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Report on

HACK'S CANYON URANIUM MINE

by

Chas. H. Dunning, Director
Arizona Dept. of Mineral Resources

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September 1, 1948

Mr. G. C. Harwood
1521 West Wilshire
Phoenix, Arizona

Dear Mr. Harwood:

After many difficulties and delays we are finally able to send you our report on the Hack's Canyon uranium property. At best it can only be considered as an interim report as there are many important points that we have still been unable to determine.

There is no doubt but that the type of mineralization - being distinctly not the "carnotite or roscoelite type" - would permit ore from this deposit to qualify under the rules of the \$10,000 bonus as offered by the Atomic Energy Commission.

These rules, however, require 20 tons of 20% U_3O_8 ore or mechanically produced concentrates. No selective mining or hand sorting from this property could produce that grade of ore.

In attempting to ascertain the possibilities of mechanical concentration we felt that it was necessary to have considerable data regarding the mineral occurrence of the uranium. We sent specimens to the Atomic Energy Commission, the Arizona Bureau of Mines at Tucson, and Smith-Emery at Los Angeles, but so far we have not been able to get a determination of all the uranium minerals. We plan to keep trying but will not hold up this report any longer. When additional data is available we will advise you.

When we do have a better knowledge of the mineralogy of the uranium occurrence we will have our Bureau of Mines or others make further concentration tests.

Yours very truly,

Chas. H. Dunning
Director

CHD:mh

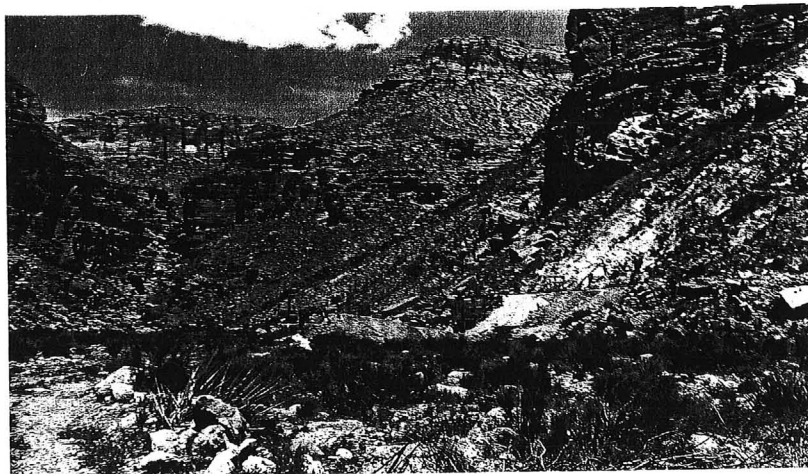
HACK'S CANYON URANIUM MINE

Location and Description:

The Hack's Canyon Uranium Mine, consisting of fourteen unpatented mining claims, is owned by G. C. Harwood of 1521 West Wilshire, Phoenix, Arizona, and three partners, and is located in Hack's Canyon, 37 miles southwest of Fredonia, Arizona.

Topography is very rough and typical of that general area of the Colorado Plateau where the canyons are sharp and narrow and the bottoms eight hundred to twelve hundred feet below the plateaus.

Access to the property is obtained in two ways - one by road to a point on the rim above the mine workings, from whence a steep and rough trail, somewhat over a mile in length, winds down the canyon walls with a drop of about 1,000 feet to the mine. The other is by road to the head of Hack's Canyon and thence by a rough road down through the bottom of the canyon six miles to the mine. This latter stretch of road is very susceptible to washouts during stormy periods, but no great difficulty is encountered in making it again passable with a few hours' bulldozer work.



View up side canyon of Hack's Canyon.
Main canyon turns off to the right.
Dumps of uranium mine slightly below
right center.

In order to market the ore from this mine it must first be hauled out of the canyon, then trucked 30 miles to Fredonia over a rather poor dirt road, then hauled 120 miles to Marysville, Utah, over a paved highway, where it can be loaded on railroad cars.

History

The property has been worked intermittently as a copper mine since about the time of World War I. During one of these attempted operations a tramway was built down the canyon wall near the site of the present trail, but practically nothing remains of this equipment at present.

None of the copper operations were successful for any sustained period and it is doubtful if more than a total of 1,000 tons was ever produced.

During the last World War the owner-operators of this property made special effort to produce copper for our national benefit, even going to the extent of financing and building the above mentioned road down the canyon wash, but the operation was not successful.

During the latter stages of this copper mining operation the operators examined their workings with a fluorescent lamp and discovered a fluorescence arising from an undetermined mineral. The operators brought a large sample of this material to the Arizona Department of Mineral Resources for determination and advice, and we advised a spectrographic analysis. This analysis showed a rather high percentage of uranium which, as far as we know, had not been theretofore suspected by anyone. Spectrographic analyses led to quantitative chemical analyses with the result that the sample showed a uranium content of 1.56% U.

Investigation of the economic features of the deposit at that time did not lend incentive to further prospecting or developing because, in the first place, there was much "taboo" attached to searching for, developing or producing any fissionable elements, and, in the second place, the market price was far too low to lend any incentive toward finding or developing any new deposits or attempting to produce from a deposit as remotely located as this one.

So the property remained idle until the present Atomic Energy Commission seemingly realized they could not obtain desired amounts of uranium under the restraints that had pertained and changed the policy to one of offering various bonuses and prizes to stimulate production.

Under these new rules this property again became interesting and two examinations have been made by this department during the past few months. These examinations give a conclusive result that the deposit is one of unusual interest; that although there are still many undetermined factors, it can very possibly be of prime importance to the economy of our state and the economy and security of our nation.

