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Paul Ellerman

SXM

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File

RECEIVED

Quantex CORPORATION

2330 SOUTH MAIN, SUITE 9
SALT LAKE CITY, UTAH 84115
TELEPHONE 801 - 467-4516

Howard Lowell

February 8, 1972

Jerome M. Willis, Director
Natural Resources Division
Essex International, Inc.
1601 Wall Street
Fort Wayne, Indiana 46804

Dear Mr. Willis:

Enclosed is a geologic report and possible economic projection for the Silver Star property in Elko County, Nevada. The economic projection assumes that succeeding phases of exploration and development will be successful, an assumption that obviously entails a large amount of risk.

Quantex Corporation is a public company organized in February, 1970. The Company does not have adequate financial resources to place at risk to proceed with exploration and development of the property at this time because we have a large portfolio of oil and gas leases and applications in central Utah.

Quantex has expended $30,000.00 in initial exploration on the property and now seeks the participation of well financed companies, or individuals requiring an attractive tax shelter to complete additional exploration. A second and third stage of exploration is necessary to establish a proven orebody. The second stage is estimated to cost $110,000.00 and will consist principally of drilling plus preliminary metallurgical testing, some additional geologic and geophysical examination and surface trenching. The third stage is estimated to cost $267,000.00 and will consist mainly of underground exploration and drilling. Stage three is contingent upon successful results of stage two.

We believe the Silver Star property is promising. Please advise me if you are interested. The diamond drill cores are available for inspection at our office in Salt Lake City.

Very truly yours,

Allen O. Taylor

Allen O. Taylor
Vice President, Quantex Corporation

AOT:mk
encl.

PAYOUT STUDY

ON THE QUANTEX

SILVER STAR PROPERTY

ELKO COUNTY, NEVADA

Assume: 10 year mining - 1,430,000 tons, average, 20 oz. ton.
500 TPD mill for 300 days a year
Assume $2.00 per oz. silver during life of operation
Recovery @ mine 90%, @ mill 95% = 17 oz. ton = $34.00 ton

Tons produced	$ 1,430,000			
Sales value	48,620,000			
Less royalty	2,280,000			
Gross income		$46,340,000		
Mining and milling expense @ $15.00 =		$21,450,000		
Taxes, advelorem, general		100,000		
Direct cost			$21,550,000	
Net before taxes				$24,790,000
Tax deductions				
Depreciation		$ 2,665,000		
Intangible development		135,000		
Depletion		10,200,000		
Freight to smelter?		(2,800,000)		
		$10,200,000		
Taxable income				$14,590,000
Federal income tax @ 48%			$7,003,000	
State income tax ?			407,000	
Income taxes			$7,410,000	
Net after taxes				$17,787,000

Capital . . . $2,665,000 Net cash flow . . . $15,120,000

Average cash flow . . . $1,512,000 A.A.R.R. $\frac{\$1,512,000}{\$2,665,000}$ = 56.7

Payout period 120/15,122,000 = 12.6/2,665,000 = 21 months

Number of times expenditure returned = 5.67

DONALD C. LAUB

Donald C. Laub, 47, received a B.S. degree in geology from the Utah State University and a M.S. degree in mineralogy from the University of Utah. Mr. Laub has 18 years of experience as an exploration geologist and has participated in several significant mineral discoveries--including uranium in New Mexico and Idaho. His experience includes 2½ years in the Mineral Deposits Branch of the U. S. Geological Survey as a field geologist; 14 years with the Minerals Division of Phillips Petroleum Company as a Senior Geologist, District Geologist, and as Assistant Director of Field Operations. He has spent the last year as the Manager of the Minerals Section of Westland Minerals Corporation.

ALLEN O. TAYLOR

Allen O. Taylor, 45, graduated from the University of Utah in 1949 with a B.S. degree in geology. After one year of service with the U. S. AEC as a geologist and project supervisor he returned to the University for two years of graduate work. Since that time, Mr. Taylor has worked as a geologist with the Mineral Deposits Branch of the U. S. Geological Survey; Senior Geologist with Phillips Petroleum Company; geologist for Brush Beryllium Company and Federal Resources Corp. In addition to his broad background in exploration, Mr. Taylor served as General Manager for American Mining Company and was responsible for the operation of a 500 ton per day open pit copper mine and flotation concentrator. Additional management experience was acquired while serving as President and Director of Westland Minerals Corp., a broad-based natural resource company with numerous mining properties and extensive oil and gas holdings, including production in eastern Ohio.

GEORGE K. BRASHER

George K. Brasher, 43, received B.S. and M.S. degrees in geology from the University of Michigan and attended graduate school at the University of Utah for an additional year. Mr. Brasher has 20 years experience as an exploration geologist primarily in the minerals industry; however, five years of this time was spent in petroleum geology doing surface mapping in Alaska, subsurface studies in Colorado, Wyoming and west Texas, and working as part of a Special Projects Group on hydrodynamic studies. His experience includes 2½ years with the Mineral Deposits Branch of the U. S. Geological Survey on the Colorado Plateau Project; 16 years with Phillips Petroleum Company in the Exploration Projects Group, Strategic Minerals Section, Special Projects Group and the Minerals Division in staff and supervisory positions; and, six months with Westland Minerals Corp.

MILAN S. PAPULAK

Milan S. Papulak, 37, received a B.S. degree in geology from the College of the City of New York in 1954. Mr. Papulak has 16 years of varied experience in mineral and oil and gas exploration, management and investment. He spent five years as a geologic engineer with the Salt Lake Exploration Branch of the U. S. AEC, covering all phases of uranium exploration and development throughout most of the Western United States. The subsequent three years were spent as the Managing Editor of the Petrogram, an oil and gas publication which covered exploration highlights in the Rocky Mountain area. During the next seven years, he served as Manager of the Geology and Land Department of Petroleum Investment, an independent firm dealing in oil and gas property evaluation and investments in the Rockies. During the last year Mr. Papulak was employed as Manager of the Oil and Gas Section of Westland Minerals Corp.

QUANTEX CORPORATION

GEOLOGY AND PRELIMINARY EXPLORATION RESULTS

SILVER STAR PROPERTY

ELKO COUNTY, NEVADA

By

A. O. Taylor

D. C. Laub

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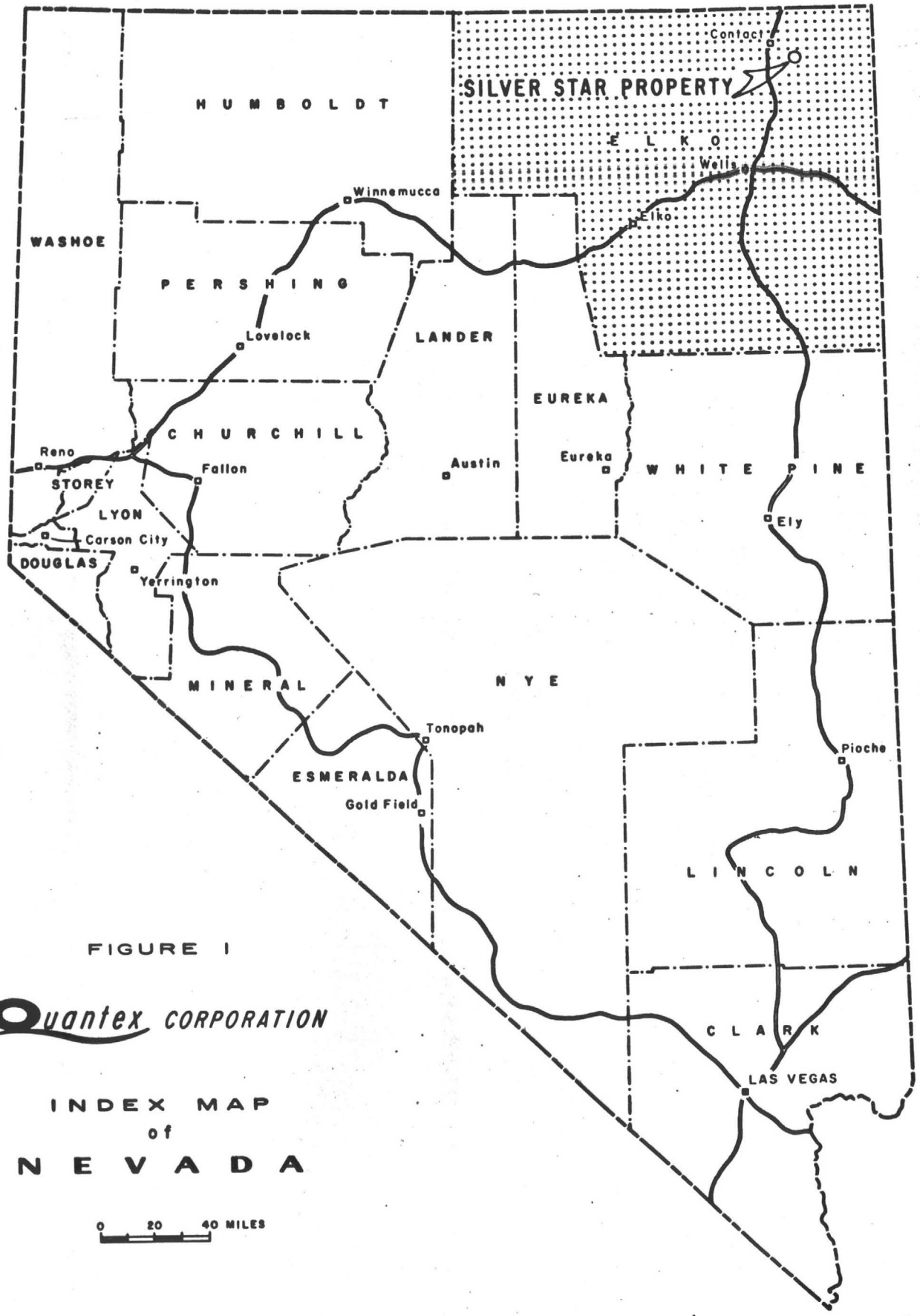

FIGURE I

Quantex CORPORATION

INDEX MAP
of
NEVADA

QUANTEX CORPORATION

GEOLOGY AND PRELIMINARY EXPLORATION RESULTS

SILVER STAR PROPERTY

ELKO COUNTY, NEVADA

Introduction

Silver mineralization has been known at the Silver Star property since 1885 when it was known as the Kratz Mine and later as the Silver King Mine, Schrader 1934. Although the mineralized structure extends over a strike length exceeding 4,000 feet with widths ranging from 15 to 35 feet at surface exposures, past exploration attempts have not explored the vein beyond a depth of 50 to 100 feet.

Quantex Corporation acquired a lease on the property in June, 1971 and completed an initial rotary and diamond drilling program during the summer and fall months, the results of which are reported herein.

Location and Accessibility

The Silver Star property consists of 96 unpatented mining claims including one unpatented mill site claim, figure 2. The claims are in Townships 43 and 44 North, Range 65 East, MDB & M, Kit Carson Mining District, Elko County, Nevada, figure 1.

The property can be reached via about 9 miles of county road and two miles of unimproved road by traveling east from U. S. Highway 93 at a point 39 miles north of Wells, Nevada, the nearest town. U. S. Highway 93 is paralleled by the railroad and electric power transmission lines. Salt Lake City, Utah is the nearest regional supply point for mining equipment and supplies.

The claims are on a northwest facing slope in the north central part of the HD Range at elevations of 7,500 to 8,500 feet.

Topography and Climate

The HD Range is made up of moderate to steep slopes and drainages breaking off from a north-northeasterly trending undulating ridge that forms the backbone of the range. The range is virtually treeless and vegetation consists of annual and perennial grasses, shrubs and alpine flowers. The area probably receives 15 to 20 inches of moisture annually. No unusual difficulties are expected in obtaining water supplies for mining and milling purposes. Year-around mining operations can be undertaken with no particular problem other than labor and the necessity of plowing drift snow from access roads from time to time in the winter months.

Ownership

The Silver Star and other claims (figure 2) are held by location by George and John Detweiler, Jule Larios, et al. of Twin Falls, Idaho. The Elko County records reflect filing of annual assessment work affidavits starting in 1963 and continuing through 1971. Annual assessment work for the year ending September 1, 1972 has been completed. Field inspection shows that the claims are well monumented with round 5 to 6 inch posts. No adverse or conflicting locations have been found.

Quantex Corporation acquired a 20 year mining lease on the Silver Star property in June of 1971. The lease terms require payment of $25,000.00 per year as minimum advance royalty beginning in December, 1972 or payment of 5% of net smelter returns, whichever is greater.

Master title plats of the Bureau of Land Management (figure 2) show State school selection lands belonging to the Salmon River Cattlemens Association. At this time it is not clear whether the SS land selections conveyed both surface and minerals. In any event, none of the lands in question are in conflict with the known or reasonably projectable extent of the Silver Star mineralized structure. A title company has been employed to examine the granting clauses of the SS selection lands.

History and Production

The mineralized structure on the Silver Star property extends over a known length of more than 4,000 feet and has been known since 1885, Schrader, 1934. Past operators are believed to have shipped small amounts of high grade ore from shallow surface shafts and drifts where erosion happened to expose mineralized croppings. The only known recorded production was in 1965 by affiliates of present owners. Three cars of ore totaling 163 tons were shipped from an open cut working above the intercepts of DDH QS-1 and QS-2, Plate 1. Two cars of mine run ore (90 tons) averaged 4 ounces silver, 4% lead and trace gold and copper with a total of less than 1% arsenic and antimony. The third car (sorted, 73 tons) assayed 0.11 ounces gold, 9.6 ounces silver, 11.6% lead and trace copper. All of the ore shipped was oxidized and contained some zinc, antimony and manganese as well as a high insoluble content and iron.

Examination of the available surface exposures in the open cut indicate that the principal oxide lead mineral is pyromorphite with lesser amounts of cerussite and anglesite. Copper is sparingly present as azurite. Silver minerals present may be argentojarosite, cerargyrite and other indefinite oxide minerals such as silver bearing manganese oxides. The residual stockpile from car number

three contained essentially the same amount of silver and lead and much higher copper, suggesting the difficulty of sorting ores mined from the oxide zone.

The net result of past exploration efforts is that less than 5% of the volumetric possible content of the Silver Star mineralized structure was explored within a vertical range of 400 feet and, in fact, all of the effort was devoted to surficial openings less than 100 feet in depth.

Geology

The HD Range, in its northern portion, is composed of a sequence of Paleozoic eugeosynclinal formations deposited more or less near the axis of the Cordilleran geosyncline. The formations were apparently first mobilized and moved in an allochthonous sequence to the east and southeast in late Devonian or Mississippian time over predominantly carbonate rocks of shelf and near shore facies. Toward the south end of the HD Range, rocks that have been assigned to the Chainman shale of Mississippian age probably belong to the autochthonous shelf sequence, Riva, 1970. North and west of the HD Range a series of formations of Permian age have also been assigned to the autochthon by Riva.

In middle Jurassic time the Contact pluton, which is of batholithic dimensions, invaded rocks of the autochthon and perhaps the allochthon on an east-west axis and produced deposits of copper, silver and gold in fissure veins within the intrusion and in contact metamorphosed rocks around its perimeter, Schrader, 1914, 1934. The pluton has been assigned an age of 150-160 million years by potassium-argon and lead-alpha methods by Coats and others, 1965, both results indicating a middle Jurassic age. The Contact

pluton's nearest exposed contact to the Silver Star structure is about 3 miles to the north.

Riva suggests that all of the already allochthonous rocks in the HD Range were moved southeastward in early Mesozoic time and then moved into their present position during a later and unrelated tectonic episode.

Following the periods of intricate thrust faulting and folding the rocks of the HD Range were folded into a broad northerly plunging anticline trending about N 20 E. Cross faults striking NE and NW appear to have been formed during this period of folding. The Silver Star structure is a prominent representative of NE cross faulting. The age of this period of folding appears to be Tertiary because basal members of the Humboldt formation have been involved in folding with the Paleozoic rocks of the HD Range and have finally been block faulted against Paleozoic rocks by normal faults of basin - range character. In addition, two inconclusive exposures suggest that rocks of Paleozoic age may have been involved in thrust faulting over basal members of the Humboldt formation indicating a Tertiary period of compression, folding and faulting.

For the foregoing reasons the age of silver and base metal mineralization in the Silver Star structure is assigned to the Tertiary.

The Paleozoic rocks in the immediate vicinity of the Silver Star structure are composed of carbonaceous cherts, shales, quartzites, siltstones, sandstones and a few thin, discontinuous beds of dolomitic limestone of Ordovician and Silurian age. From oldest to youngest the formations are the Ordovician Valder and Agort formations and the Silurian Noh formation, plate 1.

The Valder formation contains discontinuous interbeds of altered volcanic rocks composed of siliceous flows and tuffs. All of the Ordovician and Silurian rocks contain disseminated pyrite and pyrite associated with tiny veinlets of quartz and ankerite. The reader is referred to Riva, 1970 for a description of the stratigraphy and age assignments of the Paleozoic rocks in the HD Range.

Silver Star Fault Structure

The Silver Star fault structure strikes N 45° to 55° E and dips 70° to 80° northwest within a vertical range of about 300 feet. Where well exposed by past mining operations, the fault zone consists of many strands that cross back and forth from hanging to footwall in braided fashion both in plan and cross section. The width of the fault zone generally varies from 20 to 30 feet but may reach dimensions as large as 65 feet. On the hanging wall in areas of good exposure, cymoid veins curve off from the Silver Star structure in a north to northwesterly direction and dip about 45° northeast. The cymoid veins are well mineralized and contain significantly larger amounts of lead than the Silver Star structure. There is a strong possibility that the cymoid veins rejoin an unexposed and parallel structure still further northwest of the hanging wall of the Silver Star fault zone. Such a structure has never been exposed by surface operations but there is some suggestion of its presence in a few places by mineralized float fragments of quartz and igneous rock.

The Silver Star fault zone is well exposed in only three places: 1. In the open cut near drill holes QS-1 and QS-2. 2. In surface cuts and a short adit near drill hole QS-3. 3. In a bulldozer cut near line 64 south. The Silver Star structure can be traced northeasterly to a saddle on line 17 south where it is present as a few thin strands of poorly mineralized quartz

and sheared argillite. In between exposures, two old partly caved bulldozer cuts and two electromagnetic crossovers serve to establish the continuity of the Silver Star structure over a length of about 4,700 feet.

The continuity of silver and base metal mineralization within the fault zone is known only in the vicinity of the drill holes and surface cuts. Except in the open cut over drill holes QS-1 and 2, samples taken by others at the surface and in one now inaccessible short adit, range from 1 to 4 ounces silver per ton and minor amounts of lead, zinc, copper, antimony and arsenic. The southwestern 400 feet of the open cut is largely filled but the cars shipped came mainly from this area. A sample taken from the northeast end of the open cut across 22 feet contained 14.5 ounces silver per ton, 22.9% lead and 0.18% copper. The ore minerals in surface exposures are all oxidized except for trace amounts of chalcocite and tetrahedrite and consist of pyromorphite, cerussite, anglesite, azurite and unidentified arsenates and antimonates. Gangue minerals are quartz, pyrite, small amounts of ankerite and rhodochrosite and oxides of iron and manganese.

