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KINNISON COPY

PEDIMENT SEARCH, COPPER ARIZONA

by

J. E. Kinnison

November 24, 1971

Piedmont Program 3-0-1

DN

INTER-OFFICE MEMORANDUM

TO John E. Kinnison
AT Tucson

RECEIVED
NOV 10 1971
TUCSON
KAISER EXPLORATION & MINING CO.

DATE November 5, 1971

FROM Joseph J. Durek
AT 2026 KB, Oakland

COPIES TO

SUBJECT CONTINENTAL OIL PROPERTY

In Vancouver I met a geologist whose name and present affiliation I did not record, but he claimed to have made the discovery for Continental Oil near Poston Butte. He stated that he found a small mineralized exposure or outlier in the gravels, and they drilled on that evidence only.

I have mentioned before that Bob Anderson is Project Geologist, and he visited me about two months ago when on a trip to speak with Fluor-Utah regarding a feasibility study.

You are familiar with this area, and I note that George has been field checking granites there. If Continental had, in fact, made a chance discovery of a remnant hill several miles out on a pediment, there may be reason to give more emphasis to a similar kind of search. You have been doing this to some degree, but many small outliers are difficult to observe or to reach on the ground. Also, the presence of pediment exposures in washes is difficult to check easily.

This is the old problem of peeking under the gravels, and I believe it is something in which you are well experienced. I suggest only that you give consideration to possible minor exposures for 2-5 miles from mineralized range exposures, review best topo available for outliers or promising washes, and consider if low airborne reconnaissance would be of use. Geobotanical sampling might have some application where mosquite is present, and wells, springs, or seepage from below flows or gravels might provide some useful clues.

I believe that we will have to accept structural projections as sufficient reason for some detailed work, and more I.P. may be desirable on fairly slim clues. Your program with granites is a good step, but consider petrographic alteration study where geochemistry or visual evidence suggests anomalous conditions. Ground magnetics might define a concealed intrusive contact, and it appears this has been generally neglected.

These are very general comments, but we will be under pressure to increase our effectiveness during this period of hiring restriction.

JJD:la

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FROM

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Side comments by JEK

GEOPHYSICAL DIVISION
3422 South 700 West
Salt Lake City, Utah

J. E. K.
DEC 28 1966

November 16, 1966

Mr. J. H. Courtright, Chief Geologist
Tucson Office

GEOPHYSICAL SURVEYS
BLIND PEDIMENT AREAS

Dear Mr. Courtright:

This is to acknowledge copies of your letter of October 27 to Mr. K. E. Richard, and Mr. Saegart's memorandum of October 17 concerning the subject matter. The gravity-induced polarization approach is, in my opinion, a logical and well considered proposal and you undoubtedly have some specific areas in mind for initiation of the projects. Overall, however, the belts outlined still represent considerable area for this type of coverage. I am sure you have considered the matter of outlining more specific target areas through the use of additional geologic controls however obtained. I know that you are also aware of the color photogeologic and aeromagnetic means of obtaining additional geologic control information.

I hope to replace the "Copper Belts" to represent blind pediments and structures in between.

Mr. J. B. Lindsay's memorandum of October 26, to me, concerning the techniques by which photography and photogeology may best benefit Asarco is enclosed. His concept of making photo-mosaic map base control for overlay and group discussion of photogeology maps and any subsequent geophysical and geochemical maps appears to me to be well conceived. The photo-mosaic could also afford map base control for areas where good topographic maps are not available. Within the belts outlined by Mr. Kinnison, color photogeology could be used to indicate any possible structural controls related to the copper belts, such as folds, in pre-mineral rocks, and fault structures. In addition, some fault lineaments can be traced out under the valley fill and interpretation of the color photographs for various types of alluvium can give some concept concerning pediment areas.

Talk it over at staff meeting & we should be able to get some examples.

don't know what control the belts or how expressed. Maybe we should study this.

doubtful. - from photos.

[The aeromagnetic approach of obtaining additional geologic controls is well illustrated by the aeromagnetic map of the Milford area. The strong geologic east-west structure reflected by the magnetic contours is not particularly well indicated by either geologic maps, or of the outcrops in mountain ranges, or the gravity map. Both of the latter emphasize the roughly north-south basin and range features. We have other magnetic evidence to the north of this area in which aeromagnetic maps reflect major east-west structures of considerable extent.] Although the proposed aeromagnetic map of the United States would afford broader background for interpreting these major features, it is possible that our own magnetic coverage of the outlined copper belts in Arizona could be interpreted just as a similar feature is reflected in the Milford aeromagnetic map. The aeromagnetic coverage of adjacent pediment areas could also give some reconnaissance indication of shallow pediment and additional geologic information.

Milford example

when? how soon?

Very truly yours,

R. J. LACY

cc: CPPollock & KERichard
WESaegart
WGFarley

RJL:ao
Enc.