Geology

The mineralized area constituting the uranium deposit is at the contact of the Coconino Sandstone layer of the Grand Canyon Series, and the underlying bed of Hermit Shale. Details of this occurrence are hidden by the talus fill along the canyon wall, but there has evidently been considerable displacement because the mineralized rock in the mine is distinctly Coconino Sandstone but occurs at a level below the normal floor of that bed - where the Hermit Shale should be.

The adit level of the mine enters solid formation at a point about 50 feet below the normal Coconino Sandstone - Hermit Shale contact, but is in the sandstone. Ramified workings below this level usually enter the Hermit Shale strata some 60 feet below the adit, indicating a displacement in that area of some 110 feet.



General View in Hack's Canyon.
Lighter colored strata near center line
is Coconino Sandstone. The strata below
that which erodes in a more slanting
manner is Hermit Shale or Supai Formation.

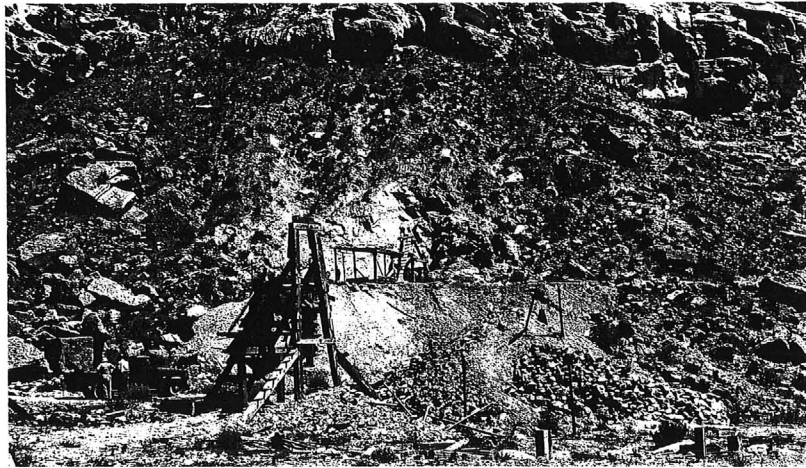
No mineralization is evident in the shale. In the mine workings the formation shows many slips and breaks but no main strike or dip of such fractures was observed. Some of the ore is a breccia consisting of angular particles of sandstone cemented together and impregnated with copper and uranium minerals. The strike, dip or limits of the mineralization itself could not be determined in the present development, but it seems quite certain that mineralization does not extend into the underlying Hermit Shale strata. No intrusive was observed in the vicinity.

It was possible to give but a brief moment to the geology of the deposit on these two examinations, but no doubt a geologist trained and experienced in Grand Canyon geology would quickly acquire a thorough understanding of all details regarding this deposit.

Development and Maps

The accompanying map, which is based partly on a transit survey and partly on a Brunton, shows the extent of the mine workings.

There has been no attempt toward systematic development, and it is difficult to understand why some of the work was done at all. The general plan seemed to be to follow indications of copper or follow "hunches", and gouge out what copper ore could be thus obtained.



This looks like one dump but is actually two separate dumps, the second being behind the one in the foreground and higher.

The vertical shaft collar is near the light weight structure in the center. The headframe is for the inclined shaft (see map). The adit entrance is a short distance ahead of the pickup truck and men in lower left corner.

Note contact of Coconino Sandstone - Hermit Shale at top of this cut.

The vertical shaft with a collar elevation of 4231 cuts the adit at 4200 and proceeds downward to 4172 where there are several winding drifts. At station F there is a winze down to the 4162 level where there are other drifts, one of which winds around to station "I" where another incline winze connects with a drift from an incline shaft some 125 feet to the north. The Hermit Shale strata is penetrated in this latter winze at an elevation of approximately 4140 and the connecting drift and incline shaft are inaccessible and reported as showing no mineralization. The vertical shaft was sunk a short distance below the 4172 level but has been filled with gob and is reported to have entered the Hermit Shale at about 4140.

Brunton station are marked on the map in capital letters and may be so referred to throughout this report. Figures alongside the drifts refer to

Geiger Counter readings. Cut samples are not marked on the map but the location of each sample will be tied in to the stations in the paragraph on assays and determinations in this report.

Fluorescence

All mine workings were examined with a mineralight and a brilliant greenish-yellow fluorescence appeared in irregular splashes and streaks throughout the workings. Common light and a hand glass showed nothing discernible that might cause this fluorescence.

Some persons who had worked in the mine stated the fluorescence appeared to be variable and would occur, disappear and reappear at various places and times. This apparent phenomenon is probably due to coatings of dust accumulating and being removed when such activities as blasting and mucking were carried on. Some, but not all, of the fluorescence is due to oil from rock drills. The subject of fluorescent minerals will be discussed further under the heading of mineralogy.

Geiger Survey

An Omaha Scientific Company Geiger counter was carried through all the accessible workings, and readings taken at frequent intervals. The dial is calibrated in milliroentgens per hour and the readings shown on the map are net after the deduction of the normal background count of 1.25. As a rule the readings were taken in about the center of the drift by the operator carrying the probe in his hip pocket (although at times this position brought the probe quite close to the roof of the drift). Practically no difference was ever observed, however, in the readings along one wall as compared to the opposite wall.

A distinct drop in readings was observed approximately where shown by the red dash line on the map and it is quite likely that the readings obtained in the two drifts to the northwest of that line are entirely due to muck and dust, as none of the rock from that area showed more than a trace of activity after being removed from contamination.