The sequence of mineralization appears to have been as follows: 1. Early faulting followed by intrusion of acidic igneous dikes (Ta) and deposition of quartz and pyrite. 2. Further faulting and shattering of early quartz followed by deposition of quartz-ankerite veinlets with sulphides of lead, zinc and silver (?) and sulphosalts of lead, antimony, arsenic, copper and silver, and perhaps, native silver. 3. Further faulting and shattering followed by oxidation, leaching and redeposition of native silver, pyrargyrite (?) argentite (?) chalcocite and other unidentified minerals.

Native silver is present in drill holes QS-1, 2 and 3 as small rosettes, wires and plates on fractures and in vugs within approximately 100 feet of the surface in intensely shattered and highly carbonaceous shale, chert and argillite of the Agort formation. It is clear that the silver has been leached and reprecipitated downdip of the Silver Star fault zone. Lead also appears to have been leached and moved to some extent as indicated by the presence of doubly terminated pyromorphite crystals in fractures in drill hole QS-1.

Recent Exploration

Larios and Detweiler: Drill Hole EM-1 - Total depth 627' - BX Core-recovery 75% avg.

In 1968 the owners of the Silver Star property, Jule Larios and the Detweilers drilled an inclined diamond drill hole EM-1 (figure 4) hoping to intersect the Silver Star vein at depth. The hole was bottomed at 627 feet in pyritic shales of the Agort formation with no indication of vein material in the core. Consequently, Mr. Sidney S. Alderman of Agricultural and Minerals Inc. was hired to log the core and take a dip survey of the hole. The dip survey indicated the hole started out at -59° and at 400 feet had deviated to -72°. Mr. Alderman's conclusions were "the absence of any mineralized vein material in the drill core under a surface exposure 15 feet wide, and the lack of a significant change in wall rock to explain a sudden degeneration of the structure leads to two possibilities: 1. The vein, at the drill hole intercept has degenerated into a zone of unmineralized gouge which was not recovered in the drill core. 2. The vein is vertical as the dip changes to the southeast at depth, causing the drill hole to miss the structure." Alderman favors the

second interpretation. The first interpretation seems erroneous because Drill Holes QS-1 and QS-2 located 150 feet north and 150 feet south, respectively, of EM-1 encountered ore grade material at depth.

We too favor the second possibility with the addition, that the hole deviated to the northeast parallel to the strike, and this along with additional steepening of dip of the hole resulted in bottoming the hole in the hanging wall of the structure.

Norandex:

On November 1, 1970 the Silver Star property was optioned by Norandex Inc. During the winter months from November to late February a survey grid, a J.E.M. survey, several magnetometer traverses, soil and rock chip geochemistry, trenching and geology were completed by Norandex.

J.E.M. survey:

Preliminary J.E.M. work on the Silver Star property was undertaken by Norandex in August 1970. Four lines approximately perpendicular to the strike of the vein were run. Over the exposed vein slight response was obtained, but immediately to the west, a substantial negative anomaly was encountered (see plate II). The 1:1 ratio of Hi and Lo readings indicated the possibility of a buried zone of massive sulfides.

Consequently, a grid was laid out and nine miles of J.E.M. work was run to better define the anomaly. The anomaly was traced over a length of 8,000 feet but was offset to the east, immediately south of line 48S (plate II).

From dozer cuts and exposures in number three adit, Norandex determined the anomaly was caused by graphitic zones in the Agort formation.

Small amounts of crystalline magnetite were found in the ore stockpile from the pit on the Silver Star No. 1 claim. Consequently, Norandex, using a McPhar M-700 fluxgate magnetometer, ran eight lines over both their J.E.M. anomaly and the known mineralization. Total range of values over the property was less than 250 gammas, with no response over the J.E.M. anomaly or over known mineralization.

Geochemistry:

Eight separate geochemical samples were taken. All samples from each soil profile in the hole were analyzed for trace amounts of silver, copper, lead and zinc. These results suggest that residual soil at the Silver Star is of the thin semi-arid mountain type and is made almost entirely of fragmentally weathered outcrop.

The geochemical samples taken where the vein crops out were anomalous for all values. Extreme variation in soil thickness and frozen ground prevented the use of further soil geochemistry.

The results of Norandex geophysical and geochemical work was inconclusive and neither the geophysical anomalies or the Silver Star vein were drilled. In May 1971, Norandex dropped their option. Shortly thereafter, Quantex Corporation took a mining lease on the property to further explore these possibilities.

Quantex:

Rotary drilling:

In July both rotary and core drilling began on the property. Rotary drilling consisted of 3,100 feet. R.D.H. nos. 4, 5, 6, 7 and 9 were drilled primarily to check our EM 16, and Norandex J.E.M. geophysical anomalies west and northwest of the Silver Star vein (plate I and II). The results of this

drilling indicated the anomalous zones were probably caused by disseminated pyrite in the black shales of the Agort formation. Drill hole R.D.H.-4 with a total depth of 705 feet is the deepest rotary hole on the property.

Rotary drill holes no. 8 and 10 were drilled on the northeast extension of the Silver Star vein where quartz float was exposed in the saddle near line 20S. These holes cut vein material at depth; however, no samples were taken for assay.

Core Drilling:

In late June of 1971 three inclined diamond drill hole stations were located along the Silver Star vein. Drill holes QS-1 and 2 were located to intersect the Silver Star vein at moderate depths below the main pit from which 163 tons of ore were shipped in 1965 (plate I).

Drill Hole Q-3, located 2100 feet south of Q-2, was planned to explore the Silver Star vein beneath the mineralized outcrop near the discovery post of the Silver Star No. 3 claim.

The core drilling contract was let to Sprague and Henwood Drilling Company and core drilling began on July 29, 1971 and was completed on October 22, 1971. During this period approximately 900 feet of core drilling was completed using a skid mounted rig with NX wire line core barrel and rods.

Results: The assay results of the core drilling are listed below.

DDH QS-1 (see figure 3)

Interval Assayed (ft.)	Thickness (feet)	% Recovery	Au (oz.)	Ag (oz.)	Pb %	Cu %	Zn %
26-36	10	13	0.02	36.0	2.0	0.138	
36-44	8	10		2.28	none		
44-53.5	9.5	85		15.48	none		
101-104	3	70	Tr.	112.7	0.7		
104-114	10	30	Tr.	24.0	0.4		
114-118	4	50	Tr.	39.4	0.7		
118-125	7	70	Tr.	25.0	0.8		
125-159	34	45	Tr.	12.0	0.4	0.012	
159-180	21	45	0.010	33.8	1.4	0.025	

DDH QS-1 deviated and was cemented back to 114 feet and re-drilled.

The results listed below are from the QS-1 called QS-1A to total depth and is included in the average width and thickness of hole QS-1.

DDH QS-1A

Interval Assayed (feet)	Thickness (feet)	% Recovery	Au (oz.)	Ag (oz.)	Pb %	Cu %	Zn %
114-123	9	not available	None	9.4	0.6	None	
123-132	9	--	Tr.	6.2	0.6	None	
132-155	23	--	Tr.	2.8	0.6	0.012	
155-161	6	--	Tr.	15.0	0.6	None	
161-174	13		Tr.	21.3	1.1	0.025	
174-180	6		Tr.	11.9	0.6	0.025	
180-184	4	75	Tr.	0.4	0.05	None	
184-188.5	4.5	100	Tr.	0.4	Tr.		None
188.5-190.5	2.0	100	Tr.	7.4	None		None
190.5-194.5	4.0	100	Tr.	0.3	None		None
194.5-199	4.5	100	Tr.	4.2	None		0.05
199-203	4.0	100	Tr.	19.8	0.8	None	None
203-206	3.0	100	Tr.	11.2	None		0.05
206-210	4.0	100		.10	None		
210-214	4.0	100		.08	None		

Average grade of hole QS-1 from 101 to 180 = 79 feet of 25.5 oz. Ag. Average grade hole QS-1A from 114' to 180' = 66 feet of 9.7 oz. Ag. Average grade of hole QS-1 and 1A is 72.5 feet of 18.4 oz Ag giving a true thickness of 60 feet.

DDH QS-2, 300 feet south of QS-1 (figure 5).

Interval Assayed (feet)	Thickness (feet)	% Recovery	Au (oz.)	Ag (oz.)	Pb %	Cu %	Zn %
105-115	10	not available	--	1.34	0.50	None	
225-238	13	95%	--	18.78	0.50	0.006	
238-244	6	100%	Tr.	34.50	2.0	0.025	
244-248	4	100%	0.30	25.30	4.60		4.1
248-252	4	98%	Tr.	18.0	0.70		
252-254	2	100%	--	5.48	0.50	None	

Average grade of hole QS-2 from 225' - 252' = 27 feet of 23.5 oz. Ag resulting in a true thickness of 20 feet.

DDH QS-3, located 2100 feet south of QS-2 (see figure 6).

Interval Assayed (feet)	Thickness (feet)	% Recovery	Au (oz.)	Ag (oz.)	Pb %	Cu %	Zn %
50- 60	10	not available	0.44	0.44	Tr.		Tr.
60- 79	19	"		0.04	None		None
79-106	27	"		0.06	"		"
106-119	13	"		0.04	"		Tr.
119-127	8	"		0.04	"		None
127-160	33	"		0.02	"		"
160-204	44	"		0.02	"		"
204-220	16	"		0.02	"		"
220-227	7	"		0.08	"		0.2
227-231	4	75	Tr.	30.40	"	None	0.3
231-237	6	80		23.72	"		None
237-242	5	50		30.50	"	0.025	"
242-247	5	100		8.10	"	0.006	"
247-250	3	100		35.88	"	0.012	"
250-258	8	70		20.32	"	0.006	"
258-263	5	90		18.76	"	None	"
263-271	8	85		9.80	Tr.	0.044	0.8
271-280	9	100		4.52	0.30	0.018	0.1
280-289	9	not available		8.14	None	0.012	0.3
289-300	11	"		0.22	None	0.006	None

Average grade of hole from 227' - 263' = 36 feet of 22.8 oz. Ag or 227-289 = 62 feet of 16.3 oz. Ag resulting in a true thickness of 27 feet and 50 feet respectively.

Ore Reserves

Ore reserves were calculated in the area of drill holes QS-1 and QS-2 and Cerro Corporation's surface sample no. 154 which assayed 22 feet of 14.5 oz. Ag and 22.9% Pb.

For measured ore the triangular method using the formula

$$\frac{1}{2} \frac{B \times H}{} = \text{Area} \qquad \frac{\text{Area} \times \text{average thickness}}{13.5 \text{ cu. ft./ton}} = \text{Tons}$$

was used.

Measured:

The factor 13.5 is a constant, representing the number of cubic feet of rock per short ton.

QS-1 - 60 feet of 18.4 oz. Ag Ton
QS-2 - 20 feet of 23.5 oz. Ag Ton

#154 22 feet of 14.5 oz. Ag Ton
Average thickness and grade 34 feet of 18.5 oz. Ag.

$$\frac{105' \times 310 \times 34}{13.5} = 82{,}000 \text{ tons measured ore}$$

This block is classed as measured reserves since the ore has been sampled on at least three sides.

Indicated:

Assuming the average grade and thickness extends 150 feet north and south of QS-1 and QS-2 and an additional 150 of depth, thence

$$\frac{600' \times 400' \times 34'}{13.5 \text{ cu. ft. Ton}} = 600{,}000 \text{ tons} - 82{,}000 \text{ tons} = 518{,}000 \text{ tons of } 18.5 \text{ oz. Ag}$$

Inferred:

The inferred reserves are based on several assumptions:

1. That the 2100 feet of strike length between hole Q-2 and Q-3 contains an average vein width of 23.5 feet. 2. That the Silver Star vein is mineralized to a depth of 275 feet. 3. That the grade of ore will average 18.5 oz. Ag per ton. Thence

$$\frac{2100 \times 275 \times 23.5}{13.5} = 1{,}005{,}000 \text{ tons of 18.5 oz. Ag}$$

Measured	82,500	tons of 18.5 oz. Ag per ton
Indicated	518,000	tons of 18.5 oz. Ag per ton
Inferred	1,005,000	tons of 18.5 oz. Ag per ton
Total	1,605,500	tons of 18.5 oz. Ag per ton

The above reserve figures are purely hypothetical and should not be construed to be the final tonnage. Additional drilling will be required both along strike and down dip of the vein to substantiate or refute these figures.

Stripping Possibilities

Because of the thickness of ore between hole QS-1 and QS-2 some thought was given to mining open pit methods to the shallow brecciated and oxidized portion of the vein to a depth of 200 feet.

The stip ratio was based on the following assumptions: 1. That the area along strike between line 32S and 40S (plate I) be stripped to a depth of 200 feet. 2. That pit walls have a 62° slope thence a total of 670,000 yards of material would be removed to expose 400,000 tons of ore for a strip ratio of 1.7 yards to 1 ton of ore.

Conclusions and Recommendations

Phase one of the exploration program on the Silver Star property was completed October 22, 1971 resulting in 3,100 feet of rotary hole and three inclined diamond drill holes on the Silver Star vein comprising 900 feet of core.

The rotary drill cuttings were not assayed but were examined in the field. They tend to support the theory that the E.M. 16 and J.E.M. anomalies present at shallow depths were caused by graphitic zones and disseminated pyrite in the Agort formation.

The core drilling on the Silver Star vein indicates the possibility of a major silver ore body along this structure. The direct results of this drilling have been to define a mineralized structure that may extend for 2400 feet along strike and to a depth of 270 feet with an average thickness of 35 feet. The average grade of ore from drill hole information appears to be about 22 ounces of silver per ton with some values in lead, zinc and antimony.

It is recommended that three additional 300 foot holes be drilled to intersect the vein between QS-2 and QS-3 and an additional five holes be drilled to intersect the vein at depths of 500 to 700 feet in the area of QS-1, 2 and 3. This would require a commitment of about 4500 feet of hole at an estimated direct cost of about $68,000.

If this drilling program is successful the indicated ore reserve may be about 2,500,000 tons of ore containing approximately 20 ounces silver per ton with some additional values in lead, zinc and antimony. This reserve

would be sufficient to warrant completion of exploration and development and consideration of a 500 to 1,000 ton per day mill on the property.

The Silver Star fault structure may be expected to extend to considerable depths because parts of the fault are occupied by altered igneous dikes that must have their source in an intrusive mass at an unknown depth. Other than the dikes themselves, there is no sign of a near-surface intrusive mass from geologic or geophysical observations. Therefore, it is not unreasonable to expect the Silver Star fault structure to extend to depths of the order of thousands of feet and possible mineralized zones therein have a future exploration potential that may greatly exceed the immediate near surface ore potential.

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T.B.Nolan: Tuscarora Mining DistrictmElko Co.Nevada. Univ.Nev.Bull.vol. 30,1936,No.1.

NE Nevada,well within basin range province.Production about $10 mil gold and silver.

Rock Formations: Pyroclastics and IB flows,mainly andesitic,dip E or SE.(Just west of Tuscarora lies Independence Range (physiographic map shows Independence Range just E of Tuscarora,Tuscarora range just W;but both rangestrend N-S,so that E-dipping Tuscarora volcanics lie on E flank of a N-S range).These intruded by most irregular andesitic masses,which favor ore as host rocks. This cover not thic,for there is a window of quartzite just NW of mineralized area.

Faults trend N to NNE,dip steep W;"and are more or less restricted to the masses of intrusive andesite".Both bedded series and intruisive andesite jointed parallel to the faults (exact counterpart of Antelope, Nevada). E and SE dips of bedded series 15-50,ave.30° A mile or so NW of mapped area dips approach vertical near borders of plug exposed on flank of Mt.Blitzen. p.22:"..it is possible that the tilting is more or less symmetrically disposed around this intrusive mass". But possibly a more reasonable view is that the tilting has affected whole mt.block and that the steep dips near the plug are superimposed upon the regional tilting. Cf.Sandia uplift,Cerillos Hills, N.M.

Faults well-defined in intrusive rock,turn to vague crushed zones in pyroclastics,largely tuff and breccia,light-colored. This change in structure refelected in HT alteration: bedded eeries highly altered to adularia,qtz-dickite as might be expected of cut by wide shear zones;but such alteration slight in intrusive andesite.

p.24: "In the absence of more intensive field mapping it is impossible to determine the relation between the tilting and the faulting.An obvious interpretaion would naturally be that the two processes were contemporaneous,as at Bullfrog and many other places.The widespread jointing,however,appears to be in part at least later,for it affects the highly altered rocks of the bedded series.The alteration is also believed to have taken place after the main period of faulting."

HT Alteration Environment: Bedded series. Mineralized area defined pretty well by intense qtz-~~xxxxxxx~~ adularia-dickite;outside of this area bedded rocks gray-green,show original texture. Inside,both pnroclastic rocks pale gray-white,loose original texture. Outside of mineralized area (NW of itPchlorite,sericite,calcite,py abundant in phenos and GM. S.t. epidote. Calcic plagiocloase albitized,now sericite. Cf.Tonopah. In mineralized area plagioclase to adularia;matrix completely replaced by fg.aggregate qtz-adularia.Locally large adularia xx along joint walls, with terminated qtz.xx.Dickite is a fg clay mineral,occurs on corroded surfaces of xx adularia.

In intrusive andesite show the proplytication and the qtz etc.types, but they are not spatially distinct,and not so intense;evidence that this alteration restricted to vicinity of OBs.

3/11/49

Suggestion that chlorite alt. first,other superimposed. Propylitization minerals--chlorite,albite.calcite,py.,are compounds of Mg,Na,Ca,Fe,which are the principal elements removed during adularixation.Peripheral relation of chloritized rocks to adularized rocks suggests that the 2 processes were complemntary,adularization occuring near the source of the mineralizong solutions while propylitization was going on farther away, Probability that adularization was superposed on a previously propyilitized rock means the rock alteration continued over a long period,and that adularization affected rocks progressively closer to the surface as time went on,the region subject to propylitization graduallymoving upward and outward concurrently.

HT alteration is therefore an ore guide,but the kind of guide it is depends on the rocks,indirectly,i.e. depends on the kind of channels available at the time for the HT solutions.In the soft pyroclastics sheeting,shear zones etc.widespread,HT alteratiin permeated whole mineralized area,only a general guide.In brittle competent intrusive andesite

few masser fissures controlled flow of these solutions. They stuck pretty well to the immediate vicinity of the fissures, and did not permeate the rock as a whole. Further, in this case the HT channels were the same as the ore channels, so that oBs have HT alteration halos; butif the channels had changed, no such guides would have been available.

Ore Deposits: So-called silver lodes, narrow, confined to intrusive andesite masses, N of town. Gold veins in adularized bedded rocks SW of town. Silver lodesin the IA are narrow veins or lodes similar to the well-defined faults in that formation. Gold deposits are wide, poorly defined and clearly related to the wide shear zones that occur in those rocks.

Silver in excess of gold by wt in both types; but in silver deposits ration is ~~xxxxx~~ 1:150 in silver deposits, 1:4 or 5 in the gold deposits. Fossibly zoning (See Nolan, Ore Deposits of W States, p.626) as elsewhere; but why zoning in relation to two such distinct forms of feposits? Also, no gradations in ratios.

