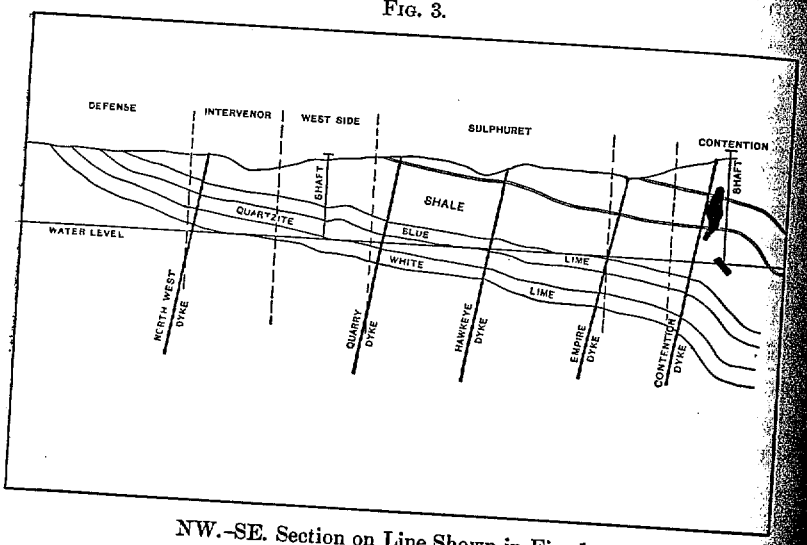
Fig. 3 shows the ore-measures from the outcrop at the town to the Contention mine, being a section taken at right angles to that in Fig. 2. The position of the dikes is indicated, and two of the ore-bodies of the Contention in cross-section. This is the region of the bedded deposits in limestone where the structure is exhibited by extensive mine-openings, and the section is confined to the rocks that outcrop here.

The last addition to the surface-rocks of the district was a flow of rhyolite, which covers an extensive field lying entirely on the Charleston side of the divide which separates that de-

funct town from Tombstone. Not even fragments of it can be found on the surface of the latter's territory. It rests on the Ajax quartzite, at least on its eastern side, and reaches from Ajax hill, which will be found on the map, northwest beyond Fairbanks and southwest to the hills on the San Pedro river, through which the Huachuca pipe-line passes.

Great numbers of dikes are found in the granodiorite, in the sedimentary rocks and in the rhyolite. In the first-named eruptive rock they run in all directions, and are remarkable only for their occasional small size. One of granophyre was

FIG. 3.



NW.-SE. Section on Line Shown in Fig. 1.

4 in. thick and 60 ft. long. The sedimentaries are especially rich in dikes at their contact with the granodiorite.

In that part of the sedimentary rocks where the ore-deposits are found the dikes are very regular in strike, parallel, and probably a mile and a half long, and they owe this regularity, probably, to the influence of the fault-face of the granodiorite. The fault runs nearly N., the dikes N. 23° E., dipping W. 80°. Against this fault-face, also, folds of the strata have been developed, whatever beginnings they had before, and the dips are steeper near it than elsewhere.

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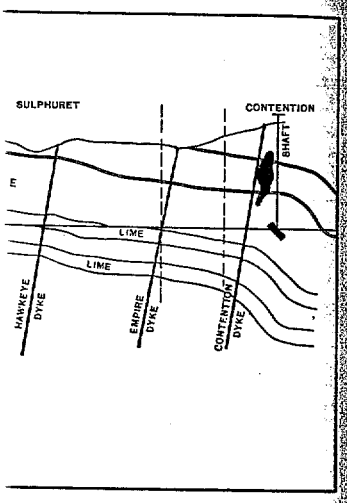

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none in other directions; but in the Lucky Cuss limestone and eastern part of the basin there are quartz-felsite dikes 150 ft. thick, striking N. 70° E.

The materials of the very thin dikes are always granophyre, usually a pink variety, with well-marked granitic texture, and these are abundant in the granodiorite, as also are dikes, usually much thicker, of a dark granophyre with large feldspars. It is the latter variety which is found exclusively in the dikes of the ore-ground, except one diabase dike in the Northwest and Vizina mines. Several diorite dikes are found in limestone near the contact, and though several feet in thickness, they are often very short. It may be that there is an uneroded portion in the limestone. They are probably a portion of the great eruptive mass in dike form, and have not been found at any great distance from it.

The two varieties of granophyre are not infrequently associated in one dike. The distinction made between them here is due to the absence of the pink variety from the ore-measures. An interesting occurrence of minette in granodiorite near its contact with Lucky Cuss limestone is referred to in connection with the mine of that name. In the rhyolite, dikes of quartz-augite-porphyrite and mica-hornblende-porphyrite were noticed. Erosion, of course, has been strong, for whatever mass was lifted up by the granodiorite has been removed almost completely; and this has been done since the rhyolite eruption, for the summits of that rock now stand 1000 ft. above the granodiorite and within half a mile of it. That flow would certainly have poured into the Tombstone basin, and left its traces there, if it had not been restrained by some lofty barrier.

It is to be hoped the United States Geological Survey will turn its attention to this interesting field, which is too extensive to be studied by private enterprise alone. The formations of the Whetstone, Dragoon and other mountains that encircle Tombstone stand in evident relations with each other and with the developments of eruptive rocks, which form a more extensive series than I have indicated. If properly studied, this would probably be found to be one of the simpler types of structure in Arizona.

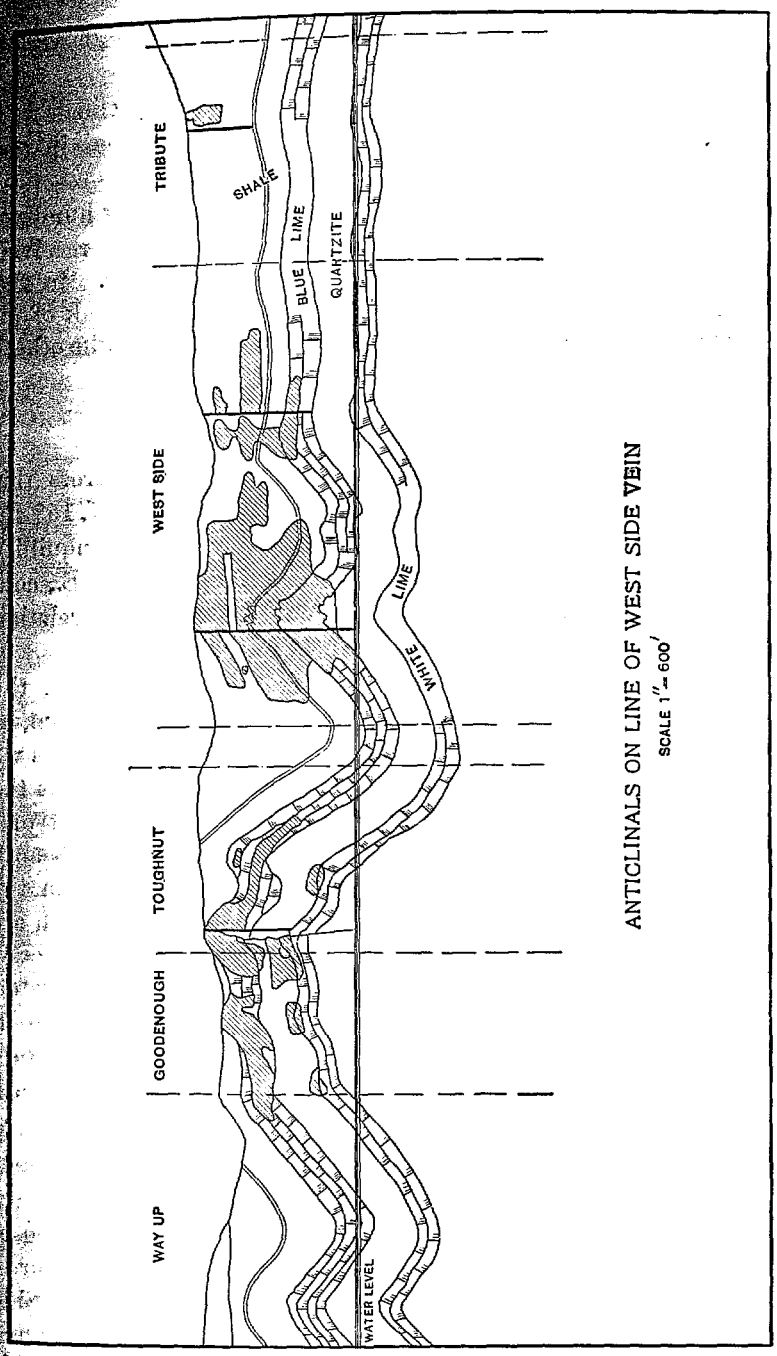
Position of the Ore.

There is nothing in Tombstone that indicates the original seat of the metals which formed the ore; but the structural conditions point strongly to some underlying source from which they have risen, through fissures, to be deposited in the fissures and in strata which had been prepared by folding for the entrance of solutions. The granodiorite has not acted except by its inertness, and the *rôle* of the dikes has been almost equally inferior. The rocks owe their ores almost entirely to the two results of pressure—folding and fissuring.

The folding is in two directions, producing anticlinals, with axes varying in direction from S. 15° E. to S. 65° E. from their outcrops, and monoclinal flexures which lie across the anticlinals. They are usually of gentle slope while the anticlinals are often highly compressed, and, in two or three instances, faulted. The level parts of the monoclinals sometimes rise a little, instead of descending; but the rise is too unimportant to destroy the contrast between the folds in the two directions.

The bedded deposits lie in the anticlinals, sometimes on the flank, sometimes in the apex; but the synclinals are barren. The monoclines do not seem to have limited the deposition of ore, which is found both where they dip strongly and where they are nearly horizontal. The compound surface produced on any stratum by these cross-folds, with their varying direction of axes and steepness of dip, is of unending variety, and undoubtedly has been a controlling factor in the distribution of ore, which is found in all shapes, from long, narrow tongues to broad sheets. There is nothing like the superposed saddle formation, made familiar to us by Rickard and others. In the Goodenough incline, especially, there are as many as three sheets of ore at different levels in the blue limestone, and they coincide vertically for portions of their extent; but they differ in the direction of their axes and dips. The simple anticlinal structure of the saddles is disturbed by the monoclinals.

Fig. 4 shows the anticlinal folding along the line of the West Side vein and across the Toughnut and Goodenough claims where the flat ore-bodies have been most important. It will be seen that there are two principal anticlinals, one in the West Side and one at the Quarry in the Toughnut. On the



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flanks of these are subordinate folds, which constitute the other anticlinals shown in Fig. 6.

One of the monoclinal flexures across these anticlinals has been plotted in Fig. 5, showing the irregular stopes in the Northwest mine of the Toughnut claim, which have received the name of Hoodoo. On this line there are great numbers of small, vertical crevices, which have sometimes received enough ore to join two overlying bodies together. In the section of this figure the ore-body B occupies the flank of an anticlinal which dips towards the spectator. A and all the others are seen in true section.

Compression-Fissures.

Two lines of vertical fissures are found lying across this system of anticlinals. On one, which has a strike of N. 15° E., the Grand Central, Contention, Head Center and Tranquillity mines are opened, while the other, striking N. 42° E., contains only the West Side mine. Their positions with relation to the anticlinal deposits are shown in Fig. 11.

The anticlinals are persistent from their outcrops on the Vizina, Goodenough and Toughnut claims, near the town, to the Contention and Grand Central, and in the fissure-veins we find the distinctive peculiarity of Tombstone, which binds the bedded deposits and fissures in one system. The largest ore-bodies of the fissures are found within the lines of these anticlinals, whether the fissure has been deep enough (as in the West Side mine) to reach the blue and white limes, which are the rocks that contain the bed deposits, or are still in the overlying shale (as in the Contention and Grand Central). The water level in the last-named two mines is calculated to be 150 ft. above the blue limestone, which contains the highest ore-bodies of the Toughnut series; but the influence of the anticlinals upon the deposition of ore in the fissures is as marked in the overlying shales through which the fissures pass in the upper levels as in the limestones of the bedded deposits.

The second result of dynamic action was the production of these vertical veins, which I regard as compression-fissures. They have been studied most thoroughly in the West Side mine, where the principal ore-body of the fissure was confined to a strongly compressed anticlinal about 450 ft. long. This

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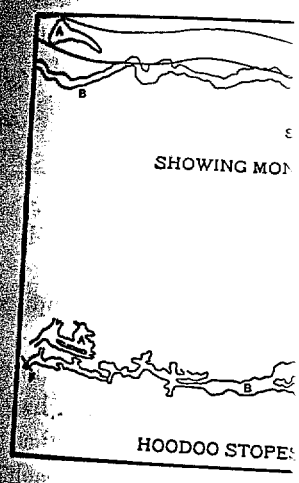

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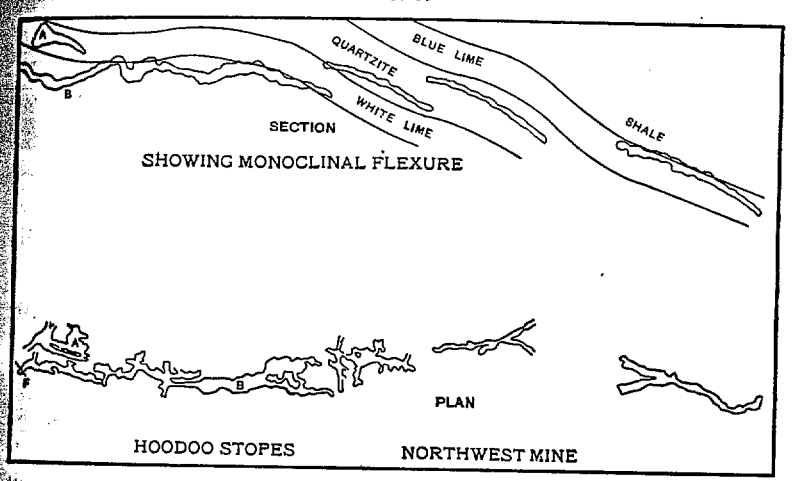
fold is succeeded on the north by a broad and barren synclinal and on the south by a narrow synclinal and a gently rising anticlinal. The fissure passes through shale for the first 200 ft. of its depth, and there is a small ore-body within the synclinal in the shale. It does not extend into the blue limestone below, and is probably due to secondary deposition.

There are at least three known parallel fissures within a width of 400 ft. at the West Side, two of which have yielded ore, though the West Side is the only important producer. The walls do not indicate faulting; and though a cross-fault of small throw is observable, it is probably a dislocation of slabs rather than of a section of the country.

Fig. 5.



Plan and Section of Monoclinal Flexure.

In Fig. 4 the ore-bodies shown in the West Side mine are all in the fissure, the anticlinal deposits stretching away from the vein on the side opposite the spectator. The ore-bodies of the Goodenough and Toughnut, on the other hand, are exclusively anticlinal. In order to show the grouping of the ore-bodies on the anticlinal, it was necessary, in a drawing on this scale, to project the flat bodies on their entire dip. The figure is faulty, therefore, in showing the ores of the fissure in section and the ores of the anticlinal in projection. Still, the figure exhibits the anticlinal deposition both in the beds and fissures, and the synclinal barrenness. Of the two ore-bodies in the West Side,

the one lying in the sharp anticlinal is markedly superior, both in size and grade of ore. The inferior one occupies the fissure where it passes through strata of gentle dip, and here there is no deposition along the anticlinal axis, as there is in the sharp fold.

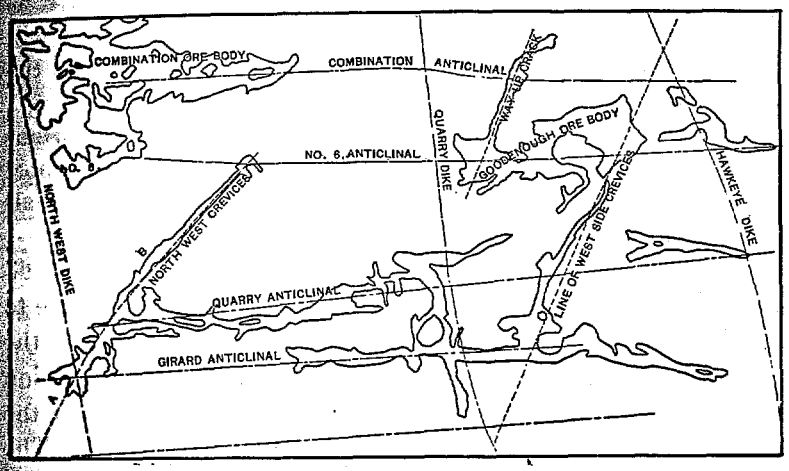
Although the Contention and Grand Central mines are not yet sufficiently cleaned up from the effects of the fires which closed them to permit examination, the extent of their ore-bodies is shown in a report made about 1890, by the late H. G. Howe, who was for many years the leading surveyor at Tombstone. He gives sections of the ore-bodies, reproduced in Fig. 8, which are taken from the south end of the Grand Central to about the center of the Contention. They show very clearly the combination of inclined anticlinal deposits and a vertical vein; and the relation of the two is more striking here than elsewhere in the district, because the two classes of deposits dip in opposite directions—the vertical to the west, the anticlinal to the east.

What is called commonly the Contention vein is a series of nearly vertical ore-bodies which extend northerly through the Grand Central, Contention, Head Center, Tranquillity and Silver Thread claims, a distance of nearly a mile. There was not one continuous vein along this line, but a series of large individual ore-bodies lenticular in cross-section, dipping to the west (with the dike) and pitching to the north. Thus, it is not to be supposed that the upper ore-body in Sec. 3, Fig. 8, has given out abruptly in full width. The figure shows a vertical section through an inclined mass, but the latter did not reach to the next section 320 ft. north.

There were several of these bonanzas in the 400 feet of shales that separate the Contention and Empire dikes, and in the shale east of Contention dike. Mr. Howe says the Grand Central had four "of these chimneys of ore," the Contention three, Head Center one and Tranquillity two. The largest of these is figured in Sec. 4, Fig. 8. Mr. Howe says it outcropped on the surface and extended to the 600-ft. level, pitching to the north; but the section shows that it was formed by three fissures in echelon. On the 300-ft. level it was more than 400 ft. long, and had a maximum width of 30 ft. A hundred feet lower it was 200 by 40 ft. These are large dimensions for so rich an ore. The sections

show that the ore-bodies lay in echelon, several of them appearing in some of the cross-sections, only one in others. It is probable that the parallel crevicing found in the West Side mine is present here also. Three sections show anticlinal deposits. Of that in Sec. 2, Fig. 8, Mr. Howe says: "This ore-body was discovered on the 300-ft. level, and followed up by a raise for 50 ft., where a large body of ore was discovered which lay almost flat; and development also showed that it pitched to the east, and a winze was sunk for 60 or 70 ft., following down upon its dip; but no drift was run along this ore-body at the bottom of the winze, and its extent is not known." No effort was made

FIG. 6.



Subordinate Anticlinals, etc., as Related to Ore-Bodies.

to cross-cut to this ore from lower levels. The three sections showing anticlinal ore-bodies are not successive sections, being separated by two others, in which only vertical bodies are shown. The meaning of this cannot be determined from the old maps, and partly for the reason that the anticlinal ores were not mined or even drifted upon, except one below the water-level, though the grade was good. The "East bodies" shown by Mr. Howe are opposite the anticlinals mined in the Toughnut series further north. The largest of the anticlinals has been followed on ore for 1150 ft. from the West Side vein, or about half the distance to the Contention. The disposition of ore-bodies along anticlinals was not generally known when

Mr. Howe made his sections, and it is probable that the Grand Central and Contention system consisted of nearly vertical ore-bodies along or near the dikes, and of others, more gently inclined, in anticlines crossing from one dike to another and beyond. The west dip of the vertical shoots and the east dip of the flatter deposits is strong evidence of this. The vertical ore-bodies were found in the center of the ground, between the dikes as well as under them.

This series of ore-bodies was the most productive of the Tombstone mines, and the explorations in depth are anticipated with great interest. When the great ore-formations of the district, the blue and white limestones, are reached by the Contention-Grand Central vein in the next 200 to 300 ft., it is expected that the conditions of maximum dynamic effect will coincide with the presence of the most favorable ore-rocks the district has had.

These compression-fissures are one of the most important features of the formation, and have probably been the most prominent factor in the introduction of ore, as the anticlinals have been in its distribution.

Until the Contention and Grand Central are opened sufficiently to allow of careful inspection, it will not be possible to say whether their ore-bodies occupy similar fissures; but the occurrence of ore in the middle ground between the Contention and Empire dikes, which are about 400 ft. apart, leads to the supposition that compression-fissures will be found there. The Head Center fault which cuts the Contention vein and dike is parallel to the West Side fissure.

Nowhere in the district is ore found in the shale except in the fissures, but its presence there proves that this rock was not unfitted for the reception of ore, by whatever method it was formed. The mobility of shale under pressure is supposed to prevent the maintenance even of minute openings, and the general absence of ore from this formation is new evidence of the controlling necessity of crevices as a preparation for ore. In Tombstone there is a contrast between the behavior under pressure of bed-seams and vertical crevices in the shale that is worthy of note. The weight of the rocks, which may not have been more than 500 or 600 ft. thick, was sufficient to close the bed-seams, but not to crush the vertical fissures, and the

delicacy of this difference is shown by the fact that a limestone 2 ft. thick has been mineralized for hundreds of feet on its dip, while the shale in which it is inclosed is barren. If such a stratum is what Mr. Bailey Willis calls "competent" enough to protect and keep open a bed-seam, the pressure of the overlying rock must have been small.

There is another kind of fracture which is found very abundantly in the blue and white limestones, and to some extent in the Toughnut quartzite, but not in the shale. Cracks of this class occurring in limestone often end abruptly at the contact with quartzite, and I suspect that is the rule, and that these crevices have been produced by a force that affected each stratum of rock for itself, without necessarily producing the same effects in other strata.

Torsion-Cracks.

The most important of these cracks is the Defence vein, which strikes N. 57° E. It is in outcropping blue limestone, and does not enter the underlying quartzite. Another is the Way Up crack, which has most of its length in the Goodenough. Its strike is about N. 65° E. Near it are two minor vertical stopes in the Goodenough incline, one striking E. and the other S. 83° E. On the 200-ft. level of the same mine there is one with strike N. 67° E., which has yielded more ore than any other except the Defence. None of these penetrate the shale, and the few stopes in quartzite nearly on the line of the Way Up crack are close to the Quarry dike, and probably due to its influence. There are some small vertical stopes in the quartzite on the Toughnut claim where the Hoodoo stope enters it; but here, as elsewhere in the quartzite, these crevices are few and insignificant, in comparison to those in the limestones.

The restriction of these crevices to the limestones and quartzite points to an origin different from that of the compression-fissures which penetrate rocks of all kinds and have vertical continuity. I am inclined to ascribe these inferior cracks to the results of torsion accompanying the deformation of the strata by pressure at an acute angle against the granodiorite, the results being produced in each stratum independently of the others. Being confined to the firm rocks, it might be expected that the brittle quartzite would show them most

prominently, which is contrary to the actual conditions; but the quartzite occasionally shows crushed areas where the rock has been broken to a mass of breccia, entirely non-coherent, for several feet in thickness, and these may show how this rock adjusted itself to a strain which made crevices merely in the limestones.

The crevices are most abundant in the area of Fig. 7, and especially toward the Defence vein, which is just outside the figure, below the lower left-hand corner. Fig. 7 is but a poor representation of the number and diversity of strike of those at the northern end of the Hoodoo stopes lying in that quarter. Probably not half of them were noted. Many are barren cracks; others make small vertical stopes confined to one or more layers in the limestone. The crevices here are not long, continuous cracks, though some run for a few hundred feet; and it is noteworthy that these are not the best carriers of ore, probably for the reason that their length and direction take them out of the narrow limits of anticlinal deposition.

Though the Defence vein is in blue limestone exclusively, the crevices shown in the same line in Fig. 7 are in the lower white limestone, the upper stratum being entirely eroded at this point, and they depart strongly from the strike of the Defence, the line curving until it is nearly east and west. Ore has been mined from the outcrop of the overlying quartzite, but it is obviously of secondary origin, and has no continuance in depth.

These cracks are found throughout the area of Fig. 7, but they are more abundant near the line of the Defence vein, which is in the area of greatest deformation, and on the line of the West Side fissure, which is 500 ft. or more below the right-hand half of the figure. There is no fissure passing through these places, no continuity in the cracks, parallelism or other connection between them. The whole Defence system belongs to what I will style these torsional crevices, and they are also strongly developed in the line of greatest compression in that neighborhood, the line of the West Side fissure.

Relation of the Dikes to Ore.

The third factor in the forces which have made the Tombstone formation is the series of dikes, the filling of which has

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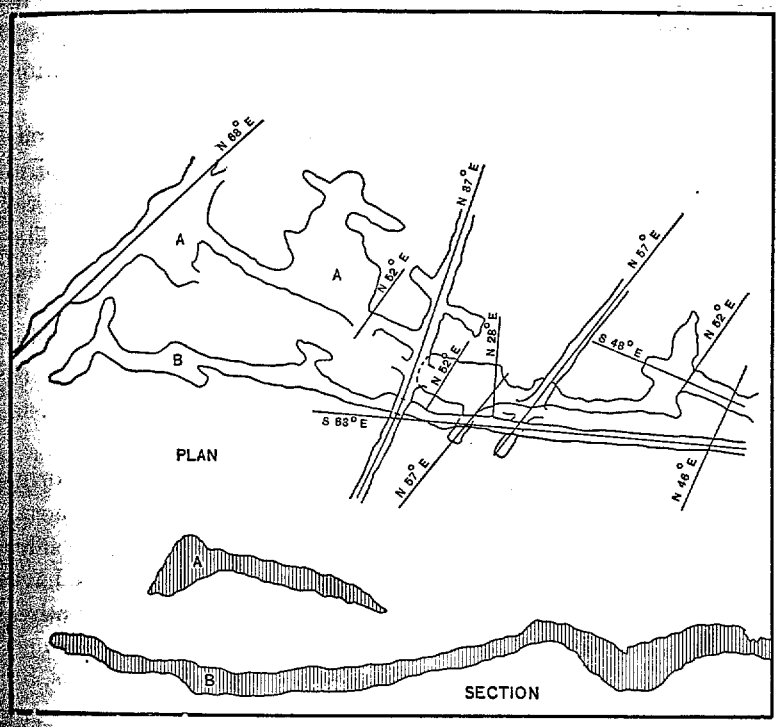
been determined as granophyre and diabase. Nearly all the ore derived from it has been taken from the 2500 ft. of ground lying between the Northwest dike on the west and the Contention dike on the east; but the deposition of ore is not confined to the space included between these two dikes. It has been mined in the Defence 500 feet and in the Ingersoll 1000 feet west of the Northwest dike, and in the Tranquillity some distance east of the Contention dike.

FIG. 7.



Plan and Section of Torsion-Cracks, Northwest Mine.

Fig. 3 shows that one of the principal vertical ore-bodies of the Contention and Grand Central is east of that dike. At least one of the anticlinal ore-bodies in these mines has the same position.

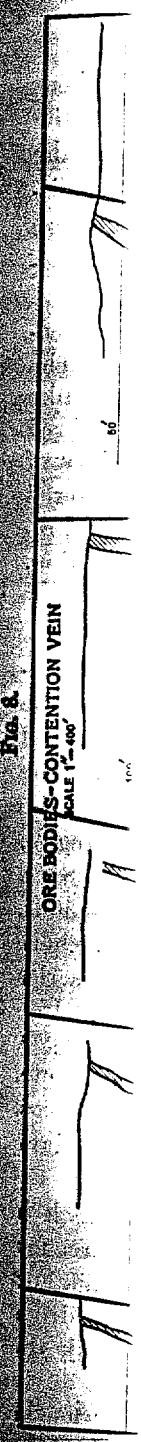
These facts show that the dikes did not have a limiting effect upon the passage of ore solutions. Locally they have modified deposition, but in general their presence was so inert that we must look elsewhere for the controlling factor, and that, as already said, is probably the two results of pressure—folding and

fissuring. All these elements of the problem, except the fissures, are combined in Fig. 6, which shows the ore-bodies (in outline) of the blue and white limestones, the axes of the anticlinals, the directions of some of the crevices, and the positions of the dikes. It shows that along the Quarry dike there is ore connecting the deposits of the Quarry and Girard anticlinals, and that on the Hawkeye dike there is some spreading of the ore in No. 6 anticlinal. The Combination and other ore-bodies begin at the Northwest dike; one small deep-lying ore-body in white limestone ends at the Hawkeye dike. These occurrences are, however, very inferior in importance to the deposition along the crevices and anticlinals.

This figure covers the territory of the Toughnut and Goodenough mines, with a portion of the Hawkeye and Empire. The names given to the different elements of the figure refer, of course, to mines and particular openings in mines. The Northwest and Quarry are both on the Toughnut. Combination, No. 6, Goodenough and Way Up are all on the Goodenough. The crevices are named from the places of their principal development. Each class of occurrences exhibits more or less parallelism in its members, but there is no parallelism between different classes.

In no case that I have found has a dike been a seat of original ore-deposition. The ore-body in the Toughnut quartzite along the Quarry dike is in the slabbed ground by its side, though the dike is thoroughly decomposed. The dikes have been drifted on and cross-cut in the anticlinals, and in all other situations, and the trivial amount of ore they have yielded must be attributed in part to secondary deposition, aided, perhaps, by the quickly diminishing influence of some crevice. In the Contention and Grand Central, where it is probable the deposition of ore has been determined by strong fissuring, the dikes may have been more affected than elsewhere; but all that is known about those mines indicates that their ore-bodies lay near, but not in, dikes.

On the surface the dikes often retain their original character unchanged, and their outcrops can be distinguished at a glance. Underground they are completely decomposed, and it is often impossible to distinguish between the rocks derived from them and from the quartzite. On the other hand, in the fissures it



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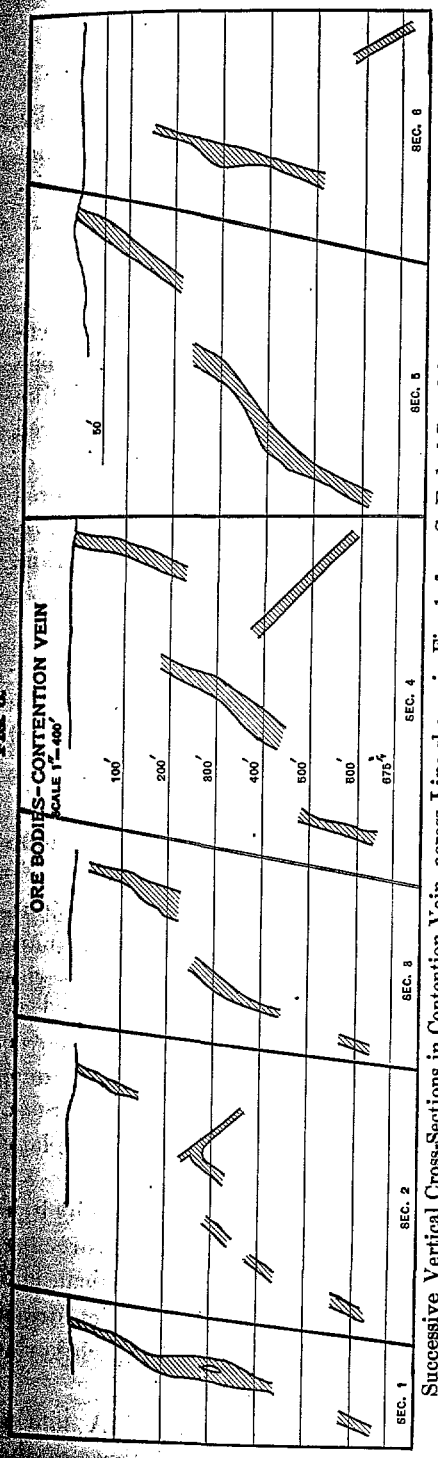

FIG. 8.

Successive Vertical Cross-Sections in Contention Vein, across Line shown in Fig. 1, from S. End of Grand Central to Middle of Contention.

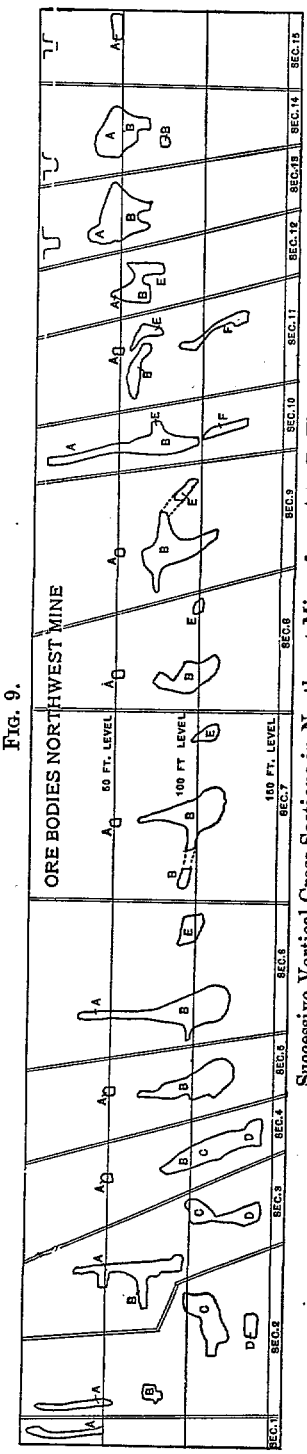

FIG. 9.

Successive Vertical Cross-Sections in Northwest Mine, from A to B, Fig. 6.

is common to find an ordinary appearing quartzite where there should be none of that rock, and with curious frequency the phenomenon is found on one side of the vein and not on the other, though in a few feet more the crossing of a stratum disproves the possibility of faulting. Apparently the vein, before its decomposition, acted as a dam, on one side of which silicification took place, while the other side was free from it.

It is odd that the conditions of dike-decomposition mentioned are not found outside of the especial ore area. The Comet mine has passed through decomposed to unchanged dike in 400 ft. In the granodiorite many of the dikes have suffered so much surface decomposition that they are now oxides of iron, calcite, etc., in a feldspathic magma. They resemble altered limestone, but in a few feet their original texture returns, reversing the conditions found in the Toughnut and Contention.

Ore-Deposition in Limestone.

It is evident that the Tombstone ores are the product of replacement, both in the crevices and the anticlinals. In the latter, especially, alteration-products, of the sort usually found in limestones, are common and are often rich in metals. The capriciousness of the attack of the ore-bearing waters upon the limestone is sometimes extraordinary, especially in the region of torsional fracturing. An example is shown in Fig. 9, Secs. 1 to 15, made from careful measurements of the 50- to 150-ft. ore-body in the Northwest mine on the Toughnut claim, where torsional cracking is especially strong. This body, or series of ore-bodies, extends almost from the surface to near the 150-ft. level, and the sections, taken from A to B, on Fig. 6, cover a length of 250 ft. The ore is entirely in the white limestone, with the overlying quartzite showing in a surface cut in Secs. 13, 14 and 15. The ore-bodies that lie in one vertical plane are enclosed in a panel numbered for each section.

The ore began near the shaft in a vertical fissure which is marked A throughout the series of sections. In Sec. 2 three flat ore-bodies, marked B, C and D, came in below the vertical, and Sec. 3 shows that one of these joins the vertical, which drops down about 40 ft. in a horizontal distance of 15 ft., while the other two stopes have coalesced.

In Sec. 4 the vertical stope has disappeared, and A marks the position of a drift along the crack. Now all three of the

flat stopes have run together, and form an inclined body with a steep dip, but not vertical. In Sec. 5 the vertical comes in again, joining the highest of the three flat stopes in Sec. 2, and in Sec. 6, only 6 ft. distant, the vertical stope has gained no less that 40 ft. in height. Meanwhile the two lower ore-bodies, C and D of Sec. 2, have disappeared, and do not appear again until we reach Sec. 9; but in Sec. 6 a new ore-body, E, comes in, which continues through seven sections. Only one of the flat ore-bodies has marked persistence. B of Sec. 2 continues through a variety of changes to Sec. 14, and it is notable that the whole series begins and ends with the vertical stope A standing alone, though it has frequently disappeared entirely in intermediate sections, and in Sec. 15 looks like a flat stope. In Sec. 10 a new ore-body, F, comes in, which is the beginning of the Hoodoo ore-body along the Quarry anticlinal, Figs. 5 and 6.

A study of these sections shows that there is nothing like a vertical vein in this place. There is verticality in certain stopes along one line for a short distance; but as an ore-body it is fully as irregular as the most variable of the flat stopes, and it is less persistent than one of the latter. It is entirely probable that the vertical arrangement which the flat stopes assume when they coalesce is due to the existence of other cracks in their path. The deposition of ore may have changed from one crack to another, limiting itself to a certain width, within which lie the flat stopes which show by their dip that their shape and position have been determined by the anticlinal folds.

This is well shown in Fig. 5, which is a plan and section of the Hoodoo stope, in the same Northwest mine. Its beginning is the stope F of Secs. 10 and 11, Fig. 9. The position of Sec. 10 is shown on Fig. 5 at F. The strike of these two series of ore-bodies is nearly at right angles. On the lower edge of the plan, Fig. 5, beginning at F, narrow stopes will be noticed following one general horizontal direction. This is the line of the Hoodoo crack, which is ore-bearing only at isolated points. Whether it is one continuous crevice or a series of nearly parallel cracks crossed or touched in slight echelon by the flat stopes cannot be determined. The general conditions of the deviced area incline me to believe that the ore is not always in the same crack. As in Fig. 9, the vertical deposition of ore

is very limited. Besides the Hoodoo crack, there are several others at various angles that show vertical deposition for small heights.

The silicified fossiliferous blue limestone already mentioned is another product of this fissuring, and also of replacement. It is found on the surface and underground in lines of limited length, appearing like veins, and in the mines areas 100 ft. wide have been passed through. They consist of this silicified rock, with scores of open crevices several inches wide. Nothing like this is known in the white limestone. This replacement was not accompanied by metalliferous deposition, except to a feeble extent. Assays of 1 to 3 ounces of silver are sometimes had from the rock, but not always. There is no recognizable relation of this rock to the ore-bodies. It is found both near to and distant from them, and is, perhaps, the only rock in the district that shows no sign of yielding to the influence of secondary deposition. This may be due to the filling of the pores in the original rock by silica before the replacement began.

Some of the thin limestones lying in the shale have been ore-carriers in the vertical veins and anticlines, and the richly mineralized layer which was called the East body of the Contention was probably one of these shale limestones.

Manganese of the Lucky Cuss Mine.

Of the mines in the lower measures, the Lucky Cuss, Fig. 10, is the most interesting. It lies within 400 ft. of the granodiorite, and outcrops about 350 ft. from a dike which Prof. A. A. Julien determined to be a minette, and which lies in the granodiorite close to the contact with limestone. A mass of this rock, 15 ft. thick, encountered below the 350-ft. level, is attributable to an apophyse from the dike. A section from it showed some chlorite, which seems to be absent from the dike. Similar occurrences are found in the Combination ore-body and elsewhere, but none so far from a dike as this.

The Lucky Cuss has had two principal ore-bodies, connected by a cross-shoot at about the fourth level, and several pipes of manganese ore, of which only one is shown in Fig. 10. Most of them are of limited depth; but this one, though otherwise of small dimensions, had a vertical depth of 350 ft.

The origin of the manganese in this mine, and also in the Knoxville and others, is a question of great interest, and was

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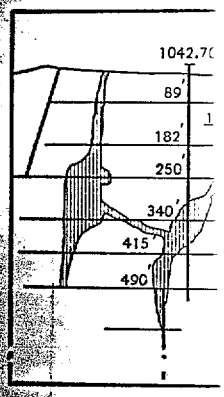

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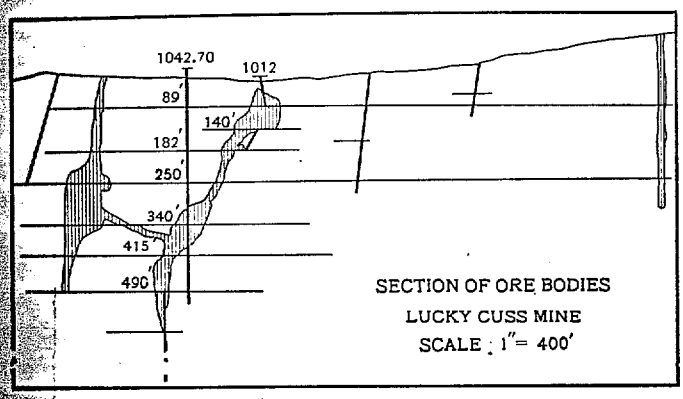
* Trans., xvii., 767,

discussed by C. W. Goodale in a paper before the Institute.* The subject received enlightenment when, under the tongue of minette on the 350-ft. level of the Lucky Cuss, a mass of rock was found which was rich in alabandite, or manganese sulphide, mingled with galena and pyrite. In this position, protected by the dike-rock from the infiltration of surface-waters, the original form of the manganese seems to have been preserved. It is difficult to believe, however, that all the manganese-oxide deposits, which usually form pipes disposed in an erratic manner over the surface of the limestone, represent old deposits of alabandite in place. I am disposed to regard some or all of them as secondary depositions derived from masses or impregnations of the sulphide in the limestone, and prob-

FIG. 10.



ably, in part, from its eroded portion. There is some manganese-oxide in all or most of the Tombstone mines, but the quantity is small in the strata above the Lucky Cuss limestone. This and the Emerald limestone produce basic ores wherever opened; but, as Mr. Goodale has pointed out, the true manganese-ores are confined to two localities. The first comprises a series of mines, the Knoxville, Wedge, Lucksure and Lucky Cuss, lying very near the contact of the granodiorite. The second group, containing the Emerald, Bunker Hill, Rattlesnake and Mammoth, is about a mile S. of E. from the contact, and the Comet is still farther away. This group yields basic ore, but the proportion of iron and lime is greater, and of manga-

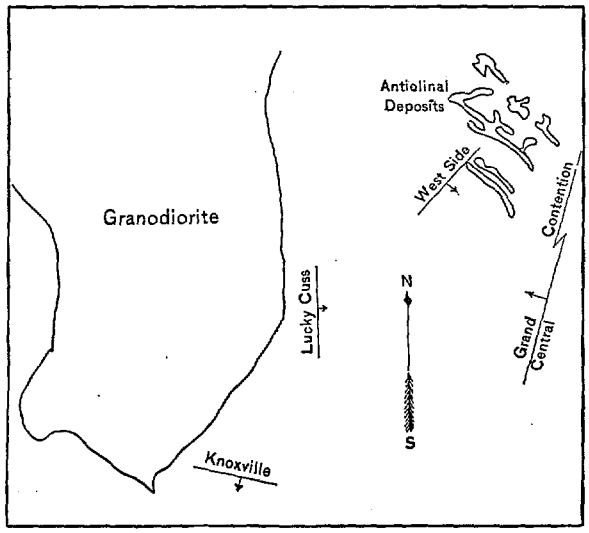
* *Trans.*, xvii., 767, and xviii., 910, with section of ore-bodies.

nese much less, than in the mines near the granodiorite. In both groups the manganese seems to decrease with depth.

The most extensive deposits of manganese are those of the Lucky Cuss and Knoxville. The Lucky Cuss has a fissure with chamber deposits of small extent reaching from it into the limestone walls. The Knoxville is described by Mr. Goodale as a series of four ore-shoots lying in the line of a continuous closed crack. The relation of these two mines to the granodiorite is shown in Fig. 11.

