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Tucson, Arizona
December 16, 1974

To: Mr. J.B. Imswiler
IMC

From: A.J. Perry
Perry, Knox, Kaufman, Inc.

Subject: Evaluation - World's Fair Silver Prospect
Santa Cruz Co., Arizona

Background

Mr. Paul Eimon, Tucson Consulting Geologist, presented IMC-PKK with data pertaining to the World's Fair Property, Santa Cruz County. Mr. Eimon represents Mr. Lyall Lichty, the owner.

The World's Fair is a small precious metals mine which reportedly has produced from narrow, high grade veins thru a vertical interval of +450 feet for the period 1879 thru 1942. There are currently no activities at the World's Fair. Kerr McGee is drilling out a larger, deeply buried porphyry copper deposit at Red Mountain, situated NE and within sight of the World's Fair.

Mr. Eimon indicated that there were geochemical anomalies (based on Ag assays) in an area somewhat removed from that of the old mine workings and on this basis the property possibly had more pervasive mineral potential than had heretofore been recognized.

Summary

Analyses for silver of a number of rock chip samples collected by R. Leisure of PKK failed to substantiate the anomalism developed by Essex (previous lessees of the World's Fair Property) and reported by Eimon.

Recommendation

On the bases of 1) failure to verify Essex's geochemical analyses (∴ the target areas), 2) the unrealistically high option demands of Lichty, and 3) the lack of suitable space for plant site, waste and tailings disposal on the World's Fair property or nearby -- PKK recommends that IMC take no interest in the World's Fair property, at this time.

Geology

The geology of the World's Fair Mine Area is not well known, and thereis considerable dispute about even the major rock units present. The mine itself appears to be principally in altered andesites overlain by andesite flow breccia and tuffs. The flow breccia and intercalated tuffs are the units that reportedly responded in Essex's geochemical survey.

Alteration around the old mine area is intense with silicification and argillization both being important. Megascopic rock identification in the more well altered zones is difficult and locally impossible.

Observations by Leisure during sampling indicate however that there is no pervasiveness of alteration or mineralization in the flow breccia-tuff series. Prospects along narrow vein/ structures are more common to the area of these rock types than is apparent from the aerial photos. Many of the anomalous samples of Essex may have been collected in too selective a manner.

Extent of Examination

Messrs. Imswiler and Perry briefly examined the World's Fair mine area in the company of Paul Eimon, November 14. Mr. Richard Leisure (PKK geologist-sampler) subsequently collected 38 samples from the claims area.

It was intended that the accessible mine area be sampled in at least a cursory manner, but the combination of unfavorable factors (see recommendation) resulted in an early termination of examination.

Rock Sampling/Analyses (PKK)

Reference to the attached plat will show sample locations and analyses by PKK and the areas judged by Essex to be anomalous on the basis of their survey. There is essentially no coincidence of anomalism.

Reportedly, Essex's samples were collected on a 100 to 200 foot grid by an experienced technician -- with the samples taken from within a $\pm 15'$ radius of the sample grid point.

PKK (Leisure) took samples, generally from predetermined areas -- some from the better anomalous areas, some from other locations to establish background. Select samples are so indicated on the attached sample map. Descriptions of PKK's samples and analyses are also attached. As we hoped to duplicate Essex's results, their sample points were sought and occasionally located. Sampling procedures used were the same as those described as having been used by Essex. PKK analyses were by Skyline Labs, Tucson, using AA method, with higher values being re-run by fire method. Essex values were all obtained by fire assay.

Values measured within the claims area for silver vary from 15.16 oz/ton (max.) for a dump sample to 0.01 oz/Ag.

Property Limitations

The World's Fair claims group consists of 9 unpatented lode claims principally covering a narrow NW trending canyon and an adjacent steep ridge. The property is nearly surrounded by the claims holdings of ASARCO on the south, north and west and by Kerr McGee onthe north and east. Lichty has or intends to stake some land claimed by an individual(s) situated west of the World's Fair. He says assessment has not been kept current on this land.

There is not sufficient acreage available at the World's Fair for plant site, dump or tailings should exploration on the Property indicate that production was warranted.

According to Eimon, both ASARCO and Kerr McGee have at one time or another approached Lichty to determine if his lands were available. Possibly their interest in the World's Fair is for non-mineral purposes(?).

Lichty's Proposed Deal

The following are Lichty's requirements, according to Eimon:

1. Upon execution of an Agreement.

    a. $14,000 cash to Lichty

    b. Committment to spend $100,000 on exploration during the following 8 mo. -- work to include more geology and geochemistry but also road building and the drilling of 3 holes -- at least one to a minimum depth of 1200'.

2. If continuing - 2nd 8 mo.

    a. $50,000 to Lichty

    b. $100,000 work committment

3. 3rd 8 mo. - $200,000 worth of work - no payment

4. 4th 8 mo. - $250,000 worth of work - $50,000 payment

5. 5th 8 mo. - $400,000 worth of work - $100,000 payment

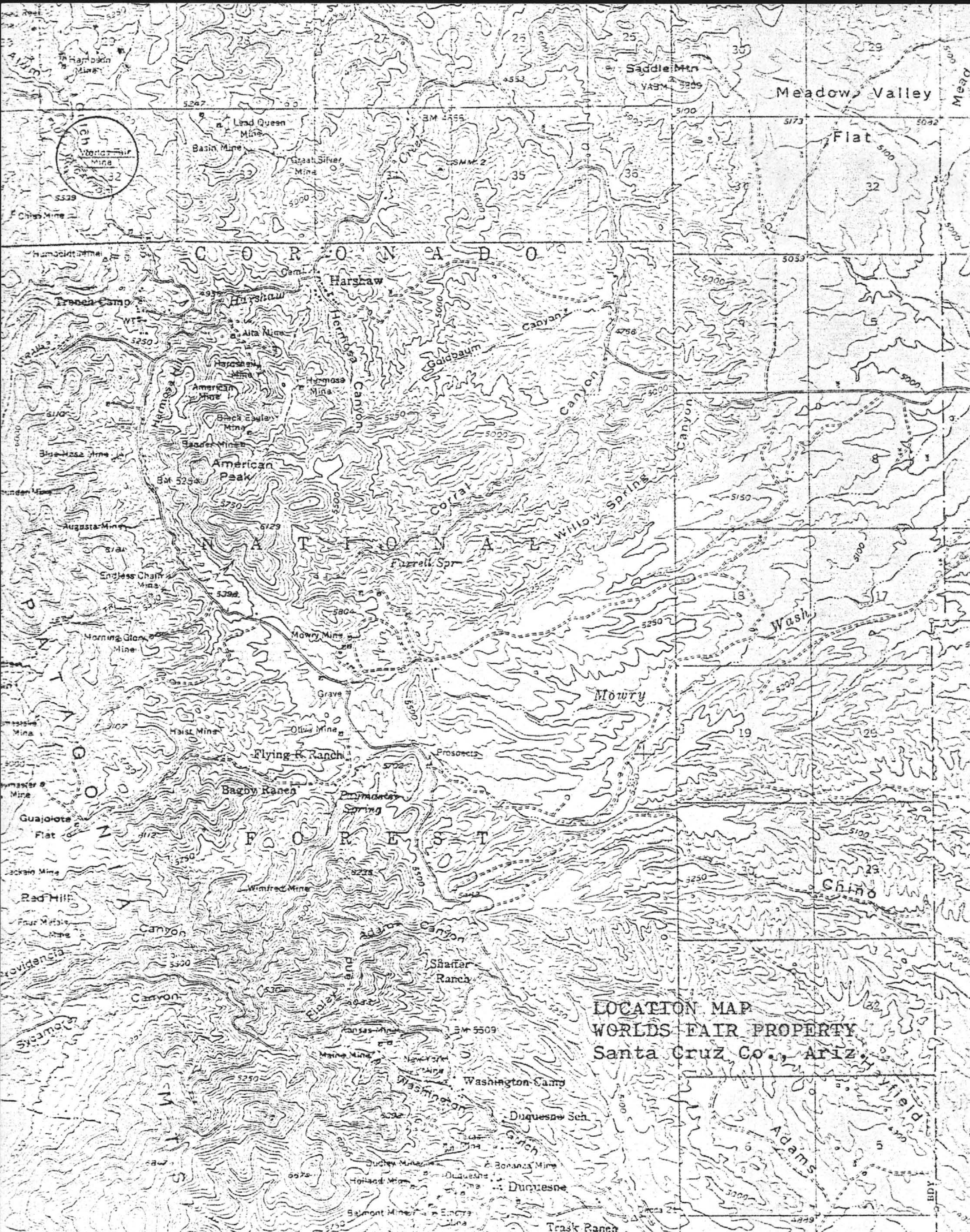
6. Lichty proposes to <u>form a Canadian styled syndicate</u> -- with IMC to furnish $500/mo. for administrative/legal costs (World's Fair Silver Inc.) - capitalized at 3 million shares - with Lichty retaining 400,000 shares, and IMC-PKK 600,000 - with 2 million shares to be sold by the Syndicate (corporation) at a $5 minimum/share -- with the total ownership of Lichty not to fall below 10%.

<u>References</u>

1. Eimon, P.; <u>World's Fair Mine</u>, Consulting report (1974) copy furnished IMC.

2. Kartchner, Wayne E., <u>The Geology and Ore Deposits of a Portion of the Harshaw District, Patagonia Mountains, Arizona</u>, PhD Thesis, University of Arizona (1944)

3. Schrader, Frank C., <u>Mineral Deposits of the Santa Rita and Patagonia Mountains, Arizona</u>, USGS Bull 582 (1915)


LOCATION MAP
WORLDS FAIR PROPERTY
Santa Cruz Co., Ariz.
CORONADO
NATIONAL
FOREST
PATAGONIA
MTS
Worlds Fair Mine
Saddle Mtn
Meadow Valley
Flat
Lead Queen Mine
Basin Mine
Great Silver Mine
Harshaw
Trench Camp
Alta Mine
Hermosa Canyon
Hermosa Mine
American Mine
Black Eagle Mine
American Peak
Goldbaum Canyon
Corral Canyon
Willow Spring Canyon
Augusta Mine
Endless Chain Mine
Farrell Spr
Morning Glory Mine
Mowry Mine
Mowry
Wash
Grave
Hoist Mine
Olive Mine
Flying R Ranch
Prospects
Bagby Ranch
Paymaster Spring
Guajolote Flat
Jackson Mine
Red Hill
Four Metals Mine
Winifred Mine
Chino
Canyon
Adams Canyon
Shaffer Ranch
Providencia Canyon
Sycamore
Kansas Mine
Maine Mine
New York Mine
Washington Camp
Washington Gulch
Duquesne Sch
Bonanza Mine
Holland Mine
Duquesne
Belmont Mine
Trask Ranch
Adams
Mayfield
Heady-Ashburn Ranch
Can

SKYLINE LABS, INC.
Hawley & Hawley, Assayers and Chemists Division
1700 W. Grant Rd., P.O. Box 50106, Tucson, Arizona 85703
(602) 622-4836

Charles E. Thompson
Arizona Registered Assayer No 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

CERTIFICATE OF ANALYSIS

ITEM NO.	SAMPLE IDENTIFICATION	Ag oz/ton	Au ppm	Ag ppm	Cu ppm
1	WF - 1	0.03			
2	2	0.09			
3	3	0.05			
4	4	0.04			
5	5	0.10			
6	6	0.09			
7	7	0.04			
8	8	0.03			
9	9	0.07			
10	10	0.14*			
11	11	0.19			
12	12	15.16*			
13	13	0.13			
14	14	0.04			
15	15	0.28			
16	16	0.04			
17	17	0.01			
18	18	0.15			
19	19	0.03			
20	20	0.44			
21	21	0.16			
22	22	0.06			
23	23	0.09			
24	24	0.31			
25	25	0.01			
26	26	0.04			
27	27	0.04			
28	28	9.96*			
29	29	0.03			
30	30	0.04			
31	31	0.03			
32	WF - 32	0.04			

TO:
PERRY, KNOX, KAUFMAN, INC.
P. O. Box 12754
Tucson, Arizona 85732

Attn: Mr. Richard Leisure

REMARKS:
Analyses by A.A.
except * by fire assay

Page 1 of 2

CERTIFIED BY:

DATE REC'D: 11/18/74
DATE COMPL.: 11/29/74
JOB NUMBER: 742281

SKYLINE LABS, INC.

