CONFIDENTIAL

April 4, 1951

Memorandum

To: Landon S. Strobel, Executive Secretary, Defense Minerals Administration

From: DMA Field Team, Region IV

Subject: DMA Docket 54, Duquesne-Washington Camp Area, Santa Cruz county, Arizona

We are attaching an original and two copies of the report of our investigation of DMA Docket 54, Duquesne-Washington Camp Area, Santa Cruz county, Arizona.

You will note that the field men indicate that ore reserves justify only small scale leasing operations. We recommend that the application be denied.

J. H. Earp, Jr.

J. H. Earp, Jr.

A. H. Koschmann

A. H. Koschmann

Attachments
One copy of report by air mail
Two copies by regular mail

Copies to: DMA files
Koschmann
Allsman
Storms
Shride

JHe/cl

DUQUESNE-WASHINGTON CAMP AREA

SANTA CRUZ COUNTY, ARIZONA

By T. H. Rosalo, A. F. Shride, and R. M. Horton

* * * * * * * DEFENSE MINERALS ADMINISTRATION REPORT
DMA DOCKET 54

UNITED STATES DEPARTMENT OF THE INTERIOR
Defense Minerals Administration
James Boyd, Administrator

APPROVED:

J. H. East, Jr.

A. H. Koschmann

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

224 NEW CUSTOMHOUSE
DENVER 2, COLORADO

Mining Division
Region IV

April 2, 1951

Memorandum

To: DMA Field Team, Region IV

From: Chief, Mining Division

Subject: DMA Docket 54, Duquesne-Washington Camp Area, Santa Cruz county, Arizona

The authors of the report do not come out and say so, but they at least infer that the application should be denied because of the lack of reserves or potential reserves of any quantity. Intense mining by former companies have exhausted possibilities for any large scale production such as was accomplished in the past and the potential quantity of remaining ore justifies only small scale leasing operations.

Paul T. Allsman

P. T. Allsman

Attachment

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

Arizona-New Mexico Branch
[redacted]
Box 4097
UNIVERSITY STATION

Mining Division
Date Rec'd.
MAR 26 1951

TUCSON, ARIZONA

MINING DIVISION
REGION IV

March 19, 1951

BUREAU OF MINES
Denver, Colorado

Memorandum

To : Paul T. Allsman, Denver, Colorado

From : Chief, Arizona-New Mexico Br., Mining Div., Region IV
Bureau of Mines
and
Acting District Supervisor, Geological Survey

Subject : Defense Minerals Administration Report on Duquesne-Washington Camp Area, Santa Cruz County, Ariz. - DMA Docket 54.

Enclosed are original and 11 copies of the above report by T. M. Romslo of the Bureau of Mines, and A. F. Shride and R. M. Hernon of the Geological Survey. It should be noted that the authors found that there is no Byrd Mining Co. as mentioned in the DMA loan application. There is a Byrd Investment Co. and a Duquesne Mining Co.

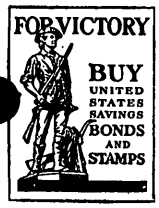
This report has our approval.

Walter R. Storms

Walter R. Storms

Andrew F. Shride

cc: P. T. Allsman
C. A. Anderson
DMA 54
DF



March 19, 1951

Memorandum

To : Paul T. Allsman, Denver, Colorado

From : Chief, Arizona-New Mexico Br., Mining Div., Region IV
Bureau of Mines
and
Acting District Supervisor, Geological Survey

Subject : Defense Minerals Administration Report on Duquesne-Washington Camp Area, Santa Cruz County, Ariz. - DMA Docket 54.

Enclosed are original and 11 copies of the above report by T. M. Romslo of the Bureau of Mines, and A. F. Shride and R. M. Bernon of the Geological Survey. It should be noted that the authors found that there is no Byrd Mining Co. as mentioned in the DMA loan application. There is a Byrd Investment Co. and a Duquesne Mining Co.

This report has our approval.

Walter R. Storms

Andrew F. Shride

cc: P. T. Allsman
C. A. Anderson
DMA 54
DF

WRStorms:nlp

DUQUESNE-WASHINGTON CAMP AREA

SANTA CRUZ COUNTY, ARIZONA

By T. M. Romslo[1], A. F. Shride[2], and R. M. Herron[3]

CONTENTS

	Page
Summary, conclusions and recommendations	1
Introduction	7
Location and accessibility	12
Physical features and climate	12
Property and ownership	13
History and production	15
Geology	16
General geology	17
Ore deposits	19
Geologic possibilities of additional ore	23
Mine workings and deposits	23
Mining operations	34
Ore reserves	36
Value of ore	41
Conclusions and recommendations	41

ILLUSTRATIONS

Figure		To follow page
1	General location map, Duquesne-Washington Camp area, Santa Cruz County, Arizona	12
2	Property map, showing outline of property and position of mines, Duquesne Mining Co., Santa Cruz County, Arizona	13
3	Sketch map showing most persistent faults that localize ore in the vicinity of the Kansas and New York mines	32
4	Geologic map of 220-level, Kansas mine, Duquesne Mining Co., Santa Cruz County, Arizona	26

1/ Mining Engineer, Arizona-New Mexico Branch, Mining Division, Region IV, Bureau of Mines, Tucson, Ariz.
2/ Geologist, Geological Survey
3/ Geologist, Geological Survey

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This report covers investigations of properties held by the Duquesne Mining Co. in the Duquesne-Washington Camp area, Santa Cruz County, Ariz. The investigations were made in connection with a request by the company for Governmental assistance, under the Defense Production Act of 1950, in carrying out a program designed to increase the reserves of zinc-lead-copper ores to the point where the construction of an ore-beneficiation plant on the property would be justified. The company suggests that the overall effect of the program would be to increase ore production from about 10 tons to 100 tons daily. The investigations were carried out by the Defense Minerals Administration under docket DMA 54.

The Duquesne Mining Co.'s request for Governmental assistance was submitted in an informal application by the Byrd Mining Co. The only specific proposal contained in the application called for the expenditure of $30,000.00 to develop ore at the Kansas mine by dewatering and rehabilitating workings at the New York mine, driving about 450 feet of tunnel, and then raising to connect with the lowest level of the Kansas mine. The application also stated the company would like to carry out other exploratory projects at the same time providing funds were available from the Government for the type of work involved. During the course of the investigations the company stated the other projects should consist of diamond drilling at the Indiana, Holland, and the South Belmont-Silver Bill areas and the

dewatering of the Duquesne and Bonanza shafts. The company submitted no estimates as to how much ore might be developed by diamond drilling but did say they were satisfied extensive ore deposits might be developed in the Estella-Louise and the San Antonio areas from the Duquesne and Bonanza workings. No estimates of the cost of these latter projects was submitted. The application did not discuss provisions for repayment of any loan that might be granted.

The writers examined the property to determine (1) if the Government would be justified in granting the applicant a loan for carrying out work involved in the one specific proposal and (2) if the other several deposits named by the applicant had merit to justify a Government loan for reasonable programs of exploration and/or development.

The mining history of the Duquesne-Washington Camp area began with the discovery of the first ore body in 1862. The periods of early activity were in the late 1870's when surface silver ores were produced and in 1898 to 1903 when the mines were worked for their oxide-copper ores. Since that time the mines have been worked for sulfide ores only during periods of high metal prices. During World War I, considerable ore was produced from the mines that had been consolidated under the ownership of a George Westinghouse. With the death of Westinghouse in 1918 the mines were in turn held by his estate, by a Bussey Curtis, and the Curtis estate from which the present owners obtained control in 1930 of most of the mines in the area. In 1939 the property was leased to the Callahan Zinc-Lead Co.

who built a 100-ton flotation mill and operated the mines until the middle of 1944 when they terminated their lease and removed all their equipment from the property. The Duquesne Mining Co. then operated the property, on a reduced scale, until production premiums were terminated in 1947. Production was again started by the company in 1948 but these operations ceased when metal prices dropped in 1949. At present some of the mines are being operated by lessees. Most of the ore produced after the Callahan operations has been shipped for concentration to nearby mills.

Probably about 300,000 tons of ore has been produced from the mines owned by the present Duquesne Mining Co. Production by the Callahan company amounted to about 116,000 tons of ore that averaged 9.38 percent zinc, 2.51 percent lead, 1.47 percent copper, and 3.63 ounces silver a ton. Subsequent to these operations the present company has produced about 34,000 tons of ore. Records on 14,000 tons of this production show the ore contained 10.94 percent zinc, 3.76 percent lead, 1.73 percent copper, and 4.35 ounces silver a ton.

The lead-zinc-copper deposits of the Duquesne-Washington Camp area are scattered through a block of sediments, mainly limestone with subordinate amounts of shaly limestone and quartzite. This block, approximately 2½ miles long and 1½ miles in maximum width is surrounded by quartz-monzonite and granite porphyry intrusives.

Small quartz-monzonite dikes and a few small irregular masses of basic intrusives crop out within the area of sediments.

In general, the sediments strike north and dip steeply to the west. Due to metamorphism the sedimentary structures have been obscured. Steeply dipping faults in general strike northeast and northwest in the northern part of the area. In the southern part of the area the most persistent faults trend almost north, but northeast and northwest-striking faults are also present.

Wide zones of limestone are almost completely garnetized at and near quartz monzonite-limestone contacts and along some fault zones in the southern part of the area. Other lime silicates are also present. Throughout the area the limestones are recrystallized and show evidence of flowage.

Ore bodies of the Duquesne-Washington Camp area are characteristically small, irregular lenses or pods of the contact-metamorphic type that replace mainly limestone but in some places replace garnet along fracture zones. Ore shoots generally are localized at the intersections or junctions of faults; in the southern part of the area a common locus for ore deposition is in limestone along a fractured limestone-massive garnet contact. The localizing faults in general are small and non-persistent. In some places flat-dipping faults and bedding are factors in ore localization.