Dumps from the mine workings are widespread over an area north of the adit and all show a high activity and make it difficult to take any nearby surface readings. A prospect hole showing iron mineralization (no copper) about 1,000 feet to the east may have given a slight reading. Also, another prospect hole about 1,000 feet to the southwest showed some copper stain and a few specks of torbernite, and possibly a slight reading. The portion of the vertical shaft between the collar and the adit level was inaccessible, but if readings could have been obtained there they no doubt would have been influenced by the general mass, so the value of that near surface area is unknown.

Mineralogy

Several spectrographic analyses of the ore have been made, but as they are all quite similar a copy of one only is attached to this report (constituting Page 11).

The ore-rock is a typical fine grained white sandstone. Many authorities consider this layer of the Coconino Sandstone as being aeolian or wind blown. Copper carbonates and silicates appear irregularly in the seams and are disseminated. The fluorescent mineral mentioned has not been determined for certain. It fluoresces like willimite (a zinc silicate) but no such mineral can be observed and a spectrographic analysis shows no zinc. It could be a calcitic coating on some of the sand grains, but is more probably an opalitic type of sand. Opal and calcedony (varieties of quartz, but not necessarily gem opal) often show a fluorescence similar to willimite. In any event it seems to have no bearing on the uranium content and is of no economic importance.

Torbernite or meta torbernite (copper-uranium-phosphate), an apple green mineral of platy appearance, appears in the seams and disseminated throughout the groundmass, and as a cementing material holding the fragments of brecciation. It no doubt accounts for a large portion of the general uranium content. Some of the torbernite is slightly fluorescent if a person has a strong quartz lamp and a good imagination, but often no fluorescence whatsoever can be observed.

Some of the ore material is dark in color because it contains fine grains of a black mineral or minerals. This type of rock is very active under the Geiger counter, but a determination of what mineral was causing the activity caused us a great deal of trouble and delay. Some of the grains appeared to be metallic but others resembled black silica. A very few were weakly magnetic. Smith-Emery Company of Los Angeles advised an x-ray diffraction test and we ordered them to make one, but after many weeks they have not reported. We sent samples to the Atomic Energy Commission but they have not reported as yet. Our own Bureau of Mines reported that they had been able to separate the mineral and it was strongly radio active, but that they could not determine what it was without an x-ray test which they were not equipped to make.

Sampling

Cut samples were taken by chipping along the walls. The material is surprizingly tough and there was insufficient time and equipment to take as large and thorough samples as should be taken. We feel, however, that the cut samples as taken represent, with perhaps undue conservatism, the ore that would be mined with no attempt to mine selectively. Selective mining could no doubt produce a much higher grade product but would be much more expensive and very wasteful.

Type samples or specimens were taken throughout the workings and the dumps, for the purpose of making mineral determinations and as a guide to determining the mode of occurrence of the economic minerals. While some of these samples could be considered as quite high grade and ore of such types and grade might be mined selectively, their value has only a small bearing on the general average.

Under the heading of Assays and Determinations a detailed description of the samples and results will be given.

Assays & Determinations

In attempting to make quantitative determinations of uranium ourselves by using our present Geiger Counter, we have run into much difficulty - in fact insurmountable obstacles. The results as given below can be considered as approximate only, especially in regard to the low grade material.

Our plan was to have a few assays made by chemical analysis to be used as standards. Then to compare readings of unknown samples by using identical conditions of mass and distance. After deducting, in each case, the background count or reading, the net results should be in proportion to the uranium content.

Dial readings on our instrument of both the background and the sample were too erratic for close work except on high grade samples. When quantities were reduced enough so the earphone count would be measurable, it was found that both the background and sample count varied widely minute by minute, and attempts to obtain an average over a ten minute period brought a steady declining rate and early exhaustion of the instrument. We know of five machines in the state of this make and each one showed early decline or exhaustion when subjected to anything but brief intermittent use, and it is evident that Geiger counters of that design and make are suitable only for intermittent field use or qualitative determinations.

After encountering the above difficulties it seemed best to send the lower grade and cut samples to the Atomic Energy Commission for quantitative determinations, but as it may take some time to get these results we felt that this report should not be further delayed. Therefore, the results of our own determinations are given below - subject to later correction.

- Sample #1: General sample compiled for the purpose of obtaining a known standard. Assayed chemically by Smith Emery Company of Los Angeles..... .74% U
- " #2: Face of drift beyond station "J". Represents entire face. Assayed by Atomic Energy Commission. For use also as a standard of higher grade. (1.40% U_3O_8)..... 1.18% U
- " #3: 19 feet along both sides of drift from station "J" toward face..... .50% U
- " #4: Around station "F" and partly down winze toward 4162 level..... 1.25% U
- " #5: Station "D" to "E" cut on wall..... .50% U
- " #6: 20 feet along wall from a point 10 feet west of shaft (at approx. red dash line) toward face of west drift on 4172 level..... Tr. U

NOTE: A 5-pound sack of this sample showed a discernible reading, but a small sample did not.

- Sample #7: Pieces selected from several samples showing very little green material (torbernite) but considerable black..... 1.50% U
- #8: Selected highly fluorescent pieces, white-soft, showing very little green..... .25% U
- #9: Selected high grade copper pieces..... .37% U
- #10: Selected pieces showing considerable torbernite..... 2.50% U
- #11: Selected low grade pieces showing very little mineral of any kind..... .10% U
- #12: Selected pieces from dump showing no torbernite but heavy in the black mineral..... 2.25% U

Metallurgy

As stated in the letter accompanying this report, we felt that accurate mineral determinations were necessary before conducting concentration experiments.

However, as a starter, we sent an average sample to the metallurgical laboratory of the Arizona Bureau of Mines at Tucson and asked them to make a preliminary flotation test.