Thinks most likely that gold-silver ratio originally about the same in the two types, and that it was changed by O-charged ground water. Supergenec silver enrichment in narrow andesite veins where lateral movement impeded; removal or dissipation of soluble silver salts in the wide fracture zones of the bedded series. See below.

Silver deposits: All in area less than half mile square. Mainly intrusive andesite. Most intemse alteration next to ore fractures. Mines inaccessible (also to Emmons) little data. OBs in two major belts. W belt trends just W of N. Vein that does OC (only one) has strike of this zone, dips 50-65W. E belt ENE or E.

Shoots narrow, shallow, most of production above 400'. High grade, $29-$107/ton. Ore largely horn silver and native silver, upper parts of shoots Below, argentite. stephanite. proustite, pyragyrite, py, enargite, arsenop, bor-

nite,ccpy,ZnS,PbS.Gangue qtz.,calcite,altered WR. Sulphide areas somewhat vuggy, vugs lined with sooty fg ore minerals. Thinks supergene enrichment.OK for horn silver and sooty mineralsmnot for xx sulphides. Barren zone at surface,40' or so down,typically of silver veins.H orn silver, desert conditions,made barren zone shallow.About 150' in Mexico.

Gold Deposits: Dexter ore body main one;on S edge of town. Opencut; jointed pyroclastic rocks show no evidence of any controlling fractures. Emmons says shoot was near rhy-andesite contact,dips flatly N,A zone mainly in the rhy is strongly fractures 1400' E-W,200' N-S.Pockets of rich ore here and there in this zone.Deposits crossed by many closely-soaced qtz veinlets strike in all directions.In many of them,not completely filled,long narrow druses line on both sides with ½" qtz xx.Adularia local.These carry high gold. Deposits crossed by several NE faults,dip NW.Normal. Ore as mined LG, $2.64-3.54.Typical. Shallow,above 300'. Emmons rhy probably adularized pyroclastic.

SW or Tusdarora prospects produced little but veins were source of placers. Qtz stringer zones N,dip W;these have higher gold conent than WR,silic.,adul.rks.

I do not go with his explanation of differing gold-silver ratios.At Pachuca was a real case of a buried OC.Normal gold silver ratio 1:200, in the oxidized vein 1:85.

While detailed evidence here is lacking,we have again uplift,antithetic faults, sheeting etc.,.like Antelope.Restriction of formal veins to intrusive andesite is paralleled by the great Candelaria OB in Dgo., where the main shoot lies in a mass of IA intruded into tuffs,which are barren.

SW zone of gold OBs may have a radial relation to intrusive andesite locus. OCs very poor here,so like Tonopah here again is a possible district that is partly covered. Geophysical methods should reveal other [illegible] IA.

TUSCARORA, NEVADA ELKO CO.

T.B.Nolan,1936, The Tuscarora mining district, Elko Co.,Nevada,Univ.Nev. Bull.,v.XXX,No.1.

Bedded pyroclastics intruded by masses of andesite.Silver bonan zas concentrated in area less than ½ squ.mi.,N of town,where there is a concentration of intrusive andesite masses. Narrow veins;ore shoots cropped out in only one instance. Most productive ore shoot,Grand Prize, which produced about $2,600,000,topped at 40' below the zurface,and extended down 325' or less.

Region is more or less covered by gravel, and it is probable that the ore shoots were not "blind" but that they were capped by gravel.

The half mile mentioned contains 52 miles of workings and may be assumed to be thoroughly explored; but Nolan points out that the mineralized silver belt,and the concentration of intrusive andesite,passes to the NE under continuous gravel; He suggests exploration of this extension, by shallow drilling to find intrusive andesite masees,then by shallow shafts and crosscuts.

Upper portions of the ore shoots carried silver as chloride;I don't thi this migrates very far;but at shallow depth ruby silvers came in.Thus As and Sb were liberated near the surface.so that geochemical prospecting might work.

I recommend Tuscarora for consideration.

faults.

At Bodie, the west-dipping veins were enriched by late-forming fractures of the Burgess system. At Antelope the vertical sheeting in the footwall of the step-faults is also probably younger than the more extensive west-dipping sheeting. But while the "enrichers" of the Burgess system at Bodie formed in tension fissures resulting from persistent or recurrent arching, the vertical sheeting at Antelope is oriented as feather joints whose parent fractures are the step-faults adjacent to the sheeted zones. Hindrance to fault movement is suggested by the presence of feather joints. Schrader states that the Antelope veins tend to flatten with depth, although this is not shown on his section (Fig. 33). Since the Antelope west-dipping faults and sheeting originated as tension joints, they lie normal to the bent rhyolite beds which they fracture. The underlying quartzite differes physically from the rhyolite; flattening of the west-dipping fractures probably took place at the rhyolite-quartzite contact, by tectonic refraction. Such flattening would tend to hinder fault movements along the Amtelope antithetic faults and set up shearing strain, reliefof which would be effected by formation of feather joints.

The fact that the vertical sheeting at Antelope is barren conforms with the suggestion made above that the antithetic faulting with which these feather joints are associated took place after the period of metallization.

Tuscarora, Nevada

Sources.-

W.H.Emmons(1910), Reconnaissance of some mining camps in Elko, Lander and Eureka Counties, Nevada, U.D.Geol.Survey Bull.408, p.58-65.

T.B.Nolan(1936), Tuscarora mining district, Elko Co., Nevada, Univ.Nev. Bull.vol.30, No.1.

The Tuscarora silver-gold district lies in northeastern Nevada and within the Great Basin (Plate 1). Production has aggregated about $10,000,000.

Like Antelope the Tuscarora district lies on the eastern shope of a north-south basin range. The country rock consists of andesitic pyroclastics resting on a basement of quartzite and intruded by an irregular mass or masses of andesite,probably only slightly younger than the pyroclastics.

As at Antelope the Tuscarora extrusive strata dip east monoclinally; as at Antelope,they are step-faulted by west-dipping normal faults. The faults extend through the intrusive andesite and are best developed there. As at Antelope,jointing parallel to the faults is intensely developed at Tuscarora;both the extrusives and the intrusive are sheeted.(Nolan,1936,p.22).

Nolan recognized the similarity between step-faulting at Tuscarora,with tilting of the faulted strata,and step-faulting at Bullfrog:

"In the absence of more extensive field mapping it is impossible to determine the relation between the tilting and the faulting.An obvious interpretatior would naturally be that the two processes were contemporaneous,as at Bullfrog and many other places.The widespread jointing,however,appears to be in part at least later,for it affects the highly altered rocks of the bedded series.The alteration is also believed to have taken place after the main period of faulting." (Nolan,1936, p.24).

Hydrothermal Alteration.- The step-faults are simple and well-defined in the intrusive but turn to vague crushed zones in the pyroclastics. Hydrothermal alteration reflects this structural change: the sheeted pyroclastics are highly altered ,not only along the crushed zones which mark the faults,but throughout an area coextensive with that of the principal metallization. Where highly altered the pyroclastics are changed to an aggregate of quartz,adularia and diskite.

Such alteration grades to propylitization on the northwest;the propylitic halo probably surrounds the highly altered core.

Although the principal mass of intrusive andesite lies within the area of highly altered bedded rocks,alteration in the andesite is confined to the vicinity of the ore-bearing veins. While both adularization and propylitization occur,they are not spatially distinct and are less intensely developed.

For the district as a whole Nolan(1936,p.27-28) believes that propylitization became active before adularization, affecting rock near solution channels first and spreading outward and upward. Adularization followed,reworking the propylitized rock near the conduit first, then spreading also outward and upward in the tracks of the propylitizing agency,which continued to keep in the lead.

<u>Ore Deposits.</u>- Ore-bearing solutions followed altering solutions , apparently utilizing the same conduits and depositing silver-bearing lodes along zones of concentrated fracturing in the andesite mass. In the adularized bedded rocks southwest of the intrusive,where fracturing instead of being concentrated within master zones as in the andesite,is diffuse and irregular,gold-bearing stockworks were formed.

Data at hand fail to make clear whether the antithetic faults at Tuscarora,which according to Nolan are post-mineral,were veins before becoming faults,as seems to have been the case with some of the faults at Antelope. Some post-mineral movement appears to have affected many Tuscarora veins,but the majority of the latter appear to have been mineralized zones of concentrated sheeting,rather than simple fractures, as Nolan describes the faults within the andesite intrusive mass.

Gangue in the silver veins included quartz,calcite and altered andesite.Metallic minerals,often abundant im proportion to gangue,included arsenopyrite,sphalerite,galena,chalcopyrite,pyrite,bornite,enargite and the silver-bearing minerals argentite,stephanite,ppoustite and pyrargyrite.

The competent intrusive andesite at Tuscarora played the same role as the competent rhyolite at Antelope, forming the host rock for the veins. Only strong rock can fissure under uplift; the soft bedded rocks at Tuscarora fractured intensely but irregularly; doubtless it "flowed" as well.

While at Antelope antithetic faulting seems to have taken place after the metallization, at Tuscarora if Nolan is correct, antithetic faulting occurred before metallization, although some movement occurred along some vein-fractures after their veins were formed. It is probable that at Tuscarora both the antithetic faults and the zones of sheeting in the intrusive andesite originated as tension fissures along the east flank of the Tuscarora arch; that with continued uplift certain tension fissures were selected to serve as rotational faults and that after they had locked themselves and could rotate no further uplift that still persisted pulled open stronger members of the sheeting system to permit entry of silver-bearing solutions. Similar post-faulting uplift at Bodie formed the "enrichers" of the Burgess series which crossed and enriched veins along the antithetic faults, movement on which had by that time ceased.

Star Peak Range, Nevada

Source.-

E.N.Cameron(1939), Geology and mineralization of the northwestern Humboldt Range, Nevada, Geol.Soc.Am.Bull.vol.50, p.563-634.

Examples of elongated arches with longitudinal tension fissures, antithetic faults and crestal graben offered so far mainly middle or late Tertiary deformations of Tertiary extrusive bedded rocks (Creede, Jarbridge, Calico, Parral, Bodie, Antelope, Tuscarora).

TUSCARORA, NEVADA ELKO CO.

T.B.Nolan,1936, The Tuscarora mining district, Elko Co.,Nevada,Univ.Nev. Bull.,v.XXX,No.1.

Bedded pyroclastics intruded by masses of andesite.Silver bonan zas concentrated in area less than ½ squ.mi.,N of town,where there is a concentration of intrusive andesite masses. Narrow veins;ore shoots cropped out in only one instance. Most productive ore shoot,Grand Prize, which produced about $2,600,000,topped at 40' below the zurface,and extended down 325' or less.

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THE TUSCARORA MINING DISTRICT, ELKO COUNTY, NEVADA

By THOMAS B. NOLAN
Geologist, U. S. Geological Survey

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reported for the ore-bearing fractures in the Grand Prize mine. The southern edge of the belt is commonly concealed beneath gravel, but observations in several places suggest that the gravel contact approximately marks the edge of the region of more intense alteration. The degree of alteration appears to decrease southwestward beyond Beard Hill, but to the northeast the possible continuation of the belt is concealed beneath gravel.

It would therefore seem probable that exploration for extensions of the mineralized area might best be conducted in this area to the northeast. Any such prospecting must be done blindly, because of the gravel that covers the surface. Possibly drilling would be the cheapest and most effective way of outlining favorable territory. If it is true that the fractures in which silver-rich ore may be concentrated are best developed in the masses of intrusive andesite, such andesite bodies, if found by drilling, would warrant prospecting by shafts and crosscuts, particularly in areas where the rocks show moderate to intense alteration.

A potential resource, which has been considered on several occasions in the past, is the low-grade material in the numerous mine dumps. Estimates of the gold and silver contents of the dumps have varied widely, and the following two groups of assays of dump samples, which appear to have been carefully made, are appended through the courtesy of the Tuscarora Consolidated Goldfields, Inc.:

ASSAYS OF DUMP SAMPLES, TUSCARORA

Dump	Gold (ounce per ton)	Silver (ounces per ton)
GROUP 1		
North Belle Isle, dump from 400 to 600 levels	0.02	1.24
Navajo, south dump (1 inch and finer)	.02	2.32
Navajo, east section No. 1 (1 inch and finer)	.05	3.95
Navajo, east section No. 2 (1 inch and finer)	.03	3.80
Navajo, north section (1 inch and finer)	.03	2.15
Commonwealth No. 1 (10 mesh and finer)	.02	2.10
Commonwealth No. 1 (1 inch and finer)	.04	1.70
Commonwealth No. 2 (10 mesh and finer)	.02	2.20
Commonwealth No. 2 (1 inch and finer)	.02	1.90
GROUP 2 (1 inch and finer)		
Navajo, north	.025	5.27
Navajo, east No. 1	.05	4.79
Navajo, east No. 2	.035	3.35
Navajo, south	.035	2.64
Eira, large dump	.09	2.16
Eira, near boiler	.01	.60
Dexter No. 1	.08	1.19
Dexter No. 2	.035	1.17
Dexter No. 3	.06	1.22
Commonwealth No. 1	.03	1.90
Commonwealth No. 2	.02	2.05

THE TUSCARORA MINING DISTRICT, ELKO COUNTY, NEVADA

By THOMAS B. NOLAN

INTRODUCTION

The Tuscarora mining district, which has been highly productive of gold and silver ores in the past, is situated in Elko County, Nevada, about 45 miles northwest of Elko (Figure 1), with which it is connected by a well-maintained dirt road. The

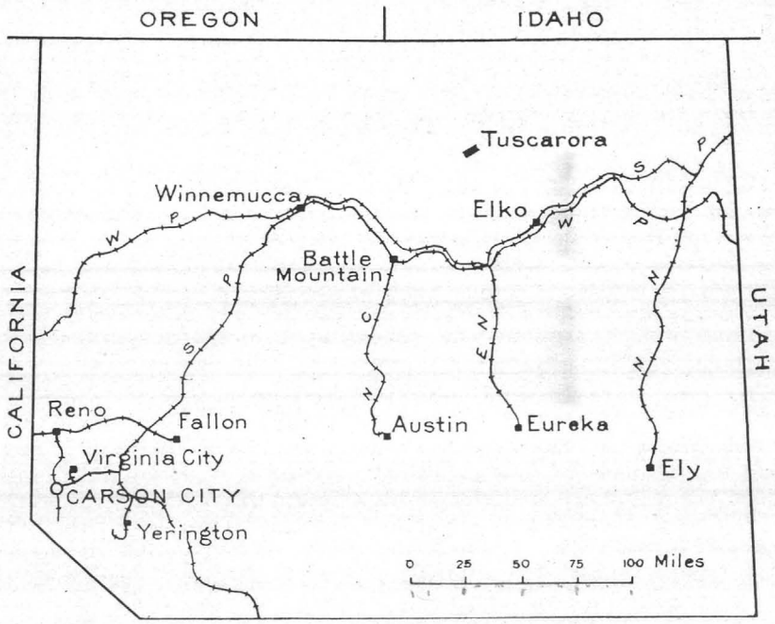


Figure 1—Index map of northern Nevada, showing location of the Tuscarora mining district.

town of Tuscarora lies at an altitude of about 6,000 feet on the west side of Independence Valley, near the headwaters of the south fork of the Owyhee River, which flows northward to the Snake River in Idaho. The Independence Range is immediately west of the district, one of its higher summits, Mount Blitzen, being about two miles northwest of the town. Partly because of the abundance of fertile hay land adjacent to the Owyhee, stock raising has been the leading industry in the region since the bonanza ores were exhausted. The annual

precipitation, particularly the winter snowfall, is considerably greater than in many other parts of Nevada, and temperatures are lower.

The present survey was undertaken at the request of the Nevada State Bureau of Mines as part of a cooperative program by that organization and the United States Geological Survey. The field work was done in the period July 28 to August 14, 1932. The officers and employees of the Tuscarora Consolidated Goldfields, Inc., extended both hospitality and assistance, for which the writer wishes to express his appreciation. The Independence Gold Syndicate, of Toronto, which was exploring the Dexter mine, made available the cores from the diamond-drill holes on that property.

As this brief investigation was hampered by poor exposures and inaccessibility of the mine workings, it has not been possible to develop specific suggestions for future development as could be desired. The work, however, has yielded significant new information concerning the extent and persistence of the shoots of rich silver and gold ores, the related alterations of the nearby wall rocks, and the structural features of the region.

HISTORY OF MINING

Browne[1] has given the following colorful account of the discovery of Tuscarora:

In July of the present year [1867] a party composed of Messrs. McCan, Beard, Heath, and others, left Austin on an exploring tour to the ranges of mountains north of the Humboldt Mountain. There had been rumors of discoveries of gold-bearing veins and placers in those ranges, also in the Goose Creek Mountains, dividing the waters of the Humboldt and Owyhee from Salt Lake. This part of the country was infested with hostile Indians, and it was regarded as dangerous to penetrate it. For that reason it had remained unexplored, yet its very dangers were inviting to the venturesome prospector, whose imagination gave the wild country wealth in proportion to the hardships and dangers attending its occupation. This party of explorers, consisting of eight men, passed the Humboldt River and, going north on about the 117th meridian, crossed a range of mountains, made up chiefly of detached hills or buttes running easterly and westerly, and when upon the northern slope, about 60 miles from the river, discovered gold in placers and in situ.

Tuscarora district—Upon making the discoveries of gold, the prospectors organized a mining district, to which they gave the name of Tuscarora. A small stream running through it northwardly was named McCan. Along this stream for about three miles, gold in small quantities was found to exist. It appears very much diffused thr[illegible]

[1] Browne, J. R., Mineral resources of the States and Territories west [illegible] Rocky Mountains for 1867, pp. 429–430, 1868.

of the area shown in Plate 1. So far as known, however, no adequate sampling of this region has been done.

SUGGESTIONS FOR PROSPECTING

At Tuscarora it is even more difficult than usual to draw any helpful conclusions from the geologic study to assist in the exploration for new ore bodies, because of the poor surface exposures and the inaccessibility of the mine workings. The suggestions here presented must therefore be regarded as tentative and based largely on interpretations and inferences from scanty and possibly incorrect data.

It is probably a safe assumption that there are few if any rich silver ore bodies remaining unmined in the area immediately north of Tuscarora, from which so much of the past production was obtained. The enriched shoots clearly had a relatively narrow vertical range, and the fact that 52 miles of underground workings are reported in an area of less than half a square mile implies that this shallow zone must have been very thoroughly prospected. Furthermore, the low grade of the ore mined at some of the properties before closing down casts some doubt as to the presence of any great amount of material of this sort remaining in the mines.

Such success as was obtained at the Dexter mine, the only gold property to make a significant production, was the result of mining and milling a large quantity of ore at a very low cost. Although at no place within the area examined were conditions exactly similar to those existing at the Dexter recognized, it is possible that a body of low-grade gold ore may be present somewhere in the highly adularized and silicified belt southwest of the Dexter. Careful and extensive sampling would be required to outline such a body, and the scattered sampling so far accomplished, though discouraging, is not necessarily unfavorable. There is no available evidence as to the geologic factors that controlled the localization of the small bodies of rich gold ore within the Dexter ore deposit.