Sphalerite, galena, and chalcopyrite are the important ore minerals; pyrite, garnet, calcite, and quartz are the main gangue minerals. Silver is present in the ores. Oxidation of the ores extends only to depths of a few feet in most places.

Prediction of new ore bodies or extensions of known bodies is difficult. Probably pods and lenses of ore do exist below depths now prospected. However, the ore-localizing structures are not persistent and therefore not projectable with confidence to aid in the search for ore bodies. Ore bodies of the habit common in this district furnish only small targets for exploration work.

The Duquesne Mining Co.'s proposal regarding the Kansas-New York area should be classified as an application for aid in carrying out exploratory work because there is no measured and little indicated ore present. On the basis of data obtained during these investigations no estimate can be made as to the inferred reserves of the area. However it would be unreasonable to expect that sufficient ore reserves could be developed to justify carrying out an extensive and high-cost program such as proposed by the applicant. Therefore it is recommended that the applicant's proposal for exploratory work in the Kansas-New York area be disapproved and that the requested loan be denied.

An alternate method for exploration of the area, in line with the writers' suggestions, might be feasible if the need for base metals becomes more urgent. The writers suggest, subject to concurrence by the Washington committees after consideration of the overall picture, that such an alternate program could be suggested to the applicant. If the applicant desires Governmental assistance

to carry out a revised program in line with the suggested plan he would be expected to submit a loan proposal with adequate cost estimates and detailed plans.

One of the projects suggested by the Duquesne Mining Co. during the course of these investigations was development of a block of ore in the Estella-Louise deposit below the 235-foot level from the Duquesne shaft. The writers have no concrete data as to the tonnage and grade of ore in this block but available data, believed to be reliable, suggests these reserves may amount to 10,000 tons. The writers have suggested plans as to how this ore might be developed. If the Duquesne Mining Co. submits a proposal in line with the authors suggestions for the development of this deposit, it should receive consideration by the Defense Minerals Administration, in event the need for base metals becomes more urgent.

Another of the company's suggested projects entailed dewatering the Duquesne mine and developing ore in the Duquesne and San Antonio areas from underground workings. The investigations indicate that little or no ore remains and found no evidence to support the company's belief that sizable ore bodies can be easily developed in these areas. The writers conclude the Government would not be justified in granting a loan for use in developing ore in these areas, under present economic conditions.

At the South Belmont, Silver Bill, Empire, and Dollana deposits, and in the area southwest of the Holland mine, the writers conclude

the chances are unfavorable for developing substantial tonnages of ore and that ore that might be developed could not be exploited profitably, under prevailing economic conditions. It is concluded the Government would not be justified at present in granting a loan for any program that may be proposed for exploratory work in these areas.

For the property, in general, the writers believe the interests of both the Duquesne Mining Co. and the Government can best be served by the continued operation of the property as at present. It is also the writers' opinion that the property can be expected to continue production for several years at the rate of a few tens of tons of ore daily.

INTRODUCTION

This report covers an examination of property held by the Duquesne Mining Co. (referred to as the Byrd Mining Co. in the application) in the Duquesne-Washington Camp area of the Patagonia Mining District, Santa Cruz County, Ariz. The examination was made by the Defense Minerals Administration as a result of the company's application for aid under the Defense Production Act of 1950.

The request for Governmental assistance, dated as DMI 5A, was made with the object of carrying out exploratory work designed to develop sufficient ore reserves to justify the construction of a beneficiation plant. The overall effect

of the proposal was intended to increase the production of lead-zinc-copper ores from about 10 to approximately 100 tons daily. The only specific proposal called for the expenditure of $30,000 to develop an ore body at a lower level in the Kansas mine. The proposed work consisted of dewatering and rehabilitating the New York shaft, driving about 650 feet of tunnel and then raising to connect with the lowest workings of the Kansas mine. The application for assistance also stated the company would like to carry out other development projects and in this connection the writers, on Feb. 5, 1951, received the following supplemental exploration program from the company.

"In my application for financial aid, November 12, 1950, to the Bureau of Mines, I mentioned one of our proposed development plans and stated there were other projects which we would like to carry on at the same time.

"It is, in our opinion, a fact that the most sizeable ore bodies have been found near the contacts with the limestone and the igneous rocks. The project already described is a connection between the New York and the Kansas, or some other type of development in that area. If funds are provided for drilling, some exploration work of this type should be made on the Indiana, Holland, South Belmont and Silver Hill, and the Duquesne-San Antonio-Estella Louise area. A brief description of these proposed projects follows:

"1. The Indiana is only 50 feet deep but old records indicate quite sizeable ore bodies of high grade ore, especially zinc. Some sinking should be done on the Indiana claim and possibly some preliminary core drill holes before starting the work. There were two

shafts on the Indiana; the most easterly shaft was caved. It is doubtful if any development work was ever carried on to get under the caved area from the present shaft. In Tom Gardner's report he mentioned that the stopes in the second were as much as 20 feet wide and the ore contained about 26% zinc.

"2. The Holland. There has been no cross cutting to the west in the Holland mine which is a project that should be carried out due to the strong surface carbonate showing. Some drill holes could be driven from the bottom of the Holland workings or the area west of the open stope could be prospected from the surface.

"3. The South Belmont and the Silver Bill. On the South Belmont is one of the strongest surface showings of any place on the property. It is probable that it would not be expensive to do some core drilling from the face of the 500 foot tunnel on the Silver Bill claim to get under the carbonate workings on the South Belmont mine. In the face of the Silver Bill tunnel is a streak of sulphide ore about 12 inches wide but extremely high grade. Drifting on this 12 inch streak might develop a body of high grade sulphide ore.

"4. The Bagnasse-San Antonio-Estella Louise Area. There were about 16,000 tons of ore produced by Callahan from the Bagnasse shaft. The entries from the Bagnasse shaft 100 feet level were driven into the San Antonio and California claims. This shaft should be unwatered as we are satisfied some sizeable ore bodies

can be easily developed in this area. Lessees are now working in the surface workings above the underground work which Callahan did at this point. Just north of the Duquesne shaft is the Estella Louise which connects with the Bonanza shaft on the 235 foot level of the Bonanza. A small tonnage of very high grade ore has been produced from the Estella Louise in the last year by lessees. On the 235 level Callahan worked an under-hand stope which produced extremely high grade mine. This stope will have to be unwatered and some sinking done at this point. The winze or underhand stope below the 235 level makes a little water but this can be pumped into the 235 level which would drain into the Bonanza shaft. Some unwatering of the Bonanza shaft would have to be done as water is up approximately to the 235 level which connects with the Estella Louise. It is a considerable job to unwater the Duquesne shaft as, while it does not make but very little water, there are probably at least 1,500 feet of drifts and cross cuts in this area, all of which would have to be drained.

. . . . . .

"If, as I understand, the purpose of the Defense Act of 1950 is to get an immediate increase of the production of strategic metals, I think all of these projects should be given consideration."

On the basis of information obtained through interviews with officials of the company and data contained in the applications it was evident to the writers that specific proposals and objectives for the supplementary request could not be secured from the applicant,

Consequently an examination of the property was made to determine if the possibilities of developing ore reserves at the several deposits on the property would justify the Government in granting a loan to the company for the purpose of carrying out necessary exploratory work.

During the first period of field work, Feb. 1 to 5, 1951, the property was examined by A. F. Shride, Tucson, Ariz., and R. M. Hernon, Silver City, New Mexico, both Geologists of the U. S. Geological Survey, and T. M. Romslo, Mining Engineer of the Bureau of Mines, Tucson, Ariz. The work consisted of a geologic reconnaissance survey of the New York-Kansas mine, an examination of various other surface and underground workings, and obtaining maps and other data from the company office on the property. This field work was followed by an inspection of the underground workings of the South Belmont-Silver Hill area and the Kansas mine, by Shride and Romslo, on Feb. 19 and 20, 1951.

References available to the writers were confidential reports on the property by the Geological Survey[4] and the Bureau of Mines,[5] both of which were based on examinations made during World War II when the property was being operated by the Callahan Zinc-Lead Co. Also available for reference was Geological Survey Bulletin 982, Mineral deposits of the Santa Rita and Patagonia Mountains, Ariz.

4/ Richards, Arthur, and Brokaw, A. L., Zinc Deposits of the Patagonia Mining District, Santa Cruz County, Ariz., confidential manuscript report, 1944. (Data collected in July ? 1943).
5/ War Minerals Report, Duquesne Unit, Callahan Zinc-Lead Co., Santa Cruz County, Ariz., April 1943.

by Frank G. Shrader, an unpublished report of 1939 on the Duquesne Property by S. K. Garrett, Geologist for Callahan Lead-Zinc Co., and another confidential report by a reputable mining-geologist.