The distinctive manganese deposits are the only ones in the

Fig. 11.



Plan, Showing Relation of the Contention and West Side Fissures to the Anticlinal Deposits, and of the Lucky Cuss and Knoxville Mines to the Granodiorite.

district that indicate by their position an intimate connection with the granodiorite. The mines in the Randolph limestone which also yield a basic and somewhat manganiferous ore, are about 3000 ft. from the contact. The presence of alabandite under an apophyse which is derived from a dike in the granodiorite, and the occurrence of the Comet ore under a granophyre dike, are indications that the entrance of manganese did not follow immediately upon the intrusion of granodiorite. It must therefore be ascribed to aqueous deposition. There is strong evidence that the bodies of oxide are depositions from solutions, but it cannot be determined whether they always

cupy the position of original sulphide bodies, which they have enlarged, or have sometimes entered barren cracks and replaced the limestone walls. The Lucky Cuss ore, which was so rich at the surface that slags made from it contained 43 per cent. MnO, gradually lost manganese and gained silica and lead. This vein undoubtedly received large accessions of oxide as a secondary deposition. Something of the same kind seems to have taken place in the Knoxville, where, Mr. Goodale says, the ore-pipes had a siliceous center, surrounded by a richly manganiferous shell next the limestone.

All the manganese-ores were very poor in gold at the surface, and I believe the Knoxville did not change; but the Lucky Cuss improved so much that the ore below the water-level contained $12 per ton of this metal. The alabandite of the Lucky Cuss was not a solid mass of that mineral, but a local enrichment of the sulphides of manganese, lead and iron, the greater portion of the mass being silica and limestone, though there were masses of the manganese sulphide several hundred pounds in weight.

The Comet mine, the largest of the manganese deposits, is an instance of the wide extent of ore-deposition in the district, lying 2200 ft. east of the Grand Central. Active deposition has taken place over an area in the Tombstone basin about 10,000 ft. long from north to south and 7500 ft. from east to west. This does not include the mines on the Charleston slope.

The Comet vein lies under and in contact with a granophyre dike 60 ft. thick, and has been mined for a length of 2000 ft., and to the 400-ft. level. Its ore is valuable for its fluxing quality, besides the silver.

Mines in the Rhyolite.

A mine of great interest from its position in the rhyolite is the State of Maine. The rhyolite on the side nearest Tombstone is poured out on the Ajax quartzite. In the State of Maine there are two nearly parallel veins in the rhyolite which reach down to the underlying quartzite, 375 ft. deep on the inclination of the shaft and 240 ft. vertically. The quartzite has been cracked by the heat to a shaly condition, or at this point one of those changes of composition which are frequent and sudden in this district may have occurred.

The sedimentary rocks are folded, and at one point appear

to be broken. It is possible that the rhyolite takes the form of a dike there, about 60 ft. thick, but the question cannot be determined until greater depth is reached or the rhyolite is cross-cut. The veins are from 2 to 7 ft. thick, and quite irregular in strike, so that they come to a junction with an angle between them of 20°. When parallel they are about 50 ft. apart, and both dip NW. 45°. These interesting veins have been very profitable for the amount of metal they have yielded, which was probably $600,000. The mine is not now in condition for proper examination, but the stopes resemble strongly those in limestone. The hanging is a smooth continuous wall of rhyolite, the veins very soft and decomposed, and apparently they carried ore in individual ore-bodies rather than a continuous vein. Their average strike is N. 35° E., and dip of the incline 40° N. 55° W. The dip varies from about 33° to 48°, with much larger variations for short distances. The ore was manganiferous and rich in silver.

There are many other openings in the rhyolite, and the mineralization of this rock appears to have been quite extensive, though the number of profitable mines was small. The Maine was the most successful, and the San Pedro, near it, probably stands next in productiveness. The Bronco, near Charleston, 7 miles away, is in siliceous schists, entirely surrounded by rhyolite. It is the oldest mine in all this region, having been a developed property before the outcrops of Tombstone were found. It has had a most checkered history, and is now worked with more vigor than ever before. In general, I believe the veins in the rhyolite have had rich ore, but have been small and irregular.

Faults.

One of the curiosities of Tombstone is a fault in Emerald gulch with shale on one side and caliche on the other. Its strike is N. 32° E., dip E. 80°. A shaft in it is 20 ft. deep, without disclosing the full extent of the throw. This interesting fault is shown in Fig. 12. It is marked by the usual zone of laminated or crushed material, which contains both caliche and shale fragments. As the caliche is entirely a product of local erosion and modern calcareous cementing, and must have been formed since the time of powerful erosion, this fault, which seems to be equal in throw to others in the district, must be quite recent.

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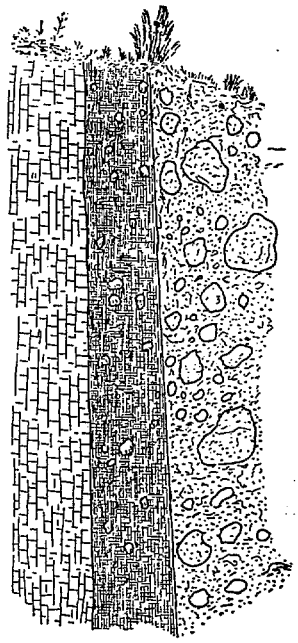
On the hill back of the Grand Central mine there is an open crevice which is said to have opened, or at least enlarged, within recent years. It is therefore commonly attributed to the caving of the stopes in that mine, its strike, N. 32° E., being about the same as that of the ore-bodies. This explanation is not satisfactory, for the thickness of rock between it and the stopes would, in this locality of shaly quartzites, be sufficient to fill the widest stopes of the Grand Central without producing any effect upon the surface. The parallelism between this open fissure and the caliche fault is suggestive. They are about 3000 ft. apart, the crack being nearly due north from the fault.

FIG. 12.



Fault between Shale and Caliche in Emerald Gulch.

There are several faults in the district, but none of moment. The largest vertical fault known is in the Empire part of No. 6 anticlinal, 50 ft. The Quarry anticlinal is faulted 35 ft. Of cross-faults, the best known is on the Contention-Head Center line, where the dike and vein have been shifted 120 ft. horizontally. There is also a small horizontal throw of 20 ft. in the Empire dike, and others noticeable in the outcrops of the shale limestones. The anticlinal faulting preceded the deposition of ore. In the Empire there is ore under the shale on the upthrow side, but none on the downthrow side. In the Quarry fault there is ore on both sides, but here we have not only one of the strongest anticlinals in the district, but a dike just through the outcrop. There is no sign of an ore-body faulted after its deposition. The dikes do not seem to have caused faulting, no instance of it being known. The torsion-crevices, on the contrary, frequently faulted the ground. In the Hoodoo stopes there is occasionally a jumble of limestone and quartzite blocks, but with small throw. The Head-Center fault is interesting because it is

closely parallel to the West Side compression-fissure and crosses the Contention vein at an angle of 30°.

With this example of faulting in a crevice, it is somewhat remarkable that the West Side fissure shows no faulting, but abundant disproof of it. There is some slipping of slabs on each other, but very little, and the bedding-lines across the drifts prove that there has been no general movement. The West Side and Contention represent the strong lines of compression-fissuring, and no faulting along their lines is known.

Ratio of Gold and Silver.

The entire yield of Tombstone is estimated at 163,000 ounces of gold, 21,500,000 ounces of silver, and 5000 tons of lead. The losses by pan-amalgamation, which was the method by which most of the product was obtained, would require an addition of 15 per cent. to the gold and silver to obtain the gross total of these metals, making somewhat more that 187,000 oz. gold, and 22,500,000 oz. silver. The proportion of gold was, therefore, only 0.827 of one per cent., by weight, of the precious metals.

The total value of all products as marketed was about $25,000,000, to which about $4,000,000 must be added for losses, and somewhat for unreported product. Some mines report only their net returns, leaving the expenses of marketing to be surmised, though they belong to the net yield.

The mines varied extremely in their proportions of gold and silver. The Contention and Grand Central produced about 20 gold to 80 silver, by value, which corresponds to about 1 ounce gold to 80 ounces silver, as the latter metal was worth about $1 at that time. Other mines show a much smaller proportion, the Tombstone Mill and Mining Company having 1 gold to 18 silver, and in mines which were confined entirely to superficial deposits in limestone the proportions may have fallen to 1 : 49 by weight.

The relative proportions of gold and silver in the ore form one of the most interesting and important problems of the district, and there are indications that a favorable change is taking place with depth. The gold value was greater in the fissure veins than in the anticlinal deposits, and it improved in both going downward.

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90 ft. below the water-level gave an average assay of more than $100 per ton in gold, and this was in an anticlinal deposit. The condition in the vertical bodies is not reported. In the West Side the ore found at the lowest points mined in the anticlinal, 1150 ft. from the vertical vein, yielded $17.20 per ton as the average of 55 shipments, which is probably four times the average of the West Side vein near the surface.

The same increase is found in both vertical and flat deposits. The Lucky Cuss, which had little more than a trace at the surface, produced ore worth $12 a ton below the water-level, and the last two shipments contained 1.7 ounces, or $35 a ton. The lowest ore of No. 6 anticlinal yielded 1.63 ounces, or $33.58 per ton, as the average of 71 shipments. The ore now mined in the Tranquillity is also rich in gold.

While these are merely specific instances, we obtain from the books of the Tombstone Mill and Mining Company a comparison of the product by periods, which is more exact and also more instructive. From June, 1879, to March, 1884, inclusive, that company produced 10,931 ounces of gold and 3,459,555 ounces of silver, or 1 : 317. From March, 1884, to December, 1898, the product was 26,745 ounces gold and 3,247,603 ounces silver, or 1 : 121, the proportion being 2.6 times as high in the second period as in the first. The only mine opened from the grass roots in the second period was the Lucky Cuss. All others were opened in the first period, and had their deep mining in the second period. This company mined two fissures and nearly all the anticlinals in the camp, and its results must be received as representative of the true conditions in the district. This increase of gold with depth is as interesting in a scientific sense as it is important to the future prosperity of the district.

If I understand Prof. Comstock* correctly, he ascribes this increase in gold tenure to impregnation following an ancient uplift and folding, which was succeeded by a later uplift that brought in silver, the latter being geologically higher than the ores of the first deposition.

Confining myself to this district, without considering evidence to be obtained from other districts in Arizona, I do not find facts at Tombstone to sustain his view. There have been two well-marked periods of folding there. One preceded the

* "The Geology and Vein-Phenomena of Arizona," *Trans.*, xxx., 1038.

intrusion of the granodiorite; the other came after the intrusion, and crowded the strata against the eruptive mass, producing effects strongly marked in its neighborhood; but I see no evidence of different ore-depositions after these events. The entrance of all the ore was later than the second folding. The difference of level in the Goodenough incline between the poorer gold-ores of the surface and the richer of the Empire is less than 300 ft., the continuity of the ore is complete, and the ore itself is as uniform in character as oxidized ores ever are.

Roughly speaking, about half the gold and silver produced in Tombstone has been taken from the upper shales, about a third from the blue and white limes, and most of the remainder from the Lucky Cuss limestone at various points of its extensive outcrop. The quartzites over and under the white lime have carried the least ore, but neither of them has been reached in the larger fissure-veins which have had richly paying ground in the quartzite included in the upper shale. The Toughnut quartzite was ore-bearing in the West Side mine.

The town of Tombstone occupies a flat gravel mesa, or table, quite level for a width of a third of a mile from north to south, and sloping gently to the west for a mile and a half. The gravel lies on the anticlinal shown on the extreme left of Fig. 4, and the white limestone of Combination and No. 6 anticlinals outcrops on the southern side of the town. Toughnut gulch is a natural boundary on that side, and, with the exception of Comstock hill, the rock exposures stop at the gulch. Some do not reach it, being covered by gravel. To the north is a waste of gravel, which a shaft near the town penetrated for 300 ft. without reaching rock.

After lying idle for several years, the reopening of the Tombstone mines has been undertaken by gentlemen who were prominent in the early mining of the district. A new shaft, with two hoisting compartments 4 by 7 ft. and two pump compartments 5 ft. 9 in. by 7 ft., has been sunk near the Contention fissure, and has reached the water-level at a depth of 569 ft. This work was done and the shaft strongly timbered in less than five months. Pumps to throw 1750 gallons a minute will be installed. It may seem remarkable that pumps of such capacity should be needed in a region that is not on

arid, but one where the underlying rocks receive an unusually small part of the rain that falls. The caliche which Prof. Blake described in a recent paper* covers a large part of the district and sheds the surface-water, and the run-off is abnormally large. The calculations are made on the results of pumping done in 1884, when about 1,500,000 gallons a day were thrown out. The water has never returned to its old level by 6 or more feet; and, though there is a great body of water in the ground, it is believed that, when once removed, the rocks will be permanently dry.

The water-level on the west side of the granodiorite is about 250 ft. higher than on the Tombstone side, which may indicate a great depth of rhyolite between the mines there and the San Pedro river, 6 miles distant and 400 ft. lower.

One of the principal objects of my examination of the Tombstone district was to ascertain what measures are likely to be encountered below the water-level. The presence of the "granite" formerly led to the supposition that it underlaid the town and ore-bearing rocks; but the evidence contradicts that impression. The mines still have about 2000 ft. of known sedimentary rocks under them, and perhaps much more.

The revival of these mines is a matter of more than usual interest, for it is based upon convictions derived from a knowledge of the structural geology of the district, and this knowledge is in no sense a theory nor an ordinary scientific explanation of facts. The mines in the anticlinals were managed for years in the light of this knowledge, and thousands of feet of drifting was done to reach anticlinals at the contacts of their rocks. The work began on a theory of Mr. Staunton's, but repeated successes soon lifted it from the plane of reasoning to the solid basis of experience.

It is this experience which will guide operations in future, and the projectors have the greatest faith in their successful outcome. All the fissure-veins, all the most productive mines in anticlinals, and many of second importance, have been consolidated in one ownership, as was necessary before a company could be formed to pay for draining the entire district.

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* *Trans.*, xxxi., 220.

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1889.

before the stripping began. The whole quantity is now awaiting the results of experiments in progress, to determine the details of subsequent treatment. At the present time the material hoisted is almost wholly first-class and lean ore.

THE OCCURRENCE AND TREATMENT OF THE ARGENTIFEROUS MANGANESE ORES OF TOMBSTONE DISTRICT, ARIZONA.

BY CHARLES W. GOODALE, BUTTE CITY, MONTANA.

(Utah and Montana Meeting, July, 1887.)

THE attention of the Institute has been called by Prof. John A. Church* and Mr. W. Lawrence Austin† to the free-milling ores of the Tombstone mines and their treatment, but the silver-bearing manganese ores of the district have received only a passing notice.

As these ores show some interesting peculiarities, and have yielded not less than 750,000 ounces of silver, they are worthy of some study.

The Knoxville, Lucky Cuss, Luck Sure, and Wedge mines (named in the order of their importance) are situated along the northern border of the district. They have been the leading producers of this manganese ore, and possess the same general characteristics. Special attention will be given to the Knoxville, as it has been the one most extensively developed.

The limestone belt, in which the Knoxville ore bodies occur, has an easterly and westerly trend, is about 1680 feet wide, and rests on granite on the north, the plane of contact being nearly vertical.

It is overlain by quartzite, the contact-plane having a dip of 82°. Some mining has been done along these contacts, and a considerable amount of pay ore has been extracted, but development has been very superficial. The ore found along these contact planes contains very little manganese, and differs entirely from the ore in the limestones.

No attempt will be made to assign this limestone country-rock to a particular geological horizon, as no fossils have been found in it.

Prof. Blake, in a paper on "The Geology and Veins of Tombstone, Arizona" (*Trans.*, x., 334), speaks of the middle and upper strati-

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* Concentration and Smelting at Tombstone, Arizona. *Trans.*, xv., 601.

† Silver Milling in Arizona. *Trans.*, xi., 91.

fied beds of limestones, shales, and quartzites as "Pale probably lower Carboniferous." There are no positive stratification in the Knoxville limestone, although indica be noted in some places which would lead to the conclusio strata are parallel to the plane of contact with the quartzite

In cross-cutting a great variation in the character of the is observed. Some zones are so siliceous as to approach though the greater part of the rock is limestone, carrying cent. of carbonate of lime.

The ore-chimneys, which dip to the east at an angle of 40 occur along a crack or plane of cleavage nearly vertical, and an easterly and westerly strike. Marked evidences of faults are entirely wanting, and an effort to apply the theory springs to account for the origin of the ore-bodies is met difficulty of explaining how a sufficient opening was made hot water to obtain access and cut out the large channels chimneys are somewhat irregular in shape and vary in size of them, all more or less connected near the surface, have be veloped—three to a vertical depth of 400 feet, and the fourth to feet.

In drifting from the main shaft, the crack or plane of clea above mentioned was a sure guide to the ore-bodies, though its was not appreciable, and there was not even a knife-blade seam "clay" or "talc" between the walls.

There were no indications of ore until the drifts were within feet of the ore-bodies, where the walls of the crack were stained black oxides of manganese and some carbonate. Small detac pockets of pure manganese oxide also indicated proximity to chimneys, but these small bodies carried very little silver filling of the chimneys included, in a great variety of forms, py lusite, wad, and psilomelane. It is not improbable that a searching examination would have discovered the rarer oxides, braunite, man ganite, and hausmannite. The gangue was quartz and calcite. enite, cerussite, pyromorphite, cuprite, melaconite, and malac were occasionally observed, and the assay showed a little go about $\frac{1}{100}$ of an ounce, or 20 cents to the ton.

Caverns were found in the widest parts of the ore-bodies wh were lined with snow-white and crystalline calcite. The pu manganese ore formed the lining of the chimneys, the percentage gangue being greater in the middle. Two classes were therefo made of the ore in preparing it for shipment, the first class be

composed of the more siliceous being low in silica, was valuabl carry enough silver to pay for The following analyses will of ore, which will be designate

M

Analysts: D. Ba

Mn_2O_3,	
SiO_2,	
CaO,	
CO_2,	
Fe_2O_3,	
MgO,	
Na and K,	
Sb,	
PbO,	
CuO,	
Ag,	
Cl,	
S,	
H_2O,	

Sh

Analy

Mn,	
O in combination,	
SiO_2,	
Fe_2O_3,	
$CaCO_3$,	
Cu,	
Pb,	
Ag,	
H_2O,	

The analyses of Messrs. L mill-runs taken out within 1 served that the percentages o their analyses than in the r Bunce on ore taken out from

All of the chimneys yiel silver per ton near the surfa

composed of the more siliceous and higher grade ore, and the second, being low in silica, was valuable as a flux, though some of it did not carry enough silver to pay for smelting.

The following analyses will show the character of the two classes of ore, which will be designated as "milling" and "smelting" ore:

Milling Ore.

Analysts: D. Baker, A. H. Low, M. W. Iles.

	Per cent.	Per cent.	Per cent.
Mn_2O_3,	74.16	42.77	41.30
SiO_2,	18.10	25.28	24.25
CaO,	1.32	21.60	18.75
CO_2,	1.33		
Fe_2O_3,	.58	3.54	6.80
MgO,	.13		
Na and K,	1.22		
Sb,	.66		
PbO,	.50		
CuO,	.20		
Ag,	.15		
Cl,	.17		
S,	.08		
H_2O,	1.67		
	100.27		

Smelting Ore.

Analyst: Walter Bunce.

	Per cent.
Mn,	47.70
O in combination,	26.22
SiO_2,	8.70
Fe_2O_3,	1.20
$CaCO_3$,	6.30
Cu,	1.21
Pb,	.45
Ag,	.06
H_2O,	6.00

The analyses of Messrs. Low and Iles were made from samples of mill-runs taken out within 100 feet of the surface. It will be observed that the percentages of Fe_2O_3 and $CaCO_3$ are much higher in their analyses than in the results obtained by Messrs. Baker and Bunce on ore taken out from a depth of nearly 350 feet.

All of the chimneys yielded ore assaying from 30 to 50 ounces silver per ton near the surface; but below 150 feet the silver con-

tents decreased as depth was gained, with the exception of [illegible] chimney (numbering from the left), which produced a [illegible] quality of ore so far as it was worked. It is therefore probable that the silver was brought up in solution through the main chimney (No. 2) and that the other chimneys received their silver by overflow from it.

It is probable that the chimneys were cut out by carbonic acid waters, for the walls show unmistakable signs of corrosive action, just the effect which would be seen on a piece of siliceous limestone after treating it with acids.

The origin of the manganese is worthy of study. Prof. W. P. Blake, after a hasty visit to the Knoxville, expressed the belief that the manganese had been segregated from the limestone, through which it had been originally disseminated as carbonate. After making an analysis of some pink-stained limestone near one of the chimneys, and finding much less manganese than he expected, he wrote: "This leaves the origin of the abundant black oxides more in doubt, but I still believe that the limestone is the source." A determination of manganese in a piece of limestone taken from the 340-foot level, about midway between chimneys 2 and 3, showed 0.1 per cent. manganese.

There is hardly sufficient evidence to justify the belief that the manganese was originally formed in the chimneys as carbonate and silicate. If, on following these chimneys down below water-level—perhaps 300 feet deeper—the fillings were found to be rhodochrosite and rhodonite below all decomposing influences, all doubts as to the first form of deposition would be settled. It would be much easier to account for the origin of these highly oxidized ores if they were found in bedded deposits, for then the theories which apply to the deposition of hematites and limonites might explain their origin.

The treatment of these argentiferous manganese ores, with no smelting works in the district and no market for them nearer than Colorado or San Francisco, was the problem to be solved in Tombstone in the fall of 1881.

Efforts were first made to work them by free milling, the heavy manganese being sorted out before shipment to the mills. This method was soon abandoned, as the silver saved did not average 60 per cent., and the loss of quicksilver was excessive—not less than 7 pounds to the ton of ore. Owing to the presence of so much manganese, this loss of quicksilver was to be expected; but it is not known whether the low yield can be accounted for by the failure to

amalgamate or by the "flouring" of the amalgam with the quicksilver. Applying the test by hyposulphite of sodium to determine the amount of silver in the condition of chloride, it was found that only 24 per cent. of the silver was soluble in the hyposulphite. But this test, when tried on the best free-milling ores of Tombstone district, gave no indication of the yield to be expected by amalgamation. Such ores as the Vizina, Ingersoll, and Bradshaw yielded from 80 to 90 per cent. of their silver by free milling, but the hyposulphite chlorination test showed that from 45 to 84 per cent. of their silver was in the form of chloride.

A sample lot of the Knoxville ore was sent to the Massachusetts Institute of Technology for examination, and from tests and analyses made there, it was believed that the silver not combined with chloride was united with copper, antimony and sulphur in tetrahedrite. It will be seen from the analyses already given that no tellurium was reported, though it is not improbable that this element was present combined with silver and gold. In Prof. Church's paper (*Trans.*, xv., 602), the presence of tellurium is mentioned in the ores mined by the Tombstone Mining and Milling Company and it was found in other mines of the district.

Before giving up the hope that some of these manganese ores could be treated by the free-milling process, every chemical known in the business was tried, and in varying quantities, but it seemed impossible to prevent the manganese from fouling the quicksilver and causing a great loss. The bullion product was nearly pure silver, and so strong was the oxidizing power of the manganese oxides that the bullion showed no trace of copper even when, as an experiment, a pan-charge was run with one hundred pounds of bluestone.

After some experimental work in chloridizing-roasting in a small reverberatory furnace, under the direction of Mr. John H. Collier, which proved that the ore could be chloridized and amalgamated up to 86 per cent., the Boston and Arizona Smelting and Reduction Coompany added a White and Howell furnace and revolving dryer to their 20-stamp mill-plant, arranged 15 stamps for dry crushing, and began the treatment of the higher grade of Knoxville ores by this process. It was found by experiments with higher and lower percentages of salt that the amount required for the proper chloridization of the silver was 6 per cent. of the weight of the ore. Ore and salt were shoveled into the rock-breaker together. Dropping into the dryer, and from the dryer into the self-feeders, it was ready for the

stamps. The batteries were provided with 40-mesh screens, having been found that with a coarser screen the furnace could not do effective work. This showed that the silver was very intimately associated with the manganese. From the batteries the pulp was taken by the ordinary elevator and screw-conveyor system to a Howell furnace, which was 24 feet long and 4 feet in diameter. The cylinder was lined with fire-brick, and, acting on the idea that it was important to keep the ore from falling through the flame as much as possible, half of the bricks were placed edgeways. A short run, however, showed that the draft carried too much of the pulp into the dust-chamber, and the bricks on edge were chipped out. A marked improvement was the result, but after making another short run a diaphragm or flange was placed on the upper end of the cylinder, which left the opening only 3 feet in diameter, and caused a still further reduction in the amount of pulp passing into the dust-chambers. This ore in the dust-chambers or flues would not have given much trouble if the auxiliary fire had been effective in completing the chloridizing action which was begun in the cylinder, but with this ore showing a chloridization of only 30 per cent., the auxiliary fire was given up as useless. There is no doubt that this dust could have been treated to the best advantage by taking it, by means of an elevator and screw-conveyor, to the lower end of the furnace and dropping it into the chamber which received the hot ore from the cylinder. But in order to carry out this plan so that the stream of ore would be regular and the action automatic, an entire reconstruction of the furnace would have been necessary. A different plan was therefore adopted. The dust-chambers were cleaned out every day, and the furnace-men fed the dust into an elevator, which raised it up to the main screw-conveyor carrying the ore from the batteries to the furnace. It may be surprising that it should stay in the furnace any better the second time it was put in than it did at first. The fact that it did so may be accounted for on the theory that the flue-dust possessed different characteristics, having been subjected to the heat of the dust-chambers long enough to lose its carbonic acid, oxygen, and moisture not expelled in the dryer.

These changes led to an increase in the chloridization from 85 up to 90 per cent. The tailings contained about 17 per cent. of the pulp-assay, which would leave 83 per cent. in bullion, but the bullion product was 81½ per cent. This difference is accounted for by the loss in dust, some of which collected on the roof of the waste-building. It assayed about 70 ounces per ton, when the pulp-assay was about 50 ounces.

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An examination of the quicksilver in the pan-charges showed a somewhat broken condition, but it was no longer foul, as in the case of raw amalgamation, and there was little difficulty in collecting it in the settlers. However, it seemed impossible to avoid a considerable loss of quicksilver—about three pounds and a half to the ton of ore.

The experience of mill-men, and the theory of the reactions in a chloridizing-roast, demanded the addition of sulphur in some form to an ore like this which contained less than 0.1 per cent. of that element. (See *Roasting of Gold- and Silver-Ores*, by G. Küstel, pages 22 and 27.) But the result showed that the decomposition of the salt was vigorous enough, and that chlorination of the silver was effected without the presence of sulphuric acid. It might have been possible to get a higher chlorination of the silver if the theory of Küstel—that "calcareous ore requires as much more green vitriol or iron pyrites as is necessary to transform all the lime into sulphate"—had been put into practice; but sulphuretted ores in sufficient quantity were not available, and the use of copperas was out of the question, as will be seen by the following figures: The analyses of Knoxville ore show from 2.65 to 21.60 per cent. of $CaCO_3$. These were probably extremes, and the average was not far from 10 per cent. This would give 5.6 per cent of CaO, or 112 pounds to the ton, and in order to convert this into CaO, SO_3, 160 pounds of SO_3 would be required, or more than 500 pounds of copperas ($FeSO_4 + 7H_2O$).

It is evident that this method of introducing sulphuric acid would not do on 50-ounce ore, when the cost of copperas laid down in carload lots exceeded 4 cents per pound.

It is worthy of note that the ore as it dropped from the cylinder into the chamber was at a very low red heat, and imperfectly chloridized (not over 60 per cent. of the silver being combined with chlorine), but that while accumulating in the hot chamber the reactions went on with vigor.

The total production of the Knoxville mine to date has been 6000 tons of "milling" ore, averaging 43 ounces per ton, and 6200 tons of "smelting" ore, assaying 23.3 ounces per ton.

Nearly all of the smelting-ore was worked by the Tombstone Mining and Milling Company in smelting concentrates, and Prof. Church has mentioned the treatment of this ore in his paper already referred to on "Concentrating and Smelting at Tombstone."

If the Tombstone district had produced lead-ores so that the "milling" ores could have been worked by smelting, the profits of

the mine would have been greatly increased. Milling was [illegible] pensive with salt at $30 per ton, boiler-wood at $9, and [illegible] wood for roasting at $12 per cord (making the cost per ton of [illegible] for steam fuel $3.50, and for roasting $2).

I am indebted to Mr. Frank C. Earle for the following anal[illegible] of the limestones of the Tombstone district:

	$CaCO_3$.	$MgCO_3$.	SiO_2.
No. 1, . . .	91.33 per cent.	trace	6.00 per cent.
No. 2, . . .	90.75 "	2.85 per cent.	5.20 "
No. 3, . . .	96.46 "	trace	2.41 "

No. 1. Main working shaft, "Lucky Cuss," near contact wi[illegible] granite. White and crystalline.

No. 2. West end of "Knoxville." Blue and compact.

No. 3. "Luck Sure." Represents general character of limestone i[illegible] the belt.

What little Fe, Al and Mn occurred in the samples was no[illegible] determined.

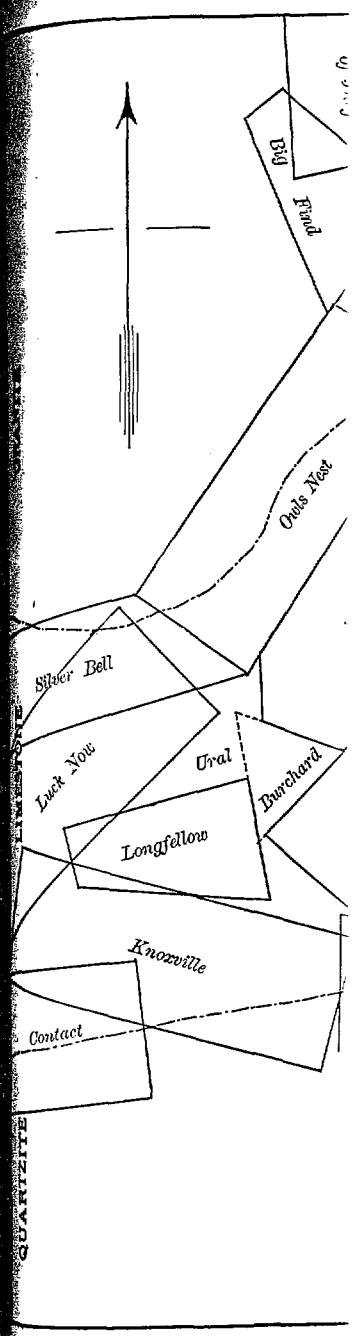
I am also indebted to Mr. H. G. Howe, M.E., for the accom[illegible] panying map, showing the location of the group of mines referre[illegible] to. The dotted lines indicate the granite-limestone and limestone-quartzite contacts as traced on the ground.

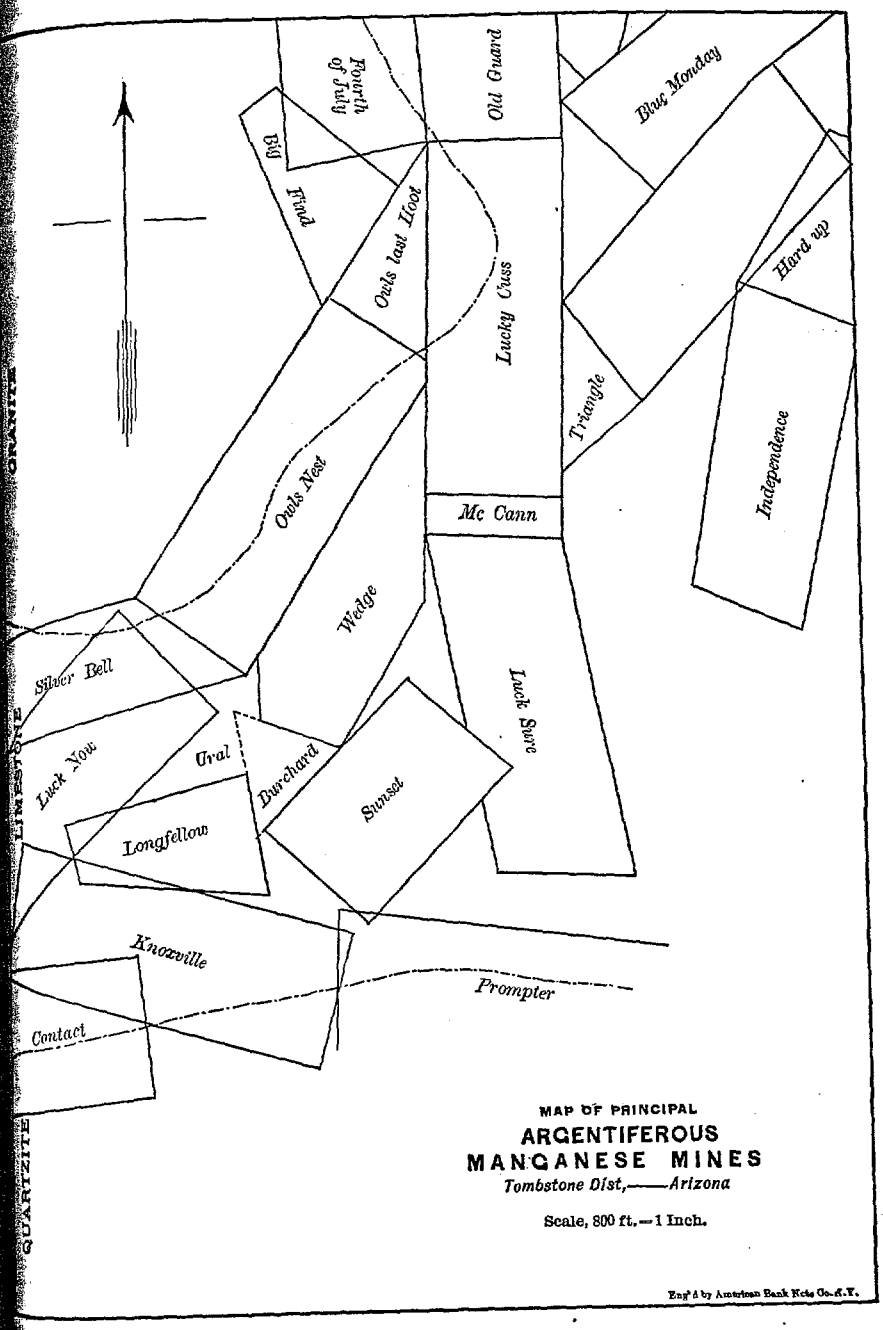
In the eastern part of Tombstone district there is another belt of limestone, in which are located the Bunker Hill, Rattlesnake, and Mammoth claims; the ores from these claims contain much manganese, though not to the same extent as the Knoxville, Lucky Cuss, and Wedge ores.

Discussion.

Richard Pearce, Argo, Colo. (Communication to the Secretary.) I do not quite see the necessity for the "channel-theory" to account for the formation of these deposits. The gradual substitution of one mineral by another, through the agency of water and carbonic acid, would be sufficient, in my judgment, to account for them.

In connection with the remarks of Mr. Goodale as to the original form of the manganese minerals in these ore-bodies, I may observe that somewhat similar conditions exist at Butte, Montana, where large deposits of psilomelane and pyrolusite are found in comparatively isolated positions in the country-rock and are evidently the result of water-action. Carbonate of manganese enters largely into the composition of the veins adjoining these isolated deposits, and

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Prompter
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MAP OF PRINCIPAL
ARGENTIFEROUS
MANGANESE MINES
Tombstone Dist,——Arizona
Scale, 800 ft.—1 Inch.
Engd by American Bank Note Co. N.Y.

water circulating through the veins, containing, perhaps, manganese carbonate in solution in carbonic acid, finds some lateral outlet through the natural joints of the rock, and by a process of gradual displacement these manganese oxides are formed.

Similar conditions also exist in regard to the silver contents of the Butte deposits. I think that, as a rule, the richer the ore in manganese, the poorer in silver; this would indicate that possibly silica may play some important part in the transfer of the silver from one point to another.

Mr. Goodale's account of mill-experiments confirms my impression that the action of MnO_2 on quicksilver in the amalgamation of silver-ores is scarcely understood. It appears from all the evidence we can obtain, that under certain conditions MnO_2 is capable of giving up its oxygen in some nascent form which acts most energetically on the quicksilver. This action is, in all probability, oxidizing, as the flouring of the quicksilver may generally be avoided by the addition of some baser metal, such as lead or copper, these metals being more readily oxidized than mercury. In the treatment of silver-ores, containing much base metal, by amalgamation, it is often found desirable to add manganese oxide, which has the effect of preventing the reduction and amalgamation of the base metals and leads to the production of a much finer quality of bullion.

Mr. Goodale speaks of the supposed necessity of adding sulphur to effect a chloridizing roasting. This my own practice leads me to think an error. I worked the Augustin process for many years on copper in a perfectly oxidized form, containing silver, without the aid of sulphur in any form. When the oxide of copper was brought to a proper temperature in the furnace, the chloridizing was effected by the addition of a mixture of fine siliceous sand and salt, moistened with water. The following is probably the reaction:

$$2NaCl + SiO_2 + H_2O = Na_2O, SiO_2 + 2HCl.$$

J. K. Clark, Butte City, Montana: I can add very little of interest to what has already been said about manganese-ores in milling; but it may be a point worth noting that it has been our experience at the Moulton mill that wherever a large amount of zinc has been present in our ores, the loss of silver by volatilization has been much reduced by a plentiful mixture of oxidized manganese ore.

Another point may be mentioned as showing the important action

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of iron in assisting amalgamation. While running the Dexter mill in Butte, in 1876, where we chloridized in reverberatory furnaces, the tailings continued to rise in value most unaccountably, until the saving was less than 60 per cent., though the chlorination tests showed 95 and 96 per cent. of the silver in the form of chloride and proved that there was no fault in the furnace-work. This happened while we were expecting new mullers, and as soon as they arrived and were put in, the yield went right back to where it should be, according to the chlorination-tests.

An examination of the old mullers and other iron parts of the pan showed that they were so heavily coated with iron oxide, say $\frac{1}{16}$-inch thick, that no metallic iron could come in contact with the pan-charge. Since that time, I have taken good care that there is no lack of bright clean iron in the pans, and I believe the plan we have adopted at the Moulton—placing two or three wrought-iron bands, $\frac{1}{4}'' \times 4''$, around the inside of the pan—will always assure enough live iron to assist the amalgamation.

It is generally believed that the poor results obtained in a pan-charge of slimes alone are due to the thinness of the pulp, and the fact that the quicksilver cannot be well mixed with it and come in contact with the silver; but it is my opinion that the coating of the iron parts of the pan by the slimes, which would prevent the activity of the iron, may offer a better explanation of such results. When slimes and sand are worked together, the scouring action of the sand gives the iron a chance to play its part.

Mr. Goodale: In connection with the remarks of Mr. Pearce about the oxidizing action of MnO_2 on quicksilver, I would say that the Boston and Arizona Company purchased all the base and sulphuretted ores they could get, and offered good prices for such ores to mix with the Knoxville ore. It was found that whenever a mixture could be made which would yield a bullion-product containing from 5 to 10 per cent. of base metal, the saving was increased and the quicksilver was in better condition.

TRANSACTIONS

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INCLUSIVE.

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1887.

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years a manager of the Institute—in that stage of its history, it be remarked, when the machine did not run itself, and the office of manager was less like a sinecure than it has since become. The formation of wise rules and the accumulation of safe precedents cost a good deal of patient thinking and planning. Mr. Coryell's contributions to the *Transactions* are confined to a few brief papers in the early volumes. Growing age and infirmity forbade him to undertake more extended labors of that kind; but he retained to the last an eager interest in the Institute, and attended the meetings whenever he could—which was, indeed, not seldom. His genial greeting was one of the pleasant things to which many of us looked forward, and upon which we now, with tearful eyes but grateful hearts, look back.

My own association with Martin Coryell, beginning as it did with the birth of the society we both loved and served, is indissolubly connected in my thought with the history of that society for more than fifteen years. It has been to me an experience of unbroken, unvarying kindness and friendship from him. I do not doubt—nay, I know—that many other members of the Institute would bear the same testimony. There can be no more fitting end to a long and honorable career than was the benign sympathy bestowed by Martin Coryell, from his well-earned repose and retirement, upon the generation that had assumed the hopes, labors and responsibilities from which he was already in large part, and is now wholly and forever, relieved.

CONCENTRATION AND SMELTING AT TOMBSTONE, ARIZONA.

BY JOHN A. CHURCH, TARRYTOWN, NEW YORK.

(Scranton Meeting, February, 1887.)

THE operations of the Tombstone Mill and Mining Company, in Arizona, have been extensive and interesting; and I will endeavor to describe what is novel in their work, without attempting to go over the well-known facts of silver milling, concentration and smelting which are the general branches of their business. Their mines are at Tombstone, and their mills at Charleston, ten miles distant.

The ore has been mined only above water-level, and at first was

composed almost entirely of horn-silver, enclosed in a gangue of quartz, containing also lead carbonate, manganese and iron oxides, and some sulphides of silver, iron, copper, lead and zinc. It had about 60 ounces of silver, and ⅝th ounce of gold per ton, and [illegible] cent. of lead. With increasing depth in the mines, the proportion of silver sulphide increased, and the chloride decreased. A constituent of especial interest is tellurium, which occurs probably in combination with lead, silver, and gold. It is in mere pin-points, and the true composition of the mineral has not been determined. It is worth noting that this telluride seemed to be locally concentrated between the water-level and the zone of extreme oxidation. It is probably a secondary product, and represented a concentration of materials that were once contained in portions of the vein that are now eroded.

This ore was stamped and amalgamated in pans of the usual "combination" type. The extraction was good so long as the ores lay near the surface, probably reaching 85 per cent. of the silver and 45 per cent. of the gold. The actual percentage of extraction is not known, because all the mills (five in number) in the Tombstone district produced a large *plus* of silver for several years, the bullion being more than 100 per cent. of the battery-assays. The cause of this *plus* is supposed to have been due to the presence of heavy minerals rich in silver, and to the insufficient slope of the battery launder, which allowed these rich portions to settle before the samples were taken. At all events it is certain that the discrepancy between the assays and the product was due entirely to mechanical causes.

These peculiarities disappeared as the ore lost its chloride character, and began to carry its silver in the form of sulphide, probably from the greater tendency of the sulphide to crush to a powder which was not so likely to settle in the launders. I found horn-silver to be an extremely comfortable substance to deal with. Its value in the amalgamating-pan is well known, and I learned that it is just as submissive to treatment in concentrating. It has a bad name as material for concentrating, but does not deserve it. Even in the finest grains, it preserves its tabular or scaly form, and can be handled with the least possible loss. We have seen lines of pure horn-silver on our concentrating tables, quite undisturbed by the flow of the water.

During this early period in the history of the mines the ore amalgamated with great freedom, and for 11 months in 1881 and 1882 no salt or bluestone was used in the pans. The disuse of these

chemicals lessened the extraction by one or two per cent.; but the treatment of the tailings had already been decided upon, and the extraction of this portion of the silver was only deferred. As the ore changed with increasing depth, the use of chemicals became absolutely necessary. At the same time, irregularities crept into the work of amalgamation. Occasionally the fineness of the bullion, which was normally about 880 thousandths, would run down to 400 and 500 in spite of these chemicals. The debasing metal was always lead, and it is supposed that the sudden appearance of this metal in the bullion without the smallest change in the mode of work having taken place, was due to an increase in the telluride spoken of above. The constant experience in the mill was that neither carbonate nor sulphide of lead tended to debase bullion. These minerals would sometimes increase in the ore three and four fold for a short period, without producing the slightest effect upon the bullion. It was noticed that when the bullion was most base, the ore sometimes showed an exceptional freedom from lead, an indication that the tendency of this metal to the bullion was dependent on its state of combination in the ore rather than on its abundance.