In general, it appears probable that the best chance for finding new ore bodies at Tuscarora lies in the extension of the mineralized belt beyond the area so far explored. The known mineralized belt has a northeasterly trend and extends for a quarter or half a mile north and south of a line between Beard Hill and a point half a mile northeast of Tuscarora. The belt thus transects the strike of most of the mineralized fractures, though its strike may be about the same as that

bedded series, but much of it is massive and shows none of the old textures. Quartz, with a somewhat larger grain size, penetrates the adularia in irregular veinlets. Locally the rock is sheared, and angular fragments of quartz are set in a matrix of adularia. At the surface no metallic minerals were observed, other than the native gold recovered by panning, but the rock has a uniform brown color due to a widespread dissemination of "limonite." Material from the shaft, however, shows locally some bluish-gray unoxidized remnants, which contain abundant small cubes of pyrite.

Some of these stringer zones apparently contained enough gold to warrant the opening of small to moderate-sized stopes, but on many of them the gold content seems to be too small or too erratic for profitable extraction. An effort has been made to develop a large low-grade ore body, similar to that of the Dexter, on Beard Hill. According to a report by J. F. Parsons, material from an area 500 by 300 feet on the southern part of the hill assays about 0.06 ounce of gold and 1 or 2 ounces of silver to the ton; another portion is said to average 0.15 ounce of gold and 0.4 ounce of silver to the ton.

Some diamond drilling has been done along the Modoc belt of stringer zones. Core recovery adjacent to the stringers has been unsatisfactory, however, and in places the zones themselves are apparently somewhat cavernous, as the drilling water was lost and in one place the bit was sheared off.

Gold placers—The placer deposits worked during the early days of Tuscarora are restricted to the area in which the gold deposits are found, southwest of the town. The gravel and soil on the interstream areas was worked in many places, as well as the gravel in the dry stream beds. The placer ground was turned over to the Chinese at an early date, and the total output was probably less than $1,000,000. Essentially no work has been done on the placers for many years; and the two ditch lines formerly used to bring water to the region can scarcely be recognized in many places. A one-man operation was being carried on in 1932 in the dry stream bed southwest of the Dexter open cut, and a small amount of black sand containing some gold was being recovered. To judge from the considerable quantities of metallic iron and amalgam in the concentrates, it is probable that much of the gold came from mine dumps and from a small tailings pile in the adjacent area.

At times in the past consideration has been given to the possibility of dredging the ground southeast of the southern border

the soil from the surface to the depth reached, which did not exceed five feet. Several ledges, or what are supposed to be ledges, were found, showing gold. The party returning to Austin with specimens reported their discoveries, and as is usual upon such occasions an excitement was created, and 100 or more men, well armed for defense against the Indians and prepared for prospecting, immediately proceeded to the new mining region. A large area of country has already been explored, and mines found in various localities. At the present time the real value of the discoveries is unknown, as but little labor has been expended upon either the gold-bearing veins or in washing the soil. The creek does not furnish water in sufficient quantities for extensive and rapid washing, and therefore unless very rich deposits are found, it is not probable any large fortunes will be realized. It is estimated, however, from the prospects obtained, that from $10 to $20 a day may be made per man, for a score or more of men. Should the specimens of gold-bearing quartz found be any criterion of the value of the veins at great depths, they are rich indeed. The geography of the region is but little known, and it cannot be stated at present whether the waters drain to the Owyhee, sink in a basin of their own, or flow to some branch of the Humboldt. A short period will determine all such doubts. The country is described as well adapted for grazing, producing an abundance of grass of a very nutritious character. There are many valleys of large size capable of cultivation, and which, when the treacherous savage is exterminated or subdued and the miners fill the hills, will furnish pleasant homes to settlers.

The original discoveries were situated southwest of the present town and were in part covered by the ground now owned by the Tuscarora Consolidated Goldfields, Inc. Browne's prediction in regard to the placers appears to have been justified, for Whitehill[2] in 1873 reported that from 1869 on the placers were worked during the spring, when water was available, by 150 to 250 Chinese. He reported a yield of $2 to $15 per man. Two ditch lines, traces of which may still be seen, were utilized for the placer operations. Prospecting for lodes was originally confined to the vicinity of the placer ground, particularly around Beard Hill and the region to the north. In 1871, however, the Young America claim was staked in the center of what is now Tuscarora, and desultory work was continued on it without production until 1875, when the first shipments of ore were made. Although these were of relatively low grade, averaging less than $30 a ton, increased activity in the district resulted, and the next year bonanza ore was discovered in the Grand Prize mine, probably east of the patented claim of that name.

After this discovery the district developed rapidly. The population of Tuscarora, which was about 50 in the summer

[2] Whitehill, H. R., Nevada State Mineralogist Bienn. Rept., 1871–72, p. 24, [illegible].

of 1876, increased to more than 3,000 in 1878, and the production for that year was over $1,000,000, obtained from only 12,000 tons of ore. During the census year ending May 31, 1880, there were 10 mines in active operation and three mills with a total of 40 stamps treating the ore. The early history of the camp resembled that of the Comstock in some respects. Overlapping claims, branching veins, and the absence of ore outcrops appear to have caused more or less litigation; and opportunities for profit in the stock market are reported to have guided more than one mine operation. The companies were commonly capitalized at $10,000,000, an amount considerably in excess of the ultimate production of any of the mines. Profits from bonanzas were paid out in dividends or increased operating expenses so rapidly that it was necessary to levy assessments at frequent intervals.

The high costs resulting from litigation and bad management were increased by the relatively high cost of supplies, especially of fuel. In 1879 wood sold for $11 a cord and charcoal for 45 cents a bushel. The shallow ground-water level throughout the district necessitated pumping at an early stage in the development of the camp, and the steam pumps used greatly increased the amount of fuel required. Three years after its discovery, for example, the capacity of the Grand Prize pumping equipment was more than 350 gallons a minute. Many of the operators, therefore, turned to sagebrush to run their steam plants and, at a price of $2.50 a cord, the region for a considerable distance around the town was soon denuded of its shrubby covering.

Although the district appears to have made at least half of its total production in the 10 years ending 1884, the operations during that period appear to have been essentially without profit to the stockholder owners of the mines. Figures given in the reports of the Tenth Census and the reports on the production of the precious metals show that dividends and assessments up to May 31, 1880, and for the years 1881, 1883, and 1884 were as follows :

Mine	Dividends	Assessments
Independence	$225,000	$270,000
Grand Prize	400,000	495,000
Navajo	275,000	200,000
Belle Isle	300,000	115,000
North Belle Isle	15,000	75,000
Argenta	40,000	230,000
Miscellaneous	.....	374,500
Total	$1,255,000	$1,759,500

The Dexter ore as mined appears to have been low grade. During the 5-year period 1898–1902, in which 88 percent of the ore mined prior to 1905 was produced, the average grade of the ore, according to the County Assessor's records, was only $3.545 a ton, and in 1900 it was only $2.64 a ton. Small quantities of ore of much higher grade, some as high as $300 a ton, were obtained from the mine, but this richer material must have been found only in small pockets or streaks. Silver was present in the ore in excess of gold, but the recorded ratio between the two varied from year to year and according to the method of recovery. This is evident in the following table:

GOLD AND SILVER CONTENT OF BULLION AND CYANIDE PRECIPITATES PRODUCED FROM THE DEXTER MINE, 1896-1902

	Bullion		Cyanide Precipitates	
Year	Gold (ounces)	Silver (ounces)	Gold (ounces)	Silver (ounces)
1896	805.03	703	837.72	3,712
1897	2,756.47	2,947	1,044.37	5,833
1898	4,236.00	4,008	2,690.53	20,736
1899	6,292.08	4,910	1,798.02	16,013
1900	5,311.16	6,102	1,456.71	27,755
1901	5,656.30	6,011	1,703.08	30,097
1902	4,883.56	3,862	1,531.21	29,517

It is reported locally that the mill heads in 1912 contained about 0.2 ounce of gold and 10 ounces of silver to the ton, representing a considerable relative increase in silver over the period 1896–1902.

The Dexter ore body was apparently restricted to a shallow depth, as the Dexter shaft was only 300 feet deep, and, according to local accounts, the best ore was found above a depth of 150 feet.

The prospects southwest of Tuscarora appear never to have been very productive, though they must have furnished the gold recovered from the placers. Much of the work has been concentrated on quartz stringer zones with a northerly strike and westerly dip, which have a higher gold content than the silicified and adularized rocks of the bedded series that form the wall rocks. In recent years the Tuscarora Consolidated Goldfields has done a considerable amount of surface prospecting on the wide belt of veins and stringers extending northward from the Modoc mine, but at the time of visit in 1932 it was exploring a similar belt on the Snowstorm and Bull Run claims, to the southeast. One of the stringer zones in this belt had been traced for more than 200 feet on the surface and had a width of about two feet. A thin section of the vein material shows abundant adularia, some of which has clearly replaced rocks of the

mineralogy, the barren zone at the surface succeeded downward by a relatively shallow zone of rich ore, and the proximity of the ground-water level to the surface all favor this conclusion.

Gold deposits — The major gold deposit of Tuscarora, the Dexter ore body, is on the southern edge of the town. Other small properties are scattered through a wide belt of country to the southwest, extending as far as Beard Hill, 2½ miles from the Dexter. The walls of these deposits are highly adularized and silicified rocks that belong to the bedded series. Locally it has been considered that the wall rock at the Dexter consists of an intrusive rhyolite dike, but so far as interpretation is permitted by exposures at the surface and in the open cut, together with the drill cores from the recent exploration by the Independence Gold Syndicate of Toronto, the wall rocks seem to belong entirely to the bedded series and consist largely of pyroclastic members.

At the Dexter open cut the thoroughly jointed pyroclastic rocks show no evidence of any controlling fractures. Emmons writes that the ore shoot is "situated near the contact of rhyolite and andesite and dips northward at a low angle. A zone, mainly in the rhyolite, is strongly fractured for a distance of 1,400 feet east and west and about 200 feet north and south. Pockets of rich ore occur here and there in this zone, and it is said that the whole mass of this rock could be worked profitably by cyaniding on a large scale. The deposit is crossed by numerous closely spaced veinlets of quartz, which strike in all directions. In many of them the fissures are not completely filled, and the centers of the veinlets contain long, narrow druses lined on both sides with well-formed crystals of quartz half an inch long. Locally there is considerable adularia in crystals up to one-fourth inch long, deposited in drusy veinlets with quartz. These veinlets are said to carry high values in gold. The rhyolite of the fissured zone is strongly impregnated with pyrite, even the freshest specimens showing much pyrite under the hand lens. The gold seems to have been deposited through replacement of the rhyolite and also in numerous small open spaces. The deposit is crossed by several faults which strike northeastward and dip toward the northwest. The throw of all these faults is said to be toward the south; the hanging wall on the west side of the fault has moved downward, causing an offset of the ore zone toward the south. The faulting is therefore normal." [21]

[21] Emmons, W. H., op. cit. (Bull. 408), p. 61.

As the bonanza ores were exhausted in these mines, the output of the district decreased, and by 1886 the annual production was valued at less than $100,000. Discoveries of bonanza ore north and west of the older mines, however, resulted in a second period of large production, but the peak, which was reached in 1890, was considerably less than the earlier one. The Commonwealth, North Commonwealth, and North Belle Isle mines were among the large producers during the years from 1888 to 1893. After the rich ores in these mines were removed production again declined, amounting to only $41,000 in 1895.

A third revival in the production of the district resulted from the mining of the low-grade ores, relatively rich in gold, from the Dexter mine. Unlike what had happened in the earlier periods, however, the discovery and extraction of this ore body was not accompanied by the discovery of ore in other mines, and the district's production from 1895 to 1912 was essentially that of the Dexter property. Most of the gold and silver produced after 1905 was obtained from the reworking of the Dexter dumps and tailing piles.

In 1906 the Tuscarora-Nevada Mines Corporation was organized to take over 80 claims, covering practically all of the productive part of the district and including the Dexter mine and mill. At this time the underground workings included are reported to have aggregated 52 miles. In addition to reopening and exploring the old mines, it was planned to work many of the old dumps, which were believed to assay $3.50 a ton in gold and silver. Litigation and financial difficulties, however, intervened and relatively little of the proposed plan was carried out. The litigation was finally settled during the war period, but the destruction by fire of the Dexter mill in 1914 appears to have prevented any active work by the company.

Several companies have been organized since that time with the expectation of reviving mining in Tuscarora. One of these, the Holden Mining & Milling Co., after considerable sampling of dumps and experimental work on milling methods, erected a 50-ton mill, but the plant was destroyed by fire in 1920 after three days' operations on rock from mine dumps. Relatively little exploration was done by these companies until 1930, when the Tuscarora Premier Mining Co. sunk a shaft and did some lateral work north of the old Grand Prize mine, but its efforts to find ore were apparently unsuccessful.

In 1932, at the time of this examination, the Tuscarora Consolidated Goldfields, Inc., was actively exploring some veins in the vicinity of the old placer workings southwest of the town, and the Independence Gold Syndicate of Toronto was engaged in prospect drilling on the Dexter property, which it held under option. A few prospectors were also working independently on lode and placer claims. The permanent population of the town did not exceed 50 people, and many of the old buildings that still remained standing were unoccupied.

PRODUCTION

The greater part of the production of the Tuscarora district was made before 1902, when the United States Geological Survey began to compile annual statistics of mine production. Largely for that reason, past estimates have varied widely, depending apparently in part upon the accuracy of the figures used as a basis for the estimate and in part upon the temperament or objectives of the persons who made it. Emmons reports that these estimates range from $25,000,000 to $40,000,000.[3] These amounts are considerably in excess of the figure that is believed to represent the closest approximation to the lode production that can be reached at the present time—slightly less than $10,000,000.

There are considerable data for the years preceding 1902, but most of them are rather unsatisfactory, because of incompleteness or obvious inaccuracy. The most nearly complete series of figures available to the writer were those reported quarterly to the Elko County Assessor by the individual mines, upon which the bullion tax was based. These figures, however, give only the gross value in dollars and do not permit segregation of the production into gold and silver. They have also been criticized in that they represent only the minimum production, because mine owners are thought to have underestimated their output in order to reduce the amount of tax to be paid. Although this may be true of some owners, there are two reasons why the practice was probably not general. One is the rather general publication by express companies of the shipments of bullion from individual camps, thus permitting county officials to check the quarterly reports to them, and the other is that the tax was levied on net production, and

[3] Emmons, W. H., A reconnaissance of some mining camps in Elko, Lander, and Eureka Counties, Nev.: U. S. Geol. Survey Bull. 408, p. 59, 1910.

from $50 to $200 a ton, but some of the larger mines that possessed their own mills treated rather low-grade ores near the end of their existence. Thus the average value of ore from the Grand Prize was $11 a ton in 1889 and only $6.30 in 1890, as compared with a range of $59 to $336 a ton in previous years. Similarly the average grade of ore treated at the Union mill for the three years 1893–95 was $13 a ton. On the whole, however, the grade was high, as shown by the following statement, based on records of the County Assessor, of the average value per ton of the ore mined throughout the life of the several mines:

Navajo	$107	Independence	$59
North Belle Isle	106	Argenta	52
Belle Isle	93	Nevada Queen	39
Eira	78	Commonwealth	29
Grand Prize	[a]77	North Commonwealth	29

[a]Exclusive of low-grade ore mined in 1889–1890, the average value is $95.

The ore itself appears to have consisted largely of horn silver and native silver in the upper portions of the shoots, possibly above the ground-water level, which Whitehill[19] reports to have stood at 100 feet throughout the district. Much of the ore, however, was rich in sulphides. These included, according to various accounts, argentite, stephanite, proustite, pyrargyrite, pyrite, enargite, arsenopyrite, bornite, chalcopyrite, sphalerite, and galena, with a gangue composed of quartz, calcite, and altered wall rock. Only one small specimen of the silver ore was available for study. This consists largely of pyrite, quartz, and small fragments of wall rock. The pyrite is veined by sphalerite and galena, and the sphalerite contains blebs of chalcopyrite. A greenish mineral with red internal reflections, which was tentatively identified as pyrargyrite by C. F. Park, Jr., of the United States Geological Survey, coats the galena and occurs in cracks in the gangue. The sulphide areas are somewhat vuggy, and the vugs are lined with a porous sooty aggregate of minerals that are too fine-grained or take too poor a polish to be readily identified. The mode of occurrence is that typical of supergene enrichment, and according to Mr. Park there may be more than one silver mineral included in the assemblage. Whitehill's description of the bonanza ore in the Grand Prize mine also suggests that the rich silver ore here was the result of supergene enrichment near the surface.[20]

It seems clear that the rich silver deposits were largely the result of enrichment due to the action of surface waters. The

[19] Whitehill, H. R., Nevada State Mineralogist Bienn. Rept., 1877–78, p. 17, 1879.

[20] Idem, p. 21.

major belts. The westerly belt trends slightly west of north and extends from the Navajo through the Belle Isle and North Belle Isle to the Commonwealth and North Commonwealth. The outcropping vein north of the Navajo shaft has the strike of the zone and dips 50°–65° W. The easterly belt comprises the Independence, Grand Prize, and Argenta mines and trends east-northeast or east. According to Whitehill,[17] the main vein in the Grand Prize and Argenta mines had a northeasterly strike and a northwest dip and yielded a large and troublesome flow of water when cut on the 500-foot level of the Grand Prize. Eighteen of these veins were developed, according to old reports, but no data could be found indicating their distribution between the two major belts.

The ore shoots appear to have been narrow and to have had a relatively small vertical range. With the exception of the vein north of the Navajo shaft, they did not crop out, and the Grand Prize bonanza is said to have been struck at a depth of 40 feet.[18] The absence of silver ore outcrops probably explains the lag between the discovery of the placers in 1867 and that of the Grand Prize bonanza in 1876 and the periodic revivals following the discovery of new ore shoots for the next 15 years. Some estimate of the maximum depth to which the ore shoots may have extended may be gained from the following tabulation of the depths of the shafts before they had caved:

	Feet		Feet
Grand Prize	700–750	Commonwealth	300
Navajo	600–650	Nevada Queen	250
North Belle Isle	600	North Commonwealth	200
Independence	550–600	Eira	200
Belle Isle	450	DeFrees	150

It is probable that relatively little ore was obtained from the deeper levels of the shafts listed in the first column as most of the old accounts agree that the bulk of the ore was obtained at shallow depths. Thus, Whitehill reports that the output from the Grand Prize mine to the end of 1878 had all been obtained above the 320-foot level. This had amounted to $1,600,000, which is over 60 percent of the total output from the mine. The ore shoots ranged from a few inches to a few feet in width, but there are no accurate figures available for stope lengths.

The ore mined showed a wide range in grade, being, according to some accounts, richer at the intersection of two fissures. The early or bonanza production for each mine commonly ranged

[17] Whitehill, H. R., Nevada State Mineralogist Bienn. Rept., 1877–78, pp. 18, 19, 21, 1879.

[18] Whitehill, H. R., Nevada State Mineralogist Bienn. Rept., 1875–76, p. 18, 1877.

generous deductions were allowed for operating expenses, which permitted many mines to escape the tax completely.