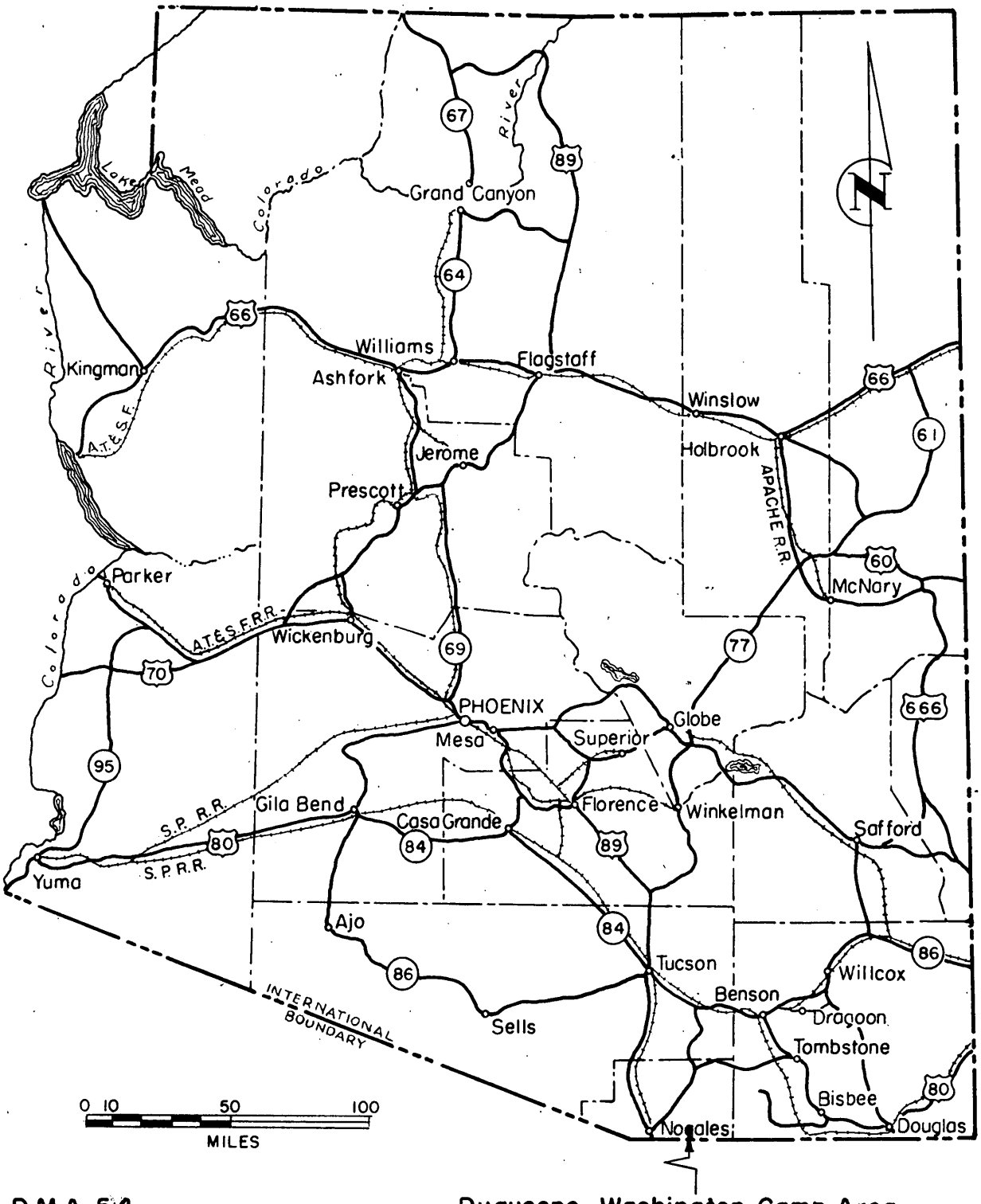
LOCATION AND ACCESSIBILITY

The properties of the Duquesne Mining Co. are about 12 air-miles southerly from Patagonia, Ariz. and approximately 15 air-miles easterly from Nogales, Ariz. (Fig. 1). Both these towns are on State Highway 82 and each is served by branch lines of the Southern Pacific railroad. Nogales is also on U. S. Highway 89. Washington Camp, a settlement in the area, is on a county-maintained dirt road about 20 miles and 18 miles from Nogales and Patagonia, respectively. The various mines of the company are accessible from Washington Camp over fair to poor mine roads that branch from the county road.

The Trench mill of the American Smelting & Refining Co., north of the area, is 9 miles by the county-maintained dirt road toward Patagonia.

PHYSICAL FEATURES AND CLIMATE

The Duquesne-Washington Camp area, at an average elevation of about 5,500 feet, is on the eastern slope of the Patagonia Mountains. These mountains extend north from the Mexican border to Sonoita Creek, near the village of Patagonia. It is in an area of fairly rough, steep-sided hills that have a range in relief of about 300 feet.



D.M.A. 54

Duquesne- Washington Camp Area

Fig. 1.-General location map, Duquesne-Washington Camp area, Santa Cruz. Co., Arizona.

Drainage from the property is southeasterly through San Antonio Canyon to the Santa Cruz River. There are no permanent streams on the property. There is adequate water for domestic, mining, and milling purposes.

Vegetation consists of forage grasses and a light to medium growth of small trees, mainly oak. There is no timber suitable for mining purposes.

Data on weather recorded at a nearby station shows an annual temperature range of -3 to 109 degrees and an annual mean temperature of 56.8 degrees. The average annual precipitation of 19.74 inches includes 11.1 inches of snow. Rarely does winter snowfall hinder transportation; the climate, winter and summer, is favorable for outside work.

PROPERTY AND OWNERSHIP

The property, consisting of 76 mining claims in the Duquesne-Washington Camp area, Patagonia Mining District, Santa Cruz County, Ariz., is held by the Duquesne Mining Co., 721 Sixth Ave., Tucson, Ariz. Fig. 2 shows the outlines of the property held and the locations of the mines.

The Duquesne Mining Co. is a partnership; a 79 percent interest is owned by the Byrd Investment Co., Inc., and the remainder is owned by C. O. Byrd and H. A. Harman. The Byrd Investment Co. is owned by various members of the Byrd family and Judge Fred H. Pickett, an attorney of Tucson.

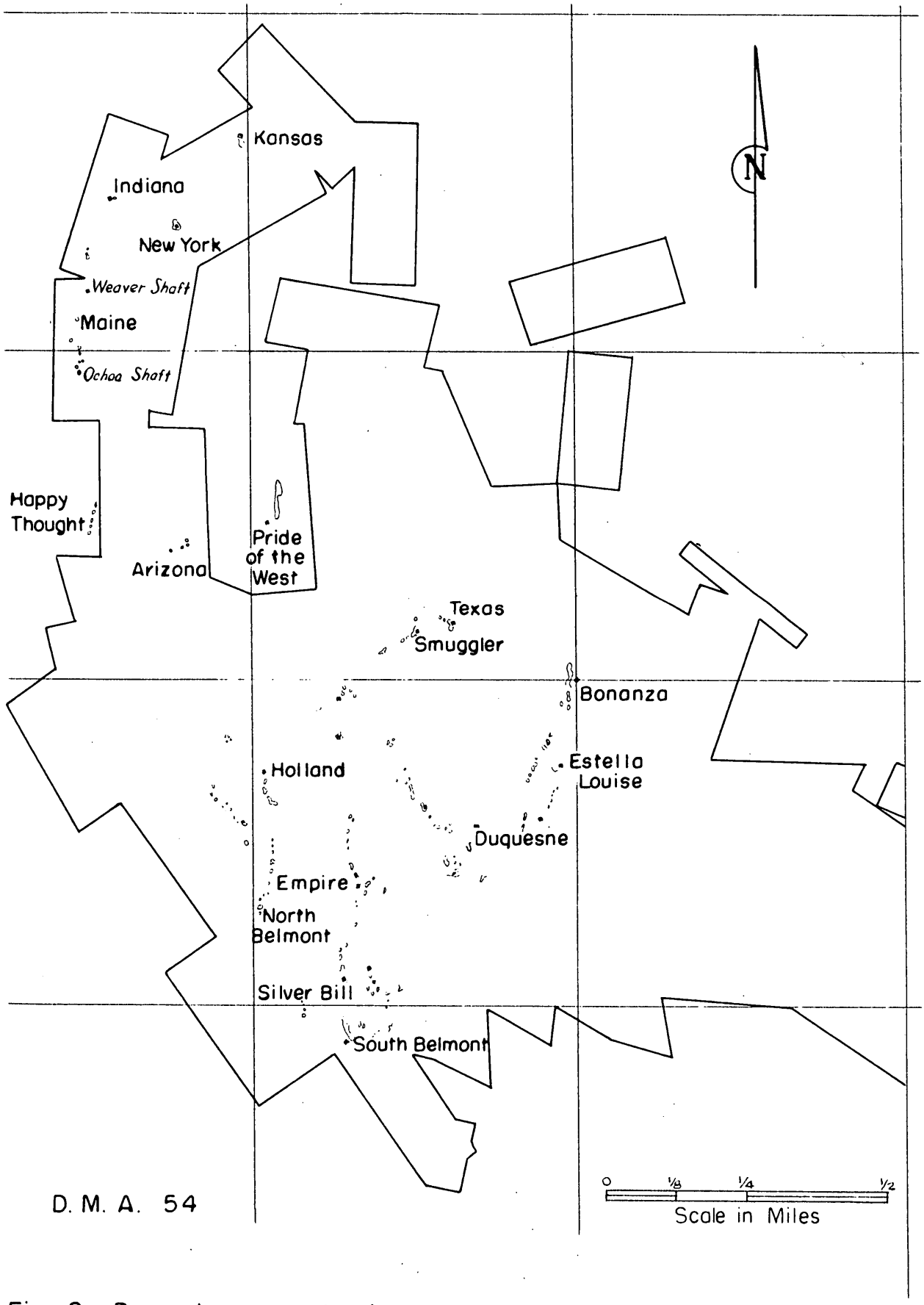


Fig. 2.- Property map, showing outline of property and position of mines, Duquesne Mining Company, Santa Cruz Co., Ariz.