The stamps weighed about 700 pounds and dropped $5\frac{1}{2}$ to 7 inches, 95 to 100 times a minute. Rough punched screens were used, giving the greatest possible variation in fineness of pulp. They were No. $4\frac{1}{2}$ and when new were finer than 60-mesh, but wore to about 20-mesh before they were removed. Under these conditions the product was 2.4 tons to the stamp per day, and 2.7 tons per 24 hours, actual running time. This was increased subsequently by various changes, until the product was more than 3 tons per stamp, per day. The pulp was settled in tanks, shovelled to the pans, run from the pans to settlers and discharged thence to tailing beds formed by earth dams. The Company had two mills, one of 15 and one of 20 stamps. In the year ending March 31st, 1884, the operations of the mills were as follows:

	Total.	Per ton.
Tons milled,	16,043	.....
Quicksilver, pounds,	20,183	1.258
Salt, pounds,	83,850	5.226
Bluestone, pounds,	19,339	1.205
Castings, pounds,	59,632	3.717
Wood, cords,	$2,096\frac{3}{4}$	0.131
Labor, days,	9,453	0.589

The changes in the amalgamating-pans varied somewhat with the changes in the ores. They were always about $1\frac{1}{3}$ tons in weight,

and the quicksilver charge was 600 pounds. In a year wh ore amalgamated freely most of the time, the charge of salt p was $5\frac{1}{8}$ pounds and of bluestone 1 pound. A year later, wh ore contained more sulphides and amalgamated less freel charge rose to 5.226 pounds of salt, 1.205 pounds of bluestone the former case, 1 pound of quicksilver was consumed and in latter case, 1.258 pound. The subsequent re-working of the ta by concentration, discovered the fact that the quicksilver wa sumed mainly by chemical combination. Though the beds conta more than 40 tons of this metal, *minus* the portion that was ca off in solution, only a few hundred pounds were recovered and in the form of a poor amalgam.

The pans ran 4, 5 or 6 hours according to the ease of amalgam ing and the friability of the ore, and grinding was resorted for 4 hours or omitted entirely, depending upon the same condition

The details of amalgamation in the years 1882–83 were as follo

		Extracted by Amalgamation.	
Tons ore milled:			[illegible]
Containing ounces silver,	1,254,531	923,336	[illegible]
Containing ounces gold,	7,928	3,763	[illegible]
Average battery-assay, silver,	33.44	0.2113	[illegible]
Average tailings-assay, silver,	8.77	0.11	[illegible]
Average percentage saved,	73.78	47.94	[illegible]
Pounds (avoir.) amalgam,	.....	.....	449
Troy ounces retort-metal,	.....	.....	80
Ratio, retort-metal to amalgam,	1:5.55	.....	[illegible]
Troy ounces retort-metal,	.....	.....	1,170
Troy ounces bars,	.....	.....	1,110
Loss in melting, ounces,	.....	.....	68
Loss in melting, per cent.,	5.83	.....	[illegible]
Silver in bars, ounces,	.....	.....	923
Gold in bars, ounces,	.....	.....	8
Average fineness amalgam (gold and silver),	142	.....	[illegible]
Average fineness retort-metal,	786	.....	[illegible]
Average fineness bars,	835	.....	[illegible]
Left in tailings, silver, ounces,	.....	.....	331
Left in tailings, gold, ounces,	.....	.....	4

In these two years the errors of sampling and assay nearly ba anced each other, so that the percentages of extraction given correct, whether calculated by comparing the ore and tailings, or and bullion.

Up to March, 1884, the mill had amalgamated 89,608 tons of o estimated to contain 4,168,527 ounces of silver and 18,244 ounc

of gold, and had ounces of gold. ounces of silver, a $15.60 at the leg prices, at the time

Co

The amount of accumulating at tl worth about $12 a ous problem. Th be expected from to extract the met fail again. Roast which was not les the value of the t ate carried a higl ately made in con and yielded about

At that day, th not at all reassur success, except on lead. Ores of 3 been successfully centrates was poo only substance th on the Company' about 20 ounces mate well, and t concentrate well.

Under these c centration of the attempt to smelt as the flux.

Experiment sl on the Frue van principal difficul the tails, which mesh, giving pul this down to the was increased gr

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ling to the ease of amalgam
grinding was resorted for
g upon the same conditions
years 1882–83 were as follows

	Extracted by Amalgamation.	Total
		87,0
,254,531	923,336	
7,928	3,763	
33.44	0.2113	
8.77	0.11	
73.78	47.94	
.....	.....	449,3
.....	.....	80,9
1:5.55	.....	
.....	.....	1,179,7
.....	.....	1,110,3
.....	.....	68,7
5.83	.....	
.....	.....	923,3
.....	.....	3,76
r), 142	.....	
786	.....	
835	.....	
.....	.....	331,7
.....	.....	4,1

sampling and assay nearly ba
ntages of extraction given
ring the ore and tailings, or o

malgamated 89,608 tons of o
es of silver and 18,244 ounc

of gold, and had produced 3,225,110 ounces of silver, and 9454 ounces of gold. This would leave tailings containing about 10.5 ounces of silver, and 0.098 ounce of gold per ton, or a value of $15.60 at the legal rate for silver. The actual value at market prices, at the time of the operations, was about $12 per ton.

Concentration of the Tailings.

The amount of silver and gold, locked up in tailings which were accumulating at the rate of 15,000 to 25,000 tons a year, and were worth about $12 a ton, was so great that its recovery became a serious problem. The ore being thoroughly oxidized, no benefit could be expected from weathering, and, amalgamation having failed once to extract the metals in the tailings, it was assumed that it would fail again. Roasting and chlorination were prohibited by their cost, which was not less than $20 a ton at that time and place, or twice the value of the tailings. Guided by the fact that the lead carbonate carried a high percentage of silver, experiments were immediately made in concentration. A second amalgamation was also tried and yielded about $1.50 per ton.

At that day, the experience had in concentrating pan-tailings was not at all reassuring. Experiments had been made, but without success, except on ore that contained as much as 8 or 10 per cent. of lead. Ores of 3 per cent. lead, like those in Tombstone, had not been successfully treated. The outlook for utilization of the concentrates was poor also. No iron-ore for flux was at hand, and the only substance that was free from silica was limestone. There were on the Company's property some mines of manganese ore, carrying about 20 ounces of silver to the ton. This ore would not amalgamate well, and trials made subsequently proved that it would not concentrate well.

Under these circumstances, it was determined to undertake concentration of the tailings on a large scale, and, if this succeeded, to attempt to smelt the concentrates in a shaft-furnace with manganese as the flux.

Experiment showed that the tailings could be concentrated either on the Frue vanner or on the German rotating round table. The principal difficulties experienced were from the extreme fineness of the tails, which had been stamped through screens of 30 and 40 mesh, giving pulp of $\frac{1}{40}$ to $\frac{1}{60}$ inch diameter as a *maximum*, and from this down to the finest particle. The proportion of very fine slime was increased greatly by grinding in the pans, so that probably 60

per cent. of the ore was in the condition of slimes sufficiently
form a tenacious mass, though not more than 3 or 4 per cent.
was present. In the course of the work two mills were built

The First Concentrating-Mill.

The first contained six Frue vanners and three round tables
latter serving entirely as tailing machines to the vanners. An
nary agitator, such as is found in pan-mills, nine feet in diam
served to receive the dry tailings taken from the old beds, and
them with water. This mixer was connected with a mill of
stamps, the tailings from which ran directly to the mixer. The
discharge-plugs, usual to settlers, were retained, but were bored
1-inch holes, limiting the discharge, so that the pulp was kept
certain height in the mixer. With about nine revolutions per mi
of the mixer arms, the current was not sufficient to carry off
heaviest part of the pulp. This settled to the bottom of the mix
and was shovelled out periodically. It was rich enough in lead
smelting, and was richer than any other part of the product in
and silver.

The rest of the tailings ran from the mixer to the six Frue vann
on which it was distributed without sizing. The tailings from
vanners were collected in a belt elevator, and raised high enough
run on the round tables.

The vanners worked well when the quantity passed over
was restricted, but when it reached 5 tons a day the fine part of
slimes was carried over and lost. On this account the saving
lead in this mill was much less perfect than afterwards, when fa
ties for handling larger quantities were obtained. This mill
for about a year and a half. The work done in the first 13 mon
is shown by the following table:

	Tons.	Assay, per Ton. Silver, oz.,	Gold, oz.	Lead, per ct.
Mill-tailings treated,	11,467	13.21	0.22	(?)8.00
Production:				
From the mixer,	93	52.65	0.48	23.20
From the Frue vanners,	1,483	45 22	9.58	30.90
Percentage saved by weight,	.....	.....	.....	.....

Weight of tailings required to make 1 ton of concentrates, 7.5 tons.
Percentage saved, by value: Silver, 41.29; Gold, 34.09; Lead, 50.61.

Although the tailings treated in this mill were estimated to
tain 8 per cent. of lead, it was known that the old beds as a wh

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agitator. The constr
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central shaft carried r
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to a basket of vertical
the machine ran for n
This mill was desig
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the settlers, each of
to 3 tons of ore with
of a settler took plac
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box about 16 feet lo
openings at one end.
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clear water which pou
water needed for mi
through the "equaliz

would not contain more than 3 per cent., the stock for this mill being taken from the best and richest parts of the beds.

THE SECOND CONCENTRATING-MILL.

The attempt to concentrate was not considered an entire success until the round tables were put in. They were introduced to prevent the loss of fine material which passed over the vanners, and they proved to be so well adapted to the treatment of the finest slimes that a new mill was designed in which they bore all the work of concentrating the slimes, while jigs were made to treat the coarse product that had settled in the mixer. In addition to these changes sizing was introduced, both by trommel-screens and by hoppers with a rising current of water. The old mixer was replaced by an agitator made like a pug-mill. It consisted of an upright box 30 inches square, with the corners filled in to make an octagon. A shaft making 105 revolutions per minute stands in the center, and carries a frame or basket of ¾-inch iron bars, which rotates just within a number of rods that project inward from the sides of the agitator. The construction of this machine gave more trouble than any other part of the mill, on account of breakages. At first the central shaft carried radial arms that ran between the fixed arms of the box; but when the latter were cut off, and the former reduced to a basket of vertical arms running past the ends of the fixed rods, the machine ran for months without a stoppage.

This mill was designed to use dry tailings from the old beds, and also the current product of tailings from a mill of 20 stamps, treating from 40 to 60 tons a day. The mill-tailings were drawn from the settlers, each of which contained two pan-charges, or about 2¾ to 3 tons of ore with about 1200 gallons of water. The discharge of a settler took place in about five minutes, and to prevent a rush upon the concentrating-machines the mill-tailings were received in a box about 16 feet long and 2x2 feet section, with three discharge openings at one end. When a settler was discharged this box would fill, and the heavy tailings settled to the bottom. As soon as the flush was over the surplus water would run out, and the deposit in the bottom of the box was then removed gradually by a stream of clear water which poured with some force from a spout. All of the water needed for mixing with the dry tailings passed in this way through the "equalizer."

The equalizing-box, as this contrivance was called, disch into the agitator or mixer, which was fed with dry tailings by h

The dry tailings were wheeled from the old settling-pits platform, and then shovelled with regularity into the agita Shovelling stopped when the mill was sending down tailings was resumed when the flush began to decline. From the agit the tailings, now become pulp, ran to a belt elevator with 12 buckets, lifting 26 feet high, and entered the mill at one corne the building. From this point they ran through two tromm screens to a series of 6 hoppers, forming the sizing-apparatus occupying the upper story of the mill. The last two of these ho pers were quite capacious, holding probably 600 gallons. Th would fill to the brim during a flush, but in the intervening pe the water-level in them would sink so low that the discharge-laun of the fifth hopper was not covered, and the sixth received no pu During a flush the water-level would rise in the hoppers and th spouts discharged an increased quantity of pulp that showed th effects immediately in a thicker deposit on all the concentrating machines. Thus the effects of flushing the tailings down from th mill were met partly by stopping the use of dry tailings, partly b storage in tanks and hoppers, and partly by greater supply of pu to the concentrating-machines, and it was constantly shown that of these resources were needed to reduce the fluctuations due to th cause to their lowest possible value as disturbing factors.

The trommels had punched screens of 3-64th inch mesh, wi screens being used also, but giving trouble from the opening of th meshes. The trommel-rosettes had round wrought-iron spokes, an a 1-inch blank nut was strung on each spoke to give percussi action. Both trommels sent their through-fall to the line of hoppe and their coarse stock to the first jig. The second jig was suppli from the first hopper, and the second, third, and fourth hoppe supplied three round tables, while the fifth and sixth hoppers su plied three other round tables. The jigs had percussive action, th pistons being carried by springs and forced down by the blows o ram. The speed, 120 strokes per minute, was not enough for su fine material.

The round tables were all 15 feet in diameter, turning 105 tim in one hundred minutes, and had a slope that varied from 7 inche in $7\frac{1}{2}$ feet for coarse slimes to $4\frac{1}{4}$ inches for fine slimes. All of the were covered with Akron cement, which is well adapted to this us Brushes were not used, the ore being cleaned and the concentra

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The cement surfac
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Days run,	
Tons treated,	
New tailings,	
Old tailings,	
Ore crushed,	
Product, tons,	
Ratio, tailings to	
Per cent. saved:	
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By tailings,	

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washed off by jets of water. These machines did excellent work. The cement surface, combined with the thinning of the stream of pulp as it spread from the center to the circumference, caused the retention of the fine carbonate of lead and other heavy minerals most perfectly. It was proved that when the concentrates were once deposited the losses by cleaning were very small, most of the loss occurring in the very fine slime that ran over the table on the raw pulp. The mill was over-crowded, and with slower work it is quite certain that much better results could be obtained, even upon pan-tailings. Two jigs and six tables were expected to treat 120 tons a day, but they frequently treated 150 to 170 tons at a time when the tailings were so fine that the jigs did not do their proper share of the work. Some of the tables treated a ton an hour constantly.

In considering the following table it is to be remembered also, that the choicest part of the tailing-beds had been removed before the second mill was built.

Concentration.

April 1*st*, 1883, *to March* 31*st*, 1884.

		Old Mill.	New Mill.	Total.
Days run,		126	144	270
Tons treated,		3,346	13,623	16,969
New tailings,		.....	6,150	6,150
Old tailings,		3,346	7,317	10,663
Ore crushed,		.....	156	156
Product, tons,		395.20	1,495	1,890.20
Ratio, tailings to product,		.....	.....	1:8.9
Per cent. saved:				
By concentrates,	Gold,	.....	.....	48.81
	Silver,	.....	.....	40.57
	Lead,	.....	.....	72.06
By tailings,	Gold,	.....	.....	55.53
	Silver,	.....	.....	53.11
	Lead,	.....	.....	77.61

The actual saving was greater than the table shows. The tailings from the tables on which the finest slimes were treated were run through a series of six settling-tanks, and a product containing about 8 to 10 per cent. of lead and 12 to 15 ounces of silver obtained. This was used as a binding substance in making the concentrates into bricks, but no account was taken of this material in estimating the work of the mill.

There were two constructive defects in the mill. The sorting-

hoppers proved to be very inefficient. It was not necessary
the stock closely, but it was very important to separate the
slime from coarser sizes; and this the hoppers failed to do.
one of the concentrating-machines that depended on the ho
received a considerable proportion of slime; and it is likely
much of the richest and heaviest part of this slime followed
coarse table stock to those tables which had the greatest slope
were least suited to its treatment. The hopper-shape seems to
the worst that can be utilized for the action of a rising stre
Many experiments were made to ascertain the source of the lo
and always with the result of locating them mostly in fine sli
contained in the pulp after it had run over a table; that is to
in material that never rested on the table-surface. When
deposited, the heavy portion of the pulp could be washed clean
very little loss.

The other defect was remedied easily enough. The coarser gra
of the tailings were rounded, and were apt to run over the ta
surface without stopping. The Frue vanners were replaced to wo
up this part of the stock, and their percussive action proved
useful.

It is impossible to say how far the losses could have been obvi
by a more perfect system of sorting. Very much could have
done, but it is not probable that the losses would have been redu
below 25 per cent., except by crushing the coarse part of the ta
ings so as to unlock the minute particles of silver-minerals inclo
in them. Probably one-half the loss was due to this cause
one-half to slimes.

It was proved conclusively that concentrating-machines can
successfully with the finest slimes. A seventh round table
built for the purpose of reducing the silica in the extremely
slimes, that were used for binding materials in making the con
trates into bricks. This material was finer than flour, and
about like the dust that rises on a light wind. Even the he
concentrates could be blown away by a light breath, though
trouble was experienced in saving them.

The cost of the work varied with the constantly increasing
tance of the tailing-beds from the mill. The first mill was run
water-power, and used a large proportion of tailings direct from
amalgamation, and under these circumstances the cost was abou
cents per ton. When the tailings were brought in by hand, w
power being retained, the cost rose to $1.39, both of these

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When the furna
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relating to Frue vanners. When the tables were put in and a larger quantity of material handled, and the treatment of tailings direct from amalgamation was resumed, the cost was $1.23, though steam-power was used exclusively, and increased the cost 24 cents a ton. These figures of cost cover the experimental stage of both mills, and should be reduced materially for regular and experienced work.

The quality of the concentrates was excellent. They contained more than 50 per cent. lead, and an amount of silver that varied according to the material from which they were made.

SMELTING.

The furnace-work presented many interesting features. On account of the sandy and even dusty condition of the concentrates they were made into bricks, at first by hand, and afterwards by a brick-machine. No clay was obtainable, but the pan-slimes supplied a good binding material, though they contained about 85 per cent. of quartz and only 2 to 3 per cent. of clay, the remainder being calcite, manganese, and iron oxides, various sulphides, and lead carbonate. The binding quality was due entirely to their extreme fineness and the trituration they had received in the amalgamating pans.

For flux there was no resort but to manganese-ore, which contained as much lime as the charge would bear. The furnace was an open-topped shaft about 11 feet high, and connected with iron dust-chambers, which ended in an iron chimney 80 feet high and 40 inches in diameter. The furnace was water-cooled, with siphon lead-tap, and did not vary from the usual types of American lead-furnaces, except that the water-jackets were of wrought-iron and built up from channel iron and plates of soft charcoal-iron. The channel-irons, $4\frac{1}{2}$ inches wide, formed the edges, and the inside plate was riveted on, the outer plate being put on with patch-bolts. Cast-iron jackets were used at first, but burned out or cracked uniformly near the top. The fuel was Colorado coke, sometimes with English patent coke added. Charcoal was avoided, except in blowing in. It was very poor in quality, and, like all other materials, high in price. At times the coke was of the worst description.

When the furnace started there was no lead available for filling the hearth, and the start was made on concentrates that were especially well cleaned for the purpose. The easy reduction of the lead carbonate made this method perfectly practicable, and no trouble

was experienced from this cause. Manganese as a flux also p[illegible] to be entirely available, but it presented two peculiarities. [illegible] fluidity of the slag allowed less fusible impurities to settle [illegible] and completely out of it, and the furnace would accumulate [illegible] in the hearth with great suddenness. This tendency was incre[illegible] by the absence of matte-forming materials. The sulphide of [illegible]ganese is dissociated readily by heat, and the small quantity of [illegible] copper, nickel, and antimony present were just sufficient to [illegible] a speiss with the arsenic present. Usually the speiss ran out [illegible] the slag; but if anything occurred to stop the flow of materi[illegible] through the hearth, even for a short time, a crust was almost [illegible] to form, and once formed it was very hard to melt it.

The furnace was run in every way possible in order to ascer[illegible] the best mode of utilizing the manganese. When the charge [illegible] strongly basic, the furnace would melt 50 to 55 tons a day, but [illegible] was a strong tendency to accumulate crusts. With a more [illegible] charge, the work was much more regular, and the furnace [illegible] about 40 tons a day. Though the composition of the slag var[illegible] daily, owing to the unfavorable conditions for fluxing, the sl[illegible] were always very clean and remarkably free from combined [illegible] and silver. Their extreme fluidity and the tenacity with wh[illegible] manganese retains its oxygen, and the readiness with which it gi[illegible] up sulphur, are probably the causes which contribute to this freedo[illegible] from lead. The experience obtained indicated that mangan[illegible] would form an excellent flux in matting-furnaces.

The composition of the slags varied so constantly that no rep[illegible]sentative analysis can be given. Their only striking characteri[illegible] was their high proportion of manganese, and an analysis made [illegible] Dr. M. W. Iles is perhaps the most interesting. It was

Silver,	trace.
Lead,	1.40
SiO_2,	29.60
FeO,	11.56
CaO,	7.50
MnO,	43.25
Al_2O_3,	6.34
MgO,	trace
	99.65

The work done in the first two years is shown in the follow[illegible] tables, the work of the first year covering only six months of act[illegible] service.

CONCENTRATI[illegible]

Concentrates,	
Tailings,	
Ore,	
Manganese,	
Silver-bearing ma[illegible]	
Limestone,	
Slag recharged,	
Cleanings recharg[illegible]	
Fluxes,	
Colorado coke,	
English coke,	
Charcoal,	
Total mater[illegible]	
Number of bars,	
Tons of bullion,	
Containing silver, [illegible]	
Containing gold, o[illegible]	
Containing lead, t[illegible]	
Days run,	
Number of charges,	
Weight of charge,	
Concentrates, slums	
Ore,	
Manganese,	
Limestone,	
Slag and cleanings,	
American coke,	
English coke,	
Charcoal,	
Number of bars,	
Shipments, tons,	
Containing silver, [illegible]	
Containing gold, ou[illegible]	
Containing lead, to[illegible]	

September, 1882, *to March* 31*st*, 1883.

	Tons.	Percentage of charge.		
Concentrates,	438	.....	23.65	.....
Tailings,	438	.....	23.65	.....
Ore,	47.92	.....	2.70	.....
Manganese,	625.25	.....	33.80	.....
Silver-bearing material,	.....	1549.17	.....	83.80
Limestone,	33.02	.....	1.80	.....
Slag recharged,	260.80	.....	14.40	.....
Cleanings recharged,	6.00	.....		.....
Fluxes,	.....	299.82	.....	16.20
				100.00
Colorado coke,	168.17	.....	.....	.....
English coke,	81.00	.....	.....	.....
Charcoal,	67.84	317.01	.....	17.15
Total material,	2166.00 tons.			

Product.

Number of bars,	2,708
Tons of bullion,	144.83
Containing silver, ounces,	45,538.37
Containing gold, ounces,	332.81
Containing lead, tons,	144.44

April 1*st*, 1883, *to March* 31*st*, 1884.

		Materials used. Tons per charge.	Materials used. Total tons.	Percentages of charges.	Total.
Days run,	279	.....	.....	.....	.....
Number of charges,	21,829	.....	.....	.....	.....
Weight of charge,	.....	0.390	8,512.152	.....	.....
Concentrates, slums and flue-dust,	.....	0.137	2,999.000	35.2	.....
Ore,	.....	0.052	1,130.082	13.2	.....
Manganese,	.....	0.161	3,511.000	41.2	.....
Limestone,	.....	0.006	124.070	01.4	.....
Slag and cleanings,	.....	0.034	748.000	09.2	100.2
American coke,	.....	.....	1,269.180	.....	21.329
English coke,	.....	.....	464.000		
Charcoal,	.....	.....	52.400		

Product.

Number of bars,	11,851
Shipments, tons,	654.470
Containing silver, ounces,	193,560.7
Containing gold, ounces,	1,178.6
Containing lead, tons,	645.84

9/11/97

Joba drilled a vertical hole at
JH Downey's Tombstone South.
The hole D-97-1 was collared about 20' from
Downey's hole ~~B~~ TS-1 (inclined to west @ -60°) into
Bx#3.

Both hit a high-silver value zone at a
similar depth. Joba's Ag values lower & with
no gold.

ACTLABS

ACTLABS-SKYLINE

REPORT OF ANALYSIS

JOB NO. VMY 025
August 7, 1997
D-97-1 (320-495)

H. J. DOWNEY, INC.
Attn: Mr. Harold J. Downey
1803 E. 10th Street
Tucson, AZ 85719

FILL-IN AG NOT ASSAYED BY JABA

Analysis of 27 Drill Cutting Samples

ITEM	SAMPLE NUMBER	Ag (ppm)
1	D-97-1 320-325	10.0
2	D-97-1 325-330	5.0
3	D-97-1 330-335	1.5
4	D-97-1 340-345	28.0
5	D-97-1 345-350	5.7
6	D-97-1 350-355	14.0
7	D-97-1 355-360	16.0
8	D-97-1 360-365	31.0
9	D-97-1 370-375	7.2
10	D-97-1 380-385	6.8
11	D-97-1 385-390	2.1
12	D-97-1 390-395	1.2
13	D-97-1 400-405	1.1
14	D-97-1 405-410	2.5
15	D-97-1 410-415	5.5
16	D-97-1 420-425	25.0
17	D-97-1 425-430	7.6
18	D-97-1 430-435	5.2
19	D-97-1 440-445	3.2
20	D-97-1 445-450	3.3

1775 W. Sahuaro Dr., P.O. Box 85670, Tucson, AZ 85754
Tel (520) 622-4836 Fax (520) 622-6065
William L. Lehmbeck James A. Martin

ACTLABS

ACTLABS-SKYLINE

JOB NO. VMY 025
August 7, 1997

ITEM	SAMPLE NUMBER	Ag (ppm)	
21	D-97-1 450-455	2.9	
22	D-97-1 460-465	60.0	
23	D-97-1 465-470	52.0	15' of 1.6 oz
24	D-97-1 470-475	52.0	
25	D-97-1 480-485	26.0	
26	D-97-1 485-490	43.0	35' 1.2 oz
27	D-97-1 490-495	9.5	
PREVIOUSLY RUN BY JABA	455-460	41.1	
	475-480	15.3	

William T. Lehmbeck
Manager

1775 W. Sahuaro Dr., P.O. Box 85670, Tucson, AZ 85754 Tel (520) 622-4836 Fax (520) 622-6065

Assay Results D97-1(H. Downey Property - Tombstone South)

SKYLINE LAB JOB NUMBER TFO141
2-Jul-97
D97-1 (0 TO 160)

Drill Hole Identity	From	To	Cu (ppm) LRL 2	Mo (ppm) LRL 2	Au (ppm) LRL .005	Ag (ppm) LRL .1	Pb (ppm) LRL 2	Zn (ppm) LRL 2	As (ppm) LRL .1	Sb (ppm) LRL .1	Bi (ppm) LRL .1	Cd (ppm) LRL .1	Hg (ppm) LRL .01	Se (ppm) LRL .1	Te (ppm) LRL .2	Tl (ppm) LRL .1
D97-1	0	5	69	13	-0.005	4.6	171	693	44.1	3.5	0.3	2.3	0.07	0.6	-0.2	0.3
D97-1	5	10	53	7	-0.005	14.5	320	1243	43.7	29.2	0.3	7.8	0.06	1.2	-0.2	0.6
D97-1	10	15	38	4	-0.005	7.8	297	1400	46.2	27.4	0.4	8.4	0.08	1.4	-0.2	0.6
D97-1	15	20	30	6	-0.005	5.6	247	1127	72.9	4.9	0.5	5.9	0.05	1.3	-0.2	0.7
D97-1	20	25	51	3	-0.005	2.6	170	973	63.1	1.6	0.2	5.4	0.04	0.9	-0.2	0.5
D97-1	25	30	40	5	0.02	1.9	279	1011	79.7	1.5	0.1	5.5	0.06	0.9	0.2	0.5
D97-1	30	35	18	2	0.015	1.9	296	573	65.5	1.2	0.1	4.1	0.08	0.6	-0.2	0.5
D97-1	35	40	13	4	-0.005	2.3	137	320	42.7	1	-0.1	2.3	0.06	0.6	-0.2	0.3
D97-1	40	45	12	4	-0.005	3.3	158	429	66.4	4	0.4	2.4	0.03	1.2	0.4	0.4
D97-1	45	50	12	3	0.025	5.9	146	381	29.8	3.1	0.3	2.3	0.06	0.8	-0.2	0.4
D97-1	50	55	9	3	-0.005	4.5	82	571	36.1	1.7	0.3	2.7	0.03	2.2	0.2	0.5
D97-1	55	60	9	5	-0.005	2.1	93	294	28.3	1	0.6	0.8	0.02	2.2	0.2	0.4
D97-1	60	65	26	15	-0.005	4.7	236	715	11.5	0.9	1	3.3	0.05	1	0.2	0.4
D97-1	65	70	54	8	-0.005	6.4	227	329	71.1	44.7	0.3	1	0.03	2.2	0.4	0.5
D97-1	70	75	28	3	-0.005	4.4	207	275	56.4	2.9	0.4	0.9	0.02	1.2	0.5	0.6
D97-1	75	80	28	7	-0.005	4.4	333	316	106.3	2.2	0.5	0.6	0.05	0.8	0.4	0.5
D97-1	80	85	8	2	-0.005	3.6	103	271	119	0.7	0.1	1	-0.01	0.7	-0.2	0.5
D97-1	85	90	10	-2	0.01	1.9	91	458	100.5	0.9	0.1	1.7	0.01	0.8	-0.2	0.5
D97-1	90	95	11	3	-0.005	4	137	903	46.2	1.1	0.5	4.3	0.03	1.5	-0.2	0.6
D97-1	95	100	24	-2	-0.005	8	74	1744	69.2	3.1	0.6	7.9	0.05	1.7	-0.2	0.7
D97-1	100	105	20	-2	-0.005	2.9	25	3473	40.2	18.1	-1	11.3	0.07	-3	-2	-2
D97-1	105	110	49	3	-0.005	-0.5	14	2054	31.8	2.2	0.4	3.2	0.01	2.2	-0.2	1.7
D97-1	115	120	15	-2	-0.005	-0.5	12	618	4.2	1.9	0.3	-0.4	-0.01	0.5	-0.2	0.6
D97-1	125	130	17	-2	-0.005	-0.5	5	329	5.1	1.5	0.2	1.8	-0.01	0.5	-0.2	0.5
D97-1	135	140	14	-2	-0.005	1	11	345	6.5	1.3	0.3	0.7	-0.01	0.4	-0.2	0.6
D97-1	145	150	20	-2	-0.005	-0.5	9	208	4.4	1.2	0.1	-0.4	-0.01	0.5	-0.2	0.7
D97-1	155	160	30	-2	-0.005	0.7	8	176	4.8	1.5	0.1	0.5	-0.01	0.3	-0.2	0.5

SKYLINE LAB JOB NUMBER TFO142
11-Jul-97
D97-1 (80 TO 85 & 165 TO 1515)

Drill Hole Identity	From	To	Cu (ppm) LRL 2	Mo (ppm) LRL 2	Au (ppm) LRL .005	Ag (ppm) LRL .1	Pb (ppm) LRL 2	Zn (ppm) LRL 2	As (ppm) LRL .1	Sb (ppm) LRL .1	Bi (ppm) LRL .1	Cd (ppm) LRL .1	Hg (ppm) LRL .01	Se (ppm) LRL .1	Te (ppm) LRL .2	Tl (ppm) LRL .1
D97-1	80	85	17	3	< .005	4.0	151	188	173.7	1.9	0.1	0.9	19	< .3	0.2	< .2
D97-1	165	170	75	< 2	< .005	< .5	11	121	2.7	1.8	0.1	< .4	<10	< .3	< .2	< .2
D97-1	175	180	36	< 2	< .005	0.5	6	156	3.1	2.4	0.1	< .4	<10	< .3	< .2	0.2
D97-1	195	200	30	2	< .005	0.5	7	167	4.8	3.2	0.1	< .4	<10	< .3	< .2	0.3
D97-1	235	240	16	2	< .005	< .5	11	457	7.7	2.9	0.2	0.4	14	< .3	< .2	0.8
D97-1	255	260	11	< 2	< .005	0.6	12	436	2.8	2.2	0.1	0.5	<10	< .3	< .2	0.3
D97-1	275	280	13	< 2	< .005	< .5	9	546	5.4	4.1	0.1	< .4	<10	< .3	< .2	0.4
D97-1	295	300	34	< 2	< .005	0.6	10	648	5.6	4.4	0.1	0.5	13	< .3	< .2	0.7
D97-1	315	320	16	< 2	< .005	9.4	11	1139	5.9	2.6	0.1	2.2	66	< .3	< .2	0.3
D97-1	335	340	13	< 2	< .005	7.5	11	909	9.4	2.1	0.1	3.7	52	< .3	< .2	0.5
D97-1	365	370	28	23	< .005	11.0	226	767	14.3	6.1	1.6	2.4	81	1.5	0.2	0.3
D97-1	375	380	20	6	< .005	7.0	131	891	26.9	4.1	0.6	2.4	70	0.7	< .2	0.3
D97-1	395	400	10	< 2	< .005	3.4	17	948	2.8	2.8	0.1	0.8	10	< .3	< .2	0.2
D97-1	415	420	122	< 2	< .005	7.9	30	661	5.4	5.1	0.2	1.2	30	< .3	< .2	0.3
D97-1	435	440	27	< 2	< .005	6.3	15	996	6.0	1.6	0.1	6.2	19	< .3	< .2	< .2
D97-1	455	460	159	3	< .005	41.1	41	791	4.3	3.9	0.1	4.8	327	< .3	< .2	0.5
D97-1	475	480	57	< 2	< .005	15.3	37	369	16.4	1.2	0.1	2.8	63	< .3	< .2	< .2
D97-1	495	500	102	2	< .005	5.5	28	866	13.6	7.5	0.1	1.1	18	< .3	0.2	0.2
D97-1	515	520	67	< 2	< .005	4.9	22	766	15.6	3.2	0.1	0.7	25	0.4	0.5	< .2
D97-1	535	540	19	2	< .005	1.7	43	133	3.6	1.7	0.3	< .4	<10	0.4	0.3	< .2
D97-1	555	560	23	2	< .005	2.5	16	670	5.3	3.2	0.2	7.5	21	< .3	< .2	0.2
D97-1	575	580	14	2	< .005	1.5	18	840	10.0	0.8	0.1	0.8	20	< .3	< .2	< .2
D97-1	595	600	49	4	< .005	3.3	102	2006	8.1	0.4	0.1	2.1	25	< .3	< .2	< .2
D97-1	615	620	25	2	< .005	1.0	50	2362	36.1	2.4	0.2	1.1	19	< .3	0.3	< .2
D97-1	635	640	11	2	< .005	6.3	44	548	17.1	0.5	< .1	2.2	35	< .3	< .2	< .2
D97-1	655	660	8	2	< .005	1.3	45	319	35.4	0.6	0.1	1.0	14	< .3	< .2	0.2
D97-1	665	670	17	2	< .005	2.6	171	730	30.0	1.1	0.1	3.9	30	2.1	< .2	0.2
D97-1	670	675	106	3	< .005	3.5	183	493	18.8	3.9	0.2	3.7	24	4.0	0.5	< .2
D97-1	675	680	352	6	< .005	3.2	288	778	27.6	4.2	4.7	1.1	22	7.7	2.4	0.6
D97-1	680	685	73	4	< .005	2.6	284	1034	25.9	4.6	1.9	0.6	23	6.1	1.0	2.0
D97-1	685	690	48	4	< .005	2.5	207	601	15.7	1.9	1.5	0.4	14	4.9	0.6	0.4
D97-1	690	695	33	3	< .005	3.4	117	337	6.4	1.1	0.4	1.3	15	2.7	0.2	< .2
D97-1	695	700	36	2	< .005	3.4	59	331	7.0	1.6	0.2	1.0	20	1.5	< .2	0.2
D97-1	700	705	25	2	< .005	2.2	39	233	20.3	1.5	0.2	0.4	16	1.7	< .2	0.3
D97-1	705	710	63	6	< .005	4.7	112	478	13.7	2.0	0.6	1.3	27	0.9	0.4	0.5
D97-1	710	715	77	9	< .005	9.1	116	807	15.7	2.4	0.8	1.5	53	1.2	0.6	0.5
D97-1	715	720	45	7	< .005	4.6	64	446	14.1	1.5	0.3	0.9	24	1.2	0.5	0.4
D97-1	720	725	35	7	< .005	2.6	64	380	10.1	1.2	0.3	1.0	17	1.0	0.3	0.3
D97-1	725	730	43	7	< .005	2.7	55	368	11.7	1.0	0.3	0.8	17	1.0	0.3	0.3
D97-1	730	735	53	6	< .005	6.1	63	487	10.9	1.5	0.4	1.3	32	1.0	0.4	0.4
Drill Hole Identity	From	To	Cu (ppm) LRL 2	Mo (ppm) LRL 2	Au (ppm) LRL .005	Ag (ppm) LRL .1	Pb (ppm) LRL 2	Zn (ppm) LRL 2	As (ppm) LRL .1	Sb (ppm) LRL .1	Bi (ppm) LRL .1	Cd (ppm) LRL .1	Hg (ppm) LRL .01	Se (ppm) LRL .1	Te (ppm) LRL .2	Tl (ppm) LRL .1

Assay Results D97-1(H. Downey Property - Tombstone South)

Drill Hole Identity	From	To	Cu (ppm)	Mo (ppm)	Au (ppm)	Ag (ppm)	Pb (ppm)	Zn (ppm)	As (ppm)	Sb (ppm)	Bi (ppm)	Cd (ppm)	Hg (ppm)	Se (ppm)	Te (ppm)	Tl (ppm)
			LRL 2	LRL 2	LRL .005	LRL .1	LRL 2	LRL 2	LRL .1	LRL .1	LRL .1	LRL .1	LRL .01	LRL .1	LRL .2	LRL .1
D97-1	735	740	32	3	< .005	3.8	37	260	11.7	1.2	0.3	1.0	15	0.6	0.5	0.3
D97-1	740	745	23	2	< .005	1.7	28	164	6.3	0.8	0.2	0.6	11	< .3	0.2	0.4
D97-1	745	750	38	5	< .005	2.9	32	170	3.8	0.7	0.3	0.6	14	0.3	< .2	0.4
D97-1	750	755	50	4	< .005	4.4	33	261	8.0	0.9	0.3	0.8	27	1.0	0.3	0.4
D97-1	755	760	39	3	< .005	2.4	31	158	10.6	0.6	0.3	0.7	18	0.3	0.2	0.4
D97-1	760	765	65	4	< .005	1.7	48	170	12.8	0.5	0.6	0.6	<10	0.3	0.2	0.4
D97-1	765	770	132	6	< .005	2.1	80	189	5.9	0.7	1.4	0.6	10	0.5	0.2	0.4
D97-1	770	775	35	2	< .005	3.2	25	153	2.4	0.5	0.2	0.9	15	< .3	< .2	0.4
D97-1	775	780	33	3	< .005	2.4	31	195	6.3	1.0	0.3	0.6	12	< .3	0.2	0.4
D97-1	780	785	22	3	< .005	2.1	29	205	7.2	0.7	0.2	0.7	<10	1.5	0.2	0.4
D97-1	785	790	53	4	< .005	1.7	39	211	9.0	0.8	0.5	0.5	<10	2.3	0.2	0.3
D97-1	790	795	20	2	< .005	1.1	16	119	2.1	0.3	0.1	0.5	<10	< .3	< .2	0.4
D97-1	795	800	22	2	< .005	1.7	21	158	5.3	0.6	0.2	0.6	<10	0.4	< .2	0.5
D97-1	800	805														
D97-1	805	810	37	2	< .005	0.9	30	117	2.6	0.3	0.4	< .4	<10	< .3	< .2	0.5
D97-1	520	525	50	5	< .005	1.9	45	174	5.8	0.6	0.4	0.4	<10	0.4	0.6	0.4
D97-1	825	830	23	3	< .005	2.3	31	158	4.7	1.0	0.3	0.5	12	< .3	0.2	0.4
D97-1	830	835	25	5	< .005	2.1	40	234	7.9	1.0	0.2	0.8	12	1.4	0.2	0.4
D97-1	835	840	27	5	< .005	2.7	32	206	6.9	1.1	0.2	0.8	11	1.4	0.3	0.4
D97-1	840	845	25	4	< .005	1.6	28	138	2.2	0.8	0.2	0.4	13	< .3	< .2	0.5
D97-1	845	850	21	2	< .005	1.1	23	232	4.9	0.5	0.1	0.5	11	< .3	< .2	0.5
D97-1	850	855	47	< 2	< .005	1.0	19	99	4.3	0.2	0.2	0.5	<10	< .3	< .2	0.5
D97-1	855	860	24	2	< .005	1.1	26	178	2.1	0.5	0.2	0.5	11	< .3	< .2	0.5
D97-1	875	880	59	26	< .005	1.5	21	399	3.8	0.9	0.2	0.4	16	0.6	0.3	0.5
D97-1	880	885	16	4	< .005	1.3	66	281	7.2	1.0	0.1	1.2	29	1.1	0.2	0.4
D97-1	885	890	24	2	< .005	3.1	67	247	10.7	2.3	0.1	1.0	41	1.0	0.2	0.4
D97-1	890	895	25	< 2	< .005	1.3	17	119	1.8	0.4	0.1	0.5	<10	< .3	< .2	0.5
D97-1	905	910	19	2	< .005	1.5	25	312	3.5	0.8	0.1	0.4	<10	< .3	0.2	0.3
D97-1	910	915	22	3	< .005	1.9	34	327	3.2	0.9	0.2	0.7	<10	< .3	0.2	0.3
D97-1	915	920	25	2	< .005	1.4	19	144	1.2	0.3	0.1	0.5	12	< .3	< .2	0.3
D97-1	920	925														
D97-1	935	940	18	< 2	< .005	1.0	27	266	27.7	1.0	0.1	0.5	19	< .3	< .2	0.4
D97-1	940	945	34	2	< .005	2.3	32	373	12.5	1.4	0.1	0.4	13	< .3	0.2	0.4
D97-1	945	950	24	< 2	< .005	1.3	18	150	14.5	1.0	0.1	0.5	<10	< .3	0.3	0.3
D97-1	950	955	18	< 2	< .005	2.2	66	228	54.4	0.6	0.1	1.4	38	< .3	0.3	0.4
D97-1	955	960	29	2	0.005	4.9	262	993	45.4	7.1	0.4	7.0	22	1.5	0.2	0.2
D97-1	970	975	16	< 2	0.12	4.0	144	376	205.5	1.2	0.2	2.5	22	< .3	0.5	0.3
D97-1	975	980	17	< 2	0.12	3.8	275	546	379.4	1.4	0.1	3.9	56	< .3	0.3	0.5
D97-1	980	985	14	2	0.025	2.7	145	560	129.6	0.9	0.1	3.2	31	0.3	0.8	0.5
D97-1	985	990	12	< 2	0.01	2.6	158	541	133.9	1.5	0.1	1.2	37	0.7	1.2	0.5
D97-1	990	995	26	< 2	<.005	5.5	555	1466	321.4	2.9	0.1	7.1	73	< .3	0.7	0.4
D97-1	1010	1015	23	< 2	<.005	2.1	105	248	67.3	0.9	0.1	1.0	24	< .3	0.3	0.3
D97-1	1015	1020	15	< 2	<.005	1.4	37	152	20.2	1.3	0.1	0.4	20	0.3	0.2	0.3
D97-1	1020	1025	21	< 2	<.005	1.7	38	165	66.5	0.7	0.1	0.6	15	< .3	0.2	0.4
D97-1	1025	1030	21	< 2	<.005	2.1	29	175	36.4	0.7	0.1	0.5	16	< .3	< .2	0.3
D97-1	1030	1035	27	2	<.005	1.9	34	184	12.4	1.0	0.1	0.8	<10	< .3	< .2	0.2
D97-1	1035	1040	22	< 2	<.005	1.1	15	119	2.1	0.8	< .1	0.5	<10	< .3	0.2	0.3
D97-1	1055	1060	23	< 2	<.005	1.4	12	98	4.4	0.7	0.1	0.5	<10	< .3	0.2	0.3
D97-1	1060	1065	13	< 2	<.005	0.6	16	67	1.9	0.9	0.1	0.4	<10	< .3	0.2	0.4
D97-1	1080	1085	25	3	<.005	2.2	30	169	5.8	0.7	0.1	0.6	20	< .3	< .2	0.2
D97-1	1085	1090	32	4	0.02	6.2	124	521	229.9	2.0	0.1	2.5	50	< .3	0.3	0.2
D97-1	1090	1095	26	3	<.005	2.2	80	246	104.3	2.2	< .1	1.3	13	< .3	0.3	0.2
D97-1	1095	1100	27	2	<.005	2.8	14	137	36.1	1.3	< .1	0.5	10	< .3	0.6	0.2
D97-1	1100	1105	28	4	0.005	1.6	20	76	5.9	0.5	0.1	0.5	<10	0.4	0.2	< .2
D97-1	1105	1110	25	2	<.005	1.9	45	163	5.5	0.7	< .1	0.9	19	< .3	0.2	0.2
D97-1	1110	1115	10	< 2	<.005	1.4	21	119	2.7	0.7	< .1	0.6	15	< .3	0.2	0.2
D97-1	1115	1120	13	2	<.005	1.1	23	123	2.7	0.6	< .1	0.4	<10	< .3	0.2	0.2
D97-1	1120	1125	33	3	<.005	3.7	44	205	4.1	1.0	< .1	0.9	22	< .3	0.2	< .2
D97-1	1165	1170	20	< 2	<.005	0.8	21	91	2.4	0.5	< .1	< .4	<10	< .3	< .2	0.2
D97-1	1180	1185	27	< 2	<.005	2.1	19	93	1.6	0.4	0.1	0.7	<10	< .3	< .2	0.2
D97-1	1185	1190	31	2	<.005	1.6	29	139	2.8	0.7	0.1	0.5	<10	< .3	0.2	< .2
D97-1	1190	1195														
D97-1	1195	1200	17	< 2	<.005	0.7	23	89	< .5	0.3	0.2	< .4	<10	0.3	< .2	0.3
D97-1	1300	1305	26	4	0.005	1.1	18	127	< .5	0.4	0.2	< .4	<10	< .3	< .2	0.3
D97-1	1345	1350	13	2	<.005	1.0	30	164	2.7	0.6	0.1	0.5	10	< .3	< .2	0.3
D97-1	1350	1355	24	5	<.005	1.8	63	272	3.8	1.0	0.3	0.4	12	0.4	< .2	0.3
D97-1	1355	1360	17	2	<.005	1.7	40	153	2.0	0.7	0.2	0.6	<10	0.3	< .2	0.4
D97-1	1405	1410	16	< 2	<.005	0.6	23	67	< .5	0.2	0.2	< .4	<10	< .3	< .2	0.5
D97-1	1410	1415	14	< 2	<.005	0.6	22	52	< .5	0.3	0.2	0.5	<10	< .3	< .2	0.4
D97-1	1460	1465	26	3	<.005	2.0	34	303	2.4	0.8	0.3	0.4	17	< .3	< .2	0.5
D97-1	1475	1480	19	< 2	<.005	1.0	18	78	< .5	0.3	0.1	0.4	<10	< .3	< .2	0.4
D97-1	1480	1485	19	2	<.005	1.6	20	153	1.0	0.6	0.2	< .4	<10	< .3	< .2	0.3
D97-1	1510	1515	14	< 2	<.005	0.8	16	72	< .5	0.2	0.1	< .4	<10	< .3	< .2	0.4
Drill Hole Identity	From	To	Cu (ppm)	Mo (ppm)	Au (ppm)	Ag (ppm)	Pb (ppm)	Zn (ppm)	As (ppm)	Sb (ppm)	Bi (ppm)	Cd (ppm)	Hg (ppm)	Se (ppm)	Te (ppm)	Tl (ppm)
			LRL 2	LRL 2	LRL .005	LRL .1	LRL 2	LRL 2	LRL .1	LRL .1	LRL .1	LRL .1	LRL .01	LRL .1	LRL .2	LRL .1

JDS

ASARCO

Southwestern Exploration Division

June 26, 1991

W.L. Kurtz

Tombstone South Property
H.J. Downey, Inc.
Cochise County, Arizona

I submit the following notes after our discussion with R.L. Brown and respond to your questions.