Another series of figures on production from 1879 to 1896 are found in the reports of the Director of the Mint on the production of precious metals in the United States. For the most part these represent the production of Elko County and are thus not exactly comparable with the County Assessor's figures for Tuscarora, although for most of the period the Tuscarora production formed a large proportion of that of the county. These figures are invariably higher than those obtained from the County Assessor, for the reasons that they include production from other districts and that the coinage value of the silver produced was used in calculating value. Moreover, Del Mar's comments[4] on the methods used in obtaining these figures cast considerable doubt upon their accuracy.

Other figures of production for individual years are provided by the Census reports and by records of the Wells Fargo Express Co. The Assessor's figures, however, are believed to give the most accurate picture of the production up to 1902 that is available and they are used in the table on page 12.

In addition to the two rough checks on these figures given by the Census reports for the years 1879–80 and 1889, an additional check was provided by the records of the Dexter Mining Co. for the years 1896 to 1902. These figures compare with the Assessor's records as follows:

Year	Company records	Assessor's records
1896	$36,968	$63,557
1897	83,899	103,691
1898	157,786	169,980
1899	179,882	185,113
1900	160,905	154,218
1901	173,675	157,090
1902	150,223	126,289
Total	$943,338	$959,938

The small differences between the two sets of figures may be explained by the arbitrary use of average silver prices in the computation of the value of the production from the company records, which gave only the gold and silver content in ounces. The variations in value in individual years, moreover, may reflect the difference in time between mining of ore and receipt of settlement checks from mint or smelter.

[4] Del Mar, Alexander, A history of the precious metals from the earliest times to the present, 2d ed., pp. 401–406, New York, 1902.

PRODUCTION OF THE TUSCARORA MINING DISTRICT, 1875-1930

[Data from 1875 to 1901, from books of County Assessor, Elko, Nevada; after 1901 from figures collected by the U. S. Geological Survey and U. S. Bureau of Mines for annual reports on the Mineral Resources of the United States, and made available by V. C. Heikes.]

Year	Ore (tons)	Gold (ounces)	Silver (ounces)	Copper (pounds)	Lead (pounds)	Total value
1875	250.0	...	...	...	...	$7,000.00
1876	90.4	...	...	...	...	27,051.66
1877	9,451.0	...	...	...	...	900,714.20
1878	12,092.5	...	...	...	...	1,107,802.38
1879	15,277.3	...	...	...	...	1,051,051.80
1880	8,631.3	...	...	...	...	[a]449,556.27
1881	1,864.8	...	...	...	...	151,549.61
1882	2,340.2	...	...	...	...	324,879.53
1883	3,525.5	...	...	...	...	501,296.15
1884	6,354.1	...	...	...	...	614,652.21
1885	2,223.3	...	...	...	...	177,672.61
1886	701.0	...	...	...	...	80,962.86
1887	1,272.4	...	...	...	...	182,849.25
1888	4,658.3	...	...	...	...	565,165.40
1889	10,545.3	...	...	...	...	[b]538,298.48
1890	30,036.1	...	...	...	...	699,552.08
1891	6,291.5	...	...	...	...	470,197.33
1892	9,012.9	...	...	...	...	381,499.55
1893	5,652.6	...	...	...	...	182,826.37
1894	3,365.4	...	...	...	...	96,378.27
1895	3,053.6	...	...	...	...	41,398.88
1896	3,852.0	...	...	...	...	63,517.28
1897	5,456.4	...	...	...	...	106,497.37
1898	25,750.0	...	...	...	...	175,482.22
1899	49,962.0	...	...	...	...	185,112.78
1900	58,367.0	...	...	...	...	159,738.90
1901	50,213.0	...	...	...	...	160,794.77
1902	30,098	5,017.11	35,823	...	...	122,569
1903	5,603	2,959.83	45,819	...	...	82,547
1904	1,808	1,355.13	8,842	...	...	33,052
1905	500	425.70	2,000	...	...	10,008
1906	8,100	1,112.63	10,448	...	...	30,000
1907	(*)					
1908	4,528	575.32	11,417	6,818	...	18,844
1909	4,184	533.53	11,017	...	...	16,758
1910	2,871	673.49	8,146	...	...	18,320
1911	17,965	850.73	20,482	...	...	28,145
1912	6,619	1,022.71	33,332	118	33,531	43,167
1913	394	462.54	9,699	...	1,994	15,508
1914	380	104.38	6,077	35	24,527	6,480
1915	332	104.71	8,461	253	63,126	9,465
1916	76	49.60	4,776	157	660	4,253
1917	11	15.44	2,531	...	...	2,405
1918	15	10.55	10	...	...	228
1919	56	10.69	742	...	...	1,052
1920	9	5.82	449	...	...	610
1921	40	33.42	26	...	...	717
1922	4	9.19	429	...	...	619
1923	1	1.00	192	...	...	178
1924	2	1.85	1	...	...	39
1925	32	40.09	325	2,477	...	1,407
1926	3	7.34	262	...	...	315
1927	1	5.60	19	...	...	127
1928	2	12.90	62	...	...	303
1929	(*)					
1930	(*)					
Total, 1875–1901	330,299	...	...	...	...	$9,403,498
Total, 1902–1930	91,734	15,401.30	221,387	9,858	123,838	$447,116
Total, 1875–1930	442,033	...	...	...	...	$9,850,614

[a] The Census report for 1880 gives the following figures for the year ending May 31, 1880: 9,721 tons ore mined; 5,113.1 ounces gold; 778,805 ounces silver.

[b] The Census report for 1890 gives the following figures for 1889: 12,282 tons ore mined; $261,653 gold; $575,908 silver.

*No record of production.

The following table, showing the production for Elko County for the years 1879–96 is added for comparison. The subdivision into gold and silver for several of the years shown is only a rough approximation, as it is based upon bullion shipments.

the gold-silver ratio varies either in space or in time in other districts containing Tertiary epithermal deposits.[16] There are, however, no deposits gradational between the two extremes, as might be expected if zoning had been operative; and it is also not apparent why zoning should result in a distinctive form for the two kinds of deposits.

A third possibility, and the one that is believed to be most probable, is suggested by the widespread surficial alteration of the ore bodies, combined with their difference in form. This is, briefly, that the gold-silver ratio was originally about the same in the two types of ore bodies and that it was changed through the agency of oxygen-charged surface water. The circulation of such water underground would be controlled largely by fractures and might result in a notable supergene silver enrichment in the narrow veins in the intrusive andesite, where lateral movement was impeded, and in a removal or dissipation of the soluble silver salts in the wide fracture zones in the bedded series. Such evidence as is available for this hypothesis is presented in the following paragraphs on the two kinds of deposits.

Silver-rich deposits—The silver bonanzas of Tuscarora were all found in a small area less than half a square mile in extent lying north of the town. This area is also characterized by a concentration of intrusive andesite masses, and the dumps of the productive mines show that andesite composed the great bulk of the material cut by the underground workings. The results of all stages in the alteration of the andesite as described on pages 24–28 are exhibited, but there was apparently a concentration of the more intense phases adjacent to the fractures in which the ore bodies are found. The exposures of the bedded series in this vicinity are uniformly and thoroughly adularized.

Little direct evidence is now available regarding either the ore-bearing fractures or the ore shoots themselves. Surface exposures are poor, and the old mine workings are inaccessible. Furthermore, except for one vein north of the Navajo shaft, none of the ore bodies reached the surface. Description and interpretation of the ore bodies must therefore be based on scanty first-hand information supplemented by the scattered and inadequate published data. It was also impossible to obtain any of the old mine maps.

The ore bodies appear to have been largely confined to two

[16] Nolan, T. B., in Ore deposits of the Western States (Lindgren volume), p. 626, Am. Inst. Min. Met. Eng., 1933.

albite, calcite, and pyrite — are compounds of magnesium, sodium, calcium, and iron, which are the principal elements removed during adularization. The peripheral relation of the chloritized rocks to the adularized rocks therefore suggests that the two processes were complementary, adularization occurring nearer the source of the mineralizing solutions while propylitization was going on farther away. The probability that the adularization was superposed on a previously propylitized rock may be interpreted as meaning that the rock alteration at Tuscarora continued over a considerable period of time, and that adularization affected rocks progressively closer to the surface as time went on, the region subject to propylitization gradually moving upward and outward concurrently.

ORE DEPOSITS

Emmons has distinguished three kinds of ore deposits at Tuscarora—silver lodes, gold-bearing fractured zones or stockworks, and gold placers.[15] The silver lodes are relatively narrow and appear to be in large part restricted to the intrusive andesite masses; they are located in the region north of the town, where the andesite bodies are specially abundant. The gold deposits occur in the adularized rocks of the bedded series and extend from the southern edge of Tuscarora southwestward to Beard Hill. Placer activity has also been confined to this area.

The forms of the two types of bedrock deposits thus correspond to the kind of fracturing in their respective wall rocks: the deposits in the intrusive andesite are narrow veins or lodes, similar to the well-defined faults in that formation, and the wide and poorly defined gold deposits in the bedded series are clearly related to the wide shear zones that occur in those rocks. The cause of the difference in the gold-silver ratio in the two types of deposits, however, is not so clear. Although silver is present in excess of gold by weight in both, the ratio is only 4 or 5 to 1 in the gold deposits, as opposed to about 150 to 1 in the silver deposits. One explanation might be that the two represent different periods of mineralization, but this seems improbable, because the fractures that they occupy and the alteration of their wall rocks appear to represent only a single period of faulting and a single epoch of hydrothermal activity. Another possibility might be that the difference in the two types of deposits is the result of zoning, especially as it is known that

[15] Emmons, W. H., op. cit. (Bull. 408), p. 60.

Much silver bullion contained considerable amounts of gold, and vice versa, but these features were not considered in the compilation of the figures. It should also be noted that the value for silver is based upon the coinage value of silver ($1.29+ an ounce) rather than the yearly average market price, which ranged from $0.63 to $1.15 during this period.

PRODUCTION OF GOLD AND SILVER IN ELKO COUNTY, 1879-1896

[Data from reports of the Director of the Mint on the production of precious metals in the United States.]

Year	Gold	Silver	Total
1879	.....	.....	[a] $1,215,030
1880	.....	.....	[a] 532,301
1881	$30,000	$500,000	[b] 530,000
1882	35,000	500,000	535,000
1883	30,000	550,000	[c] 580,000
1884	75,000	700,000	775,000
1885	16,000	472,000	488,000
1886	9,800	283,200	293,000
1887	8,000	366,910	374,910
1888	110,898	897,267	1,008,165
1889	150,000	605,000	755,000
1890	155,000	645,000	800,000
1891	90,000	484,000	574,000
1892	80,000	450,000	530,000
1893	40,000	180,000	220,000
1894	57,000	95,000	152,000
1895	44,753	54,736	94,489
1896	95,600	9,500	105,100

[a] Tuscarora only.
[b] Tuscarora production estimated at $422,396.
[c] Tuscarora production estimated at $430,000.

Just as the estimates of the district's production have been considerably magnified by the passage of time, so have the outputs of individual mines been overestimated. Thus the Navajo is reported to have made a gross production of $4,000,000 to $7,000,000; the Dexter, $2,300,000 to $11,000,000; the Grand Prize, $4,000,000 to $5,500,000; and the others in proportion. According to the County Assessor's records, however, individual mines had produced, through 1905, as follows:

Grand Prize	$2,595,476.45	North Commonwealth	$262,502.21
Navajo	1,732,549.94	Argenta	202,335.10
Dexter	1,277,982.77	Coptis	147,157.98
Commonwealth	678,117.26	Young America South	101,731.01
North Belle Isle	638,747.18	Eira	99,176.98
Belle Isle	627,322.98	Union Mill	97,978.21
Independence	617,319.39	Del Monte	25,561.24
Nevada Queen	406,128.95	Smaller properties	88,065.29

The annual production of the mines that have produced more than $500,000 is shown in Figure 2. The striking feature of the chart is the brief period of life for all the mines except the Dexter, whose longer productive period was due to a large tonnage of relatively low-grade ore, in contrast with the small bodies of bonanza ore in the older mines.

The placer production of the district is not included in the table of production except for the years after 1920. According to Emmons,[5] the placers "were extensively worked in the seventies and are said to have produced $7,000,000, but little work has been done of late years except that carried on by a few Chinese." The amount cited in this statement also appears to be a gross exaggeration. J. F. Parsons, an old resident of the district and a former superintendent of several of the mines, believes that the placer production did not exceed $700,000,[6] and there is considerable evidence to indicate that this figure is much closer to the truth. Although the placers were discovered in 1867 and work was not started on them until the next year, the diggings were turned over to Chinese in 1869.[7] Rough calculations indicate that the placer production up to 1880 probably was not greatly in excess of $500,000, and scattered figures on later shipments of gold bullion from Tuscarora suggest that the placer production after 1880 did not exceed $200,000.

The total production from the district appears from the figures given above to be somewhat less than $11,000,000, of which about $10,000,000 came from lodes and the rest from placers.

GEOLOGY

The bed rocks in the vicinity of Tuscarora may be divided into two groups — a bedded series composed chiefly of pyroclastic rocks with some interbedded lava flows, mostly of andesitic composition; and a younger series composed of intrusive bodies also of andesitic composition. The bedded rocks dip to the east or southeast rather uniformly and are invaded by the andesitic intrusives in what is probably a most irregular manner. Both groups have been affected by faulting, but the nature and extent of the displacements are very imperfectly known. Alteration effects related to the mineralization are widespread throughout the region, and in many places the alteration has progressed so far that it is difficult to distinguish between the intrusive rocks and the lava flows. Besides these two groups there is one small outcrop of quartzite, which may be of Carboniferous age, but its relations to the volcanic rocks, which entirely surround it, are not clear.

[5] Emmons, W. H., op. cit., p. 61.
[6] Personal communication.
[7] Whitehill, H. R., Nevada State Mineralogist Bienn. Rept., 1871–72, p. 24. 1873.

A thin section of the rock shows scattered outlines of old feldspar crystals now replaced by adularia or by a fine-grained mixture of sericite and quartz, set in a fine-grained aggregate of adularia, quartz, and dickite(?). Strings of tiny dots and slightly larger aggregates of a titanium mineral, probably rutile, are found throughout the rock. Quartz veinlets, locally bordered by tiny rhombs of adularia, are rather abundant. The rock might have been originally either a tuff or a flow.

Calculations based upon an assumed content of 5 percent of sericite show that this rock contains in addition 36 percent of quartz, 45 percent of molecular orthoclase, 7 percent of albite, and 7 percent of dickite. The ratio of K_2O to Na_2O is lower than in the coarsely crystalline material, perhaps indicating that this adularia contains a higher content of the albite molecule in solid solution because of the replacement of a pre-existent albite-rich plagioclase.

The intrusive andesites also show both the chloritic alteration and the alteration characterized by adularia, but the two types are not spatially distinct, as in the bedded series, nor is either alteration as intense. Almost all the specimens of the intrusive andesite collected show the development of some chlorite and calcite, especially in the dark minerals, and small patches of albite replacing the original calcic andesine were commonly observed. A few specimens thought to have been originally andesite show a fairly complete replacement by adularia, quartz, and dickite(?). This alteration appears to have been of rather slight extent, however, and there is some evidence that it may have been restricted to the vicinity of the ore bodies.

The differences between the alteration of the bedded series and that of the andesite are believed to be most easily explained by the differences in fracturing within these rocks. The wide shear zones in the bedded series, combined with the relatively high porosity of the pyroclastic members, would permit widespread and easy penetration by the solutions that caused the alteration; the narrow fractures and dense texture of the andesites, on the other hand, would permit rapid circulation and reaction only in the immediate vicinity of the fractures.

The relations between the two kinds of alteration suggest that the quartz-adularia-dickite(?) aggregate, whose introduction may be called "adularization," was commonly superposed upon a pre-existent aggregate introduced during "propylitization." The minerals formed during propylitization—notably chlorite,

chlorite, calcite, and pyrite has not been generally recognized.

To the southeast the bedded rocks have been converted to an assemblage of quartz, adularia, and dickite(?). In many places these minerals have been introduced in such quantities that most of the original texture has been destroyed; locally it is difficult or even impossible to distinguish between flows and pyroclastic rocks. The outlines of the plagioclase crystals in the original rock remain, but the plagioclase has been converted to the potash feldspar adularia. Commonly the matrix is completely replaced by a fine-grained aggregate of quartz and adularia. Small quantities of chlorite and of titanium minerals provide the only indications that dark minerals were once present. Locally adularia has formed crystals a quarter of an inch or less in diameter along the walls of joint planes in the altered rock, and this crystalline material is commonly associated with terminated quartz crystals. A fine-grained clay mineral, which is probably dickite, occurs locally upon the corroded surfaces of the crystalline adularia; it is also found in rounded nests within the adularia that has replaced the original phenocrysts, and less commonly in the groundmass.

The adularia is a rather pure potash feldspar, as is shown by the following two partial analyses by J. J. Fahey of the United States Geological Survey:

	1	2
K_2O	13.38	14.45
Na_2O	.96	.83
Li_2O	.06	n. d.
Rb_2O	.04	n. d.
Cs_2O	.00	n. d.

Both of these analyses were made on coarsely crystalline adularia collected from the ridge north of the Modoc tunnel. Miss Jewell Glass, of the Geological Survey, determined the following optical properties on material represented by analysis 2: $\alpha = 1.516–7$, $\beta = 1.520–1$, $\gamma = 1.521–2$; biaxial (—); wavy extinction; 2V variable from medium to small; twinning shadowy, locally suggesting microcline.