Of the 76 claims, 62 were acquired outright from the Bracey Curtis estate, two of which have since been paid for (the Kansas and New York). The remaining 12 claims; Maine, Indiana, Arizona, Estella-Louise, San Antonio, Holland, Empire, North Belmont, South Belmont, California, Texas, and Dudley Standard, are held under a lease and option agreement. The purchase price of $76,000 on these claims has been reduced to about $9,000 by making production payments to the Bracey Curtis estate. At present, payment toward ownership of the claims is being made at the rate of 50 cents a dry ton of ore produced.

The Duquesne Mining Co.'s title to the property was approved by a firm of Tucson attorneys at the time it was leased to the Callahan company.

There is a mortgage on the property in the amount of $17,250, held by Fred W. Fickett, attorney for the company and one of the stockholders. The company also owes $8,500 in open accounts, and owes $1,500 to Randolph Jenks that is being paid off at the rate of 50 cents a ton of ore produced. Jenks also has a mortgage on some real estate owned by the Byrd Investment Co.

Other debts of the mining company consist of $490 in Federal taxes, and approximately $925 owed to the Security Commission of Arizona for the first half of the 1949 payroll. Thus the total reported indebtedness of the company is approximately $29,000.

Structures on the property, mainly homes, have a company assessed valuation of $35,000. Equipment, consisting of hoists, compressors, gas-engines, pumps, pneumatic drills, and accessories are valued by the company at $15,000.

HISTORY AND PRODUCTION

History

The history of the Duquesne-Washington Camp area, from the mining standpoint, began with the discovery of the ore body at the San Antonio Mine in 1862. The periods of early activity were during the middle or late 1870's when surface silver ores were mined, and from 1898 to 1909 when copper ores were produced. Some of the ore produced during the latter period was milled locally but most of it was hand-sorted and shipped direct to smelters. For a rather complete history of the area to 1912 the reader is referred to the report by Schrader.[6]

A. R. Byrd, Jr., the applicant, supplied the writers with the following history of the camp for the period from 1912 to the present. A flotation mill was built at the camp in 1916 and operated for a short time. During World War I the camp was very active and much ore was shipped to smelters. These operations were by George Westinghouse who had acquired all of the mines in the area except the Pride of the West. With the death of Westinghouse in 1918 all operations were discontinued. The holdings of the Westinghouse estate were acquired by Bracey Curtis of Nogales in 1920. There is little or no record of production from operations carried out by lessees from 1920 to 1930 when Bracey Curtis died. The administrators of his estate leased the

6/ Schrader, Frank C., with contributions by J. M. Hill, Mineral Deposits of the Santa Rita and Patagonia Mountains, Arizona, U. S. Geol. Surv. Bull. 582, pp. 321-324, 1915.

Kansas and New York mines to people from New Orleans who built a mill at the Kansas mine. The operations were unsuccessful and the project was abandoned.

In 1938 the present owners obtained control of the property and leased it to the Callahan Zinc-Lead Co. in 1939. The Company built a 100-ton mill and operated the property until the middle of 1944 when it terminated the lease and moved its mill and equipment to Nevada. The owners, the Duquesne Mining Co., started operation of the mines in September 1945. Prior to starting operations the company applied to the Reconstruction Finance Corp. for a loan, the funds to be used for developing ore at the Kansas mine. An examination of the mine indicated that only about 5,000 tons of ore might be developed and the loan was not granted. Production of ore that was shipped to nearby concentrators continued to September 1947, when Government production premiums were terminated. Production was started again in January 1948 but these operations by the company were stopped after the drop of metal prices in 1949. Since that time the mines have been operated by lessees.

Production

According to Arizona Bureau of Mines Bulletin 140 the production from Duquesne-Washington Camp area during 1899 to 1925 amounted to 15,000,000 pounds of copper, 12,000,000 pounds of lead, about 3,000,000 pounds of zinc, and $350,000 of silver, for a total value of $4,000,000.

This production does not include that of the Pride of the West mine which is not owned by the present Duquesne Mining Co.

Production for the period of 1940 to June 1944, when the property was operated by the Callahan Lead-Zinc Co., amounted to 116,050 tons of ore containing 1.44 percent copper, 2.39 percent lead, 7.75 percent zinc, and 3.77 ounces silver a ton. A little over 9,000 tons of this production was from custom ores.

After 1944 the Duquesne Mining Co. shipped 13,796 tons of ore to the Trench mill of American Smelting & Refining Co. that averaged 1.73 percent copper, 3.76 percent lead, 10.94 percent zinc, and 4.35 ounces silver a ton. In addition, 9,017 tons of ore of about the same grade was shipped to the Sahuarita mill of the Eagle-Picher Mining & Smelting Co. Other shipments include 8,992 tons produced in 1945 on which no records are available as to metal content, 1,265 tons of ore containing 5.6 percent copper, and 1.75 ounces of silver a ton, and 350 tons of lead-carbonate ore of unknown grade.

The total production of 300,000 tons is probably within a few tens of thousand tons of the correct figure, assuming the 1899 to 1925 shipments averaged 5 to 7 percent copper.

GEOLOGY

General Geology

Rocks of the Duquesne-Washington Camp area consist of a block of sediments, mainly limestone with subordinate amounts of shaly limestone and quartzite. This block, approximately 2½ miles long, in a north-south direction and 1½ miles in maximum width, is surrounded by

intrusive rocks. The intrusives are quartz monzonite, which borders the block on the west, south, and southeast, and granite porphyry which bounds the block on the east and northeast. Within the area of sediments several quartz monzonite dikes and a few small irregular masses of basic intrusive rocks are reported to outcrop. The limestones is much recrystallized and the shaly limestone metamorphosed to hornfels.

In general the sedimentary beds seem to strike north and dip steeply to the west, but only at a few places in the southern two-thirds of the area, according to Richards and Brown,[1] can the attitudes of the beds be determined. Due to metamorphism the sedimentary structures have been obscured in most places.

The rocks of the area appear to be much disturbed. The sediments are folded so that they crop out as steeply dipping north-south bands, which may in part represent overturned beds, and the outcrop pattern shown on available large scale maps suggests much disturbance. However, no faults of apparent great displacement have been noted by previous investigators, nor were any apparent in our examination. Steep-dipping faults are abundant in the area, but apparently are of small displacement, irregular in distribution and not persistent. Several directions of fault trends were noted in the area, and these directions and their local significance to ore distribution will be noted in the descriptions of individual areas.

Existing geologic maps suggest that in the northern part of the area (in the vicinity of the Kansas and the New York mines) one set

---

1/ Schrader, Frank C., previously mentioned in footnote 6.

of faults strikes northeast to east-northeast and another set strikes northwest. In the southern part of the area, in addition to these fault trends, the most persistent faults strike almost north. This general pattern of faulting seemed confirmed in our brief observations of several widely spaced localities in the district.

Almost complete garnetization of the limestone at or near contacts of limestone and quartz monzonite and along some minor fault zones is common in the southern part of the district (in the vicinity of the Silver Bill, Belmont, Empire, Holland, Duquesne, and Estella-Louise shafts — fig. 2). Toward the north the amount of garnet decreases and in the vicinity of the Kansas mine there is very little garnet. Other silicates, probably those identified by Schrader[8] as actinolite, tremolite, diopside, and wollastonite were observed in the limestone. In addition Schrader notes hornblende, gedrite, and hedenbergite as metamorphic minerals in the limestone. The outstanding metamorphic effect in the area is the almost complete recrystallization of the purer limestones.

Ore Deposits

The ore bodies of the Duquesne-Washington Camp area are characteristically small, pod-like and irregular lenticular bodies of the contact metamorphic type, and apparently are not everywhere interconnected within the zone referred to locally as a single ore deposit. Sphalerite, galena, and chalcopyrite are the important ore minerals; pyrite, garnet, calcite, and quartz are the main gangue minerals.

8/ Schrader, Frank C., previously mentioned in footnote 6, pp. 326-327.

The mineral content of the ores is variable, ranging from almost all chalcopyrite or sphalerite to variable mixtures of galena, sphalerite, chalcopyrite, and pyrite.

The ore occurs as pods and lenses along fractured zones. The range of dimensions of such pods and lenses is difficult to define as they are very irregular in outline. In places there is continuity but in most places there is no continuity of mineralization between minable bodies. Individual bodies have furnished a few tons to several hundred tons of ore. From zones defined locally as a single ore deposit, as much as 40,000 tons of ore have been mined in aggregate from the more or less disconnected pods and lenses. Thicknesses of 10-20 feet (in places perhaps greater thicknesses) of ore have been mined and again, thicknesses of only 2 feet have been mined. In general the discontinuous ore zones have been followed to a depth of 150-250 feet but in one case mining to a depth of 600 feet has been done.

The contacts of ore with host rock are rather abrupt and there is little low-grade ore that could be mined if such mining were desirable.

Except in the northern part of the area, the ore bodies replace the limestone adjacent to contacts between limestone and massive garnet or between limestone and quartz monzonite. The ore occurs where these contacts are most fractured, and especially where intersecting faults and fault junctions exist. In general a dominate set of steeply dipping faults parallels the contacts and ore possibilities

are most favorable where other sets of high angle fractures intersect the dominate set. Flat fissuring contributes in places to the localization of ore and may account for some of the "blind" ore shoots. Bedding has been a contributing factor, but faults appear to dominate ore localization in most places. In the northern part of the area the ore bodies are localized along faults within the limestone and are not closely associated with limestone-garnet or limestone-quartz monzonite contacts. Throughout the area the faults which controlled ore emplacement probably persist for a few hundreds of feet at the most but more usually for only tens of feet. Displacement along these faults is apparently small and the shattering of limestone favorable to ore deposition was most pronounced at fracture intersections. Flowage of the now moderately crystalline to coarsely crystalline limestone is apparent over much of the Washington-Duquesne area. Apparently in much of the area deformation of the limestone took place by readjustment by flowage rather than by shattering of the limestone.