The production figures for Tombstone proper are non-existent from the standpoint of tonnage and grade. The figures available for all the years are the dollar value of production. Using the yearly prices and other data I have also arrived at the following.

Total tonnage was between 1 1/4 - 1 1/2 million tons, with 257,000 oz. gold (grade of 0.2 oz/ton), 31,388,000 oz. silver (25 oz/ton) and 40,000,000 pounds of lead (1.6%).

It appears that half of the production was from the Grand Central-Centention zone (Devere, B.J., 1979, Company report).

The zone is in excess of 4800 feet in length and varies from 400 to 1,400 feet in width. A number of mineralized dikes, faults, and breccia zones are within the zone and mineralized beds in the lower part of the Cretaceous Bisbee Formation (Blue Limestone, Novaculite) and favorable (karst?) beds in the top of the Permian Epitaph dolomite. The zone trends north-northeast and dips steeply (70^0) to the west. Mineral zones trend within the zone as both subparallel bodies and as cross-cutting mineralized breccias.

In the 1980's, TEI open-cut the zone and mined material from the surface to 150'in depth. Heap leaching produced 22,000 oz. Au and 1,100,000 oz. Ag.

Size of stopes are difficult to come by, with the following estimates:

Silver Thread fold: 600' long x 15' wide x 15' high by 10 ft^3/ton gives 14000 tons.

Sulphret fold: 30' long x 25'-100' wide (55') x 3'-8' high (6') by 10 ft^3/ton = 60,000 tons. This mineralization was mined in 1904-1905 at a reported value of $70 per ton, with 20% of the value in gold, and 80% in silver, or 0.68 oz. Au/ton and 94 oz. Ag/ton.

Skip Shaft body: 900' long x 10'-20' wide (15') x 20'-40' high (30') by 10 ft^3/ton = 41,000 tons.

Thus it would appear that mineralized bodies at Tombstone proper were generally less than 50,000 tons each, with a sufficient number in proximity to one another.

At Tombstone South, the Downey hole TS-1 intercepted a drill length of 30 feet of 4.56 opt Ag, trace gold, 0.88% lead and 2.45% manganese at 385'-415' (-60° hole).

The hole was angled northwesterly into the #3 breccia zone and cut the breccia from 255'-420' with indicative gold (0.01-0.02 ppm), silver (1-10 ppm) and manganese (3,000-10,000 ppm), down to the 30-foot interval of 4.56 opt silver intercept.

Three possible settings for the mineralized zone:

1. It represents the favorable stratigraphy lateral to the pipe, along the fold nose exposed on the surface.

2. It represents mineral controlled by the northeast-trending shear zone on the west side of the property. This zone is 100 plus feet wide.

3. It represents the mineral along the northeast fault connecting the two breccia pipes and which down drops the Bisbee on the north side.

In the main district the following ore zones were mined:

From base of Bisbee under the mudstone-shale:

10' ore in limestone
24' barren shale
35' (20'-40') ore, Blue Limestone
60' barren-weak mineral in shale-conglomerate
65' (55'-70') ore, Novaculite

110' ore out of 194' section

At Tombstone South, Figure 2 of June 11, 1991 report, the distance between breccia #3 and #4 is 800 feet and, based on the trend of the west shear and the east fault, opens to the south. Surface expression of the fold in Cretaceous mudstone-quartzite is 1400 feet.

Using a 100' thick favorable replacement unit x 600' wide x 1000' long gives an excess of 6 million tons of potential replacement horizon at a possible depth of 350-450' below the surface. With 100' of ore, this might be a 4 or 5/1 stripping situation.

To test the property: Several vertical drill holes in the fold area to determine the depth to the replacement horizon and find alteration/mineralization; several holes going southwest along the western shear and angled into the shear zone, at the 400' depth, to check for continued mineralization in the shear; and a hole drilled between the two breccias, angled northwest to cut the down dropping fault, check its alteration-mineralization, and continue to find the base of the Bisbee on the north side of the fault (or a new vertical hole on the north side).

Additional mapping of the surface at 1" = 200' to outline the fold, its type, any cross faults, and the three suggested faults and shear zones should be undertaken. The poorly exposed area of breccia #1 and #2, is on a similar trend as the northern breccias, and lies some 4000 feet south, and this area should also be mapped and further sampled.

Attached is the outline of terms as now stated with purchase price end by the year 2000.

As noted, only a moderate front end payment is suggested along with a six-months' free time (until Dec. 31., 1991) for any work.

The property is held by three Arizona State prospecting permits (Exhibit A, attached) and 10 unpatented claims.

Downey will proceed with converting the two earlier prospecting permits into mineral leases (as the 5th year is approaching) and secure a State Royalty figure for any future production, if possible.

At present Downey has submitted the property to several other groups but has had no response from them.

James D. Sell

James D. Sell

JDS:mek
Attachment

OUTLINE OF TERMS FOR ACQUISITION OF THE TOMBSTONE SOUTH PROPERTY, COCHISE COUNTY, ARIZONA

1. Ownership:

The property is held by the Limited Partnership, "Tombstone South Minerals, Ltd.", Tucson, AZ under lease agreement with Philip J. Sterling, Albuquerque, NM and Manuel Hernandez, Pearce, AZ, who hold prospecting permits and federal lode claims described in EXHIBIT A attached. An additional prospecting permit is held by the partnership adjoining the southern boundary of the above group, legal description attached.

2. Schedule of Payments

Front end payment	$ 2,500.00
January 1, 1992	25,000.00
July 1, 1992	25,000.00
January 1, 1993	25,000.00
July 1, 1993 and each 6 month anniversary thereafter.	50,000.00

July 1, 1998 is end of term of lease with Sterling/Hernandez at which time a balance of approximately $550,000.00 will remain on the purchase price of $750,000.00. A payment to cover the balance will have to be made or terms will have to be re-negotiated. It may be well to re-negotiate earlier.

3. Purchase Option:

On or before January 1, 1995	$ 1,500,000.00
" " " " " 1997	2,500,000.00
" " " " " 2000	5,000,000.00

(Purchase Price tied to CPI of 1/1/92)

4. Work Committment: Maintain state and federal work requirements and/or payments.

5. Boundary agreement: Any new acquisitions by either party within 1/2 mile become part of agreement.

6. Data turnover upon termination (includes core, cuttings, rejects, pulps, copies of assays, geologic, geochemical,and geophysical results).

7. 90 day prior notice of termination after first six months.

EXHIBIT A

CLAIMS

The following-described unpatented lode mining claims situated in the Tombstone Mining District, Cochise County, Arizona, the names of which and the Dockets and the pages of recording of the location notices in the office of the Cochise County Recorder of which, and the Bureau of Land Management Serial Numbers of which, are as follows:

Name of Claim	Transaction Number Docket	Page	A MC NO.
Tombstone South #1	860919758		260126
Tombstone South #2	860919759		260127
Tombstone South #3	860919760		260128
Tombstone South #4	860919761		260129
Tombstone South #5	860919762		260130
Tombstone South #6	860919763		260131
Tombstone South #7	860919764		260132
Tombstone South #8	860919765		260133
Tombstone South #9	860919766		260134
Tombstone South #10	860919767		260135

SUBJECT TO:

1. Paramount title of the United States;

2. All roads, rights-of-way and easements existing or of record in the office of the Recorder of Cochise County;

3. Leases, permits, rights-of-way or any other rights or uses granted by or under the authority of the United States as to the unpatented claims.

PERMITS

State of Arizona Prospecting Permit Nos. 08-93948 and 08-94136 covering the following described lands in Cochise County, Arizona:

08-93948: The NE 1/4 and the E 1/2 of the NW 1/4 of Sec. 32, T20S, ~~R33E~~ R22E

08-94136: The SE 1/4 and the E 1/2 of the SW 1/4 (minus patented claim #23312) of Sec. 32, T20S, R22E.

08-96962: THE NW 1/4 OF SEC. 4, T21S, R22E - PERMIT ACQUIRED BY TSM LTD. 9/6/89

JDS

ASARCO

Southwestern Exploration Division

September 23, 1991

FILE NOTE

Ore Grades-Production
Tombstone Mining District
Cochise County, Arizona

While browsing, I ran across the ADMR SR-7 paper on Tombstone ore grades and production (attached).

As Greeley notes, the production figures are hard to come by and a number of assumptions are noted throughout, but, nevertheless, this report is one of interest.

The high-grade nature of the early production is evident from the Contention-Grand Central zone, about 3,300 feet long, between 1880 and 1887, produced 272,545 tons of ore yielding 12,825,488 ounces of silver and 162,348 ounces of gold, or 47.06 opt silver and 0.596 opt gold.

From 1880 thru 1977, the district produced 1,358,270 tons of ore with 31,862,345 ounces silver, and 36,530,667 pounds of lead. During that period miscellaneous tails, dumps, slags heap, etc. were reworked with 1,347,936 tons of material reporting 336,926 ounces silver, and 4,470,440 pounds of lead.

The average grades they report in SR-7 are misleading as they use the total tons produced but the production item may have come from specific years. Since the district was primarily a lead-silver district, those figures reflect the district totals - 23.7 opt silver, and 1.51% lead per ton of ore. Their gold average is 0.098 opt gold, but if you recalculate the value to the years produced, you then have a value of 0.139 opt gold, from the numbers given.

James D. Sell

James D. Sell

JDS:mek
Att.

cc: W.L. Kurtz
H.J. Downey

SR-7 6107

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

James D. Sell

BY
Michael N. Greeley
Field Engineer
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.

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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%		

Feb. '84

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					

Feb. '84

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]					

Feb. '84

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%		

Feb. '84

MISCELLANEOUS

Tombstone Mill & Mining Assay Office Dump	Tons	oz Ag	oz Au	lbs Cu	lbs Pb	lbs Zn	Reference
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%		

Feb. '84

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%			

Feb. '84

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%		

Feb. '84

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%		

Feb. '84

ORE

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%	

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%		
Grand Total-Ore	1,358,720	31,862,345	120,895	3,298,401	36,530,667	1,058,834	
G. Total Mix Tails, dumps, slag etc.	1,347,936	336,926	11,930	254,898	4,470,440	—	

Feb. '84

WEIGHED AVERAGE RECOVERED SILVER GRADE (oz/short ton) 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	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																?				
01																?	121.66			
02																108.70				
03									75.00(?)							16.80		?	?	
04																13.77		?	?	
05																13.35		50.00	50.00	
06																8.74		82.50		
07																7.09		129.02		
08																6.97		57.01		
09																7.44				
1910		26.20(?)							14.54							22.20		15.85	49.55	
11		28.51(?)														25.47		18.84	21.40	
12																21.40				
13												0.14(?)				21.94		16.32		
14																17.87			17.77	
15																11.12			2.77	
16																7.62			11.48	
17																7.71			0.46	
18																14.53				12.08
19																16.41		26.23		
1920																15.41		41.70	27.54	
21																22.01				
22						15.26										13.84			10.85	
23						14.39										15.13			12.77	
24																16.03				
25																11.87				
26																8.10			13.13	
27																9.73			7.83	
28																7.06			10.04	
29						5.29 (?)										8.72			22.00	
1930						42.54										6.29				7.97
31						34.30										9.09				19.36
32						29.94										?				13.40
33																?		18.90	14.44	13.42
34										4.04						?		9.20	22.37	11.39
35	19.68									0.57						?		0.96	10.85	12.38
36	16.50															?				12.91
37																?				10.76
38																?				?
39																?				?
1940																?				?
41																?				?
42																?				?
43																?				?
44																?				?
45																?	121.00			?
46																?				?
47																?				?
48																?				?
49																?				?
1950																?				13.34
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					
Average: 1901-1957	17.53	27.96				28.90			25.53	2.55						11.45	121.66	29.73	22.08	8.76
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 ton) 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

ARIZONA DEPARTMENT OF MINERAL RESOURCES

BOARD OF GOVERNORS

JDS

ASARCO

Exploration Department
Western USA

July 2, 1992

G.D. Van Voorhis
New York Office

Tombstone South
H.J. Downey, Inc.
Sec. 29, 32, T20S, R22E
Sec. 4, T21S, R22E
Cochise County, Arizona

Attached is Mr. Sell's recommendation to drill two (2) reverse-circulation rotary holes to test a silver-gold target to the southwest of the greater Tombstone District, Cochise County, Arizona.

Mr. Sell believes Tombstone type manto mineralization may exist with mineable grades of plus 20 oz. silver and ±0.10 oz. gold contained in 1 to 6 million tons within the horst block.

The upper Zone I is covered by 200-300 feet of mudstone of the Bisbee group. Favorable units continue for 450 additional feet to the top of the Naco formation. Major production in the Tombstone district was extracted from the lower Blue Limestone and Novaculite at the base of Zone II.

One angle diamond drill hole cut mineralization at a brecciated fault zone and contained a 30 foot intercept of 4.60 oz. silver and 1.01% lead, with only traces of gold.

The property lies mainly on Arizona State Lease Land. Our agreement would be with H.J. Downey, Inc., who is purchasing the State leases and 10 lode unpatented Federal mining claims for an upset price of $750,000. Downey is asking for a purchase price of $1.5 million if the option is exercised prior to January 2, 1995. First payment on underlying lease is $30,000 due January 2, 1993.

One patented claim is not controlled by either Downey or the underlying owners. The patented claim "Terrible" (survey #23312) of 20.36 acres is located a half mile south of the proposed drilling. The claim is along the Arlington vein on the south boundary of Section 32. It is owned by James Barko, Jr., and P.A. Barko of 3644 N. Doe, Kokomo, Indiana 46901.

Mr. Sell estimates $27,000 to drill the two reverse-circulation holes (1550' total) and includes a $3,000 consulting fee to Mr. Downey for a geologic map of the claim area.

WLK

W. L. Kurtz

WLK:mek
Atts.

cc: J.D. Sell

ASARCO

Southwestern Exploration Division

July 2, 1992

W.L. Kurtz

Tombstone South Property
H.J. Downey, Inc.
Cochise County, Arizona

Mr. H.J. Downey has drilled a significant intercept of silver-lead-manganese (30' of 4.60 opt silver, 1.01% lead, and 2.40% manganese) in an inclined (-60°) hole at a depth of 385'-415' (Figure 1) which may be part of a new silver-lead district.

The target at Tombstone South is 1-6 million tons of plus 20 oz. silver and ±0.10 oz. gold in manto-type replacement deposits similar to those mined in the Tombstone District located 5 miles to the northeast.

Approximately 837 acres covered by ten Federal unpatented mining claims and three Arizona State exploration leases (Figure 2) is under option to Mr. Downey. One patented mining claim inside the H.J. Downey group is held by Mr. James Barko, Jr.

Figure 3 shows the outline of the lease block located southwest of Tombstone in Cochise County, Arizona. Also shown is the breccia #3 which was cut by the drill hole TS-1. The target area was reviewed in the field as was the TS-1 core.

The TS-1 intercept (Figure 4) is within the breccia #3 located at the intersection of a N60°E shear zone connecting breccias #3 and 4, and a fault zone trending N25°E. A N15°W shattered zone bounds the east side of the area of immediate interest. This zone intersects at the breccia #4 position (Figure 4).

The area bounded by the three fault-shear-shattered zones is 800 feet wide on the north end and expands to the south for 7500 feet to the property boundary. Within the area the surface Bisbee group mudstones-sandstones are folded into a large open syncline plunging south with a steep western limb and a moderated dipping eastern limb. Bleaching of the mudstone (Figure 4) in the horst block as well as manganese-trace lead-trace silver in the surface breccias suggest the movement of mineralizing altering solutions.

Two reverse-circulation holes (850' and 700') are recommended to test the horst block for manto-type Tombstone mineralization on the folded portion and/or manto-type within the N25°E fault zone similar to the Grand Central Contention-Head Center trend in the Tombstone area.

The Grand Central trend was mined for 3000 feet along strike, in excess of 200 feet wide between porphyry dikes, and mined orebodies from surface to 700 feet in a 400 foot stratigraphic packet from the top of Zone I to the base of Zone II. Between 1880-1887, the Grand Central zone produced 272,545 tons with 12,825,488 ounces silver (47 opt), and 162,348 ounces gold (0.60 opt) recovered. In 1981-1983, Tombstone Exploration Inc. mined the Contention zone by open-pit, producing 5,262,271 tons with a head grade of 2.2 million oz. silver (0.41 opt) and 33 thousand ounces gold (0.006 opt) down to a depth of 150 feet.

Figure 4 shows the two proposed holes with the cross-section A-A'. Figure 5 is the cross section A-A' and suggests the TS-1 intercept is within the Zone I packet of limestone-shale-sandstone. Between the faults, from the surface to around 200-300' is mudstone, then Zone I followed by 170 plus feet of shale, then the main mineralized Zone II resting on Naco limestone. Water was found 350' below the surface in TS-1 and the lower Zone II would be sulfide mineralization.

The mined ore zones at Tombstone proper, Figure 6, were mined from about Zone I to the base of Zone II, and similar distribution of values could be found at Tombstone South.

Table 1 shows the various intervals in TS-1, the inclined intercept, the vertical equivalent, the rock type, and the values for gold, silver, lead, zinc, and manganese. The proximity of the hole to the breccia mass does not lend itself to a valid interpretation of possible zoning within the horst block area, but it does suggest that silver-manganese values may pick up a hundred or more feet above Zone I.

Table 1. TS-1 Value

Inclined Depth	Inc.Ft.	*Vert.ft.	Rock	Oz.Au	Oz.Ag	Pb %	Zn %	Mn%
125-262.5	137.5	115	Mudstone	tr	tr	tr	0.05	0.13
262.5-385	122.5	110	bx mud/ss	tr	0.21	0.01	0.05	0.79
385-415	30	26	bx ss/qtzite	tr	4.60	1.01	0.06	2.40
fault 415-490	75	65	qtzite	tr	0.22	0.02	0.05	0.28
490-598 T.D.	108	94	qtzite	tr	0.02	0.02	tr	0.17

Stratigraphy has not been resolved at the Tombstone South property, and at present (Figure 5) I believe the holes will penetrate 200-300 feet of mudstone/shale before the Zone I intercept. If shale is found below the Zone I intercept of limestone/shale/sandstone, then the drilling should progress to Zone II and the underlying Naco limestone. The holes have been programmed for the deeper target. As the water table is around 350 feet deep in this area, Zone I will probably be oxidized whereas Zone II would be sulfide.

Estimated expenditures for the two holes:

Direct Drilling (RC) 1550' at $9.00/ft.	$14,000
Supervision, Site Preparation	3,000
Assaying (Au-Hg-Pb-Mn)	7,000
Drilling Subtotal	$24,000
Mapping Fee to HJD	3,000
TOTAL	$27,000

Attachment A is the outline of terms by H.J. Downey and the property description.

Contact has not been made with Mr. James Barko, Jr., owner of the "Terrible" patented claim #23312 on the extension of the Arlington Vein at the south side of Section 32. The Arlington Vein has not been mined to any extent, but numerous pits show its strike direction, subparallel to the structure connecting breccia #3 and #4.

Success in the proposed drill holes will prompt a contact with Mr. Barko, as the Arlington vein structure could be a leakage feature as represented by the zone of breccia #3 and #4.

James D. Sell

James D. Sell

JDS:mek
Attachments

cc: G.D. Van Voorhis

ATTACHMENT A

OUTLINE OF TERMS FOR ACQUISITION OF THE TOMBSTONE PROPERTY
COCHISE COUNTY, ARIZONA

1. Ownership:

   The property is held by the Limited Partnership, "Tombstone South Minerals, Ltd.," Mr. Harold J. Downey, 1803 E. 10th Street, Tucson, AZ 85719, under lease agreement with Philip J. Sterling, Albuquerque, NM, and Manuel Hernandez, Pearce, AZ, who hold prospecting permits and Federal lode claims described in Exhibit A, attached. An additional prospecting permit is held by the partnership adjoining and southern boundary of the above group, legal description attached.

2. Lease of 25 years with 25 year extension, with option to purchase.

3. Schedule of Payments to Limited Partnership:

Front end payment	$ none
January 2, 1993	30,000.00
January 2, 1994	50,000.00
January 2, 1995 and each anniversary thereafter	100,000.00

   (Note: July 1, 1998 is end of term of Limited Partnership lease with Sterling/Hernandez at which time a balance will remain on the purchase price of $750,000.00. A payment by the Limited Partnership, to cover the balance will have to be made or terms will have to be renegotiated. Mr. Downey intends to renegotiate earlier.)

4. Purchase Option:

On or before January 2, 1995	$1,500,000.00
After January 3, 1995 and on or before January 2, 1997	2,500,000.00
After January 3, 1997 and on or before January 2, 2000	5,000,000.00

   (Purchase Price tied to CPI of January 1, 1992)

5. Work Commitment: Maintain state and Federal work requirements and/or payments.

6. Boundary Agreement: Any new acquisitions by either party within one-half mile become part of agreement.

7. Data turnover upon termination (includes core, cuttings, rejects, pulps, copies of assays, geologic, geochemical, and geophysical results).

8. Ninety day prior notice of termination after January 2, 1993.

EXHIBIT A

CLAIMS

The following-described unpatented lode mining claims situated in the Tombstone Mining District, Cochise County, Arizona, the names of which and the Dockets and the pages of recording of the location notices in the office of the Cochise County Recorder of which, and the Bureau of Land Management Serial Numbers of which, are as follows:

Name of Claim	Transaction Number Docket	Page	A MC No.
Tombstone South #1	860919758		260126
Tombstone South #2	860919759		260127
Tombstone South #3	860919760		260128
Tombstone South #4	860919761		260129
Tombstone South #5	860919762		260130
Tombstone South #6	860919763		260131
Tombstone South #7	860919764		260132
Tombstone South #8	860919765		260133
Tombstone South #9	860919766		260134
Tombstone South #10	860919767		260135

SUBJECT TO

1. Paramount title of the United States;

2. All roads, rights-of-way and easements existing or of record in the office of the Recorder of Cochise County;

3. Leases, permits, rights-of-way or any other rights or uses granted by or under the authority of the United States as to the unpatented claims.

PERMITS

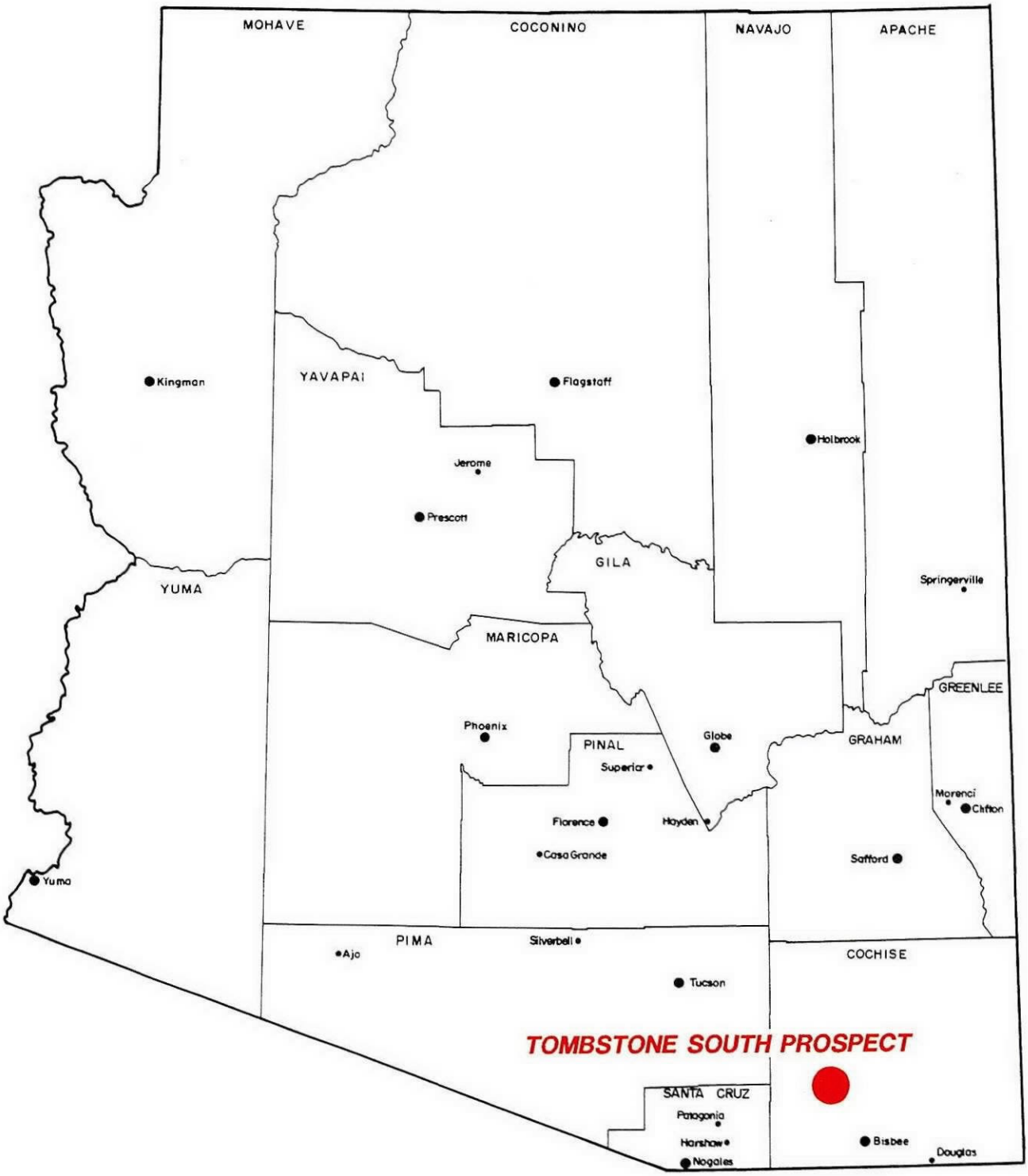
State of Arizona Prospecting Numbers covering the following described lands in Cochise County, Arizona:

08-99349: The NE 1/4 and the E 1/2 of the NW 1/4 of Sec. 32, T20S, R22E. 240 acres. Ann. date start Aug. 26, 1991.

08-99362: The SE 1/4 and the E 1/2 of the SW 1/4 (minus patented claim #23312) of Sec. 32, T20S, R22E. 222 acres. Ann. date start Oct. 28, 1991.

08-96962: The NW 1/4 of Sec. 4, T21S, R22E - Permit acquired by TSM Ltd. 9/6/89. 181 acres.

FIGURE 1



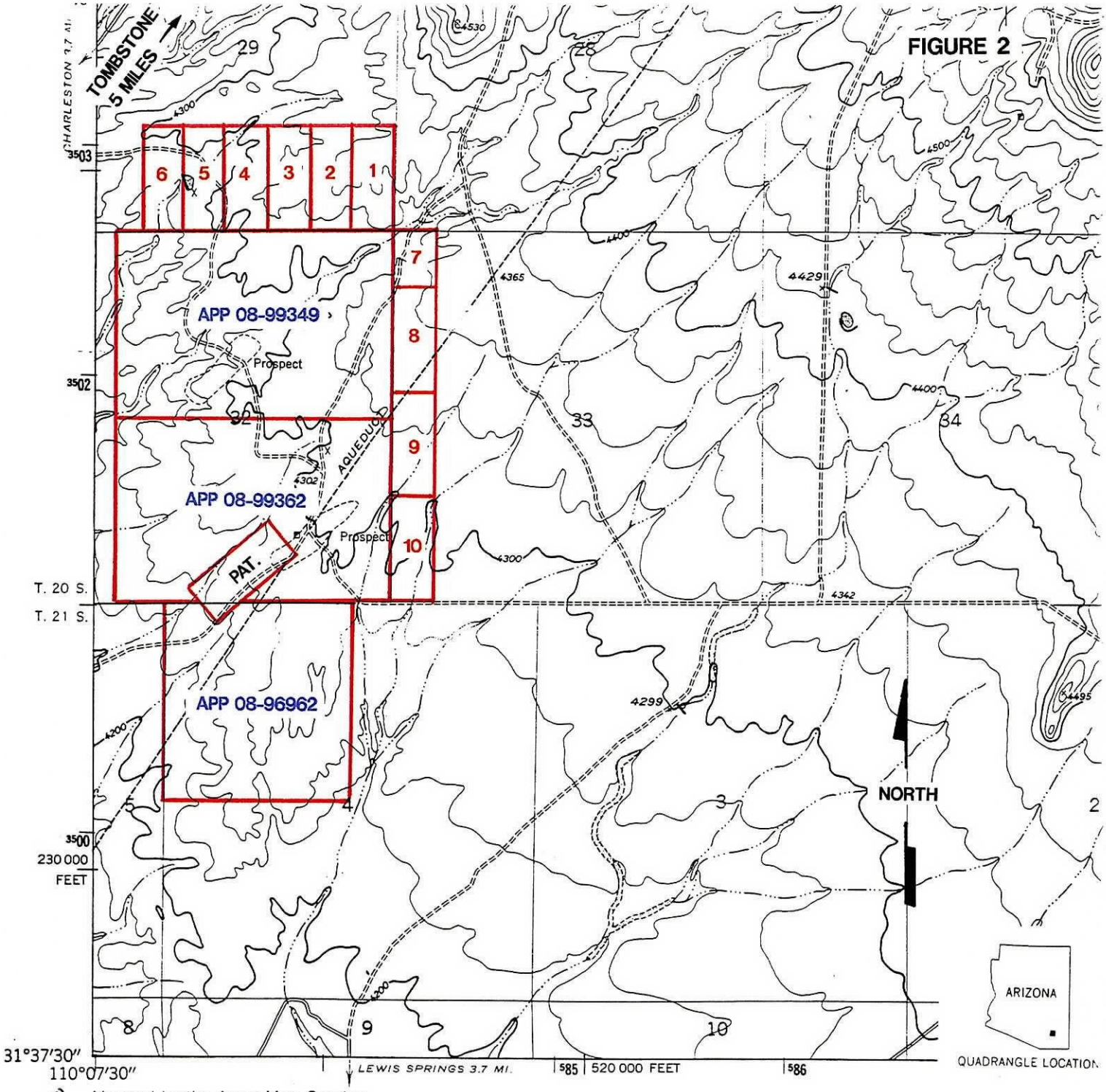
ASARCO Incorporated

TOMBSTONE SOUTH

COCHISE CO.,ARIZONA

J.D.SELL **6-92**

mn TS920605 6-30-92



Mapped by the Army Map Service
Published for civil use by the Geological Survey

2000'

APP AZ STATE PROSPECTING PERMIT

PATENTED CLAIM #23312

TS-1 thru 10
UNPATENTED FED MINING CLAIMS

LAND STATUS

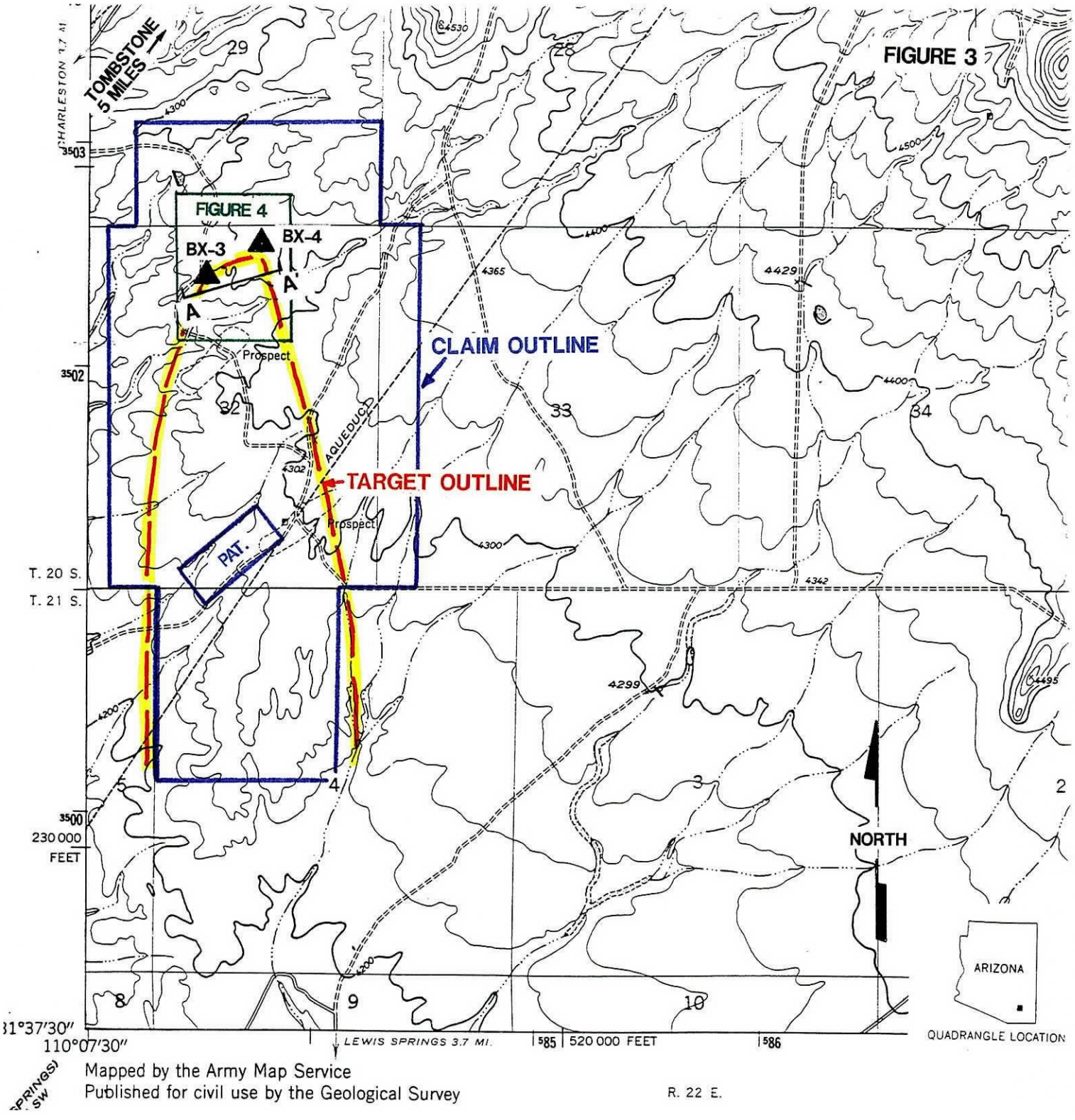
ASARCO Incorporated

TOMBSTONE SOUTH

COCHISE CO.,ARIZONA

J.D.SELL 6-92

mn TS920606 6-30-92



TARGET OUTLINE AND CLAIM OUTLINE

ASARCO Incorporated

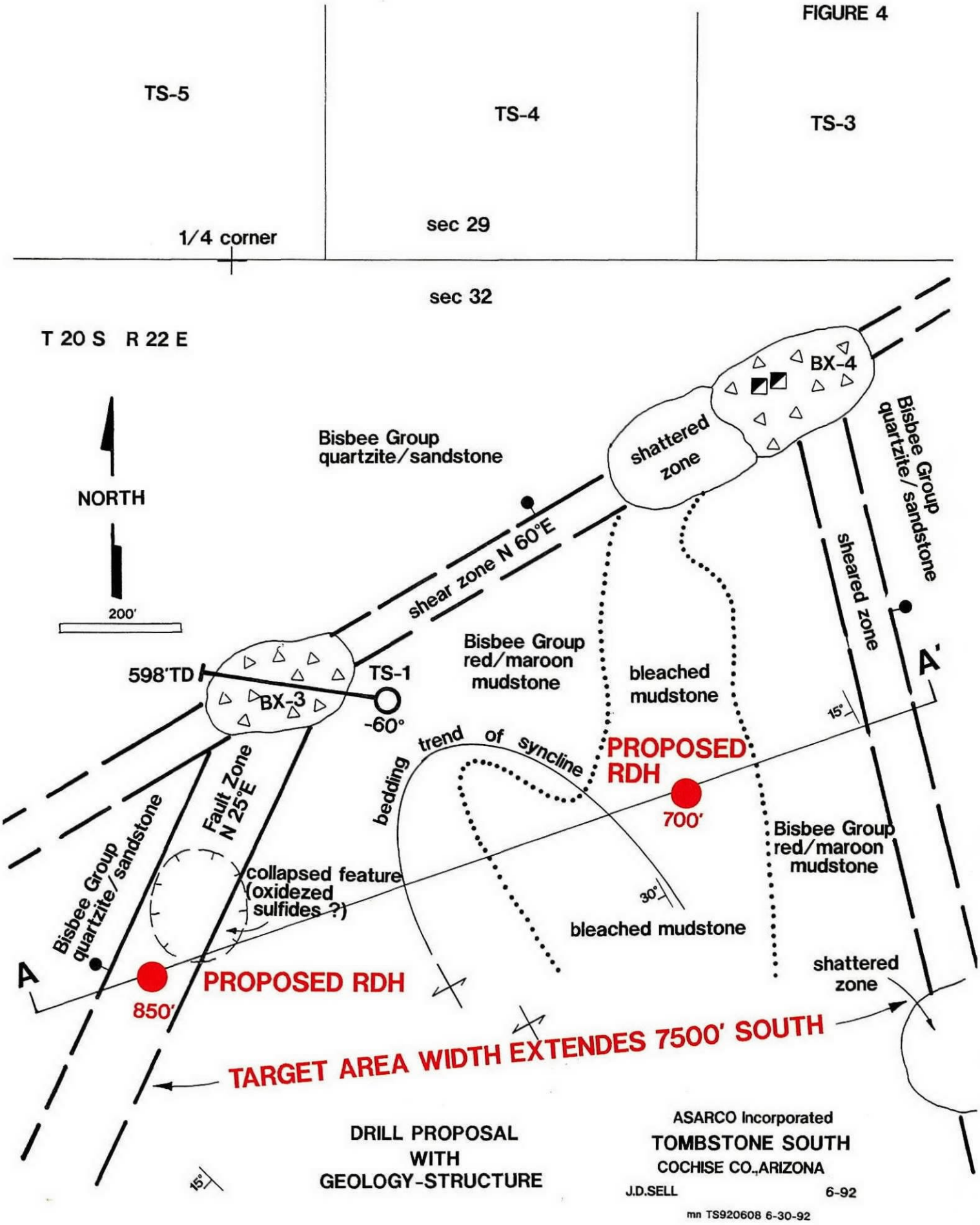
TOMBSTONE SOUTH

COCHISE CO.,ARIZONA

J.D.SELL 6-92

mn TS920607 6-30-92

FIGURE 4



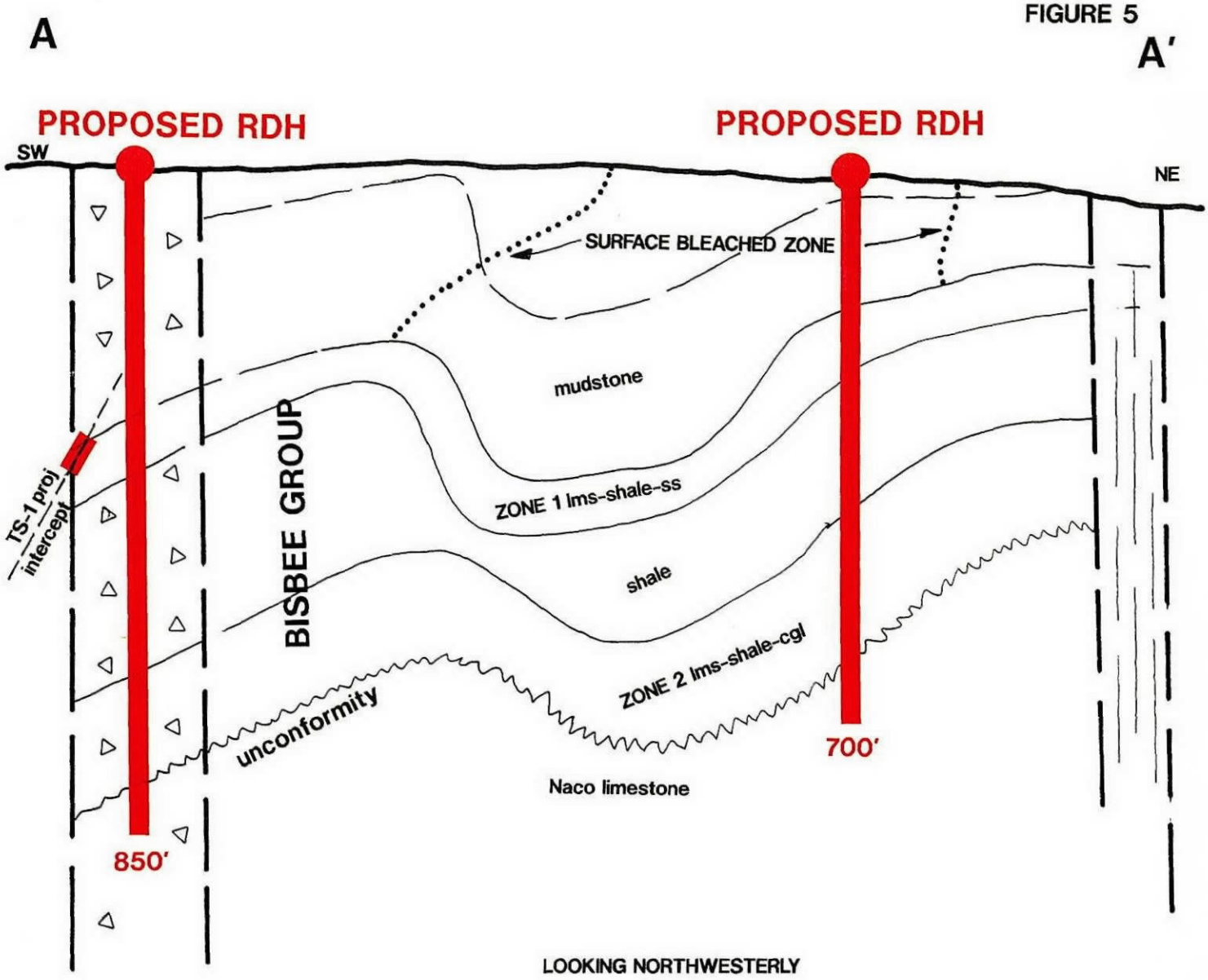
DRILL PROPOSAL
WITH
GEOLOGY-STRUCTURE

ASARCO Incorporated
TOMBSTONE SOUTH
COCHISE CO.,ARIZONA

J.D.SELL 6-92

mn TS920608 6-30-92

FIGURE 5



SECTION A-A'