One of the highly adularized rocks, which shows a faint banding in hand specimens, was collected 300 feet north of the open stope on the Bull Run claim. It was analyzed by J. J. Fahey, of the Geological Survey, with the following result:

SiO_2	74.75	Na_2O	.66
TiO_2	.40	K_2O	8.21
Al_2O_3	13.61	Li_2O	.03
Fe_2O_3	.83	Rb_2O	.02
MgO	.21	H_2O	1.58
CaO	.02		100.32

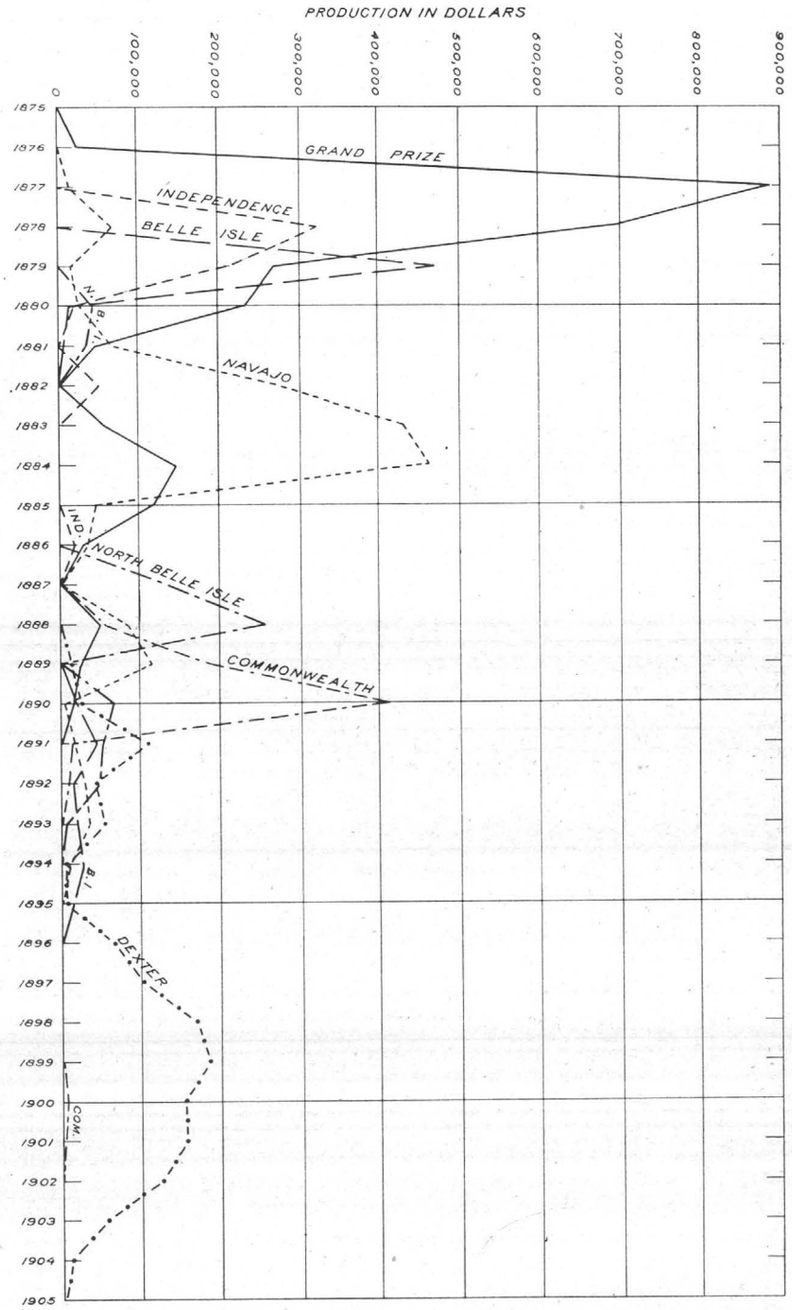


Figure 2—Annual production of Tuscarora mines that produced more than $500,000 during the period 1875-1905.

A satisfactory study of the relations of the bed rocks was made difficult by three factors. The outstanding one was the general lack of outcrops over much of the region, due in large part to the gravel that covers the alluvial or bajada slope upon which Tuscarora lies. (See Plates 2–A, 2–B.) Along much of the southeastern border of the region the gravel is 20 feet or more thick, and the underlying rock can be determined only through study of the spoil from shafts that have penetrated through the gravel or from sporadic outcrops in or along stream courses that have cut through the gravel into the bedrock.

This difficulty could be considerably overcome if the extensive

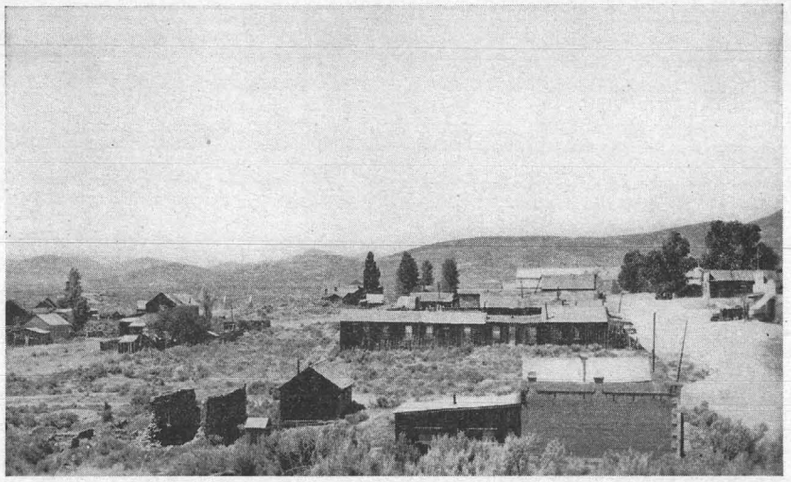


Plate 2-A—View looking southwest from the east end of Main Street, Tuscarora. The Dexter mine lies just outside the view in the left foreground; the end of the Navajo dump is visible in the middle distance to the right; and the Modoc mine is located in the hills in the left background. Photo by A. G. Burritt.

underground workings were open for inspection, but all the old deep shafts have caved at the surface, and the high level of the ground water has caused the flooding of practically all the old mine levels.

In addition, there appears to be no adequate base map of the region. A sketch map of the mineralized region (Plate 1) was made by compass and pace traverses, on a base provided by a transit survey of the claims of the Tuscarora Consolidated Goldfields, Inc., and a plat of the claims surveyed for patent furnished by the Reno office of the General Land Office. The map contains numerous inaccuracies, as it was found to be impossible to locate many of the patent survey corners or to reconcile

feldspar, but the alteration to quartz, adularia, and dickite(?) has been slight in extent and intensity. This difference between the two formations, as already suggested, appears to be due in large part to the nature of the fracturing in them, the widespread shearing in the bedded series permitting an extensive penetration by the altering solutions, which in the andesite were restricted to the vicinity of the narrow fracture zones. There is a comparable difference in the ore deposits found in the two kinds of rocks.

The boundary between the rocks showing the two types of alteration in the bedded series is not sharply defined, but appears to trend southeasterly through a point north of the Modoc tunnel. Northwest of this line the rocks are commonly grayish green and exhibit their original texture and relations to a fair degree. Southeast of this line both flows and pyroclastic rocks are pale gray or even white and are commonly so highly altered that in many places it is difficult to determine their original nature except with the aid of the microscope. In a few places within this bleached zone, however, some of the bedded rocks that appear to have been originally lavas are greenish. The lava exposed in the prospect 75 feet north of the north end line of the Comstock No. 8 claim is an example of a flow that has escaped the intense bleaching.

The greenish rocks to the northwest include both flows and breccias. The microscope shows that although the original textures have been preserved the rocks have nevertheless been altered. Chlorite, sericite, calcite, and pyrite are abundant in both the phenocrysts and the groundmass. Small amounts of epidote are found in places. The feldspar crystals have been extensively sericitized, but wherever they have been determined they appear to be fairly pure albite. The albite is believed to be an alteration product of an originally calcic plagioclase, because in the intrusive andesite, in which the chloritic alteration was less extensive, albite has clearly replaced the original andesine. At Tonopah also, albitization has accompanied the introduction of chlorite, calcite, and pyrite.[13] Quartz has been formed locally in addition to the other introduced minerals, but its absence in many of the chlorite-rich rocks suggests that its formation may have been independent of that of chlorite.

Rock alteration of this type has been commonly referred to as "propylitic," [14] although the association of albite with the

[13] Nolan, T. B., Underground geology of the Tonopah mining district, Nev.: Nevada Univ. Bull., vol. 29, No. 5, pp. 21–22, 1935.

[14] Lindgren, Waldemar, Mineral deposits, 4th ed., pp. 457–458, 1933.

The nature of the faulting in the district must, in large part, be studied from exposures in the few underground workings that were accessible, because outcrops at the surface are too few and too poor to determine the presence or absence of faults. The Modoc tunnel (Figure 3) provided the greater part of this information. It shows that persistent crushed zones are fairly abundant and that they have a rather uniform northerly strike and commonly a steep westerly dip. It also appears in this tunnel that the well-defined faults are more abundant in or adjacent to the intrusive andesite, whereas wide and rather poorly defined crushed zones or shear zones are found in the bedded series.

Exposures are not good enough to establish the validity of this observation over the whole area, but its application is strongly suggested by the differences in alteration of the two units. Thus the bedded series is highly altered to adularia and quartz throughout most of its extent, as might be expected if it were cut by wide shear zones, in contrast with the relatively slight extent of the adularia-quartz stage of alteration in the intrusive andesite.

In the absence of more intensive field mapping it is impossible to determine the relation between the tilting and the faulting. An obvious interpretation would naturally be that the two processes were contemporaneous, as at Bullfrog [12] and many other places. The widespread jointing, however, appears to be in part at least later, for it affects the highly altered rocks of the bedded series. The alteration is also believed to have taken place after the main period of faulting (p. 27).

ROCK ALTERATION

The Tuscarora district appears to exhibit some phases of rock alteration that are of unusual interest and have some bearing on the study of the related ore deposits. The bedded series and the intrusive andesite have behaved in notably different ways during the alteration. The bedded rocks have undergone a widespread and intense alteration by which the original minerals have been replaced by quartz, adularia, and dickite(?) throughout the mineralized area; beyond this area chlorite and other minerals have been introduced. In contrast the intrusive rocks have undergone relatively little change: chlorite, calcite, and other minerals have replaced the original dark minerals and albite has developed to a small extent in the

[12] Ransome, F. L., Emmons, W. H., and Garrey, G. H., Geology and ore deposits of the Bullfrog district, Nev.: U. S. Geol. Survey Bull. 407, pp. 82–85, 1910.

the locations of those that were found either among themselves or with the land net. The locations of many of the various shafts and prospects therefore represent a compromise between different observations.

Sufficient information was not obtained to draw geologic boundaries or to show the location of faults with any degree of accuracy, and Plate 1, therefore, shows these features only where their positions are fairly well known. The areas believed to be largely underlain by andesitic intrusive bodies are shown by a line pattern. Where alteration is intense, however, it is possible that lavas of the bedded series have been included with

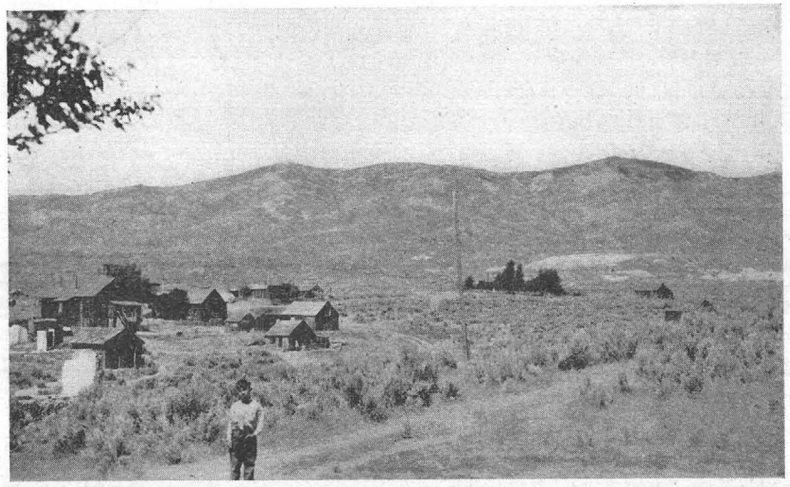


Plate 2-B—View looking northwest from the east end of Main Street, Tuscarora. Mt. Blitzen in the background. Commonwealth dumps in right center; Independence dump on right. Photo by A. G. Burritt.

the intrusives, or less probably, that some of the intrusive masses have been included with the bedded rocks.

ROCK FORMATIONS

Carboniferous(?) quartzite—A small body of dark quartzite and black chert is poorly exposed about 200 feet north of the northwest corner of the Found Treasure No. 2 claim. The exposure is entirely surrounded by volcanic rocks, but the nature of the contact is not clear. There is no direct evidence of any extensive faulting in this region, and the material may represent a hill in the prevolcanic floor.

The quartzite and chert are lithologically similar to beds exposed at several places in this part of Nevada. At Mountain City, rock of this type is overlain, probably conformably,

by limestones that contain Carboniferous fossils.[8] The quartzite and chert are also believed to be of this age, although not themselves fossiliferous. Emmons correlated similar quartzites in the Independence Range, north and west of Tuscarora, with the Weber (?) quartzite of the Eureka section, also of Carboniferous age.[9]

Bedded series — The rocks that constitute the bedded series include both pyroclastic rocks and lava flows. The proportions in which the two varieties are present differ from place to place, but on the whole the pyroclastic rocks appear to be considerably more abundant.

The pyroclastic rocks include both volcanic breccias and tuffs. The breccias are in general more abundant in the western and northwestern parts of the area mapped, where fragments an inch or more in diameter may be observed; to the east and south the fragments are smaller, and the rocks are typically tuffs. Most of these rocks within the mineralized area are pale gray, but locally greenish or gray-green tints predominate, especially to the west and northwest. In many places the bedding planes are obscure; in others they are marked by changes in grain size or by a pronounced easy fracture. Locally fine-grained quartz has been introduced along the bedding planes in the tuffaceous rocks. The rock fragments in the breccias are composed almost exclusively of altered fine-grained volcanic rocks; crystal fragments of both feldspar and quartz are also found.

The microscope shows clearly the pyroclastic nature of the rocks, as well as the intense alteration they have undergone. All the specimens examined are composed chiefly of potash feldspar, quartz, and a fine-grained mineral that is probably the clay mineral dickite. All the large feldspar crystals in the rocks are complexly twinned potash feldspar (see p. 26), which is probably an alteration product, as identical potash feldspar is equally abundant throughout the matrix, even in places where the outlines of former glass shards may be recognized. Commonly the feldspar itself has been attacked and replaced by the supposed dickite or less commonly by quartz. Rutile and other titanium minerals are universally present. Small quantities of sericite are found in some specimens, and rocks collected from the western part of the region contain a green chlorite and locally calcite. Pyrite occurs in a few specimens, but in most

[8] Nolan, T. B., Unpublished report on the Mountain City mining district, Nev.
[9] Emmons, W. H., op. cit., p. 58.

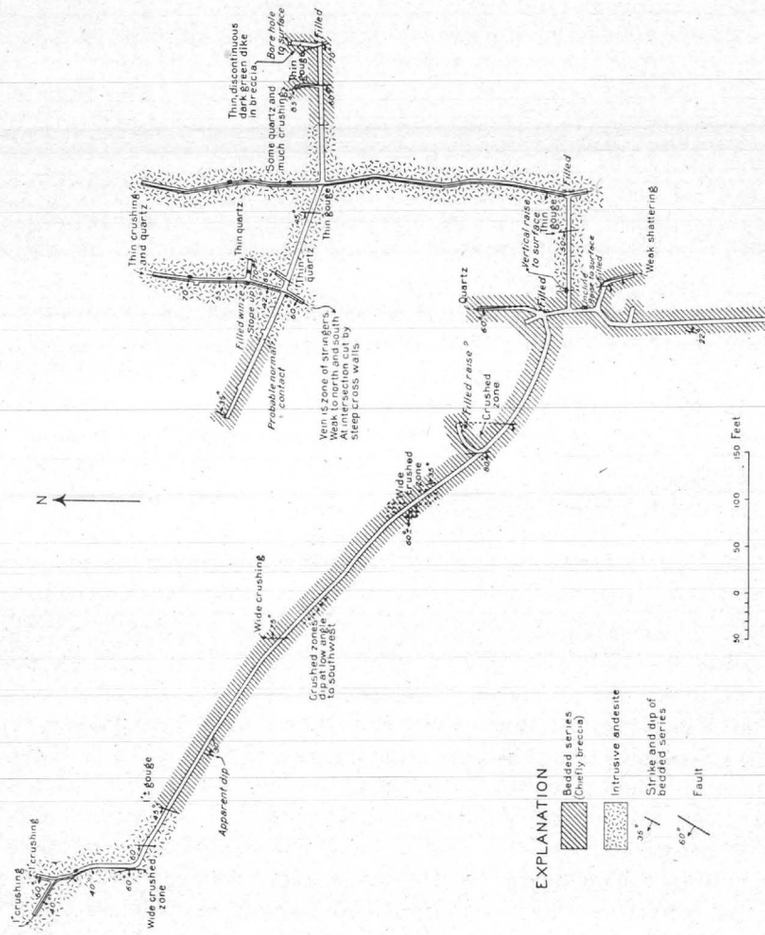


Figure 3—Plan of tunnel workings, Modoc claim.

west from the southwest corner of the Contention claim, for example. The maximum thicknesses observed were commonly on the interstream areas; the thickness of gravel decreases generally northwestward and locally toward the stream bottoms. The western and northwestern border of gravel caps on the interstream areas is a poorly defined line that is convex to the northwest and extends through the area mapped. Beyond this border the surface is composed of rock fragments or "float," locally rather thoroughly altered by surface weathering, but in large part derived from the underlying bedrock. There is, however, no topographic break between the gravel areas and the surface cut on bedrock.

The dry stream channels are cut into both areas and, together with the exposures in the shafts, show that the rock surface beneath the gravel is slightly steeper than the present surface. There is little doubt that at one time the gravel capping was thicker and extended farther to the northwest than at present, and that it is now being removed by erosion.

GEOLOGIC STRUCTURE

Both tilting and faulting have affected the rocks at Tuscarora. Several exposures of the bedded series indicate that they have been rather uniformly tilted at moderate to low angles to the southeast and east, but there is not much evidence at hand regarding the character and extent of the faulting. There are, however, grounds for the belief that the well-defined fault fractures trend north to north-northeast, dip steeply west, and are more or less restricted to the masses of intrusive andesite. Both the bedded series and the andesites also show a widespread jointing, which is parallel to the faults.

The tilting of the bedded series is shown by the dips of bedding planes in the pyroclastic rocks and of flow lines in the lavas. These dips are consistently to the east and east-southeast, range from 15° to 50°, and average about 30°. A mile or two northwest of the mapped area the dips in the bedded series approach the vertical near the borders of an intrusive plug that is exposed on the flank of Mount Blitzen; and it is possible that the tilting is more or less symmetrically disposed around this intrusive mass. An alternative view, and possibly a more reasonable one because of the absence of westerly and southwesterly strikes in the southern part of the area, is that the tilting has affected the whole mountain block and that the steep dips near the plug are superposed upon the regional tilting.

it cannot be recognized, probably because it has been removed by surface oxidation. At the surface the pyroclastic rocks contain more or less of a clay-like mineral that is quite different optically from the dickite. This is optically and chemically similar to fine-grained sericite. In a pit at the south end center of the Comstock No. 10 claim this mineral forms the bulk of the rock.

Lava flows are interbedded with the pyroclastic rocks. They are commonly much altered porphyritic rocks with a dense groundmass, which is locally flow-banded. The less altered facies, which is found to the west and north, is greenish brown and contain numerous small dull feldspar phenocrysts and less abundant and smaller dark phenocrysts, most of which are apparently biotite. In the southern part of the area studied the flows are practically all light gray to buff and only the outlines of former feldspar phenocrysts can be recognized. As with the pyroclastic rocks, a soft claylike mineral is abundant at the surface, especially in the phenocrysts.

The sections of the less altered flows show phenocrysts of albite and pseudomorphs of chlorite, calcite, iron ore, and sericite after biotite and, less commonly, hornblende. The groundmass, which in many specimens was originally a glass, has been recrystallized to a fine-grained mixture of feldspar (probably albite) and quartz. In the highly altered rocks of the southern part of the area the albite has been completely replaced by potash feldspar, both in the phenocrysts and in the groundmass. This, with quartz, small quantities of dickite(?), rutile, and apatite, makes up the whole rock.