Much of the development in the district in search of new ore bodies or extensions of known deposits was done by following minor fractures. In places these fractures are marked by minor amounts of sulfides, particularly pyrite, but, for the most part where observed by us, such fractures were essentially barren. Where these minor fractures were intersected by other fractures and the limestone sufficiently shattered, sulfide pods "blossom out."

Eventually the fractures observed prove to be non-persistent and the limestone becomes "tight", both laterally and vertically.

In some places ore has been mined in zones of fractured garnet, but generally the massive garnet was less susceptible to shattering and therefore to mineralization than the limestone. Mineralization took place mainly on the limestone side of garnet-limestone contacts. No ore bodies are known to the writers to exist in the quartzite. In a few places there is a strong suggestion, from observations limited b y what can be seen in a few of the mine workings, that ore bodies terminate laterally and vertically where controlling faults enter the shaly limestones. Therefore, to the best of our knowledge, the purer crystalline limestone is the most favorable host for ore bodies of even small tonnage.

Oxidation of the ore bodies extends in much fractured rock to a few tens of feet, but in most places oxidation is very shallow, occurring for only a few feet below the surface. The ore deposits considered in this report are developed to sufficient depths below the zone of oxidation so that oxidation products will not be a problem in milling the ore.

Oxide zones as indicators of moderate tonnages of sulfides at depth probably are not too reliable in this district. Probably without exception it can be said that all the ore bodies of consequence that do outcrop had well defined oxide outcrops. However, the reverse is not true — that is, not all of the well defined oxide outcrops were indicative of minable widths of sulfides at depth. It should be noted that some ore shoots did not outcrop.

Geologic possibilities of additional ore

It is difficult to predict extensions of known ore bodies or the possibility of new ore bodies in this district. Probably pods and lenses of ore do exist below depths now prospected. However, the structures that controlled ore emplacement are not persistent and therefore not projectable with confidence to aid in the search for new ore bodies or the extension of known bodies. Past development in the district indicates that in the vicinity of areas of general structural disturbance and mineralization, potential ore bodies of the habit common to the Washington-Supreme area offer very small targets for exploration work. Therefore, even though ore bodies of the type and size exploited in the past may exist below the present workings, drilling or other exploration programs have little chance of outlining sufficient ore to justify exploitation other than small-scale operations. In addition, it should be noted that the zones which were geologically most favorable and which included the main ore shoots are essentially mined out.

MINE WORKINGS AND DEPOSITS

Much of the following information has been abstracted from the Geological Survey report of 1944 and the report by Garrett. Only those workings pertinent to the present report are described.

An inspection of some of the old workings by the writers indicated very little 'heavy' ground was encountered in mining operations and that only a very small percentage of the total workings required timber support.

Bonanza-Estella Louise Area

Bonanza Mine. — The Bonanza mine consists of a vertical shaft with levels at 100-foot intervals from 135 feet to the bottom at 635 feet. The workings are largely confined to a limestone-porphyry contact along which extensive stoping has been done. Very little ore had been encountered on the bottom level to the end of 1943. The Callahan company produced ore from this mine to the end of their operations in 1944. At present the mine is filled with water to about 4 feet above the 235-foot level.

Estella-Louise Mine. — The Estella mine explores the same contact as the Bonanza. It is developed by stopes that extend nearly to the surface from the 235-foot level. The Estella shaft is abandoned and the Callahan company exploited the deposit from the 235-foot level that connects with the same level of the Bonanza. The Estella ore body below the 235-foot level was being worked from an underhand stope by the Callahan company in 1944. At present lessees are working the deposit and are producing a little ore from pillars near the surface. Water standing above the floor of the 235-foot level at the Bonanza shaft made it impossible to inspect the deposit workings of the Estella mine.

Holland Mine and Adjacent Area

The Holland deposit is developed by a 250-foot inclined shaft at one of the ore shoots. The ore bodies have been worked from levels at 100 and 200 feet. Drilling by the Callahan company indicated the contact is barren below the 200-foot level and to the north and south

of the present workings. Production of but 116 tons of ore from this mine in 1944 indicates the mine was abandoned early in that year.

The Holland deposit is along a pre-mineral fault or along beds that strike N. 20°W. and dip 40° S.W. The limestone along this fault is garnetized to widths that vary between 3 and 30 feet. Two distinct ore shoots that plunge directly down the dip of the fault or beds are exposed. Other small ore bodies are reputed to exist along the northeast fracture zone, but were not accessible during our examination. In general the ore occurs in limestone along the footwall of the garnet zone, but the garnet contains sulfides in places. At fault intersections the limestone was replaced, judging from the size of the stopes, for widths of 5 to 20 feet.

The ore shoots appear to narrow downward, and at and below the 200-foot level there is little persistent faulting that would suggest that chances for more ore at depth are encouraging. Development work below the 200-foot level by the present lessee is said to show little promise. Only a few tens of tons of ore that occur as pillars was seen in the workings observed during this examination.

About 500 feet southwest of the Holland shaft and approximately 150 feet higher than the collar of the shaft is a line of pits that prospect a discontinuous oxidized zone which trends about N. 40°W. The Duquesne Mining Co. proposes to explore this zone either by drill holes from the bottom Holland workings or from the surface. The faults along which the oxide zone occurs are weak. Oxide zones,

beneath which sulfide ore has been developed in this general vicinity, have been much more persistent and much larger than the ore exposed southwest of the Holland mine. Oxide zones such as that at the South Belmont open-cut were much larger and more persistent than that west of the Holland mine, yet sulfides were not found in minable quantity below such zones. Therefore, the writers feel that there is little chance that ore will be found in the zone southwest of the Holland mine if exploration is done as suggested by the Dequesne Mining Co.

Empire Mine

The Empire mine is in an area where little development work has been done but where diamond-drilling has indicated ore along north trending limestone-garnet contacts. The ore bodies mined in 1943 are located where two broad arms of garnet diverge, the ore being largely confined to the tip of the salient of limestone between the garnet zones. The Callahan company put down 6 diamond drill holes in this area prior to 1939. As a result of this drilling and inspection of the accessible workings, Garrett concluded that ore bodies in the area are small, irregular, and quite widely separated. It is probable the small production from this area by the Callahan company came from a zone where drilling encountered a little ore. This area is now being worked by lessees who are producing a small amount of ore from shallow workings. Production is from pillars and pods of ore.

Maine Mine

The Maine mine consists of a surface cut and a 350-foot tunnel that explores the westernmost quartz monzonite-limestone contact

which here trends north. Several small ore bodies have been mined along the contact and diamond drilling by Callahan indicated the presence of other small ore bodies along the contact within 1,000 feet of the present workings. At present lessees are producing a small tonnage of ore from pillars and pods of ore exposed in the tunnel.

Duquesne Mine

The Duquesne mine, aside from inaccessible shallow surface workings, consists of a 164-foot shaft with levels at depths of 103 and 157 feet. The levels, consisting of about 2,000 feet of lateral workings, explore several north and northwest trending limestone-garnet contacts. Development work conducted during mining operations encountered very little new ore. The mine, after producing about 17,000 tons of ore, was abandoned in July 1943.

Indiana Mine

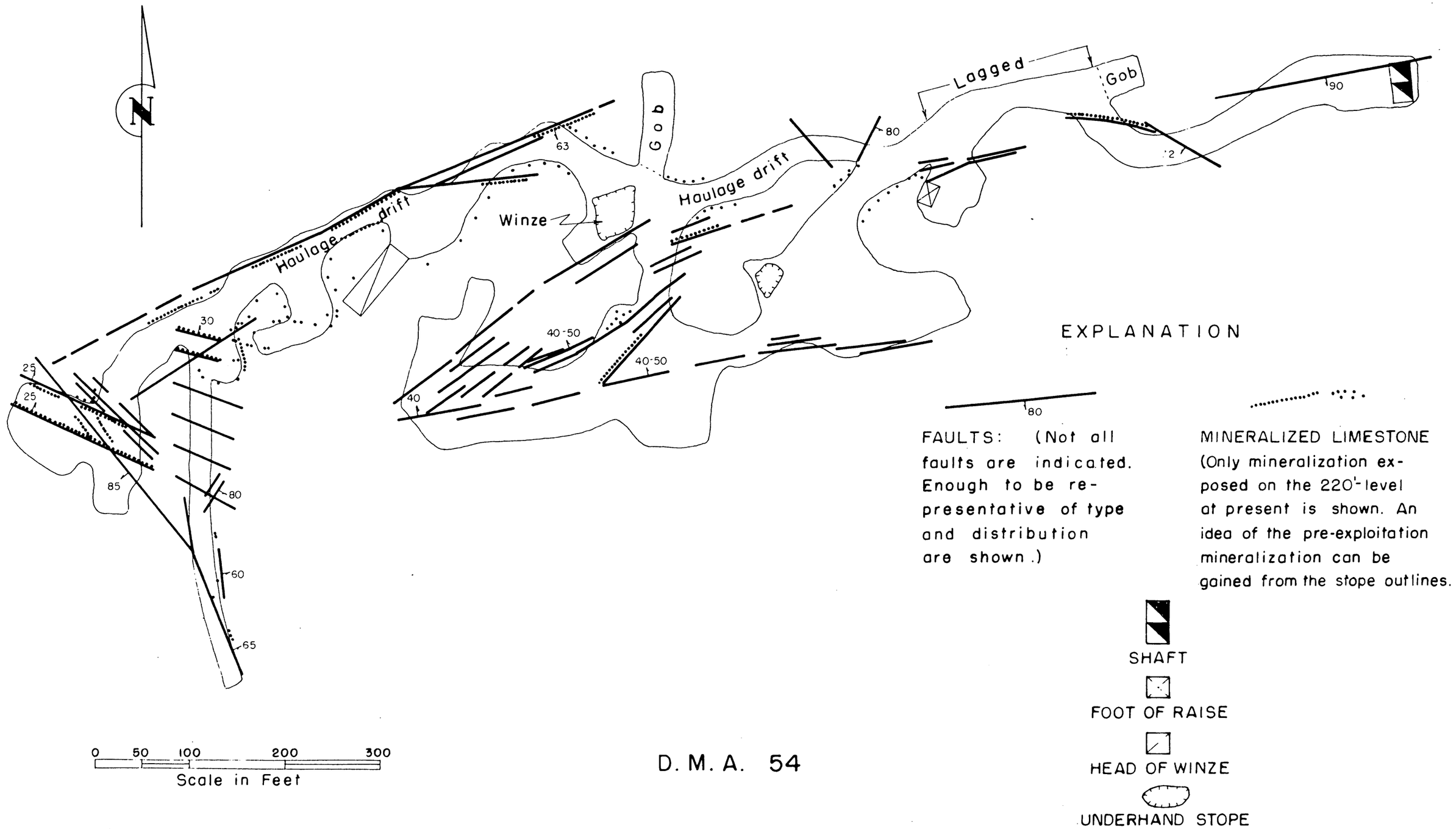
The Indiana mine consists of a 100-foot shaft with levels at 30, 90, and 100 feet from the collar. Here the ore bodies, as at the Kansas mine, occurred near the main western contact of limestone with quartz monzonite. The Callahan company reopened the mine in 1941 but found very little ore and abandoned the mine. At present there is no activity at this mine.