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CERTIFICATE OF ANALYSIS

ITEM NO.	SAMPLE IDENTIFICATION	Ag oz/ton	Au ppm	Ag ppm	Cu ppm					
33	FLX - 1	7.54*								
34	2	4.46*								
35	72	0.03								
36	X	0.04								
37	FLX - 1969-2	0.03								
38	SUL - 10		<.02	0.01	20					

TO:

REMARKS:

CERTIFIED BY:

DATE REC'D: 11/18/74

DATE COMPL.: 11/29/74

JOB NUMBER: 742281

Geochemical Survey
World's Fair Mine Area
November 14, 15, 19 & 20, 1974
By Richard Leisure

WF-1 Brunton to Humbolt Mine dump S 30° E.
Brunton to tree in road intersection S 58½° E.
Red hematite stained 4" wide bordering fracture 7' long. 6" from Mn and limonite stained fracture with limonite somewhat disseminated 2" into wall rock. Wall Rock is mixed andesite flow Bx. Fracture runs N 36° W, dips 78° E. Fracture is probably highest grade on outcrop. Sampled across 16". Did not sample weaker hematite stained fractures 2' away with 6" of staining across fracture.

WF-2 6' x 3' outcrop on crest of hill. Location is 30' N 60° W of WF-1. Slightly fractued and partly Mn stained friable rock. Rock is andesite flow Bx or tuff with irregular fractures. Probably low grade outcrop.

Found stake 48A SE CTR ARGENTOR 4 W. C. Stake is roughly 90' S 51° W of WF-1.

WF-3 10' x 30' outcrop of fractured andesite flow Bx. Fractures unmineralized except for Mn. Fractures run N 2° W dip 65° E on 4" to 12" spacing over 20'. Outcrop located 30' SW of WF-1.

WF-4 Hematite stained crushed ? zone actually two zones intersecting. Minor zone 2" to 6" wide strike N 14° E vertical. Major zone 1' to 2' wide strike N 56° W vertical. Some of zone may be silicified fault gouge (?) or close spaced shear zone. Located 10' east of stake 48A described above.

Found cemented in base of survey (?) pipe located as follows:
Brunton to Humbolt Mine Dump is S 26½° E
Brunton to World's Fair Mill Site is N 11½° W
Brunton to top of shallow trench running downhill is about N 65° E
Brunton to low knob outcrop on other side of Flux Canyon is N 21° E.
Survey Pipe is among silicified outcrop standing 10' high. Took following two samples in more dike like structure off to one side

WF-5 Silicified white rock. origin unknown try silexite dike, outcrops like a dike. strike N 58° W dips 49° W at sample point

WF-6 Hematite stained talus below WF-5. Sampled most Fe and Mn stained fragments I could find.

WF-7 The west 10' of shallow trench running downhill. Brown gumbo clay from bottom of trench, no outcrop, some float pebbles in trench, many plant roots in sample. Trench runs N 75° E. Brunton to low knob outcrop is N 1° E . Brunton to peak above Humbolt Mine Shaft & Dump is S 28° E.

WF-8 30' section of trench, the west 15' in gumbo clay went into sample.

WF-9 The next 15' of same trench in bed rock went into sample. End of sample and trench is 10' SW of 4' x 4' x 100' deep shaft. All sections of shallow trench run in same direction and are almost in line.

WF-10 Sampled best red hematite and black Mn stained chips from dump.

WF-11 Sampled best yellow and yellow-brown limonite stained chips from dump. There are two parts to the dump with this definite color change so it was easy to sample each type color.
Brunton from shaft to peak above Humbolt Mine Dump is S 26° E.
Brunton to low knoby outcrop is N 4° W.

Next Day November 15, 1974

WF-12 Brunton to knoby outcrop is N 2° E. An about 50' tunnel running in structure 3' wide strike S 26° E dip 69° NE. Took two samples WF-12 is best dump mtl. 90% galena, 10% pyrite and oxidized mtl(PbO). 3' patch on dump may be salted (?).

WF-13 Wall rock mtl. on dump. Limonite and hematite stained rock.

WF-14 Wall rock from around mouth of tunnel. Bleached and limonite coated fractures. Rock is andesite flow Bx.

WF-15 Smaller dump from irregular pit or caved stope. Rock is andesite flow Bx. Sampled best dump mtl, ie. hematite, limonite, wad stained rock. Brunton to WF-10 is S 17° E over 50'
Picked up far traveling float hand sample perhaps altered diabase labelled as WF-15.

Shallow trench continues downhill from WF-10, took four samples. Sampling starts at base of mine dump and goes downhill.

WF-16 60' of trench, weathered and Mn stained bedrock thru 50% of distance. Shows many Mn coated irregular and all direction fractures.

WF-17 20' of trench, better exposed bedrock, less Mn staining.

WF-18 Next 20' of trench, about same Mn staing as WF-17.

WF-19 Next 35' of trench, not good bedrock, lots of washed in mtl. Trench runs about S 81° W at this end. Slight curve to trench. Trench steps 10' east at dump.

WF-20 Within sight of trench is inclined 2' x 2' x 10' deep inclined shaft with galvanized iron on dump. Sample is best dump mtl, only medium hematite, limonite, perhaps jarosite (see hand sample) stained rock. Rock is fine grained volcanic tuff. Nearby is 5' trench which I did not sample. Structure in inclined shaft is shear zone 4' wide strike N 15° W dip 43° NE.

Moved car, found stake N.W. Cor. ORB # 8

At rough man made cut in bluff. 40' x 40' outcrop of clay altered and Fe stained rock.
Brunton to car S 74° E
Brunton to tree in road intersection S 51° E
Brunton to Humbolt Mine Dump S 20° E
took following two samples:

WF-21 Hematite and limonite stained veins of (?) or silicified wall rock running thru rock, 1" to 2" thick. Sampled only one vein strike N 50° E , dip 30° S.

WF-22 Sample of bleached and clay altered wall rock. Rock looks like conglomerate but may be volcanic agglomerate since pebbles weather out. This outcrop is the largest alteration patch I have found in area so far.

Climed uphill to stake SE CTR ARGENTOR 4 W.C. Found pile of rocks possible claim corner at S 52° E from stake about 35' downhill. took following sample 25' S66° E of stake.

WF-23 Sampled heavy hematite stained crushed zone 2" to 3" wide,strike N 19° W , dip 85° NE . Rock is andesite flow Bx. This structure is probably parallel and 7' east of similar structure at sample point WF-4.

WF-24 4' x 4' x 10' deep shaft. Sampled best dump mtl. ie. yellow-brown limonite and black Mn stained, clay altered volcanics. Some red hematite, some $\frac{1}{4}$" vein altered mtl. in sample. 1' wide silicified zone in shaft strikes S 60° W , irregular to vertical dip.

Went thru abandoned road cut to stake NORTH END CTR ORB # 8, then to stake SE Cor ARGENTOR 7 50A

Climbed to top of hill north of car, jumbled rock not a good clean outcrop, however collected two following samples.

WF-25 Heavy Mn stained rock, this is heaviest Mn staining I have seen in area.

WF-26 Close spaced (1") hematite stained veinlets. Collected hand specimen also. Called it Zebra Rock.
Brunton to WF-5 is N 75° W
Brunton to an unknown mine dump is S 55° W

WF-27 Came downhill found shallow 2' cut 10' x 20' along slope, this may be anomalous area on map. Sampled best dump mtl.

Drove to Humbolt Mine , 5 adits and a wood compartment shaft. Shaft has water at 20'.

WF-28 Sampled best pyrite and quartz on Humbolt shaft dump. Took hand specimen of "log jam form" quartz.

Drove back to stream crossing in Flux Canyon

WF-29 Sampled soft hematite seam and altered rock (clay) in bluff just above adit that runs in diabase. Took hand specimen also. Sample may be very altered diabase. Shear (?) zone 5' wide. Adit runs N 61° E, adit has 1' of water in it and small concrete dam at mouth.

WF-30 2' x2' x 4' deep pit just off of road. Rock is weathered volcanics. Sample is best dump mtl. ie. not strong Mn and Limonite stained rock,

WF-31 Sampled Mn stained volcanics along east edge of road. Took only Mn stained fragments in sample.

WF-32 Limonite and Mn stained 10' x10' outcrop on south side of gully. Opposite flagging of previous geochem survey.

Drove to Flux Mine Glory Hole within sight of road. took following FLX samples:

FLX-1 Heaviest Mn psilomelane around glory hole.

FLX-2 Best hematite (porous, siliceous) aroung glory hole.

FLX-72 Drill hole cutting around #72 drill hole

FLX-X Drill hole cuttings around un-numbered drill hole.

FLX-1969-2 Drill cuttings around # 1969-2 drill hole.

November 19, 1974

WF-33 Found orange flagging in tree 50' S 30° W of prospect dump. Hung red & orange flagging also. Sample is chips from float cobbles and some whole pebbles. Fe and Mn stained. Nothing spectacular here. No outcrop, no structure. Rock is rhyolite, some silicified beyond recognition, some Fe staining thruout (disseminated) See hand specimen.

Went to white-washed pile of rocks, old claim corner(?) no identification. Five pieces of orange flagging in bushes.
Brunton to rock peak S 57° W
Brunton to lower rock peak N 50° W took following sample:

WF-34   Sample is chips from loose float cobbles and pebbles Some Mn and Fe staining, some red hematite staining. Some pieces silicified with visible pyrite $\frac{1}{2}$%. I hung red and orange flagging in white-washed rock pile.

Went uphill and found stake EE CTR ARGENTOR 8
WE CTR ARGENTOR 9 5A

Went over crest of hill and found black round 4" fiber pipe post with paper reading: Affidavid of Performance of Drilling as Location Work, ORB #3, #4, #5, #6. in ORB #5 - four 10' holes located approx. 150' W from location monument etc. Book 150 page 502-505 dated 11/13/72.

Found faded orange flagging in tree 5' from pile of rocks, possibly old claim corner. Brunton to Rock Picacho S 41° W . Took following sample:

WF-35   Loose rock float, picked up pebbles, some chips, finally found 2 solid outcrops, got lots of outcrop. Rock is rhyolite flow Bx. Also took hand specimen.

WF-36   Found red flagging in pine tree. Brunton to nearest rock picacho is S 76° W . Brunton to previous uppermost picacho is N 59° W Sampled "ripped up" ground float under and around pine tree. Found tin foil sample marker # S-67 on ground. Sample is lots of orange-red hematite stained rock, some xln Mn, some quartz. Rock is rhyolite flow Bx. with much hematite alteration.

Went downhill and found stake NE COR ARGENTOR 9 11B

WF-38   Found orange flagging. Sample 20 lbs of cobble float, some Fe and Mn staining, no outcrop, in shallow gully. I flagged orange-red no number.

WF-39   Found orange flagging. Sample is float cobbles broken in half. No outcrop, Some silicification, some Fe & Mn staining. Rock is andesite (?) flow Bx.

Remeasured to WF-15 it corresponds to dump which has 1.05 value on previous geochem survey. Can see faded orange flagging near irregular pit.

WF-40   Best pyrite, sphalerite (?), quartz on Trench (Josephene) Mine Dump. 20' from road.

November 20, 1974

WF-41   Found orange flagging in tree. Sampled some outcrop, some float. Rock is fine grained gray-green rhyolite flow or tuff

10' away is 10' x 10' x 4' deep hole with dump and with a minor trench above it, took following sample:

WF-42 Sampled best dump mtl. ie. Fe and Mn crusted rhyolite. I hung red and orange flagging at both sample points 41 and 42.

WF-43 Found blue and yellow flagging in tree. No outcrop. Sampled float cobbles broken in two. Rock is fine grained silicified volcanics with Mn staining.

WF-44 Found faded orange flagging in tree 50' east of WF-43, my location may be wrong. No outcrop. Sampled float. Rock is fine grained silicified volcanics with Mn staining.

WF-45 Found faded orange flagging in bush. No outcrop, sampled float. Rock is same as 43 and 44. Broke large cobbles in two.

WF-46 Found faded orange flagging in bush. Went farther north into woods about 50'. Sampled float, many epidote and Mn coated fractures, also Fe stained fractures. Broke cobbles in two.

CHF -1 Sampled best quartz and pyrite on dump of Chief Mine Shaft slightly caved with galvanized water tank fallen into mouth of shaft. Head frame fallen to ground. Some tunnels or caved stopes still open.

Report prepared by owners.

WORLD'S FAIR MINE

ABSTRACT

The World's Fair Mine, located in the northern Patagonia Mountains of Santa Cruz County, Arizona was discovered by early Spanish explorers and was intermittently operated by Americans from 1879 through 1942. Production records are incomplete but the mine has probably produced well in excess of 200,00 ounces of silver along with some gold and substantial amounts of lead from narrow, high veins.