Quartz appears to have been originally absent from all the lava flows and, where now found, has been deposited by mineralizing waters. It is also uncommon as a primary constituent of the pyroclastic rocks. The potash feldspar, which is so abundant in the bedded rocks, also appears to be entirely a product of mineralization. These rocks must therefore have been andesites at the time of their eruption, either albite andesites, if the albite phenocrysts found in the less altered facies can be considered primary, or, more probably, normal andesites if the albite is secondary. (See p. 25.) The prevailing light color of the pyroclastic rocks and the flows has, however, in the past caused them to be classed as rhyolites,[10] but there is no doubt that the present abundance of quartz and potash feldspar is not an original feature.

[10] Emmons, W. H., op. cit., pp. 58–60.

As neither the top nor the bottom of the bedded series is exposed within the area mapped, no estimate of the total thickness of this group of rocks can be made. To judge from the width of outcrop and the apparently rather regular eastward dip, however, nearly 5,000 feet of beds may be present. This figure does not allow for any repetition or elimination of beds by faulting, but during the field work it was not possible to make any estimate of either the extent of faulting or its magnitude.

There is also no evidence at hand as to the age of the bedded series at Tuscarora. According to Emmons,[11] the volcanic rocks in this part of Nevada are probably of Miocene age. This suggestion, however, is based upon the relations of the volcanic rocks to sedimentary beds that in the past have been assigned to the Eocene and the Pliocene. In recent years these assignments have been questioned by some geologists, and it is probable that the true age of the rocks at Tuscarora will not be definitely known until fossils are found in the pyroclastic portions of the series.

Intrusive andesite—A dark-greenish andesite porphyry that contrasts strongly with the light-colored pyroclastic rocks and lavas is exposed at several places in the mapped area. At some of the occurrences it is clearly intrusive into the lighter-colored rocks. Thus, about 300 feet south of the north end line of the Butterfly claim the eastern contact of an andesite mass is exposed. The contact dips 65° W., and the adjacent andesite shows a banded chilled phase against the bedded rocks, which dip eastward at a low angle. Similarly about 800 feet west of south from the southeast corner of sec. 33, T. 40 N., R. 51 E., andesite is exposed with well-developed nearly horizontal columnar jointing. As this jointing is at right angles to the boundaries of the mass, its contacts with the gently dipping bedded series at this point must be nearly vertical.

Most of the andesite bodies shown on plate 1, however, are not well enough exposed to determine their relations to the adjoining rocks, and in places the rock is so altered that it cannot be confidently distinguished from the porphyritic flows in the bedded series. Many of the larger masses, however, appear to transgress the strike of the pyroclastic rocks and flows and are therefore best considered to be intrusive. An exceptionally fresh mass of the andesite crops out north of

[11] Idem, p. 35.

the Jeannette claim and exhibits columnar jointing dipping 50° NW. This indicates a dip of 40° SE. for the mass—approximately the same as that of the bedded series. This mass may therefore be either an interbedded flow or an intrusive sill, so far as its attitude is concerned. Although its contacts are not well exposed, the second alternative appears the more probable, partly because it does not show the intense alteration found in the adjoining bedded series, and partly because it is petrographically identical with some of the known intrusive bodies.

In hand specimens the andesite is a dark greenish-gray or purplish-gray rock with abundant glassy greenish feldspar phenocrysts from one-sixteenth to one-fourth inch long and less abundant and smaller dark phenocrysts in a dense dark-gray matrix. Where alteration has affected the rocks the color ranges from grayish green to light gray, and the phenocrysts are dull and obscure.

Under the microscope the feldspar phenocrysts are all found to be slightly zoned plagioclase, whose average composition is that of a calcic andesine. In many of the specimens studied this mineral is irregularly replaced by small areas of the more sodic plagioclase, albite. Such rocks also commonly contain sericite in both the phenocrysts and the groundmass. The dark phenocrysts, even in the freshest specimens, are almost entirely altered to calcite, chlorite, and iron oxides, but, to judge from their outlines, pyroxene, amphibole, and biotite were all originally present. Only the biotite pseudomorphs contain remnants of the original mineral. The matrix appears originally to have been composed of tiny laths of plagioclase in a glassy groundmass, but in most specimens is now recrystallized into a poorly defined mixture of quartz, and a feldspar more sodic than the phenocrysts.

Locally some of these andesites have been altered in the same way as the members of the bedded series, with the development of considerable amounts of potash feldspar, both in the phenocrysts and in the matrix. This feldspar is accompanied by quartz and the clay mineral dickite(?). Similarly specimens at the surface may contain considerable amounts of the mineral similar to sericite.

Gravel—All the pits and shafts along the eastern border of the area mapped show a considerable thickness of gravel, 30 feet or more being present in a shaft about 750 feet north of

EXPLANATION

ALLOCHTHON

TERTIARY
- Th — HUMBOLDT FORMATION
- Ta — ACIDIC DIKES and SILLS

UNCONFORMITY

PERMIAN
- Pbm — BUCKSKIN MOUNTAIN FORMATION

DISCONFORMITY

- Pq — QUILICI FORMATION

UNCONFORMITY

MISS.
- Mdp — DIAMOND PEAK FORMATION

ANGULAR UNCONFORMITY

SILURIAN
- Sn — NOH FORMATION

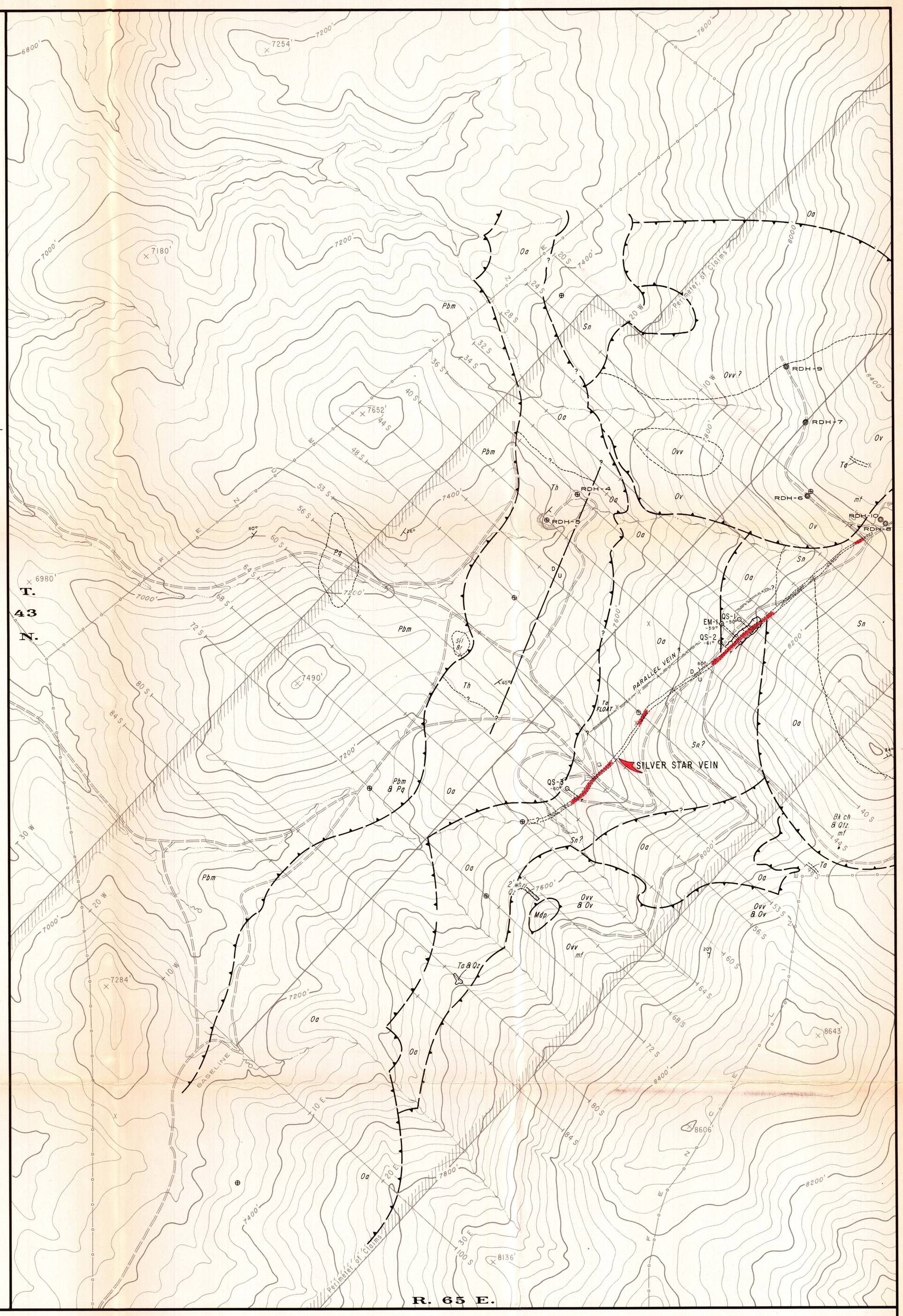
DISCONFORMITY

ORDOVICIAN
- Oa — AGORT FORMATION
- Ov / Ovv — VALDER FORMATION, Ovv, VOLCANICS

mf Mineralized Float

- EM16 (RonKa) CROSSOVER
- FAULT showing DIP
- THRUST FAULT
- CONTACT
- STRIKE and DIP
- INTERMITTENT STREAM
- UNIMPROVED ROAD
- BULLDOZER CUT

RDH-4 ROTARY DRILL HOLE
QS-1 DIAMOND DRILL HOLE



Quantex CORPORATION

TOPOGRAPHY AND GEOLOGY

SILVER STAR PROPERTY

Kit Carson Mining District

ELKO COUNTY NEVADA

500 0 500 1000 1500 2000 2500

SCALE in FEET
CONTOUR INTERVAL 40 FEET

PLATE 1

November, 1971 A.O.T.

EXPLANATION

J.E.M. (Crone) DUAL SURVEY - *High Frequency* by NORANDEX INC. (1971)

J.E.M. (Crone) DUAL SURVEY - *Low Frequency* by NORANDEX INC. (1971)

READINGS - *RESULTS in DEGREES*

COIL SPACING - *200 Feet*

-30° 0 30° 60° 90° 120°

PROFILE SCALE in DEGREES

NOISE LEVELS

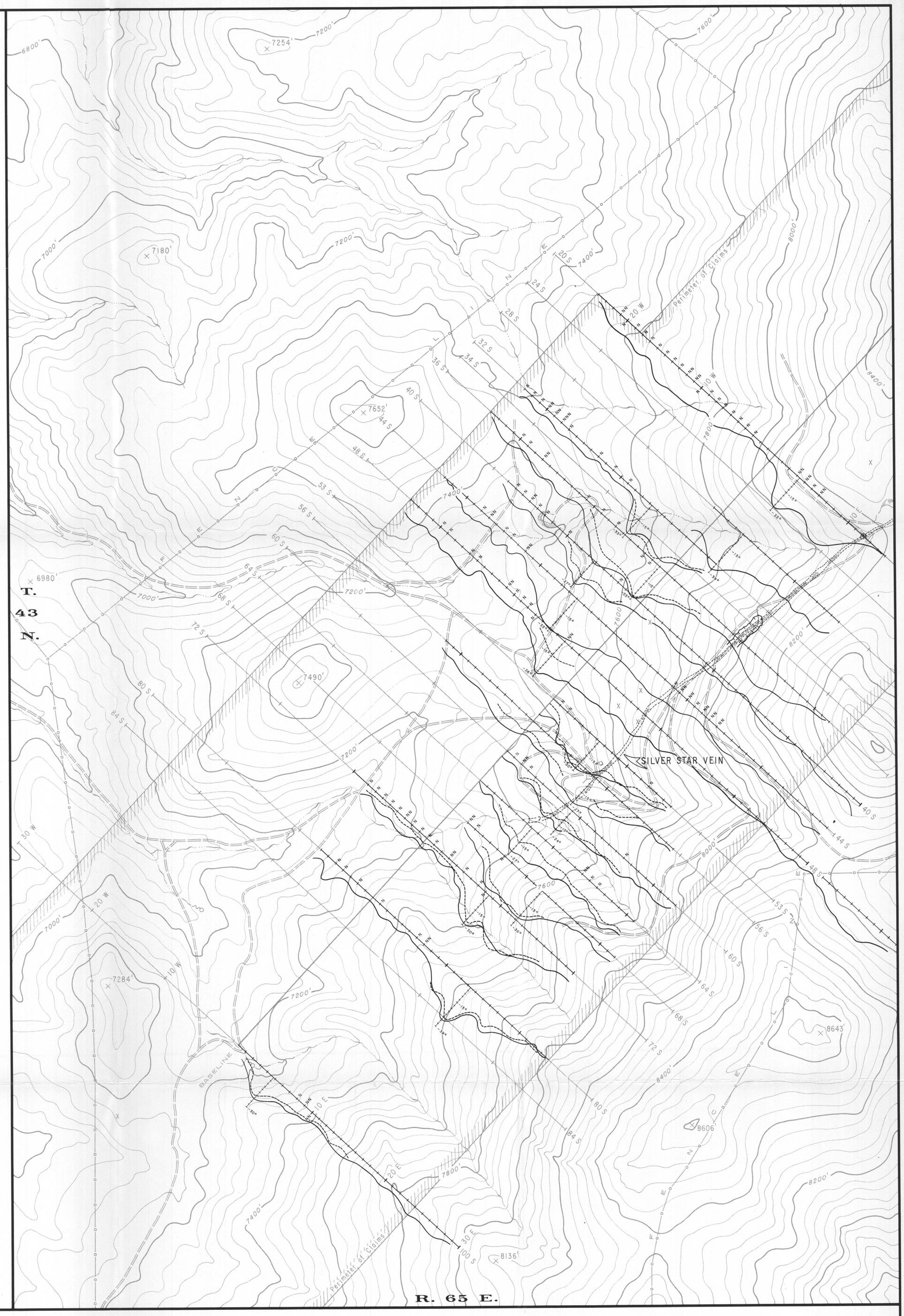
N 5° to 10°

NN 10° to 15°

NNN >15°

TRUE NORTH

17½°



Quantex CORPORATION

ELECTROMAGNETIC SURVEY

SILVER STAR PROPERTY

Kit Carson Mining District

ELKO COUNTY NEVADA

500 0 500 1000 1500 2000 2500

SCALE in FEET

CONTOUR INTERVAL 40 FEET

PLATE 2

November, 1971 A.O.T.