R. J. L.

OCT 27 1966

R. J. L.

GEOPHYSICAL DIVISION
3422 South 700 West
Salt Lake City, Utah

October 26, 1966

MEMORANDUM TO R. J. LACY:

PHOTOGEOLOGY AND PHOTO INTERPRETATION

Dear Bob:

It would seem to me that the initial objective of mineral geologic exploration is to examine as closely as possible large areas of interest. The purpose being to understand them geologically, then to reduce them to specific areas where more concentrated effort can be applied. By this reasoning, photogeology should be the first step.

I would like to review briefly our recent discussion concerning the techniques by which photography and photogeology may best benefit ASARCO. I think we have convinced everyone who has seen the plotter that it is a good and useful tool. The next step is to see if we can get our monies worth by producing outstanding maps and reports. To review quickly our position: We will have plotters in Spokane, Tucson, Knoxville, and Salt Lake. We have the beginning of a first class photo lab here in Salt Lake and with a little effort and expenditure we could have it operating and contributing. I would like to list the steps that I feel we must pursue to get our photogeologic program operating in a highly efficient manner.

1. Utilizing our stereo plotters prepare from colored 35mm stereo photography photogeologic maps. This will allow us to train ASARCO geologists in the use of the plotter. This can probably best be done at any of the four division offices.

2. In conjunction with our acquisition of the 35mm colored slides, acquire 90mm color negatives.

3. Hire a good photo lab technician capable of producing excellent colored prints from 90mm colored negatives. By using Eastman's new technique for printing we estimate an 8" x 10" print will cost us about 75¢. This price also includes labor.

4. Build large scale color mosaics of each project being studied using map control where available. This will require an additional girl employee. The mosaics can be used as a base map in all subsequent studies (geophysics, geochemistry, drilling or whatever they may be). For our purposes, however, the mosaic will be used to support the photogeologic map produced from the plotter. It will repre-

why? what audience?

sent an exhibit by which the area can be seen by an audience. Using a 90mm negative we should have excellent sharp detail.

5. The geologist, who has constructed the map on the plotter, can now report on it verbally using the color mosaic to support his arguments. There should be as many other geologists present at this discussion as possible, in a seminar type group, discussing the geology in terms of what can be seen on the map and mosaic. Additional knowledge may be added by others who have worked in adjacent areas, or who have a better understanding of regional events through broader experiences. If other studies such as magnetics, gravity, geochemical, etc., have been done, these can be incorporated into the discussion. The seminar can be terminated by summing up the discussion, particularly in regard to what additional studies might be done. A short report can be prepared on the thoughts of the meeting and can accompany the photogeologist's written report. If additional studies are needed to gain more knowledge, a current base map is now readily available from the mosaic. Photogeologic, aerial magnetic, gravity, geochemical, induced polarization, field studies, or whatever, should support each other to a degree. The photogeologic approach should be the first step in evaluating a particular area. It is the easiest and by comparison to other studies, it should be the cheapest.

Bull shit

Field geologic mapping comes first!

I feel that if we can get the support along the lines I have outlined, we will have the most efficient, and I'm confident the most successful photo branch in existence. There is considerable research yet to be done, but it will fall into place once we have our operation going.

Sincerely,

James B. Lindsay

JBL:ao

JAMES B. LINDSAY

we may have - or aquire - best photo outfit and people - so what? - photogeology in my opinion is of very limited use in the complex rock-distribution setting of the southwest. I definitely believe in photographs as a base for recon mapping in the field, but not in the office.

JEP
Keep

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

October 27, 1966

Mr. K. E. Richard, Chief Geologist
American Smelting and Refining Company
120 Broadway
New York, N. Y. 10005

GEOPHYSICAL SURVEYS
BLIND PEDIMENT AREAS

Dear Sir:

Attached is Mr. Saegart's proposal to initiate extensive gravity and I. P. surveys along the flanks of mountain ranges that lie within the known porphyry copper belts.

The objective would be to search for concealed zones of mineralization by using gravity to define bedrock pediments followed by I. P. surveys over those portions within depth range of the method. Rather than moving progressively along the lineaments, the work would be concentrated first in those areas which (1) by topographic and geologic expression indicate the probable existence of a broad, shallow pediment, and (2) show some evidence of mineralization-alteration in outcrops adjacent to the covered pediment. An example is the Owlhead District lying along the Silver Bell-San Manuel-Copper Creek trend.

The cost of the program would range between $1,000 and $6,000 per month, depending mainly on the amount of I. P. work. It is recommended that the surveys be started as soon as the necessary field operators can be engaged.

Yours very truly,

J. H. Courtright

J. H. COURTRIGHT

JHC/kw
Attachment
cc: RJLacy, w/att.
WESaegart
WGFarley, w/att.

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

October 17, 1966

MEMORANDUM TO: J. H. COURTRIGHT

PROPOSAL
GEOPHYSICAL SURVEYS
BLIND PEDIMENT AREAS

There is general agreement that the future chances of finding an exposed porphyry copper deposit in the Southwestern U. S. are almost nil. In recent years our exploration efforts have been directed toward the search for exposed fringe type mineralization bordering alluvial or post-mineral rock cover. It is now apparent that even fringe outcrops are becoming increasingly scarce. Most, if not all, of the known fringe leads have been tested as a result of accelerated copper exploration since 1960. The rate of discovery of new fringe leads is progressively decreasing.