A test was made using oleic acid with hope that the uranium might follow the copper carbonates. Some of it did.

The results of this test are tabulated below, but because the quantities were very small we feel that the results are an indication only:

<u>Product</u>	<u>% Weight</u>	<u>% U</u>	<u>Weight times Assay</u>
Conc. #1 (no copper)	2.0	2.58	5.16
Conc. #2 (copper)	2.4	1.25	3.00
Midds #1 (sand)	6.4	2.65	16.96
Midds #2 (slime)	11.0	.70	7.70
Tails - sand	77.2	.39	30.11
Tails - slime	1.0	1.48	1.48
	100.0		64.41

Calculated heads from above : .644% U

Combined and weighted average -
eliminating Midds #2 and sand tails 2.22% U

Extraction - 40%

Concentration ratio - 11.8% (8.5 - 1)

The above can hardly be considered as a successful test, but as a starter it is not entirely bad. The test rather indicates that the uranium in torbernite form went with the copper concentrate, whereas other uranium minerals went largely with the sand middlings and non-copper concentrate.

It seems entirely possible that some combination method might be worked out to give a fair extraction, but it also seems rather doubtful if crude ore of .50 - .75% U content could be mechanically concentrated on the ground to yield a 16.5% U (20% U_3O_8) product as required by the Atomic Energy Commission, without great waste.

We had planned to make gravity concentration tests and screen analyses, and we have all such samples prepared. But a breakdown of our Geiger Counter has precluded that work. It may take some time to get the counter in satisfactory operation again, and as we do not wish to further delay this report, we will report such tests along with the additional mineral and metallurgical information above mentioned.

General Comment

Present development is insufficient to permit any estimate of the lateral extent of the deposit, or of the tonnage or grade available. Without much strain on the imagination, however, a block of ground 75 x 35 x 50 feet deep might be assumed to be fairly well mineralized. This would make something over 10,000 tons. The average grade of such a block would be only a wild guess with the limited data available, and likely may not exceed .50% U.

We can estimate the mining costs and the transportation costs but have no idea about the treatment costs. It is quite probable that .50% U ore would not stand all the costs that would pertain in that location without some special dispensation. Nor do we have any idea as to whether or not the crude ore could be successfully concentrated on the ground.

At the same time it seems reasonable that if the deposit proves to be border line or marginal, and if our country wants and needs uranium as much as is proclaimed, sufficient assistance should be given to make a supply such as this available for useful purposes. If it is so greatly needed why limit the price at \$4.00 per pound or \$40.00 per pound, or other than what it takes to get it?

While there is no doubt but that some selective mining might be done to produce some profitable ore, such a plan would be most wasteful of this most critical mineral and should not be considered or tolerated. And, furthermore, we would not advise any actual mining until the limits of the ore body had been sufficiently defined to permit the selection of the most economical and least wasteful mining method or plan.

There is no reason to assume that the mineralized area as shown is the limit of the ultimate tonnage or grade. One of the best looking spots in all the workings is the face of the drift beyond station "J". The mineralization has weakened between station "J" and that face, but appeared there to be coming in again with renewed strength.

On a whole the deposit has very unusual qualities. Probably none other like it is known. It could well be of prime importance to our national economy, and further study and development should be carried on without delay, in spite of cost.

Recommendations

The present samples and results, while far from being conclusive as to tonnage and grade, seem sufficient to justify additional development to further determine the lateral extent, and better determine the average grade. The quickest, simplest and most accurate way to accomplish this would be by a diamond drilling program.

Such holes should be on close coordinates, probably 10 feet apart to start, with provision for a hole to be put down in the center of the 10 foot squares later on if desired. Such a program should start with and include the present developed area and spread out therefrom. These holes should be put down to the bottom of the Coconino Sands with possibly a few holes penetrating the Hermit Shale to see if "anything happens".

A reasonable percentage of core should be obtainable in that sandstone formation and these cores, together with the cuttings, should be analyzed systematically with a proper Geiger counter and then preserved.

At the same time it might be advisable to further advance the drift beyond station "J" and to run some crosscuts in places from the present working such as at "J" and "H" and north from "F".

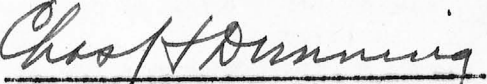
If further preliminary sampling is desired the crew should be prepared for some heavy cutting, possibly by plugs and dynamite, and should be equipped with a small crusher and sample splitter. Such equipment can be rented locally.

First of all, however, a few days further work should be done on the canyon road to make it a little less liable to washouts and a little less difficult for an ordinary car or truck. Some spots on the road at present are too narrow and crooked to permit the passage of a truck of normal width or a car or pickup of long wheel base.

If the present owners of the property are not prepared to finance a program as above outlined, I would advise that the proper governmental authorities be approached with view to obtaining assistance or some incentive beyond the regular present program. Surely some arrangement should be worked out to further determine and develop such a new and important possibility for a supply of such a vital metal.