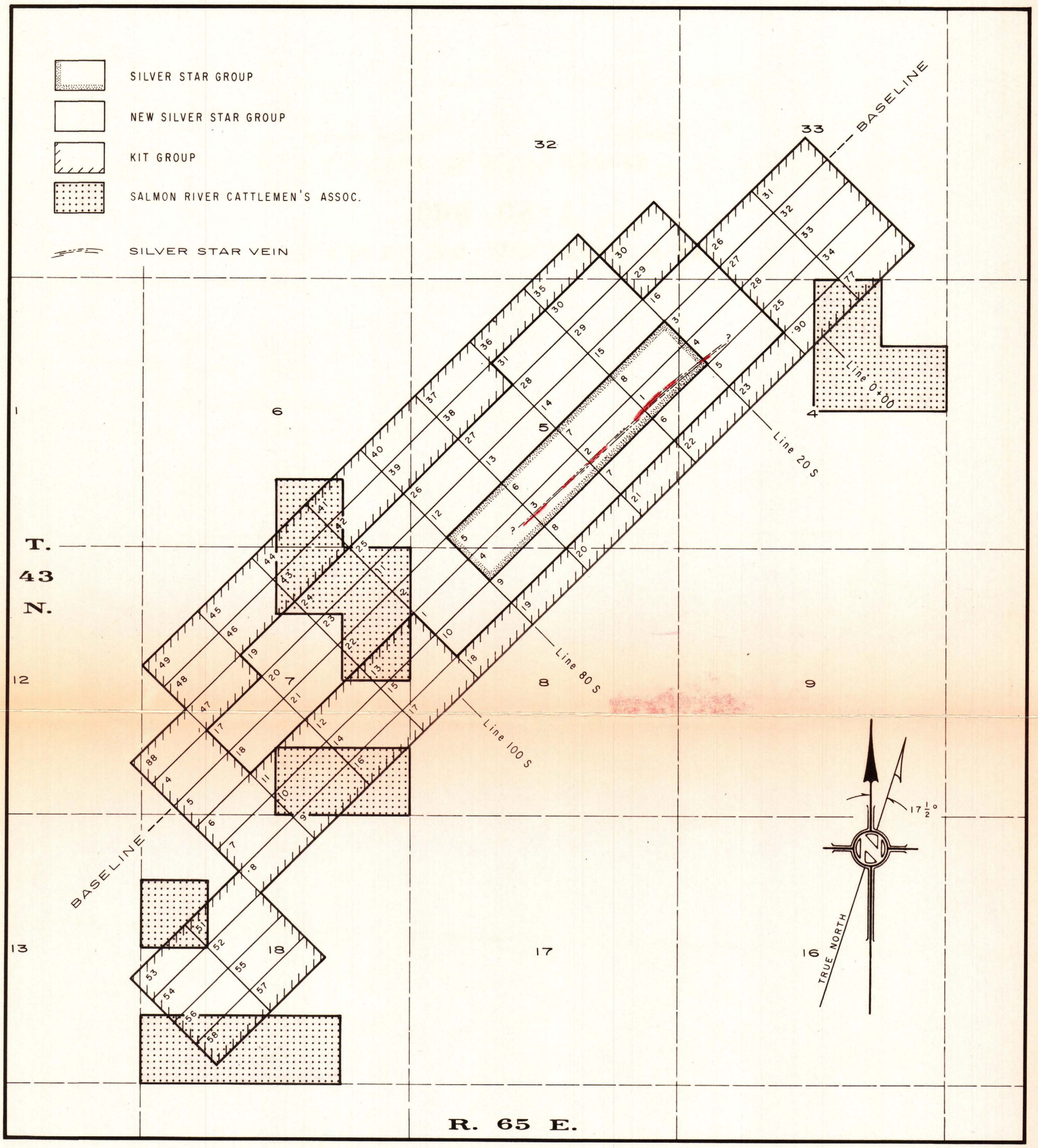


FIGURE 2

CLAIM MAP

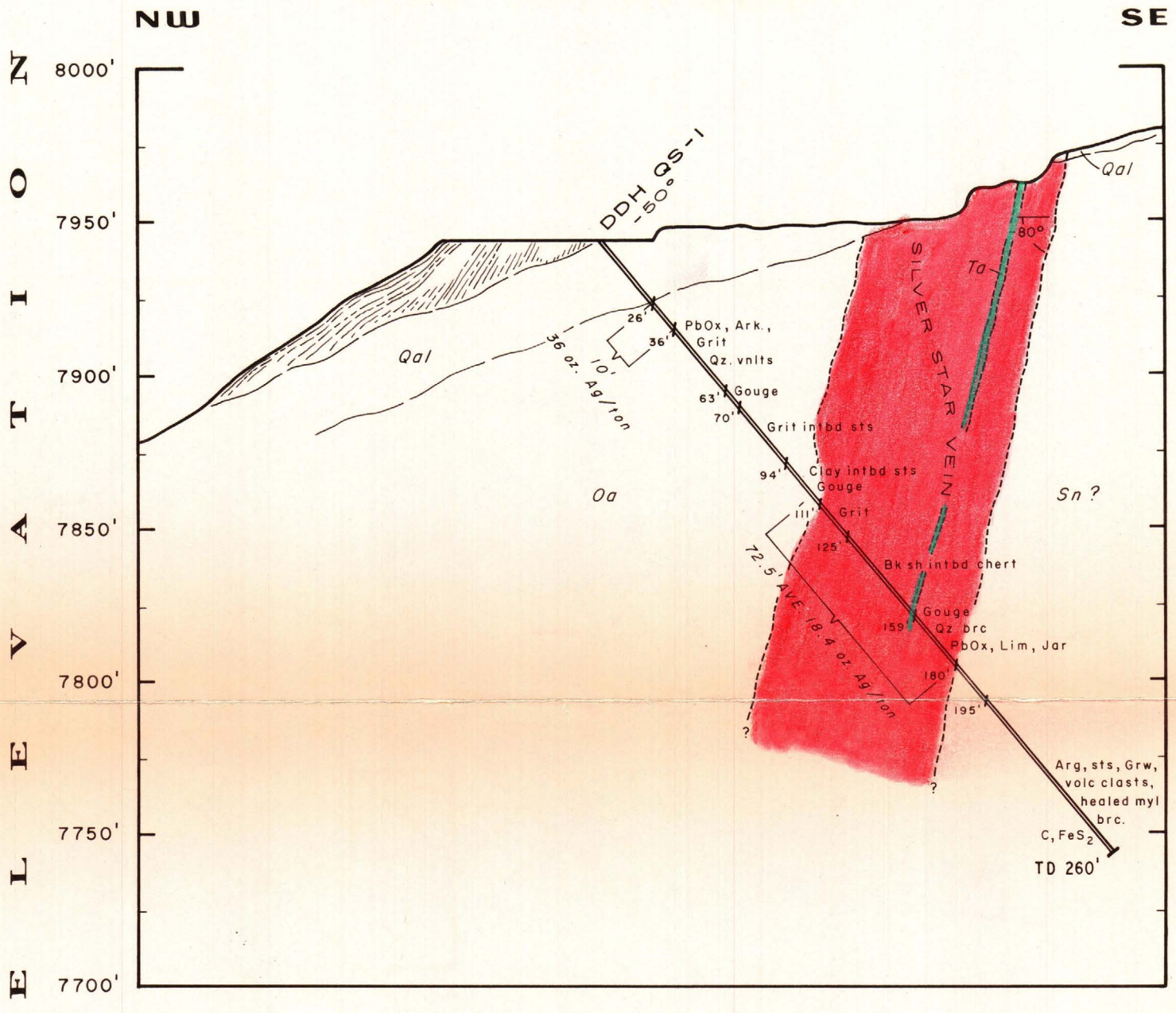
SILVER STAR, et al CLAIMS

Elko County - Nevada

2000 0 2000 4000 6000 8000 10,000

SCALE in FEET

Quantex CORPORATION



Ta	ACIDIC DIKES and SILLS
Sn	NOH FORMATION
Oa	AGORT FORMATION

FIGURE 3

LINE 34+30 SOUTH

DDH QS-1

Silver Star Property

ELKO COUNTY NEVADA

50 0 50 100 150 200

HORIZONTAL and VERTICAL SCALE in FEET

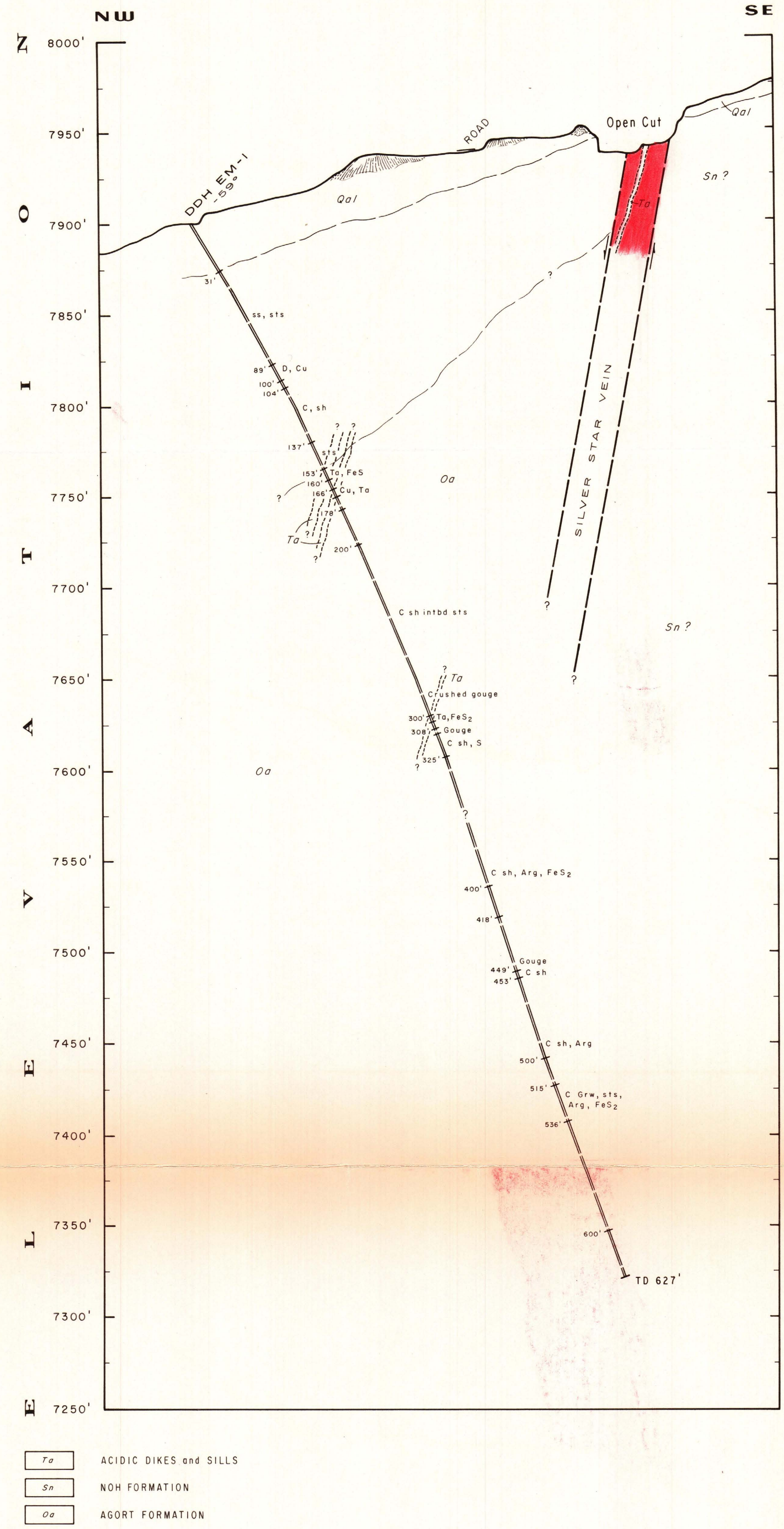


FIGURE 4

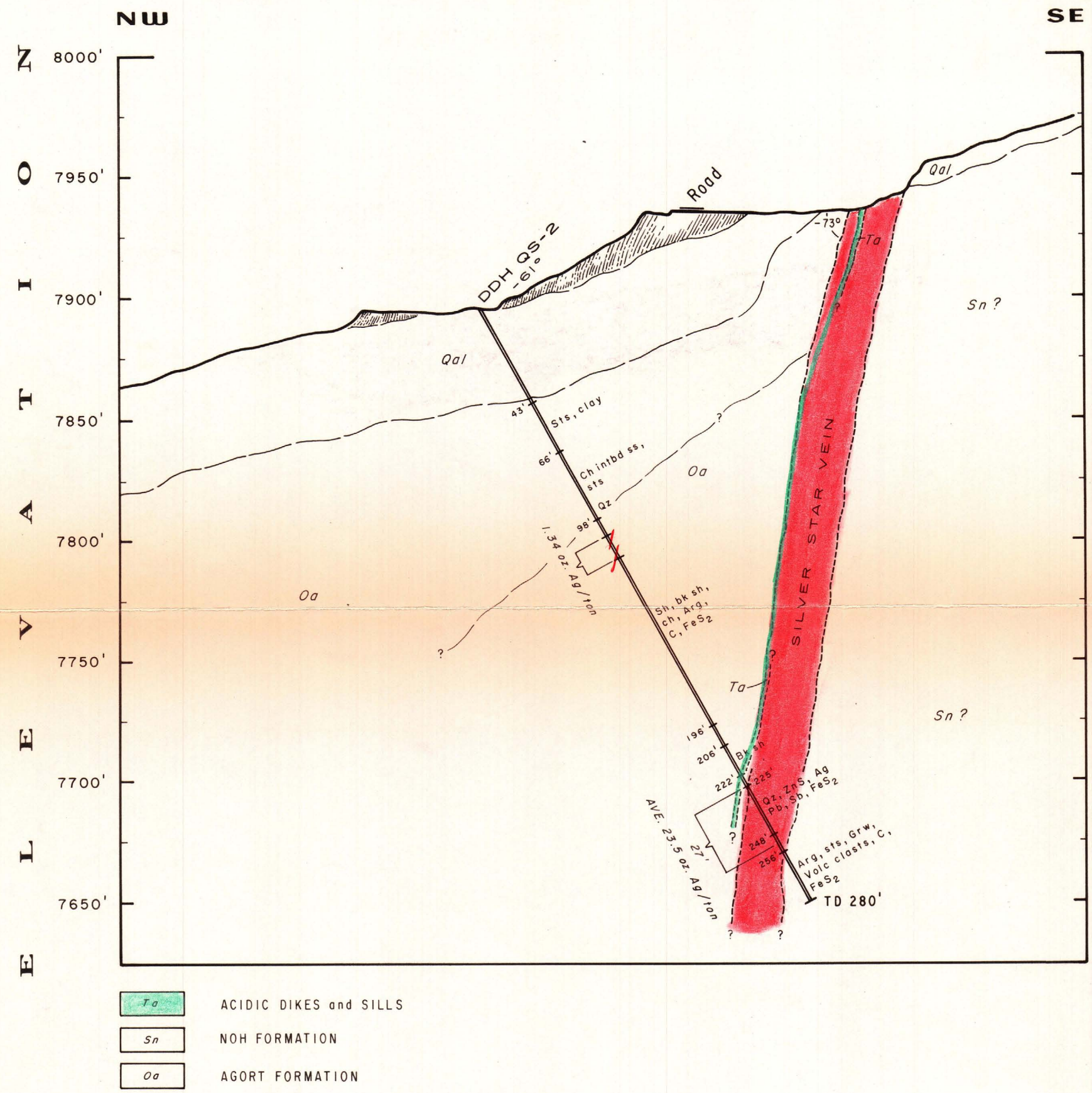
LINE 35+80 SOUTH
DDH EM-1

Silver Star Property

ELKO COUNTY NEVADA

50 0 50 100 150 200

HORIZONTAL and VERTICAL SCALE in FEET



Ta — ACIDIC DIKES and SILLS

Sn — NOH FORMATION

Oa — AGORT FORMATION

FIGURE 5

LINE 37+30 SOUTH

DDH QS-2

Silver Star Property

ELKO COUNTY NEVADA

50 0 50 100 150 200

HORIZONTAL and VERTICAL SCALE in FEET

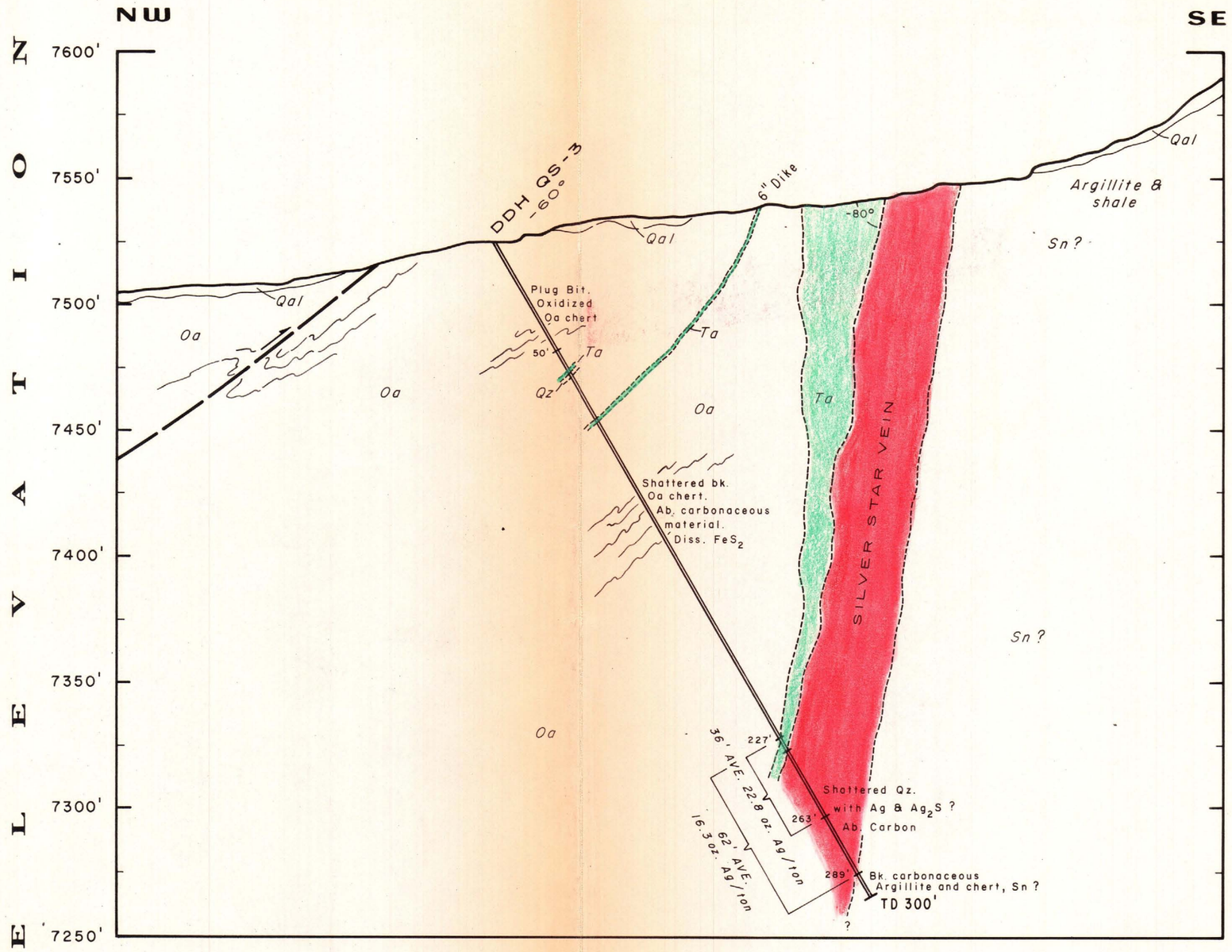


FIGURE 6

LINE 58+50 SOUTH

DDH QS-3

Silver Star Property

ELKO COUNTY NEVADA

Ta — ACIDIC DIKES and SILLS

Sn — NOH FORMATION

Oa — AGORT FORMATION

50 0 50 100 150 200

HORIZONTAL and VERTICAL SCALE in FEET

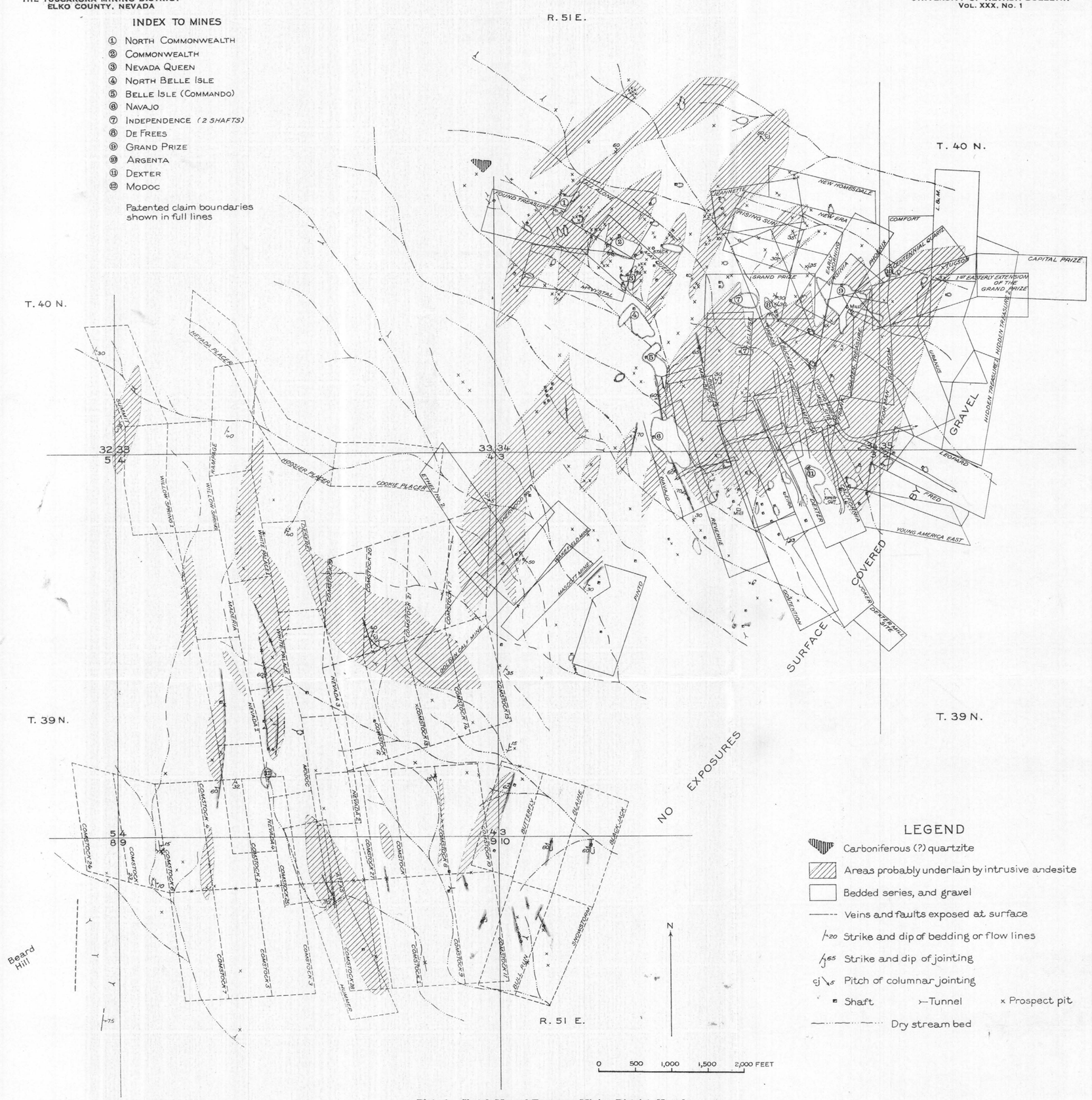


Plate 1. Sketch Map of Tuscarora Mining District, Nevada