We will continue to find occasional porphyry copper targets through intelligent ground reconnaissance and mapping along known mineral trends. Additional target discoveries can be anticipated in the course of low-level helicopter observation.

To increase the opportunities of discovery, our current reconnaissance methods should be supplemented by new approaches. An exploration technique which is most simply identified by the phrase "Gravity - Induced Polarization Blind Pediment Testing" is now recommended. The objective of this program would be to systematically test the alluvial covered flanks of each mountain range along the lineament belts of Arizona. In this approach, the exploration targets are totally blind porphyry copper deposits.

The first step to implement this program would be to determine the existence and locations of true pediments flanking mountain ranges. Gravity traverses using altimeter elevation control can be established to identify pediment areas. The gravity method is rapid, inexpensive and is usually effective in this application. There are examples where gravity results have failed in pediment interpretation. Sacaton is such an example. Valid gravity applications have been demonstrated, however, in many areas.

The second phase of the recommended program is a follow-up with induced polarization surveys of all gravity indicated pediments. I. P. surveys would be limited to those areas

where we could expect shallow bedrock (less than 1000 feet - preferably less than 500 feet) to permit effective I. P. penetration.

The porphyry copper lineaments, as reported in Mr. J. E. Kinnison's memo of September 2 and previously, are plotted on the attached relief map of Arizona. Some of the ranges which would be included in the program of blind pediment testing are listed below. The accompanying numbers correspond to locations as plotted on the attached relief map of Arizona.

MOUNTAIN RANGES INCLUDED IN PROPOSED BLIND PEDIMENT EXPLORATION PROGRAM

1 - Patagonia
2 - Santa Rita
3 - Sierrita
4 - Tucson
5 - Roskruge
6 - Silver Bell
7 - Picacho
8 - Sawtooth
9 - Silver Reef
10 - Casa Grande
11 - Tat Momoli
12 - Sacaton
13 - Salt River
14 - White Tank
15 - Vulture
16 - Wickenburg
17 - Date Creek
18 - Hualpai
19 - Cerbat
20 - Black
21 - Mule
22 - Tombstone
23 - Dragoon
24 - Little Dragoon
25 - Winchester
26 - Galiuro
27 - Black Hills
28 - Tortilla-Picketpost
29 - Superstition
30 - Empire
31 - Whetstone
32 - Pinal
33 - Santan
34 - Table Top
35 - Vekol
36 - Maricopa
37 - Sand Tank
38 - Sauceda
39 - Batamonte
40 - Crater
41 - Pozo Redondo
42 - Little Ajo
43 - Growler
44 - Harquahala
45 - Little Harquahala
46 - Pinaleno
47 - Santa Teresa
48 - Tortolita
49 - Vaca Hills
50 - Santa Rosa
51 - Slate
52 - N. Comobabi

Blind pediment testing as envisioned would be of a long range, continuing nature. This work should be initially limited to Arizona. Ultimately it could be extended into portions of New Mexico, Nevada, and perhaps other states. To systematically test the flanks of all the mountain ranges along mineral belts could span a period of several years. An aggressive, far sighted program of this type would materially improve our odds for successful exploration.

To implement this program, the Tucson based geophysicist should have two assistants, a gravity meter operator and an

I. P. crew chief. These positions could be filled by non-professionals at salaries in the $450-500/mo range. The total cost of this program, including salaries is estimated at $6000.00/mo during periods of continuous field work.

If this proposal is approved, the two field operators should be hired immediately and the program initiated without delay.

W. E. Saegart

W. E. SAEGART

WES:pjc
Attachment: Relief Map of Arizona
cc: JHCourtright, 5 Extra w/ attachment

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

December 13, 1961

Mr. C. P. Pollock, Exploration Manager
American Smelting and Refining Company
120 Broadway
New York 5, New York

PORPHYRY COPPER EXPLORATION
Regional Mapping
Southern Arizona

Dear Sir:

Enclosed is copy of memorandum by Mr. Blucher which is a record of his regional mapping in south-central Arizona.

Some of his mapping was incomplete. His index map provides a reference for the location in our files of his field sheets for the incompleted areas. You will recognize the names of those districts and areas which he completed and for which you have maps and reports in the New York files.

I might mention that it has been our practice to do this kind of regional mapping only in areas where we have particular reason to expect that obscure porphyry copper occurrences would be brought to light only by this kind of work.

I have no specific plans to complete any of Blucher's unfinished areas in the near future. He has made sufficient coverage of these areas to insure there are no good exploration possibilities. The geological information on his incompleted field sheets will be very useful to those of us working in the field here, but there seems no present need to draft final maps.

Yours very truly,

Original Signed By
K. Richard

KENYON RICHARD

Enclosure
KR/z
cc: RKKirkpatrick, w/attach.
JHCourtright, " "
AGBlucher - Santiago Office, w/attach.
JEKinnison, w/attach.