Respectfully submitted,

Phoenix, Arizona
September 1, 1948


Chas. H. Dunning, Director
Department of Mineral Resources

SMITH-EMERY COMPANY

CHEMICAL ENGINEERS AND CHEMISTS

METALLURGICAL AND TESTING ENGINEERS

920 Santee Street

LOS ANGELES

LABORATORY

No. 293681

Date June 14, 1948

Sample Rock

Received 6-10-48

Marked

Submitted by State of Arizona
Department of Mineral Resources
Mineral Building, Fairgrounds.,
Phoenix, Arizona

REPORT OF QUALITATIVE SPECTROGRAPHIC EXAMINATION

Element

Approximate Quantity

Silicon, Aluminum -----

Major Constituents

Copper -----

Intermediate Constituent

Minor Constituents

Uranium -----	0.5%
Calcium -----	0.5%
Iron -----	0.5%
Titanium -----	0.1%
Magnesium -----	0.1%
Zirconium -----	0.1%
Barium -----	0.1%
Strontium -----	0.05%
Lead -----	0.05%
Molybdenum -----	0.05%
Nickel -----	0.01%
Vanadium -----	0.005%
Chromium -----	0.001%
Boron -----	0.001%
Cobalt -----	0.001%
Manganese -----	0.001%
Phosphorus -----	Present
Silver -----	Present
Thorium -----	None found

REPORT OF DETERMINATIONS

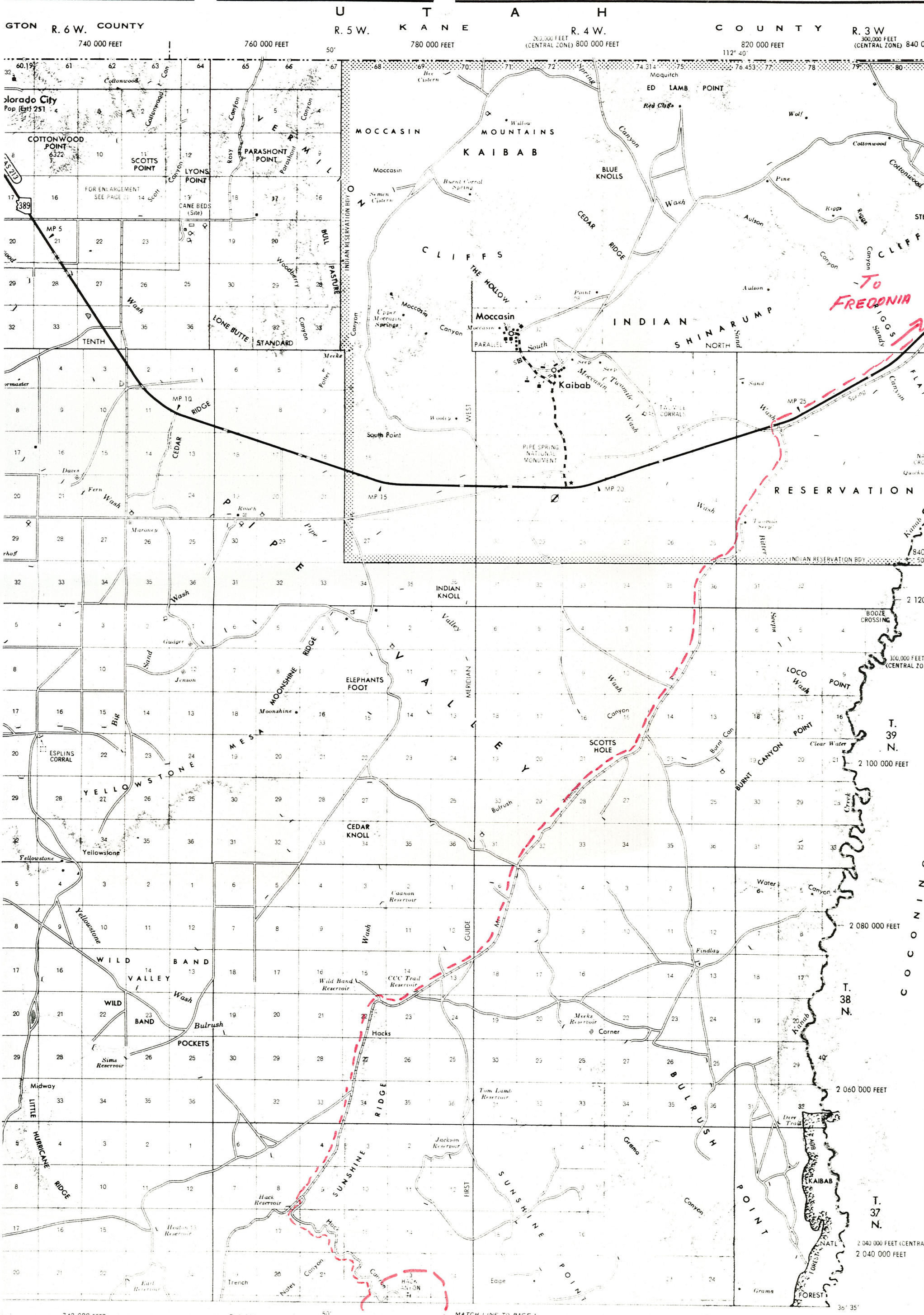
Uranium (U) by Gieger Counter ----- 0.8%
Uranium (U) by Chemical determination 0.74%