The veins that have been mined occur in a northwest trending diorite intrusive that is bounded by andesite flows on the east and a west dipping fragmental rhyolite or ignimbrite on the west. Hydrothermal alteration and limonite mineralization appears to extend beyond the limits of the narrow veins, and preliminary sampling has shown that, in places, these altered zones contain more that 1/2 ounce of silver. An initial grid geochemical sampling program, undertaken to determine the range and extent of silver values at the surface has discovered a large area of anomalous silver values in a previously unprospected portion of the claims on a steep, brush covered slope south of the old workings. Over an area of some 1700 feet long by approximately 400 feet wide silver values jump from a background of 0.05 ounce per ton to a range of 0.20 ounce to 2.05 ounces per ton. If one half of this anomalous area represents the leached surface outcrop of a body containing mineable amounts of silver it would contain 30,000 tons per vertical foot or 15 million tons if extended to a depth of 500 feet. Although the property available for option is limited to 9 claims of about 175 acres, sufficient room exists for development of a large tonnage. Little geologic data exists on the outcrop characteristics of bulk silver occurrences but the potential value of a large tonnage of several ounce silver ore justifies additional work on the World's Fair property.

Darwin

More detailed geological mapping, geochemical sampling, the building of a short road, and three to five rotary or diamond drill holes are recommended for further testing of the larger anomalous silver area and the ground underlying the old World's Fair mine workings.

WORLD'S FAIR PROSPECT

SANTA CRUZ COUNTY, ARIZONA

The World's Fair mine and property consists of nine unpatented claims lying approximately 10 miles by road south of the town of Patagonia, Arizona in T22S, R16E, Section 21 of Santa Cruz County. Patagonia is a small town situated 20 miles northeast of the city of Nogales, Arizona which lies on the Arizona-Mexico border.

The World's Fair mine was discovered by early Spanish prospectors and was first located in 1897 by a Mr. McNamee. The mine is described in Bulletin 582 of the United States Geologic Survey, "Mineral Deposits in the Santa Rita and Patagonia Mountains, Arizona," by Frank C. Schrader (1915). The write-up on pages 248 through 251 from Schrader's report follows as the next page in this report.

Records of shipments from the property indicate the following ore was produced during the period 1937-1942:

Year	Tons	Gold oz/T	Silver oz/T	Lead %
1937	538	.025	22.1	16.6
1938	198	.065	151.7	7.3
1939	526	.139	107.1	7.6
1940	200	.21	65.4	7.8
1941	167	.04	98.2	9.3
1942	53	.01	12.4	22.2

In 1963 the mining claims lapsed and the property was acquired by staking by the Platoro Corporation. Platoro Corporation was one of the Thayer Lindsley companies and the field engineer directing the staking of the claims in 1963 was Lyall Lichty who at that time was part owner of Platoro. Lichty has continued to supervise the assessment work on the claims and has maintained his participation in the property to the present date.

Geology

Geology in the immediate area of the World's Fair mine has not been mapped in detail and some features of existing maps may be inaccurate. Rock types known in the area are volcanic flows, intrusive diabase, and a series of conglomerates and agglomerates.

The area is one of rugged topography cut by many canyons. Several former producing mines are found adjacent to the World's Fair property. Adjoining to the south is the January-Tranch property which was operated for 20 years by ASARCO. To the northwest about a mile is the Flux property operated by ASARCO and later by Nash and McFarland. These properties produced silver-lead-zinc ores with small amounts of copper and gold from fault zones in the Tertiary sedimentary rocks.

The World's Fair property is mostly underlain by diabase with an exposure to Chief conglomerate overlies diabase and dips at an angle of 70 degrees to the northeast. Various rhyolite dikes intrude the diabase. Fault zones, more or less mineralized, cut through the diabase. One large fault related to the ore mined, strikes north 70 degrees east and dips 70 degrees northwest.

Alteration and mineralization on the World's Fair property includes a number of vein breccia and alteration zones and possible areas of stock-work mineralization. These should be mapped in more detail.

Current exploration activity in the area surrounding the World's Fair area is intense. Kerr-McGee has discovered a porphyry copper deposit in several hundred million ton class immediately northeast of the World's Fair. ASARCO is conducting exploration for silver and copper immediately south of the World's Fair property. Other companies are exploring the ground to the southwest of the World's Fair property.

The mine is developed by a main level tunnel about 1180 feet long from which most of the ore was extracted. At a point about 680 feet underground from the adit portal is an internal shaft 348 feet deep with levels at 99, 148, 188, 252 and 348 feet below the collar. above the main level is an upper level with stopes reaching through to surface. Farther up the slope is a short level, designated the uppermost level, from which good ore was extracted but which did not reach the downward extension of ore found at surface.

The stopes are found mainly on two vein systems designated as the hanging wall zone and the footwall zone. The main stope on the footwall zone occurs on the contact of diabase and conglomerate. A strong fault cutting the veins almost at right angles is observed in the shaft station on the main level.

Some 1,000 feet in a northeasterly direction from the main level adit is a second adit which produced some high grade ore, remnants of which remain.

When Platoro Corporation acquired the property, the main level was cleaned out and made accessible and the upper level and the uppermost levels were partially cleaned out. The main level was surveyed and a start was made for the preparation of diamond drill locations to search for ore extensions. No attempt was made to pump out the water from the internal shaft, but the flow is not great and this could be done without difficulty.

The Platoro Corporation, because of other exploration demands, did not undertake the recommended diamond drilling of geologic mapping they had planned.

Present data on the World's Fair mine claims indicates an interesting precious metal-base metal prospect with significant bulk silver potential. Geochemical values shown in the initial surface sampling indicate silver, lead and copper associated with fracturing the diabase, and show silver values from .05 to 2.75 ounces per ton, lead values to

3.85%, and copper values to 1,000 parts per million. The exploration target indicated can be tested cheaply by further geological mapping, geochemical sampling, the construction of a short road, and rotary exploratory holes. This will be done to see if a commercial precious metal-base metal deposit underlies the geochemical anomaly and/or the old World's Fair workings. The property is available on favorable option terms.

WORLD'S FAIR MINE.

The World's Fair mine is near the center of the western part of the district, 2 miles west of Harshaw, on Alum Gulch, at an elevation of about 4,680 feet. (See Pls. I and II, in pocket.)

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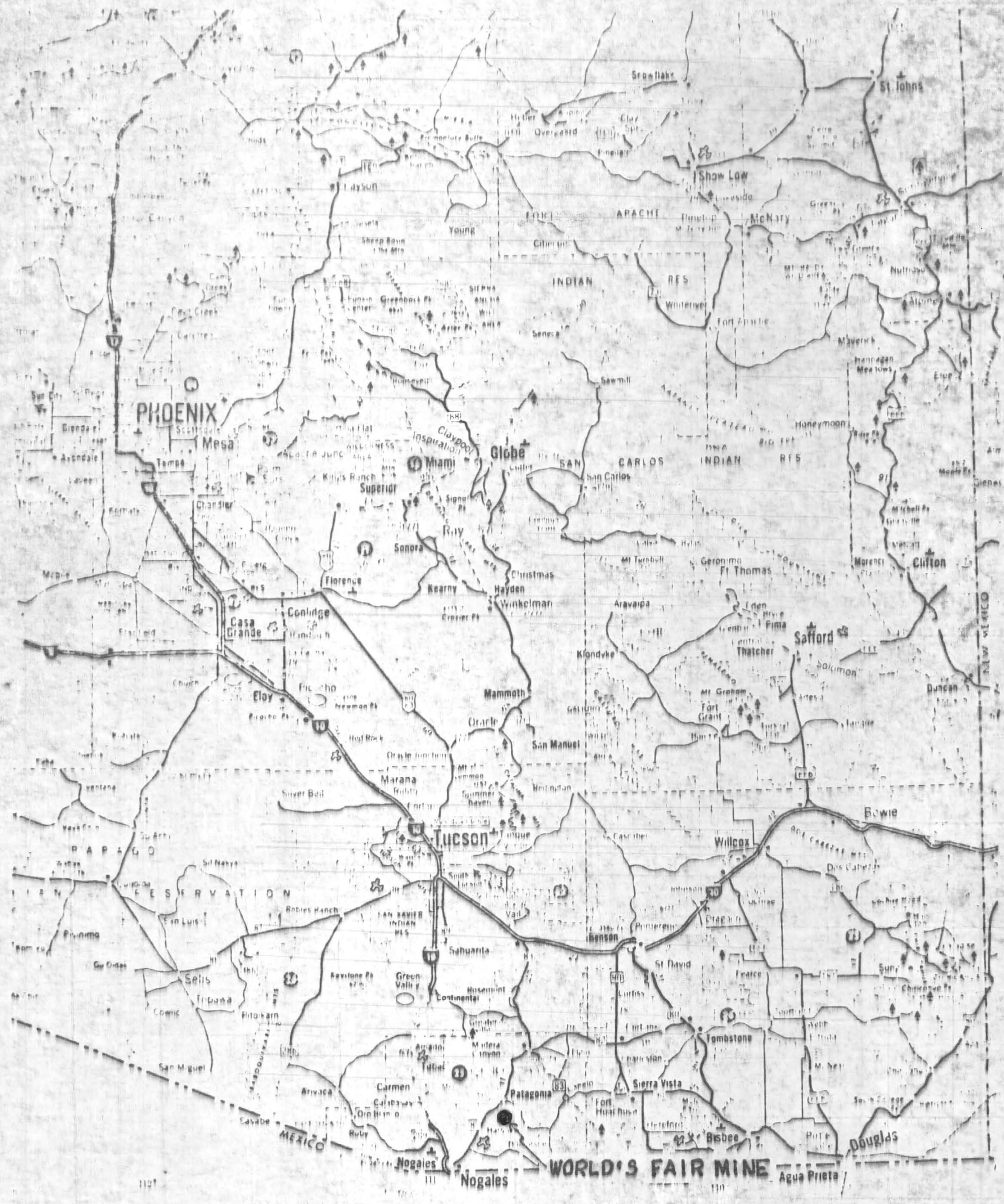

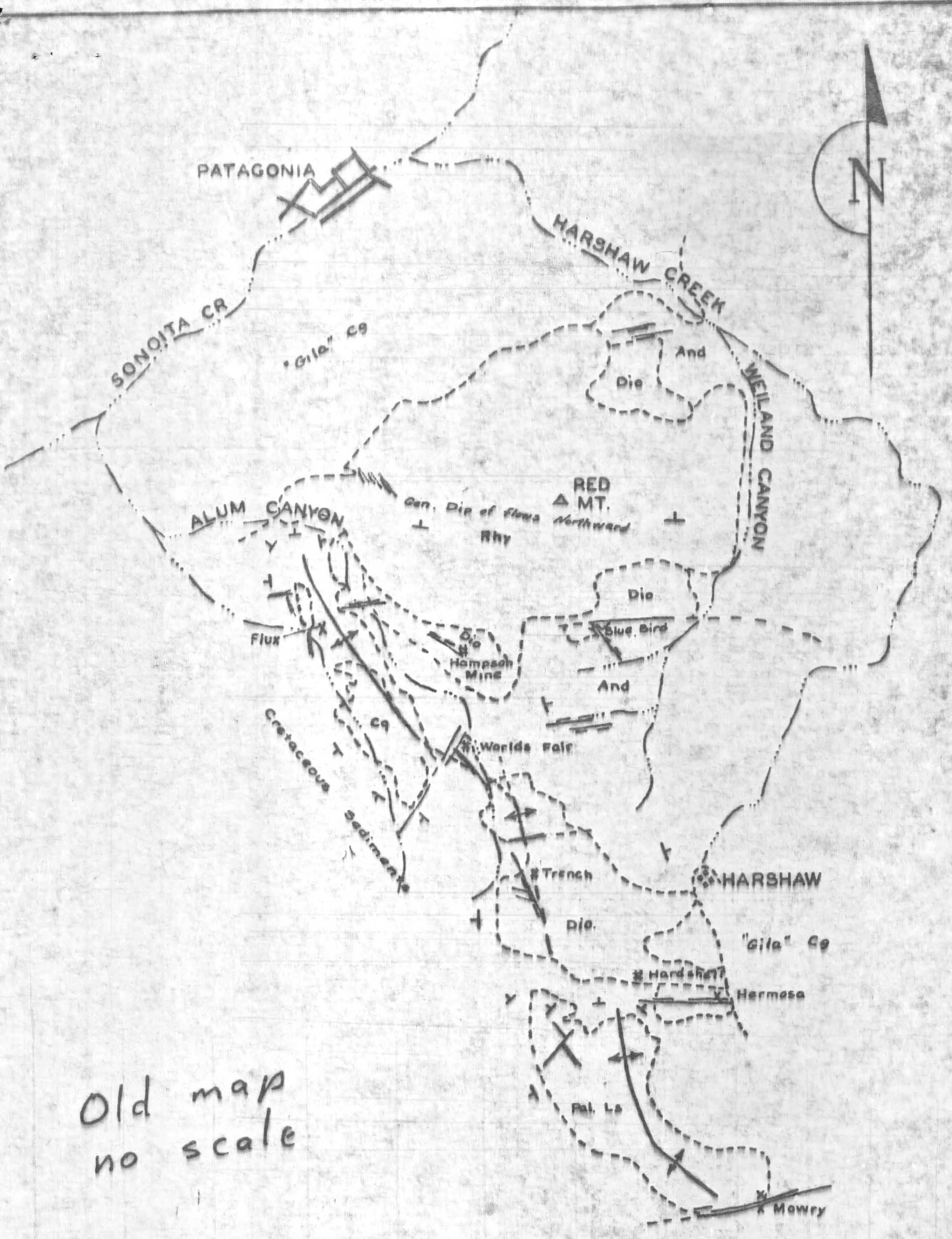

Old map
no scale

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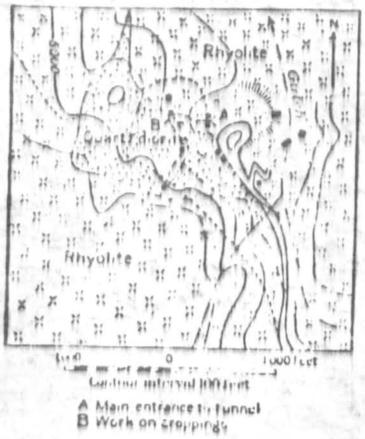

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Report Prepared by owners.