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

December 6, 1961

MEMORANDUM FOR K. E. RICHARD:

PORPHYRY COPPER EXPLORATION
Regional Mapping
Southern Arizona

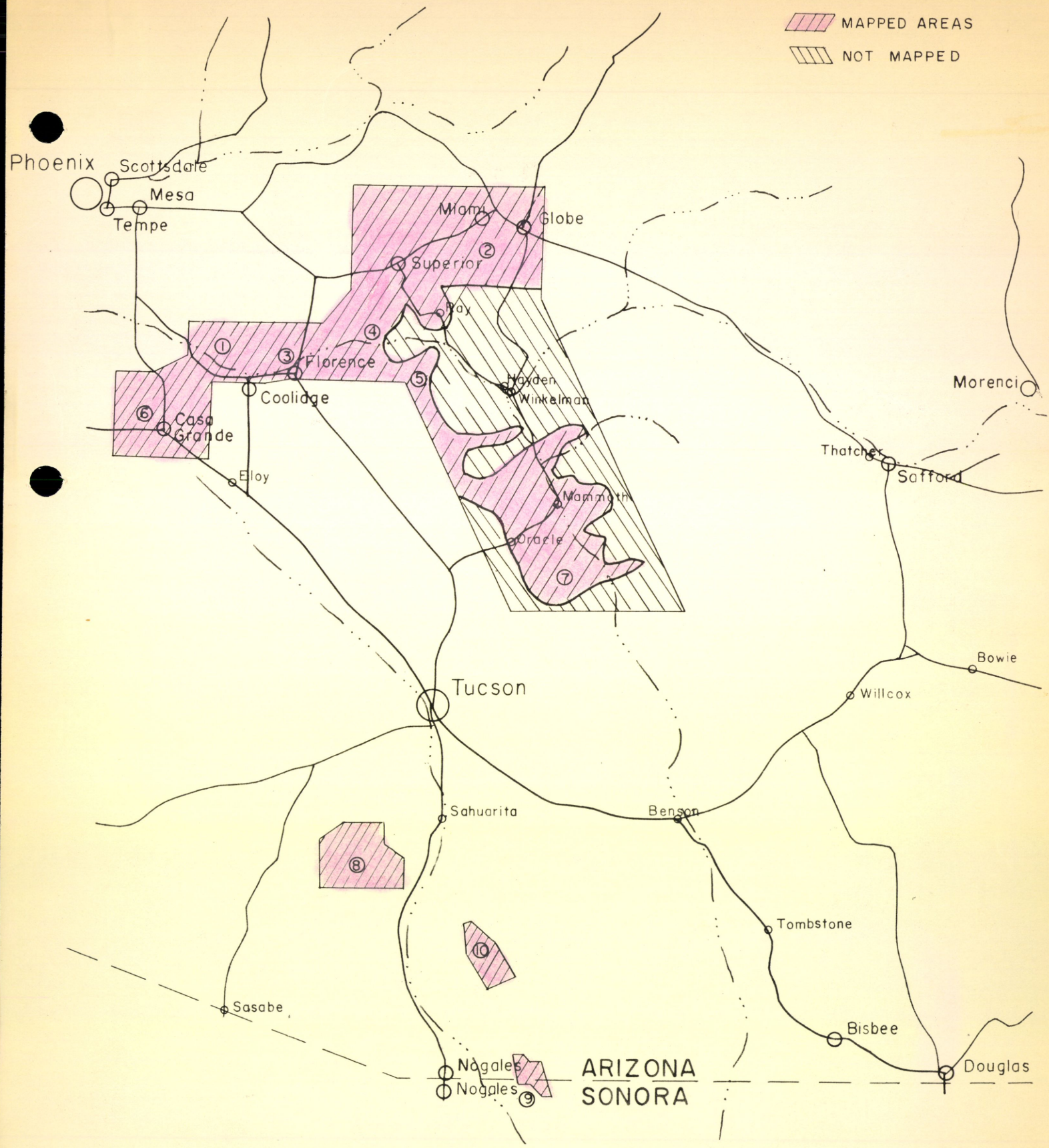
In the summer of 1957 it was decided that the broad reconnaissance studies of the "porphyry note program" had checked out most of the obvious prospecting leads in southern Arizona, and that a somewhat more detailed program should be undertaken. Accordingly, you instructed me to begin a reconnaissance mapping program in which particular attention would be given to alteration extending beneath the edge of covering post-mineral formations. This work was started in November of 1957 in the region between Globe and Superior, Arizona.

As this work progressed, procedures were established which have been generally followed throughout the mapping of this and subsequent areas. These are outlined in my memorandum entitled, Progress Report, Regional Mapping, Globe-Superior Area, dated March 24, 1958. On the attached map are shown all of the areas so mapped since the beginning of this project. Most of this work was accomplished between regular geological assignments, and in some quadrangles the mapping is incomplete. However, in most cases sufficient knowledge was gained in each quadrangle to indicate that the best potential areas were within that part of the quadrangle in which mapping was complete.