200'

ASARCO Incorporated

TOMBSTONE SOUTH

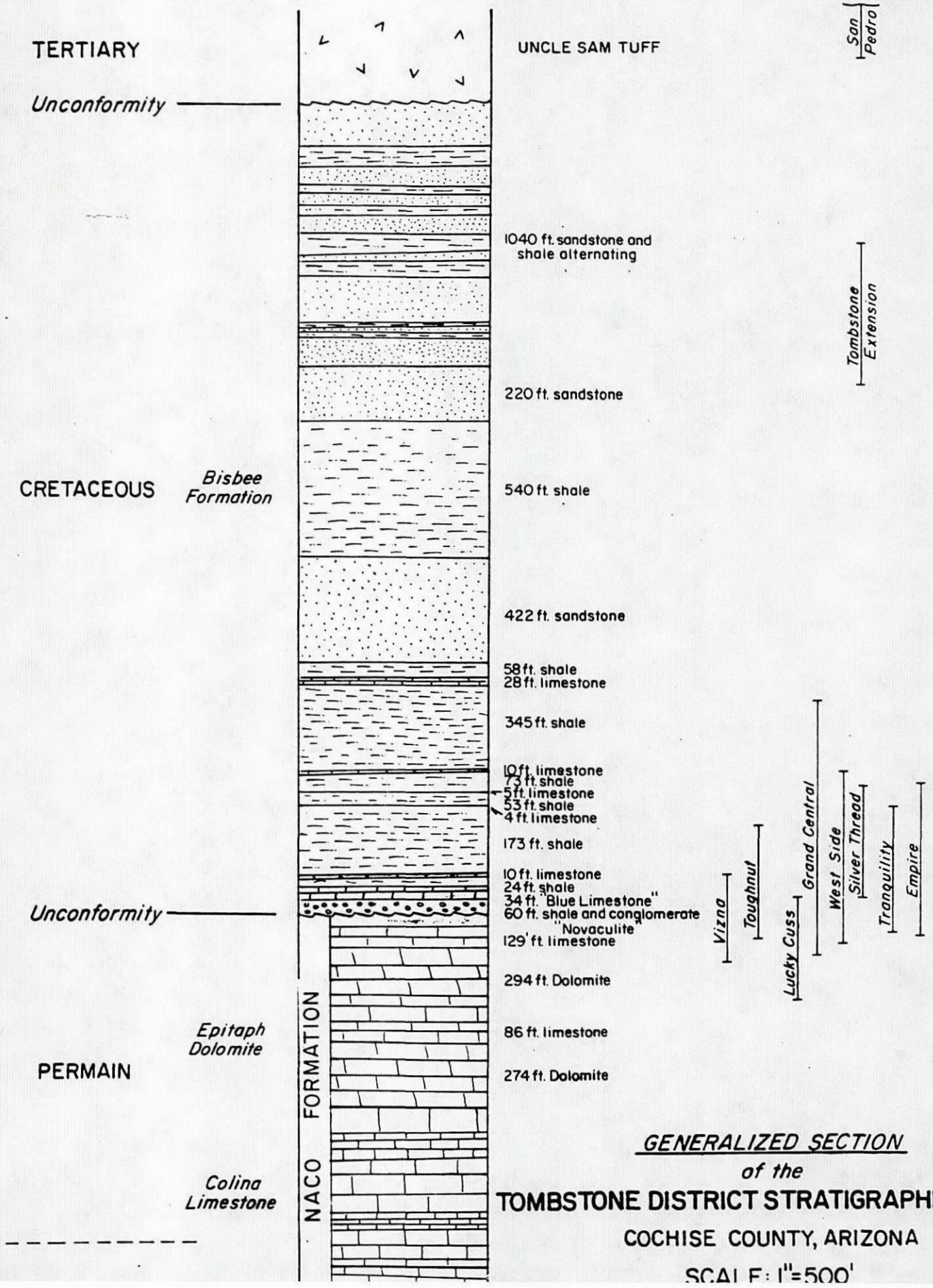
COCHISE CO.,ARIZONA

J.D.SELL 6-92

mn TS920609 6-30-92

FIGURE 6

APPROXIMATE LOCATION OF SELECTED MINES



GENERALIZED SECTION

of the

TOMBSTONE DISTRICT STRATIGRAPHIC COLUM

COCHISE COUNTY, ARIZONA

SCALE: 1"=500'

JDS

ASARCO

Southwestern Exploration Division

July 2, 1992

G.D. Van Voorhis
Vice President of Exploration
New York Office

Application for Exploration
Appropriation
Tombstone South Property
Cochise County, Arizona

I attach Form 302-M, Application for Exploration Appropriation for your consideration.

This new, original, request is for the Tombstone South prospect/project, a multi-million ton target for silver (+20 oz.) - gold (±0.10 oz.) - lead (1-2%) values in manto-type orebodies under 300 feet of cover rock.

A lease-option agreement with the general terms as submitted by H.J. Downey in Attachment A also needs to be prepared and signed.

A report with a cover letter by Mr. W.L. Kurtz is also submitted.

James D Sell

James D. Sell

JDS:mek
Att.

cc: W.L. Kurtz

cc: C.L. Snow
(w/Form 302-M)

bl.cc: W.D. Gay (w/atts.)

PRINTED IN U.S.A. 1/73

FORM 302-M

New York No. .....

APPLICATION FOR EXPLORATION APPROPRIATION

July 2, 1992.

Originating Office Tucson, SWED

DESCRIPTION:

LOCATION OF PROSPECT/PROJECT: Sections 29 and 32, T20S, R22E
Section 4, T21S, R22E
Cochise County, Arizona

PARTNERS: None

Partner's Per Cent .....

COMPANY: [X] ASARCO

[ ] Subsidiary. Specify .....

WORK CONTEMPLATED:

Consummated lease/option agreement with Mr. Harold J. Downey of Tombstone South Minerals, Ltd., a Limited Partnership.

Reverse-circulation drill 1550 feet in two holes to test for manto-type mineralization in 1-6 million tons of mineralization with plus 20 ounces of silver, possibly 0.10 oz. gold and 1-2% lead.

Total estimated cost $27,000

Reviewed by [signature] for Acct. Mgr. or Chief Acct.

Approved by ..... Vice President

Recommended by [signature] Supervisor, Mgr SWED

Approved by ..... Comptroller

Account Chargeable to .....
To be designated by Comptroller

Approved by Advisory Committee .....19 ...

Approved by Board of Directors .....19 .....

.....
Secretary

ATTACHMENT A

OUTLINE OF TERMS FOR ACQUISITION OF THE TOMBSTONE PROPERTY
COCHISE COUNTY, ARIZONA

1. Ownership:

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2. Lease of 25 years with 25 year extension, with option to purchase.

3. Schedule of Payments to Limited Partnership:

Front end payment	$ none
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January 2, 1994	50,000.00
January 2, 1995 and each anniversary thereafter	100,000.00

   (Note: July 1, 1998 is end of term of Limited Partnership lease with Sterling/Hernandez at which time a balance will remain on the purchase price of $750,000.00. A payment by the Limited Partnership, to cover the balance will have to be made or terms will have to be renegotiated. Mr. Downey intends to renegotiate earlier.)

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   (Purchase Price tied to CPI of January 1, 1992)

5. Work Commitment: Maintain state and Federal work requirements and/or payments.

6. Boundary Agreement: Any new acquisitions by either party within one-half mile become part of agreement.

7. Data turnover upon termination (includes core, cuttings, rejects, pulps, copies of assays, geologic, geochemical, and geophysical results).

8. Ninety day prior notice of termination after January 2, 1993.

EXHIBIT A

CLAIMS

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Tombstone South #9	860919766		260134
Tombstone South #10	860919767		260135

SUBJECT TO

1. Paramount title of the United States;

2. All roads, rights-of-way and easements existing or of record in the office of the Recorder of Cochise County;

3. Leases, permits, rights-of-way or any other rights or uses granted by or under the authority of the United States as to the unpatented claims.

PERMITS

State of Arizona Prospecting Numbers covering the following described lands in Cochise County, Arizona:

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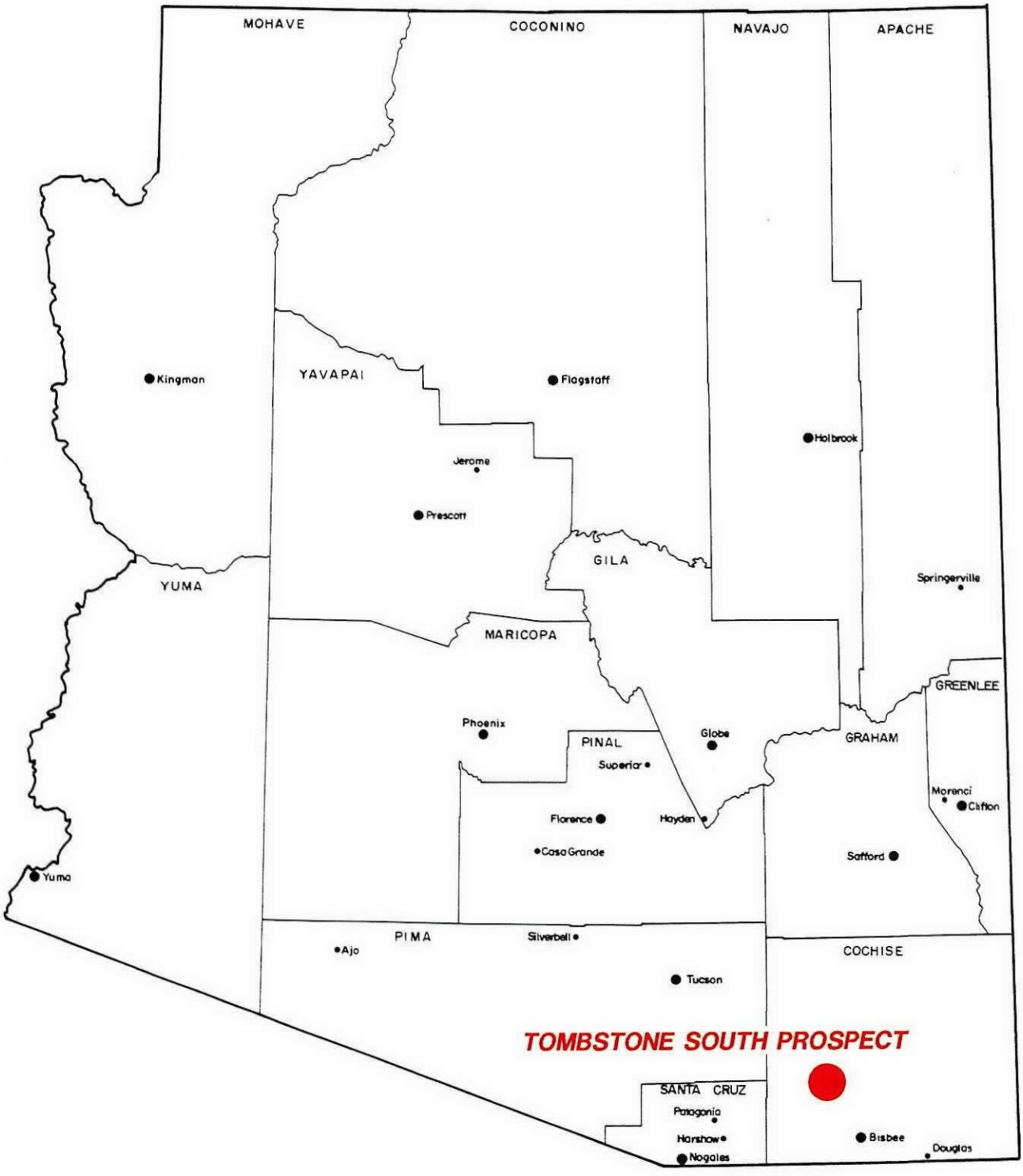
08-99362: The SE 1/4 and the E 1/2 of the SW 1/4 (minus patented claim #23312) of Sec. 32, T20S, R22E. 222 acres. Ann. date start Oct. 28, 1991.

08-96962: The NW 1/4 of Sec. 4, T21S, R22E - Permit acquired by TSM Ltd. 9/6/89. 181 acres.

FIGURE 1



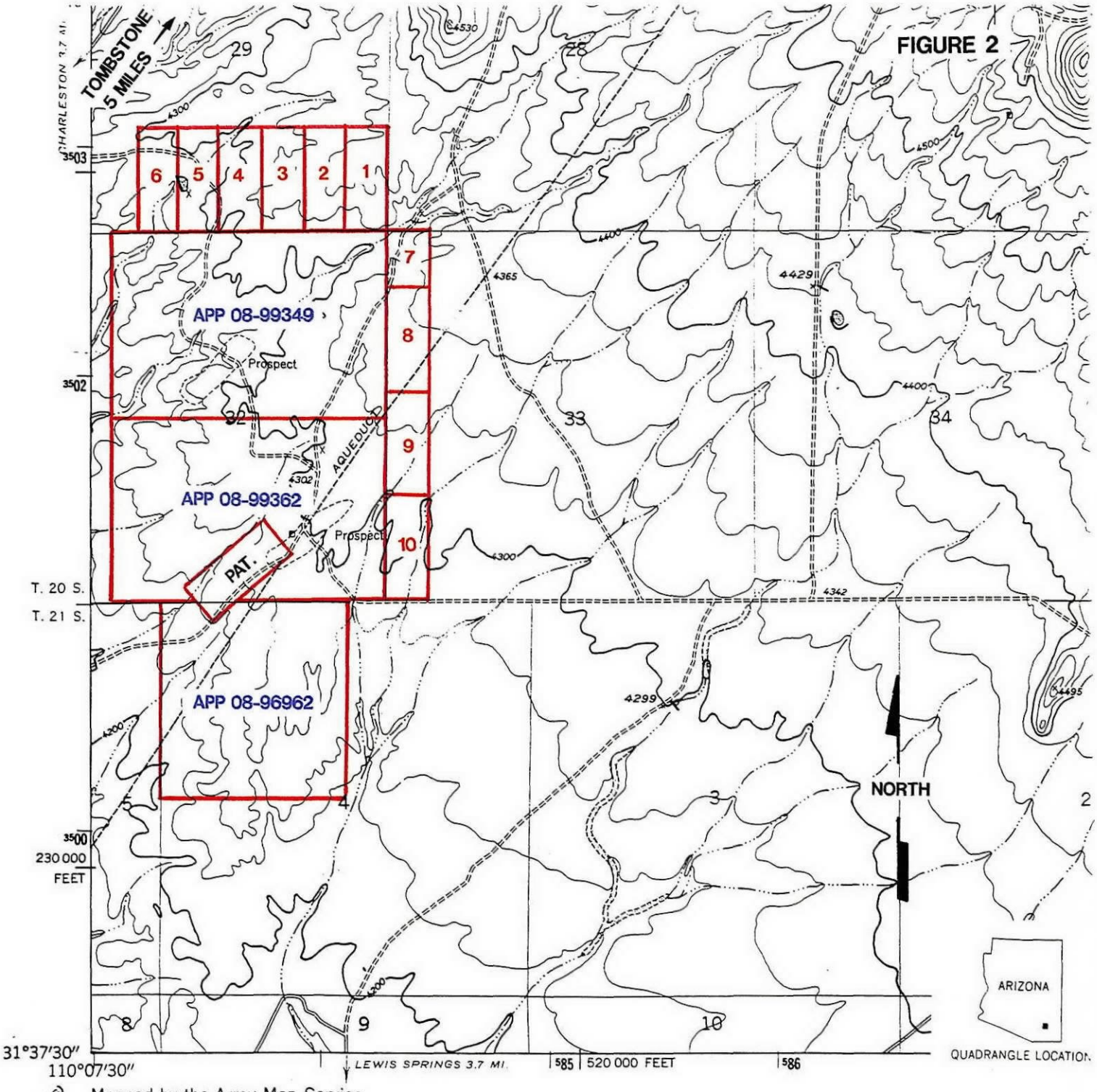
ASARCO Incorporated

TOMBSTONE SOUTH

COCHISE CO.,ARIZONA

J.D.SELL 6-92

mn TS920605 6-30-92



APP AZ STATE PROSPECTING PERMIT

PATENTED CLAIM #23312

TS-1 thru 10
UNPATENTED FED MINING CLAIMS

LAND STATUS

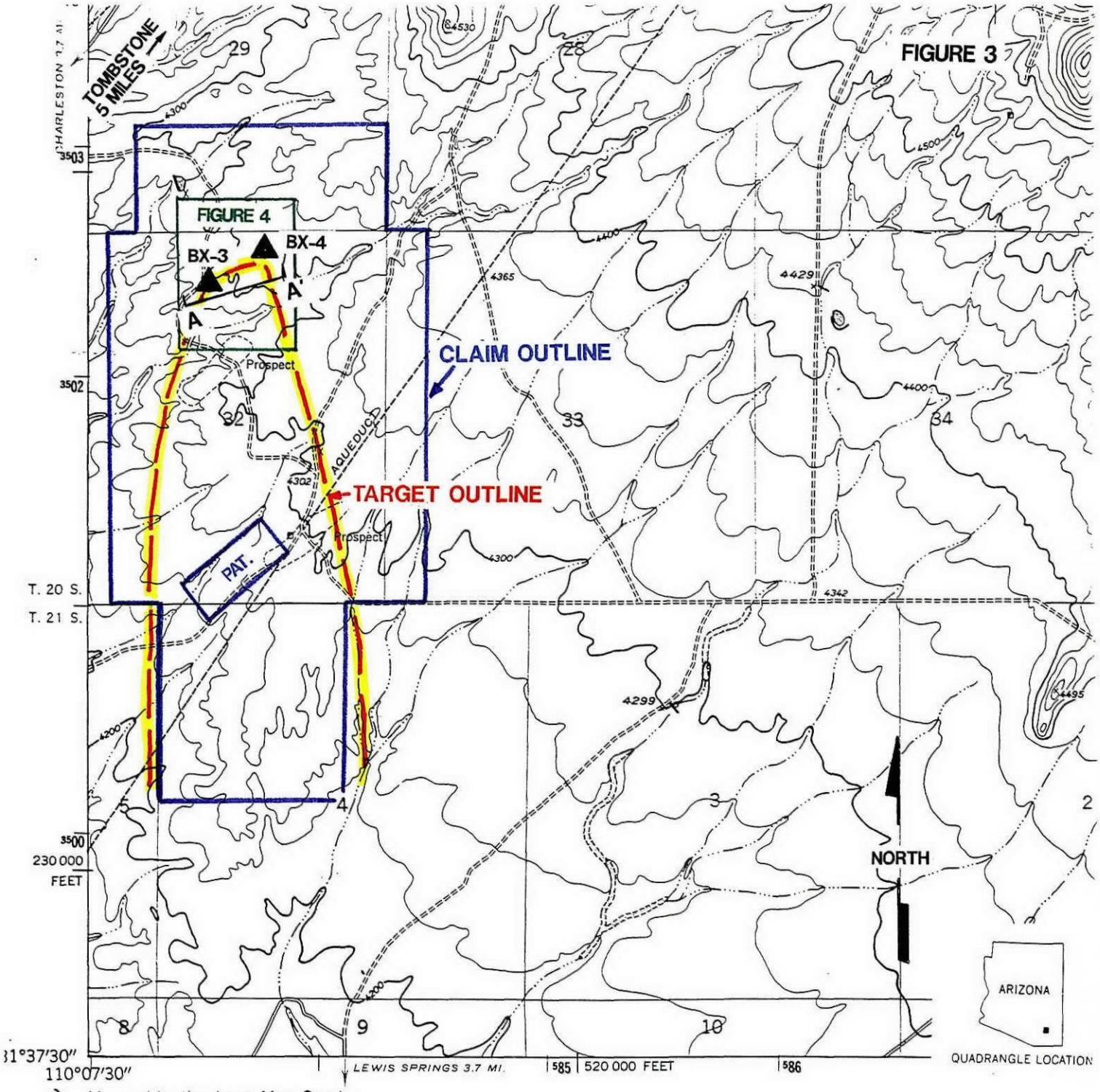
ASARCO Incorporated

TOMBSTONE SOUTH

COCHISE CO.,ARIZONA

J.D.SELL 6-92

mn TS920606 6-30-92



TARGET OUTLINE AND CLAIM OUTLINE

ASARCO Incorporated

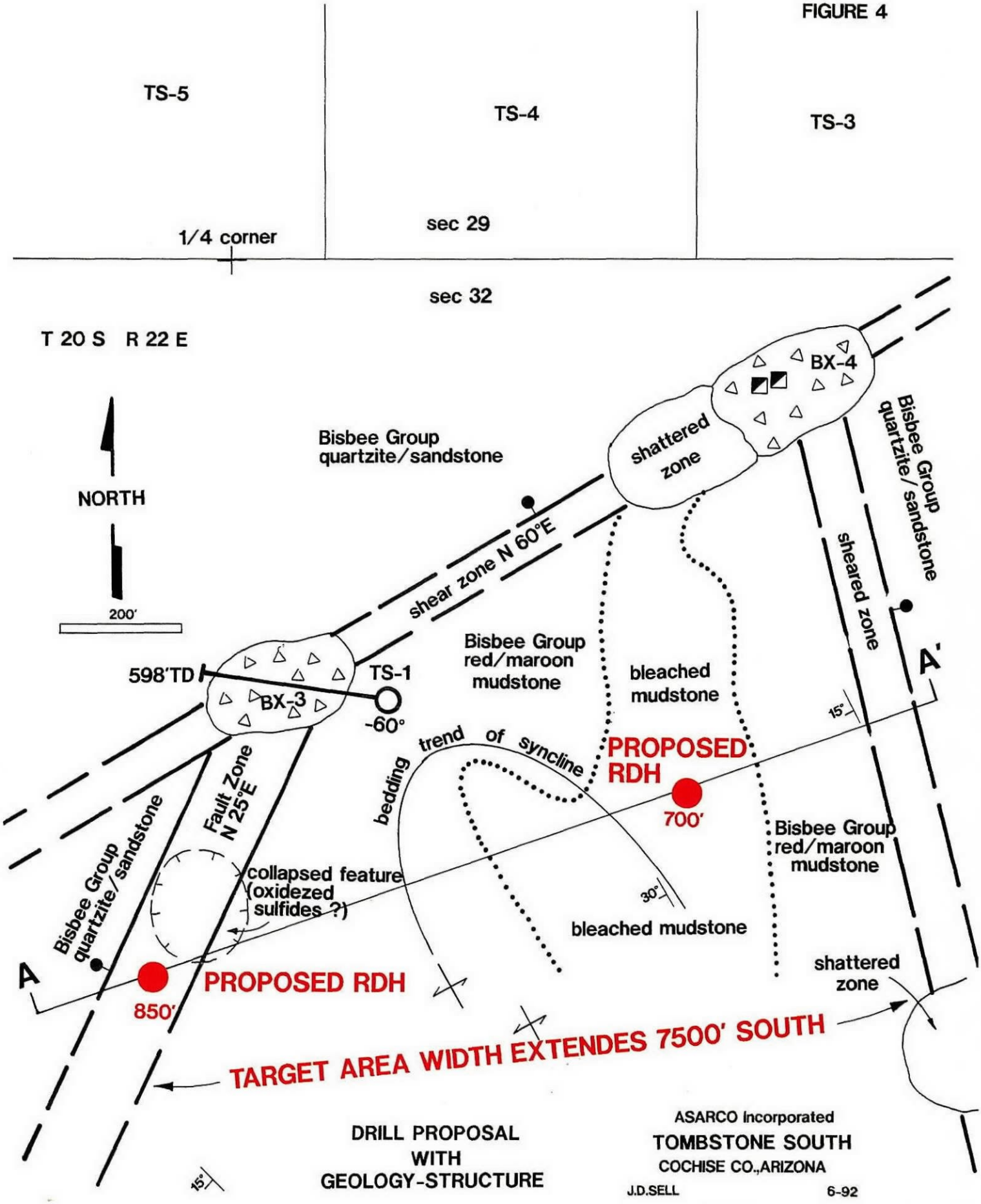
TOMBSTONE SOUTH

COCHISE CO.,ARIZONA

J.D.SELL 6-92

mn TS920607 6-30-92

FIGURE 4



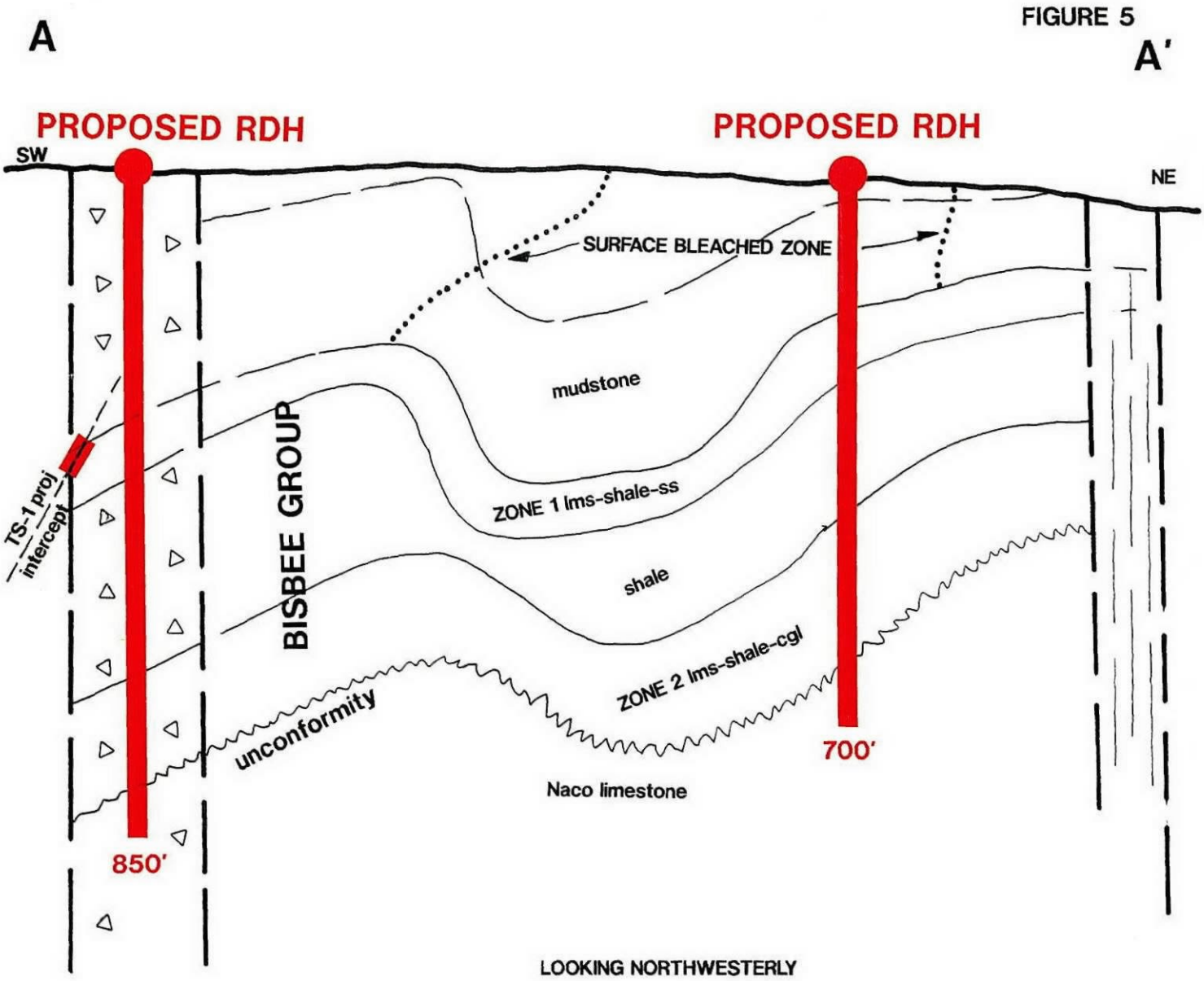
DRILL PROPOSAL
WITH
GEOLOGY-STRUCTURE

ASARCO Incorporated
TOMBSTONE SOUTH
COCHISE CO.,ARIZONA

J.D.SELL 6-92

mn TS920608 6-30-92

FIGURE 5



SECTION A-A'

200'

ASARCO Incorporated

TOMBSTONE SOUTH

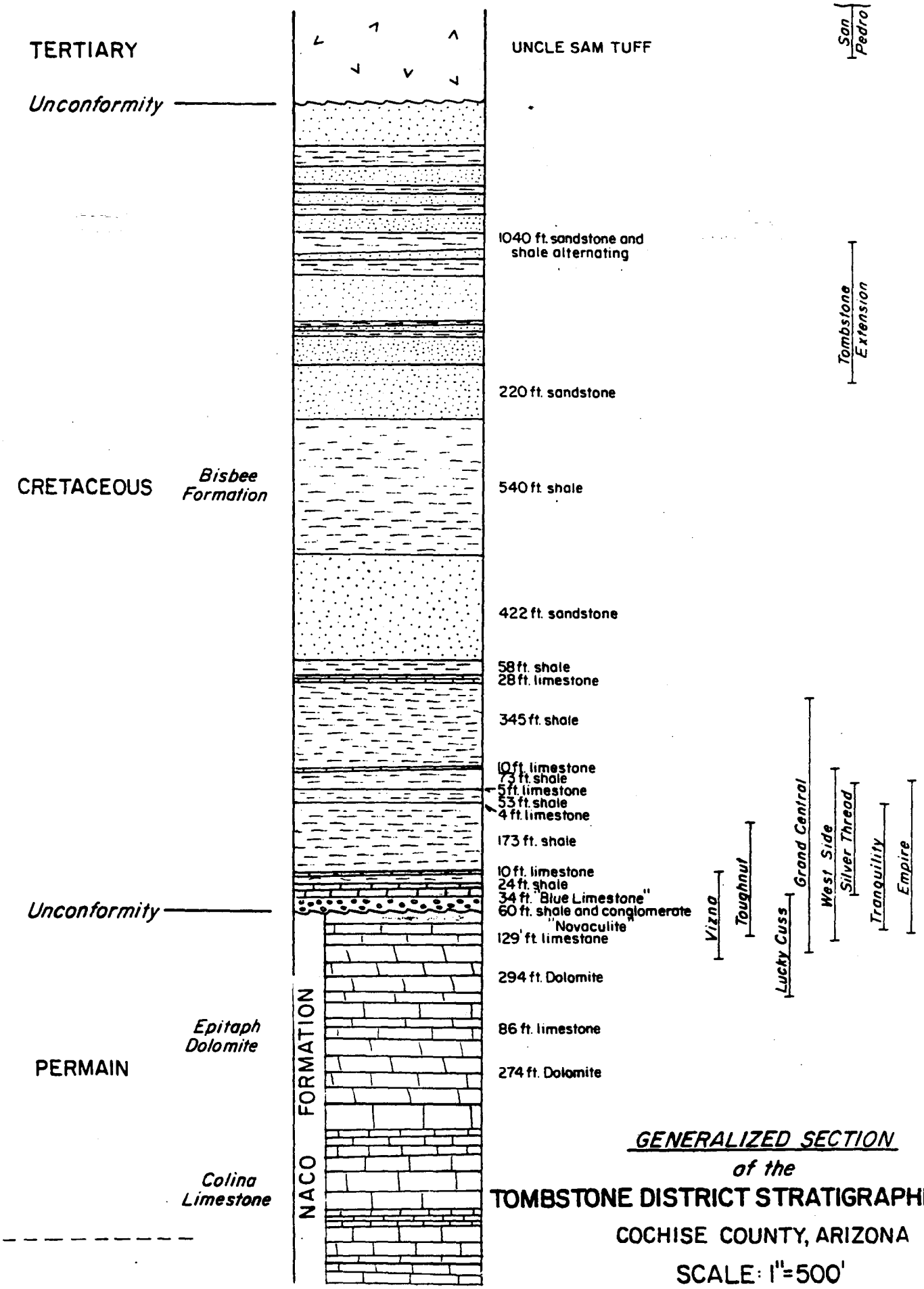
COCHISE CO.,ARIZONA

J.D.SELL 6-92

mn TS920609 6-30-92

FIGURE 6

APPROXIMATE LOCATION OF SELECTED MINES



GENERALIZED SECTION

of the

TOMBSTONE DISTRICT STRATIGRAPHIC COLUMN

COCHISE COUNTY, ARIZONA

SCALE: 1"=500'

WLK to talk to GDVV before sending this out

JDS

ASARCO

Southwestern Exploration Division

June 17, 1992

G.D. Van Voorhis
New York Office

Tombstone South Property
H.J. Downey, Inc.
Cochise County, Arizona

If you are interested in El Gachi, Mexico with a difficult drilling situation and high end cost, may I submit a packet on Tombstone South where easy access and a shallow target awaits with a comfortable deal with the owners.

I submit copies of three reports which may be in the New York archives, but nevertheless, another copy is attached. These three memos should give you the necessary information.

Downey has now repermitted the northern leases with the State of Arizona and they are now in the first year of a new five-year prospecting permit phase.

The southern prospecting permit (08-96962) is still operational from 9/6/89, and thus the third year of the five-year permit is about to slide by.

To hold the prospecting permits with the State of Arizona, one must expend the following:

Year 1	-	$10.00	per acre
Year 2	-	$10.00	" "
Year 3	-	$20.00	" "
Year 4	-	$20.00	" "
Year 5	-	$20.00	" "

Attachment A is the outline of terms for the acquisition of the Tombstone South property, Cochise County, Arizona, with Exhibit A the list of the property position.

I was bullish on the property last year, but the philosophy of NO work on Arizona State Lease ground for exploration purposes was in effect and the proposal was turned down.

Although the present State Lease language says the royalty rate will be established when the prospecting permit is changed to a mining permit, at the end of the five year period for exploration, I would imagine that the rate would not be onerous and Asarco should put its weight behind any negotiation of that rate as they now do at Mission, etc.

The three reports/memos attached are:

1. Tombstone South Property, June 11, 1991, to W.L. Kurtz, 3 pages plus attachments of H.J. Downey, Inc. update, target, geophysics, drill hole log, assays, etc., 9 pages plus 3 sheets drill hole log, plus 2 photos.

2. Tombstone South Properties, June 26, 1991, to W.L. Kurtz, 3 pages plus 2 page attachment of Outline of Terms (as of that date).

3. File Note. Ore Grades-Production, Tombstone Mining District by J.D. Sell, 1 page plus SR-7, A Brief History and Review of Ore Grades and Production in the Tombstone Mining District with emphasis on the Contention Mine area, by M.N. Greeley, ADMR, June 1984, 23 pages.

I would be looking at discovery of a new Tombstone equivalent district, with 1-5 million tons of ore with a grade of 20-30 opt silver, 1-2% lead and a credit of ±0.10 opt gold.

Expenditure prior to August 25, 1992, would be:

Mapping	$ 3,000
Drilling, Supervision, Assaying	12,000
Total	$15,000

James D. Sell

James D. Sell

JDS:mek
Atts.

cc: W.L. Kurtz

ATTACHMENT A

OUTLINE OF TERMS FOR ACQUISITION OF THE TOMBSTONE SOUTH PROPERTY, COCHISE COUNTY, ARIZONA

1. Ownership:

   The property is held by the Limited Partnership, "Tombstone South Minerals, Ltd.," Tucson, AZ, under lease agreement with Philip J. Sterling, Albuquerque, NM, and Manuel Hernandez, Pearce, AZ, who hold prospecting permits and Federal lode claims described in Exhibit A, attached. An additional prospecting permit is held by the partnership adjoining the southern boundary of the above group, legal description attached.

2. Schedule of Payments

Front end payment	$ None
January 2, 1993	30,000.00
January 2, 1994	50,000.00
January 2, 1995 and each anniversary thereafter	100,000.00

   July 1, 1998 is end of term of lease with Sterling/Hernandez at which time a balance will remain on the purchase price of $750,000.00. A payment to cover the balance will have to be made or terms will have to be re-negotiated. It may be well to re-negotiate earlier.

3. Purchase Option:

On or before January 2, 1995	$1,500,000.00
On or before January 2, 1997	2,500,000.00
On or before January 2, 2000	5,000,000.00

   (Purchase Price tied to CPI of 1/1/92)

4. Work Commitment: Maintain state and Federal work requirements and/or payments.

5. Boundary Agreement: Any new acquisitions by either party within 1/2 mile become part of agreement.

6. Data turnover upon termination (includes core, cuttings, rejects, pulps, copies of assays, geologic, geochemical, and geophysical results).

7. 90 day prior notice of termination after January 2, 1993.

EXHIBIT A

CLAIMS

The following-described unpatented lode mining claims situated in the Tombstone Mining District, Cochise County, Arizona, the names of which and the Dockets and the pages of recording of the location notices in the office of the Cochise County Recorder of which, and the Bureau of Land Management Serial Numbers of which, are as follows:

Name of Claim	Transaction Number Docket	Page	A MC No.
Tombstone South #1	860919758		260126
Tombstone South #2	860919759		260127
Tombstone South #3	860919760		260128
Tombstone South #4	860919761		260129
Tombstone South #5	860919762		260130
Tombstone South #6	860919763		260131
Tombstone South #7	860919764		260132
Tombstone South #8	860919765		260133
Tombstone South #9	860919766		260134
Tombstone South #10	860919767		260135

SUBJECT TO

1. Paramount title of the United States;

2. All roads, rights-of-way and easements existing or of record in the office of the Recorder of Cochise County;

3. Leases, permits, rights-of-way or any other rights or uses granted by or under the authority of the United States as to the unpatented claims.

PERMITS

State of Arizona Prospecting Numbers covering the following described lands in Cochise County, Arizona:

08-99349: The NE 1/4 and the E 1/2 of the NW 1/4 of Sec. 32, T20S, R22E. 240 acres. Ann. date start Aug. 26, 1991.

08-99362: The SE 1/4 and the E 1/2 of the SW 1/4 (minus patented claim #23312) of Sec. 32, T20S, R22E. 222 acres. Ann. date start Oct. 28, 1991.

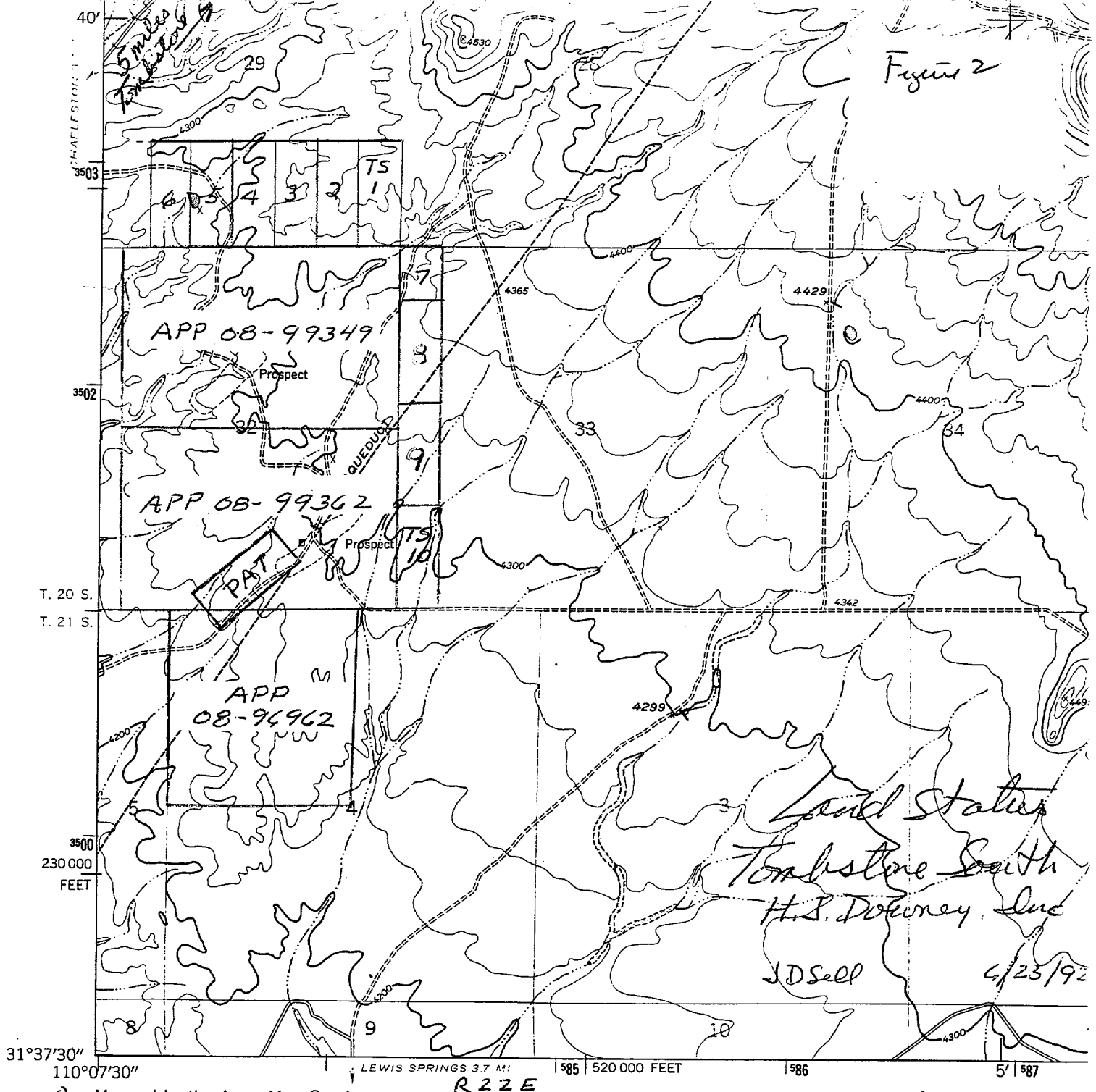
08-96962: The NW 1/4 of Sec. 4, T21S, R22E - Permit acquired by TSM Ltd. 9/6/89. 181 acres.