WORLD'S FAIR MINE

ABSTRACT

The World's Fair Mine, located in the northern Patagonia Mountains of Santa Cruz County, Arizona was discovered by early Spanish explorers and was intermittently operated by Americans from 1879 through 1942. Production records are incomplete but the mine has probably produced well in excess of 200,00 ounces of silver along with some gold and substantial amounts of lead from narrow, high veins.

The veins that have been mined occur in a northwest trending diorite intrusive that is bounded by andesite flows on the east and a west dipping fragmental rhyolite or ignimbrite on the west. Hydrothermal alteration and limonite mineralization appears to extend beyond the limits of the narrow veins, and preliminary sampling has shown that, in places, these altered zones contain more that 1/2 ounce of silver. An initial grid geochemical sampling program, undertaken to determine the range and extent of silver values at the surface has discovered a large area of anomalous silver values in a previously unprospected portion of the claims on a steep, brush covered slope south of the old workings. Over an area of some 1700 feet long by approximately 400 feet wide silver values jump from a background of 0.05 ounce per ton to a range of 0.20 ounce to 2.05 ounces per ton. If one half of this anomalous area represents the leached surface outcrop of a body containing mineable amounts of silver it would contain 30,000 tons per vertical foot or 15 million tons if extended to a depth of 500 feet. Although the property available for option is limited to 9 claims of about 175 acres, sufficient room exists for development of a large tonnage. Little geologic data exists on the outcrop characteristics of bulk silver occurrences but the potential value of a large tonnage of several ounce silver ore justifies additional work on the World's Fair property.

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More detailed geological mapping, geochemical sampling, the building of a short road, and three to five rotary or diamond drill holes are recommended for further testing of the larger anomalous silver area and the ground underlying the old World's Fair mine workings.

WORLD'S FAIR PROSPECT
SANTA CRUZ COUNTY, ARIZONA

The World's Fair mine and property consists of nine unpatented claims lying approximately 10 miles by road south of the town of Patagonia, Arizona in T22S, R16E, Section 21 of Santa Cruz County. Patagonia is a small town situated 20 miles northeast of the city of Nogales, Arizona which lies on the Arizona-Mexico border.

The World's Fair mine was discovered by early Spanish prospectors and was first located in 1897 by a Mr. McNamee. The mine is described in Bulletin 582 of the United States Geologic Survey, "Mineral Deposits in the Santa Rita and Patagonia Mountains, Arizona," by Frank C. Schrader (1915). The write-up on pages 248 through 251 from Schrader's report follows as the next page in this report.

Records of shipments from the property indicate the following ore was produced during the period 1937-1942:

Year	Tons	Gold oz/T	Silver oz/T	Lead %
1937	538	.025	22.1	16.6
1938	198	.065	151.7	7.3
1939	526	.139	107.1	7.6
1940	200	.21	65.4	7.8
1941	167	.04	98.2	9.3
1942	53	.01	12.4	22.2

In 1963 the mining claims lapsed and the property was acquired by staking by the Platoro Corporation. Platoro Corporation was one of the Thayer Lindsley companies and the field engineer directing the staking of the claims in 1963 was Lyall Lichty who at that time was part owner of Platoro. Lichty has continued to supervise the assessment work on the claims and has maintained his participation in the property to the present date.

Geology

Geology in the immediate area of the World's Fair mine has not been mapped in detail and some features of existing maps may be inaccurate. Rock types known in the area are volcanic flows, intrusive diabase, and a series of conglomerates and agglomerates.

The area is one of rugged topography cut by many canyons. Several former producing mines are found adjacent to the World's Fair property. Adjoining to the south is the January-Tranch property which was operated for 20 years by ASARCO. To the northwest about a mile is the Flux property operated by ASARCO and later by Nash and McFarland. These properties produced silver-lead-zinc ores with small amounts of copper and gold from fault zones in the Tertiary sedimentary rocks.

The World's Fair property is mostly underlain by diabase with an exposure to Chief conglomerate overlies diabase and dips at an angle of 70 degrees to the northeast. Various rhyolite dikes intrude the diabase. Fault zones, more or less mineralized, cut through the diabase. One large fault related to the ore mined, strikes north 70 degrees east and dips 70 degrees northwest.

Alteration and mineralization on the World's Fair property includes a number of vein breccia and alteration zones and possible areas of stock-work mineralization. These should be mapped in more detail.

Current exploration activity in the area surrounding the World's Fair area is intense. Kerr-McGee has discovered a porphyry copper deposit in several hundred million ton class immediately northeast of the World's Fair. ASARCO is conducting exploration for silver and copper immediately south of the World's Fair property. Other companies are exploring the ground to the southwest of the World's Fair property.

The mine is developed by a main level tunnel about 1180 feet long from which most of the ore was extracted. At a point about 680 feet underground from the adit portal is an internal shaft 348 feet deep with levels at 99, 148, 188, 252 and 348 feet below the collar. above the main level is an upper level with stopes reaching through to surface. Farther up the slope is a short level, designated the uppermost level, from which good ore was extracted but which did not reach the downward extension of ore found at surface.

The stopes are found mainly on two vein systems designated as the hanging wall zone and the footwall zone. The main stope on the footwall zone occurs on the contact of diabase and conglomerate. A strong fault cutting the veins almost at right angles is observed in the shaft station on the main level.

Some 1,000 feet in a northeasterly direction from the main level adit is a second adit which produced some high grade ore, remnants of which remain.

When Platoro Corporation acquired the property, the main level was cleaned out and made accessible and the upper level and the uppermost levels were partially cleaned out. The main level was surveyed and a start was made for the preparation of diamond drill locations to search for ore extensions. No attempt was made to pump out the water from the internal shaft, but the flow is not great and this could be done without difficulty.

The Platoro Corporation, because of other exploration demands, did not undertake the recommended diamond drilling of geologic mapping they had planned.

Present data on the World's Fair mine claims indicates an interesting precious metal-base metal prospect with significant bulk silver potential. Geochemical values shown in the initial surface sampling indicate silver, lead and copper associated with fracturing the diabase, and show silver values from .05 to 2.75 ounces per ton, lead values to

3.85%, and copper values to 1,000 parts per million. The exploration target indicated can be tested cheaply by further geological mapping, geochemical sampling, the construction of a short road, and rotary exploratory holes. This will be done to see if a commercial precious metal-base metal deposit underlies the geochemical anomaly and/or the old World's Fair workings. The property is available on favorable option terms.

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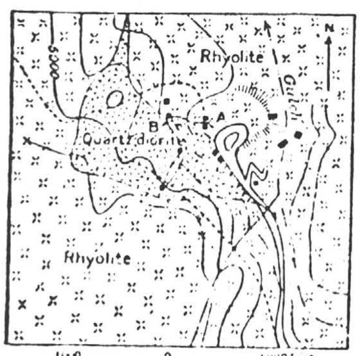

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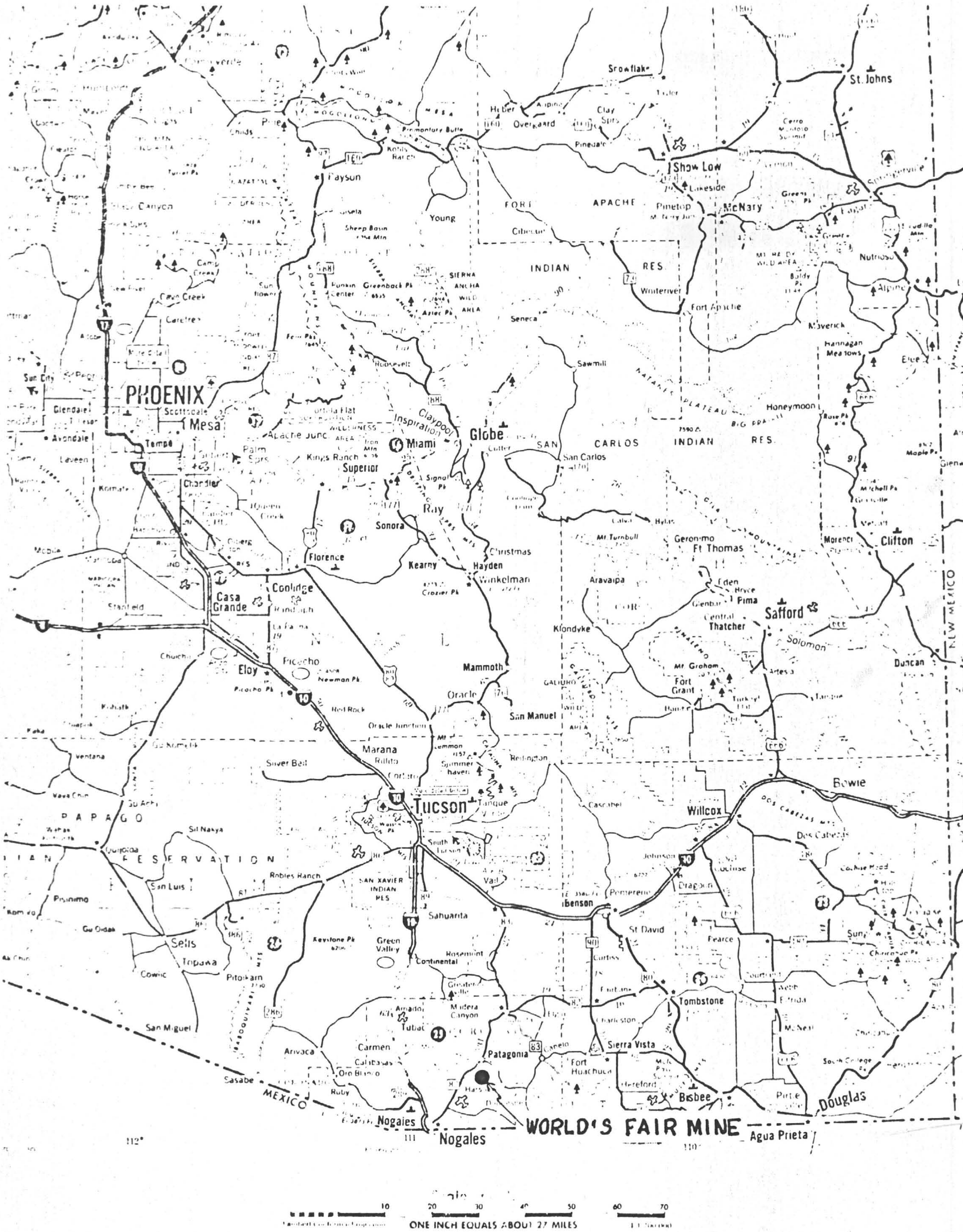