New York-Kansas Area

Kansas Mine. — The Kansas mine is developed by a 220 foot vertical shaft with levels at 90 and 220 feet. The mine was abandoned by the Callahan company in 1941. The Duquesne Mining Co. reopened the

mine in 1948 and produced 30 carloads of ore before stopping operations in 1949. At present this mine is being operated by the Ritter Mining Co. under a 3-year lease agreement with the owners. The lease has been in force for a period of 1 year. The Ritter company developed and produced about 300 tons of ore from a segment of the deposit extending below the 220-foot level. At present their production is coming from a shoot of ore that branches from the main deposit above the bottom level. According to the mine operator only a few tons of tons remain in this ore shoot.

The Kansas mine is in an irregularly-shaped lense of ore that replaces essentially garnet-free limestone mainly along northeast-striking faults. At the surface oxide ore occurred at the intersection of northeast and north-northwest faults that dip 70 to 85 degrees to the south. On the 220-foot level (the only level examined by us) the most persistent faults strike N. 65° - 80°E. and dip steeply to the south. In the areas from which most of the ore has been stoped (to the south of the haulage drift - see fig. 4) fractures striking N. 60°E. and dipping 40°-50° N.W. were apparently significant in ore emplacement. At the west end of the 220-foot level intersecting faults were strong factors in ore localization. Here two sets of northwest faults, one steeply dipping set and one gently dipping set (see fig. 4) intersect a prominent N. 60°E. fault. The intersections of these faults are particularly favorable to ore. The prominent N. 60°E. fault, seen on the 220-level, is probably represented by an unmineralized fault found at the surface approximately 120 feet west of the collar of the shaft.



D. M. A. 54

Figure 4.- Geologic map of 220-level, Kansas mine, Duquesne Mining Co., Santa Cruz County, Ariz.

Thin shaly beds of limestone seen on the 220-level are relatively barren of sulfides. At the west end of the level apparently a thick shaly limestone acts as a wall against which the ore pinches out. There is some suggestion that this shaly unit, which probably dips steeply to the southeast, plunges under the ore zone below the 220-level; therefore, the ore zone may pinch out at depth. However, without more evidence to show the existence of shaly limestone beneath the level, this bottoming of the ore cannot be considered as proved.

In the underhand stopes to the south of the haulage drift, little pre-mineral fracturing was seen that would suggest that the Kansas ore body persists downward. Galena, sphalerite, and chalcopyrite were scattered through the limestone in small amounts but no continuations of the ore shoots were seen in the underhand stopes accessible for observation.

It would be hazardous to predict that any of the pre-mineral faults observed on the 220-level persist very far in depth. Assuming, as is probable, that northeast faults, like but not necessarily identical with those faults prominent on the 220-level, do occur at greater depths, intersecting pre-mineral faults would be required to suggest "geologic" extension of the ore body. Many of these more favorable auxiliary faults at the 220-level are flat in dip, and their intersection with the northeast fault system is exposed in the ground already stoped. Therefore, there are few of these faults exposed

that could be projected to intersect at greater depths than the present workings. Flat-dipping faults, that would "make" ore, are likely at greater depths but their position and value as an ore controlling factor is not predictable.

On the basis of past development in this mine and in the district, it may be said that additional pods of ore at depths below the present Kansas workings are likely, but that the best possibility for finding these pods seems to be by small scale development work, designed to follow the most favorable ore-bearing fissures of the 220-level.

New York Mine. — The New York mine, according to Garrett, is developed by a 150-foot vertical shaft and 3 levels; namely, the 50, 110, and 150 levels. Garrett states the mine was dewatered to the 110 level at which point the shaft was found filled with muck. This work was done by the Callahan company in 1939 prior to obtaining a lease from the Duquesne Mining Co. During this work several stope margins on the 110 and 50-foot levels were sampled and it was concluded no tonnage of any consequence existed in pillars and stope margins above the 110 level and the small amount present was probably too badly tarnished to be millable. Diamond-drilling exposed ore below the 110-foot level. One of the 2 holes drilled entered open ground, probably a drift of the 150-foot level. The mine was rehabilitated by the Callahan company in 1943. One of the present owners stated the shaft was opened to the 150-foot level from which a 50-foot winze was sunk. Production of about 3,000 tons during 1943-44 was probably mainly from a block of ore between the 110 and 150-foot levels and an underhand stope developed by the

winze. Later the Duquesne Mining Co. worked the mine and produced some ore before stopping operations in 1949. Open ground encountered at one place during these operations indicate part of the deposit had been worked previously. At present the mine is flooded.

The New York shaft is near the contact of highly altered igneous rock and limestone. Only the surface workings of the New York mine were accessible for inspection. However, our observations in these surface workings, confirmed by a private geologic map of the 150-level indicates that the New York ore body replaced limestone at and near the intersection of two fault systems. One fault system strikes approximately N. 50°E. and dips steeply; the other set of faults strikes east and individual faults dip steeply both north and south. Some garnet occurred in this deposit but apparently the ore is not along a limestone-massive garnet contact as for some of the deposits further south in the district.

<u>Area Between the New York and Kansas Deposits.</u> The proposal by the Duquesne Mining Co. to drift from the New York to the Kansas mine is apparently predicated on two beliefs:

(1) That the northeast fault zones seen in both mines are in reality parts of the same zone and should be continuous between the mines.

(2) The back developed under the Kansas workings would certainly contain ore that would at least in part pay for drifting approximately 650 feet.

If there were, as the Duquesne company postulates, a fault continuous between the two area, drifting along such a structure might very well pass through now undiscovered ore bodies, expecially if fault junctions and intersections were encountered. However, there is no evidence or liklihood of a fault connection between the two areas. A line between the two deposits has a bearing of N. 30°E. Faults prominent in the Kansas and New York areas have strikes trending too much in an easterly direction to allow projection between the deposits as continuations of the faults that control ore-localization in the two areas (see fig. 3). A compass and chain traverse was carried between the two mines to check the above and to plot in reconnaissance fashion the surface geology in the intervening area. Very little faulting and shattering of the sediments was observed. Approximately 450 feet northeast of the New York shaft and on a line between the two mines a fault striking N. 40°- 45°E. and dipping 40° N.W. was observed. This fault apparently does not persist to the northeast or southwest much beyond the limits shown on fig. 3. In this fault zone, 1 to 1½ feet wide, sulfides, mostly pyrite, are exposed over a strike length of forty feet. In the vicinity of this sulfide zone there are minor vertical fractures that average in strike about N. 30°E. None of these faults suggest extensions of the Kansas or New York faults. The fault zone occupied by this sulfide body is not persistent enough to encourage prospecting.