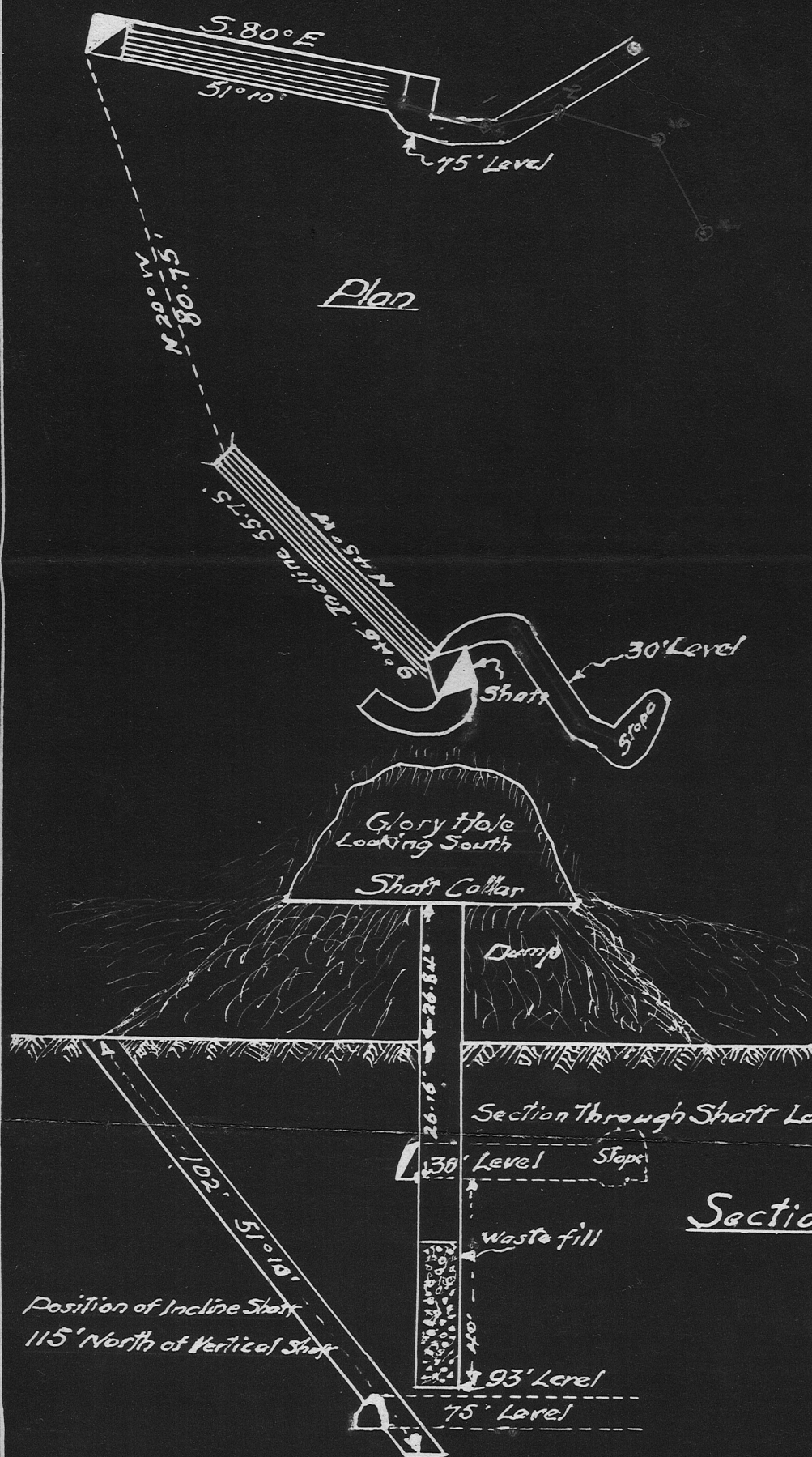
Respectfully submitted,

[Signature]
CHEMISTS AND ENGINEERS

(See statements on reverse side regarding qualitative spectrographic examination)

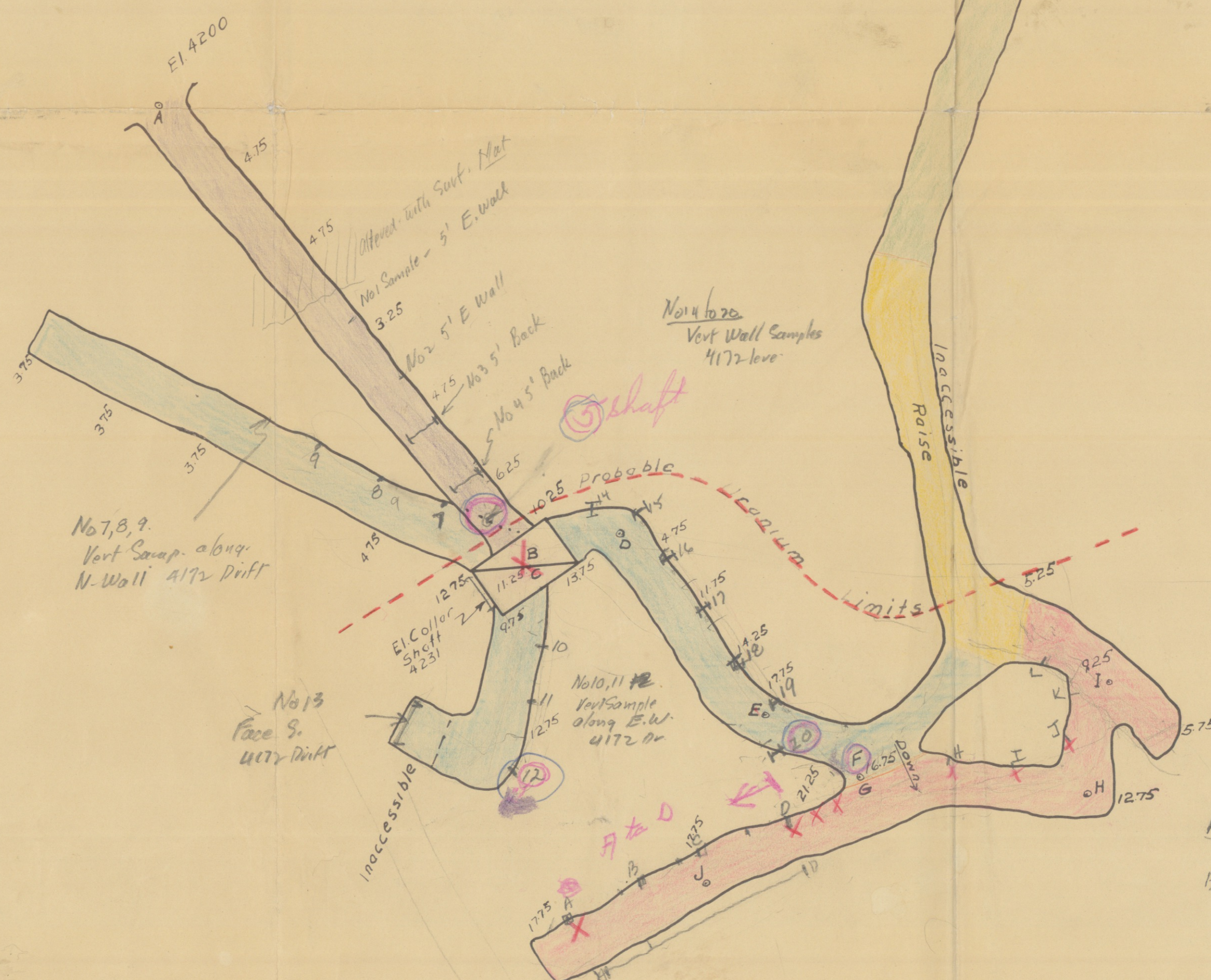
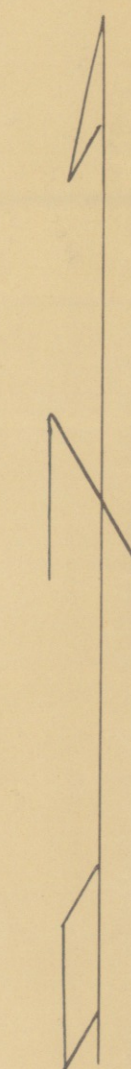