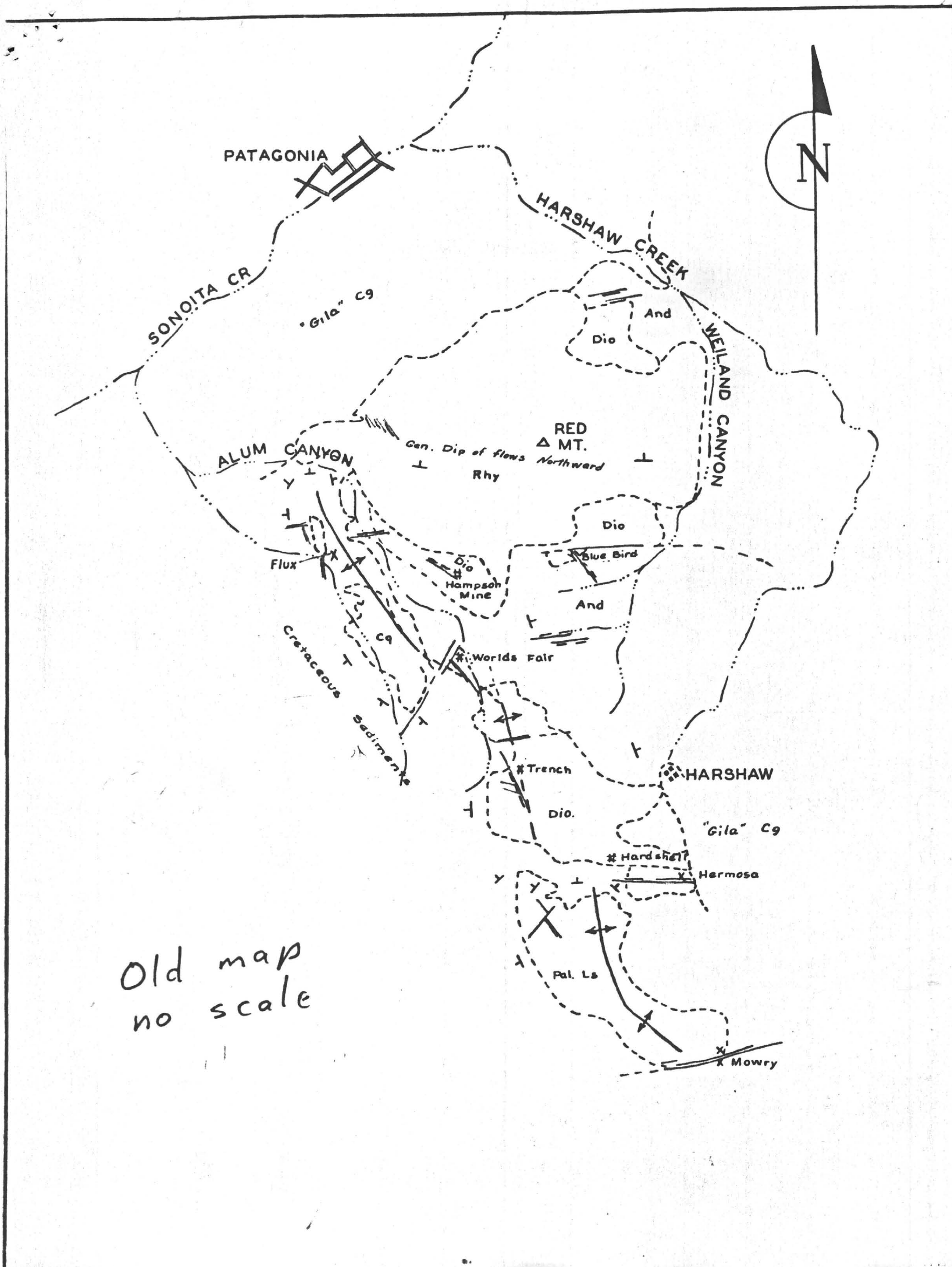
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SONOITA CR
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Worlds Fair
Trench
HARSHAW
Dio.
"Gila" Cg
Hardshell?
Hermosa
Pal. Ls
Mowry
Old map
no scale

OFFICES:
TUCSON, ARIZONA (BUSINESS)
2343 E. BROADWAY, SUITE 206
P. O. BOX 12754, ZIP 85732
TELEPHONE (602) 622-0582
SPOKANE, WASHINGTON
NORTH 20 PINES ROAD, SUITE 21
P. O. BOX 14336, ZIP 99214
TELEPHONE (509) - WA 4-0878

PERRY, KNOX, KAUFMAN, INC.

MINERAL EXPLORATION AND DEVELOPMENT

Tucson, Arizona
December 23, 1974

Mr. Lyall Lichty
C/O Mr. Paul Eimon
Essex International, Inc.
1704 West Grant Road
Tucson, Arizona 85705

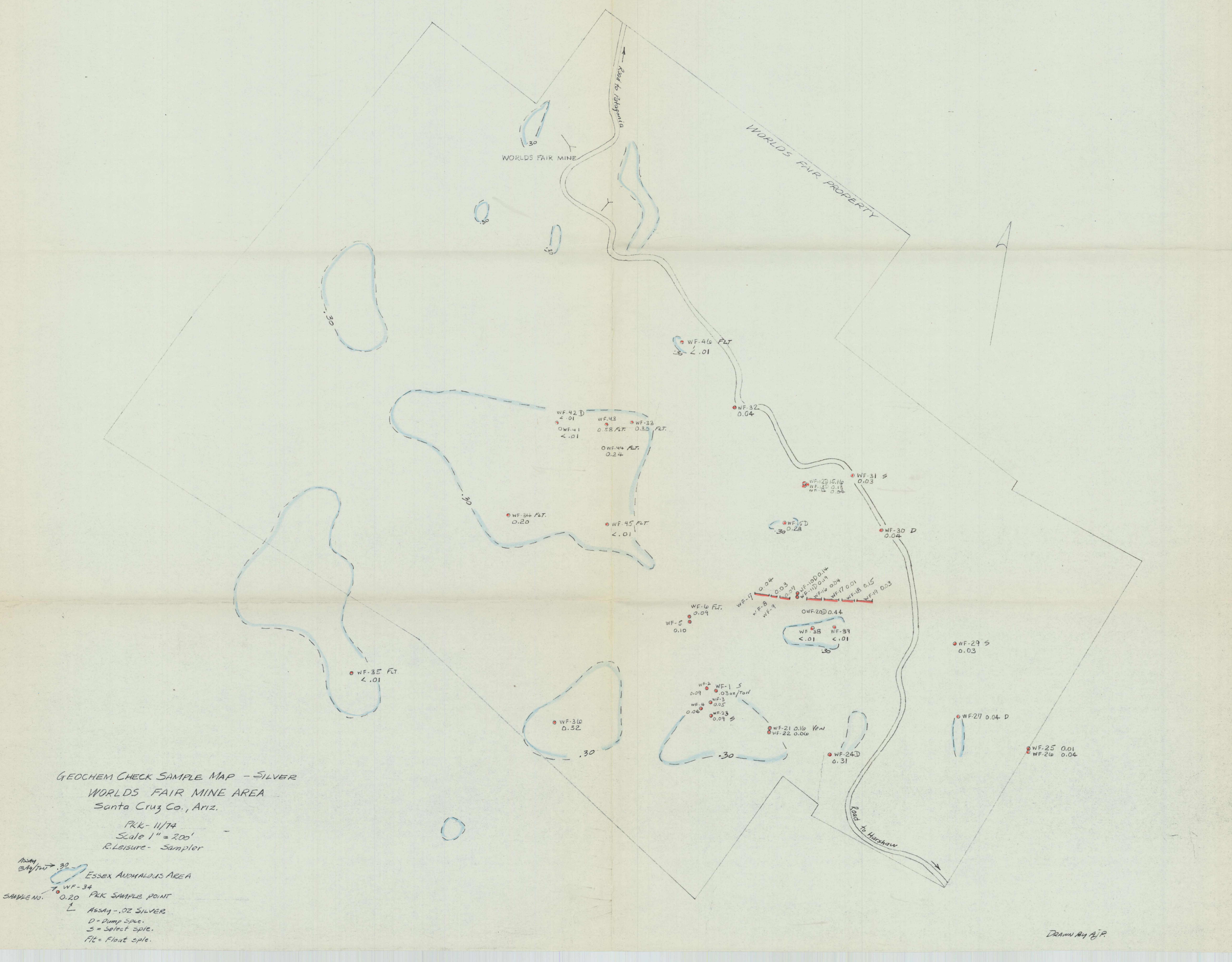
We have examined your World's Fair Property and taken a substantial number of rock samples from surface. Please be advised that we are not interested in optioning your property for exploration purposes.

Thank you for making this exploration opportunity available for our analyses.

A.J. Perry

AJP/sc

cc Mr. J.B. Imswiler
IMC


Road to Patagonia
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<.01
WF-42 D
<.01
WF-41
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WF-43
0.58 FLT.
WF-33
0.30 FLT.
WF-44 FLT.
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WF-31 S
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WF-12D 15.16
WF-13D 0.13
WF-14 0.04
WF-15D
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WF-30 D
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WF-34 FLT.
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WF-45 FLT
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WF-7 0.04
WF-8 0.03
WF-9 0.07
WF-10D 0.14
WF-11D 0.19
WF-16 0.04
WF-17 0.01
WF-18 0.15
WF-19 0.03
WF-6 FLT.
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WF-5
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WF-20D 0.44
WF-38
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WF-39
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WF-29 S
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WF-35 FLT
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WF-2
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WF-1 S
.03oz/TON
WF-3
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WF-4
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WF-23
0.09 S
WF-21 0.16 VEIN
WF-22 0.06
WF-36
0.32
WF-24D
0.31
WF-27 0.04 D
WF-25 0.01
WF-26 0.04
Road to Harshaw
GEOCHEM CHECK SAMPLE MAP - SILVER
WORLDS FAIR MINE AREA
Santa Cruz Co., Ariz.
PKK- 11/74
Scale 1" = 200'
R. Leisure- Sampler
ASSAY OZ Ag/TON .30
ESSEX ANOMALOUS AREA
SAMPLE NO. WF-34
0.20 PKK SAMPLE POINT
ASSAY - .OZ SILVER
D = Dump Sple.
S = Select Sple.
Flt = Float Sple.
Drawn By AJP.

AIME Trans. v. 36, 1906

The Limestone-Granite Contact-Deposits of Washington Camp, Arizona.

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Introduction.

WASHINGTON CAMP, in Santa Cruz county, Arizona, is a small and little-known mining-district situated on the lower, eastern slope of the Patagonia mountains, about 20 miles east of Nogales and a like distance south of Patagonia Station on the Sonora railroad, which connects at Benson, 83 miles from Nogales, with the main line of the Southern Pacific. This district is also about 4 miles north of the international boundary, 35 miles west of Bisbee and 40 miles north of Cananea, in Sonora. The topography of the district, which lies at a general elevation of 5,500 ft. above the sea, is only very moderately rugged, and presents no obstacles to mining-operations.

Although some of the claims of the camp, including the Pride of the West, Belmont and Holland, were extensively worked for silver 25 years ago, they passed, at moderate depths, as in so many other districts, out of the argentiferous lead carbonate and sulphide, into zinc, copper and iron sulphides; and for two decades the camp was abandoned and almost forgotten. In recent years, however, its apparent possibilities as a copper-producer have led to a revival of mining-activity; but not, as yet, with conspicuous success.

Although economically relatively unimportant, the deposits of Washington Camp are, mineralogically and structurally, nevertheless, typical examples of ore-bodies developed in connection with the garnet ledge now recognized as a normal feature of granite-limestone contacts; and, in the opinion of the writer, this is an instance where a minor example is yet essentially normal and capable of throwing important light upon the origin and genetic relations of the type.

I visited Washington Camp in 1901, and again in 1902; and have devoted, in all, about a week to the study, in the field, of the geologic relations of its ore-deposits, adding, incidentally, a suite of the rocks and ores to the economic geological collections of the Massachusetts Institute of Technology.

General Geology.

Washington Camp consists (geologically) of an irregular area of limestone and quartzite of uncertain age, about 7,000 ft. in extreme length north and south, and 3,000 ft. in maximum breadth east and west. This body of sediments is bordered on all sides by igneous rocks—granite and porphyry; and it may be regarded as an island in the sea of granitic rocks composing the main part, at least, of the Patagonia range. The granite and the porphyry (which is clearly a somewhat-later phase of the granite) are newer than the sedimentary rocks, and have been erupted through the latter; and the area in question is simply a remnant of the original formation which was so deeply engulfed by the igneous rocks that it has survived the extensive erosion which has long since swept away the rest of the sedimentary cover of the granite over an area of many hundreds of square miles. That the erosion has been extensive we have also positive proof in the coarsely crystalline character of most of the granite and in the highly metamorphic character of the limestone, even at points remote from the border of the granite. The sedimentary rocks are not now absolutely continuous, but several detached masses occur in the granite along the eastern border of the main area; and the latter is more or less completely divided towards its western margin by several large north-south dikes of granite. Although no fossils have survived the metamorphism of the limestone, by which its geological age might be determined, there is no reason to doubt that it is a part of the great Paleozoic limestone-formation, so characteristic of many of the mining-districts throughout the entire Rocky Mountain region.