The field sheets of these areas in which mapping was not finished have been placed in the files. Although they do not have legends, the color code described in the above mentioned progress report has been used consistently. In the event I return to work in this area, or another geologist is assigned to continue this work, they can be added to or extended without editing or recopying.

A. G. BLUCHER, JR.

Attachment
AGB/z



DISTRICT	MAP NO	REPORT
1 Blackwater Mining District	1457	Aa-16A.2.0
2 Globe-Superior District	1407	Aa-7.7.0
3 Poston Butte Prospect	1465	Aa-16A.2.0A
4 Price Prospect	1483	Aa-16A.6.16A
5 Ray-Christmas District	1495	No Report
6 Sacaton Prophyry Copper Prosp.	1490	Aa-16A.3.19B
7 San Manuel Copper Creek	1496	No Report
8 Sierrita District	1474	Aa-16.19.0B
9 Southern Patagonia Mountains	1401	Aa-19.16.0
10 Southern Santa Rita Mountains	1400	Aa-19.19.0

INDEX MAP

REGIONAL MAPPING
Southern Arizona

Scale 1"= 20 Miles

December 1961

A.G. Blucher

1) Qualifications *

all methods regarded as inexact, therefore:

A. All altered zones of porphyry aspect w/covered extensions will be drilled regardless of postulated depth or geophysical cons.

B. Definition of Pediment out considered to be usually very inexact

C. I.P. anomalies need supporting data to warrant drilling if they are not on very shallow pediment

A. Size and shape

B. Mineralized structure trending into area

C. Nearly weak min significant enough in subjective sense

D. Magnetics on supportive for ped out

E. Gravity principal ped outline geophysical methods.

E. Well logs inexact, cuttings more definitive but still often vague

*. Exception — considered that leached outc or sub outc can be evaluated correctly in term of deposit, and that prop alt types alone are not diagnostic

Pediments or volcanic cover in general vicinity of:

1. Vincinity of porphyry deposits or hydrothermal tactites

2. On possible strong lineaments or intersections.

3. Widespread mineralization — example: Black Mtn

Methods[1] 1. Recom exam to find

A. altered beads on pediment or mtn fringe

B. Rock distribution

1. Post ore sequence
2. Pre-ore intrusives
3. Extent of pediments by:
   a. field checking wells and spotting outcrops.
   b. follow by groundwater office records and drillers personal logs.

C. Water Well Mo-Cu anomalies

~~C. Gravity~~

~~D. I.P.~~

On Pediments or over. water well anomalies

2. A. Gravity & Magnetics

B. I.P.

3. Drilling

a. on I.P. anomalies

b. on proj of alt areas regardless of geophysics or pediment

(1) Underlying limitations of hypothesis

DN

INTER-OFFICE MEMORANDUM

TO J. J. Durek
AT Oakland, California

DATE November 24, 1971

FROM J. E. Kinnison
AT Tucson, Arizona

COPIES TO File
Blue

SUBJECT Pediment Search, Copper, Arizona

In response to the points contained in your memorandum on the discovery of the Continental Oil property at Posten Butte near Florence, I thought I should comment on our present degree of emphasis and our general handling of small or obscure outcrops on pediment slopes. Although we have discussed this verbally to some extent, I do not believe I have written on the procedures currently being used.

Before discussing our current methods of pediment search, and future possibilities, I would like to list some specifics regarding Posten Butte. I had always assumed that Continental Oil had acquired to some extent knowledge of the Asarco drilling program at Posten Butte in the early '60's. This is contrary to your recent information however, and Continental may well have made the discovery on their own, without benefit of previous knowledge.

The Asarco work, done jointly by Art Blucher and myself, represents a sequence of steps carried out without benefit of an over-all plan. Each step led, perhaps fortuitously, to the next. I will digress to give these in detail because it is a case history which will be of interest to you, and perhaps to others in Oakland. The information is now largely historical, and there is scarcely anything privileged about the data.

1. The Asarco Posten Butte project may be said to have its origin in 1953, when F. V. Richard (no relation to Kenyon) noted a color anomaly in the San Tan Mountains, while on a commercial flight from Tucson to Phoenix. This was eventually located on the ground by Harold Courtright, and recognized as a legitimate porphyry copper deposit previously unknown in Asarco files.

Courtright and Byron Hardy made a reconnaissance of the altered zone, and by some omission in the field were under the impression that the zone of mineralization terminated on the northeast before bedrock dipped beneath recent alluvium. The exposed portion of the mineralized zone was regarded as pyritic on the basis of capping interpretation, and no further work was done at that time.

2. In 1959 the porphyry alteration zone listed above, known as Blackwater (or Mineral Butte) was revisited, during which time we determined that alteration and mineralization actually did not

terminate on the northeast, but indeed could be projected beneath alluvium. Blucher and I mapped the area in detail at this time, but due to a combination of property status and the general weakness of mineralization, Asarco did not follow the Blackwater project with drilling.