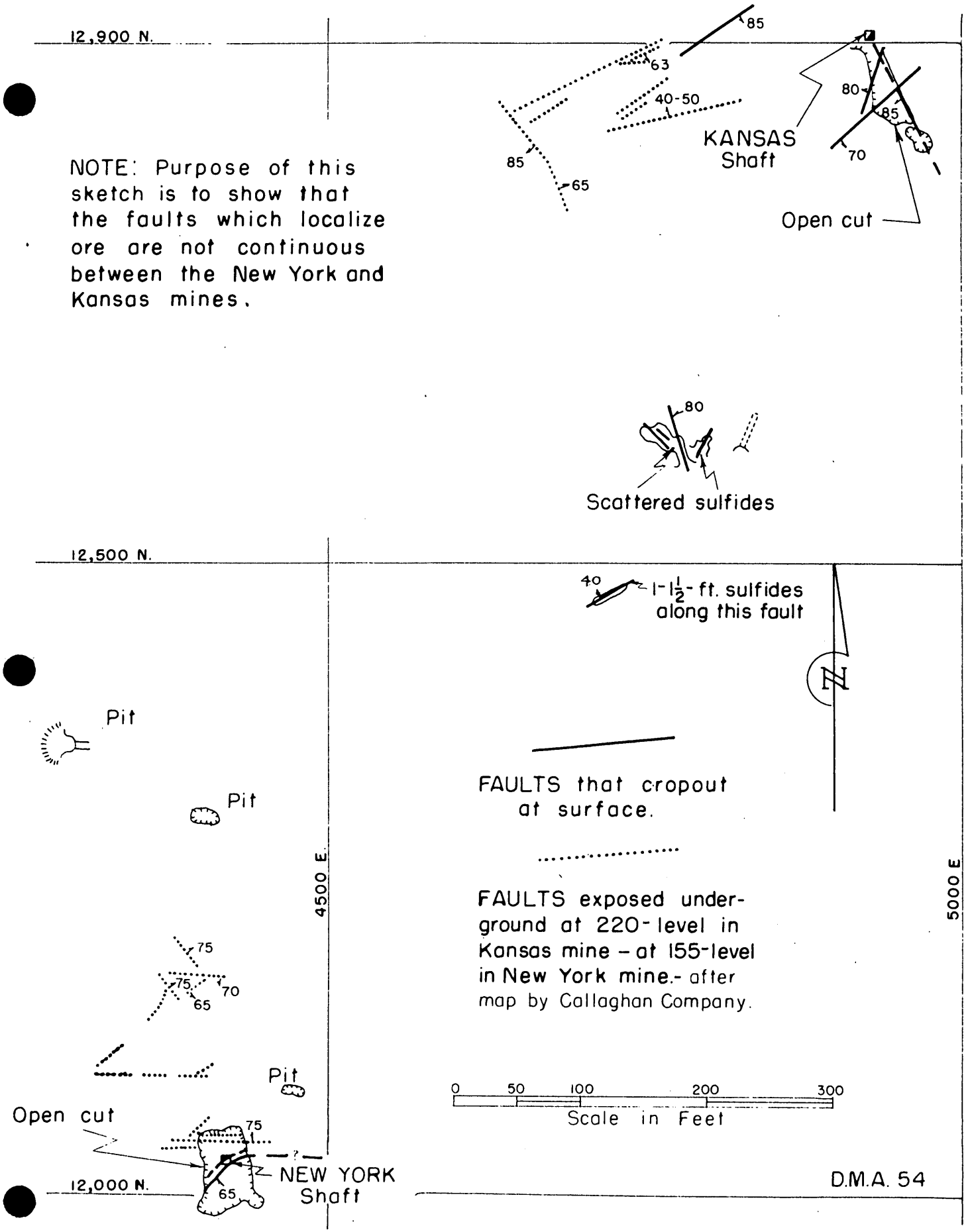


Fig. 3 - Sketch map showing most persistent faults that localize ore in the vicinity of the Kansas and New York mines.

Approximately 670 feet northeast of the New York shaft, and on a line between the New York and Kansas mines, three short adits explore slightly mineralized limestone. The mineralization at this locality is predominately along north-northwest or northwest striking, very small fractures. In one pit in this vicinity northeast fractures were observed.

The faulting and mineralization described in the above two paragraphs were the only indications of ore bodies seen between the two mines. Certainly neither occurrence suggests that additional exploration is warranted between the two areas.

South Belmont-Silver Bill Area

The South Belmont mine consists of an open-cut about 250 feet long, 5 to 12 feet wide, and 5 to 15 feet deep. The open cut follows an irregular, generally steep-dipping limestone-garnet contact. There is an inaccessible vertical shaft, probably about 100 feet deep, at the south end of the open-cut. Reports indicate no workings extend from the shaft. Shallow workings beneath the open-cut are connected to surface by an adit. The presence of some sphalerite and chalcopyrite indicates the depth of oxidation probably is less than 30 feet. The limestone-garnet contact below the open-cut also has been cut at two places by the Silver Bill tunnel no. 1 at a point approximately 70 feet below the open-cut. The inaccessible Silver Bill shaft is about 100 feet deep with 2 short drifts from the bottom. Southeast of the Silver Bill shaft several glory holes, and about 2,000 feet of lateral

workings explore the eastern part of the area. The tunnels explore the zones beneath the glory holes with very little ore being encountered.

The writers examined the accessible workings on the South Belmont and Silver Hill claims. The stoped area on the Silver Hill claim was not accessible, but these stopes are not in a part of the area proposed for exploration by the Duquesne Mining Co.

The South Belmont deposit was localized along north-northwest and north-northeast fractures, most of which dip steeply to the west. The surface cut made in oxidized material was larger than most of the workings that are in oxides. Heavy limonite stains and traces of copper carbonate are present near the surface in the open-cut which exposes the garnet-limestone contact. However, the drifts below the open-cut expose only widely scattered traces of sulfides, and there is no geologic evidence that more intense mineralization should be expected north or south of the west end of the Silver Hill workings (i.e. — below the open-cut on the South Belmont claim).

MINING OPERATIONS

The operations of the Callahan Zinc-Lead Co. were conducted during the period when the price-premium plan was in effect. About 95 percent of their production came from deposits that showed strong outcrops and where early mining operations found rather persistent ore mineralization. These deposits were the Bonanza, Duquesne, Estella-Louise, Holland, Kansas, and New York. Of these only the Holland and the Kansas were accessible for examination by the writers. The findings at these mines and available data concerning the other mines indicate

the major deposits on the property were essentially worked out to their lowest levels of development and that for some deposits at least the extent of mineralization decreased with depth. The company also had been unsuccessful in developing other ore bodies. All evidence indicates the company ceased operating when ore reserves had declined to the point where sufficient ore could not be mined to keep the mill operating at capacity.

The investigations indicate most of the ore produced by the Duquesne Mining Co. from 1944 to 1949 came from ore developed by the Gallahan company in the larger deposits. These operations were also conducted during periods when premiums were paid for production or when metal prices were high.

At present, lessees are operating the following mines: Holland, Empire, San Antonio, Monsanito, Smuggler, Estella-Louise, Dudley Standard, Arizona, California, Kansas, and Maine. All these leases, except at the Kansas and New York, are for 60- to 90-day periods. The lease on the Kansas and New York mines, for a period of 3 years from February 1950, is held by the Ritter Mining Co.

Terms of the leases call for the lessee to receive the following payments from net proceeds of production:

1. 90 percent on ore having a net value under $15.00 a ton.
2. 85 percent on ore having a net value over $15.00 and under $20.00 a ton.

3. 60 percent on ore having a net value over $20.00 a ton.

Under this system of mining the lessees probably earn 'day wages' or more, when they are producing from an exposed ore body. While working out an ore body they sometimes encounter narrow veins of ore that lead to other small pods or lenses of ore. During periods when they are attempting to develop other ore bodies the lessees may produce a little ore and earn but a few dollars a day. If a reasonable amount of exploratory work fails to develop minable bodies of ore the lessees move to more favorable areas.

At present about 300 tons of ore is being produced monthly. By operating more working places with more efficient lessees the company hopes to increase production to an average of about 400 tons monthly. The production is coming from pillars and the working faces of old operations. In general each working place is equipped with a compressor and the necessary mining tools. Hoists and pumps are also in use at some of the operations.

No records are available on tons of ore produced per man shift.

All ore is hauled under contract to the Trench Mill of the American Smelting & Refining Co. at the rate of $1.25 a wet ton.

It is reported the ores mill and concentrate well; recoveries are high and concentrates are clean.

ORE RESERVES

The following quotations concerning ore reserves were taken

from the 1944 report[3] on the property by the U. S. Geological Survey. At that time most of the mines were accessible for examination.

"In none of the mines is any low grade ore left which might be mined at some future date if prices increased. The only ore bodies not being mined are those too small to be mined profitably at present prices (1944). The total tonnage of such known bodies is small.

"The reserves tabulated on page 11 (Present writer's note — For comparable tabulation see page 39). are minable at present emergency prices and prevailing mine costs, but due to the high exploration and mining costs, none of the mines could operate at normal peace-time prices. Due to the irregularity in shape and size of the ore bodies, only the ore broken in the stopes can be classed as measurable ore. The indicated ore is largely estimated from ore exposed in stopes. The estimates of inferred ore are in part based upon diamond-drilling which is insufficient to block out the ore, or upon expected downward extensions of ore below workings which are now mostly inaccessible.

"The estimate of inferred ore in the Estella mine is based upon an expected ore extension below the 235-foot level.

"The estimate of inferred ore in the Empire mine is based upon scattered drill holes, drilled by the Callahan company, which show ore south of the present workings.

"The estimate of inferred reserves of the Maine mine is based upon diamond drilling, by the Callahan company, along the limestone-monzonite contact between the present workings and a point 1,000 feet south on this contact.

3/ Richards and Brokaw, op. cit.

"The ore bodies exposed in the mines and prospects of the area between the Pride of the West mine and the west igneous contact are too small to pay the cost of development.

"The New York mine reserves are entirely inferred as there are no geologic maps of the old workings available and the mine is inaccessible. The Callahan Company drilled two holes from the surface to explore the area underneath the old workings and obtained indications of zinc ore in both holes. The estimate is based in part on the known existence of good zinc stopes, in part on the diamond drilling and in part on the Callahan Company's past experience with mines in the area which were big producers but which have been unworked since the days when zinc in the ore was penalized.

"The ore bodies of the south Belmont-Silver Hill area were shallow, as the tunnels under the large surface pits did not encounter any ore in commercial quantities. No reserves are listed for this area."

	Reserves in tons				Estimated grade (From Past Production). Figures given good for Measurable and Indicated. Inferred ore assay within 25% of figure given.			
Mine	Measurable ore broken in stopes only	Indicated	Inferred low figure may reasonably be expected	Total	Silver in ounces to the ton	% Cu	% Pb	% Zn
Bonanza	1250-1300	1400-1600	0	2650-2900	2.0-2.1	2.7-2.9	0.5-0.6	8.0-8.5
Butella	1700-1750	2000-2500	10,000-20,000	13,000-24,000	2.3-2.5	1.2-1.4	1.1-1.3	8.7-9.3
Holland	0	200	0	200	6.0-6.2	0.8-1.0	3.7-3.9	7.5-8.0
Empire	280-320	800-1000	2,000-5,000	3,000-6,000	3.1-3.3.	1.0-1.2	3.0-3.3	5.9-6.2
Maine	0	1000-1200	2,000-5,000	3,000-6,000	2.8-3.1	1.4-1.6	1.1-2.2	7.7-8.5
New York	0	0	10,000-20,000	10,000-20,000	No data available.			