The strata are highly inclined at all points, but the dip varies greatly in direction and amount; the prevailing dip, however, is to the west, at angles of from 30 to 90 degrees, but mostly above 60 degrees; while toward the eastern border the dip, at a few points, is reversed, or easterly, at similarly high angles;

and, in general, it may be said that the stratification is highly disturbed, with, in some cases, abrupt and extreme variations in strike and dip.

Beginning on the west side of the belt we have:—first, a band of quartzite from 100 to several hundred feet wide, which may, tentatively, be regarded as of Cambrian age. Following this, and magnificently developed in Washington mountain, the highest point in the district, is a massive limestone, characterized by numerous narrow bands and lenses of chert. Dividing the limestone on the eastern slope of Washington mountain is a second band of quartzite, at least 100 ft. thick. This is followed by a broad band of blue, crystalline limestone, or marble, extending well down toward the base of the mountain. Still farther east, this limestone is interstratified with one or more heavy beds of chert, which, having commonly a somewhat crystalline character, are usually called quartzite. On the eastern slope of the mountain are also to be seen the great dikes of granite, three in number, previously referred to, the most easterly of these dikes forming the hanging-wall of the Pride of the West mine. This brings us approximately to the middle of an east-west section of the sedimentary series; but farther east the limestone is comparatively free from chert bands, presenting extensive bodies of gray to white, crystalline marble in which the stratification is often very indistinct.

It thus appears quite certain that the section is not repeated or folded upon itself; and, notwithstanding the prevailing westerly dip, it is probable that the western quartzite is the oldest member of the series; and the entire formation may, therefore, be regarded as partly inverted.

The sedimentary series is, apparently, conformable throughout; and one is tempted to correlate the western or assumed basal quartzite of the Washington Mountain section with the Bolsa quartzite of the Bisbee district, described by Ransome.[1] The latter, however, with a maximum thickness of 430 ft., is seen to rest unconformably upon the Pinal or Algonkian schists; while the former, though not so thick, is everywhere in igneous contact with the granite, and it is improbable that its full normal thickness is now exposed. The limestone following this quartzite and forming the main mass of Washington mountain, becomes, then, the equivalent of the Abrigo limestone of Bisbee, which has a thickness of 770 ft. These two limestones are certainly comparable in thickness and in the prevalence of chert; but the Washington Mountain limestone is more massive and, apparently, non-fossiliferous, due, possibly, to more intense metamorphism; while the Abrigo limestone is definitely proved by its fossils to be of Middle Cambrian age. In each district this older limestone is followed by a second, white quartzite; but this is only 8 ft. thick at Bisbee, and fully 100 ft. on the eastern slope of Washington mountain. Above this quartzite, at Bisbee, come several thousand feet of limestone, including the Martin limestone (Devonian), 340 ft.; the Escabrosa limestone (Lower Carboniferous), 800 ft.; and the Naco limestone (Upper Carboniferous), 1,500 to 2,000 ft. These Upper Paleozoic limestones of Bisbee may, perhaps, be correlated tentatively with the Washington Camp section above the parting quartzite; and I have been inclined to regard the latter as a general equivalent of the Harding sandstone in Colorado.[2] The heavy beds of chert in the middle part of the Washington Camp section appear to be lacking at Bisbee.

From the northwest border of the area of sedimentary rocks, at least three great dikes of granite extend southward along the strike of the limestone. The most easterly dike, fully 100 ft. wide, forms the hanging-wall of the upper ore-body in the Pride of the West mine, and is separated by several hundred feet of chert and limestone from the second dike, which is proved by a cross-cut tunnel to be over 150 ft. wide. These two dikes converge southward and become one. The united dike can be traced across Double Standard gulch, passing west of the Holland mine; and it probably continues until it crosses the southern border and rejoins the main body of granite on the Belmont claim or the Lead King claim. The second dike, on the eastern slope of Washington mountain, is separated by a broad band of blue, crystalline limestone and the parting quartzite from the third dike, which is at least 100 ft. wide, but appears to die out southward before reaching Double Standard

[1] *Geologic Atlas of the United States, Bisbee, Folio No.* 112, *U. S. Geological Survey* (1904).

[2] *Geologic Atlas of the United States, Pike's Peak, Folio No.* 7, *U. S. Geological Survey* (1894).

gulch. Above this dike, the very massive crystalline limestone, with innumerable lines and lenses, but no heavy beds, of chert, extends to the summit and to the contact with the basal quartzite on the west slope.

In further comparison with the Bisbee district, it may be noted that the garnet ledge is more prominently developed than at Bisbee, and that faulting is relatively unimportant at Washington Camp, so that there appears, in general, to be little difficulty in tracing a particular horizon from end to end of the sedimentary island or inclusion in the granite.

The granite varies from a normal biotite-granite to a well characterized granodiorite, with dikes, also, of a highly acid, aplitic variety. The porphyry seems to show a similar range in composition, and occurs chiefly, at least, as dikes, cutting both the granite and the sedimentary rocks, although, probably, essentially contemporaneous with the former.

The metamorphic influence of the inclosing and intrusive acid igneous rocks is seen, not only in the crystallization of the limestone to form marble, and of the chert bands to form quartzite, but also, and very strikingly, in the development in the less-pure layers of the limestone of enormous bodies of green garnet (grossularite), and other secondary silicate minerals. The original limestone may safely be assumed to have contained silica, clay and iron oxide, as the chief impurities; and from the more-impure beds of limestone, during the process of metamorphism, the garnet-zones have been developed. These zones are commonly from 50 to 100 ft. or more in breadth; and they are found not only along the limestone-granite contacts, but also running in a north-south direction through the middle of the limestone remote from the granite, wherever, we may suppose, the original composition of the limestone favored their development, and chiefly along lines passing longitudinally through the Pride of the West, Holland, Double Standard and Annie belts of claims. The garnet rock, again, is not a constant feature of the contact, its absence at the north end of the district, on the eastern border and across a part of the south end, as also, in general, along the granite dikes, being especially noteworthy; but it is, apparently, developed only where the limestone was sufficiently impure to furnish, in both quality and quantity, the material required for the

formation of the garnet and related minerals. This selective relation is particularly obvious at the south end, where the contact cuts squarely across the strike of the limestone, and the garnet-zone is developed only on the less-pure beds of limestone. It is a very significant fact, in this connection or in its bearing upon the origin of the garnet-zone, that, along that part of the western border of the district where the basal quartzite intervenes between the granite and limestone, the garnet-zone is found between the quartzite and limestone, and not along the contact of the quartzite and granite.

The granitic rocks not only completely surround the sedimentaries, but, at some depth, they must underlie them, so that a vertical shaft at any point would, eventually, pass out of the limestone into the granite; and it is altogether reasonable to suppose that this lower contact, at least equally with the lateral contacts, is characterized by the garnet-zone.

The fact that the metamorphism of the sedimentary rocks is not confined to the borders, but is, in general, somewhat uniform over the entire area, varying only with the original composition of the limestone, and the absence, at most points, of a fine-grained or compact border in the granite itself, show, not only that these rocks were very deep-seated at the time of the intrusion of the granite, but also, apparently, that the granite underlies the limestone now at no very great depth; although the Westinghouse shaft, on the extreme eastern margin of the limestone, has failed to reach the bottom at a depth of 650 feet.

Ore-Deposits.

Although having, in general, more or less the forms of veins, the ore-deposits are not, to any important extent, true veins; but are better classed as substitution-deposits or replacements in the limestone. Among their more-striking characteristics are the following:—

(1) They are entirely confined to the sedimentary rocks, and chiefly to the limestone, and have not been observed in any instance to extend ever so slightly into the surrounding granite. This seems to force upon us the conclusion that the ores have not been derived from the granitic rocks, and have not, therefore, come from a great depth in the earth.

(2) Save where the contact is transgressive, they correspond closely, but not always exactly, with the limestone in dip and strike, and are at all points clearly to be recognized as replacements of the limestone.

(3) Where not accompanying the limestone-granite contact, they usually occur along the contact of the limestone with a principal bed of chert.

(4) They are, in general, very intimately associated with the garnetiferous zones, which undoubtedly represent what were originally exceptionally-impure members of the limestone series. This association is so constant that the garnet has come to be recognized as a fairly-reliable indication of the occurrence of the ores; and the garnet rock and the ores are often very intimately commingled, the garnet forming, in most cases, the principal gangue of the metalliferous minerals or ores.

(5) The ore-body accompanying a contact garnet-zone is always on the inside of the zone, that is, between the main body of the garnet ledge and the limestone, and not between the garnet ledge and the granite.

The ores include, chiefly, chalcopyrite and sphalerite, with, at the present time, very subordinate amounts of galena. Secondary ores are relatively very unimportant, and are now pretty well worked out. The oxidized copper-ores, including cuprite, the carbonates and chrysocolla, occur but sparingly, and the secondary sulphides (bornite and chalcocite) are rarely seen. Although the copper-ore (chalcopyrite) ranks first in value at the present time, the zinc-ore (sphalerite) predominates in the deposits, tending to become relatively more important with depth; and an important output of zinc would seem to be among the possibilities for this district.

Metamorphism of the Limestone and Chert.

The crystallization of the purer phases of the limestone to form white to gray saccharoidal marbles, and of the chert (in part) to form non-clastic quartzite are normal phenomena, demanding no special discussion. In part, however, the metamorphism of the chert has gone far beyond the degree here indicated. Thus, in the southwestern part of the field, on the Lead King and Belmont claims, bordering, but not penetrating, the granite, is a compact body of coarsely crystalline quartz fully 100 ft. wide and extending, northward, in the direction of the strike and away from the granite, at least 300 ft. and possibly much farther. In large part this body is essentially structureless, consisting of massive, vitreous quartz; but enclosing, also, many more or less distinct crystals of quartz ranging in size up to at least 2 ft. in length and 5 in. in diameter, and occurring to a considerable extent in radiate groups. A shaft sunk 20 ft. into this mass disclosed nothing but pure quartz in a plexus of gigantic crystals. The outcrops in this part of the field are less continuous than could be desired; but the facts clearly indicate that this remarkable body of nearly pure crystalline quartz is not in any sense a vein, or a pegmatitic phase of the granite; but rather that it marks an extreme degree of metamorphism of a broad band of chert, the quartz being in the line of strike of such a chert horizon, and seeming to grade longitudinally into it. Although an extreme, it is by no means an exceptional or unparalleled phase of the metamorphism, except, perhaps, in the magnitude of the resulting body of crystalline quartz; for coarsely crystalline quartz, sometimes in stellate groups, is a constantly recurring feature of the garnet-zones and ore-bodies; and it is probable that a detailed study of other chert bands in the vicinity of the granite would show that a gradation from the normal to the most highly-metamorphic forms of the chert is a general fact. Unfortunately, no economic interest attaches to the chert; and hence exploitation has added but little to our knowledge of its occurrence.

No correspondingly coarse crystallization of the limestone, on a large scale, has been noted; although, near the igneous contacts, and in the garnet-zones, it is distinctly sparry, with cleavage faces of calcite from one to several inches across. The chief interest of the metamorphism of the limestone is found, of course, in the secondary minerals; among which the pale yellowish or brownish-green lime-alumina garnet (grossularite) largely predominates, in finely to coarsely crystalline massive aggregates. The form is dodecahedral, and the individual crystals rarely exceed 2 in., and are commonly less than 0.25 in. in diameter. Associated with the garnet, in some parts of the field, is more or less epidote in slender, green prisms, with, possibly, some vesuvianite and various forms of amphibole, including actinolite and tremolite, the latter being most abundant and often very intimately associated with the ores. Quartz, in coarse and irregular masses, is usually, as previously noted, rather a prominent feature of the garnet-ledge, which, because of the hard and resistant character of its component minerals, forms bold and rugged outcrops, made, in detail, more rugged by the solution of the included sparry calcite and the weathering-out of the ores. The crystalline iron-ores (magnetite, etc.), and the jasperoid forms of silica often associated with the garnet-zones of other districts are practically wanting in Washington Camp.

A rather specially interesting phase of the metamorphism of the limestone, though not as yet identified as a feature of the garnet-ledge or the ore-bodies, is massive lime silicate or wollastonite occurring commonly as a reaction-zone, bordering layers and nodules of chert in those portions of the cherty limestone nearest the granite, or within several hundred feet of the contact. The relations are very clear, the chert masses, often with frayed and disintegrated margins, being separated from the enclosing crystalline limestone (white marble) by zones from one to several inches broad of white, massive wollastonite, which, like the chert, is left in high relief on the weathered surface of the limestone. That the silica of the chert has replaced the carbon dioxide of the limestone is obvious.