Figure 1

Normal State
Location Map

Tombstone South Prospect
Cochise Co AZ

Don: Mary has text.



Mapped by the Army Map Service
Published for civil use by the Geological Survey

Control by USGS, USC&GS, and USCE

Topography from aerial photographs by photogrammetric methods
Aerial photographs taken 1951. Field check 1952

Polyconic projection. 1927 North American datum
10,000-foot grid based on Arizona coordinate system, east zone
1000-meter Universal Transverse Mercator grid ticks,
zone 12, shown in blue

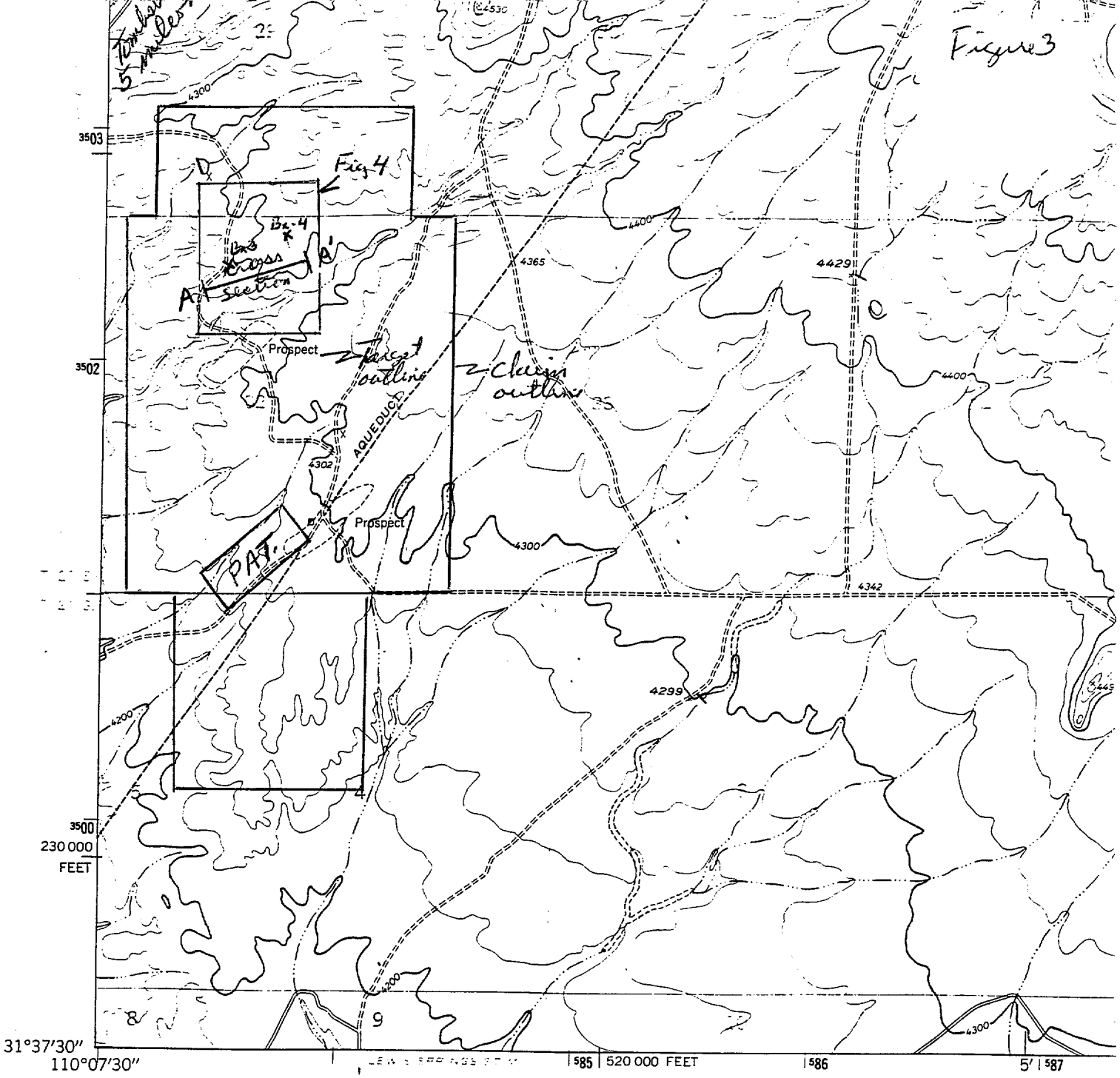
Unchecked elevations are shown in brown

APP AZ STATE PROSPECTING PERMIT
TS-1, et al Unpatented Federal mining claim
PAT, Patented Claim #23312

GN
0°30' 9 MILS
13° 231 MILS

UTM GRID AND 1952 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

FC



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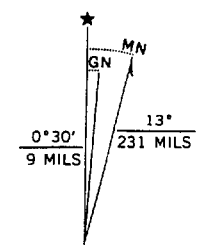


UTM GRID AND 1952 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET

Tombstone South
Target outline,
Claim outline,
Figure 4 Location
1" = 2000'

Figure 4

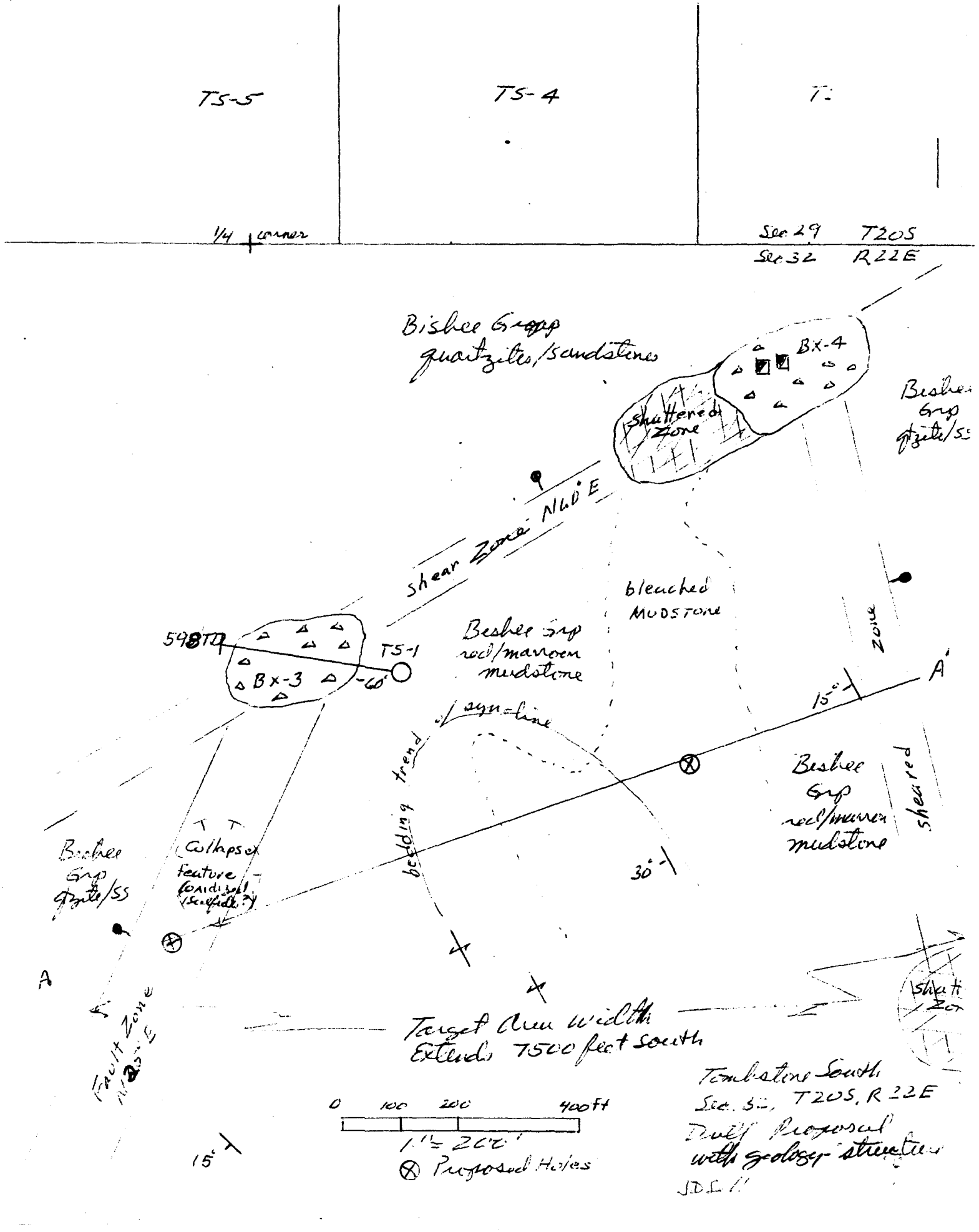
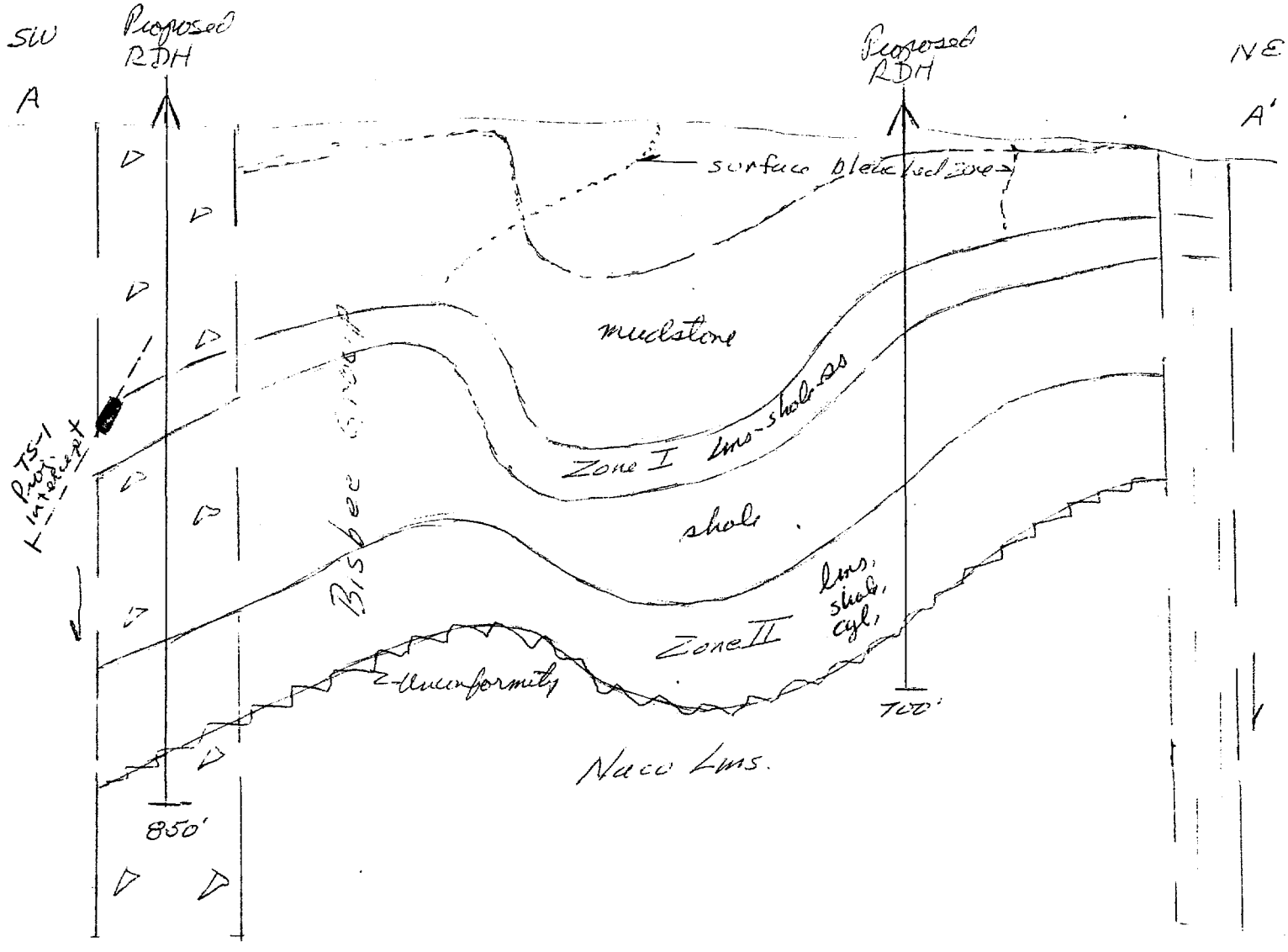

TS-5
TS-4
1/4 corner
Sec 29 T20S
Sec 32 R22E
Bisbee Grp
quartzites/sandstones
BX-4
Shattered Zone
Bisbee Grp qtzite/ss
Shear Zone N40°E
bleached MUDSTONE
Bisbee Grp red/maroon mudstone
598TD
TS-1
BX-3
-60°
A'
15°
bedding trend
sym-line
Bisbee Grp red/maroon mudstone
sheared
Bisbee Grp qtzite/SS
Collapse feature (sinkhole?)
30°
A
Fault Zone N35°E
Target Area width
Extends 7500 feet South
Tombstone South
Sec. 32, T20S, R22E
Draft Proposal
with geology structure
JDL
0 100 200 400 ft
1" = 200'
Proposed Holes
15°

Figure 5



Looking Northwesterly

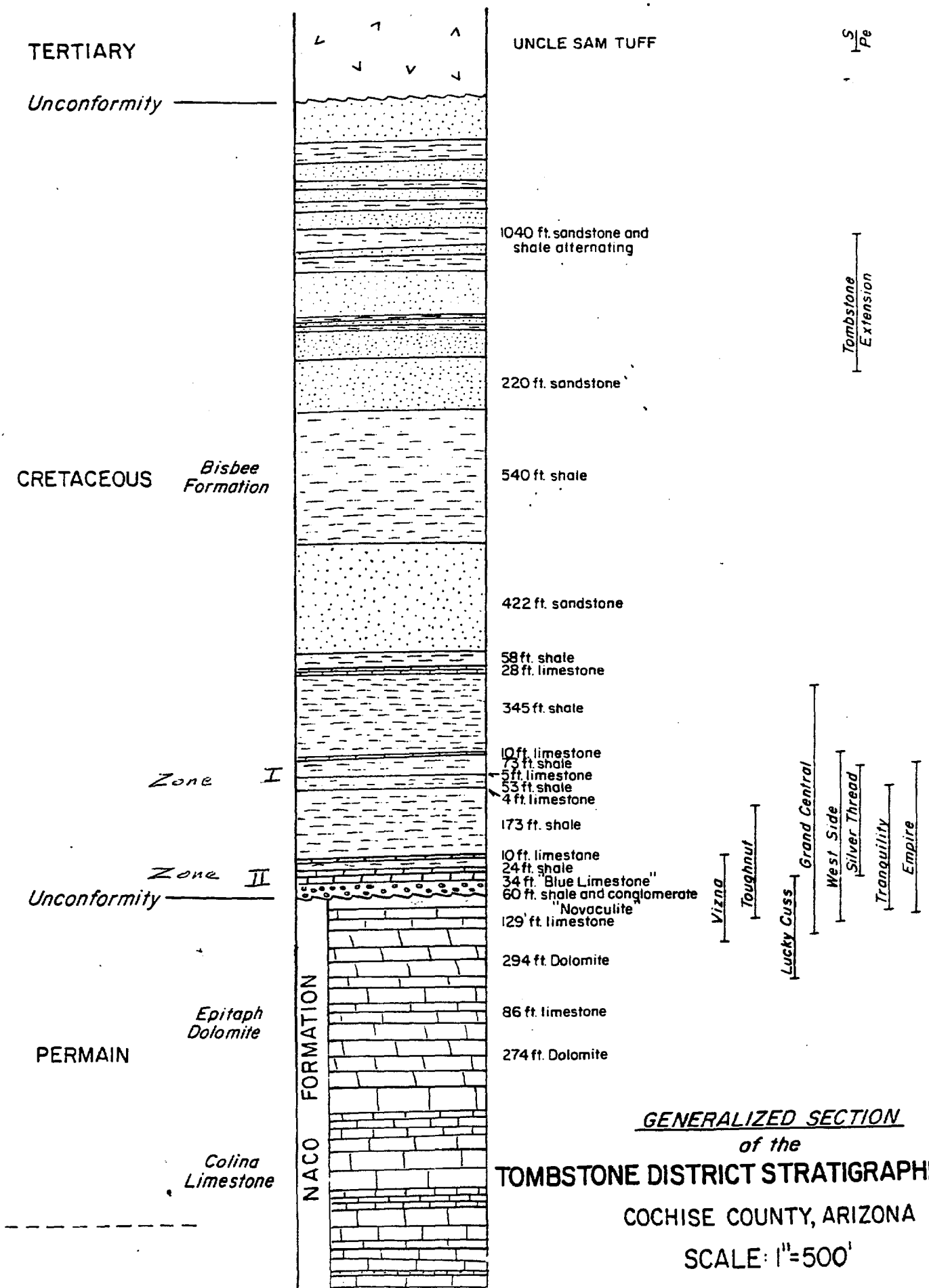
0 100 200 400 ft

1" = 200'

Section A-A'
Tombstone South
Sec. 32, T20S, R22E
~~Scale 1" = 200'~~

9.85a

Figure 6



GENERALIZED SECTION
of the
TOMBSTONE DISTRICT STRATIGRAPHIC COLUM
COCHISE COUNTY, ARIZONA
SCALE: 1"=500'

JDS

ASARCO

Southwestern Exploration Division

November 3, 1992

G.D. Van Voorhis
Vice President of Exploration
New York Office

Renewed Interest
Tombstone South Property
Cochise County, Arizona

I rebring to your attention the Tombstone South property on Arizona State lands.

The target is multi-million tons of +20 ounce silver, ±0.10 oz. gold, and 1-2% lead in manto orebodies under 300 feet of cover rock.

You have in New York several reports plus the last "Application for Exploration Appropriation," dated July 2, 1992.

As noted, I believe two holes using reverse-circulation at an estimated cost of $27,000 would tell us if the system is where we indicate and lead to a follow-up program.

Any interest by the Exploration Department would initiate an agreement with H.J. Downey.

James D. Sell

JDS:mek

James D. Sell

cc: W.L. Kurtz

who owns patented claim section 32; is it in the way

✓ Index Map

✓ Property Map plus target outline – ~~show type~~

Geology Plan showing faults, bx, gracemi, limit of section, target area location TS-1; proposed holes

X-section – one by Downey & Sat clean-up to go with your text

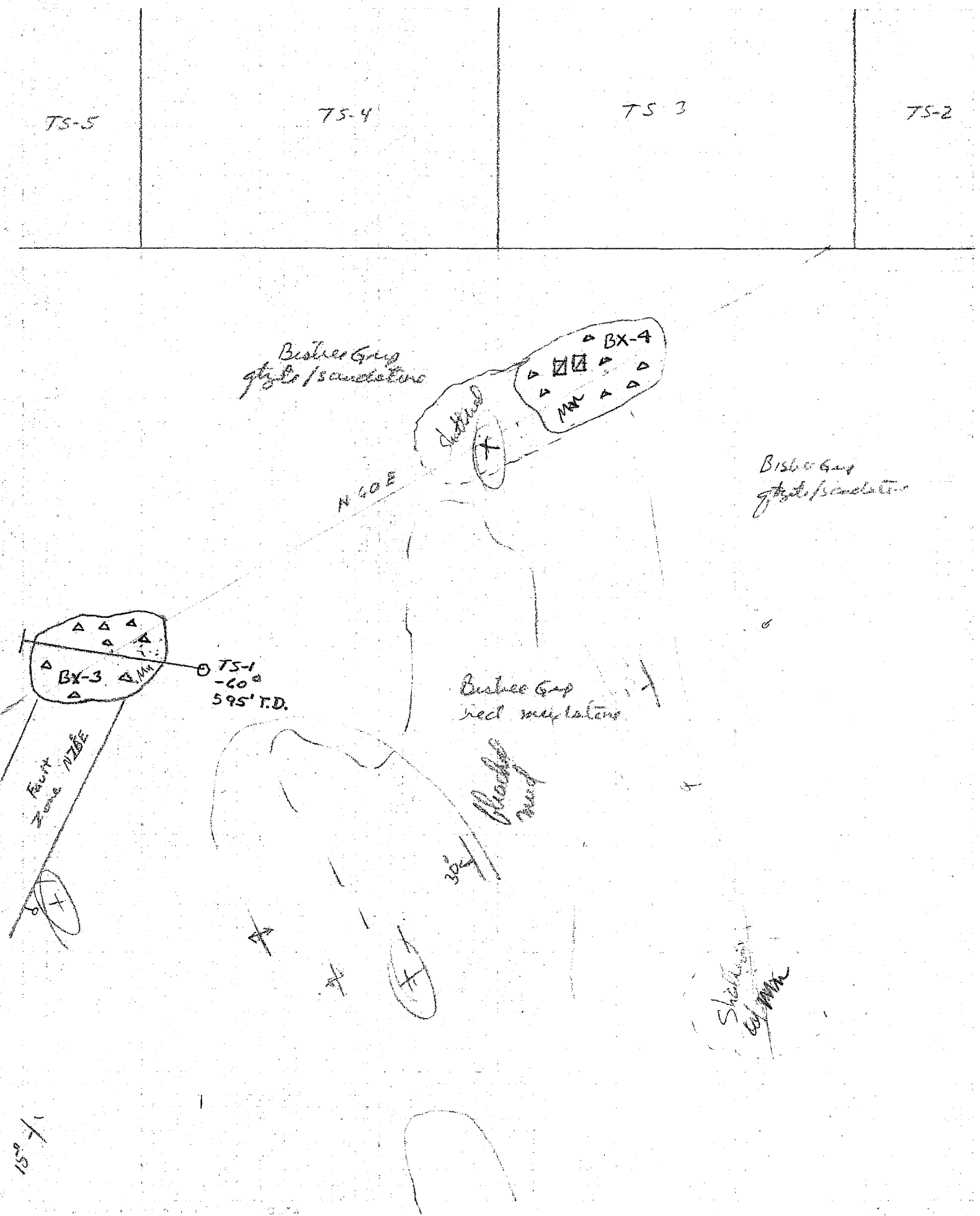
Further Option – meaning of chart?

Your program – dd or rdh; how many holes

Statement you visited property in the field and agree with geology as presented

Write as EA

1" = 200'


TS-5
TS-4
TS 3
TS-2
Bisbee Grp
slate/sandstone
BX-4
N 60 E
Bisbee Grp
slate/sandstone
BX-3
TS-1
-60°
595' T.D.
Bisbee Grp
red mudstone
Fault
zone N2BE
Alluvial
mud
30°

1882-1887

Contention-Grand Central - (Head Center)

3300 long produced 272,545 tons

12,825,488 oz Ag 47 opt

162,348 oz Au 0.40 opt

H_2O table at 560' or extends 100' below

Church 1887 AIME Trans V. 15, p. 601-613

" 1903 AIME Trans V 33, p. 3-37

Goodale 1889 AIME Trans V 17, p. 767-777

Tombstone Exploration Inc. Contention surface pit

1981-1983 5,262,271 tons 50% ore 50% ore.

3/4" crush

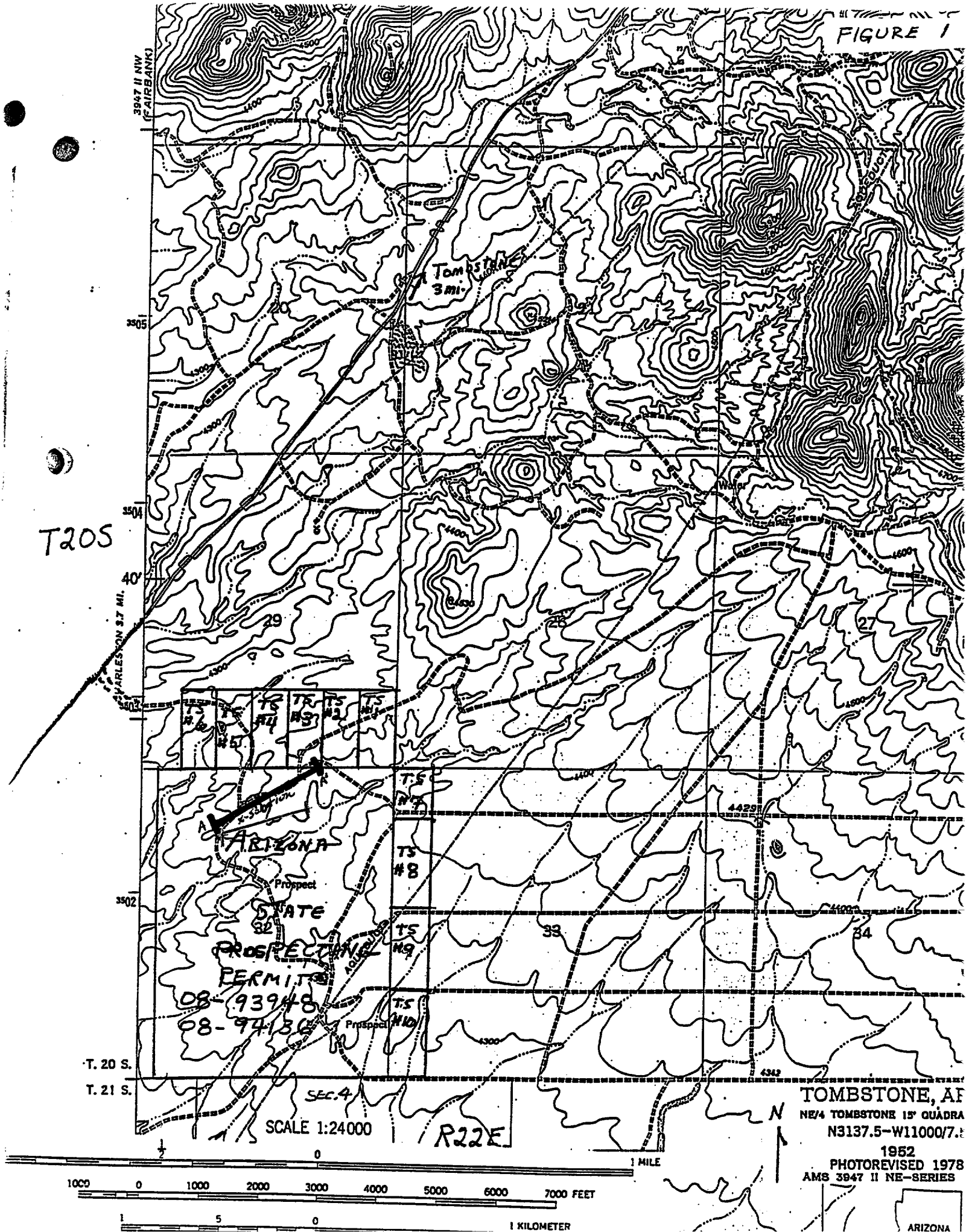
recovered 1.1 mill oz Ag & 22 Thousand oz Au

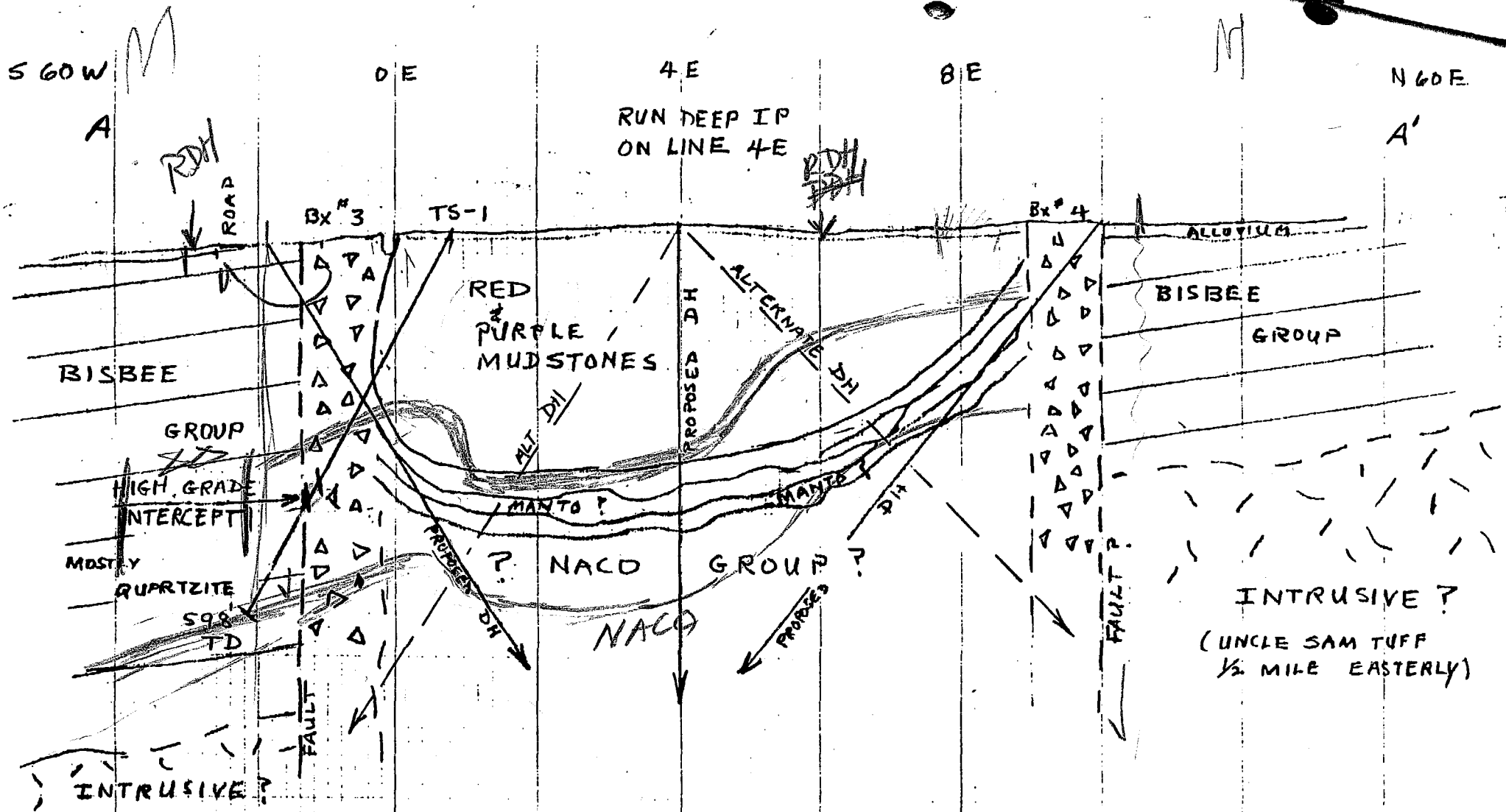
between surface & 150' level.

(head assay of over 2.2 mill oz Ag & over 33 Thousand oz Au).

0.41 opt. 0.006 opt

FIGURE 1


3947 II NW (FAIRBANK)
Tombstone 3 mi.
T20S
Water
Prospect
ARIZONA
STATE
PROSPECTING
PERMITS
08-93948
08-94136
TS #8
TS #9
TS #10
TS #4
TS #3
TS #2
TS #1
TS #6
TS #5
Prospect
SEC. 4
R22E
T. 20 S.
T. 21 S.
SCALE 1:24000
1 MILE
7000 FEET
1 KILOMETER
TOMBSTONE, AR
NE/4 TOMBSTONE 15' QUADRA
N3137.5–W11000/7.5
1952
PHOTOREVISED 1978
AMS 3947 II NE–SERIES
ARIZONA



INTERPRETIVE VERTICAL SECTION A-A' ALONG
SHEAR/FISSURE CONNECTING Bx #3 & Bx #4

Looking Northwesterly

TOMBSTONE SOUTH PROPERTY

SCALE: 1" = 200'
H. DOWNEY 6/5/81

FIGURE 3

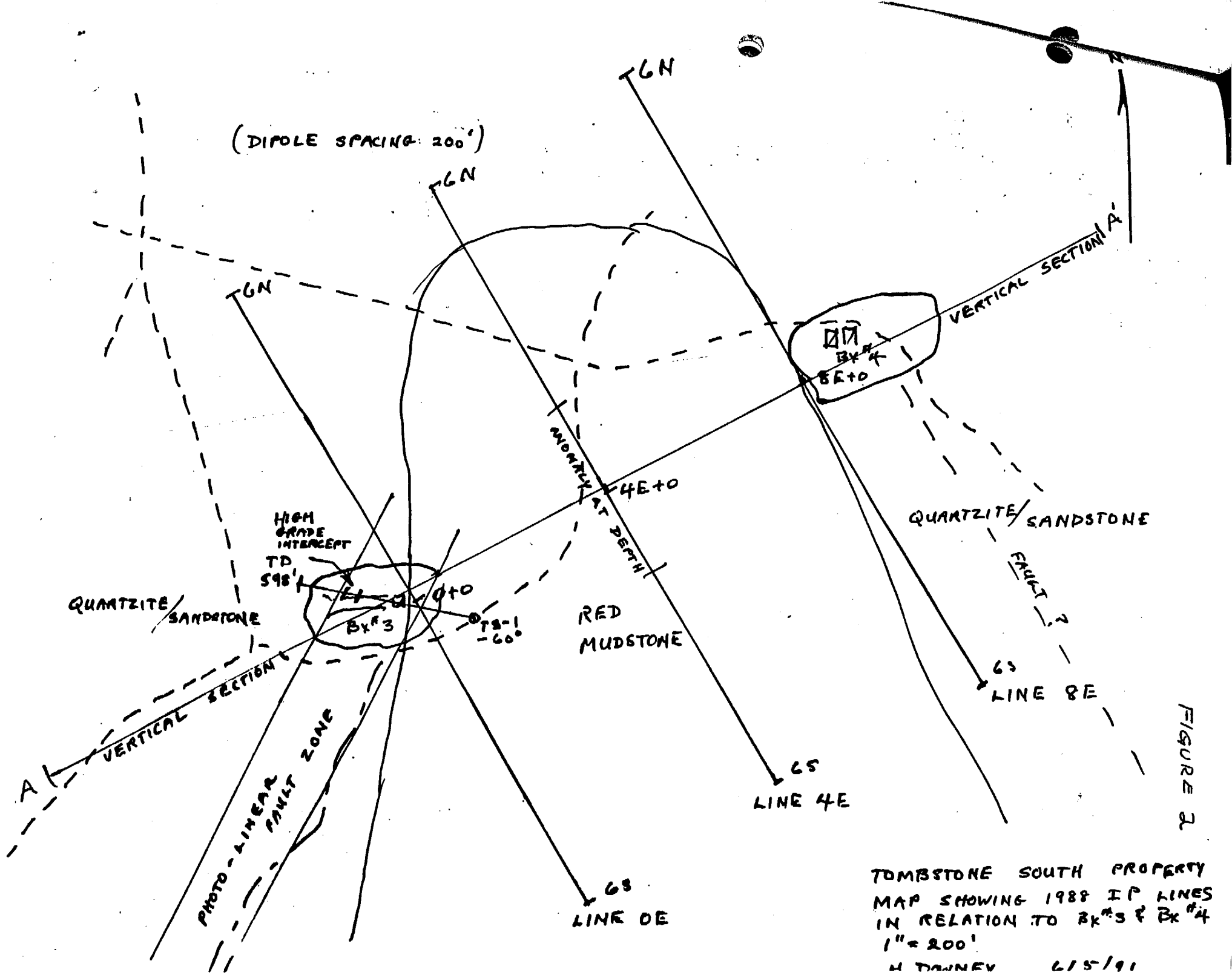
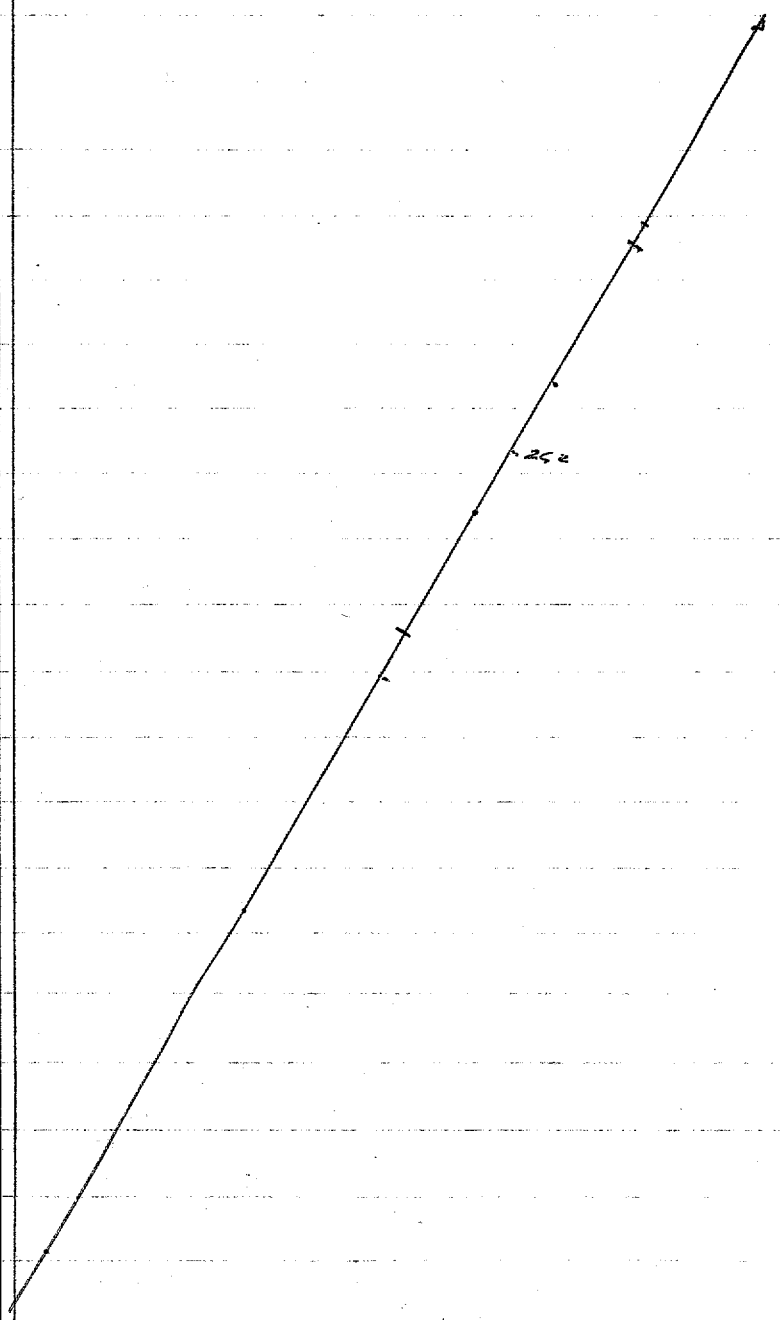


FIGURE 2

TOMBSTONE SOUTH PROPERTY
MAP SHOWING 1988 IP LINES
IN RELATION TO Bx#3 & Bx#4
1" = 200'
H DAWNEY 6/5/91

Assays.