This table is a partial quotation from similar table by Richards and Broker.[10]

Above estimates probably made in July 1943 at a date when roughly 60 percent of the Callahan company's total production had been mined.

10/ Op. Cit.

Records of production subsequent to the above ore estimates indicate all of the measured and indicated ore and part of the inferred reserves noted in the table have been mined. The status of ore reserves at the end of the Callahan company operations is contained in a confidential report by a reputable mining-geologist. His findings substantiate those of the 1944 Geological Survey report. He found little or no ore reserves at the Kansas, Empire, Bonanza, and Holland mines and indicated the chances of developing more ore at these mines were unfavorable. At the Maine mine he found two places that seem to have untested possibilities: (1) "The face of the original adit where a stope just above the level shows a width of up to 4 feet of high grade ore which can probably be followed south," and (2) "The surface cuts in the vicinity of the Ochoa shaft." (The Ochoa shaft is a shaft in the Maine ore zone.) As a result of his investigations he inferred ore reserves of 10,000 tons at the Estella mine and 5,000 to 10,000 tons at the New York mine. The present writers have no means of estimating how much of these inferred reserves were mined later by the Bagnesne Mining Co. The present investigations indicate a reserve of possibly a few thousand tons of ore are present in the several ore shoots being worked by lessees. Summarizing the above information the total indicated and inferred reserves where the ore occurs as extensions of known ore shoots probably amounts to about 15,000 tons. In addition, inferred reserves of several times this amount may be present in undiscovered ore shoots. As emphasized under Geology and under Economic Possibilities such ore shoots very likely would be difficult to find

and expensive to develop.

VALUE OF ORE

Smelter settlement reports to the Duquesne Mining Co. during December 1950 and January 1951 show a wide range in the metal content of the ores. The lowest grade ore contained 6.85 percent zinc, 3.13 percent copper, 1.81 percent lead, and 3.52 ounces of silver a ton. The highest values were in a shipment containing 22.2 percent zinc, 1.76 percent copper, 2.66 percent lead, and 4.3 ounces silver a ton. The average grade of present ore shipments is probably close to the average of about 14,000 tons shipped by the Duquesne Mining Co. during 1945 to 1949. This ore contained 10.94 percent zinc, 1.73 percent copper, 3.76 percent lead, and 4.35 ounces silver a ton. Ore of this grade, at present metal prices, shows a liquidation value of $31.44 a ton before deductions of about $7.40. Under the present leasing system the gross return to the Duquesne Mining Co. is about $3.60 a ton of ore.

CONCLUSIONS AND RECOMMENDATIONS

General

Production records indicate probably more than 90 percent of the sulfide ore produced has come from the Bonanza, Duquesne, Estella-Louise, Holland, New York, and Kansas mines. They also indicate each of these mines was developed from outcrops where early mining operations found ore mineralization to be fairly consistent with depth. Investigations also indicate some of these

mines are essentially worked out to their lowest levels of development and that with depth the extent of mineralization decreased. It is probable that pods and lenses of ore exist below depths now prospected at the major deposits and at the many other deposits of indicated less extensive mineralization. Geological structures that control the emplacement of the pods and lenses of ore are not persistent and therefore not projectable with confidence to aid in the search for new ore bodies. In the following pages the writers conclude that exploratory work could not reasonably be expected to develop much ore and that any ore that might be developed probably could not be exploited at a profit, under prevailing economic conditions. Thus indicated and inferred ore is restricted to the pods and lenses now being worked by the lessees. It is reasonable to assume the lessees will continue to develop other pods of ore and it is possible future operations may develop several thousands tons of ore as extensions of deposits mentioned below. The writers believe the interests of both the Duquesne Mining Co. and the Government can best be served by continuing to operate the property as at present. Under the present system of operations the property can be expected to produce ore at the rate of a few tens of tons daily for several years.

Kansas-New York Area -- The following is quoted from the Duquesne Mining Co.'s informal application for a development loan:

> " One of our projects would be to connect the workings of the New York and Kansas mines. There

is a difference in elevation between the Kansas and the New York shaft of about 250 feet. Both mines have been worked approximately to the 200 foot level. By connecting the New York workings with the Kansas workings, which we believe would develop considerable ore, we would have 250 feet of backs under the Kansas mine which has been one of our best producers. This work would mean drifting partly in ore for approximately 600 feet and raising to the present level of the Kansas mine and would cost approximately $30,000.00."

A sketch map of a longitudinal section furnished the writers by the Duquesne Mining Co. shows the proposed tunnel, if driven from the 155-level of the New York mine would require a 138-foot raise, not a 250-foot raise as stated by the applicant, to connect with the 220-foot level of the Kansas mine. It is possible the proposed work could be done at the applicant's estimated cost of $30,000 provided part of the necessary equipment would be supplied by the Duquesne Mining Co.

However present faces of the lowest stopes in the Kansas ore-bearing zone expose almost no minable ore. Judging from the general habit of the ore bodies in the district more ore may be found at greater depths where fault intersections are more favorable for ore localization. This depth is unpredictable but likely reduces the volume of potential backs that might include ore by an appreciable

percentage of the 135-foot interval between the proposed drift and the lowest workings of the Kansas mine. Reconnaissance examination in addition indicates that between the New York and Kansas deposits the likelihood of finding new ore shoots is very poor. From the available information concerning the now inaccessible New York mine, the writers would judge that not more than a few hundred tons of ore exist above the 150-foot level. Therefore it is unreasonable to expect that enough ore would be developed by the proposed drift to justify a loan by the Government to carry out the Duquesne company's proposal.

An alternate program designed to develop ore at the Kansas mine might be feasible. The possible extension with depth of the Kansas ore body could be tested by the drilling of several diamond drill holes from the lowest workings of the mine. If this exploratory work produced favorable results the ore could be developed by sinking a winze and opening sub-levels or by repairing and deepening the present shaft. The success of such an alternate program would in part depend on employment by the Duquesne Mining Co. of a supervisor competent to direct drilling and interpret the results.

Bonanza-Estella-Lewis Area. -- Available data suggests the possibility of developing up to 10,000 tons of ore in a block of the Estella deposit that occurs below the 235-foot level from the Bonanza shaft. This possibility is based on opinions by competent observers, but no concrete data as to the possible grade or extent of the ore is available to the writers. In order to mine this ore a hoist and compressor would have to be installed at the Bonanza shaft and the mine

would have to be partially dewatered. The ore body could be mined from the winze on the 235-foot level or it could be exploited by raising and stoping after drifting about 700 feet on the 435-foot level from the Bonanza shaft. Any plan that might be proposed for development of this ore should entail diamond drilling to test for extension in depth of the ore shoot. The confidential report by a mining geologist states Callahan's drilling in this area "was not adequate for the apparent location in depth of the ore shoot in question." If an attempt is made to develop this block of ore the company should first make the 235-foot level accessible for examination. If the possibilities of developing ore below this level are favorable a few diamond drill holes could be put down or after deepening the winze exploratory sub-levels could be driven. The results of this work would determine the advisability of carrying out additional development work that might be required before starting mining operations.

South Belmont-Silver Bill-Empire-Indiana-Area southwest of Holland Mine.

In general, the outcrops of the subject areas were small and early mining operations indicated ore in these areas was confined to widely scattered small pods. Subsequent exploration of these less extensively mineralized areas by the Callahan company and/or lessees have proved that the mode and extent of mineralization has not changed with depth. In the zones of most extensive mineralization in the

district the ore reserves have ranged between 25 and 150 tons a foot of depth. On this basis the subject areas can not reasonably be expected to yield much more than 25 tons of ore per foot of depth. Any program for exploring these areas by diamond drilling would probably be designed to find ore at a depth below the surface at about 200 feet or about 100 to 150 feet below present workings. Initial drilling in any one of these areas would probably consist of holes designed to intersect the ore zone at 50-foot intervals at one horizon. As these zones have a strike length of about 200 feet the initial exploration of one area would involve drilling a minimum of about 1,500 feet of hole at an estimated cost of approximately $15,000. Translating the results obtained from diamond drilling into ore reserves would be difficult. However, assuming the findings were favorable and development of the ore was undertaken the total cost of opening one level for mining of the ore would probably be not less than $50,000. On the basis of reserves of ore that might reasonably be expected, the cost before mining would probably be between $13 and $20 a ton. In addition to level development it would be necessary to run prospect raises and drifts to adequately explore and develop the expected ore reserves. It is probable these operations would add a few dollars a ton to the costs before mining. Mining of a deposit of this type would probably result in a production of about 1 ton per man shift and overall mining costs would be in the neighborhood of $15 a ton of ore. Thus the estimated minimum cost a ton of ore produced

would be several dollars more than its indicated value.

The Government would not be justified in granting a loan for any program that may be proposed for exploration of those areas.

Pacuasco-San Antonio Area. -- The Callahan company produced about 17,000 tons of ore from this area and carried out considerable development work. Very little new ore was encountered in the development program and the area was abandoned about a year before the company terminated all operations. These data indicate little or no developed ore remains in this area and the writers found no evidence to support the applicant's belief that sizeable ore bodies can be easily developed in the area.

The writers conclude the Government would not be justified in granting the applicant a loan for use in developing ore in this area, under present economic conditions.