The geological interest of the metamorphism of the limestone centers in the source of the materials of the garnet and other secondary silicates. Although some recent writers have regarded the garnet-zones as intrusive igneous masses, or, possibly, as differentiation-products of the granite magma, the general consensus of opinion, at the present time, is that they are normal products of the contact-metamorphism of the limestone. No other view can be made to fit the facts of Washington Camp; and the question of vital interest is, as to whether the limestone has furnished all or only a part of the ingredients of the garnet and other silicates, the necessary elements being approximately the same for them all. It is a significant fact that they are practically all lime-silicates; and apparently no one accepting the metamorphic theory doubts that the lime is wholly indigenous, that is, was furnished exclusively by the limestone. All the other required elements are normal impurities of limestone, including silica, alumina, magnesia and iron. The first two, with a little iron, suffice for garnet and epidote; and the addition of the magnesia makes the amphiboles a possibility. It is certainly a very exceptional limestone which does not contain the small amount of magnesia, called for in this case; and surely we have no need and no warrant to go outside of the limestone for such a normal, abundant and stable or insoluble impurity as alumina. The *onus probandi* clearly rests upon those who hold to the contrary view. Similarly, ferrous carbonate, not to mention the oxides and sulphides of iron, is a nearly universal constituent of limestones, and a ready source of iron for the metamorphic ferruginous silicates, as well as for magnetite and sparry siderite.

Finally, silica, including free silica, both clastic and organic, and the combined silica of kaolin and other silicates, is, perhaps, the most important of all the non-essential elements of limestone. The ratio of silica to alumina in kaolin is less than in grossularite; but original free silica may easily make good the difference; and any excess of lime may or may not be eliminated by solution. The sufficiency of the free silica is indicated by the fact that, in many analyses of limestones not visibly siliceous, the total silica is far in excess of the amount required to form kaolin with the alumina. The averages of 42 analyses of limestones made in the laboratory of the United States Geological Survey,[3] including all those for which both the silica and alumina are given separately, are: SiO_2, 8.514, and Al_2O_3, 1.077 per cent., the ratio being very nearly 8:1.

Analyses of unaltered limestone are, of course, devoid of special significance in this connection, unless it can be shown that they represent closely-adjacent portions of the same beds which have, locally, suffered metamorphism by silication. Limestones, more than most other kinds of sediment, are, in successive beds, subject to marked and abrupt changes of chemical composition, due to fluctuations in the proportions of the normal (organic) and the accessory (organic, clastic and chemical) constituents; and gradations into beds of chert, shale and even sandstone are not uncommon.

In view of these considerations, further argument might almost be deemed superfluous, at least as regards the adequacy

[3] *Bulletin No.* 228, *U. S. Geological Survey*, p. 331 to 336 (1904).

of the limestone, considered as a source of the raw materials of the contact minerals. But some of the arguments based upon the structural relations of the limestone are also peculiarly cogent. For instance, the garnet-zone is, as previously noted, by no means a constant accompaniment of the granite-limestone contact; and in strength and persistence it obviously varies inversely as the purity of the limestone, being very weak or wholly wanting where the purer beds of limestone, the typical white or light gray marbles, meet the granite. This selective relation is very noticeable across the ends, and especially the broad southern end, of the limestone island, where the granite contacts successive beds of limestone of varying composition, and fails to develop a garnet-zone wherever the limestone is of notable purity. Besides the variable and intermittent character of the garnet-zone along the contact, we must take cognizance of the very persistent garnet-zones, which, disregarding the granite contact, follow each a particular bed or horizon of impure limestone longitudinally through the district; and of special interest and significance among these is the garnet-zone at the base of the limestone, in the siliceous and argillaceous beds of passage between the basal quartzite and the limestone, and separated by the quartzite, from 100 to 200 ft. thick, from the western granite.

Among those who accept the metamorphic origin of the garnet-zones of granite-limestone contacts, Professor Kemp is the foremost exponent of the view that the granite has contributed not only the heat or thermal energy, but also, in large part, the material, required for the formation of the garnet and related silicates. Apparently, Professor Kemp would look to the granite or acid plutonic for everything needful, except, perhaps, the lime; although it may be noted that the plutonic rock is, in general, rich in lime as well as alumina, and the transfer of the former base would be the simpler chemical problem. However, the lime is not needed; and in my opinion it has not been proved that we need look beyond the sedimentaries for any of the raw materials of the garnet-zone. To simplify the phraseology, and, at the same time, to emphasize the vital contrast of the two explanations of the garnet-zone now under consideration, we may restrict the term "metamorphic" to the theory which derives all the material from the

limestone and refers to the granite only for the agents—heat and, possibly, some water, and designate as "metasomatic" the theory which derives an important and essential part of the material, as well as the agents, from the granite.

Except where the limestone is very impure, the lime will naturally be in excess of the amount required to form the garnet and other secondary lime-silicates; but that this is, in no sense, a bar to the metamorphic theory must be obvious when we consider the possibility of disposing of the excess by either contemporaneous or subsequent solution or re-crystallization. An instructive illustration, on a minor scale, is offered by the writer's observations on the calcareous Lower Cambrian slates of the Boston Basin. In this instance, the calcareous element assumed originally the form of calcareous concretions or clay stones; and when, in later Paleozoic times, the strata were invaded by the granitic series and suffered metamorphism, the outer part of each calcareous concretion became a shell of impure epidote. In many cases, the silica and alumina within this shell have been exhausted in the formation of the epidote, and the residuary calcium carbonate has re-crystallized, forming a core of white marble in the epidotized calcareous concretions of a red slate.

If we regard the granite as an important or, possibly, principal source of the materials of the garnet-zone, as we may for the sake of argument, it gives to the contact-relations and character of the granite special significance and interest, since it is not easily credible that the granite might transfer to the limestone a large part of the material of the garnet-zone and still remain entirely normal, giving no sign of its loss. As a matter of fact, both the granite and porphyry, so far as can be determined by macroscopic observations, are unchanged in texture and composition, and entirely normal on and near the sharply defined line of contact. In other words, the granite shows no reaction-zone, and there is absolutely nothing to suggest the leaching, depletion or mineralization of either formation by, or at the expense of, the other. These statements are applicable alike to the main body of the granite and to the granite dikes.

If the silica and alumina have been derived from the granite, and the limestone has furnished only the lime, magnesia and iron, the garnet-zone should be a constant feature of the contact; or, at least, there is no apparent reason why it should fail, as it does, just where silica and alumina are wanting in the limestone. Again, the metasomatic theory affords absolutely no explanation of the essentially similar and equally strong garnet-zones developed independently of the granite contacts, in the limestone, or between the limestone and the basal quartzite; for surely we cannot suppose that material in liquid or gaseous solution would pass through hundreds of feet of solid limestone or quartzite, to react with the limestone of certain definite and narrow horizons.

Professor Kemp has minimized the normal ground-water of oceanic and meteoric origin, and maximized the magmatic water emanating from plutonic and intrusive magmas before and during refrigeration, as regards both volume and geological efficiency, and especially as regards their efficiency in the formation of veins and ore-deposits. The only definite and positive indication that the magmatic water is abundant is afforded by the copious exhalations of steam accompanying volcanic eruptions. But the argument that this is all, or even chiefly, magmatic water is far from conclusive. Its deposits certainly do not indicate it. A distinguishing feature of magmatic water is supposed to be its heavy burden of dissolved elements, which, combined to form various mineral species, must be left behind, on or in the lava, as the water escapes into the atmosphere. Except, perhaps, in, or in the immediate vicinity of, vents of long-continued solfataric activity, these deposits are usually conspicuous by their absence. The water promotes the liquidity of the lava, and thus, in a sense, holds in solution the entire body of the magma, and, although diminishing with the pressure, like the gases dissolved in molten metals, it manifests no marked tendency to escape in advance of the general refrigeration of the magma; and then, in general, it leaves behind no deposit other than the normal lava.

The argument for the sufficiency of magmatic water requires us to assume that, below the superficial, shallow and wet zone of the vadose circulation in the earth's crust, is a deep and relatively arid or anhydrous zone, the upper part of which has been discovered by numerous mines and borings, and below

that, in the plutonic regions, where magmas are developed, a third zone which, like the vadose, is highly hydrated, but the water of which is original or primitive, and has never formed a part of the hydrosphere. The intermediate, relatively dry zone, comprising the main body of the earth's crust, is composed, for an average thickness to be measured by miles, of sedimentary rocks, which must have once been in a state of supersaturation, but which have suffered extensive dehydration under the combined influence of long-continued heat and pressure. How it is that the water of the plutonic zone, exposed for an immensely longer time to far higher temperature and pressure, has escaped expulsion has not been explained. Further, it is virtually asserted that the volcanic chimney belongs to that bad class which will not "draw"; in other words, that the subterranean chimney does not create an in-draught of the ground-water analogous to the in-draught of air to a sub-aërial chimney. This anomaly, if true, also awaits explanation.

For the magma, the conditions are dominantly thermal; but for the resultant lava they are, or soon become, dominantly aqueous. The component minerals then prove to be more or less unstable compounds, and are subject to alteration by the in-drawn ground-water, the solvent and decomposing action of which is promoted, rather than retarded, by the high temperature still prevailing. In other words, solfataric waters, by which alone important deposits are made within the range of observation, are probably not, chiefly, magmatic waters struggling up from plutonic depths; but, rather, they are to be regarded as marking the first and most vigorous attack of the normal ground-water upon the intrusive and effusive igneous rocks, and hence as positive proof that the chimney does draw at this stage, if not earlier.

In any speculation as to the volume of water set free by the freezing of a magma under plutonic conditions, it is important not to forget the shrinkage due to crystallization and cooling, or that the liberated water, though above the critical temperature, may yet have the density of the liquid, or that there exists a real affinity between this water and the magma residuum, as so clearly proved by the phenomena of pegmatite. It is the excess water, if there be any, that concerns us now; and its natural avenue of escape, it would seem, should be upward, rather than lateral.

The picture of a copious exudation of magmatic water which, reinforced by various mineralizers and overladen with a large variety of elements, actively invades and alters the enclosing terranes by metamorphic and metasomatic processes, is not easily visualized, in view of the plain, every-day facts of the case. In the vicinity of Boston, and extending throughout eastern Massachusetts, the coastal district of New England and the maritime provinces, are hundreds of miles of contact of granitic rocks, not to mention a vast net-work of acid and basic dikes, intrusive in Cambrian and other early Paleozoic sediments. These sediments exhibit various degrees and kinds of metamorphism; but very seldom indeed do we find in them elements which may not fairly be regarded as original. Fluorite and other minerals regarded as specially indicative of the presence and agency of the so-called mineralizers are found chiefly in the igneous rocks, and have not migrated into the sediments. Apparently, heat is the one important contribution of the igneous rocks; and the normal ground-water, stimulated or energized by this heat and acting on the original elements of the sediments, has done the rest. Even quartz-veins and segregations, excepting those of pegmatitic origin, are comparatively rare accompaniments of the plutonic contacts of this region, and where occurring may usually be proved to antedate (as in the case of the auriferous veins of Nova Scotia) or postdate the development of the contact.

Especially difficult of visualization is the picture of the magmatic water gushing forth in so great volume that, merely by the deposition of its excess load, it may build a garnet-zone 100 ft. thick, equal to 100 cu. ft. of garnet and the emission of many thousand cubic feet of water for every square foot of the contact. The magma must, indeed, be highly hydrated to meet such a demand, and yet it is now of strictly normal character up to the sharply defined contact.

The development of the garnet-zone, whether by metamorphic or by metasomatic process, must have been centripetal with reference to the limestone, at least if we are to look to the limestone for the lime; necessitating, according to the metasomatic theory, the transfer of the silica and alumina and other imported elements required for the inner part of the zone through the outer part. Also, the refrigeration or crystallization of the magma to form the granite must have proceeded centripetally or away from the contact, thus opposing a barrier of steadily increasing thickness to the emission of the magmatic water. In other words, the water liberated by the crystallization of the magma is forced inward, where it is needed to maintain the fluidity of the magma residuum.[4]

Origin and Relations of the Ore-Deposits.