Vertical		ft	oz Au	oz Ag	% Pb	% Zn	% Mn
115 ~~230~~'	125 – 262.5 mudstone	= 137.5'	tr	tr	tr	0.05%	0.13%
110 ~~195~~'	262.5 – 385.0 bx	= 122.5	tr	0.21	0.01	0.05	0.79
26'	385 – 415 bx	= 30	tr	4.60	1.01	0.04	2.40
65'	415 – 490 ~~cgl~~ cgl	= 75	tr	0.22	0.02	0.05	0.28
94'	490 – 598 T.D. cgl	= 108	tr	0.02	0.02	tr	0.17



in PPM

	Interval	ft	Au	Ag	Cu	Pb	Zn	Mn
	255.0 - 262.5	7.5	0.006	0.47	38	29	595	2500
	262.5 - 285.0	22.5	0.037	6.47	51	262	844	15,500
	285.0 - 330.0	45.0	0.018	5.24	19	102	497	6,700
	330.0 - 365.0	35.0	0.020	12.68	48	354	445	9,000
	365.0 - 385.0	20.0	0.018	3.50	40	77	204	400
	385.0 - 415.0	30.0	0.045	4.6 oz 155.00	624	1.01% 10,088	565	2.40% 24,600
	415.0 - 450.0	35.0	0.008	14.37	65	307		
bx	262.5 - 385.0 = 122.5		0.022	= 0.21 oz 7.31 ppm		0.01% 199 ppm	0.05% 498 ppm	0.79% 7,945 ppm
	385.0 - 415.0 = 30		0.045 ppm	4.6 oz		1.01%	0.06% 565 ppm	2.40%
~~end bx~~	~~415.0 - 420.0 = 5~~		~~0.010 ppm~~	~~0.21 oz 7.2 ppm~~		~~0.00% 860~~	~~0.02% 080~~	~~0.15%~~
	420 - 598							
(15)	415 - 490 = 75'		0.005 ppm	0.22 oz 7.37 ppm		0.02% 156	0.05% 508	0.28% 2780 ppm
(22)	490 - 598 = 108'		0.005 ppm	0.02 oz 0.530 ppm		0.02% 184	tr% 43	0.17% 1460 ppm
(13)	125 - 262.5						0.05% 512 ppm	0.13% 1334 ppm

James Barko, Jr & PA Barko
3644 N 100 E
Kokomo, Indiana 46901

Terrible 20.36 ac. Sec 32 T20N R22

Contention, Grand Central, Head Gate 40% of total
destined seed-
TEST

1800
24

2400

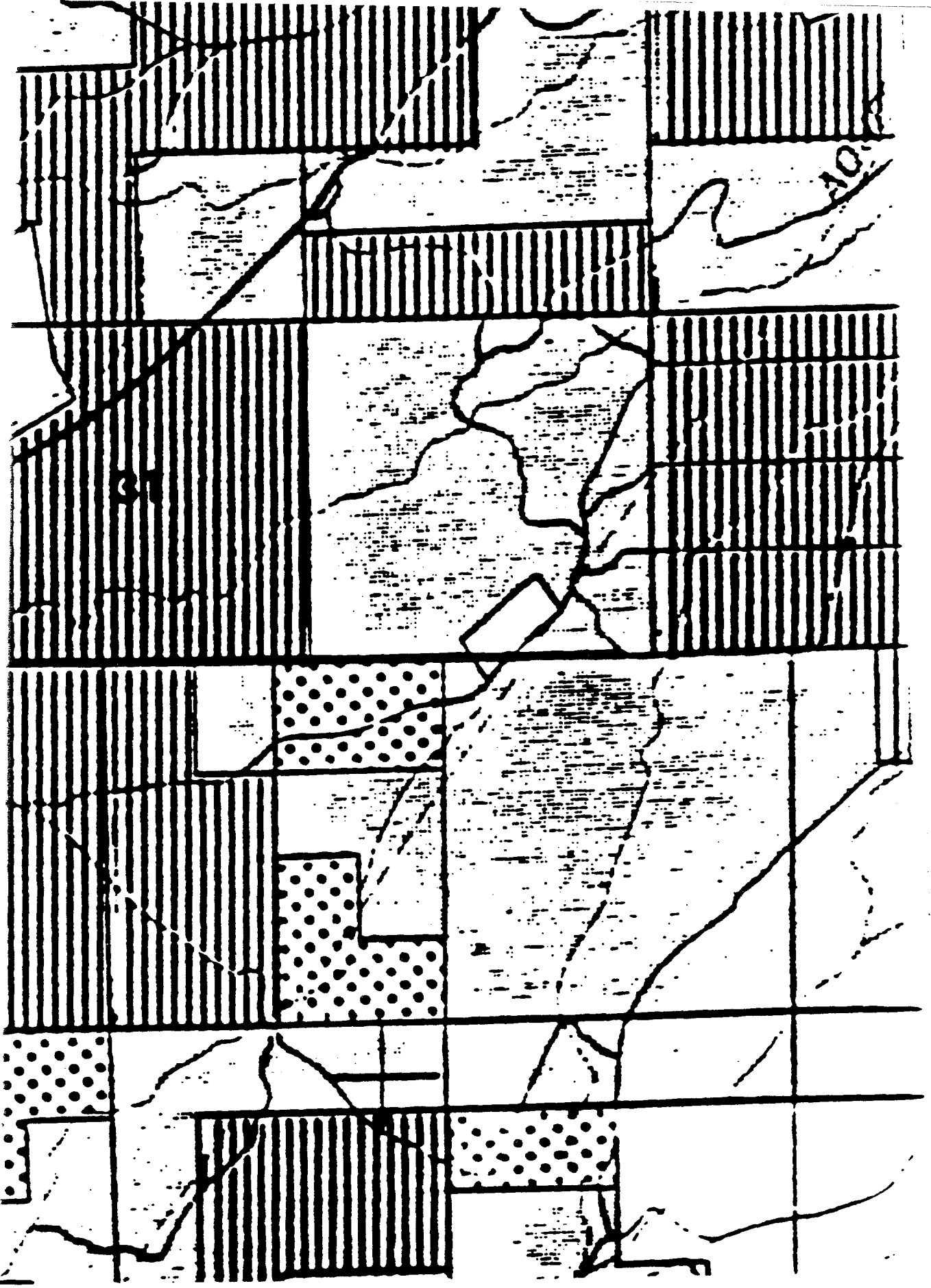
12
36
$

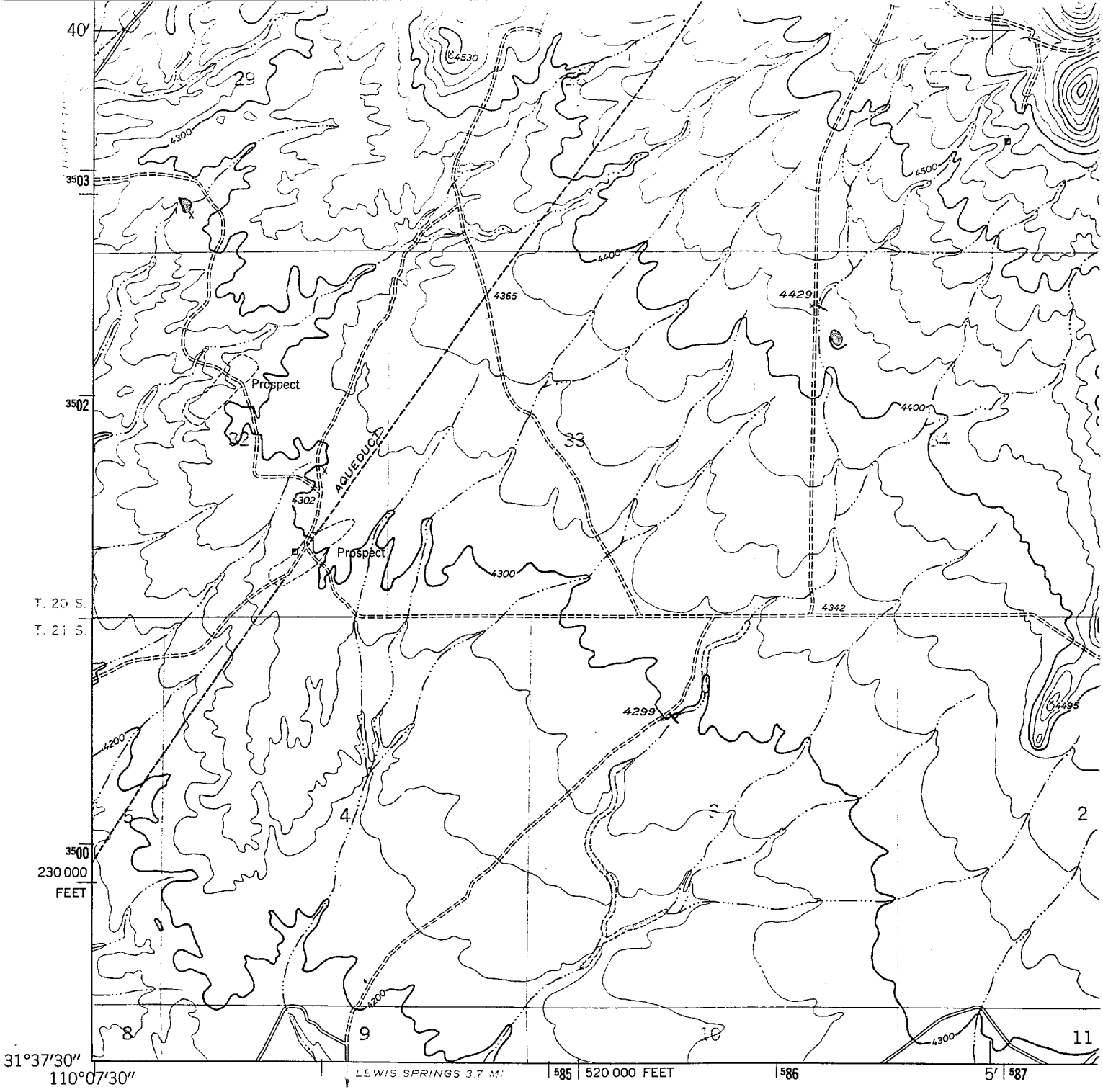
$24/ft
500

AutoCad V.11

John
B143

60°	V		
52 +	45+	0 - 52	Ins
50	30	52 - 101	Siltstone
20	12	101 - 121	Cgl + / ss
135	75	121 - 254	Siltstone - mudstone, calcareous shaly
bx 170		254 - 420	Bx mudstone, ss, gbt bleached FeOx MnOx
170 TD		420 - 598 TD.	Cgl limestone shale, calc mudstone, cgl-calsh. gbt





(LEWIS SPRINGS)
3947 II SW

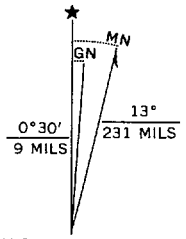
Mapped by the Army Map Service
Published for civil use by the Geological Survey

Control by USGS, USC&GS, and USCE

Topography from aerial photographs by photogrammetric methods
Aerial photographs taken 1951. Field check 1952

Polyconic projection. 1927 North American datum
10,000-foot grid based on Arizona coordinate system, east zone
1000-meter Universal Transverse Mercator grid ticks,
zone 12, shown in blue

Unchecked elevations are shown in brown



UTM GRID AND 1952 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET

FOR

RANGE 22 EAST OF THE GILA AND SALT RIVER

T 20 S R 22 E

Tombstone South

10 chains to inch

29

32

2 39.06

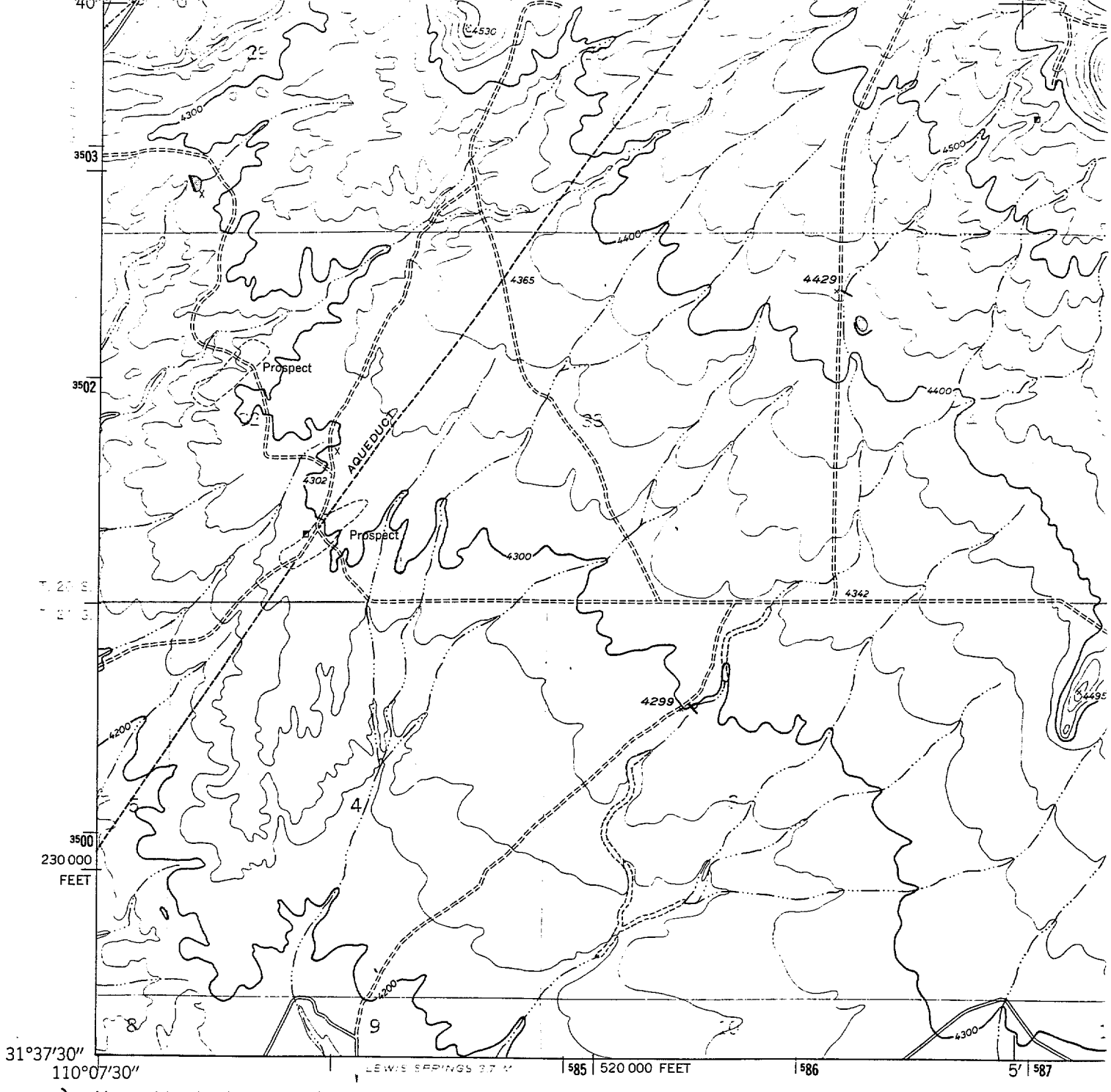
1 18.05

LOT 118 (MS) 20.36

23312

SG 4/5/1906

3 4.78



(LEWIS SPRINGS)
39117 SW

Mapped by the Army Map Service
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Topography from aerial photographs by photogrammetric methods
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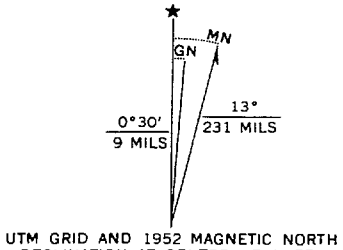
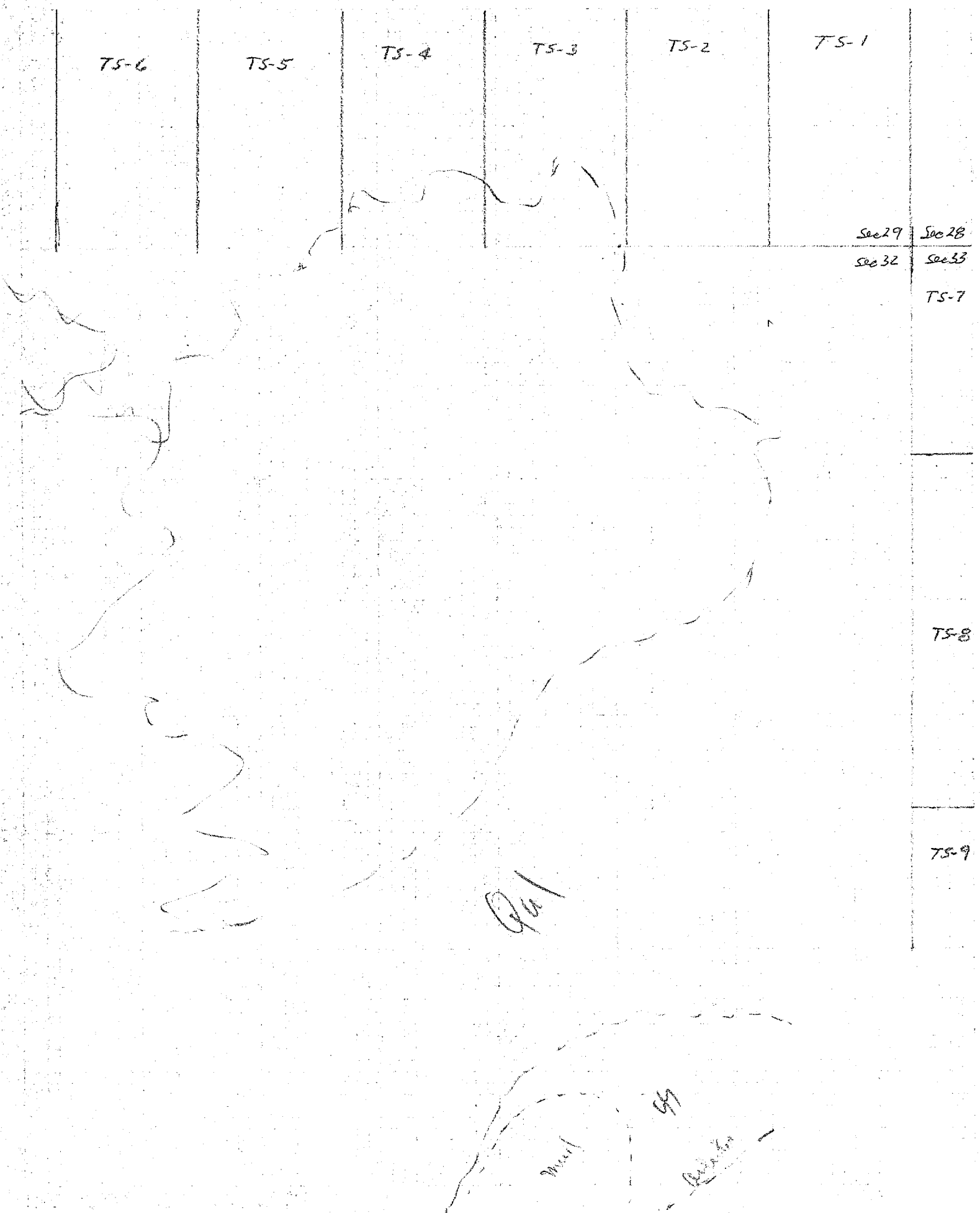


UTM GRID AND 1952 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET

FC

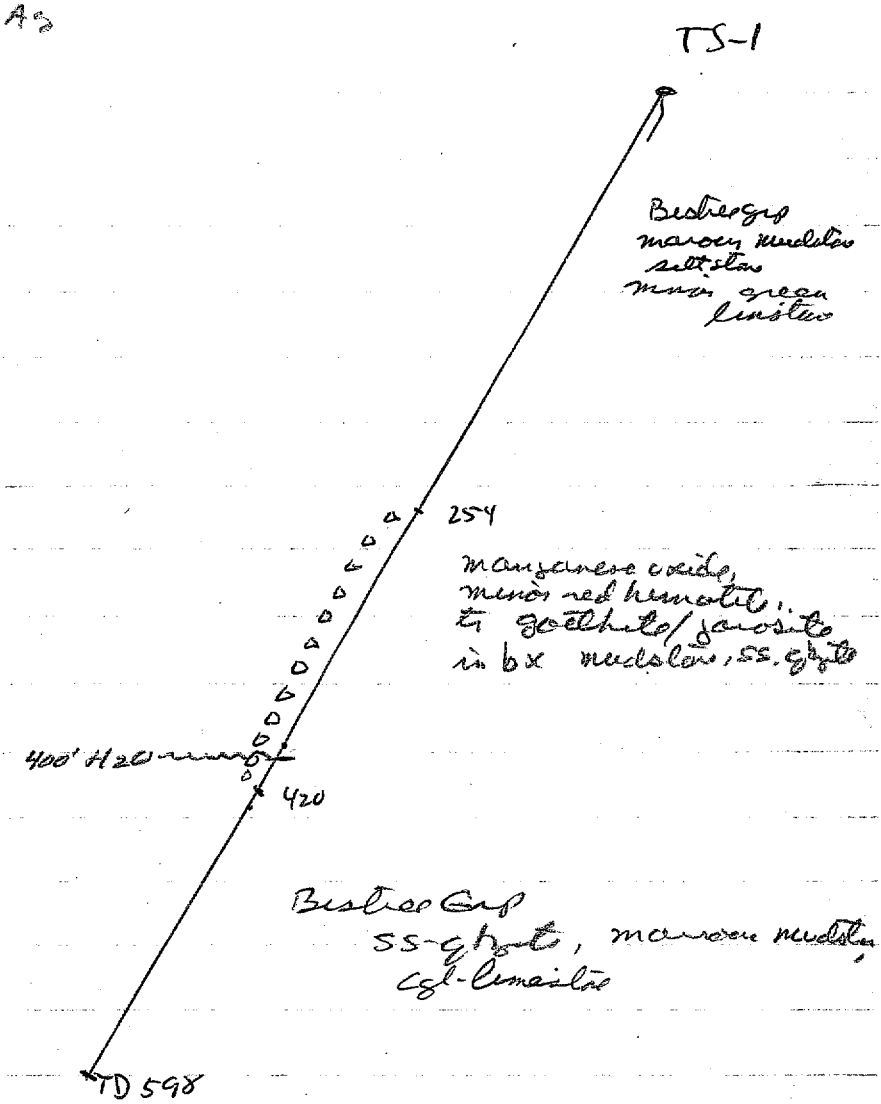
1" = 500'


TS-6
TS-5
TS-4
TS-3
TS-2
TS-1
Sec 29
Sec 28
Sec 32
Sec 33
TS-7
TS-8
TS-9
Qal

1" = 100'

Au Ag

262 1/2 - 285, 12 1/2'



Chuckwalla at Tonkolora

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NUMBER VGN 220
May 17, 1991
TS-1

KENNECOTT EXPLORATION
Attn: Mr. Linus Keating
1515 Minerals Square
Salt Lake City, UT 84112

REPORT OF ANALYSIS

Analysis of Drill Core Samples

	ITEM	SAMPLE NO.	FIRE AASSY Au* (ppm)	Ag* (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mn (ppm)	Mo (ppm)
	1	TS-1 45-50	.004	< .2	6.	14.	40.		< 2.
	2	TS-1 50-52	.004	< .2	26.	10.	36.		< 2.
	3	TS-1 52-55	.002	< .2	12.	16.	65.		< 2.
A	4	TS-1 85-90	< .002	< .2	8.	16.	44.		< 2.
	5	TS-1 90-95	.002	< .2	8.	14.	42.		< 2.
	6	TS-1 95-100	.002	< .2	16.	12.	38.		< 2.
	7	TS-1 100-105	.004	< .2	34.	12.	55.		< 2.
	1	TS-1 125-130	.002	.10	4.	10.	44.	510.	<2.
B	2	TS-1 130-135	< .002	.40	18.	14.	22.	2350.	2.
	3	TS-1 240-245	.002	.15	26.	18.	570.	580.	<2.
	4	TS-1 245-250	.002	.20	50.	14.	800.	840.	<2.
	5	TS-1 250-255	.002	.15	44.	16.	1000.	600.	<2.

cc: Mr. Harold Downey
1803 E. 10th Street
Tucson, AZ 85719

REGISTERED ASSAYER
CERTIFICATE No
9425
WILLIAM L. LEHMBECK
ARIZONA

5/17/91

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin

1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NUMBER VGN 221
May 20, 1991
TS-1

KENNECOTT EXPLORATION
Attn: Mr. Linus Keating
1515 Minerals Square
Salt Lake City, UT 84112

REPORT OF ANALYSIS

Analysis of Drill Cutting Samples

ITEM	SAMPLE NO.	FIRE ASSAY Au* (ppm)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mn (ppm)	Mo (ppm)
1	TS-1 255-257.5	.008	.20	55.	20.	650.	3350.	<2.
2	TS-1 257.5-260	.006	.80	46.	34.	800.	3400.	<2.
3	TS-1 260-262.5	.004	.40	14.	34.	335.	830.	<2.
4	TS-1 262.5-265	.016	2.40	44.	165.	1100.	11000.	<2.
5	TS-1 265-267.5	.070	26.00	190.	1150.	2150.	56500.	100.
(1) 6	TS-1 267.5-270	.036	22.00	140.	600.	1700.	32500.	80.
7	TS-1 270-272.5	.022	4.40	28.	155.	1100.	18500.	12.
8	TS-1 272.5-275	.020	.80	14.	180.	440.	6050.	6.
9	TS-1 275-277.5	.018	.80	12.	55.	255.	3700.	<2.
10	TS-1 277.5-280	.022	.60	12.	16.	275.	2600.	<2.
11	TS-1 280-285	.066	.60	10.	18.	290.	4250.	<2.
1	TS-1 285-290	.018	1.10	14.	50.	265.	4750.	<2.
(2) 2	TS-1 290-295	.016	1.00	14.	48.	290.	3700.	<2.
3	TS-1 295-300	.028	.90	18.	32.	405.	9200.	<2.
4	TS-1 300-305	.008	6.30	8.	95.	650.	4150.	2.

cc: Mr. Harold Downey
1803 E. 10th Street
Tucson, AZ 85719

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NUMBER VGN 223
May 23, 1991
TS-1

KENNECOTT EXPLORATION
Attn: Mr. Linus Keating
1515 Minerals Square
Salt Lake City, UT 84112

REPORT OF ANALYSIS

Analysis of Drill Cutting Samples

ITEM	SAMPLE NO.	FIRE ASSAY Au* (ppm)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mn (ppm)	Mo (ppm)
1	TS-1 305-310	.010	6.50	12.	110.	780.	8250.	<2.
2	TS-1 310-315	.014	5.50	10.	80.	570.	11500.	<2.
3	TS-1 315-320	.020	7.70	18.	100.	790.	8950.	<2.
4	TS-1 320-325	.022	3.20	14.	60.	210.	4000.	<2.
5	TS-1 325-330	.022	15.00	60.	340.	510.	5550.	16.
3 6	TS-1 330-335	.026	12.00	80.	430.	610.	7800.	22.
7	TS-1 335-340	.034	8.20	55.	405.	200.	5550.	4.
8	TS-1 340-345	.012	23.00	50.	220.	600.	13500.	4.
9	TS-1 345-350	.044	12.00	60.	255.	540.	11000.	2.
10	TS-1 350-355	.010	6.90	32.	580.	440.	6250.	2.
11	TS-1 355-359	.006	1.50	16.	280.	180.	280.	<2.
12	TS-1 359-361.5	.006	33.00	38.	400.	770.	28500.	14.
13	TS-1 361.5-365	.006	5.70	38.	230.	280.	4400.	8.
14	TS-1 365-370	.028	3.70	28.	85.	200.	660.	<2.
15	TS-1 370-375	.026	3.10	40.	90.	220.	290.	<2.
16	TS-1 375-380	.008	2.60	60.	24.	265.	200.	<2.

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NUMBER VGN 222
May 20, 1991
TS-1

KENNECOTT EXPLORATION
Attn: Mr. Linus Keating
1515 Minerals Square
Salt Lake City, UT 84112

REPORT OF ANALYSIS

Analysis of Drill Core Samples

ITEM	SAMPLE NO.	FIRE ASSAY Au* (ppm)	Ag* (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mn (ppm)	Mo (ppm)
5	TS-1 380-385	.008	4.50	30.	110.	130.	470.	<2.
6	TS-1 385-390	.012	29.00	50.	730.	85.	3000.	4.
12	TS-1 390-395	.008	430.00	820.	4200.	1250.	45000.	4.
13	TS-1 395-400	.030	210.00	1300.	21500.** 2.70%	920.	53000.	14.
7	TS-1 400-405	.022	21.00	155.	1900.	210.	380.	145.
8	TS-1 405-410	.110	75.00	170.	2800.	165.	1200.	24.
9	TS-1 410-415	.090	165.00	1250.	21500.** 2.39%	760.	41500.	185.
10	TS-1 415-420	.010	7.20	75.	960.	180.	1500.	120.

*NOTE: Method of analysis by combination

*NOTE: Method of analysis by combination fire assay and atomic absorption.

**NOTE: Quantitative analysis to follow.

cc: Mr. Harold Downey
1803 E. 10th Street
Tucson, AZ 85719

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NUMBER VGN 221
May 20, 1991
TS-1

KENNECOTT EXPLORATION
Attn: Mr. Linus Keating
1515 Minerals Square
Salt Lake City, UT 84112

REPORT OF ANALYSIS

Analysis of Drill Cutting Samples

ITEM	SAMPLE NO.	FIRE ASSAY Au* (ppm)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mn (ppm)	Mo (ppm)
17	TS-1 420-425	.006	17.00	44.	485.	75.	350.	28.
18	TS-1 425-430	.008	15.00	70.	255.	305.	1550.	65.
19	TS-1 430-435	.006	6.40	70.	16.	475.	3400.	<2.
7 20	TS-1 435-440	.006	14.00	42.	220.	435.	7550.	175.
21	TS-1 440-445	.006	14.00	70.	65.	620.	5250.	12.
22	TS-1 445-450	.014	22.00	85.	150.	860.	9650.	28.
1	TS-1 450-455	.002	3.00	70.	36.	1250.	1400.	<2.
2	TS-1 455-460	< .002	2.00	28.	26.	780.	2900.	<2.
8 3	TS-1 460-465	< .002	1.60	28.	16.	330.	990.	<2.
4	TS-1 465-470	.002	.80	24.	16.	340.	800.	<2.
5	TS-1 470-475	.004	4.40	12.	28.	380.	1300.	<2.
6	TS-1 475-480	.006	.60	< 2.	20.	135.	660.	<2.
7	TS-1 480-485	.006	1.20	12.	38.	1050.	3300.	<2.
8	TS-1 485-490	.004	1.40	8.	16.	410.	1100.	<2.
1	TS-1 490-495	.004	.3	16.	16.	130.	690.	<2.
2	TS-1 495-500	.030	1.2	12.	14.	32.	520.	<2.
3	TS-1 500-505	< .002	.1	4.	12.	20.	490.	<2.
4	TS-1 505-510	< .002	.2	6.	10.	24.	830.	<2.
5	TS-1 510-515	< .002	.8	4.	6.	110.	510.	<2.
6	TS-1 515-520	.002	.4	6.	20.	380.	1050.	<2.

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NUMBER VGN 222
May 20, 1991
TS-1

KENNECOTT EXPLORATION
Attn: Mr. Linus Keating
1515 Minerals Square
Salt Lake City, UT 84112

REPORT OF ANALYSIS

Analysis of '' Drill Core Samples

ITEM	SAMPLE NO.	FIRE ASSAY Au* (ppm)	Ag* (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mn (ppm)	Mo (ppm)
6	TS-1 520-525	.006	.70	14.	530.	205.	1100.	8.
7	TS-1 525-530	.006	.40	12.	305.	95.	930.	10.
8	TS-1 530-535	.002	1.40	14.	115.	26.	470.	10.
9	TS-1 535-540	.004	.20	6.	180.	20.	950.	8.
10	TS-1 540-545	.012	.85	6.	450.	185.	6250.	6.
11	TS-1 545-550	.006	.25	8.	630.	75.	2800.	8.
12	TS-1 550-555	< .002	.30	10.	165.	22.	990.	6.
13	TS-1 555-560	< .002	.15	8.	60.	24.	570.	<2.
14	TS-1 560-565	.002	.05	10.	70.	28.	480.	2.
15	TS-1 565-570	.012	2.20	20.	510.	285.	5700.	8.
16	TS-1 570-575	.008	1.00	12.	520.	270.	4100.	4.
17	TS-1 575-580	< .002	.15	12.	105.	10.	1000.	4.
18	TS-1 580-585	< .002	.25	6.	75.	14.	970.	4.
19	TS-1 585-590	.004	.30	6.	145.	60.	4400.	6.
20	TS-1 590-595	< .002	.25	6.	70.	18.	830.	6.
21	TS-1 595-598 TD.	.002	.20	10.	50.	14.	890.	4.

*NOTE: Method of analysis by combination fire assay and atomic absorption.

cc: Mr. Harold Downey
1803 E. 10th Steet
Tucson, AZ 85719

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NUMBER VGN 220
May 17, 1991
TS-1

KENNECOTT EXPLORATION
Attn: Mr. Linus Keating
1515 Minerals Square
Salt Lake City, UT 84112

REPORT OF ANALYSIS

Analysis of Drill Core Samples

	ITEM	SAMPLE NO.	FIRE AASSY Au* (ppm)	Ag* (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mn (ppm)	Mo (ppm)
	1	TS-1 45-50	.004	< .2	6.	14.	40.		< 2.
	2	TS-1 50-52	.004	< .2	26.	10.	36.		< 2.
	3	TS-1 52-55	.002	< .2	12.	16.	65.		< 2.
A	4	TS-1 85-90	< .002	< .2	8.	16.	44.		< 2.
	5	TS-1 90-95	.002	< .2	8.	14.	42.		< 2.
	6	TS-1 95-100	.002	< .2	16.	12.	38.		< 2.
	7	TS-1 100-105	.004	< .2	34.	12.	55.		< 2.
	1	TS-1 125-130	.002	.10	4.	10.	44.	510.	<2.
B	2	TS-1 130-135	< .002	.40	18.	14.	22.	2350.	2.
	3	TS-1 240-245	.002	.15	26.	18.	570.	580.	<2.
	4	TS-1 245-250	.002	.20	50.	14.	800.	840.	<2.
	5	TS-1 250-255	.002	.15	44.	16.	1000.	600.	<2.

cc: Mr. Harold Downey
1803 E. 10th Street
Tucson, AZ 85719

REGISTERED ASSAYER
CERTIFICATE No.
9425
WILLIAM L. LEHMBECK
ARIZONA
5/17/91

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NUMBER VGN 221
May 20, 1991
TS-1

KENNECOTT EXPLORATION
Attn: Mr. Linus Keating
1515 Minerals Square
Salt Lake City, UT 84112

REPORT OF ANALYSIS

Analysis of Drill Cutting Samples

ITEM	SAMPLE NO.	FIRE ASSAY Au* (ppm)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mn (ppm)	Mo (ppm)
1	TS-1 255-257.5	.008	.20	55.	20.	650.	3350.	<2.
2	TS-1 257.5-260	.006	.80	46.	34.	800.	3400.	<2.
3	TS-1 260-262.5	.004	.40	14.	34.	335.	830.	<2.
4	TS-1 262.5-265	.016	2.40	44.	165.	1100.	11000.	<2.
5	TS-1 265-267.5	.070	26.00	190.	1150.	2150.	56500.	100.
(1)								
6	TS-1 267.5-270	.036	22.00	140.	600.	1700.	32500.	80.
7	TS-1 270-272.5	.022	4.40	28.	155.	1100.	18500.	12.
8	TS-1 272.5-275	.020	.80	14.	180.	440.	6050.	6.
9	TS-1 275-277.5	.018	.80	12.	55.	255.	3700.	<2.
10	TS-1 277.5-280	.022	.60	12.	16.	275.	2600.	<2.
11	TS-1 280-285	.066	.60	10.	18.	290.	4250.	<2.
1	TS-1 285-290	.018	1.10	14.	50.	265.	4750.	<2.
(2) 2	TS-1 290-295	.016	1.00	14.	48.	290.	3700.	<2.
3	TS-1 295-300	.028	.90	18.	32.	405.	9200.	<2.
4	TS-1 300-305	.008	6.30	8.	95.	650.	4150.	2.

cc: Mr. Harold Downey
1803 E. 10th Street
Tucson, AZ 85719

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NUMBER VGN 223
May 23, 1991
TS-1

KENNECOTT EXPLORATION
Attn: Mr. Linus Keating
1515 Minerals Square
Salt Lake City, UT 84112

REPORT OF ANALYSIS

Analysis of Drill Cutting Samples

ITEM	SAMPLE NO.	FIRE ASSAY Au* (ppm)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mn (ppm)	Mo (ppm)
1	TS-1 305-310	.010	6.50	12.	110.	780.	8250.	<2.
2	TS-1 310-315	.014	5.50	10.	80.	570.	11500.	<2.
3	TS-1 315-320	.020	7.70	18.	100.	790.	8950.	<2.
4	TS-1 320-325	.022	3.20	14.	60.	210.	4000.	<2.
5	TS-1 325-330	.022	15.00	60.	340.	510.	5550.	16.
3 6	TS-1 330-335	.026	12.00	80.	430.	610.	7800.	22.
7	TS-1 335-340	.034	8.20	55.	405.	200.	5550.	4.
8	TS-1 340-345	.012	23.00	50.	220.	600.	13500.	4.
9	TS-1 345-350	.044	12.00	60.	255.	540.	11000.	2.
10	TS-1 350-355	.010	6.90	32.	580.	440.	6250.	2.
11	TS-1 355-359	.006	1.50	16.	280.	180.	280.	<2.
12	TS-1 359-361.5	.006	33.00	38.	400.	770.	28500.	14.
13	TS-1 361.5-365	.006	5.70	38.	230.	280.	4400.	8.
14	TS-1 365-370	.028	3.70	28.	85.	200.	660.	<2.
15	TS-1 370-375	.026	3.10	40.	90.	220.	290.	<2.
16	TS-1 375-380	.008	2.60	60.	24.	265.	200.	<2.

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NUMBER VGN 222
May 20, 1991
TS-1

KENNECOTT EXPLORATION
Attn: Mr. Linus Keating
1515 Minerals Square
Salt Lake City, UT 84112

REPORT OF ANALYSIS

Analysis of Drill Core Samples

ITEM	SAMPLE NO.	FIRE ASSAY Au* (ppm)	Ag* (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mn (ppm)	Mo (ppm)
5	TS-1 380-385	.008	4.50	30.	110.	130.	470.	<2.
6	TS-1 385-390	.012	29.00	50.	730.	85.	3000.	4.
12	TS-1 390-395	.008	430.00	820.	4200.	1250.	45000.	4.
13	TS-1 395-400	.030	210.00	1300.	21500.** 2.70%	920.	53000.	14.
*NOTE: Method of analysis by combination								
7	TS-1 400-405	.022	21.00	155.	1900.	210.	380.	145.
8	TS-1 405-410	.110	75.00	170.	2800.	165.	1200.	24.
9	TS-1 410-415	.090	165.00	1250.	21500.** 2.39%	760.	41500.	185.
10	TS-1 415-420	.010	7.20	75.	960.	180.	1500.	120.

*NOTE: Method of analysis by combination fire assay and atomic absorption.

**NOTE: Quantitative analysis to follow.

cc: Mr. Harold Downey
1803 E. 10th Street
Tucson, AZ 85719

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NUMBER VGN 221
May 20, 1991
TS-1

KENNECOTT EXPLORATION
Attn: Mr. Linus Keating
1515 Minerals Square
Salt Lake City, UT 84112

REPORT OF ANALYSIS

Analysis of Drill Cutting Samples

ITEM	SAMPLE NO.	FIRE ASSAY Au* (ppm)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mn (ppm)	Mo (ppm)
17	TS-1 420-425	.006	17.00	44.	485.	75.	350.	28.
18	TS-1 425-430	.008	15.00	70.	255.	305.	1550.	65.
19	TS-1 430-435	.006	6.40	70.	16.	475.	3400.	<2.
7 20	TS-1 435-440	.006	14.00	42.	220.	435.	7550.	175.
21	TS-1 440-445	.006	14.00	70.	65.	620.	5250.	12.
22	TS-1 445-450	.014	22.00	85.	150.	860.	9650.	28.
1	TS-1 450-455	.002	3.00	70.	36.	1250.	1400.	<2.
2	TS-1 455-460	< .002	2.00	28.	26.	780.	2900.	<2.
8 3	TS-1 460-465	< .002	1.60	28.	16.	330.	990.	<2.
4	TS-1 465-470	.002	.80	24.	16.	340.	800.	<2.
5	TS-1 470-475	.004	4.40	12.	28.	380.	1300.	<2.
6	TS-1 475-480	.006	.60	< 2.	20.	135.	660.	<2.
7	TS-1 480-485	.006	1.20	12.	38.	1050.	3300.	<2.
8	TS-1 485-490	.004	1.40	8.	16.	410.	1100.	<2.
1	TS-1 490-495	.004	.3	16.	16.	130.	690.	<2.
2	TS-1 495-500	.030	1.2	12.	14.	32.	520.	<2.
3	TS-1 500-505	< .002	.1	4.	12.	20.	490.	<2.
4	TS-1 505-510	< .002	.2	6.	10.	24.	830.	<2.
5	TS-1 510-515	< .002	.8	4.	6.	110.	510.	<2.
6	TS-1 515-520	.002	.4	6.	20.	380.	1050.	<2.

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
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JOB NUMBER VGN 222
May 20, 1991
TS-1

KENNECOTT EXPLORATION
Attn: Mr. Linus Keating
1515 Minerals Square
Salt Lake City, UT 84112

REPORT OF ANALYSIS

Analysis of " Drill Core Samples

ITEM	SAMPLE NO.	FIRE ASSAY Au* (ppm)	Ag* (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mn (ppm)	Mo (ppm)
6	TS-1 520-525	.006	.70	14.	530.	205.	1100.	8.
7	TS-1 525-530	.006	.40	12.	305.	95.	930.	10.
8	TS-1 530-535	.002	1.40	14.	115.	26.	470.	10.
9	TS-1 535-540	.004	.20	6.	180.	20.	950.	8.
10	TS-1 540-545	.012	.85	6.	450.	185.	6250.	6.
11	TS-1 545-550	.006	.25	8.	630.	75.	2800.	8.
12	TS-1 550-555	< .002	.30	10.	165.	22.	990.	6.
13	TS-1 555-560	< .002	.15	8.	60.	24.	570.	<2.
14	TS-1 560-565	.002	.05	10.	70.	28.	480.	2.
15	TS-1 565-570	.012	2.20	20.	510.	285.	5700.	8.
16	TS-1 570-575	.008	1.00	12.	520.	270.	4100.	4.
17	TS-1 575-580	< .002	.15	12.	105.	10.	1000.	4.
18	TS-1 580-585	< .002	.25	6.	75.	14.	970.	4.
19	TS-1 585-590	.004	.30	6.	145.	60.	4400.	6.
20	TS-1 590-595	< .002	.25	6.	70.	18.	830.	6.
21	TS-1 595-598 T.D.	.002	.20	10.	50.	14.	890.	4.

*NOTE: Method of analysis by combination fire assay and atomic absorption.

cc: Mr. Harold Downey
1803 E. 10th Steet
Tucson, AZ 85719

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NUMBER VGN 220
May 17, 1991
TS-1 45 TO 105

KENNECOTT EXPLORATION
Attn: Mr. Linus Keating
1515 Minerals Square
Salt Lake City, UT 84112

REPORT OF ANALYSIS

Analysis of 7 Drill Core Samples

ITEM	SAMPLE NO.	FIRE AASSY Au* (ppm)	Ag* (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mo (ppm)
1	TS-1 45-50	.004	< .2	6.	14.	40.	< 2.
2	TS-1 50-52	.004	< .2	26.	10.	36.	< 2.
3	TS-1 52-55	.002	< .2	12.	16.	65.	< 2.
A 4	TS-1 85-90	< .002	< .2	8.	16.	44.	< 2.
5	TS-1 90-95	.002	< .2	8.	14.	42.	< 2.
6	TS-1 95-100	.002	< .2	16.	12.	38.	< 2.
7	TS-1 100-105	.004	< .2	34.	12.	55.	< 2.

*NOTE: Method of analysis by combination fire assay and atomic absorption.

cc: Mr. Harold Downey
1806 E. 10th Street
Tucson, AZ 85719

REGISTERED ASSAYER CERTIFICATE NO. 9425 WILLIAM L. LEHMBECK ARIZONA U.S.A.
5/17/91

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NUMBER VGN 221
May 20, 1991
TS-1 (255 TO 400)

KENNECOTT EXPLORATION
Attn: Mr. Linus Keating
1515 Minerals Square
Salt Lake City, UT 84112

REPORT OF ANALYSIS

Analysis of 13 Drill Cutting Samples

ITEM	SAMPLE NO.	FIRE ASSAY Au* (ppm)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mn (ppm)
1	TS-1 255-257.5	.008	.20	55.	20.	650.	3350.
2	TS-1 257.5-260	.006	.80	46.	34.	800.	3400.
3	TS-1 260-262.5	.004	.40	14.	34.	335.	830.
4	TS-1 262.5-265	.016	2.40	44.	165.	1100.	11000.
5	TS-1 265-267.5	.070	26.00	190.	1150.	2150.	56500.
(1) 6	TS-1 267.5-270	.036	22.00	140.	600.	1700.	32500.
7	TS-1 270-272.5	.022	4.40	28.	155.	1100.	18500.
8	TS-1 272.5-275	.020	.80	14.	180.	440.	6050.
9	TS-1 275-277.5	.018	.80	12.	55.	255.	3700.
10	TS-1 277.5-280	.022	.60	12.	16.	275.	2600.
11	TS-1 280-285	.066	.60	10.	18.	290.	4250.
(5) 12	TS-1 390-395	.008	430.00	820.	4200.	1250.	45000.
13	TS-1 395-400	.030	210.00	1300.	21500.** 2.70%	920.	53000.