Canyon Copper Co.
Hacks Mine

Scale 1 inch = 30 feet



Sample 5 Vertical Shaft Raise - 36' along W. Wall
Sample 6 - 50' ✓ ✓ ✓

A to L Vertical Chip Samples
along Wall of 4162 Drift
A-D one 18 Foot Hor. Chip Sample

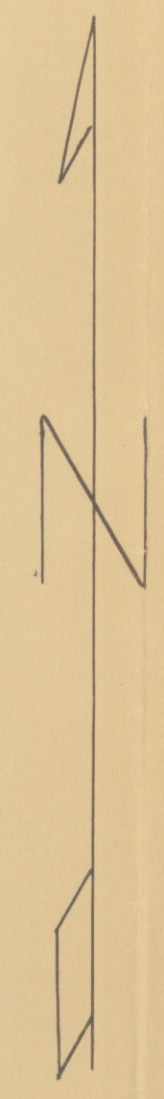
4200	Adit	4200
4172	Drift	4172
4162	Drift	4162
	Incline Shaft	
4126	Drift	4126
	Raise	

Geiger Counter readings are net

CANYON COPPER COMPANY
FREDONIA, ARIZ.

SCALE 1" = 10'

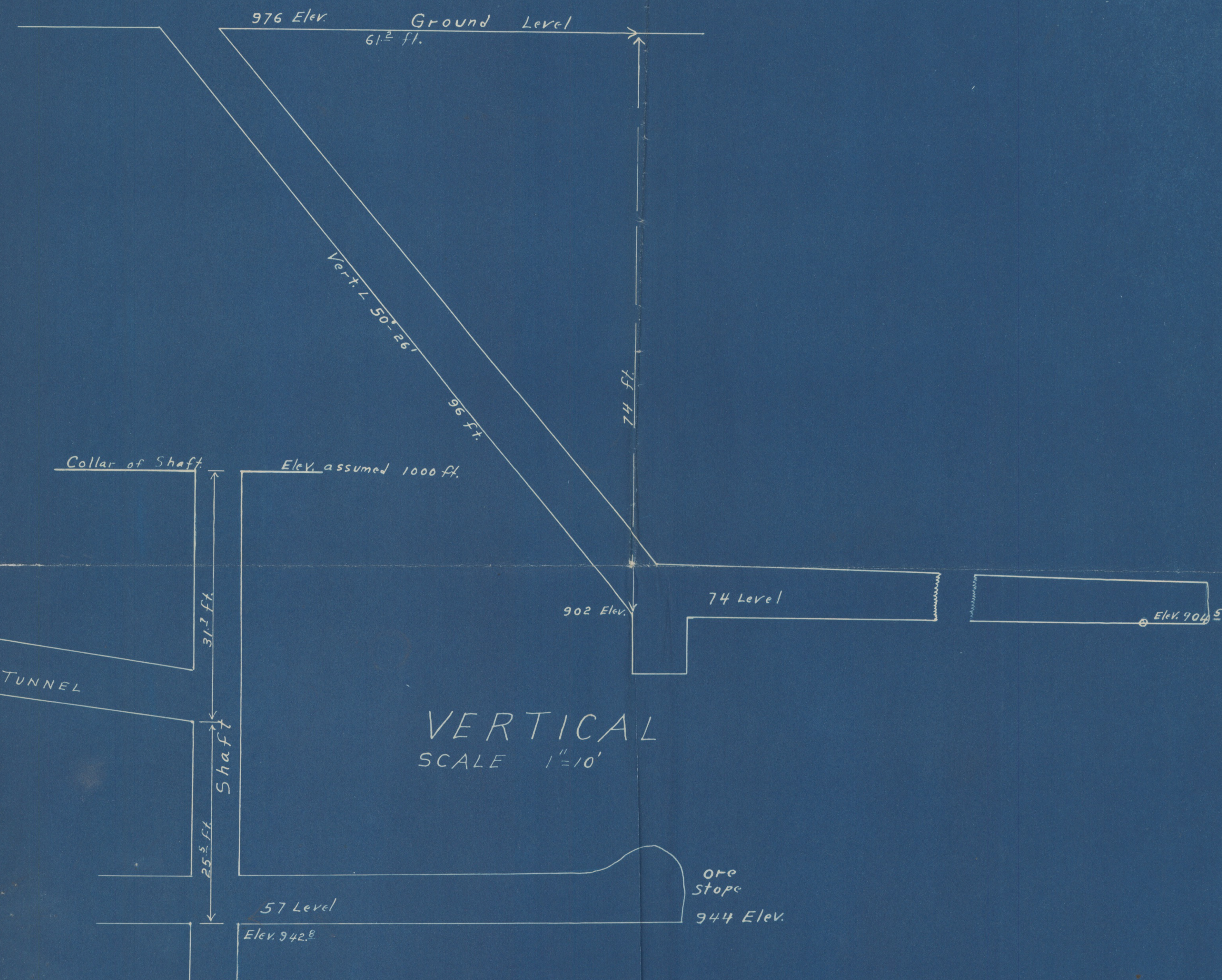
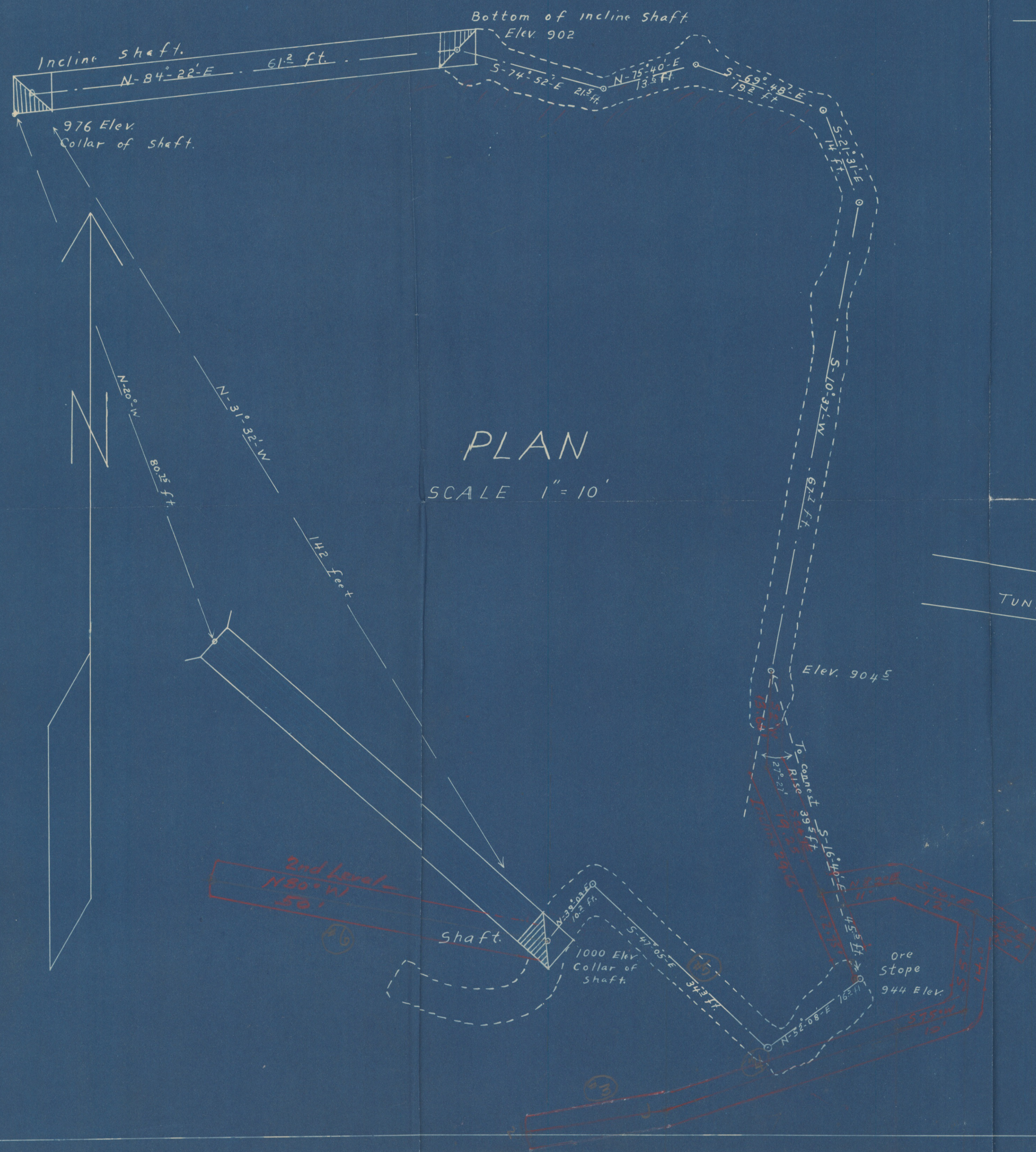
7-1-48



- 4200 Adit 4200
- 4172 Drift 4172
- 4162 Drift 4162
- Incline Shaft
- 4126 Drift 4126
- Raise

Geiger Counter readings are net

CANYON COPPER COMPANY
 FREDONIA, ARIZ.
 SCALE 1" = 10' 7-1-48



CANYON COPPER CO.
HACKS MINE
SCALE 1" = 10'
NOV. 18, 1946

by J. Mark Holmes C.E.
Kanas, UT.