3. In conjunction with the work outlined above, Blucher and I wished to reconstruct the history of post-mineral volcanism and erosion, to better understand conditions which would have had an effect on the history of chalcocite enrichment at the Blackwater deposit. The post-ore rocks in that vicinity are of two main divisions -- an older series of conglomerate, dacite, and basalt, and a somewhat younger basalt. Locally much erosion had intervened between the older series and the younger basalt, and in places the younger basalt rested directly on pre-mineral rock.

4. As an outgrowth of the Blackwater study, to "wrap up the package" as it were, we elected to conduct reconnaissance in the southern portion of the San Tan range in search of any other nearby mineral occurrences.

5. While conducting step 4 above, it became evident by distant observation of small outliers in the valley, that these very likely were comprised of the youngest basalt flow, exposed at random eastward across the valley toward the Tortilla range. They appeared to be erosional remnants of an essentially horizontal lava sheet. Cognizant of the repetitive mineral occurrences which extended southwesterly toward the San Tan area from Miami, and also from Ray, constituting two "belts" or "zones," we discussed the basaltic outliers with relation to exploration potential, and concluded the following:

Statement of Facts

a. This younger basalt, owing to prior erosion of the earlier post-mineral volcanic sequence, locally rested on pre-mineral rock.

b. This basalt was not very thick, so far as we knew.

c. The valley area around Florence lay astride the projection of a demonstrable mineral zone, traceable from Ray southwesterly to Price.

Conclusions

a. That basaltic hills could form a protective cap above pre-mineral rocks which might otherwise suffer total erosion.

b. That field-checking the base of the basalt knobs would be simple and would take little time.

c. That although such reconnaissance was strictly "wild-cat," it appeared justifiable.

In actual fact, pre-Cambrian granite was found beneath a protective basalt cap in two localities, one of which is at the west base of Posten Butte. The original outcrop at Posten Butte was but a few feet wide. However, an early-day prospector had been attracted to copper silicate adsorbed by a post-mineral andesite dike; he trenched the initial outcrop, and trenched through talus on strike with this outcrop in several places. In all, he exposed four small areas, over a distance of 1,000 feet, of pervasively altered pre-Cambrian granite, with evidence in the limonite of meager chalcocite enrichment.

Blucher and I felt quite optimistic about these exposures, although there was a distinct hazzard in that they were all along strike, and no appreciable width was exposed. IP work partly removed the question of width, although over the greater part of the mineralized zone IP was valueless due to highly anomalous response from the water-soaked gravel along the Gila River. Drilling done in 1960 and 1962 by Asarco outlined a zone of porphyry copper mineralization and alteration about 4,000 feet wide and 12,000 feet long, including an area of monzonite porphyry about 4,000 feet long. Although primary copper mineralization was a high as .45% locally, for the most part it was less than .2%, and chalcocite enrichment was generally weak or absent. One area, approximately 3,400 feet by 2,000 feet, penetrated by three holes, contained intersections of .4 - .5% copper as oxide and primary, and one thin penetration of .8% copper as secondary chalcocite. Asarco dropped the property "cold" due to the general weakness of primary mineralization, and failure to encounter a substantial ore grade (say .7 - .8% copper) column of chalcocite in any hole. Although this decision may not have been wise in view of the widely spaced drill hole pattern, it is noteworthy that data so far released by Continental indicate mixed oxides and sulphides of about .5% copper.

As further background, I will also briefly describe the discovery of the mineralized outcrop at Sacaton, which followed rather closely on the heels of the Posten Butte reconnaissance. This discovery, unlike the step-by-step field reconnaissance which led ultimately to the location of the Posten Butte mineralization, resulted from a direct decision to examine all outcrops which occur on the southern pediment flanking the Sacaton mountains. This area was chosen because, although no mineral occurrences of consequence were there known, the area was within an apparent intersection of two well-defined mineral "zones," and was a natural extension of our Posten Butte work. Also, somewhat fortuitously, I had noted on a routine trip to Phoenix, driving on the highway at dusk, that small hills could be seen to arise from the sloping bajada south of the Sacaton range, suggesting that a pediment might well exist. This casual observation was followed with a rapid field reconnaissance by Blucher and myself. The vagaries of nature had provided,

as a small knoll protruding from alluvium, leached capping over what later proved to be the pyritic southern margin of the Sacaton deposit.

COMMENTS

The two preceding examples certainly point up the possibility of small but highly important pediment exposures. Posten Butte is detached about six miles from a mountain range, whereas Sacaton is closer -- 1.5 miles -- to a range front.

The classic Arizona pediment surface is on the average a rather narrow fringe along the mountain. Other surfaces, however, variously ranging from the classic pediment to a dissected pediment, to a semi-buried or completely buried pediment, straggle far out into the valley areas. In the instance of the Florence region (Posten Butte), a dissected and semi-buried pediment appears to span the valley. Field evidence accumulated to date indicates that the Arizona pediments are post-Miocene, and thus in addition to scouting for obscure pre-mineral outcrops, we also are forced to peek under middle-Tertiary but pre-pediment volcanics as well.