*NOTE: Method of analysis by combination fire assay and atomic absorption.

**NOTE: Quantitative analysis to follow.

cc: Mr. Harold Downey
1803 E. 10th Street
Tucson, AZ 85719

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. VGN 221A
May 30, 1991
TS-1 (255 TO 400)

KENNECOTT EXPLORATION
Attn: Mr. Linus Keating
1515 Minerals Square
Salt Lake City, UT 84112

Analysis of 1 Pulp Sample

ITEM	SAMPLE NUMBER	Pb (%)
13	TS-1 395-400	2.70

cc: Mr. Harold Downey
1803 E. 10th Street
Tucson, AZ 85719

REGISTERED ASSAYER
CERTIFICATE NO.
9425
WILLIAM L.
LEHMBECK
ARIZONA U.S.A.
5/30/91

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

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Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. VGN 221B
November 8, 1991
TS-1 (255 TO 400)

KENNECOTT EXPLORATION
Attn: Mr. Linus Keating
1515 Minerals Square
Salt Lake City, UT 84112

Analysis of 13 Pulp Samples

ITEM	SAMPLE NUMBER	Mo (ppm)
1	TS-1 255-257.5	<2.
2	TS-1 257.5-260	<2.
3	TS-1 260-262.5	<2.
4	TS-1 262.5-265	<2.
5	TS-1 265-267.5	100.
6	TS-1 267.5-270	80.
7	TS-1 270-272.5	12.
8	TS-1 272.5-275	6.
9	TS-1 275-277.5	<2.
10	TS-1 277.5-280	<2.
11	TS-1 280-285	<2.
12	TS-1 390-395	4.
13	TS-1 395-400	14.

cc: Mr. Harold Downey
1803 E. 10th Steet
Tucson, AZ 85719

REGISTERED ASSAYER CERTIFICATE NO. 9425 WILLIAM L. LEHMBECK ARIZONA U.S.A.

11/8/91

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NUMBER VGN 222
May 20, 1991
TS-1 285 TO 420

KENNECOTT EXPLORATION
Attn: Mr. Linus Keating
1515 Minerals Square
Salt Lake City, UT 84112

REPORT OF ANALYSIS

Analysis of 10 Drill Core Samples

ITEM	SAMPLE NO.	FIRE ASSAY Au* (ppm)	Ag* (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mn (ppm)
1	TS-1 285-290	.018	1.10	14.	50.	265.	4750.
2	TS-1 290-295	.016	1.00	14.	48.	290.	3700.
3	TS-1 295-300	.028	.90	18.	32.	405.	9200.
4	TS-1 300-305	.008	6.30	8.	95.	650.	4150.
5	TS-1 380-385	.008	4.50	30.	110.	130.	470.
6	TS-1 385-390	.012	29.00	50.	730.	85.	3000.
7	TS-1 400-405	.022	21.00	155.	1900.	210.	380.
8	TS-1 405-410	.110	75.00	170.	2800.	165.	1200.
9	TS-1 410-415	.090	165.00	1250.	21500.** 2.39%	760.	41500.
10	TS-1 415-420	.010	7.20	75.	960.	180.	1500.

*NOTE: Method of analysis by combination fire assay and atomic absorption.

**NOTE: Quantitative analysis to follow.

cc: Mr. Harold Downey
1803 E. 10th Street
Tucson, AZ 85719

Charles E. Thompson
Arizona Registered Assayer No. 8427

William L. Lehmbeck
Arizona Registered Assayer No. 8425

James A. Martin
Arizona Registered Assayer No. 11122

SKYLINE LABS, INC.
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Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. VGN 222A
May 30, 1991
TS-1 285 TO 420

KENNECOTT EXPLORATION
Attn: Mr. Linus Keating
1515 Minerals Square
Salt Lake City, UT 84112

Analysis of 1 Pulp Sample

ITEM	SAMPLE NUMBER	Pb (%)
9	TS-1 410-415	2.39

cc: Mr. Harold Downey
1803 E. 10th Street
Tucson, AZ 85719

REGISTERED ASSAYER
CERTIFICATE NO. 9425
WILLIAM L. LEHMBECK
ARIZONA U.S.A.
5/30/91

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. VGN 222B
November 8, 1991
TS-1 285 TO 420

KENNECOTT EXPLORATION
Attn: Mr. Linus Keating
1515 Minerals Square
Salt Lake City, UT 84112

Analysis of 10 Pulp Samples

ITEM	SAMPLE NUMBER	Mo (ppm)
1	TS-1 285-290	<2.
2	TS-1 290-295	<2.
3	TS-1 295-300	<2.
4	TS-1 300-305	2.
5	TS-1 380-385	<2.
6	TS-1 385-390	4.
7	TS-1 400-405	145.
8	TS-1 405-410	24.
9	TS-1 410-415	185.
10	TS-1 415-420	120.

cc: Mr. Harold Downey
1803 E. 10th Steet
Tucson, AZ 85719

REGISTERED ASSAYER
CERTIFICATE NO.
9425
WILLIAM L.
LEHMBECK
ARIZONA, U.S.A.

8/91

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NUMBER VGN 223
May 23, 1991
TS-1 (305 TO 450)

KENNECOTT EXPLORATION
Attn: Mr. Linus Keating
1515 Minerals Square
Salt Lake City, UT 84112

REPORT OF ANALYSIS

Analysis of 22 Drill Cutting Samples

ITEM	SAMPLE NO.	FIRE ASSAY Au* (ppm)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mn (ppm)
1	TS-1 305-310	.010	6.50	12.	110.	780.	8250.
2	TS-1 310-315	.014	5.50	10.	80.	570.	11500.
3	TS-1 315-320	.020	7.70	18.	100.	790.	8950.
4	TS-1 320-325	.022	3.20	14.	60.	210.	4000.
5	TS-1 325-330	.022	15.00	60.	340.	510.	5550.
3 6	TS-1 330-335	.026	12.00	80.	430.	610.	7800.
7	TS-1 335-340	.034	8.20	55.	405.	200.	5550.
8	TS-1 340-345	.012	23.00	50.	220.	600.	13500.
9	TS-1 345-350	.044	12.00	60.	255.	540.	11000.
10	TS-1 350-355	.010	6.90	32.	580.	440.	6250.
11	TS-1 355-359	.006	1.50	16.	280.	180.	280.
12	TS-1 359-361.5	.006	33.00	38.	400.	770.	28500.
13	TS-1 361.5-365	.006	5.70	38.	230.	280.	4400.
14	TS-1 365-370	.028	3.70	28.	85.	200.	660.
15	TS-1 370-375	.026	3.10	40.	90.	220.	290.
16	TS-1 375-380	.008	2.60	60.	24.	265.	200.
17	TS-1 420-425	.006	17.00	44.	485.	75.	350.
18	TS-1 425-430	.008	15.00	70.	255.	305.	1550.
19	TS-1 430-435	.006	6.40	70.	16.	475.	3400.
7 20	TS-1 435-440	.006	14.00	42.	220.	435.	7550.
21	TS-1 440-445	.006	14.00	70.	65.	620.	5250.
22	TS-1 445-450	.014	22.00	85.	150.	860.	9650.

*NOTE: Method of analysis by combination fire assay and atomic absorption.
cc: Mr. Harold Downey/Tucson, AZ

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. VGN 223A
November 7, 1991
TS-1 (305 TO 450)

KENNECOTT EXPLORATION
Attn: Mr. Linus Keating
1515 Minerals Square
Salt Lake City, UT 84112

Analysis of 22 Pulp Samples

ITEM	SAMPLE NUMBER	Mo (ppm)
1	TS-1 305-310	<2.
2	TS-1 310-315	<2.
3	TS-1 315-320	<2.
4	TS-1 320-325	<2.
5	TS-1 325-330	16.
6	TS-1 330-335	22.
7	TS-1 335-340	4.
8	TS-1 340-345	4.
9	TS-1 345-350	2.
10	TS-1 350-355	2.
11	TS-1 355-359	<2.
12	TS-1 359-361.5	14.
13	TS-1 361.5-365	8.
14	TS-1 365-370	<2.
15	TS-1 370-375	<2.

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NO. VGN 223A
November 7, 1991

ITEM	SAMPLE NUMBER	Mo (ppm)
16	TS-1 375-380	<2.
17	TS-1 420-425	28.
18	TS-1 425-430	65.
19	TS-1 430-435	<2.
20	TS-1 435-440	175.
21	TS-1 440-445	12.
22	TS-1 445-450	28.

cc: Mr. Harold Downey
1803 E. 10th Steet
Tucson, AZ 85719

REGISTERED ASSAYER
CERTIFICATE No.
9425
WILLIAM L.
LEHMBECK
Arizona U.S.A.
11/7/91

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NUMBER VGN 224
May 23, 1991
TS-1 450 TO 490

KENNECOTT EXPLORATION
Attn: Mr. Linus Keating
1515 Minerals Square
Salt Lake City, UT 84112

REPORT OF ANALYSIS

Analysis of 8 Drill Core Samples

ITEM	SAMPLE NO.	FIRE ASSAY Au* (ppm)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mn (ppm)
1	TS-1 450-455	.002	3.00	70.	36.	1250.	1400.
2	TS-1 455-460	< .002	2.00	28.	26.	780.	2900.
3	TS-1 460-465	< .002	1.60	28.	16.	330.	990.
4	TS-1 465-470	.002	.80	24.	16.	340.	800.
5	TS-1 470-475	.004	4.40	12.	28.	380.	1300.
6	TS-1 475-480	.006	.60	< 2.	20.	135.	660.
7	TS-1 480-485	.006	1.20	12.	38.	1050.	3300.
8	TS-1 485-490	.004	1.40	8.	16.	410.	1100.

*NOTE: Method of analysis by combination fire assay and atomic absorption.

cc: Mr. Harold Downey
1803 E. 10th Street
Tucson, AZ 85719

William L. Lehmbeck
Manager

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. VGN 224A
November 7, 1991
TS-1 450 TO 490

KENNECOTT EXPLORATION
Attn: Mr. Linus Keating
1515 Minerals Square
Salt Lake City, UT 84112

Analysis of 8 Pulp Samples

ITEM	SAMPLE NUMBER	Mo (ppm)
1	TS-1 450-455	<2.
2	TS-1 455-460	<2.
3	TS-1 460-465	<2.
4	TS-1 465-470	<2.
5	TS-1 470-475	<2.
6	TS-1 475-480	<2.
7	TS-1 480-485	<2.
8	TS-1 485-490	<2.

cc: Mr. Harold Downey
1803 E. 10th Steet
Tucson, AZ 85719

REGISTERED ASSAYER
CERTIFICATE NO.
9425
WILLIAM L.
LEHMBECK
ARIZONA, U.S.A.
11/7/91

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NUMBER VGN 225
May 30, 1991
TS-1 490-520

KENNECOTT EXPLORATION
Attn: Mr. Linus Keating
1515 Minerals Square
Salt Lake City, UT 84112

REPORT OF ANALYSIS

Analysis of 6 Drill Cutting Samples

ITEM	SAMPLE NO.	FIRE ASSAY Au* (ppm)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mn (ppm)
1	TS-1 490-495	.004	.3	16.	16.	130.	690.
2	TS-1 495-500	.030	1.2	12.	14.	32.	520.
3	TS-1 500-505	< .002	.1	4.	12.	20.	490.
4	TS-1 505-510	< .002	.2	6.	10.	24.	830.
5	TS-1 510-515	< .002	.8	4.	6.	110.	510.
6	TS-1 515-520	.002	.4	6.	20.	380.	1050.

*NOTE: Method of analysis by combination fire assay and atomic absorption.

cc: Mr. Harold Downey
1803 E. 10th Street
Tucson, AZ 85719

9127 CHARLES E. THOMPSON DATE SIGNED Arizona U.S.A.
5/30/91

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. VGN 225A
November 7, 1991
TS-1 490-520

KENNECOTT EXPLORATION
Attn: Mr. Linus Keating
1515 Minerals Square
Salt Lake City, UT 84112

Analysis of 6 Pulp Samples

ITEM	SAMPLE NUMBER	Mo (ppm)
1	TS-1 490-495	<2.
2	TS-1 495-500	<2.
3	TS-1 500-505	<2.
4	TS-1 505-510	<2.
5	TS-1 510-515	<2.
6	TS-1 515-520	<2.

cc: Mr. Harold Downey
1803 E. 10th Steet
Tucson, AZ 85719

REGISTERED ASSAYER
CERTIFICATE NO.
9425
WILLIAM L.
LEHMBECK
STATE OF ARIZONA

11/7/91

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NUMBER VGN 226
May 30, 1991
TS-1 (125 TO 598)

KENNECOTT EXPLORATION
Attn: Mr. Linus Keating
1515 Minerals Square
Salt Lake City, UT 84112

REPORT OF ANALYSIS

Analysis of 21 Drill Core Samples

ITEM	SAMPLE NO.	FIRE ASSAY Au* (ppm)	Ag (ppm)	Cu (ppm)	Zn (ppm)	Pb (ppm)	Mn (ppm)
1	TS-1 125-130	.002	.10	4.	44.	10.	510.
B 2	TS-1 130-135	< .002	.40	18.	22.	14.	2350.
3	TS-1 240-245	.002	.15	26.	570.	18.	580.
4	TS-1 245-250	.002	.20	50.	800.	14.	840.
5	TS-1 250-255	.002	.15	44.	1000.	16.	600.
6	TS-1 520-525	.006	.70	14.	530.	205.	1100.
7	TS-1 525-530	.006	.40	12.	305.	95.	930.
8	TS-1 530-535	.002	1.40	14.	115.	26.	470.
9	TS-1 535-540	.004	.20	6.	180.	20.	950.
(10) 10	TS-1 540-545	.012	.85	6.	450.	185.	6250.
11	TS-1 545-550	.006	.25	8.	630.	75.	2800.
12	TS-1 550-555	< .002	.30	10.	165.	22.	990.
13	TS-1 555-560	< .002	.15	8.	60.	24.	570.
14	TS-1 560-565	.002	.05	10.	70.	28.	480.
15	TS-1 565-570	.012	2.20	20.	510.	285.	5700.

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

KENNECOTT EXPLORATION
Attn: Mr. Linus Keating
1515 Minerals Square
Salt Lake City, UT 84112

REPORT OF ANALYSIS

Analysis of 21 Drill Core Samples

ITEM	SAMPLE NO.	FIRE ASSAY Au* (ppm)	Ag (ppm)	Cu (ppm)	Zn (ppm)	Pb (ppm)	Mn (ppm)
16	TS-1 570-575	.008	1.00	12.	520.	270.	4100.
17	TS-1 575-580	< .002	.15	12.	105.	10.	1000.
18	TS-1 580-585	< .002	.25	6.	75.	14.	970.
19	TS-1 585-590	.004	.30	6.	145.	60.	4400.
20	TS-1 590-595	< .002	.25	6.	70.	18.	830.
21	TS-1 595-598	.002	.20	10.	50.	14.	890.

(11)

*NOTE: Method of analysis by combination fire assay and atomic absorption.

cc: Mr. Harold Downey
1803 E. 10th Street
Tucson, AZ 85719

Charles E. Thompson 5/31/91

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

SKYLINE LABS, INC.
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Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. VGN 226A
November 7, 1991
TS-1 (125 TO 598)

KENNECOTT EXPLORATION
Attn: Mr. Linus Keating
1515 Minerals Square
Salt Lake City, UT 84112

Analysis of 21 Pulp Samples

ITEM	SAMPLE NUMBER	Mo (ppm)
1	TS-1 125-130	<2.
2	TS-1 130-135	2.
3	TS-1 240-245	<2.
4	TS-1 245-250	<2.
5	TS-1 250-255	<2.
6	TS-1 520-525	8.
7	TS-1 525-530	10.
8	TS-1 530-535	10.
9	TS-1 535-540	8.
10	TS-1 540-545	6.
11	TS-1 545-550	8.
12	TS-1 550-555	6.
13	TS-1 555-560	<2.
14	TS-1 560-565	2.
15	TS-1 565-570	8.
16	TS-1 570-575	4.
17	TS-1 575-580	4.
18	TS-1 580-585	4.
19	TS-1 585-590	6.
20	TS-1 590-595	6.
21	TS-1 595-598	4.

cc: Mr. Harold Downey
1803 E. 10th Steet
Tucson, AZ 85719

REGISTERED ASSAYER
CERTIFICATE NO.
9425
WILLIAM L.
LEHMBECK
ARIZONA U.S.A.

7/91

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NUMBER VGN 220
May 17, 1991
TS-1

KENNECOTT EXPLORATION
Attn: Mr. Linus Keating
1515 Minerals Square
Salt Lake City, UT 84112

REPORT OF ANALYSIS

Analysis of Drill Core Samples

	ITEM	SAMPLE NO.	FIRE AASSY Au* (ppm)	Ag* (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mn (ppm)	Mo (ppm)
	1	TS-1 45-50	.004	< .2	6.	14.	40.		< 2.
	2	TS-1 50-52	.004	< .2	26.	10.	36.		< 2.
	3	TS-1 52-55	.002	< .2	12.	16.	65.		< 2.
A	4	TS-1 85-90	< .002	< .2	8.	16.	44.		< 2.
	5	TS-1 90-95	.002	< .2	8.	14.	42.		< 2.
	6	TS-1 95-100	.002	< .2	16.	12.	38.		< 2.
	7	TS-1 100-105	.004	< .2	34.	12.	55.		< 2.
	1	TS-1 125-130	.002	.10	4.	10.	44.	510.	<2.
B	2	TS-1 130-135	< .002	.40	18.	14.	22.	2350.	2.
	3	TS-1 240-245	.002	.15	26.	18.	570.	580.	<2.
	4	TS-1 245-250	.002	.20	50.	14.	800.	840.	<2.
	5	TS-1 250-255	.002	.15	44.	16.	1000.	600.	<2.

cc: Mr. Harold Downey
1803 E. 10th Street
Tucson, AZ 85719

REGISTERED ASSAYER
CERTIFICATE NO
9425
WILLIAM L
LEHMBECK
ARIZONA

5/17/91

Charles E. Thompson
Arizona Registered Assayer No. 8627

William L. Lehmbeck

James A. Martin

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NUMBER VGN 221
May 20, 1991
TS-1

KENNECOTT EXPLORATION
Attn: Mr. Linus Keating
1515 Minerals Square
Salt Lake City, UT 84112

REPORT OF ANALYSIS

Analysis of Drill Cutting Samples

ITEM	SAMPLE NO.	FIRE ASSAY Au* (ppm)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mn (ppm)	Mo (ppm)
1	TS-1 255-257.5	.008	.20	55.	20.	650.	3350.	<2.
2	TS-1 257.5-260	.006	.80	46.	34.	800.	3400.	<2.
3	TS-1 260-262.5	.004	.40	14.	34.	335.	830.	<2.
4	TS-1 262.5-265	.016	2.40	44.	165.	1100.	11000.	<2.
5	TS-1 265-267.5	.070	26.00	190.	1150.	2150.	56500.	100.
(1)								
6	TS-1 267.5-270	.036	22.00	140.	600.	1700.	32500.	80.
7	TS-1 270-272.5	.022	4.40	28.	155.	1100.	18500.	12.
8	TS-1 272.5-275	.020	.80	14.	180.	440.	6050.	6.
9	TS-1 275-277.5	.018	.80	12.	55.	255.	3700.	<2.
10	TS-1 277.5-280	.022	.60	12.	16.	275.	2600.	<2.
11	TS-1 280-285	.066	.60	10.	18.	290.	4250.	<2.
1	TS-1 285-290	.018	1.10	14.	50.	265.	4750.	<2.
(2) 2	TS-1 290-295	.016	1.00	14.	48.	290.	3700.	<2.
3	TS-1 295-300	.028	.90	18.	32.	405.	9200.	<2.
4	TS-1 300-305	.008	6.30	8.	95.	650.	4150.	2.

cc: Mr. Harold Downey
1803 E. 10th Street
Tucson, AZ 85719

CERTIFICATE 9425 WILLIAM L. LEHMBECK 5/20/91

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NUMBER VGN 223
May 23, 1991
TS-1

KENNECOTT EXPLORATION
Attn: Mr. Linus Keating
1515 Minerals Square
Salt Lake City, UT 84112

REPORT OF ANALYSIS

Analysis of Drill Cutting Samples

ITEM	SAMPLE NO.	FIRE ASSAY Au* (ppm)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mn (ppm)	Mo (ppm)
1	TS-1 305-310	.010	6.50	12.	110.	780.	8250.	<2.
2	TS-1 310-315	.014	5.50	10.	80.	570.	11500.	<2.
3	TS-1 315-320	.020	7.70	18.	100.	790.	8950.	<2.
4	TS-1 320-325	.022	3.20	14.	60.	210.	4000.	<2.
5	TS-1 325-330	.022	15.00	60.	340.	510.	5550.	16.
3 6	TS-1 330-335	.026	12.00	80.	430.	610.	7800.	22.
7	TS-1 335-340	.034	8.20	55.	405.	200.	5550.	4.
8	TS-1 340-345	.012	23.00	50.	220.	600.	13500.	4.
9	TS-1 345-350	.044	12.00	60.	255.	540.	11000.	2.
10	TS-1 350-355	.010	6.90	32.	580.	440.	6250.	2.
11	TS-1 355-359	.006	1.50	16.	280.	180.	280.	<2.
12	TS-1 359-361.5	.006	33.00	38.	400.	770.	28500.	14.
13	TS-1 361.5-365	.006	5.70	38.	230.	280.	4400.	8.
14	TS-1 365-370	.028	3.70	28.	85.	200.	660.	<2.
15	TS-1 370-375	.026	3.10	40.	90.	220.	290.	<2.
16	TS-1 375-380	.008	2.60	60.	24.	265.	200.	<2.

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NUMBER VGN 222
May 20, 1991
TS-1

KENNECOTT EXPLORATION
Attn: Mr. Linus Keating
1515 Minerals Square
Salt Lake City, UT 84112

REPORT OF ANALYSIS

Analysis of Drill Core Samples

ITEM	SAMPLE NO.	FIRE ASSAY Au* (ppm)	Ag* (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mn (ppm)	Mo (ppm)
5	TS-1 380-385	.008	4.50	30.	110.	130.	470.	<2.
6	TS-1 385-390	.012	29.00	50.	730.	85.	3000.	4.
12	TS-1 390-395	.008	430.00	820.	4200.	1250.	45000.	4.
13	TS-1 395-400	.030	210.00	1300.	21500.** 2.70%	920.	53000.	14.
7	TS-1 400-405	.022	21.00	155.	1900.	210.	380.	145.
8	TS-1 405-410	.110	75.00	170.	2800.	165.	1200.	24.
9	TS-1 410-415	.090	165.00	1250.	21500.** 2.39%	760.	41500.	185.
10	TS-1 415-420	.010	7.20	75.	960.	180.	1500.	120.

*NOTE: Method of analysis by combination

*NOTE: Method of analysis by combination fire assay and atomic absorption.

**NOTE: Quantitative analysis to follow.

cc: Mr. Harold Downey
1803 E. 10th Street
Tucson, AZ 85719

5/20/91

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NUMBER VGN 221
May 20, 1991
TS-1

KENNECOTT EXPLORATION
Attn: Mr. Linus Keating
1515 Minerals Square
Salt Lake City, UT 84112

REPORT OF ANALYSIS

Analysis of Drill Cutting Samples

	ITEM	SAMPLE NO.	FIRE ASSAY Au* (ppm)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mn (ppm)	Mo (ppm)
	17	TS-1 420-425	.006	17.00	44.	485.	75.	350.	28.
	18	TS-1 425-430	.008	15.00	70.	255.	305.	1550.	65.
	19	TS-1 430-435	.006	6.40	70.	16.	475.	3400.	<2.
(7)	20	TS-1 435-440	.006	14.00	42.	220.	435.	7550.	175.
	21	TS-1 440-445	.006	14.00	70.	65.	620.	5250.	12.
	22	TS-1 445-450	.014	22.00	85.	150.	860.	9650.	28.
	1	TS-1 450-455	.002	3.00	70.	36.	1250.	1400.	<2.
	2	TS-1 455-460	< .002	2.00	28.	26.	780.	2900.	<2.
(8)	3	TS-1 460-465	< .002	1.60	28.	16.	330.	990.	<2.
	4	TS-1 465-470	.002	.80	24.	16.	340.	800.	<2.
	5	TS-1 470-475	.004	4.40	12.	28.	380.	1300.	<2.
	6	TS-1 475-480	.006	.60	< 2.	20.	135.	660.	<2.
	7	TS-1 480-485	.006	1.20	12.	38.	1050.	3300.	<2.
	8	TS-1 485-490	.004	1.40	8.	16.	410.	1100.	<2.
	1	TS-1 490-495	.004	.3	16.	16.	130.	690.	<2.
(9)	2	TS-1 495-500	.030	1.2	12.	14.	32.	520.	<2.
	3	TS-1 500-505	< .002	.1	4.	12.	20.	490.	<2.
	4	TS-1 505-510	< .002	.2	6.	10.	24.	830.	<2.
	5	TS-1 510-515	< .002	.8	4.	6.	110.	510.	<2.
	6	TS-1 515-520	.002	.4	6.	20.	380.	1050.	<2.

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NUMBER VGN 222
May 20, 1991
TS-1 285 TO 420

KENNECOTT EXPLORATION
Attn: Mr. Linus Keating
1515 Minerals Square
Salt Lake City, UT 84112

REPORT OF ANALYSIS

Analysis of 10 Drill Core Samples

ITEM	SAMPLE NO.	FIRE ASSAY Au* (ppm)	Ag* (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mn (ppm)
1	TS-1 285-290	.018	1.10	14.	50.	265.	4750.
(2) 2	TS-1 290-295	.016	1.00	14.	48.	290.	3700.
3	TS-1 295-300	.028	.90	18.	32.	405.	9200.
4	TS-1 300-305	.008	6.30	8.	95.	650.	4150.
5	TS-1 380-385	.008	4.50	30.	110.	130.	470.
(4)							
6	TS-1 385-390	.012	29.00	50.	730.	85.	3000.
7	TS-1 400-405	.022	21.00	155.	1900.	210.	380.
8	TS-1 405-410	.110	75.00	170.	2800.	165.	1200.
(6) 9	TS-1 410-415	.090	165.00	1250.	21500.**2.39%	760.	41500.
10	TS-1 415-420	.010	7.20	75.	960.	180.	1500.

*NOTE: Method of analysis by combination fire assay and atomic absorption.

**NOTE: Quantitative analysis to follow.

cc: Mr. Harold Downey
1803 E. 10th Street
Tucson, AZ 85719

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NUMBER VGN 222
May 20, 1991
TS-1

KENNECOTT EXPLORATION
Attn: Mr. Linus Keating
1515 Minerals Square
Salt Lake City, UT 84112

REPORT OF ANALYSIS

Analysis of '' Drill Core Samples

ITEM	SAMPLE NO.	FIRE ASSAY Au* (ppm)	Ag* (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mn (ppm)	Mo (ppm)
6	TS-1 520-525	.006	.70	14.	530.	205.	1100.	8.
7	TS-1 525-530	.006	.40	12.	305.	95.	930.	10.
8	TS-1 530-535	.002	1.40	14.	115.	26.	470.	10.
9	TS-1 535-540	.004	.20	6.	180.	20.	950.	8.
(10) 10	TS-1 540-545	.012	.85	6.	450.	185.	6250.	6.
11	TS-1 545-550	.006	.25	8.	630.	75.	2800.	8.
12	TS-1 550-555	< .002	.30	10.	165.	22.	990.	6.
13	TS-1 555-560	< .002	.15	8.	60.	24.	570.	<2.
14	TS-1 560-565	.002	.05	10.	70.	28.	480.	2.
15	TS-1 565-570	.012	2.20	20.	510.	285.	5700.	8.
16	TS-1 570-575	.008	1.00	12.	520.	270.	4100.	4.
(11) 17	TS-1 575-580	< .002	.15	12.	105.	10.	1000.	4.
18	TS-1 580-585	< .002	.25	6.	75.	14.	970.	4.
19	TS-1 585-590	.004	.30	6.	145.	60.	4400.	6.
20	TS-1 590-595	< .002	.25	6.	70.	18.	830.	6.
21	TS-1 595-598 TD.	.002	.20	10.	50.	14.	890.	4.

*NOTE: Method of analysis by combination fire assay and atomic absorption.

cc: Mr. Harold Downey
1803 E. 10th Steet
Tucson, AZ 85719

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NUMBER VGN 226
May 30, 1991
TS-1 (125 TO 598)

KENNECOTT EXPLORATION
Attn: Mr. Linus Keating
1515 Minerals Square
Salt Lake City, UT 84112

REPORT OF ANALYSIS

Analysis of 21 Drill Core Samples

ITEM	SAMPLE NO.	FIRE ASSAY Au* (ppm)	Ag (ppm)	Cu (ppm)	Zn (ppm)	Pb (ppm)	Mn (ppm)
1	TS-1 125-130	.002	.10	4.	44.	10.	510.
B 2	TS-1 130-135	< .002	.40	18.	22.	14.	2350.
3	TS-1 240-245	.002	.15	26.	570.	18.	580.
4	TS-1 245-250	.002	.20	50.	800.	14.	840.
5	TS-1 250-255	.002	.15	44.	1000.	16.	600.
6	TS-1 520-525	.006	.70	14.	530.	205.	1100.
7	TS-1 525-530	.006	.40	12.	305.	95.	930.
8	TS-1 530-535	.002	1.40	14.	115.	26.	470.
9	TS-1 535-540	.004	.20	6.	180.	20.	950.
(10) 10	TS-1 540-545	.012	.85	6.	450.	185.	6250.
11	TS-1 545-550	.006	.25	8.	630.	75.	2800.
12	TS-1 550-555	< .002	.30	10.	165.	22.	990.
13	TS-1 555-560	< .002	.15	8.	60.	24.	570.
14	TS-1 560-565	.002	.05	10.	70.	28.	480.
15	TS-1 565-570	.012	2.20	20.	510.	285.	5700.

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

STATE PROSPECTING PERMITS

#	ACRES	EXPIRATION	YEAR
08-99349	240	8/26/92	1
08-99362	222	10/28/92	1
08-96962	181	9/5/92	3

FEDERAL

TOMBSTONE SOUTH 1-10 AMC #S 260126-135

46

240 × 10 = 2400

222 × 10 = 2220

180 × 20 = 3600

8220

+10 dam 1000

9220

? State Lease — Fed land when can drill for both.

500

20

1000

H J Downey

If drilling may 5 holes x 600 - 3000'
free in between
Payment in January 10,000 - 25,000

Grand Central - Contention
State Leases
~~End Aug~~ & ~~End~~ Oct.
end of 5th year.

± June 13

FROM: W. L. KURTZ

TO: J D Bell

① Insufficient report for budget request but agree maybe we can first decide if AR will take it on.

② Therefore I need to know, before I call Rowan,

a) what is target size, grade open pittable

b) what are "other target areas"

c) what kind of "deal" are we talking about

are they on state land.

Tombstone:

Probably 1¼-1½ mill tons
with 257,000 oz Au = 0.21 oz/ton ave
31,388,000 oz Ag = 25.1 oz/ton ave
& 40 million # Pb = 1.6 % Pb ave.

Probably ½ from the Grand Central-Contention zone.
3000' long by 100-150' wide with ~~[illegible]~~ irregular zones along & across at angle to zone. (100,000 oz Au / 15 mill oz Ag)
Later: TEI 1970's open-pitted zone & produced (22,000 oz Au / 1.1 mill oz Ag) on heap leach. Surface-150' depth.

Other:
Silver Thread fold mined 600' length (say 15 × 15 ÷ 10 = 14,000 tons)
Sulphuret fold 300' long, 25-100' wide (55), 3-8' hi (6) ÷ 10 ft³ = ±60,000 tons (1904-1905, $70/ton value
1904-1905: Au $20.67 ; Ag 59.5¢
~~×20% $4.13~~ ~~×80% $6.47~~ ~~(4.6 lb oz) ≅ 1512 oz [illegible]~~
@ 20% = $14 Au @80% $56 Ag
= 0.68 oz Au = 94 oz Ag

Skip Shaft 900' long ; 10-20' wide (15) ; 20-40 hi (30) ÷ 10 ft³ = 41,000 tons
AZ Queen, 10-12' wide

See: ASARCO file Tombstone
Contention-Engine Dike-Fault-Fissure Zone, by
BJ Devere Jr. June 12, 1979.

Say 10' + 30' + 60' = 100' ore w/ 400' overburden.

100' thick x 600' wide x 1000' long ÷ 10 ft³ = 6 million tons

p39	median $ Silver	Prod	= oz	UA 143
1877-80	$ 1.17½	$ 2,318,567	=	1,973,249
1881-86	1.06½	16,877,175	=	15,847,113
1887-96	0.84	4,564,650	with	5,434,107
1897-1911	0.60	5,575,900	=	9,293,167
1912-1914	0.584	379,917	=	650,543
1915-1917	0.665	1,117,687	=	1,680,732
1918-1932	0.70	5,150,789	=	7,358,270
1933-1936	0.56	1,118,325	=	1,997,014
				44,234,195 oz
				vs 37,248,749 Table.

B&D, Jr. (29th FC, Land of Lochiel, 1978)

Approximately 1 million tons worth $39 Million

Grand Central Centennial zone 3000 ft long, irregular bodies within it. Prod ½ of total from here. Later TEI open pitted zone & produced 1.1 million oz Ag + 22 Thousand oz Au from out surface - 150'.

Silver Thread fold mined 600' ±

Sulphuret fold 300' long, 25-100' wide, 3-8' hi $70/ton (1904-05)

Ship Shaft 900' long, 10-20' wide 20-40' hi

AZ Queen, 10-12' wide

Valued on indet.
8% Ag
14% Au
5% Pb

Bureau report Nov. '82

Prod. Tables.

1874-1907 108,300 192,356 oz Au (0.32) & 24,337,159 oz Ag (40.01)

1908-1934 6,08,345 tons, 57,971 oz Au (0.10) & 6,659,692 oz Ag (10.95)

1935-36 22,212 6,375 (0.29) & 390,305 (17.57)

1,238,857 256,702 oz Au & 31,388,154 oz Ag

Base of Bisbee under shale.

10' lens ore
24' shale barren
20-40 34' Blue Lis ore
60' shale-cgl barren or weak
55-70' ~~30-40'~~ Novarulite ore

·unker Hill Mines Company shipped
ore and milled nearly 40,000 tons,
entrates, a little wulfenite concen-
and silver-manganese tails. The Sil-
and Old Guard also produced small

closed and the mines of the Bunker
'er to lessees. Most of the production
)32 was by lessees on this property.
carried on at the Ingersol, Herschel,
unset, Old Guard, and Rocky Bar
: was smelting ore. Small local mills
aterial and a little ore. The Grand
eaded by Lewis Douglas and Harry
from the old Grand Central mill in
airbank from June, 1924, to Septem-

Mine, which started production in
: of lead ore in Arizona during 1932-
operated by the American Smelting
g fifteen months in 1933-34 and sub-
ners, the Tombstone Mining Com-

of the Phelps Dodge Corporation in
taken over by the Tombstone De-
Ed. Holderness as Superintendent.
have since carried on the most ex-
ict and, to the end of 1936, produced
. early 1934 to May, 1937, the U.S.
.g Company did considerable under-
tern part of the district, on claims
evelopment Company, and shipped

has led to development in the part
l. It has also encouraged lessees to
.nps in small local mills.

.bstone district prior to 1908 is not
to estimates by John A. Church,[30]
e Tombstone Mill and Mining Com-
d of 1901 amounted to about $25,-
nd estimates compiled by J. B. Ten-
: and other sources indicate that the
)proximately $28,400,000 distributed

.ie, Arizona, Mining District" (Am. Inst.
)2), 34.

Year	Ag #/oz	Total value	≈ oz
1879-80	1.135	$ 2,318,567	2,042,790
1881	1.13	5,040,633	4,460,737
1882	1.14	5,202,876	4,563,926
1883	1.11	2,881,900	2,596,306
1884	1.11	1,380,788	1,248,953
1885	1.07	1,320,976	1,234,557
1886	0.99	1,050,000	1,060,606
1887	0.98	600,000	612,245
1888	0.94	600,000	638,298
1889	0.94	250,000	265,957
1890	1.05	600,000	571,429
1891	0.99	674,650	681,465
1892	0.87	490,000	563,218
1893	0.78	450,000	576,923
1894	0.64	300,000	468,750
1895	0.65	300,000	461,538
1896	0.68	300,000	441,176
1897-1901	0.605	1,539,610	2,544,810
1902-1906	0.588	2,550,000	4,336,735
1907	0.66	550,000	833,333
Total, 1879-1907	2,000,000 tons?	$28,400,000	30,198,752

As recorded in the *Mineral Resources of the United States*, the production from 1908-34, inclusive, was as follows:

Year	Tons	Gold (value)	Silver (ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)	Total value
1908	51,266	$ 84,866	357,414	7,608	1,770,794	173,313	$ 357,818
1909	27,123	47,119	201,700	27,706	1,535,637	713,116	260,145
1910	4,619	21,947	116,520	31,163	305,876	.....	102,285
1911	8,797	44,554	224,098	68,209	982,010	.....	216,042
1912	7,405	28,177	158,377	27,723	617,820	.....	157,956
1913	5,760	25,415	126,392	10,657	334,923	36,503	120,189
1914	6,063	28,532	108,868	14,217	234,345	39,324	101,772
1915	9,003	25,135	100,115	36,075	164,136	63,386	97,780
1916	57,200	81,654	343,453	131,546	983,983	.....	411,592
1917	57,474	69,721	444,139	229,488	1,278,754	.....	608,315
1918	19,507	28,719	283,412	41,503	457,183	.....	354,892
1919	27,445	40,220	450,366	290,182	289,424	.....	613,943
1920	28,946	36,953	456,855	144,010	243,946	.....	560,939
1921	18,594	31,141	423,688	132,688	678,946	.....	502,498
1922	44,347	48,005	613,700	196,740	744,529	.....	729,214
1923	32,770	63,924	495,943	195,485	465,914	.....	531,947
1924	15,448	50,820	247,642	72,836	465,323	.....	263,508
1925	27,760	55,328	241,381	77,340	1,527,019	32,592	369,157
1926	47,708	61,796	220,579	113,476	1,970,986	.....	373,003
1927	31,196	64,757	159,944	68,876	900,178	.....	221,179
1928	24,172	47,471	164,161	135,643	247,316	.....	177,382
1929	15,601	34,530	99,423	86,793	843,817	.....	155,959
1930	8,734	38,746	74,937	32,903	936,862	.....	118,717
1931	15,623	45,555	101,504	62,440	476,814	.....	98,315
1932	5,067	10,030	48,021	24,810	1,166,700	.....	60,136
1933	7,016	36,836	100,323	27,875	1,744,270	.....	138,261
1934	3,701	129,529	296,737	70,512	2,400,324	.....	415,627
Total	608,345	$1,281,480	6,659,692	2,358,504	23,767,829	1,058,234	$8,138,571

Subsequent production, as stated by the Tombstone Development Company and the Tombstone Mining Company, has been as follows:

Year	Tons	Gold (value)	Silver (ozs.)	Copper (lbs.)	Lead (lbs.)	Total value
1935	12,907	$120,581	243,087	103,574	2,228,288	$343,680
1936	9,305	102,234	147,218	53,962	969,017	220,757

The total production by the district to the end of 1936 is, therefore, as follows: 32,248,749

1879-1907	$28,400,000
1908-1934	8,138,571
1935-1936	564,437
Grand total	$37,103,008

MINERALOGY[31]

General statement

A detailed study of the mineralogy of the Tombstone mining district has shown a large number and wide variety of minerals. In addition to the minerals of the copper mining districts of the state, a great variety of lead, silver, and zinc minerals is found together with manganese, tellurium, molybdenum, and vanadium minerals. Some of the minerals are exceedingly rare. Tombstone is the only place in Arizona from which tellurides have been described. The contact zone formed by the intrusion of the granodiorite stock into the Paleozoic limestones is a source of rare calcium silicate minerals.

The arrangement in Dana's *System of Mineralogy* is followed in the following discussion of the minerals. An alphabetical list of the minerals is given for general reference.

Actinolite
Alabandite
Allanite (orthite)
Andesine
Andradite
Anglesite
Apatite
Argentite
Aurichalcite
Augite
Azurite
Barite
Beaverite
Bindheimite
Biotite
Bornite
Bournonite
Brochantite
Bromyrite
Calamine (hemimorphite)
Calcite
Cerargyrite
Cerussite
Chalcocite
Chalcopyrite
Chlorite
Chrysocolla
Clinozoisite
Connellite
Copper (native)
Covellite
Cuprite
Descloizite
Diopside
Embolite
Emmonsite
Epidote
Ettringite
Famatinite
Fluorite
Galena
Gold (native)
Grossularite
Gypsum

[31] Abstracted from C. A. Rasor, "Mineralogy and Petrography of the Tombstone Mining District, Arizona," unpublished doctorate thesis, University of Arizona, 1937.

Hematite
Hessite
Hessonite (?)
Hetaerolite
Hillebrandite
Hollandite group (?)
Hornblende
Hydrozincite
Iddingsite
Idocrase (vesuvianite)
Jarosite
Kaolinite
Labradorite
Limonite
Magnetite
Malachite
Manganite
Merwinite (?)
Microcline
Monticellite
Mottramite (cuprodescloizite
Muscovite
Olivine
Oligoclase
Opal
Orthoclase
Pigeonite

Native elements

Sulphur (*S*).—Resinou
yellow sphalerite, occurs
Skip shaft fissure on the

Tellurium (*Te*).—Micr
tellurium-bearing galena

Gold (*Au*).—Gold wa
Contention, Flora Morr
Tranquility mines, all sit
The Tribute and Hersch
Native gold occurs as thi
shales and dike rock and
Some of the kaolinized d
of gold on fractured sur
that it was deposited fro

Assays of hypogene su
depending on the kind of
stope close to the Arizo
gold. Galena-sphalerite
ounce. Clean galena ore
level of the Empire Mi
bournonite ore from an
Empire Mine assayed 1.5
more gold is associated
earlier. Galena probably
ence of gold tellurides v

Silver (*Ag*).—Small s
from the Empire Mine

TOMBSTONE SOUTH ACQUISITION

1. (a) WORK COMMITTMENT 1992:
H. J. DOWNEY TO GEOLOGIC MAP AREA OF CLAIMS & PERMITS @ 1" = 200'. COST: $ 3,000.00

(b) ASARCO TO DRILL ONE 500' HOLE — ~~(ON NE HIGH ANGLE STRUCTURE)~~.

2. PAYMENT SCHEDULE:

JAN 2,	1993	$ 30,000.00
"	1994	50,000.00
"	1995	100,000.00

3. PURCHASE OPTION:

ON OR BEFORE	JAN 2, 1995	$ 1,500,000.00
" " "	" " 1997	2,500,000.00
" " "	" " 2000	5,000,000.00

4. MAINTAIN STATE & FEDERAL WORK REQUIREMENTS AND/OR RENTAL PAYMENTS

5. ½ MILE BOUNDARY AGREEMENT

6. DATA TURNOVER AT TERMINATION
(CORE, CUTTINGS, REJECTS, PULPS, COPIES OF ASSAYS, GEOLOGICAL, GEOCHEMICAL, GEOPHYSICAL DATA).

7. 90 DAY PRIOR NOTICE OF TERMINATION AFTER JAN 2, 1993.