The ore-deposits of this district clearly belong to certain more or less well-defined zones in the limestone, which may or may not follow granite-limestone contacts, but which are, in general, characterized by a more or less marked development of the garnet-ledge. The relations of the ore-bodies to the garnet-zones are very intimate and irregular, and the garnet and other secondary silicates, together with a limited amount of quartz and sparry calcite, constitute the normal gangue of the ores. But although we may regard the garnet-ledge as, in a general way, favorable to the occurrence of ore, some important ore-bodies are devoid of garnet; and the garnet-zones are at some points devoid of ore, or the ore occurrences are very limited and sporadic. Where associated with garnet-zones following the granite-limestone contact, the normal position of the ore, as previously stated, is, clearly, on the inner margin of the zone, facing the limestone and not the granite. The ore-bodies are, practically, never vein-like in form or structure; and they are devoid of true walls, since they clearly antedate all shearing and fracturing of the formation. The contact of the ores, alike with the limestone and the garnet, is often sharply defined, but always highly irregular; and, in the association or grouping of the ores, there is nothing even remotely suggestive of crustification, banding or comb-structure, or deposition in open spaces of any kind. Obviously enough, the ores, as we now have them, are due to a metasomatic impregnation and replacement of the limestone against and in the massive garnet-ledge; and the questions of special geological interest are, whence? and how? That is, what is the original source of the ores? and how were they concentrated?

[4] Origin of Pegmatite, *American Geologist*, xix., 170 (1897).

We cannot avoid the conclusion that the ores have come from either the limestone or the granite. Nowhere in the district has the slightest trace of ore been found in the granite. The ore rarely contacts the granite, and then only sparingly or sporadically, its normal position being between the garnet-ledge and the limestone, and irregularly impregnating both. The most persistent and strongest ore-bodies, again, are associated with the non-contact garnet-zones, which are, in part, far removed from the nearest border of the granite. In no instance has it appeared possible to correlate the ore-bodies with antecedent fissures, which might, conceivably, have served as channels of supply from underlying granite. The demonstrated faults of the district are clearly newer than the ores; and the latter sometimes exhibit beautiful slickensides where traversed by shear-planes and displacements.

The main body of the limestone, apart from the garnet-zones and ore-deposits, is, apparently, as barren of ore as the granite; and accepting either of these formations as the source of the ore, forces the conclusion that the processes of segregation and concentration have been singularly complete; although it is, of course, possible that refined analysis would prove the presence of zinc and copper where none are apparent to the eye. The plain indications are that, during the metamorphism of impure and, presumably, metalliferous beds of the limestone to form the garnet-zones, the metallic sulphides contained in these beds, and, possibly, in large volumes of the adjacent strata, were segregated by metasomatic process along the common boundary of the garnet-zone and the limestone.

As previously noted, Washington Camp is undoubtedly an outlier, isolated by igneous intrusion and erosion, of the great series of Paleozoic limestones in which are found a very large proportion of the ore-deposits of the Rocky Mountain region and the Pacific coast, as well as the widespread and rich zinc- and lead-deposits of the Mississippi valley, the last-mentioned district having been, from the beginning of Paleozoic time, remarkably free from every phase of vulcanism, and having suffered as little deformation as any part of the continent.

It appears difficult, in view of these considerations, to find any warrant for doubting that this great limestone-series, or some part of it, is normally and originally metalliferous; or

that, stimulated by intense and long-continued igneous and metamorphic agency (which was not required in the Mississippi valley), the circulation of the normal ground-water has proved equal to a more or less complete concentration of the metallic contents of the limestone.

Structural Details.

It is proposed to give here some local observations, which, although not conveniently included in the foregoing discussion, are of interest in their bearing upon the general theory of the district.

West Contact.—Beginning at the north end, a shaft on the Kansas claim, 150 ft. from the limestone-quartzite contact and 100 ft. deep to water-level, with about 200 ft. of drifting, shows mainly pyrite, with subordinate chalcopyrite, galena and blende and abundant quartz gangue. The main ore-body is vein-like in form, but without walls, and clearly a replacement in the limestone, with many isolated bunches or pockets of ore from 3 in. to 3 ft. or more in diameter, and usually parallel to the main ore-body and the bedding of the limestone. The garnet-ledge is not developed here; but a feature of special mineralogical interest is found in the pseudomorphic cavities due to the oxidation of the pyrite.

Next, south of this, on the New York claim, where the garnet-ledge is also wanting, a shaft 205 ft. deep has developed, at a distance from the quartzite-contact, one large and one small irregular ore-body, carrying good values of lead and silver above the water-level.

Between the New York and Maine claims, the quartzite is broken or sharply flexed, being offset to the west several hundred feet, on the northern slope of Washington mountain; and the garnet-ledge is developed on the blending contact of the quartzite and limestone. Mingled with and following the garnet is the ore-impregnated limestone. All along this western contact the reaction-zones of wollastonite are a nearly constant accompaniment of the chert lenses and nodules in the limestone; but this feature gradually dies out as we recede from the granite.

On the Ella claim, crossing the upper western slope of Washington mountain, the basal quartzite is well developed, with a breadth of from 100 to 200 ft.; and, as before, it separates the garnet-ledge, about 50 ft. wide, from the granite. The ore, which runs largely to black sphalerite, in part, admirably crystallized, occurs chiefly in the inner part of the garnet-zone, forming an irregular, weak or fragmentary body, accompanied by some striking stellate groups of quartz crystals.

On the contact claim, crossing the hill at the head of Bonanza gulch, this section is repeated from the granite through the quartzite and the ore-bearing garnet-zone to the limestone. But, although the garnet-zone is strong, the ore is weak and does not form continuous bodies. These conditions recur, also, on the Montezuma claim, which marks the southwest corner of the district; but the basal quartzite is here distinctly ferruginous and carries low values in gold.

On the Lead King claim, at the extreme southern end of the district, the granite is well exposed in two tunnels driven to cut the contact. Although of a highly acid, and, in the main, essentially normal character, it is, in part, also, more or less pyritiferous, the pyrite occurring chiefly, but not wholly, in the seams. No other instance of mineralization of the granite has been observed.

Eastern Contact.—Toward the southern end of this contact is the chief occurrence of porphyry which appears to be somewhat later than the granite and of rather more acid character; but, so far as observed, does not differ from the granite in its relations to the limestone and the ore-bodies. The eastern garnet-zone follows the contact somewhat continuously across the San Antonio and Duquesne claims to the Bonanza claim, on which is located the Westinghouse shaft, 650 ft. deep. The shaft starts in the porphyry; but all the lower part is in coarsely crystalline white limestone, and the bottom is said to be 65 ft. from the porphyry, proving that the contact overhangs the limestone a little. Farther north along this contact, the garnet-zone and ore-bodies are wanting, and we pass abruptly from the granite or porphyry to the gray to white marble, which is uninterrupted for a breadth of 1,000 feet.

North of Washington Post Office the contact is easily traced, and where it is crossed by the road for the last time it is well exposed in a cutting, showing normal granite against white crystalline limestone, with no signs of a garnet-zone, although a prospect hole shows a thin line of ore, while a little farther

north a line of prospect holes shows that the contact is there more heavily mineralized.

Central Ore-Zones.—These zones practically begin with the Pride of the West claim, in the latitude of Washington Post Office. This property, which produced a large amount of oxidized lead-silver ores above the water-level 25 years ago, embraces two ore-horizons from 10 to 20 ft. thick, separated by from 20 to 50 ft. of limestone, and dipping west 33° beneath the eastern dike of granite, which forms the hanging-wall of the western ore-body, and is, in turn, overlain by a heavy bed of chert. The granite seems to conform in with the bedding of the limestone, but the under surface of the granite or hanging-wall of the ore is very plane, more or less coated with garnet, as a rule, and beautifully slickensided. This is, evidently, a fault-plane which has, apparently, cut out the main part of the garnet-zone.

In their southward extension, these ore-bodies leave the granite dike on to the next ridge, the great bed of chert, 500 ft., and are thrown eastward, with transverse flexure or fault. and possibly nearly 1,000 ft., by a continued, still on the east side of the chert, in the similar and parallel ore-bodies of the Beyond this displacement they are ther east is the parallel Smuggler claim. About 300 ft. farTexas claim, which ore-zone, from 10 to 15 ft. thick, of the West ground. The Tilbury, not been identified on the Pride of the limestone; and the is chiefly blende, with walls of north of Double Standard garnet-zone is not prominently developed tion to the displacement dard gulch; but we have now, in addition West ore-zone on continuation of the double Pride of the same relation to the Smuggler claim, and still holding the separated from the great bed of chert, though now widely Texas claim. granite dike, the parallel ore-zone of the

A series of prospect holes extending from the Smuggler workings shows very clearly that the dual ore-body is here flexed backward and, pinched and dragged out, trends directly toward the tunnel on the Double Standard claim. In other words, we have here a compensating displacement, the dual ore-body being thrown from the south end of the Pride of the West claim eastward into the Smuggler claim, and then westward into the Double Standard claim, where both members, with their ... have been cut by the Double

Standard tunnel. The fact that the granite dike is not thrown with the chert-bed and ore-zones indicates that the displacements, in this case, antedate the intrusion of the granite; but that there has been some movement, at least, along these breaks subsequently to the formation of the ore is made very clear by certain phenomena brought to light in the Double Standard workings. The tunnel cuts the ore-zones just at the break, where they are regaining the normal north-south strike; and a winze was sunk at this critical point on the eastern zone. ... ugh ze is directly in the crushing and disturbance ac-
That this win continut fault is evident from the highly broken companying the gre laim, of the ground. That the movement and cavernous condition asal en structure is due was subsequent to which this broken and op es limestone and the formation of the to the metamorphism of the h at since both are involved in the ore-bodies is unquestionable, exp vement was also accompanied crush breccia. But that this m f a ble to ore-deposition is proved or followed by conditions favora it is artz, etc.; and especially by by druses of pyrite, sphalerite, qu ng chet in diameter lined with a the occurrence of a cavity several fe inera senic from one to several reniform layer or crust of native a ative arsenic, which has inches thick. This occurrence of n outhe ,[5] undoubtedly finds its been described by Dr. C. H. Warre which ng along the fault, that best explanation in thermal waters risi rathe action. is, in something analogous to fumarole iffer fied, separating Double

On the ridge which we have now reac e ore-lon from east to west Standard and Bonanza gulches, a secti newhat ced extension of the across the ore-zones shows: (1) the displ aims to im; (2) a strong and ore-zone first recognized on the Texas cla ase shaft, of the Pride of the typical garnet-zone; (3) the double ore-zon all the ns; (4) the massive West, Smuggler and Double Standard clai and the al ore-zone; (5) an chert-formation everywhere overlying the d that the limestone; (6) the unmeasured thickness of crystalline, gray uth along , with its garnet-Holland ore-zone, not previously recognized ing, and recognizable again zone. All of these various horizons are re ay to white Jane and other south of Bonanza gulch, in the Annie, Mary 0 feet. e and Belmont claims; and still farther south on the Empir e contact appear to gain in claims, the garnet-zones, if not the ore-zones, a r the last strength as we approach the granite. l granite

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ore, while a

[5] American Journal of Science, 16, pp. 337–339 (1

Are the Quartz-Veins of Silver Peak, Nevada, the Result of Magmatic Segregation?

BY JOHN B. HASTINGS, DENVER, COLORADO.

(British Columbia Meeting, July, 1905.)

CHIEF among the varied problems facing the mine-manager is that of vein-structure and origin, which is highly important as a guide to successful discovery and development. If metalliferous deposits can be traced to the intrusion of waters along definite lines, then is there something tangible for him to study. But when he is told by a geologist that metalliferous deposits are due to some other cause, like magmatic differentiation, while not perhaps discouraged, he is impressed with a vague sense of new worlds to be conquered.

In 1897, while manager of the War Eagle mine at Rossland, B. C., where, previously, the ore-bodies had not been supposed to occur as veins, I suggested to visiting members of the Canadian Geological Survey that, perhaps, the structure of the pyrrhotite-bodies of that mine, which had been proved to occur along well-defined fractures, might throw some light on the similar deposits of Sudbury, then held to be basic aggregations from the original magma. Later investigation has at least provoked discussion of this last deduction, questioning its correctness and suggesting that, perhaps, the deposits are actual veins.

The following extract from a paper by J. E. Spurr[1] is quoted, because it sets forth Mr. Spurr's theory of the quartz-occurrences of the Silver Peak mines, which will be discussed in this article. It also graphically describes the attendant geological features.

"The Drinkwater group of mines, which is the most important part of the Blair gold properties, and which has produced practically all of the million dollars' worth of ore, as above stated, may be taken as typical of the gold-veins which, though widespread and numerons, show a wonderful similarity of character. On the surface two adjacent veins outcrop, the Crowning Glory and the

[1] Ore Deposits of Silver Peak Quadrangle, *Bulletin No.* 225, *U. S. Geological Survey* (1904).