I have visited both Posten Butte and Sacaton with our Tucson staff, as these are prime examples of what can exist, and I find that reaction is one of astonishment. Of more importance, however, is that these obscure and isolated outcrops lend considerable moral support to the search for other such leads. As you are aware, I hope to pursue avenues of pediment search which might be effective in the total absence of mineralized outcrops, and this must necessarily entail even more hazardous geologic projections than those used at Sacaton or Posten Butte.

CURRENT PRACTICE

Our existing Maricopa County copper program has encompassed three geologic objectives to date:

1. Reconnaissance to determine the distribution of Laramide intrusives (Granite or porphyries).

2. Distribution of mineralization.

3. Location of pediments, or areas of probable buried pediments.

This work has been concentrated along the possible path of a mineral zone which presumably extends northwest from Sacaton toward Bagdad. The outcome of this work -- among other things -- is hoped to better define the location of this mineral zone, particularly in the Wickenburg district.

The small mountains of the Arizona Desert Region, for the most part, lend themselves readily to what might be termed "skeleton" reconnaissance. The base of the range is circled with four-wheel drive auto, and the range is traversed

if possible by jeep roads. By judicious use of four-wheel drive, access is obtained to actual outcrop at the mountain base at widely spaced points, and intervening areas are evaluated on the basis of float in drainages. In addition, visual observation from a distance is afforded of the mountain side, to seek color anomalies and approximate rock-type distribution. Fixed-wing aerial reconnaissance augments the search. Initial data on flanking pediments is obtained by aerial reconnaissance and by the field traverses.

Flanking pediments, once established, are reconnoitered by relatively close traversing. Outcrops in washes, or otherwise isolated, are searched for using a variety of special techniques, which I will not detail, but which are highly dependent on the mobility of four-wheel drive. Topographic contours and the AMS high-altitude photographs offer guides to outcrop. To date, I have not employed low-level aerial pediment search, other than at the beginning of the White Tank project, and perhaps such use should be increased.

Mesquite sampling is a complex technique, and I hesitate to employ it as a general practice. Water wells, however, offer a potential both as a source of ground water for sampling, as well as rock type penetrated. All wells in a reconnaissance area are examined in the field to determine if cutting piles are still existent, and the U.S.G.S. compilation of well logs is examined. We have not yet reached a situation where water analysis is indicated, but will employ this approach wherever feasible.

I consider <u>any</u> portion of a valley as an unknown, and as an area which may contain outliers. For example, you will recall that small hills of reddish conglomerate (Tertiary) occur between Tempe and Phoenix -- certainly a major valley. Pre-Cambrian granite is exposed at the base of one of these hills, and also exists as an isolated outlier on Van Buren St. near the stockyards. These valley outliers may be searched for by aerial reconnaissance, aerial photographic study; they may be located on field traverses, or by topographic map study.

It is interesting to note (and a good object lesson) that the effectiveness of search techniques vary from one situation to another. A very outstanding example is the appearance of the Sacaton outcrop viewed from the air versus the ground. I am enclosing two photographs of this outcrop, taken from a point on the highway about two miles distant. The yellow (jarosite) color of the hill is readily apparent against a grey background. From the air, this small hill blends with the yellowish alluvial plain, and is virtually invisible. At very low airborne levels the hill is more visible, but appears generally grey. Also, there is not a single prospect pit to hint of mineralization -- an unusual situation for Arizona, where virtually every mineralized stringer has been worked over by prospectors. This color anomaly was, in fact, missed by Asarco aerial reconnaissance of the early '50's.

<u>FUTURE PRACTICE</u>

I believe we are on the right track to pediment search, and that current practice is likely to combine thoroughness with relative speed. Nonetheless,

there may be possibilities to improve effectiveness of a limited staff. Additional use of fixed wing aircraft, as you have suggested, is perhaps the most promising modification. Also, I suggest consideration of helicopter use wherever local conditions indicate that a material increase in speed of reconnaissance could be obtained. Due to the high cost of helicopter rental, it will rarely be possible even to show cost equality compared with present methods, and I propose helicopter charter, if used at all, be done only if we truly can say that relative cost is not a principal concern, but that speed of coverage is.

I am opposed to a sustained program of helicopter work for two reasons.

1. We have not enough staff for rotation to withstand the fatigue of sustained daily observation.

2. No matter how good intentions may be, the cost of a sustained helicopter operation, as the program wears on, inevitably leads to cutting corners to save money. My own observation of sustained helio programs suggests that the geologist in the chopper, conscious of the daily cost, strives to attain ever increased daily coverage; he makes fewer set-downs, employs wider lines, etc., and ultimately this must lead to error.

I feel that, as costly and imperfect as I.P. reconnaissance may be, we must resort to this in selected pediment areas. Ground magnetics and gravity, used in reconnaissance manner, may be indicated as a precursor of I.P. to aid the deliniation of pediments.

You have mentioned petrographic studies in areas of minor anomalous conditions, whether geochemical or visual. This may be an avenue to overcome the difficulty in evaluating possible peripheral propylitic alteration. Whereas pervasive alteration and sulphidation typical of porphyry copper mineralization can scarcely be misinterpreted, the very feeble propylitic halo, including minor development of chlorite or epidote, resembles alteration due to other processes (deuteric or metamorphic). I have never attempted microscopic study to determine characteristics which might resolve the origin of such weak types of alteration, but certainly this is worth considering. In this regard, we should consider placing John Guilbert under contract for petrographic work. Although Sid Williams may be equally experienced, he is not accessible for direct discussion -- which I believe mandatory to get the most benefit from a petrographic consultant.

As a final remark, I have no firmly fixed prejudices regarding steps to increase effectiveness. I offer the above comments as an opening discussion, and invite comments. While we are proceeding with methods which are effective if a direct lead (an exposed outcrop of pervasive mineralization) somewhere exists yet unrecognized, the chances of this are admittedly remote, considering the concentration of exploration during the last decade. The discovery of a totally blind deposit, or with only a feeble propylitic margin exposed, calls for a state of art apparently not perfected by anyone at this time.

JEK/bl
Encl.

SACATON DISCOVERY OUTCROPS

Viewed from 2 miles south on
Maricopa highway

SACATON DISCOVERY OUTCROP
(Telephoto lens)

Viewed from same location

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

STATE OF ARIZONA

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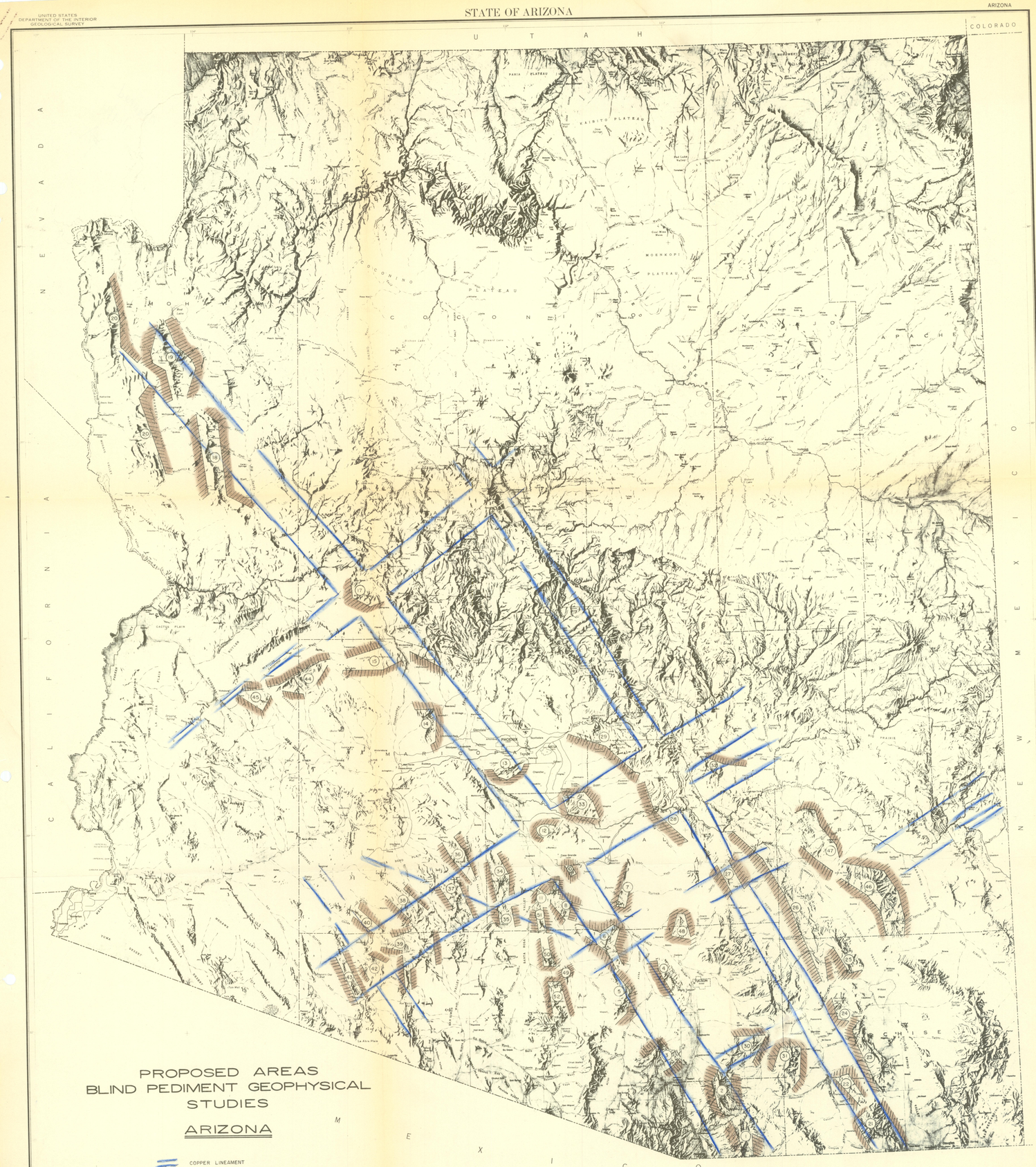

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